



SCAR 2022

Antarctica in a Changing World

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ABSTRACT BOOK



SCAR 2022

Antarctica in a Changing World



सत्यमेव जयते

**Ministry of Earth Sciences
Government of India**



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C O N T E N T S

ID	TYPE NAME	SESSION	Pg.No
1	Astronomy and geo-space observations from Antarctica	Physical Sciences	1 - 31
2	Polar atmospheric processes: water cycle, snow, clouds, aerosols, radiation and gravity waves	Physical Sciences	32 - 58
3	Polar meteorology: short term climate variability	Physical Sciences	59 -91
4	Past polar climate variability and their teleconnections with the tropics	Physical Sciences	92 - 115
5	Polar climate variability, teleconnections, and global monsoon; past, present, and future	Physical Sciences	116 - 127
6	Southern Ocean Circulation: change and consequences	Physical Sciences	128 -144
7	Physical drivers and climate implications of Antarctic sea ice variability and change	Physical Sciences	145 - 175
8	Critical challenges in modelling past and future evolution of the Antarctic and Greenland ice sheets - scales, uncertainty, processes, implications for sea level	Physical Sciences	176 - 210
9	Radio sciences for Arctic and Antarctica: from the atmosphere to the geospace	Physical Sciences	211 - 230
10	Surficial processes-geomorphology, chemical weathering, exposure age dating, and permafrost dynamics	Geosciences	231 - 252
11	Permafrost dynamics and relations with climate change	Geosciences	253 - 258
12	Antarctica and its neighbours in supercontinent cycles	Geosciences	259 -293
13	Antarctic ice sheet behaviour from marine and terrestrial records	Geosciences	294 - 322
14	Polar environmental studies along the Antarctic margin: past and present perspectives	Geosciences	323 - 340
15	Deformation of the Antarctic: influence of tectonic, volcanic, hydrological, and climate change processes	Geosciences	341 - 356
16	Birds and marine mammals	Life Sciences	357 - 399
17	Southern Ocean plankton diversity, food web ecosystem and biogeochemical cycle	Life Sciences	400 - 439
18	Management implications of Southern Ocean ecosystem dynamics and biodiversity thresholds	Life Sciences	440 - 456
19	Sea ice in the atmosphere-ice-ocean-biosphere system: how, where and why is it changing, and what are the effects?	Life Sciences	457 - 465
20	Chemicals of emerging Antarctic concern; a rising tide in a warming climate	Life Sciences	466 - 475
21	Solutions to pollution: contaminant impacts and remediation in Antarctica	Life Sciences	476 - 509
22	Sub-Antarctic islands: sentinels of change	Life Sciences	510 - 523
23	Environmental factors driving diversity and composition of fossil and living Antarctic communities	Life Sciences	524 - 560
24	Biological dispersal: connections at continental and inter-continental scales	Life Sciences	561 - 577
25	Genomic insights into past and present Antarctic biodiversity	Life Sciences	578 - 612
26	Ecological implications and adaptations of microorganism in the Polar environments	Life Sciences	613 - 658
27	Microbial diversity of the polar oceans and their role in the biogeochemical cycles under the global warming scenario	Life Sciences	659 - 669
28	The Antarctic seafloor: ecosystem interactions and environmental drivers of change	Life Sciences	670 - 690
29	Antarctic expeditioners and spaceflight: lessons learned in health and medicine off the grid	Life Sciences	691 - 702
30	The changing face of Antarctic tourism	Humanities and Social Sciences	703 - 711
31	Antarctic heritage	Humanities and Social Sciences	712 - 718
32	The ATS, international law, and governance	Humanities and Social Sciences	719 - 726
33	Understanding 'The Ice' through the humanities, arts and social sciences	Humanities and Social Sciences	727 - 732
34	Antarctica and the arts	Humanities and Social Sciences	733 - 748
35	New approaches to Antarctic and Southern Ocean histories	Humanities and Social Sciences	749 - 754
36	Values in Antarctica: identification and vulnerability to anthropogenic impacts	Humanities and Social Sciences	755 - 762
37	Living and working in Antarctica	Humanities and Social Sciences	763 - 776
38	Emerging technologies and their applications from the depth of the ocean, to the deep Antarctic field and space	Cross-disciplinary	777 - 788
39	Predicting and detecting tipping points and regime shifts in Antarctic and Southern Ocean systems	Cross-disciplinary	788 -- 796
40	Air-sea interaction and its linkages with ecosystem response in the Southern Ocean	Cross-disciplinary	797 - 803
41	Emerging frontiers in Earth observation (EO) and geoinformation (GI) science in Antarctica	Cross-disciplinary	804 - 821
42	Sub-ice geology and east Antarctic Ice Sheet (EAIS) stability	Cross-disciplinary	822 - 831
43	The resilience of the Antarctic Treaty System in the Anthropocene	Cross-disciplinary	832 - 844
44	Inclusive collaborations in Antarctic research	Cross-disciplinary	845 - 863
45	Public engagement with Antarctica in a changing climate	Cross-disciplinary	864 - 885
46	Rethinking Antarctic environments and conservation	Cross-disciplinary	886 - 897
47	Human impacts on Antarctica	Cross-disciplinary	898 - 915
48	Workshop: Sharing science data FAIRly to support interdisciplinary research collaborations	Cross-disciplinary	916 - 927
49	Other Posters	Cross-disciplinary	928 - 948



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

PHYSICAL SCIENCES

**Astronomy and geo-space
observations from Antarctica**

CONVENORS

Tony Travouillon, Lucilla Alfonsi, Adriana Gulisano,
Jennifer Cooper

Accepted as: Oral Presentation

Abstract No : 736

Experiment of Space Debris Observation in Antarctica

Chenwei Yang, Polar Research Institute of China

The risk of satellite collisions with space debris is increasing, and mitigating this hazard is a focus of the United Nations Committee on the Peaceful Uses of Outer Space. The Pole regions are the most densely distributed regions of Low-Earth orbit space debris, and are efficient sites for monitoring LEO space debris. Investigating Antarctica as an advantage point to the skies for satellite traffic management has long been identified as an important goal for Antarctic Astronomy. The promising performance of space debris observation at Kunlun Station has been demonstrated by revisiting archived data taken by CSTAR in polar night. In this year, we deployed a new small telescope array at Zhongshan Station to carry out more Antarctic experiments and joint observations with telescope in north hemisphere. Additionally, the telescope array is also conducting follow-up observation of TESS Exoplanet candidates with simultaneous multi-bands photometry.

Accepted as: Oral Presentation

Abstract No : 890

The Askaryan Radio Array: Results and Prospects

Amy Connolly, Ohio State University

The Askaryan Radio Array (ARA) is a neutrino telescope at South Pole aiming to make a first discovery of cosmic neutrinos above $\sim 10^{17.5}$ eV using a radio detection technique. Neutrinos are expected to be produced from the same extreme events and environments that produce the highest energy cosmic rays, measured to above 10^{20} eV, and are the only particles that can reach us from the most powerful sources at cosmic distances. Neutrinos in this energy regime will produce interactions at center-of-mass energies higher than those probed by the Large Hadron Collider at CERN, making them probes of new physics beyond the Standard Model. The neutrino flux falls rapidly with energy, and at the highest energies detector volumes well beyond a km^3 are needed. Five ARA stations of antennas spanning a few square kilometers in area are deployed up to 200 m depth in the ice and their signals digitized and recorded at the surface. Neutrinos are sought as impulsive signals originating from within the ice. I will review results of ARA searches for astrophysical neutrinos, knowledge of the Antarctic environment and radio properties of ice gained from over a decade of operations and analysis, and projections for future results.

Accepted as: Oral Presentation

Abstract No : 842

Spectral distortions of the Cosmic Microwave Background from Dome-C: the COSMO experiment

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The COSmic Monopole Observer (COSMO) aims at the measurement of tiny (< 1 ppm) spectral distortions in the isotropic component of the Cosmic Microwave Background (CMB). These are due to several astrophysical and cosmological phenomena, and provide unique information on the early and late phases of the evolution of the universe. COSMO is based on a cryogenic differential Fourier Transform Spectrometer, measuring the spectral brightness difference between the sky and a combination of cryogenic blackbodies. The Italian PRIN and PNRA programs funded the first implementation of COSMO, which will operate from the Concordia station at Dome-C, in Antarctica. COSMO will use a fast sky-dip technique to measure the atmospheric emission and its fluctuations, in order to remove this contribution to the measured brightness. We focus on the configuration of the instrument and its capabilities. We also discuss its follow-up on a stratospheric balloon, within the COSMOS program of the Italian Space Agency.

Accepted as: E-poster Presentation

Abstract No : 63

New Japanese Antarctic observation research program: auroraXcosmic project

Ryuho Kataoka, National Institute of Polar Research

New Japanese Antarctic observation research program AJ1007 (Space environmental changes and their effects on the Earth's atmosphere explored from the polar cap region, 2022-2027), auroraXcosmic project in short, is supported by NIPR/JARE. We will study space weather and space climate from Antarctica to understand how the Earth system is open to space. The polar cap (magnetic latitude >75 deg) is a special region where geomagnetic field is mostly open to the solar wind, and therefore the atmosphere is directly affected by various types of energetic particles from space. We will contribute to developing the international network observations of both aurora and cosmic rays. We develop a cutting-edge auroral imager, including a tough housing bearable for Antarctica. The system will be low-power, portable, and the data will be obtained real-time. The first model will be tested in new Dome-Fuji station in 2023, and then distributed for future international collaboration in Antarctica. Main targets are high-altitude red aurora at 630.0 nm and low-altitude polar glow at 391.4 nm. The red aurora is used to identify the open/closed boundary of geomagnetic field. The polar glow is used to measure the low-energy solar energetic particles (SEP). The high-energy SEP is also observed by neutron monitor and muon detector at Syowa Station. The cosmic ray observation at Syowa will be full-system and the real-time data will be obtained every 10 min.

Accepted as: Oral Presentation

Abstract No : 398

Progress of the lower and middle atmosphere lidar system at Zhongshan Station, Antarctica

Rui Wang, Polar Research Institute of China

A lower and middle atmosphere lidar system has been established at Zhongshan Station (69.4°S, 76.4°E) since Mar. 2020 during the summer part of 36th Chinese National Antarctic Research Expedition (CHINARE). It includes a pure rotation Raman lidar, a Rayleigh/Mie scattering lidar module, and a coherent Doppler wind lidar, which could realize the high-precision measurement of troposphere-stratosphere-mesosphere temperature and boundary layer wind. The pure rotation Raman lidar could observe the nocturnal and diurnal temperature around ~0.5–10 km (night) and ~0.5–3 km (day), while the Rayleigh/Mie scattering lidar module will observe the temperature and density within 40–60 km. Meanwhile, the boundary layer atmospheric wind field from 30 to 800 meters is monitored by the coherent Doppler wind lidar. It is combined with the Na Doppler lidar (capable of measuring the diurnal temperature and 3-D winds around 75–110 km) to form a Polar Atmosphere Lidar Observation System (PALOS), which is the first synthetic lidar observation system covering all layers of neutral atmosphere in Antarctic region. At present, the lower and middle atmosphere lidar system works normally and has accumulated thousands of hours of observation data, which can be used to study the basic characteristics of the polar atmosphere, the characteristics of aerosol and cloud, the thermal / dynamic changes and processes of the middle and upper atmosphere, etc. The report will introduce the detail of the system composition and preliminary observations.

Accepted as: Oral Presentation

Abstract No : 476

AST3 project progress and status

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Over a decade has passed since the first one of trio Antarctica Survey Telescopes (AST3) was deployed at Dome A. AST3 is the first generation of movable telescopes running at Dome A. In this talk, we will update the status of the telescopes, and review the effort that we have been making for autonomous observation in the harsh environment of Antarctic plateau.

Accepted as: Oral Presentation

Abstract No : 640

Argentine Space Weather Laboratory (LAMP group) activities in Antarctica

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In this work the activities of the Argentine Space Weather Laboratory (LAMP for the Spanish acronym Laboratorio Argentino de Meteorología del esPacio) in the Antarctic Peninsula will be addressed. LAMP is a center that works inter-institutionally mainly among the Institute for Astronomy and Space Physics, IAFE (CONICET--UBA), the Argentine Antarctic Institute (IAA-DNA) and the Department of Atmospheric and Ocean Sciences (DCAO) of the Faculty of Exact and Natural Sciences (FCEyN) of the University of Buenos Aires (UBA). The center is gathering researchers with expertise on physical sciences, high energies, atmospheric sciences, numerical modeling, and the design and development of instrumentation. The Antarctic project of LAMP, deployed and installed a Space Weather Laboratory in the Argentinean Marambio Station at the Antarctic Peninsula in March 2019. In this work, first results of the Antarctic Laboratory progress and recent activities will be addressed, as well as, the detailed status of Space Weather instrumentation (riometer, flux gate, magnetometer and ionosonde) available at San Martin Station and, the ones installed at Belgrano II station (protonic magnetometer, flux gate measurements, riometer and ionosonde), since to understand the different processes involved it is necessary a multidimensional approach in terms of measurements (at high latitudes and from space) and, in terms of scientific disciplines.

Accepted as: Oral Presentation

Abstract No : 642

Instrumentation and Polar Infrastructure Development Supporting the BICEP Array Telescope Program

Benjamin Schmitt, Harvard-Smithsonian Center for Astrophysics

Measurement of the polarized Cosmic Microwave Background (CMB) over the past few decades has enabled precision probes of the evolutionary history, composition, and dynamics of the primordial Universe. Next-generation CMB experiments will extend this scientific reach, allowing for tests of the inflationary theory of the early Universe, driven through constraints on the tensor-scalar ratio “ r ” via the search for primordial B-mode polarization. The BICEP Array telescope program is targeting observation of B-modes at large angular scales, building on constraints already placed by the BICEP/Keck program. BICEP Array comprises four BICEP3-class receivers which will operate in conjunction with BICEP3 at 30/40, 95, 150, and 220/270 GHz. The 30/40 GHz receiver was deployed to the Amundsen-Scott South Pole Station during the 2019–2020 Austral summer with further receiver deployment to take place during the 2022–2023 Austral summer season. With all receivers deployed, BICEP Array will measure primordial gravitational waves to a precision of $\sigma(r)$ between 0.002 and 0.004 after a full three years of observations, with over 30,000 detectors on the sky. This talk will provide an overview of the instrumentation design of the BICEP Array telescope, and infrastructure in development – notably the BICEP Array Replacement Tower (BART) project – that will enable a sustainable future for BICEP Array and next-generation CMB science at the South Pole.

Accepted as: Oral Presentation

Abstract No : 706

Proposal of Terahertz Interferometry from Dome Fuji

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Dome Fuji on Antarctic plateau is situated 3810m above sea level, where atmospheric transmission and stability at terahertz frequency is much better than Chilean Andes, where ALMA observatory is situated. We are planning the first terahertz interferometry on Antarctic plateau with high angular resolution in terahertz frequencies. We plan to make two-element interferometer with 30-cm terahertz telescopes equipped with 492 GHz SIS mixer receivers and 1.46 THz SIS photon detectors. Observations will be made with heterodyne interferometry for [CI] 492 GHz line and intensity interferometry for [NII] 1.46 THz line toward massive star-forming regions in the Southern hemisphere. Using the VLBI-like data recording system and off-line data analysis, baseline could be extended to 50 km between old and new Dome-Fuji stations. The first antenna will be installed in new Dome-Fuji in 2025 to start single dish observations with the 492 GHz receiver. The second antenna will be installed in later seasons together with 492 GHz SIS mixers and 1.46 THz SIS photon detectors to start test observing for the terahertz interferometry.

Accepted as: Oral Presentation

Abstract No : 787

New Developments in Cosmic Microwave Background Experiments at the South Pole

Marion Dierickx, BICEP Array and CMB-S4 collaborations

Cosmic Microwave Background (CMB) telescopes are mapping the millimeter-wave sky from the South Pole in search of answers on the origins of the Universe. Detecting faint signals from the dawn of time requires instruments with exceptional sensitivity and stability. This talk will present new developments in the BICEP Array and CMB-S4 experiments, highlighting how the South Pole site uniquely enables the science goals of these next-generation telescopes. BICEP Array has been gathering multi-frequency data since 2020 and will make leading constraints on the primordial gravitational waves predicted by the theory of cosmic inflation. Looking ahead, the CMB community has come together for the next-stage CMB-S4 experiment, designed to cross critical thresholds in our understanding of the Universe's origins. CMB-S4 will rely on the combined powers of several BICEP-like refractor telescopes and a new high-throughput 5-meter aperture telescope at the South Pole. The full experiment, which also includes two 6-meter telescopes located on the high Chilean Atacama plateau, will conduct the definitive search for the signature of primordial gravitational waves, look for yet to be discovered relic particles, determine the neutrino mass scale, provide insights into dark energy and dark matter, and open up a window on the transient Universe. Based on its spectacular science promise and its technical maturity, CMB-S4 was endorsed by the report of the Particle Physics Project Prioritization Panel "Building for Discovery," the NAS/NRC report "A Strategic Vision for NSF Investments in Antarctic and Southern Ocean Research," and the Astro2020 Decadal Survey.

Accepted as: Oral Presentation

Abstract No : 770

Searching For Axion Dark Matter with the South Pole Telescope

Kyle Ferguson, UCLA

Axions and other axion-like particles (ALPs) remain compelling dark matter candidates with a wealth of possible detection methods. A photon traveling through an axion field will experience a rotation in its polarization proportional to the difference in the axion field value at photon emission and photon absorption. Thus the apparent polarization of a static astrophysical source will oscillate in time as the local axion dark matter field oscillates (with a frequency proportional to the axion mass). The cosmic microwave background (CMB) is polarized, well-studied, and extremely static, making it an ideal source with which to search for this effect. We present the results of such a search for ultra-light ALPs with masses roughly between 10^{-21} and 10^{-19} eV using data from the 2019 observing season of the South Pole Telescope (SPT), a millimeter-band telescope with arcminute resolution that is located at the geographic South Pole and designed to observe the CMB.

Accepted as: Oral Presentation

Abstract No : 707

Dome A Snow Mechanics analysis and its application in Alpine skiing

Haikun Wen, The Nanjing Institute of Astronomical Optics & Technology

Located in the highest point of Antarctic inland, Dome A has been considered as one of the best astronomical observatory sites in the world. Some survey telescopes are planning to be installed in Dome A. Unlike any other areas, these telescopes have to be settled on the snow ground. In that case, it is very important to analyze the Snow mechanics to keep the foundation stable. The presentation firstly introduced the analysis of the snow strength in Dome A. Secondly, the dynamic and statics analysis of the telescope tower and the dome tower will be shown in this presentation. Meanwhile, some instruments have been developed to test the snow stress in Dome A by the NIAOT Antarctic team, these instruments also have been used in Alpine skiing.

Accepted as: Oral Presentation

Abstract No : 828

High-quality daytime seeing windows at the Antarctic Taishan station and atmospheric turbulence measurements at Dome A

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We present the initial results of seeing measurements at the Antarctic Taishan Station (ATS) using a differential image motion monitor observed at a height of 2.5m above the snow surface carried out on 2014 January 13 and 15. The median seeing was found to be 0.73 arcsec with a minimum of ~ 0.5 arcsec at $\sim 16:00\text{--}19:00$ local time (UTC+5). Such a seeing minimum has a good temporal association with the refractive index structure constant (C_n^2) minimum simultaneously observed at ATS by micro-thermal sensors. Interestingly, both temporal windows of C_n^2 and seeing minimum coincide with those of minimum temperature gradients. Weak turbulence was found at ATS with more than one month of continuous measurements of C_n^2 between 2013 December 30 and 2014 February 10. This suggests that high-quality seeing windows might be opened at ATS with the potential for astronomical activities. We also carried out C_n^2 measurements at a height of 2.0m at Dome A on 2015 January 20 to 22. Pretty weak C_n^2 , median value is about one fourth of that at ATS, implies that the boundary layer might be either below 2m or disappeared altogether during these times. To confirm this assumption, we observed C_n^2 at 5 different heights, 1.5, 3.0, 4.5, 6.0 and 6.95m, during 2019 summer, and ~ 160 hour data was obtained. The C_n^2 at 3.0m and above can be two orders smaller than that at 1.5m lasting more 10 hours, indicating the boundary layer can be lower than 3.0m. We will present the results and future plans.

Accepted as: Oral Presentation

Abstract No : 241

The SOLARIS observatory: a smart Solar imaging system at high radio frequency for continuous Solar monitoring and Space Weather applications

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Solaris is a scientific and technological project aimed at the development of a smart Solar monitoring system at high radio frequencies based on single-dish imaging techniques. It combines the implementation of a dedicated and interchangeable 100 GHz receiver on existing small radio telescope systems (1.5/2.6m class) available in our laboratories in Milan and in Antarctica, to be adapted for Solar observations. The Solaris Observatory is designed for operations in Antarctica, that will offer unique observing conditions (very low sky opacity and long Solar exposures) and unprecedented Solar monitoring in radio W-band. This will be achieved through state-of-the-art single-dish imaging techniques at radio frequencies, that allows to map the entire Solar disk in less than 30 min with spatial resolution of a few arcminutes. This opens for the identification and spectral analysis of Active Regions before, after and during the occurrence of Solar flares. These system features will allow Solaris to explore cutting-edge aspects of Solar Physics (e.g. chromosphere dynamic monitoring) and Space Weather applications (e.g. flare forecast). Solaris can perform continuous Solar imaging observations nearly 20h/day during Antarctic summer exploiting the observation facilities existing in East Antarctica, and it will be the only Solar observatory offering continuous monitoring at 100 GHz. Solaris will be able to collect and disseminate data in synergy with the existing lower frequencies systems (see e.g., the SunDish INAF project, <https://sites.google.com/inaf.it/sundish>) within the international networks of Space Weather facilities.

Accepted as: E-poster Presentation

Abstract No : 927

Update of progress in the development of the Argentine Antartic Robotic Observatory: Dome Installation

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The Argentine Antartic Robotic Observatory is a project to install a 50cm robotic telescope with a BVRI filter wheel and guiding system at the Argentine Antartic Base Belgrano II (77°52'S, 34°37'W). The Base is located on the Nunatak Bertrab by the Bay of Vahsel some 1300km from the South Pole, where the polar night has a duration of approximately 130days, but clear sky conditions with winds below 20km/h are estimated to occur on about 40% of that time, in windows of up to 200h of duration. The scientific goals of the project are related to photometry of intense enough sources, such as variable stars, detection of exoplanetary transits and Solar System moving objects. In the summer antartic campaign (SAC) of 2021-2022, a dome with a diameter of 2.6m and 3m high, equiped with a robotic shutter and automatic azimuth rotation, was transported to the site by the ship "ARA Almirante Irizar" and installed on a platform 1.5m high with a peer that goes directly to the rock of the Nunatak, where the telescope will be installed on. The platform and the peer were previously installed. During the winter of 2022 we are testing the performance of the dome under the harsh climatic conditions of the site. At the moment the dome is operated manually. In the SAC the plan is to install the robotic operating system of the dome and in the following summer to transport and install the telescope and the rest of the instruments.

Accepted as: Oral Presentation

Abstract No : 427

ITM – International Telescope Maffei – Upgrades and Updates

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The ambitious target of the International Telescope Maffei (ITM) 2021–2022 summer campaign activity was the complete reassembly of the telescope, dismantled in 2019 for the maintenance and update of its components caused by several malfunctions, to have it fully operational by the end of the campaign to start the commissioning operation during the winter period. This required from one side, the complete re-cabling of the infrastructure to adapt it to the new electronic components distributed in thermalized boxes newly produced. On the other side it was required to install and test the new electronics in the Antarctic environment, assess the telescope movement capability, mount and align and collimate the mirrors . All to be done before the winter campaign start. During the first phase of the Winter campaign some base tests on the telescope functionality has been carried out with optimal results. The pointing model is under testing and for the end of the winter some scientific acquisitions in the optical band are expected. In the near future the project will open a call for collaboration regarding the installation of focal plane instruments in the IR bands.

Accepted as: Oral Presentation

Abstract No : 1006

The Dependence of Ionospheric Peak Height of F2 Layer over Jang Bogo Station at Antarctica to Solar Zenith Angle During Southern Summer

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Zehra Can, Yildiz Technical University

The polar ionosphere is a highly dynamic natural plasma affected by many parameters such as space weather, solar activity, hours, and latitude. In this study, the dependence of the Solar zenith angle on the ionospheric peak electron height measured by the JB57N URSI coded ionosonde in Antarctica was determined between 21 December 2019 to 21 March 2020, which corresponds to the summer season in the Southern hemisphere. Examining the effect of solar radiation, which is the main cause of ionization in the ionosphere, in the Antarctic regions, which have been understudied compared to the Arctic regions, is very important in order to better understand the global ionosphere-magnetosphere system, considering the ability of particles accelerated to larger energies due to the concentration of magnetic field lines in the Polar regions to penetrate the ionosphere. Since the examined times naturally coincide with the longest daytime periods in the region, the effect of solar radiation, which is the main reason for the ionization of the ionosphere, could be more easily examined. In the study, it was observed that for the changing Solar Zenith Angle, hmF2 increased as the angle increased towards the end of the examined date and as expected.

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Abstract No : 418

Machine learning-based seeing estimation and prediction using multi-layer meteorological data at Dome A, Antarctica

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The superb free atmospheric seeing of 0.31 arcsec at Dome A, Antarctica has proved that Dome A is an excellent site for telescopes, especially optical telescopes. However, due to unattended observatories and challenging environments, it poses great challenges to obtain long-term and continuous seeing measurements by the standard DIMM instrument. Therefore, it is desirable to develop an alternative method to estimate the seeing at Dome A by a more reliable instrument. Besides, being able to predict the seeing in advance can guide observing decisions and significantly improve the efficiency of telescopes. We present a novel machine learning-based framework for estimating and predicting seeing at Dome A using only the data from a multilayer automated weather station (AWS). In comparison with DIMM data, our estimate has a root mean square error (RMSE) of 0.18 arcsec, and the RMSE of predictions 20 minutes in the future is 0.12 arcsec for the seeing range from 0 to 2.2 arcsec. Compared with the naïve approach, where the forecast is the same as the last data point, our framework reduces the RMSE by 37 percent. Our method predicts the seeing within a second of computing time, making it suitable for real-time telescope scheduling.

Accepted as: Oral Presentation

Abstract No : 922

The Future of the IceCube Neutrino Observatory: the IceCube Upgrade and next-generation IceCube-Gen2

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In the decade since the start of operations at the South Pole, the IceCube Neutrino Observatory has observed more than a million neutrinos and has discovered a cosmic neutrino flux in the energy range from 10 TeV to beyond 10 PeV. The next planned extension, the IceCube Upgrade, will add seven densely instrumented detector strings deployed in the 2025/26 field season. The Upgrade will allow the measurement of neutrino properties with unprecedented precision, specifically neutrino oscillation parameters, in the energy range from 5 to 50 GeV. In addition, the Upgrade will allow more precise measurements of the optical properties of the glacial ice, and thus improve IceCube's performance. The IceCube Upgrade will also set the stage for the next-generation IceCube-Gen2, a large-scale extension that improves IceCube's reach at high energies. IceCube-Gen2 has been optimized using all knowledge obtained with IceCube and will allow resolving astrophysical neutrino sources that are currently too faint to observe with IceCube. IceCube-Gen2 will increase IceCube's instrumented volume by almost an order of magnitude and, in addition to an extended optical detector array, will have a surface cosmic ray detector array as well as a large array of radio detectors added to reach the required sensitivity at the highest energies.

Accepted as: Oral Presentation

Abstract No : 733

IceCube model of optical properties of the South Pole ice

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IceCube collaboration continues to make incremental improvements to the model of the optical properties of ice surrounding our sensors. We have recently come to a better understanding of the possible cause of the observed optical anisotropy (seemingly more light propagating along the axis of the local ice flow). As light propagates through thousands of ice crystals, tiny refractions at the crystal boundaries due to ice birefringence build up to a measurable macroscopic effect, which fits the optical anisotropy in our data with excellent accuracy. The crystal fabric, elongation, and density fitted to our calibration data are also in agreement with those extracted from the nearby ice cores. Second, I will discuss our renewed effort to fit the depth profiles of ice layers (layers with same optical properties) across the entire detector in-situ. We have shifted to a fully 3d modeling of the ice layers, and the fitted behavior is in agreement with our interpretation of the ground-penetrating radar data collected in the vicinity of the South Pole, suggesting that the ice at the South Pole is locally flowing up a small hill.

Accepted as: Oral Presentation

Abstract No : 574

Space Physics and Astronomy observations from Chinese Polar Stations: Current and future research directions

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Space weather has a remarkable effect on modern human activities, e.g, communication, navigation, space exploration etc. Space physics study from polar stations is as an important part of the entire solar-terrestrial space, and conduct quantitative research from the perspective of overall space plasma behavior. One of the most important issues is to identify the dominant processes that transfer plasma and momentum from the solar wind to Earth's magnetosphere. Thus, it is necessary to carry out research for combination the observations from polar ground stations and spacecraft observations in the space. The ZHS is located at a unique geographical site that is well suited to take measurements on the magnetospheric cusp where solar wind could entry directly into the Earth's magnetosphere. Also, together with YRS, it provide excellent opportunity to perform conjugated space weather observations for both northern and southern hemisphere. Along this line, conjugated observations can be offered by the these unique geomagnetic conjugate locations: GWS (with Millstone Hill), ZHS (with YRS), and the CIAO (with Syowa) stations. Observations at Antarctica can be as a window to the space for satellite traffic controls. The operation of the observation chain- ZHS-Taishan -Kunlun Station could monitor polar space debris in a large area with high temporal and spatial resolution. Also, night-time measurements of astronomical seeing at Dome A in Antarctica make it less challenging to locate a telescope above it, thereby giving greater access to the free atmosphere because of a thinner boundary layer.

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Abstract No : 672

Sky brightness evaluation at Concordia Base (Dome-C) for solar corona observation

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In the following, we show the results obtained as part of the “Extreme Solar Coronagraphy Antarctic Program Experiment” (ESCAPE) in Antarctica. During three different Antarctic missions at Concordia Station (Dome-C Antarctic plateau; ~3300 m a.s.l.) it was possible to evaluate, for the first time, the local sky brightness. A low value of sky brightness ($\sim 10^{-6}$ solar disk brightness) is essential for the ground-based observation of the outer solar atmosphere, the solar corona. To date, the only place on Earth with sky characteristics that allow continuous coronagraphic measurements is the Mauna Loa Observatory - MLO (Hawaii, ~3400m a.s.l.). In optimal atmospheric conditions, the sky brightness measured at Concordia base has reached very low values of the order of $0.7 - 1 \times 10^{-6}$ solar disk brightness. The first observation of the solar corona from Antarctica was possible as well. These data were carried out with an antarctic coronagraph (AntarctiCor) designed for Antarctic environments and able of capturing, at the same time, images with four different polarizations.

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Abstract No : 677

Ionospheric Plasma Structuring over Antarctica based on satellite and ground observations.

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The upper polar atmosphere is partially ionized and is called the ionosphere. In the polar regions, its dynamics is coupled to the Earth's magnetosphere and the solar wind. The dynamic processes lead to structuring of the ionosphere and result in ionospheric plasma irregularities at various scales. Due to differences in the topology and strength of the Earth's magnetic field between the two hemispheres, the ionospheric structuring in the Antarctic is different than in the Arctic. We use satellite and ground-based data to investigate these differences based on both case- and statistical studies. Based on the Swarm satellite data we study the plasma structuring in the polar regions accounting for changing conditions during a solar cycle. We demonstrate that the ionosphere in the Antarctic is subject to more irregularities and structuring than in the Arctic both during quiet and active conditions. The seasonal variations are also distinct between the two hemispheres. We discuss these differences in terms of known interhemispheric asymmetries. Finally, we carry out case studies using data from the Norwegian Research Station Troll in Dronning Maud Land, other complementary datasets in Antarctica, and the magnetically conjunct stations in the Arctic. We identify plasma irregularities at the edge of expanding auroral oval and fast flows at the edge of the convection cell.

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Abstract No : 902

Transient Response of Polar-Cusp Ionosphere to an Interplanetary Shock

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Interplanetary (IP) shock-driven sudden compression of the Earth's magnetosphere produces electromagnetic disturbances in the polar ionosphere. Several studies have examined the effects of IP shock on magnetosphere-ionosphere coupling systems using all-sky cameras and radars. In this study, we examine responses and drivers of the polar ionosphere following an IP shock compression on 16 June 2012. We are interested in the vertical drift and concurrent horizontal motion of the plasma. We observe ionospheric thin sporadic E (Es) layer and associated vertical downward plasma motion in digisonde observations located at Antarctic Zhongshan Station (ZHO). In addition, horizontal ionospheric convection reversals were observed on the Super Dual Auroral Radar Network (SuperDARN) ZHO and McMurdo (MCM) radar observations. Findings suggest that the narrow layer of Es was generated by the combination of intensified precipitation of energetic particles in the lower altitude ionosphere and change in the dusk-to-dawn electric field. The horizontal motion of the plasma was attributed to only the dusk-to-dawn electric field that existed during the preliminary phase of SI. We also found that ionospheric convection reversals were driven by a downward-aligned current. The results of these observations reveal, for the first time, the immediate and direct cusp ionosphere response to the IP shock, which is critical for understanding the global response of the magnetosphere following an abrupt change in IMF conditions.

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Abstract No : 302

Neutrino Astronomy at the South Pole with IceCube

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The Universe has been studied using light since the dawn of astronomy, when starlight captured the human eye. The IceCube Neutrino Observatory, located at the geographic South Pole, observes the Universe in a different and unique way: in high-energy neutrinos. IceCube's discovery in 2013 of a diffuse celestial neutrino radiation, in other words, isotropic high-energy neutrinos from beyond the solar system, started an era of neutrino astronomy. Since then, spectacular observations have been made that indicate the first astronomical source to emit such astrophysical neutrinos being identified. I will motivate why neutrinos are a necessary messenger in high-energy astronomy, and review what these milestones mean. I will reconcile various IceCube analysis results to draw a coherent picture that is the state of neutrino astronomy.

Accepted as: Oral Presentation

Abstract No : 863

The daytime seeing at Dome A, Antarctica

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Michael Ashley, University of New South Wales

The daytime seeing at Dome A were obtained by the KunLun Differential Image Motion Monitor (KL-DIMM) on an 8-m tower between January and March in 2019. We present the daytime seeing statistics and compare them with those from other sites in Antarctica. Besides, we find the strong correlation between seeing (or boundary layer thickness) and near-ground meteorological parameters. The temperature inversion is the key factor, and the wind speed also plays an important role. It implies that the seeing could be estimated and forecasted by weather data. We estimate the seeing at other heights from historical weather data, and consequently, discuss the potential for daytime observations at Dome A.

Accepted as: E-poster Presentation

Abstract No : 847

Cross Polar Cap evolution during the geomagnetic storm of 25 August 2018.

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Following the arrival at the Earth's orbit of an Interplanetary Coronal Mass Election (ICME) originated by a filament eruption on the Sun on 20 August 2018, a strong geomagnetic storm was initiated on 25-th of August. The storm lasted for several days and affected the entire magnetosphere-ionosphere system. This ICME propagation in the interplanetary space and its effects in the magnetosphere, ionosphere and at the ground level have been extensively studied. Here we present a preliminary study of the Cross Polar Cap Potential (CPCP) as inferred from SuperDARN measurements during the initial, main and part of the recovery phases of the storm. In particular, we compare the SuperDARN CPCP with the predictions by the Siscoe-Hill and the Kivelson-Ridley models and discuss potential reasons for the observed differences.

Accepted as: Oral Presentation

Abstract No : 643

Microwave astrophysics with the South Pole Telescope

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The microwave sky provides us with a wealth of information about our universe. Measuring the cosmic microwave background radiation, often called the afterglow of the big bang, helps us understand what the universe is made of and how it has evolved. In addition, studying microwave emission from celestial objects such as stars and galaxies allows us to learn more about their physical processes. Being a high-altitude polar desert, the South Pole is an excellent observing site since its exceptionally dry atmosphere leads to less absorption and emission of microwave radiation by water vapor. Built in the 2006–2007 austral summer, the 10-meter South Pole Telescope has been operating for more than 15 years and making important contributions along the way with 200+ publications and 20,000+ citations. The imaging instrument of the telescope underwent a significant upgrade in 2017, and it has been collecting high-quality data to date at 3 frequency bands centered at 95, 150, and 220 GHz. First science results constraining cosmology and particle physics using about a year of the data from the new instrument have been published, and multiple exciting analysis projects using much more data are ongoing. At the same time, active developments of the next generation of the instrument are underway.

Accepted as: Oral Presentation

Abstract No : 515

Mesospheric ionization due to energetic electron precipitation during substorm growth phase

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Many studies have been conducted about the impact of energetic charged particles on the atmosphere during geomagnetically active times, while quiet time effects are poorly understood. We identified two energetic electron precipitation (EEP) events during the growth phase of moderate substorms and estimated the mesospheric ionization rate and the impacting area for an EEP event for which the most comprehensive dataset from ground-based and space-born instruments was available, as described in Murase et al. (2022). The mesospheric ionization signature reached below 70 km altitude and continued for ~15 minutes until the substorm onset, as observed by the PANSY radar at Syowa Station. The possible spatial extent of EEP is estimated to be ~8 h MLT in longitude and ~1.5° in latitude from a global magnetohydrodynamic simulation REPPU and the precipitating electron observations by the POES satellite, respectively. Such a significant duration and spatial extent of EEP events suggest a non-negligible contribution of the growth phase EEP to the mesospheric ionization. Combining the cutting-edge observations and simulations, we shed new light on the space weather impact of the EEP events during geomagnetically quiet times. In this presentation, we also show results of superposed epoch analysis of the mesospheric echo profiles against the zero epoch at the substorm onset, which would be helpful to quantify the higher-altitude ionization by less-energetic electrons during the different phases of a substorm. Reference: Murase et al., 2022, Mesospheric ionization during substorm growth phase. Journal of Space Weather and Space Climate. <https://doi.org/10.1051/swsc/2022012>.

Accepted as: Oral Presentation

Abstract No : 474

A case study on sporadic E layer and sporadic sodium layer coupling process over Zhongshan Station, Antarctica

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It has been widely proposed that sporadic E (Es) layers play an important role in the formation of sporadic sodium layers (SSL), but detailed studies of their dynamic process and evolution are still lacking at high latitude. To clarify the Es/SSL-related ionosphere/thermosphere coupling, a three-frequency Sodium (Na) resonance fluorescence Doppler lidar has been recently deployed at Zhongshan Station (69.4°S, 76.4°E), Antarctica. A case study of the Es/SSL evolution process will be presented. We suggested that the flow shears associated with the duskside convective circulation were responsible for the evolution of the Es layer, while the dynamic properties of the SSL were modulated by the Es layer electrodynamics and the background wind field.

Accepted as: Oral Presentation

Abstract No : 1032

Search for quantum gravity using astrophysical neutrino flavour with IceCube

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Experimental confirmation of the presence of Quantum Gravity (QG), a unified theory of particle physics and general relativity, is the holy grail of modern physics. Expected signals of QG would be extremely high-energy such as the Planck energy ($\sim 10^{19}$ GeV) and is inaccessible. On the other hand, QG effects may be suppressed and permeated in our spacetime with the inverse of the Planck energy or higher order. This extremely weak signal in spacetime is invisible by ordinary methods but could be seen by neutrinos. High-energy astrophysical neutrinos propagate long distances without any disturbance, and tiny new effects in spacetime may cause unexpected phase shifts, which can be encoded in the quantum mixing of neutrino states. Astrophysical neutrino flavour is a very sensitive tool to measure QG-motivated effects such as Lorentz symmetry violation. We analyzed the 7.5-yr high-energy starting event sample from the IceCube Neutrino Observatory, Antarctica. Data flavour information is compared with simulation to look for anomalous flavour mixings. The sensitivity of this analysis exceeds all known methods to look at some types of QG signals, from tabletop experiments to cosmology. We will present our latest results and future prospects to search for QG signals with neutrinos.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

PHYSICAL SCIENCES

**Polar atmospheric processes:
water cycle, snow, clouds, aerosols,
radiation and gravity waves**

CONVENORS

Takashi Yamanouchi, Damian Murphy,
Anoop Mahajan, Marc Mallet

Accepted as: Oral Presentation

Abstract No : 875

M-transform, a phase velocity analysis for continuous 2-D imaging data for studying atmospheric gravity waves and traveling ionospheric disturbances

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Atmospheric gravity waves play important roles in vertical dynamical couplings in the atmosphere and ionosphere by transporting energy and momentum in vertical and horizontal directions. In order to discuss and understand its generation and propagation, quantitative analysis of the wave energy and the wave propagation direction is required. Among various observation techniques, airglow imaging is useful in characterizing horizontal propagation direction and phase velocity of gravity waves, and provides information on vertical propagation through background horizontal wind, directions of momentum and body force. However, the gravity wave packets are transient and spatially limited, which makes difficult to describe the energy and momentum of the wave fields quantitatively. NIPR and SOKENDAI have developed a new analysis tool of obtaining phase velocity spectrum of the airglow images using 3-D Fourier transform (Matsuda+ 2014). The phase velocity spectrum is the power spectrum of airglow intensity perturbation in horizontal phase velocity domain. This diagram displays the wave energy of transient wave packets of the gravity waves quantitatively, and clearly indicates wind filtering effects, direction of momentum, and possible source of gravity waves. This technique has been applied to the airglow image data observed by ANGWIN (Antarctic Gravity Wave Instrument Network) project (Matsuda+ 2017). The software package for transferring airglow images into phase velocity spectrum, i.e., M-transform, is delivered as an open software on the web site. M-transform can also be used to analyze TID (Traveling Ionospheric Disturbance) characteristics observed in the GPS/TEC maps (Perwitasari+ 2022). This paper will review the various results by M-transform.

Accepted as: E-poster Presentation

Abstract No : 702

The first observation of calcium ion layer with a frequency-tunable resonance scattering lidar in Antarctic

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Layers of metal ions in the mesosphere and lower thermosphere (MLT) are produced by meteoric ablation. The meteoric metal ions have relatively long chemical lifetime in the MLT region and behave as plasma affected by neutral atmosphere dynamics. In the mid-latitude, the meteoric metal ions in the MLT region are generally accepted as key species for generation of sporadic E (Es) layer in the wind shear theory. The close link between the Es layer and metal ion layer has been also clearly by radar and lidar observations [Raizada et al., 2012; Ejiri et al., 2019]. However, distribution and behavior of metal ions at the high latitude especially in the southern hemisphere are still unknown because observation lacks except at the mid-latitude in the northern hemisphere. A new resonance scattering lidar system with frequency-tunable alexandrite laser was developed by the National Institute of Polar Research (NIPR) and installed at Syowa Station (69°S, 40°E) by the 58th Japan Antarctic Research Expedition (JARE 58). Density profiles of calcium ion (Ca⁺), which is only metal ion can be measured by a ground-based lidar, in the MLT region over Antarctic were successfully observed 6 nights in total in 2017 and 2018. In this presentation, we will show temporal variation of the Ca⁺ layer in Antarctic for all events and discuss its characteristics.

Accepted as: Oral Presentation

Abstract No : 1008

Black carbon footprint of local emissions in Antarctica

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Black carbon (BC) from fossil fuel and biomass combustion darkens the snow and makes it melt sooner. In order to assess the BC footprint of human activities in Antarctica, we took snow samples from 28 sites across a transect of about 2,000 km from the northern tip of Antarctica (62°S) to the southern Ellsworth Mountains (79°S). The surveys have shown that, presumably due to local emissions, BC content in snow surrounding research facilities and popular shore tourist-landing sites is up to 4 times higher than background levels measured elsewhere in the continent. The radiative forcing owing to measured BC concentration is accelerating snowmelt and shrinking the snowpack of BC-impacted areas of the Antarctic Peninsula and associated archipelagos by up to 23 mm w.e. every summer. Burdens of BC deposition varied geographically, but we estimate that premature snowmelt due to the BC footprint of tourism is on the order of dozens to hundreds of tons per visitor. The intensive use of fuel-powered equipment at scientific stations makes the average snow losses attributable to each researcher at least one order of magnitude larger.

Accepted as: Oral Presentation

Abstract No : 386

Spatial and seasonal variations in Black Carbon over the Antarctic region in a regional climate model

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Black Carbon (BC) aerosols can have a crucial impact on the Polar climate through their interaction with the sea, cryosphere and clouds. BC aerosols are mainly produced by biomass and fossil fuel combustion. They can absorb radiation and warm the atmosphere; and are reported to be the second strongest contributor to global warming after carbon dioxide. The simulations of the Weather Research and Forecasting model coupled with Chemistry (WRF-CHEM) were investigated and compared with the aerosol observations over the Antarctic region. The model simulations were performed at a horizontal grid resolution of 35 km × 35 km. The 6-h initial and lateral boundary conditions for the meteorological fields from National Centre for Environmental Predictions, Final Analysis (NCEP/FNL) were utilized in the simulations. The chemical mechanism for gas-phase chemistry in WRF-CHEM simulations was provided from Community Atmosphere Model with Chemistry (CAM-chem) and for the aerosol process based on Goddard Chemistry Aerosol Radiation and Transport (GOCART) bulk aerosol scheme (MOZCART). Higher BC masses were simulated over the Eastern Antarctic region during the forest fire seasons in Australia. This may be attributed to the transport of BC produced by biomass burning. The detailed results on spatial and seasonal variations of BC over the Antarctic and surrounding regions will be presented and discussed.

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Abstract No : 488

Comparison of different machine-learning algorithms and empirical models used for the solar radiation predictions: A case study of Horseshoe Island, western Antarctica

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The estimation of global solar radiation has great importance in terms of directing solar energy conversion systems (design, modelling and operation), selecting suitable regions, and even for the future investment policies of decision-makers. Albeit the importance of solar radiation observations, there are still some deficiencies in the ground data collections, especially in the remote geographic settings (e.g., Antarctica). In this regard, the study aims to predict the solar radiation data by performing several machine-learning algorithms (e.g., support vector machine, artificial neural network, and decision tree) on the hourly measured ground data collected from Horseshoe Island (western Antarctica) during two years period. The variables in the dataset (e.g., temperature, wind speed and direction, relative humidity, and pressure) have different balances and statistical distributions, and hence various feature-scaling methods are performed (e.g., z-score normalization, min-max transformation). In addition, the preliminary feature sensitivity analysis reveals that most of these parameters seem to have impacts on the solar radiation variations. The pre-processed data have been trained, and the prediction scores for the solar radiation are compared to select the best algorithm. The machine-learning model is tested using both separated data from the original dataset and a new dataset obtained from other stations in the region. The same dataset is then used for the available empirical models on the solar radiation predictions to compare their performances with the machine-learning-based predictions. This ongoing project presenting a comparative methodology will presumably contribute to the current knowledge on solar radiation predictions.

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Abstract No : 587

ANGWIN: ANtarctic Gravity Wave Instrument Network

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Atmospheric gravity waves play an important role in transporting energy and momentum between atmospheric spheres and drive circulations that affect key processes such as formation of the ozone hole and the cold summer polar mesosphere. The lack of comprehensive observations over the Antarctic region has an impact on our understanding of these processes. The ANtarctic Gravity Wave Instrument Network (ANGWIN) is a highly successful grassroots programme that was started in 2011, and has been active as a SCAR action group since 2018 . It seeks to use a network of observations to measure gravity waves continent wide and through all levels of the atmosphere, in order to fully understand their impact and to constrain modelling work. Although ANGWIN initially focused on the Antarctic, the group is now aiming to develop collaborations in both polar regions. Current member countries of ANGWIN are Australia, Brazil, Japan, South Korea, the United Kingdom and the United States of America. The objective of ANGWIN network include; Qualify the longitudinal variations in gravity waves and determine causes; Characterize wave propagation and influence; Relate observed gravity waves to sources throughout the atmosphere; Study interactions of gravity waves with planetary scale waves; Compare polar wave observations to model parameterizations; Determine the effects of gravity waves on polar stratospheric cloud formation. In pursuit of these objectives, ANGWIN researchers build our understanding of the effect of climate change on gravity-wave generation, propagation and momentum deposition, and the impact of this change on global atmospheric circulation.

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Abstract No : 690

Investigation of major factors to affect concentration variability of Radon-222 measured at Jang Bogo Station (74°S) during 2016–2020.

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We report on high-sensitivity Radon-222 measurements from a two-filter detector at Jang Bogo Station (74° 37' S; 164 ° 12' E), Terra Nova Bay, East Antarctica during JAN, 2016 to FEB, 2020. The average concentration of atmospheric Radon to using hourly data was $783 \text{ mBq/m}^3 \pm 590 \text{ mBq/m}^3$ (median 633 mBq/m^3) for the study period. On the average, these values were considered high, in comparison to results reported for other sites in Antarctica. The highest monthly average values were shown in January ($1052 \text{ mBq/m}^3 \pm 908 \text{ mBq/m}^3$) and February ($1000 \text{ mBq/m}^3 \pm 729 \text{ mBq/m}^3$), respectively, mainly due to maximum emission of Radon to the atmosphere from the ice free coastal ground. Radon concentration is the most distributed around 250 mBq/m^3 during summer months and it is characterized by a lower concentration than other seasons. However, the seasonal average concentration of Radon is the highest in summer because it has a higher concentration frequency more than 1000 mBq/m^3 compared to other seasons. Especially, a concentration of 3500 mBq/m^3 or more that does not appear in other seasons was also observed. Radon concentrations were closely associated with wind (speed and direction) during summer months rather than other seasons. The wind speed was clearly higher under westerly (260–300°, frequency: 36.0 %) and Radon concentrations generally had a tendency to decrease. On the other hand, under northeasterly (0–50°, frequency: 25%), the average wind speed was less than 1.9 m/s and Radon concentrations were generally higher.

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Abstract No : 739

The atmospheric hydrological cycle in Antarctica – past and future.

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The hydrological cycle sets the climate of polar regions through changes in surface albedo, ice sheet surface mass balance, sea surface temperature and salinity, in particular in Antarctica. Global warming is known to cause an intensification of the global hydrological cycle. A serious obstacle to a quantitative understanding of the Antarctic hydrological cycle is the lack of reliable observations. Recently, a new atmospheric reanalysis (ERA5) has been released by the ECMWF. In parallel, a large database of historical and climate change projection simulations has become available through the CMIP6. Few specific studies exist in the field but no global study. Here, we document for the first time the seasonal state, year-to-year variability and long-term trends of the Antarctic atmospheric hydrological cycle by process and regions. We find that seasonal thermodynamic (temperature and sea ice) and dynamic (surface pressure) drivers explain the seasonal variability of the cycle. Our analysis indicates an intensification of the atmospheric hydrological cycle over the last four decades, largely driven by precipitation and moisture convergence changes (with little role for evaporation). Changes in temperature, sea ice, and surface pressure (SAM) explain this multi-year evolution of the processes. By analyzing the ACCESS-ESM1.5 data, we show that the atmospheric hydrological cycle is projected to intensify by the end of the century, with a leading role from moisture convergence (increasing by +22.1% compared to present-day levels), followed by precipitation (+18.5%) and evaporation (+10.4%). Our study could be a starting point for the study of the global freshwater cycle in Antarctica.

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Abstract No : 320

Quantifying stratospheric ozone loss over Antarctica using corrected satellite profiles

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A validation study of satellite retrieved ozone profiles (Hulswar et al., 2020) was carried out over the Indian Antarctic station 'Bharati' which indicated that there was a significant positive bias in the measurements by Microwave Limb Sounder (MLS) instrument onboard Aura satellite. This has implications for the estimations of ozone recovery over Antarctica based on MLS. Hence to study the bias in MLS profiles over Antarctica, a similar study was carried out over nine different stations spread across Antarctica (Hulswar et al., 2021). Although the results showed that the MLS data match the in-situ observations over longer averaging periods, the discrepancies for individual profiles were much higher and need to be considered when computing the ozone impacts using MLS data. The satellite profiles were corrected based on the recommendations of the two studies for quantifying stratospheric ozone loss over Antarctica (Hulswar et al., 2022). The analysis showed that at some stations the original MLS observations underestimated the number of loss events by 5–10%, however, at other stations, they were overestimated by the same margin. Irrespective of the bias, the number of loss events decreased gradually from 2004 to 2013 suggesting a recovery trend. After 2013, no significant trend is visible, with large variation seen especially between 2015–2019. The interannual variation was strongly coupled to the temperature, highlighting the key role that polar stratospheric clouds play in causing saturated ozone loss.

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Abstract No : 874

Snowmelt processes over perennial Antarctic sea ice observed by CFOSCAT and ASCAT

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Snowmelt processes can alter the physical properties of the snowpack, which are closely related to energy and mass budgets of the sea ice. The role of snow on Antarctic sea ice is particularly important as the snow typically survive throughout the summer. Therefore, we used Ku-band Chinese-French Oceanography Satellite Scatterometer (CFOSCAT) and C-band Advanced Scatterometer (ASCAT) daily backscatter data to observe the snowmelt in the Antarctic perennial sea ice region. The onset dates of two snowmelt stages from 2019/2020 to 2021/2022, namely pre-melt and snowmelt are retrieved in this study. Results show that the average pre-melt and snowmelt onset dates for the pan-Antarctic perennial ice region are Nov 28 and Dec 15 respectively. Comparison between the onsets of these two melt stages and air temperatures from The Fifth Generation ECMWF Reanalysis (ERA5) shows that pre-melt onset is a good indicator of the start of the temporary snowmelt period while snowmelt onset dates are generally later than the start of continuous melt events. In addition, significant differences in retrieval results between CFOSCAT and ASCAT were also observed, with ASCAT detecting a pre-melt onset date of Nov 26, 4 days earlier than the CFOSCAT results. Combining the snow depth data, we expand an existing conceptual model that explains how microwave signals of different wavelengths respond to the pre-melt process of snow at different snow depths. It shows that combining multiband scatterometers can help to observe the variation of snow properties across the vertical snow column on perennial sea ice in Antarctic.

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Abstract No : 810

How can Antarctic gravity-wave observations influence model parameterization improvements?

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The ANGWIN Antarctic Gravity Wave Instrument Network has the ability to measure gravity-wave characteristics at various locations and height ranges. An ANGWIN objective is to make comparisons to the parameterized gravity waves in climate models with a view to improving their performance; A significant modelled temperature bias exists in the southern polar winter stratosphere due to a lack of gravity-wave forcing, with consequences for studies of the ozone layer and southern hemisphere climate. The success of model-observation comparisons depends on both the way gravity waves are observed and the design of model representations. Contemporary parameterizations, designed approximately 20 years ago, include attributes influenced by a need for computational simplicity. They are formed around momentum flux, the most dynamically important gravity-wave parameter but also the hardest to measure. They also integrate the gravity-wave field across parameter spaces in a manner that is hard to precisely replicate in observations. As a result, the cause of disagreements between observed and modelled gravity waves are difficult to isolate. This presentation explores the path between gravity-wave observations and climate model improvements. In the light of recent insights brought about through observations, it considers how current parameterizations can be changed to better represent gravity wave processes. In so doing, a path whereby observations and parameterizations can meaningfully interact is described.

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Abstract No : 242

Measurement of Atmospheric Particles and Volatile Organic Compounds at Princess Elisabeth Antarctica Station: Properties and Air Mass Origin

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Antarctica is considered the best preserved region on Earth from anthropogenic emissions. However, the impact of anthropogenic airborne particles and pollutants could be significantly larger than expected. Furthermore, a detailed understanding of present-day atmospheric transport pathways of particles and of volatile organic compounds (VOC) from source to deposition in Antarctica remains essential. Since 2010, the aerosol total number and size distribution, and aerosol optical properties have been measured at the Belgian research station Princess Elisabeth Antarctic (PEA). The station is situated in Dronning Maud Land, East Antarctica (71.95° S, 23.35° E, 1390 m asl). Atmospheric particles have been collected for analysis on organics and trace elements by high-volume sampling at PEA during four austral summers (2017/18 to 2020/21). At seven locations along a 250 km N-S transect from the coast to the Antarctic plateau, year-round passive samplers (VOC and trace elements analysis) have been installed and surface snow samples (trace elements) have been collected. The FLEXPART dispersion model and the FLEXTRA trajectory model were applied in order to investigate possible source regions and transport pathways. 10-days backward trajectories were calculated for the period 01/01/2010 to 31/12/2020, in 3-hour-intervals. A k-means cluster analysis was done, revealing four clusters of air mass origin. Results will be presented for the seasonal air mass origin clusters and also the distribution of measured particle properties between and within the air mass origin clusters. Potential source regions will be shown for the results of VOC analyses for samples of different time periods.

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Abstract No : 732

Summertime high abundances of Citric, Succinic, and Glyoxylic acids in Antarctic aerosols

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The Antarctic is Earth's southernmost continent surrounded by the Southern Ocean where continental transport of anthropogenic pollutants is trivial. To better understand the sources and formation processes of organic aerosols over the pristine environment, PM₁₀ samples collected from Bharati station were studied homologous series of dicarboxylic acids and related organic compounds during the austral summer (Dec 2017 to Feb 2018) by employing a water-extraction followed by dibutyl ester derivatization analyzed using capillary gas chromatography (GC). We found that succinic and citric acids are the foremost abundant among the measured organic acids followed by glyoxylic, azelaic, and adipic acids. Such a typical molecular distribution of organic acids completely different from the continental urban aerosols, suggests the dominance of natural sources in the Antarctic. Two distinct air masses arrived from different altitudes, high and low altitude-troposphere (HTAs and LTAs), showed a significant difference in mass concentrations of organic acids with higher values in LTAs. We also found significant depletion of oxalic and malonic acids, attributed to the photo Fe-complex reactions in the aqueous-phase atmosphere. The present study demonstrated that the secondary formation of organic aerosols are primarily contributed by the marine-derived biogenic organic matter such as biogenic unsaturated fatty acids, phenolic compounds, etc., enriched in sea-surface micro-layer, via sea-to-air emissions followed by photooxidation processes. Since diacids are highly water-soluble, the measured organic compounds in this study have significant implications for cloud activation properties such as their lifetime and albedo in the pristine Antarctic environment.

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Abstract No : 457

Study of Aerosol–Cloud interaction over the western part of Indian Regions

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The collected aerosol and cloud products from the MODerate Resolution Imaging Spectroradiometer (MODIS) over Western part of the region were inferred to bring out their conspicuous features and investigate interaction between aerosol–cloud. Values show modest annual variations and increased aerosol optical depth (AOD) during the monsoon, while it increases in most places throughout the winter. Over the selected stations, the results show a positive or negative relationship between AOD and practically all cloud characteristics. In this study, the impact of elements such as cloud type, cloud dynamics, and interactions between aerosol–cloud were investigated.

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Abstract No : 687

Investigations on traces of human-induced Aerosols over Antarctica

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Global warming and climate change are a matter of great concern these days, and various impacts are witnessed globally. The poles are also not untouched by the effects of global warming, and significant impacts are seen over here. Several components and feedback mechanisms are involved in the earth system, which causes climate change. Aerosols are a crucial component of the earth's system due to their direct and indirect effects on the climate and environment. The Aerosols are one of the fussiest components of the earth's climate system concerning their impact on radiative forcing and climate. Studies have mentioned the traces of continental/dust aerosols over the polar region; thus, it is essential to quantify the characteristics of aerosols. In the present work, we have investigated the characteristics and dominant aerosols type present in the Antarctica atmosphere. We selected the AERONET data for this work. Several sites fell over the Antarctica region, and the nearby South America region are chosen for this work. As this land is free and far from human activities, thus a relatively low value of Aerosol optical depth (AOD) as compared to other continents was noticed. AOD and Angstrom Exponent frequency distribution, volume size distribution, AOD-Angstrom Exponent scatter, and curvature effect on AOD and AE are studied for the characterization and classification of the aerosols. Results indicated clear evidence of human-induced aerosols over this isolated place. This study provides a signature of humans' indirect encroachment (i.e., through the wind) over such remote environments.

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Abstract No : 83

Bromine, Iodine and Mercury on the East Antarctic plateau: preliminary results from sampling along a traverse.

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Sunlit snow is photochemically active and plays a key role in the exchange of gas phase species between the cryosphere and the atmosphere. Bromine (Br), Iodine (I) and Mercury (Hg) can be photoactivated by the UV radiation and released from the snowpack into the atmosphere. Mercury is a heavy toxic metal very labile in the snowpack where it can be photoreduced back to elemental Hg (Hg(0)) and exchanged with the atmosphere. Similarly, iodine can undergo photochemical activation in surface snow and be remitted in the atmosphere where it has a role in new particle formation. Bromine is involved in the polar mercury cycle (Atmospheric mercury depletion events) as well as contributing to the polar tropospheric ozone cycle causing the so-called Ozone depletion events. However, it seems to be more stable after deposition into the snowpack. Here we present measurements of bromine, iodine and mercury performed by ICP-MS, on bulk and surface snow samples taken over a 600 km traverse in East Antarctica (East Antarctic International Ice Sheet Traverse, EAIST 2019). The samples give us deposition records of the last season and the last few years for the surface and bulk samples, respectively. The analyses show a decrease of concentrations toward the inland except for the sites characterised by a strong snow metamorphosis caused mainly by the wind friction. Future studies will investigate the possible link between the concentration profile and the variation of the solar radiation reaching the Antarctic Plateau during spring caused by the ozone hole formation.

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Abstract No : 409

Atmospheric aerosol measurements at Vernadsky and Mendel stations, maritime Antarctic Peninsula

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Data on the amount and variability of tropospheric aerosols over Antarctica remain sparse. Regular and sporadic measurements with the Microtops II sun-photometer fill partly this gap. Since March 2021, the year-round Microtops II aerosol measurements have been carried out at the Vernadsky station (Ukraine) in the western coast of the Antarctic Peninsula and the seasonal measurements in January–February have been operated at the Mendel station (Czech Republic) northeastern Antarctic Peninsula in the Weddell Sea region. The report presents the measurement results of the aerosol optical depth (AOD) and calculations of the Angstrom exponent in the 2021–2022 period. The largest daily mean AOD (500 nm) values measured at both stations are less than ~0.2. The seasonal aerosol variations exhibit largest AOD values in austral autumn and early spring at the Vernadsky. The comparison AOD data was provided with measurements at other Antarctic stations of the AERONET network and with measurements at the AERONET Kyiv station in Ukraine. Angstrom exponent values by Vernadsky measurements are less than ~1.0 in the most of observations and lower than in other Antarctic station measurements, which indicate the presence of coarse mode particles in the atmosphere. During simultaneous measurements at the Vernadsky and Mendel stations in January–February 2022, the daily AOD (500 nm) values vary of ~0.05–0.15 (Vernadsky) and of ~0.04–0.20 (Mendel), which confirms the similar conditions at both maritime sides of the Antarctic Peninsula affected by uniform air masses and weather systems.

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Abstract No : 911

Gravity wave characteristics and propagation conditions were observed in the mesosphere above Comandante Ferraz Antarctic Station

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Climatological studies on gravity waves over the Antarctic Peninsula are essential for a better understanding of the upper atmosphere dynamics in that region. The objective of this work is to contribute to answering how the small-scale gravity waves (SSGW) can propagate from the lower atmosphere to the mesosphere near the Antarctic Peninsula. This work presents the wave parameters, and horizontal and vertical propagation conditions of the mesospheric gravity waves observed over King George Island (KGI) from the years 2015 to 2017. The parameters were obtained by the 2D Fourier transform which showed similar values to previous works carried out at Ferraz and other stations nearby the Antarctic Peninsula. The main results of the gravity wave parameters are: the horizontal wavelengths range between 20 and 40 km, periods from 5 to 20 min, and phase speed ranging mainly from 20 and 80 m/s. Propagation directions and filtering conditions were analyzed by using the blocking diagrams technique, on which was used monthly averaged winds. The results exhibited typical anisotropy with a major number of waves propagating to the west and a few faster waves to the east. We attributed this anisotropy to stratospheric wind filtering. Intrinsic parameters and vertical wavelength were calculated with wind data from the King Sejong station (KSS) meteor radar, and the vertical propagation conditions were obtained by inspecting the squared vertical wavenumber profile. The vertical propagation showed a large number (80%) of waves vertically propagating, and only a few cases (20%) were evanescent or ducted waves.

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Abstract No : 420

Anthropogenic and natural contributions to the Black Carbon variability at the Indian Antarctic stations

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The biomass burning and fossil fuel combustions are the primary sources of the atmospheric black carbon (BC). The wind circulation could transport BC aerosols to the far-off locations like Antarctica and where the BC plays an important role in the climate change. BC is recognized as the second largest absorber of radiation after the CO₂. BC deposited over the snow surface can influence the snow albedo and lead to warming and melting of snow over the Antarctic region. Under the umbrella of Integrated Atmospheric Observation Facility for Antarctica (IAOFA), dedicated aerosol observatories are operational at Indian Antarctic stations Maitri (70° 46.01' S & 11° 43.85' E) and Bharati (69° 24.41' S & 76° 11.71' E) since the austral summer 2018-19. The black carbon mass concentration and aerosol spectral absorption coefficients are continuously being measured at both the stations at 1-minute temporal resolution using seven channel aethalometer (model: AE-33 of Magee Scientific). The observations indicate traces of the black carbon (ng/m³) with a profound day-to-day variability at both the stations, which could be attributed to the local anthropogenic factors under the prevailing meteorological conditions. Moreover, the seasonal variability, such as, the minimum in austral winter, and higher in spring and summer appear to indicate the changes due to the long-range transport and the possible relation to the wildfire in the southern hemisphere. In this study, we present the results based on the 4-years of BC observations.

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Abstract No : 891

CHARACTERIZATION OF AEROSOLS IN THE COASTAL ANTARCTIC REGION DURING AUSTRAL SUMMER

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Aerosol characteristics prevailing in Antarctic coastal region (64°S–69°S) were studied from in-situ observations made in austral summer during 9th and 10th Indian Southern Ocean Expeditions (SOE-9 & SOE-10). Mean aerosol optical depth at 500 nm (AOD500) estimated from SOE-9 and SOE-10 were 0.062 ± 0.012 and 0.069 ± 0.008 , respectively. In general, though the AOD spectra during both the expeditions were flat, an increase in the mean AOD at 1020 nm was observed during SOE-10. BC mass concentrations ranged between 24.08 and 143.35 ng m⁻³ for both expeditions. HySPLIT trajectory and Concentration Weighted Trajectory analysis revealed that the aerosols are mainly of maritime and continental (aerosols from Antarctica) origin, with few advected ones from South Africa and Patagonia. The mean total ambient aerosol mass was higher during SOE-10 ($35.97 \pm 11.85 \mu\text{g m}^{-3}$) in the region compared to SOE-9 ($21.64 \pm 10.71 \mu\text{g m}^{-3}$), whereas accumulation mode percentage was higher during SOE-9 ($36.53 \pm 17.30 \%$) than SOE-10 ($29.96 \pm 8.36 \%$). This is indicative of coarse mode sea-salt aerosols, produced due to stronger winds in SOE-10, dominating the ambient aerosol composition. CALIPSO vertical feature mask profiles showed more aerosol during SOE-9 compared to SOE-10. The aerosol subtype profiles established that dust and smoke are the two types of aerosol prevailing at higher altitudes. The dust in this region is mainly advected from Patagonia. There was a significant change in aerosol composition between the two expeditions despite only a year having elapsed, owing to the change in atmospheric conditions.

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Abstract No : 265

Preliminary results from routine meteor wind observations as by-products of mesosphere turbulence measurements of PANSY radar, Antarctic

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PANSY radar at Syowa station (69S, 39E) has been conducting continuous mesosphere, stratosphere and troposphere observations as the only MST/IS radar in the Antarctic [Sato et al., 2014, JASTP]. These observation techniques are characterized by their three dimensional wind velocity measurement ability including vertical wind component with high time/height resolutions. The mesosphere observations, however, need ionized media in the mesosphere and are limited to day-light hours. To compensate this we have developed an external interferometry system for reception which can detect meteor echoes throughout a day in the height region of 70-95 km as purely by-products of the routine mesosphere measurements. A pioneering external meteor system attached to the MU radar, Japan, by Nakamura et al [1997, Radio Sci.] is a proto-type of the current system. This newly developed system, consisting of five Yagi antennas, has continuously been operating since March 2021. The number of detected meteor echoes is comparable to or even more than that of commercial meteor radars. Inter-comparison with the routine mesosphere wind measurements and analyses of mean winds and atmospheric waves are to be made. References Sato et al., 2014, J. Atmos. Sol.-Terr. Phys., 118, 2-15, doi:10.1016/j.jastp.2013.08.022. Nakamura et al., 1997, Radio Sci., 32, 1203-1214.

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Abstract No : 877

Monitoring of Atmospheric Aerosols and Water Vapor in the 6th Turkish Antarctic Expedition on the Horseshoe Island

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Recent climatological and meteorological observations show that glaciers are melting and the average temperature in the western part of the Antarctic continent is increasing. Therefore, long-term observations through ground-based and satellite-based systems in Antarctica are essential for monitoring global climate change, which is affected by changes in the Earth's radiation balance. Within the scope of bilateral cooperation between TUBITAK (The Scientific and Technological Research Council of Turkey) and BAS (Belarusian National Academy of Sciences), atmospheric aerosol and surface albedo were measured in the 6th Turkish Antarctic Expedition. Since the ground-based measurements are poor for gathering dense information from the south pole, it is thought that the measurements made from Horseshoe Island will contribute to a better understanding of atmospheric changes. In this context, the studies and measurements made within the scope of the 6th Antarctic expedition are given. Key Words: Antarctic Peninsula, aerosol, water vapor, global climate change.

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Abstract No : 142

Multi-layer clouds over the high latitudes of the Southern Ocean

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A bias in the radiation budget over the high latitudes of the Southern Ocean persists in present day reanalysis products and climate simulations. This region has previously been found to be spatially correlated with the frequent presence of multi-layer cloud scenes. Motivated by the need to improve our understanding of key atmospheric processes, a collection of four field campaigns took place between 2016 and 2018, yielding an unprecedented wealth of measurements across the Australian sector of the SO. Amongst these observations, a combined total of 2186 upper air soundings were undertaken to help map out the thermodynamic structure and synoptic meteorology. Employing these soundings, a synoptic climatology has been developed that defines seven unique clusters across the Southern Ocean: one warm cluster, four clusters across different stages of the SO storm track, one cold cluster over the high latitudes of the Southern Ocean and a second cold cluster along the Antarctic coastline. In this work we explore the occurrence of multi-level clouds scenes as inferred from the upper air soundings. This analysis is then extended to evaluate the ability of the ERA5 reanalysis product to produce these multi-layer cloud scenes. We have found that ERA5 systematically underestimates the number of multi-layer clouds scenes, particularly in the cold cluster associated with the high latitudes of the Southern Ocean. Case studies are presented examining the impact of this bias on the radiative transfer through the region and the formation of dynamics of this multi-level cloud structure.

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Abstract No : 784

Mesospheric gravity waves and winds observations over Comandante Ferraz Antarctic station: update of the MLT instrumentation and recent results

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Gravity waves have been observed at Comandante Ferraz Antarctic station since 2007, using all-sky airglow imagers. However, no observations were made in the last four years due to technical problems, the rebuilding of the station, and the COVID-19 pandemic. In 2022 a new all-sky imager with three airglow filters (OI NIR, OI 557.7 nm, and OI 630.0 nm) was installed, together with a wide-angle photographic camera which was repositioned to observe noctilucent clouds. Besides the installation of a new imager capable of observing gravity waves and ionospheric phenomena such as traveling ionospheric disturbances (TIDs), periodic maintenance of the meteor radar antennas was also carried out. This has resulted in the provision of good mesospheric and lower thermospheric wind data by the instrument. The ANTArctic Gravity Wave Instrument Network (ANGWIN) group initiative contributes to the understanding of gravity wave propagation, their origin and ways of generation around Antarctica, and their impact on the upper mesosphere and thermosphere circulation process. Several kinds of data, especially the all-sky images, obtained at Ferraz station can contribute to the main objectives of ANGWIN. In this work, we review the main results on gravity waves and present the recent progress in terms of instrumentation, and observation of gravity waves and noctilucent clouds at the Brazilian Comandante Ferraz Antarctic station.

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Abstract No : 709

Aerosol chemical mapping in combination with ice core data suggest ozone depletion in Antarctica triggers intense changes in polar chlorine geochemistry

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Due to the stratospheric ozone depletion detected in the early 80s decade, the antarctic environment has been used as a natural field laboratory for the impact of enhanced UV-B radiation over the biosphere and the cryosphere. The real dimension of the ozone depletion threat to the Antarctic environments and the atmospheric chemistry is not fully described. We present a new data of synchrotron-based multi-element microscopic/molecular speciation of individual aerosol particles sampled in West Antarctica, using Scanning Transmission X-ray microscopy with Near-Edge X-ray Absorption Fine Structure Spectroscopy (STXM/NEXAFS) combined with Computer-Controlled Scanning Electron Microscopy (CCSEM). The reanalyzed data show that aerosol chlorine geochemistry is by far more impacted by incoming UV radiation. These data were integrated with a reanalysis of regional ice cores providing new insights into the intensity of the photolytic processes involving chlorine-enriched particles during the ozone depletion period. The results show that an intense interaction of sea-salt particles with snowpack byproducts is significantly increased chlorine depletion from sea salt, confirmed by Cl/Na ratios in ice cores ions measurements and, even though during the last 10k years Cl/Na ratios exhibited punctual higher values than the bulk seawater signature due to several factors as volcanism and probably to post-depositional processes, in the recent time period, modern Cl/Na ratios values reached frequently unprecedented levels. Finally, our results point to the need to deeply investigate the sea salt chemical interactions from the sea surface emissions to deposition in ice sheets, which is crucial to model the net radiation balance in Antarctica satisfactorily.

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Abstract No : 712

Black Carbon aerosol on the Southern Atlantic Ocean Coast and King George Island (Antarctic Peninsula): relative contributions of fossil fuel and biomass burning sources

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Carbonaceous aerosols can affect climate, especially particles containing Black Carbon (BC). BC originated from the incomplete combustion of fossil fuel and biomass, which can heat the atmosphere and increase ice melting, but little is known about BC sources in Antarctica. We quantified the contribution of distant origin (biomass burning) and local emissions (fossil fuel) to atmospheric BC concentration in the King George Island (Antarctic Peninsula) and the Southern Ocean. We examine the BC concentrations using a multi-wavelength Aethalometer AE-33 and AE-42 aboard the Brazilian Oceanographic Research Ship Almirante Maximiano. The results indicate that the region is influenced by local sources and air masses coming from surrounding continents. Fossil fuel combustion was the major source of carbonaceous aerosols in the region, whereas the total average concentration was $41.8 \pm 22.8 \text{ ng m}^{-3}$. The findings indicate a contribution of biomass burning coming from low and mid-latitudes of South America over the Antarctic Peninsula and the Southern Ocean around 62°S latitude. We demonstrated that fossil fuel is the main contributor to atmospheric BC concentration for the Austral summer and autumn. Scientific stations, local tourism, and traffic are possible local BC sources. Our work invokes the urgency of questionable sustainability issues about Antarctica exploration.

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Abstract No : 754

Release of Micro-Bubbles from Snow Melting in Open Waters: A Novel Source of Polar Aerosols

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Aerosols are an important driver of cloud formation and radiative forcing in polar regions, but primary aerosol generation in these regions is not well understood. Aerosols are consequently a large source of uncertainty in regional and global climate models. Here I identify the bursting of bubbles released from snow particles melting in surface waters as a likely physical mechanism generating these aerosols. These snow particles may comprise fresh snowflakes that fall into open waters or previously fallen, wind-transported snow particles that are blown into these waters. Here I present high-magnification, high-speed videos of snowflakes entering a transparent bath of artificial seawater (acquired at 500 Hz). These videos show that snowflakes cross the air-water interface intact and subsequently release trapped micro-bubbles upon melting. Large, morphologically complex snowflakes may release hundreds of micro-bubbles which are up to 0.15 mm in diameter. Large snowflakes melt milliseconds after entry and subsequently form a downward-moving vortex ring of freshwater, evident from the motion of the bubbles it contains, which may penetrate up to 16 mm below the surface. Buoyant freshwater and bubbles then rise, with larger bubbles escaping from the downward flow more quickly than the smaller bubbles. These bubbles reach the surface and subsequently burst, releasing sea spray aerosol particles. A better understanding of the small-scale physical processes involved in primary aerosol generation via snow melting in open leads could help to parameterize future models of Antarctic aerosol production as a function of sea ice coverage, wind speed, snowfall rate, and other meteorological conditions.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

PHYSICAL SCIENCES

**Polar meteorology:
short term climate variability**

CONVENORS

David Bromwich, Steve Colwell,
Adriana Gulisano

Accepted as: Oral Presentation

Abstract No : 259

Modelling the hydrological connectivity of glacial meltwater during a foehn wind event in the McMurdo Dry Valleys

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The McMurdo Dry Valleys (MDV) are the largest ice-free region in Antarctica and a polar desert. Air temperatures are sub-zero apart from several weeks in the summer where they can hover around zero, resulting in highly dynamic transitions between the phases of water. They are home to an ecosystem of cyanobacteria that are able to survive in this extreme climate by solar radiation and the availability of freshwater—originating entirely from glacial melt rather than precipitation. Previous studies have identified foehn wind events as a driver for extreme warming and have focused on glacial energy balance models and temperature indices paired with direct discharge measurements to estimate the quantity of melt. However, the limiting factor is that they did not resolve the spatial distribution of streamflow. This research is a proof of concept that aims to fill this gap by modelling the hydrological connectivity of glacial meltwater in the MDV. The objectives are to implement and test a hydrometeorological modelling system framework to assess glacial meltwater generation and transport during a foehn induced warming event. This is done using WRF-Hydro, a modelling framework linking atmospheric forcing with a 200m resolution land surface model and a hydrological routing model at 8m resolution. The model is then validated using automatic weather stations and stream gauge measurements to understand the full hydrological story of glacial melt in this region.

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Abstract No : 509

An Overview of the YOPP-SH 2022 Winter Special Observing Period

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The Year of Polar Prediction in the Southern Hemisphere (YOPP-SH) aims to enhance environmental prediction for the Southern Ocean and Antarctica on time scales up to a season. Following a very successful summer campaign, the project undertook an experiment aimed at improving the forecasting skill during the non-summer months, specifically during April 15–July 15, 2022. In view of the limited resources and personnel at this time of year, the emphasis was on limited duration events rather than continuous observing for the three months. These so-called Targeted Observing Periods (TOPs) focused on the prediction of major oceanic cyclones and associated phenomena like atmospheric rivers and featured enhanced collection of radiosonde ascents from 22 stations. Based on the summer results, a major effort was made to increase soundings from middle latitudes to better capture the oceanic cyclone characteristics. The 4 TOPs were scheduled to last 5 days each with 3 days prior to landfall to build up the impact of the additional soundings in the weather forecast models followed by 1 day for the coastal impact of the phenomenon and 1 day following. In contrast to the summer campaign, the region was divided into two sectors to make the investigations more tractable, namely East Antarctica-Ross Sea and the greater Antarctic Peninsula. A forecasting team was established for each sector to decide when the TOPs should be initiated. The presentation will summarize what was actually achieved, and the subsequent investigations assessing the value of the additional soundings in forecasting the TOP events.

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Abstract No : 232

Seasonal Characteristics of Troposphere Heights calculated from 2018–2020 Ozone Sonde Data of Jangbogo Station (74°S, 164°E) and Korean Stations

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Ozone(O_3) is a gas material mostly located in the stratosphere. But often, the stratospheric ozone is transported to the troposphere, and this process is known to be associated with the large-scale circulation and climate variability. To clarify this process, we need to know the variation of tropopause height, which can be estimated using the vertical profile of ozone or temperature. In this study, we calculated the Ozone Tropopause (OT), Lapse Rate Tropopause (LRT), and Cold Point Tropopause (CPT) using the ozone sonde observations from 2018 to 2020, in Antarctica (Jangbogo Station, 74°S, 164°E) and several Korean sites (Pohang, Anmyeondo, and Yongin, 33–37°N, 126–129°E). These tropopauses calculated using temperature(K) and ozone mixing ratio (ppbv), were compared to examine how they are consistent or different. As a result, tropopauses in Jangbogo Station (Antarctic region) were generally less changing through a year than Korean stations (mid-latitude region). CPT was the highest tropopause among all stations. LRT and OT were similar each other in all periods except the mid-latitude summer; OT descended below 10km height. LRT was also changing in mid-latitude summer, ascending by the increased heating of Earth surface.

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Abstract No : 531

A McMurdo Dry Valley foehn warming case study from a new continental scale air temperature dataset – AntAir v.2

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Extreme warming events in the McMurdo Dry Valleys (MDV) of Antarctica are often associated with foehn processes. In winter, foehn winds can erode valley cold pools and increase near-surface air temperature by 40 °C. In summer, foehn-induced warming can raise temperature to above freezing and thereby generate and potentially sustain melt. Foehn-induced warming is furthermore documented in other regions of Antarctica such as the Antarctic Peninsula, Ross Ice Shelf, and Enderby Land. However, an Antarctic-wide spatially and temporally comprehensive climatology of foehn-induced warming and identification of anomalous warming spots along the complex coastal topography of Antarctica is still lacking. We have developed AntAir v.2, an Antarctic-wide and remotely sensed near surface air temperature dataset with daily resolution for the past 19 years, as a part of a data driven approach to detect local warming anomalies including foehn-induced warming. AntAir v.2 has a gridded spatial resolution of 1km² and is derived from daily MODIS land and ice surface temperature measurements and fitted against Automatic Weather Stations (AWS). AntAir v.2 captures well the temperature variations within complex topography and when compared to the ERA5 2m temperature reanalysis product, AntAir v.2 has a higher accuracy in reproducing in-situ measurement from AWS. Within the MDV, foehn-induced warming with a duration of 5 hours or more are identified in AntAir v.2 as a warming anomaly. Identified extreme events are linked to the synoptic-scale circulation that are known to control the strength and occurrence of foehn-induced warming.

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Abstract No : 129

The impact of foehn events on the energy balance of Joyce glacier, McMurdo Dry Valleys, Antarctica

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The McMurdo Dry Valleys (MDV), the largest ice-free region of Antarctica, hosts a unique and fragile ecosystem. This vulnerable ecosystem is strongly dependent on glacial meltwater in the dry climate of the MDV, and short-term changes in glacial runoff can impact the ecosystem over several years. Foehn events in this region can cause episodic warming events and have been linked to years with extreme glacial runoff. In this study we use 14 months of observations from an automatic weather station at Joyce glacier and model output from the Antarctic Mesoscale Prediction System (AMPS) to study the impact of foehn events on the glacial energy balance and meltwater generation. The observations are used to run both an energy balance model and in combination with AMPS data a foehn-detection algorithm. Melt occurs more frequently during foehn events as the foehn events provide extra heat to bring the surface to melting, also lowering the albedo. Melt energy is strongly solar radiation dominated in the MDV and the lowered albedo provides together with stronger sensible heating more energy for melt, which is largely compensated for by energy losses to sublimation. Given the changes observed in the energy balance during foehn conditions, the next logical step is to determine in greater detail the spatial and temporal variability of foehn-melt interaction as controlled by synoptic-scale atmospheric circulation in the MDV. Eventually this helps us to understand how changes in synoptic events in a changing climate might severely impact glacial runoff and the ecosystems depending on it.

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Abstract No : 609

Reanalysis representation of low-level winds in the Antarctic near-coastal region

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Low-level easterly winds encircling Antarctica help drive coastal currents which modify transport of circumpolar deep water to ice shelves, as well as the formation and distribution of sea ice. Reanalysis datasets play an important role at high southern latitudes where observations are few. In this research, representation of the mean state and short-term variability of coastal easterlies is evaluated in three recent reanalyses, ERA5, MERRA-2 and JRA-55. Reanalysed winds are compared with summertime marine surface wind observations from the ASCAT scatterometer and surface and upper air measurements from coastal stations. To characterise short-term variability, reanalysis and coastal station winds are composited using self-organising maps (SOMs) which cluster timesteps under similar synoptic and mesoscale influences. Reanalysis coastal easterlies correlate highly with ASCAT ($r=0.91$, 0.89 and 0.85 for ERA5, MERRA-2 and JRA-55 respectively) but notable wind speed biases are found close to the coastal margins, especially near complex orography and at high wind speeds. Reanalysis performance is sensitive to the driving conditions at stations near steep coastal slopes, where they fail to capture the magnitude of surface wind speed variability when katabatic forcing is important. ERA5 exhibits the best overall performance, has more realistic orography and a more realistic jet structure and temperature profile. However, ERA5 also exhibits the largest negative biases at high wind speeds. These results demonstrate the regime behaviour of Antarctica's coastal winds and indicate important features of the coastal winds which are not well characterised by reanalysis datasets.

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Abstract No : 326

Extreme Precipitation Events and associated atmospheric processes over Dronning Maud Land, East Antarctica

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Extreme Precipitation Events (EPE), defined as the top 10% of high precipitating days (occurring over 10–15 days a year), constitute about 40–60% of annual precipitation at an ice core location (IND33) in coastal Dronning Maud Land (DML), East Antarctica. These EPEs are a major factor in determining the interannual variability of snow accumulation in DML and may influence the proxy-based ice core studies. We analyze the occurrence of these EPEs and the accompanying atmospheric processes over DML by using a combination of composite anomalies, empirical orthogonal function (EOF) analysis of atmospheric variables, and moisture transport pathways using ERA5 reanalysis. The major EOF modes demonstrate that a trough-ridge-trough pattern appears north of DML during the EPEs, with low-pressure systems to the west and blocking high-pressure systems to the east of the location. Moisture transport and vertically integrated water vapour patterns suggest that the top 10% of the EPEs are linked to atmospheric rivers with high moisture flow from low latitudes. A detailed case study of the top precipitating atmospheric river event on 08–09 November 2015, which contributed 22% of the yearly annual precipitation in just 2 days, indicates a strong moisture inflow from 20° S to 30° S in the presence of significant negative and positive MSLP anomalies west and east of DML, respectively. Further analysis of this event using a high-resolution regional atmospheric model (Polar WRF) is underway and will provide insight into the topographic influence on the landfall of such events.

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Abstract No : 899

Atmospheric observations with wind profiler radar at Maitri, Antarctica: comparison with radiosonde, reanalysis, satellite observations and study of tropopause fold events.

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Observations from a wind profiler radar were validated against ground measurements and also used for inter-comparison with the recently launched Aeolus satellite. The VHF MST radar (54.5MHz) installed at the Indian Antarctic research station, Maitri (70° 46'S, 11° 43'E) serves as one of the very few tools available for validation of the Aeolus wind product in Antarctica. The radar wind measurements at altitudes between 0.5 and 11 km from the ground were first validated against radiosonde observations and found to be in good agreement. The mean bias between radar and radiosonde observations is close to zero for both wind components. In comparison with the ECMWF-ERA5 reanalysis, the mean bias ranges from -0.5m/s to 0.1m/s depending on the component and season. The biases in horizontal line-of-sight winds from Aeolus and the radar in the troposphere are not significantly different from zero. This provides confidence in Aeolus wind measurements over Antarctica. Seasonal characteristics of the horizontal winds between 0.5-10km altitude from the radar are also explored and compared with NCEP, ERA-Interim and MERRA reanalysis products. The observed tropospheric zonal winds are easterlies throughout the year with the occurrence of intermittent westerly wind bursts. Meridional winds are generally southerlies during summer, whereas northerlies during winter. Further, observations from the radar are used to detect tropopause fold events at the location. The temporal variability of these tropopause fold events and characteristics of vertical mixing associated with those events are investigated. Tropopause fold events are followed by the rapid mixing of stratospheric air in the troposphere.

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Abstract No : 827

The near-ground stable atmosphere and strong temperature inversion monitored at Dome A, Antarctica

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We present weather data from the surface to 15 meters at Dome A for 50 months, including air temperature, wind speed, and wind direction at different heights as well as air pressure and relative humidity at 2 meters. There are also data of ice temperature at a depth of 1 meter. Valuable continuous data of 20 months in 2015-2016 and 17 months in 2017-2018 (up to only 4 meters) are available. We find strong, long-lasting temperature inversion, indicating that the boundary layer could become as thin as close to the ice surface. Although the data show consistent weather trends over years, there is also evidence of annual variation of atmospheric processes. All the data are made available to the public to promote further studies.

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Abstract No : 1012

Simulated ocean wave field evaluation in the Atlantic sector of the Southern Ocean during the austral summer of 2020.

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The objective of this project is to evaluate the simulated ocean wave field in the Atlantic sector of the Southern Ocean during the austral summer of 2020. The study area includes the Antarctic Circumpolar Current region and regions adjacent to the Antarctic Peninsula such as Weddell Sea and Bransfield Strait. Initially, some of the ice parameterizations in the WAVEWATCH-III (WW3) wave model were tested to choose the one with the best performance. The simulations were evaluated with a buoy record, a global wave reanalysis and satellites. Statistical parameters such as Pearson correlation and root mean square error (RMSE) were calculated for significant wave height (SWH). Small bias values were obtained for SWH (satellites and WW3 model), showing areas with negative bias in places with low ice concentration such as east of the Weddell Sea. A good similarity was obtained in the wave direction analysis (wave rose) for each model's output points. The dominant wave directions were well represented, as well as, the SWH range and their frequencies in each direction. Comparing the wave roses (simulated and wave reanalysis) with the wave rose from the buoy record, it was concluded that the simulated wave rose by the ww3 model obtained the best result.

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Abstract No : 894

Recent Antarctic ozone trend using satellite observations

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The recovery trend of Antarctic ozone is investigated in this study. Total ozone observation from Ozone Monitoring Instrument (OMI) and ozone profile observation from Microwave Limb Sounder (MLS) from October 2004 to December 2021 (spring season, September–December) are used. We exclude the effect of climatological factors (e.g., ENSO, QBO) on ozone variation by constructing a multiple linear regression model using several climatological factors as inputs. The recovery of total ozone concentration is well confirmed over most of Antarctica. However, in September and October, the decreased trend of total ozone concentration is still observed in East Antarctica (90–180°E, 56–72°S) and West Antarctica (90–0°W, 60–80°S). As a result of performing the same analysis on the observation of the MLS ozone profile, the different trends of total ozone depending on the region are attributed to the spatial difference of ozone concentration in the middle stratosphere (50–10 hPa). The largest decreased trend is -31.05%/decade at 38.312 hPa altitude in the region of 27.5°W, 66–78°S. Since the ozone concentration is highly related to the temperature, we conducted the climatological analysis on the MLS temperature observation as well. Temperatures of the middle stratosphere also show spatially different patterns similar to ozone and positive correlation with ozone. This positive correlation could be interpreted as a result of strong ozone depletion in cold weather conditions or the radiative effect of ozone. These results suggest that since the ozone depletion is still developing in some regions of Antarctica, more dense monitoring of ozone is continuously required.

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Abstract No : 698

Thermodynamic Characteristics of Marine Atmospheric Boundary Layer (MABL) over the Indian Ocean sector of Southern Ocean (ISSO) Fronts based on Three Field Campaigns

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Populated with planetary-scale fronts i.e., Sub-Tropical Front (STF), Sub-Antarctic Front (SAF), Polar Front (PF), Southern Antarctic Circumpolar Current Front (SACCF), Southern Boundary of ACC (SB), and Coastal Antarctica (CA), the Southern Ocean (SO) influences weather and global climatic patterns. These patterns are regulated by the dynamics of marine atmospheric boundary layer (MABL) controlled by air-sea coupling. This study presents the first record of MABL characteristics in the Indian sector of SO (ISSO; 25°S–68°S, 57°E–78°E) using measurements on surface-meteorology and high-resolution soundings generated during austral summers of 2017, 2018, and 2020. The stability of MABL was strongly controlled by surface forcing (i.e., air-sea temperature gradient, ΔT) encountered at each front. In STF, positive $\Delta T \approx 0.62^\circ\text{C}$ led to low-level convection that weaken the stability of MABL. This augmented formation of mixed-layer capped by multiple high-altitude inversion (INV) (>3 INV's with strength $\approx 0.35\text{Km}^{-1}$ above $\approx 1,200\text{m}$) and thin clouds at mid/high-altitudes (cloud-base and top $\approx 828\text{m}$ and $\approx 1736\text{m}$ with cloud-thickness $\approx 583\text{m}$) that limits convective mixing. In contrast, negative $\Delta T \approx -0.42^\circ\text{C}$ stabilized MABL over SAF, PF, and SACCF. Stability is further enhanced by the development of low-pressure cyclonic systems triggered by the advection of cold-air masses. This accounted for significant low-level condensation and precipitation leading to multi-layered (>2 cloud layers with cloud-base and top $\approx 500\text{m}$ and $\approx 2860\text{m}$ with cloud-thickness $\approx 1419\text{m}$) mixed-phase clouds capped by multiple-inversions (>2 INV's with strength $>0.4\text{Km}^{-1}$ around $\approx 1,836\text{m}$). In SB and CA, positive $\Delta T \approx 1.88^\circ\text{C}$ caused low-level convection capped by weak mid-altitude inversion (INV strength $\approx 0.22\text{Km}^{-1}$ around $\approx 1632\text{m}$). Presence of mixed-phase ice-water clouds ($T_{\text{air}} < -18^\circ\text{C}$; cloud-base and top $\approx 992\text{m}$ and 2417m with cloud-thickness $\approx 1062\text{m}$) were supported by sublimation leading to virga conditions.

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Abstract No : 1013

Strong Warming over Antarctic Peninsula during combined Atmospheric River and Foehn Events

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The Antarctica Peninsula (AP) has experienced more-frequent and intensified warm events in the past few decades. Atmospheric rivers (ARs), or long corridors of intense atmospheric moisture transport, have a significant impact on melting and ice loss; ARs contributed to the collapse of Larsen A and B ice shelves. When ARs propagate over the AP, the leeside can experience strong foehn warming due to latent heat release via precipitation on the upwind side, enhancement of sensible heat transfer from the upper foehn flow to the surface, and cloud clearance, which allows strong downward shortwave radiation (DSR) to reach the surface. The detailed mechanisms and their strengths vary. One unresolved question relates to the strength of the contribution of DSR to surface warming, given the lower solar elevations over the AP. Here we present an analysis of two extreme surface warming/melting cases over the northeastern AP, occurring in austral summer 2018 and 2022, with the goal of improving our understanding of the relationship between ARs and foehn warming and the impact of clouds on the surface energy balance (SEB). Polar WRF is used to quantify the contributions of the physical mechanisms. Observations, including radiosoundings and broadband radiation, are used to validate model results and further characterize the SEB. Both cases were characterized by extensive leeside foehn warming and strong AR impacts. Preliminary results suggest that sensible heat transfer had a small effect, while enhanced DSR associated with foehn clearing was the major driver of warming and melting in the northeastern AP.

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Abstract No : 1064

Substantial seasonal forecasting skill of Antarctic sea ice in a dynamical forecasting system

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We assess the seasonal forecast skill of pan-Antarctic and regional sea ice extent in a dynamical seasonal forecasting system (the Canadian seasonal to interannual prediction system version 2), which consists of two coupled atmosphere-ocean-sea ice models, CanCM4i and GEM-NEMO. For pan-Antarctic sea ice extent, we find statistically significant forecast skill (as quantified by the anomaly correlation coefficient) for all considered lead times (up to 11 months) and target months, except for August to October lead times 2–5 months predictions. Forecasting skill of year-to-year variations that are independent of the long-term trend is substantially larger than for the Arctic, and generally larger than previously reported in other seasonal forecasting systems for the Antarctic. Sea ice forecast skill is found to be substantially higher in GEM-NEMO than in CanCM4i, which may be related to a larger mean model biases in CanCM4 and improved sea ice thickness initialization in GEM-NEMO. Finally, the skill of CanSIPsv2 is found to vary substantially across the different regions of the Antarctic, with lower skill in the Amundsen, Bellingshausen, and West Pacific sectors compared to that of the Ross and Weddell seas. These results highlight the potential of dynamical seasonal forecasting systems to provide useful predictions of Antarctic sea ice on seasonal timescales.

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Abstract No : 34

Quality Control and Analysis of Newly Digitised Meteorological Data: A South Orkney Islands Case Study

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Data quality control is an important step to ensure newly digitised meteorological observations are reliable, to be able to accurately represent the underlying climate trends and variability. In this study, we present how reanalysis datasets can be used to quality control newly digitised historical meteorological data from Signy station, in maritime Antarctica. Hourly ERA-5 and six-hourly ERA-Interim meteorological data, extracted from locations of both Signy and nearby station, Orcadas, can be used as a comparison against station observations to find potential digitisation errors in the station-based data, such as offsets and outliers. While the mean sea-level pressure fields conform well, ERA-5 underestimates temperature extremes and has a cold bias at both Signy and Orcadas, likely due to the representation of the islands as ocean instead of land in the model used for ERA-5 data assimilation. Foehn events at Signy are also not included in the reanalysis assimilations, as the maximum surface elevation in the model is 80 m, but in reality, Coronation Island to the north of Signy reaches > 1200 m. These biases must be acknowledged when comparing the reanalysis data to station temperature observations. Following data quality control, we present the climatology of Signy's station-based temperature and a comparison of the temperature trends at Signy with Orcadas. The number of extreme warm days at both stations is shown to have increased significantly during 1950–1995 for Signy, and 1956–1995 for Orcadas (due to data availability). This has subsequently driven an increase in the annual mean temperature at both stations.

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Abstract No : 1018

Impact of downward longwave radiative deficits on Antarctic sea-ice extent predictability during the sea ice growth period

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Forecasting Antarctic atmospheric, oceanic, and sea ice conditions on subseasonal to seasonal scales remains a major challenge. During both the freezing and melting seasons current operational ensemble forecasting systems show a systematic overestimation of the Antarctic sea-ice edge location. The skill of sea ice cover prediction is closely related to the accuracy of cloud representation in models, as the two are strongly coupled by cloud radiative forcing. In particular, surface downwelling longwave radiation (DLW) deficits appear to be a common shortcoming in atmospheric models over the Southern Ocean. For example, a recent comparison of ERA5 global reanalysis with the observations from McMurdo Station revealed a year-round deficit in DLW of approximately 50 Wm^{-2} in marine air masses due to model shortages in supercooled cloud liquid water. A comparison with the surface DLW radiation observations from the Ocean Observatories Initiative (OOI) mooring in the South Pacific at 54.08°S , 89.67°W , for the time period Jan 2016 – Nov 2018, confirms approximately 20 Wm^{-2} deficit in DLW in ERA5 well north of the sea-ice edge. Using a regional ocean model, we show that when DLW is artificially increased by 50 Wm^{-2} in the simulation driven by ERA5 atmospheric forcing, the predicted sea ice growth agrees much better with the observations. A wide variety of sensitivity tests show that the anomalously large, predicted sea-ice extent cannot be due to limitations in the ocean model and that by implication the cause resides with the atmospheric forcing.

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Abstract No : 688

Antarctic low-level jets during climate change

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Low-level jets (LLJs) are horizontal wind speed maxima of a vertical profile in lower atmosphere (usually below 1 km). They are a common feature of katabatic winds that form over the Antarctic ice sheet but LLJs can also occur over the ocean. Results of LLJ climatology are shown for regional climate modelling using CCLM with 15km resolution for the whole Antarctic. Results are shown for time-slices at the beginning (2000–2014) the mid (2036–2050) and end (2086–2100) of the century for the SSP3–7.0 scenario. The climatological analysis includes distributions of height, wind speed, directional shear and stability of the LLJs. We further investigated the frequency and length of LLJs. Our findings show that LLJ frequency decreases over the slopes of the East Antarctic and coastal areas during climate change. In contrast, an increase is found over the plateau area and some ice shelf areas. The height of LLJs gets lower for some ocean areas. Both signals are less pronounced for the first half of the century. The near-surface wind field shows a slight increase in wind speed over the ocean towards the end of the century. For near-surface temperature an increase of up to 2°C is seen by the mid of the century and of 4°C and more towards the end of the century.

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Abstract No : 127

Earlier stratospheric final warming has caused warmer Antarctic summers in recent decades

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We propose that the slight warming trend of the Antarctic surface since 1999 is linked to the earlier occurrence of the onset date of stratospheric final warming (SFW). During events of the early SFW occurrence, the positive polar-cap-height (PCH) anomaly developed in the stratosphere in early October propagates downward to the troposphere and surface in late spring and summer, resulting in high-pressure anomalies over Antarctica, that leads to colder surface in the Antarctic Peninsula, but warmer surface in the rest of Antarctica. During late SFW events, on the other hand, negative PCH anomaly propagates down to the troposphere, resulting in low-pressure anomalies at surface, especially over west Antarctica. The different surface pressure anomalies depending on the timing of SFW occurrences play a significant role in surface temperature responses in Antarctica, that could influence glacier or sea-ice melting.

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Abstract No : 41

Topographic effect of the Antarctic Peninsula on strong wind event

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The topographic effect on the strong wind event occurred on 7 January, 2013 at the King Sejong Station (KSJ), Antarctica was investigated using the Polar Weather Research and Forecasting (WRF) model. Numerical experiments applying three different terrain heights of the Antarctic Peninsula (AP) were performed to quantitatively estimate the topography effect on the selected strong wind event. The experiment employing original AP topography successfully represented observed features in strong wind, both in terms of peak wind speed by around 94% (~19.7m/s) and abrupt transitions of wind speed. In contrast, the experiment with a flattened terrain height significantly underestimated peak wind speeds by around 51% (~10.4m/s) of observations. An absence of AP topography failed to simulate both a strong discontinuity of sea-level pressure fields around the east coast of the AP and a strong southeasterly over the AP. As a result, the observed downslope windstorm, driven by a flow overriding a barrier, was not formed at the western side of the AP, resulting in no further enhancement of the wind at the KSJ station. This result demonstrates that the topography of the AP plays a critical role in driving strong wind at the KSJ station on 7 January, 2013, accounting for approximately 50% of the total wind speed.

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Abstract No : 879

Direct and indirect measurement of CO₂ turbulent fluxes in the Southwest Atlantic Ocean and the Southern Ocean

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Carbon dioxide (CO₂), one of the most important greenhouse gases, has increased by over 40% since the pre-industrial period. Relevant scientific questions about global climate involve understanding the interaction between the ocean and atmosphere. There are several methods for quantifying carbon flux between the ocean and the atmosphere, direct (eddy covariance) and indirect (bulk parameterizations). However, those indirect estimations result in uncertainties about the CO₂ balance in the ocean-atmosphere system. The major source of uncertainty in the Bulk methodology is the transfer velocity coefficient (K) parameterizations. The main objective of this work is to propose a gas transfer coefficient for the Southern Atlantic Ocean and its portion of the Southern Ocean through the evaluation of CO₂ fluxes obtained by EC and Bulk methodologies. Furthermore, we will validate the gas transfer coefficient for other Antarctic campaigns. The data sets were collected by a micrometeorological tower installed on the bow of the Brazilian Navy Polar Vessel Almirante Maximiano during the ACEX and Antarctic Operations 32, 33, 34, 37, 38, those which happened occurred between 2012 and 2019. We found the best fit was $K=0.4007 \cdot u^2 + (-3.03 \cdot u) + 9.948$ with R² of 0.986 and 95 % of confidence, and it showed an adequate representation of ocean-atmosphere fluxes for this region.

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Abstract No : 944

The detection of Atmospheric River's impacts in West Antarctica Ice Sheet at Criosfera 1 remote laboratory (84S)

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Atmospheric rivers are narrow corridors at tropospheric levels where moisture is concentrated and heat is transported through the atmosphere. Although it has long been recognized at the tropical and extratropical regions of the globe as part of the hydrological cycle, our knowledge on the dimension of its impacts in the Antarctic ice and surrounding sea ice and ocean is not fully described. Since 2012, the Criosfera 1 remote laboratory located at WAIS (West Antarctic Ice Sheet), latitude 84S, has been continuously monitoring atmospheric parameters and solar radiation together with snow deposition. Despite the seasonal behavior of these parameters and the inland location of Criosfera 1, our record shows individual rapid increases in air temperature and humidity events in winter and spring seasons. For air temperature, abrupt increases from -55°C to -25°C were observed during episodes of air mass advections from the Indian Ocean and Weddell sea sector. For the last 10 years we present frequency and duration of these events at Criosfera 1 accompanied by the calculation of the integrated water vapor in the atmospheric column (IWV) and the integrated vapor transport (IVT). We observed that these events profoundly affect the snow mass balance at WAIS and that the west-east asymmetry of the Antarctic ice sheet morphology controls the air mass incursions bringing heat and moisture into more inland site of WAIS.

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Abstract No : 1038

Regional Warming Event in Winter on the Ross Ice Shelf, Antarctica as Observed by UW–Madison Automatic Weather Stations

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From 12–15 July 2007, a regional warming event in winter (RWEW) on the Ross Ice Shelf (RIS) was observed by the University of Wisconsin–Madison (UW–Madison) Automatic Weather Station (AWS) network. A warming event is defined as an AWS observing an increase in temperature of 30° C or greater in five days or fewer. Preceding this RWEW, a stationary low in the Ross Sea and ridge downstream in the Amundsen Sea built up a pool of warm air just off the coast and northeast of the RIS. Calm conditions over the RIS led to cooling surface temperatures and a strong baroclinic zone. A barotropic cyclonic disturbance progressed from the Adelie Land coast along a baroclinic zone and merged with the stationary cyclone in the Ross Sea, after which it deepened and progressed southward towards the RIS. The approaching cyclone eroded the cold pool and initiated the RWEW with a warm front that brought warm air advection, cloud cover, and increased wind speeds. Fourteen AWS observed warming events during this RWEW. Due to their spread across the RIS and varying topographical influences, several mechanisms led to the warming events. This work investigates how the atmospheric environment evolved throughout the RWEW in the context of known circulation regimes such as the Amundsen Sea Low, the Ross Air Stream, and leeside cyclogenesis off the Adelie Land coast. This work also compares AWS observations during the RWEW to their climatological means to investigate the significance of the temperature and wind changes because of this RWEW.

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Abstract No : 464

Can the prolonged period of stratospheric ozone depletion be recorded in Antarctic snow?

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Stratospheric ozone can absorb ultraviolet radiation and consequently influences the radiation balance and the oxidation capacity of the earth's atmosphere. The variability of stratospheric ozone in the past, however, remains largely unknown. Snow nitrate is closely associated with near-surface ultraviolet radiation dose which is largely dependent on the total column ozone (TCO). Therefore, the question arises as to whether snow nitrate in Antarctica can act as a proxy for stratospheric ozone. Here, we present 60-year records of nitrate and its isotopic composition ($\delta^{15}\text{N}$, $\delta^{18}\text{O}$, and $\Delta^{17}\text{O}$) in snow in central Antarctica, Dome A. In the deeper snowpack (~1960–2000), we observe prolonged period of trends in concentration and isotopic composition of nitrate, which are best explained as enhanced snow nitrate photolysis due to the long-term decreasing TCO. That is, prolonged period of trends in nitrate and its isotopes in low snow accumulation sites such as Dome A could relay information on variations in TCO and consequently surface solar ultraviolet radiation over time.

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Abstract No : 187

Attribution of the Antarctic Peninsula 2020 record-breaking event to climate change

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On February 2020 the Antarctic Peninsula region registered one of the most intense heatwaves ever recorded in Western Antarctica. A new all-time temperature record for continental Antarctica was observed at Esperanza station on 6 February 2020 with 18.3°C sparking a debate about the role played by climate change on this new record. To clarify this, we analyzed the regional heatwave event, which occurred between 6 and 11 February 2020 from a long-term climate perspective. According the ERA5 reanalysis, the spatially averaged magnitude of the 6-day event over the Antarctic Peninsula (T2m anomaly of 4.5°C) was unprecedented since 1950 and was associated with a quasi-stationary high-pressure system over the Drake Passage. Based on an analog circulation method we investigated recent changes in the magnitude of this class of event and the potential role played by concurrent changes in the large-scale atmospheric circulation and regional warming. We find that regional warming of the last decades exacerbated the magnitude of this heatwave event in circa 25%. Recent changes in atmospheric circulation, such as the increase in the Southern Annular Mode index, cannot explain the exceptional magnitude of this event.

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Abstract No : 511

Antarctic Data Impact Experiments with Polar WRF During the YOPP-SH Summer Special Observing Period

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Data impact experiments are conducted employing the Polar WRF model during the YOPP-SH summer special observing period (SOP) using the Antarctic Mesoscale Prediction System (AMPS) framework to determine the forecast impact of numerous additional radiosondes collected during the SOP. Hybrid variational-ensemble three-dimensional data assimilation is performed on model forecast domains over Antarctica and the Southern Ocean using all regular observations normally available (Experiment “NoSOP”) and using the same set plus the extra soundings launched for the SOP (Experiment “SOP”). The SOP results show better near-surface temperature and wind speed forecasts than the NoSOP results, primarily over West Antarctica. Radiosonde profiles confirm that temperature and wind speed forecasts are improved throughout the troposphere with the addition of the SOP radiosonde data, but the results for relative humidity are variable. Temperatures are improved at lower levels early in the forecasts, whereas wind speeds are better at higher levels later in the forecasts. An evaluation against the ERA5 global reanalysis that provides a much broader perspective reveals that the improved forecast skill for the SOP experiment persists to 72 hours for temperature, wind speed, and relative humidity. The gains, however, are primarily confined to the Antarctic continent, consistent with the additional radiosonde spatial coverage being mainly poleward of 60°S. With extra radiosondes concentrated over the Antarctic Peninsula, SOP forecasts of the region downstream of the Peninsula were significantly improved compared to NoSOP forecasts. The results also suggest that increasing radiosonde launches at lower southern latitudes would improve forecasts over the Southern Ocean.

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Abstract No : 541

Atmospheric drivers of extreme precipitation events over Amundsen Sea Embayment of west Antarctica

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Snowfall/precipitation is a major component of the mass balance of the West Antarctic ice sheet. Extreme precipitation events (EPEs) contributes around 35% of the total precipitation over the Amundsen Sea Embayment (ASE) of West Antarctica (WA). We investigate the atmospheric drivers of extreme precipitation over the ASE of WA using daily output from RACMO2 model and ERA-Interim reanalysis data for the period 1979-2016. Empirical orthogonal function (EOF) analysis was performed on geopotential height anomalies at 850 hPa, identifies the dominant drivers of atmospheric variability over WA. EOF-1 mode represents the Southern Annular Mode (SAM) pattern. EOF-2 mode captures the PSA-pattern associated with Amundsen Sea Low (ASL) while EOF-3 resembles the PSA-pattern associated with El Nino Southern Oscillation (ENSO) signal over coastal WA. EOF-4 is likely to be associated with 'atmospheric river' events. Overall, 93.7% of days with extreme precipitation at the 2 coastal stations (i.e Evans Knoll and Bear Peninsula) of ASE are associated with these patterns. EOF-2 mode associated with the westward movement of ASL is the main driver of extreme precipitation over ASE (associated with 44.75% of extreme precipitation days) followed by PSA-1/ENSO (22.16%), suspected ARs (21.1%) and SAM (12%). EOF-2 mode is the main driver of extreme precipitation in all seasons except summer where EOF-4 mode is dominant. Extreme precipitation linked to EOF-2 and EOF-4 are more intense (by ~ 2 mm/day) than the rest.

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Abstract No : 822

The role of large-scale atmospheric forcing on short-term ice surface warming in the coastal Dronning Maud Land, East Antarctica

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The spatial inhomogeneity of surface ice sheet temperature in different regions of Antarctica can only be understood by closely looking at atmosphere-ice interactions. An ice core borehole temperature record along with reanalysis data from coastal Dronning Maud Land, East Antarctica during 2014 – 2018 observed a total of 72 warming events having more than 2 °C temperature change and having > 3 days' time span. Our analysis observed that strong wind events prevailed during these short-term warming events over the study region. It is also observed that 84% of the warming events occurred during the strong north-easterly wind and caused high precipitation, while the rest of the warming events were during high south-easterly winds (katabatic) without any precipitation over the region. The study suggests that the high downward longwave radiation during warm air advection and thick clouds during strong north-easterly winds caused the enhanced warming/high precipitation, whereas increased katabatic winds generated high turbulent heat flux, which caused the surface warming without any precipitation over the Antarctic ice sheets. The study emphasizes the role of large-scale atmospheric forcing on the surface temperature of ice sheets over Antarctica.

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Abstract No : 289

Evaluation of medium range near surface atmospheric forecasts over Antarctic and surrounding Southern Ocean

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Most of the model forecast errors and biases build up in the first few days (say short to the medium range). In the polar regions, the ocean and sea-ice models are forced by atmospheric model output. In a coupled system, it is important to estimate the sources of biases in Ocean and Ice parameters. That is why it is crucial to document the biases of stand-alone atmospheric model in polar regions and Southern Ocean. The global atmospheric model (NCUM) is used operationally at the National Center for Medium Range Weather Forecasting (NCMRWF), India. In this study, the near surface medium range forecasts over the Southern Ocean and Antarctic regions are evaluated during the peak summer (JFM) and winter (JAS) seasons for the year 2020. The skill of the NCUM 12 km forecasts from day 1 to day 10 are evaluated. The medium range forecasts for the parameters, 10m winds, 2m air temperature, mean sea level pressure (MSLP), relative humidity, and total precipitation are compared with the analysis data. There is a systematic error in the model forecasts from day1 to day 10 in near surface parameters. However, the skill of the model is encouraging to use it for operational purpose and to use it for forcing the ocean and sea-ice models hence to generate the medium range forecasts for ocean and sea-ice parameters.

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Abstract No : 328

Rossby waves in total ozone distribution over the Arctic at the beginning of the 21st century

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We have considered TOMS (2000–2004) and OMI (2005–2021) total ozone column (TOC) data sets for the second part of winter cold period (January–March). Variations in both total ozone and characteristics of the Fourier wave harmonics with zonal numbers 1–5 are analyzed. We have indicated the different behavior of the wave-1 amplitude in winters with sudden stratospheric warmings (SSW) and winters with no-SSW. Amplitude of the quasi-stationary wave-1 is determined by tropospheric pressure anomalies in the regions of the Aleutian Low (TOC zonal maximum) and the North Atlantic – European High (TOC minimum). It is worth denoting that the wave amplitudes and TOC interannual variations are largest in the polar cap. The Arctic Oscillation is one of the key factors of climate variability in the Northern Hemisphere. It is shown that it negatively correlates with TOC; Pearson correlation coefficient reaches -0.56 at 70°N . This corresponds to polar vortex strengthening and cooling with increased positive Arctic Oscillation, which is accompanied by negative ozone deviations. Our analysis confirms the dominant role of zonal wave-1 and its quasi-stationary component in the winter Arctic ozone distribution. At the same time, we evaluate parameters of the waves with higher zonal numbers, mainly wave-2. Besides, we have analyzed distinctions in the wave-1 variations under strong vortex conditions in 2020 and weak vortex in 2021. A negative trend of the quasi-stationary wave-1 in middle latitudes was revealed during the studied period.

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Abstract No : 761

Evaluation of global solar radiation and cloud cover from ground-based measurements and reanalysis data in the Antarctic Peninsula region

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The Antarctic Peninsula region is very sensitive to recent climate change, which is reflected in high variability of atmospheric parameters or components of the cryosphere. For better understanding of these processes, atmospheric and glaciological models are frequently used. Global solar radiation is an important input parameter in many of these models. Incident solar radiation on the ground surface is modified mainly by amount and type of the clouds. Antarctic Peninsula provides an important orographic barrier determining regional differences in cloud cover between western and eastern part of the Peninsula due to influence of atmospheric circulation and high cyclonic activity. In order to study these differences, global solar radiation and total cloud cover were evaluated at J.G. Mendel station (JGM) on the eastern side and King Sejong station (KSJ) on the western side of the Antarctic Peninsula in the period 2011–2013. Global radiation was measured using high-class pyranometers in 10-minute (JGM) or 30-minute (KSJ) intervals. Total cloud cover was derived from a cloud modification factor and obtained from ERA5 reanalysis datasets. The evaluation showed a significantly lower intensity of global radiation (by ~25 %) and higher total cloud cover (by ~35 %) at KSJ station compared to the JGM measurements. Furthermore, both global radiation and total cloud cover were successfully simulated using the Weather Research and Forecasting (WRF) model at 700 m horizontal resolution and compared with in-situ observations.

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Abstract No : 327

Comparison of the planetary wave spectrum in the 2019 Antarctic SSW with the 2020 non-SSW strong vortex conditions using ozone data

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The zonal wavenumber spectrum of planetary waves in the atmosphere above Antarctica was studied in two contrasting years: in 2019 when there was a sudden stratospheric warming (SSW), and in 2020 when the Antarctic stratospheric vortex was unusually strong and long-lived. The data on the total ozone column (TOC) distribution from the Ozone Monitoring Instrument (Aura NASA mission) and ground-based measurements from the Dobson spectrophotometer at Vernadsky station in Antarctica were used. The 2019 SSW strongly displaced the Antarctic vortex off-pole, and aided the breakdown of the ozone hole. The SSW occurred during the peak activity of quasi-stationary planetary wave-1, which was enhanced at the time of the warming by the large prevailing amplitude of travelling wave-2. In the spring of 2020, the stratospheric polar vortex was relatively undisturbed, which allowed the ozone hole area to attain a size close to its historical size maximum. The relatively small amplitude of wave-1 in 2020 aided the stability of the vortex. The stability was maintained despite regular periods when the amplitude of travelling wave-2 attained or even exceeded values around the time of the SSW in 2019. The contributing factor to the differences between the wave effects in the two years was the zonal phasing of the quasi-stationary wave-1. Anticorrelation of the wave-1 and wave-2 amplitudes near the edge of the vortex was clearly observed in 2020, which indicates that planetary wave energy was being transferred between different spectral wave components, unlike the processes in 2019.

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Abstract No : 1031

High-Resolution Remote Sensing Study Of ENSO Energetics, Sea-level Variability Mechanism, Sub-Mesoscale Dynamics and their Correlation with Climate Variability Over Pacific Transitional Areas(TAs) and in the Arctic Sea.

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The El Niño Southern Oscillation (ENSO) originates in the tropical Pacific Ocean TAs & is a source of year-to-year climate variability. (TAs) are strong gradients areas in the physical environment associated with Sea-level Variability Mechanism, Sub-Mesoscale Dynamics over the Oceanic areas impacting the Climate change & are the potential oceanic regions of early detection of Climate variability. The study examines the ENSO Energetics, Sea-level variability mechanism on time & Space Scales through SSTs, and dynamics of sub-mesoscale systems by making use of High-Resolution Satellite imageries, data access assimilation; HPC, and cloud computing for real-time analysis; with emphasis on the large scale kinematic and thermodynamic behavior of selected sub-mesoscale Systems over Pacific Transitional Areas (TAs). The kinematic & thermodynamic characteristics, e. g. lifetime, distribution, trajectories, size, and three-dimensional structure, i.e., the vertical extent of these systems would be computed in order to develop a Correlational Climate Variability ENSO Forecasting Model (CCVEFM) over the tropical Pacific Ocean. Also, the efforts are on to Co-evolute climate and marine life in the Arctic Sea through the Correlation of Ocean-atmosphere-cryosphere interactions with Climate Variability i.e., to evaluate the correlation between the impacts of multiple stressors on the ocean and the associated risks of abrupt state shift, rising of sea level, melting of the glaciers, vis-à-vis climate variability.

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Abstract No : 65

Digitisation of early Antarctic Peninsula meteorological records for climate research

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Early instrumental observations are valuable resources for climate products and services. By extending records back in time, such observations provide a means to better estimate long-term climate trends and variability. Pre-satellite-era records from Antarctica are extremely valuable due to scarceness of observations in the region. Since 1944, three to twelve hourly surface meteorological observations were taken at fifteen stations operated by the UK near the Antarctic Peninsula (AP). Only four of the stations have had the records continuously digitised. Handwritten, paper-based records from eleven stations are archived at National Meteorological Library as well as the British Antarctic Survey (BAS). These early-era data sets are at risk of damage and even permanent loss due to paper degradation and ink fading. Digitising the entire records would be a strenuous and time-consuming process as it requires keying in millions of numbers manually. With recent advancement of digital technology, this project recovers, extends, and consolidates meteorological data back in time at these eleven AP stations. The paper-based records are first gathered, sorted, and scanned at BAS archive. The records on the scanned images are then automatically converted to digits and output as Excel format using an inhouse-built Optical Character Recognition software. The output Excel files are then manually checked against the original scanned images. Quality controls, including comparison with reanalysis data sets, are then carried out for each station. The digitised data sets will be made available for studying climate variability and extreme weather events and to be incorporated into future reanalysis projects.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

PHYSICAL SCIENCES

**Past polar climate variability and
their teleconnections with the tropics**

CONVENORS

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Abstract No : 557

Role of Mascarene High in Regulating Indian Summer Monsoon during the Medieval Warm Period and Little Ice Age

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Role of Mascarene High in Regulating Indian Summer Monsoon during the Medieval Warm Period and Little Ice Age
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Mascarene High is a high pressure region located in the southern Indian Ocean. It plays a crucial role in modifying the Indian summer monsoon by modulating the strength of moisture transport between the southern Indian Ocean and the Indian subcontinent. There has been little research conducted on Mascarene High's role in regulating the Indian summer monsoon over the last millennium. Using reanalysis data and CMIP5 model simulations, we gather evidence on the role of the Mascarene High in regulating Indian summer monsoon during the last millennium, with a focus on the Medieval Warm Period (MWP, 1000–1300 AD) and Little Ice Age (LIA, 1400–1850 AD). The enhanced mean sea level pressure (MSLP) gradient between Mascarene High and the Indian subcontinent is consistent with a strengthened Indian summer monsoon over MWP, along with augmented cross equatorial winds. The reduced rainfall associated with LIA is attributed to a weakened cross equatorial pressure gradient and weakened cross equatorial winds.

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Abstract No : 104

An evaluation of Antarctic ice core nitrate records as a proxy for solar activity

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The nitrate (NO_3^-) deposited in polar ice sheet is an excellent archive for past solar variability. However, the interpretation of the Antarctic ice core NO_3^- record is hindered by limited understanding of the physical processes governing its atmospheric production, transport and deposition to the ice sheets. This issue is addressed by evaluating selected ice core NO_3^- records from Antarctica against the instrumental records of past solar activity and reanalysis climate data. High resolution NO_3^- records (1905–2005 CE) from coastal Dronning Maud Land, East Antarctica revealed a strong periodicity of ~11 years solar cycle signal during the interval of 1940 –2005 CE, however, such periodicity was absent during 1905–1940 CE. In order to resolve the issue of discontinuous signals and inconsistent signals in various ice core records from Antarctica, we have extended our investigation to ten ice core nitrate records available across the Antarctica for the common interval during 1738–1990 CE. Our investigation based on Principal Component analysis (PCA) of NO_3^- records reveals that the solar activity is the dominant controlling factor (PC1) that explains 22 % of the total variability followed by precipitation modulated by ENSO (PC2, 18%). The key finding in the present study improves our current understanding about the processes/factors that control ice core NO_3^- variability and its application as a solar proxy for past solar variability.

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Abstract No : 322

Glaciological site survey to determine an optimal coring site in coastal Dronning Maud Land, Antarctica

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A trilateral (India-UK-Norway) project “Sea Ice and Westerly winds during the Holocene in coastal Antarctica (SIWHA)” aims to drill an ice core in coastal Dronning Maud Land near India’s Maitri station to obtain high resolution climate records spanning the last ~11000 years. Ice-rise summits are ideal candidates for obtaining such an ice core, with their simple local ice-flow regime and large surface mass balance. During the 2021–22 field season, glaciological site surveys were conducted over two candidate ice rises, Kupol Verbljud (VER) and Kamelryggen (KAM), near the Lazarev Ice Shelf. VER is an isle-type ice rise situated at the calving front, whereas KAM is a promontory-type ice rise, landwards of VER. Both have distinct dome-shaped summit regions, which are 320 m (VER) and 370 m (KAM) above sea level. We made both shallow and deep sounding radar profiling of more than 400 km of survey lines. Underneath these summits we found rather smooth beds with an ice thickness of 560 m for VER and 525 m for KAM. VER has a steeply sloping bed south of the summit, whereas for KAM the bed slope stays gentle around the summit region. Englacial stratigraphy shows well defined Raymond Arches, suggesting stable ice-divide positions. A preliminary age-depth estimate at KAM’s summit accounting for internal stratigraphy suggests ~20 k-year-old ice 75 m above the bed at a resolution of 3 year per centimetre. More detailed analysis is underway to determine the best-suited coring site over the survey area.

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Abstract No : 691

Arctic Stratification and its Role in Sea Ice Melt during the Mid Pliocene Warm Period

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Arctic sea ice coverage is reducing in response to the current global warming and it is predicted to be ice-free in the Arctic by the end of the century. The sea ice loss and its positive feedback are majorly contributing to global climate change. A study of the past climate with similar boundary conditions as today can help in testing the validity of future climate prediction. The Mid Pliocene Warm Period (MPWP) spanning from 3.264 to 3.025 Ma presents the best analog for understanding the impacts of future warmer Earth. The relative nutrient utilization and surface productivity can provide an insight into the nutrient availability at the surface governed by the stratification strength. Here we present the relative nutrient utilization and surface productivity during late Pliocene using sediments collected during ODP 151 Site 910C from Fram strait. We find that high relative nutrient utilization and high productivity during warmer periods including MPWP indicate enhanced stratification, while they are low during the colder periods indicating weakened stratification. Stronger stratification existed during the warmer periods likely due to the increase in river discharge from the adjacent land regions and the enhanced summer sea ice melting. The enhanced stratification is also predominantly controlled by the eccentricity cycle during the MPWP. As a consequence, the freshened surface layer could have accelerated the sea ice melt by absorbing more heat. It implies that enhanced stratification and the upper layer freshening in the current warming scenario may lead to more sea ice melt in the Arctic Ocean.

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Abstract No : 1010

Variability and Trends of the South Pacific Subantarctic Mode Water Subduction and Relationship with Tropical Pacific Teleconnections

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The subantarctic mode water (SAMW) is a major water mass in the Southern Ocean formed by deep convection in winter, and it plays a fundamental role in the uptake of anthropogenic heat and carbon by the ocean. Using Simple Ocean Data Assimilation outputs, the evolution of the subduction of the South Pacific SAMW (SPSAMW) during 1980–2017 is examined. Results of our analysis show that the subduction rate of the SPSAMW has exhibited large interannual variability and an overall increasing trend since 1980. The subduction of the SPSAMW is mainly controlled by the lateral induction associated with the mixed layer depth (MLD), and it directly contributes to the variability of the SPSAMW's volume. The variabilities of the SPSAMW subduction reflect the changes in the overlying atmosphere. The changes in the wind field associated with the Amundsen Sea Low (ASL) lead to anomalies in the Ekman and air-sea turbulent heat fluxes, resulting in MLD anomalies and, in turn, subduction anomalies. The increasing trend of the SPSAMW subduction can be explained by the deepening of the MLD, which is forced by the strengthening westerly winds under the deepening ASL. Further analysis shows that the phase change of the Interdecadal Pacific Oscillation (IPO) can generate a Rossby wave train across the South Pacific and deepen the ASL, which suggests that the increase in SPSAMW subduction is associated with the phase change of the IPO.

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Abstract No : 210

Impact of Stratospheric Ozone hole recovery on 2019/20 Antarctic summer anomalous temperatures.

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The present study aims to establish the impact of Stratospheric Ozone hole recovery on 2019/20 Antarctic summer anomalous high temperatures observed all over the continent. Ozone hole recovery has substantially reduced Polar Westerlies to weaken thus enabling more transfer of energy from warmer mid-latitudes. Bharati station located in Eastern Antarctica has been recording high anomalous temperatures in the summer months(DJF). In the future, studying trends in the Columnar Ozone Concentration(DU) can help forecast summer temperatures/heatwaves.

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Abstract No : 176

Quantitative climate reconstruction in the Southern Ocean: Implications to Southern mid-latitude climate-Indian monsoon teleconnection

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A significant driver of global climate trends, the Southern Ocean climate variability across different time scales is both unique and crucial to the overall nature of the Earth's climate system. Particularly, the Southern Ocean can potentially influence the monsoon-dominated Indian climate in significant ways involving atmospheric and oceanic channels. However, high-resolution quantitative records of past climate change from the Southern Ocean, particularly from the Indian sector, are scarce. Here, a sediment core ABP-S4, collected from the subtropical front region in the Indian sector of the Southern Ocean, was used to reconstruct the first high-resolution quantitative climate (SST) record from this data-sparse region. The multi-centennial SST record spans distinct climatic regimes covering the late MIS-3, the last deglacial period, and a major portion of the Holocene interval (39.09–3.4 ka). The quantitative climate data provided by Mg/Ca paleothermometry is well-suited for model-proxy intercomparison and for investigating the southern hemispheric influence on the sub-orbital component of Indian monsoon variability. The SST record exhibits some prominent features: a cooling tendency between the early and mid-Holocene, a gradual Antarctic-type deglacial change with HSI warming and ACR cooling, and an anomalously warm MIS-3. The record is comparable to the LOVECLIM model's deglacial temperature simulation, sharing all the millennial-scale features and absolute values within one standard deviation of the reconstruction at site ABP-S4. Further, we observed both dynamic and thermodynamic coherence between the coring site's surface conditions and prominent structural elements of the Indian monsoon variability during the last glacial period.

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Abstract No : 163

Forcing factors and anomalous behaviour of South Asian Monsoon during Mid-Pleistocene Transition

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The agrarian economy of the South Asian countries depends on the South Asian Monsoon (SoAM). Thus, understanding the variability of SoAM, especially during periods of climate transitions is necessary. Mid Pleistocene Transition (MPT, 0.68 to 1.16 million years ago, Ma) is one of the recent fundamental climate transitions in the earth's history. During MPT the earth's climate cycle shifted from 41 kyr (thousand years) to quasi-100 kyr cyclicity. We present here the productivity and denitrification variability linked to SoAM during MPT. We find distinctive variability of SoAM during different phases of MPT. The denitrification decreases anomalously during the onset of 100 kyr cyclicity at 0.95 Ma. This might be due to enhanced oxygenation of seawater during prolonged glacial periods. The SoAM was strong during the interglacials and weak during the glacials of mid (0.95 Ma to 0.79 Ma) and late (0.79 Ma to 0.67 Ma) MPT. The SoAM was anomalously strong during some of the glacial periods of early-MPT (1.19 Ma to 0.95 Ma) which indicates a strengthened Northeast monsoon. We also studied the forcings of SoAM and find that SOAM predominantly varied in response to the dynamic effect of precession during early MPT. However, during the mid and late MPT, both the dynamic (precession, interhemispheric insolation gradient) and the thermodynamic (CO₂ variability) effects govern the SoAM.

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Abstract No : 186

Enhanced warming over Dronning Maud Land during the recent decades caused by coupled interactions between ENSO and SAM

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El Niño Southern Oscillation (ENSO) and their phase relation with Southern Annular Mode (SAM) largely control Antarctic climate variability. The relative roles of these climate modes remain elusive, particularly in the backdrop of global warming. We present an annually resolved new ice core record of oxygen isotope ($\delta^{18}\text{O}$) for the past two centuries (1809–2013 CE) from coastal Dronning Maud Land (DML) to investigate the role of these climate modes on the Antarctic temperature variability and trend. Our investigation combined with other available records from the DML region reveals that nearly 32% variability in $\delta^{18}\text{O}$ records is related to late spring to summer (Nov–Dec–Jan) temperature rather than the annual temperature. We reconstructed DML temperature record of the past two centuries (1809–2019 CE) based on $\delta^{18}\text{O}$ ice core record (1809–1993 CE), combined with the recent ERA5 surface air temperature record (1994–2019 CE). The reconstructed temperature anomaly record reveals a significant cooling trend in the 19th century during 1809–1907 CE with a rate of -0.164 ± 0.045 °C decade⁻¹ followed by a warming trend from 1942–2019 CE with a rate of 0.452 ± 0.056 °C decade⁻¹. This long-term warming trend since the 1940s coincides with an increase in ENSO events and its strong anti-phase relation with SAM, suggesting an increasing influence of SAM-ENSO coupling in modulating the DML temperature in recent decades.

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Abstract No : 871

Assessment of the relationships between the Solar irradiance (SI) on the Atmospheric Rivers (ARs) and associated precipitation over the Arctic Region.

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With the warming climate, the hydroclimatic extremes are being faced by all types of climate and various parts of the world. The occurrence of precipitation, the transport of the moisture and temperature through the Atmospheric Rivers (ARs) becomes more variable over space and time. ARs are the long, narrow paths, transporting huge amount of water vapour for a longer distance in the lower atmosphere from the tropical region to polar region horizontally, causing copious rainfall. Under warming climate increasing ARs affects the precipitation of the Arctic Region and the characteristics of the ARs are largely depends on the energy received from the sun's shortwave radiations, varies from region to region. For this the precipitation patterns of the Arctic region is affected by the solar irradiance (SI) and ARs. Hence, this study attempted to understand how the Arctic region's precipitation are being affected by the SI, and ARs from the tropical region to the polar region. In the present research to study the impact of the SI and ARs on the Antarctic Region, ERA5 from the European Centre for Medium-Range Weather Forecasts (ECMWF), the WRCF's monthly Global Energy and Water Exchanges (GEWEX) Surface Radiation Budget (SRB) obtained from the NASA, and the Climatic Research Unit dataset (CRU v4) monthly gridded precipitation data have used to calculate indices of hydroclimatic extremes, ARs, and SI. Subsequently, spatial correlation and multiple regression have used to study the effects of the SI and ARs on the occurrence of the precipitation in the Antarctic region.

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Abstract No : 276

What controls the stable isotope ratios of precipitation in coastal Antarctica?

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The coastal Dronning Maud land (DML) is characterized by numerous ice rises, having their own local ice-flow regime and thus offers suitable sites for ice coring to study the paleoclimate of coastal Antarctica. Two new ice cores from the summit of Djupranen and Leningradkollen ice rises from this region were retrieved as part of the Indo-Norwegian project MADICE and analysed for accumulation rate and stable isotope variability. To better understand the stable isotope variability, lagrangian moisture source diagnostic is used to study the seasonality of moisture sources for precipitation and compared with satellite-based sea ice distribution since 1980. The average annual accumulation rate is 0.32 m w.e. a^{-1} at the Djupranen (1726 – 2016 CE) and 0.24 m w.e. a^{-1} (1868 – 2016 CE) at the Leningradkollen ice rise. Both records show high variability in accumulation rates with a significant decreasing trend since the 1980s, concurrent with the positive shift in Southern Annular Mode. The stable water isotope records are, however, poorly correlated to surface temperature records. Moisture origin for precipitation at the ice rises has strong seasonal asymmetry related to the varying sea ice coverage. The reduced sea ice cover at source regions leads to more enriched isotope values, whereas increased sea ice cover results in longer transportation and, in turn, more depleted isotope values. Therefore, the seasonal and interannual variability of sea ice cover is the dominant factor controlling the variation in snow accumulation and their stable isotope composition at the studied coastal ice rises in DML.

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Abstract No : 429

Dramatic reduction in the Arctic Sea ice during the mid-Pliocene Warm Period caused by northward expansion of the Atlantic regime

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The Arctic sea ice has been undergoing dramatic decline in recent decades and projected to be summer sea ice-free Arctic in the near mid-century (IPCC AR6, 2021). Relative roles of atmospheric versus oceanic forcing and timing of ice free Arctic in future have been topic of a great debate in recent years. The computer based model simulations for Arctic Sea are associated with large uncertainty. Quantifying the contribution of poleward ocean heat transport to Arctic Ocean sea ice loss is imperative for improving such future climate predictions. In this study², we have reconstructed past water-mass exchange and sea ice extent records based on authigenic Nd isotope and IP25 proxy records respectively from the Fram-Strait (the major gateway between the Atlantic and the Arctic Oceans), during the mid-Piacenzian warm period (mPWP; 3.264–3.025 Ma), the most recent geological analogue for future climate change. Our semi-quantitative estimates of volume transport of North Atlantic warm waters into the Arctic Ocean suggests orbitally-forced changes, with near complete “Atlantification” of the Eurasian sector of the Arctic Ocean during the mPWP and consequential reduction in Arctic summer sea ice by ~30–35%². This study highlights the need for validation of current generation models against proxy data of Atlantification and provides critical input for improving the robustness of future climate modelling in the Arctic. References: 1. IPCC AR6, 2021. 2. Rahaman et al., 2020, EPSL

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Abstract No : 579

Effects of physical and biological oceanic processes in the geochemistry of deglacial sediments from the Kerguelen Plateau, southern Indian Ocean

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Elemental abundance and its associations in sedimentary records of the Kerguelen plateau (KP) can reveal the influence of island weathering on regional biogeochemistry. In this study, we are assessing the effects of regional oceanic processes in sediment column geochemistry at the Northern flank of KP. The principal component, regression, and factor analysis of the geochemical dataset of alternative sections of 104 cm long, (SOE-11-GC01) sediment successions (water depth of 3000m) collected during the Indian Scientific Expedition to Southern Ocean (ISESO-2011) are utilized for this study. All the (measured) six radiocarbon dates indicated the absence of modern sediments and the sediment successions belong to the deglacial period. The deep-reaching and fast-flowing ACC drives mesoscale eddies and meanders and strong current activity resulted in modern sediment winnowing or curtailing the modern sediment deposition or both. Factor one represents 53% of the total variance and is loaded with elements Al, K, Fe, Mn, Ti Cr, Co, Zn, Pb, and V. The stronger associations ($r > 0.8$, $n = 51$, $p < 0.0001$) of these elements further suggests its terrigenous origin mostly from KP. The average concentration of Mn is ~0.040 % and the strong association of Mn with Fe, Co suggests the oxic depositional environment of sediments, in the well-oxygenated ACC waters. Despite the island-sourced Fe-induced productivity, Fe and Corg are negatively correlated mostly due to oxidation of Corg. While, proxies of dissolved Fe and productivity ie Fe/Al and Ba/Al, are strongly associated due to the prevalence of natural iron fertilization during the deglacial period.

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Abstract No : 439

Relationship between Azores High and Indian summer monsoon

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The interannual variation of Indian summer monsoon (ISM) not only affects millions of people in India, but also the global weather and climate. The teleconnections of this variation are not stable. A dominant mode of the recent four decades ISM rainfall shows west-east dipole pattern with above normal rainfall towards west and central India and subdued rainfall towards the east and northeast India, and is related to the vigorous Azores High. The vigorous Azores High is accompanied by enhanced subsidence resulting in well-built widespread upper-troposphere convergence. This forms the meridional vorticity dipole consisting of anomalous cyclonic and anti-cyclonic circulation at 30°N and 50°N, respectively. The meridional vorticity dipole increases the Asian jet at its entrance. In addition, the widespread North Atlantic convergence boosts the Rossby wave source. The cascading down Rossby wave train imposes successive negative, positive and negative Geopotential height (GPH) anomalies over north Mediterranean, northwest of India and northeast of India, respectively. The negative GPH anomaly at the north Mediterranean further increases the Asian jet towards the Caspian Sea. The increased Asian jet strengthens the monsoon circulation through the 'silk-road' pattern. While, the dipole GPH anomalies north of India shift the core of the Tibetan High westward triggering monsoon activity towards the west and central India and subdued monsoon over east and northeast India, forming an anomalous west-east dipole rainfall pattern and vice-versa. Future work should examine the extent to which these teleconnections are represented in the climate forecast models to aid the seasonal prediction of ISM.

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Abstract No : 88

A record of volcanic eruptions over the past 2200 years from Vostok firn cores, central East Antarctica

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Volcanic activity is one of the major Earth's climatic forcings. The records of the volcanic eruptions are available from historic and natural archives. Ice cores drilled in polar ice sheets are an important source of information on the past volcanic activity due to the fact that the products of the eruptions (soluble and insoluble aerosols) are deposited on the glacier surface. Here we present a new detailed record of the volcanic events based on 3 shallow (down to 70 m depth) firn cores drilled in the vicinity of central Antarctic Vostok station. Along all the cores electrical conductivity measurements (ECM) have been performed, and in one core the analysis of the major ions content has been also completed. The ECM records demonstrate spikes that correspond to an increased concentration of the chemical content and are usually attributed to the layers containing the products of volcanic eruptions, which is confirmed by the non sea salt SO₄ concentration. In total we were able to identify 33 volcanic peaks that are found in all ECM records and in the nss-SO₄ profile. The oldest peak is dated by 168 BCE. Most of the peaks can be associated with the known and well-dated volcanic events. However some of the peaks are unidentified and may be related to the volcanic events not previously found in Antarctic cores. This new record of the volcanic eruptions was used for the absolute dating of the studied firn cores. This study was funded by Russian Science Foundation grant 21-17-00146.

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Abstract No : 713

Deep water mass Circulation changes in the Indian Sector of Southern Ocean during the last glacial cycle

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The deep water circulation (DWC) in the Southern Ocean plays important role in distributing heat, carbon, and nutrients to global oceans and thus modulating global climate. Previous studies indicate that any changes in the production and export of deep water masses (North Atlantic Deep Water and Antarctic Bottom Water) to the Southern Ocean result in glacial-interglacial climate variability. The Indian sector of the Southern Ocean is an ideal location for reconstructing the past circulation as it does not have any deep water formation but only acts as a host for the global overturning circulation. However, there is no suitable record of the past deep circulation from this oceanic sector which limits our present understanding about the past climate-ocean circulation relationship and their feedback mechanism. In this study, we reconstructed a high resolution record of the DWC in this region for the last glacial cycle based on the authigenic Neodymium isotopes (ϵNd) which show significant changes during the glacial-interglacial periods. These changes in the authigenic Nd record indicate changes in the water mass sourcing during glacial-interglacial periods; more radiogenic ϵNd values during the glacial periods indicating a dominant Pacific source whereas less radiogenic interglacial values indicate more contribution from the Atlantic. These changes in deep water circulation in the Indian sector of Southern Ocean has significant implications for global atmospheric CO_2 variability and past climate change.

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Abstract No : 833

Sea Surface Temperatures in the Indian sector of the Southern Ocean over the last 26 kyrs

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The variability of Southern Ocean (SO) sea-surface temperature (SST) over the deglacial and Holocene periods is poorly constrained, particularly from the Indian sector, because most of the available high-resolution records are from the Atlantic and Pacific sectors. We present a high-resolution SST reconstruction for the past 26 kyrs from the west of the Kerguelen Islands. The SST data were reconstructed using the Modern Analog Technique – transfer function on diatom assemblages preserved in sediment core MD12-3394 (48°22'54"S – 64°35'17"E; 2310 m water depth). The reconstructed SST data demonstrate a glacial-interglacial pattern, with average SSTs 2–3°C lower during the last glacial period (26–18 ka) than during the Holocene (11.7–1.8 ka) and deglacial (18–11.7 ka) periods. The SST demonstrates progressive warming with considerable millennial-scale variability during the deglacial period. The early Holocene average SST was 2°C higher than the mid-Holocene and late-Holocene average SSTs within the Holocene. Millennial-scale variability is however larger in the early and mid-Holocene SST records than in the late Holocene SST record. Our results show that the colder SST during the last glacial period may have been caused by northward frontal migrations during the glacial period, as previously suggested. However, warmer SSTs during the deglacial and early Holocene periods correspond to northern hemisphere insolation and atmospheric CO₂ concentrations. Therefore, we hypothesize that a combination of insolation, CO₂, and ocean-cryosphere interactions caused not just warmer interglacial(s) beyond the Holocene, but also deglacial and early Holocene warming in the Indian sector of SO.

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Abstract No : 96

Arctic–Monsoon Teleconnection during late Pliocene – a modern–like warm period

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Due to global warming, the Arctic sea ice extent (SIE) is declining at an alarming rate with observations exceeding the model projections. A few short time-series studies have noted that this reduction in the Arctic SIE can influence the monsoon through atmospheric pathways. But such studies span only a few decades and hence are uncertain. Late Pliocene including the Mid Piacenzian Warm Period (MPWP, around 3 million years ago) is considered the nearest analog to the modern climate with similar CO₂ concentration. Considering its relevance to understanding the effect of current global warming, many earlier studies have stressed reconstructing monsoon intensity variations during the late Pliocene and MPWP. We have reconstructed the South Asian monsoon variability during the late Pliocene using geochemical proxies in sediment collected during IODP Expedition 355 from the eastern Arabian Sea. We find two distinct intervals of monsoon intensification during the MPWP and at 2.9 Ma. The South Asian monsoon is governed by various dynamical and thermodynamical effects including Arctic SIE variability. We find that lower (higher) Arctic SIE leads to a stronger (weaker) South Asian monsoon. Our study helps to understand how the South Asian monsoon may behave in the present scenario of global warming and how the Arctic SIE may influence it.

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Abstract No : 128

Tropical Indian Ocean contribution to the last deglaciation

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A periodic gradual cooling followed by a relatively abrupt warming termed as termination, is the key feature of Quaternary climate. The precise mechanism especially the factors triggering terminations, are still debated. Although, the atmospheric carbon dioxide (CO₂) sourced mainly from the Southern Ocean is often suggested as the major driver of deglacial warming, the lead-lag relationship between warming and CO₂ during the beginning of termination as well as its sources, are uncertain. Here, we reconstruct the sea surface temperature (SST), runoff (from foraminiferal Mg/Ca, Ba/Ca and stable oxygen isotopic ratio) and upwelling intensity record (relative abundance of *Globigerina bulloides*) of the last deglaciation (8–24 kyr) from a marine core (SSD004 GC03) collected from the upwelling affected southeastern Arabian Sea. We report that a distinct warming phase (1.4°C) preceded the deglacial warming in the tropical Indian Ocean. A synchronous abrupt increase in *G. bulloides* relative abundance suggests intense upwelling during this initial phase of deglacial warming. This initial phase of deglacial tropical warming is synchronous with the local summer insolation rise, regional CO₂ outgassing and reorganization of Atlantic Meridional Overturning Circulation (AMOC). We propose that the early tropical warming was the precursor for the weakening and collapse of AMOC and subsequent global glacial termination. The first major phase of deglacial increase in atmospheric CO₂, however, warmed the northern Indian Ocean, very rapidly.

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Abstract No : 729

Long-Term Warming in the Brazil-Malvinas Confluence

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The Brazil-Malvinas Confluence region has been experiencing one of the highest warming rates in the world's oceans since the mid-20th century. This study investigates changes in the BMC local dynamics and its relationship with climate drivers to understand the warming trend in the region. Long-term variability is investigated using 160 years of reconstructed sea surface temperature (SST) and the Southern Annular Mode (SAM) index. Singular value decomposition analysis identifies the first mode as the El Niño (58%) pattern and the second mode as the SAM (18%). The second mode evidence positive anomalies mainly in the southwest Atlantic and western Pacific, and the principal component is correlated to the SAM in 0.6. Composites of years of positive (negative) SAM also evidence warming (cooling) in the BMC region and on the east coast of Australia, suggesting that changes in the SAM are a potential driver of the warming trend.

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Abstract No : 145

SIWHA – a project for exploring the role of sea ice and westerly winds on the ocean–atmosphere exchange of CO₂ in coastal Antarctica during the Holocene

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Westerly winds and sea ice around Antarctica have a critical role on the global climate system through its influence on Southern Ocean circulation, upwelling and oceanic carbon exchange. Considering the limited data, annually resolved ice cores from coastal Antarctica provide the only means for a better understanding the long-term link between westerly winds, sea ice and atmospheric CO₂. Recent studies have revealed that the coastal Dronning Maud Land (DML) in East Antarctica is an ideal region for reconstructing the past sea ice conditions and westerly winds in the Atlantic and Indian sector of Southern Ocean. Against this background, a collaborative project entitled SIWHA (Sea Ice and Westerly winds during the Holocene in coastal Antarctica) has been initiated between India, UK and Norway to retrieve about 500 m ice core from a suitable ice rise from coastal DML. The SIWHA project offers a unique and first ever opportunity for a continuous reconstruction of westerly winds, sea ice, and atmospheric CO₂ from a single archive from Antarctica for the full Holocene. During 2021-22, geophysical surveys were undertaken over two ice rises (Kamelryggen and Kupol Verbljud) for finalizing the ice core drilling location (see more details in a separate presentation). The preliminary results support the potential of both ice rise summits to retrieve a climate history for the entire Holocene, with Kamelryggen as the leading site. The drilling would be undertaken during 2022-23 and 2023-24 field seasons.

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Abstract No : 89

Recent increase of the snow accumulation rate in central Antarctica is unprecedented in the last 2000 years

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The reaction of the polar ice sheets on the present and future climate changes is one of the most important issues due to the direct influence of the ice mass on the global sea level. Climate models predict an increase of the Antarctic surface mass balance (SMB) with atmospheric warming that will partly slow down the sea level rise, although experimental evidence of the SMB sensitivity to air temperature is limited. An important source of such evidence is paleoclimatic data from ice cores. In this work we present the snow accumulation rate records obtained from 3 firn cores drilled in the vicinity of Vostok station in central Antarctica. The cores were robustly dated based on the known volcanic events found in the profiles of non sea salt SO₄ concentration and electrical conductivity. The newly obtained SMB time-series spans the last 2200 years and demonstrates a slight decrease of the snow accumulation rate until early XIX century with the average of 18 mm w.e. per year. Since the early 1800s the SMB is increasing with the average for the last 200 years equal to 20 mm w.e. per year. The last 50 years are characterized by even stronger SMB increase to about 23 mm w.e. per year, which is confirmed by the instrumentally observed SMB at the accumulation-stake farm. The SMB record obtained in this study was used to deduce the accumulation rate – air temperature relationship for central Antarctica. This study was funded by Russian Science Foundation grant 21-17-00146.

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Abstract No : 578

A data-model intercomparison study of SST in the Southeastern Arabian Sea since the Last Glacial Period

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The Eastern Arabian Sea being a landlocked basin results in complex hydrography. The basin experiences strong monsoon-induced circulation changes during summer and winter. SST also shows a huge variability due to moderate upwelling during monsoon season. The annual average variability of the SST in the Arabian Sea is ~4 degrees Celsius. Historically, paleoceanographic time series reconstructions of the South Asian monsoon have taken advantage of signals associated with summer monsoon-induced upwelling in the western Arabian Sea, such as the percentage and/or isotopic composition of specific planktic foraminifera within the upwelling regions (Prell, 1984; Naidu and Malmgren, 1995; Overpeck et al., 1996; Anderson et al., 2002; Tiwari et al., 2010 and references therein). In contrast, the eastern Arabian Sea received little attention. These studies explained penultimate interglacial and last glacial SST variability. The southeastern Arabian Sea (SEAS) in particular is relatively less studied for water column temperature reconstruction. Thus, there is a huge scope for geochemical proxies like Mg/Ca to be used for quantifying water column temperature reconstruction in this under-sampled basin. A sediment core was recovered during SK-274 cruise from SEAS near the Southern tip of India where extensive cross basin exchange of waters takes place. The core spans from ~6 to 40 thousand years Before Present (kyrs BP), We have reconstructed past temperature variability using Mg/Ca of planktic foraminifera *Globigerinoides ruber*. During the last glacial, MIS 3 was relatively warmer than MIS 2 by ~4°C. Thereafter, the SST declined during the colder MIS 2 to an average of around 24 °C. During deglaciation, the SST increased by 4 °C till mid-Holocene. We have also used an intermediate complexity model (LOVECLIM) to extract SST data for our study region for data-model intercomparison. We find that the proxy-based SST reconstruction matches very well with the model data. Various processes governing this SST variability will be discussed.

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Abstract No : 340

Nonstationary Teleconnection Between the Pacific Ocean and Arctic Sea Ice

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Over the last 40 years observations show a teleconnection between summertime Pacific Ocean sea surface temperatures and September Arctic sea ice extent. However, the short satellite observation record has made it difficult to further examine this relationship. Here, we use 30 fully coupled general circulation models (GCMs) participating in Phase 5 of the Coupled Model Intercomparison Project to assess the ability of GCMs to simulate this teleconnection and analyze its stationarity over longer timescales. GCMs can temporarily simulate the teleconnection in continuous 40-year segments but not over longer, centennial timescales. Each GCM exhibits considerable teleconnection variability on multidecadal timescales. Further analysis shows that the teleconnection depends on an equally nonstationary atmospheric bridge from the subequatorial Pacific Ocean to the upper Arctic troposphere. These findings indicate that the modulation of Arctic sea ice loss by subequatorial Pacific Ocean variability is not fixed in time, undermining the assumption of teleconnection stationarity as defined by the satellite record.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

PHYSICAL SCIENCES

**Polar climate variability,
teleconnections, and global monsoon;
past, present, and future**

CONVENORS

Suchithra Sundaram, Deepa Ravindran Pillai,
Sourav Chatterjee

Accepted as: Oral Presentation

Abstract No : 913

Observed decreases in surface snow accumulation rate in inland East Antarctica from ~2005 to 2020 linked to the enhanced meridional circulation

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Based on the field observations, spatiotemporal variability in the surface snow accumulation rate from 2005 to 2020 along a traverse from the coast to the summit of the Antarctic ice sheet, Dome A (~1250 km), was investigated. The results show that the snow accumulation rate decreased significantly in interior Antarctica (from ~600 km from the coast to Dome A) ($p < 0.01$), with an average declining trend of $2.03 \text{ kg m}^{-2} \text{ a}^{-1}$ per year, while the snow accumulation rate in the coastal ~600 km shows no clear trend during this period. The decreasing trend in inland Antarctica may be associated with the enhanced near-surface wind speed and, consequently, the stronger sublimation of surface snow. The changes in near-surface wind speed are likely linked to the positive trend in geopotential height over the subantarctic Indian Ocean, which leads to poleward movement of the polar jet and an enhanced polar vortex.

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Abstract No : 807

Coastally generated near-inertial currents in an Arctic fjord, Kongsfjorden

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Wind stress changes typically excite near-inertial oscillations near the surface layer of the ocean. In shallow coastal regions, these near-inertial motions can interact with the continental shelf and induce oscillating upwelling and downwelling motions. The resulting readjustment of upward and downward moving isopycnals can then excite offshore propagating waves at near-inertial frequencies (CNIWs). An upward-looking ADCP sensor mounted at the bottom of the IndARC mooring within an Arctic fjord, Kongsfjorden shows the occurrence of CNIWs during storm events. The observed currents filtered around the near-inertial frequency initially show a distinct mode-1 structure followed by higher modes in the form of downward propagating waves. The aforementioned mode-1 structure of the near-inertial currents is associated with a strong shear layer near the bottom of the mixed layer, whose depth varies with the season. Three-dimensional high-resolution numerical simulations are performed to understand the physical mechanisms in detail, and further investigate the role of semi-diurnal barotropic tides, whose frequency is nearly identical to the local inertial frequency (latitude=78.95).

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Abstract No : 399

Response of Indian Ocean sector of Antarctic sea ice to the ENSO and SAM

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Satellite and Reanalysis observations over the past four decades (1979–2019) have been used to study the ice-ocean-atmosphere dynamics in the Indian Ocean Sector (IOS) of Antarctica. The study revealed that the annual sea ice extent (SIE) in the IOS increases at a rate of $0.7 \pm 0.9\%$ decade⁻¹, with a maximum increase in austral summer ($5.9 \pm 3.7\%$ decade⁻¹). The influence of El Niño/Southern Oscillation (ENSO) and southern annular mode (SAM) over the IOS sea ice was investigated using the Wavelet approach. Our results demonstrate that the SIE has a significant association with both indices during the summer and autumn. In comparison to ENSO, the sea ice variability associated with SAM is typically seasonal in nature and lacks distinct patterns. The wavelet coherence analysis showed a relatively weak relationship between ENSO and SAM but a highly significant coherence between climatic indices and SIE. We observed that sea ice in the IOS is influenced significantly by climatic oscillations during their negative SAM/El Niño or positive SAM/La Niña phases. This implies that the climatic disturbances demonstrated a substantial impact on the sea ice variability in the IOS.

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Abstract No : 576

The trend of Meteorological Parameters: Maitri Climatology of the last 30 years

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Research in Polar meteorology is growing as it is recognized as an essential part of the earth system for understanding climate change. Understanding the behavior of the Antarctic climate system is crucial as it has important linkages within the context of present-day global environmental changes. India Meteorological Department taking long-term observations in Indian Scientific Expeditions to Antarctica since the very first expedition during 1981-1982. In this paper, we have examined measured meteorological parameters collected at Maitri station for the period 1989 to 2019. The long-term analysis of temperature, surface winds, and mean sea level pressure has been analyzed. The Maitri station showed a cooling of 0.04 °C per year between 1989 and 2019, with similar pronounced seasonal trends. The long-term trend of blizzards was also discussed from 1989 to 2019. Variation of monthly wind speed during the period 1989-2019 is depicted, as the slight decreasing trend of 0.006 hpa per year was observed during 1989-2019 at Maitri station. In this study, we also investigate the correlation of monthly averaged wind speed and temperature with the Southern annular mode Index. In 2011, India also established another permanent station in Antarctica named Bharati, where India's meteorological department has a permanent observatory and collects data on meteorological parameters, Ozone, and solar radiation to understand the Antarctic atmospheric turbidity and dynamics.

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Abstract No : 268

Projected impacts of Antarctic meltwater anomalies over the 21st Century

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Antarctic margin and Southern Ocean surface freshening has been observed in recent decades and is projected to continue over the 21st Century. Surface freshening due to precipitation and sea ice changes are represented in coupled climate models, however Antarctic ice sheet/shelf meltwater contributions are not. As Antarctic melting is projected to accelerate over the 21st Century this constitutes a fundamental challenge in projecting high-latitude climate. Southern Ocean surface freshening has been shown to cause a surface cooling by reducing both ocean convection and the entrainment of warm subsurface waters to the surface. Over the 21st Century Antarctic meltwater is expected to alter the pattern of projected surface warming as well as having other climatic effects. However, there remains considerable uncertainty in projected Antarctic meltwater amounts, and previous findings could be model-dependent. As such, investigating the sensitivity of climate model response to meltwater perturbations is required. Here, we use the ACCESS-ESM1.5 coupled model to investigate global climate responses to low and high Antarctic meltwater additions over the 21st Century. Our high meltwater simulations produce anomalous surface cooling, increased Antarctic sea ice, subsurface warming and hemispheric differences in precipitation. Our low meltwater simulations suggest that the magnitude of surface temperature and Antarctic sea ice responses are strongly dependent on the applied meltwater amount. Together, these highlight the importance of constraining projections of Antarctic ice sheet/shelf melt to better project global surface climate changes over the 21st Century.

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Abstract No : 924

Quantifying CMIP6 Epistemic Uncertainty in AOT projections over Antarctica

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Antarctica directly influences the lives of more than half of the world's population living in the coastal regions. Therefore, it is highly needed to better understand the past and to project its climate for the future as well. Since climate models are the only tools for giving a synoptic perspective of climate projections and predicting future climate over this pristine region, quantifying the uncertainty in models may answer various questions about the robustness of the projections. In this study, we obtained Ambient Aerosol Optical Thickness at 550nm (od550aer) from CMIP6 database for the period 1985–2100. We also used MERRA2 reanalysis of AOT at 550 nm for the period 1985–2014 in order to compare and quantify the uncertainty that existed in CMIP6. The epistemic uncertainty and signal-to-noise ratio (SNR), as well as mean changes in AOT, are majorly addressed in this study. Over the 20-year time period, the highest mean change of 0.019 was observed during autumn (March–May) where-as the lowest, 0.003, was noted in spring. High SNR of 28.3 was obtained for the winter while low SNR of 8.971 was obtained for spring. The epistemic uncertainty is quantified using Shared Socioeconomic Pathway (SSP) 585 scenario, and it is evident that it increases over time. The East Antarctica region shows the highest epistemic uncertainty of 0.0302, 0.0439, 0.0379, and 0.0422 for summer, autumn, winter, and spring respectively. The corresponding values for the West Antarctica region were 0.0029, 0.0030, 0.0041 and 0.0032 respectively, and showed the lowest during the study period.

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Abstract No : 549

Relationship between Annular Modes and regional aspects of Summer Monsoon rainfall over India: An observational study

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The dominant mode of variability in summer monsoon rainfall reveals that rainfall over Northeast (NE) India is out-of-phase with rainfall over other parts of India. This study evaluates potential role of annular modes in deciphering contrasting signatures of rainfall over the Indian region in recent decades. Positive (negative) Southern Annular Mode (SAM) during February–March is favorable (unfavorable) for ensuing summer monsoon rainfall over major parts of India, excluding the NE Indian region. When a negative (positive) phase of SAM occurs, it gives rise to anomalous meridional circulation in a longitudinally locked air–sea coupled system over the central Pacific that persists up to the subsequent boreal summer and propagates from sub-polar latitudes to equatorial latitudes inducing a warming (cooling) effect over the central equatorial Pacific region. In turn, this effect concomitantly weakens (strengthens) monsoon rainfall over the Indian mainland. Eurasian snow is observed to be modulating the North East-Indian Summer Monsoon Rainfall (NEISMR) with a lead time of almost 6 months. This link is manifested by changes in high-latitude atmospheric winter snow variability over Eurasia associated with Northern Annular Mode (NAM). Excessive wintertime Eurasian snow leads to anomalous cooling of overlying atmosphere and is associated with negative mode of NAM, inducing a meridional wave-train descending over the tropical north Atlantic and is associated with cooling of this region. Once the cold anomalies are established over the tropical Atlantic, it persists up to the following summer leading to anomalous zonal wave-train further inducing descending branch over NE-India resulting in weak summer monsoon rainfall.

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Abstract No : 228

The internal origin of the west-east asymmetry of Antarctic climate change

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Recent Antarctic surface climate change has been characterized by greater warming trends in West Antarctica than in East Antarctica. Although this asymmetric feature is well recognized, its origin remains poorly understood. Here, by analyzing observation data and multimodel results, we show that a west-east asymmetric internal mode amplified in austral winter originates from the harmony of the atmosphere-ocean coupled feedback off West Antarctica and the Antarctic terrain. The warmer ocean temperature over the West Antarctic sector has positive feedback, with an anomalous upper-tropospheric anticyclonic circulation response centered over West Antarctica, in which the strength of the feedback is controlled by the Antarctic topographic layout and the annual cycle. The current west-east asymmetry of Antarctic surface climate change is undoubtedly of natural origin because no external factors (e.g., orbital or anthropogenic factors) contribute to the asymmetric mode.

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Abstract No : 298

The atmospheric response to the Weddell Sea Polynya and the importance of model resolution.

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The Weddell Sea Polynya is a large opening within the sea ice cover of the Weddell sea sector, typically found sitting over the Maud Rise in its largest occurrences. It has been a rare event in the satellite period, appearing throughout the 1970s and again in 2016/17. Many mechanisms have been suggested to cause the onset of the Weddell Sea Polynya, from deep convection of the ocean and upwelling at the Maud Rise, in addition to increased cyclone activity and the influence of atmospheric rivers. It is thought that with increasing atmospheric greenhouse gasses, the Weddell Sea Polynya will be even less frequent, due to an intensification of the haline stratification within the polynya region. The opening of the polynya creates an ocean to air heat flux in the cooler months, with the potential to influence atmospheric dynamics. The atmospheric response to the polynya and regional ice loss may be observed locally within the low-pressure region of the Weddell Sea, or further afield climate. Here, we use high and low resolution AGCM experiments with the HadGEM3 UK Met Office model, ECHAM5 and OpenIFS, alongside PRIMAVERA high-resolution analysis of the polynya, to evaluate the atmospheric response to the polynya and associated features, in addition to the role of model resolution in resolving the polynya and its associated features.

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Abstract No : 9

Climate variability as a major forcing of recent Antarctic ice-mass change

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Multiple datasets show the Antarctic Ice Sheet has overall lost mass over recent decades, and hence contributed to sea-level change. The forcing of the multi-decadal mass trend is not well understood, while its shorter-period variability has been partly associated with El Niño Southern Oscillation (ENSO) both for the grounded ice sheet and its bounding ice shelves, but the connection with the dominant climate mode, the Southern Annular Mode (SAM), is not clear. Here we show that space gravimetric (GRACE) estimates of non-linear ice-mass change over 2002–2021 may be largely explained by a simple linear relation with both SAM and ENSO. We decompose the detrended GRACE time series using empirical orthogonal functions and show that the principal components are dominated by decadal variability that correlate closely with detrended, time-integrated SAM and ENSO indices. Multiple linear regression reveals that SAM and/or ENSO explain most of the inter-decadal variability from the whole ice sheet down to individual drainage basins, while 43% of the net whole-of-ice-sheet change (2002–2021) can be ascribed to persistent SAM forcing. Understanding the forcings of SAM variability over the GRACE period, which is largely anthropogenic over multi-decadal timescales, may be a pathway to partially attributing ice-sheet change to human activity. Assuming the relationship to SAM and ENSO hold over other timescales, accurate projection of the future of the ice sheet will require climate forcing which accurately represents the evolution of SAM and, for very near-term projections, ENSO.

Accepted as: Oral Presentation

Abstract No : 402

Spatio-temporal variations and trends of Antarctic sea ice from 1979 to 2020

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Climate scientists have long been interested in Antarctic sea ice due to major and atypical changes over the past few decades. Using passive-microwave satellite data (1979–2020), we analysed Southern Ocean sea ice extent (SIE) on monthly, interannual, decadal, and seasonal timescales. Long-term seasonal and annual SIE trends in Antarctica are observed to be positive, with autumn having the highest seasonal trend magnitude at $9060 \pm 7700 \times 10^3 \text{ km}^2 \text{ yr}^{-1}$ and spring having the lowest ($500 \pm 7100 \times 10^3 \text{ km}^2 \text{ yr}^{-1}$). The maximum positive SIE trend observed between 1979 and 2014 ($22400 \pm 4300 \times 10^3 \text{ km}^2 \text{ yr}^{-1}$) has decreased dramatically by an estimated 70% for 42 years trend ($6800 \pm 5200 \times 10^3 \text{ km}^2 \text{ yr}^{-1}$). The last four decades have shown marginal cooling trends in sea surface temperature (SST) and a positive trend in 2 m air temperature (AT) over the Southern Ocean, while the annual SIC anomaly has shown an overall positive trend. The AT anomaly indicates cooling in the Southern Ocean, but an increase in the Indian Ocean and Ross Sea. SIC and SST exhibit a minor negative anomaly trend in the summer, while AT is nearly constant. After 2015, the autumn AT anomaly intensified and was linked to the negative SIC anomaly. In winter, the SIC spatial anomaly is positive and highest in the Western Pacific Ocean, and Bellingshausen and Amundsen Sea sectors. In spring, the positive AT anomaly can be attributed to a substantial positive trend in recent decades. The study revealed that 2015–2018 sea ice loss is linked to thermodynamic and atmospheric factors.

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Abstract No : 401

Rapid sea ice changes and variability in the Weddell Sea

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The Weddell Sea sector is unique amongst all other sectors in Antarctica. The seasonality of sea ice in the Weddell Sea is largely associated with ocean-atmospheric forcings and climate fluctuations. The study analysed long-term sea ice variability and trends (1979–2019) based on satellite and reanalysis measurements. The result shows the expansion of yearly SIE is $2.5 \pm 3.5 \times 10^3 \text{ km}^2 \text{ yr}^{-1}$ with a significant increase in the austral summer ($12.4 \pm 4.6 \times 10^3 \text{ km}^2 \text{ yr}^{-1}$), whereas a decrease in the spring SIE ($-4.8 \pm 5.0 \times 10^3 \text{ km}^2 \text{ yr}^{-1}$) over the last four decades. The study highlighted the role of latitudinal thermal differences and westerlies intensification over the sea-ice concentration (SIC) variations. The significant positive SIC trends were recorded in the western and eastern parts of the Weddell Sea during the austral summer and autumn, respectively. During the austral winter and spring, significant negative SIC trends (north of 65°S) were recorded due to the easterlies intensification and weakening of the Weddell Gyre. While the significant positive trends observed along the coast are linked with the easterlies intensification and sea-ice advection. Our analysis shows that the SIC variability during austral summer and spring is influenced by the sea surface temperature (SST), whereas during the austral winter and autumn SIC is regulated by both SST and net heat flux. Further, the positive Southern Annular Mode is associated with an increase in sea ice during austral summer, while sea-ice decreases during the winter in the Weddell Sea.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

PHYSICAL SCIENCES

**Southern Ocean circulation:
change and consequences**

CONVENORS

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N. Anil Kumar

Accepted as: E-poster Presentation

Abstract No : 1037

Experimental measurements of physicochemical parameters of ocean water in the region of the Bulgarian Antarctic base during the astral season 2019–2020

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This work presents a research project that began in November 2019 during the 28th Bulgarian Antarctic Expedition, organized by the National Center for Polar Research. The main goal of the launched research project is to obtain comprehensive data on the hydro environment, which will be the subject of future research in the subsequent expeditions after delivering the necessary equipment and tools. Preliminary results from the analysis of the first measurements of ocean temperature, salinity and conductivity are presented. Selecting the equipment, measuring locations after the initial survey of the coastal zone, and the performance of the measurements themselves near the coast and in the bay up to about one nautical mile are briefly described. Initial salinity and temperature measurements were performed in selected areas in the ocean water with floating ice pieces. The physicochemical parameters are determined for the surface ocean layer, and at a depth of 8 m. Small variations in the conductivity values were found, which is explained by intensive ice drift and wind influence. The processed results confirm the assumptions of lower salinity values for the coastal zone compared to the more open part of the bay and the relative stability of the stratification regarding the salt content for the water layers. The measured temperature of ocean water for the studied period varies from 6.30C for the surface layer to 0.70C for a depth of 8 m. The next stage of seawater research involves taking measurements in remote areas at depth and taking samples from ocean water.

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Abstract No : 893

Current observations in the Ross Sea

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The Ross Sea is a crucial region of the Earth's Climate. Approximately 25% of Antarctic Bottom Water (AABW) originates from the Dense Shelf Water (DSW) produced on its continental shelf. Changes in AABW properties and formation rate propagate into the global ocean and affect stratification, sea level, heat content, and the carbon cycle. Understanding the long-term variability of the Ross Sea DSW physical properties and its controlling factors is critical to assessing the AABW variability. The Italian Marine Observatory in the Ross Sea (MORSea) project, funded by the Italian National Program of Research in Antarctica (PNRA), has a network of moorings in crucial areas of the Ross Sea, collecting multi-decadal physical observations, Since 1995. Many studies have analyzed the DSW properties changes of the Ross Sea, but few have focused on continental shelf circulation. Here using mooring and LADCP data we present a study on the Ross Sea circulation and its role in the dense water formation. In particular, we analyzed the circulation in Terra Nova Bay where the saltiest AABW precursor is formed and then compared the current-meter time-series of the mooring situated in the polynya with the other MORSea moorings located close to the shelf break in the western and central Ross Sea. Recent studies have suggested that the tides are the dominant source of currents in the Ross Sea, and have a central role in shaping the AABW outflow, therefore we have performed and compared spectral and tidal analyses of the current measurements registered on those moorings.

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Abstract No : 362

Analysis spatiotemporal correlation in the eddies at the Brazil–Malvinas Confluence: A comparison between observations ocean numerical model

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The ocean frontal systems are mixing regions of water masses, due to the high energy of these areas. The Brazil–Malvinas Confluence (BMC) is considered one of the regions with the highest values of Turbulent Kinetic Energy (TKE) in the global oceans. In this manuscript we showed the hydrodynamic signatures of BMC during the Antarctic Operation 38 (OP38) cruise. The hydrodynamic patterns data was collected in situ and modeled by the Global Ocean Analysis Forecast System (GOAFS), were analyzed in order to characterize the high frequency variability of ocean properties in BMC and 2 eddies borne from this region. First, we used the in-situ data to evaluate the performance of Copernicus model in representing the mesoscale structures. The results show that, despite the delay in the position of the eddies, the model can reproduce the general circulation patterns with values close to observed in the field. The smallest cross-vertical correlations are observed in the salinity data, with a greater deepening of the warm vortex structure and lower salinity values at the coldest edge. On the BMC, the ocean modeled variables are close to those observed in situ data, but the thermal gradient is restricted to the frontal region, with variations of 14°C in about 70km of section. For the Sea Level Anomaly (SLA) values, the compatibility with the observed data occurred with biases less than 0.2 m on the BMC and eddies. We calculated the mean barotropic change in sea height (SSH) through mass balance and conservation of potential vorticity.

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Abstract No : 331

Study of the fresh-water inflow through the eastern gate on the Ross Sea

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The production of Antarctic Bottom Water (AABW) plays a major role in determining the strength of the Meridional Overturning Circulation and, therefore, is an important element in the ocean's contribution to global climate. AABW is formed especially in the Ross and Weddell Seas, with distinct thermohaline characteristics. Observations within the Southern Ocean's Pacific sector indicate a decadal trend of reduced salinity of the shelf waters which are related to the AABW modification. In the Ross Sea changes in the thermohaline characteristics of the shelf waters, precursors of the AABW, have been observed since 1995. Despite the negative salinity trend, a rebound in salinity has been observed for the last 5 years. The Ross Sea freshening was attributed to the inflow of waters from West Antarctica where a dramatic melting of glaciers is occurring. To determine the freshwater inflow from West Antarctica and the role of these waters in the salinity field variability, an oceanographic cruise was carried out during austral summer 2020 and 2021 in the eastern sector of the Ross Sea. Using physical data from the CTD and LADCP casts, glider deployment and drifters, we estimated water mass characteristics and dynamical features. Eventually, discrete sea water sampling for chemical analyses (nutrients, carbonate system, trace metals, persistent organic compounds) has been carried out to provide new information about the biogeochemistry of the area and origin of the water masses.

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Abstract No : 774

Heat transport across the Antarctic Slope Front

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The Antarctic Slope Front (ASF) is a strong gradient in water mass properties close to the Antarctic margins. Heat transport across the ASF is important to Earth's climate, as it influences melting of ice shelves, the formation of bottom water, and thus the global meridional overturning circulation. Previous studies based on relatively low-resolution models have reported contradictory findings regarding the impact of additional meltwater on onshore heat transport onto the Antarctic continental shelf: it remains unclear whether meltwater enhances shoreward heat transport, leading to a positive feedback, or further isolates the continental shelf from the open ocean. In this study, heat transport across the ASF in three distinct regimes (fresh-shelf, dense-shelf, and warm-shelf) is investigated using high-resolution, process-oriented simulations. We find that both freshening of the fresh shelves and salinification of the dense shelves lead to increased shoreward heat flux. For fresh shelves, there is a shallow, eddy-driven overturning circulation that is associated with an export of fresh surface waters and a near-surface shoreward heat flux; the residual of the mean and tidal components transports heat across the shelf break. For dense shelves, the overturning consists of a dense water outflow that drives a shoreward heat flux near the seafloor. For warm shelves, the eastward undercurrent is critical in transporting Circumpolar Deep Water toward the ice shelves through submarine troughs; the sensitivities of the undercurrent and ocean heat transport to winds, tides, buoyancy forcing, and bathymetry will be discussed.

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Abstract No : 565

Interannual Variability of hydrological fronts and geostrophic transport between Cape Town and Antarctica during the austral summers

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Using seven years (2013–17) of expendable conductivity–temperature–depth profiles recorded between Cape Town and Lazarev Sea (69°S), the hydrological fronts were identified: the north and south subtropical Fronts (NSTF and SSTF), Agulhas Front (AF), branches of Subantarctic Front (SAF1 and SAF2), and branches of Polar Front (PF1 and PF2). The mean location of NSTF was found to be $37.6 \pm 1.4^\circ\text{S}$, while the AF was detected at a mean position of $38.5 \pm 1.5^\circ\text{S}$. The AF coalesced with NSTF in 2013, 2015, 2016, and 2017, and formed a merged front (NSTF–AF), which spanned 110, 275, 187, 66, and 33 km, respectively. The mean SSTF position was found to be $42.5 \pm 0.6^\circ\text{S}$, while SAF1 and SAF2 were placed at a mean location of $44.6 \pm 0.7^\circ\text{S}$ and $47.5 \pm 0.7^\circ\text{S}$, respectively. The positions of PF1 and PF2 were $49.20.4^\circ\text{S}$ and $51.30.4^\circ\text{S}$, respectively. The NSTF and SAF2 had a southerly meandering pattern, whereas the AF, SSTF, SAF1, and PF1 had a northerly meandering trend. The geostrophic transport relative to 1000 m showed a gradual increase from 34 Sv (1 Sv=106 m³/s) in 2013 to 38.4 Sv in 2017. The transport associated with the North Subtropical front showed an increasing trend, whilst that for SAF1 showed a decreasing tendency. The split and merging of the jets within the Antarctic Circumpolar Current modulate the transport. Jets moving in the opposite direction to that of ACC were also detected in some years. The variables that cause fronts to meander and changes in transport are discussed.

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Abstract No : 916

Biological response to vertical and horizontal fluxes in the South Atlantic Ocean: the Subtropical and Subantarctic transition zone

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We use a high-resolution coupled physical-biogeochemical model to investigate the physical processes that drivers lateral and vertical fluxes that could affect the marine biological productivity and carbon export in three unique oceanographic environments in the South Atlantic Ocean: the Subtropical and Subantarctic transition zone, the Brazil-Malvinas Confluence and the South Atlantic Subtropical gyre. On these sites its well known that oceanic mesoscale motions such as eddies and fronts at spatial scales of $O(10 - 100)$ km affect the marine ecosystem by horizontal dispersion and vertical displacements of isopycnals. Its well known also, globally, that small-scale processes such submesoscale motions at spatial scales of $O(1 - 10)$ km, associated with frontal regions and the periphery of mesoscale eddies, could substantially impact biological production and organic matter export due to their much larger vertical fluxes compared to those associated with mesoscale eddies. On the first part of this study, the Subtropical and Subantarctic transition zone, we use a flow decomposition methodology to separate the flow in the mesoscale and submesoscale components. We seek to understand the relative importance of mesoscale and submesocale flows. The preliminary results shows that strong horizontal and vertical fluxes are indeed associated with the submesoscale component, especially, in the late winter and in the beginning of spring. These fluxes are not only important to bring nutrients from deep layers to the well-iluminated surface layers that could enhance marine primary productivity estimates locally, but also export organic matter into the ocean's interior that could impact globally the carbon budgets.

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Abstract No : 719

Simulated warm water access to ice shelf cavities in the Amundsen Sea, Antarctica

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The West Antarctic Ice Sheet is losing mass at an accelerating rate, contributing to sea level rise. Ocean forcing is considered to be the main driver of this mass loss, associated with warm intrusions of Circumpolar Deep Water onto the continental shelf. Here we describe these intrusions, focussing on the role of the Amundsen Undercurrent. The Amundsen Undercurrent is an eastward, bottom-intensified current located at the shelf break/upper slope that transports warm Circumpolar Deep Water. This current enters the continental shelf through deep canyons that connect the shelf break with ice shelf cavities, bringing oceanic heat to the base of the ice shelves. We use a regional ocean model to introduce the forcing mechanisms of the Amundsen Undercurrent and the drivers of its temporal variability. We conclude by discussing how this variability ultimately influences melting of ice shelves in the Amundsen Sea.

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Abstract No : 224

Characteristics of short-period internal waves in the Antarctic Seas inferred from satellite SAR data

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This paper presents the results of observations of short-period internal waves (SIWs) over ice-free areas of the Southern Ocean. The study was conducted in the Indian and Atlantic sectors, namely in the Drake Passage and the Scotia, Weddell, Riser-Larsen, Lazarev, Cosmonauts, and Commonwealth Seas according to Sentinel-1 A / B satellite data for January 2020. The analysis of surface manifestations of SIWs in SAR images was determined by the areas of their generation and space-time characteristics, such as the crest length of the leading wave and the packet width. In total, 1152 radar images were analyzed and 5439 surface manifestations of SIWs were identified. Key areas of SIWs activity defined by their maximum probability were recorded in the Drake Passage, above the continental slope to the northeast of the Antarctic Peninsula in the Scotia Sea and above the shelf slope in the Commonwealth Sea. Internal waves were observed as packets of 4–5 solitary waves with a leading wave crest length of about 15–30 km, an average packet width of about 15 km (most values are within 10–25 km), and a characteristic decrease in the distance between them towards the rear of the packet, single solitons were rarely recorded. This study was supported by the state assignment № 075–03–2021–372/5 of the Ministry of Science High Education of the Russian Federation.

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Abstract No : 1014

Characterization of Lower Circumpolar Deep Water intrusions in four submarine canyons of the West Antarctic Peninsula.

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Circumpolar Deep Water (CDW) is a water mass transported in the deep layers of the Antarctic Circumpolar Current (ACC) that is divided into Upper Circumpolar Deep Water (UCDW), with a core of maximum temperature at depth, and Lower Circumpolar Deep Water (LCDW), with salinity and density values above 34.72 and 27.79 kg·m⁻³, respectively. CDW is characterized by its intrusions in depth (> 200 meters) from the Southern ACC Boundary (Sbdy) to the waters on the continental shelf of the West Antarctic Peninsula (WAP), through multiple submarine canyons that connect with the shelf break and channel the flow of CDW. Two main transport mechanisms for CDW have been suggested, which are directly related to the type of CDW: UCDW, it's transported mainly by eddies that form at the continental shelf slope; while the transport of LCDW has been scarcely described and is usually associated with the transverse flow of CDW that enters through these canyons. The objectives of this study are 1) to estimate the heat fluxes associated with LCDW intrusions and 2) to characterize the spatio-temporal variability of this water mass in the Belgica Trough (BT), Marguerite Trough (MT), Anvers-Hugo Trough and Boyd Strait, for the period between December 2007 and May 2010. To respond to these objectives, a numerical modeling approach was used, based on an oceanic ROMS model implemented for the WAP and flow simulations were performed through the 4 aforementioned canyons. The results show the presence of LCDW only in the BT and MT with seasonal, submonthly and synoptic variability.

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Abstract No : 98

The salinity budget of the Ross Sea shelf, Antarctica

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Significant trend and variability in salinity of the bottom water in the Ross Sea have been observed. Using a recently coupled ocean-sea ice-ice shelf regional model, the processes that drive the seasonal cycles of the salinity budgets in the Ross Sea shelf were assessed quantitatively. Both brine rejection and advection contribute to establishing the pattern of saltier western shelf and fresher eastern shelf, resulting in the saltiest water in the Terra Nova Bay Polynya. Vertically, during the initial sea ice formation phase in the polynyas, the brine rejection leads to the increases in the mixed layer, but the advection of fresher water leads to the decrease in the salinity below the mixed layer; as the mixed layer deepens, the layer with decreasing salinity also deepens. Sea ice forms broadly over the shelf, particularly during the early freezing season, contributing to the formation of High Salinity Shelf Water. Along with the brine rejection, the intrusion of the surface water and modified Circumpolar Deep Water and the outflow of High Salinity Shelf Water, which reach peak values from February to April, control the seasonal cycle of the salt content over the shelf. While the salt exchanges across the RIS front are important to the salt budget in the RSP, the overall freshening effect of the RIS basal melting on the salt content over the shelf is minor. This study offers an important basis for quantifying the processes that drive the interannual variability in the dense water formation on the Ross Sea Shelf.

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Abstract No : 1011

Temporal variability of ocean heat of the South Shetland Islands and its physical forcing

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The West Antarctic Peninsula is an area that is geographically exposed, which allows it to be highly vulnerable to climate change. Variations in the southern ocean and small- and large-scale atmospheric phenomena could generate sustained changes in the water column, having a major impact on Antarctic ecosystems, sea ice extent and circulation on a regional scale. In February 2022, CTD-GPS sensors were deployed to four Weddell Seals (*Leptonychotes weddellii*) on King George Island, northern region of the Antarctic Peninsula. These sensors allow to obtain hydrographic data through the behavior of the seals, for estimated times of 1 year. For this study, the data obtained in the surroundings of the South Shetland Islands, from late February to May of this year were used in order to characterize the hydrographic conditions of the area and evaluate the influence of physical and atmospheric forcings on the seasonality of the temperature. Anomalous heat values were detected throughout the water column, reaching 2°C on the surface specifically in austral autumn, coinciding with positive events of the annular mode. It is still study if there is any other process that is altering the distribution of heat in coastal and oceanic areas of the South Shetland Islands and if there is a relationship with the heat waves detected in the eastern part of Antarctica.

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Abstract No : 39

Topography-mediated Transport of Warm Deep Water across the Continental Shelf Slope, East Antarctica

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Warm Deep Water intrusion over the Antarctic continental shelves threatens the Antarctic ice-sheet stability by enhancing the basal melting of ice shelves. In East Antarctica, the Antarctic Slope Current (ASC), along with the Antarctic Slope Front (ASF), acts as a potential vorticity barrier to prevent the warm modified Circumpolar Deep Water (mCDW) from ventilating the cold and fresh shelf. However, mCDW onshore transport is still observed within certain shelf regions, such as submarine troughs running perpendicular to the continental shelf. This study focuses on the dynamic mechanisms governing mCDW intrusion within a submarine trough over the fresh shelf regions, East Antarctica. Based on an idealized eddy-resolving coupled ocean-ice shelf model, two high resolution process-oriented numerical experiments are conducted to reveal the mechanisms responsible for the mCDW onshore transport. Three dynamic mechanisms governing cross-slope mCDW intrusion are identified: 1) the bottom pressure torque, 2) the topography beta spiral, and 3) the topography Rossby waves. These three mechanisms simultaneously govern the mCDW intrusion together. The bottom pressure torque plays a leading role in driving the time-mean onshore flow whose vertical structure is determined by the topography beta spiral, while the topography Rossby waves contribute to the high-frequency oscillations in the onshore volume and heat transport. The simulated spatial distribution and seasonality of mCDW intrusion qualitatively coincide with the observed mCDW intrusion over fresh shelf regions, East Antarctica. Both the topography beta spiral and the ASC play an important role in governing the seasonality of mCDW intrusion.

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Abstract No : 294

Interannual variability of water mass characteristics in the west Antarctic shelf

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Interannual and climatic variability monitoring is done by repeating hydrological sections through the shelf and continental slope in the selected areas. In the Bransfield Strait, 6 repetitions of the section were made through the central basin. Characteristics of the deep bottom water in this basin show significant interannual variability. From 2016 to 2020, the potential temperature increased from -1.80°C to 1.58°C (salinity decreased from 34.60 to 34.56 psu) in the deep bottom layer. In 2021, warming was replaced by cooling to -1.75°C (34.59 psu), and in 2022, warming to -1.64°C (34.59 psu). These changes are determined by the variability of the characteristics and ratio of cold waters entering this basin from the Weddell Sea and warm waters of the Bellingshausen Sea. From 2020 to 2022, a section was made in the area between the Ross and Amundsen seas along the meridian $138^{\circ}30' \text{ W}$, crossing the shelf from the coastline to the foot of the continental slope. There is a transition from cold and dense bottom shelf waters of the Ross Sea to warm and saline CDW characteristic of the Amundsen Sea. In 2020, the penetration of mCDW (potential temperature above -0.5°C at a depth of more than 500 m) reached the coast through depressions. However, in 2021 and 2022, weakening of the mCDW inflow to the shelf was detected, which led to a decrease in the temperature of the bottom layer near the coast. This cooling is also associated with interaction with the glacier located to the south.

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Abstract No : 652

Influence of physical factors on the stratification breakdown and dense shelf water formation in Antarctic coastal polynyas

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Antarctic coastal polynyas are sites of strong wintertime vertical mixing due to sea ice formation and brine rejection. As mixing in the polynya water column is a prerequisite for the export of dense shelf water at the bottom, understanding the timing and magnitude of mixing is vital to understanding variability in dense shelf water formation in polynyas. Previous studies mostly characterize polynya mixing as a one- or two-dimensional process, and neglect the momentum transfer from winds into the ocean and/or the impacts of icescape and coastline geometry. Here, we combine observations, idealized numerical models, and analytical scaling to investigate the three-dimensional polynya circulation and explore the physical factors affecting destratification in coastal polynyas. The high-resolution model qualitatively reproduces the observed polynyas and sea ice plumes. It shows that strong offshore ocean currents driven by katabatic winds carry some newly-formed dense water away from the polynya in the upper water column, weakening the destratification rate. In contrast, coastal easterly winds induce onshore Ekman transport, constrain dense water outflows in the upper water column, and intensify mixing. Moreover, icescape and coastline geometry can modify sea ice and ocean circulations, influencing the dense water dispersal pathways and destratification in polynyas. Our analyses show that the destratification rate is subject to the influence of offshore winds, alongshore winds, air temperature, initial stratification, water depth, ice tongues, and headlands. The results will help explain the observed spatial and temporal variability in the destratification process and the succeeding dense shelf water formation in Antarctic coastal polynyas.

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Abstract No : 117

On the influences of the continental shelf bathymetry correction in Prydz Bay, East Antarctica

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The bathymetry around Antarctica can govern the shelf sea circulations and play a key role in conditioning water masses. In Prydz Bay, the Prydz Bay Gyre and coastal currents are also determined by the continental shelf topography. However, due to the paucity of beam echo sounding data, the bathymetric datasets in Prydz Bay still have large uncertainties. With the aid of in situ hydrographic observations, this study focuses on the correction of an up-to-date bathymetric dataset and the resultant influences on the shelf circulation and the basal melting of the ice shelves. The corrected bathymetry mainly improves the biased shallow representations in the uncorrected bathymetric data set, with a maximum change of ~500 m deepening in the eastern flank of Prydz Bay. Sensitivity numerical experiments show that the bathymetric corrections in Prydz Bay have a significant impact on the circulation pattern and onshore warm water intrusions. In addition, the corrected bathymetry markedly decreases the heat transport towards the calving front of the Amery Ice Shelf. The onshore heat transport reduces by ~22.18% from $\sim 5.23 \times 10^{13} \text{ J s}^{-1}$ to $\sim 4.07 \times 10^{13} \text{ J s}^{-1}$ over the outer shelf. Over the inner shelf, the heat transport towards the Amery Ice Shelf reduces by ~18.15% from $\sim 5.95 \times 10^{13} \text{ J s}^{-1}$ to $\sim 4.87 \times 10^{13} \text{ J s}^{-1}$. Consequently, the temporally and spatially averaged basal melting rate of the Amery Ice Shelf reduces by ~13.04% from $\sim 0.69 \text{ m yr}^{-1}$ to $\sim 0.60 \text{ m yr}^{-1}$.

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Abstract No : 131

Water masses distribution offshore the Sabrina Coast (East Antarctica)

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Current glacier melt rates in West Antarctica exceed those on the East Antarctic margin. However, on Wilkes Land, the Totten Glacier retreated significantly in recent decades, highlighting its sensitivity to climate change. This process is strongly influenced by ocean dynamics, which change in concert with the evolution of the ice cap. Here we present recent results based on oceanographic data collected in January–February 2017 off the Sabrina Coast (East Antarctica) from the continental shelf edge to about 3000 m depth. There are very few in situ oceanographic observations in this area. The main water masses, that can be identified by their thermohaline properties, are: the Antarctic Surface Water (potential temp. $\theta > -1.5$ °C, salinity $S < 34.2$, potential density anomaly $\sigma\theta < 27.55$ kg m⁻³), the Winter Water ($-1.92 < \theta < -1.75$ °C and $34.0 < S < 34.5$, $27.55 < \sigma\theta < 27.7$ kg m⁻³), the Modified Circumpolar Deep Water, mCDW, with $\theta > 0$ °C and $S > 34.5$, and $\sigma\theta > 27.7$ kg m⁻³), and the Antarctic Bottom Water, a mixture of dense waters from the Ross Sea and the Adélie Land continental shelves, with $-0.50 < \theta < 0$ °C and $34.63 < S < 34.67$ ($27.83 < \sigma\theta < 27.85$, neutral density $\gamma_n > 28.30$ kg m⁻³). The spatial distribution of water masses offshore the Sabrina Coast appears to be closely related to the complex morpho-bathymetry. Moreover, the preferential pathway of mCDW penetrating the shelf between 118°E and 120°E is evident.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

PHYSICAL SCIENCES

**Physical drivers and
climate implications of Antarctic sea
ice variability and change**

CONVENORS

Babula Jena, John Turner, N. Anil Kumar, P. Sabu

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Abstract No : 412

Diagnosing opposing Antarctic sea-ice trends in satellite observations and model projections

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Antarctic sea ice has slightly expanded over the period of continuous satellite monitoring, whereas a majority of climate model simulations indicate distinct sea ice reduction over the same period in response to imposed greenhouse gas forcing. Although a variety of hypotheses have been proposed to explain the observed Antarctic sea-ice expansion and model-observation discrepancy, the issue has remained unresolved. In this study, by analyzing both idealized and more comprehensive model simulations along with available observations, we show that the observed Antarctic sea-ice expansion results in part from ocean surface cooling associated with multi-decadal variability in the Southern Ocean, which is closely linked to climate variability in the tropical Pacific and Atlantic via atmospheric teleconnections. The linkages between the Southern Ocean and the tropics are, however, distinctly weaker in model simulations than in observations. Furthermore, global-mean warming response is found to be distinctly stronger in model simulations due to potential model biases and weaker tropical internal variability. Thus, the forced response dominates in model simulations, resulting in apparent discrepancy with observations.

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Abstract No : 917

Past sea surface temperature and sea ice variation from the Kerguelen Island Region, Southern Ocean

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This study is an attempt to understand the interaction between the Paleo-Sea Ice Extent (SIE) and frontal positions along with the oceanic circulation over the last 30,000 years. Although the role of the Southern Ocean in the Earth's climate is very important, there are limited records of paleoceanography and sea ice from the Indian sector of the Southern Ocean. The presence of islands and plateaus that impede the Antarctic Circumpolar further increases the complexity of paleoceanography in the Indian sector of the Southern Ocean. The present study provides high-resolution insights into sea surface temperature (SST) and SIE based on diatom counts to gain an understanding of past history around the Kerguelen Plateau. The sediment core is located east of the Kerguelen Plateau at latitude 44 ° 40'S and longitude 80° 23'E in the Indian Sector of the Southern Ocean. The core site downcore sea surface temperature (SST) logs show an overall temperature range of 5 ° to 12 ° C. Strong warming was seen from the 16000 to 13000 years, and the glacial period is characterized by a drop in temperature of up to 4 ° C. The current temperature recorded in the core site is 10.80 ° C. The core shows that sea ice sporadically occurs during MIS2. The overall abundance of diatoms varies between 60–80x10⁶ valve / g of sediments. Comparing our core with the core of the surrounding area, we can see that the Antarctic polar front moved to the core site between 20 to 17kyr.

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Abstract No : 99

Open-Ocean Polynyas in the Cooperation Sea, Antarctica

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Extensive studies have addressed the characteristics and mechanisms of open-ocean polynyas in the Weddell and Cosmonaut Seas. Here, we show that more persistent open-ocean polynyas occur in the Cooperation Sea (CS) (60°E–90°E), a sector of the Southern Ocean off the Prydz Bay continental shelf, between 2002 and 2019. Polynyas are formed annually mainly within the 62°S–65°S band, as identified by sea ice concentrations less than 0.7. The polynyas usually began to emerge in April and expanded to large sizes during July–October, with sizes often larger than those of the Maud Rise polynya in 2017. The annual maximum size of polynyas ranged from $115.3 \times 10^3 \text{ km}^2$ in 2013 to $312.4 \times 10^3 \text{ km}^2$ in 2010, with an average value of $188.9 \times 10^3 \text{ km}^2$. The Antarctic Circumpolar Current (ACC) travels closer to the continental shelf and brings the upper circumpolar deep water to much higher latitudes in the CS than in most other sectors; cyclonic ocean circulations often develop between the ACC and the Antarctic Slope Current, with many of them being associated with local topographic features and dense water cascading. These oceanic preconditions, along with cyclonic wind forcing in the Antarctic Divergence zone, generated polynyas in the CS. These findings offer a more complete circumpolar view of open-ocean polynyas in the Southern Ocean and have implications for physical, biological, and biogeochemical studies of the Southern Ocean. Future efforts should be particularly devoted to more extensively observing the ocean circulation to understand the variability of open-ocean polynyas in the CS.

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Abstract No : 81

Conserving the radiative and freshwater fluxes through PWRF – MITgcm interface in the Scripps–KAUST model for the Ross Sea Region.

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In order to investigate future changes of the cryosphere and the impact on global sea level rise, complex coupled numerical models are developed. Such models aim at tackling and representing various levels of interactions and feedback between the different components. Over Antarctica, these usually include an atmosphere – ice sheet – ocean and sea ice models. These models exchange information through a central coupler, allowing each component to communicate to and be impacted by the other. In this presentation, efforts were undertaken to couple the ocean model MIT General Circulation Model (MITgcm) to the atmospheric Polar-Weather and Research Forecasting Model model (PWRF) over the Ross Sea domain, using the ESMF/NUOPC coupler as developed in the Scripps–Kaust model. One of the most challenging part in coupling these models is to balance fluxes of heat and mass between the two components. Standalone models do not suffer from this as they assume that heat and mass are moved out of the model domain (e.g. melt of snow on sea ice, sea ice advection, runoff from surface melt of ice sheets ...). Here, we present results from a summer and a winter month simulation which takes into account the heat and mass flux exchanges between the atmosphere, sea ice and ocean models in the coupled model and show their impact on sea ice-ocean-atmosphere interactions and polynyas formation.

Accepted as: E-poster Presentation

Abstract No : 190

Summer sea-ice variability on the Antarctic margin during the last glacial period reconstructed from snow petrel (*Pagodroma nivea*) stomach-oil deposits

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Antarctic sea ice is a critical component of the climate system, affecting a range of physical and biogeochemical feedbacks, and supporting unique ecosystems. During the last glacial stage, Antarctic sea ice was more extensive than today, but uncertainties in geological (marine sediments), glaciological (ice core), and climate model reconstructions of past sea-ice extent continue to limit our understanding of its role in the Earth system. Here, we present a novel archive of past sea-ice environments from regurgitated stomach oils of snow petrels (*Pagodroma nivea*), preserved at nesting sites in Dronning Maud Land, Antarctica. We show that by combining information from fatty acid distributions and their stable carbon isotope ratios with measurements of bulk carbon and nitrogen stable isotopes and trace metal data, it is possible to reconstruct changing snow petrel diet within Marine Isotope Stage 2 (ca. 24,300–30,300 calendar yr BP). We show that, as today, a mixed diet of krill and fish characterises much of the record. However, between 27,400–28,700 calendar yr BP signals of krill almost disappear. By linking dietary signals in the stomach-oil deposits to modern feeding habits and foraging ranges, we infer the use by snow petrels of open water habitats ('polynyas') in the sea ice during our interval of study. We interpret the interval of reduced krill consumption to correspond to polynyas opening up over the continental shelf during a time of extensive, thick, multi-year sea-ice development offshore, highlighting the potential of stomach-oil deposits as a palaeo-environmental archive of Antarctic sea ice.

Accepted as: Oral Presentation

Abstract No : 67

Winds, Waves and Ice Production Rates in the Terra Nova Bay Polynya

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Antarctic coastal polynyas have high sea ice formation rates under the influence of cold katabatic winds from the Antarctic continent in the open water areas created by the wind-blown advection of the new ice formed. During the May 2017 PIPERS cruise into Terra Nova Bay (TNB) in the Ross Sea, we observed unique coupling between the winds, waves and ice formation rates in TNB. Observation of the newly formed ice showed the primary ice type generated was pancake ice formed in the wave fields. Heat flux measurements (Guest, 2021) showed a 50% enhancement when sea spray is generated by the breaking waves in the open water sections of the polynya at high wind speeds. Wave spectra obtained contemporaneously with a SWIFT buoy showed the high-frequency spectra indicative of breaking waves as also seen visually in the open water areas. The automatic weather station data near the head of the polynya for May 2017 was used to generate heat flux estimates including waves and sea spray generation when wind speeds were above a threshold of 9ms^{-1} . Mean ice growth rates for the month in open water areas using the combined interfacial heat flux and sea spray contribution were 0.46 m/day compared to 0.3m/day for the interfacial fluxes only. We conclude that ice production in coastal polynyas is currently underestimated from remote sensing or from the winds in coupled air-ice-ocean models and need to include sea spray contributions to the heat flux when wind speeds are high enough to generate breaking waves.

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Abstract No : 206

OCEAN-SEA ICE PROCESSES AND THEIR ROLE IN MULTI-MONTH PREDICTABILITY OF ANTARCTIC SEA ICE

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Antarctic sea ice is a critical component of the climate system and acts as a vital habitat for Southern Ocean ecosystems. Therefore, understanding the drivers and physical processes influencing Antarctic sea ice predictability is of broad interest. We investigate the predictability of Antarctic sea ice and the underlying physical processes using data from a global coupled ocean-sea ice model (ACCESS-OM2 0.1). Our results present sea ice predictability as a signature of local ice-ocean interaction. Sea ice growth and melt drive changes in the underlying ocean. The upper ocean sustains these changes and influences sea ice processes over future seasons. We find that this oceanic 'memory' is largely confined to the Winter Water layer and it responds to seasonal modification of the upper ocean water column, mainly driven by sea ice processes. We find the loss of predictability in winter, when the mixed layer deepens and reaches the permanent pycnocline. This is when warm Circumpolar Deep Water with no sea ice related memory entrains into the mixed layer and dissipates predictability. We investigate six regions around Antarctica, each with varying and unique sea ice predictability patterns, which closely followed the evolution of the upper ocean structure. Our results show the strong dependence of sea ice predictability pattern emerging in a region on its local vertical ocean structure. Implying that a warming climate might alter sea ice predictability patterns in the future.

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Abstract No : 209

The impact of the Indian Ocean Basin mode on Antarctic sea ice concentration in interannual time scales

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The Antarctic sea ice variability has been linked to tropical sea surface temperature (SST). However, little is known as to whether and how the Indian Ocean Basin Mode (IOBM) influences Antarctic sea ice changes. We revealed the existence of a teleconnection between the IOBM and Antarctic sea ice anomalies, which is much stronger in austral spring and autumn than summer and winter. In particular, under the positive phase of the IOBM, significant positive sea ice anomalies occur in the Bellingshausen and northern Weddell Seas, in contrast to negative anomalies in the Amundsen Sea, the southern Atlantic Ocean, and the coastal seas off Dronning Maud Land. This teleconnection is established by planetary wavetrains excited over the TIO and the tropical Pacific Ocean and is modulated by ENSO. The IOBM-related Antarctic sea ice anomalies are largely consistent with those of the anomalous surface air temperature and wind fields associated with the IOBM.

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Abstract No : 493

Studying Tropical–Antarctic teleconnection using Linear Response Method

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Understanding the dynamics of tropics to high latitudes teleconnection is crucial as a significant influence of tropical convective processes on Antarctic climate has been reported in recent studies. Tropical convection is associated with the upper tropospheric divergence which often leads to the formation of quasi-stationary Rossby waves which propagates to the southern high latitudes and influence the local climate at different time scales around Antarctica. Using daily observational data (precipitation from CMAP and geopotential height from NCEP–DOE Reanalysis 2) and a semi-empirical Linear Step Response method, we produced extratropical response at 250-hpa geopotential height, to the tropical Indian Ocean Dipole at high latitudes in the Southern Hemisphere during the austral spring season (September–October–November, 1980–2015). The step response in the geopotential height closely resembled the composite of extratropical geopotential height anomaly during the same period. With the ability to isolate the response of individual forcing regions, the Linear Response Method complements existing techniques such as idealized barotropic / baroclinic models and General Circulation Model experiments. Examining the responses over a range of CMIP5 models, a large inter-model spread was observed. As the teleconnection patterns are not properly represented in climate models, this can obscure future projections in the Southern Hemisphere. This study will be useful for the improvement of climate models in terms of capturing the teleconnection patterns, as well as providing improved projections.

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Abstract No : 1024

Enhanced Analytical Model to Estimate Sea Ice Formation in polynyas adjacent to Antarctic ice shelves

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The atmosphere influence affects mass, heat and salt fluxes in marine regions adjacent to Antarctic ice shelves. The role of thermal interaction between the atmosphere and ocean in the vicinity of ice shelves significantly increases in winter because of large thermal contrasts between the atmosphere and underlying surface. Mass and heat exchanges between the atmosphere and ocean reaches maximum magnitudes in coastal polynyas causing enormous production of sea ice. The contribution of climate changes to forming ice in coastal polynyas is not yet taken into quantitative consideration though related convective mixing in polynyas is a major factor modifying ocean water masses down to bottom from where Antarctic Bottom Water propagates as far as North Atlantic presenting an important linkage in global climate change. The uncertainty in estimates of ice thickness on the basis of satellite observations is high because the dependence of underlying surface temperature on snow depth was not accurately taken previously into account. The deeper snow the closer surface temperature to air temperature, representing a negative feedback included in the new consistent model definition modifying surface temperature according to changes in snow depth. This enhanced model of ice growth enables analytical solution simplifying calculations of ice growth and related fluxes. The solution could be transformed to explicit dependence only on meteorological parameters: air temperature, solid precipitation rate and wind speed. It means that the solution of a meteorological problem allows to estimate the influence of the atmosphere on the processes of offshore polynyas.

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Abstract No : 425

Using observed historical ice cover to help constrain Antarctic sea ice projections

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Confidence in projections of 21st century change in Antarctic sea ice area (SIA) is low, due mainly to deficiencies in the representation of sea ice in climate models. When compared to sea ice area as observed by satellites, climate models generally exhibit significant biases. However, some models perform significantly better than others illustrating that not all should be treated equally. Performance against historical (satellite-era) observations is strongly related to future projections across the CMIP6 multi-model ensemble of climate models, an 'emergent relationship'. This suggests that models with historical sea ice area closest to what we have observed may be more reliable in their future simulations. This information is used in a simple statistical model to show that, firstly, under strong forcing, the newest climate models (CMIP6) largely show near-total sea ice loss in summer by the end of the 21st century, which was not universally true for older climate models (CMIP5). In addition, ensemble spread in historical summer SIA is smaller than in CMIP5, and CMIP6 gives a more robust constraint on future SIA. In winter, by the year 2100 under a strong forcing scenario, 40% of SIA disappears on average, and ensemble spread in historical mean SIA explains approximately half the spread in projected change. The higher climate sensitivities of some CMIP6 models helps to explain a larger overall winter sea-ice loss in CMIP6 than CMIP5. The dual importance of model improvements and emergent relationships in improving estimates of future sea ice change will be discussed.

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Abstract No : 121

Drivers of extreme Antarctic ice extents in summer over the period 1979–2022

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The Antarctic sea ice variability and its underlying drivers remain overall unsettled, particularly since the sea ice extent (SIE) during the last two decades has first exhibited a slight increase, somewhat in contrast with the global warming trend, followed by a rapid reduction in the more recent years. The unprecedented SIE minimum registered in February 2022 has received great attention and already constitutes an important case study, as the prior record low in 2017. However, other extreme anomalous events are present in the observational record, and a comprehensive analysis of both minima and maxima in the summer SIE is essential to identify and separate potential common drivers from event-specific dynamics. In this work, we aim at assessing the relative roles of atmospheric and oceanic processes in the summer SIE extremes and at disentangling the dynamic contributions to sea ice changes – such as wind-driven transport and divergence – from the thermodynamic part. Furthermore, we identify the key regions at play during such events, the local dominant mechanisms, and the mutual interactions that result in a total maximum or minimum. The timing and persistence of the sea ice, atmosphere and ocean anomalies in the prior months is also examined to clarify the time scales of the processes during the melting season that lead to the summer extremes. We use observations and reanalysis over the satellite period and compare our main findings with results obtained from an ocean-sea ice model driven by prescribed atmospheric fields from ERA5 on the same period.

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Abstract No : 718

Possible Linkage between the Antarctic Sea Ice and Indian Summer Monsoon Rainfall

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Antarctic sea-ice extent (ASIE) is an active component of global climate, modulated by the tropical ocean-atmospheric variability through atmospheric teleconnections. Further, the necessity for finding a new predictor of Indian summer monsoon rainfall (ISMR) has been realised recently as the relationship between the ISMR and the predictive physical parameters keeps changing in space and time. The linkage between the satellite-derived ASIE and ISMR by interacting physical processes occurring between the ocean-atmosphere-sea-ice system from 1979 to 2016 (38 years) was explored. Lead-lag cross correlation indicated a significant relationship in austral autumn ($r = -0.5$, $p < 0.05$) between ASIE over the Bellingshausen–Amundsen Sea (BAS-SIE, lead by 2–3 months) and ISMR. The atmospheric circulation patterns over the BAS and Ross Sea were analysed using a composite of extreme rainfall event years. Excess (deficit) rainfall years showed anomalous cyclonic (anticyclonic) wind patterns that led to anomalous positive (negative) air temperature that facilitated anomalous negative (positive) BAS-SIE. Hence, the excess rainfall (deficit) events were observed corresponding to a large negative (positive) anomalous BAS-SIE. This linkage possibly occurred through El Niño–Southern Oscillation (ENSO) associated sea surface temperature (SST) variability. Wavelet analysis was performed to explore the coherence, dominant mode of variability, and common frequency distribution in the ASIE, Niño3.4 SST and ISMR. The spectral and wavelet analysis results showed that the ASIE and ISMR have dominant oscillations in 2–8 years frequency bands similar to the ENSO. An improved understanding of the complex relations between the polar and tropical regions will help better predict the ISMR.

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Abstract No : 950

Identifying the drivers of anomalous sea ice retreat in Weddell Sea sector and Indian Ocean sector of East Antarctica.

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Sea ice area (SIA) is considered as an important indicator of climate change. Antarctic sea ice has not shown any significant trend until the last decade, but recent years have shown instances of anomalous sea ice retreat. We focus on the SIA changes in the marginal ice zone of East Antarctica to understand the drivers of these changes. Daily anomaly of SIA is calculated from satellite data (U.S. National Snow and Ice Data Center) and compared against the 2-sigma levels of daily SIA timeseries to identify the anomalous seasons and years. Anomalous retreat occurred in Weddell Sea sector and Indian Ocean sector in the years 1983,1986,1990,2016 and 2017 during Austral Spring. To understand the synoptic conditions driving these changes, composite of geopotential height anomalies at 850 hPa and 10m wind anomalies were computed (using NCEP-DOE Reanalysis 2data) over the East Antarctic sector during the anomalous seasons. In the Weddell Sea sector, which has the greatest amount of multiyear sea ice, the ice retreat was associated with a deep depression that gave strong northerly flow across the area. The atmospheric circulation at high southern latitudes was clearly anomalous in those years, and there is a strong correlation between the marked periods of northerly atmospheric flow and ice retreat.

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Abstract No : 825

Unusual sea ice condition around the Antarctica from 2016 to 2021

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The sea-ice cover is often used as an indicator of the polar environmental change that modulates albedo, ocean-atmosphere exchange of carbon, ocean-atmosphere circulation, cryosphere ecosystems, and biogeochemical cycle. In this article, we quantified changes in sea-ice observations derived from various satellite observations in the Southern Ocean (SO) from 1979 to 2021. In the context of global warming, sea-ice extent in SO increased at a rate of 1.95 %/decade from 1979 to 2015. Over the extended period of 1979–2021, however, the rate of growth decreased slightly to $46.05 \times 10^3 \text{ km}^2/\text{decade}$ (0.38 %/decade). Even though sea-ice growth over the past 37 years has been continuous, a sudden shift in 2016 led to a dramatic drop in sea-ice in 2017 followed by 2019, 2018, and 2021. After a rapid decline during 2016–2019, sea-ice was thought to have recovered in 2020. However, an anomalously large sea-ice decline in 2021 and 2022 (January–May) indicates more long-term decline in the future. The unusual sea-ice variability during 2016–2021 was thought to be caused by tropical-polar teleconnections that intensified the atmospheric zonal waves. The positive trend of zonal wave index showed significant relation with sea-ice in summer, autumn and winter seasons, suggesting the increase in northerly flow of warm air during 2016–2021. We have examined the SO sea-ice variability driven by ENSO and SAM. The ENSO influences the strength of Amundsen Sea Low in summer season. The zonally asymmetric patterns of SAM are consistent with atmospheric zonal waves that impacts on sea-ice variability in SO.

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Abstract No : 720

Decadal Variability of Sea Ice Extent in the Antarctic

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Antarctic sea ice is an integral component of the global climate system and teleconnected to the tropical and extratropical weather and climate change through Atmospheric and oceanic bridges and vice versa. The decadal variability of the sea ice extent in different sectors of the Antarctic are studied using nearly four decades of sea ice observation from the space bourn systems. Prominent decadal variability is observed in the Bellingshausen-Amundsen seas sector. However, other sectors do show decadal variability. The drivers from the tropics and sub-tropics are explored to examine and explain the decadal variability of sea ice in different sectors of the Antarctic. It is found that the decadal variability in the Pacific perturbed the rossby wave train to the polar region, thus exciting the Southern Hemisphere circulation in a similar time scale and impacts the sea ice extent in different sectors of the Antarctic.

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Abstract No : 248

Impact of atmospheric forcing uncertainties on Antarctic sea ice simulation in CMIP6 OMIP

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Atmospheric reanalyses are valuable datasets to drive ocean-sea ice general circulation model and to propose multi-decadal reconstructions of the ocean-sea ice system in polar regions. However, these reanalyses exhibit biases in these regions. It was previously found that the representation of Antarctic sea ice in models participating to the Ocean Model Intercomparison Project Phase 2 (OMIP2, using the Japanese 55-year atmospheric reanalysis) was significantly more realistic than in the OMIP1 (forced by atmospheric state from the Coordinated Ocean-ice Reference Experiments version 2, CORE-II). To understand why, we study the sea ice concentration budget and its relations to surface heat and momentum fluxes, as well as the connections between the simulated ice drift and the ice concentration, the ice thickness and the wind stress in a subset of three models (CMCC-CM2-SR5, MRI-ESM2-0, and NorESM2-LM). It is found that negative summer biases in high-ice concentration regions and positive biases in the central Weddell Sea (CWS) regions are reduced from OMIP1 to OMIP2 due to surface heat fluxes changes. There is also an influence of improved surface wind stress in OMIP2 giving better winter Antarctic ice concentration near the ice edge. The ice velocity direction simulation in the Pacific and Atlantic sectors of the Southern Ocean in OMIP2 are also improved owing to surface wind stress changes. This study provides clues on how improved atmospheric reanalysis products influence Antarctic sea ice simulations. Our findings suggest that attention should be paid to the radiation fluxes and winds in atmospheric reanalyses.

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Abstract No : 1009

Impacts of grounding icebergs on sea ice and polynyas in Eastern Prydz Bay, Antarctica

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Based on satellite remote sensing, several polynyas have been found in Prydz Bay, East Antarctica. Compared with the Mackenzie Bay Polynya, the only polynya in the west, the polynyas in eastern Prydz Bay have a larger area and higher ice production. Four recurrent polynyas were identified in eastern Prydz Bay from remote sensing positive microwave data during 2002–2011. Their areas generally exhibit synchronous temporal variations and have good correlation with wind speed, which indicates that they are primarily wind-driven polynyas that need at least one stationary ice barrier to block the inflow of drifting sea ice. The components of the ice barriers of these four polynyas were identified through comparison of satellite remote sensing visible images and synthetic aperture radar images. All types of fast ice, including landfast ice, offshore fast ice and ice fingers serving as ice barriers for these polynyas are anchored by an assemblage of small icebergs and have an approximately year-round period of variations that also regulates the variability of polynyas. The movement and grounding of giant icebergs near the polynyas significantly affects the drifting of sea ice and development of the polynyas. The results of this study illustrate the important impact of grounding icebergs on fast ice and wind-driven polynyas.

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Abstract No : 296

Effect of polynya on the structure and dynamics of waters on the shelf and continental slope in the Cooperation Sea (East Antarctica).

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Observations in the form of hydrological sections across the shelf and continental slope were completed in the Cooperation Sea of the Russian Antarctic Expeditions (RAE) in the summer season (2004 – 2016) to study cascading process. This data regularly confirmed the presence of a summer runoff of Antarctic shelf water (ASW) in certain areas of the Cooperation Sea, which is provided by a huge amount of ASW accumulated in shelf depressions during the winter period. In 2016, a submesoscale hydrological polygon was done between the meridians of 70° and 71° E. Some of the sections were combined into a small-scale polygon, in which the distances between the sections and hydrological profiles are close to $\approx 1.8\text{--}2$ km, which is less than the local baroclinic Rossby deformation radius. Such data made it possible to describe the three-dimensional process of dense water runoff correctly, and to verify a numerical experiment for reproducing the formation of dense shelf waters in a polynya. To analyze the processes occurring in winter, an original 3-D numerical experiment based on the small-scale non-hydrostatic Fluidity-ICOM model was performed. Winter surface conditions in ice-free polynya area were defined as extreme salt flux produced by rapid frazil ice production in the turbulence upper layer. The model reproduces the dynamics and transformation of density currents. Results showed good agreement of geometric, dynamic, hydrophysical cascading characteristics with data obtained in RAE expeditions.

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Abstract No : 797

Fall and winter variability of hydrographic conditions around South Shetland Islands using sensors on pinnipeds.

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The South Shetland Islands (SSI) is a highly productive region influenced by complex bathymetric features, temporal variations of sea ice concentration and oceanic processes that modulate water inputs from the Weddell Sea, the Drake Passage, the Bransfield Strait and Gerlache Strait. The main objective of this study was to describe the spatial and temporal variability of hydrographic conditions around the SSI. To accomplish this goal temperature, conductivity and pressure were obtained from CTD-tags deployed on pinnipeds: Weddell (*Leptonychotes weddellii*) and Leopard (*Hydrurga leptonyx*) seals. A total of 17 seals were tagged at Livingston Island (SSI) in later summers of year 2010, 2014, 2015 and 2018 as part of the Antarctic Marine Living Resources (AMLR) program. The spatial distribution of CTD profiles showed four regions that concentrated most of the observations. In each of these regions the temporal evolution of hydrographic conditions was obtained using time series analyses. Correlations to the main physical forcings were analyzed. Atmospheric conditions were obtained from automatic weather stations at King George Island and Greenwich Island and ERA 5 reanalysis. The vertical structure of temperature and salinity showed contrasting conditions between years. Year 2015 was saltier and colder, consistent with a higher concentration of sea ice. The spatial coverage sampling by the seals allowed us to temporally describe hydrographic conditions at small spatial scales. The results obtained by this study provide a base line of the current state of the coastal environment of the SSI, a region highly impacted by environmental changes. Financing: ANID-FONDECYT 1210988

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Abstract No : 267

Variability in fast ice thickness in McMurdo Sound over 25 years and its connections to ocean, ice-shelf and atmosphere.

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The seasonal fast ice cover in McMurdo Sound, Antarctica, has been remarkably stable since the earliest records more than 100 years ago. We think this is due to supercooled water flowing out from under the floating McMurdo ice shelf and allowing the sea ice to grow through heat loss to the ocean, as well as to the atmosphere. In this talk I will give an overview on our monitoring program of the fast ice in McMurdo Sound since 1996, focusing on thickness and growthrate. I will connect our 25-year time series to atmosphere and ice-shelf--ocean interactions to provide a baseline of the natural interannual variability in the ice. Future extreme events and long-term trends can be assessed against this baseline, helping us better understand the balance between ice, ocean and atmosphere. Further, possible drivers for interannual variations will be explored.

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Abstract No : 139

Influence of sea ice processes, ocean and atmosphere feedbacks on the seasonal cycle of Southern Ocean Sea ice

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The seasonal cycle of the Antarctic sea ice extent is strongly asymmetric, with a relatively slow increase followed by a more rapid decrease after the winter maximum. This cycle is intimately linked to the seasonal cycle of the insolation received at the top of the atmosphere, but it is expected that sea ice processes as well as the exchanges with the atmosphere and ocean modulate the sea ice response to insolation. To quantify those effects, a series of sensitivity experiments have been performed with an eddy-permitting ($1/4^\circ$) NEMO-LIM3 Southern Ocean configuration including a representation of ice shelf cavities, in which the model was either driven by an atmospheric reanalysis or coupled to the COSMO regional atmospheric model. In those experiments, sea ice thermodynamics and dynamics together with exchanges with the ocean and atmosphere are perturbed. One of the key conclusions of those experiments is that the initial sea ice advance during fall and early winter is largely independent of the perturbation and is thus likely a direct response to insolation changes. Besides, the duration of the period during which the sea ice extent remains close to its maximum and the spring-summer sea ice melting rate depend critically on sea ice processes and feedbacks, in particular the way they influence the winter sea ice thickness and the amount of energy available for melting.

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Abstract No : 125

Understanding differences in 20th century Antarctic sea ice extent reconstructions in the Pacific sector

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Prior to 2016, Antarctic total sea ice extent, was growing at a small and weakly statistically significant rate. The growth was most marked in the western Ross Sea, west of 180°, and partially offset by losses in the Bellingshausen Sea, just west of the Antarctic Peninsula. In 2016, rapid declines of total Antarctic sea ice reduced the positive trend; this decline was followed by several years of below-average Antarctic sea ice extent. After returning to near-normal conditions in 2020, Antarctic sea ice extent reached an early peak in 2021, followed by an early retreat that led to a record minimum in Antarctic sea ice extent in February 2022. The short nature of the satellite record of Antarctic sea ice extent, beginning around 1979, makes it challenging to understand the significance and historical importance of these changes. To this end, reconstructions based on both paleo-proxies and observations have helped to shed light on longer-term Antarctic sea ice variations throughout the 20th century. While these reconstructions generally show a long-term decline in sea ice extent in the 20th century prior to satellite observations, they have notable differences in the Pacific sector (Ross – Bellingshausen Seas), including different signs of trends. This talk will further explore these regional Antarctic sea ice extent reconstruction differences in the 20th century and provide some preliminary suggestions on mechanisms (both statistical and climatological) that may contribute to these differences.

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Abstract No : 156

An assessment of Antarctic Sea-ice Thickness in CMIP6 simulations with comparison to the Observations

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Fully coupled climate models as well as observational data have long shown a wide range of Antarctic sea ice states and evolution over the satellite era. Among other sea-ice parameters, sea-ice thickness(SIT) remains a relatively less understood measurement of sea-ice variability in Southern Ocean. Long-term high quality (daily and high spatial resolution) observations of Antarctic SIT remain limited because of few satellites and in-situ observations. Currently available SIT observations exist for a very short period starting in 2002, restricting its reliable long-term assessments. Therefore, the paper aims to assess modeled SIT in 4 Antarctic Regions and select models with maximum agreements with the observations. Here, we present an evaluation of historical simulations of Antarctic SIT in 46 models from the most recent phase of the Coupled Model Intercomparison Project(CMIP6) by comparing them with the observations. Our preliminary results show that most of the CMIP6 models capture key characteristics of the mean annual cycles of regional SIT, particularly during the austral summers(DJF). Large inter-model spread is observed in all the regions due to implausible historical mean states compared to satellite observations. Regionally, Weddell Sea shows highest and increasing trends in observed sea-ice while thinnest and declining sea-ice is observed in Ross Sea. Most models have SIT at the maximum in August-September, while all have the minimum SIT in February. In contrast to the satellite data, which exhibit a slight increase in monthly SIT, the mean SIT of the models shows decrease in each month/season, with significant results during fall/summer.

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Abstract No : 16

Sea ice thickness in the Weddell Sea from SSM/I passive microwave radiometer data

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The leading information on sea ice thickness (SIT) is obtained through surface drilling, observations on ships, airborne electromagnetic induction techniques, upward-looking sonars and laser altimeters embedded in satellites. One limitation of these methods is in spatiotemporal studies elaboration on SIT seasonality. To evaluate the feasibility of other techniques, this study statistically analysed, during the freezing period, the relationship of brightness temperature (Tb) data of the 37V polarisation and the GR3719 (Gradient Ratio 37V and 19V) obtained by Special Sensor Microwave/Imager (SMM/I) from F11 and F13 satellites with SIT data obtained in the Weddell Sea through Antarctic Sea Ice Processes and Climate (ASPeCt) program. The multiple regression linear model (MRL) was applied at 1,520 points, with 70% of these points being randomly separated to generate the MRL and 30% to carry out the validation. We found in the validation that MRL presented an $R^2 = 0.57$, RMSE = 0.268 m, and an average difference of 0.103 m. These answers consider SIT limitation in up to 1.5 m due to the data provided by ASPeCt and also the correlation of Tb with the development of new ice for first-year ice is inverse between the correlation of Tb on development for second-year ice. From this, we can consider that 37V and GR3719 parameters of the SSM/I sensor can be applied in other more advanced modelling techniques.

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Abstract No : 84

Role of snowfall forcing on sea-ice variability in the Antarctic

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We have quantified the impact of snowfall forcing on sea-ice variability in the Antarctic sea in the recent decade (2011 – 2020) using an ocean sea-ice couple model, known as Modular Ocean Model (version 5) with simulator (MOM5). Our model MOM5 successfully simulates satellite observed climatological sea-ice concentration (SIC) and sea surface temperature (SST) in the Antarctic during all four seasons, which includes southern winter (June – August), spring (September – November), summer (December – February) and autumn (March – May). In the absence of snowfall forcing, our model shows increase of SIC and decrease of SST in the eastern Antarctic (0-120E) compared to western during southern winter and spring seasons compared to summer and autumn seasons. We have also found similar increase of sea-ice thickness and Ice velocity during southern winter and spring seasons in the eastern Antarctic. Maximum impact of snowfall forcing in the eastern Antarctic sea during southern winter and spring seasons are linked to strong presence of climatological snowfall in the eastern Antarctic sea compared to western during southern winter and spring seasons.

Accepted as: Oral Presentation

Abstract No : 721

Antarctic sea ice concentration estimation using bi-frequency SARAL/AltiKa data

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Many studies for the estimation of sea ice concentration (SIC) in the Arctic and Antarctic have been exclusively researched for the last four decades with the beginning of satellite remote sensing using passive microwave data. Here, we derived the monthly SIC from SARAL/AltiKa (SRL) bi-frequency radiometer (23.8 GHz and 36 GHz) in the Antarctic for the year 2020 at polar stereographic projection with spatial resolutions of 28 x 37 km. SRL SIC estimation is based on an adaptive algorithm motivated by the original Bootstrap SIC algorithm. The brightness temperature tie-points are determined using a statistical method. The results have been compared quantitatively with monthly National Snow Ice and Data Centre Climate Data Record (NSIDC CDR) SIC. Root-mean-square error (RMSE) values range from about 9% (all data), 7% (winter months) to 10% (summer months). According to our comparisons, the largest RMSE values typically occur in summer (12.96%) while the smallest RMSE values in winter (6.84%). The comparison results show a reasonable match with the reference data set. Hence, our algorithm can be used to generate basic SIC data sets in the Antarctic waters.

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Abstract No : 332

Pacific Antarctic Ridge: a barrier against eddies and the Antarctic Circumpolar Current that favours sea ice formation

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The understanding of the recent variability of Antarctic sea-ice, both in its extent and concentration, is essential to a study of the equilibrium of the Earth's climate. Passive microwave-derived sea ice concentration data for the 2002–2020 period have been used to analyse the year-to-year variability of the Antarctic sea ice in the Pacific sector of the Southern Ocean. The results provide observational evidence of the periodic formation, during the winter period, of a sea ice protrusion that extends up to 60°S at about 150°W. This peculiar recurring shape might be associated with several processes, mainly linked to the oceanic and atmospheric circulation, that contribute to the determination of this phenomenon. Among others, the role played by the interaction between bathymetry, especially the Pacific Antarctic Ridge, and cold/warm core eddies is investigated and discussed in this manuscript.

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Abstract No : 584

The evolution of an ice regime drifting through the Weddell Sea

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The seasonal mass budget of Antarctic sea ice is dominated by the year-around snow cover and related transition processes at the snow/ice interface. The Weddell Sea has a particular role in this respect as it consists primarily of perennial sea ice in the west, while seasonal sea ice is dominant in the east. However, the quantitative description of the evolution of a particular ice regime and its snow cover along the drift trajectory from the southeastern to the northwestern Weddell Sea has not yet been studied in detail. To do so, we present here a unique data set of in-situ snow and sea ice properties obtained during the interdisciplinary sea ice work in the southeastern Weddell Sea in February and March 2021 and in the northwestern Weddell Sea in February and March 2022. From satellite data analyses and a deployed snow buoy, it is known that the sampled ice regime in the northwestern Weddell Sea corresponds to the drifted sampled ice regime of the southeastern Weddell Sea in 2021. First results show a modal snow depth of 10 to 60 cm in the southeastern Weddell Sea, which reduced to 5 to 20 cm in the northwestern Weddell Sea one year later. This reduction in snow depth is caused by the formation of up to 16 cm of superimposed ice along the ice drift through the Weddell Sea. Combined with the formation of snow ice, the meteoric ice contributes significantly to the ice growth at the top of the sea ice.

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Abstract No : 154

Impact of winds and Southern Ocean SSTs on Antarctic sea ice trends and variability

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Antarctic sea ice extent (SIE) has slightly increased over the satellite observational period (1979 to the present) despite global warming. Several mechanisms have been invoked to explain this trend, such as changes in winds, precipitation, or ocean stratification, yet there is no widespread consensus. Additionally, fully coupled Earth system models run under historic and anthropogenic forcing generally fail to simulate positive SIE trends over this time period. In this work, we quantify the role of winds and Southern Ocean SSTs on sea ice trends and variability with an Earth system model run under historic and anthropogenic forcing that nudges winds over the polar regions and Southern Ocean SSTs north of the sea ice to observations from 1979 to 2018. Simulations with nudged winds alone capture the observed interannual variability in SIE and the observed term trends in SIE from the early 1990s onward, yet for the longer 1979–2018 period they simulate a negative SIE trend, in part due to faster-than-observed warming at the global and hemispheric scale in the model. Simulations with both nudged winds and SSTs show no significant SIE trends over 1979–2018, in agreement with observations. At the regional scale, simulated sea ice shows higher skill compared to the pan-Antarctic scale both in capturing trends and interannual variability in all nudged simulations. We additionally find negligible impact of the initial conditions in 1979 on longterm trends in SIE.

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Abstract No : 846

Evaluation of satellite-observed ozone profiles at the Jang Bogo station, using the ozonesonde measurement

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In this study, vertical ozone profiles from multiple satellite observations were evaluated by the comparison with the those from the in-situ ozonesonde measurements at the Jang Bogo station, Antarctica. The comparison was performed after the convolution process of ozonesonde measurements using a-priori information of each satellite ozone retrieval algorithm. Here two limb-viewing (MLS and OMPS) and one nadir-viewing (OMI PROFOZ) satellite measurements were examined with the 4-year ozonesonde measurements at Jang Bogo station (2015–2018). The analysis is only focused on the austral springtime when the Antarctic stratospheric ozone is largely depleted. Similar to the previous studies, ozone profiles from the limb-viewing satellites generally have a better quality of ozone profile than those from the nadir-viewing satellite. Nevertheless, the quality of nadir-viewing satellite ozone profile (OMI PROFOZ) also shows the moderate quality, and it seems associated with the reliable quality of a priori ozone profile. While the OMI PROFOZ ozone profile has the larger inter-annual variation and biases near the tropopause, its moderate quality implies that the mean pattern analysis of polar ozone profile from the surface to the stratosphere looks possible, enabling better understanding for the polar ozone distribution.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

PHYSICAL SCIENCES

**Critical challenges in modelling
past and future evolution of the
Antarctic and Greenland ice sheets -
scales, uncertainty, processes,
implications for sea level**

CONVENORS

Frank Pattyn, Rupert Gladstone, Adam Treverrow,
Felicity McCormack, Chen Zhao

Accepted as: E-poster Presentation

Abstract No : 1045

Analyzing Antarctic GNSS Velocities Affected by Antenna Icing

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The POLENET/ANET network of continuously operating GNSS instruments span the margin of the East Antarctic craton in the Transantarctic Mountains and across the West Antarctic rift system and its component crustal blocks. The network also spans the drainage basins of the West Antarctic Ice Sheet. GNSS time series of sufficient length are now available to define the horizontal and vertical velocity fields at mm level. However, GNSS signals in Antarctica are commonly affected by polar environmental conditions that result in growth of rime ice on the antenna radome and mast, and in intrusion of blowing spindrift snow and accumulation of ice inside choking antennas even when covered by radomes. Since the discovery of ice intrusion in 2014, mitigation efforts to stop intrusion have been taken, culminating in the decision to begin replacement of choking antennas with sealed GNSS antennas in 2018. Here we analyze the effects on position time series and trajectory models that define crustal motions resulting from removing ice and plugging choking drainage holes, followed by replacing potentially ice contaminated choking antennas. At a subset of locations, time series change quite drastically: some sites lose previously dominant seasonal signals, while others show a change in time series trend. With several years of continuous data now available with the sealed antennas, we can compare velocities before and after the antenna swaps and determine preferred velocities and uncertainties for these ice-biased sites. Improved velocities will yield better understanding of Antarctic crustal motions for implementation into GIA modeling.

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Abstract No : 1056

SICOPOLIS-AD v2: Inverse modeling framework for ice sheet modeling enabled by automatic differentiation

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We present a new inverse modeling framework for the ice sheet model SICOPOLIS that is enabled by source transformation using the open-source Automatic Differentiation (AD) tool Tapenade. Ice sheets are grounded ice masses of continental size, with areas greater than 50,000 sq. km, such as Antarctica and Greenland. They are dynamic entities whose evolution is governed by non-linear Partial Differential Equations (PDEs) that conserve mass, momentum, and energy. Ice sheet evolution is driven by its present state and uncertain forcings such as surface temperature, precipitation, basal sliding, geothermal heat flux, etc. These uncertainties propagate to our Quantities of Interest(QoI) such as projections for sea-level rise, which is an economically and societally important problem. It is thus desirable to evaluate the sensitivities of our QoI to these independent input variables. Furthermore, recently collected data can be used to calibrate model parameters to improve our simulations, which is an exercise in PDE-constrained gradient-based optimization. Posterior uncertainties around these optimal sets of parameters can be quantified elegantly using the Bayesian framework. The gradient for the optimization is evaluated efficiently using the adjoint model generated by the AD tool Tapenade. The entire framework is open source and freely available.

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Abstract No : 447

A Deep Learning model to Extract Bedrock and Internal layers from Radio Echo Sounding Imaging of Ice Sheets

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The radar-echo-sounding data nowadays has been one of the most important methods in the sub-glacial investigation. The internal isochronal layers, including ice layers and bedrock interfaces, are widely applied to infer the ice characters and subglacial topographies. Conventionally, these two types of layers are manually extracted based on the visual feature indications by the human expert. Filtering methods are feasible in reducing types of random noise and enhancing the layer features, but it is still a hardship to precisely and efficiently extract the layers from observational radar images. Therefore, we propose EisNet, a deep-learning-based network system, to extract and separate both the internal ice layers and bedrock interface from radar images. Subnetworks in EisNet are trained on the synthetic datasets generated by a novel method based on the visual texture of objects and noises in observations. Transfer training in field data later improves the subnetwork's performance in identification. After training, EisNet is first validated on field radar image slices and shows the capacities for extracting both ice layers and bedrock interfaces. We second apply EisNet in the large-scale radar observation data from CHINARE, and the extractions also reveal the performance. The fusion application of the filtering method pre-processing and EisNet extraction is recently proposed and suggests the enhanced capacities in the low SNR radar image. The code and package of EisNet are under development. We hope that EisNet can be applied in more ice radar datasets and promote glacial research.

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Abstract No : 832

Ground Penetrating Radar limitations for the assessment of the ice thickness of the Antarctic Ice Sheet

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Precise measurement of the ice thickness is an important component to estimate the mass balance, ice dynamics study and sometime geo-hazard assessment. Non-destructive and indirect measurement can be done using Ground Penetrating Radar (GPR). GPR delineated the underground material by differentiating electromagnetic property at given frequencies. Usually the commercially available GPR instruments provides the central frequency ranges from 4000MHz to 5MHz. GPR could be utilized for the shallow depth due to its penetration capacity. Central frequency ranges from 400MHz to 5MHz are being used to assess ice thickness. Geological Survey of India (GSI) has carried out the GPR survey and estimated the land-ice-sea interface at the depth of 750 m in the north-east of Schirmacher Oasis, E. Antarctica. Other researchers assessed depth from 93m to 100m using 100MHz to 200MHz frequencies range in McMurdo Dry valleys and Baishui River Glacier to penetrate. Belvedere Glacier (Italian Alps), Ice Cap on King George Island, Antarctica and Outlet Glacier of east Antarctica have been surveyed using 70MHz to 25MHz frequency and but reached upto the depth of 420 m at Outlet Glacier. 16MHz to 5MHz frequency range was used at Himalayan Glacier to reach deeper; Gourdon Glacier, Antarctic Peninsula; Pedersenbreen Glacier, Svalbard and Znosko Glacier, King George Island could reached the depth upto 183±9m. Maximum depth estimation was 619 ± 13m that could be achieved in Wedel Jarlsberg Land Glaciers, Svalbard using 20MHz central frequency antenna. Hence, detecting more than 400m depth at icy surface is very rare.

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Abstract No : 517

Future Projections for the Antarctic Ice Sheet until the Year 2300

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As part of the Coupled Model Intercomparison Project Phase 6 (CMIP6), the Ice Sheet Model Intercomparison Project for CMIP6 (ISMIP6) was devised to assess the likely sea-level-rise contribution from the Earth's ice sheets. Here, we construct an ensemble of climate forcings for Antarctica until the year 2300 based on original ISMIP6 forcings until 2100, combined with climate indices from simulations with the MIROC4m climate model until 2300. We then use these forcings to run simulations for the Antarctic ice sheet with the SICOPOLIS model. For the unabated warming pathway RCP8.5/SSP5-8.5, the ice sheet suffers a severe mass loss, amounting to ~1.5 m SLE (sea-level equivalent) for the fourteen-experiment mean, and ~3.3 m SLE for the most sensitive experiment. Most of this loss originates from West Antarctica. For the reduced emissions pathway RCP2.6/SSP1-2.6, the loss is limited to a three-experiment mean of ~0.16 m SLE. The means are approximately two times larger than what was found in a previous study (Chambers and others, 2022, doi: 10.1017/jog.2021.124) that assumed a sustained late-21st-century climate beyond 2100, demonstrating the importance of continuously projected Antarctic climate change in the 22nd and 23th centuries. Within the ISMIP6 community, additional scenarios will be considered, and other working groups will contribute results obtained with different ice-sheet models (tinyurl.com/ismip6-ais-2300).

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Abstract No : 149

The RINGS initiative addresses critical knowledge gaps in the coastal regions all around Antarctica

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Bed topography under the Antarctic Ice Sheet most matters in its margin where oceanic-induced grounding line retreat will occur as a main driver of predicted mass loss from Antarctica in the future. Bed elevations in the ice-sheet margin are, however, little known despite the fact that it is also crucial to estimate ice discharge from Antarctica today. Therefore, there is an urgent need to carry out airborne geophysical surveys in the coastal regions. Such surveys all around the 62,000-kilometer-long margin of the Antarctic Ice Sheet is too big a challenge for any one country alone. SCAR therefore established an action group RINGS in 2021 to generate strong international collaboration. The RINGS initiative aims to carry out three concentric rings around Antarctica to address critical knowledge gaps identified by the IPCC and tipping points of the Antarctic and Southern Ocean system. The primary rings will survey the grounding line vicinity to accurately constrain the current ice discharge. The seaward rings will fly over ice shelves to constrain its mass balance and bathymetry underneath. The landward rings will examine topographic constraints for outlet channels of subglacial meltwater and for marine ice sheet instability for example. Gravimetric and magnetic geopotential fields will also be surveyed to constrain geology and geodynamics, in particular geothermal flux heterogeneity. We present preliminary-compiled outcomes from our workshop in late June on scientific priorities, survey protocols for a suit of geophysical instruments, and survey implementations in different regions.

Accepted as: E-poster Presentation

Abstract No : 624

Assessment of Elevation Change Over Antarctic Ice Sheet Using Exact Repeat Mission and Geodetic Mission of SARAL/AltiKa Radar Altimeter Data

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Polar cryosphere region provides a pristine environment to perform scientific observations which reflects the impact of climate change on cryospheric elements in that region. Variability in atmospheric temperature alters the melting status of overlying snow, leading to change in elevation which is further reflected in the mass balance of the ice sheet. In this study, SARAL/AltiKa radar altimeter 40Hz geophysical data record products for the period of 2013 (Exact Repeat Mission-ERM mode) and 2020 (Geodetic Mission- GM/drifting mode) was used to extract the elevation over the Antarctic ice sheet. A priori available Digital Elevation Model (DEM) from NASA's Ice, cloud and land elevation satellite (ICESat) was used to apply slope corrections on the retrieved elevations, or as a priori topography model. Here, three approaches based on Direct Method (DM) to compute slope corrections were carried out and a comparative analysis was also performed. It was observed that biases from all three approaches deteriorate when slope increases from 0° to 0.85° . This corrected dataset was used to estimate annual average elevation, and further elevation changes over Antarctic ice sheet between year 2013 and 2020. Also, change in elevation was estimated between 2013 and 2020 (SARAL/AltiKa) and 2003-2005 (ICESat) revealed that the inner part is showing negligible change, whereas considerable change was observed at margins. The extracted elevation changes were further categorized to make a comparative analysis over Central and Peripheral regions, and Eastern and Western regions to understand regional anomalies observed in Antarctic ice sheet mass balance.

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Abstract No : 136

Parameterizing Antarctic Energy Surface Mass Balance during past interglacials: a model–data comparison approach

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The spatial pattern of Antarctic Surface Mass Balance (SMB) mainly results from snowfall spatial distribution. Other processes come into play: sublimation of snow, wind-driven snow erosion, melting and refreezing. Most of those processes involve feedbacks within the snowpack and to a lesser extent with the underneath ice once all snow has melted. The computational cost of atmospheric regional simulations is too high for paleoclimatic studies. Here we use a parametrised energy surface mass balance model (with a 1-layer snowpack), EBAL, based on the existing energy balance model SEMIC by Krapp et al. When compared with the SMB computed by a regional atmospheric model such as MAR forced, for example, by ERA–Interim reanalysis data, EBAL shows good agreement, but not in specific areas where high melting rates occur, such as in the Peninsula or for some ice shelves of the West Antarctic Ice Sheet. To solve those issues, a snowpack model is implemented within EBAL. When properly calibrated and validated, EBAL coupled with the snowpack can be a fast model to use over long time frames. The aim of this work is to reduce the necessary input climatic data to simulate recent past Interglacials, forced by PMIP4 experiments, and improve the interpretation of ice core records and the understanding of Antarctic SMB evolution under past warm climatic conditions.

Accepted as: E-poster Presentation

Abstract No : 953

Estimating Ice Discharge from Antarctic Peninsula Using Different Ice-Thickness dataset

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Accurate estimates of ice discharge from Antarctica are crucial to improve the predictions of sea-level rise from ice-mass losses. Ice discharge is usually calculated using velocity fields derived from satellite data, together with ice-thickness at flux gates defined near the grounding lines. In this work, we calculated and compared the ice discharge from the outlet glaciers of the Antarctic Peninsula ice sheet north of 70°S using different ice-thickness datasets, namely Huss and Farinotti-2014, DeepBedMap, Bedmap2 and Bedmachine v.2. For this estimate, we used 368 flux gates in the Antarctic Peninsula, and a common ice velocity field for all the glacier-thickness datasets. The total discharge using Huss and Farinotti-2014, DeepBedMap, Bedmap2 and Bedmachine v.2 ice-thickness dataset were 143.64 km³/y, 125.03 km³/y, 74.94 km³/y and 52.25 km³/y, respectively. For each of the flux gates, we computed the standard deviation of the model mean, normalized by the corresponding mean, and we also computed the mean of the normalized standard deviations of the whole flux-gate dataset, with a value of 1.17. We additionally calculated the normalized mean differences between pairs of models. All differences were within 1.34 and 1.65, except for the difference between Bedmachine v.2 and Bedmap2 with a difference of 0.65. These results indicate a high spread of the ice-flux calculation using different ice-thickness models. We foresee two main ways to overcome this problem. The first is to enhance the acquisition of ice-thickness data in the region. The second is to improve the ice-thickness modelling, combining various approaches.

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Abstract No : 585

Temporal variation of flow velocity of Shirase Glacier, East Antarctica in 2018–2021 observed by Sentinel-1 SAR data

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The Shirase Glacier is one of the fastest ice streams in East Antarctica. Previous research reported that the flow velocities show seasonal variations at the terminus of Shirase Glacier (Nakamura et al., 2022). The seasonal variation has the possibility to be affected by the buttressing effect of landfast ice surrounding the glacier terminus, whereas its mechanism is less understood. Therefore, this study aimed to find out suppressing direct calving of the glacier, which investigated the relationship between the temporal variation of the flow velocity of the glacier and the surface elevation of its surrounding landfast ice. The flow velocity of the glacier was determined using the synthetic aperture radar (SAR) data onboard the Sentinel-1A satellite. The surface elevation of the glacier and its surrounding the landfast ice was measured using the altimeter data onboard the ice, cloud and land elevation satellite-2 (ICESat-2). The seasonal variations of flow velocities were extracted by the 40 km downstream from the grounding line to the terminus of Shirase Glacier. The flow velocity in summer was approximately 0.3 km year⁻¹ faster than that in winter from 2018 to 2021. As a result, the flow velocity increased as the surface elevation of landfast ice in front of the glacier decreased. Hence, this suggests that the thickness of landfast ice affects the strength of the buttressing effect, which means the changing conditions of landfast ice.

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Abstract No : 489

Temporal fluctuations in Dakshin Gangotri polar Ice fronts in Schirmacher Oasis, cDML, East Antarctica.

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Cryosphere is a key indicator of past and present climate variability. These climate variabilities are being indicated by advancing and retreating of ice sheets fronts. The polar ice fronts can also sketch their variable behavior with respect to changing climate. The Dakshin Gangotri Polar Ice Sheet Front (DGPIF) is a tongue shape ice-sheet front in south central part of Schirmacher Oasis, East Antarctica. The ground based monitoring of this ice front is being done from fixed observation points by calibrated digital-tape-distometer. The average annual retreat of DGPIF varies from -0.96m to 1.36m with average net retreat of 21.5m during year 1996 to 2020 with the average rate of retreat is ~0.64m/year. A cyclic pattern of recession has also been recorded with an interval of five years with minor fluctuations within the said interval. Western wall of DGPIF is continuously monitor since 2001 having recession of 42.9m till year 2020 at the rate 2.25m/year. Annual recession of the ice fronts shows similar trend to the surface air temperature as well as ground temperatures of the area. Average net recession of DGPIF is 16.03m, while their adjacent western wall shows average net recession of 42.90m in the same period of observation from 2001-2020. Rate of recession of western wall is higher than DGPIF, lying in same climatic set-up. This may due to their geomorphic position where they layover. The western wall stand as a cliff receives higher amount of solar energy, dissimilar to the valley type establishment of DGIPF.

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Abstract No : 486

Spatio-temporal variation in surface mass balance and ice dynamics of Polar ice sheet in Larsemann Hills, East Antarctica

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Prediction of climate change through the ice sheet surface mass balance is one of the main contributing factor in Antarctica. The research area of ice sheet comprises ~220km² is monitored using 13 stake network and 06 single network to snow accumulation/ablation measurement between Dalk and Polararbroken glaciers, Larsemann Hill, Prince Elizabeth, East Antarctica. The surface mass balance and ice velocity has been calculated from 2018 to 2021. The annual accumulation/ablation data are calculated in ArcGIS for estimation of surface mass balance and ice dynamics. The correlation of glaciological data with meteorological parameter has been interpreted since 2014. Monthly accumulation/ablation rate is not uniform during the period and is being influenced by meteorological parameter including precipitation, wind speed, wind direction and temperature. The net displacement has been calculated 35.23m from 2020 to 2022 and average velocity is 17.61m/y. The ice velocity ranges from 1.11m/y to 33.75m/y. In between 2019 to 2020, average velocity of the ice sheet is 24.3m/y and ranges from 0.78m/y to 61m/y. The higher velocity is observed at the margin of the Dalk and Polararbroken glaciers and interior part of the ice sheet. The general direction of the ice sheet is NNW to North. The net mass balance is 0.088gt and 0.067gt. for 2020 and 2021 respectively. The specific surface mass balance is estimated 0.088m weq and 0.067m weq for 2020 and 2021. Keywords: Larsemann Hill, Mass Balance, Ice dynamics

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Abstract No : 430

Spectral Linear Mixing Model application in passive microwave data to analyze Antarctic surface melting dynamics (1978–2021)

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This study aims to apply a subpixel mixture analysis for melt detection in passive microwave data to analyze the Antarctic surface melting dynamics from 1978 to 2021. We used Special Sensor Microwave-Imager (SSM/I) EASE-grid data and classified ASAR wide swath images, covering the Antarctic Peninsula (AP), in a Spectral Linear Mixing Model (SLMM) for a subpixel analysis of the Wet Snow Zone (WSZ) in the SSM/I images. The components' proportions (fraction images) of endmembers in the study area, namely WSZ, Dry Snow Zone, and rock outcrops, were derived from the classified ASAR images. These fraction images and co-registered SSM/I images (channels 19H, 19V, 37H and 37V), acquired on the same date, were used in this SLMM to estimate the unknown spectral signatures (i.e., brightness temperature on each SSM/I channel). After that, we applied this SLMM to detect the superficial snowmelt in the whole Antarctic continent by using calibrated images of the Scanning Multichannel Microwave Radiometer (SMMR), SSM/I, and the Special Sensor Microwave Imager Sounder (SSM/IS). This dataset allowed a daily subpixel analysis of the superficial snowmelt in Antarctica from 1978 to 2021. The daily fraction images were used to calculate the intensity and extension of the superficial snowmelt for seven different regions: the Antarctic Peninsula, Filchner-Ronne Ice Shelf, Mary Bird Land, Ross Ice Shelf, Dronning Maud Land, Amery Ice Shelf, and Wilkes Land. The most persistent and intensive snowmelt was observed on the Antarctic Peninsula, mainly on Larsen and Wilkins ice shelves.

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Abstract No : 783

Freshwater contributions to the coastal dynamics of the Antarctica Peninsula

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The freshwater contributions to the ocean and the associated variability significantly impacts the oceanic structure, affecting the stratification, circulation, heat, water masses formation, and contribution to sea-level rise. This work aims to improve the understanding of the impacts due to the increased contribution of freshwater to the oceanic system around the Antarctic Peninsula resulting from melting derived from floating glaciers. On this sense, we performed numerical oceanic simulations at AP adjacent oceanic regions (Bellingshausen and Weddell Seas) between 2000–2019. Sensitivity experiments were designed changing the quantities of freshwater input (through variations in heat content under the shelves) on each side of the AP to evaluate the impacts on the near ocean and its contribution to the water masses formed in that region. We used in this study the Rutgers Regional Ocean Modeling System with ice-shelf and sea-ice modules activated. The grid extends from ~97°W–10°W and ~84°S–40°S with a 6.5 km grid resolution. Here we will present the first results and validation of reference simulation, without the variations of heat content under the ice-shelves. Preliminary results indicated that it provided a good representation of the mesoscale ocean processes in the study area. However, the surface temperature over the region of the Antarctic Circumpolar Current appears approximately 3°C higher when compared with the NOAA 1/4° Daily Optimum Interpolation Sea Surface Temperature (OISST), which affects the sea-ice production near this area, along with the simulation. Adjustments to the model settings are being made to reduce this error in the region.

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Abstract No : 421

Influence of summer biogeochemical processes on glacial meltwater composition in coastal Antarctica

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Fjords in coastal Antarctica that receive considerable glacial meltwater discharge from the surrounding glaciers during summer, are likely impacted by the nutrient inputs. We present chemical changes in a supraglacial stream over 30 days of austral summer, along a 1.2 km transect, starting from the ice cap margin in Larsemann Hills and traversing through a melt-pool before discharging into the Thala fjord. Higher Al and Fe concentration and dissolved organic carbon (DOC) were observed in the melt-pool compared to the supraglacial stream owing to longer hydrologic residence time in the former promoting greater sediment dissolution and higher primary productivity ($2.96 \text{ mgC L}^{-1} \text{ d}^{-1}$). Dissolved organic matter (DOM) was predominantly humic-like in the melt-pool with the intensity of humic-like DOM increasing through the melt season. In the supraglacial stream, there was a shift from protein-like to more humic-like DOM over melt season. A concomitant decrease in the DOM aromaticity with a greater prevalence of lower molecular weight compounds with time indicates photo-degradation of DOM during summer. Our results imply that supraglacial biogeochemical processes alter the meltwater composition discharged from the ice sheet. This, together with fast-changing hydrological regimes through the melt season could have important biogeochemical implications for adjacent fjords.

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Abstract No : 991

Analysing aeromagnetic, aerogravity and satellite data as a tool to help constrain subglacial geothermal heat flux (4D Antarctica)

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Geothermal heat flux (GHF), coupled with subglacial topography and hydrology, influences Antarctic ice sheet flow. GHF is related to crustal and lithospheric architecture as well as composition, tectonothermal evolution and heat production. It is also modulated by subglacial sedimentary basins and bedrock morphology. Despite its importance for coupling solid earth and cryosphere studies, our knowledge of Antarctic GHF heterogeneity remains limited compared to other continents- especially in terms of regional scale heterogeneity. Here we present our recent aeromagnetic, aerogravity and satellite data compilations for five study regions, including the Amundsen Sea Embayment sector of the West Antarctic Ice Sheet, the Wilkes Subglacial Basin, (WSB), the Recovery glacier catchment, the South Pole and Gamburtsev Subglacial Mountains and East Antarctic Rift region. We showcase results from our Curie Depth Point (CDP) estimation on a new satellite conformed aeromagnetic anomaly compilation that includes several new datasets. We tested the centroid, modified centroid, Bayesian inversion and defractal methods and compare the results with prior estimates and independent imaging of crustal and lithosphere thickness and geological interpretations of crustal provinces, derived mainly from potential field data. This enables us to discuss if different crustal provinces differ in terms of CDP estimates, or if these are either not or only partially resolved. We conclude that although such approach is relatively low resolution and uncertain, it provides constraints to help upscale (also via wider community driven efforts) to 3D models of GHF heterogeneity and ultimately enhance next generation coupled ice sheet and subglacial hydrology models.

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Abstract No : 215

Evolution of glaciation above Lake Vostok in Antarctica

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Ice sheet formation above the Antarctic Lake Vostok began in the Eocene – Oligocene – 34 million years ago or in the Middle Miocene – 15–13 million years ago. Based on data of glaciological and geophysical studies, the following natural ice sheet layers corresponding to glaciation stages are identified. Ice cover formation caused by a decrease of air temperature and water surface freezing. First layer 3 610 – 3 769 m – “clean” lake ice 2 with water pockets from frozen water and absence of mineral inclusions. Second layer 3 539 – 3 610 m – “dirty” lake ice 1, formed due to water melting/freezing. Characterized by dust and mineral inclusions, thermophilic bacteria and water pockets. Third layer 3 460 – 3 539 m – “clean glacial ice” formed by glacial ice from “Dome B” creeping to the lake. Characterized by absence of a successive paleo-climatic signal and structure of intensive shear deformations. Fourth layer 3 360 – 3 460 m – “clean glacial ice” from atmospheric precipitation forming a relict ice cap. Characterized by absence of a successive paleo-climatic signal 1 256 000 years old. Fifth layer 3 310 – 3 360 m – “clean glacial ice” formed by glacier creeping from Gamburtsev Mountains. Characterized by absence of a paleo-climatic signal and tectonic discord in bedding of ice layers. Sixth layer 0 – 3 310 m – “clean glacial ice” of atmospheric origin. Characterized by undisturbed paleo-climatic signal.

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Abstract No : 940

Glacial surface velocity estimation of Pine Island Glacier by DInSAR and offset tracking using repeat Sentinel-1 images

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Pine Island is known to be one of the fastest receding glaciers in the Western Antarctica region. Synthetic Aperture Radar (SAR) imagery is efficient in the calculation of displacement for fast-moving glaciers. In this work, currently, active Sentinel-1 images are utilized separated by 6 days, acquired in interferometric wide (IW) swath mode, descending path, in Single Look Complex (SLC) data, and Ground Range Detected (GRD) product. The images are taken in September'2019, August'2020, January'2021 for SLC products, and October'2019, January'2020, June'2020, August'2020, January'2021 for GRD products. In this work, glacial surface velocity is estimated by two methods namely by Differential Interferometry Synthetic Aperture Radar (DInSAR), and the offset tracking method. The average velocity calculated by the DInSAR method for September'2019 is 86.908 meters/year, August'2020 is 147.35 meters/year and January'2021 is 158.83 meters/year. Whereas the average velocity calculated by the offset tracking method for October'2019 is 389.89 meters/year, January'2020 is 392.39 meters/year, June'2020 is 384.66 meters/year, August'2020 is 385.36 meters/year, January'2021 is 386.051 meters/year. On comparing with glacial velocity data in Antarctica datasets, results of both the DInSAR method and offset tracking method are giving low values of velocity. However, the DInSAR method is much lower values of glacial velocity than the offset tracking method, which may be accounted for by due inability of the differential interferogram to capture the displacement of very fast-moving glaciers.

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Abstract No : 250

Antarctic ice-ocean interactions, sea level changes and dynamic ice loss with the ice-sheet model Yelmo

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Climate change represents one of the biggest threats that our planet will have to face in the next centuries. In the mid-long term, the Antarctic Ice Sheet (AIS) could be influenced by these climatic transformations and Antarctica could become the main contributor to sea-level rise, especially through the loss of ice that its western sector, the West Antarctic Ice Sheet (WAIS), is experiencing. The WAIS is marine-based and as a consequence strongly exposed to interactions with the ocean. Nonetheless, there is substantial uncertainty in the future contribution of the AIS to sea-level, mainly as a result of a poor understanding of physical processes such as ice-ocean interactions and ice-sheet dynamics. The uncertainty in future AIS projections has been studied in the Ice Sheet Model Intercomparison Project (ISMIP6). The first results showed that the sea-level contribution of the AIS increases with increasing emission scenarios by 2100. Nevertheless, that response to warming varies widely among the models, with the climate forcing and the ocean-induced melt rates being the largest sources of uncertainty. In this study it is investigated the contribution of the higher-order ice-sheet model Yelmo to the ISMIP6 projections, but also the evolution towards 2500 is explored in order to look further into the future. Our results show a strong sensitivity of the AIS contribution to sea-level rise to the calibration of the basal-melting parametrization, particularly remarkable in the WAIS, but in the range of the results reached by other ice-sheet models in the context of ISMIP6.

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Abstract No : 371

Compensating errors in inversions for subglacial bed roughness: same steady state, different dynamic response

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Subglacial bed roughness is one of the main factors controlling the rate of future Antarctic ice-sheet retreat, and also one of the most uncertain. A common technique to constrain the bed roughness using ice-sheet models is basal inversion, tuning the roughness to reproduce the observed present-day ice-sheet geometry and/or surface velocity. However, many other factors affecting ice-sheet evolution, such as the englacial temperature and viscosity, the surface and basal mass balance, and the subglacial topography, also contain substantial uncertainties. Using a basal inversion technique intrinsically causes any errors in these other quantities, to lead to compensating errors in the inverted bed roughness. Using a set of idealised-geometry experiments, we quantify these compensating errors and investigate their effect on the dynamic response of the ice-sheet to a prescribed forcing. We find that relatively small errors in ice viscosity and subglacial topography require substantial compensating errors in the bed roughness in order to produce the same steady-state ice sheet, obscuring the realistic spatial variability in the bed roughness. When subjected to a retreat-inducing forcing, we find that these different parameter combinations, which per definition of the inversion procedure result in the same steady-state geometry, lead to a rate of ice volume loss that can differ by as much as a factor of two. This implies that ice-sheet models that use basal inversion to initialise their model state can still display a substantial model bias despite having an initial state which is close to the observations.

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Abstract No : 778

GNSS Observations of Antarctic Glacial Isostatic Adjustment: Science Requirements Driving Ongoing Observational Constraints

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Geodetic time series from autonomous GNSS systems distributed across Antarctica are revealing unexpected patterns and startling rates of crustal deformation due to GIA. Linked with seismic mapping and derived rheological properties of the Antarctic crust and mantle, and with new modeling capabilities, our understanding of the timescales of GIA response to ice sheet change is swiftly advancing. Rapid GIA response allows for cryosphere–solid earth interactions that can alter ice sheet behavior on decadal and centennial timescales. Continued progress in understanding how such feedbacks may influence future contributions of polar ice sheets to global sea level change requires continuing and expanding our geodetic observations. SCAR and U.S. science vision documents pertaining to the changing cryosphere and future sea level all point to international collaborative efforts as the way to achieve ambitious science goals and extend observational capacities in polar regions. SCAR research programmes facilitated the network vision and collaborative relations that led to the POLENET (POLar Earth observing NETwork) network of geophysical and geodetic instruments during the International Polar Year 2007–08. Can the SCAR INSTANT SRP provide a framework for collaborative initiatives between national Antarctic programs and form a sustainable model for ongoing observations required to meet community science objectives? Let's review critical challenges for modeling the evolution of the Antarctic ice sheet and future sea level, identify the observational priorities to underpin the modeling and establish uncertainties, then consider 'grass roots' science community actions to move international, interdisciplinary frameworks forward.

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Abstract No : 864

Melt-elevation feedback in Western Greenland triggering threshold behavior for substantial, long-term ice sheet loss

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While the existence of threshold behaviors for the long-term evolution of the Greenland Ice-Sheet (GrIS) is still debated, it has long been considered that a tipping point for GrIS instability is reached when its Surface Mass Balance (SMB) becomes negative. Here, we investigate the existence of threshold behaviors and tipping points in SMB for the long-term stability of the GrIS using the Community Ice Sheet Model version 2 (CISM2), forced off-line with SMB calculated with the Community Earth System Model version 2 (CESM2) in a preexisting coupled CESM2/CISM2 simulation under high greenhouse gas forcing. We find that the long-term evolution of the GrIS shows a sharp threshold behavior leading to three main final scenarios: (1) less than 2 m Sea Level Equivalent are lost; (2) nearly 50% of the GrIS volume is lost; (3) more than 90% of the GrIS volume is lost. In the simulations leading to nearly complete deglaciation, the tipping point is passed when the Central-Western ice margin retreats far enough from a stabilizing topographic high. In four of these simulations, the initial integrated SMB forcing is positive, and becomes negative only after 1,000–4,000 years due to the melt-elevation feedback. Associated timescales for deglaciation in these four simulations range between 12,000–40,000 years, whereas when the initial integrated SMB forcing is negative, the ice-sheet deglaciates in 6,000 years or less. Overall, our results show that melt-elevation feedback alone is capable of triggering long-term GrIS deglaciation for relatively modest SMB perturbations, leaving initial integrated SMB positive.

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Abstract No : 481

Separation of Antarctic Ice Sheet mass variation signals via principal component analysis

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How the Antarctic Ice Sheet (AIS) responds to climate change still poses several open questions. Scrutinizing mass variations in Antarctica is required for obtaining new sources that affect mass signals and are difficult to capture, as well as for a better understanding of AIS surface mass balance variability. The Gravity Recovery and Climate Experiment (GRACE) and GRACE Follow-On (GFO) satellite missions and RACMO2.3p2 surface mass balance (SMB) model are two means of providing robust insight into Antarctica's mass change patterns over the recent decades. In this study, interannual mass change patterns from GRACE/GFO and RACMO2.3p2 time series were investigated. The mass changes under investigation are residual time series from which annual, semi-annual amplitudes, offset, and trends have been subtracted and were analyzed by principal component analysis (PCA). The results demonstrate that the remaining variations can be effectively decomposed into several patterns influenced by different physical processes. Ice dynamics, as well as residual oceanic mass signals which were not fully captured by the GRACE/GFO dealiasing products (during data processing), were identified as most dominant signals.

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Abstract No : 1040

Analyzing Antarctic GNSS Velocities Affected by Antenna Icing

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The POLENET/ANET network of continuously operating GNSS instruments span the margin of the East Antarctic craton in the Transantarctic Mountains and across the West Antarctic rift system and its component crustal blocks. The network also spans the drainage basins of the West Antarctic Ice Sheet. GNSS time series of sufficient length are now available to define the horizontal and vertical velocity fields at mm level. However, GNSS signals in Antarctica are commonly affected by polar environmental conditions that result in growth of rime ice on the antenna radome and mast, and in intrusion of blowing spindrift snow and accumulation of ice inside choking antennas even when covered by radomes. Since the discovery of ice intrusion in 2014, mitigation efforts to stop intrusion have been taken, culminating in the decision to begin replacement of choking antennas with sealed GNSS antennas in 2018. Here we analyze the effects on position time series and trajectory models that define crustal motions resulting from removing ice and plugging choking drainage holes, followed by replacing potentially ice contaminated choking antennas. At a subset of locations, time series change quite drastically: some sites lose previously dominant seasonal signals, while others show a change in time series trend. With several years of continuous data now available with the sealed antennas, we can compare velocities before and after the antenna swaps and determine preferred velocities and uncertainties for these ice-biased sites. Improved velocities will yield better understanding of Antarctic crustal motions for implementation into GIA modeling.

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Abstract No : 1026

Influence of ice loading and earth properties on horizontal GPS motions in the Ross Sea region, Antarctica

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ANET-POLENET (Antarctic Network of the Polar Earth Observing Network) bedrock GPS sites in the Ross Sea region of Antarctica are in close proximity to a major LGM load center in the Siple region, and therefore are thought to reflect motion due to GIA. We observe three primary patterns of deformation; 1) motions reversed towards the load in the southern region of the Transantarctic Mountains (TAM), 2) motions radially away from the load in the Marie Byrd Land (MBL) region, and 3) an overall gradient in motion, with magnitudes progressively increasing from East to West Antarctica. We aim to understand these distinct patterns of motion and the causal sources of deformation. We explore ice loading scenarios for the Wilkes Subglacial Basin (LGM time scale) and the Siple Coast (centennial and millennial time scales), using GIA models with 1D earth models. We find that the spatial extent of deformation resulting from Wilkes and Siple loading is significant, but that no 1D model is able to reproduce all three distinct patterns of observed motion at the same time. For select loading scenarios, we also examine 3D GIA models by invoking a boundary in Earth properties beneath the Transantarctic Mountains. This approach accounts for the strong lateral gradient in earth properties across the continent by effectively separating East and West Antarctica into two different earth model profiles, and some models are able to reproduce predicted motions that directionally match all three observed patterns of deformation.

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Abstract No : 857

Migration and characterization of snow megadunes in Antarctica

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Megadunes are distinctive features shaped by the interaction of atmosphere and cryosphere and are only present on the East Antarctic plateau and other planets. In this analysis, we have examined the glaciological dynamic of megadunes and their spectral properties and morphology on areas of the East Antarctic plateau where in the past field measurements were sampled. At first, analysing the spatial and temporal variability of megadune surface parameters, i.e., near infrared (NIR) albedo, thermal brightness temperature and Slope along the Prevailing Wind Direction (SPWD), we performed an automatic detection of the glazed surfaces on the leeward flanks of the dunes, which are known to be ablation areas, showing a persistent Surface Mass Balance (SMB) close to zero or negative. Additionally, using remote and field observations, for the first time we analysed all the components of upwind migration. This analysis was carried out following two different approaches: transect evaluation using field measurements, implemented with DEM results, and applying a feature tracking module on satellite images acquired in the area, providing similar results. These analyses show that the migration is determined by the snow accumulation on the crest and through advancing upwind on the previous windward flanks characterised by glazed surface. Therefore, this research presents relevant implications for SMB estimation and paleoclimate reconstruction using ice cores in the megadune area.

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Abstract No : 600

Antarctic Ice Sheet simulations using Yelmo ice sheet model and a series of IPSL CM5A2 climate simulations between 17 Ma and 14 Ma

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The mid-Miocene Climatic Optimum (MMCO, ~17–15 Ma) and the mid-Miocene Climatic Transition (MCT, ~15–13.5 Ma), represents a period of high policy relevance because of the high atmospheric pCO₂ concentrations. Exploring this period offers the opportunity to investigate the Antarctic Ice Sheet (AIS) response to CO₂ forcings that are close to those projected in the medium to worse case emission scenarios. A set of equilibrium simulations with the 3D ice sheet model Yelmo allows us to study the envelope of the AIS volume and extent during the MMCO (17 Ma) and MCT (14 Ma). These simulations are forced off-line with equilibrium climatic conditions obtained with the Atmosphere– Ocean General Circulation Model (AOGCM) IPSL CM5A2. Two values of the reconstructed atmospheric pCO₂, i.e. 420 ppm and 700 ppm, are prescribed, for an orbital configuration corresponding to minimum and maximum insolation values at 75°S each (9 climate simulations in total). Thanks to these different configurations we simulated the AIS dynamics and the forcing's sensitivity. Results show that at 17 Ma, warmer and more humid conditions cause a significant deglaciation on the EAIS with 700 ppm. So, as expected, the smallest ice sheet is obtained for 17 Ma with 700 ppm but interestingly, the impact of a maximum insolation is more notable at 17 Ma with 420 ppm particularly in the south-eastern part. At 14 Ma, the insolation impact is not very marked, cooler climatic conditions allow the AIS to expand again. This is in agreement with the geological records of the AIS dynamics that reveal a substantial expansion of the ice sheet at the end of the MCT.

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Abstract No : 387

Mixing and transport in a subglacial coastal cavity: Observations from the Kamb Ice stream grounding zone

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Here we report on recent in situ ocean observations from the Kamb Ice stream grounding zone on the eastern shores of the Ross Ice Shelf, Antarctica. The location is an under-ice inlet incised several km inland from the ocean cavity-proper. During a field expedition in the 2021/22 season a borehole through the ice sheet was successfully opened and maintained for over 10 days. Through this we were able to conduct profiling as well as deploy a hydrographic mooring that successfully collected and telemetered data in the months after. Imagery of the seafloor and ice underside provides evidence of a complex range of processes as well as variable ecology. Profiling instruments included conductivity-temperature-turbidity-depth, shear microstructure and acoustic backscatter. Additional sampling included high frequency temperature variability as well as acoustic scanning of the channel dimensions. The narrow channel in the ice sheet is oceanic with a modest signature of meltwater and is stratified into several layers which are generally consistent but vary with the tide. There is a layer with elevated turbidity that looks to be subglacial discharge. We provide estimates of bulk transport as well as rates of mixing and dilution.

Accepted as: Oral Presentation

Abstract No : 183

Modelling water-induced glacier seismic signals with hydrodynamic simulations

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A thorough understanding of the passages and reservoirs of glacier meltwater is vital in assessing ice sheet stability. In particular, the movement of ice sheets through their containing basins is altered by rapid injections of water into the basal environment, either from surface drainage through englacial conduits or from subglacial sources (for example subglacial lake or aquifer discharge). In accordance with this, seasonal accelerations in Greenland glaciers are currently observed in response to summer melting, and the onset of fast-flowing Antarctic ice streams are frequently coincident with active subglacial lakes. This makes the monitoring of glacial hydrology a critical challenge in projecting ice sheet evolution, this being especially true for subsurface water where direct observation and use of satellite imagery become ineffective. Developing complementary methodology for detecting changes in ice sheet hydrology to assist current approaches is therefore a key step in monitoring change that could foreshadow accelerated sea level rise. We aim to model the seismic signatures of moving water by coupling hydrodynamic simulations with seismic wave propagation methods. Detecting surface seismic expressions of hidden and transient subglacial processes offers a pragmatic and non-invasive method for characterising hydrological pathways. Our overall goal is to model the general character of the produced waveforms. We anticipate these indicative models will be a valuable guide for the classification of seismic signals into generative process groups through unsupervised machine learning algorithms. In doing so, and interpreting the information held in seismic data, we can improve the spatial and temporal resolution of glacier monitoring.

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Abstract No : 801

Ice velocity in Antarctica from long timespan historical satellite imagery: the overestimation issue

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In comparison to velocity maps derived from recent satellite images, historical maps, from before the 1990s, generally cover longer time spans (e.g., > 10 years) due to the scarce spatial and temporal coverage of earlier satellite image data. We found velocity overestimations (OEs) in such long-span maps that can be mainly attributed to velocity gradients and time span of the images used. In general, they take effects in places of high ice dynamics, for example, near grounding lines and often in ice shelf fronts. Velocities in these areas are important for estimating ice sheet mass balance and analyzing ice shelf instability. We propose an innovative Lagrangian velocity-based method for OE correction without the use of field observations or additional image data. The method is validated by using a set of “ground truth” velocity maps for the Totten Glacier and Pine Island Glacier. It is demonstrated that velocity overestimations of up to 195 m a⁻¹ for Pine Island Glacier can be effectively corrected. Our experiment results in PIG show that OEs of a 15-year span can reach up to 1,300 m a⁻¹ along the grounding line and cause an overestimated GL flux of 11.5 Gt a⁻¹ if not corrected. When used alongside recent velocity maps of 1990s – 2010s, they may lead to underestimated long-term changes for assessment and forecast modeling of the global climate change impact on the Antarctic ice sheet.

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Abstract No : 789

Tidal flexure of a shear margin: field observations and elastodynamic modelling of Priestley Glacier, Antarctica

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Fast-flowing Antarctic outlet glaciers are restrained in part by lateral drag within shear margins, zones of intense deformation between faster-flowing ice and slower ice or rock. The mechanical properties of shear margins (ice temperature, crystal fabrics, ice thickness) affect glacier sensitivity to ocean or climate perturbations. This study examines the tide-modulated flexure and deformation of a floating shear margin of Priestley Glacier in Terra Nova Bay, Antarctica. We observed 3D ice motion over 18 days with a combination of high-precision GNSS and optical-electronic total station positioning. Precise total-station positioning allows us to observe across-flow ice flexure and surface strain in response to the rise and fall of the ocean tide at diurnal and semidiurnal frequencies. These datasets are used to inform a tidally-forced 2D dynamic elastic bending model of an across-flow section of the glacier. We consider model-simulated vertical motion, horizontal strain and stress states under varying lateral boundary conditions (extent of ice coupling at the margin), and different representations of ice stiffness within the shear margin. Observed ice flexure is concentrated within a narrow, <1 km wide zone, requiring a spatially variable apparent elastic modulus to replicate both observed vertical motion and the magnitude of the observed compression and extension along the ice surface. This analysis suggests that investigations of tide-modulated ice flow and flexure based on vertical ice motion alone, but neglecting horizontal displacement and surface strain, will lead to incorrect conclusions about the elastic properties of ice.

Accepted as: Oral Presentation

Abstract No : 345

On the attribution of ice thickness change to sea-level change.

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Polar ice sheets are integral components of the Earth system. As the geometries of land, ocean, and ice sheets evolve, they must be consistently captured within the lexicon of geodesy. It is essential for estimating the barystatic sea-level contribution from marine ice sheets and understanding their interplay with sea level and solid Earth. Here we present a unified method to accurately compute the sea-level contribution of evolving ice sheets based on the change in ice thickness, bedrock elevation, and mean sea level caused by any geophysical processes. The new formalism can be applied to arbitrary geometries and at all timescales. We consider an example model simulation to show that the new method systematically yields 10 %–15 % more sea-level contribution from the Antarctic Ice Sheet than the conventional methods would predict.

Accepted as: E-poster Presentation

Abstract No : 216

Dynamics of glaciation of Antarctica in the area of subglacial Gamburtsev Mountains – Dome B – Lake Vostok

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Study of the vertical glacial structure above Lake Vostok showed presence of six natural layers of different origin and characteristics, which are presented in the other abstracts of same authors at this Conference 1. By-stage ice accumulation is formed by the glacial flows of different direction and intensity. The entire ice strata of glaciation (at the depth range of current state 0 – 3 310 m) is in the “transit” “flow” state. That is, it does not accumulate but moves in two general flows separated by the subglacial mountain range-ice divide in two directions: in the northern part of the lake to the NNE; and in its southern part from west to east. As a result, a drift-divide forms over the middle part of the lake valley. This conclusion is based on the highly precise multiyear geodetic observations. Radio-echo sounding of the glacial strata and geophysical observations in the deep ice borehole at Vostok station show the existence of differences of the vectors of ice sheet motion by its depth in the layers of the aforementioned natural evolution origin.

Accepted as: E-poster Presentation

Abstract No : 1015

The role of melange in simulation of ice shelf rift propagation

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Laterally propagating, through-cutting rifts govern the iceberg calving component of Antarctic ice-shelf mass balance and determine the geometry of the seaward fronts of these floating ice masses. Despite their importance, the limits of control on rift propagation are neither well-investigated nor well-understood. The present work proposes a novel numerical approach that applies linear elastic fracture mechanics (LEFM) to simulate antarctic ice-shelf rifts, including rift-filling melange. The model is used to consider three cases for a rift in a mid-shelf location: (1) the traditional engineering, void-filled rift; (2) the ocean-filled rift; and (3) the ocean and melange-filled rift. Case (1) reproduces observed rift geometries but places no limit on propagation. In case (2), propagation does not occur (the limit is 0). Case (3) demonstrates how melange introduces a non-zero limit on rift propagation.

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Abstract No : 1055

INCORPORATING ANTRACTIC ICE SHEET DYNAMICS & VERTICAL LAND MOVEMENTS INTO LOCATION-SPECIFIC PROBABILISTIC SEA-LEVEL PROJECTIONS

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Anticipating and managing the impacts of sea-level rise depends critically upon improved understanding of two factors: (1) rate of sea surface elevation change in relation to the rate of coastal land elevation known as vertical land motion (VLM), and (2) the role instabilities, such as Marine Ice Cliff Instability (MICI), may play in the future melting of the Antarctic ice sheet. Coastal zone planners and decision makers urgently require reduced uncertainties in sea-level projections beyond mid-century. Therefore, understanding the key processes that will determining future mass change of the Antarctic ice sheet is primary goal if the SCAR INSTANT Programme. Here, we utilise the vertical velocity field from synthetic aperture radar (InSAR) time series, calibrated with interseismic campaign and continuous cGPS to determine the VLM component for the entire coastline of New Zealand, and some locations in Antarctica. We use the probabilistic projection methodology of Framework for Assessing Changes to Sea-level (FACTS) from the IPCC 6th Assessment Report. We present ensembles of probability distributions of RSL for medium confidence processes for SSPs to 2150 and low confidence processes (that include MICI) for SSPs to 2300. For regions where the absolute rate of VLM is $> 2\text{mm.yr}^{-1}$, then VLM makes a significant contribution to localised RSL projections for all scenarios out 2150. Beyond 2150, and especially for warmer SSP's, the land ice contribution to RSL starts to dominate. This is especially the case where MICI is invoked for Antarctica.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

PHYSICAL SCIENCES

**Radio sciences for
Arctic and Antarctica:
from the atmosphere to
the geospace**

CONVENORS

Giorgiana De Franceschi, Nicolas Bergeot,
Shreedevi P R, Emilia Correia, Domenico Di Mauro,
Renata Lukianova, Sonya Lyatskaya

Accepted as: Oral Presentation

Abstract No : 769

Recent developments towards deciphering the low-frequency radio universe with ALBATROS—an upcoming, high-resolution interferometer observing from Arctic and sub-Antarctic regions.

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The 21-cm signal of neutral hydrogen from Dark Ages—a period preceding the formation of the first luminous objects in the universe—is of prime significance to cosmologists. This signal is thought to peak between 5 and 20 MHz, and encodes a wealth of information about the universe's evolution at small spatial scales. Detection of this signal, however, is a formidable challenge because at such low frequencies, its observation is impeded significantly by terrestrial RFI, ionospheric aberrations, and exceedingly bright galactic foregrounds. Galactic emission at sub-10 MHz is still uncharacterized because of a dearth of high resolution, full-sky maps around that frequency, which precludes efficient foreground removal. ALBATROS is a new interferometer that is being designed to map the full sky at low frequencies with an order-of-magnitude better resolution than current maps. To mitigate RFI contamination, primary ALBATROS arrays will be installed in Axel Heiberg island—located in the high Arctic, and in Marion island—a remarkably radio-quiet sub-Antarctic location. Both arrays have a planned maximum baseline of 20 km for high-resolution interferometry. Such large baselines require the antenna stations to operate autonomously and collect data for subsequent offline correlation. This talk will touch upon the long-term scientific goals of the experiment, provide updates on the development of the correlation pipeline, and demonstrate preliminary baseband and directly correlated spectra from pathfinders at both observing sites. Towards the end, the talk will summarize the ongoing effort to use ORBCOMM satellites to synchronize antenna timestreams with sub-nanosecond accuracy.

Accepted as: Oral Presentation

Abstract No : 1033

Transient behaviour of the concentration of the bipolar small ions monitored at Indian Antarctic station (70. 76°S, 11.74°E), Maitri, and its correlations to radon and meteorological parameters

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Gopi Seemala, Indian Institute of Geomagnetism, Mumbai, India

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Monitoring of the air ions is an important environment observational activity as their production in the atmosphere involves the terrestrial radioactive sources and galactic cosmic ray sources, whereas their loss is influenced by the quality of the air. The present study brings out the diurnal and seasonal variation of the air ions and involved physical processes using data from various complementary experiments carried out at Maitri, Antarctica during December 2018 to February, 2022. The spectral analysis reveals the presence of a diurnal cycle in the concentration of ions during the summer season. The maximum concentrations of negative ions ($\sim 1100 \text{ cm}^{-3}$) and positive ions ($\sim 800 \text{ cm}^{-3}$) are observed in the peak austral summer during local noon and the minimum concentrations, (\sim below 200 cm^{-3}) are observed during the night hours. The diurnal cycle is largely absent in the winter months and the concentrations of negative and positive ions are nearly steady at $\sim 200 \text{ cm}^{-3}$ and $\sim 400 \text{ cm}^{-3}$ respectively. Therefore, an excess of negative ions in the summer and positive ions in the winter are evident. Random Forest Regression technique and Principal Component Analysis reveal that $\sim 80\%$ of the variation in the ion concentration can be attributed to winds and temperature variations. Radon and thoron have a very minimal ionization contribution of about 7.7% and 3.9% respectively as the exhalation rate is considerably low. The source of excess ions could lie in the electrostatic interface effect and the excessive positive ions could be due to the electrode effect.

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Abstract No : 665

Geospace research of Ukraine in Antarctica

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Most part of the geospace scientific activity of Ukraine in Antarctica is conducted at the Ukrainian Antarctic Station Akademik Vernadsky (former Faraday station, UK). The station was transferred to Ukraine in 1996. The State Institution National Antarctic Scientific Center of Ukraine coordinates scientific activity in the framework of the State Special-Purpose Research Programs in Antarctica. The leading institution in geospace and space weather research is the Institute of Radio Astronomy (IRA) NAS of Ukraine. The Ukrainian scientists continue the majority of observations initiated by British Antarctic Survey and implemented a set of new research facilities and types of measurements. At the moment the instrumental park of the station includes: geomagnetic observatory; Dobson spectrophotometer for measurements of ozone content; two ionosondes (old IPS-42 and new portable Doppler digital sounder produced in Ukraine); multi-channel Doppler HF receiver to study long-distance propagation; ELF and VLF wavebands magnetometers for studying of global lightning activity, power line harmonic radiation and the state of lower ionosphere; two frequency GNSS receiver capable to estimate total electron content. The paper discusses in details the current set of research facilities and types of measurements. In the paper we present the scientific results in the fields of troposphere-to-ionosphere energy transfer; using the global electromagnetic resonators as indicators of space weather; global location of powerful lightning discharges; HF propagation; power feeding the ionospheric waveguide; discovery and study of the effect of "self-scattering"; monitoring the spread of man-made radiation to Antarctica and studying of "electromagnetic climate" and "electromagnetic smog".

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Abstract No : 745

Space weather studies at the Troll Ionospheric Observatory in Dronning Maud Land, Antarctica

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The ionosphere is the uppermost, partially ionized part of the Earth's atmosphere. In the polar regions, it is directly coupled to the interplanetary space. Here the solar wind deposits energy into the upper atmosphere and leads to dynamical processes such as plasma instabilities and aurora. The dynamics and structuring are distinct in the northern and southern hemispheres, mainly due to differences in the topology and strength of the Earth's magnetic field. A good understanding of these differences is important for the development of large-scale models for the whole ionosphere and space weather. The ionosphere and the space weather effects related to its coupling with the magnetosphere are best studied at high latitudes. Such studies require a multi-instrumental approach, including radars, optical instruments, radio receivers and satellites. In recent years, we have seen increased efforts within international cooperation in coordinating space instrumentation in Antarctica. As a part of these efforts, a new ionospheric observatory has been established at the Norwegian Research Station Troll in Dronning Maud Land, East Antarctica. We present the first results from space weather studies using data from the All-Sky-Imagers and scintillation receiver at the Troll station and complementary datasets. We also present the future developments within the observatory, including the deployment of magnetometer and ionosonde within the scope of the Troll Observing Network (TONE), which is a large scientific infrastructure project that starts this year. The synergy effects and complementarity between Troll Ionospheric Observatory and other stations in Antarctica and in the Arctic, will also be highlighted.

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Abstract No : 845

First results of RF measurements on board the Ukrainian research vessel Noosfera on the way to Antarctic Peninsula

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The former flagship of Britain's Royal Scientific Navy RRS James Clark Ross was bought in 2021 by Ukraine and renamed to Noosfera. During her first voyage from Ukraine to Antarctica we carried out the RF measurements in various scientific fields. The installed equipment includes high frequency (HF) and very low frequency (VLF) receivers and corresponding antenna systems. HF instrument identical to devices used in the ground-based network of Doppler HF receivers in the Antarctic at the Ukrainian Antarctic station Akademik Vernadsky (UAS), on the Svalbard archipelago, in Ukraine and Africa was deployed on-board. Bistatic sounding of the ionosphere were carried out using signals of time service stations and special transmitters. The range of tasks to be addressed includes studies of the features of long-distance HF propagation, in particular, by scattering on plasma irregularities of various natures, as well as scattering of HF signals by the sea surface waves and to solve the radio-oceanographic problems. We also received the signals of Doppler ionosondes, which are currently operating in Ukraine and UAS, on board the ship. Simultaneous sounding of the ionosphere in vertical and oblique modes with varying distance between the ionospheric reflection points while the ship is moving was conducted. The second line of measurements was the monitoring in VLF band of global lightning activity and the conditions of the lower ionosphere. Together with the already operating three-position (Ukraine-Antarctic-Arctic) ELF system, the land-ship VLF system will essentially complement a synchronous network for monitoring the global thunderstorm activity.

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Abstract No : 898

Poleward Dissemination of the Ionospheric disturbances associated with the 2022 Tonga volcanic eruption

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The polar regions – The Arctic and Antarctica recorded the effects of a major deep-sea volcanic eruption that occurred on January 15, 2022, near Tonga, a Pacific archipelago nation. Active pressure waves emerging from the Tonga volcanic eruption spread concentrically throughout the globe not sparing the polar regions as well, inducing ionospheric disturbances which are detected by the dense network of global GNSS stations. The powerful volcanic eruption caused a jump in the atmospheric pressure at various stations. Maitri, the Indian base station in Antarctica located at a distance of 9784 km from the epicenter has also recorded a leap in the atmospheric pressure accompanied by ionospheric disturbance, nearly 12 hours after the volcanic eruption at Tonga. A similar jump in the atmospheric pressure is also observed in the northern polar region, situated at a distance of 12680 km, ~14 hours after the eruption. The travelling ionospheric disturbances at a speed of 360 m/s persisted for ~12 hours in the northern polar region while the ionospheric disturbances with a speed of 700 & 300 m/s are very feeble in Antarctica and sustained for a lesser time. This study demonstrates that the ionospheric perturbation, albeit direction-specific, has travelled in all directions, especially to both the polar regions, due to the volcanic eruption.

Accepted as: E-poster Presentation

Abstract No : 137

A new Italian INGV installation for geomagnetic field monitoring at Talos Dome, a remote site away from permanent observatories

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In the frame of the PNRA Project “Temporary magnetometer network for longitudinal and latitudinal monitoring in Antarctica” an automatic geomagnetic station for monitoring the Earth's magnetic field variations has been installed in December 2020 at Talos Dome, a remote site on the Antarctic Plateau, about 300 km away from the permanent observatory at Mario Zucchelli Station. This autonomous station has been designed and assembled in the INGV electronic laboratories in Rome, using a vector magnetometer specifically manufactured by Lviv Institute (Ukraine) for very low temperatures and a low-power system supplied by batteries charged by wind generators and solar panels. Data sampling is 1Hz. The achieved goal was to obtain the longest data series and to keep the station working even during the austral winter when the temperature can reach -60°C ; we recorded almost 11 months of data in one year. Another goal was to integrate observatory data and better geomagnetically monitor an Antarctic area. In fact, it is well known that the distribution of geomagnetic observatories strongly favors the northern hemisphere and new station installations in Antarctica are always a useful attempt to balance the geomagnetic monitoring in the two hemispheres. Data from the new station, together with data from permanent observatories, will contribute to improve the analysis of the magnetospheric dynamics and the ionosphere-magnetosphere coupling. Indeed, Talos Dome, together with the Italian Mario Zucchelli Station and New Zealand Observatory Scott Base, constitutes a network along the 80°S geomagnetic parallel, which is interesting for studying the longitudinal propagation of signals.

Accepted as: Oral Presentation

Abstract No : 966

ALBATROS front-end electronics development for low-frequency radio observations from the sub-Antarctic and Arctic

Pamela Yaninska, McGill University

Observations of redshifted 21-cm emission at ≤ 30 MHz are crucial for probing the cosmic dark ages in the history of the universe. The cosmic dark ages began after recombination and lasted until the birth of the first stars. Galactic foregrounds, human-made radio-frequency interference (RFI) and ionospheric interference pose challenges for such low frequency observations. The Array of Long Baseline Antennas for Taking Radio Observations from the Sub-Antarctic/Seventy-ninth parallel (ALBATROS) is a cosmology experiment that will take high-resolution maps of the low-frequency radio sky. The interferometric array is comprised of antenna stations that record and store data independently. The antenna stations will have baseline lengths up to 20 km, allowing for an order of magnitude improvement in resolution compared to other low-frequency sky maps. The ALBATROS installation sites are selected to have minimal RFI and reduced ionospheric activity. In particular, polar or near-polar regions in the winter are promising deployment sites for our antennas. We have installed ALBATROS instrumentation on Marion Island, the McGill Arctic Research Station (MARS), and Uapishka station. A dual-polarization dipole antenna, front-end electronics, back-end electronics, methanol fuel cell and solar hybrid power system, and a custom designed data storage system are the building blocks of each antenna station. This talk will present the ALBATROS instrument design and recent development work on the front-end electronics to improve the low-frequency response. I will discuss instrument performance from field tests and future measurement plans.

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Abstract No : 848

Study of changes in global lightning activity during sudden volcanic eruption.

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Schumann resonances (SR) is the global electromagnetic resonance phenomenon produced by low frequency electromagnetic radiation ($<100\text{Hz}$) generated by global lightning discharges within the Earth-ionosphere cavity. Due to the low attenuation, these radiated signals can be observed anywhere on earth. This phenomenon enables the monitoring of global lightning with a few observation sites around the globe. It is expected that all worldwide lightning contributes to the measured SR field and hence have a main advantage over many other lightning detection methods which have inherent detection efficiency problem. Regular diurnal variation of measured SR field shows the dominance of thunderstorm activities in three major sectors viz. south-east Asia, Africa and South America, however extreme claimant event like super El Niño and sudden volcanic eruption affect the SR measured field. In this work, attempt has been made to study the change in global lightning activity during sudden Volcanic Eruption using SR field data from Indian Antarctic stations.

Accepted as: Oral Presentation

Abstract No : 887

Machine learning for curing scintillation data in SANAE IV Antarctic station

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A Septentrio PolaRx5 Ionospheric Scintillation Monitoring (ISM) receiver, as well as software-defined radio (SDR) ISM receiver, were installed in SANAE IV in 2015 for real-time scintillation monitoring. The system provides scintillation alarms when the amplitude or phase scintillation metrics exceed predefined thresholds. Both receivers have been providing continuous scintillation data products for more than 6 years now. However, these ISM receivers are susceptible to errors due to interference from the environment around the receiver as well as anomalies originating from the satellites and receivers' oscillators. This results in false scintillation alarms raised by the real-time monitoring system. Moreover, when processing the data for scientific studies, the curation of this data is exhausting and time-consuming, especially for such an amount of data. In this paper, we present how we applied a machine learning model, developed using the Septentrio receiver data, to detect scintillation. The model takes as input the ionospheric measurements provided by the receiver (including the scintillation metrics). The decision on scintillation occurrence is thus given not based on the scintillation metric only but based on a wider set of measurements. We investigate the usefulness of each measurement for detecting scintillation by analysing how much the model relies on the measurement for identifying scintillation. The decision mechanism is thus not a simple threshold, but a data-driven model developed by the machine learning algorithm. This model can be used to curate the repository of SANAE IV scintillation data before incorporating the scintillation data in further studies.

Accepted as: Oral Presentation

Abstract No : 590

Polar Cap Patches and Airglow Intensity Variations – A Comparative Study with Ionosonde

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Polar cap patches, a form of ionospheric density structures, have been studied using various techniques over the last 60 years. Those studies accumulated a wealth of information regarding these structures' formation, electrodynamics, and decay. Many of these studies used All-Sky Imager (ASI) measurements using the 630 nm emissions from the F region to identify the patches. 630 nm emission arises from the charge exchange between O^+ and O_2 and recombination, which yields excited O^* atoms in the $O(1D)$ state from which 630 nm emission occurs. The volume emission rate of 630 nm emission is proportional to O^+ density, which is dominant in the F region and the 630 nm emission peak near the F layer peak. This study compares airglow intensity and F layer electron density measured by an ionosonde at Eureka (a polar cap station) over an 11-year period. The comparison yielded results that are not straightforward to explain and contradicts our conventional thinking.

Accepted as: Oral Presentation

Abstract No : 275

Hemispheric Asymmetry in the Cosmic Noise Absorption Response during Intense Solar Flare Events

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Geeta Vichare, Indian Institute of Geomagnetism

Ashwini K Sinha, University of Bahrain

Rahul Rawat, Indian Institute of Geomagnetism

Solar flare releases intense electromagnetic radiation towards the Earth, with emissions being virtually across the entire electromagnetic spectrum. During the flare activity, enhancement in the ionization of the D-region and lower E-region ionosphere takes place over the entire solar illuminated part of the Earth due to the emitted solar EUV and soft x-ray radiation. Such enhancements can lead to the absorption of radio waves passing through the medium. These absorption phenomena generally last for the duration of the associated flare event. Two X-class solar flares were observed on 06th September 2017 and one X-class flare on 10th September 2017. These solar flare events lead to intense ionization across latitudes on the sun-lit side of the Earth's atmosphere. Since, these events occurred during the solar equinox, symmetric spread of radiation is expected across the hemisphere. Riometer datasets of high latitude stations spread across latitudes were taken for the present case study to verify the hemispheric symmetry of absorption of cosmic radio noise in response to such intense solar flare radiations. It was observed that on 06th September 2017, Maitri station (GLat=-70.40; LT=UT+00:44) observed much less ionospheric absorption than its near conjugate station Abisko (GLat=68.40; LT=UT+01:16). For the second event (10th September 2017), no absorption was observed in Maitri since it was in the dusk sector, but the northern hemisphere stations showed appreciable absorption from noon to dusk. This asymmetry can be attributed to the location of solar flare eruption at the surface of the sun.

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Abstract No : 1039

Unusual Stable Auroral Red (SAR) Arc Observed at King George Island during a magnetic storm occurred on May 27, 2017

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During the geomagnetic storm (DST: -125 nT) due to the interplanetary coronal mass ejection (ICME) that occurred on May 27–28, 2017, a Stable Auroral Red (SAR) arc event was observed using an all-sky imager in OI 630 nm emission at the Brazilian Antarctic Station (Comandante Ferraz), located at 62.1°S , 58.4°W (geomagnetic latitude: 48.34°S longitude: 12.05°E), King George Island, ~ 130 km North of the Antarctic Peninsula. The island is located under the mid-low latitude SAR-arc zone, in $L = 2.26$. The SAR-arc started to display at 02:40 UT (May 28) in the southern sky of the all-sky imager field of view, and gradually moved toward the zenith, lasted up to 08:40 UT, and disappeared in the northern sky. Simultaneous, OI 557.7 nm emission measurement did show an enhancement in the southern horizon, but no enhancement in the SAR-arc belt region. The plasmaspheric hiss waves within the inner radiation belt are detected in the center of the South Atlantic Magnetic Anomaly (SAMA), concomitant with the occurrence of this SAR-arc. It means that the pitch angle mechanism driven by hiss waves can be responsible for the low-energy electron precipitation at the Brazilian Antarctic Station, which can be considered the main component in the SAR-arc formation far away from the auroral oval. Also, the particle precipitation is confirmed through the digital ionosonde in the center of SAMA with the auroral sporadic E layer (Esa) presence. Finally, we will discuss the possible physical mechanisms that make the SAR arc reach this region

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Abstract No : 68

Overview of the SCAR Expert Group GRAPE (GNSS Research and Application to Polar Environment) activity 2012–2022

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One particular technological system that has rapidly grown in the last decades is the Global Navigation Satellite System (GNSS). The main threat to the reliable and safe operation of GNSS is the variable propagation conditions encountered by GNSS signals as they pass through the Earth's upper atmosphere, particularly at high and low latitudes and under perturbed conditions coming from the outer space. With the aim of tackling the polar atmosphere and its effects on GNSS-based systems, GRAPE (GNSS Research and Application for Polar Environment) was established as an Expert Group of SCAR (Scientific Committee on Antarctic Research) during the Delegates meeting of the XXXII SCAR OSC (Portland, USA, 2012). GRAPE (www.grape.scar.org), built on the former SCAR Action Group GWSWF (GPS for Weather and Space Weather Forecasting), deals with the multi-instrument monitoring and investigation of the bi-polar neutral and ionized atmosphere, by encouraging the establishment of a permanent network of GNSS receivers for multi-purposes investigations over the Arctic and Antarctica and by involving international efforts within the topic of solar terrestrial interactions and space weather. The main activities of GRAPE 2012–2021 are presented to stimulate discussions and to encourage scientists and research groups to participate in the future actions leading to a possible new SCAR Scientific Research Program (RESOURCE– Radio Sciences Research on AntarCtic AtmosphEre).

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Abstract No : 699

Gravity waves characterization in the lower ionosphere using VLF observations at Comandante Ferraz Brazilian Antarctic Station

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Gravity Waves (GW) affect the thermal structure, general circulation, and the transport of energy of the atmosphere (Alexander et al., 2010). GWs are mainly observed with airglow all-sky imagers, capable of monitoring their activity in nights with clear-sky conditions at about 90 km of height, here using VLF signal analysis, GWs can be characterized by their effects at the base of the ionosphere regardless of atmospheric conditions 24 hours a day. When passing through the region of the VLF signal reflection the GW induces spatial modulations in the neutral density, that affects the electron production rate changing the electron density of the region, which can be detected as fluctuations in the phase and amplitude of the VLF signals. The wave parameters are obtained using Morlet's Wavelet analysis of the VLF signal, from which we obtain the GWs event duration, wave period and morphology. When using data of recordings from different transmitters, such as VLF signals from NPM (Hawaii) and NAA (US West Coast), recorded at the Brazilian Antarctic Station Comandante Ferraz (EACF), can be also possible to determine the direction of wave propagation, which are then compared with features obtained from airglow observations to validate the results. The cases that will be presented refer to a mesospheric front observed on July 10, 2007, and a band event observed on August 18, 2007, both at the EACF which properties were obtained using wavelet analysis applied to VLF amplitude and phase.

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Abstract No : 499

Characterization of the ionosphere response in the South America sector to the 30 March 2022 solar event

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The ionospheric response to the X1 solar event that occurred on 30 March 2022 is analyzed using data from riometers, GNSSs, and ionosondes from high latitudes in the Antarctica Peninsula up to low latitudes over North America (Caribbean region), which are compared with surface magnetic field variations. This event produced a blackout of the HF communication band for about 30 min. The preliminary results show clearly the absorption of the cosmic noise (CNA) at 30 MHz by the riometers operating at the Comandante Ferraz Brazilian Antarctic Station (EACF, 62°05'07" S; 58°23'28" W) and the Island of Culebra (part of the Puerto Rican archipelago – 18°19'03" N; 65°16'40" W). Slight variations in foF2 and in hmF2 were detected by the ionosondes at low- and mid-latitudes. Intriguingly, a pronounced increase in the fminF parameter was detected by the ionosondes at all latitudes. The delta VTEC measurements, from low to high latitudes in the AS, show significant variations during the CNA observed at EACF and Culebra, which accompanied the H-component variations of the surface magnetic field. Delta VTEC presented variation in close association with CNA, but the H-component presented a complex variation showing latitudinal differences. The short wave blackout has a close temporal association with the observed CNA.

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Abstract No : 905

Simultaneous ground-based optical and SuperDARN observations of the interplanetary Shock Sudden Compression

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Interplanetary shocks or solar wind dynamic pressure pulses have prompted impacts on Earth's magnetospheric and ionospheric environment, especially in causing dynamic changes to the bright aurora and ionospheric convection transients in the polar ionosphere. The auroral phenomenon associated with shock impingements, referred to as shock aurora, exhibits distinct signatures differing from other geophysical features on the dayside polar ionosphere. Shock aurora provides a direct manifestation of the solar wind-magnetosphere-ionosphere interaction. imagers onboard satellites can obtain the associated large-scale auroral characteristics during shock impingement on the magnetopause. Therefore, auroral data from satellites are very useful for surveying the comprehensive features of shock aurora and their general evolution. Nonetheless, the ground-based high temporal-spatial resolution all-sky imagers installed at Antarctic and Arctic stations play an essential role in revealing medium- and small-scale characteristics of shock aurora. Here, we will show shock aurora imaging signatures measured mainly by ground-based all-sky imagers and simultaneous ionospheric plasma convection responses observed by Super Dual Auroral Radar Network (SuperDARN).

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Abstract No : 426

Ionospheric effects of the 04 December 2021 Solar Eclipse observed at the Brazilian Antarctic Station

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The ionospheric impact of the total solar eclipse occurred on 04 December 2021 in Antarctica was monitored at Comandante Ferraz Brazilian Antarctic Station (EACF), where the Sun was 85% occulted by the Moon. The ionospheric behavior was monitored using measurements of Total Electron Content (TEC) and amplitude and phase scintillation indexes using a Novatel GNSS receiver. The analysis considered only visible satellites with elevation above 25 degrees at EACF. Results from Global Positioning Satellites (GPS) suggest that the ionospheric effect of the eclipse was more pronounced on the satellites orbiting the northern and eastern sectors of EACF. During the eclipse, there were three satellites which transits covered the full period of occultation. Two of these satellites were in their ascending phases (from 35° to 69° and from 47° to 67°) and one in its descending phase (from 78° to 40°). It can be observed from TEC and differential TEC data, a significant fluctuation during the occultation. Others satellites were available from the beginning until the maximum occultation, one in its descending phase (from 48° to 28°) and one in its ascending (from 28° to 30°) and descending phase (from 30° to 27°). There were also TEC fluctuations present during their observed time. Despite the low elevation of the sun at EACF, 4.4° at the maximum occultation, the ionospheric behavior was still affected by the eclipse.

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Abstract No : 455

Radio Sciences Research on AntarCtic AtmosphEre

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We report the proposed establishment of a Programme Planning Group for developing a SCAR Scientific Research Programme (SRP) entitled “Radio Sciences Research on AntarCtic AtmosphEre” (RESOURCE). The proposed SRP aims to gather the communities that investigate the Arctic and Antarctic atmosphere, using radio probes into a shared initiative. The scope is to improve the current understanding of the polar atmosphere by sharing the expertise and the experience achieved by several scientific teams in the world, thus facilitating the advancement in the field and avoiding any duplication of activities already in action. SCAR is the best platform to create the necessary environment to assess the current understanding and to address the efforts required to fill the gaps. The combination of radio techniques enabled by ground and satellite-based sensors have proved to be very effective when probing the lower, middle and upper atmosphere. In parallel, several scientific communities using radio techniques spent significant efforts to remove “atmospheric noise” to extract the desired information from their measurements. However, these communities do not sufficiently interact to share resources. RESOURCE aims to take advantage of the experience of the SCAR Expert Group GRAPE (GNSS Research and Application for Polar Environment). Thanks to the ongoing RESOURCE initiative, a core group of about 40 scientists from all over the world just submitted for publication a survey to highlight the importance of conducting integrated and multi-disciplinary research to enhance the current capability of investigating the atmospheric dynamics in polar regions from the troposphere up to the plasmasphere.

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Abstract No : 594

Magnetic field mapping of the Argentine Islands shelf zone, West of the Antarctic Peninsula

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The magnetic field of Antarctica is studied by the international ADMAP program to construct of magnetic map of the continent. A piece of important additional information contains the results of magnetic surveys conducted by different countries within certain parts of Antarctica. Ukrainian Antarctic Station "Akademik Vernadsky" locates in the Antarctic Peninsula (AP) with its giant magnetic anomaly over Antarctic Peninsula Batholith. The latter displays a subduction-related Mesozoic-Cenozoic magmatic arc on the ancient margin of Western Gondwana. We constructed a detailed magnetic map of the anomalous magnetic field for the area based on the magnetic survey conducted with Zodiac boats. Analysis and zoning of the magnetic map, using geological data on the rocks exposed on the islands, and their magnetic properties from laboratory data, allowed to identify of characteristic anomalies of the magnetic field and their origin. The most ancient volcanic rocks of the Jurassic-Lower Cretaceous age relate to bands of the negative magnetic field of N-NE extension. The Lower Paleogene granitoids creates a positive magnetic field with a large number of local anomalies over the gabbro bodies of the Lower Cretaceous age. Performed 2D magnetic modeling has shown that magnetic inhomogeneities in the upper crust could have magnetic susceptibilities in the range of 0.005-0.42 SI. Interpretation of the magnetic field pattern shows an orthogonal system of tectonic faults including the main NE fault along the Penola Strait (along the AP coastline) and three intersecting faults, associated with different stages of the AP continental margin evolution.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

GEOSCIENCES

**Surficial processes-geomorphology,
chemical weathering, exposure age
dating, and permafrost dynamics**

CONVENORS

Berry Lyons, Mauro Guglielmin, Marc Oliva,
Dan Morgan, Melisa Diaz

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Abstract No : 976

Geochemical characterization of marine sediments in Port Foster Bay, Deception Island, Maritime Antarctica

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Deception Island, located in the South Shetland archipelago in Maritime Antarctica, is one of the most active volcanoes in the Southern Ocean. As a result, dozens of eruptions have been recorded in the last centuries, the last being the most representative of the late 1960s and early 1970s. Understanding the climatic functioning of the island from its sedimentation environment is essential to trace parameters on the influence of climate variability and volcanic action on regional warming and glacier melting. Sediment marine samples were collected during Brazilian Antarctic Expeditions XXXII (2013/2014) and XXXVI (2017/2018) with box-corer in central and coastal areas of Port Foster Bay. Geochemical analysis was employed with Wavelength Dispersive X-ray Fluorescence (WDXRF) and X-ray diffractometry. Subsequent geochemical proxies, such as the elemental Fe/K ratio and Chemical Alteration Index (IAQ), were used to estimate the chemical weathering conditions in sediments. The results suggest the geographical location of the points and indicate incipient chemical weathering in the samples. Considering the high sedimentation rates in Port Foster Bay, according to the literature, we can infer that this configuration is the result of the last volcanic activities of the 1960–70s, being the first centimeters of the cores formed by volcanic material, therefore younger and slightly altered.

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Abstract No : 334

A review on glacial exposure ages of Dronning Maud land using In situ ^{10}Be and ^{26}Al cosmogenic nuclides: implication to paleoclimate

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In situ cosmogenic nuclides have been extensively used to date quaternary deposits in Antarctica to understand the evolution of Antarctic ice sheet during Quaternary and shed light on the application of exposure dating. The current review focuses on ^{10}Be and ^{26}Al exposure ages from Dronning Maud land. Sparse records constrained from Nuntaks and few Oasis provide a limited information of glacial fluctuation during Holocene period. Exposure dates from Donning Maud land and Sor Rondanne Mountains reveal ice sheets retreated more than 400 meter during Pleistocene possibly due to the reorganization of southern ocean cooling. High concentration of cosmogenic nuclides at Peterman Kitten Mountains suggest low erosion rates. This could be due to the hyper arid and cold conditions. The results also indicate that since LGM ice surface has lowered approximately 50m which possibly started after 14ka. This implies that EAIS in Queen Maud Land was not a major contributor to post glacial rise in sea level. It is also inferred that Grounding line of ice sheets was close to the present day by 5ka. However at Weddell Sea it was towards seaward. Keywords: In situ ^{10}Be , ^{26}Al , Antarctica, Dronning Maud land, Exposure dating

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Abstract No : 945

Soil–landform–vegetation relationships and mapping on Harmony Point, Maritime Antarctica

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Pedogenic and geomorphic processes related to permafrost and the Antarctic vegetation are indicators of environmental alterations in the Maritime Antarctica region. We mapped the soils, landforms and plant communities in Harmony Point (HP), Nelson Island, and analyzed their relationships. Soils were classified (Soil Taxonomy). An 0.05 m resolution mosaic was obtained through Unmanned Airborne Vehicle imaging. The geomorphological mapping was obtained through photointerpretation and field observations. The soil mapping was obtained using soil classes, geomorphological map and image mosaic. We applied semiautomatic object-based classification for the vegetation mapping, using field descriptions, image mosaic and GRVI image. Marine terraces (21.4% of the total mapped area) predominate in the coastal environment, where shallower, sandy and eutrophic soils (Entisols) occur. Lichens dominate in rocky cliffs and outcrops, carpet subformation (CS) in the plains, and *Prasiola crispa* occur around penguin rookeries. In the periglacial environment, patterned ground was the most extensive (16%) landform, where more gravelly, silty, clayey and less acidic soils (Gelisols) predominate. Lichens, carpets and moss turf subformation (LCTS) predominates and are spatially distributed according to soil moisture content. Rock outcrops of the platforms (8%) are occupied by flying birds, favoring the formation of P-rich ornithogenic soils in the slopes. The LCTS predominates on the Entisols of the rock outcrops and the CS on the Gelisols and Inceptisols. *Prasiola crispa* dominates around bird nests. The more developed soils (Inceptisols) occur in the rock outcrop slopes and present dense and diverse plant communities, due to guano nutrient input and soil moisture content.

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Abstract No : 952

Spatio-temporal analysis of Surge and Calving dynamics of Tunabreen glacier in Svalbard

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The present study is based on temporal change in frontal part location and variations in surge and calving activity of the Tunabreen glacier. This is a tidewater glacier and forecasted by previous studies to surge in 2040 due to its surging cycle of 35 years, but in 2017 it surged dramatically. To observe this dynamic change, satellite data from 2015 to 2019 (Landsat 8 and Sentinel 2A) have been analysed and calculated the movement of the frontal part and velocity estimation using the feature (optical data) and offset tracking methods. The frontal part of the Tunabreen glacier has retreated 4.08 km from 1936 to 2016 observed by historical aerial photographs. An acceleration in the retreat occurred from 1976 to 2016 by 2.48 km. In 1976, the surrounding 5 glaciers were part of the Tunabreen glacier system but now they all are separated and have their own snout. VonPostbreen (to the East of Tunabreen) retreated as much as 6.07 km (1936–2016) other than five glaciers. Now Tunabreen is in the surging stage and the front has advanced by 1.40 km from June 2016 to July 2019. This changing pattern draws attention to a comprehensive study of this glacier and its neighbours. The results are correlated with meteorological data obtained from eKlima website that provides AWS data from the Svalbard region near the glacier. Glacier velocity from optical data has been obtained during the melting time (June–July) and surging time (February–March). The maximum velocity is calculated as 1.92 m/day (2015–2016) and a minimum of 1.22 m/day (2016–2017) from the feature tracking method. Keywords: Surging, Landsat, Sentinel, SAR, Calving, Tunabreen.

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Abstract No : 13

Machine learning for GPR signal analysis

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GPR applications in extractive industries geosciences hydrocarbon ,minerals and mining,coal,geothermal energy resources, geotechnical and environmental engineering, hydropower dam investigation, glaciology ice sheet thickness measurements,pedology soil science and subsurface water,etc Ground Penetrating RADAR GPR signal analysis is like seismic imaging.Electromagnetic(EM) signal passes through the ground in a diffusive manner around frequencies 10MHz. EM signal propagates like wave which inherits diffraction, refraction and reflection around 100MHz-10 GHz(Mega to Giga Hertz-Georadar). Independent component analysis and principal component analysis is employed for GPR signal processing to rectify cluttering effect. Wow effect low frequency noise dewow Filter Empirical Mode Decomposition nonlinear nonstationary signal processing, diffraction imaging, full waveform inversion, tomography, drones GPR airborne survey,Microsoft kinect sensor, GPR Signal analysis by artificial intelligence machine learning ,deep learning, statistical learning,etc. . Machine learning ML in seismic interpretation uses computer algorithms for understanding the relationships between large amounts of complex interrelated subsurface geological information data.Artificial intelligence adaptive, cognitive science applications for geosciences subsurface imaging and interpretation,Artificial Neural Network ANN-CNN Convolutional Neural Network,DNN Deep Neural Network, ResNet Residual Neural Network, unsupervised and supervised machine learning, deeplearning, reinforcement learning for seismic imaging and inversion, seismic attributes ,seismic interpretation, reservoir characterization, geosciences data analytics ,bigdata analytics,data assimilation modelling and simulation,etc. Physics Informed Neural Network PINN ,greybox model [whitebox-physics,blackbox-data, black+white= grey], Graph Neural Network GNN machine learning for subsurface imaging and interpretation. GPRInvNet,GPRNet deep learning based GPR data inversion,GPR radargram analysis by machine learning,etc.

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Abstract No : 57

What are the products of the Chemical Weathering of Aluminosilicate Minerals in the Streams of the McMurdo Dry Valleys

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Research since the early 2000's by a number of McMurdo Dry Valley's (MCM) LTER scientists have clearly demonstrated that chemical weathering of alumino-silicate minerals takes place at high rates when liquid water is present in stream channels of Taylor and Wright Valleys. These processes are thought to primarily occur in the hyporheic zones of these channels where waters of differing residence time react with fresh mineral surfaces. Although there has been speculation that freeze/thaw action may also play a role in weathering processes, little work has been done to establish this. We present three lines of evidence suggesting that the freeze/thaw process in the stream channels may exert a control on the high alumino-silicate weathering rates observed. Firstly, we have run a series of laboratory experiments simulating freeze-thaw, as well as a frozen control, on crushed igneous rocks from the MCM. The freeze/thaw samples have much less H_4SiO_4 than the control over time, suggesting removal of dissolved Si through freezing. This loss has previously been reported by other authors. PHREEQC calculations of the major streams in the valleys shows continual undersaturation with respect to amorphous SiO_2 as well as primary minerals found in the stream sediments. Finally SEM images and EDX spot analyses of reacted surfaces suggest the presence of precipitated amorphous phases coating some of the stream sediments. All of these data imply that freeze/thaw cycles in these streams during the austral summer remove previously solubilized H_4SiO_4 , thus potentially increasing

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Abstract No : 904

Alarming rate of disintegration process along Prince Harald Coast and Shirase Glacier, East Antarctica

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Ice shelves and floating glaciers fringing the Antarctica are major source of the rise in sea level by constant supply of ice mass from ice sheet into the ocean. In this case study, Prince Harald Coast and Shirase Glacier (Lat 69°45'10.57"S Long 36°44'58.07"E nearby Syowa Japanese Research Station) is chosen which comprise a portion of the coast of Queens Maud Land Antarctica. RAMP (1997) mosaic image along with monthly time series of Sentinel-1 A/B images (total of 80 images) from 2015–2022 were analyzed. We observed that Prince Harald Coast and Shirase Glacier has been constantly disintegrating and losing mass in Lutzow–Holm Bay from 1997 to 2015. Calving observed in 2015 was not so substantial, however 2016 showed a number of small/big calving events. Shirase Glacier had a major loss in the month of May 2017, whereas some new calving fronts were developed in 2018, followed by release of more Ice parcels in 2019 and 2020. Observations indicated that huge rifts are getting developed from 2021 to 2022 and expanding at an alarming speed, signifying possibility of more calving events in future. Further study using InSAR data can be carried out to understand the forces acting on the ice surface. This study indicates that East Antarctica is also showing significant disintegration at number of places along the margin covered by two Indian Stations Maitri and Bharati.

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Abstract No : 817

Dating alpine glacier moraines in lower Taylor Valley: Implications for regional climate and proglacial mega-lakes during the Ross 1 glaciation

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During the Ross 1 glaciation, the northward advance of the Ross Ice Sheet is hypothesized to have altered weather patterns in the McMurdo Dry Valleys of Southern Victoria Land, leading to a decrease in precipitation and the retreat of local alpine glaciers, causing them to be far less extensive than they are today. At that time, large proglacial lakes are thought to have existed in several of the Dry Valleys, including Glacial Lake Washburn (GLW) in Taylor Valley. New data from cosmogenic nuclide dating of moraine deposits indicate that certain alpine glaciers in lower Taylor Valley were in fact far more advanced during the latter part of the Ross 1 glaciation than they are today. The advanced position of Canada Glacier during this time may have acted as a barrier preventing GLW from penetrating up-valley into the Bonney Basin, leading to a much less extensive than hypothesized proglacial lake bound to lower Taylor Valley.

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Abstract No : 942

Landscape influence on ornithogenic soils in Harmony Point, Maritime Antarctica

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The bird influence is one of the main forming factors contributing to pedogenesis in the ice-free areas of the Maritime Antarctica region: a well-known process called ornithogenesis. Here, we analyzed the ornithogenesis degree of the soils of Harmony Point (HP), Nelson Island, emphasizing the soil-landscape interactions. Soil profiles were collected at different environments under penguins, petrels and kelp gull's influence. Morphological, physical, chemical and mineralogical analysis were applied. The soils were classified according to Soil Taxonomy. The marine terraces soils were classified as Entisols. They presented high amounts of coarse sand and gravels and single grain structure, due to marine deposition. Higher pH and base saturation are associated with fresh guano deposition in present day penguin rookeries. The soils of the patterned ground area under bird influence were classified as Umbriterrubels and are characterized by higher clay+silt contents and available P, due to an intense penguin influence. Soils of the rock outcrop slopes of the platforms were mainly classified as Humiglepts. Their characteristics are associated with a significant vegetation influence (moss carpets and turfs), evidenced by high contents of total OC and N, and CEC, and greater weathering due to phosphatization, evidenced by lower pH and presence of crystalline Fe-Al-phosphates minerals. Contents of P were higher in surface horizons at current bird influence areas and increased with depth at past bird influence areas. The development of ornithogenic soils in HP is driven by landscape stabilization and intensity of bird activity, leading to vegetation occupation and, consequently, increasing of pedogenesis.

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TEMPERATURE BEHAVIOUR AND COLLAPSE OF BOECKELLA LAKE, TRINITY PENINSULA, NORTHERN ANTARCTIC PENINSULA

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This work presents climatic and landscape information of the deglaciated area of Boeckella Lake, Trinity Peninsula, Northern Antarctic Peninsula, based upon the interpretation of near-surface air temperature indices from Hope Base Meteorological Station for the period 1971–2016 (maximum and minimum, anomalies, Positive Degree Days, Freeze–Thaw Days, and 5th and 95th percentiles), and Landsat imagery from 2003, 2015 and 2021. It is considered the relationship between variability and change of annual and monthly temperatures and the Boeckella Lake disappearing. Rising temperatures since the mid-20th-century in the Antarctic Peninsula region have generated extensive ice-free areas, and consequently, more exposure to the atmospheric and erosive events. Boeckella Lake, the largest water body, and former water supply to the Argentine Antarctic Hope Base, had 67.454 m² and maximum depths between 7 and 9 m. After two events of overflowing since the beginning of 2000s, the lake began to dry up and shrunk into two separated ponds: from 44.060 km² in 2003 March to 5330 km² in 2021 March. The lake floor and the past levels became exposed due to the fall in the water level. Based on the statistical analysis of the temperature time series, it is inferred that the shrinkage of the Boeckella Lake reflects the regional warming conditions, especially from the mid-1990 decade –1997 as the “breaking point”. The minimum temperatures raised, in special, in the October–March period, whereas no significant change was detected in the maximum temperatures over the same period, except for the extreme temperature peaks in 2012 and 2016.

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Abstract No : 680

The provenance of clay-sized sediments in the front end of major ice shelves around Antarctica and differences in chemical weathering intensity of their source regions

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Geochemical observations of continental outcrops and marine sediments provide insights into the nature of bedrock and weathering in Antarctica. We characterized the provenance of the surficial fine-grained detrital sediments in the front ends of major ice shelves in the Amundsen Sea, Ross Sea, and Prydz Bay sections through comparisons to proximal rocks using the elemental compositions, as well as the Sr and Nd isotopic compositions, of the clay-sized ($<2\ \mu\text{m}$) fraction, rock samples, and bulk sediments and some residual fractions. We used the Li and Mg isotopes and the Chemical Index of Alteration (CIA) of clay-sized sediments to investigate the differences in chemical weathering intensity of the sourcing areas. The clay-sized sediments in the Western Amundsen Sea shelf are largely from the Eastern Amundsen Sea coast. The Western Ross Sea can receive sediments from both East Antarctica and West Antarctica, while the clay-sized fractions in this study are mainly from southeastern Victoria Land, transported northward by bottom currents. The contribution from coarse ice-rafted debris (IRD) is minor, possibly because of blocking by the Drygalski Ice Tongue. The clay-size sediments of Eastern Prydz Bay are largely contributed by Princess Elisabeth Land and western Wilhelm II Land, while those in Western Prydz Bay are possibly derived from the Lambert-Amery Ice Shelf system and the western coast. These very fine-grained sediments are generally affected by oceanic currents (e.g., Antarctic Coastal Currents and Antarctic Bottom Currents). The continent of the Amundsen Sea sector (West Antarctica) presents higher $\delta^{26}\text{Mg}$ and CIA, and lower $\delta^7\text{Li}$ than those of the Ross Sea and Prydz Bay sector (East Antarctica), suggesting more intensive chemical weathering may have occurred in West Antarctica.

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Abstract No : 58

Processes driving ice-free Antarctic surface water chemistry and projected future changes

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Polar regions are highly sensitive environments that are showing signs of alteration due to climate change. This will affect ice-free Antarctic surface waters due to their direct connection to the surface environment and atmosphere. Our research aims to provide a cohesive meta-analysis and overview of 1) the distribution of various surface water chemistry parameters in ice-free freshwater environments in Antarctica, 2) the processes driving the water chemistry and hydrology of these environments, and 3) the likely impacts of climate change on these environments in the future. Median concentrations of sodium and chloride in Antarctic surface water environments are particularly high compared to global rivers, suggesting predominant sea-spray aerosol inputs into these low elevation and usually coastal environments. Other major processes identified as affecting Antarctic surface water chemistry in the literature include evaporation and precipitation, water-rock interactions, snow melt and groundwater inputs. Under future climate change scenarios, temperatures at current Antarctic surface lake locations are projected to increase by 1.2 – 5.6 °C. This could dramatically increase liquid water availability, which can trigger a cascade of long-lasting impacts including reduced ice cover, bedrock weathering/pedogenesis and vegetation growth and expansion. As a result, nutrient availability in Antarctic surface waters is expected to increase. Furthermore, temperature increases are likely to result in increased numbers and sizes of meltwater lakes and streams along the coast, and lead to the appearance of ice-free lakes and streams higher at elevations and further inland where IPCC projections show temperatures could increase by 6°C.

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Abstract No : 695

Sequential bedform development in mixed turbidite–contourite systems: An example from the Cosmonaut Sea, East Antarctica

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Mixed turbidite–contourite depositional systems are commonly found on continental margins, but their bedforms and associated sedimentary processes have not been studied in depth. In this work, we used multibeam echo– sounder, sub–bottom profiling, and multichannel seismic data from the continental rise of the Cosmonaut Sea, East Antarctica, to (1) identify primary bedforms in a combined–current (i.e., turbidity current + contour current) channel–levee system and (2) infer bedform–associated sedimentary processes. Within turbidite channels and on adjacent levees and distal overbank deposits, scours, furrows, and sediment waves of varying dimensions and trends were identified. These bedforms are interpreted to have formed in two steps, which have been likely repeated over and over again through time. First, scours and sediment waves within the channels were formed by turbidity currents, while sediment waves on adjacent levees were likely formed by synchronous interactions between overspilled unconfined turbidity currents and the westward Antarctic Bottom Water (AABW) contour current. Second, after waning of the episodic turbidity currents, AABW flow created a field of erosional furrows on a distal overbank, with these furrows truncating the large field of sediment waves earlier generated by the combined flow of interacting currents. Bedform locations, orientations, and truncating relationships are key for identifying the likely origins of mixed–system bedforms.

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Abstract No : 152

Lake ice-phenology in Fildes Península, Maritime Antarctica, using TerraSar-X and Sentinel-1 images and fieldwork observations

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The work aims investigate the ice-phenology of the sediment and rock-bound Antarctic lakes in ice-free regions of the Fildes Peninsula, on Maritime Antarctica, using TerraSar-X and Sentinel 1 images. These images were processed in SNAP, while the meteorological data were obtained from the Eduardo Frei Montalva Base. The backscatter values for open-water and ice-covered surface targets in lakes was obtained from TerraSar-X (TSX) and Sentinel 1A - EW (S-1) images to evaluate the relationship between backscatter and meteorological data. Fieldwork observations of lakes made during austral summer 2015. Backscatter threshold of -32 dB to -21 dB was obtained for open water in the lakes through the TSX image, although, for Sentinel-1, there was a range from -18 dB to -15 dB. S-1 provided conditions to map challenges of some small size glacial lakes. The TSX image is the most suitable for monitoring lake phenology, due to its spatial resolution. The geomorphological and meteorological conditions, especially wind, snow precipitation, and temperature changes, represented significant changes in the backscatter values. TSX and S-1 images are highly complementary to monitor changes in glacial lake characteristics. The number and area of lakes has grown in most regions of the King George Island during the last decades due to the ongoing atmospheric warming and retreating glaciers. It is therefore important to identify and monitor the ice-phenology these lakes.

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Abstract No : 662

Glacial history, soil development, and rates of geomorphic activity in Ong Valley, Antarctica

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We present data on the glacial history, soil development, and rates of geomorphic activity in Ong Valley, an ice-free dry valley in the Central Transantarctic Mountains. Ong Valley contains a sequence of three tills (oldest, middle, and youngest), two of which are underlain by relict glacial ice (the middle and youngest drifts). We use the concentration of cosmogenic Beryllium-10 and Neon-21 in quartz from glacial boulders in moraines and from the middle of the drifts to determine the exposure age of the glacial tills. We determine exposure ages of 10–20 ka, > 2 Ma, and > 6 Ma for the youngest, middle, and oldest tills, respectively. We also collected bedrock samples above the glacial limit and calculated long-term rates of erosion using the concentration of cosmogenic Ne-21 in quartz from the bedrock, yielding rates of 0.14 – 0.41 m/Ma. We studied the provenance of the glacial tills, colluvium, and glacial ice with grain size, major and minor elements, and detrital zircon populations. These results indicate that the source material of the three tills is the same, which we interpret as indicative that the Argosy Glacier flowed the same way to deposit each of these tills. Major element concentrations are used to calculate the chemical index of alteration of the bedrock and tills, which indicate a weathering-limited environment in Ong Valley. We measured the concentration of water-soluble aerosol salts in the clay fraction of the tills, which generally increase with distance from the modern ice front.

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Abstract No : 273

Glacial landforms of Nubra valley, Ladakh, India

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The Nubra valley known for one of the largest glaciers on the continents (Siachen, 72 km) is a mystifying glaciated landscape sandwiched between the Karakoram and Saltoro mountain ranges. Previous studies have reported widely differing and generalized interpretations of the glacial landforms and current understanding of the glacial events in this area is partly restricted by the absence of field observations aided detailed glacio-geomorphological landform mapping . To address this issue extensive field work was carried out along the Nubra valley and some small valleys of Karakoram covering an area of > 250 km². Glacial landform mapping with excellent field photographs combined with interpretation of fine resolution satellite imagery and Digital Elevation Models (DEMs) has revealed a variety of glacial, fluvial, eolian, periglacial and permafrost landforms within the valley. We have identified different glacial sediment-landform assemblages (moraine and debris types), lake sediments indicating damming of valleys, rock glaciers, glacial benches, roche moutonnées, trim lines, and dissected glaciogenic material etc. Among the most remarkable landforms annual moraines, hummocky moraines, esker-like landforms, flutes, kettle ponds, dirt cones, glacifluvial deposits, pronival ramparts and collapsed moraines are found. The present work provides detailed observations on the Nubra valley glacio-geomorphological aspects particularly the glacial landforms and processes operating in this vastly glaciated terrain. These landforms directly and without any doubt define the past extent and the relative thickness of ice bodies in the Nubra valley.

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Abstract No : 51

Tephra layers in Perunika Glacier, Livingston Island, Antarctica

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Perunika Glacier is an 8 km long and 3 km wide roughly crescent-shaped glacier in Livingston Island, South Shetland Islands, Antarctica. The glacier contains several dark layers of unconsolidated ash (tephra), resulting from volcanic activities at Deception Island, a active volcano in Bransfield Strait. The ice and tephra stratigraphy seen in the ice cliffs is the result of deposition within the accumulation zone in the interior of the island. The distortion of tephra layers during glacial transport and ablation may result in different local tephra stratigraphies. In the cliff of Perunika Glacier there are 10 tephra layers. The lower six levels are located at relatively equal intervals. The layer 7 is situated about 10 m above the others and is 10–12 cm thick. All tephra layers consist predominantly of black and subordinately of red components. Powder X-ray diffractometry assay shows uniform phase composition of the crystal component from samples at 7 assayed levels – plagioclase (34–47%) and pyroxene (7–10%). Comparison between registered diffraction lines and different pyroxene types from the reference database (PDF-2 of ICDD) identifies pyroxene from all samples as ferrian diopside. This phase composition corresponds with basalt and basaltic andesite. In three of the levels was discovered andalusite (2–6%) and mica (5–7%). Considering their metamorphic genesis, the most reasonable source is the metamorphic fundament of this Antarctic area. The lithotypes it is built are represented by phyllites, schists, Ca-silicate rock types, marbles, rare amphibolites and fine layers of volcanic metaconglomerates (Marsh, Thompson, 1985).

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Abstract No : 550

Luminescence depth profiles of striated bedrock surfaces: Indication of accelerated East Antarctic Ice Sheet (EAIS) retreat during Late Quaternary in Prydz Bay

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The experiments to develop the OSL surface exposure dating for deciphering advancement/retreat of the East Antarctic ice sheet in Larsemann Hills area of East Antarctica were initiated. Systematic samples from different peninsulas of Larsemann Hills were collected for determination of exposure ages. The luminescence depth profiles of mainly granite-gneisses samples from Broknes Peninsula, East Antarctica were generated. The experiments involved depth-wise measurements of sensitivity corrected natural luminescence signals L_{natural} (L_n) and L_{test} dose (T_n) at 1mm progressive depth intervals from surface. Six samples (BR-1 to 6) were used to obtain surface to depth luminescence profiles. The samples locations choice was based on existence of glacial advance features on rock surfaces. Preliminary assessment and analysis of luminescence surface to depth profiles from glacially striated/polished/grooved granite gneisses bedrock surfaces indicate accelerated rates of Ice sheet retreat during Late Quaternary. The experimental results also indicate a positive correlation between the luminescence property (counts per second) and its dependencies to natural environment. The L_n/T_n data at saturation depths (D_s) of luminescence follow decreasing systematics towards the present Ice Sheet location. This added information and quantification of D_s in similar rock type confirms the dependency of luminescence saturation depth on exposed length of time and its applicability to assess the glacial retreat rates in Ice free areas of Antarctica.

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Abstract No : 989

Geochemical properties and their relationship to sedimentary process from marine sediments in Port Foster, Deception Island (South Shetland Islands, Antarctica)

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The South Shetland Islands present rapid environmental changes due to regional warming and new climate conditions. Deception Island is the southernmost of the South Shetland Islands and the largest active volcano in Antarctica. The depositional environment responds to local geothermal processes and annual trends in regional warming that affect the mass balance of the glaciers on the island. The present study characterized the geochemical of the sediments to understand their different sources. Marine sediment cores with an average depth of 20 cm were collected with a Box-Corer sampler in four areas in the Port Foster during OPERANTAR Expedition XXXII and XXXVI (2014/2018). Total major and trace elements were determined by Wavelength Dispersive X-Ray Fluorescence (WDXRF). The method was validated by the NIST 2710a standard reference material (SRM). Values of the stable isotope ratio of $\delta^{13}\text{C}$ were measured using the DELTA V Advantage Isotope Ratio Mass Spectrometer. Principal component analysis (PCA) was used for data exploration. Elemental Si/Al and Ca/Ti ratios decay according to depth and also difference in weathering rates showed distinct sources or reworking. The $\delta^{13}\text{C}$ values ranged between -24.71‰ and -23.0‰ on the surface suggesting mosses and lichens as the source of organic matter. The highest rates of organic matter are found near the coast of the Cerro Caliente, which contains thermokarst terrain by permafrost degradation with debris slopes directed towards the beach.

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Abstract No : 1036

Estimation of tidal components from observations at sea level in 2019 in the Bulgarian Antarctic base

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Sea Level is one of the primary indicators of global climate change, the so-called essential climate variable. Measuring the sea level in Antarctica is particularly important for many fundamental studies. In situ observations of variations in the local ocean level by installing tide gauge stations to accurately determine variations in different time ranges are crucial for determining the trend of ocean level change. This paper presents the research and logistics project launched in 2017 for the construction of a tide gauge station in the coastal zone of the Bulgarian Polar Base “St. Kliment Ohridski” on Livingston Island in Antarctica, the Southern Ocean, funded by the Bulgarian Antarctic Institute. The organizational and technological activities for installing a sensor for continuous registration at the ocean level are described. The processing of the first several months of observations from the tide gauge is presented as a case with an emphasis on the quantification of tidal components and assessment of their accuracy. The average daily change in tide level at the BAB is evaluated at 2.4 m. More than 30 tidal components are determined as significant using the Utide software. The results show that the tides are mixed with half-day behaviour and daily inequality between high and low waters. The possibility of forecasting the sea-level values with modern methods is discussed. Comparative analyses have been made with the results of tidal analyzes from other studies for the Livingston Island area. The provision of logistics for the planned permanent installation of TG is briefly outlined.

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Abstract No : 622

First Multi-GAS measurements of the magmatic-hydrothermal emissions at Deception Island volcano, Antarctica

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Deception Island (DI) is an active volcano located to the southwest of the South Shetland Islands, within the Bransfield Strait. The last eruptions at DI took place between 1967 and 1970. Several areas with thermal anomalies and gas emissions are the surface expressions of an extensive magmatic-hydrothermal system on the island. Hydrothermal sites such as Whalers Bay host steaming grounds and soil diffuse degassing, whereas Primero de Mayo bay hosts three main fumaroles, named F1, F2 and F3. During the 2021-2022 Argentine Antarctic Summer Expedition, a portable Multi-component Gas Analyzer System (Multi-GAS) was used, for the first time, to measure CO₂, H₂S and SO₂ gas concentrations in the thermal areas of DI. Real time measurements were conducted manually and in close proximity to the gas discharges. Multi-Gas measurements detected CO₂ and H₂S as the dominant acidic gas species in Primero de Mayo bay and Whalers Bay. From the concentration data, CO₂/H₂S ratios were obtained by calculating the slopes of the best fit regression lines. The CO₂/H₂S ratios on Primero de Mayo bay showed an average of 72 and 110.8 for F2 and F3 (with R² between 0.5 and 0.7 in both cases), whereas on Whalers Bay the CO₂/H₂S ratio was 30.6 (R² = 0.5). Moreover, the occasional presence of SO₂ was also detected on Primero de Mayo bay. This project intends to establish an automated measurement baseline of DI gas manifestations that will contribute to the volcano monitoring work and the management of volcanic hazards in the region.

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Abstract No : 389

Glacial landforms and quantification of past glacial movements in Schirmacher Oasis, East Antarctica.

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Schirmacher Oasis is an ice-free area situated in the central Dronning Maud Land (cDML) East Antarctica. A plethora of quaternary deposits are developed in this region due to the retreat of the East Antarctic Ice sheet. Several glacial valleys traverse through the oasis and are archives of Spatio-temporal changes. Paternoster lakes occupy the glacial valleys, and hence the sedimentary sequences are formed of glaciolacustrine units. These sedimentary sequences are primarily glacial with sporadic horizons of lacustrine units, the mega and macro-scale landforms comprising various sections with well preserved sedimentary structures and distinct lithological facies. Additionally, the orientation of 276 glacial striations from 20 locations was analyzed, and it was deduced that the resultant direction for the flow of glaciers in past was N15°E. The paleo direction of flow is in agreement with the present movement of the continental ice sheet as ascertained from the Global Positioning System. Interestingly the orientation data is also congruent with the earlier reported subsurface geo-electrical structural trend inferred from the magnetotelluric (MT) study.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

GEOSCIENCES

**Permafrost dynamics and
relations with climate change**

CONVENORS

Mauro Guglielmin, Joe Levy

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Abstract No : 996

Temporal trend and dynamic of the active layer at different monitoring points in Maritime and Peninsular Antarctica

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Antarctica provides a unique chance to understand changes in permafrost, and in the global climate. In order to study the temporal trend, air and soil temperature, and the dynamics of the active soil layer, five monitoring sites were chosen, located between Shetlands Islands and Antarctica Peninsula. The Mann-Kendall method was applied to identify the existence of a trend. The calculation of the Active Layer Thickness - ALT was estimated according to the maximum monthly temperature. Spearman's correlation was used from large scale climatic events, ENSO and AAO and soil temperature at different depths. The dynamics of the active layer and the thermal regime were influenced by the local effects of each site. Differences were observed in the regime, in the sites with vegetation cover and in the sites with medium and thick gravel cover. Soil moisture and texture also exerted control over freezing and thawing periods. The thermal regime in the sites was not uniform. The Mann-Kendall test was significant for all sites under study. ALT was thicker for sites located near the Peninsula in relation to sites located in the Shetlands. The time series were influenced by the strong El Niño and La Niña of moderate class, with occurrence of harsh winters and very hot summers, with effect also at the point of sudden change of the trend line. The warming is not widespread throughout Antarctica, due to its own natural variability and the action of local and regional climatic factors.

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Abstract No : 1003

Temporal trend, Active Layer Thickness and correlation with climatic events

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Soil temperature has received more attention due to its sensitivity to climate change and its control over permafrost. We aimed at monitoring and analyzing the temporal trend, estimation of the Active Layer Thickness - ALT and correlation with climatic events, through soil temperature, in different depths at Fildes peninsula, KGI. The data were recorded using thermistors connected to a data logger at different depths., Serial autocorrelation test, Mann-Kendall, Sen-Slope, Pettitt tendencies, spearman's correlation were applied to study the trend of soil temperature. The thickness of the active layer was estimated through the maximum monthly temperature and the lower limit of permafrost through the minimum monthly temperature. Spearman's correlation between ENSO (El Niño South Oscillation), AAO (Antarctic Oscillation) and soil temperature were calculated. Seasonal trend analyzes were significant only for summer, with Mann-Kendall tau, positive Sen-Slope and Pettitt slope for depths 67.5 and 83.5 cm. The monthly analyzes were significant, with predominance for the months of August, September and November. The annual and different lag's analyzes, on the other hand, showed cooling at different depths. However, for the complete series (2008 - 2018), there was no trend. Freezing was the predominant process at all depths. The average ALT was 92.61 cm, there was an increase in isothermal days with depth, and migration of the maximum freezing days from winter to spring. Spearman's greatest correlations between soil temperature and ENSO phenomena were in 2015 with a correlation value above 0.86. The correlations with AAO, were significant in 2011, 2017 and 2018.

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Abstract No : 202

Determining the duration of active Antarctic wetlands using high temporal- and spatial-resolution satellite imagery in the McMurdo Dry Valleys: Towards a regional measure of changing thaw patterns

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Antarctic water tracks and ephemeral active layer wetlands are a primary location for biogeochemical soil processes driving cold desert soil formation. They are observable using satellite remote sensing and provide a regional measure of active layer thermal state over time. While the spatial extent of water tracks and wetted soils has been mapped in the McMurdo Dry Valleys (MDV) on the basis of mapping darkened pixels in high-resolution commercial satellite imagery, the timescale over which water tracks and wetlands form and the duration of these biogeochemically active environments remains unknown. Here, we determine the start dates and end dates and the duration of wetted soils at ten sites located across the MDV using a combination of in situ soil sensors and two complementary remote imaging platforms (Planet and Worldview). Our remote sensing employs a terrain-correction workflow that removes the contribution of differential direct illumination and small-scale shadowing on pixel brightness, reducing false-positives (soils identified as wetted when in fact they are shadowed or darkened as a consequence of high phase angle). Our findings extend the known water track and wetland hydroperiod by over a month, showing darkening occurring from November to March, suggesting hydrological contributions from ground ice thaw, snowmelt, and salt deliquescence and soil brine growth. These measurements provide a critical baseline for assessing changes to Antarctic active layer and permafrost thawing patterns and can be monitored over time to detect climate-driven change to the terrestrial cryosphere.

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Abstract No : 196

Soils physical-chemical behavior monitoring in an ice-free area, Nelson Island, Antarctica maritime

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Achieving UN sustainable development goal 13.3. related to climate change precocious alert, relies on strategic areas identification to evaluate climatic alterations in Antarctica. This is major goal aimed by scientists worldwide awered of global climate regulation that Antarctica performs. Enhancing this effort, the objective of this study was to characterize the pedoclimatic regime, based on the monitoring of soils with permafrost influence, in a para-periglacial ice-free area between the Nelson Glacier and the Fildes Strait, on Stansbury peninsula, Nelson Island, Antarctic maritime. Soil Profiles were opened where five monitoring sensors (temperature) were installed: Turbic Cryosol (Skeletal, Novic), Turbic Skeletic Cryosol (Fluvic), Turbic Cryosol (Fluvic), Colluvic Skeletic Regosol (Fluvic, Turbic), Protostagnic Fluvisol (Oxyacquic), Turbic Skeletic Reductaquic Cryosol (Fluvic). Using Algorithm for Quantitative Pedology (AQP) in R was possible to illustrate the chemical and physical results behavior in soil depths. To perform an accurate investigation about the soil characteristics that may have had influence over the thermal behavior of these soils, we used a Principal Component Analysis (PCA) on the physical and chemical results, aiming to identify other correlations among the soil conditions. The results indicate that similarities among sampled sites did occur and PCA grouped soils in three clusters which differed it considerably one from the another. This could be confirmed not only by the difference among physical characteristics, but also with morphological and the geoenvironmental position in the landscape which has strong influence by the freezing and tawing events that regulate the superficial temperature of soils.

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Abstract No : 375

Spring snow melt timing controls ground surface temperature regimes in Maritime Antarctica

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Ground Surface Temperature (GST) is an indicator of climate change in permafrost regions such as the Antarctic Peninsula, where a strong long-term warming trend has been detected. To better understand the GST dynamics and the topo and microclimatic controlling factors, 20 temperature sensors (iButtons) were installed in Barton Peninsula (King George Island) at sites with different elevation, aspect, curvature, and distance to snow patches. The data recorded from March 2019 to February 2020 allowed the characterisation of GST regime. Results show a mean annual GST from -2 to 0.6 °C and severity of the freezing season from 438 to 1041 FDDs (Soil freezing degree days). A Multiple Factorial Analysis (MFA) using temporal patterns of daily ground temperature regimes was used to assess the influence of topo and microclimatic variables. The MFA revealed the significance of elevation, snow cover, and solar radiation on GST. These variables were selected for a Discriminant Analysis model allowing for the spatialisation of daily ground temperature regimes types. These are mainly distinguished by the duration of the freezing season and the ground warming rates during the thawing season. This research was funded by PERMANTAR (PROPOLAR/FCT) and CEG/IGOT (UIDP/00295/2020). Joana Baptista is funded by the Fundação para a Ciência e a Tecnologia with a doctoral grant (2021.05119.BD).

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Use of ERA5 data in the permafrost study

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The Antarctic Peninsula, including the Shetland Islands, is one of the hotspots for global warming and the soils in this region can be an important indicator of climate change in that sector. The objective of this work was to perform an assessment of soil temperature parameters using ERA5 reanalysis compared to observations at monitoring sites located in the South and East Shetlands of the Antarctic Peninsula. Data from eight soil temperature monitoring sites that are part of the Terrantar-UFV Project network, located in the South Shetlands Islands and in the east of the Antarctic Peninsula, were used. The reanalysis data used were from ERA5. The dataset generated by the ERA5 system was combined with site temperature data by date and time. Data were analyzed at hourly intervals and with daily averages. Pearson and Spearman correlation analyze were performed and all results showed statistically significant values. In general, the mean air temperatures obtained by the reanalysis showed a close agreement with the in-situ measurements. The correlations obtained were all high, always above 0.9. However, in relation to soil temperature, in places with in situ records of the presence of permafrost, the reanalysis data showed positive temperatures in all summers, not compatible with the presence of permafrost. This behavior demonstrates that the ERA5 data was not sensitive enough to distinguish this behavior, which may be due to the spatial resolution of the data, which may mask local details.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

GEOSCIENCES

**Antarctica and its neighbours
in supercontinent cycles**

CONVENORS

Jacqueline Halpin, Nathan Daczko, Laura Morrissey,
Geoff Grantham

Accepted as: E-poster Presentation

Abstract No : 287

First data on gold in Livingston Island, South Shetland Islands, Antarctica

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The current study presents first data on gold in Livingston Island. The samples were collected from ore veins in Hurd Peninsula, at the area of Bulgarian Antarctic Base (BAB) in Antarctic season 2019/2020. The veins are structurally controlled, hosted by sandstones of Miers Bluff Formation and with quartz-polymetallic composition. The paragenetic relationships of the ore minerals were examined in polished sections by optical microscopy and their chemistry was investigated by electron microprobe (EPMA) and LA-ICP-MS analyses. The mineral assemblage consists mainly of pyrite, galena, sphalerite, and chalcopyrite. The gangue minerals are quartz and chlorite. Gold is found for the first time and occurs as free grains in pyrite with oval forms up to 5 μm and pale yellow color. EPMA indicate that the composition corresponds to native gold with 16.34 wt.% Ag and fineness 836, and electrum with 19.94–27.22 wt.% Ag and fineness 774–727. LA-ICP-MS analyses also reveal so-called “invisible” gold as micro-inclusions in pyrite with concentrations from not detectable to 169.55 ppm (average 19.20 ppm). Two forms of gold occurrence were established in pyrite from the quartz-polymetallic veins in the BAB area: 1) microscopically visible discrete grains of native gold and electrum and 2) invisible gold. The investigation was financially supported by the National Program of Polar Research funded by the Ministry of Education and Science of Bulgaria (project No 70.25-176/ 22.11.2019). The author gratefully acknowledges Prof. Christo Pimpirev, Bulgarian Antarctic Institute, and all members of the 28th Bulgarian Antarctic Expedition for the logistic support and help.

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Abstract No : 317

Sedimentary basins of interior East Antarctica and paleolandscape through the Gondwana cycle.

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Outside of several core ‘basin-dominated’ regions, East Antarctica has a generally high elevation, and has been considered to possess a largely crystalline bedrock, despite the lack of a focused effort to characterise the presence of basins. Building on major data compilations and also new approaches to subglacial geological mapping, recent studies have mapped the presence of sedimentary basins throughout Antarctica, including East Antarctica, in which numerous sedimentary basins are identified. The mapped basins clearly include several generations of basin and also a variety of orientations and morphologies that suggest multiple phases of basin forming have influenced the paleolandscape of the continent. Here we review the evidence for these East Antarctic basins, and assess their characteristics to understand their formation and potential links to plate-margin processes, in turn associated with global tectonic events. Although geochronological data are sparse, we seek to define broad groupings of basins by approximate age (i.e. by tectonic event), and review the development of the paleolandscape during the Gondwana Supercontinent cycle, including the formation, stability and dispersal phases, with implications for both the development of the Antarctic continent and the nature of the basin fill. A better knowledge of the characteristics of basin fill, and the structure of basin boundaries, is important for the developing understanding of basal conditions for the Antarctic Ice Sheet, including its heat flux, erosion and subglacial hydrogeological systems.

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Abstract No : 126

Tectonic Map of the Antarctic

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Garrik Grikurov, Retiree

We present the draft of the 2-nd edition of Tectonic map of the Antarctic at 1:10 M scale. The 1-st edition was published by CGMW in 2012. Significant input of new data during the past decade required upgrading of the 2012 map. Design of the legend allows compact visual presentation of both geodynamic and age-related information. Map units are in the first place distinguished by the type of crust; formation at either plate boundaries or in within-plate settings is another fundamental criterion. Oceanic crust is mapped in accordance with its age identified by magnetic anomalies. Archean complexes are grouped in a separate block of the legend; they lack clear plate tectonics markers and believed to represent a primeval continental plutonic/metamorphic infrastructure (protocrust). Proterozoic and Phanerozoic complexes are referred to either unstretched or stretched continental terranes. The former comprises accretionary fold belts (orogens), structural products of their reworking, platform covers and intraplate fold systems. Stretched continental crust controls distribution of rift systems and associated sedimentary basins. A greater part of Antarctic continental margin belongs to a magma-poor type. Within lengthy zones contiguous to COB continental crust is hyperstretched to the extent, in some places, of unroofing the upper mantle. Generalized view of Antarctic tectonic structures, including their inferred distribution under ice, is provided in a smaller-scale inset. It also shows the rates of sea-floor spreading and areas with thickened oceanic crust. The map is accompanied by extended Explanatory Notes booklet with illustrations and references.

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Abstract No : 410

Petrogenesis of Neoproterozoic – Cambrian granitoids, Princes Elizabeth Land, East Antarctica

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Neoproterozoic – Cambrian granitoids intrusions are found along the coast of Prydz Bay, Princes Elizabeth Land, East Antarctica. Systematic sampling along the entire coast of Prydz Bay extending from Rauer Group of Islands to East Amery Ice shelf and outcrop mapping was carried out during the present study. The syn- to post-kinematic granitoids of varied composition occur as stock, dykes, concordant veins and sheet like bodies of various dimensions. These are broadly biotite granite, biotite-garnet granite and hornblende-biotite granite. Field evidences, mineralogical composition and preliminary geochemical data suggest that Prydz Bay granites are mainly S and I types. The Progress and Amanda Bay granites show typically S type signature and possibly derived from the partial melting of metasedimentary rocks. Besides, hornblende-biotite granite at Vestkantten Nuntak and Landing Bluff areas are possibly derived from partial melting of lower crust and/or upper mantle. Moreover, felsic microgranitoid enclave (FME) and mafic microgranitoid enclaves (MMEs) were of different shapes and sizes were observed in Dalkoy and Landing Bluff granitoids respectively indicating magma hybridisation. The study suggests a complex Pan-African tectono-thermal process in Prydz Bay region.

Indicators of UHT metamorphism in granulites from the Bunger Hills, East Antarctica

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The Bunger Hills is part of the East Antarctic Shield. It is composed of large bodies of tonalite-granite orthogneisses occupying the southern part of the territory and, to the north, a sequence of intensely migmatized garnet-sillimanite-cordierite paragneisses interbedded with amphibole-biotite-pyroxene schists and gneisses. According to the studied composition and relations between oxides (alumospinel, corundum, ilmenite, rutile) and silicates (garnet, sillimanite, orthopyroxene, cordierite) from metapelitic granulites of the Bunger Hills signs of UHT metamorphism are distinguished. Intergrowths of spinel and quartz are observed as well as the presence of nano-inclusions in quartz of titanium-containing alumospinel, were noted. In addition, alumospinel is associated with subparallel corundum-magnetite-ilmenite intergrowths derived from the high-temperature solid solution (Ti-Magss) as well as ilmenite with lamellae of rutile possibly produced as a result of breakdown of the high-temperature Fe-Ti phase (armalcolite). The most intriguing feature of the studied granulites is flame-like exsolutions of titaniferous magnetite and ulvöspinel (XUsp 0.55–0.78) occurred in intergrowth with ilmenite, corundum, and needle-like rutile. The calculated temperatures of the Usp-Ilm equilibrium vary between 950 °C and 1250 °C. Ulvöspinel coexists with garnet and orthopyroxene containing 7 to 9 wt % Al₂O₃. Temperature estimated using Grt-Opx thermobarometry are in range of 930–1010 °C. The clockwise P–T path defined by mineral thermobarometry and isochemical phase diagram modeling shows an increase in temperature and pressure up to peak values of T > 1000 °C, P ~ 10 kbar, followed by isothermal decompression to 6–7 kbar, and then isobaric cooling.

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Abstract No : 482

Siliciclastic deposition on the western margin of Australo–Antarctica during the Rodinia–Gondwana transition

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Concealed by thick ice cover, sedimentary sequences in the Knox Rift located near the paleo-plate boundary between Australo–Antarctica and Indo–Antarctica provide critical information to inform paleogeographic reconstructions of East Gondwana assembly and breakup. However, the timing of formation of the Knox Rift is controversial, with previous studies supporting either a Mesozoic or Precambrian origin. Here we report the first evidence for two distinct episodes of siliciclastic influx linked to basin formation, based on petrographic, geochemical, and isotopic signatures of in situ sedimentary rocks and transported glacial moraine sedimentary samples originating from the Knox Rift. This analysis demonstrates an older (Neoproterozoic) cycle that records the transition of western Australo–Antarctica from passive to active margin during convergence with Indo–Antarctica and a younger cycle that corresponds to the formation of the Knox Rift with accumulation of Permian–Triassic sediments during intra-Gondwana continental rifting. In addition, the revised timing of deposition of Neoproterozoic sequences exposed at Mount Sandow and Amundsen underlines a close paleogeographic affinity between Australo–Antarctica and Indo–Antarctica by 600 Ma and argues for an earlier timing of convergence than previously proposed.

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Abstract No : 459

Studying of Princess Elizabeth Land with new geophysical data

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The RAE 60–67 airborne surveys over Princess Elizabeth Land in 2015–22 were completed by the Russian Polar Marine Geosurvey Expedition (PMGE) using the standard profile spacing of 5 km with tie-line intervals of 15–25 km. The aerogeophysical surveys collected more than 41,300 line-km of magnetic and ice-probing radar data over the largely ice-covered Princess Elizabeth Land. These surveys provided new constraints on the suture between Indo–Antarctica and Australo–Antarctica (IAAS) that trends south-southeast from the Scott Glacier inland for some 1,500 km (Aitken et al., 2014). More recently, it's been argued that the India – Australia paleo-plate boundary may pass through Antarctica close to the Mirny Station (93.01°E, 66.55°S) because it appears to correspond to an unnamed subglacial fault identified by Aitken et al. (2014) which intersects the coast near ~94°E. However, new detailed Russian bedrock topography and magnetic anomaly data mapped to the east of Mirny Station up to the Denman Glacier clearly fail to observe Daczko et al. (2018)'s dubbed Mirny Fault (Golynsky et al., in-preparation) so the crustal attributes of the IAAS remain enigmatic. At that time the linear narrow bedrock depression that corresponds to the Northcliffe Glacier together with accompanied distinctive negative magnetic anomaly belt of NE–SW orientation may represent the suspected suture in accordance with our preliminary interpretation. It intersects the coast along the western side of Mill Island. The estimated length of the IAAS that existing geophysical data allow to distinguish in ice-covered interior of East Antarctica does not exceed 600km.

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Abstract No : 855

Large geometry-secondary ion mass spectrometer (LG-SIMS) contributions to Antarctic geology

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LG-SIMS has contributed to the geological investigation of Antarctica by providing highly reliable isotopic data with high mass resolution. LG-SIMS archives precise isotopic analyses with analytical spots of 5 to 25 μm diameter and 1 to 2 μm depth, which can carry out the multi-element and isotope analysis in the same analytical spot. In this presentation, we introduce the study cases and the results of Antarctic geology using SHRIMPs, one of the LG-SIMS, installed in National Institute of Polar Research, Japan. The Napier Complex, located in the Enderby Land, East Antarctica, experienced extremely high temperatures ($>1100\text{ }^{\circ}\text{C}$; Harley, 2016 and reference therein). U-Pb zircon geochronology integrated with rare earth element (REE) and oxygen isotope of a garnet-bearing quartzo-feldspathic gneiss collected in the Fyfe Hills revealed that the gneiss experienced high-temperature metamorphism at 2501 Ma (Takehara et al., 2020). We also found the zircon, which contains the galena inclusions in the hydrothermally altered domain of an orthopyroxene-felsic gneiss collected from the Harvey Nunatak. The $^{207}\text{Pb}/^{206}\text{Pb}$ ratios of galena suggest that a timing of the hydrothermal activity is close to the present (Takehara et al., 2018). The Sør Rondane Mountains are located in the Neoproterozoic to Early Cambrian East African-Antarctic collisional orogen. We analyzed zircons of a metacarbonate rock collected in this area by SHRIMP. They show a crystallization temperature of $> 800^{\circ}\text{C}$ and heavy $\delta^{18}\text{O}$ data of $\sim 23.4\text{‰}$ (Satish-Kumar et al., 2016). It is suggested that the zircons re-equilibrated with the surrounding carbonate minerals for the oxygen isotope.

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Abstract No : 188

Rift in the Australian – Antarctic margin: the William's Ridge (Kerguelen Plateau) – Broken Ridge sector

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In Early Cretaceous time, the rupture of the remnants of East Gondwana evolved through a triple junction plate boundary that separated the Indian, Australian, and Antarctic plates. Following the initial separation of the plates, the interaction of the Kerguelen mantle plume and the triple junction led to the creation of segments of the Kerguelen Large Igneous Province from ~130 Ma. William's Ridge and Broken Ridge initially formed together, and concurrently with the first phase of opening of the Labuan Basin and Diamantina Zone. Although consensus has been reached on the configuration of the westernmost portions of the Australian and Antarctic margins at the end of the Mesozoic, the Paleocene and Eocene rifting and breakup history between William's Ridge (Kerguelen Plateau) and Broken Ridge remains poorly understood. We present preliminary results from the analysis of multichannel seismic reflection (MCS) profiles acquired on the conjugate Williams and Broken Ridge divergent margins during RV Rig Seismic (1997), RV Investigator (2020), and RV Sonne (2020) voyages. Using both legacy and newly acquired MCS data, we investigate the depositional and tectonic histories of Williams Ridge and Broken Ridge. We aim to better understand how the sedimentary sections, unconformities, and faults illuminate the vertical and horizontal tectonism of William's Ridge and Broken Ridge, during the pre-rift and syn-rift stages. Preliminary interpretations of the dataset reveal similarities in the pre-rift development of the two conjugate divergent margins. In contrast, the syn-rift infill shows evolutionary differences, possibly related differential tilting of William's Ridge and Broken Ridge.

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Abstract No : 166

The early Cretaceous Abor magmatic rocks in eastern Himalaya had an older history of magmatism attributed to the Gondwana assembly

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The eastern Himalayas represents an important part of the eastern segment of the Gondwana supercontinent. Abor volcanic is often considered evidence of the Gondwana breakup during the early Cretaceous but probably remained untouched by the Gondwana assembly due to the unavailability of older ages. Here we present geochemical, Sr-Nd isotopic, and zircon U-Pb data of the mafic intrusive (gabbro) and felsic rocks of the Abor magmatic rocks to gain insights into the tectono-magmatic evolution of the eastern Gondwana (assembly and breakup). Zircon U-Pb dating of the mafic intrusive rocks yielded ages of 500–473 Ma, and felsic rocks yielded ages of 145–132 Ma, indicating emplacement during the Cambrian-early Ordovician and early Cretaceous period, respectively. Mafic intrusives are characterized by OIB to E-MORB affinities and have a relatively narrow range of initial $^{87}\text{Sr}/^{86}\text{Sr}$ (0.703887–0.705513), $^{143}\text{Nd}/^{144}\text{Nd}$ (0.511978–0.512118) and $\epsilon\text{Nd}(t)$ (–0.323 to +2.43). Mafic intrusive were generated by low degree (~3–13 %) partial melting of an enriched asthenosphere mantle source (garnet and spinel lherzolite) in an extensional environment. The felsic rocks display A-type granite, high initial $^{87}\text{Sr}/^{86}\text{Sr}$ (0.707878–0.717650) and negative $\epsilon\text{Nd}(t)$ (–14.35 to –9.21). The felsic rocks were possibly generated by the interaction between high-temperature upwelling OIB basaltic magmas in a shallow crustal source. The older mafic intrusions are attributed to the events of the Gondwana assembly, whereas the younger felsic rocks could represent the second wave of magmatism in the region influenced by the eastern Gondwana breakup during the early Cretaceous.

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Abstract No : 460

Post ADMAP-2 surveys reduce aeromagnetic data coverage gaps in Antarctica

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Since the release of ADMAP-2 map in 2017, the international Antarctic geomagnetic community remains very active in crustal magnetic anomaly mapping. More than 670,000 line-km of new air- and shipborne data have been added to the 3.5 million line-km of the previous database. Many of these new surveys were completed by major international programs and multidisciplinary projects that also acquired complementary airborne laser altimetry, radio echo sounding, and aerogravity data for comprehensive studies of the ice sheet surface and thickness, englacial features, the subglacial hydrology and crustal geology. The new aeromagnetic data provide key coverage of the Recovery Basin and the South Pole region, southern Princess Elizabeth Land and the Ross Ice Shelf, and other poorly investigated Antarctic regions. Some surveys are currently proprietary and hence cannot yet be combined with the existing publicly available datasets. For example, AWI/BGR aeromagnetic data from the southern and eastern Sør Rondane regions offer further insights on the southern and eastern extents of the Tonian Oceanic Arc Super Terrane. Russian aeromagnetic surveying over Princess Elizabeth Land also has imaged the East Antarctic extent of a major Stenian-aged accretionary orogen. At the South Pole, the European Space Agency PolarGAP aeromagnetic data allow to identify an irregular cratonic margin and an embayment similar to those formed by late Neoproterozoic rifting along Rodinia's cratonic margins in Australia and Laurentia. Magnetic anomalies from the ROSETTA-Ice's survey highlight a major crustal boundary between the rifted edge of East Antarctica, which may extend significantly further west than generally assumed.

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Abstract No : 512

First zircon ages from William's Ridge, Kerguelen Plateau, suggest continental basement

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In early 2020, the scientists aboard RV Investigator (IN2020_V01) sampled the Kerguelen Plateau and Broken Ridge, collecting new multichannel seismic reflection, sub-bottom profiling, multibeam bathymetry/ backscatter and gravity data, as well as a dredged suite of rock samples. The newly sampled William's Ridge is a prominent ~300-km-long bathymetric feature extending southeast from the Central Kerguelen Plateau. The William's Ridge and neighbouring Rig Seismic Seamount dredge haul include a substantially high proportion of continental rocks for an oceanic plateau comprising dominantly basaltic crust. While not definitively sampled in situ, the size, shape, and location of the dredge samples may suggest a proximal source for the continental material. To further constrain their provenance, we present reconnaissance U-Pb zircon dating of several metamorphic and igneous rock samples. Protolith ages for the metamorphic rocks are dominantly Mesoproterozoic, with most displaying Pb-loss trends towards and/or new zircon growth at ~550 Ma. Crystallisation ages of granite samples include ~1180 Ma and ~485 Ma, and samples of diorite yield ages of ~44 Ma and ~7 Ma. The Precambrian ages represent previously contiguous Gondwana continental crust in East Antarctica and/or north-west India. Whether these rocks represent ice-rafted material from Antarctica or slope debris from continental crust in William's Ridge requires further investigation. This first description of the likely basement at Williams Ridge may contribute to a new or revised submission to the United Nations Commission on the Limits of Continental Shelf to extend Australia's marine jurisdiction along and around William's Ridge.

Accepted as: Oral Presentation

Abstract No : 381

Learning from Australia: subglacial geology and heat flow in Wilkes Land, East Antarctica

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The sparsity of direct Antarctic geothermal heat flow measurements requires an indirect estimation from geophysical data with assumptions about a simplified and undifferentiated lithosphere. This often results in weakly constrained and inconsistent models. From denser sampled continents, we know that thermal parameters and heat flow can exhibit large spatial variations depending on geology and tectonic history. We infer information about the crustal structure and possible geological features in South Australia and Wilkes Land, East Antarctica by jointly inverting for gravity and magnetic data. Both datasets are combined through a coupling method which increases the mutual information to get similar and statistically compatible inversion results. Data misfit and variation of information are minimized under the coupling constraint. Subsequent clustering of the obtained parameter properties indicates similarities to known lithological units in South Australia. The former connection of both continents during the Gondwana assembly allows for the exploitation of the well-known geology in Australia and identification of coherent structures along the adjacent margins. The inverted parameter relationship between susceptibility and density, as well as the clusters, can be used as input for machine learning techniques to define a spatially variable heat production map, which in turn leads to improved heat flow estimates. For this, we rely on existing petrophysical and geochemical databases to correlate and confine thermal parameters with our results. Finally, we will present a preliminary refined heat flow map for Wilkes Land with increased spatial variability which is a crucial boundary condition for ice sheet modeling.

Accepted as: E-poster Presentation

Abstract No : 82

Geologic framework and crustal evolution of eastern Dronning Maud Land and Enderby Land, East Antarctica

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Basement geology programs of the Japanese Antarctic Research Expedition (JARE) have covered the area of longitude between 10°E and 55°E (eastern Dronning Maud Land and Enderby Land) of the Antarctic continent since 1957. Total 39 sheets of the geological maps have been published. This part of the Antarctic continent comprises of deep crustal high-grade metamorphic and plutonic rocks. Main part of this area recorded Neoproterozoic–early Cambrian (>600–520 Ma) metamorphic events (central Dronning Maud Land, Sør Rondane Mountains, Yamato–Belgica Complex, Lützow–Holm Complex, Western Rayner Complex). To the east, Archaean–early Palaeoproterozoic (>2550–2480 Ma) UHT metamorphic terrane of the Napier Complex, and Meso–Neoproterozoic (1000–900 Ma) granulite terranes of the Rayner Complex and the Cape Hinode Block are distributed. This presentation summarizes the current understanding of the geologic framework and crustal evolution of this part of Antarctica (e.g., Shiraishi et al., 2008, *GSL-SP308*, 21–67; Horie et al., 2016, *Journal of Mineralogical and Petrological Sciences*, 111, 104–117; Dunkley et al., 2020, *Polar Science*, 26, 100606; Baba et al., 2021, *Gondwana Research*, 105, 243–261), and discuss the future planning of Antarctic field programs expected to start from 2023– seasons.

Accepted as: E-poster Presentation

Abstract No : 498

Orbicular rocks of the Hovgaard Island, Graham Coast region: New insights on magmatic evolution of Antarctic Peninsula Batholith

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Rare igneous rocks were recently discovered by Mytrokhyn and Bakhmutov (2021) on the Hovgaard Island of Wilhelm Archipelago where the Antarctic Peninsula batholith is well exposed. Their distinctive feature is orbicular structure. Orbicules are large spherical mineral aggregates that have concentric-zonal structure. New variety of orbicular rocks named hovgaardite represents their rarest petrographic representative namely orbicular gabbro. Hovgaardite forms an irregular patch 200 m² in amphibole gabbroids presumably Cretaceous age. Igneous breccias are common among host gabbroids and hovgaardites. Comb-layered gabbroids were found on the nearby islands. Hovgaardite contains numerous orbicules 3–10 cm in size immersed in gabbroid matrix. Cores of the orbicules are composed by equal-sized aggregate of calcium plagioclase (An_{88–93}), hornblende (#Mg=0,77–0,81) and clinopyroxene (Wo_{48–50}En_{43–47}Fs_{5–8}). The cores are surrounded by one or several shells composed by radial-oriented aggregates of plagioclase (An_{89–97}), hornblende (#Mg=0,76–0,80), spinel (Sp_{65–72}Hrc_{12–19}Mt_{13–17}), actinolite, phlogopite, chlorite. The interorbicular matrix differs from orbicules in less-calcium plagioclase and less-magnesian hornblende as well as in the absence of spinel. Randomly oriented texture of the matrix varies from phaneritic to porphyritic one. The geological position and textures of the hovgaardite indicate that its crystallization occurred at the shallow depths. Authors suggest that the origin of the hovgaardite is similar to some orbicular gabbroids in cordilleran-type batholiths. According to modern concepts this type of orbicular gabbroids can be an indicator of decompression-driven crystallization of superheated hydrous mafic magmas in subvolcanic conduits. So they represent connecting link between deep-seated arc plutons and surface volcanic eruptions.

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Abstract No : 714

Orography of the subglacial relief in the coastal sector 60E – 100E of East Antarctica

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The coastal sector 60E – 100E of East Antarctica is the most interesting area to multidisciplinary research. It contains Amery Ice Shelf, the third ice shelf on the size in the world, and one of the largest rift systems of Antarctica which includes Lambert Deep. Also, several subglacial lakes were discovered there, including one active lake (Lambert I) which change its size due to outburst. This study demonstrates the results of Russian subglacial topography research. It based on the radio-echo sounding and reflection seismic soundings which collected in 1970s (seismic) and since 1985 until now (radio-echo sounding). The main tectonic and orographic form is Lambert rift valley which dominates in the research area and defines the tectonic structure of the research area. Aquatic, Subglacial, and Subaerial zones are there which are preliminary divided to nine orographic regions: Mainland foot, Mainland slope, Underwater plain (shelf), Lambert rift valley, Low-mountains, Plateaus and hills, Upland and low-lying plains, Subglacial depressions and Individual uplifts. The main directions of the large bedrock landforms are concentrated mostly in three intervals: 345–30°, 45–70°, and 70–100°. The bottom melting partly take place under the ice sheet in the research area. The melting rate was estimated based on the simple Zotikov model. The average annual melting rate is about 1.5 mm/yr. The bedrock topography, orographic chart with melting zones and hypsographic curve are demonstrated in the presentation.

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Abstract No : 840

Modelling the Pan-African Clino-humite bearing Calc-Silicate rocks of central Dronning Maud Land, East Antarctica with reference to CaO-Al₂O₃-SiO₂-CO₂ system

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Central Dronning Maud Land, East Antarctica is a high grade polymetamorphosed and poly deformed terrain. Calc-silicate rocks have been found to be intimately associated mainly with the metasedimentary units and occur as prominent reaction zones exposing prominent marble bands and associated calc-silicate rocks. The marble bands present in cDML have shown a peak assemblages of forsterite-spinel-calcite-dolomite-plagioclase-biotite suggesting metamorphism at 750°-780°C under high XCO₂ (0.9) condition. The occurrence of granulite and enderbitic-charnockites, having anhydrous mineral assemblages related to the magmatic event in cDML. The calc-silicate rock shows scapolite-wollastonite-diopside-plagioclase assemblage with development of coronal garnet. The peak metamorphism temperature is around 900°C under high pressure (~ 9kbar) conditions. The calc-silicate rocks and the marble have shown effect of amphibolite facies retrogression under influence of high H₂O content and reduced XCO₂ value. The clinohumite occurs as replacing forsterite hinting at 650°C temperature and XCO₂ ~ 0.3. The presence of clinohumite diopside on other hand suggests further fall in XCO₂ values and increased the fluid activity. Previous experimental estimates obtained for calc-silicate rocks appears to be higher than that of the metapelite. However, there are reported occurrences of UHT assemblages in cDML area. The P-T fluid histories indicated for cDML calc-silicate rocks are strikingly similar to the calc-silicate marbles reported from Ambasamudram area of Kerala Khondalite Belt (KKB) and in Highland complex of Sri Lanka. These areas have been shown to be part of East African Orogen (EAO) associated with formation of Gondwana.

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Abstract No : 221

Extensional tectonics in the Princess Elizabeth Land, East Antarctica: insights on deformation patterns of Pan-African orogeny

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The position along with the nature of amalgamation and dispersion of the Antarctic continent within the supercontinents of Rodinia and Gondwana continues to be debated. The most critical element of the problem is to characterize terrane boundaries in the East Antarctic Shield. Princess Elizabeth Land (PEL), East Antarctica is one sector that combines both Indo-Antarctic and Australo-Antarctic segments archiving poly-deformed granulites, exposed along the coast. This study presents evidence for a third deformation event D3 that has overprinted and transposed earlier S1 and S2 fabrics associated with D1 and D2 deformation events respectively, in the Larsemann granulites, East Antarctica. Megascopic field observations during the 41st Indian Scientific Expedition to Antarctica (2021-22), integrated with microstructural information, indicates that D3 is manifested in the form of a F3 fold with SW plunging fold axes, with rare plunges towards NE. This coast-parallel post-compressional deformation is discussed in light of Pan-African orogeny and the relationship of the associated S3 fabric with the UHT assemblage of the Larsemann granulites is currently under investigation. The microstructural characteristics of the S3 fabric is compared with the post-D2 fabric reported from northern Eastern Ghats Province (nEGP), India at $\sim 711 \pm 18$ Ma. The structural and microstructural data is also being compared with published aeromagnetic anomalies to delineate the extent of the regional-scale deformation events in the ice-covered interior of the PEL. This study examines if the deformation event is localized within the Larsemann Hills, or if it is linked to the Neoproterozoic extension in the nEGP, India during Rodinia break-up.

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Abstract No : 413

New zircon ages from Mount Lanyon link the northern and southern Prince Charles Mountains

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The Rayner Complex, east Antarctica, is a Mesoproterozoic orogenic belt that was formerly contiguous with the Eastern Ghats Province, India. In current tectonic models, the Rayner Complex comprises a series of outstepping arcs that formed on the highly extended margin of India between 1400 and 1020 Ma. The extended margin was then shortened and thickened during collision with cratonic Antarctica, resulting in voluminous magmatism and high to ultrahigh temperature metamorphism between 1000 and 900 Ma. This event dominates the geological record, and as a result there is relatively little known about the protolith ages within the Rayner Complex. New LA-ICP-MS U-Pb zircon geochronology and Hf isotopic data were collected from Mount Lanyon, in the southernmost Rayner Complex, to better understand the links between the Mesoproterozoic rocks of the Rayner Complex exposed in the northern Prince Charles Mountains (nPCM) and the Archean to Paleoproterozoic crust of the southern Prince Charles Mountains (sPCM). This identified two samples of c. 1700 Ma felsic gneiss, a sample of c. 1050 Ma felsic gneiss containing inherited zircon populations at c. 1300 and 1190 Ma, and two samples of c. 930 Ma mafic gneiss. These zircon age populations are consistent with known magmatic or inherited ages in rocks of the Rayner Complex. However, a quartzite with a maximum depositional age of 2100 Ma and Archean detrital age peaks is more typical of the sPCM. The recognition of old crust with sPCM affinities within the Rayner Complex has implications for tectonic models of the Rayner Complex.

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Abstract No : 431

Cenozoic dykes of the Argentine Islands, Wilhelm Archipelago, West Antarctica

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Mafic dyke swarms intrude the Paleogene granitoids of Antarctic Peninsula Batholith on the Argentine Islands near the Graham Coast. These post-plutonic dykes are represented by 10–15 cm to 2 m thick subvertical intrusions of the NW, NE, and EW trending without consistent compositional-directional trends. They cut the granitoids with distinct intrusive contacts and signs of chilling against the host rocks. Field relations and petrographical studies indicate that at least part of the dykes was intruded after the complete exhumation of the country granitoids suggesting that magmatic activity in the region didn't cease at least until the Miocene. All dykes can be divided into three petrographical groups: 1) most common basalts and diabases; 2) less common microdiorites; 3) rare dacite. According to major element chemistry, the dykes fall into 2 categories: high-K calc-alkaline basalts and calc-alkaline microdiorites with dacites. The basalts are enriched in LILE relative to N-MORB, specifically K, Rb, and Ba, but depleted in HFS elements, except for Th and Ce, with a marked negative anomaly of Ta and Nb. Compared to basalts, the microdiorites follow the same patterns, but exhibit higher amounts of LILE and HFS elements, except for K and Rb. The dacites are the most enriched in HFS elements among the other dykes. The results suggest that studied dykes were intruded in pulses of slightly different age in the following order: microdiorites – dacite – basalts. The latter poses questions about the geodynamic aspects and the presence of several magmatic sources of these dyke swarms.

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Abstract No : 929

New constrains on Bunger Oasis Metamorphic Evolution and Comparison with Metamorphic Evolution of Proterozoic Components in Australia: Albany Fraser Orogen, Eucla basement and Musgrave Province

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Bunger Hills area is considered to be associated with East Australian Proterozoic compounds: Wilkes – Albany–Fraser – Madura – Eucla orogenic belt. Our aim is to constrain petrochronology for Bunger Hills and correlate Antarctic part with Australian. Obtained from metapelittic migmatites geochronology on gray and dark in the CL zircons (rims and sector-zoned grains) is in agreement with the previously established age interval of 1220–1180 Ma. Black in CL zircon rims give an age distinctly younger, ca. 1141 Ma, – ca. 1153Ma. REE spectra, the distribution of HREE and Y between zircon and garnet, and the DREE values indicate a lack of equilibrium between garnet and gray in CL zircon generations (rims and sector-zoned grains). Comparison of the distribution of REE in zircon and garnet, the distribution of HREE and Y between them, as well as the DREE values indicate that only black in CL rims are in equilibrium with garnet. A stage of high-gradient metamorphism with an age of ca. 1140–1150 Ma, which led to the formation of black in CL generation borders. Apparently, thermal events with an age of 1140–1150 Ma are the final ones for the high-gradient metamorphism extended in time and represent decompression migmatization. The closest event to the time of the final granulite metamorphism is emplacement of orthopyroxene granitoids intrusion at 1180 Ma and a major mafic dyke suite at 1130 Ma. Obviously, peak of granulite metamorphism and migmatization are correlated with such events occurred within Australian compartments, also syn- and postorogenic magmatic events are correlated between compartments.

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Abstract No : 40

Granulite grade metamorphism from Schirmacher Oasis, cDML, East Antarctica: implications for East African Orogeny geodynamics.

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The coastal nunataks of Schirmacher Oasis located in Central Dronning Maud land (cDML), East Antarctica provides a vital link in understanding geodynamic processes involving East Antarctic mobile belts. Schirmacher Oasis mainly exposes interbanded sequence of quartzo-feldspathic gneiss, pyroxene granulite, meta-mafics, metaultramafics and intrusive lamprophyre, dolerite and quartz veins. Majorly basement of Schirmacher is quartzo-feldspathic gneiss with or without orthopyroxene and garnet. The mineral assemblage of pl+qtz+bt+grt+opx+amph indicates granulite facies peak metamorphism. The metapelite assemblages is comprised of qtz+bt+pl+grt+sill and peak metamorphism has been estimated at $\sim 780 \pm 66^\circ\text{C}$. Pyroxene granulite enclaves are composed of pl+opx+cpx+bt +Ca-amph \pm ilm. Two pyroxene geothermometer indicates peak temperature $775^\circ\text{C} \pm 60^\circ\text{C}$ at 6-7Kbar. The peak granulite assemblage is Opx-Cpx-Plag-amph \pm qtz \pm ilm. Breakdown of hornblende across amphibolite to granulite facies transition given by Hbl+qtz=Opx+Cpx+Plag+H₂O. The transition marked by appearance of Clinopyroxene and temperatures over 800°C by orthopyroxene or somewhat reduced temperature if quartz is present in assemblage. The exhumation is represented by later developed amphiboles which either encircles orthopyroxene or occurs in matrix along with plagioclase and quartz. The end of D3 shears shows age of 540Ma-550Ma which indicates end phase of East African Antarctic Orogeny. Elongated Monazites from D3 shear which traversed country rock foliation represents end stage of East Antarctic orogeny in Schirmacher. The X-ray mapping on monazite depicts ages of 542 Ma, 549 Ma signifying last stage of D3 deformation. From similarities of ages and geologic setting, Schirmacher Oasis is interpreted part of Klippen of Lurio Belt of northern Mozambique and considered extension of East African Orogen into Antarctica.

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Abstract No : 961

The Kuunga Accretionary Complex of Sverdrupfjella, western Dronning Maud Land, Antarctica.

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Three complexes are recognised in Sverdrupfjella WDML, Antarctica. A western basal ~1140Ma Jutulrora Complex, consisting mostly of arc-related TTG orthogneiss with evolved Sr-Nd isotopic signatures with TDM ages >2by; structurally overlain by the Fuglefjellet Complex, comprising supracrustal intercalated ~800–900Ma carbonates and ~1100–1200Ma quartzo-feldspathic gneisses; in turn in the east overlain by the Rootshorga Complex which contains paragneisses with minor orthogneisses (~1100–1200Ma), intruded by granitic orthogneiss of similar age. Sr-Nd isotopic signatures from the Fuglefjellet and Rootshorga Complexes have TDM ages <1.8by. D1 and D2 deformation verges top-to-NW. In contrast D3 deformation verges top-to-the-SE. In the Jutulrora Complex, D3 comprises ~100m scale folds with NW dipping axial planes, cut by SE dipping dilational granite sheets. In the Rootshorga Complex D3 is characterised by syntectonic granite veins with extensional and compressional displacements with top-to-the SE shear. Zircon ages of the granitic sheets are 490–500Ma. Sr-Nd isotopic signatures of the granitic sheets intruded into all complexes are consistent with melting of Jutulrora Complex crust with Archaean and Mesoproterozoic xenocrysts in some samples. P-T-t studies from the Rootshorga Complex yield an ITD path with decompression from ~1.4Gpa at ~570Ma to ~0.7Gpa at ~500Ma whereas P-T-t estimates from the Jutulrora Complex are <~0.8Gpa at ~500Ma with a path consistent with crustal loading. The Rootshorga and Fuglefjellet Complex are inferred to comprise a mega-nappe, emplaced during the Kuunga Orogeny ~500Ma ago, over the footwall Jutulrora Complex. Geophysical data are consistent with this interpretation.

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Abstract No : 809

Petrogenesis of the Hughes Bluff granitic pluton in the Transantarctic Mountains, Antarctica

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In order to elucidate the petrogenesis of the Hughes Bluff granitic pluton, the SHRIMP zircon U-Pb geochronology, petrology and geochemistry of its rocks were conducted, and the results show that the Hughes Bluff granitic pluton emplaced at 514 Ma and is composed of the monzogranite, intruded by fine-grained monzogranite dikes in the later period (509 Ma). They both are characterized by high abundance of silicon, alkali and potassium, enriched in Rb, Th, U and K and depleted in Nb, Ta, Nd and Ti relative to those of the primitive mantle, with the Rittmann Indexes less than 3 and the A/CNK values less than 1. They both also have a low total amount of rare earth elements and an abundance of light rare earth, showing weakly negative Eu anomaly and slightly positive Eu anomaly in the chondrite-normalized REE pattern for the monzogranite and granitic monzogranite dike respectively. All the data show that the rocks from the Hughes Bluff granitic pluton belong to the I-type granites, and the source region is probably the lower continental crust, but the contribution of mantle material cannot be ruled out. The magma in the source region underwent varying degrees of fractional crystallization of plagioclase, ilmenite, rutile and apatite, and was derived from a volcanic island arc environment related to subduction.

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Abstract No : 373

Antarctic Plate absolute rotation poles determination based on continuous GNSS stations data

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The work aims to establish absolute rotation poles of Antarctic Plates based on continuous GNSS station data. We investigate 59 continuous GNSS stations on Antarctic Plate from 1994 to 2021. The components of recent horizontal displacements of continuous GNSS stations have been determined and a map of their distribution pattern has been constructed. The obtained components of the recent horizontal displacement vectors of continuous GNSS stations have been used to determine the absolute rotation poles of the Antarctic Plate in ITRF2014/IGS14 reference frame. The obtained values are in good agreement with modern plate models. Calculation and analysis of average annual rotation poles of the Antarctic Plates have been carried out to study the dynamics of change over time. The analysis confirmed the migration of the rotation poles of the Antarctic Plate plate. The presented algorithm and the obtained values of absolute rotation poles can be used to develop new and improve existing models of Antarctic plate motion and coordinate systems, as well as to forecast the motion of the Earth's crust on a global scale.

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Abstract No : 325

Distribution of trace elements in garnet during metamorphism and partial melting of metasedimentary granulites from Schirmacher Oasis, central Droning Maud Land (cDML), East Antarctica

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Schirmacher Oasis is the extension of the East African Orogen (EAO) into East Antarctica, in close proximity to the postulated suture in cDML. An overall clockwise P-T-t path is known for Schirmacher rocks with two granulite facies metamorphism recorded during the Grenvillian orogeny (M1) and EAO (M2). Finally, isobaric cooling under amphibolite facies conditions (M3). These high grade events have lead to migmatization of the metasediments forming compositionally unequilibrated metatexite, diatexite and layer parallel leucosomes with melt production at 750°C to > 815°C by biotite dehydration. The scale of elemental variation in Schirmacher Oasis is envisaged by LAICPMS analysis of garnet and other major phases in the migmatites and their protoliths. Garnets form two modal populations in the metatexite – idioblastic grains in the matrix separated from the melt fractions and poikiloblasts within the leucosomes. There is significant enrichment of Mn, Cr, Y and Σ HREE in leucosome garnets (Mn-0.8-1%, Y>2900 ppm, Σ HREE-1418-2100 ppm) compared to the garnets from metapelites (Mn-0.14%, ~200 ppm, Σ HREE-93-210 ppm) and may be correlated with progressive anatexis and migmatization. This is may be due to Y and HREE partitioning during production of peraluminous melts by anatexis abetted by dissolution of monazite and xenotime. Trace and RE elements are redistributed during migmatization and sequestered by the newly formed phases in the leucosome. The study indicates that there is considerable variation in trace element distribution in the protolith and product rocks in Schirmacher, therefore most trace elements may not have acquired melt-residue equilibrium.

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Abstract No : 170

The age and chemistry of granitic gneisses from the western H.U. Sverdrupfjella, Maud Terrane, western Dronning Maud Land, Antarctica.

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The Jutulrora and Roerkulten tabular granite intrusions in the Maud Terrane, western Sverdrupfjella have ages of ca. 1085 Ma, marginally younger than the 1140 Ma arc related tonalitic Jutulrora Formation gneiss they intrude. Unlike the tonalitic Jutulrora Gneiss, which has Paleoproterozoic–Archean Nd TDM ages, the Jutulrora and Roerkulten granites have Nd TDM ages, Hf TDM ages and ϵNd 1080Ma and Sr initial 1080Ma characteristics comparable to the on-craton ca. 1110 Ma Borgmassivet Suite, correlated with the Umkondo Large Igneous Province. The Brekkerista Granite has an Archean age of ca. 2850 Ma and has Archean Nd TDM and Hf 2 stage TDM zircon ages of ca. 3100 and 3300 Ma respectively. These ages and chemistry of these granites, previously assumed to be Mesoproterozoic in age and related to the continental arc setting of the Maud Belt, confirm the existence of Archean age crust underlying the Maud Belt in Sverdrupfjella and additionally suggest that the 1080 Ma granite sheet magmatism in the Maud Belt may be related to the intracratonic ca. 1105 Ma Umkondo Large Igneous Province, rather than the marginally older ca. 1140 Ma arc accretionary setting previously inferred. On reconstruction of Gondwana, the ca. 2850 age of the Brekkerista Granite is similar to ages from the Pietersburg block of the northern Kaapvaal Craton. In contrast the ca. 3100 Ma age of the Annandagstoppane Granite is comparable to granites from the Barberton block of the southeastern Kaapvaal Craton in South Africa.

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Abstract No : 171

Magnetic properties of the Neoproterozoic rocks from the southern Bunger Hills, East Antarctica

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The Neoproterozoic metamorphic rocks of the southern and southeastern Bunger Hills can be subdivided into four major lithological series. The Remote (Dalyokaya) series is dominated by migmatitic pyroxene-bearing schists and melanogneiss with moderate to high magnetic susceptibilities $(6.37\div 77.5)\times 10^{-3}$ SI units. The Apfel series is characterised by ortho and two-pyroxene (\pm Bt, hornblende) orthogneiss of quartz-dioritic composition with minor orthoschists of gabbro-diorite composition. The Knox series has the largest area of distribution among the other Neoproterozoic metamorphic units and is composed with orthopyroxene (\pm Bt, Gr) orthogneiss of plagiogranite-tonalite-granodiorite-granite composition. The length of the Long (Dlinnaya) series exceeds 4.2 km, its width varies from 75 to 500 m. It is composed by two-pyroxene orthogneiss of granosyenite-syenite-monzonite composition. All Neoproterozoic metamorphic rocks are characterised as moderately magnetic with modal values of magnetic susceptibility of 11.9×10^{-3} SI units for Apfel series and 26.2×10^{-3} SI units for Long series. The Knox series has two particular samplings, granite-gneisses show modal value of magnetic susceptibility of about 4.02×10^{-3} SI units, whereas orthogneiss of granodiorite-granite and plagiogranite composition yield susceptibility value of roughly 14.1×10^{-3} SI units. The Neoproterozoic-Paleoproterozoic rocks of the Southern (Yuzhnaya) series are dominated by migmatitic Bt-orthopyroxene gneisses and schists with garnet, cordierite and sillimanite. They are characterized by bimodal susceptibility distribution centered on values of roughly 7.6×10^{-3} SI units and 41.5×10^{-3} SI units.

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Abstract No : 985

New discoveries of Eoarchean rocks in East Antarctica

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The Napier Complex of Enderby Land and Kemp Land is a unique part of East Antarctica because it contains some of the oldest rocks on Earth as parts of an craton built by the end of the Archean at 2.5 Ga. Eoarchean (>3.6 Ga) rocks in this region are known from a very few localities, namely in the western part of the Tula Mountains of Enderby Land and at Aker Peaks of Kemp Land, ca. 200 km further east. Tonalitic gneiss from eastern part of the Tula Mountains were investigated in this project, and include a sample with the oldest apparent $^{207}\text{Pb}/^{206}\text{Pb}$ ages, reaching 4.08 Ga. However, most data are reversely discordant, as has been seen in granulites of similar age elsewhere in the Tula Mountains. Concordant data scatter from ca. 3.8 to 3.6 Ga, with 2.5 Ga ages recording high-T metamorphism. An upper intercept age of ca. 3.85 Ga provides an approximate age, with 'older' estimates being due to unsupported radiogenic lead. These data further indicate that Eoarchean crust might be widespread across the Napier Complex. This research was founded by a GRIEG grant UMO2019/34/H/ST10/00619 to MAK and Australian Antarctic Science Grant No. 4548 to SAW.

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Geochemistry of extremely lithium-enriched zircon of Harvey Nunatak in the Napier Complex, East Antarctica

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Zircon, a valuable accessory mineral for geochronometers, has become a powerful geochemical tool for Antarctic geological and petrological research. We found extremely lithium (Li)-enriched zircons (Li content, [Li]: ~300–600 ppm) in an orthopyroxene-felsic-gneiss collected from Harvey Nunatak in the Napier Complex, East Antarctica by JARE-58 Geological Field Survey Team. The Napier Complex, including Harvey Nunatak experienced extremely high temperatures (>1100 °C) based on the mineral assemblage of sapphirine + quartz (Harley, 2016 and reference therein). The thermal history is essential for unraveling the earth's crustal evolution, including deep crust; however, geochronological constraints, such as the timing and duration of the metamorphic events, are still debated. We characterized the zircons of Harvey Nunatak based on the concentration of trace elements analyzed by a sensitive high-resolution ion microprobe (SHRIMP-IIe) in NIPR. The Li and oxygen isotope ratios of zircons are also analyzed by SHRIMP-IIe/AMC in NIPR. The Li isotope ratios ($\delta^{7}\text{Li}$) of the high Li zircons indicate a wide range from -2.8‰ to 12.7‰ (average is 3.5‰), which suggests the sources of the zircons were affected by contamination of sediment. The correlation between Nb/Yb and U/Yb of the zircons suggests a magmatic arc origin. Therefore, the protolith of the orthopyroxene-felsic-gneiss is derived from the magmatic arc where sediments from continental crust subduct with water. In addition, some zircon grains have been affected by hydrothermal alteration recently, since the zircons indicate high concentrations of non-formula elements and light REE. The altered domains indicate lower Li concentrations than those of unaltered domains.

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Geological Evolution of Mirny Station area (Pravdy Coast, East Antarctica) and its Correlation with Neighboring, New Chemical, Nd isotopic data and U–Pb zircon geochronology”

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The knowledge of the geological structure and composition of Mirny area is important for reconstruction of tectonic evolution of East Antarctica and amalgamation of the Gondwanaland. Mirny station geological events are similar to that reported from the Rayner Province/Prydz Orogen (earliest magmatic zircons provided age ca 1320–1300 Ma corresponds to the age of the Fisher Zone whereas ca 1150–1020 Ma zircons correspond to major tectono-magmatic events documented from the Beaver Zone. Less evident is a correlation of ca 880–850 Ma zircons reflected a distinct phase of the tectono-thermal evolution interpreted as a high-grade event in the central Prydz Bay Coast. Sedimentary rocks drilled in the Kerguelen Plateau contain zircon and monazite grains yielding ages of ca 940–800 Ma and ca 820–670 Ma. attributed to high-grade metamorphic event. The Shillong-Meghalaya Complex in north-east India experienced a protracted history of major tectono-magmatic activities at ca 1800 Ma, ca 1600–1400 Ma, ca 1200–1100 Ma, and ca 500 Ma and Metamorphic events were dated to ca 1600–1500 Ma, 1270–930 Ma, 820 Ma, and ca 500 Ma . Thus, our data provide a provisional link to the Rayner Province and confirms the data by other researches (e.g., Arora et al., 2020; Chatterjee and Nicolaysen, 2012; Chatterjee et al., 2007, 2011; Yin et al., 2010) who showed that the early Cryogenian (ca 850–800 Ma) high-grade event affected large crustal domains in the eastern part of Indo-Antarctic palaeocontinent.

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Abstract No : 926

Evolution of rare borosilicates bearing lithounits of Brattstrand Paragneiss, East Antarctica: insights from bulk and mineral scale geochemistry

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Bratstrand Paragnesiss and associated anatectic pegmatites exposed in Larsemann Hills sector of Princess Elizabeth Land, East Antarctica comprises rare borosilicate minerals occurring in metaquartzite, metapelite and metapsammite. This work attempts to understand the petrogenetic diversity of the rare borosilicate minerals in hydrothermal-metamorphic system. Prismatic, grandidierite and tourmaline (schrol and dravite) are found along the foliation planes in thin separate layers associated with the matrix minerals in pelitic granulite and in matrix of pegmatites. The mineralogical and textural studies along with geochemical data suggest multiple episodes of generation of borosilicate formation in these rocks and indicate hydrothermal system in marine environment associated with Pan-African orogeny. Bunched nature of trace element data for metaquartzites and a spread for pelitic granulites is observed. Pelitic granulites show affinity with both pegmatite (melt product) as well as quartzite (non-melted part?). Distinct REE patterns of matrix and inclusion grandidierite grains confirm their polygenetic evolution. LREE depletion in some of the grandidierite grains present as inclusions in prismantine grains. We suspect that the prismatic grains of prismatine and grandidierite indicate growth at higher pressure granulite metamorphism whereas growth of grandidierite-quartz and grandidierite-cordierite symplectite texture indicate development at lower pressures while decompression. We infer presence of single generation B-rich phases in quartzite and more than one generation in pelitic granulites. B-rich fluid was added to the sediment sequence prior to metamorphism, instead of being a product of anatexis. The argillaceous to araneceous sequence represents a typical Proterozoic marine basin with active volcanism, later subjected to poly-metamorphism.

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Abstract No : 161

Similarity-driven segmentation of the Antarctic continent

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Understanding subglacial geology and tectonic setting, and by implication, the properties of the deep Earth beneath is needed to improve models of heat flow at the base of the ice sheets, and glacial isostatic adjustment. Those parameters are required to better predict Antarctica's contribution to future sea-level change in response to a changing climate and ocean temperature. Geophysical and geological data are sparse in Antarctica and are often associated with more considerable uncertainties than elsewhere. Consequently, many suggestions regarding the tectonic architecture of the interior are at best speculative, and there has been significant disagreement between studies. To provide a robust tectonic segmentation map of Antarctica on a continental scale, we collect an ensemble of observables from recent datasets and models covering the continent. Included observables are derived from seismic tomography, satellite potential field surveys, airborne geophysics, and geological observations. We match those Antarctic observables with global references to detect the most similar geological and tectonic settings. The degree of similarity between Antarctic locations and the global reference generates a similarity rating map for each location. We use this map to extract the suggested classes from global tectonic regionalisation models and geological maps. We optimise the selection criteria and evaluate the results by investigating the information entropy in the resulting maps. The maps suggest a complex East Antarctic interior, with the East Antarctic interior comprising several distinct blocks. The West Antarctic map shows high information entropy, with interpretations remaining open under this analysis.

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Abstract No : 854

International Lithosphere Program Coordinating Committee for East Antarctica: Activities in 2022 and 2023

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The Coordinating Committee (CC) for East Antarctica is a five year initiative (2021–25) that aims to coordinate and promote best practice in lithosphere, and deeper Earth structure, research for East Antarctica. It was formed with a particular imperative to connect the global lithosphere communities with Antarctic research initiatives, and thereby leverage these combined networks for research progress. The International Lithosphere Program was established in 1980 by the International Council of Science at the request of IUGG and IUGS and thus embraces both geophysical and geological foundations of participation in solid Earth geoscience. Our Coordinating Committee for East Antarctica addresses the ILP challenges through strengthening interdisciplinary connections, raising the profile of lithosphere-related research, promoting integrated research approaches, and encouraging training and network-building for early career researchers. In 2022, the activities of the CC for East Antarctica are focused on fieldwork coordination: providing a central focus for information regarding approved and proposed field activities, and activities to aid technical success in instrument deployments. We are also revisiting 2021 efforts to expand our CC and contact list that were hampered directly and indirectly by the global pandemic. In 2023, the CC is developing a workshop/summer school with opportunities for collaborative discussions and skills development. The summer school is planned for Sweden in July 2023 (scope and details to be confirmed). New contacts are always welcome, and we encourage those interested to contact the lead author.

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Abstract No : 316

Detrital garnet Lu–Hf geochronology: a novel tool to probe into Antarctic geological history from Australian shorelines

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The Fleurieu and Yorke Peninsula coasts (South Australia) host a number of garnet-bearing heavy mineral placer sands which were winnowed from glacial sediments in the Permian Troubridge Basin and concentrated by wave action. The source of the garnets is enigmatic, but it's been hypothesized that they might have an Antarctic origin and were transported by Permian glaciers, together with a variety of rock clasts (erratics), to what is now the South Australian margin of the formerly contiguous Australian–Antarctic system within the Nuna–Rodinia–Gondwana supercontinent configuration. We test this hypothesis by constraining the age of the garnets using a novel analytical method. Traditional Sm–Nd or Lu–Hf dating methods are unrealistic for dating detrital garnets, given the laborious and time-consuming sample preparation requirements that would need to be applied to individual grains. We have developed laser-based in-situ garnet Lu–Hf geochronology which allows several hundreds of garnets to be dated in a single day. Applied to the placer garnets, our Lu–Hf age results reveal a dominant ~600–590 Ma and minor ~1200–1100 Ma provenance that cannot be linked to local Australian continent tectonic events. Instead, the garnets are considered to have been derived from Antarctica, where Grenvillian- and Pan-African-aged metamorphic events have been extensively described. Hence, our novel analytical capability provides the opportunity to probe into Antarctic tectonic history from Australia to reveal key information from study areas that are presently entirely ice-covered or were entirely eroded away during the last 250 million years of Earth history.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

GEOSCIENCES

**Antarctic ice sheet behaviour from
marine and terrestrial records**

CONVENORS

Richard Jones, Mike Bentley, Julia Wellner,
Ruthie Halberstadt

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Abstract No : 446

Deep radiostratigraphy constraints support the presence of persistent wind scouring behavior for more than 100 ka in the East Antarctic ice sheet

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The characterization of unconformities in the wind-scoured zones is not only crucial for the accurate estimation of the Antarctic mass balance, but can also provide strong constraints on climate models. In this study, the age-depth stratigraphy of the wind scours area in the vicinity of the Dome A region is proposed by merging the available six isochronous internal reflecting horizons (IRHs) with ages ranging from 35.6 ka to 160.4 ka, which is matched with the locations of intersections of different ice-penetrating radar survey lines during CHINARE 21 (2004/05), 29 (2012/13) and 32 (2015/16). The dimensions and morphology of the englacial stratigraphy structure of the ice sheet are reproduced by tracing the deep IRHs below 500 m from the ice surface in the southern part of Dome A. A one-dimensional steady-state vertical strain-rate model is used to quantitatively estimate the upper limit for the earliest erosional activity of the unconformity of ~105.6 ka. Interpretation of the radar images supports that the persistent wind scouring behavior on the age scale of ten thousand years began during the Last Interglacial- Last Glacial (128 ~ 10 ka B.P.). High-resolution unconformities and internal structural characteristics associated with erosion contribute to providing important constraints for ice flow and climate models, and for ice core analysis to estimate the distribution of aeolian rate and strain rate anomalies.

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Abstract No : 641

Antarctic subglacial precipitates record ice sheet response to millennial-scale Southern Ocean warming

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The response of the Antarctic ice sheet (AIS) to orbitally forced climate change on glacial-interglacial time scales is reasonably well characterized by offshore sediment records and model simulations. What remains poorly understood is how the AIS is affected by millennial-scale changes in Southern Ocean temperature. This study presents a compilation of U-Th age and isotopic compositional data ($^{87}\text{Sr}/^{86}\text{Sr}$,

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Abstract No : 205

Resolving solid earth properties through co-location of ice load histories and GNSS measurements in West Antarctica

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Glacial Isostatic Adjustment (GIA) is a complex suite of ice sheet-bedrock-sea level feedbacks critical for projections of future global sea level. Modelling GIA requires knowledge of both solid earth properties and past ice load histories, both sparsely constrained in Antarctica. Global Navigation Satellite System (GNSS) measurements of bedrock deformation record the integrated response to both modern and ancient ice mass change. The elastic component due to modern ice mass fluctuations can be modelled using satellite observations constraining ice mass balance. The viscous component recording a ‘memory’ of centennial- to millennial-scale ice load history can be constrained using cosmogenic nuclides extracted from glacial deposits. Accumulation of these rare nuclides (e.g. ^{10}Be , ^{26}Al , ^{14}C) in bedrock and glacial deposits provides direct, quantitative constraints on the timing and magnitude of changes in ice thickness over centennial to millennial timescales. Glacial erratic samples opportunistically collected by POLENET scientists from two difficult-to-access sites in West Antarctica provide a proof-of-concept for integrated studies, logistical efficiency, and leverage critical interdisciplinary science. Results from Clark Mountains show strong agreement with established ice load reconstructions, while results from Lepley Nunatak provide the first ice load constraints for a vast region along the Bellingshausen Sea sector. We will also highlight two newly collected glacial thinning records adjacent to Thwaites Glacier. Combining local ice load histories, GNSS measurements of crustal deformation, and GIA modelling, will enable improved assessment of ice sheet change and deeper understanding of solid earth deformation and feedback processes that may influence future sea level.

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Abstract No : 59

Heat source and flux distributions in the western Ross Sea seafloor, Antarctica

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There has been little in situ investigation made in the Ross Sea on how lithospheric heat flux contributes to cryosphere dynamics over time despite advancement in reconstructing cryosphere timeseries in Antarctica. We discuss available geological samples, geophysical remote sensing data and observations to date from the western Ross Sea in demonstrating the distribution and impacts from heat source and flux. Local, short-term heat flux, such as volcanism and associated hydrothermal circulation, can contribute to instantaneous melting of ice whereas longer-term heat flux, such as geothermal gradient radiating from magmatism, can contribute to background heat that likely control overall ice flow dynamics. Particularly in the western Ross Sea is the Terror Rift, which represents the youngest phase of extension within the West Antarctic Rift System, one of the world's largest rifts and the only one covered by continental ice sheets. The western Ross Sea lithosphere and Terror Rift encompasses active volcanism that range from 5 Ma to present-day, suggesting that dynamic changes in ice sheet extent and thickness over this time period are concurrent with magmatic activities. Refining our understanding on the linkage between the distribution of heat source and flux to glacial cycles is a novel science effort in the western Ross Sea. We consider that magmatic intrusion and volcanism is the primary lithospheric heat source, and their locations and resulting heat flux have impacted lithosphere processes, such as evolution of geothermal and seafloor hydrothermal activities, which in turn, have influenced the dynamics of the ocean-cryosphere

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Abstract No : 726

An analysis of how deep-sea sediments and ice cores provide a record of Quaternary climate change

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This article explores the range of methods available to analyse ice and deep-sea sediment cores. It also explores the value of such cores in the context of reconstructing a record of Quaternary climate change, or paleoclimatic reconstruction. Paleoclimatic reconstruction is an extremely important and useful field of research due to the practical benefits it provides for the study of climate change. The historical record of past climates that paleoclimatic researchers map extends our knowledge of the intricate dynamics of the climate system, provides analogues of climate change (which are invaluable for future prediction (Snyder, 2010)), and allows for the accuracy of climate models to be tested. Models are run using past planetary conditions and the accuracy of their predictions is evaluated against paleoclimatic reconstructions (Snyder, 2010)

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Abstract No : 592

Deep water sedimentary processes in the Enderby Basin and its implication to the ice sheet variability on the East Antarctic margin during the Cenozoic time

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The thick sequence of mid-late Cenozoic sediments preserved within the Enderby Basin of the East Antarctica margin contains key information regarding glacial history and palaeo-oceanographic conditions during the last 34 My. The interplay between glacial processes and ocean circulation can be reconstructed from seismic stratigraphic studies. Here, interpretations of seismic sequences and geomorphology from an extensive 2D seismic dataset (~75,000 km) are correlated with lithological data of the ODP site 1165 drilled on the continental rise, and used to assess the age and origin of the sediment, and the possible influence of oceanic currents on its distribution. Mapping of seismic units and facies reveals that, in addition to glacial sediments derived from the Antarctic mainland, the upper Cenozoic succession includes drift units with prograding sequences building out from the Mac. Robertson Land margin, west of the Prydz Bay. Three contourite drifts grew on the western side of submarine channels and large sediment wave fields suggest a mixed system of turbidity currents influenced by west-flowing bottom currents. The drifts are composed of four seismic units representing stages of onset (Lower Oligocene), main growth (Early-Middle Miocene), maintenance (Middle-Late Miocene) and burial (Pliocene). The internal geometry and reflection patterns of the drifts imply an intensified current activity from the Early to Middle Miocene. The results plausibly reflect that the formation of proto Antarctic Bottom Water (AABW) started around the Eocene-Oligocene boundary and intensified episodically from the early to middle Miocene.

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Abstract No : 681

Green clay authigenesis: A reliable paleoenvironmental indicator for reconstructing Antarctic Cenozoic climate history

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Clay minerals ('hydrous phyllosilicates') are major constituents of sediments deposited in the marine environment, and glaucony (green clay) authigenesis in marine sediments has played an important role in the understanding of Earth's climate history. Glaucony formation and evolution are driven by the activity of bacteria thriving in the organic-rich environment, a bio-geochemical system now considered to play a significant role in the control of global ocean chemistry. Investigation of the reaction mechanisms throughout the formation of glaucony provides reliable information about (i) macro-scale environmental conditions, such as ocean transgression-regression cycles and ocean circulation changes, and (ii) the micro-scale sedimentary environment, such as sediment permeability, ion mobility and organic matter content – all of which are registered in the fabric and crystal-chemical characteristics of glaucony. In addition, K-Ar dating of glaucony has provided 40% of the absolute-age dates for the geological timescale of the past 250 Ma. Glaucony is therefore an important tool to date depositional ages of sediments and to reconstruct paleoenvironmental conditions. The Southern Ocean, a key control of global climate, contains glaucony deposits of ages matching Cenozoic climatic variations. Glaucony investigation can establish the timing of these tectonic and climatic changes. However, the nature, depositional setting control, and paleoenvironmental effects of authigenic glaucony in Antarctic regions are currently only loosely constrained. Here we present an in-progress international project investigating Cenozoic glaucony-bearing deposits from several locations around the Antarctic margins.

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Abstract No : 639

Ground-penetrating radar evidence for relative sea-level oscillations across the Northern Antarctic Peninsula

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Recent studies have provided evidence for Holocene oscillations in the glaciers and ice sheets of Antarctica as well as a relatively weak rheology beneath many parts of West Antarctica. Did these factors result in high-frequency oscillations in relative sea levels across portions of the Antarctica Peninsula? We test this hypothesis by collecting ground-penetrating radar (GPR) profiles from two locations within the Antarctic Peninsula – Joinville Island along the NW Weddell Sea and Livingston Island within the South Shetland Islands. Erosional surfaces and scarps imaged within the GPR profiles from both locations provide evidence for relative sea-level (RSL) oscillations at both locations. New and existing radiocarbon and optically stimulated luminescence ages suggest that these oscillations occurred in concert with known periods of glacial advance and retreat, including the “Little Ice Age.” These oscillations suggest that the RSL signal from the Last Glacial Maximum may be contaminated by late Holocene events. Thus glacial-isostatic adjustment models that ignore more recent Holocene glacial advances and retreats may misrepresent the amount of ice in Antarctica during the Last Glacial Maximum.

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Abstract No : 400

Antarctic Ice Sheets dynamic in two basins of the western Ross Sea continental shelf: evidence using multidisciplinary stratigraphic markers.

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The study of the continental shelf of the Ross Sea (Antarctica), is nowadays an important topic to evidence the role of the Antarctic Ice Sheets (EAIS and WAIS) in the evolution of this sensitive sector. In marine settings of polar areas, this study is normally carried out in ice-free areas, as they represent suitable regions for collecting past marine ancient sediments. In order to reconstruct the paleoenvironmental evolution of the EAIS, some sectors of the Western Ross Sea continental shelf have been investigated, using marine cores collected in both Joides Basin and Pennell Through. These materials, as a part of the CHIMERA project – Cryptotephra in Marine sEquences of the Ross Sea, Antarctica: implications and potential applications – granted by PNRA (Progetto Nazionale delle Ricerche in Antartide, Italy), allowed us to document the position of the EAIS (and WAIS) during a time period covering the last 30–40 ka BP. AIS advances and retreats leave signatures that can be recognized from textural, micropaleontological (foraminifers and diatoms), geochemical and environmental magnetic proxies. These markers are mainly addressed to the ice shelf changes during the late Quaternary glacial-interglacial climate variability. Marine sediments of Ross Sea continental shelf also include tephra and cryptotephra, material produced by explosive eruptions of Antarctic volcanoes and widely dispersed by wind. Their accumulation both as primary deposits or as transported materials in marine sediments is very useful to testify the absence of the ice sheet in the studied area.

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Abstract No : 539

Ice was thicker than present surrounding Lambert Glacier, East Antarctica, during the Last Glacial Maximum

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Our understanding of how the Antarctic ice sheet has responded to Quaternary climate change relies on a combination of ice-sheet modelling and geological observations. Existing models and observations suggest that the East Antarctic Ice Sheet (EAIS) maintained an approximately stable thickness across its interior throughout the Pleistocene and Holocene. However, observations are limited owing to the lack of exposed rock in interior Antarctica. Here, we present a chronology of past ice-surface elevation changes derived from radiocarbon (^{14}C) surface-exposure dating of bedrock and erratic samples from the Grove Mountains in East Antarctica, 380 km inland from the Antarctic coast. Our data provide evidence of thickening at the Last Glacial Maximum (LGM). Radiocarbon-saturated samples 88 m above the current ice surface indicate that the nunatak summit was exposed during the LGM, while unsaturated samples indicate that thinning subsequently occurred, with some (25–45%) post-LGM thinning recorded at ~15–11 ka and most (55–75%) recorded during the Holocene. Average thinning rates calculated from our data indicate that the ice surface lowered at ~6 m kyr⁻¹ since the LGM. The ice surface reached its current elevation by 1.3 ka. These results imply that at least part of the interior EAIS was thicker at the LGM, and that ice-sheet models that do not account for this thickness change may fail to accurately characterize the post-LGM geometry of the EAIS and underestimate EAIS contributions to deglacial sea-level rise.

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Abstract No : 1053

Establishment of tidal series in Deception and Livingston Islands (Antarctica).

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Deception and Livingston Islands belong to the Bransfield Strait; this region is a geodynamically complex area caused by the interaction of several tectonic plates. Deception Island is one of the active volcanoes in this subduction zone, so Livingston Island is taken as a reference to volcanic studies. It is difficult to set up and maintain equipment on the Antarctic continent and its vicinity due to the adverse conditions of the austral winter. So tide records are highly valued for tidal prediction in the region for scientific work. Two tide stations were established in 2012, one at Deception Island (DECMAR) and other at Livingston Island (LIVMAR). Continuous records have been recorded since 2015 in Livingston and 2016 in Deception. These time series, were studied using pressure sensors with a sampling interval of 20 min. Tidal constituents are solved by a yearly harmonic analysis with results about 98% agreement with the predictions estimated. Tides in the Bransfield Strait are described as mixed, mainly semi-diurnal, so there are daily two high and two low waters. The tidal time series will be referenced to the ellipsoid and the monthly mean sea level and its rate of rise. A first approximation of the monthly mean sea level and the rate of rise are calculated with a linear regression.

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Abstract No : 214

On evolution of formation of Lake Vostok in the epoch before glaciation of Antarctica

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To present evolution of formation of the Antarctic Lake Vostok in the pre-glaciation epoch, tectonic, geophysical, geodetic, glaciological and microbiological data of full-scale studies and numerical modelling of through freezing of lake water to the bottom collected in the early 21st century were used. Formation of lake valley in the bedrock relief of East Antarctica is related to rifting processes during disintegration of Gondwana supercontinent 140–135 million years ago. The valley was filled with water from different hydrological sources and atmospheric precipitation in ancient Antarctica located at that time in the temperate climatic belt and with geothermal water characteristic of rift faults. The latter hydrological source resulted in strongly stratified by density vertical structure of lake water strata. Stable ice formation on the lake surface began around 15–20 million years ago and was accompanied with different natural processes creating by-layer vertical distribution of glacial structures that existed in different time intervals. Two lower layers of the ice sheet above the lake were formed of frozen lake water as confirmed by studies of the ice core isotopic composition. Numerical modelling of through freezing of lake water shows such suggestion to be invalid even at most fantastic prescribed boundary conditions. This testifies to existence beneath the glacial strata of more ancient water and bottom sediments.

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Abstract No : 288

Different Impacts of Antarctic Last Interglacial Ice Sheet Changes on West and East Antarctic Isotope Records

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Global temperature during the Last Interglacial (LIG) period (116,000–130,000 years ago) was ~0.8°C warmer than that today. This is associated with a global mean sea level which is 6–9m higher than today. Given most of the sea level increase likely came from the Antarctic ice sheet, understanding how Antarctic ice sheet changed in this warmer scenario is very useful in constraining future global sea level predictions. Six existing East Antarctic ice cores, containing LIG ice, have previously been used to study the relationships between Antarctic Ice Sheet (AIS) changes and the LIG stable water isotopes. However, none of these studies have included records from the key West Antarctic ice sheet (WAIS) region. Roosevelt Island Climate Evolution (RICE) ice core, a new 763 m long ice core from Roosevelt Island, which offers the new possibility of a LIG West Antarctic record. Here, our research is to combine new RICE information with measurements from the other six ice cores to explore the impacts of AIS changes on the LIG stable water isotope. We will explore the stable water isotope response to different AIS scenarios using the isotope-enabled coupled ocean–atmosphere–sea ice General Circulation Model, HadCM3. Two control simulations are used: (1) preindustrial (PI) simulation, with present orbit and greenhouse gas forcing; (2) LIG isotope maximum 127ka simulation with modern AIS configuration. A suite of simulation focused on 127 ka is then used to investigate the isotope response to different AIS elevations. Model outputs would be compared with ice core records.

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Abstract No : 814

An investigation of the source of the Sirius Group deposits in the Transantarctic Mountains, Antarctica

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The Sirius Group is found throughout the Transantarctic Mountains, and it represents a massive glacial event that can help us to understand the evolution of the East Antarctic Ice Sheet (EAIS). Using samples from Sirius Group deposits found at Tillite Spur (Scott Glacier), Bennett Platform (Shackleton Glacier), and Meyer Desert (Beardmore Glacier), we constructed provenance profiles using X-ray fluorescence, grain size, and detrital zircon U/Pb age data. Samples were provided by the Polar Rock Repository at The Ohio State University. At each site, we studied samples from different stratigraphic sections to look for changes in the provenance over time, which we could interpret as changes in the flow and erosion of the EAIS. At each site, we see very little change in grain size, major elements, and minor element composition throughout their respective stratigraphic sections. Zircon U/Pb ages from Tillite Spur range from 279 Ma to 3.2 Ga, with a dominant peak at 515 Ma. Using the Kolmogorov-Smirnov test, the five samples of till at Tillite Spur have zircon populations that are statistically indistinguishable, and two layers of interbedded gravels show profiles that are similar but statistically distinct from the tills. We interpret this to indicate that the Scott Glacier flowed the same way to deposit each of the layers of Sirius Till at Tillite Spur, and it did not erode down to new layers of material during this time either. Zircon from the Bennett Platform and Meyer Desert have been separated and will be analyzed similarly.

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Abstract No : 724

LGM – Holocene transition in the Glomar Challenger Basin (Easter Ross Sea, Antarctica): preliminary results

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While the history of the Western Ross Sea (WRS) is quite well understood, the history of the Eastern Ross Sea (ERS) is still affected by lacks and uncertainties, in particular the Last Glacial Maximum (LGM) – Holocene transition. A multidisciplinary approach is very useful to reconstruct the evolution of the WAIS since the LGM and sedimentary dynamics in the Glomar Challenger Basin (ERS). This is a crucial site because it is close to the WRS, characterized by different morphologies and different mechanisms of the ice sheet retreat. The Glomar Challenger is also connected to the Hillary Canyon, one of the main drainage channel of the continental shelf, which favors the inflow and outflow of water masses. A transect of five gravity cores were collected from the inner shelf, near the actual position of the Ross Ice Shelf (RIS) to the shelf break during several PNRA expeditions. A combination of sedimentological, micropaleontological and geochemical analyses (XRF, IPSO25) have been performed. Gravity cores dating have been obtained using Accelerator Mass Spectrometry (AMS) on organic matter. Here we presents the preliminary results of this study. Three facies have been recognized, from the oldest to the most recent: 1) Glacial: heterogeneous over-compacted subglacial diamicton; 2) Glacial marine: sub-ice shelf sediments characterized by the high presence of Ice Rafted Debris (IRD) and sparse carbonate foraminifera; 3) Holocene: muddy sediments in the inner shelf, coarse sediments in the outer shelf; both are characterized by the presence of agglutinants foraminifera, radiolarians and sponge spicules.

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Abstract No : 134

GEOMORPHIC INVESTIGATION OF MARTEL INLET, KING GEORGE ISLAND, ANTARCTICA USING TOPO-BATHYMETRIC OBSERVATIONS

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This study investigated the terrestrial and submarine geomorphology and glacial landform records in the Martel inlet (Admiralty Bay, King George Island) using a 4 m multi-resolution DEM based on topobathymetric and high-resolution seismic and multibeam surveys. Geomorphometric analysis provided details of the morphological characteristics and evidence of glacial landforms and sedimentary processes. The submarine sector has a mean depth of 143 m, a maximum depth of 398 m, and a low slope (0° – 16°). Steep slopes ($>30^{\circ}$) are found along the mid-outer sectors transition area. The fjord was mapped and divided into inner fjord (49 m depth), middle fjord (119 m), and outer fjord (259 m), based on depth, elevation and slope. The topobathymetric digital model to evidence geomorphological contrasts between these zones in the fjord's seafloor and subaerial environments. A prominent morainal bank in the transition between the inner and middle parts marks the limit of a past glacial advance and the last long stationary stage of the Dobrowolski-Goetel ice margin. Streamlined glacial lineations demonstrate an NE-SW past ice flow direction and a wet-based thermal regime. Keywords: Antarctic fjord, submarine landform, multibeam bathymetry, glacier forelands.

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Abstract No : 52

Asymmetry in Antarctic ice sheet cover during the early Oligocene glacial maximum

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Team of Expedition, PS104

The Eocene–Oligocene transition (EOT; ~34.4–33.7 Ma) was a major shift in Earth’s long-term climatic evolution, marking the cooling from the Early Paleogene greenhouse to the icehouse regime that has prevailed from the Oligocene until today. However, it remains uncertain which landmasses were already covered by ice sheets during the Early Oligocene Glacial Maximum (EOGM; ~33.7–33.2 Ma), an interval of peak glaciation immediately following the EOT. The scarcity of earliest Oligocene climate records in both Arctic and Antarctic regions hitherto prevented the reconstruction of environmental conditions and ice-sheet extent during the EOGM. Such constraints, however, are critical for assessing ice–ocean–atmosphere interactions during the early stages of the Cenozoic icehouse. Here, we present the first shallow-marine drill-core record of earliest Oligocene environmental conditions in West Antarctica’s Pacific sector. It comprises marine mudstones documenting the presence of a cool-temperate Nothofagus-dominated forest situated within a marine archipelago at 73.5°S palaeolatitude. Any evidence for marine-terminating glaciers is lacking, thus no land-based ice or only small ice caps existed in West Antarctica during the EOGM. Our new EOGM temperature and topographical constraints allow for more reliable verification of a fully-coupled Earth System Model. It simulates a large East Antarctic ice sheet already during the EOGM. However, West Antarctica does not glaciate until ~26 Ma, thereby illustrating the significance of asymmetric Antarctic ice sheet response during initial Cenozoic glaciation and highlighting the importance of differential regional response for future cryospheric change.

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Abstract No : 114

Bottom current control on sediment deposition between the Iselin Bank and the Hillary Canyon (Antarctica) since the late Miocene: An integrated seismic-oceanographic approach

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We analyze how oceanic circulation affects sediment deposition the continental margin between the Iselin Bank and the Hillary Canyon, and how these processes evolved since the Late Miocene. We use seismic, morpho-bathymetric and oceanographic data interpreted together with age models from U1523 and U1524 drilling sites (IODP Expedition 374). Oceanographic data, together with a regional oceanographic model, are used to support our reconstruction by showing the present-day oceanographic influence on sediment deposition. Regional correlation of the main seismic unconformities allows us to identify eight seismic sequences. Seismic profiles and multibeam bathymetry show a strong influence of bottom current activity on sediment deposition since the Early Miocene and a reduction in their intensity during the mid-Pliocene Warm Period. Oceanographic data and modelling provide evidence that the bottom currents are related to the dense waters produced on the Ross Sea continental shelf and flowing out through the Hillary Canyon. The presence of extensive mass transport deposits and detachment scarps indicate that also mass wasting participates in sediment transport. Through this integrated approach we regard the area between the Iselin Bank and the Hillary Canyon as a Contourite Depositional System (ODYSSEA CDS) that offers a record of oceanographic and sedimentary conditions in a unique setting. The hypotheses presented in this work are intended to serve as a framework for future reconstructions based on detailed integration of lithological, paleontological, geochemical and petrophysical data.

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Abstract No : 880

A deep learning approach to automatically interpret Grounding Zone Wedges in Antarctic seismic stratigraphic data

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The interpretation of glaciogenic sedimentary features in the Antarctic marine seismic stratigraphic record, combined with lithological/age constraints from drill sites, provides many insights into past ice-sheet fluctuations. Erosional surfaces, massive diamicton on the Antarctic continental shelf and Trough Mouth Fans are associated with continental margin expansion and are good indicators of ice-stream flow during past glacial advances. Paleo-ice-stream stationarity, during ice retreat or advance across the continental shelf is indicated by the presence of stacked sediment depocenters (Grounding Zone Wedges, GZWs). Seismic interpretation is however time-consuming, and relies on expert judgment, and as such it is difficult to quantify uncertainties in the interpretation. Machine learning applications can (1) reduce the time needed for seismic interpretation, (2) provide quantitative uncertainty estimates to detected sedimentary features. Here, as a first attempt to apply machine learning to the Antarctic marine seismic stratigraphic record, we train deep Convolutional Neural Networks (CNNs) to identify GZWs. The CNNs are trained using two seismic profiles from the Ross Sea intersecting the same GZW and the deep Sea Drilling Project DSDP272 site. The seismic profiles are segmented, in order to provide a number of training examples sufficiently high. The trained CNNs are then first validated over the original, full size seismic profiles, and then applied to a seismic profile acquired from a different Ross Sea area, where a GZW feature is identified. We will discuss preliminary results, challenges and limitations in this application, which has the potential to greatly speed-up and integrate the traditional human-based interpretation.

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Abstract No : 748

Impact of Eocene–Oligocene Antarctic glaciation on the paleoceanography of the Weddell Sea

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The Eocene–Oligocene Transition (EOT) at ~34 Ma marked a climatic shift from greenhouse to icehouse conditions, towards long-lasting lower global temperatures and a continental ice sheet in the Antarctic. The relative importance of ocean gateways, pCO₂, and ice growth as drivers of this transition are not fully understood. We report on sedimentological and inorganic geochemical results across the EOT at Ocean Drilling Program (ODP) Site 696 in the Weddell Sea, within the Antarctic limb of the Atlantic circulation. The geochemical composition of detrital, authigenic and biogenic marine sediment components, and sortable silt proxies demonstrate the impact of ice growth on high latitude water masses. Sortable silt grain size and Zr/Rb ratios attest to a period of vigorous circulation at ~36.2–35.8 Ma, coincident with a known warm interval in the Southern Ocean. Across the EOT, detrital provenance suggests that regional ice growth in the western Weddell Sea was stepwise, first expanding in the Antarctic Peninsula, followed by parts of West Antarctica. In conjunction with regional ice growth, high uranium enrichment factors (U EF) in sediments spanning the EOT interval indicate anoxic conditions in the sediment with evidence of carbonate dissolution. Following glacial expansion and sea-ice formation at ~33.6 Ma, a return to oxic conditions and carbonate preservation is observed with excess barium and phosphorous indicative of an increase in productivity, and potentially carbon export. Our results highlight the important connections between ice growth and the changing properties of high-latitude water masses at the EOT with impacts on the global ocean circulation.

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Abstract No : 93

Pliocene West Antarctic Ice Sheet Dynamics in the Amundsen Sea Sector: Results from IODP Expedition 379 Drill Records and Seismic Analysis

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Evidence about the reaction of the West Antarctic Ice Sheet (WAIS) to past warmer-than-present climates including its dynamic behavior to modification in oceanic and atmospheric forcing in the Plio- and Pleistocene may have strong relevance for assessing present and future climate states. During the International Ocean Discovery Program (IODP) Expedition 379, sediment cores from two drill sites were recovered from the Resolution Drift on the continental rise in the Amundsen Sea sector, a key region for understanding past and present WAIS dynamics. Both drill sites provide continuous records from the late Miocene to the Pleistocene including the warmer-than-present intervals of the Pliocene. Sites U1532 and U1533 are located on a network of seismic lines enabling a correlation of seismic key horizons and sequence characteristics by core-log seismic integration. We identified an interval with alternating physical properties and high diatom abundance correlating with distinct seismic reflection characteristics. This interval has been dated to 4.2–3.2 Ma and is interpreted to represent a highly dynamic WAIS with prolonged grounding line retreat periods in the Amundsen Sea sector. Due to the comprehensive network of seismic lines, the results are extrapolated to other sediment drift bodies in the Amundsen and Bellingshausen Seas for providing an extended regional analysis of past WAIS dynamics.

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Abstract No : 749

Terrestrial Record of Antarctic Ice Sheet Dynamic Response to Pleistocene Millennial-Scale Climate Cycles

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Records of changing ice mass in offshore sediments and ice cores suggest that the Antarctic ice sheet experienced millennial-scale ice loss during the last termination. However, the distal location and short temporal coverage of these records leads to uncertainty in both the spatial footprint of ice loss, and whether millennial-scale ice response persists outside of glacial terminations. Here we present a >100kyr archive of episodic Antarctic ice sheet basal melt events recorded by mineralogic variation in subglacial precipitates. ^{234}U - ^{230}Th dates for two precipitates are used to build a time series of 32 opal-calcite transitions that correspond to Late Pleistocene millennial-scale climate cycles, with precipitation of opal during cold periods and calcite during warm periods. Geochemical data indicate that opal precipitation occurs via cryoconcentration of silica in brines beneath the ice sheet margin, while calcite precipitation is triggered by the addition of subglacial meltwater originating from the ice sheet interior. These freeze-flush cycles represent changes in subglacial hydrologic-connectivity driven by ice sheet velocity fluctuations, which we propose occur in response to Southern Ocean thermal forcing acting on grounding lines within the Ross Embayment. Our results suggest that oscillating temperatures in the Southern Ocean affect the mass of the Antarctic ice sheet by regulating the delivery of heat to buttressing ice shelves and grounding lines on millennial timescales, regardless of the background climate state.

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Abstract No : 269

The relationship of the Totten and Vanderford glaciers revealed in offshore depositional patterns

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The Totten glacier is currently one of the major drainage outlets of the marine portion of the East Antarctic Ice Sheet (EAIS), dwarfing its neighbouring glacial systems, such as the Vanderford glacier in output of ice, meltwater and therefore sediment transport and deposition offshore. Today, the Law Dome separates these two neighbouring ice streams, draining a common source region, the Aurora and Sabrina subglacial basins. To better parameterize a retreating EAIS, we use offshore seismic reflection data to look to the first establishment of the EAIS as well as its Neogene evolution, including periods of significant ice sheet retreat or potentially collapse, especially in the marine sector of the EAIS. With low-lying basement in the hinterland of both outlets, the Totten and Vanderford region are prone to potential collapse during times of EAIS retreat and can be expected to recover similarly with the re-establishment of continental-wide glaciation. The legacy multi-channel seismic reflection data we are using from the continental slope and rise enables us to investigate the signature of the collapse and recovery of the neighbouring Totten and Vanderford glacial systems during significant steps of the EAIS development. Our preliminary seismic stratigraphic analysis reveals significant behaviour changes between the two outlets, which might have shaped regional ice sheet behaviour and bed rock erosion significantly in the past, pointing to the possible importance to recognize the potential of regional outlet switching in marine ice sheets with ice sheet growth.

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Abstract No : 542

Antiphase dynamics between cold-based glaciers in the Dry Valleys and ice extent in the Ross Sea, Antarctica during MIS 5

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During interglacial conditions of Marine Isotope Stage (MIS) 5, outlet and alpine glaciers in the Dry Valleys, Antarctica, appear to have advanced in response to increased open ocean in the Ross Sea. We provide evidence of antiphase behaviour through retreat of a peripheral lobe of Taylor Glacier in Pearse Valley. We measured cosmogenic ^{10}Be and ^{26}Al in 3 granite cobbles from thin, patchy drift to constrain a minimum age of last retreat of Taylor Glacier to no later than 65 ka. Paired ^{10}Be and ^{26}Al depth profiles to ~3 metres in permafrost cores, taken from below the drift and adjacent to the cobbles, indicate a minimum depositional age for surface layer permafrost at Pearse Valley is 143 – 420 ka, implying emplacement of permafrost predates the last MIS 5 advance of Taylor Glacier. The combined cosmogenic ^{10}Be and ^{26}Al data set reveals an advancing MIS 5 Taylor Glacier that was non-erosive, preserving underlying surface permafrost, and peppering boulders and cobbles onto the older, relict surface. Our data corroborate antiphase behaviour between outlet and alpine glaciers advancing in the Dry Valleys, in response to a reduction in ice extent in the Ross Sea. We suggest a causal mechanism for cold-based glacier advance and retreat is controlled largely by the increase and decrease of moisture availability, respectively, as a result of sea ice and ice shelf retreat and expansion in the Ross Sea. Similar permafrost cores have also been collected at Lower Wright Valley to investigate long-term recycling processes of Dry Valleys

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Abstract No : 581

Seismic-stratigraphic analysis of the South Orkney Microcontinent (SOM) sedimentary basins

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The development of the Scotia Arc resulted in the opening of ocean basins that are important conduits for the exchange and interaction of deep water masses. However, how the oceanic circulation evolved in the early stages of the Scotia Arc formation is still poorly constrained. In this work, we analyzed the sedimentary infill of the South Orkney Microcontinent (SOM) interior basins. The SOM was part of the ancient continental connection between South America and the tip of the Antarctic Peninsula and it is now located in the southern Scotia Arc separating the Scotia and Weddell Seas. Due to its paleogeographic evolution, the sedimentary basins of the SOM recorded changes in tectonics, climate/ice-sheet dynamics and oceanography during the Scotia Arc opening. Spatial and temporal distribution of the postrift seismic units has been defined from multichannel seismic profiles and attributed a formation age spanning from late Oligocene to present by correlation with Ocean Drilling Program sites 695 and 696. A regional unconformity truncating pervious strata marks the Eocene-Oligocene boundary. Above this unconformity, preliminary results indicate the presence of contourite drifts and sediment waves developed in the SOM since the early Miocene (23 Ma). This contrasts with the seismic and sedimentary record of the southern Scotia Sea basins that shows the widespread development of bottom current deposits to occur above a regional unconformity ("Reflector-c") with an age between 14.2 and 8.4 Ma.

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Abstract No : 819

Sub-Ice Shelf Sedimentary Event Deposits: Insights into Subglacial Hydrological Systems from Kamb Ice Stream, West Antarctica

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The extent and velocity of West Antarctica's ice streams exert a significant influence on global climate stability because of their role in determining ice sheet mass balance. Ice stream velocity is of particular interest and is thought to be controlled by local climate and subglacial hydrology. However, the primary control is thought to be the location and movement of water at the ice-rock interface. Remotely sensed geophysical evidence suggests that the inter-annual fill and drain of meltwater through a series of subglacial lakes connected by channels may be a primary mechanism for surges of ice streams. In the 2021/22 field season we retrieved a 0.53 m sedimentary core from a subglacial channel ~ 5 km from the Kamb Ice Stream grounding line (152°29'S, 82°47'W) that contains laminated muds with common reworked diatom remains and other organic compounds interspersed with graded sand and gravel. In detail, the mud contains parallel and non-parallel laminations which we interpret to represent local sedimentation. We interpret the graded beds as possible turbidity deposits indicative of fill-drain cycles of subglacial lakes. The presence of such event deposits has not been noted previously in sub-ice shelf sediments and is consistent with a binge-purge subglacial hydrology model. Ecology within subglacial lakes as well as the interaction between inflowing and outflowing water is poorly understood. This research will further advance our understanding on subglacial hydrological systems and their influence on ice stream behaviour, as well as our understanding of grounding-line proximal sedimentary processes and their influence on local ecology.

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Abstract No : 882

Bottom current strengths versus sea-ice advances in the eastern Hillary Canyon (Ross Sea, Antarctica) during the last 43 ka: Multiproxy evidence for its oceanographic evolution

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The Ross Ice Shelf is the Antarctic region that over the last deglaciation experienced the greatest change in areal ice cover. Today, cold, dense and saline water masses, forming the Ross Sea High Salinity Shelf Water (HSSW), flow from the shelf to the deep ocean providing a significant contribution, boosting the global ocean circulation and regulating the climate. In particular, the Hillary Canyon in the Eastern Ross Sea is one of the main conduits through which brines descend the slope to reach the deeper ocean and it is characterised by the presence of a sediment drift (ODYSSEA drift) that potentially contains the record of the variability of HSSW formation. Six sediment cores from the upper and middle slope of the central part of the Ross Sea were studied to reconstruct climate and paleoceanographic variability since the Marine Isotope 3, in the Hillary Canyon region. We carried out a multiproxy approach: micropaleontological (foraminifera, calcareous nannofossils and diatoms) sedimentological and geochemical analysis, paleomagnetic measures and radiocarbon dating, that reveal that the area was subjected to several oceanographic changes during the last 43 kyr BP. We identified strong millennial scale climatic variability characterised by waning deglacial conditions with enhanced meltwaters influxes and colder phases with strong bottom currents. Inferred variations in dense water formation, contour current strength and ice sheet dynamics are discussed in the light of our data interpretation.

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Abstract No : 105

A Resource for Paleoclimate Research: the Polar Rock Repository

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The Polar Rock Repository (PRR) is a National Science Foundation facility that provides online access to metadata and physical samples of rocks, unconsolidated glacial deposits, terrestrial cores, marine dredge samples and an image archive from Antarctica and surrounding areas. More than 59,000 samples are available as no-cost loans for research, including destructive techniques. The collection contains Cenozoic samples from more than 3200 sedimentary and ~ 4700 igneous rocks in Antarctica. There are many specimens from the Sirius Group, the glacial deposits around the Dry Valleys and almost all the Cenozoic volcanoes on the continent. The PRR records ancillary information, e.g., weathering rinds, glacial striae, organic residues, etc. Weathering rinds have been used to identify warmer periods and ice streaming. The dredge collection includes samples with corals and marine plants from known depths, collection dates and coordinates. Researchers may search for samples on the PRR website using multiple search fields. Map layers (REMA, USGS, SCAR geology) are available to facilitate searches. Results can be viewed as a table or thumbnail, downloaded as a spreadsheet, plotted on an interactive map and/or placed into a 'shopping cart' for loan requests. The online database includes information useful to paleoclimate studies by noting locations with biological activity in ancient lakes, soil horizons, and glacial surface features. The image archive (with some dating back more than 60 years) provides geologic and glaciological information as well as recording temporal slices of surface features (ephemeral lakes, icebergs, streams etc.) reflecting environmental and climate change.

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Abstract No : 608

Internal Structure and Age-Depth from Patriot Hills to the South Pole, Inferred from a Ground-Based Radar Traverse and Ice-Core Chronology

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In November 2004, the Centro de Estudios Científicos (CECs) carried out an over-snow traverse of ~1000 km from Patriot Hills to the South Pole, in order to measure bed topography using a radio echo sounding system, with a central frequency of 150 MHz and ~5 m of vertical resolution. Nearly 20 years later, these data are again being analyzed, but now with the aim of examining the internal structure of the ice sheet and trace internal reflecting horizons along the traverse. We have identified and mapped six isochrones; three shallower with less than 1000 m depth, called M1, M2 and M3, and three deeper approaching the South Pole and with ~1500 m depth called M4, M5 and M6. Additionally, this traverse intersects the Institute-Moller Antarctic Funding Initiative (IMAFI) radar lines, which connects to the Byrd Ice Core. Based on this ice core and SPICEcore (South Pole Ice Core) projects, some isochrones have been dated as M1, M2 and M6 with ages corresponding to 3.5-6.0 ka, 4.6-8.1 ka and 33-37 ka, respectively, thus connecting two ice cores. From the above, it is possible to use models and depths to estimate ages of other isochrones and understand the contribution of the West Antarctic Ice Sheet to past and future sea level.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

GEOSCIENCES

**Polar environmental studies along
the Antarctic margin:
past and present perspectives**

CONVENORS

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Anish Kumar Warriar, Stephen Roberts, Rahul Mohan,
Cheryl A Noronha-Dmello

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Abstract No : 231

Variations in environmental magnetism influenced by changing sea level, paleogeography, and paleoclimate from an East Antarctic coastal lake

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We hypothesize that environmental magnetic records from a coastal lake are intimately tied to relative sea level (RSL) fluctuations, climatic change, the depositional environment, and the paleogeographic location of siliciclastic sediment sources. A 63cm core retrieved from Pup Lagoon, Larsemann Hills, spanning the last 6411 years was analyzed for environmental magnetism, Total Carbon and Total Nitrogen content. Three contrasting zones were identified from the downcore distribution of the environmental magnetic parameters. In zone 1, spanning 6.4 to 2.6 cal. kyr BP, the presence of coarse-grained magnetic minerals and high superparamagnetic mineral content indicated terrestrial and aeolian inputs. The higher RSL, warmer sea surface temperature, and lesser sea-ice duration in the Prydz Bay promoted the fast ice retreat along Stornes Peninsula that resulted in more aeolian deposits between 6.4 and 4.9 cal. kyr BP. Subsequently, superparamagnetic mineral inputs reduced post 4.9 cal. kyr BP due to the greater sea-ice duration in the coastal region. Following this phase and the ongoing glacio-isostatic uplift of Stornes, in the zone spanning 2.6– 2.1cal. kyr BP, the lake underwent high sedimentation owing to increased meltwater runoff, transporting terrestrially derived sediments and reduction of anoxia inferred from partial oxidation of magnetite. The third zone from 2.1 kyr to 307 cal. kyr BP exhibited low sedimentation, higher concentration but overall decreasing trend of magnetic minerals of finer grain size, that suggested slow and intermittent inputs of meltwater due to cooler and arid conditions while TC and TN percentages indicated the biotic development and isolation of the lake.

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Abstract No : 1002

Relationship between Crane glacier retreat and sea ice collapse with high positive degrees days during the summer of 2022 in east Antarctic Peninsula.

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Since 2002, after the disintegration of the Larsen B ice shelf (east of the Antarctic Peninsula), the Crane Glacier has entered a phase of very rapid retreat, registering a maximum retreat during the summer of 2005. After 2011, Crane glacier has advanced rapidly, and at the end of 2021, its front reached its most distal position registered for the last decade. At the end of March 2022, the glacier front retreated by more than 7 km, registering the greatest loss of glacier mass due to calving (80%), concentrated in less than a month (between January 18 and February 10, 2022). From SAOCOM radar images, it was determined that the concentration of sea ice collapsed at the end of January 2022, which led to an accelerated advance by calving on January 21, 2022. In addition, a relationship was obtained between the disintegration of sea ice and the positive degrees days during the summer. As in the event there are no ice shelves involved, allows us to estimate that the variations in the position of the glacier front are related to the permanence of sea ice in contact with it, which has a linear relationship with the positive degree days during the summer in the study area, suggesting that the summer glacier ablation is accelerated by the action of the ocean waves and the tension generated by the water at the front.

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Abstract No : 500

Impact of Glacial Mass Loss on the Geomorphology of King George Island

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King George Island (KGI) is the largest of all the South Shetland Islands in the Antarctic Peninsula. This island located between 57° 35' W and 59° 02' W, 61° 54' S and 62° 16' S has an approximate length of 79 km (from southwest to northeast), an approximate width of 27 km, and an altitude that varies in the range of 0 -700 m.a.s.l. In this study, images from Landsat and Sentinel 2 satellites were analyzed from 1989 (1098.4 km²) to 2020 in order to determine the glacier coverage loss. The analysis showed that glacier loss amounted to 108.97 km² (10% of its total coverage), where only 05 glaciers with marine termination represent an accumulated loss of 43.4 km², while the smallest (less than 10 km²) are the ones that they lost more percentage of area. In addition, a detailed study of Znosko Glacier (located in KGI) through the use of GPR and a network of stakes installed in the last 04 years showed important changes in its morphology, as aside from a considerable loss of surface mass despite its reduced area (≈ 2 km²). The present study shows the changes in the glacier surface of KGI, and specifically a small glacier is evaluated, observing that despite having little superficial loss, its thickness loss is important (> 10 meters in some sectors), that allows us to have an approximation of what is expected in the future.

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Abstract No : 1041

Antarctic Peninsula warming activates subglacial hydrological networks

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Rapid regional warming of the Antarctic Peninsula region over the last five decades had led to the widespread accumulation of seasonal meltwater, particularly on the surface of ice shelves and the shear zones of their feeder glaciers. This refreezes in winter, percolates into fractures, or drains into the underlying ocean through moulins or ice dolines. Collectively these processes have contributed to ice shelf collapse due to meltwater driven fracture. In contrast to ice shelves, the role of meltwater on the surface, within and at the base of the region's glaciers is less well studied. This is important because changes in glacial and subglacial hydrology can result in significant changes in glacier dynamics including accelerating ice flow. In this paper we use the Reference Elevation Model of Antarctica (REMA), airborne radar, lidar and photography to characterise the catastrophic drainage of a subglacial lake under Mars Glacier on Alexander Island. We review evidence for similar features elsewhere in Antarctica and discuss whether they are an early warning of a threshold shift in the thermal regime of (some) Antarctic glaciers and the activation of their subglacial hydrological networks.

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Abstract No : 333

Organic matter source in the sediments of Larsemann Hills, East Antarctica

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Algal mat, moss and sediment samples were collected from Larsemann Hills in East Antarctica during the 38th Indian Scientific Expedition to Antarctica. Here, we compare the n-alkane distribution and stable isotope signatures in the samples to understand the source and preservation of organic matter (OM). The $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of sediment samples (-9.5‰ to -21.4‰ and 0.0‰ to 4.3‰ , respectively) lie close to $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values of algal samples (-8.5‰ to -16.2‰ and -0.6‰ to 6.99‰ respectively), indicating a possible algal contribution to the soil OM. Higher Odd over Even n-alkane predominance in algal and moss samples, compared to the sediments, indicates selective loss of odd carbon n-alkane chains via bacterial and diagenetic effects. The absence of isoprenoids (pristane and phytane) suggests the presence of a weak oxidation-reduction environment that poses favourable conditions for the growth of certain bacterial flora, which can produce a high abundance of even carbon numbered n-alkanes (Wang et al., 2010). References: Wang, Y., Fang, X., Zhang, T., Li, Y., Wu, Y., He, D., Wang, Y., 2010. Predominance of even carbon-numbered n-alkanes from lacustrine sediments in Linxia Basin, NE Tibetan Plateau: Implications for climate change. *Applied Geochemistry*, 25, 1478-1486.

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Abstract No : 313

Sulphur as a proxy for Southern Hemisphere westerly wind strength on sub-Antarctic Macquarie Island

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Sub-Antarctic islands, such as Macquarie Island, are ideally suited for palaeoclimate studies of the Southern Hemisphere westerlies (SHW). They are at latitudes where surface winds are greatest, and the SHW strongly control their climates, water chemistry and ecology. Stronger winds mean higher production of sea spray aerosols (SSA) over the ocean and deposition in lakes, resulting in higher measured electrical conductivity in lake water. To establish the relationship between SSA and wind strength on Macquarie Island, and potential for SHW reconstructions, a combination of in-situ aerosol monitoring (2018–2019CE), hydrochemical surveys of 40 lakes, and models of SSA production and lake water balance were used. Hydrochemical surveys found that while most lakes were dilute, their ionic ratios were similar to seawater, and sulphate (SO_4^{2-}) was most likely derived from marine aerosols. Other ions indicated additional processing (Cl^- , Na^+) or contribution from non-marine sources (Ca^{2+} , Si , K^+). Sulphur (S) was considered the most appropriate geochemical tracer for reconstructing SHW strength and measured in sediment cores spanning the last ~1800 years from two lakes on the western edge of Macquarie Island's plateau. Downcore variations in bulk S from X-ray fluorescence core scanning, and total bulk S measured by Proton Induced X-ray Emission and elemental analysis on subsamples were broadly similar. S isotope ($\delta^{34}\text{S}$) analysis showed S was marine-derived. Higher bulk S measurements indicated stronger SHW between 550–950CE and 1250–1450CE. Work is underway to extend these and other records and investigate relationships between SHW strength and precipitation across the Southern Hemisphere mid-high latitudes.

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Abstract No : 1042

A HIGH-RESOLUTION ENVIRONMENTAL MAGNETIC RECORD OF PALEOENVIRONMENTAL CHANGES DURING THE MIDDLE-LATE HOLOCENE FROM AN EAST ANTARCTIC LAKE

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Late Quaternary climate events such as the Mid-Holocene Hypsithermal and Neoglacial cooling are not very well represented in the geological archives from East Antarctica. In this investigation, we present a high-resolution environmental magnetic record of a 94 cm long sediment core encompassing the past 4668 years obtained from a land-locked lake (Lake L6) in Schirmacher Oasis, East Antarctica. The entire suite of environmental magnetic measurements starting from low- and high-frequency susceptibility (χ_{lf} and χ_{hf}) to remanence measurements were made on the samples and inter-parametric ratios were calculated. The S-ratio values remain greater than 0.90 for all the samples and most samples saturate at fields < 300 mT, suggesting the dominance of magnetically soft ferrimagnets like magnetite/titanomagnetite. The Hard Isothermal Remanent Magnetisation (HIRM) values remain relatively low indicating insignificant contributions from high coercivity magnetic minerals such as hematite/goethite. The $\chi_{ARM}/SIRM$ and χ_{ARM}/χ_{lf} values remain relatively low for all the samples indicating coarser magnetic grain sizes. The inter-parametric plots reveal an admixture of coarse SSD and MD grains in the sediments. The concentration-dependent parameters, χ_{lf} , χ_{ARM} (susceptibility of anhysteretic remanent magnetization), and Saturation Isothermal Remanent Magnetisation (SIRM) show a decreasing trend from 3.8 cal ka B.P., suggesting a shift to warmer conditions coinciding with the Mid-Holocene Hypsithermal. Higher values of $\chi_{fd}\%$ are observed during this period suggesting contributions from fine-grained pedogenic magnetic minerals, which is due to chemical weathering in response to the relatively warmer climate. Further, χ_{lf} , χ_{ARM} , and SIRM show increasing trends at ~ 2.1 cal ka B.P. and ~ 500 cal

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Abstract No : 1007

New occurrences of Echinoidea for the López de Bertodano Formation, Cretaceous of Antarctica

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The following work aims to perform the morphological analysis and preliminary description of echinoid spines collected in the López de Bertodano Formation (Marambio Group), outcropping on Seymour Island, which contains strata from the Cretaceous to the Pliocene and is located at the tip of the Antarctic Peninsula. New echinoids have been described on Seymour Island since the 1980s. NERAUDEAU, CRAME & KOOSER (2000) recorded for the López de Bertodano Formation, based on three spines of cidaroid echinoids, the species *Cyathocidaris Nordenskjoldi* and *C. Patera*. The analyzed spines were collected during the expedition of the FLORANTAR Project (PROANTAR/CNPq Program) in the period 2019/2020 and selected for morphological analysis, description and identification based on the Treatise on Invertebrate Paleontology. The preliminary morphological analysis allowed the identification of five morphotypes that were grouped in the order CIDAROIDA. Morphotypes 1 and 2 were assigned to the family Cidaridae, subfamily Cidarinae, genus *Cidaris*, being identified as *Cidaris aspera* and *Cidaris trigonacantha*. Morphotype 3 was assigned to the family Cidaridae, subfamily Cidarinae, genus *Cyathocidaris*. Morphotype 4 was allocated to the family Cidaridae, subfamily Rhabdocidarinae, genus *Rhabdocidaris*. Finally, morphotype 5 was assigned to the Miocidaridae family. Thus, these results expand the diversity of echinoids for this unit, through the description of spines belonging to the genera *Cidaris*, *Cyathocidaris* and *Rhabdocidaris* and the family Miocidaridae. The analysis of the variation of the morphological characteristics of these fossil spines will be essential to reach a more refined taxonomic classification and present it in future works.

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Abstract No : 502

Flooded ice floe detection in the Amundsen Sea with Sentinel-1 SAR

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During the summer months in the Antarctic, perennial and seasonal sea ice floes flood. Flooding is caused by snow at the surface weighing down the ice, causing a negative freeboard and flooding the basal snow layer with seawater. This creates a brine-slush layer. The appearance of these flooded ice floes changes dramatically in synthetic aperture radar (SAR) scenes with season and as the dielectric constant changes with brine content. In addition to this, the incident look angle of the radar imager affects the returned backscatter intensity across the scene. The Sentinel-1 instrument began collecting data with its S1A instrument in 2014 and later S1B in 2016 and continues to acquire SAR data across the globe. Sentinel-1 supplies an unprecedented, dual-band look at sea ice in the North and South poles to understand the dynamics of sea ice processes during polar nighttime. The satellite instrument provides a unique opportunity to study the signal attenuations and the subsequent backscatter intensities in the SAR scene that may change with seasonal ice flooding. This paper uses the Sentinel-1 radar data to understand the changes in backscatter intensity in flooded floes in the Amundsen Sea from summer to winter, as the flooded top layer refreezes into snow ice.

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Abstract No : 762

USE OF A PALINOLOGICAL APPROACH TO INFER ENVIRONMENTAL CHANGES IN NORTHERN ANTARCTIC PENINSULA SINCE LAST 5 KYR BP

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Paleoclimatic studies from ice cores and sediment cores carried in the Antarctic region have been applied in understanding climate change. For the Maritime Antarctic sector, paleoecological information retrieved from lake sediment profiles can provide relevant clues to describe climate changes, sea variability, past volcanism and other variables. The present study analyzed a lacustrine sediment core from the Lake Long/King George Island - Antarctic Peninsula, in order to investigate pollen contents and its relation to depositional process. In addition, biogeochemical information was analyzed. The 1m-sediment core studied spanned the mid-to-late Holocene presenting a high laminated structure. The pollen record seemed to respond to post-depositional processes being related to melting pulse events in that region. The palynological grouping according to the habit of the represented species showed the predominance of herbaceous species occurring in South America, suggesting a high influence of northern winds from the Southernmost South America to the Antarctic Peninsula during mid-to-late Holocene. Keyword: Sedimentology; Palynology; Antarctica; Biomarker; Paleoclimate.

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Abstract No : 876

Chemical and physical characteristics of the seasonal snow layer in the Bunger Oasis

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Ice-free areas are an unusual feature of the Antarctic landscape. Most of them occur in the coastal zone of the continent. Those located further inland, surrounded by glaciers, are isolated. One such area is the Bunger Oasis (Bunger Hills). The surface of this non-glaciated oasis is covered by a ground moraine cut by numerous lakes. In winter, the snow forms drifts, which may last through the cold summer. At the turn of January and February 2022, during the 4th Polish Antarctic Research Expedition (4th PARE) to the A. B. Dobrowolski Polish Antarctic Station, we made snow pits at selected sites within the Bunger Oasis, determined the thickness and density of snow layers and took snow samples. After the snow had melted, we measured pH and conductivity. The water was then filtered through a 0.45 µm membrane filter. The samples were preserved and transported to Poland, where they were subjected to chemical analyses in the laboratory of the Faculty of Chemistry, UAM. Ion chromatography allowed to determine the concentration of anions, and ICP-MS – the content of selected elements in the snow. The identification of physical and chemical parameters of snow accumulated in the Bunger Oasis, located far from the sea, makes it possible to determine the influence of marine aerosols and inflow of pollutants to this isolated part of East Antarctica. We present the first results of this investigation.

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Abstract No : 1043

PALEOWEATHERING AND PROVENANCE STUDIES OF LACUSTRINE SEDIMENTS FROM EAST ANTARCTICA DURING THE MIDDLE HOLOCENE

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In this study, we present the geochemical record of a 94 cm long sediment core spanning the past 4668 years from Lake L6, Schirmacher Oasis. The elemental concentrations and their ratios were calculated to gain insights into the weathering regime and the sediment transportation processes and provenance. Aluminum was found to be the most abundant element and shows a statistically significant correlation with most other elements indicating a common lithogenic origin for the sediments. The chemical weathering indices suggest a moderate degree of chemical weathering occurring in the catchment. The indices are found to be highest from 4.6 to 2 ka B.P. reflecting warmer conditions in the region, providing a conducive environment for chemical weathering. In the A-CN-K ternary diagram, the samples plot in the upper central region, trending towards the illite line, suggesting that the degree of weathering was not high enough for complete alteration to clay minerals. The index of compositional variation (ICV) remains >1 for all samples reflecting immature sediments undergoing progressive weathering. The ICV values are lowest for the samples from the Mid-Holocene Hypsithermal reflecting a higher degree of alteration of samples from this period. The biplot of TiO_2 vs Al_2O_3 indicates an intermediate igneous provenance for the sediments of lake L6. The chemical weathering indices can be seen decreasing from 2 ka B.P suggesting a shift from a warm and wet climate to colder conditions. The study provides evidence for the existence of a mid-Holocene Hypsithermal and Neoglacial cooling in the Schirmacher Oasis.

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Abstract No : 307

Determining Snow Distribution and Influence in Taylor Valley, Antarctica, Using Remote Sensing

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The McMurdo Dry Valleys is the largest ice-free area in Antarctica, but seasonal snow sporadically covers the valley floors. Here we focus on snow in Taylor Valley and how snow cover influences the total energy budget of the valley. Snow cover influences the hydrologic budget of Taylor Valley, soil moisture, and soil temperature. Snow reduces photosynthetically active radiation, inhibiting photosynthesis in the water column of the permanently ice-covered lakes. Snow may have similar effects on soil productivity. Quantifying snow in Taylor Valley is challenging because snow redistributes with winds, sublimates, or melts within a short period. While precipitation in Taylor Valley is less than 10 cm/yr in snow water equivalent (SWE), snow cover may have major controls on processes in the valley. To better understand the controls and feedbacks of snow cover in the valley, a long-term record of its occurrence and distribution is required. This research aims to create a long-term record of snow cover data in Taylor valley using satellite imagery. During the 2021-2022 field season, 250 m x 250 m quadrats were sampled to approximate how area and volume relate to SWE. Volumetric SWE was calculated by measuring length, width, depth, and density of each snowpack in the quadrat. Temperature and soil moisture were also measured. We found that soil moisture is greater directly under the snowpacks than compared to further away from the snowpacks. We found a relationship between the area and volume of the snowpacks ($R^2=0.9373$), this relationship can estimate the SWE from satellite imagery.

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Abstract No : 501

Calculation of the mass balance of the Znosko glacier (Antarctica) through the use of UAV and the ICESat-2 ATLAS satellite

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Znosko Glacier ($\approx 2 \text{ km}^2$) is located on King George Island, which is part of the South Shetland Islands, and since 2018 its dynamics has been evaluated combining/using images taken with unmanned aerial vehicles (UAV) and satellite products. This study presents the mass balance calculated with altimetric data from the ATLAS sensor installed on the ICESat-2 satellite for the period 2018 and 2021, which were validated (accuracy) with a sub-metric Digital Elevation Model (DEM) obtained from the UAV overflight during the summer 2020. The results show a high coefficient of determination (>0.98) between the DEM and the satellite information obtained on the ablation and accumulation zone corresponding to more than 10 passes. In addition, we obtained an initial root mean square error (RMSE) of 19.2 meters, which was reduced (up to a maximum of 3.4 meters) after the correction with the DEM The mass balance was calculated for 06 periods between October 2021 and December 2018 with a cumulative balance of -4.2 m.equiv.water, observing that there were periods in which the glacier lost (-3.73 m.equiv.water during the summer 2020) or gained mass (1.62 m.equiv.water between April to September 2019). Finally, we show that remote sensing is a valuable tool for obtain reliable data in areas characterized by difficult access.

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Abstract No : 956

CHARACTERISATION OF SURFACE SEDIMENTS AND PUP LAGOON LAKE SEDIMENT CORE FROM LARSEMANN HILLS, EAST ANTARCTICA

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Our study indicates climatic record from surface sediments and 51 cm long radiocarbon dated sediment core of Pup Lagoon Lake, Larsemann Hills, East Antarctica. The inferences are made from sediment, grain size variation and quartz surface textures. The quartz grains of surface sediments are mostly angular to a sub-angular having a variety of microstructural features. SEM observations show parallel and non-parallel striations, microfrost action. XRD study indicates presence of illite, smectite, chlorite and kaolinite along with non-clay minerals muscovite and quartz. Distribution of clay minerals varies in each lake but the overall concentration of illite was in abundance followed by smectite, kaolinite, and minor proportion of chlorite. Lake surface sediments give evidence for formation of clay minerals in both detrital and authigenic under intense physical weathering along with weaker chemical weathering. Pup Lagoon Lake comprises of smectite, illite, palygorskite, chlorite and kaolinite. Illite was abundant with chlorite in minor proportions. Other minerals were quartz and muscovite. Muscovite occurs from 34-13cm depth along with Palygorskite which is indicator of arid climate. The occurrence of poorly crystallized palygorskite and decreasing kaolinite and increasing chlorite collectively indicate an arid environment. The basin was under in marine waters (40-18cm). The lake exhibits transitional conditions (18-10 cm). The shift from to marine regime to transitional zone at 2451 ky BP (18 cm) indicated by an increase in illite concentration and decrease in smectite, chlorite and kaolinite at 4765.5y BP. Illite percentage has decreased after 2101.4y BP since the lake has become freshwater lake.

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Abstract No : 566

Evolutionary inferences from the sedimentary deposits of Lake LH73, Larsemann Hills, East Antarctica

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The lake sedimentary sequences of the ice-free regions of Antarctica offer unique climate records. We present the evolution of a lake reconstructed from its sedimentary sequence. A 60cm long radiocarbon-dated sediment core spanning the last 11.8 kyr from Lake LH73, Broknes Peninsula (Larsemann Hills) is studied for grain size fractions, magnetic susceptibility, and diatom abundance. Based on the diatom and grain fraction data, it is inferred that the lake persisted as a proglacial lake during the early-Holocene (11.8 to 7.2 ky BP) dammed by ice-sheet towards the south. The lake level was 3m higher than the present level (4m) as inferred from the diatom transfer-function owing to the presence of ice-dam. The retreat of the ice-sheet and the collapse of the ice-dam between 7.2 and 7 ky BP resulted in the lake transitioning to an isolated lake with the lake level attaining current level (4m). As a consequence, the catchment area increased and the lake received meltwater from the snowbanks hence largely modulating the sedimentary process. Absence of glacial clay from 5 ky BP suggests that the lake was cut-off from glacial input. The appearance of diatom at ~ 8.6 ky BP indicates the establishment of optimal condition for productivity in the lake ecosystem. *Stauroforma inermis* and *Plannothidium quadripunctatum* (*Psammothidium abundans*) dominates between 7 ky BP till present (11.8 to 7 ky BP), responding to lake level variation. Ice-sheet retrieval and ablation led to transition of proglacial-to-isolated lake leading to shallowing of the lake as reflected in diatom assemblage changes.

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Abstract No : 395

Sub-bottom profiling of lakes in the Larsemann Hills, East Antarctica.

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The Larsemann Hills, East Antarctica is marked with more than 150 freshwater lakes spread across three peninsulas along with numerous islands. The structure and nature of the lakes of each region is different owing to the geomorphic settings, proximity to the coastal region or the continental ice sheet. During the austral summer of 2021, as part of the Indian Scientific Expedition to Antarctica, a sediment coring campaign was carried out to determine the bathymetry, mapping the subsurface terrain of lakes and their sedimentary profile. We used a sub bottom profiler (SyQwest Stratabox HD) with a dual acoustic impedance of 3.5 and 10 kHz frequency and 0.1-meter resolution. Sub-bottom profiling of three lakes at Stornes and four lakes at Broknes respectively was carried out. The maximum depth of Progress Lake was revised to 43.7 m against previously reported depth of 38 m, while Lake Nella was amended from 8 to 17 m water depth. The maximum depths of Discussion Lake and LH04 was also recorded at 4 m. The sub-bottom profiles of lakes help to understand the bathymetry and sedimentary profile of the lakes sediment deposits that will help to identify the depocenter. It will also help to retrieve longer sediment cores that will enable paleoenvironment reconstructions of higher resolution and across longer time scales. This data further helps to understand the transportation history of the sediments, geomorphology and landscape development of the lake basin and controlling factors of the past and modern depositional and weathering processes of the area.

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Abstract No : 884

High-resolution palaeoclimate archive from Macquarie Island peat

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Palaeoclimate reconstructions are vital for understanding variability in climate before instrumental records. Peats potentially preserve high-resolution climate information due to how they form. Peat develops in water-saturated areas when new plants grow in place on senescent plants, while plant decomposition is slowed in the anoxic conditions below the water table. Peat accumulation rates average $< 0.1 \text{ cm yr}^{-1}$ and vary with environmental and climate conditions. We used a 3-metre peat core from Macquarie Island to reconstruct palaeoclimate from the mid-Holocene. We developed an age-depth model from ten ^{14}C and seven ^{210}Pb analyses and anthropogenic actinide (Pu and U) concentrations as independent chronostratigraphic indicators. The ^{14}C data indicate a basal age of 4445 ± 26 years before present (yBP). Following peat initiation, the initial accumulation rate of c. 0.1 cm yr^{-1} declines to c. 0.05 cm yr^{-1} about 2000 yBP. The accumulation rate then declines sharply between c. 1500 and 500 yBP, after which it recovers to c. 0.08 cm yr^{-1} . We assume the variability in peat accumulation rates reflects climate variability, and we compare our results with other climate reconstructions from the subantarctic. Future work will investigate stable carbon ($\delta^{13}\text{C}$) and nitrogen ($\delta^{15}\text{N}$) isotopes in relation to the accumulation rates and reconstruct peat decomposition rates through the relative abundance of recalcitrant vs labile peat organic matter. The variability in peat accumulation and decomposition rates reflects changes in plant growth. Peat plant response to climate variability enables our reconstruction and also foreshadows the response of primary producers to a changing climate.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

GEOSCIENCES

**Deformation of the Antarctic:
influence of tectonic, volcanic,
hydrological, and climate
change processes**

CONVENORS

Vineet Gahalaut

Accepted as: Oral Presentation

Abstract No : 451

Post-seismic deformation in the Northern Antarctic Peninsula following the 2003 and 2013 Scotia Sea earthquakes

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Large earthquakes in the vicinity of Antarctica have the potential to cause post-seismic viscoelastic deformation on the continent, affecting measurements of displacement that are used to constrain models of glacial isostatic adjustment (GIA). In November 2013 a magnitude 7.7 strike-slip earthquake occurred in the Scotia Sea around 650 km from the northern tip of the Antarctic Peninsula. GPS time series from the northern Peninsula show a change in rate after this event indicating a far-field post-seismic viscoelastic deformation signal is present. We use a global spherical finite element model with a suite of 1D Maxwell and Burgers earth models to investigate the extent of post-seismic deformation following this earthquake. Model output is compared with GPS time series to place constraints on the earth structure in this region. There is a slight preference for a thin lithosphere combined with a Burgers rheology in the asthenosphere with a steady-state viscosity of 4×10^{18} Pa s and transient viscosity one order of magnitude lower. Initial tests using a 3D earth structure show lateral variations in viscosity do not improve the fit. Using the best fitting earth structure, we run a forward model of the 2003 magnitude 7.6 strike-slip earthquake and combine the predictions for both earthquakes. We show that post-seismic deformation is wide-spread across the Northern Peninsula with rates up to 1.5 mm/yr in the east direction for the period 2015–2020 and that this signal persists for decades after the events.

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Abstract No : 102

Total isostatic response to the complete unloading of the Greenland and Antarctic Ice Sheets

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The land surface beneath the Greenland and Antarctic Ice Sheets is isostatically suppressed by the mass of the overlying ice. Accurate computation of the land elevation in the absence of ice is important when considering, for example, regional geodynamics, geomorphology, and ice sheet behaviour. Here, we use contemporary compilations of ice thickness and lithospheric effective elastic thickness to calculate the fully re-equilibrated isostatic response of the solid Earth to the complete removal of the Greenland and Antarctic Ice Sheets. We use an elastic plate flexure model to compute the isostatic response to the unloading of the modern ice sheet loads, and a self-gravitating viscoelastic Earth model to make an adjustment for the remaining isostatic disequilibrium driven by ice mass loss since the Last Glacial Maximum. Feedbacks arising from water loading in areas situated below sea level after ice sheet removal are also taken into account. In addition, we quantify the uncertainties in the total isostatic response associated with a range of elastic and viscoelastic Earth properties. In Antarctica, we find that a maximum change in bed elevation of +940 m occurs over the centre of the landmass following full re-equilibration. By contrast, areas around the ice margins experience up to -120 m of lowering due to a combination of sea level rise, peripheral bulge collapse, and water loading. The computed isostatic response fields are openly accessible, actively maintained, and have applications for studying regional geodynamics, landscape evolution, cryosphere dynamics, and relative sea level change.

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Abstract No : 746

Deciphering the sub-ice basement architecture of the Rennick–Aviator fault zone: insight from outcrop scale fracture analysis.

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The northern termination of the Transantarctic Mts in North Victoria Land (NVL) is characterized by a complex architecture deriving from long-lived tectonic activity along major crustal faults that have been reactivated several times until Recent. These are both first-order faults, which separate the Wilson, Bowers and Robertson Bay Terranes, and second-order faults which cut through homogeneous lithotectonic units. The Rennick Graben Fault (RGF) and Aviator Fault (AF) represent two NW-SE strike-slip fault zones that are interpreted to crosscut all the NVL. Their Meso-Cenozoic activity has been related either to the fracture zones in the Southern Ocean and the extensional tectonics of the Ross Sea rift, but ground truth evidence is still insufficient. RGF and AF bound an elongated area (tens-of-km wide) mostly covered by ice that includes the Rennick Graben. In this contribution we present the analysis of 1317 structural data measured during the last Antarctic campaign in the exposed outcrops between the two fault zones to improve the definition of i) their geometry and mutual interplay in the ice-covered regions, and ii) their polyphase tectonic activity and connection with the Cenozoic kinematics of the fracture zones in the Southern Ocean and the extensional tectonics in the Ross Sea. Brittle structures measured in the field includes faults, with kinematic indicators, and fracture corridors (including attitude, length-H, spacing-S of fracture sets). These data are merged with previously collected measurements. Preliminary results of their cumulative geostatistical processing, will be presented, including a map of the spatial distribution of fracture intensity.

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Abstract No : 8

GPS rates of vertical bedrock motion suggest late Holocene ice-sheet readvance in a critical sector of East Antarctica

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We investigate present-day bedrock vertical motion using new GPS timeseries from the Totten-Denman glacier region of East Antarctica ($\sim 77\text{--}120^\circ\text{E}$) where models of glacial isostatic adjustment (GIA) disagree, glaciers are likely losing mass, and few data constraints on GIA exist. We show that varying surface mass balance loading (SMBL) is a dominant signal, contributing random-walk-like noise to GPS timeseries across Antarctica. In the study region, it induces site velocity biases of up to $\sim +1$ mm/yr over 2010–2020. After correcting for SMBL displacement and GPS common mode error, subsidence is evident at all sites aside from the Totten Glacier region where uplift is ~ 1.5 mm/yr. Uplift near the Totten Glacier is consistent with late Holocene ice retreat while the widespread subsidence further west suggests possible late Holocene readvance of the region's ice sheet, in broad agreement with limited glacial geological data and highlighting the need for sampling beneath the current ice sheet.

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Abstract No : 941

GPS geodetic measurements to understand the deformation of the Earth's crust in Antarctica

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With the purpose of contributing to the understanding of geodynamics in the Antarctic region, more than 100 GPS geodetic stations located in Antarctica and neighboring regions have been processed, which allow observing the interaction between the different plates in this part of the world. The data from these stations correspond to stations available on the UNAVCO and IGS servers, including stations that have data available from 2000 to 2022. The data processing has been carried out at the International Geodetic Laboratory of the Space Geodetic Research Group-GeoRED of the Geological Survey of Colombia through the use of GIPSY-X/RTGx v1.3 software, developed by JPL-CALTECH-NASA. The coordinates of each site are obtained using the Precise Point Positioning (PPP) strategy and expressed in ITRF2014. The geodetic time series have been estimated by applying the combined noise model Power law and white noise and parameters such as seasonal signal as well as offsets, using the HECTOR v1.9 software developed by SEGAL (Space & Earth Geodetic Analysis Laboratory). To evaluate the goodness of the applied noise model, the Power Spectral Density (PSD) technique was used. Finally, a preliminary crustal strain model is obtained.

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Abstract No : 1048

CECA geothermal station for volcanic monitoring of Deception Island

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Deception Island (South Shetland Islands) is one of the most active volcanoes in Antarctica. During the most recent eruptions occurred in 1967, 1969 and 1970, ash fall and lahars destroyed two scientific bases and significantly changed the island geomorphology. At the surface, the main indications of current volcanic activity are the existence of fumarolic areas with gas emissions and thermal anomalies of up to 100°C in the area known as Cerro Caliente. Since 1991, Deception Island is being mostly monitored by recording seismic activity and ground displacements. In 2011, a geothermal station was installed to study the temperature of the Cerro Caliente soil, in order to determine the state of volcanic activity on the island by correlating all these parameters. This work focuses on the analysis of the time series obtained from the geothermal station installed on Deception Island, from 2011 to 2022. A mathematical procedure is established that allows modeling the behavior and extracting the relevant information from the time series. The results show that the periods of greatest surface deformation obtained with GPS coincide with the increase in soil temperature recorded on Cerro Caliente. A significant event is observed in the 2012 austral winter, initially detected in the seawater temperature and in the soil temperature on Cerro Caliente. These anomalies were precursors to the other analyzed observables – the seismicity and ground deformation data – registered only in the following austral summer campaign, suggesting rapid increase in geothermal activity and the beginning of an inflation process on the island.

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Abstract No : 853

GIANT-REGAIN: A comprehensive analysis of geodetic GNSS recordings in Antarctica for geodetic and geodynamic applications

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In Antarctica, solid-earth deformation can be attributed to various processes such as surface load variations mainly caused by present-day (elastic deformation) and past ice-mass changes (glacial isostatic adjustment) or tectonic processes. Geodetic GNSS observations on bedrock provide a powerful tool to assess these deformations. Multiple studies have already utilized GNSS to derive bedrock motion for Antarctica, but were limited to specific regions and time periods. The SCAR-endorsed project GIANT-REGAIN aims to re-process all available Antarctic GNSS data that have been acquired by episodic and permanent recordings at bedrock for more than 25 years. We succeeded to include more than 280 sites providing recordings between 1995 and 2021. We will report on the data acquisition and on the treatment of metadata, which are indispensable for a correct assignment of the hardware setup. In the processing precise point positioning (PPP) and differential GNSS are applied using different scientific software packages (GIPSY, GAMIT, Bernese). As a major product, time series of consistent point coordinates will be inferred. The comparison of the different processing solutions allows assessment of the uncertainty and to estimate the ‘software noise’. The inferred time series shall then be used to estimate coordinate velocities. Here, one has to consider different aspects like a proper noise model, spatial correlations (e.g. using common-mode error analysis for PPP results) and a suitable ‘trend model’ (e.g. piecewise linear trends). The treatment of the instantaneous elastic response due to present-day ice-mass changes raises a specific research question and will be discussed briefly.

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Abstract No : 454

Cause of large seasonal variation in deformation in Antarctica

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Antarctica continent offers large spatial variations in rheological properties, besides playing a crucial role in the functioning of the global climate system. The Antarctica region is quite challenging and interesting for the study of glacial loading feedbacks on crustal deformation and tropospheric water vapor estimations which is useful to constrain evaporation and evapotranspiration. The plate motion of the Antarctic plate varies from ~4 to 20 mm/yr. This is mainly because the Antarctica continent is surrounded by mostly the divergent plate margins due to which the plate experiences spin motion without undergoing any significant convergence with other neighboring plates. Besides the secular motion, there is a large variation in seasonal deformation at sites closer to the pole and we try to ascertain whether the seasonal deformation is controlled by the tectonic and volcanic activity, ice-sheet movement, hydrological loading, or the variation in the ionosphere conditions. To decipher the reason for such large variation in seasonal deformation we have analyzed several aspects which can affect the Antarctica continent i.e. Meteorological (Temp, Pressure, Humidity), Ionospheric Total electron content (TEC), Equivalent water height (EWH) derived from GRACE. From the results, we found that the meteorological parameter, mainly the temperature variation, shows a good correlation with the seasonal displacement time series. A good correlation with temperature variation implies that hydrological loading and unloading of ice sheets in the polar region control the seasonal deformation. Indeed, the GRACE-derived displacement, mainly due to hydrological loading, is consistent with the GPS-derived seasonal variation.

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Abstract No : 1001

Use of LIDAR data to identify mass movement processes on the Keller Peninsula, King George Island, Antarctica

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Antarctic ice-free areas are subjected to land readjustment processes, which are accentuated during the hottest periods of the year. With the objective of identifying the main processes in the landscape of the Keller Peninsula, the LIDAR data technology was used to evaluate the dynamics in four different environments. Terrestrial laser scanner was used and point clouds obtained in 2015 and 2018 were compared through the algorithm m3c2, realized in the software CloudCompare. The results were related to the present geomorphological features and morphometric variables of the relief. Site one, which comprises part of the glacial cirques present in the area, presented processes predominantly related to crinival and slope systems. The site two comprised part of the Flagstaff Hill, being verified processes involved by gravitational forces and slope processes, with slope being the preponderant factor for the changes in talus ramps. The third site presented processes occurring high altitude, such as falls of cliffs on escarpments, besides crinival processes occurring in ramps and niches. The fourth site was the one which presented the lowest rate of altimetric change, with changes occurring in saturated terrains, positioned in high elevations and moderate slope. The use of Lidar data and high-resolution aerial images proved to be adequate in the identification of geomorphic processes in large areas. It made it possible to cover inaccessible areas and identify small changes in the terrain, despite the small-time interval analyzed.

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Abstract No : 1035

Elastic deformation due to Surface Mass Balance Variability in the Southern Antarctic Peninsula

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Observing the feedback between solid Earth deformation and ice dynamics across Antarctica is a key element for understanding the contribution of the Antarctic ice sheet to global sea-level rise. Observations from the Global Positioning System (GPS) are now widely used to derive contemporary vertical and horizontal bedrock surface displacements. In this study, we examine GPS vertical time series at four locations in the southern Antarctic Peninsula where interannual variations of surface mass balance (SMB) anomalies are thought to cause measurable elastic deformation. We use regional climate model output to calculate time series of displacement due to SMB anomalies assuming a perfectly elastic Earth. Our comparison between GPS time series and elastic deformation calculated using SMB models shows good agreement and a reduction of the WRMS of the residuals after fitting the time series using a standard linear trajectory model. We find that the elastic deformation derived using the high-resolution SMB model RACMO2.3 (5.5 km) is in better agreement with the GPS observations than RACMO2.3 (27 km) and MAR3.11 (35 km), perhaps due to the high sensitivity of accumulation patterns to local topography. We show the importance of correcting GPS time series for SMB-related deformation for providing estimates of long-term vertical land motion rates. However, a more complete description of SMB-related deformation should include the mantle response at longer time scales by considering viscoelastic models.

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Abstract No : 980

Petrographic analysis of xenoliths of volcanic rocks from Deception Island, Antarctica

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Deception Island is one of the most active volcanoes in Antarctica, with a record of recent eruptions (1967, 1969, and 1970), continuous seismic activity, and constant fumarolic emissions to date. The island is located between multiple tectonic settings within the South Shetland Islands arc with a subduction tectonic limit at the North, over the Bransfield Strait rift, and the Hero Fracture to the West zone. This tectonic setting indicates a complex formation history. Various eruptive events of the volcano are evident in the pre-caldera, syn-caldera, and post-caldera formations on the island surface. To learn more about the volcano, samples of lava and xenoliths were taken during the past Antarctic summer (December to March 2021-2022) within the VIII Colombian Expedition to Antarctica in cooperation with the Argentine Antarctic Program. The rock samples collected are basalts, andesites, and plutonic rocks. Petrographic and geochemical analyses of lava samples and xenoliths are carried out to determine the magmatic affinity to contribute to understanding the geotectonic environment and the structure of the magmatic chamber of the Deception Island volcano in Antarctica. Analyzing the volcano's internal structure will allow us to understand the island's magmatic system in greater detail. It will contribute to a better interpretation of the volcanic monitoring data.

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Abstract No : 1051

Monitoring and surveillance of the volcanic activity of Deception Island using GNSS techniques

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Deception Island is one of the most active volcanoes in Antarctica, with recent eruptions in 1967, 1969 and 1970. It is located at the beginning of the expansion axis of the Central Bransfield Basin, between the Antarctic Peninsula and the South Shetland Islands, a geodynamically very complex region. Monitoring of the Deception Island's tectonic and volcanic behavior through GPS observations has been carried out since 1991-1992 until 2021-2022. For this purpose, three geodetic networks have been deployed: the DIESID system, the REGID network and the RENID network. This work describes these geodetic networks and the results obtained with each one. The DIESID system is the geodesic structure for monitoring volcanic activity in quasi realtime. This system consists of three stations that record data continuously during each Spanish Antarctic campaign. The slope distance variation between these stations shows different inflation and deflation processes. The REGID network consists of 15 geodetic benchmarks located around Port Foster, Deception's inner bay open to the sea. Two additional geodetic benchmarks were installed outside Deception Island to be used as reference benchmarks for the differential positioning strategy. Geodetic ground-displacement velocities between the successive austral summer antarctic campaigns are obtained from the processing of the data of this geodetic benchmarks. The RENID network consists of 48 stations distributed in 6 independent lines located around Port Foster. The observation of this network provides information on the geodynamic evolution of Deception Island, complementing the results obtained with the REGID network.

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Abstract No : 638

Chemical composition of acidic gases from fumarolic emissions at Deception Island volcano, Antarctica

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Deception Island (62°43'S, 60°57'W) is an active basaltic-andesitic volcano that forms part of the South Shetlands archipelago (Antarctica), in the Bransfield Strait. The island is the most active volcano in the region, where the most recent eruptions occurred between 1967 and 1970. This horseshoe-shaped island hosts a magmatic-hydrothermal system, developing areas with thermal anomalies and gas emissions mainly on the internal coast. The manifestations in Primero de Mayo bay constitute the largest fumarole field on the island. Previous studies have shown that gas emissions are enriched in acid gases CO₂ and H₂S compared to other hydrothermal areas, where no species of S were detected. Samplings from this area show vapor/gas ratios between 85 and 95%, with CO₂ and H₂S values up to 15% and 0.25%, respectively. The CO₂/H₂S ratios ranged between 25 and 90. The absence of magmatic gases (SO₂-HCl-HF) suggests gas scrubbing by a hydrothermal reservoir. From January-March 2022, we took 40 samples of fumarolic gases by direct sampling alkaline trap (NaOH-Cd(OH)₂) in 10 subaerial and submerged emission spots. The highest temperature gas emissions (90-100°C) were identified in Primero de Mayo bay and Mount Pond fumarolic fields. In comparison, the thermal areas of Cerro Caliente, Whalers Bay, Pendulum Cove and outer Stonethrow Ridge are characterized by steaming grounds with temperatures below 60°C. The results from a complete set of geochemical and isotopic data will allow identifying the different sources of fumarolic gases and the processes controlling the activity of the magmatic-hydrothermal system of Deception island.

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Abstract No : 378

Asthenospheric mantle electrical anisotropy and its role in Glacial Isostatic Adjustment: insights from long period magnetotelluric measurements

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Understanding the geodynamic evolution of Antarctica is essential to determine the processes controlling future climatic warming and sea level rise. The Antarctic continent has been isolated since the tectonic opening of two gateways (Drake-Scotia and Tasman) creating the Antarctic Circumpolar Current ~30-40 Ma. This change in oceanic circulation doubtlessly affected the global climate and Antarctic ice sheet evolution with consequent sea level change. The motion of lithospheric plates and the Glacial Isostatic Adjustments (GIA) are influenced by mantle rheology, which may be imprinted on mantle structure including anisotropic features. Mantle electrical anisotropy may be identified by means of long period magnetotelluric (LMT) measurements. GOLETA project aims to identify and characterise Antarctic mantle anisotropy through assessment of existing and new LMT data and integration of complementary seismic models. LMT data were collected at seven sites distributed on the Antarctic Peninsula and South Shetland Islands, from January to March 2022. Here we present preliminary data analysis that suggests possible presence electrical anisotropy in the asthenospheric mantle of this portion of the Antarctic Peninsula and South Shetland Islands. Accounting for the tectonic evolution of Antarctica, is essential to identify the source of potential mantle anisotropy i.e. is it a result of geodynamic or GIA processes.

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Abstract No : 946

Relationship among megmatism, rifting and mantle melting of the Terror Rift, West Ross Sea

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Two Neogene igneous lineaments along the Terror Rift can be delineated from the Erebus Volcanic Provinces to the Hallett, Melbourne Volcanic Provinces. Meanwhile, there occurs a mantle low velocity zone beneath the Terra Rift. Obviously, a geodynamic mechanism is necessary to address the relationship among megmatism, rifting of the Terror Rift and melting of the MLVZ. According to the global plate model, combined with the rotation parameters of 9 key time nodes and tectonic outlines of the Antarctic plate, we refined the relative movements between the East and West Antarctica since 100 Ma on the GPlates. The rift axes of the East Ross Sea Basin, Central Trough and VLB overlapped the MLVZ just before they had taken shape. The MLVZ may represent a failed subbranch of the triple junction driving the East Gondwana continent to rupture. Although the plate movement was the major drive to create the WARS, the MLVZ released heat, weakened the strength of overlying lithosphere, and had determined where these basins grew. Furthermore, there exists coupling or balance between maintenance of the MLVZ and extension of these basins. The transtension from the strike-slip faulting may import more water into upper mantle than the orthogonal extension with detaching faults, and promoted mantle melting and magmatism, especially at the two ends of the rift. Sea water enters into upper mantle, which be apt to serpentinized and magnetized, and depths to the Curie should be deeper than depths to the Moho, supported by magnetic anomalies to some extent.

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Abstract No : 1049

Regional tectonic model of the South Shetland Islands, Bransfield Sea and the Antarctic Peninsula

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The region defined by the South Shetland Islands archipelago, the Bransfield Basin and the Antarctic Peninsula is characterized by a highly complex tectonic environment driven by the two major tectonic plates converging in this region: the South American and Antarctic Plates. The boundary between both plates is even more complex due to the interaction of four minor tectonic plates originated by the relative movements of the main plates, i.e. Scotia, South Sandwich, Phoenix and South Shetland plates. The South Shetland archipelago is a volcanic arc, except for Deception and Penguin Islands, attributed to the subduction of the Phoenix microplate under the Antarctic plate. To build a geodynamic model for the South Shetland Islands, Bransfield Basin and Antarctic Peninsula region based on surface deformation, the Spanish Antarctic geodetic network (RGAE network) was deployed from 1987 onwards. It comprises several benchmarks with precise coordinates in the ITRF reference frame sequence. Since 2007, the RGAE network consists of 13 geodetic benchmarks, distributed around the South Shetland Islands (11 benchmarks) and the Antarctic Peninsula (2 benchmarks). This work describes this geodesic network and the geodynamic model obtained. The results reveal two different geodynamic patterns, each confined to a distinct part of the South Shetland Islands archipelago. The inferred absolute horizontal velocity vectors for the benchmarks in the northeastern part of the archipelago are consistent with the opening of the Bransfield Basin, while benchmark vectors in the southwestern part of the archipelago are similar to those of the benchmarks on the Antarctic Peninsula.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

LIFE SCIENCES

Birds and marine mammals

CONVENORS

Michelle LaRue, Ryan Reisinger, Mark Hindell,
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Abstract No : 903

Long-term ecological monitoring of vertebrate populations in the Indian area of operation in east Antarctica

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Antarctic vertebrates such as seabirds and marine mammals, as top predators in a complex food web, act as ecosystem sentinels. Continuous monitoring of their populations is required to ascertain population changes and ensure sustainable human activities in Antarctica. This study was initiated under the “Antarctic Wildlife Monitoring Program” to develop strong baselines on vertebrates in east Antarctica and inform conservation management. This program targets pelagic seabirds and marine mammals in the Southern Ocean, focusing on estimating abundance, mapping distribution patterns, monitoring breeding behaviour, and assessing genetic connectivity. Surveys were conducted in multiple years utilizing vessel-based, aerial (helicopter and UAVs) and on-ground methods. It included vessel-based pelagic seabird, marine mammal counts; aerial mapping of ice-breeding seals and penguin distribution and on-foot monitoring of pelagic seabirds. Further, use of advanced monitoring tools such as automated nest cameras and drones was employed to collect targeted data on select species such as snow petrels (breeding biology, genetics) and Adelie penguins (colony counts, distribution). The program generated a strong baseline on seabird distribution (nesting and moulting areas), seals and whales’ distribution in the east Antarctic sector. Snow petrel colonies were selected for long-term nest monitoring to cover complete breeding phenology of the species. Intensive monitoring of nesting behaviour and a systematic genetic sampling (including Wilson’s storm-petrel) provided crucial ecological information. Long-term monitoring (> 10-20 years) is planned to ensure sustainable human activities and understand climate change impacts on vertebrate populations in Antarctica.

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Abstract No : 280

Temporal variation in marine mammal community structure at South Orkney Islands revealed through passive acoustic data from 2016 and 2017

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Passive Acoustic Monitoring (PAM) is a non-invasive method providing high-resolution information about marine mammal acoustic presence. Multi-species PAM studies can increase our understanding of seasonal- and temporal changes in community structure and composition and are especially useful in remote areas such as the Southern Ocean. This study was based on 16 months of acoustic data spanning two austral autumns and winters, collected through an autonomous underwater recorder deployed in the Coronation Trough northwest of the South Orkney Islands, Scotia Sea. This region has been recognized as a hotspot for Antarctic krill (*Euphausia superba*) and is among the most important commercial krill fishing grounds. Acoustic recordings were used to characterize seasonal and inter-annual patterns in the acoustic presence of marine mammals formerly undescribed in this area. Using previously documented species-specific vocalizations, five baleen whale species, two pinniped species, and odontocete spp. were identified. Although there was little change in the level of species diversity over time, there was an almost complete shift in guild composition related to season, reflecting marine mammals' differential habitat preferences and response to the strong seasonality defining the Southern Ocean. The high degree of seasonality was further evidenced by inter-annual variation in species' acoustic phenology during one recording period that was defined by the strongest El Niño event on record. This study showed the utility of PAM as a tool in characterizing the distribution and habitat use of these top predators in response to changing environmental conditions.

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Abstract No : 444

Differences in age-dependent survival between male and female Southern Elephant Seals

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Individual life-history traits, such as age and sex, influence vital rates in most large vertebrate species. Developmental differences are especially profound in polygamous mating systems. One of the most polygamous of all mammals, the southern elephant seal (*Mirounga leonina*) is a sexually dimorphic, capital breeding marine predator. Only one of its four major breeding populations, Macquarie Island, continues to slowly decline. We use a demographic model, supported by long-term capture-mark-recapture records to investigate the influence of sex and age on survival in this population. This study revealed a clear difference between female and male age-dependent survival rates. Overall, juvenile survival showed consistent parallel trends for both sexes, initially increasing for two years, then tipping towards a slow decline. Male survival estimates were consistently 5–10% lower than females in the same age classes until 8 years of age, at which point male survival decreased more rapidly than female survival (males aged 10-years: $50\% \pm 10\%$ vs. $80\% \pm 5\%$ for female aged 10-years). Female survival estimates peaked at age 3 (85%) slowly decreasing to 75% at 12 years of age. Different energetic requirements could be underpinning intersex differences in adult foraging behaviour. The marked sexual dimorphism and polygamous mating system may lead to males pursuing riskier foraging strategies than females to prioritise growth. Specifically, adult males are known to frequent energy rich shelf habitats where encounters with killer whales or sleeper sharks are likely. Maximising growth is especially advantageous for males, with size being a major determinant of breeding success.

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Abstract No : 1027

Self-Awareness in Wild Adélie Penguins *Pygoscelis adeliae*

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This preliminary study, conducted in January–February 2020, during the 39th Indian Expedition to Antarctica, investigates the presence of self-awareness in a population of wild Adélie penguins on the Dog’s Neck Ice Shelf and on Svenner Island in East Antarctica. It is based on the responses and reactions of penguins, either individually or as a group, to their self-images, generated in mirrors during three experimental paradigms: a group-behaviour test; a novel, modified mirror test and a further extension of this test, a hidden-head test. To the best of our knowledge, this set of experiments not only constitutes possibly the first investigations into mirror self-awareness in any penguin species but is also pioneering in conducting a set of cognitive experiments on free-ranging individuals of a nonhuman species in its natural environment, without subjecting the test animals to any prior familiarisation, conditioning or acclimatisation to the experimental tests employed. More importantly, we demonstrate that Adélie penguins are possibly self-aware, in terms of their responses to mirror images and argue that such self-awareness may play a critical role in their complex social lives within communal rookeries. Future studies, integrating the socioecology and cognitive ethology of penguins, may provide insights into whether such self-awareness may have evolved under conditions in which individual penguins need to engage in cooperative behaviour with conspecific individuals, while maintaining their independent decision-making capacities, throughout their communal lives.

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Abstract No : 42

Ecosystem shifts inferred from long-term stable isotope analysis of male Antarctic fur seal teeth

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The Atlantic sector of the Southern Ocean has been rapidly changing over the last century. Many of those changes are driven by climate anomalies such as the El Niño Southern Oscillation and the Southern Annular Mode, which affect biological processes that scale up the food web. In this paper, we use $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ time-series of dentine Growth Layer Groups (as a proxy of individual foraging history from multiple years, $n = 41$ teeth) to assess temporal shifts in foraging habits of subadult/adult male Antarctic fur seals (*Arctocephalus gazella*) in two areas of high concentration of Antarctic krill (*Euphausia superba*): the South Shetland Islands and the South Orkney Islands. Our analyses, which represent the first long-term isotopic assessment of male AFS sampled in Antarctic waters, revealed a significant decrease of $\delta^{13}\text{C}$ (0.04‰yr^{-1}) from 1974 to 2015. Nitrogen isotope values also increased after the late 1990s. The observed changes are likely driven by shifts in latitudinal and longitudinal distribution of krill, and increased incorporation of ^{15}N -enriched sources (higher trophic level prey and/or feeding on different areas) in the most recent period for reasons that are not yet clear. We were able to trace ecosystem changes through isotopic bio-archives of Antarctic fur seals, highlighting the role of this species as an ecosystem indicator of the trophic cascade effects caused by climate change in the Southern Ocean.

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Abstract No : 235

Bigger is Better: The importance of Nest Structure for Adélie Penguin Breeding Success

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Breeding success is an important demographic parameter that can be driven by environmental and behavioural factors operating on various spatial and temporal scales. As seabirds breed on land and forage in the ocean, processes occurring at both locations can influence their breeding success. Here, we investigated the breeding success of 450 Adélie penguin *Pygoscelis adeliae* nests at four breeding sites in the Windmill Islands of Casey, East Antarctica. In contrast to other locations in East Antarctica, this region has limited fast-ice present during the breeding season. Hence, this study will allow us to improve our understanding of breeding success drivers for East Antarctic penguins. We examined breeding success over a 10-year period using images obtained from remotely-operated cameras. We utilised survival analysis to identify breeding success drivers using climate indices, regional weather conditions, site-specific factors, and nest-specific attributes reflecting environmental conditions at the nest and parental investment as our covariates. Overall, there was strong association between nest structure and chick survival, with well-structured nests having higher breeding success. Well-structured nests frequently produced chicks even with high levels of ground moisture. Earlier nesting birds were more likely to build bigger nests, though it is unclear whether this is due to more time available to put into nest building or whether early arrival and quality nest building are complementary traits. Our study highlights the importance of incorporating behavioural attributes into breeding success analyses and to assess the extent that behaviour can mediate deleterious environmental impacts.

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Abstract No : 342

Detection of the food web structure of top predators in the Antarctic Peninsula by eDNA Metabarcoding

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Polar ecosystems are dramatically affected by and respond to environmental changes, including climate change. Specifically, new habitats form due to fast glacial retreat as well as the physical, chemical and biological characteristics of existing ecosystems alter due to the changes in precipitation and temperature patterns. Food web structure and function are among the highly affected ecosystem properties. In this study, carried out in 2018–2019, faecal samples of 7 species (Adelie Penguin, Brown Skua, Gentoo Penguin, Chinstrap Penguin, Weddell Seal, Elephant Seal and Antarctic Shag) living on the peninsula were collected from 9 different locations and dietary analyzes were done with environmental DNA metabarcoding. A detailed literature review was conducted for seven top predator species and their food preferences were determined. According to these results, PCR amplifications were performed by selecting universal primers (vertebrate (12SrRNA), invertebrate (COI) and eukaryotic (18S V4)). The libraries of the samples were prepared with one-step PCR and adapters were added with the adapter ligation method. Analysis was performed with the next generation sequencing platform to obtain paired end amplicons with a length of 300 base pairs. Approximately 1 million nucleotide sequence reads were obtained per library. Reads were analyzed with various bioinformatics filtering steps and matched with reference databases for vertebrate, invertebrate and eukaryotic species. Results showed that important organisms for Antarctic species diets (such as Antarctic krill, North Pacific krill, Antarctic yellow-bellied rock cod and Antarctic silverfish) were successfully identified at the species level by eDNA metabarcoding.

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Abstract No : 324

The ontogeny of southern elephant seal foraging migration strategies: finding their way as they go

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The roles of innate navigational abilities, environmental cues and individual learning in shaping animal habitat selection and migration strategies are poorly understood. Naïve juvenile southern elephant seals (*Mirounga leonina*) depart from their natal islands after weaning unaccompanied by experienced conspecifics and immediately undertake long foraging migrations into the Southern Ocean, before survivors return to their natal islands several months later. We describe 35 foraging migrations undertaken by 21 recently weaned (< 1 yr old) southern elephant seals from Marion Island and compare these with 161 foraging migrations undertaken by more experienced (71 sub-adults, 15 adult male and 37 adult females) seals. Foraging migrations of underyearlings were shorter in duration and they remained nearer to Marion Island than older seals. Sub-adults and adult female seals displayed similar directional travel, foraging over deep water south of the Subantarctic Front. However, underyearlings travelled in multiple directions away from the island, showing little evidence of common directional travel. Underyearlings tracked over multiple migrations during their first year at-sea displayed little repeatability in foraging ranges and substantial variation in direction and distance of travel among tracks. In contrast, older seals displayed consistency in their use of foraging ranges and high levels of repeatability in direction and distance of travel. The overall dissimilarity in movement patterns exhibited by the underyearling elephant seals when compared with more experienced seals suggest that individual foraging strategies of this species are strongly influenced by individual learning, especially during the first year of life.

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Abstract No : 20

Crash and learn? The rapid population collapse of Antarctic fur seal colonies in the northern Antarctic Peninsula endangers genetic diversity and resilience to climate change

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Antarctic fur seals (AFS) are an ecologically important predator and a focal indicator species for ecosystem-based Antarctic fisheries management. This species suffered intensive anthropogenic exploitation until the early 1900s, but recolonized most of its former distribution, including the southern-most colony at Cape Shirreff, South Shetland Islands (SSI). The IUCN describes a single, global AFS population of least concern; however, extensive genetic analyses clearly identify four distinct breeding stocks, including one in the SSI. To update the population status of SSI AFS, we analyzed 20 years of field-based data including population counts, body size and condition, natality, recruitment, foraging behaviors, return rates, and pup mortality at the largest SSI colony. Our findings show a precipitous decline in AFS abundance (86% decrease since 2007), likely driven by leopard seal predation (increasing since 2001, $p < 0.001$) on pups and potentially worsening summer foraging conditions for adult females. We estimated that leopard seals consumed an average of 69.3% (range: 50.3 – 80.9%) of all AFS pups born each year since 2010. AFS foraging-trip durations, an index of their foraging habitat quality, were consistent with decreasing krill and fish availability. Significant improvement in the age-specific over-winter body condition of AFS indicates that observed population declines are driven by processes local to the northern Antarctic Peninsula. The loss of SSI AFS would substantially reduce the genetic diversity of the species, and decrease its resilience to climate change. There is an urgent need to reevaluate the conservation status of Antarctic fur seals, particularly for the rapidly declining SSI.

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Abstract No : 850

VIROLOGICAL EVALUATION OF OCULAR SURFACE SAMPLES TAKEN FROM PYGOSCELIS PENGUIN SPECIES OF ANTARCTIC PENINSULA

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Antarctica is a region that has been isolated for a long time due to geographical and climatic conditions. Antarctic penguins are thought to have limited microbial diversity, given their disease susceptibility in foreign environments. Little is known about the viral agents seen in Antarctic Penguins. Different approaches are needed to determine the pathogenic potential of viruses in penguin populations. The aim of this project; to identify and characterize possible viruses from eye swabs taken from penguins. Virological study mainly; It includes virus isolation in cell cultures, viral RNA-DNA extraction and electrophoresis gel profile examination for diagnostic purposes and the application of RT-PCR and PCR tests. Turkish Antarctic Science Expedition (TAE-3) - within the scope of Bilateral Cooperation, the INACH -55 of the Chilean Antarctic Institute (Instituto Antartico Chileno, INACH) will be launched with the title "Cytological, Microbiological and Ophthalmic Evaluation of Samples of Ocular Surface from the Antarctic Peninsula Penguins" Ocular surface samples taken from the project formed the material of this study. Ocular surface sampling was performed on the South Shetland Islands and the northern part of the Antarctic Peninsula. Samples were taken from adult (n=87) and chick (n=13) The genus *Pygoscelis* penguins from all islands. Samples stored at -80 °C will be used in the study. In order to isolate possible virus from eye swab samples, different cell lines (Primary chicken embryo cell culture, Vero) will be inoculated and cultured 3 times with blind passage. Samples with suspicious cytopathogenic effects will be heated to -80 °C and subjected to virus identification tests.

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Abstract No : 442

Shoreward intrusion of oceanic surface waters alters physical and biological ocean structures on the Antarctic continental shelf during winter: Observations from instrumented seals

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Ocean circulation plays a key role in structuring marine ecosystems in the Southern Ocean. However, the seasonal dynamics of ocean circulation are poorly understood in the ice-covered continental shelves due to difficulties in conducting observations. We, therefore, investigated spatial and temporal variations in oceanographic conditions and their biological effects on the continental shelf off East Antarctica (35°E–50°E) by deploying conductivity–temperature–depth (CTD) tags on Weddell seals. The seals moved up to 633 km east from the tagging location. We successfully obtained 1254 CTD casts from seven seals. Winter Water (WW) was most prevalent (77.4% of the total data), followed by Supercooled Water (14.2%), Antarctic Surface Water (AASW: 7.4%), Modified Circumpolar Deep Water (mCDW; 0.9%), and Modified Shelf Water (0.1%). During our study period, landfast ice broke up extensively, and the easterly wind was most prevalent during autumn. AASW was observed in the subsurface layer over the shelf in autumn, suggesting that AASW intruded from the surface of off-shelf areas through Ekman transport. Particular water masses (mCDW, AASW, and WW below the AASW) had positive effects on the seals' foraging behavior. These results highlight the importance of easterly wind-driven shoreward intrusion of oceanic surface waters onto the shelf in autumn. This physical process may enhance transport and accumulation of additional prey and increase local prey availability during winter. Such a process may play important roles in the Antarctic coastal marine ecosystems that are influenced by landfast ice.

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Abstract No : 470

Mystery in the Shetland's: unexplained mortality of snow petrels at non-breeding areas of the maritime Antarctic

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Snow petrels (*Pagodroma nivea*) are a gregarious, pagophilic and endemic species to the Antarctic region with a circumpolar breeding distribution. Between Dec 2021 and Feb 2022, we registered 49 carcasses of adults of the subspecies *Pagodroma n. nivea* scattered along the coast of Harmony Point (62°18'S; 59°10'W), Nelson Island, and at least 7 carcasses at Fildes Peninsula (62°11'S; 58°57'W), King George Island, both areas with no report of breeding activities. Few carcasses still had flesh on the body and most were an articulated skeleton with feathered head, bill with intact rhamphotheca, wings, tail and feet. A previous complete scan of Harmony Point during the 2019/2020 austral summer revealed no carcasses, therefore, the deaths must have occurred between March 2020 and November 2021. We did not perform necropsies and the causa mortis was not identified. Adult mortality has been previously linked with less extensive winter sea-ice in Terre Adélie, however studies for the Antarctic Peninsula region are scarce. We encourage the Antarctic community to share any recent records of snow petrel carcasses in non-breeding areas of the region to track such mortality events and better understand the causes.

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Abstract No : 545

Characterisation of the bacterial isolates from regurgitated samples of South Polar Skua (*Stercorarius maccormicki*)

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South Polar Skua (*Stercorarius maccormicki*) is breeding in the Antarctic peninsula and winters on the sea in the Pacific, Atlantic and Indian Oceans. They are known for their notorious behaviour of pirating food from other birds and eating chicks of penguins and other seabirds. South Polar Skua regurgitated samples were collected during Indian Antarctic Expedition 2020, from near the Indian Research Station, "Maitri". Seventy-one isolates were isolated from the regurgitated samples. Selective media, MaCconkey Agar media was used for the isolation of the Enterobacteriaceae from the samples. We found undigested bone remains from the samples, indicating their feeding behaviour. The evaluation of the hydrolytic enzyme production capability of the bacterial isolates revealed good lipase activity followed by asparaginase activity. None of the isolates showed glutaminase and cellulase activity. Antibiotic sensitivity testing of the isolates showed that several bacterial isolates from regurgitated samples were resistant to penicillin, vancomycin and erythromycin. These ARBs were transferred to their young ones along with the regurgitated matter. These ARBs were transferred to their young ones along with the regurgitated matter. Migratory birds like South Polar Skua not only carry ARBs to remote locations but also transfer them to next-generation, which have not even come into contact with antibiotics.

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Abstract No : 1046

Molecular identification of Antarctic whales based on insertion and deletion polymorphisms

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At the beginning of the 20th century, the South Shetlands were the scene of intense whaling activity, which is found today not only in the form of ruins of hunting stations and vessels, but also in numerous whale bones scattered on the beaches of Admiralty Bay. Historical records and archaeological surveys record the capture of thousands of individuals of different species of whales present in the Southern Ocean, such as Humpback Whales, Blue Whales, and Fin Whales. The present study uses molecular identification techniques based on insertion and deletion regions (InDels) of the mitochondrial DNA for the identification of bone fragments from the whaling period of Antarctica, still deposited on the beaches of Admiralty Bay, King George Island, Antarctica. Despite the years in which they were exposed to degrading elements, these fragments are frozen most of the time and still present viable DNA allowing the molecular identification. These techniques based on rare insertion deletion polymorphisms are a forensic “gold-standard”, and focus on the species determination based on small InDel regions rather than sequencing large mitochondrial fragments such as the COI and 16S, therefore allowing its use on degraded samples such as those found on the beaches of Admiralty Bay. Our results suggest that it is possible to identify any Antarctic whale by analyzing the numerical length relationship between just two insertion and deletion regions with ca. 200bp of the mitochondrial DNA using the proposed methodology.

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Abstract No : 490

The applicability of Optimum Foraging Theory to *Pygoscelis* spp. memory and effort allocation at the sub-mesoscale

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According to optimum foraging theory (OFT), predators should use previous foraging success to inform their subsequent foraging behavior. However, in the marine environment, research on whether central place foragers (CPF) base foraging locations on previous foraging success is conflicting. The aim of this study is to test whether the similarity of sequential CPF penguin trajectories is influenced by previous foraging trip success. Sequential foraging trips (N=108) were recorded from two *Pygoscelis* penguin species in the Western Antarctic Peninsula on Anvers Island in 2019 and 2020 using fastLoc GPS and depth recorders. Foraging success per trip was quantified using depth data and the similarity of repeated foraging trips was calculated using Fréchet distance. Repeated penguin tracks were significantly more similar to each other than tracks from two different random animal movement models. While this increased similarity was weak, it could not be explained by foraging success, daily wind speed, or tidal stage. Two ADCP moorings within Palmer Canyon showed that the mean acoustic backscatter, a measure of food availability, in this region was not highly variable. Therefore, two possible explanations arise. One explanation is the prey field within this region is heterogenous on a scale that does not significantly benefit targeted foraging. A second explanation is that factors other than previous experience, average wind speed, or tidal stage may influence the location of repeated foraging trajectories. These results suggest that OPT may not accurately depict foraging in these species and further marine foraging behavior should be reevaluated using high-quality location data.

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Abstract No : 540

Passive acoustic monitoring of marine mammals in the Ross Sea region marine protected area

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Acoustic measurements were made from November 11 to December 15, 2021, at six locations in the Ross Sea region Marine Protected Area (MPA) with three autonomous passive acoustic recorders. Sea ice movement and deformation were large during this period. Acoustic data were recorded continuously from a few hours to about a month with a sampling rate of 96 kHz, and the sound generated from various underwater sound sources was recorded. Hydrophones were operated in the main habitats of Adelie penguins and Emperor penguins, such as Cape Hallett, Cape Washington, Inexpressible Island, and Edmonson point. Vocalizations of Weddell seals and leopard seals were mainly recorded, and those of killer whales and minke whales were also measured. Air drones and underwater cameras, often used in ocean monitoring recently, were used together to enhance the reliability of passive acoustic monitoring data.

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Abstract No : 226

Wilson's Storm-Petrel Nestlings in a changing World: Consequences of Heterothermy on Physiology and Growth

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Heterothermy offers many species worldwide the possibility to survive times of malnourishment by lowering metabolic rate and body temperatures. Especially during development, heterothermy is expected to have disadvantages for juveniles. Our study aimed at identifying potential trade-offs between use of heterothermy and investment into growth, body condition, immunity, as well as telomere maintenance in Wilson's storm-petrel *Oceanites oceanicus* nestlings. Wilson's storm-petrels are the smallest birds breeding in Antarctica, and nestlings are known to be capable of heterothermy during prolonged fasting intervals. In a highly seasonal environment like the Antarctic ecosystem, prolonged development can result in desertion by the parents. Our study was able to show slower nestling growth under the influences of heterothermy, and the acquired immune system tended to be less effective at lower body temperatures. Triglycerides as a marker for body condition decreased after pronounced heterothermy during chick development. However, innate immunity was not affected by heterothermy. In the changing climate of the Antarctic Peninsula, snowfall, and hence nest blockage, is predicted to increase, and the use of heterothermy may ensure nestling survival during continuous events of food limitation. However, our study presents possible consequences for the petrels' adult life due to poor development, which may result in declining populations due to lower individual fitness.

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Abstract No : 180

Fine-scale foraging behaviours of lactating Weddell seals in Erebus Bay, Antarctica.

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Weddell seals *Leptonychotes weddellii* have substantial energy requirements while lactating, with many foraging to offset loss of body mass. Obtaining knowledge about foraging frequency and targeted prey is therefore crucial to understanding vulnerabilities possibly arising from limited ecosystem resources. We investigated foraging behaviour of lactating Weddell seals in Erebus Bay during spring 2018 and 2019 by fitting seals with time-depth recorders (TDRs) and animal-borne video recorders. We aimed to 1) identify prey species and foraging depth, 2) investigate relationships between seal condition and behaviour, and 3) infer whether lactating Weddell seals target particularly energy-dense prey, i.e., Antarctic toothfish (*Dissostichus mawsoni*). Across >65 hours of video and >2300 hours of TDR data, we recorded 2782 dives, 903 of which were deeper than 50 m. The average dive depth was 91.3 m (SD = 46.4) and the maximum depth reached was 449.3 m. Seals foraged with 16-day old pups, but females with older pups completed significantly more dives (Spearman $R = 0.583$, $p\text{-value} = 0.002$) and reached significantly greater depths (Spearman's $R = 0.439$, $p\text{-value} = 0.028$). Breeding history was significantly correlated with deep dives (>50 m, Spearman's $R = -0.715$, $p\text{-value} = 0.002$) and dives per foraging bout (Spearman's $R = -0.525$, $p\text{-value} = 0.045$), where females with fewer previous pups dived more often, suggesting experience may influence postpartum foraging strategy selection. We observed 848 prey encounters from nine seals. Crustaceans were observed most often (46.1%), followed by Antarctic silverfish *Pleuragramma antarcticum* (19.1%); two encounters with juvenile toothfish were also observed.

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INVESTIGATIONS ON TISSUE AND SMEAR SAMPLES OF PYGOSCELID PENGUINS OF ANTARCTIC PENINSULA: PATHOLOGICAL, MICROBIOLOGICAL AND PARASITOLOGICAL PERSPECTIVE

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In this study; it is planned to perform virological, bacteriological, parasitological, cytological and histochemical analyzes of cloacal and pharyngeal swab samples from Penguin species in the *Pygoscelis* (P) genus [Adelie penguin (*P. adeliae*), Chinstrap penguin (*P. antarctica*) and Gentoo penguin (*P. papua*)] and tissue samples from deceased penguins. In addition, the tissue samples from penguins will be examined immunohistochemically via appropriate antibodies to the bacterial and viral isolates that will be obtained. Brush cytology (cytospin technique) will be used for cytological investigation of swap samples. A total of 200 penguins (100 adults and 100 chicks) will be sampled from King George, Livingston, Deception, Rongé , South Shetland ,Ardley , Goudier islands, Base Gabriel Gonzalez Videla, Base Bernardo and Narębski point along the Antarctic peninsula. It is planned to take four swap samples from each penguin for each analysis For the microbiological analyses, swaps and tissue samples will cultured on Uriselect 4 plates Bio-Rad, UK) to detect Enterobacteriaceae ((*E. coli*, *Salmonella* spp., *Citrobacter* spp, *Klebsiella* spp, *Shigella* spp., *Enterobacter* spp.) *Staphylococcus aureus*, *Staphylococcus epidermidis*, *Streptococcus agalactiae* and *Acinetobacter* spp. The aim of identifying and characterizing some RNA and DNA viruses which are known as the main respiratory and digestive system infectious agents, and new viral agents, virological analyses will be composed of cell cultures. Stool samples will be examined in terms of protozoa, protozoan cysts, and helminth eggs using a light microscope. In addition, tissue samples of dead penguins will be examined for the presence of helminths. We believe that every step towards the goal of monitoring infectious diseases in Antarctic penguins and generating data on the causative agents of pathogen pollution is important. Key Words: Microbiology, Parasitology, Pathology, Pygoscelid penguins, virology

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Abstract No : 865

Antarctic krill and marine mammal abundance at the South Orkney islands krill fishing grounds

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The shelf around the South Orkney islands has become a major commercial fishing ground for Antarctic krill in the recent years. The area exhibited some of the highest krill densities in recent and historic large-scale surveys and receives influx from both the Scotia Sea and the Weddell Sea. Since 2011 the Norwegian Institute of Marine Research conducts annual ecosystem surveys of krill and krill predator abundance along 5 transects around the islands. In this talk we present an initial analysis of the abundance time series, spatial distribution patterns and a comparison to environmental covariables. Krill abundance was measured with calibrated echosounders and the krill length distribution was derived from towed net samples. Marine mammal abundance was estimated using distance sampling, based on visual observation data from dedicated observers stationed on the bridge. Fin whales (*Balaenoptera physalus*) were the most abundant baleen whale species, followed by Humpback whales (*Megaptera novaeangliae*) in El Niño years. Even though each survey represents only a snapshot of the ecosystem state we observed significant relationships between krill and marine mammal abundance and large-scale climate indices.

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Abstract No : 618

Predator-derived bioregions in the Southern Ocean: characteristics, drivers and representation in Marine Protected Areas

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Multiple initiatives have called for large-scale representative networks of Marine Protected Areas (MPAs). MPAs should be ecologically representative to be effective, but in large, remote regions this can be difficult to quantify and assess. We present a novel bioregionalization for the Southern Ocean, which uses the modelled circumpolar habitat importance of 17 marine bird and mammal species. The habitat-use of these predators indicates biodiversity patterns that require representation in Southern Ocean conservation and management planning. In the predator habitat importance predictions, we identified 17 statistical clusters, falling into four larger groups. We characterized and contrasted these clusters based on their predator, prey and oceanographic characteristics. Under the existing Southern Ocean MPA network, some clusters fall short of 10% representation, yet others meet or exceed these targets. Implementation of currently proposed MPAs can in some cases contribute to meeting even 30% spatial coverage conservation targets. However, the effectiveness of mixed-use versus no-take MPAs should be taken into consideration, since some clusters are not adequately represented by no-take MPAs. These results, combined with previous studies in the Southern Ocean, can help inform the continued design, implementation, and evaluation of a representative system of MPAs for Southern Ocean conservation and management.

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Abstract No : 513

Historical climatic influences on Antarctic seabirds: From Pleistocene to present

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Climate change is the main threat to global biodiversity and its potential impacts are especially evident at higher latitudes. To safeguard Antarctic species there is an urgent need to understand how species will respond to future climate change. Past climatic oscillations during the Pleistocene shaped current population distributions and genetic diversity, hence providing a lens into possible species responses to future climate change. This study will thus investigate the impacts of climate change observed in six Antarctic volant seabirds with varying habits and biology. Ninety-one whole genomes were sequenced for samples across East Antarctica and sequenced reads were used to generate genomic markers to reconstruct historical and modern demographic history. The reconstructed demographic histories will be used to reveal how past climate change has affected populations, thus providing an insight into how species may respond to future climate change. These comparisons seek to understand how and if there is a recurring factor that affects the responses of species to past climate change, and if climate change impacts can be generalized across terrestrial-breeding Antarctic predators.

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Abstract No : 591

Influenza A(H1N2) detection in fecal samples from Adelie (*Pygoscelis adeliae*) and chinstrap (*Pygoscelis antarcticus*) penguins, Penguin Island, Antarctic.

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Although wild birds play a role in the transmission and ecology of Avian Influenza Viruses (AVIs) across the globe, there are significant gaps in our understanding of the worldwide distribution and circulation of these viruses in polar environments. Fecal samples of penguins were collected throughout November and January/February of the 2019/2020 breeding season in the Antarctic summer season, in the South Shetland Islands. Fecal material was tested for Influenza A viruses by real time RT-PCR assay and positive samples were submitted to whole genome sequencing, by the Illumina MiSeq System. The obtained sequences were used for phylogenetic analyses. Five out of seven samples collected in Penguin Island were positive; four of these were collected in the environment from the colony of *P. antarcticus* and one sample collected from one isolated *P. adeliae*. AIVs whole and partial genomes were recovered from four samples. The phylogeographic analysis revealed the clusterization of obtain sequences with all available Antarctic AIVs subtype H1N2, in a highly supported cluster. This identification suggests the persistence of Influenza A(H1N2) in penguins' colonies in South Shetland Islands once it was first identified in 2014 in *P. adeliae* living around the Antarctic Peninsula. Our results reinforce the need for continuous surveillance of avian influenza in the Antarctic continent adding new data in regards to the natural history and ecology of AIV.

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Abstract No : 504

Albatrosses and seals as bio-indicators of Southern Ocean cephalopods under a climate change context

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Southern Ocean cephalopods play an important role in the diet of numerous predators. In this presentation, we review new insights into the trophic ecology and distribution of cephalopods obtained through their predators in a region that has been exhibiting considerable changes. Our long-term studies involved analyses of changes in stable isotope ratios of squid beaks obtained from diet samples of wandering albatrosses *Diomedea exulans* in the last 50 years (1976 – 2016) in relation to annual indices of environmental conditions (Southern Oscillation Index and Southern Annular Mode). These showed that several squid species changed their habitat (based on $\delta^{13}\text{C}$ values) but showed minimal changes in trophic levels ($\delta^{15}\text{N}$ values) across decades. As adult squid may therefore move southwards with climate change, there are likely to be impacts on top predators breeding on islands at more northerly latitudes in the Southern Ocean. Indeed, this is demonstrated by our work on Antarctic fur seals *Arctocephalus gazella* that already showed that in years of unusually warm oceanographic conditions, with squid increasing in seal diets related to their foraging strategy. Finally, in grey-headed albatrosses *Thalassarche chrysostoma*, analyses of a long-term dataset (1996-2017) showed that breeding success was positively related to the importance in the diet of the sub-Antarctic squid *Martialia hyadesi*. The presentation will conclude with a call to increase monitoring of the diet and foraging ecology of Southern Ocean top predators, associated with ongoing SCAR research programmes and the UN Southern Ocean Decade.

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Abstract No : 628

First report of the Adélie penguin blood biochemistry on arrival at nesting site and the comparison with the reproductive stage

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The Adélie penguin (*Pygoscelis adeliae*) is one of the most abundant seabirds in the Antarctic ecosystem. This species has a circumpolar distribution. The arrival of adults on the coast begins in late September or early October and the breeding season lasts until February. A marked environmental variability and loss of sea ice cover are being in the Antarctic Peninsula as a result of rapid climate warming. Due to these conditions, penguins are exposed to an extreme environment, variation in food availability, and thermal stress and they are forced to make changes between physical maintenance and energy expenditure at different life cycle stages. Besides, the Adélie penguins are key species in the Antarctic food web with a marked trend of population decline. So it is important to know the physiological status during pre-breeding and breeding stages. For this reason, blood samples were taken and, the levels of total proteins, uric acid, calcium, inorganic phosphorus, glucose, lipid peroxidation, and protein oxidation were measured. Furthermore, studies were carried out according to sex. The blood biochemistry on arrival at the colony, as well as the weight, showed values within the reported range for birds but higher than those of the reproductive stage. This would be showing that the penguins arrive at the nesting sites with a better body condition to face courtship and egg-laying, which decreases throughout the reproductive period. In addition, the significant higher values of uric acid and lipid oxidation could be related to the increased energy demand in the reproductive stage.

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Abstract No : 518

Sperm whales forage year-round in the Ross Sea

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Sperm whale (*Physeter macrocephalus*) are one of three species known to commonly eat Antarctic toothfish (*Dissostichus mawsoni*) in the Ross Sea region, along with killer whales and Weddell seals. Commercial fishing for toothfish in the Ross Sea region began in 1997 and CCAMLR's Principles of Conservation require that fishing does not adversely affect these predators. We report new information on the seasonal and spatial overlap between sperm whales, sea-ice and fishing activity in the Ross Sea region obtained from long-term deployments of hydrophones. Passive acoustic data over a 1-year period beginning in austral summer 2018 were collected by two Autonomous Multichannel Acoustic Recorders (AMARs) moored about 15 m above the seabed. Acoustic data from these hydrophones were analyzed using signal processing scripts to detect sperm whales' echolocation signals and validation by visual inspection of spectrograms. At the site in the Pacific-Antarctic Ridge in the northern Ross Sea region, the number of sperm whale detections was almost ten times higher than at the site on the Iselin Bank (Ross Sea continental slope), but there was evidence of sperm whale presence year-round at both sites. The data provide evidence of spatial and seasonal overlap between sperm whales, Antarctic toothfish and commercial fishing and contrast to the paucity of reported sightings of sperm whales from fishing and research vessels in this region. Subsequently, a further 2-years of acoustic data were collected at three sites in the Ross Sea region to start tracking change in sperm whale occurrence over the long-term.

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Abstract No : 428

Population trend of Adélie penguins breeding in Hope/Esperanza Bay, Antarctica

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Several studies reported decreases in populations of Adélie penguins in the north and west of the Antarctic Peninsula. Thus, from 1994 to 2019 we studied the population trend of Adélie penguins at Hope/Esperanza Bay. For such propose, following the CCAMLR-CEMP Methods_A.6 procedure_A-B, we estimated the numbers of breeding pairs, the clutch size, the hatching success, and the survival of chicks to crèche (breeding success). The survival of crèched chicks to adults, and adults' annual survival were obtained from the literature. We constructed a matrix population model to estimate the eigenvalues (λ) as a measure of grow rate of the population. The logarithm of λ_1 (dominant eigenvalue) is equivalent to the per capita grow rate (r), so the population grows if λ_1 is higher than one, remains stable if is one, and decrease if lower than one. Every two years, using a temporal series of six years, we estimated λ_1 for each period; then we compute an average λ_1 . Survivorships were: eggs to hatching=0.77; guard chicks to fledged chicks=0.87; fledged chicks to two years age=0.26; adults per year=0.89. The estimated fecundity was 1.9 eggs/female, and due the ratio female/male reported is 1:1, the estimation of net reproductive rate (R_0) was 0.95. The average value of λ_1 was 1.07. Results suggest that during the study period, the colony remained stable. Given that populations are complex systems, to advance in the knowledge of the dynamic of this population it is important to identify which parameters have the higher sensitivity (stronger influence on λ_1).

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Abstract No : 337

Spatial transferability of population dynamics: A case study with the Adélie penguins

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Ecological predictions are fundamental for informing conservation management decisions in response to environmental change. To be useful in this regard, these predictions must be transferable in one or more dimensions, where transferability is the successful prediction of responses outside of the model data bounds. While much is known as to what makes spatially-oriented models transferable, there is no general consensus as to the spatial transferability of ecological time series models. As a case study, we use a suite of environmental covariates to predict Adélie penguin population growth rates from abundance time series collected at 22 long-term study sites around Antarctica in order to measure their spatial transferability. We demonstrate that the spatial forecast horizon for each study site, defined as its ability to predict growth rates at other sites as a function of distance, is surprisingly small. We argue that limited spatial forecast horizon across all colonies is caused either by stochastic demographic events that do not have consistent temporal patterns or by missing key variables that are closely related to population demography of Adélie penguins. This case study calls into question the necessary assumption common to conservation management that detailed investigations of population dynamics at well-studied sites allows us to better understand their dynamics at less well known locations under various scenarios of future climate change.

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Abstract No : 1005

Where to live? The role of fast ice characteristics in shaping the presence of emperor penguin colonies around Antarctica

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Predicting species persistence in the face of climate change requires an understanding of the drivers of species distribution. The emperor penguin's reliance on landfast sea ice is complex: low fast ice extent reduces the availability of breeding sites and may have consequences on food resources, but extensive fast ice causes longer foraging trips decreasing the frequency of food delivered to the chicks. Until recently, knowledge on emperor penguin distribution and habitat was limited, because continent-wide observations were scarce. Recent technological developments enabled the use of satellite imagery to observe emperor penguin colonies and a characterization of the sea ice habitat at finer spatial scale. Our research aims to determine habitat suitability of emperor penguin colonies across Antarctica using novel fast ice metrics from 2010 to 2018 (i.e. persistence, trend, volatility, extent, magnitude of the seasonal signal, timing), topography and biological factors such as inter- and intra-specific competition. The most contributing fast ice variables were persistence, volatility, and magnitude of the annual cycle. Using model-based clustering, three main habitats were identified based on penguin presence. An habitat suitability probability was then computed across Antarctica within fast ice regions. This research will help understand the mechanisms by which climate change may impact penguins in the realistic ice landscape, by studying the role of fast ice on the distribution and persistence of penguin colonies. This has both short to long-term impacts for the conservation of this species, by understanding its past and present distribution to better predict their distribution in the future.

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Abstract No : 32

Antarctic blue and fin whale baleen isotopes reveal insights on ecology and life history

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Southern hemisphere blue (*Balaenoptera musculus*) and fin (*Balaenoptera physalus*) whales share several similarities in morphology, physiology, and distribution, but understanding of their life history and foraging is limited due to their low population abundances and lack of historic and modern ecological data. Powder from 1947–1948 archived Antarctic blue ($n = 5$) and fin ($n = 5$) whale baleen plates from the Smithsonian National Museum of Natural History were analyzed for bulk ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) stable isotope analyses. Isotopic oscillations observed from these data show that blue whale baleen plates contain approximately six years ($14.35 \pm 1.20 \text{ cm yr}^{-1}$) of life history data while fin whale baleen records about four years ($16.52 \pm 1.86 \text{ cm yr}^{-1}$). Analyses of isotope signatures from these plates suggest that: 1) blue and fin whales feed at the same trophic level ($\delta^{15}\text{N}$ values: $(6.60\text{‰} \pm 1.02\text{‰})$ and $(6.71\text{‰} \pm 0.74\text{‰})$, respectively) but in different habitats ($\delta^{13}\text{C}$ values: $(-24.62\text{‰} \pm 0.97\text{‰})$ and $(-22.77\text{‰} \pm 1.69\text{‰})$, respectively), 2) fin whales have more consistently cyclical stable carbon and nitrogen isotopic oscillations than blue whales, and 3) blue whales appear to reside year-round in the Southern Ocean ($\delta^{13}\text{C}$ values for isotopic peaks: $(-23.74\text{‰} \pm 0.91\text{‰})$), while fin whales likely migrate to sub-Antarctic waters ($\delta^{13}\text{C}$ values for isotopic peaks: $(-20.85\text{‰} \pm 1.14\text{‰})$). These results suggest niche partitioning between blue and fin whales and differences in life history strategies. This historical data provides a better understanding about potential factors that may continue to shape the migration and foraging dynamics of these whales.

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Abstract No : 363

Adélie penguins north and east of the `Adélie Gap' continue to thrive in the face of dramatic declines elsewhere in the Antarctic Peninsula region

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While Adélie penguin population declines and gentoo penguin increases on the Western Antarctic Peninsula are well established, the dynamics of penguins at the northern tip of the Peninsula and into the Weddell Sea are less well known. Here we describe the findings of an expedition to the northern and eastern sides of the Antarctic Peninsula designed to investigate the distribution and abundance of penguins in this region that has not been surveyed in over a decade. We found that Adélie colonies have remained stable overall, and gentoo penguins have moved in towards the southern end of their range. Our findings suggest that the transition zone that separates the stable Weddell Sea region from declining populations of Adélie penguins and skyrocketing populations of the more sub-Antarctic gentoo penguin lies in the “Adélie gap” – a 400 km stretch of the Antarctic Peninsula where Adélies are conspicuously absent. Our analysis of annual sea-ice concentration trends between 1979–2018 suggests that sea-ice declines along the Western Antarctic Peninsula are notably faster south of the Adélie gap, where the greatest declines in Adélie penguin population have occurred, than north of the gap where Adélie populations are stable. This work clarifies the boundary between declining and stable Adélie populations and identifies the northern Peninsula as a key refuge for the region. Understanding the importance of this region, which represents a distinct ecoregion whose dynamics stand in sharp contrast to surrounding areas, should inform the development of Marine Protected Areas east and west of the Antarctic Peninsula.

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Abstract No : 1047

The use of environmental DNA in the analysis of the persistence of penguin colonies on King George Island, Antarctica

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Due to the extreme climate the Antarctic region presents itself as an important laboratory for research related to fundamental life processes that have global implications. Recent studies suggest the increase in global temperature is greater in polar regions than in temperate and tropical regions, therefore the continuous monitoring of climate and the consequences of climate changes in the Antarctic biodiversity is a key for the future of this biodiversity in the extreme south of the planet. Antarctic penguins are specially affected by climate change since many species rely on the sea-ice cover that its currently receding. Environmental DNA (eDNA) could be used as a valuable tool for the assessment of how these changes affect the biodiversity. The present study evaluate the use of eDNA as a tool for monitoring species of interest, since it allows the investigation of recent phenomena and processes as well as the temporal monitoring of the effects of the global climate change on the populations of Antarctic species. A glacial lake sedimentary core from the Fields Peninsula, King George Island is used to assess the abundance of organisms that lived in its edges in a specific timeline, given that genetic material such as feces and the remains of the animals precipitate to the bottom of the lake together with the sediment.

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Abstract No : 546

Role of Arctic tern (*Sterna paradisaea*) and South Polar Skua (*Stercorarius maccormicki*) in the dissemination of antibiotic-resistant bacteria to the pristine Antarctic

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Migratory birds have a significant role in the dissemination of antibiotic-resistant bacteria (ARB) to the pristine Antarctic environment. They carry ARBs beyond borders. The Arctic tern is the longest migration bird, travelling between the breeding place in the Arctic to the non-breeding place in the Antarctic. Similarly, South Polar Skua breeds in the Antarctic and migrates to the Pacific, Atlantic and Indian Oceans for their wintering. During their migration, they have many stopovers along their migratory route. They intermix with other birds and animals at the stopovers and migrate through polluted and anthropogenically influenced habitats that might result in the pickup ARBs. . In this study cloacal samples of 16, Arctic tern was collected from Longyearbyen, Svalbard and analysed for the bacterial flora. *Staphylococcus* (21.5%), *Aerococcus* (19%), *Alcaligenes* (19%), *Bacillus* (14%), *Micrococcus* (13%), *Enterococcus* (6%) and *Lysobacter* (6%) were the major genera in the cloacal samples. Most of the bacterial isolates were resistant to the antibiotic ceftazidime followed by penicillin G, ampicillin and nalidixic acid. South Polar Skua faecal samples were collected during Indian Antarctic Expedition 2020, near to Indian Antarctic station "Maitri". *Sanguibacter* (23.94%), *Enterococcus* (22.8%), *Clostridium* (15.1%), *Bacillus* (8.68%), *Escherichia* (5.87%) and *Carnobacterium* (4.58%) were found to be the major genera. The isolates showed resistance against penicillin, vancomycin, erythromycin and ampicillin. When the ARBs reached the polar environment, the antibiotic-resistant genes can be horizontally transferred to environmental microbes. Migratory birds can act as reservoirs of ARBs and disperse far and wide.

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Abstract No : 510

Identifying a network of Key Biodiversity Areas in the Southern Ocean using animal tracking data

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Identifying key at-sea foraging locations of Southern Ocean predators is vital for informing conservation management. The Retrospective Analysis of Antarctic Tracking Data (RAATD) dataset is a Scientific Committee for Antarctic Research project led jointly by the Expert Groups on Birds and Marine Mammals and Antarctic Biodiversity Informatics containing 17 predator species, 4060 animals, and more than 2.9 million observed locations. This project has already mapped ecologically important regions in the Southern Ocean via habitat modeling. Our work complements existing research by leveraging this dataset to locate Key Biodiversity Areas (KBAs), a standardized set of criteria for identifying areas important to the global persistence of biodiversity. We used state-space model outputs created by the RAATD project managers from raw tracking data, which we partitioned based on species, tagging location, and breeding stage. Using the track2kba R package, for each data group we identified core use areas per individual with 50% kernel density estimates (KDEs) and assessed how well the collected data represented the sampled population. Individual KDEs were aggregated to identify colony level high-use areas. The size and number of mature individuals in the site delineated for assessment against KBA criteria are proportionate to the representativeness value. We will be continuing the next phase of work – moving from individual KBAs to regional Southern Ocean KBA delineations – starting with a KBA workshop held during this SCAR 2022 conference. We invite all interested participants keen to support delivery of a new network of KBAs for the Southern Ocean (see workshop list for details).

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Abstract No : 785

Real or social monogamy in Gentoo and Chinstrap Penguins?

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Molecular studies have shown that, although most avian species are socially monogamous, they can exhibit different reproductive strategies, such as extra-pair paternity (EPP) and intraspecific brood parasitism (IBP). We investigated the genetic mating system of the Chinstrap, *Pygoscelis antarcticus*, and Gentoo *Pygoscelis papua*, penguins species that is reported to be monogamous, with little or no evidence of extra-pair paternity, high partner faithfulness over the years and intense biparental care. Thus, we proposed that if EPP does occur, the rate will be low and could be related to increased genetic diversity among offspring. For this we evaluated EPP in 92 nests from Chinstrap penguin, and 40 nests from Gentoo penguin in Elephant Island. In contrast to expectations, EPP was detected in 58% of the offspring in Chinstrap and 48% of the offspring Gentoo Penguin, corresponding to 66% of the nests in Chinstrap and 78% of the nests in Gentoo. However, we did not find a difference in genetic diversity between nests with or without EPP. These results reveal a high rate of EPP, both of which were previously unknown for these species. Our findings demonstrate that the Chinstrap and Gentoo penguins have a more complex social mating system than previously thought. To understand the reason of EPP behavior it is important to study other characteristic, how influence of immune systems in choice partners.

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Abstract No : 1044

Seasonal dynamics of the Weddell seal in the area of Argentine Islands (West Antarctic Peninsula) in 2021–2022

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Weddell seal (*Leptonychotes weddellii*; WS) is the most southerly ranging mammal, and this marine predator permanently inhabits the Antarctic continent. The changing conditions of the West Antarctic Peninsula (WAP) region, which is experiencing fast rates of climate change, affect this sensitive pinniped species. Despite the intensive studies of WS, little is known about its current population dynamics in the WAP region. Our goal was to monitor WS in the waters of the Argentine Islands and adjacent areas from April 2021 to April 2022. The shore-based and boat-based studies were conducted at the Ukrainian Antarctic Akademik Vernadsky Station. WS were present throughout the year, with peaks in the austral spring and summer – up to 19 individuals. During the second part of September and the first part of October, six WS pups were born in the area of Stella and Skua Creeks, between the Galindez, Winter and Skua Islands: four females and two males. During the breeding period, studies of WS reproductive behaviour were conducted using visual observations, automatic stationary photo cameras, underwater acoustic recordings, and photo-identification. The area of the Argentine Islands is essential for the different stages of the WS life cycle. Our results show the ability of the quality year-round studies of the species in changing conditions of the region.

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Abstract No : 663

Over-winter migration of Adelie penguins from the northern and southern extremes of the Ross Sea Marine Protected Area

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The world's largest Marine Protected Area (MPA) was gazetted within the Ross Sea in 2017. Adélie penguins (*Pygoscelis adeliae*) are a bio-indicator because of their sensitivity to changes in ice and the marine ecosystem. The breeding-season ecology of Adélie penguins is well studied, but much less is known about how environmental conditions influence their over-winter migration to the northern edge of the Ross Sea. Migration is a period of high risk to survival and is important for preparing for the subsequent breeding season. To address this knowledge gap, we deployed geolocator tags on 19 breeding adult Adélie penguins at Cape Adare, northern-most colony inside the Ross Sea MPA, and on 53 penguins from Cape Bird in the southern Ross Sea. We explored how penguins from widely separated colonies used the northern Ross Sea to determine how, if at all, penguins partition over-winter use of the northern Ross Sea, and what proportion of the migration is within the MPA. We also developed a hidden Markov movement model to examine how migratory movement behaviour is influenced by sea ice concentration, ocean currents and ambient light level. Results will be discussed in terms of potential impacts on Adélie penguin population dynamics due to changes in sea ice conditions and the marine ecosystem.

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Abstract No : 197

Characterizing Pack-ice Seal Spatial Distributions using Satellite Imagery

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Antarctic pack ice seals, a group of four species of true seals (Phocidae), play an important role in the Southern Ocean food web as apex predators. Due to their circumpolar distribution along coastal Antarctica and because of logistical difficulties of performing large-scale population surveys in a remote environment, there is considerable uncertainty about their true population sizes. In the last decade, growing availability of modern high-resolution satellite imagery datasets and ever-maturing artificial intelligence methods have led to a sea-change for how researchers approach such questions. In this effort, we discuss the application of Very High Resolution satellite imagery, deep- and machine-learning methods to investigate local proximity relationships, body size distributions and fine-scale sea-ice habitat preferences of pack-ice seals hauled-out on sea-ice during the Austral breeding season (Oct-Dec). Our examination of inter-individual spatial patterns, group clustering, body-size and sea-ice characteristics offers a novel perspective on the spatial ecology of Antarctic pack-ice seals. This work represents important first step in advancing our understanding of the roles played by fine-scale spatial dynamics and environmental features in determining seal behavior and may better inform future population census efforts.

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Abstract No : 632

Screening of avian fecal samples from the South Shetland Islands for fowl adenoviruses (FAdVs) and coronaviruses (CoVs).

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The intensification of human presence in the Antarctic, due to scientific activity, research stations but especially tourism, brings new disease threats to the Antarctic fauna and already a great number of introduced microorganisms have been described among Antarctic animals. Moreover, although it is well established that wild bird species play a role in the transmission and ecology of many viruses, there are considerable gaps in our understanding of the significance and worldwide distribution of these viruses especially in polar environments. Fowl adenoviruses (FAdVs) and Coronaviruses (CoVs) are known to cause severe disease among vertebrates and are associated with important diseases in poultry, but relatively little is known about the biology of these viruses in Antarctic avifauna. Considering that these viruses replicate in the intestines of infected birds and high concentrations of virus can be excreted in the feces, we collected samples in a non-invasive way, also avoiding disturbance of birds during the breeding season. Fresh fecal avian samples were collected throughout the 2019/2020 breeding season in the South Shetland Islands. Genetic material was extracted from the samples, and analyzed by RT-PCR. In a total of 76 samples, all tested negative for the presence of both FAdV and CoV viruses. To increase our understanding of the complex relationship of viruses with their hosts in this environment, it is crucial to integrate virus and host ecology within long-term surveillance studies that may be used as an early warning system for the incursion of zoonotic viruses.

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Abstract No : 1030

Do Adélie penguins care about boundaries? Spatio-temporal consistency in the wintering behaviour of Antarctic sentinel species – implications for conservation

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In polar regions, temporal variability in the sea ice may trigger yearly shifts in seabird movements and behaviour as an adaptation to changing environments. Thus, assessing this feature is crucial to evaluating possible threats. We evaluated the spatio-temporal consistency in wintering behaviour of Antarctic sentinel species within an ecologically relevant region proposed as a candidate Marine Protected Area (MPA). We tracked 62 Adélie penguins using geolocators with wet-dry sensor over 5 years from Ile des Pétrels (East Antarctica). Migratory movements were longitudinal and bounded by the 60°S latitude, reaching up to 1600 km westwards from the colony between July–August. Inter-annual overlap of wintering grounds indicated high spatio-temporal consistency (Bhattacharyya's affinity index: 0.82–0.96 among all years). Individual activity budgets varied throughout the winter, but foraging was mostly restricted to daylight. Daily time spent on water was the shortest around the winter solstice (June, 5.6 ± 1 h), and increased with daylength towards the end of wintering period (September, 11.2 ± 1.6 h). At a medium-temporal scale, individuals spent a relatively small proportion of the winter time within the proposed D'Urville Sea–Mertz (DUSM) MPA (12.3 ± 18.9 % of individual locations). Our results highlight the need to consider multiyear tracking datasets to properly assess the appropriateness of proposed MPAs, and call to extend the DUSM proposal to protect Adélie penguins in the critical winter period. More generally, the high inter-annual consistency found might imply species' vulnerability in the face of climate change. Overall, our work provides key knowledge to conservation and policymaking in the Southern Ocean.

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Abstract No : 603

Penguins living in a challenging environment: assessment of immuno-haematological parameters in specimens of Adélie penguin from the Ross Sea, Antarctica

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Human activities, pollution and biological invasions summed up to climate change represent an increasing pressure on the Antarctic ecosystem and its biodiversity. The Adélie penguin *Pygoscelis adeliae* is considered a sentinel species able to reveal the impact of anthropogenic pressures on the Antarctic ecosystem and reflecting changes in habitat quality and in the availability of marine resources. Here we investigate immune-haematological parameters (erythrocyte nuclear abnormalities, ENAs, and white blood cells, WBCs) as indicators of health status in specimens of Adélie penguin breeding in three colonies in the mid-Victoria Land, Ross Sea. Total ENAs including specific abnormalities and WBCs values did not differ between specimens from the three colonies. The discriminant functions reflecting variability in immuno-haematological parameters showed a low discriminatory power (ENAs cross-validated discriminant rate 37.9%; WBCs cross-validated discriminant rate 40.7%), and discriminant scores overlapped substantially among colonies, meaning that immune-haematological responses failed to explain the separation among breeding sites. Sex differences were found on total number of ENAs and WBCs, which were respectively ~30% and ~20% higher in males than in females. Our work integrated the measurement of immune-haematological parameters to identify a series of proxy of penguin's health by analysing small amounts of non-destructive samples and couple them with the bio-ecological responses, establishing a baseline against which signals of ecosystem change can be detected.

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Abstract No : 937

Stepwise Construction of an Anatomical Atlas of the Adélie Penguin Brain: A Multidisciplinary Approach

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Penguins are flightless birds and one of the oldest surviving species on earth, with their available skeletal remains dating back to 60 million years. They exhibit a remarkably organised and networked social life. Their cooperative lifestyle in communal rookeries in the extreme environment of Antarctica appear to have influenced their physiological and anatomical characteristics. Although penguins have a primitive brain, they show striking adaptability, anatomically, physiologically and socially, to suit the extreme climate conditions of Antarctica. Till date, details of the penguin brain are not available. The aim of the present investigation was to study the penguin brain to construct a comparative brain atlas. Adélie penguin heads were collected from carcasses, which had died naturally, from Svenner Island, Antarctica (S 69°08'12", E 76°44'45"), during the 39th Indian expedition to Antarctica. The samples were preserved in 4% formalin and brought to Abstract, SCAR 2022, Tenth SCAR Open Science Conference, Online, India 1–10 August 2022 India. The functional architecture of the brain was reconstructed using histochemistry and other staining techniques. For histological studies, the entire penguin brain was cryoprotected in 30% sucrose and 50 microns thick frozen sections were cut and studied. Preliminary data revealed that areas such as the pallium (cortex), hippocampus and basal ganglia could be identified using Nissl staining. MRI was performed on penguin brains to study the basic anatomy of the various parts of the brain. Attempts will be made to correlate the neuroanatomy of the brains to the overall behavioural patterns of Adélie penguins while the scans obtained from Magnetic Resonance Imaging (MRI) will be used to create a basic atlas of the Adélie penguin brain.

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Abstract No : 414

King penguins adjust their fine-scale traveling and foraging behaviors to spatial and diel changes in feeding opportunities

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Central place foragers such as pelagic seabirds often travel large distances to reach profitable foraging areas. King penguins (*Aptenodytes patagonicus*) are well known for their large-scale foraging movements to the productive Antarctic Polar Front, though their fine-scale traveling and foraging characteristics during long-distance trips remain unclear. Here, we investigated the horizontal movements and foraging patterns of king penguins to understand their fine-scale movement decisions during distant foraging trips. We attached multi-channel data loggers to the penguins and obtained data (n=8 birds) on their horizontal movement rates from reconstructed dive paths and their feeding attempts based on rapid changes in swim speed. During transit toward main foraging areas, penguins increased the time spent on shallow traveling dives (< 50 m) at night and around mid-day, and increased the time spent on deep foraging dives (\geq 50 m) during crepuscular hours. The horizontal movement rates during deep dives were negatively correlated with maximum dive depths, suggesting that foraging at greater depths is associated with a decreased horizontal traveling speed. Penguins concentrated their foraging efforts (more deep dives and higher rates of feeding attempts) at twilight, when prey may be more accessible due to diel vertical migration, while they traveled rapidly at night and mid-day when prey may be difficult to detect and access. Such behavioral adjustments correspond to a movement strategy adopted by avian deep divers to travel long distances while feeding on prey exhibiting diel vertical migration.



SCAR 2022

Antarctica in a Changing World

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**Southern Ocean plankton diversity,
food web ecosystem and
biogeochemical cycle**

CONVENORS

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Abstract No : 843

Species distribution models of twenty-six Antarctic copepods from the ROSS SEA (ANTARCTICA)

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Zooplankton plays a fundamental role in aquatic ecosystems and links the lowest trophic levels with the highest ones. This ecological category shows strong changes in its population structure in relation to environmental shifts such as acidification and warming of water. Marine copepods, representing for approx. 70% of zooplankton, are helpful for monitoring and evaluating marine areas such as the Southern Ocean. Here, we present three-dimensional predictive maps, first time, for twenty-six Antarctic copepod species obtained by applying machine learning techniques to “gray literature” data. The data analyzed were acquired in the Ross Sea during the IIIrd, Vth and Xth expeditions of the Italian National Antarctic Program. The distribution models of the species were evaluated using TreeNet, RandomForest and Ensemble algorithms that analyzed the presence or absence of copepods throughout the Ross Sea area and at different depth classes as a function of environmental descriptors obtained from Polar Macroscope Layers present in the package Quantarctica. These predictive maps quantify, in three-dimensions, the food chain for the individual depth classes, showing the relative occurrence index (RIO) and identify the presence for each copepod analyzed in the Ross Sea. These maps are useful tools for the conservation and management of zooplankton biodiversity. The results obtained show that there are differences on the geographic distribution of the copepods, based on the food strategy implemented by the organisms. Machine learning is a good tool, in terms of accurate prediction, to assess the presence of Antarctic copepods, help guide future sampling, management and preserve copepod assemblages.

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Abstract No : 50

Life beneath the ice: jellyfish and ctenophores from the Ross Sea, Antarctica, with an image-based training set for machine learning

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Southern Ocean ecosystems are currently experiencing increased environmental changes and anthropogenic pressures, urging scientists to report on their biodiversity and biogeography. Two major taxonomically diverse and tropically important gelatinous zooplankton groups that have, however, stayed largely understudied until now are the cnidarian jellyfish and ctenophores. This data scarcity is predominantly due to many of these fragile, soft-bodied organisms being easily fragmented and/or destroyed with traditional net sampling methods. Progress in alternative survey methods including, for instance, optics-based methods is slowly starting to overcome these obstacles. As video annotation by human observers is both time-consuming and financially costly, machine-learning techniques should be developed for the analysis of in situ /in aqua image-based datasets. This requires taxonomically accurate training sets for correct species identification and our study was the first to provide such data. For this, twice conducted three week-long optics-based surveys of jellyfish and ctenophores found under the ice in the McMurdo Sound, Antarctica. This constituted the first optics-based survey of gelatinous zooplankton in the Ross Sea and the first study to use in situ / in aqua observations to describe taxonomic and some trophic and behavioural characteristics of gelatinous zooplankton from the Southern Ocean. Despite the small geographic and temporal scales of our study, we provided new undescribed morphological traits for all observed gelatinous zooplankton species (eight cnidarian and four ctenophore species). Three ctenophores and one leptomedusa likely represent undescribed species. Furthermore, we provided a taxonomist-ratified image training set for future machine-learning algorithm development concerning Southern Ocean gelatinous zooplankton species.

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Abstract No : 831

Ectoparasite infections and host–parasite trophic relationships for *Champsocephalus gunnari* (Lonnberg, 1905) at South Orkney Islands, Antarctica

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An analysis of ectoparasite infections in *Champsocephalus gunnari* (*C. gunnari*) at South Orkney Islands, Antarctica, was performed, which revealed the incidence, prevalence, and mean infection intensities of the two parasites collected. The parasites' preference for parts of the infected host fish was also investigated. The host–parasite trophic relationship was further examined using stable carbon and nitrogen isotopic analysis. The results showed that *Eubrachiella antarctica* (*E. antarctica*) was more inclined to parasitize the fins of *C. gunnari*. The carbon isotope ratio ($\delta^{13}\text{C}$) of the host was negatively correlated with the values for carbon isotopic discrimination ($\Delta\delta^{13}\text{C}$) between host and *E. antarctica*. *E. antarctica* is a parasitic parasite of *C. gunnari*, with a higher trophic level than *C. gunnari*, while *Trulliobdella capitis* may be a carrier parasite of *C. gunnari* or show a “symbiotic” relationship with it. The ecological niche spaces of the three species do not overlap, indicating the existence of specific trophic niches in the marine food web.

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Abstract No : 1058

Quantifying the in-situ abundance and type of microplastic within Southern Ocean Antarctic Krill (*Euphausia Superba*) and Salps (*Salpa Thompsonii*)

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Plastic production has increased exponentially in the last 50 years, with outputs into the marine environment percolating into the most remote regions, such as the Southern Ocean (SO). A category of particular concern are microplastics (particles <5mm), which can be ingested by zooplankton and incorporated into the food web. Antarctic Krill (*Euphausia superba*) and Salp (*Salpa thompsoni*), two keystone species of the SO ecosystem, have already been seen to ingest microplastic under laboratory simulation. This study investigates the abundance and type of microplastic (>100µm) found within *E.superba* and *S.thompsoni* collected in the Atlantic sector of the SO. Microplastic polymers were identified using a novel oxidative-enzymatic digestion protocol coupled with optical analysis using a Fourier-Transform Infrared Spectrometer (FT-IR). Preliminary results suggest a presence of microplastic in both salp and krill, with krill having relatively larger abundances contained within them. We observe a positive correlation between organisms' size and microplastic concentration with high presence of microplastic in largest organisms. The most common synthetic polymer found is polyamide, followed by ethylene-vinyl-acetate. These results suggest a potential important incorporation of microplastic into the SO food web, raising concerns about further impacts on higher trophic levels.

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Abstract No : 571

Plankton diversity and dynamics in the upper surface of the Indian sector of Southern Ocean ecosystem: biogeochemical implications

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The phytoplankton community in the Indian sector of the Southern Ocean was dominated by phytoplankton with *Fragillariopsis* spp. followed by *Chaetoceros* sp. and zooplankton with *Pleuromamma* spp. followed by *Oithona similis* in the ecosystem. Significant latitudinal variations were observed among physio-chemical parameters at the Subtropical Front (STF), Sub Antarctic Front (SAF), Polar Front (PF), and South of Polar Front (SPF) during austral summer, 2019. The *Fragillariopsis* spp. of diatoms ($\sim 5 \times 10^5$ Cells L^{-1}) was dominant and followed by *Chaetoceros* sp. ($\sim 1 \times 10^5$ Cells L^{-1}) and *Coscinodiscus* sp. ($\sim 5 \times 10^4$ Cells L^{-1}) at the surface along the fronts except for STF. While *Gyrodinium* spp. ($\sim 2.4 \times 10^4$ Cells L^{-1}) of flagellates was most dominant followed by *Proto-peridinium* sp. ($\sim 2 \times 10^4$ Cells L^{-1}) and *Amphidinium* sp. ($\sim 1 \times 10^4$ Cells L^{-1}) at the STF. While zooplankton biovolume in the upper 200m varied between 0.71–10 ml $100\ m^{-3}$. Relatively higher zooplankton biovolume and numerical abundance have been found in the SAF than in PF. Lower zooplankton biovolume was associated with high Chlorophyll *a* (Chl-*a*) concentration may have substantial negative consequences for higher trophic levels in the PF. The nitrate (NO₃⁻), phosphate (PO₄³⁻), and silicate (SiO₄) increased considerably from the STF to SPF towards higher latitude. The result suggests that the phytoplankton biomass and community composition in the frontal regions have diverse due to the combined impact of physical, chemical, and biological processes varying over time and has a greater implication in the regional biogeochemical cycle.

Accepted as: Oral Presentation

Abstract No : 684

Assessing zooplankton using a ZooSCAN and nets: latitudinal gradients in size spectra and diversity driven by temperature and chlorophyll a

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In the Southern Ocean food web, zooplankton occupy a key position in the overall structure and functioning of the ecosystem. Zooplankton communities are very susceptible to change, particularly in a dynamic environment that is expected to experience change through warming, increased storms, and changes in sea ice cover. In this context, it is becoming increasingly important to understand how the zooplankton community size spectrum will respond to environmental changes. The ZooScan Integrated Imaging System was deployed to derive empirical relationships between zooplankton size structure and taxonomic composition over a latitudinal gradient of the Southern Ocean, from the subantarctic to south of the Polar Front. Linear mixed models were developed for Normalised Biomass Size Spectra (NBSS) slopes of the zooplankton community in the Indian sector of the Southern Ocean. These revealed that temperature has the most significant effect on the abundance of the population, while primary productivity was most significant for the size spectra. However, despite there being clear differences in the diversity of zooplankton across the sites, these changes were not reflected in the slopes of the size spectra. Our study, which focused on the whole community, found that the general shape and slope of the NBSS did not vary across the wide geographical and thermal range sampled in the study. We conclude that when you consider the whole zooplankton community, the effect of temperature is not as significant as food availability.

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Abstract No : 1062

The role of euphasiid faecal pellets in the carbon transport in the eastern South Pacific.

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Latitudinal variations in the vertical flux of euphausiid fecal carbon (EFC) exported to the deep ocean regions were analyzed in three-time series from different systems, the oceanic Humboldt Current (HCS; 20°S-30°S and 36.5° S), the sub-Antarctic (SAS, 54°S) and the Antarctic coastal environment (ANTS, 64°S), using automatic sediment traps located at 200m (SAS and ANTS), 1000 and 2300m depth (HCS). The average EFC flux ranged between 0.2 and 1.7 mgC m² d⁻¹ in the HCS (5-10% of the total particulate organic carbon, POC), 12.6 mgC m² d⁻¹ in the SA (6% of the POC) and 17.3 mgC m² d⁻¹ (36% of the POC) in ANT systems. The highest EFC were collected during the summer representing 12% of the HCS POC average and 24% of the POC average in the SA and ANT systems. The lowest fluxes occurred in spring and autumn (SCH) corresponding to 4% and 7% of the average SA and ANT POC, respectively; while for the SAS and ANTS the lowest fluxes occurred during winter, representing ~3% of the POC. The general trend of the average EFC fluxes for each time series shows a north to south latitudinal increase along the 5 studied sites, with maximum fluxes in the southernmost region of the HCS (36.5°S), while in the SAS and ANTS regions the EFC fluxes were significantly higher by up to an order of magnitude, compared to HCS values.

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Abstract No : 553

Effect of fronts and mid-oceanic islands on coccolithophore biogeography in the Southwest Indian Ocean

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Coccolithophore ecology and biogeography in the Southwest Indian Ocean was studied during the austral summer of 2019 within the area 35oS–46oS and 45oE–53oE. A total of 29 sea surface water and 8 surface sediment samples were collected to investigate the role of oceanic fronts, ocean circulation, topographic changes, and influence of mid-oceanic islands on coccolithophore production, diversity, and biogeography within the GCB. Elevated coccolithophore abundance ($\sim 996 \times 10^3 \text{ cells/l}$) and diversity (~ 61 taxa) was observed within the ARFZ owing to the warm oligotrophic waters. This area was also influenced by highly dynamic eddies originating from the Agulhas Return Current. In the southern stations, low coccolithophore abundance ($< 189 \times 10^3 \text{ cells/l}$) and diversity (< 8 taxa) was observed attributed to reduced SST, SSS, and high macronutrient concentrations. The low coccolithophore abundance and diversity in the S–N transect ($5 \times 10^3 \text{ cells/l}$ – $707 \times 10^3 \text{ cells/l}$; 1–15 taxa at each station) compared to the N–S transect ($53 \times 10^3 \text{ cells/l}$ – $1630 \times 10^3 \text{ cells/l}$; 3–60 taxa at each station) was attributed to the presence of warm anticyclonic eddies, highly stratified waters, and possibly due to the grazing pressure by heterotrophs. We show that the coccolithophore production close to/around the mid-oceanic islands located within the GCB remains low during the austral summer period that leads to formation of ‘blank spots’ of PIC within the GCB. We project the possibility of enhanced coccolithophore production and diversity in the Southwest Indian Ocean in the upcoming decades attributed to the future-ocean warming, intensification of the ARC, and southward migration of the oceanic fronts which may alter the regional biogeochemical cycles with feedback to the global climate.

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Abstract No : 227

Phytoplankton variability in nearshore regions of the western Antarctic Peninsula in relation to a temperature gradient

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The Gerlache Strait is a narrow channel that separates the western coast of the Antarctic Peninsula from the Palmer Archipelago. This is a place where various water masses converge and mix producing a well-defined stratification of the water column with implications for the biology and chemistry of the area. This area is also characterized by the presence of interconnected fjords, bays, islands, and channels. A citizen science project – FjordPhyto – in collaboration with the International Association of Antarctica Tour Operators vessels (IAATO) allowed us to collect phytoplankton samples to assess biomass and composition in six little-explored nearshore areas connected to the Gerlache Strait (between 64° and 65°S) during three consecutive summers, from November to March, 2016–2019. We found significant differences in the phytoplankton composition in the northern and southern Gerlache Strait during the first two summers, with cryptophytes dominating in the north and prasinophytes and microplanktonic diatoms to the south. Analyzing 10 years of satellite images we were able to detect a North–South temperature gradient during the summer (December – February) with warm waters to the north and colder waters to the south. We also found different successional patterns of phytoplankton groups north and south during the summer months, with different bloom compositions and timing. During December cryptophytes bloom in the north while microplanktonic diatoms dominate south, and during January small centrics dominate in the north while prasinophytes bloom south. This work highlights a high variability of summer phytoplankton in contiguous coastal areas closely related to surface water masses.

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Abstract No : 286

Environmental sequencing offers reasonable assessments of the picoeukaryotes diversity and distribution across the meridional transect of the Indian sector of the Southern Ocean.

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Environmental sequencing offers reasonable assessments of the picoeukaryotes diversity and distribution across the meridional transect of the Indian sector of the Southern Ocean. Authors: Mangesh Rajguru^{1*}, Anilkumar N², Rahul Mohan², and Tushar Kaushik^{1*} Affiliation: 1 Biodiversity and Palaeobiology Group, Agharkar Research Institute, Pune 2 National Centre for Ocean and Polar Research, Headland Sada, Goa Corresponding authors: Mangesh Rajguru and Tushar Kaushik Corresponding authors email: mrajguru@aripune.org, tussharkaushik@gmail.com Abstract: In an oligotrophic ecoregion of the open ocean, picoeukaryotes and their distribution play a significant role in recycling biogenic components and energy. Despite their noteworthy contribution in regulating biotic dynamics, their diversity and associated activity are less studied, especially from the Indian sector of the Southern Ocean, characterized by a complex oceanographic setting. In the present study, the diversity and distribution of the picoeukaryotes across the meridional transect of the Indian sector of the Southern Ocean is investigated using Illumina platform sequencing targeting the V9 region of the 18S rDNA. The sequencing results were further correlated with the environmental parameters obtained using in-situ CTD measurements. The results indicated that the DNA Pico eukaryotic assemblages were mainly represented by supergroups SAR (63% of total DNA reads) and Opithokonta, Haptophyta, Amoebozoa, Archaeplastida and Excavata. The environmental factors significantly affected the number of operational taxonomic units (OTUs) and were observed to decrease towards the sub-tropical oceanographic front. Overall, our study is the first attempt to shed light on picoeukaryotes diversity and distribution in the Indian sector of the Southern Ocean and revealed the correlation between the diversity of marine picoeukaryotes

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Abstract No : 616

Impact of the amphipod *Themisto gaudichaudii* on ecology and carbon export in the Southern Ocean

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The amphipod *Themisto gaudichaudii* can reach high abundances in the subantarctic Southern Ocean. It feeds omnivorously on the most common zooplankton prey and is in turn an important food item for higher trophic levels, such as fish and seabirds. Therefore, it is suggested to play a significant ecological role similar to Antarctic krill further south. However, due to the high temporal variability and spatial patchiness, the impact of *T. gaudichaudii* on the pelagic ecosystem as well as on the carbon export in the Southern Ocean is still understudied. During the SOLACE (Southern Ocean Large Area Carbon Export) voyage during austral summer 2020/2021, scattering layers in the upper 50–70 m of the water column were targeted with the Rectangular Midwater Trawl. *T. gaudichaudii* dominated the samples with some of the highest abundances (208.3 – 473.8 ind. 100 m⁻³) and biomass (10.5 – 56.4 mg dw m⁻³) ever recorded for the open ocean. This presentation explores the impact of amphipod swarms on the oceanic ecosystem, in particular on the salp bloom in the Polar Frontal Zone. Then, we present an estimate of carbon exported by the swarms, by using the results of respiration and faecal pellet production experiments at sea. Our results will reveal that swarms of *T. gaudichaudii* can play an important role in the ecology and biogeochemistry of the Southern Ocean. However, further research is needed to fill current knowledge gaps in the distribution and physiology of the species as well as understand future developments in the changing Southern Ocean.

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Abstract No : 678

Antarctic krill swarms recycle and export iron and carbon in the Southern Ocean

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In large areas of the Southern Ocean, primary productivity (and thus, carbon (C) uptake) is limited by the trace element iron (Fe). Antarctic krill (*Euphausia superba*) produce faecal pellets rich in Fe and C however, information on the concurrent release of Fe and C from sinking pellets is lacking. In this study, we quantified sinking, dissolution and remineralisation rates of Antarctic krill faecal pellets. These results were extrapolated to krill densities from the Trends in Euphausiids off Mawson, Predators, and Oceanography (TEMPO) voyage. Due to the fragile nature of krill faecal pellets, we undertook all experiments using intact and fragmented pellets. Our results indicate that intact pellets sink more rapidly (mean = 246.1 m d⁻¹) than fragmented pellets (mean = 207 m d⁻¹). Intact pellets also leach a larger percentage of Fe (0.1%) and C (0.00018%) within the mixed layer compared to fragmented pellets (Fe = 0.03%, C = 0.000093%). At experimental temperatures of 1°C, our 12 and 60-hour experiments showed that remineralisation was limited. Using krill density estimates from the TEMPO voyage, we estimate 0.00015 to 1.13 μmol Fe m⁻² d⁻¹ and 0.00001 to 1.75 mmol C m⁻² d⁻¹ is recycled within the mixed layer, and 2 to 1,892 μmol Fe m⁻² d⁻¹ and 1.4 to 1,170 mmol C m⁻² d⁻¹ is exported out of the mixed layer. This study provides the first quantitative estimate for the recycling and export potential of krill swarms, highlighting the biogeochemical importance of Antarctic krill in the Southern Ocean.

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Abstract No : 182

Role of diel vertical migration of gelatinous zooplankton in downward carbon export: a Southern Ocean mesopelagic-migrant pump case study

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The passive flux of particles through the biological carbon pump is a long-established mechanism for carbon export. However, carbon-rich particles can also be actively injected to deep waters through the diel vertical migration (DVM) of biota from the surface to the ocean twilight zone (200-1000m), termed the mesopelagic-migrant pump (MMP). Blooms of two migratory tunicate species, the pyrosome *Pyrosoma atlanticum* and the salp *Salpa thompsoni*, were observed at three Southern Ocean sites, N and S of the Polar Front (PF), in December 2020 – January 2021 during the SOLACE (Southern Ocean Large Areal Carbon Export) voyage. DVM and micronekton community composition were investigated using a suite of complementary sample methods including RMT-16 net trawls, acoustics, and imagery. Downward carbon export was measured through four pathways, i.e., faecal pellet and carcass production, excretion, and respiration, to understand how these blooms contributed to the MMP at each site. Results from SOLACE suggest active carbon flux of both blooms is of the same order of magnitude as the gravitational flux. However, while strong DVM was observed in the pyrosome population at the northern site, salp migration at the sites S of the PF was more complex and may be linked to the different stages of a phytoplankton bloom. This finding suggests a potential lag between phytoplankton blooms and a subsequent increase in active carbon flux driven by gelatinous blooms. A better understanding of the timescales on which these carbon pumps operate will enable improved projections of carbon export in the Southern Ocean.

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Abstract No : 816

Interannual changes (2015–2020) in diatom species assemblages of Scotia Bay (South Orkney Islands, Antarctica)

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The temporal variation of biomass-dominant diatom species from Scotia Bay (South Orkney Is.) was explored in water samples collected monthly at a fixed site over five years (April 2015–March 2020), and analyzed in association with sea ice and air temperature variability. Species biomass was estimated by cell counting and measurements under an inverted microscope, while species identifications were made from the observation of permanent slides under phase contrast microscopy. Biomass peaks above 200 $\mu\text{gC l}^{-1}$, occurring exclusively during the first two warm periods, were dominated by *Odontella weissflogii* in 2016 and by this and other three species (*Eucampia antarctica*, *Chaetoceros socialis*, *Thalassiosira tumida*) in 2017. The biomass maxima in subsequent years were lower in one order of magnitude, with *T. tumida* as the dominant species. While every year showed one or two biomass peaks between November and January, years 2018 and 2020 also presented an additional late increase in April and February, respectively. The persistence of sea ice progressively decreased between 2015 (218 days) and 2018 (62 days), to recover in 2019 (183 days). Among the five years studied, 2018 stood out for presenting: 1) highest winter biomasses of diatoms with dominance of *T. tumida*; 2) the earliest maximum of biomass (November); 3) the largest number of ice-free days; 4) highest air temperatures. These results suggest that the temporal dynamics of diatom assemblages in Scotia Bay is influenced by the persistence of sea ice, and that longer ice free periods promote the development of diatom biomass secondary peaks.

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Abstract No : 994

Structure of mesozooplankton communities in nearshore waters of the Argentine Islands (West Antarctic Peninsula): preliminary results of the year-round pilot study

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Pelagic marine ecosystems are changing in response to the ongoing climate change. The mesozooplankton and copepods are among the critical indicators of the state of aquatic ecosystems. In 2021–2022, at the Ukrainian Antarctic Akademik Vernadsky Station (Argentine Islands, West Antarctic Peninsula), a year-round pilot monitoring of the mesozooplankton communities was conducted for the first time as a part of marine biological studies. The preliminary information was obtained on the taxonomic composition and functional characteristics of the taxocene of copepods in the coastal waters of the Argentine Islands. The samples were collected from the motor boats using three types of plankton nets depending on the weather and ice conditions. The diversity of mesozooplankton was influenced by the weather conditions and the available sampling gear. From June to February, the predominant species were the common coastal species and species adapted to feeding in the cold upper layers in winter. Trawling samples collected from March to late May best illustrate the seasonal dynamics of the mesozooplankton communities' temporary and permanent components. Twelve copepods from eight families were identified at the species level. Most species were omnivorous (7), followed by detritophags (3). This trophic distribution likely indicates that we worked in the surface layer, which is not always favorable for copepod feeding. Thus, the percentage of omnivorous opportunists in it is relatively high. The species composition was highly similar to the recently published studies conducted in the other locations of the West Antarctic Peninsula.

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Abstract No : 90

Characterization of Phytoplankton Productivity and Bio-Optical Variability in the Indian Sector of the Southern Ocean

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Knowledge of Southern Ocean carbon cycling is limited by a paucity of phytoplankton primary productivity (PP) and spectral absorption data in this globally-important region. We measured ^{13}C -based PP in the Indian sector of the Southern Ocean (ISSO) during the austral summer of 2016, examining its link with spectral absorption coefficients and phytoplankton size structure derived from an absorption-based global model. Phytoplankton productivity was assessed at both coastal (60°S - 69°S) and frontal stations (40°S - 60°S), characterized by silicate-replete and -depleted water masses, respectively (indicated by measured nutrient ratios) to capture a range of phytoplankton growth conditions. Bio-optical relationships were used as indicators of phytoplankton community size structure and to assess the extent of cellular pigment packaging – a phenomenon reported previously for phytoplankton cells in this region. Blue-Red (B/R) ratios of phytoplankton absorption (aph) spectra indicated that microplankton (more prone to “package effects”) were the dominant size class at most sites sampled. Overall, PP was better explained by aph ($R^2=0.85$) than total phytoplankton biomass (chlorophyll-a) ($R^2=0.64$) in surface waters. The $a^*\text{ph}$ (675)-chlorophyll-a relationship explained package effects more effectively in frontal regions ($R^2=0.63$) than stations further south ($R^2=0.30$). The global absorption-based model captured smaller phytoplankton (pico, nano) size classes but failed to identify larger (microphytoplankton), underscoring the need for region-specific algorithm modifications. Our findings improve the existing understanding of spatio-temporal trends in PP and bio-optical variability within the ISSO – knowledge that is essential to improve the capacity to retrieve PP from satellite-based models in this perennially under-sampled important region.

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Abstract No : 836

Summer Eugregarine infection of Antarctic krill *Euphausia superba* relates to station, body weight and diet of host in the Dumont D'Urville Sea, East Antarctic

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Antarctic krill *Euphausia superba* plays a key role in the Antarctic food web. The trophic linkage between krill and other macro-biomes is studied in the past decades, but the role of parasites in krill is less studied and remains poorly known. Therefore, it is important to understand the factors that control abundance and infection of parasites in krill, particularly Eugregarine, which inhabits the digestive tracts of krill. We investigate abundance of Eugregarine within the digestive tract of krill and the factors influencing the infection of Eugregarine to krill in East Antarctic. The infection rate of Eugregarine to krill is 94%, only 3 krill individuals are not infected. Abundance of Eugregarine in krill differed among 5 stations, and the lowest abundance occurs in the station nearest to the coast. Eugregarine abundance varies among sexual maturity stages of krill. Moreover, Eugregarine abundance increases with the increasing of krill weight, but decreases with the increasing of dinoflagellate abundance in krill stomach, although diatom is still the overwhelmingly important food item of krill.

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Abstract No : 838

Can fatty acids profile of carnivorous fish reflect variation in diet of prey? a case study of mackerel icefish (*Champsocephalus gunnari*) and Antarctic krill (*Euphausia superba*)

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Mackerel icefish (*Champsocephalus gunnari*) and Antarctic krill (*Euphausia superba*) not only has important values in commercial fishery but also plays vital role in the energy transfer from primary producers to higher trophic levels. Stomach content analysis and fatty acids analysis was used to determine the diet of mackerel icefish at South Georgia and the South Orkney Islands and elucidate the trophic relationships between mackerel icefish and krill. The results of stomach content analysis showed krill was the dominant diet of mackerel icefish at the South Orkney Islands and the South Georgia. Fatty acid analysis revealed significant differences in the fatty acid profiles of mackerel icefish from both of the areas, and Fatty acid analysis also showed that krill in the stomach contents of mackerel icefish from the two regions were also significantly different, and the fatty acid patterns was present the same trends as that of mackerel icefish. The prominent variability in fatty acids of mackerel icefish between the two regions was mainly driven by dietary fatty acids, in similar proportions to that consumed in the krill. As such, regional variability of fatty acids in mackerel icefish points to variations in the fatty acids of krill rather than the diet changes in mackerel icefish. This result showed that the variations of fatty acids profiles of *C. gunnari* was affected by the changes of fatty acids profiles of *E. superba* and *C. gunnari* can be an indicator to reflect the variation of feeding habits in *E. superba*.

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Abstract No : 602

Seasonal Species Succession Controlled by Zooplankton Grazing on *Phaeocystis antarctica* in the Iron-limited Ross Ice Shelf Polynya

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The seasonal species succession of phytoplankton from *Phaeocystis antarctica* to diatoms in the Ross Ice Shelf Polynya identified by observation plays a basic fundamental role in food webs and ecosystem functioning. Previous studies have revealed that this seasonal succession is affected by differences in light, iron demand, aggregation and subsequent sinking between these two taxa. This study further investigated the dominant process of species succession by analyzing the results of a box-ecosystem model. The progression of *P. antarctica*-to-diatom bloom in the upper mixed layer in the growing season averaged over 2001–2006 was well reproduced by the model. Light triggered the spring bloom dominated by *P. antarctica* in iron-rich surface water, which is resupplied by winter convective mixing from the lower layer pool. After reaching its maximum in mid-November, the biomass of *P. antarctica* declined progressively until it became equal to that of diatoms. The main factor contributing to the species succession was the seasonal decline of *P. antarctica* rather than the accumulation of diatoms. During this key period, the collapse of *P. antarctica* biomass was controlled by the coupling effect of limited iron availability and enormous loss via sinking and microzooplankton grazing. The results of sensitivity experiments suggest that microzooplankton grazing on *P. antarctica* promotes the seasonal decline of *P. antarctica* biomass in iron-limited surface water during austral summer. Top-down process, i.e. the zooplankton grazing, played a critical role in shaping the phytoplankton composition and promoting the seasonal species succession in the iron-limited upper mixed layer of the RISP.

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Abstract No : 390

Distribution of Snychobactin and other siderophore-like compounds in the Indian sector of Southern Ocean and an Arctic fjord system

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Organic ligands like siderophores may play an important role in regulating primary production in iron-limiting High Nutrient Low Chlorophyll (HNLC) waters as well as in biogeochemistry of carbon and iron. Seawater samples from Nine stations and 3 depths (surface, sub-surface chlorophyll maxima-SCM, 200 m) in the Indian sector of Southern Ocean (ISO) and the surface waters at 4 stations of the Kongsfjord (KF)-Krossfjord (Kr) system (Kf-Kr) in Svalbard were filtered through 0.2 μm filters and passed through Chelex column using a tangential flow filtration system. The siderophores and siderophore-like compounds adsorbed on to XAD-16 packed column were back-extracted into 300 ml methanol, which was then desalted, concentrated, and analyzed using a LC-MS. Overall, 27 different types of siderophores were identified in the ISO while only 9 different siderophores were identified in the Kf-Kr fjord system. In the ISO, Desferrioxamine was found only in STF surface waters while Snychobactins (A, B & C) were found widely distributed across all depths. Surface waters had the maximum siderophore diversity (18 different types) while 11 types were associated with SCM. In the Kf-Kr fjord system, Desferrioxamine was conspicuously absent while Snychobactin-B was present in all stations. Interestingly, siderophores like Neocoprogen-II, Rhizobactin, Myxochelin, and Bisucabarin were identified in both the fjord and ISO waters. This set of data shows that diverse forms of siderophore-like organic ligands were distributed in the surface waters and the diversity decreased with depth. Moreover, the types of siderophores in the Kf-Kr system were distinctly different from ISO waters.

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Abstract No : 685

Inter-annual variability of summer dissolved nutrients in the Sub-Antarctic Zone of the Indian Sector of the Southern Ocean

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Field data collected in the Indian sector of the Southern Ocean (ISSO) during the austral summer of 2009, 2010, and 2011 is used to understand the inter-annual variability of dissolved nutrients. The cruise tracks were along 57.5°E away from the islands and characterized by the deep bottom topography (>2000 m). In the subtropical zone, macronutrients were limited and the dissolved nutrients were mainly governed by the mesoscale eddy activity associated with the Agulhas Return Current. High nutrient low chlorophyll conditions prevailed in the Sub-Antarctic Zone and further south, as the cruise track was away from the lithogenic iron sources. A strong latitudinal gradient of nitrate and silicate concentrations was observed, with high values in the south and low values in the north. While the nitrate concentration decreases mildly towards the north, the silicate concentration shows strong gradients across the Sub-Antarctic Zone. The zone was also characterized by substantial depletion of silicate with respect to nitrate ($N:Si > 4$). The observed high nutrient ratio was associated with the enhanced drawdown of silicate due to the Winter/Spring diatom blooms in the region.

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Abstract No : 595

Chlorophyll-a within East Antarctic coastal polynyas during the austral autumn and winter collected from animal biotelemetry

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Antarctic coastal polynyas are persistent regions of open water located between the coast and the pack-ice. In spring, they are the first polar marine systems to be exposed to solar radiation, enabling early phytoplankton blooms making polynyas potential areas of great ecological interest in sea-ice regions. Knowledge of polynyas during winter is limited due to their inaccessibility. This study focuses on describing the fluorescence signal (an indicator of chlorophyll-a) during the winter months within two polynyas and identifying its oceanographic drivers from in situ biotelemetry data (698 profiles) recorded from polar predators in 2011, 2019, 2020 and 2021. For both polynyas, the chlorophyll-a signal remained significant until April with a peak around 40m depth for Cape Darnley's and 120m for Shackleton's polynya. There was a non-negligible signal around 130m depth in August in Cape Darnley's polynya. This shows the maintenance and genesis of a productive system in fall/winter. The decrease and deepening in chlorophyll-a with time was accompanied by a cooling of the waters and an increase in salinity. A principal component analysis revealed unexpected drivers such as i) potential ice-shelf melting by intrusion of warm water, likely providing iron supply for phytoplankton growth, and ii) seafloor topography controlling depth and intensity of chlorophyll-a. Finally, a neural network provides prediction of 46965 fluorescence profiles from temperature and salinity data collected from seals between 2004 and 2020. This unique prediction is crucial for defining potentially important ecological areas that will be integrated in future marine protected area planning.

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Abstract No : 452

Gelatinous Zooplankton as an energy roundabout in the changing Southern Ocean ecosystem

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Gelatinous zooplankton (GZP; including salps and cnidarians) are reputed to be climate change winners. This so-called “jellification” is affecting several marine ecosystems worldwide, including the Southern Ocean (SO) in particular which has undergone a significant shift from a krill-based to a salp-based ecosystem over the last decades. A better knowledge on the role of GZP as prey in the pelagic ecosystem is needed to predict the impact of such an increase in GZP. Until recently, GZP were considered as a “trophic dead end”. However, their true importance in diets has remained unresolved since the rapid digestion of their watery and soft tissues has hampered the identification of GZP species in predators’ stomachs. The application of molecular techniques and in-situ observations has shown that many invertebrate and vertebrate taxa (e.g., fish, crustaceans, seabirds) consume GZP. It follows that GZP could function as an “energy roundabout”, moving energy through different trophic levels, from zooplankton to apex consumers. To address this, our project will carry out molecular diet analyses on SO hyperiid amphipods and fish species (myctophids, notothenioids). Specifically, we will investigate the stomach contents of different amphipod and fish species with mtCOI and 18S rRNA metabarcoding, and assess the occurrence of GZP predation across different spatial (distinct hydrographic regimes) and temporal (seasonal, interannual) scales. In turn, by measuring the carbon content of the most conspicuous GZP species, we will derive carbon budgets for the GZP consumed by higher trophic levels in the SO.

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Abstract No : 786

A novel annular flume to measure schooling behavior of Antarctic krill (*Euphausia superba*) under various environmental cues

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Antarctic krill (*Euphausia superba*) are a key species in the Southern Ocean food web and form schools that may stretch several kilometers horizontally and hundreds of meters vertically. Besides possibly providing a hydrodynamic advantage to members, krill schools may enhance their collective response to surrounding environmental cues such as light, flow, and the presence of prey and predators. Despite progress in mapping krill distributions, little is known about the relationship between these environmental factors and the collective behavior of krill schools. Thus, we present a novel annular flume having inner and outer diameters of 0.3 m and 1.2 m, respectively, a water depth of up to 0.3 m, and the capability of generating flows up to 100 mm s⁻¹. Flow is generated by rotating the inner cylinder and by submersible pumps and flow conditioners positioned along the outer wall. This design provides the ability to expose krill schools to varying flow levels while allowing the schools to swim continuously around the annulus without encountering the test section wall (as would occur in a linear flume). Flow in the annular flume was characterized using particle image velocimetry (PIV). Light intensity is controlled via full spectrum lamps, and near-infrared backlighting underneath the translucent tank provides light for optical detection of krill at all ambient light levels. 3D krill positions are measured via an overhead stereophotogrammetric camera system at around 20 Hz. Measurements of nearest neighbor distance, school polarity, and swimming speed as a function of various environmental parameters are presented.

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Abstract No : 793

Autumn structure of phytoplankton and protozoans in two shallow cold water areas within Scotia Arc: Scotia Bay (Laurie Island, Antarctica) and the Namuncurá MPA (Burdwood Bank)

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In this work we compared temporally and spatially two shallow areas located at different latitudes within the Scotia Arc: an Antarctic one (Scotia Bay-SB, Laurie Island: 60°43'S, 44°31' W) and a Subantarctic one (Namuncurá Marine Protected Area-NMPA-Burdwood Bank: 54°43' S, 59°60'W). This comparison was based on characteristics of phytoplankton and protozoans (chlorophyll a concentration, size structure, abundance and biomass of diatoms, dinoflagellates and ciliates) and on nutrients concentration during two consecutive autumns (March-April 2016 and April-May 2017). Records for 2016 indicate greater values of chlorophyll-a, higher abundance and biomass of both the total community and each of the groups explored, and the prevalence of microplanktonic chain-forming diatoms (*Odontella weissflogii* in SB; *Rhizosolenia crassa* in NMPA). In autumn 2017 we found a higher relative contribution of protozoans in abundance and biomass and the occurrence of loricate ciliates. These features suggest an earlier successional stage for 2016. As compared to SB, the NMPA showed a higher chlorophyll-a average value (only for 2016), lower average values of abundance and biomass of both the total community and each group, lower nutrients concentration (especially of silicic acid), and a considerably higher SST. Trends in community structure were similar in both areas, despite local differences (temperature, nutrients) and environmental processes typical of each region.

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Abstract No : 487

The Fall: insights into biogenic matter fluxes beyond the summer in an Antarctic coastal setting.

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Mass and energy (e.g., organic carbon) fluxes in the marine water column are important to refine estimations on biogeochemical cycle dynamics (e.g., C and Si) and atmospheric carbon sinks into the ocean. In Antarctic offshore areas, >95% of these annual fluxes develop during the spring and summer; however, these information is scarce for the coastal environment. This province exports organic matter to the adjacent offshore areas becoming an important energy reservoir for life in the oceanic vicinity. In the present study, we set a sediment trap to assess near shore particle fluxes in Doumer Island's South Bay (Gerlache Strait), off the Chilean Antarctic Research Station "Yelcho". Particle fluxes collected at 190 m water depth on a site at 240 m water depth showed that organic carbon (OC), biogenic silica (bSi) and faecal pellet fluxes in the autumn were similar to those observed during the late summer. Microplankton (e.g. diatom, flagellates, tintinnids) fluxes were clearly dominated by diatoms along the study. In contrast, flagellates were more seasonal. Autumn OC and bSi fluxes were higher than those collected elsewhere in the oceanic Antarctic and for OC, comparable to the results of the only study developed at the coastal Antarctic, at Deception Island in the Bransfield Strait. Our results demonstrate the importance of the autumn biogenic matter fluxes in the annual context, remark the importance of coastal zone biogenic matter exports for the oceanic province and raise the question on whether this is a consequence of climate change in the Antarctic.

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Abstract No : 285

Exploration of cryptic genetic diversity in *N. pachyderma* from the Indian sector of the Southern Ocean using integrative taxonomic approaches.

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Exploration of cryptic genetic diversity in *N. pachyderma* from the Indian sector of the Southern Ocean using integrative taxonomic approaches. Authors: Mangesh Rajguru^{1*}, Anilkumar N², Rahul Mohan², and Tushar Kaushik^{1*} Affiliation: 1 Biodiversity and Palaeobiology Group, Agharkar Research Institute, Pune 2 National Centre for Ocean and Polar Research, Headland Sada, Goa Corresponding authors: Mangesh Rajguru and Tushar Kaushik Corresponding authors email: mrajguru@aripune.org, tussharkaushik@gmail.com Abstract: The exploration of cryptic genetic diversity in the planktonic foraminifera *Neogloboquadrina pachyderma*, has revealed the existence of eight SSU rDNA genetic types. However, the scarcities of the correlation amongst molecular, environmental, geochemical or morphological data remain largely unexplored in this morphospecies. Hence, many aspects of integrative taxonomy are yet unresolved. In the present investigation, we attempt to combine traditional morphological, morphometric, environmental and geochemical analyses of the specimens of *N. pachyderma* sampled from the Indian sector of the Southern Ocean. We identified three genetic types of *N. pachyderma* that inhabit the southern Indian Ocean, of which Type IV is the only genetic variety found to dominate the polar oceanographic front region and prefers nutrient-enriched polar waters. Thus the integrated taxonomic analyses highlight the true cryptic nature of the *N. pachyderma* from the Southern Indian Ocean.

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Abstract No : 883

Sources of particulate organic matter in the Bransfield Strait, Antarctica

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King George (KG) is the largest island of the South Shetland Archipelago (Antarctic Peninsula). It is separated to the south by the Bransfield Strait (BS). The particulate organic matter (POM) found in BS can be influenced by the organisms living in the water column, the water exchange with the continent, and the ice melting. We evaluated the total particulate organic carbon (POC), and total particulate nitrogen (PN) concentrations present in the BS, assessing their sources through isotopic analysis. Seawater samples were taken at the surface and maximum chlorophyll depth along the BS facing the Admiralty Bay. This water was filtered using calcinated glass fiber filters. Analyses were performed in an elemental analyzer coupled to an isotope ratio mass spectrometry. Concentrations of POC and PN ranged from 0.24 ± 0.00 to 1.21 ± 0.05 mg g⁻¹ of POM and from not detected to 0.23 ± 0.0 mg g⁻¹ of POM, respectively. There were significant differences between the sampled days ($p < 0.05$). C/N ratio values ranged from 5.51 to 13.7. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values ranged from -31.6 ± 0.3 to $-25.7 \pm 0.8\text{‰}$, and from 1.27 ± 0.37 to $3.70 \pm 0.75\text{‰}$, respectively. Phytoplankton is the main source of POM to BS. However, more depleted $\delta^{13}\text{C}$ values can also be associated with the influence of mosses. This work is a contribution of the Project MEPHYSTO, from the Brazilian Antarctic Program (CNPQ 442695/2018-7) and the Program “For the women in Science – Brazil”.

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Abstract No : 826

Hydrodynamics have shaped regional heterogeneity in the autumn diet composition of the Antarctic krill (*Euphausia superba*) in the northern Antarctic Peninsula

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The Antarctic krill *Euphausia superba* is an endemic species in Antarctica, which is the hub of a range of organisms from the primary producer to high-trophic-level predators, plays a key role in the sensible ecosystems in the northern Antarctic Peninsula (NAP). Using krill stomach contents and fatty acid analyses in combination with the temperature-salinity data (0-500 m) of the sampling areas and the dissolved organic matter (DOM) optical parameters of seawater, we investigated the spatial variability of krill diet in three regions with heterogenetic hydrological structures in the NAP during late autumn 2019. Our results show that diatoms were the dominant component of krill diet in the northern shelf of the South Shetland Islands. Krill from the central basin of the Bransfield Strait (BS) had a relatively high level of diatom-specific fatty acids and the largest proportion of dinoflagellates and heterotrophic components in stomach contents. Krill from the western basin of the BS near the Low Island consumed the highest quantity of diatoms and heterotrophic components, and they exhibited a high degree of omnivory and terrigenous organic matter fatty acids. The mutual corroboration of stomach content and fatty acid reflects regional differences in the diet composition of krill, suggesting that biogeographical patterns in food availability and the energy provision of organisms govern the diet of krill, whereas food availability and energy provision depend on environmental factors driven by hydrodynamics.

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Abstract No : 829

Biological-physical processes regulate autumn prey availability of spiny icefish *Chaenodraco wilsoni* in the Bransfield Strait, Antarctic

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Muscle fatty acids of the spiny icefish *Chaenodraco wilsoni* were collected from three areas in the Bransfield Strait, northern Antarctic Peninsula during February–April 2016 give a good representation of their feeding variability. The compositions of 22:6n3 (DHA) and 20:5n3 (EPA) were both higher in the Transitional Zonal Water with Bellingshausen influence (TBW)–controlled *C. wilsoni* than in the Transitional Zonal Water with Weddell Sea influence (TWW)–controlled fish. This was positively correlated with photoadaptation and carbon sequestration in TBW–controlled phytoplankton. Results for the fatty acids 16:1n7, 16:0, DHA, and EPA indicate the presence of dinoflagellates in all three areas, suggesting that during late summer and early fall, there is a seasonal phytoplankton succession, where small phytoplankton become dominant, in the Bransfield Strait. In addition, the compositions of some long-chain fatty acids (> 20, such as 20:0, 20:1, 22:0, and 22:1n9) and $\Sigma 18$ indicated that the food chain based on flagellates and copepods was more apparent in TWW–controlled *C. wilsoni*, especially the effect of El Niño–Southern Oscillation (ENSO) on the variation of prey communities in TWW–controlled areas. Fatty acid markers such as SFA/(PUFA+MUFA), $\Sigma 15 + \Sigma 17$, and ARA were more pronounced in TWW–controlled *C. wilsoni*, indicating a more strongly carnivorous and benthic food source. In the TBW–TWW confluence, the complex hydrological structure, including the presence of many mesoscale eddies, allows rich nutrients and krill larvae to remain in it, providing a rich food source for the *C. wilsoni*. Overall, our fatty acid data help elucidate *C. wilsoni* survivability at the face of climate change.

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Abstract No : 923

In situ observations of the benthic ctenophore *Lyrocteis flavopallidus*

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In January and February 2017 a submersible-based cruise was conducted along the western Antarctic Peninsula. The goal of the cruise was to obtain high definition video footage of scientists exploring the deep waters of Antarctica for a documentary (Deep Antarctica). Eighteen sites ranging from the Antarctic Sound to the Palmer Deep were surveyed and included many noteworthy observations of pelagic and benthic organisms, some common to all dives, some not. One of the more unique sightings was a small population of the unusual benthic ctenophore *Lyrocteis flavopallidus*, encountered at 450 m in the Gerlache Strait. Individuals of *L. flavopallidus* actively feeding via the characteristically long tentacles fully extended were observed. Numerous individuals were witnessed ensnaring small zooplankton and even adult krill on the sticky tentacles. In all such instances the tentacle(s) were rapidly retracted bringing the prey to the mouth of the ctenophore. It is not known whether the trapped prey eventually escaped or were ultimately consumed. Tentacles were also observed facilitating movement of an individual. These curious behaviors, natural or induced by submersible lights, warrant further study.

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Abstract No : 561

Hydrography of the Southern Ocean fronts – The zooplankton link: A study in the Indian Ocean sector

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Zooplankton diversity, biomass and numerical abundance with reference to hydrographic properties are still poorly known in the Indian Ocean sector of the Southern Ocean (SO). In order to understand the importance of high nutrients and low chlorophyll-a region, a systematic zooplankton sampling has made in various expeditions in the Indian sector of SO, with particular reference to Copepoda. Copepods were predominant in the entire water column across the entire study region and contributed significantly to the total zooplankton biovolume. Zooplankton numerical abundances were high in the Polar Front, associated with microphytoplankton biomass. On the other hand, low zooplankton abundance was perceived in the warmer waters coupled with picophytoplankton biomass. Four copepod species were identified, characterized by ecological niche which were strongly correlated with oceanographic fronts, demonstrating both biogeographic importance and oceanographic conditions. Phytoplankton growth rate and zooplankton grazing pressure were high in the PF zone, where zooplankton removed ~81 % of the daily phytoplankton production. Besides, Antarctic surface water and shelf water masses were exhibited a vital role in niche species composition of zooplankton in the coastal Antarctica. In the neritic zone copepod community was dominated by high densities of *Oithona similis* and *Oithona frigida*. We assume that the abundance of these two small copepods is more strongly influenced by surface water temperature than the primary production. Our results suggest that the latitudinal distribution of zooplankton species composition and phytoplankton size class variations were chiefly driven by temperature and various nutrients concentrations in the Indian sector of the SO.

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Abstract No : 233

Identification of Phytoplankton size classes using in situ phytoplankton absorption in the Indian sector of the Southern Ocean

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Identifying phytoplankton size-classes (PSC) in the Southern Ocean (SO) is crucial for perceptive of the abundance of the phytoplankton community, the carbon sequestration capacity of the biological pump, and phytoplankton photosynthetic efficiency. We have measured in situ phytoplankton absorption (aph) data (n=150) using the quantitative filter technique (QFT) for three years (2011, 2013, and 2015). The PSC models were developed using aph(443) and slope, S (S443-510), which showed three clusters in the entire dataset. Based on the clusters, the aph was categorized into three groups; $\text{aph}(443) > 0.0375 \text{ m}^{-1}$, $0.01-0.0375 \text{ m}^{-1}$, and $< 0.01 \text{ m}^{-1}$ for deriving micro, nano, and picophytoplankton, respectively. The aph ratio $B(443\text{nm})/R(675\text{nm})$, which is an indicator of pigment package effect varied between 1.9 and 2.7 (mean: 2.3), 1.3 and 8.8 (2.9), and 1.84 and 6.4 (3.2) for micro, nano, and picophytoplankton, respectively also supported the above classification. We have slightly modified a global PSC absorption model (Hirata et al., 2008) that failed to capture the micro-phytoplankton in the Indian sector of the SO (ISSO) probably due to absorption ranges being less ($0.001-0.060 \text{ m}^{-1}$) in the ISSO compared to the Atlantic and Pacific sectors. The modified model better detected all PSC including micro-phytoplankton in ISSO. The current models showed less RMSE for nano (0.000478) and microplankton (0.0009) and higher RMSE for picophytoplankton (0.00039) than the global models (RMSE: 0.0003 (Pico), 0.001 (Nano)). Further, the PSC models were validated with satellite data. This study would facilitate synoptically deriving phytoplankton size classes using space-borne sensors in this remote and relatively inaccessible polar

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Abstract No : 64

Where are the jellyfish? An integrative molecular study to reveal the gelatinous zooplankton species diversity, distribution, and connectivity within a changing Southern Ocean

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Gelatinous zooplankton (GZP) are a polyphyletic and ecologically diverse planktonic group comprising cnidarians, ctenophores, and tunicates. GZP are notorious for their detrimental impacts on ecosystem functions/services and human activities. However, a recent paradigm shift has shown their widespread importance and benefits, including their key role in the trophic pelagic web and their contribution to the carbon pump through “jelly-falls”. In the Southern Ocean, besides the extensively studied salps, a considerable knowledge gap on other GZP taxa persists since nets appear inefficient for studying these fragile organisms. Therefore, the main goal of this project is to integrate molecular methodologies with ecological niche models to characterize the species diversity, distribution, and population connectivity of Antarctic GZP and to link these to environmental parameters. Firstly, environmental DNA analyses will be used to characterize the GZP species composition and link distributional patterns to hydrography. Environmental DNA found in marine sediments will also be compared with those of the overlaying water column, to better understand the role of GZP in the carbon pump. Secondly, we will apply phylogeographic analyses to test whether populations are circumpolar and assess to which extent the Antarctic Polar Front limits gene flow. Finally, ecological niche modelling will be used to project the distribution range of Antarctic GZP and potentially define their limiting abiotic factors. Establishing this baseline information will be crucial to predict how environmental change will affect the GZP community composition and distribution, and by consequence, how it will impact regional trophic networks and carbon fluxes in the future.

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Abstract No : 503

Iron biogeochemistry in surface waters of Admiralty Bay, King George Island, Antarctica: an exploratory assessment

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Iron is an important micronutrient for many cellular processes, such as photosynthesis, with influence on the global climate. Hence, understanding its biogeochemistry in different environments is very relevant. The determination of dissolved iron concentrations and speciation was conducted for the first time in surface seawater coastline samples collected during the austral summer of 2020 in Admiralty Bay, King George Island, Antarctica. For this, the technique of competitive ligand exchange/adsorptive cathodic stripping voltammetry with 2,3-dihydroxynaphthalene as the competing ligand was used. Physicochemical parameters such as temperature, pH, salinity, and dissolved oxygen were measured in situ to correlate with dissolved iron results. Salinity (32.7 ± 0.8), pH (7.85 ± 0.2), and dissolved oxygen ($51.3 \pm 26.6\%$) were compatible with those of the literature; however, the average temperature (4.2 ± 0.8 °C) was higher, possibly as a reflection of global warming. For dissolved iron mean value was 18.9 ± 6.1 nmol L⁻¹, with a total ligand concentration of 23.6 ± 12.2 nmol L⁻¹ and a conditional stability complex constant of 12.2 ± 0.2 , indicating humic substances as possible ligands. On average, the calculated free iron concentrations were 0.7 ± 0.3 pmol L⁻¹. These relatively higher concentrations of iron observed in Antarctic waters indicate a possible local source of Fe, likely predominantly from upwelling sediments and secondarily from ice-melting waters, which does not limit the growth of the phytoplankton in this region.

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Abstract No : 1004

Vortices effect in phytoplankton community at the BRAZIL–MALVINAS CONFLUENCE.

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To test if Cold (CCE) and Warm Core Eddy (WCE) increase phytoplankton density and change species diversity of the Brazil–Malvinas Confluence (BMC), the community and environmental parameters were collected in two depths (Surface and Deep Chlorophyll Maximum – DCM) during austral spring 2019. A total of 62 species were identified and distributed in Bacillariophyta, Miozoa, Cyanophyta, Haptophyta and Ochrophyta. The WCE environmental conditions differ from the CCE that presented low values of temperature and salinity. The phytoplanktonic density was reduced (WCE) and increased in CCE (93.213×10^5 cells.L⁻¹). The conditions in both vortices provided the high diversity, in contrast with Brazil Current (BC) and Malvinas Current (MC) (low diversity). The diatoms were predominant in species richness in all regions with emphasis on the high density and dominance of *Minidiscus* sp. and *Pseudo-nitzschia* cf. *pungens* in the MC, while the dinoflagellate *Karlodinium* sp. was dominant in the BC and vortices. Diatoms, dinoflagellates and silicoflagellates were indicators of CB, MC, DCM and cold regions (MC + CCE). Was verified the increase in cell density of dinoflagellates *Azadinium* sp., *Gonyaulax scrippsae*, *Oxytoxum laticeps*, *O. graciles*, *Protoperidinium minimum* and diatoms *Fragilariopsis kerguelensis*, *Thalassionema nitzschioides*, *Thalassiosira gravida*, in the CCE, and *Azadinium* sp. and *Dictyocha fibula* in the WCE in comparison to BMC. The environmental conditions of the vortices modified the structure of the phytoplankton community, favoring the dinoflagellates density and increasing species diversity. This work is a contribution of the Project MEPHYSTO, from the Brazilian Antarctic Program (CNPq Grant 442695/2018–7).

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Abstract No : 272

A study on the energy content and demographic composition of Antarctic krill (*Euphausia superba*) swarms in East Antarctica

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Antarctic krill aggregations are a key prey source in the Southern Ocean ecosystem. However, the amount of energy that krill swarms contain remains unknown. In this study, we determined the population structure of *E. superba* swarms in East Antarctica and estimated their energy content based on calorific values for different body tissues and whole animals at different life stages. We found a relationship between the energy content of muscle and gonads in gravid and adult females was detected: the higher the energy content in muscle tissue, the lower the energy content in the gonad tissue. This suggests a trade-off in energy allocation between somatic growth and reproduction. Females will redirect energy to gonad development at the expense of the maintenance of muscle tissue. Total swarm energy was calculated using the volumetric density of each swarm, which was estimated using acoustic data. Four swarm types (A-D) were determined based on the individuals' body length and maturity stage. The highest energy content was found in Type B swarms, composed predominantly of adult males and females, and Type D swarms, comprising mostly gravid females. As a side note, during the research cruise, many Humpback and Blue Whales were sighted feeding on high energy swarms. Information about the energy content of swarms may be used as input into current predator-prey models of baleen whale energy intake and assist with identifying which characteristics of krill swarms are potentially targeted by baleen whales.

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Abstract No : 564

Particulate organic matter dynamics and its implications on the efficiency of the biological pump in the Indian sector of the Southern Ocean

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The Southern Ocean is a highly dynamic region with a strong frontal structure and the influence of water masses. Besides, the region experiences both short-term and seasonal changes that influence the hydrography and biogeochemical processes in these waters. This study attempts to understand key factors/processes contributing to the spatial and inter-annual variability of particulate organic matter (POM) dynamics and its influence on the efficiency of the biological pump in the Indian sector of the Southern Ocean (ISSO). Seawater samples were collected at discrete depths and analyzed for POM composition and other auxiliary variables across the fronts of the ISSO. A strong variation in the elemental and isotopic composition of particulate organic matter was evident across the fronts of the ISSO. Also, a significant interannual variability was noted in the composition, transformation and fate of POM, especially at the subtropical frontal region which was triggered by sporadic events. This study suggests that nutrient variability, biological processes including the community structure strongly influence the transformation and characteristics of POM across the frontal structure of the ISSO. This study also indicated that the efficiency of the biological pump varied frontally and temporally with some regions occasionally supporting a regenerative system, and was largely controlled by front specific factors. Besides variability in the SAM driven factors along with sea-ice cover, eddies, etc. trigger changes in the biogeochemical processes and food web dynamics that control the efficiency of the biological pump in the ISSO.

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Abstract No : 1021

Effects of sea ice concentration and dissolved iron variability on phytoplankton dynamics of the Ross Sea using a 1-D model.

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The Southern Ocean is an important component of the global carbon cycle, where the sea-ice dynamics, thermohaline convection with consequent formation of cold, salty water masses, and biological productivity all influence the exchange of CO₂ between the ocean and atmosphere. About 40% of the total primary production of the Antarctic Ocean occurs in the Ross Sea, a high-latitude, nutrient-rich continental shelf system. The Ross Sea plankton communities are driven by sea ice dynamics and associated polynyas, grazing by zooplankton, light limitation due to sea ice cover, and availability of micronutrient elements such as iron. A one-dimensional physical-biological coupled model is used to assess the impact of sea ice concentration and the availability of dissolved iron on the plankton ecosystem of the Ross Sea. We aim to understand how the different phytoplankton communities respond to seasonal and inter-annual changes of these environmental drivers.

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Abstract No : 203

Antarctic krill (*Euphausia superba*) behavioural and swimming kinematic responses to chemical, photic and physical stimuli

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Antarctic krill are highly studied. However, little is known about what stimuli causes individual krill swimming behaviours to change, what causes schools and swarms to form/disperse, or what cues the movement and structure of swarms. This study is constructing an Individual-Based-Model (IBM) that scales up from individual to aggregate behaviour. Using a horizontal flume, krill swimming kinematics and behaviour in relation to chemical, physical and photic stimuli were examined. Our video analysis aided to clarify: search/foraging or avoidance behaviour in relation to chemical stimuli, the grouping and alignment of krill in a current and their ability to exit/enter a current (physical stimuli), energy efficient swimming (positive stimuli in high flow), as well as maintenance of a heading and search behaviour under low photic conditions. Krill swimming in high flow showed few strong directional changes (low frequency of large turn angles) which indicates energy efficient, non-searching swimming behaviour. In contrast, krill turned more frequently in low flow regardless of chlorophyll level, suggesting that the energetic demands of aligning to a current may constrain foraging. Roughly 1/3rd of krill tracks in low flow conditions had bimodal swim velocities, suggesting more searching behavior flexibility when not constrained by strong flows. Heading was more consistently aligned with the flow in low photic conditions, possibly to avoid hitting objects. However, this also reduced their ability to “search” even when chemical stimuli were added to low photic conditions. Information and analysis gathered from this study will be used to construct an individual-based-model (IBM) for Antarctic krill.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

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**Management implications of
Southern Ocean ecosystem dynamics &
biodiversity thresholds**

CONVENORS

Jilda Caccavo, Cassandra Brooks,
Christopher Jones

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Abstract No : 657

Applying integrated stock assessment methods to diagnose exploitation status and population variables of the Antarctic Krill.

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The Antarctic krill (*Euphausia superba*), is a key species in the Southern Ocean (SO) and constitutes one of the largest marine populations on the planet. Its populations are subject to a fragile balance between intrinsic population dynamics and environmental-oceanographic conditions. It has been also subject to fishing exploitation for decades, mainly in the southwest Atlantic sector of the SO, where 70% of its population is distributed. The current krill's stock assessment is based on hydroacoustic surveys that does not allow to assess its population status; however, a new management strategy for this fishery is under development, which will update and improve stock assessment procedures. This research aims to assess the population levels and exploitation status of krill through integrated stock assessment models. These statistical methods are useful tools for management decision making and have been widely used in fisheries science worldwide. This methodology allows: (1) to make historical analyses of stock indicators; (2) to integrate different sources and pieces of available information (biological parameters, surveys, fishery data, etc.); and (3) to propose Biological Reference Points (BRP) such as MSY or its proxies. In addition, this approach allows for the explicit inclusion of environmental variables relevant to fishery management in the current challenging climate change scenario. Our analyses suggest that this kind of population assessment of the Antarctic krill, which integrates most pieces of available information, is adequate to assess fishing mortality, biomass, recruitment levels, exploitation status of the krill population, and finally, to support the current management.

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Abstract No : 654

Unravelling the effects of bycatch–mortality, predation–release and environmental change on macrourids and icefish in the Ross Sea region

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Antarctic toothfish (*Dissostichus mawsoni*) are the major piscine predator in the marine ecosystem of the Ross Sea region and toothfish diet in areas of highest biomass is dominated by two species of macrourids (*Macrourus whitsoni* and *M. caml*) and Dewitt's icefish (*Chinobathyscus dewitti*). Commercial fishing for toothfish in the Ross Sea region began in 1997 and CCAMLR's Principles of Conservation require that fishing does not adversely affect these prey species. Predation release (a kind of trophic cascade) is expected as there is a single dominant predator and the spawning stock biomass of Antarctic toothfish is reducing towards the CCAMLR management target of 50%. Macrourids and icefish are also taken as bycatch in the toothfish fishery. We report on a suite of work carried out to understand and inform effective management of fishing in the Ross Sea region taking into the combined effects of bycatch mortality and predation release, both in the context of environmental variability/change: (1) improved biological understanding of macrourids, including new tools for species identification; (2) modelling of macrourid distribution using VAST (vector autoregressive spatio-temporal); (3) ecological-niche analysis for macrourids; (4) spatial population modelling of Antarctic toothfish; (5) bycatch characterization for the toothfish fishery in the Ross Sea region; (6) isotope and diet studies of Antarctic toothfish; (7) multi-species modelling. We also report on efforts to develop non-lethal monitoring for macrourids, including using identification of macrourids from fishing vessel acoustics and the use of underwater towed video.

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Abstract No : 1020

Investigating the impacts of environmental variability on the Kerguelen Plateau Patagonian Toothfish fishery

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The Kerguelen Plateau is a large, isolated submarine plateau in the southern Indian Ocean. The plateau is home to a significant and high-value Patagonian toothfish fishery, as well as being home to significant populations of seals, seabirds and whales. In 2016, the Australian longline fishery on the Kerguelen Plateau experienced lower than average catch rates. At the same time, the Kerguelen Plateau experienced a surface heatwave. A preliminary investigation concluded that the declining catch rates were unlikely to be caused by a decline in fish stock biomass, but instead could have been related to a change in fish catchability driven by environmental factors. Here we examine the influence of environmental variability on Toothfish catch rates over the last 20 years on the plateau. We combine the outputs from satellite products and oceanographic models with detailed catch data using spatio-temporal models. We find that our models can capture the average trend in catch rates through time and there are some consistencies in how environmental variables influence catch rates. We discuss the implications of these models for predicting environmental impacts on future catch and for management within the fishery.

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Abstract No : 184

Fish energy pathways: Diet of the bald rockcod (*Trematomus borchgrevinki*) in the fast ice zone of Terre Adélie, East Antarctica

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Notothenioid fish are the dominant group of mesopredators in the high-Antarctic. Obtaining information regarding their ecological role is key for understanding potential success or failure under changing Antarctic conditions. Diet analyses can reveal information about a species' functional placement in the food chain and direct observations of predation events and use of resources. The autecology of the notothenioid fish *Trematomus borchgrevinki* was studied in the Terre Adélie region of East Antarctica, near Dumont d'Urville station during summer. Stable isotopes ($\delta^{13}\text{C}$ and $\delta^{15}\text{N}$) and stomach contents were used to describe feeding ecology and foraging grounds throughout the summer season of mature specimens. The diet of *T. borchgrevinki* consisted mainly of the copepods *Paralabidocera antarctica*, *Stephos longipes*, and *Drescheriella glacialis*, all well-known ice-associated species, and the neritic krill *Euphausia crystallorophias*. Less common taxa included amphipods, chaetognaths, and larval fish, as well as some rarely observed pteropods, ostracods, and eggs. $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ signatures were characteristic of inshore secondary consumers. Stomach contents analysis showed that the fish were zooplanktivorous generalist feeders, primarily foraging at the sea ice interface and in the pelagic zone, and occasionally on the nearshore benthos. The plasticity we observed in diet and foraging indicates resilience to expected changing sea-ice conditions in the high-Antarctic.

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Abstract No : 623

Warming precludes lower biomass of Antarctic krill in the South Shetland Islands: the train of consequences for Chinstrap penguins foraging and breeding success

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Breeding seabirds are central place foragers, therefore variability of feeding resources around breeding colonies can affect their feeding behavior and breeding success. By using tracking data from Chinstrap Penguin (*Pygoscelis antarcticus*) individuals breeding in Nelson Island (Maritime Antarctic Peninsula) combined with Antarctic krill (*Euphausia superba*) acoustic biomass estimates, we compared foraging behavior during two years of contrasting environmental conditions (2019/20 and 2021/22). Our results showed that foraging trips were longer in terms of covered distance and duration, with foraging dives being deeper in the 2021–22 season compared to 2019/20. Breeding success in the 2021/2022 season was 1.4 times lower than in the previous season. The 2021/22 season was characterized by warmer sea surface temperature, lower chlorophyll-a concentration, lower winter sea ice cover and considerably lower krill density. It is likely that a warmer winter in 2021/22 resulted in a lower spring and summer productivity and low krill recruitment, the changes in foraging effort were not enough to compensate for such changes in krill which reflected in a lower breeding success. These results suggest that the general decrease of Chinstrap Penguin population in the South Shetlands can be traced back to climate change acting over the krill population. Climate change projections indicate an increase in the frequency of warm winters in the area, therefore, Chinstrap Penguin populations in the area might experience further reductions in the future.

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Abstract No : 932

Climate genomics of Antarctic toothfish (ClimGenAT)

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Antarctica is experiencing climate change impacts at a rapid clip, resulting in warming trends and increased environmental variability. Estimating the ecological impact of climate change is an unprecedented challenge that drives the emergence of novel cross-disciplinary studies. Recently, the potential for genomics to address climate change impacts on species has come to the fore. This burgeoning field, which we refer to as climate genomics, is spurred on by the use of genomics to understand how climate change impacts species, populations, and ecosystems. The conservation of Antarctic ecosystems and vulnerable species requires the integration of climate change impacts into management strategies and predictions. Antarctic toothfish (*Dissostichus mawsoni*) are a commercially exploited top predator in the Southern Ocean, whose early-life stages are vulnerable to the environmental perturbations caused by climate change due to their strong association with sea ice and life history connectivity via surface circulation. This presentation will introduce the recently funded project ClimGenAT (Climate genomics of Antarctic toothfish), which will use genomics data derived from whole-genome resequencing of circumpolar distributions of toothfish to identify local adaptation and genetic structure on the population level. These data will be used for a genotype-environment association (GEA) study, and to develop a genetically-informed species distribution model (gSDM) for Antarctic toothfish. ClimGenAT delivers an innovative cross-disciplinary approach to studying the ecological impacts of climate change, in addition to providing critical data to inform the long-term management of the Antarctic toothfish fishery, and Southern Ocean ecosystems as a whole.

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Abstract No : 630

Trophodynamics of the Antarctic toothfish (*Dissostichus mawsoni*) in the Antarctic Peninsula: prey composition and fatty acids profile

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The Antarctic toothfish is the largest notothenioids species in the Southern Ocean, playing a key ecological role in the trophic web, as food source for marine mammals, and as top predator in deep-sea ecosystems, structuring the population dynamics of its prey through a trophic cascade. Most ecological information on this species rely on samples from areas where direct fishing is allowed by CCAMLR, whereas in areas such as the Antarctic Peninsula (AP), where it is prohibited, there are still important gaps. Here we characterize the trophic ecology of Antarctic toothfish in the northern tip of the AP, based on a combination of dietary morphological identification of prey composition and fatty acid analysis from samples collected in two seasons (2020–2021). From the 159 stomachs sampled, results showed that the diet of *D. mawsoni* was mainly composed of Macrouridae (24.75 IIR %), Anotopteridae (2.66%IIR) and Channichthyidae (2.26%IIR) with other prey items such as Cephalopods (8.42%) as relatively important items. Other rare groups found were crustaceans and penguin remains. Prey composition did not vary between years, sexes and sizes groups. On the other hand, based on a total of 28 fatty acid profiles identified, we observed three statistically different prey groups (G1: Anotopteridae–Macrouridae; G2 Channichthyidae; and G3: cephalopoda). These results provide important information to improve our understanding of the trophic dynamics of this species, its generalist feeding behavior probably consuming the most abundant prey, and updated information on its benthic–demersal ecological role in the AP, highly relevant for its ecosystemic fisheries management

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Abstract No : 309

Climate change, fisheries management, and modelling changes in fish community structure in the Southern Ocean

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Heard Island and McDonald Island are located within the northern half of the Kerguelen Plateau in the Southern Ocean. The Kerguelen Plateau is a biodiversity hotspot with many endemic fish species, and the region has economic importance in supporting valuable fisheries. This region is also a climate change hotspot with notable changes in water temperatures and ocean currents. Most existing information on fish species and their distribution in this region is derived from annual random trawl surveys, fishery observations, and indirectly from research on fish predators. In this study we use trawl survey data and contemporary joint species distribution models to understand how the fish assemblages have changed through time and space. Using a joint species distribution modelling approach, we demonstrate that several species, including mackerel icefish, have realised large changes in their distribution and abundance through time. These changes are likely to be related to environmental factors such as sea surface temperature anomalies and southern annular mode. Our results indicate that the prevalence and abundance of many species, and overall species richness, have increased over the period 2003 to 2016. It is unclear whether these changes reflect shifts in the fishery, management, or the effects of climate change. We also found evidence of several species' distributions responding to temperature variability, and these species are potentially exposed to the ongoing impacts of climate change. This new information can be used by managers and policy makers to ensure sustainable fisheries and the protection of biodiversity into the future.

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Abstract No : 376

The role of inshore areas as spawning grounds in Antarctic notothenioids

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The knowledge of reproductive biology in Antarctic notothenioids (Cryonotothenioidea) arises mostly from scientific surveys conducted in offshore areas of the continental shelf (>120 m depth), and considerably less from inshore shallower water sampling. Apart from prolonged gametogenesis, high gonadosomatic index at spawning, low fecundity and large yolky eggs, parental care and nest guarding seem to be also a sheared feature in some Cryonotothenioid species. Although reproductive aspects such as fecundity, spawning period, and size and age at sexual maturity have been described for many notothenioids, an important and basic reproductive feature like spawning ground remains unknown for the majority of the species. Elucidating this reproductive trait is essential because the protection of fish reproductive grounds is one of the most successful management strategies in the scope of sustainable exploitation and conservation of fish populations and marine ecosystems. In particular, logistic constraints caused by the harsh environmental conditions in Antarctica difficult the representative sampling of fish populations, and so the location and substrate type associated to spawning have been described only in a few notothenioid species. Moreover, how environmental factors that act as reproductive cues (particularly photoperiod and temperature) affect the spatio-temporal window in which notothenioids reproduction occurs have been scarcely explored. Coupling reproductive information from ichthyologic research conducted at Potter Cove, South Shetland Islands and at Paradise Bay, West Antarctic Peninsula, with literature data from nearby areas, we analyze biological, oceanographic and environmental conditions of these localities to evaluate the role of inshore areas as spawning grounds in Antarctic notothenioids.

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Abstract No : 629

Spatial and temporal catch concentrations for Antarctic krill: Implications for fishing performance and precautionary management in the Southern Ocean

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Rapid climate changes recorded along the Western Antarctic Peninsula (WAP) in combination with the increasing seasonal catches reported by the krill fishery have raised concerns as to whether the management strategy established by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is effectively avoiding impacts on the krill stock and related ecosystem. Despite the current fixed catch limit being spread across fishing areas to reduce spatial catches concentrations, our 38-year analysis revealed the highest historical spatial (ton/km²) and temporal (ton/day) fishing concentration levels across the WAP and South Orkney Islands. Higher seasonal catches in recent decades removed persistently within the same small fishing areas and during shorter fishing seasons are key factors influencing this situation. We used the catch per unit effort (CPUE) as a measure of fishing performance, standardized using a GAMM model including operational factors such as fleet composition, trawling methods, seasonality and daily catches. We detected negative CPUE trends over time and across the different fishing areas. Results suggest that fishing performance has responded to the elevated spatio-temporal fishing concentration and changes in sea-ice. We discuss whether the negative CPUE trends are caused by fishing-induced depletion or driven by other factors such as krill flux, krill abundance contraction and increased cetacean foraging due whale populations recovery. Finally, we also highlight the need to expand the survey's coverage (by acoustic or net-based methods) to the new, highly fished, and non-monitored areas such as Gerlache Strait, which is an important area for krill and dependent predators

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Abstract No : 521

Shaping the landscape of mid-trophic level organisms in the Ross Sea region

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With an area of 1.6 million km², the Ross Sea region Marine Protected Area (MPA) harbours a large and diverse pelagic ecosystem which extends from the shelf to deep open-ocean waters. Mid-trophic level (MTL) organisms are responsible for the energy transfer between primary and tertiary consumers, playing a key role in the trophic ecology and biogeochemical cycles. In the Ross Sea region, key MTL groups are Antarctic krill (*Euphausia superba*), lanternfishes (Myctophidae), and Antarctic silverfish (*Pleuragramma antarctica*). To better understand the distribution and abundance of these groups in the Ross Sea region MPA, we used fisheries multi-frequency acoustic data (18, 38, 70, 120 and 200 kHz) collected by the research vessel Tangaroa and catch information from targeted midwater trawling to develop a depth-partitioned classification model for six pelagic groups using random forests. The model was validated using a k-fold validation approach and was successful at classifying three dominant MTL species: *E. superba*, *Electrona carlsbergi* (myctophid), and *P. antarctica*; and three groups where the mixing of species in the catch did not enable a separation by species: mesopelagic fish mix, gelatinous zooplankton, and zooplankton mix. We applied the resulting model to underway acoustic data collected by RV Tangaroa in the Ross Sea region in 2015, 2018, 2019 and 2021, to predict the spatial distribution and relative abundance of these groups. This research has improved our understanding of the distribution and composition of pelagic fauna in the Ross Sea region.

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Abstract No : 619

Projected availability of Antarctic krill (*Euphausia superba*) to *Pygoscelis* penguins in the Antarctic Peninsula

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The Western Antarctic Peninsula (WAP) has experienced fast warming, with known consequences over the spatial distribution and density of the Antarctic krill (*Euphausia superba*). *Pygoscelis* penguins are species highly specialized in feeding on krill, and they are under steep declines throughout the WAP, likely as a response to changes in krill abundance and distribution. A Hurdle Model indicated that presence ($z=25.5, P<0.001$) and density ($z=45.7, P<0.001$) of *Pygoscelis* penguin colonies were related to krill density (estimated through an Ecological Niche modeling applied over krillbase data). Forecasts of krill density towards 30 to 80 years considering future climate change scenarios indicated that while availability of krill to penguins is expected to decrease throughout the area, it would not cross a minimum threshold for penguin colonies presence in the Bransfield Strait, Southeastern and Southwestern Peninsula. However, the threshold would be crossed in the South Shetland Islands and Gerlache Strait, two zones where krill availability was forecasted to be reduced, corresponding to zones where penguin populations are already under fast decrease. That is of particular concern for Chinstrap Penguins (*P. antarcticus*) as a substantial part of its global population is located in areas where krill availability is forecasted to decrease the most. The results of this exercise emphasize the need of increasing protection of the WAP in order to avoid other stressors, such as increased krill fishing catches, adding further impacts over the populations in those areas.

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Abstract No : 645

A parasite outbreak in notothenioid fish in an Antarctic fjord

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Climate changes can promote disease outbreaks, but their nature and potential impacts in remote areas have received little attention. Waters of the Southern Ocean have been environmentally stable and chronically cold, hovering near the freezing point for the past 15–20 million years. However, Antarctica now faces among the fastest changing climates on Earth, with rising air temperatures and melting glaciers contributing to warmer and fresher bottom waters. Strong abiotic stressors already affect the highly endemic and specialized Antarctic fauna, causing a cascade of responses from molecular to community levels. The integration of these perturbations on species interactions, however, remains poorly understood. In a hotspot of biodiversity on the West Antarctic Peninsula, we captured specimens of two notothenioid fish species affected by large skin tumors at an incidence never before observed in the Southern Ocean. Molecular and histopathological analyses revealed that novel X-cell parasitic alveolates, members of a new genus *Notoxcellia*, are the etiological agent of these tumors. Parasite-specific molecular probes showed that xenomas remained within the skin but largely outgrew host cells in the dermis. We further observed that tumors induced neovascularization in underlying tissue and detrimentally affected host growth and condition. Although many knowledge gaps persist about X-cell disease, including its mode of transmission and life cycle, it cannot be excluded that this outbreak may expand within this population, spread to other localities, and potentially infect other species. With alarming forecasts for continued global climate change, these findings raise concerns about potentially active biotic threats to vulnerable Antarctic ecosystems.

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Abstract No : 297

Pygoscelis penguin colony locations along the West Antarctic Peninsula could be driven by high retention and accumulation of simulated krill

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Pygoscelis penguins are central place foragers during the austral summer, meaning that they must return to their nests to provision their growing chicks. Optimal foraging theory suggests that this behavior is only feasible if resources are abundant adjacent to the penguin colonies. However, prey availability to penguins, especially of the Antarctic krill, a keystone species along the West Antarctic Peninsula (WAP), is difficult to quantify. One potential physical oceanographic mechanism that could increase prey availability within penguin foraging grounds is retention. Recent modeling studies using the Regional Ocean Modeling System (ROMS) around Palmer Deep Canyon have illustrated that a recirculating subsurface eddy over the canyon can retain simulated krill performing realistic diel vertical migrations (DVM) for as long as 30 days. The subsurface eddy also increases simulated krill concentrations within adjacent penguin foraging regions. These results suggest that retention and accumulation of prey may be an important driver of penguin colony locations. Here, we expand these retention and accumulation calculations to the entire WAP to test this hypothesis. Using simulated krill performing realistic DVM behaviors within Pygoscelis penguin foraging depths in the ROMS, we calculate potential prey retention and accumulation near known colony locations along the WAP. We hypothesize that colonies will be close to areas of relatively high retention and accumulation of simulated krill. The relationship between penguin colony location and retentive oceanographic features may help improve future habitat suitability models in this region and may be especially critical to predicting future expansion of gentoo penguin colonies.

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Abstract No : 659

Modeling Antarctic Krill Circumpolar Spawning Habitat Quality to Identify Regions With Potential to Support High Larval Production

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Antarctic krill (krill) are a key prey item for many Southern Ocean marine predators and also support an expanding commercial fishery. However, there is a need to identify areas of the Southern Ocean that are best for both the production of eggs, and subsequent survival until free-swimming larvae. We create a model for spawning habitat which considers the temperature and food conditions that adult female krill need to successfully produce eggs, as well as the density of predators feeding on spawned eggs. We optimize our model using existing regional-scale data of krill eggs and larvae and use this to predict where good spawning habitat may exist around the whole Southern Ocean. Our model found that nearly half of the best spawning habitat occurs in the southwest Atlantic. Within this area, small-scale krill fishing management areas around the Antarctic Peninsula contain good-quality spawning habitat. Krill fished here are likely to be locally produced. But, other small-scale management areas contain little good-quality spawning habitat (except around South Georgia) and probably rely on krill being imported by ocean currents. This is important for understanding how fishing may impact both local ecosystems and those that are downstream.

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Abstract No : 869

RESURGENCE OF THE ANTHROPOCENE IN THE ROSS SEA, ANTARCTICA

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The Ross Sea, during the late 20th century, was classified as the ocean area least affected by human activities, despite appreciable exploitation of whales and seals as well as intense local pollution before the period of classification. Those direct impacts were removed by the 1980s under the Antarctic Treaty and International Whaling Commission. Subsequently, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) included most of the Ross Sea within a marine protected area (MPA), proposed “to protect [undefined] ecosystem structure and function.” Populations of each in the southwestern Ross Sea, monitored for several decades, were stable for a couple decades, but during 1998–2018 increased to attain or surpass historical levels. We review historical impacts to populations and trends, decadal data sets of ocean climate, as well as fishing pressure of a trophic competitor and another selected indicator species, the Antarctic Toothfish (*Dissostichus mawsoni*). Our results indicate that variability in a few climate factors, plus cumulative extraction of toothfish, may well explain the indicator trends. Despite decades of ocean/weather variables changing, penguin and seal increase began only after fishery initiation. We hypothesize that toothfish removal may be altering intraguild predation dynamics, leading to competitive release of the intraguild prey, the silverfish. The fishery has reduced toothfish spawning biomass by >25% since initiation; management should be re-evaluated in keeping with the rational use, ecosystem-based viewpoint espoused by CCAMLR and its Ross Sea Region MPA.

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Abstract No : 497

Distribution patterns and population structure of demersal fish species in relation to benthic communities in the Weddell Sea

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Despite the general thought that the Southern Ocean harbors low fish biodiversity than expected, the Weddell Sea hosts a multitude of fish species and also stands out for the presence of macrobenthos. Most of the macrobenthic organisms, such as gorgonians, sponges and bryozoans are considered ecosystem engineers as they generate a three-dimensional structure that increases habitat heterogeneity. This structural complexity serves as a refuge against predators and nursery grounds for many organisms, including fish species. By analyzing video transects recorded by a Remotely Operated Vehicle, we investigated density, spatial distribution and population size of the demersal fish species inhabiting macrobenthic communities. Also, we attempted to unveil if there is any relationship between benthic and fish communities, as well as some fish behavioral patterns. The study area covers a depth range from 251 to 361 m and it is located in front of the Filchner Ronne Ice Shelf, in the southernmost part of the Weddell Sea. We observed the dominance of juveniles in the surveyed fish assemblage provides evidence that, at this life stage, some fish species appear to be positively associated with benthic communities. Moreover, about 37% of all specimens recorded were resting on benthic invertebrates or they were using them to hide, implying that Antarctic benthic communities might offer a suitable shelter from predators. As such, it can be concluded that there was an apparent relationship between certain species of fish and the different benthic communities, albeit the exact triggers behind such association still remain partially elusive.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

LIFE SCIENCES

**Sea ice in the atmosphere-
ice-ocean-biosphere system:
how, where and why is it changing,
and what are the effects?**

CONVENORS

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Accepted as: Oral Presentation

Abstract No : 686

The PRAISE21–22 campaign: overview and preliminary results

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The PRydzbay Air-Ice-Sea Exchange (PRAISE) field campaign in the Prydzbay region of eastern Antarctica was successfully carried out from 10th December 2021 to 10th February 2022 as a part of the 41st Indian Scientific Expedition to Antarctica. The primary objective of this project is to understand the exchange of mass and energy across the air-ice-sea interface. A summertime PRAISE Observatory was set up to achieve the objective at 69°24'1558S, 76°13'5401E in the Quilty Bay, near Indian Antarctic Station Bharati. The field campaign also attempted to measure under-sea-ice water column properties through a borehole from 1st January to 22nd January 2022. The significant parameters measured include temperature, salinity, turbulence, nutrients, and chlorophyll. The preliminary analysis suggests a strong variability in terms of background physics and biogeochemistry during the melting phase of sea-ice. Under ice turbulence measurement further showed that movements by higher trophic level animals (like seals) have the potential to be a source of turbulence and mixing in a weakly stratified ice-covered ocean system. The results of this campaign will add to the ongoing efforts to understand the Air-Ice-Sea exchanges in Polar Regions.

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Abstract No : 303

The influence of meltwater on the contribution of suspended particulate matter and nutrients in surface waters of Admiralty Bay, Antarctic Peninsula

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This study aimed to evaluate the spatial distribution of suspended particulate matter (SPM), and nutrients and their relationship with temperature, salinity, and pH in surface waters from Admiralty Bay, King George Island, Antarctic Peninsula, using principal component analysis (PCA). Admiralty Bay covers an area of 131 km², with a maximum depth of 600 m, and 3 inlets: Mackellar, Martel, and Ezcurra. SPM ranged between 4.28 e 21.05 mg L⁻¹ (mean \pm standard deviation = 12.08 \pm 4.07 mg L⁻¹) and the higher values were detected in Mackellar and Ezcurra inlets. The nutrients (in μ mol L⁻¹) silicate, phosphate, and nitrate ranged from 6.79 to 97.51 (71.48 \pm 18.99), 1.29 to 2.25 (1.79 \pm 0.30), and 10.08 to 28.49 (18.61 \pm 6.35), respectively, and presented the highest concentrations in Ezcurra inlet. In the PCA, PC1 explained 49% of the data variation and had a greater association with pH (negatively correlated), nutrients, and temperature. The samples that presented the highest scores were from Ezcurra, indicating that the highest nutrient values in the region could be associated with the input of meltwater, represented by the lowest pH and highest temperature values. PC2 explained 15% of the data and the variables associated were SPM, pH, and salinity, the last two were negatively correlated, indicating that the freshwater input also affected the SPM. This study can contribute to the assessment of contaminants input to the water column since they often tend to have the same sources as nutrients and MPS.

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Abstract No : 370

Flow-through dissolution of Antarctic iron particles with and without ligands

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Primary productivity in the Southern Ocean can be limited by low iron concentrations. Iron limitation in the surface ocean around Antarctica may be alleviated by particle dissolution of dust from exposed rock, glacial moraine, resuspended sediment, and sea ice. Among these sources, sea ice is considered a large reservoir for accumulating and altering particles that contain iron. Ligands, which are ubiquitous in seawater, chelate some metals and keep them in solution. Ligands are thereby thought to increase metal, including iron, solubility. Leaching studies of Antarctic particle sources are rare but important due to the current rapid changes occurring around Antarctica. Here, we quantified the solubility of iron in particles using vertical flow-through leaching experiments that ran for 90 minutes at 4°C, under trace metal-clean conditions. Both unaltered and ultraviolet (UV) irradiated seawater leaching solution treatments were used to test the effect of ligands on iron dissolution. For the unaltered treatment, sediment could leach the highest proportion of iron ($3.6 \pm 1.7\%$), followed by dust ($3.0 \pm 2.4\%$), glacial moraine ($2.1 \pm 1.3\%$) and sea ice ($1.7 \pm 0.4\%$). For the UV treatment, glacial moraine could leach the most ($13.1 \pm 11.3\%$), followed by sea ice ($4.3 \pm 0.1\%$), sediment ($3.0 \pm 4.3\%$) and dust ($1.4 \pm 2.0\%$). For dust and sediment, ligands did appear to help dissolve iron, the opposite was the case for glacial moraine and sea ice. We discuss these laboratory results in relation particle availability and how this affects primary productivity in Antarctic surface waters.

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Abstract No : 570

The role of Antarctic land-fast sea ice breakup and across-shelf export in Southern Ocean biogeochemical processes

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Most of the Southern Ocean (SO) is a high-nutrient, low-chlorophyll area, where the phytoplankton growth is partially limited by light and iron availability. As the exponential decrease of iron (Fe) concentrations as a function of distance from the Antarctic coast, the offshore water is sensitive to Fe release from sea ice, promoting a phytoplankton bloom during the melting season. Landfast sea ice (fast ice) is the sea ice fasten to the coast and stores abundant Fe. However, the effects of Fe-rich fast ice on regional biogeochemical processes, especially when it becomes pack ice post-breakup, remains unclear. Using 18 years (2000~2018) of fast ice distribution data in conjunction with sea ice velocity data, the trajectory of broken-out fast ice (ex-fast ice) was calculated. We found that ex-fast ice largely stays on-shelf. Using ocean colour data, the Fe fertilization potential was assessed by determining the timing of fast ice breaking and following the subsequent decay. The analysis indicates the presence of two peaks in summer chlorophyll-a (chl-a) concentration along the Victoria land and Mawson coasts. The first peak may be caused by the pack ice melting, and the second peak may be caused by the combination of disintegrated fast ice melting, removing the light limitation and replenishing Fe to the phytoplankton. The second chlorophyll-a concentration peak has a significant relationship ($R^2=0.60$, $p=0.001$) with the fast ice coverage area in summer. This study contributes to a deeper understanding of the drivers of high concentrations of chl-a observed on the continental shelf of Antarctica.

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Abstract No : 380

Has the calving of the Mertz Glacier Tongue affected zooplankton community structure in a region of variable fast ice?

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In Antarctica, the fast ice environment is not only biologically and ecologically important but is also highly variable in space and time, which has important implications for the wider Antarctic coastal ecosystem. The calving of the Mertz Glacier Tongue (MGT) in February 2010 is one example of the changes that can occur within a fast ice environment, however, the effects of this event on the local biology – specifically zooplankton community structure – is poorly understood. This study investigated changes to the physical environment and to the zooplankton community structure before and after the calving event and aimed to identify any links between environmental controls and zooplankton community assembly. A significant difference in the zooplankton community structure between the two periods was detected, and zooplankton abundance also increased steadily in the decade following the calving of the MGT. It was found that winds typically blow from the southeast in the region, however, a storm in February 2010 was found to predominantly blow from the northeast, which may have contributed to the build-up of fast ice following the calving event. This meant that the region was then occupied by perennial sea ice, which likely drove a shift in the zooplankton community structure and may also have facilitated the observed increase in zooplankton abundance. The eventual break-up of the perennial ice in 2015 was followed by a large increase in zooplankton diversity. Overall, these results indicate a clear relationship between the fast ice environment and the zooplankton community structure in the region.

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Abstract No : 377

Hot spots in the ice: revealing relationships between marine ecosystems and sea ice in coastal Antarctica

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Polynyas – open water areas within the sea ice – are unique Antarctic features and likely hot spots of high biological productivity, yet they remain understudied. Connections between coastal polynyas and primary and secondary biological production are important to quantify in both present and future climate conditions. This presentation will describe novel ways in which satellite observations and coupled Earth-System-Models are being used to aid in quantifying the importance of specific areas for sustaining Antarctic ecosystems. In particular, we use a Community Earth System Model forced ocean-sea ice hindcast simulation spanning 1958–2018 that includes biogeochemistry and an expanded marine ecosystem. Specifically, we simulate multiple small and large phytoplankton and zooplankton types, allowing us to better estimate potential food resources for upper trophic levels. We present regional identification, statistics, and variability of Antarctic coastal polynyas based on both long term satellite observations of sea ice concentrations, as well as within the model hindcast. We assess the primary and secondary production by phytoplankton and zooplankton, respectively, within the polynya zones as compared to the general sea ice zone and find that primary and secondary production is generally elevated within polynya regions. We also address measures of sea ice and biogeochemical predictability within the polynya zones on seasonal to interannual timescales, and how these connections are important for identifying possible changes to biological systems within polynya zones. Finally, we evaluate the physical and biological covariance between polynya zones around the Antarctic continent to determine the important spatial linkages between physical features and similar

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Abstract No : 304

Temperature, salinity, and pH in surface waters of Admiralty Bay, Antarctic Peninsula, during an atmospheric temperature record in summer 2020

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Admiralty Bay, located on King George Island, Antarctic Peninsula, is the first Antarctic Specially Managed Area and includes the Antarctic Specially Protected Area no. 128 established to protect areas featuring important or rare assemblages of species from unpredicted and potentially hazardous human activities. This study aimed to evaluate the temperature, salinity, and pH in 20 surface water samples and compare them with previous studies in Admiralty Bay. Data were collected when the atmospheric temperature reached maximum historical values in Antarctica, in the summer of 2020. The results indicated high values of sea surface temperature, varying between 2.50 and 6.70 °C (mean \pm standard deviation = 4.32 ± 0.99 °C). The minimum sea surface temperature detected in this study was higher than the maximum temperature recorded in other studies in Admiralty Bay, even including analysis at the end of summer. This period is generally characterized by higher temperatures due to increased solar incidence, atmospheric temperature, and defrost. Salinity presented the minimum values compared to previous studies, varying between 30.9 and 34.0 (32.7 ± 0.75), these low values suggest that all analyzed bay areas were under the influence of defrost water. The salinity values did not indicate a high variability between samples, the same was detected for pH, which ranged from 7.60 and 8.10 (7.85 ± 0.12). Considering that in recent decades the Antarctic continent has been facing accelerated warming, reporting these data could contribute to the understanding of the possible effects of this event on a local scale.

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Abstract No : 538

Primary production by algae in Antarctic sea-ice: spatio-temporal comparison between a sea-ice biogeochemical model and a satellite-based light penetration index

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Sea ice algae in the Southern Ocean have strong ecological and biogeochemical significance but estimating seasonal or interannual changes in ice algal production at the Antarctic circumpolar scale is challenging because of high spatio-temporal variability and invisibility of sea ice algae to remote-sensing methods. A simple satellite-based index of potential primary production by ice algae has been developed and successfully validated against two models of ice algal production. The satellite-based index is based on the product of ice concentration and irradiance penetrating into sea ice, with differential quantum yield of sea ice algae in summer and in other seasons. Satellite-based estimates of surface reflectance and sea-surface light intensity were taken from the International Satellite Cloud Climatology Project (ISCCP) H-series. In this presentation we describe two advances to this approach. First, we compare the satellite-based index of potential ice algal production with estimates of ice algal production from the ACCESS-OM2-BGC (Australian Community Climate and Earth System Simulator) 0.1 degree model coupled with the CICEv5.1.2 BGC model for sea ice biota and WOMBAT for ocean BGC (courtesy of Consortium for Ocean–Sea Ice Modelling in Australia). Second, we explore alternatives to ISCCP in order to extend the time series of estimated ice algal production beyond June 2017 (beyond which the ISCCP data is not currently available). By leveraging the long-term commitment to Earth observation by the global research community, the satellite-based ice algal production index can help track and understand spatial and seasonal changes to Southern Ocean ecosystems.

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Abstract No : 223

Incorporation of phytoplankton into newly-formed sea ice in Dalton Polynya and off Totten Ice Shelf (Southern Ocean) during late summer

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Newly-formed sea ice incorporates significant amounts of protists, organic matter, and trace metals from the underlying seawater. This initial incorporation influences the ice-algal phenology and biomass subsequently released when the sea ice melts in spring/summer. Previous studies reported wide range for chlorophyll *a* (chl *a*) concentration in new ice (0.0–26.8 µg/L), presumably due to different degrees of physical incorporation of phytoplankton. Relatively little is known about algal incorporation relative to ice texture (granular vs columnar) for thin (< 0.1 m) sea ice in the Southern Ocean. Hence, observations of new ice, 1st-year or multi-year ice (FYI/MYI), and seawater were conducted in East Antarctic coastal areas from late February–early March of 2018 and 2020. We investigated the species composition and enrichment of phytoplankton (chl *a* or biogenic silica: BSi) in relation to texture (proportion of granular ice thickness [%]) and stable oxygen isotopes of sea ice. The chl *a* and BSi concentration of new ice ranged 0.2–11.6 µg/L and 0.03–10.1 µmol/L, respectively, being significantly higher than those in seawater. Neither chl *a* nor BSi enrichment was positively correlated with the presence of granular ice layer of new ice, implying other factors, e.g., sea surface temperature, wind speed and sea-state (calm vs turbulent) may be important for late-summer phytoplankton incorporation. The clustering analysis based on the algal compositions of all samples (FYI/MYI, new ice, and seawater) implied that ice algae released from FYI/MYI was incorporated in new ice, which may influence the variability of algal enrichment into new ice.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

LIFE SCIENCES

**Chemicals of emerging
Antarctic concern; a rising tide in
a warming climate**

CONVENORS

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Accepted as: Oral Presentation

Abstract No : 768

Perfluoralkylated substances: an investigation of oceanic transport across the Antarctic Circumpolar Current

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Perfluorinated alkyl substances (PFAS) are diverse group of synthetic chemicals, listed under the Stockholm Convention on Persistent Organic Pollutants (POPs). They are widely used in industry and consumer products, such as water repellent coating and fire-fighting foam. Atmospheric transport of precursor PFAS compounds and oceanic transport of PFAS are known to facilitate their long range environmental movement, but primary input pathways of the chemicals to Antarctica and the Southern Ocean are unknown. The Antarctic Circumpolar Current (ACC) is a physical barrier that surrounds the entire Antarctic continent. It stretches from the surface to the bottom of the seafloor allowing minimal mixing with the surrounding oceans. Oceanic transport of PFAS south of the ACC is therefore expected to be slow. To investigate present day input, sampling campaigns were carried out between Australia and the Antarctic continent from 2011 to 2015; surface water was collected at every degree of latitude until the Polar Front Zone, where the samples were taken every half-degree. Predictably, a declining trend between the Australian mainland and south of the ACC was observed, albeit with frequent peaks near the Antarctic continent. PFAS were detected in every sample, with a dominance of perfluorooctanoic acid (PFOA). These findings support both long range oceanic transport, as well as local Antarctic emissions of PFAS. However, the concentrations obtained (up to 9 ng L⁻¹) were higher than previous studies in the same area and depth. Hence, a survey was conducted on the quality of the sampling to propose a correction the data obtained.

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Abstract No : 839

Microplastics in Antarctic snow

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Microplastics are becoming an ever-increasing threat globally, with atmospheric transport allowing them to reach remote and sensitive environments previously thought untouched by plastic pollution. Antarctica's limited accessibility and uninhabitable environment has often left us believing that anthropogenic changes experienced in other regions of the world may not be felt as strongly in this isolated continent. To understand how widespread microplastic pollution is in the Antarctic we undertook a field study in the Ross Island region of Antarctica. Snow samples were collected from 19 different sites across the Ross Island region, suspected microplastic particles were isolated and their composition confirmed using micro-Fourier transform infrared spectroscopy (μ FTIR). Average concentrations of 29 particles L⁻¹ melted snow were found. To understand the potential sources into the environment, both long range transportation and local inputs were explored. This talk will expand on the findings of this research, as well as the wider implications to the Antarctic environment and the path forward for microplastic research in remote regions.

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Abstract No : 906

Occurrence and characterization of microplastic particles from carcasses of Adélie penguin collected from Antarctic region

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Anthropogenic microplastic (<5mm in size) has been widely reported as an emerging threat for pristine ecosystems of Arctic and Antarctic. This study first time reports about the occurrence of microplastic in the carcasses of Adélie penguin (*Pygoscelis adeliae*) collected during 39th Indian Scientific Expedition to Antarctica, by examining their gastrointestinal tracts, scats and five different organs (liver, lung, muscle, trachea and spleen). It highlights the presence of 34 microplastic particles in gut, scat, lung and trachea but no microplastic were detected in muscle, liver and spleen. Stereomicroscopic analysis shows microplastic fibres as a predominant shape in the samples. <1mm sized particles and blue coloured microplastics were most common in the present study. μ -FTIR analysis identified 5 different types of polymers (LDPE, Polyisoprene Rubber, Polyacrylamide, Ethylene/Propylene copolymer and PVC) of which LDPE was the most prevalent type (63%). Existence of microplastic within lung and trachea might be due to the entry and deposition of air-born microplastic. Although no data has available on the presence of MP in the Antarctic aerial system, we speculate that microplastic pollution in the aerial system might be due to increased load of microplastics in marine and terrestrial systems. Thus, the study established the invasion of anthropogenic plastics in Adélie penguins, affecting the delicate food chain of the Antarctic ecosystem.

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Abstract No : 867

New and legacy persistent organic pollutants (POPs) in breeding seabirds from the East Antarctic

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Persistent organic pollutants (POPs) are a pervasive, significant threat to polar regions. Yet, within Antarctica, there are significant geographical gaps recording POPs contamination in living seabird populations and studies focussed on emerging contaminants is still a developing field. Blood concentrations offer a snapshot of contamination within live populations, and have been used widely for Arctic and northern hemisphere seabird species but less so in Antarctica. This research presents baseline concentrations of both legacy POPs and some emerging contaminants, brominated flame retardants (BFRs), in the blood of five Antarctic seabird species breeding within Prydz Bay, East Antarctica. Legacy polychlorinated biphenyls (PCBs) and organochlorine pesticides (OCPs) were detected in all species sampled, with Adélie penguins showing comparatively high Σ PCB levels (61.1 ± 87.6 ng/g wet weight (ww)) compared to the four species of flying seabirds except the snow petrel (22.5 ± 15.5 ng/g ww), highlighting that legacy POPs are still present within Antarctic wildlife despite decades-long bans. Polybrominated diphenyl ethers (PBDEs) were detected in all species (range 0.7–55.2 ng/g) and hexabromobenzene (HBB) was quantified in cape petrels (0.3 ± 0.2 ng/g ww) and snow petrels (0.2 ± 0.1 ng/g ww), comparable to concentrations found in Arctic seabirds. Comparisons between the two polar regions highlight the value of using blood sampling to compare contaminant levels between species on a globally relevant scale. These results fill a significant data gap within the Antarctic region for POPs studies, adding to the growing body of evidence indicating the increasing chemical contamination of the Antarctic environment.

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Abstract No : 72

Inventory of unintentional POPs emission in Antarctica

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Persistent organic pollutants (POPs) are a group of toxic chemical substances which are considered a global issue and are regulated by Stockholm Convention on POPs. In spite of remote location and very limited human activities, Antarctica is affected by POPs due to their long range transport and unintentional formation from local anthropogenic sources. Despite of long history of investigation of POPs in Antarctic environment, there is a significant knowledge gap in assessment of POPs emission at this continent. In the paper the results of the first inventory of unintentional POPs emission from anthropogenic sources in Antarctica are presented. Assessment of dioxin/furans (PCDD/Fs) emission in different media, as well as polychlorinated biphenyls (PCBs) and hexachlorobenzene (HCB) in the air, based on application of emission factors and indicators of human activity levels was made. The following sources of POPs emission have been assessed: power generation and heating, waste incineration, mobile sources and open burning of waste (in the past). Assessments have been made for modern period and preliminary for the late 1980s. According to the data obtained, waste incineration makes the greatest contribution into the POPs emission. Comparison of PCDD/Fs emissions in Antarctica with emission in gateway countries is made. Dramatic decrease of POPs emission over 30-year period is established. It is shown, that further measures should be undertaken aimed at reduction of POPs emission in Antarctica, including flue gases abatement systems installation, application of better waste incineration practices, as well as introduction of regular POPs emission control and reporting.

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Abstract No : 599

Assessing single and combined exposures to nanoplastics and nanometals in oxygen consumption, lipids peroxidation and proteins carbonylation in *Laternula elliptica*

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An increasing amount of evidence shows that micro- and nano-plastic are present in the Southern Ocean and Antarctic sea ice. On another hand, nanometal particles have been found in tourist areas such as Mediterranean coasts, and the augmented number of anthropogenic activities in Antarctica could allow these nanoparticles to reach the Southern Ocean. Antarctic filter-feeding bivalves are key organisms coupling pelagic-benthic energy flow and accumulate chemicals and particles dissolved in water. The aim of the present study is to evaluate the biochemicals and macro-physiology effects of nano-polystyrene and nano-titanium-dioxide in single and combined exposures (5 and 50 µg/ml), in the Antarctic soft clam *Laternula elliptica*. This work assesses the impact of Reactive Oxygen Species (ROS) after nanoparticle exposures in lipid and protein damages measuring lipid peroxidation product (malondialdehyde) and protein carbonylation, respectively. Oxygen consumption was also investigated to detect physiological alterations such as changes in metabolism. Lipid peroxidation and protein carbonylation were significantly affected in gills by nanoparticle exposures, nevertheless no effect was detected in digestive glands. Interestingly, Oxygen consumptions were affected by co-exposures nanoplastic and nanometal at the two concentrations applied, with a significant decrease. Oxidative stress has been previously reported for other aquatic metazoans exposed to nanoplastic and nanometal, and this study confirms that lipid and protein damage by ROS in clam gills. Since few studies have assessed the combined effect of two nanoparticles, this constitutes the first work showing that a nanometal and nanoplastic co-exposure affects oxygen consumption, suggesting a synergetic mechanism decreasing metabolism.

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Abstract No : 21

Perchlorate occurrence at different points in Antarctica during 2017–2020

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Perchlorate is an emerging naturally occurring contaminant in Antarctica that affects thyroid function by inhibiting iodine uptake; which is frequently detected in different ecosystems in concentrations relevant to human health and biota. In this study, we measured the perchlorate concentrations of 3000 samples of marine sediments, using a selective electrode; during the months of January to March 2017, 2018, 2019 and 2020, during the 3rd, 4th, 5th and 6th Colombian Scientific Expedition to Antarctica. The sampling areas were located at fifteen points, in the South Shetland Islands, including the Livingston Islands, Byers Peninsula, Deception Island, King George Island and Half Moon Island, and in the Antarctic Peninsula it was measured at Punta Cierva, Petermann Island, Goudier Island, Neko Harbor, Danco Island, Couverville Island, Palmer Archipelago, Avian Island, Horseshoe Island, and Lagotellerie Island. The concentration data show that perchlorate reached a minimum concentration of 90 ppm on Horseshoe Island and a maximum concentration of 465 ppm on Deception Island, which suggests a spatial variation in perchlorate concentrations, attributed to the natural formation of this contaminant. due to volcanic eruptions. Furthermore, a homogeneous distribution of perchlorate is not observed in Antarctica.

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Abstract No : 823

First Comparison of Humpback Whale (*Megaptera novaeangliae*) Phthalate Burdens in High and Low Pollution Areas

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With demand for plastic products only increasing, so too is the prevalence of toxic plastic additives within the marine environment. Phthalates are a type of plasticiser and leach readily into the environment following minor changes in abiotic factors such as temperature and pH. Phthalate exposure has been linked to cancer and decreased reproductive success, however, there is very little research regarding the phthalate exposure of filter-feeding megafauna. The combination of the feeding strategy and extreme energy demands of large filter-feeding cetaceans such as humpback whales, make them particularly vulnerable to phthalate exposure. As such, this study sought to compare the phthalate burdens of two humpback whale populations: the EI population that migrates between their Antarctic feeding grounds and their breeding grounds in north-east Queensland, Australia, and the NA population that migrate through the North Atlantic garbage patch off the coast of Bermuda. Blubber samples were collected from each population and the concentrations of eight phthalates were quantified via gas chromatography-mass spectrometry analysis. Only DEHP and DIBP were consistently detected in levels exceeding their respective LODs. DEHP was the most abundant phthalate amongst both populations, with the NA population having the higher mean concentration. In contrast, mean concentrations of DIBP were higher in the EI population. This was unexpected, given the higher pollution levels of the NA populations migratory path. This study sought to facilitate a greater understanding of the phthalate exposure of humpback whales by comparing the phthalate burdens of two geographically distinct populations.

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Abstract No : 878

Influence of climate change on bioaccumulation pattern of legacy and emerging persistent organic pollutants in Antarctica

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The Antarctic marine ecosystems are fragile, meaning that even small variations can cause extreme changes; they also show low resilience. In this context, the climate crisis can have a devastating impact on the Antarctic ecosystems, including effects on food web structure and availability of food resources that may shift the trophic position of organisms and consequently the POP bioaccumulation pattern. A review was conducted as part of the AMAP assessment POPs and Chemicals of Emerging Arctic Concern (CEACs): Influence of climate change. Although no POP time series exist for Antarctic biota, we focussed on studies that linked contaminant concentrations with biological parameters (e.g. trophic and reproductive habits). The peculiarity of the marine Antarctic ecosystems and the effects of the pelagic-benthic coupling leave still open the question whether the POP amount accumulated in the Antarctic ecosystems is decreasing or not depending on the climate-driven changes. Main goal of our projects is to establish a comprehensive toolbox for evaluating the distribution and accumulation of inorganic and organic pollutants in different Antarctic ecosystems, focusing on both the role of the criopelagic community and bioaccumulation in predators to support resilience and adaptation of these ecosystems to changes, starting point for a sustainable development. Such understanding will become increasingly important in environmental management in the future, by identifying hotspots where species ranges need to be most sensitive to climatic variability. A bipolar approach will improve our knowledge capacity, to see how the Polar Regions are reacting to the effect of climate change on contamination.

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Abstract No : 351

Toxic Anthropogenic Signature of Pesticides in the Surficial Sediments of Prydz Bay, East Antarctica

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Anthropogenic activities especially the industrial activity generates a lot of harmful chemicals which show the nature of trans - boundary pollution. They get transported via aerial and water currents to long distances where the ultimate deposition takes place. The remoteness and the apparent geophysical isolation developed with the flows of the Antarctic circumpolar current and the ring of westerly winds surrounding the continent makes Antarctica a pristine environment, but most surprisingly there are reports of harmful chemicals from these untouched habitats. Long-range atmospheric transport (LRAT) of pollutants has been detected in the Antarctic since the 70's. POPs (e.g., polycyclic aromatic hydrocarbons (PAHs), polychlorobiphenyls (PCB), organochlorine pesticides) have been detected along the Antarctic trophic food, however, there exist scarce information about their presence in marine sediments of this region. This paper focuses on the distribution of pesticides in Prydz Bay, the Indian sector of the Southern Ocean during the austral summer period. The pesticides detected are Diuron, HCB, Dichloran, BHC β , Chlorpyrifos, Pendimethalin and p,p'-DDD. The presence of Diuron (3-(3, 4-dichlorophenyl)-1,1-dimethylurea) was observed in the eastern as well as western side of Prydz Bay. In the station SOE-32 presence of Diuron, HCB, Pendimethalin and p.p' - DDD was observed. Long-range atmospheric transport (LART) from the neighbouring countries or re-emission from melting glacier act as a major contributor towards the input of pesticides. The presence of Pendimethaline - a di-nitro aniline compound as well as chlorpyrifos, an organophosphate pesticide was detected from the sediments along with other organochlorine compounds.



SCAR 2022

Antarctica in a Changing World

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**Solutions to pollution:
contaminant impacts and
remediation in Antarctica**

CONVENORS

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Abstract No : 562

Occurrence of Coliform and Faecal coliform Bacteria in Lake Water Samples Collected From Larsemann Hills Area Over East Antarctica

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Antarctica waters are being polluted due to anthropogenic activities caused by various research activities. The Larsemann Hills area contains more than 150 lakes on different islands and peninsulas. Coliform bacteria are not pathogens themselves but their presence indicates the possibility of finding pathogens. In contrast, Faecal coliform bacteria such as *Escherichia coli* are found in faeces, and their presence in drinking water indicates faecal contamination. In the present study, eleven lake water samples were analyzed to study coliform and faecal coliform bacteria. Out of six lake water samples collected during the 34th Indian Scientific Expedition to Antarctica (ISEA), four samples were found to be contaminated with coliform bacteria, however, Faecal coliform was absent when tested with selective media. MPN coliform was found to be present in two out of five samples collected during the 35th ISEA. Faecal coliform was absent in all samples. The presence of MPN coliform indicates the degree of pollution and sanitary quality of lake water. Coliform contaminations are found in the lakes which are in the vicinity of those areas which are regularly accessible. However, there are other factors that may lead to coliform contamination such as the migration of microbes through birds and the transport of food items from ships to research stations. Similarly, the presence of coliform in Brookness Peninsular and McLeod Island lakes is for the same reason. Moreover, the presence of coliform bacteria in the samples indicates an alarming situation and needs to be investigated further.

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Abstract No : 92

MARINE MICRODEBRIS IN SURFACE WATERS OF LIVINGSTON ISLAND (SOUTH SHETLAND ISLANDS, ANTARCTICA)

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Marine microdebris are found worldwide. The Southern Ocean, still considered a pristine region, is not exempt of this contamination. Due to the huge environmental impact and lack of information about these debris, there is a strong need of research, particularly in Antarctica. Here we report for the first time microdebris items in the surface waters of Livingston Island (South Shetland Islands, Antarctica). We investigated their abundance, characteristics, and distribution along two bays: South Bay and False Bay, the first with clear human activity due to the presence of two research stations and vessels traffic, including tourism, and the second being pristine. No clear distribution patterns were found. Microdebris ranged from 0,05 to 0,59 items / m³. The most common shapes were fibers followed by fragments. A redundant majority of those items had a dominant short length ranged from <0,1 mm to 0,99 mm. Black and blue were the main colors. Regarding the polymer types, we found mainly polyester fibers and polyethylene fragments. Considering all these results, we propose that the main sources of pollution are probably local: tourism and scientific research stations, as well as fisheries. We urge for proper management policies to protect the Antarctic environment and its organisms. Further research is needed to keep filling the gaps that escape our knowledge yet. Key words: Southern Ocean, Pollution, Microdebris, Environmental risk, Waste management

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Abstract No : 281

Modelling the transport of microplastic pollution in the Southern Ocean

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Microplastic pollution is widely accepted to be a ubiquitous environmental contaminant, with microplastics recorded in a range of marine environments across the world. The Southern Ocean is no different, with a number of studies reporting microplastic pollution in the region, including south of the Antarctic Circumpolar Current (ACC). However, given the expense and difficulty associated with collecting data on microplastic abundance in the Southern Ocean, combined with the majority of previous research focusing on the Antarctic Peninsula, there are large areas of the Southern Ocean where plastic concentrations are unknown. The transport pathways and processes that drive transport of microplastic pollution across the ACC are similarly unknown. To tackle these knowledge gaps, we use a modelling approach to simulate transport pathways of plastic debris in the Southern Ocean, with a focus on the cross-ACC transport of microplastics. Specifically, we use the Lagrangian particle tracking framework Ocean Parcels, forced with ocean velocity fields from a Southern Ocean configuration of NEMO-LIM3 with 1/12 degree horizontal resolution. By including Stokes drift, sub-grid scale diffusion and sea ice drift alongside the ocean currents, we aim to better understand how and where microplastics may cross the ACC and identify regions of the Southern Ocean where microplastic pollution may accumulate. This will allow improved targeting of future research into microplastic pollution impacts in the Southern Ocean.

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Abstract No : 818

BIODEGRADATION OF DIESEL HYDROCARBONS BY FRESHWATER MICROALGAE ISOLATED NEAR O'HIGGINS STATION, NORTH-WEST ANTARCTIC PENINSULA

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Sources of diesel contamination in Antarctica include long-distance transportation, local spillages and release of stored contaminants as ice melt accelerates. These contaminants typically persist in cold ecosystems such as those of Antarctica, for long periods. While research has increasingly examined the ability of indigenous bacteria to break down hydrocarbons, Antarctica's algal communities have received less attention. In this study, 12 terrestrial (soil and freshwater) Antarctic microalgal samples were isolated from samples obtained near the Chilean Bernardo O'Higgins Station (north-west Antarctic Peninsula). Their diesel degradation potential was assessed using 10% (v/v) algal culture in Bold's Basal medium supplemented with 1.0% (v/v) diesel. The culture was maintained at 10°C with aeration, illuminated with a fluorescent lamp (42 $\mu\text{mol}/\text{m}^2/\text{s}$) on a 12:12h light-dark cycle. Algal cell concentration was measured using UV-visible spectroscopy at 620 nm and diesel degradation was determined gravimetrically. Diesel biodegradation conditions were optimised using the conventional one-factor-at-a-time (OFAT) approach, testing different nitrogen sources, salinity, pH, and initial diesel concentration. The highest diesel degradation ($85.05 \pm 2.41\%$ (v/v)) was achieved by the algal culture ref BO-11 isolate. Optimum conditions of NaCl (25 mM w/v or 1.5 ppt salinity), pH (7.5) and initial diesel concentration (1.0% v/v) were identified in the analyses. Application of a polyphasic approach comprising morphological and molecular examination will be used to confirm the identity of the BO-11 algal culture. The data obtained in this study confirm the ability of Antarctic microalgae to degrade diesel hydrocarbons and provide a foundation for future novel bioremediation studies in Antarctica.

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Abstract No : 261

Interactive effects of exposure to metals and elevated temperatures under a warming climate on an Antarctic marine ostracod

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While concentrations of contaminants in Antarctic marine waters are typically low, a number of coastal sites, such as those adjacent to past waste disposal tips at research stations have increased levels of contaminants, including the metals cadmium, copper, lead, and zinc. To assess the risk associated with mobilisation of these metals in meltwater streams into the marine environment, chronic toxicity of metals to a common Antarctic ostracod (*Bradleya antarctica*) were examined. Tests were conducted at 0°C; representative of current environmental conditions. For copper, two elevated temperatures were also tested (2 and 4°C) to assess potential interactive effects of exposure under elevated temperatures. Ostracods were exposed to metals for 10 weeks, with periodic observations of behaviour and survival throughout the testing period. Sub-lethal behavioural responses were observed in the first week of exposure; however, there was no significant mortality observed up to 10 days. Toxicity increased with exposure time, up to 10 weeks, with 50% Lethal Concentrations (LC50) for these long exposures comparable to those reported for related temperate species over shorter exposures of only 10 days. The response of Antarctic ostracods to metals was therefore delayed, and may in part be attributed to reduced metabolic rate that is characteristic of Antarctic marine invertebrates living at constant low temperatures. Sensitivity to copper increased under the higher temperatures, indicating that, under a warming climate, these Antarctic biota may be subject to elevated risk if exposed to contaminants.

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Abstract No : 1057

Investigating potential intergenerational effects of nanoplastic on the lipid reserves of Antarctic krill embryos

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Plastic pollution has been acknowledged as a potential threat to Southern Ocean marine ecosystems. The effect of nanoplastics ($<1\ \mu\text{m}$) are less well studied than microplastic but deleterious consequences can be higher due to their small size enabling permeation of cell membranes and provoking toxicity. Antarctic krill (*Euphausia superba*) plays a central role in the Antarctic marine food web and biogeochemical cycles and has been identified as a potentially vulnerable species to plastic pollution. Here, we assessed the intergenerational impact of polystyrene nanoplastic (50 nm) on krill embryos, subjecting maternally exposed versus control embryos to further direct nanoplastic exposures. Nanoplastic did not impact the total lipid, or fatty acid composition across maternal treatments or direct embryo treatments, and no interactive effects were observed. The provision of a food source during maternal exposure had a positive effect on fatty acids, which are identified to be important during embryogenesis, including higher total PUFA, eicosapentaenoic acid (EPA), docosahexaenoic acid (DHA) and EPA/DHA ratio when compared to the control. Whilst the short exposure time was ample for digested material of the flagellate to be incorporated into embryos, we discuss why the nanoplastic/ fatty acid relationship may be more complex, addressing species breeding strategy and nanoplastic surface properties, among other factors. Our study is the first to scope intergeneration effects of nanoplastic on the lipid and fatty acid reserves of krill. From this, we provide suggested directions for future research.

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Abstract No : 964

Examining the environmental footprints of McMurdo and Palmer Stations, Antarctica

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While the term “footprint” is commonly used in Antarctic environmental research, only recently has research been done to help develop a common understanding of its meaning. This recent work provides an ideal framework for synthesizing over 15 years of environmental monitoring observations made at McMurdo Station and for a shorter period at Palmer Station. These two stations span the range of station sizes found on the continent – from a mid-size peninsular station to the largest human occupancy on the continent. Extensive field work coupled with Geographic Information Systems (GIS) and remote sensing analysis has enabled the spatial extent of multiple overlapping footprints (geochemical, building, ground disturbance) at these two stations to be defined that adhere to the newly established “footprint” definitions. After delineation of individual “footprints” (e.g., total petroleum hydrocarbons or buildings) a systematic analysis of their overlap was undertaken. Typically, areas heavily impacted by human activities at both stations are found to occur within multiple “footprints.” A methodology to employ GIS overlay operations as straightforward means of producing a hierarchical assessment of impact for a station and its environs was developed. As accurate estimates of two footprints (buildings and ground disturbance) exist for both stations from their construction until present, including early expansion of the each stations footprint followed by their relative stability in more later years, temporal trends in these two “footprints” will be described in detail.

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Abstract No : 74

Surface snow chemical composition monitoring in Vecherny Oasis, Thala Hills, East Antarctica

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Surface snow sampling is a cost-effective method to monitor human activities impact as well as environmental changes and trends. Surface snow monitoring in the Vecherny Oasis, Thala Hills, East Antarctica has been conducted since 2012 as a part of environmental monitoring for evaluation of Belarusian Antarctic Station impact in accordance with requirements of the Protocol on Environmental Protection to the Antarctic Treaty. The network for snow sampling covers an area with human activities and background area (ice sheet edge) includes about 25 points. Snow samples are collected during austral summers by seasonal Belarusian Antarctic expeditions. Content of main ions, about 20 trace elements, pH and electrical conductivity are analyzed. Snow observations are made in connection with lakes and soils observation networks. The results have shown that the snow of the Vecherny Oasis, which is slightly acidic and very low-mineralized sodium chloride is characterised by high spatial and temporal variability of main ions and trace elements content. The elevated average concentration of trace elements as well as sulfate ion in surface snow within the human impacted areas has been revealed. Based on the concentration of elements and enrichment factors, the anthropogenic origin of Sb, Se, As, Cd, Zn, Cr, Cu, Mo, V and Pb in the snow is supposed. Impact of local sources of the modern (station construction and logistics) and past (airfield base and airfield operation) activities is considered for interpretation of observed snow chemical composition variations.

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Abstract No : 396

Plastic microfibers in wild specimens of the Antarctic whelk *Neobuccinum eatoni* (Smith, 1875) from Terra Nova Bay (Ross Sea, Antarctica)

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Antarctica has been affected directly and indirectly by human pressure for more than two centuries and recently plastic pollution has been recognized as a further potential threat for its unique biodiversity. Global long-range transport as well as local input from anthropogenic activities are potential sources of plastic pollution in both terrestrial and marine Antarctic territories. The present study evaluated the presence of microplastic in specimens of the Antarctic whelk *Neobuccinum eatoni*, a key species in benthic communities of the Ross Sea, one of the largest marine protected areas worldwide. To this aim, a thermo-oxidative extraction method was applied for microplastic isolation and quantification and polymer identification in a representative sub-sample was performed by manual μ -FTIR spectroscopy. Microplastics were found in 33.3% of whelk specimens, suggesting a low risk of bioaccumulation along Antarctic benthic food webs in the Ross Sea. Colored fibers (length range: 0.2–5 mm) were the most common shape (88.2%) extracted from *N. eatoni*. Their polymer composition (of polyethylene terephthalate or cellulose-based composites) matched those of selected textile fibers from outdoor technical clothing in use by the personnel of the Italian “Mario Zucchelli” station near Terra Nova Bay in the Ross Sea. Such findings indicate that waste waters from base stations may act as potential local sources of textile fibers in this remote environment. More in-depth monitoring studies aiming at defining the extent of microfibers contamination related to such sources in Antarctica are encouraged in order to define mitigation actions and avoid potential impacts on marine biodiversity.

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Abstract No : 667

TAXONOMIC IDENTIFICATION AND PHYTOREMEDIATION MECHANISMS OF AN ANTARCTIC MICROALGA ACTING ON DIESEL HYDROCARBONS

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Microalgae are well known for their metal sorption capacity, but their potential in the remediation of organic compounds such as diesel has received little attention to date in polar regions. In this study, a microalga isolated from Greenwich Island, South Shetland Islands, maritime Antarctica was identified, screened and characterised in order to help understand its remediation mechanisms towards diesel hydrocarbons. The isolated microalga grown in culture had a morphology conforming to *Stichococcus bacillaris* Nägeli 1849. The cells are characterised by a hydrophobic nature and a more negative surface charge based on microbial adhesion to hydrocarbons (MATH) analysis. Microalgal culture was grown in Bold's Basal Medium enriched with 1% v/v diesel for nine days. Gravimetric analysis showed that biodegradation is the primary mechanism, facilitated by biosorption. Both processes accelerated on the fifth day in culture, consistent with the log-growth phase. Gas chromatography with flame-ionization detection (GC-FID) analysis showed that the microalga degraded predominantly medium length alkanes and a noticeable reduction of C-21 alkanes was observed. Diesel is a mixture of paraffinic, naphthenic and aromatic hydrocarbons, hence the detection of other compounds using GC-MS and/or GC-FID is now required to obtain a comprehensive degradation profile.

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Abstract No : 821

Novel *Pseudomonas silesiensis*, a heavy metal tolerant and hydrocarbon-degrading Antarctic bacteria with bioremediation potential, selected using a new solid media capable of screening and insolation of hydrocarbon-degrading bacteria

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The Antarctic continent currently faces high levels of Diesel related pollution, including heavy metals and hydrocarbons such as the toxic and recalcitrant PAHs. Despite small scale, although effective remediation efforts using physical and chemical methods, no significant advances in the remediation of antarctica have been made, mainly due to difficult implementation and high cost. On the other hand, Bioremediation, which uses microorganisms for the biodegradation of these pollutants, lacks these drawbacks, however, heavy metal co-contamination negatively impacts hydrocarbon biodegradation. With these antecedents, we set to find microorganisms capable of hydrocarbon biodegradation in the presence of heavy metals. First, we developed a solid media capable of easily screen and isolate hydrocarbon degrading bacteria in the presence of heavy metals, such as cadmium. This media allowed us to select *Pseudomonas silesiensis* 68, a bacteria isolated from Diesel polluted soil in Antarctica, which was able to degrade Diesel and phenanthrene in the presence of cadmium. Further testing showed that the *Pseudomonas* not only was tolerant to cadmium, but the presence of the mentioned hydrocarbons increased its metal tolerance twofold, from 250 µg/mL to over 500 µg/mL. This result led us to investigate if the *Pseudomonas* could decrease the available cadmium by biomineralizing the metal, via semiconductor fluorescent nanoparticles (quantum dots) synthesis. We found that *Pseudomonas silesiensis* was capable of intracellular and extracellular cadmium quantum dots synthesis, thus decreasing its availability. These results indicate that *Pseudomonas silesiensis* 68 could be a promising Antarctic bioremediation agent capable of biodegradation of hydrocarbons and biomineralizing heavy metals.

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Abstract No : 697

Microplastics and other anthropogenic particles in Antarctica: Using penguins as biological samplers

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Microplastics (< 5 mm in size) are known to be widespread in the marine environment but are still poorly studied in Polar Regions, particularly in the Antarctic. As penguins have a wide distribution around Antarctica, three congeneric species: Adélie (*Pygoscelis adeliae*), chinstrap (*Pygoscelis antarcticus*) and gentoo penguins (*Pygoscelis papua*) were selected to evaluate the occurrence of microplastics across the Antarctic Peninsula and Scotia Sea. Scat samples were collected from breeding colonies over seven seasons between 2006 and 2016. Microplastics were found in 15%, 28% and 29% scats of Adélie, chinstrap and gentoo penguin respectively. A total of 92 particles were extracted from the scats ($n = 317$) and 32% ($n = 29$) were chemically identified via μ -FTIR. From all the particles extracted, 35% were identified as microplastics, particularly polyethylene (80%) and polyester (10%). It was not possible to ascertain the identification of the remaining 10% of samples. Other anthropogenic particles were identified in 55% of samples, identified as cellulose fibres. The results show a similar frequency of occurrence of particles across all colonies, suggesting there is no particular point source for microplastic pollution in the Scotia Sea. Additionally, no clear temporal variation in the number of microplastics in penguins was observed. Overall, this study reveals the presence of microplastics across Antarctica, in three penguin species and offers evidence of other anthropogenic particles in high numbers. Further research is needed to better understand the spatio-temporal dynamics, fate and effect of microplastics on these ecosystems, and improve plastic pollution policies in Antarctica.

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Abstract No : 229

Contaminated site risk assessment in Antarctica: application of toxicity tests with native soil micro-invertebrates

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Toxicity tests are used routinely worldwide to assess impacts of contaminated sites, and are fundamental to the derivation of Environmental Quality Guidelines and Remediation Targets. However, to date, few protocols have been developed using native Antarctic species, especially for terrestrial systems, and sensitivity data is limited. *Plectus murrayi* is a common and ecologically important nematode inhabiting Antarctic soils and mosses. For this species, we have optimised culturing techniques, and developed robust toxicity test procedures using the most sensitive juvenile stage, providing a standardised test for use in site-specific Environmental Risk Assessments. Here we present results of toxicity testing for common pollutants including metals and fuels. For copper, nematode response was dependent on life history stage and exposure duration, with sensitivity of juveniles increasing through time, and 50% lethal concentrations (LC50) of 478 and 117 µg/L at 21 and 28 d, respectively. For fuels, toxicity of fresh and aged diesel contaminated soil was assessed in elutriates prepared using soil from Casey station spiked with Antarctic diesel. Fuel ageing and toxicity test exposure concentrations were quantified through a suite of chemical analyses on soils and elutriates. Toxicity was influenced by concentrations of hydrophilic polar and non-polar compounds in elutriates, and proportions of total compounds in the carbon range C10–14, with aged fuel generally less toxic than fresh. Critical effect concentrations for *P. murrayi*, along with other terrestrial biota, contribute valuable data towards development of Soil Quality Guideline Values and Remediation Targets for site restoration and soil reuse at contaminated sites in Antarctica.

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Abstract No : 260

Environmental Risk Assessment of contaminants in Antarctica: How clean is clean enough?

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The Antarctic and subantarctic are generally considered pristine, yet contamination from local and global sources regularly occurs. Contaminated sites from past and present human activities are currently being remediated by Australia, including fuel spills and former waste disposal sites. But when should these sites be considered clean? Ecotoxicological assessments and toxicity tests that determine effects of contaminants on biota are used worldwide as the basis for derivation of Environmental Quality Guidelines, and as lines of evidence in Environmental Risk Assessments. Standardised toxicity tests and Environmental Guidelines are available for temperate and tropical regions, but are not yet developed for Antarctica. Due to the unique properties of Antarctic environments and biota, these guidelines must be based on the response of a representative range of native Antarctic species. Over the past 15 years, the Australian Antarctic Program has developed a suite of traditional and novel ecotoxicological approaches to determine biological responses and the potential risk of contaminants to terrestrial soils and marine waters in Antarctica. Here we summarise progress to date and the process by which concentration-response curves from toxicity tests are used to derive scientifically robust Environmental Guidelines using Species Sensitivity Distribution models. These models predict concentrations that are protective to a certain proportion of the native community, which can be used as Remediation and Clean-up Targets. This work informs environmental decision making in the AAP, and will be incorporated into the Committee for Environmental Protection (CEP) Clean-up manual, and available for use by other Antarctic Treaty nations more broadly.

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Abstract No : 473

Bioremediation of fuel contaminants across Antarctica. Key findings from field-based studies at Argentinian and Australian stations

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In response to the Madrid Protocol (1991), joint signatory nations Australia and Argentina have actively researched and implemented strategies for managing and remediating environmental impacts from human activities in Antarctica. Both nations have ongoing research programs into the effects of contaminants on the Antarctic environment, including the application of bioremediation techniques for hydrocarbon-contaminated soils. Assessing human health and environmental risks and implementing effective bioremediation strategies for hydrocarbon fuels vary depending on a range of contaminant and site-specific factors. The chemical composition of the fuel and its amenability to biodegradation as well as physicochemical and biological characteristics of Antarctic soils influence the assessment of risk and the selection of optimum bioremediation strategies. Through examination of field-scale case studies, we present jointly on the similarities and differences in bioremediation of hydrocarbon contaminated soil in Antarctica, including fuel type and composition (fuels used by Australia and Argentina), environmental conditions (particularly differences between Carlini Station and Casey Station, at opposite sides of Antarctica), soil types, microbial responses, nutrient amendment, and measurement and assessment techniques. Our research demonstrates the Antarctic-wide benefits of international collaboration through development of effective remediation strategies for Antarctica. These findings directly inform the guide for best practice environmental assessment and remediation in Antarctica, the Antarctic Clean-up Manual, developed by the Committee for Environmental Protection to provide scientifically proven guidance that can be applied to the clean-up of a range of impacted sites in Antarctica.

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Abstract No : 185

Sensitivity of Antarctic terrestrial micro-invertebrates to contaminants and environmental stressors

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Antarctica is often perceived to be a pristine environment largely untouched by the impacts of humans. In reality, legacy waste tip sites and human activities at research stations have resulted in localized contamination of terrestrial environments. Antarctic terrestrial micro-invertebrates (including rotifers, tardigrades, nematodes, and mites) are among the most physiologically extreme organisms on Earth, tolerating sub-freezing temperatures and desiccation. While remediation activities conducted by the Australian Antarctic Division are focused on reducing contaminant levels in soils, the actual impact of these contaminants to native biota is largely unknown. Sensitivity estimates based on toxicity tests with local biota are critical to informing remediation targets and to answering the question “how clean is clean-enough?” This project will use direct experimental exposure of selected contaminants found at legacy waste sites in Antarctica to native Antarctic micro-invertebrates. Culturing conditions will be optimized, and a battery of single-species toxicity tests developed for a range of common micro-invertebrates including several bdelloid rotifers, *Acutuncus* tardigrades, and *Scottnema* nematodes. Tests will provide sensitivity data using life history parameters including hatching success, maturity, reproductive output, and survival as end points. The hypothesis that widely distributed generalist species will have higher tolerance thresholds than specialist species will be tested. Novel toxicity tests developed for these organisms will provide essential experimental evidence for risk evaluation, risk assessments and post-remediation risk and efficacy. Results from this project will inform Antarctic contaminated site risk assessments and the development of environmental guidelines and standards for the Australian Antarctic Territory.

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Abstract No : 257

Evidence-based environmental protection for Macquarie Island fuel spill sites by provision of Environmental Quality Guidelines and Remediation Targets

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To ensure effective restoration and environmental protection of remediated fuel spill sites on Macquarie Island, the Australian Antarctic Division has developed site-specific Environmental Quality Guidelines and Remediation Targets. Contemporary best practice ecotoxicological and statistical modelling methods, following Australia/New Zealand Water Quality Guidelines and the National Environmental Protection Measure have been applied. This body of work includes compilation of more than a decade of ecotoxicology research that has produced a comprehensive suite of toxicity tests for a representative range of native biota, including invertebrates, plants and soil microbes. Tests have been conducted using a range of soil conditions, representative of that found on the island (fresh to aged diesel fuel and wide soil carbon range). The most robust and representative sensitivity data were selected for incorporation into a cumulative distribution model. From this model, we quantitatively estimate fuel concentrations that will achieve ecosystem protection at levels appropriate to land use status. Our results estimate that protection of 99% of biota requires concentrations of total hydrocarbons (TPH) in soil not exceed 9.2 mg/kg. Less conservative levels of protection, protective of 90% & 80% of biota, is achieved at 51 & 105 mg TPH/kg soil. The conservative 99% protective concentration may be appropriate for most of the high conservation status area of Macquarie Island, while a lower level of protection may be considered suitable for impacted areas, such as within the station footprint. These site-specific Remediation Targets for Macquarie Island directly inform site management and may be suitable for the broader subantarctic region.

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Abstract No : 323

Levels, sources and influence mechanisms of Copper, Nickel and Zinc in the surficial sediments of Prydz Bay, East Antarctica

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The Antarctic continent is considered one of the most pristine regions on earth, an accelerating human activities in this remote continent, such as scientific operations and the functioning of numerous scientific stations, logistics, and tourism activities, have raised the threats of environmental impacts in recent decades. Trace metal contaminants in Prydz Bay, Antarctica, have rarely been studied and the source and influencing factors are poorly understood. This paper investigates the natural and anthropogenic processes controlling the trace metals (Cu, Ni and Zn) in Prydz Bay, the Indian sector of the Southern Ocean during the austral summer period. The research clearly indicates that the level of trace metals on the eastern side of Prydz Bay is considerably higher than on the western side. A significant surge was observed in the concentration of metal in the fine sediment fraction ($<63\ \mu\text{m}$) than in the total metal fraction. The findings of this investigation clearly show that humans have an impact on the natural environment in this Antarctic region. In the face of the ongoing development of human activities in Antarctica, further effective implementation of a wide range of measures is indispensable, to ensure comprehensive protection of the Antarctic environment.

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Abstract No : 912

Soil microbial communities capable of biodegrading polycyclic aromatic hydrocarbons in the presence of heavy metals

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During the last decades, anthropogenic impact in Antarctica has increased, and to the detriment of the environment. Because the main source of energy is diesel, several areas near the bases have been contaminated due to accidental spills. This fuel contains polycyclic aromatic hydrocarbons (PAHs), recalcitrant compounds that are highly toxic to living organisms. The use of microorganisms for the biodegradation of PAHs (bioremediation) constitutes an environmentally friendly and low-cost alternative that, under the Antarctic Treaty, requires endogenous microorganisms. Furthermore, although it is known that diesel contains heavy metals which affect the efficiency of biodegradation, the effect of co-contamination has been scarcely studied. Here, we aimed to select microorganisms from Antarctic soil samples capable of biodegrading PAHs in the presence of heavy metals. For this, we studied and characterized soil samples from contaminated and uncontaminated sites in the South Shetland Islands. Bacterial diversity was determined before and after selection processes in a medium supplemented with glucose, diesel, or phenanthrene, as carbon sources, and in presence of heavy metals. When comparing impacted vs. non-impacted soils, it was found that the presence of the contaminants changes microbial structure, enriching hydrocarbon-degrading bacteria. Moreover, most genera found had been reported to have heavy metals resistance mechanisms. Also, when selecting bacterial consortia, biodegradation and microbial growth were mainly observed in cultures with contaminated samples. In summary, these results assess the effect of co-contamination of hydrocarbon and metals on microbial communities and highlight the relevance of considering heavy metals when selecting the most efficient microorganisms for bioremediation.

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Optimisation of Biodegradation Efficiency Towards Diesel Hydrocarbons For a Microalgal Isolate From Greenwich Island, Antarctica

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Vegetation development in Antarctica is limited due to the small area of terrestrial habitat available and the extreme environmental conditions. Microalgae are among the best represented vegetation groups, along with lichens and mosses. In previous research, we have demonstrated that a *Stichococcus*-like microalga isolated from Greenwich Island, South Shetland Islands, Antarctica, has the capability to biodegrade diesel oil. In this study, the conventional one-factor-at-time (OFAT) was employed followed by statistical response surface methodology (RSM) to optimise the biodegradation efficiency of this microalga. The microalga was grown in Bold's Basal Medium enriched with 1% v/v diesel for seven days with the selected parameters (type and concentration of nitrogen, salinity, pH and photoperiod) manipulated at OFAT level. Both Plackett-Burman design and Box-Wilson central composite design, tools within RSM, identified that the concentration of nitrogen, salinity and pH played a significant influence on biodegradation. The biodegradation efficiency of the microalga towards diesel hydrocarbons was improved by 23% after optimisation. This suggests a promising in-situ bioremediation application of this alga, along with a 3-fold increase in biomass production. Further studies of the microalga's effectiveness across a range of diesel concentrations are now required.

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DIESEL: FOOD FOR ANTARCTIC SURFACE SEAWATER BACTERIA

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Human activities in and around Antarctica rely on hydrocarbon (diesel fuel) combustion, with inherent risks of environmental contamination. Any contamination events that do occur in Antarctica are also compounded by the very slow natural attenuation rates achieved at the continent's chronically low temperatures. Antarctica's native microbes provide a reservoir of cold-adapted taxa, some of which have the potential to break down and metabolise hydrocarbon pollutants. This study evaluated the hydrocarbon-degrading ability of a marine bacterial consortium (o2b), obtained from non-contaminated Antarctic surface seawater, to assimilate diesel fuel as its sole carbon source. Growth conditions for consortium o2b were optimised using one-factor-at-a-time (OFAT) and statistical response surface methodology (RSM), which identified optimal degradation conditions of pH 8.0, 10 °C, 25 ppt NaCl and 1.5 g/L NH₄NO₃. Further investigation was carried out into the effect on diesel biodegradation of the presence of 1 ppm concentrations of different heavy metals (Ag, Al, As, Cd, Co, Cr, Cu, Hg, Ni, Pb or Zn) as co-contaminants. Diesel degradation was inhibited most strongly by Ag, followed by Hg, Co, Cu, and Ni.

Accepted as: E-poster Presentation

Abstract No : 1060

Modelling how zooplankton consuming & excreting microplastics impacts carbon export

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How do buoyant microplastics eaten by zooplankton influence the oceanic carbon pump? Experiments demonstrating zooplankton eating microplastics, which alter the density of their faecal pellets, prompted the hypothesis that buoyant plastics consumed in the open ocean are transported to depth embedded within sinking faecal pellets and that these plastics disrupt/diminish carbon export. To derive quantitative answers we develop a data-driven model of zooplankton grazing in microplastic-contaminated environments and excreting plastic-laden faecal pellets. Our initial modelling effort is a case study focused on a single keystone species, Antarctic krill. As krill are voracious feeders, foraging in enormous, dense shoals that produce vast quantities of faecal pellets, they are an important component of zooplankton-mediated carbon export in the Southern Ocean. The model will quantify disruption to carbon export as a function of microplastic pollution rate. It should also provide insight into a cyclical vertical transport pathway for buoyant plastics consumed by zooplankton. Although less polluted than lower latitude seas, the Southern Ocean is being contaminated by plastics at an increasing rate. The model will estimate the effects of increased plastic pollution upon detrital dynamics and carbon export under forecast future scenarios.

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Abstract No : 723

Microplastics in the Antarctic clam on the coastal water of Fildes Peninsula (King George Island).

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Microplastics (MPs) in the Southern Ocean of Antarctic Peninsula has been well documented in seawater and biota. Recent estimates report an average of 1794 plastic debris/km² in the surface waters of the Antarctic Peninsula raising concerns on their potential impact on Southern Ocean biodiversity, already coping with other sources of anthropogenic disturbances such as climate change. Antarctic bivalves are of particular interest because their extensive filter-feeding activity exposes them directly to microplastics present in the water column. The present study evaluated the presence of microplastics in specimens of the Antarctic clam (*Laternula elliptica*) close to research stations. The Antarctic clam is a key species in benthic communities of South Shetland Islands and the Antarctic Peninsula. The microplastics were collected from the digests by density floating method and the quantification in the organisms was carried out by the Nile red staining technique. The preliminary results shown that the number of total MPs varied from 0.3 to 2.23 items/g and from 31 to 102 items/individual. The most common MPs were fibers (70.3 %), followed by fragments (26.6 %). MPs colors most common were black and blue. Qualitative identification of the polymers will be carried out by microFTIR method. We proposed that Antarctic clam could be used as a potential bioindicator of microplastic pollution of the coastal environment.

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Abstract No : 144

Detailed site and contaminant characterisation using drones and ground based soil gas surveys across a perennial Antarctic snowpack and a legacy catchment at Casey station, Australian Antarctic Territory.

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Remotely Piloted Aircraft (drone) imagery and RTK GNSS data was used to create high resolution digital surface models and orthomosaics of two diesel contaminated sites at Casey station, East Antarctica, using Structure from Motion (SfM) techniques (e.g. James et al., 2019). The presence of a thick cover of wind-blown snow and an underlying perennial snow-pack (> 5m depth) at one of the sites limited the ability of the field team to assess the extent of the diesel contamination through traditional techniques (such as the use of photo ionisation detectors and soil samples). The second site studied was from a well-studied legacy diesel spill near Old Casey station (Revill et al., 2007). Data from traditionally obtained soil and water samples, and from two high resolution passive soil gas investigations (e.g. Clarke et al., 2008) were combined with the detailed site survey data to identify specific sub-surface hydrocarbon contaminant migration pathways at Australia's Casey Station in Antarctica. Contaminant surfaces were generated in ESRI ArcGIS Spatial Analyst using data from passive soil gas samplers to visualise hydrocarbon intensity within the context of a three dimensional model of surface snow and ground surface conditions. This helps reveal the dominant fuel migration pathways, how they relate to observed changes in surface snow and melt conditions and ground topography to better inform environmental risk and site management.

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Abstract No : 804

APPLICATION OF ANTARCTIC BACTERIAL CONSORTIA IN WASTE CANOLA OIL DEGRADATION

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Canola oil is one of the most widely consumed vegetable oils used in Antarctica. the provisions of the Protocol on Environmental Protection to the Antarctic Treaty specify that waste cooking oil should be stored in secure containers before being shipped out of the Antarctic Treaty area for disposal, in order to minimise the risk of accidental release into the environment. This study screened, optimised and identified Antarctic bacterial consortia effective in waste canola oil (WCO) degradation. Consortia cultured from 27 soil samples obtained in the vicinity of General Bernardo O'Higgins Riquelme Station (Trinity Peninsula, north-west Antarctic Peninsula) were tested for their ability to degrade WCO. Most consortia were able to degrade >10% of the initial amount of WCO. One consortium (sample BS14) showed both rapid bacterial growth and high degradation. Biodegradation of WCO by this consortium was then optimised using the combination of one-factor-at-a-time (OFAT) and response surface methodology (RSM) approaches. The optimum conditions identified using OFAT were 0% (w/v) NaCl, pH 7.5, 1 g/L ammonium sulphate, 10°C, 1.25 g/L yeast extract and 0.5-1% (v/v) initial substrate concentration. After further optimisation using RSM, 94.99% degradation of WCO was achieved in 6 days. The composition of the bacterial consortia from the original culture and after RSM-validated WCO treatment were compared by the use of PacBio metagenomic sequencing. High proportions of Pseudomonadaceae family was identified in WCO treated media. The efficiency of WCO biodegradation achieved in this study provides support for the development of practical strategies for efficient bioremediation in the Antarctic environment.

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Abstract No : 614

Assessment of Microplastics in the Southern Ocean Water

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Microplastics (MPs) – the recent addition to the list of anthropogenic pollutants – are characterized by: persistence, pervasiveness and bioavailability. The current study has detected their presence in the remote waters of the Southern Ocean that encircles the Antarctica. Microplastic pollution load in the subsurface waters of eight selected locations varied from 1250 to 2550 MPs m⁻³ with a mean abundance of 1618.75 ± 429 MPs m⁻³. The ocean with least human interference in the world receives MPs most probably through the Antarctic circumpolar current that flows all the way round the planet connecting the Atlantic, the Pacific and the Indian ocean. The study identifies fibers (54.45%) as the predominant morphotype; the source of which can be attributed to abandoned fishing gears, laundry wastewater etc. Blue colored MPs (50.7%) were detected in maximum followed by transparent, red, yellow, black and green. Microplastics belonging to the size class of 100 – 500 µm are most abundant (45.5%); which would threaten the organisms inhabiting the ocean due to their easy bioavailability. Polyamide (PA), Polypropylene (PP), Chlorinated Poly Vinyl Chloride (CPVC), Polyethylene co Vinyl Acetate (PEVA), Polystyrene (PS) and Polyethylene (PE) are the major polymer types identified using micro-Raman spectroscopy. The distribution of these polymers at this remote ocean points out that not any region on this planet earth is spared from the menace of plastic pollution, further studies are needed to explore the distribution and abundance of MPs in the sediment and biota of the Southern Ocean.

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Abstract No : 15

Antarctic granite rocks as catalysts for wastewater surfactants degradation

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Antarctica had been disturbed by atmospheric pollution, fuel spills, inadequate waste management, and wastewater discharges. Several antibiotics, formaldehydes, surfactants, trace metals, sunscreens products, and coliforms have been detected at the seawater nearby scientific stations. The surfactants removal from water remains a problem because biological technologies are not optimal to mineralize organic matter. To determine effectiveness of an advanced oxidation process on the degradation of surfactants at the Ecuadorian scientific station "Pedro Vicente Maldonado", the performance of Antarctic granite rocks as catalysts and hydrogen peroxide as oxidant was investigated. After a coagulation-flocculation process, the chemical reaction reduced surfactants from 19,50 to 0,97 mg/L representing a degradation up to 90%. This short communication presents preliminary findings on a low-cost wastewater treatment process as an alternative to degrade surfactants after coagulation-flocculation treatments.

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Abstract No : 155

Activity of *Acinetobacter johnsonii* in the degradation of low-density polyethylene

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The massive use of polyethylene and the absence of efficient degradation technologies have motivated this research with the purpose of evaluating the degradation of low-density polyethylene using an Antarctic bacteria (*Acinetobacter johnsonii*). During the tests a bioreactor with two compartments was used; where the bacterial kinetics growth and the concentration of CO₂ released for the respirometric method after the degradation process were measured. The treated polyethylene was analyzed by infrared spectroscopy (FT-IR), additionally to the weight variation to determine the plastic reduction after the application of the treatments. After 52 days of treatment, the sample pretreated with Tween 80 showed its best growth dynamics of 1.85×10^9 UFC/ml and the best reduction in plastic weight 20 ± 0.12 f %. The treatment plastic with Tween 80 that was exposed to the bacteria was the one that presented the highest value of CO₂ (190 ± 4.53 b mg/L), as a product of degradation of plastic due to the fact that in the FTIR analysis slight changes in their spectra could be evidenced in the treated plastic. Although the metabolic activity of *Acinetobacter johnsonii* was low, its adaptability in the medium "Bushnell Hass Broth" may be improved by changing the conditions. Finally, it is remarkable to say that this is the first report of the bacteria in plastic degradation processes, which will encourage future research.

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Abstract No : 1059

Microplastic characteristics and distribution in surface seawaters around the South Sandwich Islands.

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9 billion metric tonnes of plastic has been produced from 1950–2000, with an estimated 59% discarded as waste. The Southern Ocean (SO) is considered an area of low plastic pollution, but not exempt, with the role of strong circumpolar frontal systems in physically isolating the region as biogeographic barriers often exaggerated. Furthermore, SO organisms are more vulnerable to anthropogenic environmental stressors than species of lower latitudes; due to specialized adaptations to extreme yet stable environmental conditions. This study investigated the distribution and characteristics of sea surface microplastic pollution sampled from surface seawaters in the Atlantic sector of the Southern Ocean; and are characterized by increasing shipping traffic from fishing and the growing tourism market. Samples were collected during a cruise research expedition around the South Sandwich Islands on the RRS Discovery using a modified surface-towed neuston net comprising of two nets with different mesh sizes (100 and 300 micron). Microplastic polymers were identified using Fourier Transform Infra-Red Spectroscopy. Preliminary results indicate that microplastic abundance, shape and type vary between stations. We also observed that significant amounts of microplastic were associated with ship traffic, such as paint chips (from anti-fouling paint) and black rubber. The amount of microplastic in pelagic amphipods collected with the net were investigated opportunistically, finding that microplastic was present in groups tested. This study highlighted the need to prioritize long-term comparative investigations into seawater and biota microplastic distributions to develop a more comprehensive understanding of microplastic pollution interactions to Southern Ocean marine ecosystems.

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Abstract No : 670

BIOREMEDIATION OF DIESEL HYDROCARBONS USING AN ANTARCTIC MICROALGA FROM DECEPTION ISLAND

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Diesel is commonly used in Antarctica as a fuel to provide power. This creates risks of oil contamination due to accidental spills and discharges, which poses a threat to the Antarctic environment. Studies of the potential of Antarctic bacteria in degrading diesel pollution have gained increasing attention. However, despite the known ability of indigenous Antarctic microalgae to contribute to biodegradation, studies of this group remain limited, with little knowledge of the conditions required. This study aimed to document the potential of an Antarctic microalga (strain DCIB) isolated from Deception Island (South Shetland Islands) to effectively degrade diesel contamination. Bioremediation using microalgae is an environmentally friendly approach, convenient and less harmful to the environment. We investigated microalgal growth and photosynthetic pigments, followed by identification and characterization of strain DCIB using a conventional analytical approach, one-factor-at-a-time (OFAT). The parameters included in optimization using OFAT were pH, salinity, nitrogen source, nitrogen concentration and photoperiod. Optimized conditions of pH 6, 0.005 ppt, 0.5 g/L NaNO₃ and 12:12 h (L/D) photoperiod, resulted in 69% oil degradation over the experimental period. Morphological and molecular examination suggested that strain DCIB represents the species *Chlorella vulgaris*. The findings of this study will contribute to the development of future diesel bioremediation techniques in Antarctica.

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Abstract No : 812

STATISTICAL OPTIMISATION AND KINETIC ANALYSIS OF MOLYBDENUM REDUCTION USING A COLD-ADAPTED MARINE BACTERIUM ISOLATED FROM ANTARCTICA

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The accidental and intentional discharge of wastes containing heavy metals into the environment has significantly contributed to global pollution. The presence of heavy metals, including molybdenum (Mo), derived from anthropogenic activities has been observed even around the remote and geographically isolated continent of Antarctica. A sustainable approach to removing Mo pollution from the environment is via microbial bioremediation. In this process, microorganisms are utilised to reduce hexamolybdate, Mo_6^{6+} , into a less toxic form, Mo-blue. The aim of this study was to optimise Mo reduction using the psychrotolerant Mo-reducing Antarctic marine bacterium, *Marinomonas* sp. strain AQ5-A9, and to analyse the kinetic profile of reduction. Mo reduction was optimised using a statistical response surface methodology approach by growing the bacterium in varying conditions, subject to several significant environmental parameters, namely salinity, temperature, substrate concentrations and pH. Optimisation gave the greatest molybdate reduction at 16°C with a culture medium at pH 6.0, 47 ppt salinity and sucrose, nitrogen and molybdate concentrations of 1.8%, 2.25 g/L and 16 mM, respectively. The kinetic study of Mo reduction revealed the Aiba model as the best-fitting model, with a calculated Aiba coefficient of maximum Mo reduction rate (μ_{max}) of 0.067 h⁻¹. This study confirms the potential applicability of this psychrotolerant bacterial strain for the bioremediation of Mo-containing pollution in low temperature environments such as those of Antarctica.

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Abstract No : 727

CHARACTERIZATION OF PLASTICS ENCOUNTERED IN THE REGURGITATED SAMPLE FROM SOUTH POLAR SKUA AND PROFILING OF MICROBIAL COMMUNITY ATTACHED TO THE PLASTICS

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The south polar Skua (*Stercorarius maccormicki*) is a seabird, widespread throughout coastal regions in the Antarctic. Synthetic polymers are persistent and very common and showed their presence in even remotest locations such as Antarctica. In the present study, we have focused on the characterization of plastics collected from the Skua bird (Regurgitated material) and risk assessment of biofilm forming multidrug resistant bacteria associated with these plastics. The samples collected were analyzed using FT- IR. The spectra revealed two types of plastics such as polyethylene and polyethylene terephthalate. There are several reports stating that plastics colonized by pathogenic viruses or bacteria may be potentially pathogenic. Accordingly, we have analyzed the plastic samples by scanning electron microscope. Scanning electron microscopy images revealed the presence of bacteria on plastic samples. A total of 6 bacterial strains were isolated which were tested for their ability to form biofilms. These biofilm forming bacteria were tested for the prevalence of antibiotic resistance among them by the Kirby Bauer method. Results revealed high degree of multiple antibiotic resistance among the isolates. The isolates were resistant to Ampicillin, Amoxicillin, Chloramphenicol, Ceftazidime, Cephalothin, Co Trimoxazole and Trimethoprim. All isolates were sensitive to Ciprofloxacin, Cefpodoxime and Streptomycin. The present study highlights the impact of plastic litter. Besides being a threat to marine flora, it offers an ideal substratum for long distance dissemination of biofilm forming multi drug resistant bacteria which pose a considerable threat to humans via the food chain. Keywords: Regurgitated plastic samples, biofilm, bacteria, antibiotic resistance

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Abstract No : 157

The Toxicity of Cu, Cd, and Pb to the Antarctic Terrestrial Nematode, *Plectus murrayi*

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Ice free areas make up <1% of the total land area of the Antarctic continent, and are generally in coastal areas. These ice free areas are hotspots for terrestrial biodiversity, and are also popular locations for scientific research facilities. As such, they are subject to human impacts, particularly soil contamination. Environmental Quality Guidelines are used to regulate soil assessment and remediation, however, Antarctic specific guidelines are currently lacking due to the limited number of test organisms and standardised toxicity tests available. This study aims to add to the limited database of terrestrial toxicity data available for metals, using established toxicity test methods for the Antarctic terrestrial nematode *Plectus murrayi*. Clean soils collected from Casey station (East Antarctica) were used to create porewaters, which were spiked with the metals copper, cadmium and lead, both individually and in mixtures, to make concentration series. Immobility of juvenile nematodes was assessed as a proxy for death for up to 21 days exposure. Survival decreased with increasing concentrations of copper, cadmium, and lead. Differences in toxicity were observed between the three metals, with dissolved metal concentrations of ≥ 63 , ≥ 121 , ≥ 124 $\mu\text{g/L}$ causing a significant decrease in survival relative to controls, for copper, cadmium, and lead, respectively. The LC50s with 95% CIs were estimated at 181 (115 – 252), 747 (471 – 1028), 1063 (634 – 1634) $\mu\text{g/L}$, for copper, cadmium, and lead, respectively. Critical effect concentrations for metals for *P. murrayi* will be used in the future development of Antarctic specific Environmental Quality Guidelines.

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Abstract No : 705

STATISTICAL OPTIMISATION OF AN ANTARCTIC BACTERIAL CONSORTIUM AS A DIESEL-DEGRADING AGENT AT LOW TEMPERATURE

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One of the greatest challenges in sustaining human presence in Antarctica is providing the energy required to power human activities. At present, the large majority of energy production in Antarctica is achieved via diesel combustion, leading to risks of pollution events. Given that human activities in Antarctica are likely to intensify and diversify further, this presents a major and immediate challenge to Antarctic environmental protection and conservation. Bioremediation is increasingly considered a superior and eco-friendly approach for removing or neutralising contaminants. In order to maximise the effectiveness of bacterial remediation, the optimal conditions for each bacterium or mixed consortium need to be evaluated. In this study, a bacterial consortium (BS9) originating from hydrocarbon-contaminated soil in Antarctica was used as an experimental biodegrading agent and was optimised using the one-factor-at-a-time (OFAT) approach and response surface methodology (RSM), the latter including Plackett-Burman and central composite design as the statistical approach. The factors considered in OFAT were pH, temperature, salinity, nitrogen source and concentration and initial diesel concentration, with only the statistically significant factors then being taken forward to RSM. The optimisation study revealed optimal degrading conditions to be pH 7, 15°C, 0.4% (w/v) NaCl and 1 g/L NH₄Cl. Using these optimised values, 66.77% degradation efficiency was achieved from an initial 4% (v/v) concentration of diesel within a 6-day incubation period. This study confirms the potential of consortium BS9 as a practical agent of diesel bioremediation in Antarctic conditions.



SCAR 2022

Antarctica in a Changing World

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**Sub-Antarctic islands:
sentinels of change**

CONVENORS

Christel Hansen, Craig Cary, Justine Shaw,
Mia Wege

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Abstract No : 776

Current and future distribution of the subantarctic intertidal *Telmatogeton magellanicus* (Chironomidae) in the Cape Horn Biosphere Reserve

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Freshwater insects are convenient model organisms to assess the ecological consequences of climate change since they are affected by the thermal variation of their environments. By studying insect responses to these changes we can generate predictions on their adaptation to future scenarios, being good sentinels of change. Using ecological niche modeling (ENM) it is intended to know changes in the distribution patterns of the subantarctic dipteran *Telmatogeton magellanicus* (Chironomidae), native to the intertidal habitats of the Cape Horn Biosphere Reserve (CHBR), the largest in Chile and the southernmost in the world (54.1°S – 56.2°S). To do this, intensive sampling was carried out at the RBCH during 2018, registering presences of *T. magellanicus*, and coupled with Worldclim bioclimatic variables. All this information was analyzed with the maximum entropy algorithm (MaxEnt) obtaining the first preliminary models for the current and future distribution under climate change scenarios predicted by the IPCC. Our results indicate that there is a good coincidence between what we know about the distribution of the species in the CHBR and the information generated by the model. The projection under climate change scenarios foresees a change of distribution to the south and west of the CHBR, but the most catastrophic scenario (SSP5-8.5), for the 2100s, foresees a disappearance of suitable habitats for *T. magellanicus*. These first ENMs indicate that the ecological consequences of climate change would not favor *T. magellanicus*, almost eliminating its suitable habitats potentially driving local extinctions of several populations.

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Abstract No : 633

Unique benthic foraminiferal communities from sub-Antarctic fjords of South Georgia

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Sub-Antarctic fjords are among the environments most affected by the recent climate change. In our dynamically changing world, it is essential to monitor changes in these vulnerable settings. Here, we present a baseline study of “living” (rose Bengal stained) benthic foraminifera from fjords of South Georgia, including fjords with and without tidewater glaciers. Four assemblages dominated by different species are recognized. *Miliammina earlandi* dominates in the most restricted, near-shore and glacier-proximal habitats, *Cassidulinoides* aff. *parkerianus* in mid-fjord areas, and *Globocassidulina* aff. *rossensis* and *Reophax subfusiformis* in the outer parts of fjords. Their distribution is analyzed in the light of new fjord water and sediment property data, including grain size and sorting, total organic carbon to total sulfur ratio, and $\delta^{13}C$ of bulk organic matter. As compared with similar habitats in southern Patagonia and the South Shetland Islands, the inner- and mid-fjord assemblages seem unique to South Georgia, however, with continued warming and deglaciation they may become more widespread in the Southern Ocean.

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Abstract No : 312

Legacy effects of an eradication: How the loss of invasive prey altered the foraging landscape and breeding success of a top-order predator.

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Brown skuas are widespread, occurring across the sub-Antarctic and in Antarctica where they function as top-order predators. Across their range they have diverse foraging strategies and high dietary plasticity. In many cases that have adapted to prey on invasive mammals and include them as a key component of their diet. More recently, we have seen eradication of invasive mammals across their range, which have potential to shift ecosystem state. The eradication of invasive species from islands often results in the rebound or recovery of threatened native species. For native predators however, the eradication of invasive prey can change their dietary options and foraging decisions. Following the eradication of rabbits from Macquarie Island, brown skuas suffered a sharp breeding decline. Prior to their eradication rabbits were an abundant prey resource for skuas. Here we report on the relationship between contemporary diets and foraging strategies of brown skuas in relation to breeding success. We found successful breeders specialised on higher quality prey, and foraging strategies that enabled them to spend less time foraging and more time at the nest territory. We also found a greater number of failed breeders nesting in areas of historically high rabbit dependence with skuas in these areas now traveling large distances to find food. With eradications of invasive small mammals planned for several other sub-Antarctic islands, including Auckland, Gough, Marion, Amsterdam Islands, our work informs how future eradications can impact the movements and foraging landscape of top-order predators.

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Abstract No : 448

Protecting terrestrial communities from climate change – invasion synergies on South Georgia Island.

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Context The effects of climate change are already marked on South Georgia Island, with rapid glacial retreat. In parallel, the island continues to harbour non-native invasive plants and invertebrates, posing a threat to native ecosystems, with some species now so widespread that eradication is impossible. **Objectives** Our project is assessing the vulnerability of South Georgia's unique terrestrial ecosystems to invasive plants and invertebrates that may benefit from climate change. To do so, we are : 1) Recording colonisation of recently deglaciated areas by non-native species. 2) Identifying 'winning' and 'losing' native and non-native plants under simulated warming. 3) Mapping invasive carabid beetle and native invertebrate distribution and abundance. 4) Identifying high-risk potential future invaders from the Falkland Islands. **Impact** This research generates information that will directly help conservation management on South Georgia in a warming climate.

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Abstract No : 563

Variability in circulation and exchange in a sub-Antarctic Island fjord

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South Georgia is a heavily glaciated sub-Antarctic island in the Southern Ocean in the path of the Antarctic Circumpolar Current. The island hosts a rich ecosystem supported by krill and fish and is a target area for important commercial fisheries. Cumberland Bay is the largest fjord on the island, split into two arms, Cumberland East and West Bay, with a large marine terminating glacier at the head of each arm. Water circulation in such fjords, and associated transport and exchange of heat, directly governs the stability of glaciers at the ice-ocean interface and the subsequent glacier dynamics. Cumberland Bay is an important spawning ground for the commercially fished mackerel icefish, with the transport and retention of icefish larvae controlled by fjord circulation and shelf exchange. Fjord circulation patterns are complex with influencing factors including winds, freshwater input, bathymetry, and coastal current systems. Understanding of the variability in circulation and exchange in Cumberland Bay cannot be derived from limited observational data alone. A new high-resolution simulation of the fjord water circulation in Cumberland Bay is built using the NEMO4 modelling framework. The model will help determine the dominant physical drivers of variability and elucidate the role of such variability on glacier dynamics and rate of retreat. Model flow fields will drive an Individual Based Model to investigate the transport and retention of mackerel icefish larvae, aiding fisheries management.

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Abstract No : 811

The monthly transcriptome dynamics of Antarctic moss, *Sanionia uncinata* (Hedw.) Loeske, throughout the year in natural environments, reveals seasonal adaptation of extremophile plants

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The maritime Antarctic is covered with snow and ice for most of the year, but during the austral summer season, snow melts and a variety of vegetation is revealed. During this period, terrestrial plants actively perform cellular activity during the prolonged daytime. However, the Antarctic summer is still unfavorable condition for plant growth. After growing season ends, the snow starts to pile up and plants stop growing and enter dormancy in a long and dark winter. Here, in this study, we investigated the seasonal growth regulation of extremophile plants, *Sanionia uncinata*, naturally habituated on the King George Island (62°14' S; 58°44' W). The laboratory moss cultures grown in conditions of summer and winter showed clear differences in growth rate and morphology, and also distinctive characteristics in cellular architectures. From the analysis of the monthly transcriptome of naturally habituated *S.uncinata* and the transcriptome of laboratory cultured *S.uncinata*, we could identify groups of genes that fluctuate with rhythmicity according to the seasonal changes in the field transcriptome. And three seasonal gene clusters that might regulate cellular responses and growth were founded. And we observed the induction of cellular ABA level and signaling in the winter season in *S.uncinata*. Accordingly ABA treatment inhibited the growth of moss culture. It is supposed that Seasonal gene expression and ABA signaling during the seasonal changes might establish the annual cycle of growth and dormancy in *S.uncinata* in the natural habitat.

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Abstract No : 1023

Characterization of specimens of the genus *Psolus* Oken (Echinodermata: Holothuroidea: Psolidae) from the Falkland/Malvinas Island

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The family Psolidae (Echinodermata, Holothuroidea) are characterized by large, imbricate or contiguous dorsal and lateral scales, a thin, naked sole with marginal podia, which are associated with hard marine bottoms. Species of the genus *Psolus* Oken, 1815 have dorsal imbricate scales, without ambulacral feet. Lateral scales delimiting a ventral sole, may have podia. Ossicles shaped like buttons, baskets; perforated plates and bars. The following three species belonging to *Psolus* converge in the biogeographic Magellanic Province: *P. squamatus*, *P. patagonicus* and *P. antarcticus*. Due to the wide distribution of *Psolus squamatus* in the Magellanic Province, which extends to the sub-Antarctic islands and the maritime Antarctic sector we assume that these correspond to *P. squamatus*. We identify the samples using external and internal morphological characters, that are defined as taxonomic importance within the group. However, some taxonomic difficulties hinder the identification of species of this genus, so its diversity remains uncertain. In this study we analyzed morphologically 50 specimens of the family Psolidae from three localities of the Malvinas/Falkland Islands. A photographic register of each individual was generated. Due to ossicles from podiums, tentacles, soles and the depth at which the samples were taken, the new specimens must correspond to *Psolus squamatus*. Corroborating the taxonomic utility of ossicles as discriminatory character at species level and show a new record for the distribution range of *P. patagonicus*, extending to Falkland Islands. However, due to high intraspecific morphological variability it is necessary to complement with molecular approaches applied to systematics and taxonomy.

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Abstract No : 1017

Snow algae drive snowmelt along Sub-Antarctic island coastlines

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Here, we present radiative forcing (RF) estimates by snow algae in the Antarctic Peninsula (AP) region from multi-year measurements of solar radiation and ground-based hyperspectral characterization of red and green snow algae collected during a brief field expedition in austral summer 2018 and 2020. Our analysis includes pigment content from samples at three bloom sites. Algal biomass in the snow and albedo reduction are well-correlated across the visible spectrum. Relative to clean snow, visibly green patches reduce snow albedo by 40% and red patches by 20 %. However, red communities absorb considerably more light per milligram of pigment compared to green communities, particularly in green wavelengths. Instantaneous RF averages were double for green (180 Wm^2) vs. red communities (88 Wm^2), with a maximum of 228 Wm^2 . Based on multi-year solar radiation measurements at Palmer Station, this translated to a mean daily RF of 26 Wm^2 (green) and 13 Wm^2 (red) during peak growing season – on par with mid-latitude dust attributions capable of advancing snowmelt. This results in 2522 M m^3 of snow melted by green-colored algae and 1218 M m^3 of snow melted by red-colored algae annually over the summer, suggesting snow algae play a significant role in snowmelt in the AP regions where they occur. This positive feedback will likely increase with warming temperatures in the region.

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Abstract No : 404

Uncovering the unexplored: the microbial ecology of sub-Antarctic island soils

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The sub-Antarctic islands (SAIs) are broadly categorised as those islands positioned around the Antarctic Polar Front and with a biogeographic link to continental Antarctica. Due to their remote locations and wide spatial separations, most have been poorly characterized in terms of macro- and microecology. The remoteness of these islands, and the likelihood that dispersal processes may be limited by the extreme inter-island and island-continent distances, suggests that strong local homogenizing forces may lead to unique microbial community compositions. In 2016–2017, the Antarctic Circumnavigation Expedition (ACE) provided a near-unique opportunity to source biological materials, including soil samples, from a number of these highly inaccessible and rarely visited SAIs. In turn, this provided an unprecedented opportunity to investigate, and compare the soil microbial ecology of these locations. In the present study, we describe the unique microbial biodiversity of SAI soils, with a specific focus on the role of local habitat selection in shaping community structure and functional potential. Taxonomic comparison of the soil communities indicated that the various SAIs harboured spatially segregated microbiomes with a limited degree of overlap. However, we identified a shared microbial fingerprint of lichen-associated taxa, suggesting that terrestrial lichens may be key drivers of sub-Antarctic island soil microbial ecology. In addition, investigation of the functional profiles of these soil microbial communities suggested a location-specific specialization shaped primarily by the temperature range of the SAI habitats. The results presented in this study represent the most extensive characterization of the microbial ecology of the SAI soils to date.

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Abstract No : 830

Recent changes in vegetation and glacier extents on Heard and McDonald islands from VHR satellite images

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Heard and McDonald are two intermittently active volcanic islands located in the southern Indian Ocean. McDonald, the smaller of the two (2.5 km²), has seen dramatic changes to its landscape after an eruption in the 1990s that saw the island double in size. In this study we look at the vegetation changes between 1980, 2003, 2012 and 2020 on McDonald using aerial photographs, satellite images and a normalised difference vegetation index (NDVI). Heard Island, located 44km to the east of McDonald, is much larger (368 km²) and higher (2745 m). Both of its major peaks are covered in glaciers with vegetation on the coastal fringes. On Heard we examine what is occurring at the boundaries between the glaciers and vegetation. As the temperature increases in this region the glaciers have begun retreating, especially on the lower Laurens Peninsula peaks (~700 m asl) and on the eastern, leeward side of Big Ben (2745 m asl). With increased available land, vegetation is starting to expand into these higher elevations. The Heard Island 1980s baseline vegetation map has been compared to several very high resolution satellite images for 2008, 2012/14, and 2018/19. A NDVI has been applied to each of these images to map the extent of vegetation and change detection was used to assess the landscape changes between 1980 and 2019. We also make some recommendations for further research possibilities and priorities for both satellite based and field based science projects.

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Abstract No : 153

Microhabitat characteristics drive morphological plasticity in nymphs of the world's southern-most dragonfly, *Rhionaeschna variegata*

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Rhionaeschna variegata (Odonata: Aeshnidae) is the world's southern-most occurring dragonfly. Its distribution ranges from northern Chile to the Cape Horn archipelago in southern South America. The species has been poorly studied and little is known of its biology. Morphological features can be phenotypically important and can indicate responses or adaptations to the environment. Using a geometric morphometric approach, we evaluated size and shape patterns of *R. variegata* nymphs inhabiting four different microhabitats (backwater creeks, peatbog and wetland ponds) on Navarino Island, in the Magellanic sub-Antarctic ecoregion of southern Chile. The microhabitats were selected to assess whether morphological variation is associated with specific environmental features/parameters. We identified a significant allometric influence on nymph shape (21.86%) associated with overlapping generations. After removing the allometric influence, differences in morphological features were identified, primarily in abdominal and head width, with nymphs obtained from peatbog ponds being stouter than those from wetland ponds and backwaters in the northern aspect of the island. Regression analysis between body size and wing pad development identified five different nymphal stages. A multivariate analysis indicated a strong influence on the measured morphological characteristics from a combination of all environmental parameters, with canopy cover and pH having the strongest influence. Our study is the first to link microhabitat features with *R. variegata* nymph morphology, explaining aspects of natural variation between local populations that could serve as a baseline for future research.

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Abstract No : 160

Impacts of sea-spray aerosols and water-rock interactions on lake water chemistry across Macquarie Island.

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Isotopic and hydrochemical surveys of lake provide direct information on catchment response to changing rainfall, evaporation, nutrient cycling, and the health of ecosystems. These techniques have not been widely applied to lakes in the Southern Hemisphere high latitudes, including Southern Ocean Islands (SOIs) that are experiencing rapid, significant shifts in climate. Historical work has highlighted the localised nature of geochemical drivers such as geology, sea spray contribution, vegetation, geographical location, and ice cover extent in controlling the hydrochemical evolution of lakes. Here we present the first comprehensive, island-wide hydrochemical and isotopic survey of lakes on a SOI. Forty lakes were examined across Macquarie Island, using comparable methods to identify key environmental processes and their geochemical drivers. Methods include stable carbon ($\delta^{13}\text{C}_{\text{DOC}}$: dissolved organic carbon and $\delta^{13}\text{C}_{\text{DIC}}$: dissolved inorganic carbon), oxygen ($\delta^{18}\text{O}$), hydrogen ($\delta^2\text{H}$) and strontium isotopic ratios ($^{87}\text{Sr}/^{86}\text{Sr}$). These provide essential baseline data for hydrological, biological and geochemical lake processes. Lakes on the western side of the island are influenced by sea spray aerosols. Lakes at higher elevations are dilute and those located in lower catchments have experienced more water-rock interactions as water moves from higher to lower elevations. Solutes in the lower catchments are transported by either overland flow or groundwater. Increasing temperatures and changing rainfall patterns predicted for the region will lead to shifts in nutrient cycles, and impact the island's unique ecosystems. Future research will focus on long-term monitoring to understand seasonal, annual and long-term variability to test fundamental hypotheses concerning ecosystem function on Macquarie Island.

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Abstract No : 506

Biological and geochemical proxies in sediment cores reveal shifts in marine predator population dynamics relative to historic anthropogenic exploitation and recent climate change at South Georgia Island

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Historical climate change and human exploitation are thought to have played important roles in shaping population dynamics of sub-Antarctic marine predators, such as king penguins (*Aptenodytes patagonicus*) and Antarctic fur seals (*Arctocephalus gazelle*). For example, Antarctic fur seals on the sub-Antarctic South Georgia Island were nearly hunted to extinction by humans before the early 1900s. However, records of occupation history pre- and post-anthropogenic stress are often sporadic and challenging to interpret. In this study, we investigated paleoecological proxies in sediment cores from South Georgia Island to examine past marine predator population dynamics in the face of climate change and exploitation pressure. Sediment cores representing 1854 CE to present were collected from two sites on South Georgia Island in the South Atlantic and analyzed for geochemical (total carbon, total nitrogen, $\delta^{13}\text{C}$ and $\delta^{15}\text{N}$ values) and biological (e.g. seal hairs, penguin feathers) proxies. Proxies in both cores indicated the onset of the recovery of penguin and fur seal populations in the early to mid-1900s, following the cessation of hunting. Additionally, our results suggest marked increases in both penguin and seal populations beginning around 1950 CE. Between the 1950s–2019, 97% of South Georgia Island's glaciers retreated associated with recent climatic warming. This warming increased the availability of local breeding areas for king penguins, which likely explains the population rise during that time. This study deepens our understanding of the response of sub-Antarctic marine predator populations to past climate change and human exploitation, which may aid in predicting future ecosystem responses to environmental disturbance.

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Abstract No : 282

Do anisotropic processes influence fine-scale spatial genetic structure of a keystone sub-Antarctic plant species?

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Accurate predictions of how climate change will affect all aspects of our planet, including changes in species' ranges, are needed. While changes in temperature and rainfall have received the majority of research attention, there is a relatively poor understanding of how variation in wind speed and direction may impact biotic communities, particularly through their influence on dispersal and gene flow. Limited seed or pollen dispersal enhances genetic relatedness between nearby individuals and/or populations (fine-scale spatial genetic structure, SGS), with genetic differentiation between populations or pairs of individuals generally increasing as a function of the spatial distance between them. However, this pattern of fine-scale SGS may not always occur isotropically when spatially asymmetric processes, e.g., wind speed and direction, are important. Consequently, a greater understanding of the anisotropic drivers of spatial patterns of dispersal, particularly at local spatial scales, is needed. Therefore, we use molecular tools in conjunction with an advanced fluid dynamics model of wind flow and an extensive ecological dataset to understand the drivers of observed fine-scale ecological and genetic patterns. We genotyped 160 *Azorella selago* specimens, a widespread, wind-dispersed and wind-pollinated cushion plant species, from four populations located on a landform. We specifically assess the efficacy of combining SGS analyses with anisotropic spatial autocorrelation techniques to infer the impact of changing wind flow patterns on local-scale colonization and up-slope dispersal processes in these plants. We use sub-Antarctic Marion Island as a model system as the island's landscape is exceptionally heterogeneous and has experienced recent rapid changes in climate.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

LIFE SCIENCES

**Environmental factors driving
diversity and composition of fossil and
living Antarctic communities**

CONVENORS

Fernanda Quaglio, Fabiana Canini,
María Eugenia Raffi

Accepted as: Oral Presentation

Abstract No : 1054

Biodiversity and paleobiodiversity of testate amoebae on Kerguelen archipelago: a key for climate change monitoring?

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The French Kerguelen archipelago, located at the polar front level in the southern Indian Ocean, is a perfect place to study climate changes and their effects on environment. Indeed, records in the ice cap show a decrease in precipitation linked to the oscillations of this polar front. Moreover, meteorological records show an increase in temperatures over the last 5 decades. Testate amoebae are single-cell microorganisms that live in a large range of continental environments: lake, river, soil and peatlands. They peculiarly affectionate humid environments. Thanks to their shells, they are preserved after death, that's why they constitute good indicators of climate change. After 2 sampling campaigns carried out in 2019 and 2021 (logistics provided by the French Polar Institute, program ENVIKER), 120 modern surface samples were studied to define the testate amoebae distribution and their environmental range. Thanks to this database, testate amoebae fossils were used to reconstruct past environment changes in two sediment cores over 150 and 200 years long sequences respectively. 123 species have been found in modern samples to constitute the database. 10 species have a very marker environmental signature (depending on soil type, water content and TOC) whereas the others are ubiquitous. In the 2 sediment cores, 33 and 45 species were observed respectively. Applying a transfer function between the modern testate amoebae, their living surroundings characteristics and the shells fossilized, we reconstructed the past environments. The environment was more humid with peat bog vegetation and gradually gives way to drier grassy plains.

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Abstract No : 208

Unique Geothermal Chemistry Shapes Microbial Communities on Mt. Erebus, Antarctica

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Mt. Erebus, Antarctica, is the world's southernmost active volcano and is unique in its isolation from other major active volcanic systems and its distinctive geothermal systems. Using 16S rRNA gene amplicon sequencing and physicochemical analyses, we compared samples collected at two contrasting high-temperature (50°C–65°C) sites on Mt. Erebus: Tramway Ridge, a weather-protected high biomass site, and Western Crater, an extremely exposed low biomass site. Samples were collected along three thermal gradients, one from Western Crater and two within Tramway Ridge, which allowed an examination of the heterogeneity present at Tramway Ridge. We found distinct soil compositions between the two sites, and to a lesser extent within Tramway Ridge, correlated with disparate microbial communities. Notably, pH, not temperature, showed the strongest correlation with these differences. The abundance profiles of several microbial groups were different between the two sites; class Nitrososphaeria amplicon sequence variants (ASVs) dominated the community profiles at Tramway Ridge, whereas Acidobacteriota ASVs were only found at Western Crater. A co-occurrence network, paired with physicochemical analyses, allowed for finer scale analysis of parameters correlated with differential abundance profiles, with various parameters (total carbon, total nitrogen, soil moisture, soil conductivity, sulfur, phosphorous, and iron) showing significant correlations. ASVs assigned to Chloroflexi classes Ktedonobacteria and Chloroflexia were detected at both sites. Based on the known metabolic capabilities of previously studied members of these groups, we predict that chemolithotrophy is a common strategy in this system. These analyses highlight the importance of conducting metagenomics and cultivation efforts at Mt. Erebus.

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Abstract No : 792

Paleoecology of the bivalve molluscs from La Meseta Formation (Eocene), Seymour Island, Antarctica.

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The La Meseta Formation (Seymour/Marambio Island, 40 –56 Ma) exhibits a cooling trend along the Eocene, with milder temperatures prior to the formation of ice sheets in Antarctica. Understanding how biota have responded to these changes is crucial to predicting how climate changes affect different biological groups. This work aims to understand the evolution of guilds as ecological parameter in parallel with the sea deepening as well as sedimentary filling of the unit. Descriptive statistical analyzes of bivalve species and guilds richness throughout the stratigraphy indicated that at the base of the Formation (Telm1 and Telm2), where the facies granulation is coarser, both guilds and species are less diverse. In the upper strata, from Telm5 onwards, some infauna and semi-infauna guilds become more recurrent, which represents the ecological response to sea level rise. The recurrent and diversified suspensivorous guilds at the base and onwards suggests the general exploration of the substrate after environmental changes of the unit. The low diversity of guilds and species in Telm4 may be related to the presence of transgressive lag already reported in the literature. These data may be a consequence of sedimentary filling in relation to changes in facies and guilds as an ecological parameter throughout the stratigraphy. However, in order to detail these paleoecological analyzes additional environmental parameters such as bathymetry, temperature data and biogeographic distribution of current representatives are important to understand how such environmental characteristics potentially influence the dynamics of marine biota diversity.

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Abstract No : 1061

What drives the distribution of chemical defence diversity in a macroalga?

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Sessile marine organisms, such as macroalgae, commonly produce chemical defences against grazers, pathogens, and biofoulers. In Antarctic macroalgal forests, the common, red understory macroalga *Plocamium* sp. supports a high abundance of amphipods, but only one amphipod – *Paradexamine fissicauda* – feeds on the alga due to its chemical defences. Different thalli of *Plocamium* sp. produce differing mixtures (chemogroups) of secondary metabolites. From 2016 to 2018, we identified 15 chemogroups near Palmer Station, Antarctica which sort into two main *cox1* haplotypes. Feeding rate experiments revealed that the production of certain chemogroups benefits *Plocamium* sp. since individuals containing some chemogroups were consumed at slower rates. There were no clear patterns in the growth rates of *P. fissicauda* maintained on diets of *Plocamium* sp. representative of the chemogroups, but reproductive output was reduced in some feeding treatments when compared to amphipods on a diet of non-chemically defended *Palmaria decipiens*. Chemogroup distribution was largely site specific and at some sites, also depth specific. The environment unlikely impacts chemogroup production since reciprocal algal transplant experiments did not reveal any major changes. Based on preliminary analyses using six of 10 microsatellites loci, underlying patterns of genetic differentiation appear likely to play a strong role in maintaining patterns of chemodiversity. Our findings, therefore, indicate that patterns of gene flow, rather than the environment play a more important role in the geographic distribution of chemogroups in *Plocamium* sp. This study sheds light on the relative importance of genotype versus environment in the distribution of phenotypes in sessile taxa.

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Abstract No : 1025

NOVEL PIGMENTS AND BIOPEPTIDES IN MARINE FUNGI FROM ANTARCTIC

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Microbial communities from Antarctic play an important role to the functioning of the polar ecosystem. Principal studies in these organisms have taken place on taxonomy or ecophysiological fields, however their biotechnological potential is still demanded. Extreme weather conditions in Antarctica exert the expression of metabolic products for adaptation and survival. In fact, the organisms in this continent are exposed to harsh factors as UV radiation, photoperiod, wind, desiccation, temperature, and low nutrient availability which have triggered the production of molecules with biological activity. This research evaluated the recovery of antimicrobial biopeptides and pigments produced by Antarctic marine fungi. Mostly Ascomycota and Eumycota fungi strains were collected from Dee Island, Culebra river and Pedro Vicente Maldonado Ecuadorian Scientific Station. All collections were characterized and conserved at specific conditions to evaluate their biomolecules. Then, a batch submerged fermentation strategy was applied for pigment and antimicrobial biopeptides production with different culture media. Peptide profiles were analyzed by SDS-PAGE and MALDI-TOF while pigments by Thin Layer Chromatography TLC and UV/Vis spectroscopy. Next, different bioactivity and antibacterial tests were assessed with characterized fungi extracts. UTNAE17 strain reached the highest pigment production and demonstrated a markable antinematode and antioxidant activity. On the other hand, UTNAD31 and UTNAE10 strains produced peptides between 10 – 100 kDa which exerted a high inhibition for *Staphylococcus aureus* and in less grade for *Escherichia coli* y *Klebsiella pneumoniae*. These results establish a baseline for future research in other Antarctica marine fungi toward commercial and health applications.

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Abstract No : 757

Additions to the knowledge of the Astrapotheria and Litopterna mammals from the Eocene of West Antarctica

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The fossil record of Antarctic land mammals currently represented by small body mass taxa (< 1 kg) of herbivorous/insectivorous groups (Gondwanatheria, Dryolestida? and Metatheria), and larger herbivorous mammals (10–400 kg) as Xenarthra?, and several South American native ungulates. The last ones are known by the Astrapotheria *Antarctodon sobrali*, and the Litopterna Sparnotheriodontidae, *Notiolofo arquinoiensis* and *Notiolofo regueroi*. New ungulates specimens from Cucullaea I Allomember of La Meseta Formation in Seymour/Marambio Island, are here presented. (1) An astrapotherid lower right molar from the basal coquina level at DPV 2-84, differs to the holotype of *A. sobrali* in its larger size, metaconid without wear and round base, protolephid wear facet distally inclined, paracristid short but width, paraconid well integrated to the paracristid, cristid oblique strong and almost contact the protoconid. (2) A left upper molar of a sparnotheriodontid from the naticid bed at IAA 1-90 with a mesial basal rim surrounding the lingual side, strong protostyle not linked to the protocone, small protoconule almost completely fused to the preprotocrista, large protocone and hypocone appraised against it. (3) A large isolated fragment of tooth from IAA 2-13 with slightly convex enamel and basal cingular structure. (4) A scapula, from the middle section of Locutorio Hill, with an ovoid glenoid fossa (55 x 32 mm), without glenoid notch, but with a strong supraglenoid tuber, wide neck, and spine partially bent toward the infrapinuous fossa. Several features of the last two specimens, (e.g. Hunter-Schreger bands, scapula size) preliminary suggest South American native ungulates.

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Abstract No : 934

Development of plant communities in rocky outcrops affected by flying birds in Harmony Point – Nelson Island, Maritime Antarctica

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Antarctic plant communities are closely related to physical and biological factors. The birds' nesting and organic matter deposition affect the diversity of plant communities and structures, predominantly along the coast. The areas manured create new conditions for the terrestrial biota development, making the local impact of birds' presence particularly important since they contributed to nutrient inputs. In this context, this study purposed to describe the patterns of vegetation cover and their soil properties in three rocky outcrops with Giant-petrel's nests in Harmony Point, Nelson Island. The plant species were analyzed through the phytosociology method. The outcrops were divided into two substrates: rocky terrain and soil. Our results showed that the rocky outcrop 1 presented 38 species with the moss *Sanionia uncinata* predominance and soils with higher nitrogen content. The lichens showed higher diversity, with 28 species in the rocky terrain mainly. Outcrop 2 was covered with 24 species. *S. uncinata* and the lichen *Cladonia borealis* predominated with a large cushion of *Chorisodontium aciphyllum* in the surroundings. Their soils were rich in organic matter and sodium. Outcrop 3 was shorter in length and without Giant-petrel nests activity. We found 20 species with *Sanionia* spp dominating the cover and the highest contents of phosphorus in the soil. This study showed the differences between substrates, forming a gradient of distinct life forms, where lichens prefer rocky substrates and mosses were dominant over the soil. The relict orthogenic soils are also important sources of nutrients highlighting the influence of flying birds on plant species

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Abstract No : 888

A heart-warming snail: Using cardiovascular measurements to investigate the thermal acclimation potential of an Antarctic marine gastropod

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Among the range of mechanisms that animals can use to resist warming environments, acclimation has been proposed as the most important factor that will determine the success of stenothermal Antarctic organisms in an environment affected by climate change. We assessed the thermal acclimation potential of *Neobuccinum eatoni* Smith 1879, a snail with a broad Antarctic and subantarctic distribution. Snails were collected via SCUBA at four nearshore sites in McMurdo Sound, Antarctica, where water temperature ranges from -1.9°C to $> 1^{\circ}\text{C}$ annually. Individuals were exposed to two temperature treatments (-1.8°C and $+4^{\circ}\text{C}$, $n=20$ each) for two weeks. After the exposure period, we recorded each snail's heart rate over a -1.8°C to 18°C temperature ramp, conducted over 23 hours, using noninvasive infrared sensors. From these data we calculated maximum heart rate, peak heart rate temperature, and heart rate breakpoint temperature, and found that all parameters were significantly higher in snails from the warm ($+4^{\circ}\text{C}$) treatment. No snails died during the experiment and all snails survived for a two-week observation period when returned to -1.8°C . Our results are consistent with heart rate acclimation by *N. eatoni* in two weeks, which is rapid compared to other Antarctic invertebrates that require two to several months to acclimate to higher temperatures. Our findings suggest that *N. eatoni* may be able to physiologically compensate for seasonal temperature cycles, as well as at least partially compensate for the physiological demands of warming beyond the temperature range of high-Antarctic environments.

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Abstract No : 211

Composition and antioxidant properties of extracts from *Deschampsia antarctica* É. Desv. plants located at different places of the Galindez Island

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Recently, much attention has been paid to the search for plant raw materials with a high content of bioactive compounds, in particular metabolites of phenolic nature, possessing antioxidant, anti-inflammatory and antimicrobial properties. The polyphenol synthesis in plants is known to increase under stressful conditions, in particular under UV radiation. Therefore, Antarctic vascular plants growing under extreme environmental conditions may be a promising source of polyphenolic compounds with a wide range of biological action. The aim of this work was to investigate the biochemical composition of *Deschampsia antarctica* É. Desv. plants growing under various conditions and to study the antioxidant properties of the respective extracts. The plant samples were collected from various locations of Galindez Island. Composition and antioxidant properties of plant extracts were studied by means of HPLC, MALDI MS, Folin-Ciocalteu and DPPH tests. Comparison of 21 plant extracts did not reveal significant differences in their composition. All the extracts contained a large amount (up to ~ 25 mg per 1 g of raw material) of polyphenols (flavonoids, simple phenols, hydroxybenzoic and hydroxycinnamic acids, as well as their derivatives) and possessed high antioxidant and anti-radical properties. The growth conditions affect the number of synthesized compounds, while the ratio of certain polyphenol classes in the extracts is practically unchanged. Among the polyphenols, about 70% belongs to flavonoids, with 90% of which being luteolin derivatives. All the extracts also contained such possible antioxidants as carotenoids, terpenoids and sterols. Thus, *Deschampsia antarctica* is a valuable plant source of various antioxidants.

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Abstract No : 472

Paleogene Chondrichthyes of Antarctica: state of the art and perspectives

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Chondrichthyes (chimeras, rays, and sharks) inhabit mainly marine warm and warm temperate waters, with few freshwaters and/or marine deep-water species. Despite the group gather more than one thousand species, only six species live in Antarctic Peninsula. Here we present the advances of the doctoral thesis of the senior author which deals with the systematics and taxonomy of Antarctic Paleogene Chondrichthyes housed at the Vertebrate Paleontology Collections of the Museo de La Plata. Fossil chondrichthyans have been retrieved from Paleogene units at Seymour Island. They are represented by twenty-five genera and fourteen species based mainly on isolated teeth. Through the years, geologists used several informal stratigraphical units to divide the Paleogene units. Today the Paleogene record of chondrichthyans is restricted to the Unit 10 of the López de Bertodano, Cross Valley, La Meseta and Submeseta formations. Thus, allocating specimens to a precise unit is still problematic. One of the key tasks of this thesis consists of the homologation and standardization of the geological unit's nomenclature. This task highly time-consuming and sometimes tricky consists of comparing the different models proposed through the years by combining new and old information. Two of the difficulties found during this process were: localities with two or more names and localities lacking geographical allocation. To date, the information relative to the provenance of the specimens, which was obtained from literature and collection labels, was standardized, and actualized. This is a relevant first approximation which is key for further taphonomic and evolutionary history of the Antarctic Paleogene chondrichthyans

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Abstract No : 881

Diversity and ecology of the genus *Luticola* D.G.Mann at Horseshoe Island, Maritime Antarctica, preliminary results

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Antarctica was considered a barren cold desert for a long time, providing only limited resources and very harsh environmental conditions. However, studies published in past years indicate otherwise. One of the study fields in Antarctica is the diversity of diatoms and ecological factors driving their communities. Diatoms are a worldwide spread group of organisms, broadly used as bioindicators for their species-specific environmental requirements. One of the genera widely distributed within Antarctica is the genus *Luticola* D.G.Mann. It is a small-celled genus with near-lanceolate to lanceolate valves with rounded, rostrate, or capitate ends. The genus is characterized by uniseriate punctate striae, one isolated pore in the central area, and a simple raphe with variable raphe ends. Within the Antarctica, Kociolek et al. (2017) recorded 43 species, with 42 of them being endemic to the area. This study is focused on the diversity and ecology of the genus *Luticola* on Horseshoe Island, a small island of 36 km², located west of the Antarctic Peninsula. Preliminary study results from the island show a high species diversity. So far, about 25 morphologically different species are distributed all over the island in different environmental conditions, based only on the LM microphotographs.

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Abstract No : 635

A new cyathealean tree fern from the basal Upper Cretaceous of Livingston Island, Antarctic Peninsula, and its close relations with the extant *Thyrsopteris elegans* Kunze

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Sterile and fertile pinnae related with *Thyrsopteris* are described to Cenomanian beds from the volcanic succession of Hanna Point in Livingston Island, South Shetland Islands. They represent the oldest known record of such a kind of tree fern, today included in the Cyatheaceae. Its record gives support to the proposals of an origin to the genus in the insular areas of western Antarctic Peninsula, which dispersion processes were after affected by the maintained plates subduction along the Pacific margin, follows by the Gondwana break up and the resulting environmental changes. The *Thyrsopteris* related remains of Hanna Point shows exclusive morphological and reproductive features in relation to previous knowing fossils of the genus, been more next of the unique extant species *T. elegans* Kunze, today growing at Juan Fernández archipelago, in Chile. In the fossil assemblage, the dominance of pteridophytes approximates the Hanna Point beds to those of the Early Cretaceous successions of the proper Livingston Island and the nearby Snow Island (Byers Group). However, rare fragmented leaves of angiosperms give support to the younger Cenomanian age informed by the radiometric age data. Scarce and still dubious forms assigned to *Thyrsopteris* are also recorded to Mesozoic and Paleogene floras from South America and Antarctic Peninsula, where warm temperate oceanic climates and a forearc geological context was inferred, in analogous conditions to that today controls the growth of *T. elegans*, its exclusive extant species.

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Abstract No : 781

Variability of soil attributes in different cryptogam covers on Elephant Island, maritime Antarctica

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The Maritime Antarctica region has terrestrial ecosystems ice-free areas dominated by lichens and mosses, representing important ecological indicators of climate change. We still lack studies that provide evidence of direct links between the development of cryptogamic communities and the chemical and physical attributes of the soil. In this context, we aim to analyze how different covers and compositions of moss species affect the chemical and physical attributes of the soil in Maritime Antarctica. Was selected three cryptogamic communities where 20 plots (20 × 20 cm) were sampled to obtain the phytosociological parameters (cover) of each species. A composite topsoil sample was collected in each plot to determine chemical and physical soil properties. The moss turf community (P1) had 10 species and greater vegetation cover (100%) and showed higher fertility, high organic matter, and higher Mg values, but lower levels of phosphorus. The moss carpet community (P2) had 10 species and a coverage of 68.5%, presenting the lowest values of the sum of bases, Ca, Na, and K, with values of organic matter and phosphorus similar to P3. The moss cushion community (P3) presented nine species and the lowest vegetation cover (52.7%) and the highest levels of phosphorus found. P3 was a recently exposed area close to meltwater lakes following glacier retreat. These lakes are often used by wandering skuas, in the vicinity. Our study suggests that vegetation cover affects the variability of soil attributes. However, other factors, mainly the biological activity of birds, are strongly related.

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Abstract No : 103

Gentoo penguin's expansion desolate tall moss turf subformations and affect peats' microbiome composition

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Pygoscelis papua is recognized as a beneficiary of climate change in Antarctica, expanding its range southward in the last decades. It causes a notable increase in organic input with the guano and disturbance in such climax communities of Antarctica as tall moss turf subformation (moss banks). The study aimed to estimate *P. papua*'s impact on the vegetation and microbial composition of moss banks located in the Argentine Islands - Kyiv Peninsula region (central maritime Antarctica). During the austral period of 2019, 2020, and 2021 we examined the condition of three moss banks located on Galindez Island and Cape Tuxen. In 2020 microbial composition of peat with the distinct penguin's impact (unaffected, impacted, and desolated moss cover) was estimated by 16S rRNA amplicon sequencing. Visual observation revealed the die-away of the moss and its replacement with nitrophilic green alga *Prasiola crispa*, which coincided with the penguin's expansion on these territories. Relative abundance of Acidobacteriia (32% in unaffected; 20% in impacted; 7% in desolated peat) and Alphaproteobacteria (10%;10%;2%) declined with an increase in disturbance level, while the abundance of Betaproteobacteria (1%;8%;14%) and Bacteroidetes (6%;12%;19%) was significantly higher in the desolated peat. Anaerobic gut bacteria *Gottchalkia* and *Tissierella* arose among dominant genera in desolated peat indicating accumulation of gut microbiota, while taxa preferring low pH disappeared. Gentoo's penguin expansion alters the functioning of the terrestrial environment in Antarctica, which is evidenced by the destruction of the initial moss communities, and changes in the peats' microbial composition.

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Abstract No : 767

What do the wings of an Antarctic dipteran tell us? Deciphering wing variability in *Parochlus steinenii*

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Parochlus steinenii (Diptera: Chironomidae) is the only winged fly native to the maritime Antarctic. The larvae and pupae of *P. steinenii* are aquatic, inhabiting deep and permanent lakes while the winged adults are terrestrial. Their habitats have been directly affected by climate change since the mid-20th century. Studying the adaptations of insects of extreme environments can provide important information to improve understanding of the effects of ongoing climate change on Antarctic terrestrial invertebrates. In this study we documented differences in wing shape in *P. steinenii* at small geographical scale. Wing traits are likely to be strongly influenced by both habitat characteristics and genetic differences. We analyzed the wing of 365 individuals obtained from 10 lakes on King George Island and three lakes on Nelson Island in the South Shetland Islands. Thirteen landmarks were digitized and analyzed using the software Morpho J 1.06d. Our results confirmed the presence of wing sexual shape dimorphism, on the contrary, an absence of dimorphism related to size, interpreting these result to may be a response of sexual selection. Comparing individuals of same the sex, we detected consistent differences in wing size and shape between lakes, even some separated by very short distances. This morphological variation in wing traits between populations suggests considerable phenotypic plasticity in this fly species in response to terrestrial microhabitat conditions. Initial population genetic analyses further support the occurrence of differentiation and population structuring at small geographical scale.

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Abstract No : 935

Plant communities and their associations in Demay Point, King George Island, Maritime Antarctica

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Composed almost entirely of cryptogams, the Antarctic vegetation is determined by environmental conditions that control the distribution, growth, and form types. The monitoring of the vegetation distribution is a key factor that predicts environmental responses due to the climate change in this fragile region. In this study, we aimed to identify the plant communities in the Demay Point region, King George Island. We used the phytosociology method in 11 plant communities. The sites were selected based on the plant distribution and representing the different compositions between the total area possible to access. Based on 165 plots, we described five plant formations and seven distinct associations, named by the significant ecological importance of each species. Composing them, we identified 32 samples to species level, and seven species were not possible to identify. Phanerogamic communities predominated in the sample areas, with six communities forming associations mainly between the grass *Deschampsia antarctica* and distinctive moss species, as well as with the macroalgae *Prasiola crispa*. Moss carpets represented the second higher community, with *Sanionia uncinata* predominance associated with other mosses. A mixed community was characterized by the mosaic vegetation composition, dominated by *D. antarctica* but with higher plant diversity. This study provided the identification of plant communities detailed to the Demay Point region, and highlight the Antarctic grassy distribution in this region. Describe the actual plant cover promotes the baseline for future identification of overall vegetation changes in range.

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Abstract No : 494

Diatom Stratigraphy and Biogeochemical Changes of a Per-Glacial Lake on Robert Island, Antarctic Peninsula

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Polar regions are sensitive ecosystems to environmental changes. In particular, ecosystem structure and food web interactions are expected to be dramatically effected. Diatoms have been widely used as indicator primary producers to infer past environmental changes. Here, we implemented a multiproxy investigation on a short lake sediment core taken from Robert Island during 2nd Turkish Antarctic Expedition. The dating was performed using Pb210 and Cs137 analysis. The biogeochemical characteristics of the lake over time was quantified using loss of ignition, XRF, pigment and diatom analysis. The biogeochemical characteristics of the core indicate very stable environmental conditions c. last two centuries. *Planothidium* genus (43%) and *Nitzschia* species (10%) dominated the diatom communities through the core. *Navicula gregaria* species which is common in acidic lakes found higher in the earlier history of the lake and lower in the upper layers. The abundance of *Nitzschia* species which are related to alkaline conditions is higher in the upper layers of the core. Diatom analysis shows environmental conditions from acidic and oligotrophic to more alkaline and eutrophic have occurred over time. Different patterns of elemental values are observed in XRF analysis through the core. The findings will help to provide information about the lake's history and changing environmental conditions.

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Abstract No : 556

The cool-water carbonate factory of the western Ross Sea continental shelf (Antarctica): a key for the study of the climatic and oceanographic variations in the last 30,000 years

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Scientific interest in polar biogenic carbonates has increased over time since they are important paleoecological proxies in the study of high latitude settings where glacial siliciclastic sediments often prevail. Biogenic calcareous sediments are relatively rare in the Antarctic shelves, as low temperatures and highly corrosive water masses, generally force the calcite compensation depth (CCD) to approximately 350–1000 m, thus disfavoring the carbonate “factory”. Due to these conditions, biogenic carbonate deposits on the Antarctic seas are highly localised in space and in time. The northwestern area of the outer Ross Sea shelf shows carbonate-rich lithofacies consisting of poorly sorted sandy and gravelly skeletal remains, including stylasterid hydrozoans, with a good presence of ostracod and foraminifers among the microfossils. Here we present the micropaleontological results within three sediment cores, recovered during two PNRA cruises in the western Ross Sea area. In this regard, foraminifer and ostracod assemblages, analysed for the first time in these carbonate-rich deposits, allowed us to identify the late Quaternary (0.0–30.0 ka BP) oscillations (advance and retreat) of the ice shelf recorded by the active and dormant episodes of carbonate factories. Both groups showed similar responses to the palaeoenvironmental/climatic forcing, thus indicating the importance of the integrated use of the different microfossil proxies. In addition, the recovery of these sedimentary series rich in calcareous organisms offers opportunities for geochemical analyses of $\delta^{18}\text{O}$ and $\delta^{13}\text{C}$ on both planktic and benthic foraminifers, for the detailed reconstruction of the oceanographic conditions in addition to the paleotemperatures.

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Abstract No : 198

Antarctic biodiversity predictions through substrate qualities and environmental DNA

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Antarctic conservation science is important to enhance Antarctic policy and to understand alterations of terrestrial Antarctic biodiversity. Antarctic conservation will have limited long term effect in the absence of large-scale biodiversity data, but if such data were available, it is likely to improve environmental protection regimes. To enable Antarctic biodiversity prediction across continental spatial scales through proxy variables, in the absence of baseline surveys, we link Antarctic substrate-derived environmental DNA (eDNA) sequence data from the remote Antarctic Prince Charles Mountains to a selected range of concomitantly collected measurements of substrate properties. We achieve this using a statistical method commonly used in machine learning. We find neutral substrate pH, low conductivity, and some substrate minerals to be important predictors of presence for basidiomycetes, chlorophytes, ciliophorans, nematodes, or tardigrades. Our bootstrapped regression reveals how variations of the identified substrate parameters influence probabilities of detecting eukaryote phyla across vast and remote areas of Antarctica. We believe that our work may improve future taxon distribution modelling and aid targeting logistically challenging biodiversity surveys

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Abstract No : 177

Diversity and community structure of bacteria and archaea of the Antarctic Peninsula, Southern Ocean

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The increase in sea surface temperature in the Antarctic Peninsula, due to global climate change, intensifies the water column stratification and modifies the circulation, generating imbalances in the structure of the microbial community which is the basis of the marine food chain and plays a key role in the biogeochemical cycles. This study aimed to investigate the diversity and composition of the Antarctic marine microbiome in the austral summers of 2014 and 2015, relating to temperature, salinity, phosphate, silicate, and nitrogen components (ammonia, nitrate, and nitrite) from 5 m to 2900 m depth. Total DNA from water samples was extracted, the V4 region of the 16S rRNA gene was amplified and sequenced using the Miseq Illumina platform. Flavobacteriales, Cellvibrionales (Proteobacteria), Oceanospirillales, Rhodobacterales and SAR11 (Bacteroidetes) were the main families of bacteria found. Thaumarchaeota phylum was also found in every study area, except in the sea ice edge, as it usually inhabits deep waters. Alpha diversity indices (Shannon and observed OTUs) of 2014 showed a positive correlation with depth, salinity, silicate, and nitrate, and a negative correlation with nitrite in Bransfield Strait, Gerlache Strait and Weddell Sea. The Principal Components Analysis showed that the depth could explain differences in microbial communities, which corroborates previous studies that emphasize the water column stratification influencing the distribution of microbes. In conclusion, the microbial community structure was influenced by vertical stratification and water masses. The higher relative abundance of Proteobacteria, Bacteroides and Thaumarchaeota are in agreement with other studies in the region.

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Abstract No : 179

Isolated and fragmentary fossil findings: clues for fossil fish diversity and keys for further research

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Argentinian Antarctic expeditions to the Longing Gap locality (Antarctic Peninsula) where the Ameghino Formation (Kimmeridgian–Berriasian) crops out, were carried out in four summer expeditions (2016, 2018, 2020, and 2022) resulting in the finding of abundant fossil actinopterygians, including complete bodies as well as fragmentary specimens. Here, we report Late Jurassic isolated scales and scale patches of marine actinopterygians. Four morphotypes are recognized: 1) large rounded (=elasmoid) of amioid-type; 2) large, rhombic (=ganoid); 3) small, rhombic scales with four or five enameloid ridges; and 4) rectangular (higher than wide), ganoid scales with well-developed peg and socket structure. These scales are attributed to Amiiformes, †Lepisosteiformes, †?Ameghinchthys, and †Aspidorhynchiformes, respectively. Accordingly, this is the first amiiform record for the Antarctic continent, and the southernmost records for both, Amiiformes and †Lepisosteiformes, worldwide. Delicate amiiforms scales and the few well-preserved †Aspidorhynchiformes scales found isolated in black shales suggest early post-mortem or in-life detachment and short flotation in calm waters. The associated crustacean molts, complete pyritized fishes, and delicate small ammonites further indicate the reductive nature of the environment. The †Lepisosteiformes, †?Ameghinchthys, and †Aspidorhynchiformes scale patches, lack the enameloid in many of the scales and show cracking, polish, and abrasion evidencing postmortem erosion. Despite being retrieved isolated and fragmentary, the fossil material is highly informative, providing a glimpse of the actinopterygian's marine diversity during Jurassic times, their depositional environment, and taphonomic history. *Project funding: PICT 2017-0607 to MR and PICT 2019-02419 to SGC.

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Abstract No : 740

The first record of dermochelyid turtles in the Eocene of Tierra del Fuego, Argentina, provides new information to interpret the evolution of the Weddellian faunas in Western Antarctica

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The Antarctic Paleogene marine fossil record has been key to reconstructing the evolution of the Weddellian Sea and final dismemberment of Southern Gondwana. In this context, Eocene marine vertebrates from Marambio (=Seymour) Island have provided valuable information. Herein, we present the first Eocene record of marine reptiles from the southern Atlantic Coast of South America. This corresponds to several postcranial remains of turtles represented by a proximal end of the right humerus, three caudal and one thoracic vertebrae, a fragment of the left pubis, and ten ossicles of dorsal carapace, coming from Leticia Formation (late-middle Eocene) at Cabo Tiburones, Tierra del Fuego, Argentina. These materials show several features such as the size and general morphology of the humerus and vertebrae, and the presence of small, irregular, smooth and unkeeled ossicles, that allow us to assign them to Dermochelyidae indet. Dermochelyids are a cosmopolitan group of cryptodiran turtles, registered from the Late Cretaceous up to the recent, with some physiological-biological peculiarities (e.g., endothermy and an exclusive jellyfish-based diet) and characterized by the presence of an osseous carapace formed by ossicles. The new finding from Leticia Formation is an addition to the scarce and extremely fragmentary record of Eocene dermochelyids from the southern seas like those from La Meseta Formation (Antarctica) and Waihao and Burnside formations (New Zealand). This new information allows us to discuss the presence of these turtles in such high latitudes in the past and its implication in the evolution of the Weddellian faunas.

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Abstract No : 612

Community assembly in the wake of glacial retreat: A meta-analysis

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Ecosystems shaped by retreating glaciers provide a unique opportunity to study the order and timing of biotic colonization, and how this influences the structure of successive ecological communities. In the last century glaciers across most of the cryosphere have receded at an unprecedented pace. Many studies have been published from different parts of the world testing hypotheses about how soil ecosystems are responding to rapid, contemporary deglaciation events. To better understand and draw general conclusions about how soil ecosystems respond to deglaciation, we conducted a global meta-analysis of 95 published studies focused on the succession of various organisms and soil physicochemical properties in glacier forefields along the chronosequence. Our global synthesis reveals that key soil properties and the abundance and richness of biota follow two conspicuous patterns: 1) Some taxa demonstrate a persistent increase in abundance and richness over the entire chronosequence, 2) other taxa increase in abundance and richness during the first 50 years of succession, then gradually decline 50 years onward. The soil properties and soil organisms that are intimately tied to vegetation follow the first pattern, consistent with the idea that aboveground patterns of vegetation can drive patterns of belowground biodiversity. The second pattern may be due to an initial increase and subsequent decline in available nutrients and habitat suitability caused by increased biotic interactions, including resource competition among soil biota. A consensus view of the patterns of historical and contemporary soil ecosystem responses to deglaciation provides a better understanding of the processes that generate these patterns

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Abstract No : 798

Effects of temperature on early embryonic development of three Antarctic invertebrates.

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A fundamental and essential process in the development of all metazoans is early embryonic cleavage, which transforms the zygote into an embryo. Many aspects of the physiology of ectotherms in the Southern Ocean are sensitive to small changes in temperature, but comparatively few studies have investigated the effect of increasing temperature on embryonic development. We measured the effects of temperature on the cleavage rate of embryos of three species (one nudibranch and two pycnogonids) from McMurdo Sound. Uncleaved zygotes were placed in a range of temperatures from -1.8 (ambient) to +3.5°C and monitored daily until the 32-cell stage. For all but one set of embryos, development appeared normal even at the highest temperature. Cleavage rate increased with temperature; on average, cleavage was > 2x as fast at the highest compared to the lowest temperature. For our best replicated species, *Tritoniella belli* (n = 10), embryos from seven egg masses had significantly greater thermal sensitivity at the lowest end of the experimental temperature range ($Q_{10} = 36.6 \pm 16.2$) and reduced sensitivity above it ($Q_{10} = 5.1 \pm 1.5$); the greatest rate changes occurred below -0.3°C. Our results show early cleavage is highly sensitive to small temperature changes above ambient in McMurdo Sound, meaning small amounts of warming will speed up embryonic development more than standard predictions based on Q_{10} s of 2-3 for most biological processes, with potential implications for ecological timing of hatching and the energetics of development. Funded by NSF-OPP-1745130 to ALM

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Abstract No : 626

Which factors are shaping the microbial diversity in the inland high-altitude biotopes of the Western Sør Rondane Mountains (Eastern Antarctica, ACBR6)?

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The scarce ice-free terrestrial areas of Antarctica are among the most extreme environments on Earth and are therefore dominated by microorganisms. The BelSPO project BELDIVA (2009-2012) investigated soil and biological crusts' microbiomes in the vicinity of the Princess Elisabeth Station using amplicon sequencing of the SSU rRNA gene of pro- and eukaryotes and revealed that bedrock type and microhabitat conditions were shaping the community composition and that there were differences in the microbiome-environment relations in comparison to the McMurdo Dry Valleys. In addition, a pilot study of *pufM* (light harvesting) and *RuBisCO* (carbon fixation) genes suggested an important role of as yet unknown groups of prokaryotes in the primary production of these ecosystems. A more comprehensive study was recently performed during the project MICROBIAN (2016-2021) where samples were collected from a wider range of bedrock types and nunataks/ridges, and remote sensing and drone observation techniques were tested to map physical habitat characteristics and the presence/extent of microbial crust communities in ice-free areas. Indeed, slope and aspect information at different scales are expected to provide useful information to explain the differences in biodiversity at the sampling sites. Based on 142 samples from granite, marble, gneiss and moraine, preliminary results suggest that pH and bedrock type were the most important structuring factors for both Bacteria and Eukaryotes in these ice-free regions.

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Abstract No : 921

Paleoenvironmental changes recorded during the Maastrichtian–Danian at the Filo Negro Section, Seymour Island, Antarctica

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The Filo Negro Section is a 15 meters-thick very fossiliferous section in Seymour Island, Antarctica, that spans Maastrichtian–Danian sediments. However, the number of palynological studies in this section is very scarce. Herein, both geochemistry and palynology were used in order to mark the most probable position for the K–Pg (Cretaceous–Paleogene) transition in the section, as well as to infer on past environmental settings right before and after it. The palynological assessment consisted in the classification of dinoflagellate cysts (dinocysts) and sporomorph (pollen grains and spores) species, and the counting of 200 palynomorphs from 35 slides (for statistical analyses), covering 11 m. The samples were prepared by using the standard method for preparation of palynological slides. Geochemical analyses included Ti/Al (indicative of proximity to the sediments source area), siderophile elements (Cr+Ni+Cu+Co) against Al (since siderophile elements are usually enriched in K–Pg layers), and Fe/K (to evaluate weathering intensity) ratios. This study allowed us to infer a more humid climate in the latest Maastrichtian when compared to the post-transition conditions, as well as a more proximal environment upwards in the section (marine regression). The Danian was also probably colder than the final Maastrichtian. Finally, the K–Pg transition has been placed within 9.5 to 9.6 m, refining its former position.

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Abstract No : 949

Use of UV-resistant bacteria isolated from Union Glacier (Antarctica) for H₂ photoproduction mediated by the biosynthesis of Quantum Dots and O₂-tolerant [NiFe] hydrogenases.

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Biological-inorganic systems, i.e., bacteria that biosynthesize intracellularly photoactive nanostructures such as Quantum Dots (QDs), allow the synthesis of bio-products through the transfer of photoelectrons from irradiated QDs to different bacterial enzymes. One of the bio-products generated by these systems is H₂ in a reaction catalyzed by hydrogenases. However, biological-inorganic systems have some drawbacks. One of them is the low tolerance of hydrogenases to O₂. On the other hand, due to the irradiation of bacteria, it is necessary to use radiation-resistant microorganisms. Recently, high activity of O₂-tolerant [NiFe] hydrogenases has been reported in bacteria from Antarctic desert areas. Union Glacier is an Antarctic desert zone with high levels of surface radiation. Based on these characteristics, Union Glacier is an ideal place to find radiation-resistant bacteria with O₂-tolerant [NiFe] hydrogenases for H₂ photoproduction. The objective of this work was to evaluate H₂ photoproduction mediated by the biosynthesis of QDs and O₂-tolerant [NiFe] hydrogenases in UV-resistant bacteria from Union Glacier. Bacteria were isolated from Union Glacier soil samples. UV-resistant bacteria were selected by exposure to UV-B and UV-C radiation and identified as *Arthrobacter* and *Paracoccus*. Then, H₂ photoproduction through irradiation of UV-resistant bacteria biosynthesizing QDs was evaluated. Genomic identification of the [NiFe] hydrogenases of the bacteria was performed according to their amino acid sequence similarity and conserved structural motifs. Finally, the O₂ tolerance of [NiFe] hydrogenases was structurally studied through homology modeling. We conclude that UV-resistant bacteria from Antarctica are an excellent model for biotechnological applications in H₂ photoproduction through QDs biosynthesis.

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Abstract No : 802

Effect of freeze-thaw cycles on the hydraulic-photosynthetic performance of Antarctic vascular plants

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Low temperature, especially freeze-thaw events, can reduce hydraulic conductance and photosynthetic reactions. This response is because leaf gas exchange is related to the hydraulic characteristics of the leaf xylem due to the serial positioning of the xylem and stomata in the flow path of water through the plant. Antarctic vascular plants are covered with snow for 6–7 months and are often exposed to freezing and thawing cycles during the summer when the average daily temperature is around 4 °C. Due to regional climate change in Antarctica, freezing-thawing events are expected to increase in duration and frequency. These events can be more damaging than exposure to just cold temperatures. In this context, we analyzed the whole-plant hydraulic conductivity (g_{plant}) and several photosynthetic traits of *Deschampsia antarctica* and *Colobanthus quitensis* grown at 5 °C and 15 °C, before and after 10 freeze-thaw cycles. The results show that the g_{plant} and photosynthetic performance decrease with the number of freeze-thaw events in both species, but only when they grow at 15 °C. The first response can be assigned to a hydraulic failure caused by embolism, whereas the decline in photosynthesis is a consequence of the reduction in diffusion pathways. Additionally, both species showed a strong correlation between hydraulic and photosynthetic parameters indicating a mechanistic linkage through shared structural and physiological traits. The results suggest that Antarctic vascular plants may affect their ability to withstand weather uncertainty, especially sudden freezing events. Acknowledgments: INACH RT_ 13–16, INACH DG_09–21, REDES-CONICYT 170102, FONDECYT 1211231, ANILLO 210038, FB 210006.

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Abstract No : 856

Effect of the endolithic colonization on the bacterial diversity of soil in Victoria Land

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Soil and rocks represent the substrata for microbial colonization in the inner ice-free areas of Victoria Land, where the life-forms present have to cope with the driest and coldest environmental conditions on the planet. Although endolithic communities were assumed to be the predominant life-forms in this environment, molecular studies proved the existence in soils of a higher diversity than previously thought. However, the drivers of microbial colonization in Antarctic soils are poorly understood, and many questions remain unanswered. Furthermore, the potential contribution of the endolithic communities to soil diversity has never been investigated here before. Indeed, biological colonization may induce rocks' surface exfoliation, resulting in fragments serving as vegetative propagules, but many of which fall into the soils. To answer these questions, soil samples were collected in three different localities in Victoria Land where climatic stations were installed, as close as possible to well colonized sandstone outcrops and at increasing distances of 50 and 100 meters. Samples of the corresponding rock outcrops were collected as well. Bacterial diversity was investigated through a metabarcoding approach. Data on communities diversity and composition in the soils, in comparison to the corresponding rock communities, will be presented. Data on communities diversity will be correlated with physicochemical parameters, such as carbon and nitrogen content, pH, moisture, cation exchange capacity, and soil granulometry, as well as to microclimatic data, to give insights into the drivers of life establishment in such extreme environments.

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Abstract No : 86

Are existing Marine Protected Areas of the Southern Ocean representative of marine phylodiversity

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Marine protected areas (MPAs) have been recognized worldwide as an effective tool for ocean biodiversity conservation. The Commission for the Conservation of Antarctic Marine Living Resources committed to elaborate a representative network of MPAs in the Southern Ocean (SO). MPAs planning in the SO tend to be representative of areas of pelagic and benthic biodiversity, however it has been based on taxonomic diversity and habitat structure, overlooking other biodiversity facets. Yet, it has been increasingly argued that instead of species richness, phylodiversity is a more conservation-relevant metric for biodiversity. Indeed, phylodiversity integrates species shared evolutionary history drawing inferences about evolutionary processes and environmental factors that shape current biodiversity distribution. This study is the very first assessment of phylodiversity distribution patterns for various marine fauna taxa at the global scale of the SO. We used species occurrences from public data repositories (GBIF and OBIS) and time-calibrated trees to investigate 1) whether currently existing MPA network of the SO adequately represent species phylodiversity (alpha diversity); 2) what is the current phylogenetic species turnover (beta diversity) across the Southern Ocean by defining phyloregions and 3) how environmental variables could explain phylodiversity distribution. As first results, we found that current network of MPAs of the SO is not representative of phylodiversity and its hotspots remain uncovered. Moreover, phyloregions delimited with beta phylodiversity (phylogenetic similarity between study grid cells) reflected environmental conditions distribution (e.g. bathymetry). We strongly support the combined use of phylogenetic alpha and beta diversities determining areas of evolutionary importance for priority

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Abstract No : 462

Definitive evidence of terror birds in the Eocene of West Antarctica

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Phorusrhacids, also called “terror birds”, are a completely extinct group of terrestrial Cariamiformes that constituted the predominant predators during the South American Cenozoic. Their long hind limbs, large skulls, and especially their sharp and curved beak and claws, highlight their hunting skills. Cretaceous and Paleogene Antarctic remains previously referred to Phorusrhacidae have been reassigned to other groups during the last decade. However, a ungual phalanx from the Ypresian levels (La Meseta Formation) in Marambio/Seymour Island (James Ross Basin), changes our conception about the continental ecosystems dynamic during the early Eocene. The specimen is represented by a laterally compressed and curved ungual phalanx, with a neurovascular sulcus running along the entire lateral and medial surfaces, an articular facet sub-triangular and dorsoventrally elongated, and a rounded flexor tubercle. The outline and asymmetry of the articular facets and the greater depth of the neurovascular sulcus on the medial facies, allow its preliminar assignment to a right digit II. Phorusrhacids, positioned as top predators in continental Cenozoic ecosystems and without any living analog, shared their giant sizes with flightless forms (e.g., ratites) and powerful curved talons with raptors birds (e.g., falcons), groups already recorded in the Eocene of Seymour Island. Phorusrhacidae represents, however, a guild hitherto unknown to Antarctica. The specimen here described belonged to a terrestrial hunting bird, a giant carnivorous form that fulfilled the role of top predators apparently not occupied by land mammals in the Paleogene Antarctic communities.

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Abstract No : 741

Mapping the plant diversity of Elephant Island, South Shetland Islands

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Elephant Island, the northern-most island of the South Shetland Islands, is located 245 km from the north Antarctic Peninsula. The island is almost entirely ice-covered, with very limited terrestrial exposure suitable for the development of vegetation. Due to the extreme climate of the island and the challenges of accessing it safely, even today few expeditions have visited the island with, to our knowledge, plant collections carried out only in 1916, 1922, 1961, 1970, 1971, 1977 and 2014. Based on material documented in two major polar herbaria (AAS, United Kingdom; UB, Brazil), we have located a total of 113 records of collections made on the island. We have integrated these records to identify the precise geographical location of each collection made, as well as highlighting under-sampled areas to be targeted in future research expeditions. With rapid climatic and other environmental changes affecting this region, it is important to establish monitoring programmes to identify changes in the vegetation over time, as no such programmes exist at present.

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Abstract No : 731

Revisiting Deception Island's Exceptional Moss Vegetation Protected in ASPA 140

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Deception Island is one of very few active volcanoes in Antarctica, most recently erupting in 1967,1969 and 1970, with further eruptions expected. The island is in the South Shetland Islands archipelago and 57% of its surface is ice-covered. A unique feature is the presence of localized terrestrial sites that are geothermally active, including several fumaroles. While these geothermal sites can be chemically stressful, their associated warmth and moisture provide ideal conditions for mosses to grow. With the combination of its unique botanical diversity, aesthetic and scientific values, historical importance, the presence of active research stations, and being one of the most popular visitor sites in Antarctica, Deception Island has been designated as Antarctica Specially Managed Area (ASMA) 4. Within the ASMA, Antarctica Specially Protected Area (ASPA) 140 has been designated, which includes 11 distinct sub-sites, each with distinct vegetation features. At present, 57 moss species are considered to occur on Deception Island. Of these, 13 are not recorded elsewhere in the Antarctic Treaty area (although some occur on the remote South Sandwich Islands, north of the Treaty area but within the maritime Antarctic) and two are apparently endemic to the island. In recent collections obtained since 2014, 29 species from 10 families were identified in collections from ASPA 140. Here, we map these collections and update the island's known diversity in order to better inform future conservation decisions and the management of the ASPA.

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Abstract No : 799

Who's watching the kids? An answer to the century-old mystery of colossendeid sea spider reproduction

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The pycnogonid family Colossendeidae is well represented in the Southern Ocean and contains the largest and most charismatic species of sea spiders; yet, while colossendeids have been studied for > 150 years, their mode of reproduction is unknown. At McMurdo Station in 2021, we observed spawning by *Colossendeis megalonyx*, raised embryos in the laboratory, and located newly-laid egg masses in the field. In the laboratory, spawning occurred after animals were in typical pycnogonid mating posture (two to several individuals stacked on top of each other) for several days. Negatively-buoyant eggs were released in a cloud of sticky gel. The female left the eggs soon after spawning and an (inferred) male remained on the mass for > 48 h, appearing to groom the mass with its ovigers while the mass became compacted into an adherent sheet of eggs on the substrate. Eggs averaged 106.4 μm in diameter and underwent holoblastic cleavage, developing in an egg envelope over the course of > 7 months (developmental observations are still ongoing) into same-sized non-yolky embryos with chelicerae and multiple pairs of legs. Embryos remained attached to the substrate, suggesting dispersal potential of embryos is limited. In all other sea spiders the male carries the young, but because no egg-bearing males have ever been observed in any colossendeid, we suggest that the non-brooded development of *C. megalonyx* may be typical of this family and could represent the ancestral reproductive state of modern pycnogonids. Funded by NSF-OPP-1745130 to ALM.

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Abstract No : 1063

Untargeted metabolite profiling on polar and non-polar metabolites in mosses and higher plants from Livingston Island (Maritime Antarctica) through gas chromatography – mass spectrometry (GC-MS)

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South Shetlands are exposed to some of the most intensive climate changes on Earth. Ice and snow retreat trigger expansion of distribution ranges of Antarctic mosses and higher plants. We collected specimens of Antarctic hair grass (Ahg, Poaceae), Antarctic pearlwort (Ap, Caryophyllaceae) and Antarctic mosses (Am, Bryophyta) and used untargeted gas chromatography – mass spectrometry to quantify polar and non-polar metabolites. A total of 30 compounds, e.g. amino and organic acids, sugar alcohols, mono- and dicarbohydrates, were established. Predominant in the Ap samples were disaccharides (sucrose, turanose), followed by sugar alcohols (pinitol, myo-inositol) and monosaccharides (fructose, galactose). The major constituents in the Am samples were disaccharides (sucrose), followed by monosaccharides (galactose, glucose) and sugar alcohols (sorbitol). The main substances identified in the Ahg samples were disaccharides (sucrose), followed by monosaccharides (fructose, galactose, glucose), sugar alcohols (myo-inositol) and the amino acids (asparagines, proline). The lipid fraction consisted of three saturated and five unsaturated fatty acids. The major constituent for all accessions was the linolenic acid, followed by the linoleic acid as the major metabolite for Am samples. Amino and fatty acids and carbohydrates are often associated with abiotic stress in extreme environments. This initial screening of primary and secondary metabolites can provide candidate substances, potential markers of environmental changes. The study was funded through project # 70-25-68/03.08.2021. We thank the National Center of Polar Research, Bulgarian Antarctic Institute and the staff of the 30th Bulgarian Antarctic Expedition for their support, to Prof. D.Sc. Ch. Pimpirev and D. Mateev.

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Abstract No : 408

Disclosing the core cyanobacterial community dominating glacial retreat areas on the Antarctic Peninsula

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Cyanobacteria are key organisms in the Antarctic ecosystem, but the primary succession of its communities in recently deglaciated soils remains poorly understood. In this study, we surveyed the primary succession of cyanobacterial communities with an in-depth Next Generation Sequencing approach in three Antarctic recently glacier forefields. Despite the similar physicochemical characteristics of the soils, we did not find a common pattern in the distribution of the cyanobacterial communities at the finest level of taxonomic resolution. However, the metabarcoding analysis revealed a common community of 14 cyanobacterial identical sequences in all the studied soils, whose lineages were not restricted to polar or alpine biotopes. These ASVs comprised a relative abundance within the cyanobacterial community of 51.5%–81.7% among the three locations and were also found in two cyanobacterial mats from the Antarctic Peninsula. Our results suggest that (micro)biotic interactions act as a key driver of the community composition and dynamics of Cyanobacteria during the early stages of succession in recently deglaciated soils of Antarctica. A few common genera might play a key role in the ecosystem, due to their ubiquitous presence not only in these soils but also in microbial mats, conforming probably the most widely dispersed and dominant single genotypes in Antarctic soils.

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Abstract No : 495

Survey of marine invertebrate occurrences in the Antarctic Cretaceous (Fossil Bluff, Byers, Gustav and Marambio groups)

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This work aimed to survey the occurrences of fossil Cretaceous marine invertebrates in Antarctica. This bibliographic review was carried out through a wide search in Paleobiology Database, papers, dissertations and theses. The most fossiliferous Cretaceous lithostratigraphic units are the Marambio, Gustav, Fossil Bluff and Byers groups. The former has the greatest diversity recorded, possibly for being the most studied and its paleoenvironment is suitable to a larger faunal diversity. Despite the incompleteness of the geological record, is noticeable the faunal distinctiveness among the basins of the East and West Antarctic Peninsula (AP) region: from the late Aptian to Albian, interval with the greatest overlap among such basins, only 15% of the taxa are shared. The Mesozoic-Cenozoic magmatic arc along the AP separated different depositional environments to the East (back arc basins, transgression trend) and West (fore arc basins, regression trend), but on both sides there is an increase trend in the invertebrate diversity in shallower marine environments. In the eastern portion, only 29% of the taxa present before the Coniacian are found posteriorly. This faunal change may be related to an environmental change, moving from deep marine to prograding shelf. Finally, we recognized ecological guilds in the Antarctic Cretaceous, most of them composed by epifaunal or nektonic animals and also subordinate guilds of deep and semi-infaunal animals. The guilds are broader as the environment is shallower. Such data obtained are useful subsidies for future taxonomic, paleobiostratigraphic, paleoecological and paleoenvironmental works. [CNPq 442765/2018-5, 110647/2020-3, 110662/2020-3 and 474952/2013-4-PIBIC; FAPERJ E-26/200.110/2019]



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

LIFE SCIENCES

**Biological dispersal: connections at
continental and inter-continental scales**

CONVENORS

Chiara Papetti, Jamie Maxwell

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Abstract No : 586

How many species were hidden within the broadly distributed periwinkle *Laevitorina caliginosa*

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The genus *Laevitorina* includes 21 nominal shallow-benthic species around the Southern Ocean. *Laevitorina* species lack a free-swimming dispersive stage with benthic protected development, low dispersal potential and are narrow endemics. The single exception, *Laevitorina caliginosa* (Gould, 1849) has a broad distribution in the Antarctic Peninsula and across the sub-Antarctic. The existence of broadly distributed species with low dispersal potential is paradoxical and may be explained through long-distance dispersal (LDD) mediated by floating objects (rafting) or taxonomic confusion probably related to unrecognized cryptic-species complexes. Here we performed multi-locus phylogenetic reconstructions, species delimitation analyses, divergence time estimations, and geometric morphometric analyses in *L. caliginosa* populations from different provinces of the Southern Ocean. Molecular data revealed the presence of seven species-level clades within *L. caliginosa*, all supported by morphological analyses. Contrarily, Antarctic endemics *L. antarctica*, *L. claviformis* and *L. umbilicata* are conspecific. Six “*caliginosa*” clades were found in southern South America and one lineage extends its distribution from Antarctica to distant sub-Antarctic islands (Marion, Crozet and Kerguelen) across the Antarctic Polar Front (APF). The apparent broadly distribution of *L. caliginosa* is largely illusory, this taxon consists of at least seven discrete species and only one of them has a trans-APF distribution. Biogeographical patterns in *Laevitorina* reflect the role of plate tectonic vicariance together with recent LDD events. *Laevitorina* is not a cryptic-species complex, speciation was accompanied by unrecognized morphological differentiation. This study represents the most detailed integrative study on Southern-Ocean littorinids and reveals unforeseen diversity across this globally important region.

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Abstract No : 569

Deep divergences between Antarctic lineages of the tardigrade genus *Mesobiotus* indicates an ancient Antarctic-specific species complex

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Tardigrades are one of the few groups of terrestrial invertebrates to thrive on the Antarctic continent, even occurring on nunataks in the harsh continental interior. As Antarctica has been isolated from other continents for 20 million years or more, we ask the question that has been explored for a number of other terrestrial invertebrates: Are tardigrades a Gondwanan relic, isolated in Antarctica over evolutionary time, or are they recent colonisers? Tardigrades are exceptionally hardy; many can withstand freezing at -80 for several years, and some can even survive in the vacuum of space. In principle they are well-suited to survive the challenges of both long term in situ survival, or long range, perhaps windblown, dispersal. The genus *Mesobiotus* has a worldwide distribution, with well-known representatives in Antarctica as part of the “*harmsworthi*” and “*furciger*” morpho-groups. Using nuclear and mitochondrial gene sequences, we assessed the presence or absence of strong phylogeographic patterns, where presence would suggest long-term in situ evolution in isolation and absence would indicate recurrent and more recent colonization. Our data indicated strong phylogeographic structure across the Antarctic continent. Furthermore, the data highlighted that the use of “*harmsworthi*” and “*furciger*” to represent evolutionary related morpho-groups should be abandoned given they are not monophyletic. It is particularly notable that members of *Mesobiotus* from the Antarctic, including both morpho-groups, form a monophyletic group deeply divergent from all other non- Antarctic *Mesobiotus*. This result provides strong support for the long-term persistence and in situ evolution of tardigrades on

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Abstract No : 528

First record of the Indian meal moth, *Plodia interpunctella* (Lepidoptera: Pyralidae), at a research station in Antarctica

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We report the first formal record of the Indian meal moth *Plodia interpunctella* from a location within the Antarctic Treaty area. A live adult male was captured in November 13, 2021 within the Brazilian Comandante Ferraz research station on the Keller Peninsula, King George Island, South Shetland Islands. This species is a well-known pest of stored products globally and is widely recorded in synanthropic situations such as food stores. No other adults or immature stages have been observed on the station. While there is no suggestion that *P. interpunctella* could survive or establish in the natural environment beyond the station, this observation highlights the ever-present threat of unintended anthropogenically-assisted transfer of non-Antarctic species into human facilities on the continent, with some such species proving extremely difficult to eradicate if they successfully establish within these facilities.

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Abstract No : 336

Assessing habitat suitability for *Boeckella poppei* across Antarctica and the Magellanic sub-Antarctic (MSA) ecoregion

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The contemporary spatial structure of biodiversity has been strongly influenced by natural climatic and tectonic changes that have occurred over long timescales. However, today Antarctica and its surrounding archipelagos are showing alarming responses to the effects of anthropogenically-driven climate change (CC). The need to increase our understanding of how biodiversity change is driven by CC over time and space is urgent, especially in one of the most vulnerable – and uninhabited by humans – ecosystems on Earth. The copepod *Boeckella poppei* (Crustacea) is the only macroscopic terrestrial or freshwater invertebrate species known to be distributed today across the three main biogeographic regions in Antarctica as well as in the Magellanic sub-Antarctic (MSA) ecoregion. Using ecological niche modeling (ENM) we are characterizing and analyzing the species' present-day distribution across the maritime Antarctic (Antarctic Peninsula and Scotia Arc), sub-Antarctic South Georgia and the MSA using *B. poppei* occurrence data obtained from open online repositories (GBIF), the published scientific literature and intensive sampling across its distribution. This will enable prediction of habitat suitability and likely occurrence of *B. poppei*, and identification of which environmental variables have significant influence on the species' distribution. Our study represents a first milestone towards the future research to develop ecological niche models for freshwater species under different future climate change scenarios.

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Abstract No : 245

Extensive quantities of non-native kelp rafts found in Livingston Island (South Shetland Islands) and their potential for bioinvasions.

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Non-native kelp rafts floating in the open ocean or stranding on the coasts of Antarctic regions have previously been reported, often carrying along “passenger” species with invasive potential. However, information on the exact amounts and frequency of this type of arrivals to Antarctica is still scarce as reports tend to rely only on incidental finds by researchers. After several sightings on the coasts of Livingston Island, we decided to sample several areas of Livingston Island, counting, measuring, and identifying non-native kelp rafts and their associated “passengers”. During our survey, we found higher than expected numbers of rafts (103), all of them belonging to the macroalgae species *Durvillaea antarctica*, with fragment sizes comprised between 10 and 146cm long and weights up to 1.9 kg. From these, about 50% of the rafts (47) presented alive colonies of the barnacle species *Lepas anatifera*. In this context, our observations represent the largest amounts of non-native kelp raft recorded from Livingston Island and one of the few reports of quantification of these events in the South Shetland Islands and Antarctica. These findings suggest that there is a constant arrival of foreign species with colonization potential to the region, which, combined with the current perspectives of climate change, reveals an alarming situation for the conservation of Antarctic coastal ecosystems.

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Abstract No : 174

Understanding past and future Antarctic (seaway) connectivity – are under ice shelf samples key?

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The West Antarctic Ice Sheet (WAIS) maybe prone to collapse and is currently undergoing major losses. A WAIS collapse would lead to ~5 m of global sea level rise, new seaways across the Antarctic continent and likely major changes to water mass formation, ocean circulation and heat and gas exchange between ocean and atmosphere around and beyond Antarctica. Literature examining connectivity of sessile marine life around Antarctica suggested that modern bryozoan distributions were best explained by a SE Weddell Sea Embayment-eastern Amundsen Sea Embayment seaway, necessitating a WAIS collapse under conditions of a previous interglacial (perhaps 129 ka ago). Analyses are compromised by paucity of sampling at each end of the putative seaway. Such samples are urgently needed, especially from sampling sites under ice shelves in order to evaluate the feasibility of benthos survival in these presumably hostile settings. Recent samples from boreholes through the Ekström Ice Shelf (easternmost Weddell Sea) revealed remarkable rich benthos, normal levels of growth and long-term persistence. Two under ice-shelf samples included 38% of bryozoans known from the Weddell Sea. Crucially this new finding increased the species in common between the Weddell Sea and the eastern Amundsen Sea Embayment. New samples are potential game changers in our understanding of past seaway connectivity, WAIS stability and trigger points for collapse in a now rapidly changing polar environment. Molecular tools and investigation of other taxa at key sites would provide deeper insights into past climate-forced regional connectivity and help better understand present and predict future environmental changes

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Abstract No : 742

Investigating aerial diversity of non-fungal eukaryotes across a 40° latitudinal passage using DNA metabarcoding

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During the austral summer of 2021, air was sampled regularly in a ship-borne transit between Rio de Janeiro, Brazil (22°S) and Comandante Ferraz Station, King George Island (62°S). Air was pumped (ca. 350 m³/day) through 0.45 µm filter membranes that were changed every three days. DNA subsequently extracted from the filters was sequenced using High Throughput Sequencing. The data obtained suggest that diversity present in the air column decreased as latitude increased. Highest sequence diversity and abundance were detected along the south-east Brazilian coast, with 14 species assigned representing three kingdoms and five Phyla. Small increases in abundance and diversity were detected close to the southern Brazilian city of Rio Grande do Sul, and again in the proximity of King George Island. Lower diversity was detected in the channels of Chilean Patagonia, with only five taxa assigned representing two kingdoms and three phyla. Multiple factors can potentially influence aerial sequence diversity and abundance, although our data indicate that latitude and proximity to human presence are amongst the most important. Initial assessment of the assigned sequence diversity suggests that it is mostly related to that of the nearby biomes along the South American coast, although some of the assigned taxa have no obvious relationship with this region. In the vicinity of King George Island the majority of sequence assignments consisted of green snow algae (Chlamydomonadales), but also included Mammiellales and Trebouxiia. Sequences were also assigned to the South American tree *Nothofagus antarctica* likely indicating pollen transfer from southern South America.

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Abstract No : 567

The role of water mass properties in structuring Antarctic benthic communities: a study of the Pycnogonida

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No other group of animals typifies the uniqueness of Antarctic life more than Pycnogonida (sea spiders), with 20% of all known species found in the Southern Ocean, and 64% of these endemic to the Antarctic. Despite nearly 200 years of research into pycnogonids and other benthic phyla in Antarctica, the parameters which drive the distribution of benthic fauna are still poorly understood. This study aimed to investigate the influence of depth and water mass properties on the composition of pycnogonid species assemblages within the Southern Ocean using an occurrence dataset containing 255 pycnogonid species from 2190 sampling locations. We developed a new method, whereby occurrence data were categorised according to environmental parameters, to investigate how water masses may structure the composition of assemblages. At depths shallower than 1000 m, communities to the north and south of the Polar Front were distinct, while below this depth there was less differentiation. South of the Polar Front, six distinct species assemblages were identified, each inhabiting their own potential temperature-salinity space. The assemblages from the colder waters of the Weddell Sea and Bransfield Strait were more species-rich and had a higher proportion of unique species than those from warmer fresher waters of the Western Antarctic Peninsula, suggesting a reduction in pycnogonid diversity is likely under warming conditions. This is the first evidence that water masses structure the community diversity and distribution of a mobile Antarctic benthic taxon across the Southern Ocean.

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Abstract No : 150

DECEPTION VOLCANISM/SOUTH SHETLAND IS. AS A POTENTIAL SOURCE OF DIATOM (*Luticola gigamuticopsis*) DISPERSION TO NORTHERN ANTARCTIC PENINSULA

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Diatoms are phytoplankton organisms worldwide distributed, and may be cosmopolitan or endemic to a region. Its frustules impregnated with silica make them resistant to dissolution, enabling its preservation in sediment layers in long term. *Luticola gigamuticopsis* is a diatom described for Deception and Livingston Island/Western Antarctic Peninsula, Vega and James Ross Island/Eastern Antarctic Peninsula. At King George Island/Fildes Peninsula in a 23cm-sediment core from the Profound Lake, we found *Luticola gigamuticopsis* in depths of 12 and 15 cm, that according to the chronology of sediment core, based on Pb-210 in excess measurements and the CRS model, corresponded to the years of 1969 (1969-1975) and 1944 (1944-1952). These years also corresponded to the reported eruptions at Deception Island. Deception Island is the most active volcano in the South Shetland Archipelago and over 20 eruptions have been identified over the past two centuries, being the most in 1970. Considering that modeled atmospheric dispersion is consistent to a favorable condition of the volcanic ash material dispersion from Deception to King George Island, we postulate that the relative abundance of *Luticola gigamuticopsis* found in lake stratifications, corresponding to the volcanic eruption episodes, were possibly transported by an aeolian mechanism between the two islands. The occurrence of the specimen in the 1969 layer corresponds to the occurrence of the eruption VEI3 from Deception in 1969 and 1970. Our results corroborate other findings in Taupo Volcanic Zone, New Zealand, where the volcanic plumes have transported microorganisms such as diatoms for long-distance.

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Abstract No : 1019

LIMITED POPULATION CONNECTIVITY ALONG MARITIME ANTARCTICA: DISPERSAL BARRIERS AND GENETIC DIFFERENTIATION BETWEEN SOUTH GEORGIA ISLAND AND THE ANTARCTIC PENINSULA IN THE NOTOTHENIOID FISH *Harpagifer* spp.

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Connectivity is a fundamental process of population dynamics in marine ecosystems. In the last decade it has become more relevant to combine different approaches to understand connectivity among populations. On the one hand, bio-physical models that simulate larval dispersal can be used to estimate potential dispersion. On the other hand, using genetic markers to estimate population structure and gene flow, it is possible to determine effective dispersion. Maritime Antarctica is an eco-region that includes the Antarctic Peninsula (AP) and South Georgia Islands (SG). It has been described before that there could be barriers to connectivity among populations for different species in this area. In this study, the notothenioid and benthic fish *Harpagifer antarcticus* was used as model species to estimate connectivity patterns along the Maritime Antarctica. Two approaches were used, a bio-physical model and population genomics analyzes. The bio-physical model results showed that the particles released in SG are dispersed towards the northeast and that the particles released in the AP could not reach SG, generating low potential dispersal between these two zones. Population structure analyzes detected patterns of genetic differentiation between SG and AP. Also, gene flow analyzes showed asymmetrical migration rates between these two groups. Low migration rates were detected among SG and AP (<0.03), while most of settlement occurred within the parental group (>0.8). The bio-physical model and genomic approaches showed congruent results. The oceanographic conditions of these areas would impede larval exchange, acting as a barrier for *H. antarcticus* dispersal and generating low connectivity.

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Abstract No : 357

In vitro and in vivo pathogenicity fungi present in permafrost from Antarctica Peninsula

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We assessed the potentially pathogenic fungi present in Antarctic permafrost and the overlying active layer on King George, Robert, Livingston and Deception Islands, maritime Antarctica. Permafrost and active layer sub-samples were incubated at 37 °C to select fungi able to grow inside the human body. A total of 67 fungal isolates were obtained, permafrost (27) and the active layer (40). These represented 18 taxa of *Alternaria*, *Aspergillus*, *Curvularia*, *Penicillium*, *Rhodotorula* and *Talaromyces*. The majority of fungi detected occurred exclusively either in the permafrost or the active layer at each site. Only *Aspergillus thermomutatus*, *Penicillium* cf. *chrysogenum* and *Rhodotorula* cf. *mucilaginosa* were present in both samples from the same site. The genus *Penicillium* was the most abundant and widely distributed genus in both permafrost and active layer samples across the sites sampled. All fungal isolates were screened using enzymatic, pH and antifungal assays to identify their virulence potential. *Aspergillus hiratsukae*, *A. thermomutatus* and *R. cf. mucilaginosa* displayed phospholipase, esterase, proteinase and hemolytic activities resistance to fluconazole and itraconazole; additionally, *R. cf. mucilaginosa* showed resistance to amphotericin B and viability after 100 d at 80 °C. *Aspergillus thermomutatus* killed the entire larvae of *Tenebrio molitor* in six days and *R. cf. mucilaginosa* in three and four days, respectively. The melting of maritime Antarctic permafrost as a result of climate change may threaten the release of wild strains of pathogenic fungi geographically isolated for long time, which may in turn be transported within and beyond Antarctica by different biological and non-biological vectors. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 478

DNA barcodes assessment on *Ophioplinthus* Lyman, 1878 based on mitochondrial COI genes revealed multiple putative cryptic species in the Southern Ocean

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Ophiuroids are an important Antarctic benthic group in terms of diversity, abundance and ecological roles, from shallow sublittoral habitats to continental shelves and the deep sea. Moreover, there is a vast literature available about the systematics and biogeographic distributions of many ophiuroid species, with early studies dating back to the late nineteenth century, as well as recent reviews and phylogeographic analyses based on molecular data. DNA barcoding has been increasingly used since its introduction in 2003 as a routine species identification tool to effectively discriminate species. Analysis based on mitochondrial COI and 16S suggest that, like many groups, species diversity has been underestimated in this class. The brittle star genus *Ophioplinthus* Lyman, 1878 is particularly species rich on shelf regions of the Southern Ocean with genetic diversity exceeding morphological diversity. The taxonomic and spatial patterns of diversity suggest both allopatric and sympatric speciation, implying vicariance and niche competition as mechanisms pushing the evolution of populations and species. Here, we combined a large dataset of COI sequences from 690 recently collected specimens obtained from different expedition of the Italian National Antarctic Program (PNRA) and British Antarctic Survey (BAS). The evolutionary history was inferred with both Maximum Likelihood (ML) and Bayesian phylogenetic reconstruction. Various quantitative approaches to species delimitation (GMYC, bPTP, ASAP, ABGD) were employed and provided new insights into several unexpected 'sister clades' even in common species as *Ophioplinthus gelida* (Koehler, 1901) and *Ophioplinthus brevirima* (Mortensen, 1936) suggesting that our understanding of the diversity in this group is still limited.

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Abstract No : 957

Unravelling the invasive patterns of the new Antarctic fly *Trichocera maculipennis*: A first Morphometric approach.

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The spatial isolation, extreme climatic conditions (e.g. low temperatures, availability of water) and the lack of suitable habitats in the Antarctic Peninsula region (APR) (Antarctic Peninsula, South Shetland Islands and South Orkney Islands) have not provided barriers sufficient prevent this zone from being declared as the most invaded part of the Antarctica continent. There are only two native species of holometabolous insect, *Parochlus steinenii* and *Belgica antarctica*, the latter being endemic to the Antarctic Peninsula and the South Shetland Islands. However, two further non-native Diptera have also become established in the APR in recent decades, *Eretmoptera murphyi* (Chironomidae) on Signy Island and *Trichocera maculipennis* (Trichoceridae) on King George Island. Both are potentially invasive and established in the natural environment beyond the confines of research stations. In the South Shetland Islands, *Trichocera maculipennis* has been observed in natural areas and within station facilities. This research have analyzed the first pattern of wing shape adaptation to invasion at multiple bases being part of a big project which will include population genomics to understand the pattern of adaptation and establishment of *T. maculipennis* to Antarctica. Geometric morphometrics tools were used and have identified small but clear variation between 2017-2022 in Uruguayan and Russian stations which may means rapid morphological adaptation through years. Future studies, pretends to include the whole bases whith precense of the flies in order to understand and provide a better attention to the biological species vigilance.

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Abstract No : 461

Trichocera maculipennis eradication efforts at Henryk Arctowski Polish Antarctic Station (King George Island, South Shetland Islands, Antarctica) – lessons learnt after 5 years of battle.

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Trichocera maculipennis is a fly species that is primarily known from the northern Hemisphere. It is believed that they were unintentionally introduced to Antarctica with the supplies for science stations or with tourists. As a result of its food web simplicity, the Antarctic environment is likely to have free niches that can be easily occupied by alien species, like *T. maculipennis*. However, non-native species may have detrimental effects on the native environment, and therefore constant monitoring and the eradication of any identified invasive species is necessary. *T. maculipennis* was recorded for the first time in the Henryk Arctowski Polish Antarctic Station in October 2017. Since then, flies have been found regularly at and around the station despite multiple actions that have been taken to eradicate them: emptying and cleaning the septic tank; spraying with insecticides; the use of UV insecticide lamps, sticky, and pitfall traps located in various locations; and screening imported materials and food supplies. Measures taken are in accordance with the CEP Non-Native Species Manual (Edition 2019) Annex “Guidelines and resources requiring further attention or development”. The eradication of *T. maculipennis* from the Polish Antarctic Station is necessary to maintain species stability in the natural Antarctic environment, as well as being required by the Protocol on Environmental Protection. As controlling non-native insect species colonising the sewage systems is extremely difficult, only a comprehensive eradication plan, with several different methods targeting different life stages, is likely to be effective.

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Abstract No : 694

First detection of *Histoplasma capsulatum* in the Antarctic Continent

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Histoplasmosis is a systemic mycosis caused by the *Histoplasma capsulatum* species complex, a biosafety level 3 organism. The species complex is cosmopolitan, dimorphic and capable of causing outbreaks when contaminated soil is disturbed. Ecological studies of *H. capsulatum* are usually performed in regions where histoplasmosis is endemic, or after epidemic occurrence. The present work detected the gene encoding a 100-kDa-like protein of *H. capsulatum* using nested-PCR with specific primers in 5 out of 20 environmental samples from the Antarctic Peninsula. It confirms previous observations that the occurrence of *H. capsulatum* is broader than expected, and it shows for the first time that it is present in the Antarctic continent. Based on the fact, that this fungus has a high capacity to cause infections or even epidemics after activities of soil disturbance, the herein obtained results highlight the potential risk to which workers and researchers at the Antarctic Peninsula are maybe exposed and emphasis the need to use personal protective gear when they are tasked with soil digging or excavations at sites that potentially contain *H. capsulatum* spores.

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Abstract No : 655

Biogeographical patterns in the genus *Siphonaria* (Gastropoda: Pulmonata) across the sub-Antarctic.

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The sub-Antarctic region of the Southern Ocean (SO) is located between the Subtropical Convergence and the Antarctic Polar Front. It includes several provinces (Magellan, Macquarie, Indian Ocean and New Zealand Islands) separated by thousands of kilometers. The presence of remote and geographically distant islands which are influenced by the Antarctic Circumpolar Current (ACC), make this region an excellent area for long-distance dispersal studies. In this context, floating objects, particularly buoyant macroalgae serve as transport vectors for the exchange of organisms over long distances as demonstrated in different groups of invertebrates including mollusks, echinoderms, crustaceans and macroalgae. The Siphonariidae are lunged limpets, which typically live on hard (rocky) substrates in intertidal habitats across the planet. In sub-Antarctica, *Siphonaria* includes several species, two of them (*S. lateralis* and *S. fuegiensis*) are broadly distributed between South America and Macquarie Island. In sub-Antarctic New Zealand Islands two nominal species of *Siphonaria* are recognized: *S. innominata* and *S. stewartiana*. In this study we performed multi-locus phylogenetic reconstructions in sub-Antarctic populations of *Siphonaria* including specimens from southern South America, South Georgia, Crozet, Kerguelen, Macquarie, as well as from Campbell, Bounty, Snares and Auckland Islands. Phylogenetic reconstructions recognize the presence of three different species-level clades among sub-Antarctic New Zealand *Siphonaria* specimens. Two of them correspond to *S. innominata* and *S. stewartiana* which are sister species in sub-Antarctic New Zealand islands and differ from *S. lateralis* and *S. fuegiensis*.

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Abstract No : 374

Following the pathways of intrusions of Circumpolar Deep Water into a coastal embayment of the South Shetland Islands, using observations and ocean modeling.

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The Antarctic Circumpolar Current (ACC) transports Circumpolar Deep Water (CDW) and through intrusions of CDW the ACC can impact the coastal environment of the Southern Ocean. In this study, intrusions of CDW and connectivity were described and quantified around the South Shetland Islands (SSI). The pathway of CDW from the Bellingshausen Sea (BS) into the Bransfield Strait and potentially into Maxwell Bay in the SSI was determined using numerical simulations and by the analysis of temperature and salinity observations obtained from oceanographic campaigns conducted between 2017–2022. Numerical simulations, using Lagrangian particles and passive tracers, were obtained from a circulation model implemented using the Regional Ocean Modeling System. Intrusions of CDW followed a defined pathway from the BS into Boyd Strait surrounding Deception Island and continuing along the continental shelfbreak south from the SSI. The contributions of CDW from the BS were eroded along its pathway, a modified quantity of CDW (mCDW) was estimated to potentially enter Maxwell Bay. Lagrangian simulations showed a significant export from Maxwell Bay into other coastal environments of the SSI like Admiralty Bay and potentially the northern side of the SSI, due to the anticyclonic circulation observed around the SSI. Time scales of connectivity were from the order of 1 month and higher. Lagrangian particles also showed the formation of mesoscale features around the SSI. These results have implications for the connectivity of planktonic organisms locally and contribute to the understanding of possible connectivity mechanisms from the Bay to other coastal SSI environments.



SCAR 2022

Antarctica in a Changing World

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**Genomic insights into past and
present Antarctic biodiversity**

CONVENORS

Elie Poulin, Peter Convey,
Claudia Soledad Maturana Bobadilla

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Abstract No : 990

Rafting and contemporary genetic structure, revisiting *Siphonaria lateralis* in the Southern Ocean.

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Rafting is a key process for long-distance dispersal, especially in the Southern Ocean, where many marine invertebrates with low dispersal potential exhibit broad distributions, often spanning thousands of kilometers. Genetic studies of benthic organisms exhibit low genetic structure between sub-Antarctic islands, highlighting the importance of rafting in genetic connectivity. However, are these genetic patterns a byproduct historical rafting events, or is this a process sustained over time between far-away islands in the Southern Ocean? Using a genotyping-by-sequencing (GBS) approach, we evaluated if rafting can maintain present-day connectivity in *Siphonaria lateralis*, a broadly distributed gastropod across Patagonia and sub-Antarctic islands, often seen associated with *Durvillaea antarctica*, an unequivocally effective rafting kelp. Analyses of >5.000 SNPs consistently show 4 genetic groups in agreement with the 4 major geographical zones sampled; Patagonia and Falkland, South Georgia and Kerguelen islands. Patagonia and Falkland Islands, albeit geographically close, are highly differentiated units with strong evidence of barriers to gene flow, while South Georgia and Kerguelen islands are genetically closer. Moreover, South Georgia and Kerguelen exhibit low signals of long-distance dispersal (>16.000 km), suggesting that rafting is not as effective for its “passengers” in maintaining present-day connectivity.

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Abstract No : 933

A genomics perspective on Antarctic toothfish circumpolar population structure

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Antarctic toothfish (*Dissostichus mawsoni*) are top fish consumers and key prey species for whales and seals throughout the Southern Ocean. In addition to their importance to benthic-pelagic ecosystems, they support the most lucrative fishery in the Antarctic, worth over half a billion US dollars annually, and managed by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). Precautionary management of the fishery requires knowledge of toothfish population structure, in addition to life-history and tag-recapture data regularly collected by CCAMLR to inform catch limits. The last several years have seen a blossoming in interest in Antarctic toothfish population structure, with several international teams contributing research to test life-history connectivity hypotheses. Pioneering reduced-representation genomics methods in toothfish, in addition to traditional genetics methods employing nuclear and mitochondrial markers, these studies have largely supported the null hypothesis of panmixia across various regional scales, with notable exceptions. This presentation will share the preliminary results of a recently completed, multi-year study combining reduced-representation and whole-genome resequencing methods to understand Antarctic toothfish population structure on a circumpolar scale, with a particular focus on the Weddell Sea region.

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Abstract No : 262

The reconstruction of diatom communities around Antarctica using marine sedimentary ancient DNA

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Diatoms are important marine microorganisms often used in paleoenvironmental reconstructions because of their usefulness as indicators for changing climatic conditions. When diatoms die, they sink to the seafloor and gradually settle down in layers, making ocean sediments a storehouse of palaeoecological information. Analysis of ancient DNA from these sediments (sedaDNA) can be used to reconstruct the composition of past diatom communities and provide insights into Antarctic paleoenvironmental conditions. The Antarctic sea-floor provides an excellent setting for DNA preservation because of its constant low temperature, low oxygen concentrations and minimal disturbances. Overcoming the limitations of microfossil analyses, sedaDNA can detect diatom species that have little or no visible morphological features preserved, and, additionally, may provide insights into the evolutionary history of these organisms. Here, we introduce a project aiming to reconstruct diatom communities using sedaDNA from East and West Antarctica. In this pioneering work, we will extract sedaDNA from existing sediment cores, optimize these techniques to specifically target diatom sedaDNA, and analyse diatom composition changes in light of climatic changes over time. We aim to apply the optimized techniques to investigate changes in diatom community structures, in particular, sea-ice diatoms, over, at least, the Holocene. This project will generate significant new knowledge about one of Antarctica's most important marine primary producer groups' responses to past environmental change. Generating new information about how diatom communities adapt to climate change over large timescales will lead to improved prediction of how future climates will affect Antarctic primary production and aid conservation efforts for Antarctica.

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Abstract No : 725

Prokaryotic Microbiome Landscape in Different Tissues of Antarctic clam *Laternula elliptica*.

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The filter feeder clam, *Laternula elliptica*, is a key species of the Antarctic ecosystems. As a stenothermal benthic species it has a poor capacity of adaptation to rising temperatures. Despite its ecological importance and their sensitivity to climate change, studies on their microbiome are inexistent. We investigated the microbial communities of the Antarctic clam across five regions of the animal, between host taxa, and compared these communities to their local environment to understand how the microbiome of these organisms are shaped. We using high throughput 16S rRNA gene sequencing and we compared it to the one of its environment. The results showed that the microbiome of *L. elliptica* tends to be different from the one of the surrounding seawater. However, there were no significant differences in microbial composition between the body sites and no core microbiome could be identified. *Psychromonas* and *Psychrilyobacter* were particularly abundant in *L. elliptica* while *Fluviicola* dominated the seawater and the siphon. Typical polar bacteria were found such as *Polaribacter*, *Shewanella*, *Colwellia* and *Moritella*. Bacteria found in high relative abundance in the digestive gland might help for the digestion and the nutrition of the host, whereas nitrite-oxidizing bacteria and sulfur-reducers bacteria were only present in the siphon.

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Abstract No : 301

Study of Nuclear DNA Content of Three Delesseriaceae (Rhodophyta) from the South Shetland Islands (Antarctica).

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The quantification of nuclear DNA is a cytogenetic technique of great importance in numerous fields like evolution, taxonomy and ecology. However, only the nuclear DNA content of 12 Antarctic seaweed species has been measured in previous studies. The objective of our study is to quantify the amount of nuclear DNA for three Delesseriaceae (Rhodophyta) species from South Shetland Islands: *Myriogramme manginii* (Gain) Skottsberg, *Phycodrys austrogeorgica* Skottsberg and *Pantoneura plocamioides* Kylin. To achieve this, samples were fixed in Carnoy solution and quantification was performed by fluorometry and image analysis using DAPI (4', 6-diamidine-2-phenylindole, dilactate), staining fluorochrome and chicken erythrocytes (RBC), with a constant DNA value of 2.4 picograms, as a reference standard. Our results show that the nuclear content of the three species ranges from $2C = 0.45$ picograms in *Myriogramme manginii* to $2C = 0.77$ picograms in *Pantoneura plocamioides*. These values are smaller than the mean genome size of the Delesseriaceae ($2C = 1.22$ picograms) obtained from the values of the five species analysed until now and included in the plant DNA C-values database of the Royal Botanic Gardens of Kew. This suggests that, unlike some theories assume, there may be an inverse relationship between genome size and extreme environmental conditions, at least for these taxa. Nevertheless, more studies on the DNA content of the species of this family are needed to confirm this trend.

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Abstract No : 735

A multiple approach checklist for Antarctic Chlorophyta

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Recent advances in molecular tools such as DNA metabarcoding support the presence of high green algal diversity in Antarctica, considerably greater than previously recognized based on morphological studies alone. To date, no comprehensive checklist of Antarctic Chlorophyta that would include both morphological and molecular approach has been available. Here, we present a checklist derived from the available literature, and based on both morphological and molecular studies. Within this checklist, the available morphological studies uniquely represented a total of 145 green algal species, 62.5% of the total diversity identified. Molecular studies uniquely accounted for 32.3% of species diversity. Only 5.2% of species were identified in more than one approach. The most diverse Orders were Chlamydomonadales (29.7% of species), Sphaeropleales (13.8%) and Prasiolales(12.0%). The most diverse Class was Chlorophyceae (109 species), representing 47.0% of the species identified and five Orders. The second most abundant class was Trebouxiophyceae, with 31.5% of species and four Orders. A total of 200 undescribed species of green algae were listed in the literature, with half of these representing only three Orders; the most diverse of these was Chlamydomonadales (25.0% of the unidentified species), followed by Sphaeropleales and Chlorellales (12.5% each).

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Abstract No : 796

DNA metabarcoding in Bryophyta, improving the database quality for Antarctica

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Modern molecular tools, such as DNA metabarcoding of environmental samples, now enable the more efficient construction of biodiversity inventories. This approach can be applied to multiple types of environmental samples, such as soil, water, snow and air, allowing the isolation and assignment of sequence fragments of environmental DNA (eDNA) present. However, correct sequence assignment relies heavily on the quality and coverage of available databases quality; for instance for the widely-used ITS marker, the GenBank and PLANTITS are amongst the best known. DNA metabarcoding is increasingly being used in Antarctic studies, including in assessments of the potential diversity and dispersal routes of Antarctic plants. In this study, we investigate the current representation of the ITS barcode marker ITS for Antarctic bryophytes, the dominant group of macroscopic vegetation in Antarctica. At present, ITS sequences of 73% of the c. 111 known Antarctic bryophyte species are available in either GenBank or PLANTITS. However, only 42% of the species have been sequenced from an Antarctic sample. Overall, GenBank provides greater ITS sequence coverage, including sequences from 82 (73%) species recorded in Antarctica, while PLANTITS includes sequences from only 18 (16%) of these species. We conclude that considerable improvement is still required in sequence database coverage, including obtaining sequences from samples originating in Antarctica, to underpin successful and robust future application and interpretation of plant metabarcoding studies in the region. The same is likely to apply across most groups of Antarctic terrestrial biota.

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Abstract No : 862

Landscape genetics of a springtail endemic to Marion Island

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Focus has been drawn to fine-scale molecular work and its value in conservation biology has been highlighted. Previous research on sub-Antarctic Marion Island has found that landscape and climatic barriers across the island shape spatial genetic patterns. However, the relative importance that fine-scale habitat heterogeneity plays in shaping the local-scale movement of individuals has received little attention on Marion Island. Therefore, we examine the fine-scale spatial genetic structure (SGS) of the springtail, *Cryptopygus antarcticus travei* (Class: Collembola) on Marion Island. Using a species-specific suite of microsatellite markers, we explored genetic patterns for two one-kilometre-long sampling transects that were designed to investigate the influence of landscape features. Our results revealed the presence of genetic clusters across these landscape features, with gene flow being in the direction of the island's prevailing wind. Notably high levels of genetic diversity were discovered, which is in line with what is expected for the Class. Relatedness was determined to break down at approximately 150 m, and geographical distance in combination with roughness indices is responsible for shaping spatial patterns in the region. These findings allude to past historical and geological events which have left imprints on the current fine-scale SGS of springtails. These spatial patterns could be driven by micro-habitat preferences and/or a fitness funnel driven by local adaptations, which indicate that individuals do respond to environmental change. Our results may bring about far-reaching implications for conservation management on Marion Island, highlighting the importance of considering fine-scale evolutionary processes in management plans.

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Abstract No : 234

DNA barcoding of Antarctic mites, including spatial separation of three clades of *Nanorcheses antarcticus*

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Antarctic mites are relict organisms on the continent, surviving in the harsh terrestrial landscape for millions of years. We applied standard DNA barcoding methods to continental Antarctic mite species, most of which still have no DNA information available as they are small-bodied and difficult to sequence. We highlight the clear geographical separation of three major clades of *Nanorcheses antarcticus* (n = 15 sequences), one of the smaller and, until now, generally regarded as a more widespread species. This aligns with recently documented haplotype distribution patterns for Collembola, the only other group of Antarctic continental microarthropods, where the expansion and retreat of glaciers and sea ice have blocked and re-opened their long-range dispersal pathways. Morphological investigations would now be appropriate for genetically distinct populations of Antarctic mites that are currently geographically isolated, particularly in light of recent integrated morphological and molecular studies and new species descriptions in another prostigmatid genus, *Stereotydeus*. Assessing the present-day diversity and distribution of Antarctic mites will also be useful for monitoring range expansions in response to contemporary and predicted environmental change, which is likely to alter and increase dispersal opportunities.

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Abstract No : 943

LAKES OF THE SOUTH SHETLAND ISLANDS, ANTARCTICA, A VIROME ANALYSIS

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Polar freshwater ecosystems are characterized by a distinct microbiota; however, little is known about viral diversity and abundance, especially regarding the ecology of RNA viruses. In this study, we characterized the virome using shotgun metagenomic analysis in different lakes located in the South Shetland Islands (Penguin, Ardley, Deception and –King George Island), in the Peninsula Antarctica, in the summer season 2020. DNA viruses (99.4 %) prevailed overcame RNA viruses (0.6 %) in the lake samples. Six viral order were identified in the metagenomic libraries: Caudovirales (dsDNA), that was prevalent in most lakes, Picornavirales (ssRNA+), Sobelivirales (ssRNA+), Tolivirales (ssRNA+), Petitvirales (ssDNA) and Baphyvirales (ssDNA), including eight viral families (Herelleviridae, Siphoviridae, Myoviridae, Microviridae, Marnaviridae, Bacilladnaviridae, Barnaviridae and Tombusviridae) and several viruses, mainly ssRNA(+) viruses, without classification. Bacteriophages (dsDNA) infecting phylum Firmicutes (Herelleviridae) and Siphoviridae families were predominant in most lakes evaluated. Functional analysis demonstrated a prevalence of unknown proteins (68%) in the metagenomic libraries. This was a prospective study comprising virome analysis in different lakes in the South Shetland Islands, Antarctica, opening exploratory lines for future expeditions aimed at studying the biodiversity and viral ecology in this ecosystem.

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Abstract No : 516

Potential of sedimentary ancient DNA to reveal new insights into Antarctica's faunal history: a case-study of late Holocene turnover between southern elephant seal and Adélie penguin colonies at Seabee Hook

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Southern elephant seal (*Mirounga leonina*) hair and pup remains from raised beach deposits along the Victoria Land Coast reveal that the species once molted and bred from Campbell Glacier in the north to Marble Point in the south. The ages of the remains point to a period termed the 'seal optimum', between ~2,500 and 1,000 years ago, when warmer conditions and reduced sea ice allowed southern elephant seals to breed at these southern latitudes. Here, we provide new evidence for the northernmost colony of southern elephant seals in the Ross Sea at this time, located at Seabee Hook on Cape Hallett. Metagenomic analyses of sediments sampled down to 60 cm below the current ground surface show an initial period of southern elephant seal dominance followed by a subsequent increase in Adélie penguins (*Pygoscelis adeliae*) as the seals declined and disappeared. This pattern suggests a relatively rapid local faunal replacement as climatic and environmental conditions changed during the late Holocene, and demonstrates the potential of sedimentary ancient DNA to reveal new insights into Antarctica's faunal history. The results are part of the first large-scale sedimentary ancient DNA study within the Ross Sea Region, which sampled at ten current and former Adélie penguin colonies between Ross Island and Cape Adare during the 2018/19 and 2019/20 seasons.

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Abstract No : 526

Revisiting the bipolarity of *Roaldia revoluta* (Mitt.) P.E.A.S. Câmara & M. Carvalho-Silva (Bryophyta, Pylaisiaceae)

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Species with occurrence in both polar regions, with or without intermediate occurrences, is quite a common phenomenon in Antarctica, with about 45% of its flora being bipolar. Considering that morphology in polar regions is subject to extreme conditions, the use of molecular tools is indispensable to investigate bipolarity. Very few phylogeographic studies have been conducted so far in bipolar mosses, especially ones including morphological studies. *Roaldia revoluta* is a strict bipolar (without intermediates) moss species. The results of morphometric analyses of this species suggest that there are no significant morphological differences among populations from both polar regions nor between *R. revoluta* and a variety recently separated at species level, as *R. dolomitica*. Our phylogenetic and phylogeographic analyses have shown very low genetic diversity among *R. revoluta* specimens across the globe. Most of the studied specimens shared a single haplotype, with weak separation of *R. dolomitica* and few additional haplotypes in geographically widely separated specimens. According to these results, *Roaldia revoluta* (including *R. dolomitica*) is a truly bipolar species with its representatives from all over the globe forming a strongly supported clade.

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Abstract No : 919

Metagenomics insights into diversity and origin of bacteria in Antarctic cryptoendolithic communities

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Cryptoendolithic communities are microbial ecosystems dwelling inside porous rocks, able to persist at the edge of biological potential for life in the ice-free areas of the Antarctic desert. These regions include the McMurdo Dry Valleys, accounted as the closest terrestrial counterpart of the Martian environment and thought to be devoid of life until the discovery of these cryptic life-forms. Despite their interest as a model for the early colonization of earth, little is known about the evolution, diversity, and genetic makeup of bacterial species that reside in these environments. To address this knowledge gap, we generated the first metagenomes from 18 rocks collected in Continental Antarctica over a distance of about 350 km along an altitudinal transect from 834 up to 3100 m above sea level (a.s.l.). We assembled the genomes of 269 new candidate bacterial species and we found that the majority belong to monophyletic bacterial clades that diverged from 1.2 billion to 410 Ma and are functionally distinct from known related taxa. We further sequenced the metagenome of more than 200 endolithically colonized rock samples, covering a broad range of geo-environmental (e.g. altitudinal gradient, different rock typologies) conditions and geographic distribution. This comprehensive catalogue includes 4,539 metagenome-assembled genomes representing 2,238 novel species and represents, to date, the largest effort to date to capture the breadth of bacterial genomic diversity from Antarctic rocks. This significantly expands the knowledge of bacteria phylogenetic diversity, focusing on key tolerance competences promoting their spreading and perpetuation at the fringe for life sustainability.

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Abstract No : 794

Investigating the biological diversity of 4 lakes in James Ross Island (Antarctica) using DNA metabarcoding

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Despite containing the largest amount of ice on the planet, Antarctica is still a very unexplored place. Climate change is causing part of its ice to melt, mainly at the Antarctic Peninsula, releasing liquid water that may contain biological material and propagules, and also allowing other organisms to get there and settle down. Antarctic lakes are home to different microorganisms that make up a complex food chain, and are in contact with various other environments, such as rocks, soils, animals and plants. Thus, the sediment of these lakes can provide information about the organisms present in this site and may contain relevant climatic archives. James Ross Island is located at the Antarctic peninsula region and contains several of these lakes. This work analyzed, using the DNA metabarcoding tool, the sediments of four lakes, named Cecilia, Adriana, Lilia and Soledad. In order to highlight the diversity of organisms that comprise each lake, and try to understand how the Antarctic colonization process occurs, how these organisms arrive and/or settle there. It is also intended to discuss whether global warming and melting glaciers would enable the establishment and development of these organisms. The metabarcoding analysis resulted in samples of organisms from four kingdoms, being Plantae the most representative, with 85 taxa sampled, followed by Chromista with 21, Protozoa with 11 and Animalia with 4.

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Abstract No : 175

Glacial legacies: Microbial communities of Antarctic refugia

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Ice-free soils in the McMurdo Dry Valleys (MDV) have sustained life since the last glacial maximum, but the exact exposure age of many locations around the MDV aren't known exactly. In general, patterns of biodiversity are influenced both by environmental conditions, usually better suited to life at lower elevations, as well as the time since soils were last disturbed by glacier activity, longer at higher elevations. We describe biodiversity patterns across several valleys in the MDV and make inference about glaciation history of those sites based on microbial community composition. Nine valley systems were sampled at different elevations, with exposure ages from the geological record ranging between ~10kya and >5mya. 16S metabarcoding revealed distinct communities with a high proportion (11%) of the found taxa associated with a single valley system. In general, alpha diversity was significantly lower in potential refugia but was not explained by the geochemical data. Beta diversity showed strong clustering of 7 out of 8 potential refugia sites and cast doubt on the previous classification of some of the lower elevation sites. Overall these results present a biological line of evidence to describe the geological history of sites in the MDV which have remained disturbance-free during the Last Glacial Maximum, potentially serving as biodiverse refugia sites.

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Abstract No : 982

Depth structure of the polar night Antarctic Peninsula phytoplankton community

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The Antarctic Peninsula is a region sensitive to climate change. Diatoms in this polar ecosystem are critical to primary productivity, regional food webs, and carbon export. Environmental fluctuations and changes in oceanographic conditions play important roles in diatom community structuring which in turn can affect ecosystem functioning and stability. The Antarctic winter produces large scale changes in water column and sea ice dynamics that drive diatom biomass and diversity preceding the spring bloom and summer stratification. This study seeks to provide insights into the taxonomic composition of Antarctic peninsula polar night diatom communities over depth. Samples from several depths (0m, 20m, 100m, 750m) were collected in the Palmer Deep, and area near Anvers Island situated in the Palmer Archipelago of Antarctica during the 2016 austral winter. Amplicon sequencing of the 18S rRNA gene was used to generate an active diatom community structure. A species indicator analysis determined the dominant presence of potentially dark-tolerant diatoms at the 750m depth samples.

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Abstract No : 132

Glacier microorganisms as sentinels of anthropogenic perturbations in Antarctica

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Antarctica is experiencing drastic changes due to its high sensitivity to environmental alterations. The consequences of these shifts are shown at many levels. Taking into account that microorganisms are the base of trophic webs, their adaptations affect the entire ecosystem. Both abiotic (i.e. natural forces, volcanic eruptions) and biotic factors (i. e. human presence, animal and plant populations, etc.) may positively or negatively feedback these effects. Historically, South Shetland archipelago has withstood great human pressure due to the presence of explorers, fishers, whalers and more recently, scientific researchers, station support personnel, and tourism. Human pollution of aquatic environments can increase nutrient load, change pH, temperature, and turbidity, lower dissolved oxygen availability, and contaminate the environment with diverse microorganisms. Currently, this archipelago contains nineteen research stations and three field camps, located very close to the glaciers. Glacial ice acts as a trap in which microorganisms accumulate and remain over the years. A study was performed using ice samples from eight glaciers in the South Shetland archipelago to check if there was any relationship between microbial and human populations. Ice cores were extracted at each glacier, and their microbial populations were identified by metabarcoding, followed by bioinformatic analysis. A gradient in the number of microorganisms was observed in the archipelago, from the most populated areas to the least populated areas. In addition, the presence of some characteristic genera, that were present exclusively in the vicinity of the research stations, was observed. These microorganisms can be considered as sentinels of human contamination.

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Abstract No : 631

Evolution and dispersal of Cassidulinidae (benthic foraminifera) in the Southern Ocean and Cenozoic climatic changes

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Cassidulinidae are distributed worldwide and represent one of the most characteristic rotaliid benthic foraminifera of the Southern Ocean. Based on the SSU rDNA barcoding fragment and morphology, we investigated representatives of two genera (Cassidulinoides and Globocassidulina) inhabiting the continental shelves of Antarctica, South Georgia, Falkland Islands, and Patagonia. A time-calibrated Bayesian phylogenetic reconstruction suggests that the first split between sub-Antarctic and Antarctic lineages took place during the mid-Miocene climate reorganization, probably prior to the mid-Miocene cooling. It was followed by a divergence of Antarctic species ~10 Ma, possibly related to the cooling of deep water and vertical structuring of the water-column. The gene flow across the Drake Passage, as well as between South America and South Georgia, resumed between 7 and 5 Ma, during the Late Miocene to the Early Pliocene climate warming, leading to events of inter-species hybridization. Overall, it appears that this and the mid-Miocene warm climate phases played an important role in the evolution and dispersal of Cassidulinidae across the Drake Passage. The latest radiation coincided with glacial intensification ~2 Ma, which accelerated geographic fragmentation of populations and genetic diversification in Antarctic species. Demographic expansion in most species could have taken place ~400 000 years ago as geological evidence suggests that grounding line was located significantly more to the South than it is today.

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Abstract No : 527

Presence and diversity of Viridiplantae, Chromista, Protista and Metazoa DNA in Antarctic permafrost assessed using metabarcoding

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Extremely sensitive to climatic changes, permafrost is experiencing drastic impacts from global warming. Understanding the diversity and ecology of biological communities present in permafrost is critical to the mitigation of impacts of permafrost warming and melting. The majority of studies reporting biodiversity present in permafrost have focused on bacteria and fungi, with very little data yet available relating to other groups of organisms. In this study we used metabarcoding through high throughput sequencing to assess DNA sequence diversity present in permafrost samples obtained from six locations in the South Shetland Islands, north-west of the Antarctic Peninsula. The sequence data obtained were assigned to 123 taxa from four kingdoms and 10 phyla. We detected high sequence diversity representing Viridiplantae and Chromista. The most diverse phylum was Chlorophyta with 81 taxa, followed by Ciliophora with 15 taxa. Sequences of the green algal group Chlamidomonadales were most abundant, dominated by *Chlamydomonas nivalis*. Amongst the land plants, the moss genus *Sanionia* was the most abundant, followed by *Bryum pseudotriquetrum*. Sequences of eight taxa were present at all six sites. The metabarcoding approach confirmed the presence of a rich and diverse sequence diversity in Antarctic permafrost, with general phylogenetic homogeneity across the six different sampling locations. Some of the taxa identified are potentially harmful to humans and merit further research attention.

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Abstract No : 181

Tracing patterns of McMurdo Dry Valley refugia with *Scottnema lindsayae* nematode

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As part of a Long-Term Ecological Research site, the McMurdo Dry Valleys (MDV) of Antarctica boast thirty plus years of multidisciplinary data from an infamously harsh environment that fosters neither high terrestrial biodiversity nor species recruitment. Freezing temperatures and saline soils limit terrestrial life to simple, patchily dispersed, microbial communities and microscopic soil invertebrates. In this natural laboratory, we aimed to test phylogeographic hypotheses regarding dispersal patterns of terrestrial free-living nematodes after environmental disturbances like ice-sheet dynamics, glacial advance and recession, and climate-driven changes to the soil environment. We tested putative climate refugia utilizing the mitochondrial COI gene of the most ubiquitous terrestrial animal in Antarctica – *Scottnema lindsayae*. We sequenced 250 bp COI haplotypes from 24 sites across eight valley systems in the MDVs. These sites represent high and low elevations corresponding to putative refugia and recolonized glacial forefields respectively. Results reveal highly structured genetic diversity of *S. lindsayae*. The emerging genetic diversity suggests slow rates of evolutionary change, dispersal limitations, and the influence of contemporary environmental processes that increase connectivity on valley floors. Foremost, this study demonstrates phylogeographic patterns of dispersal from Antarctic refugia where terrestrial biota survived in situ periods of extreme climate-driven disturbances. Secondly, as populations are highly structured and gene flow is low, our results support that *S. lindsayae* respond slowly to disturbances. With future climate changes, slow response, colonization, and dispersal will likely have a disproportionate impact on carbon cycling given *S. lindsayae*'s dominant role in this low-diversity ecosystem.

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Abstract No : 37

Using exon capture to untangle the Doris ‘kerguelenensis’ species complex.

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The Southern Ocean benthic sea slug, Doris ‘kerguelenensis’, was long thought to be a single, widespread species. Belonging to the Dorididae family, this slug is a direct-developing, simultaneous hermaphrodite that can only crawl along the seafloor as an adult. More recently however, a combination of metabolomics, nuclear and mitochondrial DNA sequencing, has revealed a multitude of highly divergent lineages within that ‘species’. Through Sanger sequencing of Cytochrome Oxidase I, there are now estimated to be at least 59 putative species. This radiation is thought to be caused by a unique combination of selection and allopatry facilitated through millions of years of episodic glacial cycles. To gain phylogenetic resolution among these species, generating and interpreting large amounts of sequence data from across the genome was necessary. We employed an exon capture approach, targeting thousands of exons from hundreds of genes from 120 nudibranch samples across the 59 putative species. The Maximum Likelihood and ASTRAL tree topologies were congruent with our previously species hypotheses; however, we did uncover some mitonuclear discordance. We then further tested species hypotheses using exon capture data and investigated correspondence with secondary metabolites. By increasing the amount of data, we were able to strengthen the resolution of the phylogeny, and examine the distribution of metabolomic traits across the topology.

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Abstract No : 471

Belgica antarctica (Diptera: Chironomidae) as a natural model organism in Antarctica

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Antarctic terrestrial ecosystems host a relatively small number of species. As a result, they are extremely sensitive to climate changes and other influences. The endemic Antarctic insect, *Belgica antarctica* is particularly interesting, especially in the context of its potential use as a model organism for studying the influence of climate changes. *Belgica antarctica* was sampled between 2007 and 2021 during Ukrainian Antarctic Expeditions and was recorded at mainland locations on the Antarctic Peninsula and on various islands between Cape Evensen, the Stresher Peninsula and King George Island, South Shetland Islands. For some of these locations, we provide the first formal records. Our study documented the first detailed photomicrographic images and descriptions of the fourth-instar larval head capsule and posterior parapods. To assess possible sexual dimorphism, we used unsupervised analyses (PCA and hierarchical clustering). Our data suggest that the selected morphometric features were highly cross-correlated and did not differentiate sex in the sampled larvae. Data on chromosome numbers and variability were similar to reports from previous studies, which indicate the continued presence of specific inversions over a 40-year period and imply they play an adaptive role in Antarctica. We also analyzed mitochondrial DNA haplotypes via COI gene fragment sequencing in individuals collected in the Argentine Islands. All analyzed individuals belonged to haplotype D. One of the sequences contained an A->T substitution at position 598 (JQ672705.1). Finally, we analyzed pooled-seq whole-genome sequencing data and identified 44 bacterial taxa potentially associated with *B. antarctica*.

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Abstract No : 24

Fifty million years of beetle evolution along the Antarctic Polar Front

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Global cooling and glacial–interglacial cycles since Antarctica’s isolation have been responsible for the diversification of the region’s marine fauna. By contrast, these same Earth system processes are thought to have played little role terrestrially, other than driving widespread extinctions. On islands along the Antarctic Polar Front, paleoclimatic processes have been key to diversification of one of the world’s most geographically isolated and unique groups of herbivorous beetles—Ectemnorhinini weevils. Combining phylogenomic, phylogenetic, and phylogeographic approaches, we demonstrate that these weevils colonized the sub-Antarctic islands from Africa at least 50 Ma ago and repeatedly dispersed among them. As the climate cooled from the mid-Miocene, diversification of the beetles accelerated, resulting in two species rich clades. One of these clades specialized to feed on cryptogams, typical of the polar habitats that came to prevail under Miocene conditions yet remarkable as a food source for any beetle. This clade’s most unusual representative is a marine weevil currently undergoing further speciation. The other clade retained the more common weevil habit of feeding on angiosperms, which likely survived glaciation in isolated refugia. Diversification of Ectemnorhinini weevils occurred in synchrony with many other Antarctic radiations, including penguins and notothenioid fishes, and coincided with major environmental changes. Our results indicate that geoclimatically driven diversification has progressed similarly for Antarctic marine and terrestrial organisms since the Miocene, potentially constituting a general biodiversity paradigm that should be sought broadly for the region’s taxa.

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Abstract No : 806

Déjà vu: exploring 'replicate' radiations of perciform fishes to understand the genetic and developmental origins of key traits

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Much of biodiversity is thought to have arisen through the process of adaptive radiation. Central to adaptive radiation is the origin of traits that facilitate access to novel niches, yet the genetic and developmental mechanisms underlying the appearance of these traits are poorly understood. Over the last 100 million years, perciform fishes have undergone multiple independent adaptive radiations in response to similar ecological and environmental opportunities. Can such 'replicate' radiations help us to disentangle lineage-specific signals from more universal mechanisms of trait evolution? Here, we discuss comparative genomics in two perciform radiations – the marine Antarctic notothenioids and the freshwater sculpins of Lake Baikal. For both radiations, the main axis of ecological diversification has been the water column, from shallow benthic ancestors into deep-water and pelagic lineages. Notably, the pelagic lineages of both radiations have evolved despite the absence of a swim bladder, the buoyancy organ of most fishes. Lacking a swim bladder, both clades have evolved improved buoyancy through reduction in skeletal density and accumulation of corporeal lipids. Using whole genome and targeted sequencing approaches, we have assembled genomic data from 44 notothenioid species, 24 Baikal sculpins and several outgroup lineages, which enable us to track macroevolutionary phylogenetic trends and to discover patterns of protein coding and gene regulatory evolution. Here, we compare the two radiations and describe genetic signatures that underly buoyancy adaptations and their implications for understanding and treating human skeletal and metabolic diseases. Supported by US NSF 1955368 (JD, HWD), 2001584 (MH) and 1557147 (AA, MS)

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Abstract No : 782

A high degree of novelty and shared metagenome-assembled genomes (MAGs) between ice-free areas impacted by penguins in Peninsula Antarctica.

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Antarctica harbors different terrestrial ecosystems, from very oligotrophic dry-cold soils to nutrient-rich coastal soils impacted by different marine animal colonies. Penguins are the most abundant birds impacting soil microbial communities in coastal areas. Previous studies from our group show penguins decreased the soil microbial diversity and increased genes related to denitrification. In addition, metagenome-assembled genomes (MAGs) recovered from penguin-impacted soils from two different islands showed similar composition, suggesting that microbes related at the species level could be shared between geographically distant places. To test this hypothesis, we increased the sampling sites of penguin-impacted soils to 18 different sites along the Antarctic Peninsula. Then, from three soil samples per site, we performed high throughput sequencing, assembly, and binning, obtaining a total of 54 metagenomes, which allowed us to obtain 473 non-redundant MAGs. The MAGs catalog included archaeal and bacterial representatives, being the most abundant phyla Proteobacteria and Actinobacteria, represented by 121 non-redundant MAGs, although more than 99% of the MAGs likely represent novel species not included in comprehensive databases. From co-assembly, at least 712 MAGs were shared between two or more sampling sites. For instance, the population represented by a MAG classified as related to the genus Janibacter was the most predominant in our samples, matching MAGs with higher than 95% ANI in 17 of the 18 sampling sites. These results show a high degree of novelty and many shared microbial populations between sites, suggesting a transfer of the soil microbes between ice-free areas impacted by penguins in Antarctica. Funding: ICN2021_002

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Abstract No : 394

Understanding how an invasive springtail adapted to cold sub-Antarctic Marion Island

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Springtails are important soil dwelling microarthropods with a global distribution. They play a role in nutrient cycling and are commonly used as bioindicators of ecosystem health. On sub-Antarctic Marion Island, there are no vertebrate herbivores, but springtails, invertebrate herbivores, are abundant and therefore fulfil the role of herbivory, which makes them an ecologically important group on the island. Our study organism is the collembolan, *Isotomurus maculatus*, which has a natural distribution that includes Europe and North America, with some individuals present in the Western Cape, South Africa. It was introduced to Marion Island in the late 1970s and is now considered to be an invasive species on the island. Since *I. maculatus* is native to regions that are hot and dry, how did this springtail adapt to a cold and harsh environment such as that on Marion Island? In this study, we aim to answer this by identifying possible genes involved in adaptive selection, by sequencing the transcriptome of *I. maculatus* individuals from Marion Island. RNA sequencing technology is used to study the functional content of an organism's genome. We will apply a comparative genomic approach to investigate the genes and metabolic pathways involved in local adaptation and pinpoint the biochemical mechanisms that facilitate adaptation to a cold environment such as that experienced on Marion Island. The genomic basis of adaptation in invasive species is not well understood, therefore, the implication of this study is far-reaching as it will help to inform the management of invasive species.

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Abstract No : 971

Unveiling the systematics and taxonomy of the Antarctic and Subantarctic gastropod *Laevilitorina caliginosa* (Littorinimorpha:Littorinidae) based on morphological and molecular evidence.

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Littorinid snails are present in most coastal areas globally, playing a significant role in the ecology of intertidal communities. *Laevilitorina* is a marine gastropod genus distributed exclusively in the Southern Hemisphere, with 21 species reported from South America, the sub-Antarctic Islands, Antarctica, New Zealand, Australia and Tasmania. Within the genus, the species *L. caliginosa* is characterized by the widest distribution of the whole group, as well as a marked morphological variability. However, a recent phylogenetic study in *L. caliginosa* evidenced that this taxa does not correspond to a widely distributed species, but rather to multiple divergent lineages throughout its distribution. In this work, we present a review of the systematics and taxonomy of the genus focusing mainly on the new lineages found in the Magellan Province, Subantarctic Islands and Antarctic Peninsula. Here, we present a phylogenetic analysis using two mitochondrial markers (*cox1* and *12S*) and a revision of the radular morphology of the different lineages throughout the study area. As previously reported, molecular analyses identified seven species-level clades across the study sites. In addition, differences in radular morphology were found among the different lineages, mainly in the shape and number of teeth. This result would provide further evidence that this does not correspond to a species-cryptic complex, since speciation within *Laevilitorina* would have been accompanied by radular morphology differentiation. Finally, this study highlight the relevance of the integration of molecular and morphological analyses in order to carry out a detailed revision of the systematics of *Laevilitorina* in the Southern Hemisphere.

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Abstract No : 617

Cryptic Viridiplantae diversity in Admiralty Bay (King George Island, South Shetland Islands, Antarctica), investigated using DNA metabarcoding.

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Increasing temperatures are being recorded globally, but few regions have experienced increases as rapid as seen around the Antarctic Peninsula (AP). The ~3°C increase in mean annual temperature recorded over the last 50–70 years has led to the exposure of new ice-free areas, increased liquid water availability and precipitation as rain, and is predicted to facilitate colonization by new species. King George Island, with its intense centres of human activity, proximity to South America and relatively mild climate, is particularly vulnerable to the arrival and establishment of new species. Concern about the danger of biological invasion, potentially threatening native biodiversity, highlights the urgent need for development of practical means of monitoring the flora of this area at a suitable scale. DNA metabarcoding approaches are capable of identifying greater species diversity and at higher taxonomic resolution than more traditional techniques. They can also detect small and rare species and dormant stages, that are generally not identified in morphological and culturing studies. As an example, applying DNA metabarcoding to samples obtained from soil, snow and air, we recovered a total of 737,560 Viridiplantae reads, 99.91% representing the phylum Chlorophyta, 0.04% the phylum Streptophyta, and 0.05% Unknown Viridiplantae. Snow samples generated 61% of total reads, followed by soil samples with 35.7%. In total 47 taxa were identified, 27 not previously recorded from Antarctica.

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Abstract No : 94

Phylogenic Relationships and Potential Molecular Adaptations of Antarctic Bryozoans

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How marine organisms respond to the combined effects of global warming and ocean acidification may significantly influence the biodiversity of Antarctic marine communities. Antarctic bryozoan diversity is estimated at more than 400 species, the majority of which belong to three morphologically rich albeit paraphyletic groups: the Flustrina, the Lepraliomorpha, and the Umbonulomorpha. Although the evolutionary relationships among many bryozoan species have been recently tested using mitochondrial and ribosomal RNA genes, most Antarctic bryozoan species have not been thoroughly sampled. Here, we test phylogenetic relationships using newly gathered transcriptomic and genomic datasets from 24 Antarctic species and 28 species of non-Antarctic bryozoans along with other related lophotrochozoans. Additionally, we use 18S rDNA, SEM, and micro-CT to explore the taxonomic diversity of bryozoans collected from West Antarctic sites. Our results support previous molecular-based studies of bryozoan macroevolutionary relationships, but also show that the relationships of some flustrid and sclerodomid species are not well supported and require more taxon sampling. Beyond phylogeny, we completed tests of positive selection on 2,561 gene orthogroups based on 12 representative species. Approximately 6% of gene alignments showed evidence of positive selection. We characterized the functions of these genes using GO term annotations and PANTHER classifications finding that a significant proportion have catalytic activities or binding functions. Most of the genes grouped by nine functional classifications with the largest category belonging to gene functions related to the cytoskeleton. Our findings provide important context for understanding potential adaptive responses of Antarctic marine invertebrates to global change.

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Abstract No : 243

Diversity and ecology of fungal assemblages present in lake sediments at Clearwater Mesa, James Ross Island, Antarctica, assessed using metabarcoding of environmental DNA

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We detected the fungal assemblages in sediments obtained from four lakes at James Ross Island, Antarctica using DNA metabarcoding. A total of 132 amplicon sequence variants (ASVs) were detected, dominated by the phyla Ascomycota, Basidiomycota, Mortierellomycota and Mucoromycota. The uncommon phyla Chytridiomycota, Rozellomycota, Monoblepharomycota, Basidiobolomycota and Aphelidiomycota as well as members of the fungal-like Straminopila belonging to the phyla Bacillariophyta were also detected. Unknown fungi identified at higher hierarchical taxonomic levels (Fungal sp. 1, Fungal sp. 2, Spizellomycetales sp. 1 and Rozellomycotina sp. 1), *Talaromyces rubicundus* and *Betamyces* sp. dominated the fungal assemblages. In general, the assemblages displayed high diversity and richness, and moderate dominance. Fungal distribution varied between the lakes, with only 18 taxa detected in all four lake sediments, while the majority of taxa were specific to a single lake. Sequences representing saprophytic, pathogenic and symbiotic fungi were detected. The metabarcoding data suggests that the fungal communities present in the sediments of Antarctic lakes are diverse and complex and suggest that Antarctic lakes may represent a hotspot of fungal diversity in Antarctica. The fungal assemblages were dominated by saprophytic fungi, which may contribute to maintenance of the resident biological web. Lakes in the Antarctic Peninsula region are sensitive environments threatened by effects of regional climatic changes. The abundance of sequences of little known (Rozellomycota and Chytridiomycota) taxa in these ecosystems highlights the need for further studies to identify if they are metabolically active in the sediments and whether they have potentially pathogenic capabilities. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 36

Exploring the microdiversity within marine bacterial taxa: Towards an integrated biogeography in the Southern Ocean

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Most of the microbial biogeographic patterns in the oceans have been depicted at the whole community level, leaving out finer taxonomic resolution (i.e. microdiversity) that is crucial to conduct intra-population phylogeographic studies, as commonly done for macroorganisms. Here, we present a new approach to unravel the bacterial phylogeographic patterns by combining community-wide survey by 16S rRNA gene metabarcoding and intra-species resolution through the oligotyping method, allowing robust estimations of genetic and phylogeographic indices, and migration parameters. As a proof-of-concept, we focused on the bacterial genus *Spirochaeta* across three distant biogeographic provinces of the Southern Ocean; maritime Antarctica, sub-Antarctic Islands and Patagonia. Each targeted *Spirochaeta* OTU was characterized by a substantial intrapopulation microdiversity, and significant genetic differentiation and phylogeographic structure among the three provinces. Gene flow estimations among *Spirochaeta* populations support the role of the Antarctic Polar Front as a biogeographic barrier to bacterial dispersal between Antarctic and sub-Antarctic provinces. Conversely, the Antarctic Circumpolar Current appears as the main driver of gene flow, connecting the sub-Antarctic Islands with Patagonia and maritime Antarctica. Additionally, historical processes (drift and dispersal limitation) govern up to 86% of the spatial turnover among *Spirochaeta* populations. Overall, our approach represents a substantial first attempt to bridge the gap between microbial and macrobial ecology by unifying the way to study phylogeography. We revealed strong congruency with macroorganisms patterns at the populational level shaped by the same oceanographic structures and ecological processes.

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Abstract No : 23

There and back again: what we can learn about the resilience of Antarctica's cryonotothenioid fishes from their gains and losses following past climate change

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Evolution in the chronic cold of the Southern Ocean has had a profound influence on the physiology of cryonotothenioid fishes. Unfortunately, we continue to know little about the suite of genetic changes that were driven by the region's past climate change and what these means for the resilience of the cryonotothenioids in a warming world. This study therefore aims to understand the genomic signatures of past selection, by identifying the functional classes of genes that were changed following three major physiological transitions: the onset of freezing temperatures, the loss of hemoproteins, and the return of several cryonotothenioid species to temperate waters. Looking at the changes that followed the onset of freezing temperatures, positive selective pressure was found to act on multiple biosynthetic processes, including the machinery of transcription and translation, protein polymerization, cell adhesion, and cell cycle progression, suggesting that these are key challenges to life in freezing waters. In contrast, the relaxation of selective pressure relative to temperate and tropical fishes produced a more complex pattern of change. This appears to have led to the attenuation of several homeostatic processes, but the relaxation of selective pressure also acted as a key route to morphological and ecological diversification. Similarly, the loss of hemoproteins and the return to temperate waters each produced distinct patterns of change. Combined, the influence of positive and relaxed selection shows that long-term exposure to cold has led to profound changes in cryonotothenioid genomes that would make it challenging to adapt to a rapidly changing climate.

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Abstract No : 981

Genomic structure of the polar night plankton community in the Palmer Deep

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Seawater at the Palmer Deep (approximately 64.93° S and 64.40° W, at an area south of Anvers Island, Antarctic Peninsula) was collected every 6 hours for 3 consecutive days (11-13 July 2016) with concurrent environmental measurements. Samples were processed for environmental and molecular microbial community analyses. Vertical patterns of environmental measurements including temperature, salinity, oxygen, fluorescence, chlorophyll, and nutrient concentrations did not vary with time of day during the 3-day sampling period, suggesting that the environmental conditions are stable at the sampling site in the winter. Similarly, 16S and 18S rRNA amplicon sequencing data showed stable vertical patterns of bacteria and eukaryotic distribution at the family and phylum taxonomic levels, respectively, throughout the diel sampling period. This work was completed by participants in the NSF Advanced Training Program in Antarctica for Early Career Scientists who collected seawater samples from the R/V Laurence M. Gould (cruise LMG1606). These data represent the first serial sampling of the plankton community (including bacteria and phytoplankton) throughout day and night during austral winter at the Palmer Deep.

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Abstract No : 244

Fungal diversity and ecology assessed using DNA metabarcoding along a deglaciaded soil chronosequence at Clearwater Mesa, James Ross Island, Antarctic Peninsula

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We studied the fungal and fungal-like diversity present in soils sampled along a chronosequence from para- to periglacial conditions at Clearwater Mesa, James Ross Island, Antarctic Peninsula using DNA metabarcoding. A total of 88 amplicon sequence variants (ASVs) were detected, dominated by the phyla Ascomycota, Basidiomycota and Mortierellomycota. The uncommon phyla Chytridiomycota, Rozellomycota, Monoblepharomycota, Zoopagomycota and Basidiobolomycota were also detected as, additionally, were Bacillariophyta (Straminopila). Unknown fungi identified at higher hierarchical taxonomic levels (Fungal sp. 1, Fungal sp. 2, Spizellomycetales sp. and Rozellomycotina sp., as well as taxa identified at generic and specific levels (Mortierella sp., Pseudogymnoascus sp., Mortierella alpine, M. turficola, Neoscochyta paspali, Penicillium sp. and Betamyces sp.) dominated the sequence assemblages. In general, the assemblages displayed high diversity and richness, and moderate dominance. Only 12 of the fungal ASVs were detected in all chronosequence soils sampled. Sequences representing saprophytic, pathogenic and symbiotic fungi were detected. Based on the sequence diversity obtained, Clearwater Mesa soils contain a complex fungal community, including the presence of fungal groups generally considered rare in Antarctica, with dominant taxa recognized as cold-adapted cosmopolitan, endemic, saprotrophic and phytopathogenic fungi. Clearwater Mesa ecosystems are threatened by the effects of regional climatic changes and may represent a natural observatory to understand climate change effects over time. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 534

The uppermost water horizon of the subglacial Antarctic Lake Vostok is microbial DNA-free as proven by Oxford Nanopore sequencing technology

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The objective was to search for microbial life in the subglacial Antarctic Lake Vostok by analyzing the uppermost water layer that entered the borehole following the lake unsealing. The water sample was 3721m deep borehole-frozen re-cored ice. It was decontaminated and melted in the cold and cleanroom facilities, and the genomic DNA extracted was amplified with v3-v4 16S rRNA bacterial gene region-specific primers. The amplicons generated were sequenced by the Sanger method and the high through-put Oxford Nanopore sequencing technology. The Sanger DNA analyses came up with a total of 16 bacterial phylotypes. Of them, only one phylotype 3721v34-24 passed all contamination criteria. It was dominant comprising 41.4% clones with three allelic variants but remained unclassified – 87.7% (below family-level) similarity with *Mucilaginibacter daejeonensis* NR_041505 of Bacteroidetes (Sphingobacteriaceae). Applying Oxford Nanopore technology to the same amplicon, a total of 20535 reads were obtained. Of them, 92% of reads were classified with 85% accuracy. As a result, 17 bacterial phylotypes were identified above 0.5% abundance. Amongst them 13 phylotypes were shared with Sanger findings while 4 remaining phylotypes were unique but met in the control (sham DNA) Nanopore trial, i.e., were contaminants. 13 Sanger-shared finds contained 12 contaminants and the phylotype classified as *Mucilaginibacter daejeonensis* – the same as the 'true' Sanger finding. However, it was also present in a control Nanopore trial. Thus, no true finds were recovered proving that the upper-most water horizon in the Lake Vostok could be microbial DNA-free. More water samples are under study to clarify. The reported study was funded by RFBR and DFG according to the research project № 20-55- 12006



SCAR 2022

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**Ecological implications and
adaptations of microorganism in
the Polar environments**

CONVENORS

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Abstract No : 172

Bioprospecting of antimicrobials in Antarctic microorganisms

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The pursuit of a novel broad-spectrum antimicrobial has increased in the last years. The exploration of extreme and pristine environments such as the Antarctic is the key to finding microorganisms with high interest in biotechnology. In this study, we evaluated the capacity of production of antimicrobial from isolated antarctic microorganisms from soil samples collected on King George Island. The antimicrobial production for antarctic isolates was a performer in Caseine - Starch media and with the "well diffusion" method in Mueller Hinton agar, we evaluated the inhibitory spectrum of the extracts against certified pathogens. Of the isolated selected, a characterization of antimicrobial activity of the broth was carried out by measuring the inhibition activity expressed in arbitrary units (UA/ml) and the minimum inhibitory concentration (MIC) of the fraction of ethyl acetate extraction. The isolates arbitrarily named K6 and E7, obtained from a universe of 196 isolates, showed antimicrobial activity against *Fusarium oxysporum* f.sp. *cubense* (Foc) and *Staphylococcus aureus*. K6 and E7 broth present activity against Foc (320 and 160 UA/ml) and *S. aureus* (40 y 20 UA/ml), while the ethyl acetate fraction has a MIC to Foc (250 and 500 ppm). For *S. aureus* for both isolates, more than 2000 ppm is necessary to inhibit the strain. The partial results of this work demonstrate the potential of prospecting Antarctic microorganisms as a font of new antimicrobial activity molecules with applicability in various branches of biotechnology as biological control of *Fusarium oxysporum* f.sp. *cubense* in banana crops.

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Abstract No : 168

Exopolysaccharides from Antarctic yeasts elevate interferon- γ production in murine splenic macrophages and NK cells

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Scientists` knowledge about the diversity of Antarctic yeasts, as well as the production, characteristics, and practical application of their exopolysaccharides (EPSs) is still scarce. In this study, the biodiversity investigation of Livingston Island showed the presence of the species *Cystobasidium ongulense* AL101, *Vishniacozyma victoriae*, *Leucosporidium yakuticum* AL102 and *Tremellomycetes* sp. The strains accumulated exopolysaccharides during submerged cultivation. With the exception of AL101, yeasts synthesized high molecular weight EPSs. The EPSs comprised mannan- or heteromannan type polymers accompanied by a higher protein content. The biological activity of the obtained polysaccharide molecules on mouse immune cells was evaluated. We studied their effect on i) the surface expression of Toll-like receptor (TLR)-2 on bone-marrow (BM) Ly6C+ monocytes; ii) intracellular TNF- α production in BM Ly6C+ monocytes and splenic F4/80 macrophages; iii) intracellular IFN- γ production in splenic F4/80 macrophages and NK cells. We observed that EPSs failed to affect TLR2 expression and maintained a low percentage of TNF- α positive bone marrow monocytes (at 100 ng/mL). In respect to splenic F4/80 macrophages AL102-produced EPS increased TNF- α production in F4/80 macrophages probably causing tonic signals in cells. At the lowest concentration (100 ng/mL) again only AL102-formed mannan polymer increased significantly IFN- γ production in splenic macrophages and NK cells. Thus we suggest that EPS can have a selective action on particular innate receptors regulating IFN- γ signaling. Acknowledgment: We thank the staff of the Bulgarian Antarctic Expedition for their logistic support. The study was supported by Project 70.25-173/ 22.11.2019 from the National Center of Polar Studies, Sofia University "St. Kliment Ohridski", Bulgaria.

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Abstract No : 963

Diversity and succession ecology of culturable fungi detected in mosses affected by “fairy rings” disease in Antarctic Peninsula

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In the last decades, the “fairy ring” disease has been increasing in moss carpets in different regions of the Antarctic Peninsula. Inside those rings were detected the presence of different fungal species, some of them reported as phytopathogenic and/or opportunistic taxa, which have been considered responsible for the infection of the mosses. In order to identify those fungi, we monitored the increasing number of fairy and the succession of the resident fungi in two locations in the South Shetland Islands, Antarctica. Over three years, we collected, photographed and counted rings on a carpet of *Sanionia uncinata* affected by the disease at Ullman Point, King George Island and the moss carpeted *Polytrichastrum alpinum* at Deception Island, visually apparently free of the disease. Over the period, the incidence of rings increased on the *S. uncinata* carpet, while the *P. alpinum* turf remained virtually unchanged. Using molecular approaches, we identified a rich fungal assemblage associated with the rings on *S. uncinata*, composed of 39 taxa. In contrast, those associated with *P. alpinum* comprised only 8 taxa. Only *Alpinaria rhododendri*, *Helotiales* sp, *Phenolifera glacialis*, *Pseudogymnoascus destructans*, *Thelebolus balaustiformis* and *T. globosus* were detected in association with both mosses. Our data suggest that the fungal assemblage of diseased carpets of *S. uncinata* is different from those of *P. alpinum*. The high fungal richness associated with *S. uncinata* suggests that fairy rings may act as an initial gateway for fungal colonisation, which may accelerate the spread of disease in mosses in Antarctica.

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Abstract No : 238

Antibiotic resistance genes transferred by phage particles in seawater of the Western Antarctic Peninsula

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Antibiotic resistance represents a significant and growing threat to human and environmental health worldwide. However, the contribution of bacteriophages to the acquisition and spread of antibiotic resistance genes (ARGs) in the environment has not been widely explored and it is especially unknown in remote isolated regions such as in Antarctica. In this study, the prevalence and abundance of seven ARGs was analyzed in the viral DNA fraction isolated from a non-anthropogenic marine habitat such as of the Southern Ocean around the Western Antarctic Peninsula. Samples from Antarctica were compared with samples collected at the Mediterranean Sea, which is exposed to much stronger anthropogenic pressures. These ARGs were also analyzed in different marine bacterial communities, lysogens, and strains isolated from some Antarctic marine invertebrates, to assess them as the origin of these ARGs-containing phage particles. The results show a similar prevalence of ARGs in both ecosystems, Antarctica and Mediterranean coasts, confirming the presence of ARGs in natural environments with no human activity. However, abundances were much lower in Antarctica compared to the Mediterranean Sea, which points out the important influence of human activities in the environment to drive selection pressures on the antibiotic resistances. On the other hand, the results provide a strong evidence that phages from marine habitats are potential vectors for ARGs transmission not only in strongly human-influenced regions but also in pristine environments. Our results confirm the role of phages as disseminating elements of ARGs and as vectors of bacterial evolution, thus finally “everything is everywhere, but the environment selects”.

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Abstract No : 310

Detection of biosurfactants and lipids produced by fungi recovered from sediment of Antarctic lakes

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Among the environments and ecosystems of Antarctica, freshwater lakes shelter a wide variety of microorganisms, represented by virus, bacteria, fungi and microalgae. In general, microorganisms have been studied due to their potential as producers of compounds such as biosurfactants and lipids, which may be useful in different industrial processes. The present study aimed to characterize culturable fungi present in sediments of Antarctic lakes able to produce biosurfactants and lipids. A total of 56 fungi were recovered from sediment sampled in Florencia and Katerina Lakes at James Ross Island, Antarctica. To detect fungi able to produce biosurfactants, all isolates were grown in a culture medium containing 50 mL of Sunflower oil 40 g L⁻¹ + Yeast extract 10 g L⁻¹, incubated at 100 rpm, 20 °C for nine days. After that, the emulsification index (E24%), a test used for the detection of biosurfactants, were determined and seven *Pseudogymnoascus* sp. and one *Thelebolus* sp. isolates displayed high activities with E24% between 53.53 and 68.86%, which was similar to the effect of SDS 1%, a conventional surfactant used as the control. In addition, all isolates were able to produce intracellular lipids detected by confocal fluorescence microscopy. These lipid-producing fungi were identified as taxa of the genera *Pseudeurotium*, *Thelebolus* and *Pseudogymnoascus*, *Mortierella*, *Dactylaria*, *Leucosporidium*, *Glaciozyma* and *Penicillium*. Our results indicates that fungi living in sediment of Antarctic lakes can be high producers of biosurfactants and lipids under low temperatures, which may be useful in different biotechnological processes as detergent and biofuel, respectively.

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Abstract No : 558

Exploration Of Extremophilic Microorganisms Isolated From The Indian Sector Of Southern Ocean For Synthetic Surfactant Degradation Potential

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The Southern Ocean, which harbors rich microbial diversity, seems to have a promising future in the development of novel biologically active substances. With the capability to survive, adapt and thrive in diverse conditions such as extremes of temperature, pH, pressure, salinity, UV radiation, etc., extremophiles possess robust enzymatic and biocatalytic systems which are useful in a variety of biotechnological applications. In the present investigation, 80 samples (water, sediment, and algal mats) were collected during the Expedition to the Southern Ocean and Antarctica. Water and sediment samples were collected from different locations of different islands/peninsulas like Bharti Station, Fisher Island, McLeod Island, Broknes peninsula, and Stornes peninsula. Seawater samples were collected in sterilized bottles from different depths using CTD operations. On-board culturing of microorganisms was done using selective media for investigating their roles in bioremediation and other biotechnological applications. With the extensive usage, detergents and their degradation products have been detected at varying concentrations in parts of abiotic and biotic samples as well. Several bacteria have shown efficient degradation of anionic surfactants. As extremophiles can be used to actively degrade xenobiotics and convert them into less harmful substances. Several bacteria isolated from the Indian sector of the Southern Ocean were used to check the tolerance of the species towards SDS. Some samples showed growth in the presence of SDS at a maximum concentration of 100 ppm. The present work discusses the isolation, characterization, and surfactant biodegradation potential of these microbes and also the scope of future research in a similar area.

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Abstract No : 543

Study the impacts of UV radiation, antibiotics, and heavy metals on bacterial species isolated from Atlantic Ocean and Southern Ocean territory near Antarctic coastland

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Prokaryotic life on Earth's biosphere is constantly evolving to thrive under multiple extremes. In the Southern Hemisphere, Antarctic and Southern Ocean regions are featured with extremely cold, harmful solar radiation, circumpolar current, and polar front but are normally devoid of pollutants like antibiotics and heavy metals. So, for this study, sea-surface water samples were collected from three different points of the Southern Ocean of the Antarctic continent and one point from the Atlantic Ocean, 807 km away from Cap town, South Africa. The microbial load of the four water samples was analysed and different bacterial colonies were isolated. Isolated bacterial strains showed the maximum similarity index with *Pseudomonas azotoformans*, *Psychrobacter okhotskensis*, *Rhodococcus cercidiphylli*, *Halomonas alkaliantarctica*, *Halomonas titanicae*, and *Rhodococcus* sp. The species were capable to grow in a wide range of temperatures and secrete different extracellular enzymes like catalase, protease, urease, lipase, esterase, etc. Some of the species showed pigments and extracellular polymer-producing abilities. Species like *Pseudomonas azotoformans*, *Halomonas alkaliantarctica*, *Rhodococcus* sp., *Psychrobacter okhotskensis* showed resistance against penicillin-G, erythromycin, amoxicillin, ceftriaxone, chloramphenicol, ampicillin, polymyxin B, etc. However, the metal resistance was also tested. The isolated species were capable to tolerate UV-B exposure. In future, we are exploring the adaptation strategy of the isolated species under UV irradiation, metal, and antibiotics to understand the evolutionary mechanism under extreme environments.

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Abstract No : 752

Fungal airborne diversity across latitudinal gradient from Brazil to Antarctica using DNA metabarcoding

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We sampled air onboard the Brazilian polar vessel across the latitudinal gradient from the South Atlantic coast (Brazil), Chilean channels (Chile) and Drake Passage until King George Island (Antarctica). Air was pumped under sterilized conditions into filters that were changed every three days. Fungal environmental DNA was extracted from filters and sequenced by High Throughput Sequencing (HTS). A total of 643,325 fungal DNA reads were obtained, which represented 176 amplicon sequence variants (ASVs). Ascomycota was the dominant phylum, followed by Basidiomycota, Mortierellomycota and Chytridiomycota, in rank. Only *Cladosporium* sp. and *Helotiales* sp. displayed the highest abundance, 12 fungal ASVs displayed intermediate abundance and 162 represented the minor components of the fungal community. Fungal diversity indices ranged across the latitudinal gradient; the highest fungal assemblages were detected in South Atlantic and the lowest in Drake Passage. Only *Aspergillus versicolor*, *Pichia kluyveri* and *Malassezia restricta* (detected as intermediate abundance) occurred in all latitudes sampled. Despite fungi being considered cosmopolitan microorganisms, our results indicate that few taxa occur on air from South Atlantic to Antarctica, and the majority of the taxa was exclusive of each latitude sampled. However, further studies are necessary to characterize and understand how fungal propagules arrive or departure in Antarctica. Support: CNPq, FAPEMIG, CAPES, MCTIC, FNDCT

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Abstract No : 962

Bacteria and ice nucleation bacteria in the Antarctic atmosphere

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It has been known for some time that bacteria can be active in the atmosphere directly through microbial ice nucleation, which acts to lower the required temperature necessary for ice crystal formation, impacting cloud formation and albedo. This is particularly relevant in the polar regions, where albedo has an important influence on global warming. However, until relatively recently, the study of microorganisms in the atmosphere has been limited by the technology available to study them at appropriate scale and resolution. In this session, the application of DNA based methods, focused on the detection of the ice nucleation gene will be discussed. Total ice nucleation gene copies and total 16S rRNA gene copies per cubic meter of Antarctic air will be summarised. Conclusions will be drawn on the variability of total cell numbers and the relative numbers of ice nucleation capable cells, shedding light on the potential influence of microbial activity on atmospheric processes across the Antarctic.

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Abstract No : 744

Ecological succession of fungal community in Antarctic mosses affected by a fairy ring disease

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We evaluated fungal diversity in an established moss carpet on King George Island, Antarctica, affected by ‘fairy ring’ disease using metabarcoding. A total of 127 fungal taxa were assigned. Ascomycota dominated the fungal assemblages, followed by Basidiomycota, Rozellomycota, Chytridiomycota, Mortierellomycota and Monoblepharomycota. The fungal community displayed high indices of diversity, richness and dominance, which increased from healthy through infected to dead moss samples. A range of fungal taxa were more abundant in dead rather than healthy or fairy ring moss samples. Our data confirmed the presence and abundance of a range of plant pathogenic fungi, supporting the hypothesis that the disease is linked with multiple fungal taxa. Further studies are required to characterise the interactions between plant pathogenic fungi and their host Antarctic mosses. Monitoring the dynamics of mutualist, phytopathogenic and decomposer microorganisms associated with moss carpets may provide bioindicators of moss health.

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Abstract No : 753

DNA metabarcoding to assess the diversity of fungi across the air, snow and soil gradient present in Keller Peninsula, King George Island, Antarctica

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We assessed uncultured fungal diversity present in air, snow and soil samples obtained from King George Island, Antarctica, using DNA metabarcoding through high throughput sequencing. We detected 79 fungal amplicon sequence variants (ASVs) dominated by the phyla Ascomycota, Basidiomycota, Mortierellomycota, Chytridiomycota and Mucoromycota. Fungal sp., Mrakia sp., Pezizomycotina sp., Vishniacozyma victoriae, Leucosporidiales sp., Dioszegia fristingensis, Verrucariaceae sp. and Amandinea decedens were the most dominant ASVs. In addition, several ASVs could only be identified at higher taxonomic levels and may represent previously unknown fungi and/or new records for Antarctica. The community detected in the soil displayed highest diversity indices, followed by snow and air, respectively. Only the taxa Fungal sp., Helotiales sp. Pseudogymnoascus sp. occurred among the three shared habitats (air, snow and soil). The fungal diversity included saprophytic, mutualistic, and plant and animal opportunistic pathogenic taxa. Our results show that soil sheltered the highest fungal diversity probably due the deposition of fungal particles deposited from air to snow across the time. However, fungal diversity on air and snow was much lower when compared with soil, suggesting that the assemblages detected in soil may have multiple origins such as from plants, marine spray or animal vectors. Further mycological studies are necessary to understand the successional ecology among fungal assemblages present in air, snow and soil in Antarctica. Support: CNPq, FAPEMIG, CAPES, MCTIC, FNDCT

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Abstract No : 593

Herbicidal activities of fungi recovered from mosses affected by ‘fairy rings’ on the Antarctic Peninsula

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In different regions of the Antarctic Peninsula mosses are under attack by fairy rings. In the lesions along the rings there is the presence of fungal hyphae, suggesting the presence of possible phytopathogenic and/or opportunistic fungi. These fungi have been considered responsible for the infection and subsequent death of the mosses in Antarctica, which may use different mechanisms to attack and kill the mosses such as herbicides. In addition, Antarctic fungi have been called attention due the potential capabilities to have unique metabolic pathways to produce different bioactive secondary metabolites. For reasons described above, we focused on characterising cultivable fungi present carpet mosses affected by ‘fairy rings’ as producers of herbicides potentially useful in agriculture. One hundred and thirty-five filamentous fungi and six yeasts were identified, which were grown using solid-state fermentation on Potato Dextrose Agar at 15 °C for 15 days. The media and fungi were lyophilised and extracted using the solvent dichloromethane. All extracts obtained were assessed for herbicidal activity against the models *Lactuca sativa* and *Allium schoenoprasum*. Twenty-three extracts displayed herbicidal activities against both plants. The extracts of *Pseudogymnoascus destructans* UFMGCB 15877, *P. destructans* UFMGCB 18611, *P. destructans* UFMGCB 18629, *Ascochyta rabiei* UFMGCB 18705 and *Microdochium lycopodium* UFMGCB 18713 displayed strong selective herbicidal activities (100% inhibition) against *L. sativa*, while one extract of *P. destructans* UFMGCB 18611 against *A. schoenoprasum*. Our results indicate that fungi present in carpet mosses affected “fairy ring” shelter fungal taxa, potentially, producers of herbicidal compounds with potential application in agriculture.

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Abstract No : 251

Diversity and bioprospecting of fungi associated with macroalgae from Antarctica and southern Chilean channels

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The goal of our study was to isolate and characterize the fungal communities associated with macroalgae present in the southern Chilean channels and Antarctic regions, as well as to evaluate the potential of these fungi to produce bioactive secondary metabolites. A total of 241 filamentous fungi were obtained using culturing methods, which were identified as taxa belong to the genera *Antarctomyces*, *Pseudogymnoascus*, *Microdochium*, *Trichoderma*, *Cladosporium*, *Linnemannia*, *Entomortierella*, *Neosascochyta*, *Penicillium* and *Cadophora*. The fungi obtained from different species of macroalgae were cultivated for further extraction of their secondary metabolites. The 177 fungal extracts obtained were evaluated for herbicidal, trypanocidal and leishmanicidal activities. Forty-nine extracts showed herbicidal activity, four of which were strongly active, inhibiting 100% the germination of *A. schoenoprasum* at concentrations below 250 µg mL⁻¹. Nineteen extracts showed activity against trypomastigotes and amastigotes of *Trypanosoma cruzi*, nine of which was highly active. The results obtained suggest the presence of a fungal community adapted to the extreme conditions of the Antarctic environment and the southern Chilean channels. The present study is one of the first to explore, identify and evaluate the fungal community associated with macroalgae in the southern Chilean channels region, showing the potential how substrate for the isolation of associated fungi. Finally, the algiculous fungi obtained showed to be potential producers of bioactive metabolites, evidenced by the detection of herbicidal and trypanocidal activities, reinforcing the need for further studies in the taxonomic and bioprospecting areas of macroalgae present in extreme ecosystems.

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Abstract No : 866

Antibiotic Resistance in Antarctic Terrestrial Stichococcus-Like Eukaryotic Algal

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The antibiotic activity of cycloheximide (CHX) against eukaryotic algae and fungi underpins its wide application in the purification of cyanobacterial cultures from eukaryotic contaminants. In an initial isolation of cyanobacteria from soil samples obtained from Signy Island (South Orkney Islands, maritime Antarctic), discrete colonies of green algae were observed growing on multiple culture plates of agarised medium supplemented with 100 µg/mL CHX. Investigations were carried out to confirm the identity of these algae and their resistance to CHX. Morphological features were observed microscopically and they were identified as a Stichococcus-like alga. We then assessed resistance in a total of six unialgal cultures of Stichococcus-like strains, three from soil samples collected on Signy Island together with single strains isolated from Arctic, temperate and tropical locations. All the algae were grown in medium supplemented with final CHX concentrations of 1000, 500, 250, 125, 62.5, 31.3, 15.6, 8, 4, 2, 1 and 0.5 µg/mL to assess how widespread resistance was within other representatives assigned to this genus. Comparisons made between the strains' minimum inhibitory concentrations (MIC) showed all three strains from Signy Island and those from the Arctic and tropics were highly resistant to CHX (MIC > 1000 µg/mL). All highly resistant strains showed no significant differences in growth rate between control and treatment conditions. Among the highly resistant strains, the one with strongest resistance could grow in the presence of CHX without an initial adaptation period.

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Abstract No : 986

Multidecadal pigment trends suggest long-term, photophysiological adaptation of phytoplankton community along the Western Antarctic Peninsula

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In the coastal regions of the Western Antarctic Peninsula (WAP), light availability is shown to be a defining characteristic for phytoplankton dynamics, regulated by the extent of surface ocean mixing. Experiments, snapshot observations, and seasonal analyses have all shown clear evidence of light limitation and active photoacclimation in WAP phytoplankton, with important roles in defining community characteristics like growth rates, phenology, and composition. While these prior analyses have assessed photophysiology on relatively short timescales to define the mechanisms of light regulation, an analysis of photophysiology over the timescales of climatic change (i.e., multidecadal) in the WAP has yet to be done. This remains a prime opportunity to assess how the long-term press of climate change has fundamentally altered the photophysiology of the phytoplankton community. In this analysis, we use in-situ HPLC measurements from the Palmer LTER to describe multidecadal trends in the photosensitive pigments of coastal phytoplankton communities along the WAP. Our results show a multidecadal increase in the relative proportions of total accessory carotenoids, driven by an increase in photoprotective pigments. This coincides with a shallowing of the average surface ocean mixed layer along the peninsula. These results are indicative of a baseline change in the photophysiological state of the community, seemingly driven by a long-term change in peninsula light availability. It is uncertain whether these state changes are driven by true intracellular adaptations of the pigment beds, a change in community composition, or both. However, either suggests a fundamental community response to climate-driven perturbations of the environment.

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Abstract No : 701

Influence of evolutionary adaption processes in the Antarctica Peninsula – an example from lichen *Usnea aurantiacoatra*

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Lichen is the typical symbiosis of mycobiont and photobiont. The species *Usnea aurantiaco-atra* (Jacq.) Bory is the most dominant vegetation on the Fildes Peninsula, Antarctica. Our data confirms that *U. aurantiaco-atra* could grow on various substrates, including rocks, wood, concrete block, even on the other lichen *Umbilicaria antarctica* and some are found with mosses. The ITS rDNA sequences of the mycobiont did not exhibit significant differences, whereas all photobionts in this lichen species were the green algae *Trebouxia jamesii*. The observed symbionts of *U. aurantiaco-atra* which grow on various substrates enhanced their ability to adapt and survive in the changing polar environment with relative stable genetic diversity. Meanwhile, there are two growth types of *U. aurantiaco-atra*: the erect form on rocks and the prostrate form associated with mosses. Phylogenetic analysis showed that individuals of the two growth forms share genotypes. Moreover, haploid disequilibrium testing indicated no significant genetic difference for the two growth forms when fungal and algal internal transcribed spacer rDNA were treated as two alleles of one lichen individual. The two growth forms of *U. aurantiaco-atra* appear to reflect different stages of lichen–moss community succession. A mode is proposed for demonstrating the occurrence of this succession.

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Abstract No : 266

Hidden fungal diversity in deep sea sediments of maritime Antarctica revealed by metabarcoding DNA approach

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We assessed the fungal diversity in deep-sea sediments obtained from different in the Austral Ocean using the DNA by metabarcoding through high-throughput sequencing (HTS). A total of 193,436 DNA reads were detected in sediment 52 m (48,112), 151 m (104,704) and 404 m (40,620) depths. The DNA reads were identified into 133 fungal ASVs, 88 detected at 52 m, 32 at 151 m and 59 at 404 m depths. The fungal community was dominated by the taxa of the Ascomycota and Basidiomycota as well as those belonging to the fungal-like Straminopila. The dominant fungal taxa were *Thelebolus balaustiformis*, Fungal sp. 1, Ciliophora sp. and Agaricomycetes sp. *Chaetoceros* sp. (Straminopila) was the fourth most dominant taxa. The total fungal community displayed high indices of diversity, richness and moderate to low dominance. The highest values of diversity and richness were obtained at 52 m, followed by 404 m and 151 depths. Functional ecology assignments indicated that marine sediments were dominated by saprotrophic, plant and animal pathogenic and symbiotic taxa. However, taxa recognized as important animal pathogens were detected such as *Candida parapsilosis*, *Malassezia restricta*, *Aspergillus thermomutatus*, *Candida tropicalis*, *Cryptococcus neoformans*, *Malassezia arunalokei*, *Malassezia globosa*, *Malassezia japonica* and *Malassezia sympodialis*. The fungal community detected in the different sediments showed high diversity and richness, and moderate dominance, which varied between the different depths sampled. Our results reinforce that the deep-sea sediments host a complex fungal diversity.

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Abstract No : 403

Changes in bacterial community composition and predicted functions during the summer melt-season in coastal Antarctica

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The melt-water ecosystems such as cryoconite holes (nutrient and debris rich melt-water depressions) on the glacier surface offer refuge for microorganisms. These ecosystems undergo dramatic changes during a summer melt-season and have the potential to influence downstream coastal environments. We used high-throughput amplicon sequencing and predictive functional metagenomic tools to track changes in bacterial communities and functions during the summer season in a coastal Antarctic site. Over the melt-season, cryoconite holes originating from a supra-glacial environment, and a hydrologically connected adjoining fjord were sampled. The taxonomic composition in cryoconite debris varied over the summer, with a dominance of autotrophic Cyanobacteria at the beginning of the melt-season. As the season progressed and temperatures increased, there was a shift from autotrophic to heterotrophic communities, dominated by Bacteroidota. Predictive functional analyses show a corresponding shift from predominantly phototrophy related functions at the beginning of the melt-season to Chemoheterotrophy related pathways as the melt-season progressed. The bacterial diversity in cryoconite hole melt-water was consistently represented by heterotrophic Proteobacteria throughout the season. The functional prediction in cryoconite hole water showed high chemoheterotrophy and complex aromatic compound degradation abilities. The fjord waters were dominated by Proteobacteria, and Actinobacteriota, with increased representation of Bacteroidota and Cyanobacteria over the melt-season. The community in the coastal fjord showed decreased potential for chemoheterotrophy, but increase in denitrification potential as the summer season progressed. Hence, we see a shift in bacterial community composition and functioning in these temporary and transient supra-glacial and coastal meltwater ecosystems in response to seasonal warming.

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Abstract No : 107

Diversity and enzymatic activity of cultivable fungi present in lakes of maritime Antarctica

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We evaluated the diversity and enzymatic activities of cultivable fungi recovered from two lakes on the South Shetland Islands in maritime Antarctica. The fungi were isolated from cotton baits submerged for two years in Hennequin Lake, Hennequin Point, King George Island, and from benthic biofilms in Kroner Lake, Deception Island. A total of 154 fungal isolates were obtained, representing in rank abundance the phyla Ascomycota, Basidiomycota and Mortierellomycota. *Thelebolus globosus*, *Goffeauzyma* sp., *Pseudogymnoascus verrucosus* and *Metschnikowia australis* were the most abundant taxa. The fungal community obtained from the biofilm was more diverse and richer than that recovered from the cotton baits. However, the dominance of some taxa was higher within the cotton bait community relative to the biofilm. The capabilities of all cultured fungi to produce the extracellular enzymes cellulase, protease, lipase, agarase, carrageenase, invertase, amylase, esterase, pectinase, inulinase and gelatinase were evaluated. The most widely produced enzymes were protease and pectinase. Among the most active fungi, *Mrakia blollopis* UFMGCBLB21 and *Holtermanniella wattica* UFMGCBLB2 displayed the highest pectinase and esterase activities, respectively. The two lakes harbored different cosmopolitan and endemic cold adapted fungi capable of producing a range of different enzymes at low temperatures. The detection of multiple enzymes reinforces the ecological role of fungi in nutrient cycling in Antarctic lakes, making nutrients available to the complex aquatic food web. Furthermore, such low-temperature-active enzymes may find application in different biotechnological processes, such as in the textile, pharmaceutical, food, detergent and paper industries, as well as environmental application in bioremediation processes.

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Abstract No : 524

Assessing aerial biodiversity above the Keller Peninsula, King George Island, South Shetland Islands, Antarctica, using DNA metabarcoding

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The vegetation of ice-free areas in Antarctica is dominated by cryptogams and microorganisms that characteristically propagules that are assumed to be dispersed aerially. The resulting "diaspore rain" can become part of a soil propagule bank, remaining dormant until local conditions become favorable. However, how organisms or their propagules arrive and circulate in Antarctica remains poorly understood. One possible consequence of future Antarctic climate change is that new species arriving by aerial means will colonize ice-free terrestrial areas, altering community composition and species abundance, and impacting the local native biodiversity. The South Shetland Islands are particularly likely to receive higher number of diaspores in this way due to their proximity to South America and typically less challenging environmental conditions than in much of Antarctica. In this study, we used DNA metabarcoding to identify the diversity of non-fungal eukaryotes that reach and circulate in Antarctica aerially. Air samples were collected near the Brazilian Antarctic Station Comandante Ferraz from December 2019 to January 2020. DNA sequences were assigned representing a total of 35 taxa from 10 phyla within three kingdoms: Chromista - phyla Ciliophora, Cercozoa, Haptophyta and Ochrophyta; Plantae - phyla Chlorophyta, Bryophyta and Magnoliophyta; Animalia - phyla Mollusca, Arthropoda and Chordata. Our study revealed a previously unknown airborne sequence diversity that likely would have remained undetected using traditional approaches. The sequence diversity detected here suggests that the Antarctic airspora includes propagules of both intra- (local) and inter-continental (distant) origin.

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Abstract No : 367

Antifungal resistance of fungi isolated from soil and snow on King George Island, Antarctic Peninsula

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Several chemical pollutants can be transported by winds in gaseous form or by particles to the Antarctic Continent. Through snow precipitation, these pollutants are deposited and can contaminate the environment. In addition, these pollutants might influence the resistance of some fungal taxa to different antifungals. In our study, soil and snow samples were collected at six different points around the Brazilian Antarctic Station Comandante Ferraz located on King George Island, Antarctic Peninsula. Approximately 1 g of each soil sample was added to 9 mL of 0.85% NaCl and 100 µL of a dilution of 10^{-1} and 10^{-2} inoculated in Minimal Medium, Sabouraud and DRBC, which were incubated at 37 °C for 60 days. For the snow samples, 1.5 L of melted snow were filtered through membranes with a pore size of 47 µm and inoculated under the same cultivation conditions as the soil samples. The culturable fungal isolates recovered were identified and assayed on its Minimum Inhibitory Concentration (MIC) to the clinical antifungal fluconazole. In total, 35 fungal isolates were obtained, 15 from snow and 20 from soils. Fungi were identified as taxa belonging to the genera *Aspergillus*, *Cladosporium*, *Penicillium*, *Entomortierella* and *Coniochaeta*. After 96 hours, the Minimum Inhibitory Concentration test showed that 15 isolates have resistance to fluconazole. The results suggest that these fungi may display pathogenic potential; however, further in vitro and in vivo assays should be performed to confirm the pathogenic potential. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 551

What defines the composition of airborne microbial community?

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The atmosphere plays an important role in the dispersal of microorganisms and may connect in some way most of the planet's ecosystems. Previous studies have shown a seasonal and spatial variation in the microbial airborne community related to meteorological conditions and the effect of the surrounding biotopes, respectively. Moreover, atmospheric vertical mixing and movement of air masses over terrestrial surface influence the composition of airborne microbial communities. Here, we study the potential influences and their geographical scales affecting microbial airborne communities from an Antarctic location. Six air samples from Antarctic Peninsula region, in Byers Peninsula (South Shetland Islands) and in Avian Island (Adelaide Island), were collected. The microbial community composition of these samples was analysed by 16S rRNA gene sequencing, using amplicon sequence variants (ASVs). Moreover, back-trajectories of air masses during the sampling events at the locations were simulated with HYSPLIT. Our results showed that 50% of the total microbial sequences in Byers Peninsula samples were shared by 80% of the samples (Core80). Interestingly, we found that only 1.6% of the ASVs from each Byers sample were shared with the Avian's, except for one sample that shared 4.6% of the ASVs with the airborne community of Avian. That sample was taken when air back-trajectories were like those of Avian and clearly different from the back-trajectories from the other sampling events. We suggest in this study that an airborne microbial community is defined by different geographical influences (local, regional and continental), and speculate about the magnitude of these influences in Antarctica.

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Abstract No : 775

Biotechnological potential of filamentous fungi isolated from Antarctic soil

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Currently, interest in Antarctic soil microorganisms is related to its ability to adapt to extremely low temperatures, freeze-thaw cycles, ultraviolet radiation rates and high salinity concentrations. Due to these characteristics, the search for microbial enzymes from cold environments has gradually aroused interest for biotechnological purposes. In this context, the present study aimed to evaluate the production of cellulase, lipase and ligninase enzymes by filamentous fungi isolated from soil sample collected on King Georg Island, at Comandante Ferraz Antarctic Station. Ten fungal isolates were cultivated in Petri dishes containing PDA culture medium supplemented separately with the substrates cellulose (10%), Rhodamine B + oil and black and red synthetic dyes, to evaluate the production of cellulase, lipase and ligninase enzymes, respectively. The isolates were cultivated at 15 °C for 21 days and the formation of halos around the fungal colonies was considered a positive result for the enzyme production capacity. The tests were performed in triplicate. Cellulolytic, lipolytic and ligninolytic activities were observed in six, one and seven isolates, respectively. In addition, two of the isolates were morphologically identified as belonging to the genus *Cladosporium* sp., being one of them a potentially cellulase producer. The results show that the Antarctic continent harbors microorganisms with potential to produce active enzymes at low temperatures, which may be of industrial and/or environmental interest, applicable in bioremediation processes. Complementary studies should be carried out to evaluate enzymatic activity as well as to characterize these biotechnologically promising enzymes derived from cold environments. Keywords: filamentous fungi, Antarctic microorganisms

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Abstract No : 264

Fungi recovered from deep sea marine sediments from Antarctica as producers of exoenzymes active at low temperatures

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Fungi present in marine deep sea sediments sampled at 52 m, 151 m and 404 m depth in maritime Antarctica were isolated and assayed for the production of extracellular enzymes at low temperatures. Marine sediments were inoculated on marine agar, Sabouraud agar, malt extract agar, dichloran rose-bengal agar and dichloran glycerol 18% agar at 15 °C until 60 days. A total of 68 fungal isolates were obtained, 44 filamentous and 24 yeasts. All fungi were assayed to detect nine exoenzymes on yeast malt agar supplemented with specific inducing substrates for each enzyme at 15 °C for 7 days. A total of 39 isolates produced invertase, 38 cellulase, 37 carrageenan, 36 lipase, 35 agarase, 29 pectinase, 22 esterase and 15 protease. No one fungi displayed amylase activity. Most exhibited activity for more than one enzyme, with 17 isolates producing six of them, while 14 were positive for seven enzymes and only three isolates were positive for eight enzymes. The fungus UFMGCB 19640 was the most active for protease and invertase, with enzymatic indices of 2.29 and 2.12, respectively. Our results indicate that deep sea Antarctic sediments harbor fungi able to produce active enzymes at low temperatures, which may have potential biotechnological applications.

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Abstract No : 743

Detection of biosurfactants produced by potential phytopathogenic fungi recovered from mosses carpet affected by ‘fairy rings’ disease on the Antarctic Peninsula

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In different regions of the Antarctic Peninsula mosses are under attack by fairy rings. The lesions along the rings have fungal hyphae, suggesting the presence of possible phytopathogenic and/or opportunistic fungi. These fungi have been considered responsible for the infection and subsequent death of the mosses in Antarctica, which may use different mechanisms to attack and kill the mosses such as herbicides and/or biosurfactants. For the reasons described above, our present study aimed to characterise fungi isolated from mosses affected by the fairy ring disease as producers of biosurfactants. A total of 145 fungal isolates, recovered from carpet mosses sampled at Ullman Point, King George Island affected by fairy ring disease, were grown at Potato Dextrose Agar, 15°C, and screened using the drop collapse test. The isolate UFMGCB 18740 was able to collapse the glycerol similarly to the sodium dodecyl sulphate SDS (25%) control and identified using molecular biology methods as *Linnemannia gamsii* (Mortierellomycota). It was grown in Erlenmeyer flasks (125 mL) containing 50 mL of Yeast extract + Soybean oil (40g/L) and incubated at 100 rpm, 20 °C for nine days. After that, the emulsification index (E24) was done and the ratio of emulsified kerosene was calculated, displaying E24 = 72,95%, which was similar to the effect of SDS (1%). Our results indicate that fungi associated with the fairy rings disease in moss carpets could be high producers of biosurfactants under low temperatures, and a useful microorganism in different industrial processes.

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Abstract No : 780

Predicting and validating the impact of warming on terrestrial microbial systems in Antarctic Polar deserts using laboratory and field space for time approaches

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The McMurdo Dry Valleys (MDV) contain unique and sensitive ecosystems increasingly responsive to the changing global climate. However, unlike the more temperate terrestrial ecosystems, monitoring and predicting biological responses to environmental change remains a significant challenge due to the limited time frame allocated to field access, the requirement for permits, and substantial financial and logistic support. Here, we present two complementary approaches developed to help assess and validate the capacity of the MDV terrestrial microbiome to respond to future impacts of climate change. Firstly, we demonstrate how geochemically defined space-for-time gradients can help predict compositional and diversity changes across space by replicating gradients across systems with different historical legacies of water availability. Secondly, using a custom-designed environmental chamber capable of emulating polar desert conditions of MDV, we validate the use of laboratory experiments as monitoring tools for the microbial response to natural wetting events in a polar desert. We demonstrate a fast and asynchronous response from dominant taxa during wetting and re-drying disturbances, which offers insights into the diversity of metabolic traits and strategies inherent in polar desert communities. We further explore the ecological consequences of these responses for the stability and resilience of this ecosystem. Lastly, we strongly advocate that laboratory-based Antarctic research can complement field studies with adequate and controlled infrastructure. Such studies would allow more complex disturbances and activity measurements to be examined without the temporal, logistic and permit constraints, nor the environmental and anthropogenic impacts associated with Antarctic fieldwork.

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Benthic diatom assemblages under the rapid glacier retreat in Marian Cove

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The glacier melting of Antarctica has been a major concern for people who have experienced global warming during the last for decades. The importance of meltwater as a major microorganism habitat is increasing in the Marian cove on King George Island where glacier retreat is severe. The present study aimed to identify the distribution and diversity of benthic diatoms in Marian cove with increasing amount of melt water discharge. Epilithic and epipsammic diatoms were taken from surface of rock and the sediment uppermost 5mm during austral summer 2018-2019 in various meltwater habitat on King George Island: streams (n=5), pools (n=7), lake (n=2). A total of 119 diatom taxa belonging to 39 genera were identified from investigated area. *Fragilaria capucina* (14.9 %) and *Nitzschia annewillemsiana* (8 %) dominated in epilithic and epipsammic diatoms, respectively. The brackish pool exhibited the highest diatom diversity with 29 species. Meanwhile, in some areas where the Skua and Brineshrimp were observed, there were many abnormal diatom cells with deformations of the frustule and ornamentation pattern. Such deformations may imply the high environmental stress caused by meltwater discharge on the benthic ecosystem of the study area. As the melting of glaciers is accelerating, this study of diatoms in various meltwater environments would be the basis for the better understanding of antarctic ecosystem.

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Abstract No : 907

The level of habitat specificity modulates the microbial biogeographic patterns in the Southern Ocean: from community to intra-population scales

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Microbial biogeography in the Southern Ocean has been mostly studied at the whole community level, leaving the microevolutionary processes driving these patterns unknown. To tackle this challenge, we studied the microbial biogeographic patterns at different ecological levels (from community to intra-population) across four regions in the Southern Ocean (Maritime Antarctica, Patagonia, South Georgia and Kerguelen), combining 16S rRNA gene sequencing and microdiversity evaluation through oligotyping. To assess how the habitat selectivity influences microbial assembly, we studied a gradient of habitat selectivity from sediment to the gut membrane of deposit-feeder sea urchins (*Abatus* sp). The results show a significantly stronger effect of the region than the habitat-selectivity on the microbial assembly. This spatial effect was stronger for sediment than for gut microbiota. Bioindicator OTUs for each region were identified. Moreover, we highlighted a clear effect of host phylogeny on microbiota structure. In addition to the strong biogeographic pattern at the community-level, we also provide evidence of phylogeographic structure (at the intra-population level) for the shared OTUs common to all regions. The habitat consistently modulates this phylogeographic pattern: the OTUs more tightly associated to the host (gut tissue microbiota) were genetically and phylogenetically more structured than the ones from the raw sediment. This pattern reveals a connection between Antarctica and Kerguelen through the Antarctic Circumpolar Current and the role of the Antarctic Polar Front as a dispersal barrier. Our study is in accordance with the biogeographic patterns found in Southern Ocean macrofauna, bridging the gap between macro- and microbial biogeography.

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Abstract No : 218

Enzymatic activities of fungi present on different historic huts at Whalers Bay, Deception Island, Antarctica.

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We evaluated the enzymatic activities of cultivable fungi isolated from different lignocellulosic substrates (wood, rope and soil) from the whaling station, located in Whalers Bay, Deception Island, maritime Antarctica. A total of 58 fungal isolates were obtained (24 yeasts and 34 filamentous fungi), of which 47 were identified using molecular biology methods in 17 genera of the phyla Ascomycota (9) and Basidiomycota (8). The most frequent genus was *Coniochaeta*, followed by *Cadophora*, *Pseudogymnoascus*, *Mrakia* and *Leucosporidium*. Enzymatic assays to detect amylase, cellulase, inulinase and pectinase enzymes were performed with all isolates. Amylase was the most commonly detected enzyme, followed by inulinase, cellulase and pectinase. Inulinase was the enzyme detected in the majority of the fungal, which displayed enzymatic index (EI) > 2. *Coniochaeta* sp. 2 UFMGCB18967 demonstrated EI > 2 for cellulase and inulinase, and the cellulase index was the highest among all fungal isolates assayed (2.7 ± 0.07). Both filamentous isolates UFMGCB18944 and UFMGCB18955 showed EI > 2 for amylase and inulinase. *Phenoliferia glacialis* UFMGCB18987 was the only yeast able to show activity for two enzymes (cellulase and pectinase). Thus, our results show the capacity of Antarctic fungi to produce different enzymes at low temperatures, which may be applied in pharmaceutical, textile and food industries, and in bioremediation and detergent production. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 356

Herbicidal activity of fungi present in ancient geological soils at James Ross Island, Antarctica

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Extremophile Antarctic fungi have been reported as sources of different bioactive secondary metabolites. Our study aimed to evaluate the herbicidal potential of the fungi present in ancient geological soils at James Ross Island, Antarctica. Four soil samples were collected in the Mesa Clearwater geological formation at James Ross Island, Antarctica, which were inoculated into Petri dishes containing the media DRBC, DG18, MEA, minimal media and incubated at 15 °C for up to 60 days. The fungal colonies obtained were purified and cultivated under solid state fermentation in MEA culture medium at 15 °C for 15 days. After that, the fungal metabolites were extracted using dichloromethane. The extracts obtained were assayed in herbicidal biological assays, using as models monocots (*Allium schoenoprasum*) and dicots (*Lactuca sativa*). A total of 295 fungal isolates were obtained (269 filamentous fungi and 26 yeasts). The highest number of isolates (83) grew up in DRBC culture medium. A total of 189 crude extracts were produced and 54.6% of the fungal extracts tested showed activity in at least one model assay. Fifty-four fungal extracts showed activity against *A. schoenoprasum* and 38 against *L. sativa*. Among them, six fungal extracts inhibited 100% the germination of the seeds of both plants. Our results show that the soil fungal community of James Ross Island harbors isolates with herbicidal activity that can be considered promising candidates for the isolation of prototype substances of interest in agriculture. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 109

Fungal diversity in historic wooden structures at Whalers Bay, Deception Island, maritime Antarctic, using DNA metabarcoding

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We assessed fungal diversity associated with historic wooden structures at Whalers Bay, Deception Island, maritime Antarctic, using DNA metabarcoding. We detected a total 177 fungal amplicon sequence variants (ASVs) dominated by the phyla Ascomycota, Basidiomycota, Mortierellomycota, Chytridiomycota, Monoblepharomycota, Rozellomycota and Zoopagomycota, in rank order. The assemblages were dominated by the high taxonomic level taxa Helotiales sp. 1 and Herpotrichiellaceae sp. 1, which were present in all samples. Functional assignments indicated that the taxa detected were dominated by saprotrophic, plant and animal pathogenic and symbiotic taxa. The application of a metabarcoding approach revealed the presence of a rich and complex fungal community, which may be due to the wooden structures acting as baits attracting fungi to niches sheltered against extreme environmental conditions, or with easily available nutrients and favorable microhabitat conditions, generating a hotspot of fungal diversity in Antarctica. The sequences assigned included both cosmopolitan and endemic taxa, as well as potentially unreported diversity. The detection of the DNA assigned to taxa of human and animal opportunistic pathogens raises a potential concern due Whalers Bay being one of the most popular visitor sites in Antarctica, both for the tourist industry and national research operations. However, we recognize that the use of metabarcoding to detect DNA present in environmental samples does not confirm the presence of viable or metabolically active fungi and further studies using culturing approaches and/or shotgun sequencing are now required to further elucidate the functional ecology of these fungi.

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Abstract No : 456

Ice microbiome response to thermal stress

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Our corroborated investigations on the temperature dependence of ice microbiome revealed particular trends in both the community structure and associated molecules. Among glacial habitats, ice caves that harbor secluded perennial ice deposits constitute paleoclimate archives. The modeling role of climate variation along the last 13,000 years on the distribution of total and active prokaryotic and eukaryotic communities entrapped in underground ice deposits from Scarisoara cave (Romania) was uncovered by Illumina 16S rRNA/ITS2 gene sequencing of gDNA and rDNA, shotgun sequencing of rRNA, and mRNA-based functional analysis of the ice metatranscriptome. Microbial cell density variation with depositional and post-depositional processes in relation with environmental parameters highlighted a major climate impact associated with geochemical processes on the microbial abundance from this icy habitat. A heat-shock investigation mimicking the microbiome shift during glaciers melting at both taxonomic and metabolic levels had a selective short-term effect favoring the highly resilient microbial taxa dominated by Proteobacteria and Bacteroidetes (bacteria), Chytridiomycota and Blastocladiomycota (fungi), and a complex microeukaryotic community. At metabolic level, the cycling temperature variation induced upregulation of genes involved in enzyme recovery, energy storage, carbon and nitrogen regulation, and cell motility. At molecular level, gene expression and specific structural elements of enzymes involved in DNA synthesis and with applicative potential revealed adaptation mechanisms to cold-environments and temperature shift, ensuring an equilibrium between their activity, stability and flexibility required for catalysis low at temperatures. Funding: ITN MicroArctic Marie Skłodowska-Curie 675546, PN-III-P2-2.1-PED-2019-2461

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Abstract No : 795

Identification of organic solutes accumulated by two Antarctic *Phormidesmis* strains using natural abundance ¹H nuclear magnetic resonance spectroscopy

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Salinity fluctuation in Antarctica is common, especially during the winter and summer seasons and can also occur as a result of wind-blown sea spray. However, little is known about cyanobacteria response or adaptation to osmotic stress. To investigate the response to salinity stress, two *Phormidesmis* strains (CR11USMFM and CR147USMFM) were grown in modified BG11 liquid media depicting freshwater (control, 0 ppt), brackish (15 ppt), sea (35 ppt) and hyper-saline (65 ppt) condition. The presence of organic solutes synthesized by these strains were identified using Nuclear Magnetic Resonance Spectroscopy (NMR) after inoculation period of 30 days. Sucrose and trehalose were identified as the main compatible solute accumulated by both strains. The same compatible solutes were detected regardless of the salinity condition. The maximum growth for both strains was obtained at freshwater condition (0 ppt) and the growth was impaired significantly at hyper-saline (65 ppt) condition. Salt stress significantly induced carbohydrate accumulation in strain CR147USMFM, and the maximum concentration of 0.66 (%) was found at 65 ppt. Salinity had only a minor effect on carbohydrate contents in strain CR11USMFM with 0.31 (%) found at 0 ppt and 15ppt, and 0.39 (%) found at 35 ppt and 65 ppt. Salinity had less effect on protein content in strain CR147USMF, however, strain CR11USMFM showed and increased in protein content from 0.57 (5) to 2.07, 2.24 and 1.28 (%) at 15, 35, and 65 ppt respectively. This is the first report to identify compatible solutes in Antarctic cyanobacteria relative to osmotic stress.

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Abstract No : 217

Evaluation of lipid production of the oleaginous yeast *Solicoccozyma terricola* isolated from the whaling station at Whalers Bay, Deception Island, Antarctica.

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We evaluated the lipid production of the oleaginous yeast *Solicoccozyma terricola* isolated from wood fragments of the whaling station, located in Whalers Bay, Deception Island, maritime Antarctica. Wood samples of 12 sites were inoculated in tubes containing the specific medium to isolate fermenting yeasts with 8% of ethanol and 1% of raffinose. The tubes were incubated at 15 °C and 30 °C for 25 days. After that, the liquid was inoculated on Petri dishes containing Yeast Medium Agar (YMA), which were incubated at the same temperatures for 10 days. The yeast *Solicoccozyma terricola* was the only one able to grow on the plates incubated at 15 °C, which was identified using molecular biology methods. In addition, the yeast temperature profile was evaluated on YMA at 10, 15, 20, 25, 30 and 37 °C after 3 and 7 days. The best growth temperature was 20 °C and the isolates didn't grow at 30 and 37 °C. To evaluate the lipid production, two *S. terricola* isolates were inoculated on tubes containing the medium GMY, which were incubated at 20 °C for 9 days. The absorbance was adjusted to 0.1 at a wavelength of 600 nm. We used Nile Red to visualize the lipids on Confocal Microscope - Nikon - C2+. Our results show that *S. terricola* was able to produce lipids at 20 °C and grow in a medium with high ethanol concentration, showing its biotechnological potential for biofuels production. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 33

ANTARCTIC BACTERIUM, *Cryobacterium* SP. SO1 COLD ADAPTATION STRATEGIES

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The majority of *Cryobacterium* spp. are found in cold and freezing environments, including the Antarctic. As such, psychrophilic *Cyrobacterium* are good candidates for research into their cold-adaptation strategies. In this work, *Cryobacterium* sp. SO1, which has an optimal growth temperature of 20 °C, was subjected to 10 °C to assess its cold-adaptation strategies. The mRNA at the two temperatures was sequenced, evaluated, and compared. There was a total of 182 differentially expressed genes (DEGs) discovered, with 66 being up-regulated and 116 being down-regulated. Under cold conditions, metabolic and growth-related genes were substantially downregulated, as expected. From the data, we can deduce that there were two types of *Cryobacterium* sp. SO1 cells: dying cells and surviving cells under cold stress. The programmed cell death (PCD) pathways were triggered when dying cells suffered severe physical and cellular damages. The dying cells' cellular components served as an autoinducer for quorum sensing to signal the cells to adapt to the new normal cold temperature, and to adjust the expression of a series of genes. The expression of genes involved in removing misfolded and inactive proteins and RNA, repairing misfolded RNA, and synthesizing new RNA was elevated in the cells are among the major responses. To repair the broken ribosome and transport compatible substrates into the cells, several genes linked with ribosomal machinery and ABC transporters were upregulated. There are many other genes that are involved but the majority of the DEG encode protein of unknown function, which warrants more investigation.

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Abstract No : 978

Marine emissions dominate bioaerosol populations in coastal Antarctica

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Airborne microorganisms and biomolecules (i.e. bioaerosols) contribute to atmospheric processes via their role in cloud and precipitation formation. The properties and sources of bioaerosols in Antarctica are poorly understood, even though melting of marine and terrestrial ice may enhance their future fluxes and atmospheric effects. We used a real-time fluorescent particle counter (BioTrak, TSI Inc.) to quantify and size total coarse aerosols and bioaerosols (1–12 μm) over 3 weeks in summer 2019 at the Juan Carlos I Antarctic Base, Livingstone Island. In parallel, we employed a high-flow-rate impinger to collect 14 aerosol samples from ~950 m³ of air each. Finally, we collected 7 freshly precipitated snow samples and 17 potential source samples spanning terrestrial and marine environments. The samples were analysed for bacterial concentrations using quantitative PCR and for bacterial community composition using Illumina MiSeq amplicon sequencing, both targeting 16S rRNA bacterial marker genes. Using BioTrak, we found very low concentrations of bioaerosols, which negatively correlated with air temperature and precipitation. A significantly higher concentration of coarse aerosols and bioaerosols were associated with air masses that travelled over sea ice compared to air masses that travelled only over open water. Using SourceTracker software, we demonstrated that 20–25% of bacteria in aerosols/snow came from marine environments, mostly from seawater and the sea surface microlayer. Finally, we show that ASVs belonging to common bloom-associated bacterial genus *Polaribacter* were efficiently aerosolized as they were consistently present at a high relative abundance in airborne bacterial communities.

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Abstract No : 111

Enzymes at low temperature: enzymatic activities of cultivable fungal diversity present in lake sediments of James Ross Island, Antarctica

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We evaluated the enzymatic activities of cultivable fungal diversity recovered from lake sediments Florencia and Katerina Lakes located at Clearwater Mesa, James Ross Island, Antarctica. The fungi were isolated from the sediments using four different culture media: Dichloran Rose Bengal Agar (DRBC), Minimal Media (MM), Marine Agar (MA) and Malt Extract Agar (MEA). A total of 62 fungal isolates were obtained, which were identified by molecular biology methods. A total of 47 fungal isolates were evaluated to produce eleven extracellular enzymes at low temperatures. The amount of enzyme-producing fungi were inulinase (24), cellulase (22), amylase (21), lipase (20), protease (20), carrageenase (18), agarase (18), gelatinase (11), esterase (10), invertase (10) and pectinase (01), in rank. Among the fungi able to produce the enzymes are those of the genera *Leucosporidium*, *Pseudogymnoascus*, *Dactylaria*, *Pseudeurotium*, *Mortierella*, *Thelebolus*, *Penicillium* and *Glaciozyma*. The sediments of the two lakes harbor fungal assemblages capable of producing different active enzymes at low temperatures, which may display an important ecological role as decomposers in these natural environments, but also these enzymes may have promising use in industrial and biotechnological processes in the food, pharmaceutical, cosmetic and detergent industries, and also in bioremediation processes.

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Abstract No : 110

Diversity, distribution and ecology of fungal community present in Antarctic lake sediments using DNA metabarcoding

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We assessed fungal diversity in sediments obtained from four lakes in the South Shetland Islands and James Ross Island, Antarctica using DNA metabarcoding. We detected a total of 218 amplicon sequence variants (ASVs) dominated by the phyla Ascomycota, Basidiomycota, Mortierellomycota, Mucoromycota and Chytridiomycota. We also detected taxa belonging to the rare phyla Aphelidiomycota, Basidiobolomycota, Blastocladiomycota, Monoblepharomycota, Rozellomycota and Zoopagomycota as well as members of the fungal-like Straminopila belonging to the phyla Bacillariophyta and Oomycota, which are infrequently detected in Antarctica by traditional isolation methods. The fungal assemblages were dominated by unknown fungal taxa (Fungal sp. 1 and Fungal sp. 2), followed by *Talaromyces rubicundus* and *Dactylonectria anthuriicola*. However, the majority of the taxa detected were of intermediate or rare abundance. Although there was variation between the assemblages detected in sediments of the different lakes sampled, in general they displayed high diversity, richness and moderate dominance. Sequences representing saprophytic, pathogenic and symbiotic fungi were detected, including the phytopathogenic fungus *D. anthuriicola* that was abundant in the relatively young Soto Lake on Deception Island. The lake sediments studied contained the DNA of rich, diverse and complex fungal communities, including both fungi commonly reported in Antarctica and other taxa considered to be rare. However, as the study was based on the use of environmental DNA, which does not unequivocally confirm the presence of active or viable organisms, further studies are required to elucidate the ecology of fungi in these Antarctic lake sediments.

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Abstract No : 366

Xerophilic, halophilic and hydrolytic enzymatic activities of fungi present in rocks from Continental Antarctica

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We assessed the diversity of culturable fungi associated with two types of salt encrustation and carbonate veins in rocks of continental Antarctica to evaluate their xerophilic and halophilic profile and enzymatic activities. The rocks were sampled in the Heritage Range, the southern part of the Ellsworth Mountains. Approximately 1 g of each pulverizing the rocks was added to 9 mL of 0.85% NaCl. Then, 100 µL of a 10⁻¹ dilution was inoculated onto media MEA, MEA + 17% de NaCl, DG18, DRBC and incubated at 10 °C for 60 days. In addition, fungi were evaluated about their capability to grow at different concentration of NaCl (17, 23, 32%), low water activity (aw 0.66, 0.81, 0.90, 0.95) and to produce extracellular enzymes (lipase, amylase, protease, and cellulase). A total of 33 fungal isolates were obtained (22 saline crust and 11 inside rock). Using a molecular biology taxonomy approach, fungi were identified as species of the genera *Penicillium*, *Naganishia*, *Filobasidium*, *Cladosporium*, *Pseudopithomyces*, *Montagnula*, *Phomatospora*, *Periconia* and *Septoriella*. The halotolerance and xerotolerance assays revealed that most isolates displayed halo- and xerotolerance. All isolates produced at least one of the four tested enzymes. The most interesting species presenting the highest enzymatic index were *Penicillium* sp. 2, *Penicillium* sp. 3, *Penicillium* sp. 5 and *Nagashia diffluens*. Our results show that *Penicillium* spp. and *Naganishia diffluensis* have significant enzymatic activity in low temperature, demonstrating potential biotechnological capabilities. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 939

BIODIVERSITY ANALYSIS OF RNA VIRUSES IN LAKES OF THE SOUTH SHETLAND ISLANDS, ANTARCTICA – 2020

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FioAntar has the proposal to know about pathogens circulation at South Shetlands, Antarctic. This was an inquiring study comprising virome analysis in six different lakes from polar freshwater ecosystems regarding the ecology of RNA viruses. Little is known about viral biodiversity at Antarctica and here we applied water virome results using shotgun metagenomic analysis to run Shannon-Wiener's index and dissimilarity among lakes evaluated through UPGMA (Unweighted Pair Group Method with Arithmetic Mean) with Bray-Curtis coefficient in different lakes at the Islands: Penguin, Ardley, Deception and King George in the Peninsula Antarctica, in the summer season 2020. Biodiversity indexes showed high diversity and low evenness'. This was an exploratory study aimed to know the biodiversity and viral ecology in this ecosystem to start a timeline for future projections of risk analysis in public health.

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Abstract No : 873

Opportunistic human pathogenic fungus *Aspergillus fumigatus* isolated from ornithogenic soil of Antarctica

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Fungi are an important component of the microbial communities resident in different environments and substrates of Antarctica, which display different ecological roles as symbionts, saprobe, and potentially opportunistic pathogens. In Antarctica, fungi display different morpho-physiological and biochemical strategies to adapt and survive in extreme environments, which may result in their ability to infect animals, mainly those immunosuppressed. We recovered the opportunistic fungus *Aspergillus fumigatus*, a species commonly involved in cases of aspergillosis in immunocompromised patients, from ornithogenic soil of Antarctica. *Aspergillus fumigatus* displayed different virulence characteristics in vitro and its spores were inoculated in healthy and immunocompromised BALBc mice. All groups of healthy mice inoculated by the trachea with 10⁶, 10⁷ and 10⁸ spores of *A. fumigatus* had no lethality. However, in immunocompromised mice spores at 10⁶ and 10⁷ 50% died after 7 days. In addition, *A. fumigatus* displays 100% lethality after 4 days in mice that received 10⁸ spores. Our results indicated the *A. fumigatus* recovered from ornithogenic soil in Antarctica may cause disease in immunocompromised humans and should be monitored to avoid health risks to researchers and tourists that access Antarctica. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 283

Just in time: The longest baseline record of vegetation dynamics in East Antarctica shows that water availability still dominates the local patterns

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In the face of climate change, Antarctica has come under intense scrutiny due to polar amplification and the fragility of the vegetation that inhabits the area. Known as biological soil crusts, lichen, algae and bryophytes are directly and overwhelmingly impacted by changes in the environment and can serve as local integrator of climate change. Here, we present the longest, spatially explicit survey of Antarctic vegetation by harmonising historic vegetation mapping with modern remote sensing techniques. In 1961, E. D. Rudolph established a permanent survey plot for vegetation at Cape Hallett one of the most diverse areas along the Ross Sea coastline. Following a survey in 2004 using ground-based photography, we conducted the third survey of Rudolph's Plot in 2018 using near-ground remote sensing and methodologies closely mirroring the two historic surveys to identify long-term changes and trends. Our results revealed that the vegetation at Cape Hallett remained stable over the past six decades with no evidence for transformation related to climate change. Instead, the local vegetation shows strong seasonal phenology, distribution patterns that are driven by water availability and steady perennial growth of moss. Given that East Antarctica is right at the tipping point of drastic change in the near future, this record represents the unique and last-chance opportunity to establish an ecologically meaningful biological sentinel site, that will allow us to track subtle yet impactful environmental variability and change in terrestrial Antarctica in the 21st century.

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Abstract No : 330

Nine new species of cyanobacteria and microalgae in terrestrial habitats of Larsemann Hills, Antarctica

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Psychrophilic microbes are the dominant life form of the polar environments. The occurrence of cyanobacteria and microalgae in terrestrial habitats was recorded in form of epiphytic, chasmolithic, endolithic, epilithic, benthic and subsurface of the gravel soil. Apparently, it is observed that the trace metal contents in the sandy soil and the leaching of mineral rocks due to rock alteration are the source of nutrition for the psychrophilic algal community in the Larsemann Hills, East Antarctica. During the study, a total of 38 cyanobacteria, 2 green algae and 6 diatoms from the terrestrial habitats were recorded. The dominant taxa were *Gloeocapsa* and *Leptolyngbya* among non-heterocystus cyanobacteria. Similarly, *Petalonema*, *Calothrix*, *Dichothrix*, *Nostoc* and *Stigonema* were common among heterocystous cyanobacteria. *Stigonema* is often found epiphytic with bryophyte as well as with biomass of other cyanobacteria. Diatoms were mainly occurring in the benthic form and the diversity is less. Of these 9 taxa viz *Lemmermanniella bharatiae*, *Gloeocapsa adhikaryii*, *Gloeocapsa antarctica*, *Spirulina microscopica*, *Leptolyngbya senii*, *Dichothrix lamellata*, *Dichothrix indica*, *Stigonema epiphytica* and *Prasiola adhikaryii*, described and proposed as new species, whereas, 18 taxa were considered as first distributional records excluding new species to Antarctica. Though similar species occur in soils of tropical region, there are significant variations in their morphotypes. Therefore, mesophilic organisms recorded may have been transferred to Antarctica in result of horizontal gene transfer or due to their nutritional or morphological adaptation. This supports the hypothesis of long-term acclimatization took place in glacial refugia leading into a specific Antarctic flora.

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Abstract No : 773

Pyrene tolerance and laccase production by microorganisms from Antarctica

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Bioremediation using microorganisms recovered from cold environments has been considered a potential alternative for decontamination of areas polluted with petroleum-derived compounds. In this context, the present study aimed to investigate the ability of Antarctic microorganisms for laccase production and tolerance to polycyclic aromatic hydrocarbon (PAH). Bacteria and filamentous fungi isolated from Antarctic sediment from King George and Deception Islands were subjected to tests for pyrene tolerance and to produce laccase. Two bacterial and two fungal strains were inoculated in minimal medium plus 1 mg of pyrene, at 15 °C, during 14 and 21 days, respectively. The resulting fermentative extracts were separated from the cell biomasses, submitted to dry weight evaluation, and were also used to investigate the production of laccase by using the ABTS assay. Two strains were pyrene-tolerant, i.e., *Psychrobacter* sp. BAD17 (5 days of growth) and *Cladosporium* sp. FAR18 (21 days of growth). The same fungal isolate showed the highest production of the laccase enzyme in the presence of pyrene (0.10 UL⁻¹) when compared to the control (0.005 UL⁻¹), indicating that the presence of hydrocarbon stimulated the enzyme production. Both strains have been described as pyrene tolerant as well as laccase producer. These results show that polar regions may harbor microorganisms with potential for bioremediation of petroleum-derived compounds, possibly inserted in these environments by anthropic action. Complementary studies should be conducted to evaluate the degradation of PAHs by these microbial strains which showed potential for application in bioremediation processes in cold environments.

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Abstract No : 523

DNA metabarcoding of non-fungal eukaryotic diversity in air and snow of Livingston Island, South Shetland Islands, Antarctica

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A major natural route of dispersal to Antarctica is often assumed to be via atmospheric transport, although few studies have documented this in detail. However, aerial dispersal to Antarctica is very challenging as the continent is geographically remote from other land areas and is isolated by the atmospheric circumpolar vortex. In particular, detailed information on aerial routes by which eukaryotes arrive and circulate in Antarctica is lacking, as the few existing studies that focused on eukaryotes have predominantly relied on culture approaches and traditional morphological identification. Recent advances in molecular methodologies, such as DNA metabarcoding by High Throughput Sequencing (HTS), provide a powerful new tool for the study of atmospheric biological diversity, and can reveal diversity at least an order of magnitude greater than culture approaches. In this study we used HTS to investigate diversity of non-fungal eukaryotes present in the atmosphere and freshly precipitated snow on Livingston Island. Atmosphere (740 m³) and snow (3.76 L of meltwater) were sampled, DNA was extracted and sequenced using Illumina Miseq platform. DNA sequences were assigned to four Kingdoms (Protozoa, Chromista, Viridiplantae and Animalia) and five Phyla (Ciliophora, Ochrophyta, Chlorophyta, Magnoliophyta and Porifera). The most diverse phylum was Chlorophyta with 10 taxa, with *Trebouxia asymmetrica* Friedl & Gärtner being the most abundant representative.

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Abstract No : 108

Fungal diversity in lakes of Maritime Antarctica using DNA metabarcoding

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We evaluated the fungal diversity in two lakes on the South Shetland Islands, using DNA metabarcoding through high throughput sequencing (HTS). A microcosm experiment was deployed for two consecutive years in lakes on Deception and King George islands to capture potential decomposer freshwater fungi. Analyses of the baits revealed 258,326 DNA reads distributed in 34 fungal taxa of the phyla Ascomycota, Basidiomycota, Mortierellomycota, Chytridiomycota and Rozellomycota. *Tetracladium marchalianum*, *Tetracladium* sp., *Rozellomycota* sp., Fungal sp. 1 and Fungal sp. 2 were the most common taxa detected. However, the majority of the communities comprised intermediate and rare taxa. Both fungal communities displayed moderate indices of diversity, richness and dominance. Only six taxa were detected in both lakes, including the most dominant *T. marchalianum* and *Tetracladium* sp. The high numbers of reads of the known aquatic saprotrophic hyphomycetes *T. marchalianum* and *Tetracladium* sp. in the baits suggest that these fungi may digest organic material in Antarctic lakes, releasing available carbon and nutrients to the other aquatic organisms present in the complex lake food web. Our data confirm that the use of cotton baits together with HTS approaches can be appropriate to study the diversity of resident freshwater fungi present in Antarctic lakes.



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**Microbial diversity of
the polar oceans and their role in
the biogeochemical cycles under
the global warming scenario**

CONVENORS

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Abstract No : 554

Vertical distribution of bacterial and archaeal communities in the western Arctic Ocean marginal ice zone during summer sea-ice melting

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The environmental variations and their interactions with the biosphere are vital during the summer sea-ice melting period in the Arctic Ocean. Hence, we analyzed the vertical distribution of bacterial and archaeal communities in the western Arctic Ocean from sea surface melt-ponds to deep water up to a 3040 m depth. The distribution of microbial communities showed a clear stratification with significant differences among different water depths and the water masses in the Arctic Ocean; surface mixed layer, Atlantic water mass, and deep Arctic water appeared as a significant factors explaining their distribution in the water column. A total of 34 bacterial phyla were detected in the seawater and 10 bacterial phyla in melt-ponds. Proteobacteria was the dominant phyla in the seawater irrespective of depth, whereas Bacteroidota was the dominant phyla in the melt-ponds. Five archaeal phyla, Euryarchaeota, Halobacterota, Nanoarchaeota, Thaumarchaeota and Thermoplasmatota, were detected in this study. Thaumarchaeota and Thermoplasmatota were the major phyla, which together contributed an average of 91% of the total archaeal sequences. The surface and DCM depth archaeal communities were dominated by Thermoplasmatota, while Thaumarchaeota dominated in the bottom waters. The archaea phyla in this study were further clustered into 5 classes, 9 orders, and 12 families. Mainly oligotrophic heterotrophic bacteria dominated in the melt-ponds and surface waters. Whereas chemoautotrophic and mixotrophic bacterial and archaeal communities were also abundant in deeper waters. Chlorophyll and ammonium were the major environmental factors that determined the surface microbial communities, whereas inorganic nutrient concentrations controlled the deep-water communities. The strong environmental gradients in the MIZ during the summer ice melting significantly influence the microbial community distribution in the Arctic Ocean.

Culturable diversity of bacteria having hydrolytic enzyme potential in the surface sediments of Kongsfjorden and Krossfjorden, Arctic

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In the marine ecosystem, degradation of organic matter through the extracellular enzyme activity of heterotrophic bacterial communities are the key factor of marine biogeochemical cycles. In this study, we have checked the functional diversity of heterotrophic bacterial isolates in the hydrolytic enzyme activity. A total of 195 bacteria were retrieved from the surface sediments of Kongsfjorden and Krossfjorden. The isolates were screened for the enzyme activity of Protease, Lipase, DNase, Urease and Alkaline phosphatase. After DNA isolation of the isolates, rep PCR analysis was done in order to select unique isolates by the banding pattern in agarose gel. 16S rRNA sequencing of the selected isolates were done to check the taxonomic affiliation. The results indicate that, 158 isolates tested positive for the enzyme activity checked. Among the positive isolates, dominant fraction belongs to the phylum Proteobacteria (44.30%), followed by Firmicutes (34.17%), Actinobacteria (20.88%) and few isolates under the phylum Bacteroidetes (0.63%). Protease and Alkaline phosphatase activity was predominant among the isolates from the phylum Firmicutes (43.75 and 53.57% respectively). However, Lipase and Urease activity, was frequently encountered among the isolates belonging to the phylum Proteobacteria (51 and 64.10% respectively). Actinobacteria was the dominant phylum among the isolates having DNase activity (39.18%). The results of the study reveal the significant role of marine microbial communities in the nutrient cycling. Keywords: Arctic Fjords, Extracellular enzymes, Culturable bacteria, Proteobacteria

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Abstract No : 277

Diversity of Cyanoprokaryotes and Algae from Stinear Peninsula of Larsemann Hills, East Antarctica

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Larsemann Hills (69°23'S, 76°53'E), is an ice-free oasis on the Ingrid Christensen Coast, Princess Elizabeth Land, located approximately midway between the eastern extremity of the Amery Ice Shelf and the southern boundary of the Vestfold Hills. This ice-free coastal oasis named after Mr. Larsemann Christensen. It is the second largest area of only four major ice-free oases found along East Antarctica. Larsemann Hills region includes two main peninsulas, the western - Stornes and the eastern - Broknes. Other than these two, there are some more peninsulas such as Stinear, Brattnevet and Grovnes in between Stornes and Broknes. Stinear Peninsula in the Larsemann Hills projecting out of the ice plateau into the sea with uniformly steep sides rising to a central spine. Human activities in this area is promoted by the coastal location, ice free landscape, the further scientific research and the potential for tourist visits may affect the cyanoprokaryotes (cyanobacterial) and algal diversity. The Antarctic environment is highly sensitive and susceptible to the impacts of human activities and has much less natural ability to recover from disturbance than the environment of other continents. These changes ultimately affect the growth and diversity of cyanoprokaryotes and algae. Samples were sampled from diverse habitat of Stinear Peninsula. Altogether 09 species of cyanoprokaryotes (05) and Bacillariophyceae (04) were recorded from Stinear Peninsula of Larsemann Hills, East Antarctica.

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Abstract No : 968

Microbial Carbon Pump efficiency in the Southern Ocean with respect to global warming scenario – Future prospects

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In the present ‘Anthropocene’- a human-induced increase in atmospheric CO₂ levels is affecting the planet Earth and the various ecosystems including the marine and polar ecosystems. Polar regions particularly the Southern Ocean cold waters play an important role as a sink for sequestration of the atmospheric CO₂. Changing climatology- global warming will definitely have an impact on biological processes and community shift and hence the carbon cycle in this region. Ocean CO₂ sequestration through biological means needs a detailed understanding of the marine ecosystem and processes. Such kind of marine research is budding up recently. Recently proposed microbial carbon pump (MCP) is one such conceptual framework to address the microbial role in the production of refractile dissolved organic carbon (RDOC); an additional reservoir and path for long-term carbon sequestration within the ocean due to its refractory nature and hence long lifetime. It emphasizes the microbially mediated conversion of labile organic carbon to recalcitrant one. The MCP concept connects marine microbiology with marine biogeochemistry, assuming that the production mechanism of RDOC in the marine environment is mainly microbial. The Global Ocean contains a huge RDOC pool of 624 GtC which is nearly equal to the CO₂ pool (750 Gt C) in the atmosphere. Processes related to MCP and bacterial formation of RDOC remain mysteries and need to be studied in detail. Understanding the MCP and its efficiency in Sothern Ocean – polar regions will help understand the efficiency of the microbial carbon pump for the long-term carbon sequestration in this region.

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Abstract No : 671

Diversity of Actinobacteria in the sediment and water column in the Indian sector of Southern Ocean (ISO) as revealed by 16S rRNA-based metagenomic analysis

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The significance of Southern Ocean (SO) as a sink of atmospheric CO₂ and other greenhouse gases are well established. Earlier studies have highlighted the role of microbes in various SO ecosystem processes. However, the diversity and role of actinobacteria in the Indian sector of SO (ISO) water and sediments are not known. This study aimed to analyze the diversity of actinobacteria in the water and sediment samples of SO based on amplicon microbiome analyses. The taxonomic analysis identified a total number of 27 phyla of which Proteobacteria (40.2%), Actinobacteria (13.6%) and Firmicutes (8.7%) were found to be dominant. The comparative study of water and sediment samples revealed dominance of different actinobacteria in water and sediments. While the order Streptomycetales was dominant in the water samples, Micrococcales was found to be dominant in the sediment samples. The generic level analysis found the presence of eight and seventeen genera in the sediment and water samples, respectively. The genus Streptomyces, Saccharopolyspora, Nocardioides, Sva0996 marine group and Mycobacterium were seen both in sediment and water samples. Marmoricola, Ilumatobacter and Glaciihabitans were observed only in sediment samples whereas Rhodococcus, Corynebacterium, Micrococcus, Turicella, Pseudonocardia, Bifidobacterium, Nesterenkonia, Collinsella, Knoellia, Cadidatus, Actinomarina, Libanicoccus and Cutibacterium were noticed exclusively in water samples. This preliminary study highlights that actinobacterial diversity differs in sediment and water of the SO. Our study also emphasizes the need for further detailed study to understand the links between actinobacterial diversity and their ecological functions in the ISO.

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Abstract No : 388

Diversity of siderophore-producing bacteria in the Indian sector of the Southern Ocean

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Siderophore producing bacteria were screened and isolated from three depths (surface, deep chlorophyll maxima (DCM) and 200 m) at 4 locations (Kerguelen waters KW1 & KW2 and Prydz bay waters PB1 and PB2) in the Indian sector of Southern Ocean (ISO) during the 10th Indian Southern Ocean Expedition-2018. The isolates were tested for siderophore production and identified using Sanger sequencing method. Overall, a total of 173 bacterial isolates tested positive for siderophore production from ISO. The isolates produced 10 to 55% siderophores and many of the isolates were common in the diverse sampling locations. These isolates belonged to three phyla namely Actinobacteria, Firmicutes and Proteobacteria. A total of 16 different genera were identified in ISO; wherein distribution of certain genera like Halomonas, Pseudomonas, Pseudoalteromonas, Bacillus and Psychrobacter was more common while genera like Jeotgalicoccus & Rhodococcus were found restricted to certain depths/locations. Neighbour joining cluster indicates significant similarity in bacterial genera between Prydz bay and Kerguelen water samples. Bacterial isolates from KW 1 and PB 1 had 78 % similarity while PB 2 and KW 2 were 52 % similar to each other. Our study highlights the diverse forms of siderophore producing bacteria in marine environment which may play an important role in marine biogeochemistry and may have biotechnological potential.

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Abstract No : 237

Polysaccharide degrading enzyme production and carbohydrate utilization potential of Arctic actinomycetes

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The Arctic region is one of the least explored geographical locations on Earth for the diversity and bioactive potential of actinomycetes. The isolation of actinomycetes from understudied Arctic marine sediment provides an opportunity to analyze their diversity and role in the global biogeochemical cycle. It has been found that the Arctic marine environment hosts a vast variety of actinomycetes with great potential for producing novel bioactive compounds. Actinomycetes from the marine environment have a dominant role in the global carbon cycle. The carbohydrate utilization by the marine microbes and breaking down of complex polysaccharides by producing extracellular hydrolytic enzymes have an important role in the global biogeochemical cycle of carbon. It enables the carbon biological pump and sequestering of anthropogenic carbon dioxide from the atmosphere in the deep ocean. This study focuses on the isolation of actinomycetes from Arctic marine sediments and their screening for the production of complex polysaccharide degrading enzymes including amylase, cellulase and chitinase. The ability of the Arctic isolates to utilize various carbohydrates or sugars was also studied. Out of the 22 actinomycetes isolated from the Arctic sediment 17 isolates produced amylase, 11 isolates produced cellulase and 6 isolates produced chitinase enzyme. All the actinomycetes were able to utilize carbohydrates or sugars as the carbon source. All the actinomycetes isolates were capable of utilizing at least five different carbohydrates indicating their role in the carbon cycling in the Arctic environment. Therefore it is very essential to understand the Arctic actinobacterial diversity and carbon utilization potential.

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Abstract No : 668

Seasonal changes in Diatom communities in nearshore coastal regions along the Western Antarctic Peninsula

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Diatoms have been described as the main primary producers along the Western Antarctic Peninsula (WAP). Different taxa influence the carbon biomass available in the ecosystem. Previous WAP studies indicate the major blooming diatoms are *Thalassiosira*, *Fragilariopsis*, *Odontella* and *Chaetoceros* but relatively little is known about community changes throughout the growth season. Here we examined the diatom community in surface waters during the austral summer (November – March) from 2017 – 2020. Four vessels operating the FjordPhyto program sampled using a 20- μ m net at specific nearshore locations (62°– 68°S). DNA was sequenced using amplicon sequence variants (ASVs) to identify genera and species (18Sv9). Results indicate the main diatoms present were highly variable, although in all years the genus *Porosira* was relatively higher in most samples. In 2017–18 the overall trend showed *Corethron* ASVs were higher, then *Porosira* followed by *Chaetoceros*, *Actinocyclus*, *Thalassiosira*, and *Eucampia*. In 2018–19 the overall seasonal trend showed higher *Porosira* ASV abundance, followed by *Chaetoceros* and *Eucampia*. In 2019–20 *Porosira* was higher followed by *Stellarima*, then *Chaetoceros*. Six distinct locations along the WAP showed site specific and annual variability in diatom community composition. The 2017–18 season had the most diversity of taxa within succession patterns at each location. In contrast, the 2018–19, 2019–20 seasons the main taxa throughout the season at all stations was *Porosira* with less overall diversity in succession at each site. Krill selectively feed on large centric and chain-forming diatoms, shifts in the community composition are expected to affect krill populations.

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Abstract No : 552

Characterising the Southern Ocean's microbial community through novel pigment analysis

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“Pigment-based chemotaxonomy is a widely utilised tool to determine the biomasses of phytoplankton classes from pigment biomarkers. The CHEMTAX approach relies on prior knowledge of pigment-to-chlorophyll a ratios for the phytoplankton classes required. These starting ratios are modified by the CHEMTAX process but nevertheless, results are often sensitive to the initial values used. We present an alternative chemotaxonomic method that utilises simulated annealing with a steepest descent algorithm to derive class abundances and pigment-to-chlorophyll a ratios at higher accuracy than CHEMTAX, without a priori knowledge of pigment ratios. The simulated annealing approach displayed higher accuracy than two common CHEMTAX methods between for true and estimated class abundances, with symmetric mean absolute percentage error (sMAPE) ranging between 4.8 – 11% compared to 18 – 70% with CHEMTAX approaches. We implemented the simulated annealing approach to a large dataset (n = 8000) of circumpolar Southern Ocean pigment concentrations from voyages between 1995 and 2021. Biomass regimes ranged between oligotrophic water-masses of the Subantarctic to the highly productive Ross Sea with Chl a concentrations between 0.008 – 15.4 mg m³. Using multivariate statistical tools and environmental parameters derived from satellite remote sensing, we assess the relationship between the abundance of phytoplankton classes and environmental conditions”

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Abstract No : 575

Vertical segregation of particle-associated and free-living diazotrophs in a high Arctic fjord (Svalbard)

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Warming-induced water column stratification is affecting the primary productivity and nitrogen fixation potential of the Arctic Ocean. The impact of water column stratification on diazotrophs' diversity and community structure in the climatic-sensitive Arctic fjords remains elusive. In this study, we evaluated the differences in the abundance, diversity, composition, and factors affecting free-living (FL; 0.22-3.0µm) and particle-attached (PA; >3.0µm) diazotrophs in the density-driven stratified water of a high Arctic fjord, using targeted analyses of nifH gene. Our results demonstrate that different water mass types, i.e., Atlantic influenced water (AIW) and glacier influenced water (GIW), possess distinct diazotrophic communities in both PA and FL fractions (PerMANOVA; $p < 0.05$). Higher diversity and dominance of heterotrophic diazotrophs, associated with the β - and γ - Proteobacteria, in the GIW implies the impact of glacial inputs in modulating diazotrophic diversity and community composition in the fjord. A high abundance of UCYN-A diazotrophs in the AIW indicates their transportation to the fjord environment via Atlantic water advection. The salinity gradient and dissolved oxygen content control the vertical segregation of diazotrophic communities among water masses. These results suggest that glacier meltwater inputs and Atlantic water advection contribute distinct diazotrophic OTUs that might impact the fjord nitrogen cycle.

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Abstract No : 120

Inter-seasonal dynamics of bacterioplankton communities in Argentine islands region (Western Antarctic Peninsula)

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Maritime Antarctica is one of the most climatically sensitive regions on Earth and is thus an ideal place to study the climate change influence on aquatic ecosystems. Phytoplankton and bacterioplankton, constituting the base of the food web, are known to be one of the key indicators of marine ecosystem state under the ongoing climate change. The aim of the present study was to investigate bacterioplankton inter-annual and inter-seasonal dynamics in Argentine islands region (Western Antarctic Peninsula) and to reveal the factors shaping it. The samples were collected in spring, summer and autumn of 2019 – 2021, and 16S sequencing was used to determine the taxonomic structure of bacterioplankton communities. The presence of significant inter-seasonal ($R = 0.2$, $p = 1e-04$) and inter-annual ($R = 0.17$, $p = 1e-04$) difference was shown with the prevalence of Bacteroidia, Gammaproteobacteria and Verrucomicrobiae during the periods of phytoplankton mass-development in spring and early summer. Similarly, Polaribacter, Sulfitobacter, Yoonia-Loktanella were dominating during the spring-summer periods, whereas Planktomarina, SAR92, Marinoscillum, NS5 and the free-living Clade Ia, were abundant in late summer and autumn. Chla concentration ($r = 0.36$, $p = 8e-04$), total phytoplankton abundance ($r = 0.29$, $p = 0.005$)/biomass ($r = 0.29$, $p = 0.001$) and, particularly Bacillariophyceae ($r = 0.38$, $p = 2e-04$) and Cryptophyceae ($r = 0.28$, $p = 0.02$) abundance were the only significant factors correlated with bacterioplankton taxonomic distribution. Thus, significant seasonal variation driven by the dynamics of phytoplankton communities was revealed for bacterioplankton inhabiting the ocean in Argentine islands region.



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**The Antarctic seafloor:
ecosystem interactions and
environmental drivers of change**

CONVENORS

Alix Post, Narissa Bax, Huw Griffiths

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Abstract No : 361

Sources and depositional changes of aliphatic hydrocarbons recorded in sedimentary cores from Admiralty Bay, South Shetland Archipelago, Antarctica during last decades

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Organic biomarkers, as aliphatic hydrocarbons, are present in sedimentary organic matter and have been largely applied to the evaluation of recent environmental changes in the marine environment around the globe, including the Antarctic continent. Five sediment cores were taken in the Admiralty Bay, South Shetland Archipelago, Antarctica to evaluate changes in the signature of aliphatic hydrocarbons such as n-alkanes (n-C₁₀ to n-C₄₀) and isoprenoids as pristane and phytane, over the last decades. The total n-alkanes concentration ranged from 0.17 to 1.67 µg g⁻¹ (mean = 0.74 ± 0.42) which is considered low and similar to pristine sediments. Aliphatic hydrocarbons present in the sedimentary pool came mostly from terrestrial sources as Antarctic lichens and mosses, and from marine sources as the macroalgae forest debris and emergent macrophytes. Anthropogenic inputs of aliphatic hydrocarbons (e.g., petroleum and their by-products) may be neglected based on the multi-proxy approach used to distinct sources of these organic compounds. In general, no significant changes in the sources of aliphatic hydrocarbons were observed along the sediment cores; however, an increased aliphatic hydrocarbons input registered between 1975 and 1992 may be related to the increase in meltwater runoff and the relatively high abundance of marine producers more adapted to increased sea temperatures. Full text: <https://doi.org/10.1016/j.scitotenv.2021.14888>.

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Abstract No : 295

The role of macro-benthic Antarctic community on carbon sequestration in sediments of new ice-free areas.

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Antarctic benthic systems have recently been considered “blue carbon systems”. Carbon storage in coastal areas is usually referred as the amount of carbon immobilised on marine sediments, and the plant biomass growing there. Antarctic soft-bottoms are the playground of particular assemblages forming complex structures known as “animal forests”. We hypothesize that animal forests may fulfil a similar role to vegetation in the typical blue carbon systems, by stabilizing sediments, favouring its compactness, and retaining carbon in their long-living species. As a consequence of glacier retreat, new ice-free areas are prone to host new animal forests, increasing the carbon immobilisation in these soft-bottoms fjords. Nevertheless, the influence of benthic assemblages on sediment carbon sequestration has never been studied before. This work aimed to investigate the influence of benthic Antarctic assembly structure on sediment carbon sequestration. To prove this concept, biomass and sediment carbon content underneath different epibenthic patches was compared with sediment bare areas at 20 m depth both occurring in the new ice-free area of Potter Cove (Isla 25 de Mayo, Antarctica). On 3 cores per patch and bare sediment area, total organic matter was estimated by ignition while carbon remineralization was inferred from core respiration measurements. Macrofaunal patch structure was photographically assessed and the relationship between size and dry weight was used to infer carbon content. Both areas were similar in sediment carbon content. However, lower remineralization occurred underneath epibenthic patches with higher carbon retention in the biota. As expected, a higher carbon amount was observed related to epibenthic assemblage.

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Abstract No : 122

Are sponges good natural sentinels for marine biodiversity monitoring? Fish diversity in Antarctic shallow waters

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The Southern Ocean encompasses about 10% of the world's oceans, but it has shown a low fish diversity compared to other shelf habitats. Metabarcoding of eDNA is revolutionizing the field of biomonitoring aquatic ecosystems. Recently, sponges have been proposed as ideal candidates to act as natural environmental samplers. We performed a metabarcoding study amplifying a fish-specific 12S marker in eDNA extracted from sponges as natural samplers along with filtered seawater, to characterize nearshore fish communities along the Western Antarctic Peninsula. We investigated whether fish species richness and community composition differed across a latitudinal gradient. Additionally, we tested whether different sampling methods and sponge species influence our results. We were able to identify up to 14 fish and one seal species. Despite the validation of the usefulness of DNA recovered from sponges to reveal fish biodiversity patterns, sponges were not as efficient as seawater samples to recover fish species richness. Differences in efficiency of capturing fish environmental DNA among sponge species were not observed. The fact that eDNA extracted from 2-L seawater samples gives a more efficient detection of fish, despite the high filtering rates typically reported for sponges, seems to be related with something else rather than just the persistence of DNA in seawater. Our results challenge the view that the use of sponges as natural samplers can offer a more efficient way of sampling eDNA than filtered seawater, at least in Antarctic ecosystems, and prompt the need for further validation studies in temperate and tropical environments.

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Abstract No : 392

Infaunal diversity of the George V and Adélie shelf, East Antarctica: a comparison of in-situ and ex-situ variables to model and predict biodiversity patterns

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Soft sediment habitats are the most widespread benthic systems in the world, yet infauna, the organisms that live in the sediment, are severely understudied. This is especially the case for Antarctic systems with unique environmental conditions and assemblages where much remains unknown about the drivers of and patterns in infaunal biodiversity. This study compares the ability of in-situ environmental variables, such as sediment characteristics; and, ex-situ variables, such as food availability, to explain patterns in infaunal diversity, assemblages, and distribution of infauna in the Adélie and George V region. Infaunal biodiversity patterns are explored using traditional diversity indices and assemblages are explored using the Region of Common Profiles (RCP) model, a novel one-stage ecological modelling technique that directly groups stations based on environments with similar species profiles. The region is found to be abundant in polychaete worms, with the diversity strongly explained by in-situ variables. Similar infaunal assemblages were observed when using either: the in-situ variable sediment CaCO₃ content; or, the ex-situ variable horizontal flux of food particles, in the RCP models. Modelling with ex-situ variables allows for mapping the distribution of infaunal assemblages. Baseline information on infaunal biodiversity in this region provides context for comparisons under a changing environment and spatial management, such as the designation of Marine Protected Areas in East Antarctica.

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Abstract No : 634

Seabed habitats and fauna of the Ross Sea: distributions in relation to the boundaries of the Marine Protected Area

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A primary role of the Ross Sea Marine Protected Area (RSMMPA) is to conserve representative ecological structure and function. To ascertain whether the current RSMMPA boundaries are adequate for this, and will continue to be so in the future, the Science and Research and Monitoring Plan for the RSMMPA requires improved baseline knowledge about the range of habitats encompassed, assessment of how representative these are of the wider region, and of how environmental change might affect distributions. Since 2018 we have conducted seafloor photographic surveys in previously un-sampled areas on the northern and eastern continental slopes of the Ross Sea, including within the Special Research Zone (SRZ) of the RSMMPA, topographic features north of the Ross Sea, and at sites along the Victoria Land coast. The central SRZ is an area of high benthic invertebrate bycatch in the longline fishery for Antarctic toothfish (*Dissostichus mawsoni*) and Long Ridge, north of the Ross Sea, is both a focus for this fishery and thought to be a key spawning area for the target species. Analyses of imagery from these surveys, combined with data from earlier surveys and published literature, enable the best-informed description of broad-scale taxon and community distributions across the region to date. We discuss these distributions in relation to both the RSMMPA boundaries that are intended to conserve them, and to the environmental factors that are likely to change them.

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Abstract No : 859

Comparison of sampling methods to assess marine benthic communities: visual vs destructive methods

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During the last decades, great efforts have been made to study the diversity and the degree of heterogeneity of Antarctic benthic communities. Numerous investigations on macrobenthic communities have recently been carried out at different sites in Antarctic Peninsula using both visual and destructive methods covering a wide latitudinal range. In the present study, we compare the performance of two sampling gears by assessing quantitative data obtained by Agassiz trawls (AGT) and seabed images collected by the Ocean Floor Observation System (OFOS) on the continental shelf of three oceanographically very distinct regions: the Weddell Sea, the Bransfield Strait, and the Drake Passage to provide new quantitative data on the combination of different sampling methods on Antarctic megabenthos. A total of 4213 individuals were sampled with AGT and 10550 individuals with OFOS. Combining AGT and OFOS data, we found a total of 19 benthic taxonomic groups. The most dominant groups sampled with AGT were Polychaeta and Ophiuroidea, while Ophiuroidea and Ascidiacea were for OFOS. Ophiuroidea was the most abundant group representing 45% of the individuals in OFOS and 19,1% in AGT. The extremely high abundance of all the taxa observed by OFOS with respect to the abundance estimated with AGT provides important insights into the efficiency of trawl gears in the study of benthic communities. Despite considering the benthic fractions in different resolution but with similar distribution patterns, non-destructive monitoring with visual techniques is extensively recommended for the proper study of Antarctic benthic communities and their consequent management.

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Abstract No : 416

Mapping the distribution of Antarctic seafloor biodiversity: Developing the much-needed baseline for monitoring and conservation, and identifying hotspots of seafloor biodiversity.

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The Antarctic seafloor contains unique and highly diverse species communities. While the conservation value of Antarctic seafloor communities is well recognised, many aspects of the distribution of this biodiversity are unknown, hindering informed management and conservation. In this talk I will present three key developments that mark a step-change for the type of question we can ask and answer about the distribution of Antarctic seafloor biodiversity and its potential change into the future: First, collaborating with scientists from all over the world we've collated over 70,000 seafloor images from 19 major Antarctic expeditions dating back to the 1980s into a single database of circumpolar extent. We've annotated a representative subset of these images (~3,500 images) to morphospecies level in a way that the annotations are reproducible, editable by experts and suitable for training deep-learning models. Second, we've created the first circumpolar maps of estimated food-availability at the seafloor, a critical environmental factor influencing all seafloor animals. Finally, we've analysed these data and I will present at SCAR for the first time insights into the distribution of seafloor biodiversity on the entire Antarctic continental shelf.

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Abstract No : 1000

Carbohydrate signature in polar sediments indicates the algal contribution

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Carbohydrate forms a significant part of the blue carbon produced by the autotrophic communities in the coastal and marine ecosystems. To evaluate the source, reactivity, and diagenetic status of the blue carbon it is essential to characterize the carbohydrates. However, blue carbon carbohydrates are often formed as complex polysaccharides. In this work, we investigated the monosaccharide composition of the sediments collected from the various ecosystems of the polar regions dominated by different phototrophs including lacustrine, riverine, coastal, and fjord sediment samples from Antarctica and the Arctic. In the high Arctic fjords, a major contribution to the blue carbon comes from the phytoplankton that photosynthesizes in the upper water column and from macroalgal detritus. In Antarctic lakes, however, large microalgal mats on the bedrocks form a major source of blue carbon. Here, we analyzed total carbohydrates in the sediment samples using the phenol sulfuric acid method and monosaccharide composition using High-Performance Anion Exchange Chromatography (HPAEC). During the analysis of the Arctic fjord samples we are seeing significant amount of alginate monosaccharides- guluronic and mannuronic acid along with other acidic sugar components. We hypothesize that macroalgal-derived polysaccharides, especially anionic alginate, will dominate the blue carbon in the sediments of the Arctic fjords.

Photosynthetic performance in four brown algae (Desmarestiales, Phaeophyceae) *Desmarestia menziesii*, *D. anceps*, *D. antarctica* and *Himantothallus grandifolius* along a latitudinal gradient on the Antarctic Peninsula.

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Environmental variables are determinants of the spatial distribution, phenology and productivity of Antarctic seaweeds. Throughout the Antarctic Peninsula, there is a latitudinal gradient in the light intensity, temperature, salinity and turbidity. These variables force macroalgae to respond ecophysiologically in order to be able to development and survive. The aim was to analyze the effect of these environmental variables in the performance on the photosynthetic performance of four species of the order Desmarestiales (*Desmarestia menziesii*, *D. anceps*, *D. antarctica* and *Himantothallus grandifolius*), collected during summer 2022, along of 10 sites in a north-south latitudinal gradient from 62° to 67°S. Significant differences were found in environmental variables (temperature, salinity and pH), photosynthetic parameters (photosynthetic capacity; $rETR_{max}$, saturation irradiance; E_k , photosynthetic efficiency; α), and pigment composition (Chla, Chlc and Fucox) of the species collected at the different sites. The analyses show a variation in photosynthetic capacity of macroalgae along the latitudinal gradient, probably associated with local environmental variables such as temperature, salinity and turbidity. In addition, each species had different responses to local environmental variables. Knowing how environmental variables influence the ecophysiology of macroalgae is of great importance, because it allows us to understand the impact of climate change (seawater temperature increase, glacial melting, among others) in present and future scenarios of Antarctic ecosystems, where algae are key to benthic communities. This study was financially supported by the project INACH RT 27-17

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Abstract No : 496

Spatial and temporal variations on sedimentary biogenic sterols of Martel Inlet, Admiralty Bay, Antarctica, between 2002–2019

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In recent decades the Antarctic Peninsula has experienced a dramatic increase in air and seawater temperatures, being higher than the mean global temperatures. One of the consequences of these temperatures increase is associated with the decrease in the glaciers area, generating an increase in the input of continental material to the glaciomarine environment, and causing changes in the carbon dynamics cycle. Biomarkers such as sterols were analyzed in surficial sediments of four sites, in Admiralty Bay, Antarctica, in order to evaluate the spatio-temporal distribution of these indicators of sources and degradation processes of sedimentary organic matter. Cholesterol was the predominant sterol (mean = $2.43 \pm 0.87 \mu\text{g g}^{-1}$), and the contributions from penguins and seal faeces as well as contributions from phyto- and zooplankton explain this abundance. Sitosterol presented a mean concentration of $1.45 \pm 0.45 \mu\text{g g}^{-1}$, and may be related to macroalgae and prymnesiophyte algae contributions. Brassicasterol and stigmasterol were detected in practically all samples along the period evaluated, with mean concentrations of 0.95 ± 0.18 and $0.62 \pm 0.15 \mu\text{g g}^{-1}$, respectively, evidencing the contribution from diatoms, cyanobacteria, and dinoflagellates to marine sediments. In addition, during the period 2011–2013, all compounds showed higher concentrations, while between 2014–2017, the concentrations were lower. Based on these results, it is necessary to estimate whether the variability in the concentrations of biogenic sterols may be related to environmental changes, such as the variation in sea surface temperature in the locality.

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Abstract No : 928

Macroalgal Cover is Negatively Correlated with Annual Sea Ice and Positively Correlated with Overall Species Richness and Species Diversity Along the Central Western Antarctic Peninsula

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Macroalgal forests dominate hard benthos in shallow waters along the northern portion of the western Antarctic Peninsula (WAP). Macroalgal biomass and species richness dramatically decline to the south of Anvers Island but to date there have been few qualitative and no quantitative reports of macroalgal distribution in the central WAP between Anvers and Adelaide Islands. We used satellite imagery of annual sea ice duration and extent as well as water turbidity during ice-free periods to identify 14 study sites that differed in ice coverage but were similar in terms of turbidity along the central WAP between central Marguerite Bay (S 68° 41.5') and the southwestern Anvers Island area (S 64° 46.4'). Divers video recorded benthic organisms continuously on replicate vertical transects between (20 to) 40 m and 5 m. Fleshy macroalgal cover was compared to sea ice measurements from several different satellite image databases, and for all there was a strong negative correlation between macroalgal cover and annual or summer sea ice coverage. Fleshy macroalgae covered approximately 80% of the bottom at the lowest ice sites and zero or near-zero at the highest ice cover sites. At most sites, macroalgal cover was similar throughout the depth range sampled, particularly in the lower sea ice cover sites. Macroalgae were observed throughout the sampled depth ranges at all but the highest sea ice coverage sites. Macroalgal cover was positively correlated to both overall community species richness and community species diversity, although negatively correlated to those parameters for macroinvertebrates alone.

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Abstract No : 525

Non-fungal eukaryotic DNA present in South Shetland Island continental margin and Drake passage sediments assessed using metabarcoding

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Antarctic deep-sea biodiversity is poorly known, especially that of microorganisms other than Bacteria and Fungi. In this study, we provide the first report of the use of DNA metabarcoding to assess the diversity of non-fungal eukaryotic DNA present in four continental shelf sediment samples obtained from the Southern Ocean in the region of the South Shetland Islands at depths between 150 m and 1,453 m. DNA sequences representing a total of 79 taxa were assigned, representing the phyla Arthropoda, Cnidaria, Ctenophora, Cercozoa, Ciliophora, Ochrophyta, Haptophyta, Amebozoa, Chlorophyta and Traqueophyta. The phylum Chlorophyta (Plantae) had the greatest richness, with 29 assigned taxa, followed by Ciliophora with 26 taxa. The diatom *Chaetoceros socialis* (Ochrophyta) displayed the highest amplicon abundance. DNA sequences of the terrestrial vascular plant (Traqueophyta) genera *Allium*, *Quercus*, *Capsicum* and *Macroptilium* were detected, most likely deposited long ago in the sediments. The depth from which the samples were obtained appeared to have a relatively strong influence on the sequence diversity detected, with lower richness at 1,453 m. The application of DNA metabarcoding to Antarctic continental shelf sediments, using ITS2 as a marker, proved capable of detecting sequences representing a wide diversity of organisms from different groups at good taxonomic resolution.

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Abstract No : 675

Shifts in benthic megafauna communities after glacial retreat in an Antarctic fjord

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Glacial retreat strongly affects benthic ecosystems by oceanographic settings; however, the ecological impacts on benthic megafauna, one of the major components in polar benthic ecosystems, remain unanswered. We employed imagery survey to address benthic community changes of “megabenthos” in Marian Cove, a deglaciated fjord, Antarctica. The structural and functional diversities of benthic megafauna communities significantly varied with distance from glaciers and depths. The number of taxa increased with distance, but density peaked near the glacier (116 ind. m⁻²) by a rapid increase of pioneer species. Pioneer species drastically decreased (9 ind. m⁻²) and late-successional species increased (21 ind. m⁻²) at the outermost site. Dramatic increase in taxonomic diversity near the glacier (~10 years after seabed exposure) indicated that benthic communities matured rapidly in terms of structure at higher taxonomic levels. Meantime, the increase in functional diversity with distance from the glacier and diversity peak observed at 30 m depth of the outermost site could reflect different mechanisms of community change across functional and structural diversities. Looking for vertical changes, community indices at 10 m seemed to be lesser varied due to continued exposure to frequent ice-scouring. Whilst benthic community shifts at deep seabed (>50 m) were clearly observed in both functional and structural diversities. This study showed a three-step successional process of benthic megafaunal communities in the deglaciated Antarctic nearshore: colonization, transition, and maturing stages. Overall, this study provides quantitative data for the megabenthic community structure in Marian Cove, warranting further in-depth monitoring of Antarctic benthos under accelerating global warming.

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Abstract No : 533

A multi-criteria index for identifying Vulnerable Marine Ecosystems in the Southern Ocean

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In 2009, CCAMLR committed to avoiding adverse impacts to seafloor communities in the Southern Ocean, including those known as Vulnerable Marine Ecosystems (VMEs), which are characterised by fragile, slow growing, long-lived, and habitat-forming ‘VME Indicator’ taxa. CCAMLR mainly relies on fisheries bycatch data for VME identification, applying threshold-based conservation rules in which all indicator taxa are considered equal. However, these taxa have different vulnerabilities to fishing disturbance and little consideration has been given to how these taxa may combine to form components of ecosystems with high conservation value. The increasing availability of quantitative data derived from imagery provides an opportunity to consider multiple indicator taxa and numerous facets of vulnerability simultaneously. We propose a multi-criteria approach to assign a vulnerability index to spatial grid cells. Each morpho-taxon is weighted differently based on its vulnerability to fishing as per seven CCAMLR criteria. We use the “Antarctic Seafloor Annotated Imagery Database”, where 68 VME indicator morpho-taxa have been manually annotated generating >40,000 annotations from >1,800 images. Two indexes were computed, accounting for the total VME indicator taxa abundance and richness, respectively. This analysis provides a quantification of the community’s vulnerability to fishing, and allows communities to be characterised as, e.g. highly diverse or highly productive. The code and the georeferenced maps will be made publicly available, allowing other researchers to perform similar analyses with their own datasets and/or vulnerability criteria. The implementation of this robust and repeatable quantitative method could enhance VME identification and assist risk assessment.

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Abstract No : 803

Does ice cover impact macroalgal chemical composition in the Western Antarctic Peninsula?

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Sea ice in the Southern Ocean can profoundly influence photosynthetic organisms by altering subsurface irradiance. The patterns and timing of sea ice cover can vary on a monthly to annual timescale in small sub-regions of the Western Antarctic Peninsula (WAP). Sea ice is susceptible to changes in the climate. During the latter part of the 20th century, sea ice coverage significantly decreased in the WAP, a trend that aligns with warming in this area. Macroalgal biochemical components are impacted by light availability, often showing a close relationship between photosynthesis and biochemical compositions. We used satellite imagery of annual sea ice duration and extent as well as water turbidity during ice-free periods to identify 14 study sites that differed dramatically in ice coverage but were similar in terms of turbidity along the central WAP between the Terra Firma Islands in Marguerite Bay (S 68° 41.5') and the Joubin Islands west of southern Anvers Island (S 64° 46.4'). Common macroalgal species were collected by scuba divers between 35 m and 5 m depth at each site they occurred and were frozen for later biochemical analyses. Overall percentages of major biochemical components were determined. Both species of brown algae examined, *Desmarestia menziesii* and *Himantothallus grandifolius*, were found to have no significant trend between ice cover categories in lipid, carbohydrate, or protein content.

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Abstract No : 70

Temperature as a key driver shaping global patterns in mineralogical composition in bryozoans

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The Southern Ocean is showing one of the most rapid responses to human-induced global change, thus acting as a sentinel of the effects on marine species and ecosystems. Ocean warming and acidification are already impacting benthic species with carbonate skeletons, but the magnitude of these changes to species and ecosystems remains largely unknown. Here we provide the largest carbonate mineralogical dataset to date for Southern Ocean bryozoans, which are diverse, abundant and important as carbonate producers, thus making them excellent for monitoring the effects of ocean warming and acidification. To improve our understanding of how bryozoans might respond to ocean warming and acidification, we assess latitudinal and seafloor temperature patterns of skeletal mineralogy using bryozoan species occurrences together with temperature data for the first time. Our findings, combining new mineralogical data with published data from warmer regions, show that the proportions of high-Mg calcite and bimineralic species increase significantly towards lower latitudes and with decreasing seawater temperature. These patterns are consistent with the hypothesis that seawater temperature is the main driver of variations in bryozoan mineralogy at a global scale.

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Abstract No : 22

Benthic Biodiversity, Carbon Storage and the Potential for Increasing Negative Feedbacks on Climate Change in Shallow Waters of the Antarctic Peninsula

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Seafloor biodiversity provides a key ecosystem service, as an efficient route for carbon to be removed from the atmosphere to become buried (long-term) in marine sediment. Protecting near intact ecosystems, particularly those that are hotspots of biodiversity, with high numbers of unique species (endemics), is increasingly being recognised as the best route to protect existing blue carbon. This study measured globally significant stocks of blue carbon held within both rocky (17.5 tonnes carbon km⁻²) and soft (4.1 t C km⁻²) substrata shallow (20 m) seafloor communities along the Antarctic Peninsula. Along the 7998 km of seasonally ice-free shoreline, 59% of known dive sites were classified as rocky and 12% as soft substratum. This gave estimates of 253k t in animals and plants found at 20 m depth, with a potential sequestration of 4.5k t C year⁻¹. More carbon was stored in assemblages with greater functional groups. Of the Antarctic Peninsula shore, 54% is still permanently ice covered, and so blue carbon ecosystem services are expected to more than double with continued climate warming. As one of the few increasing negative feedbacks against climate change, protecting seafloor communities around the Antarctic is expected to help tackle both the biodiversity and climate crises.

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Abstract No : 292

Into the unknown: integrative assessment of the benthos of Astrid Ridge and Maud Rise, Southern Ocean

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The deep benthic fauna at Kong Haakon VII Sea –east to Kape Norvegia and north of Dronning Maud Land– is still greatly underexplored when compared to adjacent parts of the Southern Ocean. The Norwegian 2019 expedition with R/V Kronprins Haakon performed a benthic survey as part of the efforts to build a better knowledge of the area. The benthic diversity of the Astrid Ridge (67–69° S, 12° E, 2000–1200 m) and Maud Rise (65° S, 2° E, 1750–1200 m) was assessed using beam trawl, epibenthic sled, and ROV with HD-video and sample manipulators (ROV Ægir6000). The present study constitutes the first diversity assessment for the benthic assemblages at Astrid Ridge and the second ever for the Maud Rise. Over 900 curated samples were collected and processed, and 36 hours of video have been analysed both to evaluate the extent of Vulnerable Marine Ecosystem (VME) indicating taxa, and to describe the faunistic assemblages. The material processed during this cruise has generated an extensive voucher-linked reference library DNA-barcodes (COI, 16S, MtMutS) associated to physical samples that are further linked to the video footage. Results from the video analysis indicate high diversity, presence of rare taxa, undescribed species, and high abundance of few megafauna taxa. The areas surveyed show clear differences in faunal composition. These results are used to support the Norwegian contribution to the ongoing MPA process for the Weddell Sea in discussion at the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR, Domain 4).

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Abstract No : 925

In situ submersible observations of western Antarctic Peninsula deep sea macroalgal drift

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The shallow subtidal zone along much of the western Antarctic Peninsula supports highly diverse macroalgal communities and is considered to represent the highest floristic biomass of the continent. Several species of large, perennial brown macroalgae can dominate not only in biomass, but also in percent cover of the bottom; often several fleshy red algal species may co-dominate. As primary producers, macroalgae are carbon sinks and eventually with detachment from substrate, senescence or death contribute to the shallow subtidal nutrient cycle typically in the form of drift. There is little known however, about the export of this vast carbon reservoir to deeper depths. In January and February 2017 a submersible-based cruise was conducted along the western Antarctic Peninsula. The focus of the cruise, organized by Japanese NHK TV, was to obtain high-definition video footage of scientists exploring the deep waters of Antarctica for a documentary (Deep Antarctica). The three-person 1000m-capable submersible carried a scientist (MOA, CDB, or KSRB), the pilot, and a cameraman. Logging a cumulative 100 hours of dive time, the 18 survey sites included an offshore continental break site (west of Smith Island), the Antarctic Sound, Fumarole Cove (Deception Island), Boyd Strait, Wilhelmina Bay, Buls Bay (Brabant Island), Fournier Bay (Anvers Island), and Palmer Deep. Macroalgal drift was observed at most sites and in many instances identifiable to species. The sightings ranged between 150 and 1000m. Images of the observed drift algae will be presented and the impact of this carbon source

Accepted as: Oral Presentation

Abstract No : 246

Chasing glacial retreat: macroalgal expansion and blue carbon gains in coastal ice-free areas

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David K. A. Barnes, British Antarctic Survey

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María Liliana Quartino, Instituto Antártico Argentino//9 Museo Argentino de Ciencias Naturales

The West Antarctic Peninsula (WAP) is a hotspot of physical climate change, including glacial retreat. Along coastlines, this process opens up newly ice-free areas, which can be colonized by benthic organisms. We investigated this process at the Antarctic coastal ecosystem Potter Cove which showed a gradient of sediment run-off and light penetration driven by levels of glacial influence. We studied two newly ice-free areas (a low -LGI- and a high -HGI- glacier influence area). Photosynthetic active radiation (PAR, 400-700 nm) was monitored at both sites in spring and summer. The light attenuation (K_d) was significantly lower at LGI than HGI. We installed artificial substrates (tiles) at 5 m depth to analyze benthic algal colonization and succession for four years. All tiles were colonized by benthic algae, differing in species identity, richness and successional patterns between areas. We scaled up our quadrat surveys on the natural substrate to estimate benthic algal colonization in newly deglaciated areas of the whole Potter Cove. Recent decades have exposed much new habitat, with macroalgae making up an important part of communities 'chasing' such glacier retreat. Our estimation of algal colonization in newly ice-free areas shows an expansion of ~0.005-0.012 km² and a carbon standing stock of mature algal communities of ~0.2-0.4 C tons per year. Life moving into a new space in such WAP fjords has the potential to be key for new carbon sinks and export.

Accepted as: E-poster Presentation

Abstract No : 405

BIROSS – Bioconstructional organisms from the Ross Sea under climate change

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Plants and animals creating the physical structure (i.e. bioconstruction) are key elements to maintaining biodiversity and influencing ecosystem processes. Structurally complex, these ecosystems are characterised by high density and great macroinvertebrate species richness. However, they are vulnerable to climate drivers, which can alter the physiology and structure of the builders and their community composition, production, diversity, trophic structure, and nutrient cycling. Thus, bioconstructions are considered 'Vulnerable Marine Ecosystems', representing an ideal model system to monitor the effects of climate change. In particular, bioconstructors from the Antarctic are exposed to rapid warming and acidifying conditions. The international project BIROSS will explore these unique benthic ecosystems of the Ross Sea focusing on deep (200 – 600 m) habitats of coralline algae, bryozoans, cold-water corals and calcifying sponges and their associated communities to generate vulnerability maps related to global threats (ocean acidification and global warming). To understand the distribution and extent of the Ross Sea bioconstructions, the team of BIROSS will study pre-existing Antarctic material and take part in a new seabed exploration and collection aboard the New Zealand R/V Tangaroa in 2023. The multidisciplinary approach will address questions on the structure and functioning of builder species and associated communities using a range of cutting-edge instrumentation for offshore survey and sampling, and state-of-the-art analytical facilities and methods. Project results will contribute to outcomes of the Southern Oceanic Strategic Directions, specifically to understanding biodiversity and marine ecosystems (G2) and improving understanding of the oceanography, bathymetry and hydrography (G3).



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

LIFE SCIENCES

**Antarctic expeditioners and
spaceflight: lessons learned in
health and medicine off the grid**

CONVENORS

Marc Shepanek, Nathalie Pattyn

Accepted as: Oral Presentation

Abstract No : 240

Antarctic Intelligence- Infection Risk Detection (AI-IRD) utilising unobtrusive multi-parametric medical grade wearable sensors.

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Nicola Stephens, University of Tasmania

John Cherry, Australian Antarctic Division

Clive Strauss, Australian Antarctic Division

Roland Watzl, Australian Antarctic Division

David Tian, Australian Antarctic Division

Catherine Oermann, Australian Antarctic Division

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Pandemics and other infectious outbreaks pose significant challenges to National Antarctic Programs given the challenging logistics, isolated, confined and extreme environments at high risk for transmission of infections. Advances in health sensing and AI could augment traditional health screening, surveillance and infection control measures for those supporting Antarctic and space missions alike. The current COVID-19 pandemic requires all reasonable and practicable measures to ensure safety and well-being of Antarctic expeditioners and thus the success of their programs. Operationally COVID-19 prevention measures are costly and impact individuals and program delivery. We investigated the use of novel health sensing devices to provide early detection, risk prediction and alerts of possible infection in Antarctic expeditioners. During the period November 2021- April 2022 160+ Australian Antarctic Program participants enrolled utilising wearable BioSticker™ sensors during the predeparture quarantine period(14 days) and on deployment(14 days) in the AAP. The usability, acceptability and performance of the BioSticker™ multi-parameter vital signs sensor worn by Antarctic expeditioners was investigated with correlation of biometric indicators to individual-level experience through participant symptom-tracking and usability survey questionnaire. Further research may gain some insight into the sensitivity and effectiveness of the BioCloud™ based algorithms in detecting early onset of COVID-19-like(COVID-19 or Non-COVID-19) related signals in participants. Human spaceflight has parallel needs in establishing multi-parametric physiologic sensing and closed-loop feedback, to provide early detection and precision interventions. Early infection risk detection and health surveillance utilising medical grade wearable sensors could inform and support safety and health in extreme environments of Antarctica and Space.

Accepted as: E-poster Presentation

Abstract No : 808

Medical planning for remote Antarctic traverse research: Lessons from the Korean-route expedition

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Jong Won Hong*, Yonsei University; Korean Society of Polar Medicine

We review the medical support system provided for the Korean Antarctic traverse research expedition. An analysis framework was constructed based on the literature and compared to various Antarctic activities. In particular, by improving the medical infrastructure that had been provided for the 2018–2022 season, we intend to prepare the advance medical planning for the Antarctic Korean-route expedition next season.

Accepted as: Oral Presentation

Abstract No : 95

Reducing the psychological impacts on outer space activities through the analog mission conducted on Antarctic environment.

Victoria Fernanda Valdivia Cerda, CESIM

Crystian Sanchez, Escuela de Astronautas

The development of space mission, particularly those destined to the colonization of celestial bodies, implies several conditions linked with the human capability to live and to conduct daily task on hostile environment, stressing the capabilities of resilience and adequacy to new environments. These difficulties imply the need for count with training conditions that- jointly with the test of support to live technologies- will allow the training on psychological factors, improving the capabilities of future crews to success the adaptation period on outer space celestial bodies. This is a huge challenge for the development of science and particularly medical and social sciences, because the most suitable environment to simulate the celestial bodies conditions are in Antarctic. In this presentation aims to examine from a descriptive perspective, the articulation of ATS and the conduct of scientific studies oriented to reduce the physiological impacts of future human activity on outer space due to the exploitation of Antarctic continent as a natural laboratory, offering news perspectives to scientific community about the benefits of Antarctic research for humankind future.

Accepted as: Oral Presentation

Abstract No : 53

ICE Teams: Teamwork in Isolated, Confined, and Extreme Environments

Lauren Landon, KBR at NASA JSC

OVERVIEW NASA's astronaut selection process creates an astronaut corps of highly qualified, team-oriented, resilient individuals [1]. Astronauts are further developed and supported through extensive training, including team skills training, and countermeasures available to the crews throughout the mission. However, in extreme environments such as space and Antarctica, team factors such as team cohesion, teamwork, and shared team cognition are likely to change dynamically in response to daily interactions and events experienced by the individual team members and the team as a whole. Team skills and technical skills also change over time, particularly if they are not trained well pre-mission and not refreshed in-mission. Long durations of months to years further exacerbate problems as stressors and small frictions build up over time and skills decay. Understanding what happens to teams in these isolated, confined, extreme (ICE) environments will enable robust prediction of team functioning and performance decrements as well as the timely deployment of evidence-based countermeasures. Spaceflight can leverage the experiences of teams in ground-based ICE environments to efficiently and effectively prepare astronaut crews for future long-duration exploration missions to the moon and Mars. REFERENCES [1] Landon, L.B., Slack, K.J., & Barrett, J.D. (2018). Teamwork and collaboration in long-duration space missions: Going to extremes. *American Psychologist*, 73(4), 563–575.

Accepted as: Oral Presentation

Abstract No : 813

Application of extended reality (XR) technology in polar medicine

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In the polar region, restrictions on flights and a lack of medical professionals are major challenges that make it difficult for emergency response. Historically, increasing infrastructure and populations in the Antarctic have continuously generated a certain number of patients in this isolated area. In this context, telemedicine using extended reality (XR) technology has emerged as an alternative. Using this technology, we aim to enable Antarctic and domestic doctors to share medical data in real-time, receive on-site advice, and even perform surgery together. The bandwidth limitations and communication delay need to be solved in the long term. The application of XR technology has the potential to be expanded to other fields such as polar logistics and space medicine.

Accepted as: Oral Presentation

Abstract No : 424

Behavioral Medicine Risks and Mitigations in Isolated, Confined, and Extreme Environments

Sara Whiting, NASA – Johnson Space Center

Alexandra Whitmire, NASA – Johnson Space Center

Human spaceflight beyond low Earth orbit will present unique environmental challenges to astronauts' operational performance and well-being. Crews will need to work and live in confined and hazardous environments for prolonged missions that involve variable workloads and limitations to privacy, food options, exercise capabilities, leisure outlets, and communication with ground support personnel and loved ones. Currently, behavioral and cognitive risks of spaceflight are mitigated by selecting exceptionally resilient crews and providing extensive individual and team skills training pre-mission, as well as in-mission crew support via a suite of countermeasures targeting sleep and performance optimization, stress management, family support, and team cohesion. However, current countermeasures are difficult or impossible to implement in long-distance exploration as they require real-time communication with Earth and routine resupply. New countermeasure approaches are needed to adapt and enhance the current complement for the new challenges ahead. NASA therefore conducts research at ground-based spaceflight analogs to aid in characterizing the behavioral and cognitive risks of living and working in isolated, confined, and extreme (ICE) operational environments. Antarctic research stations are among the few long-duration ICE analogs in existence and are therefore uniquely positioned to support behavioral medicine research to enable human exploration beyond Earth. In this review, we will discuss previous and ongoing efforts to better understand spaceflight behavioral medicine risks, as well as validate new countermeasure approaches for future missions to the moon and Mars.

Accepted as: Oral Presentation

Abstract No : 572

Wind Chill Index Variability at King George Island (South Shetland Islands) in 2015–2019

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South Shetland Islands are the part of Antarctica in which human is the most active. There are 9 year-round stations and 10 seasonal ones and this area is very often visited by cruise ships. For this reason, despite the fact that is the warmest part of Antarctica it is interesting to define how much the meteorological conditions may be dangerous to humans. The aim of this research is to investigate biometeorological conditions using Wind Chill Index (WCI), that present combined impact of air temperature and wind speed on the human body. The calculation was based on meteorological data (air temperature and wind speed) collected at Arctowski Polish Antarctic Station (King George Island) during 2015–2019. In the analysed 5 years period WCI hourly values were included in heat feeling categories form “comfortable” through “cool” and “cold” to “frosty”, that is form 581.5 to 2326.0 W/m². However conditions felt as “cold” dominated (930.0–1628.2 W/m²), its frequency was form 56.2% in January to 85,1% in September. From November to March there were no hourly values, during which a risk of frostbite of unprotected skin may occurred – the feeling of „frosty” (WCI 1628.3–2326.0 W/m²) was noticed only during cold part of the year (April to October). It is important that even during winter months single hours, with feeling of thermal comfort occurred. In general, biometeorological conditions at King George Island are no dangerous for humans, that wear proper clothes. The biggest threat may be quite high variability of WCI during the day.

Accepted as: Oral Presentation

Abstract No : 979

Enhancing Exploration Platforms and Analog Definition (EXPAND) Program: A cross-cutting and longitudinal platform for research in spaceflight and Antarctic stations

Emmanuel Urquieta, Translational Research Institute for Space Health

Jimmy Wu, Translational Research Institute for Space Health

The Translational Research Institute for Space Health is a partner to NASA's Human Research Program and has established the Enhancing eXploration Platforms and Analog Definition (EXPAND) Program. Similar challenges exist between implementing science in spaceflight and isolated and confined environments such as Antarctica. As we move farther into space into destinations such as the Moon and Mars, new technologies and concepts of operations to provide medical care are being developed. Some Antarctic stations provide medical care through a single physician model which makes them an analog for spaceflight missions. Furthermore, some stations isolated for up to 9 months encounter the same logistical and implementation challenges that will be found in future space missions. The EXPAND program serves as a bridge to deploy meaningful and operational research both in spaceflight and Antarctic stations. This presentation will provide an overview of the program as well as one cross-cutting example of ultrasound imaging deployed both in spaceflight and Antarctica. This work is supported by the Translational Research Institute for Space Health through NASA Cooperative Agreement NNX16AO69A.

Accepted as: Oral Presentation

Abstract No : 689

Australia's Antarctic Program(AAP) COVID-19 Pandemic Response 2020-2022 – healthcare delivery in remote and extreme environments

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Roland Watzl, Australian Antarctic Division

John Cherry, Australian Antarctic Division

Meg McKeown, Australian Antarctic Division

Catherine Oermann, Australian Antarctic Division

The COVID-19 global pandemic declared during the 2019-2020 Austral summer Antarctic season posed unprecedented challenges for National Antarctic Programs to ensure safety of participants, and the success of scientific research and operational program delivery. Antarctic expeditioners and their living environment on ships, in the field and on stations are high risk given infection transmission and outbreak risk. This unique isolated confined and extreme environment(ICE) is further challenged with an austere and limited medical response without access to full suite of high level medical and intensive care. Significant, early and robust controls were required to adequately respond to the infection and health risks of the Pandemic in a multi-layered and innovative comprehensive response across the Australian Antarctic Program(AAP). These measures are costly, challenging to implement with a dynamic and limited evidence base, and have potential to impact individuals health and well-being and operational program delivery. The Australian Antarctic Program Pandemic medical response led by the Polar Medicine Unit with support from the Centre for Antarctic, Remote and Maritime Medicine(CARMM) partners will be described. Infectious Disease risk of Pandemic proportion has been a key identified risk, but not previously experienced post the Heroic Era of Antarctic exploration. Lessons from Antarctic COVID-19 Pandemic responses can inform those planning health care and support for future expeditions, and other remote and extreme environments including those planning and supporting space flight.

Accepted as: Oral Presentation

Abstract No : 213

Facilitating human functioning and team effectiveness in ICE-environments: an experience on the intersection of “Space” and “Time”.

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Thomas Van Caelenberg, European Space Agency

Loredana Bessone, European Space Agency

Nathan Smith, Coventry University

Nathalie Pattyn, Royal Military Academy Brussels (VIPER)

We performed an in-depth thematic analysis of 25 semi-structured interviews—organized by the European Space Agency (ESA) Human Behavior and Performance team—to better understand the human functioning and team effectiveness in different (e.g., Antarctica, HI-SEAS, MARS 500) Isolated, Confined and Extreme (ICE) environments. The interviews were transcribed, coded, and analyzed, using an inductive thematic analysis with a non-linear bottom-up approach. Several Human Factors and group dynamic models were combined to structure the data. Results showed that ICE sojourners’ experiences and (in)conveniences can be considered on the intersection of “Space” and “Time”. Firstly, it is important to consider the different layers of the organizational system, their respective responsibilities and how a failure in one part of the system may underlie the risk of failure in another part (“Space”). Secondly, how sojourners spend time and how a mission’s stage in terms of group dynamics (i.e., from initial team forming, over conflict management towards the ending of the team) influences their daily life is vital (“Time”). Finally, each layer of the system and each mission’s stage relate to the specific physical and psychological environmental ICE-features (“Space and Time”). Every ICE-environment imposes constraints in terms of habitat, landscape, and interpersonal contact, causing changes in e.g., circadian rhythm, exposure to altitude and daylight, communication with the outside world, and somatosensory stimulation. The integrated experiences of all these “Space and Time” related aspects construct the residents’ insider (to ICE-environment) and outsider (to the outside world) perspectives on their sojourn and should be considered for future mission preparation.

Accepted as: Oral Presentation

Abstract No : 48

Fluctuations on the oral microbiome and inflammatory markers during a prolonged summer camp in Antarctica

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Rosa Arantes, Department of Pathology, Institute of Biological Sciences, Universidade Federal de Minas Gerais, Bel

Antarctic camps pose psychophysiological ICE (isolated, confined, and extreme) challenges, including physical effort. Also, camp deployment implies purchasing in advance and transporting all the provisions, resulting in meals composed of sealed food. These ICE conditions and resources can influence the microbiome and inflammatory responses. We evaluated the effects of a 7-week Antarctic summer camp (December-January) on oral microbiome and inflammatory markers (IL1- β , IL-6, IL-8, TNF- α , hs-CRP, VEGF, leptin) during displacement on a ship (pre-Camp), and in the initial (initial-Camp) and final moment (final-Camp) of 50-days in a camp (Nelson Island, S53.178533°/O70.899750°). Microbiome analysis showed a predominance of Pseudomonadota (34,01%), Bacillota (29,82%), and Bacteroidota (18.54%), followed by Actinomycetota (5,85%), and Fusobacteria (5,74%). Staying in the field led to a large reduction of Pseudomonadota ($F=4.280$; $P=0.042$; $ES=1.3$), with no differences for the other phyla. Related to pre-Camp, there was a moderate effect and tendency for an increase in IL-8 ($F=2.86$; $P=0.097$; $ES=0.9$), a reduction with a large effect for VEGF ($F=9.264$; $P=0.005$; $ES=1.4$). For leptin, there was a moderate increase effect over time ($F=1.425$; $P=0.24$; $ES=0.7$). Staying in a long-term Antarctic camp resulted in microbiome fluctuations with a reduction in Pseudomonadota - a "microbial signature" of disease, that is increased metabolic disorders. However, the pro-inflammatory marker IL-8 tended to increase, and the angiogenic factor VEGF reduced during camp. These results suggest that distinct Antarctic natural environments and behavioral factors modulate oral microbiome and inflammation. Approved by the Research Ethics Committee of the Universidade Federal de Minas Gerais (19092819.8.0000.5149/ 3.744.162)

Accepted as: Oral Presentation

Abstract No : 195

How to use the Google Earth Engine to retrieve environmental information only over the vegetated areas in Antarctica

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Jefferson Cardia Simoes, Centro Polar e Climatico – Federal University of Rio Grande do Sul – Brazil

With the Google Earth Engine (GEE) we can access some climate and atmosphere data collection, which covers the partial or entire Antarctica continent, most with a very low spatial resolution, like "MODIS" air temperature data or "GPM" precipitation data. Also, some data are not validated over the Antarctica, as informed in the data collections description, like in the "TERRACLIMATE" data collection. To use and analyze these climate and atmosphere data, we must consider each data source's scale and limitations. Despite the limitations, these data remain as the few environmental data sources available over the Antarctic areas. The vegetated areas are easily mapped with the satellite images using the NDVI slicing technique. It can be made using the Sentinel-2 images inside the GEE, that are available over Antarctic areas, generating a mask to collect environmental information only over the vegetation areas. But, once the NDVI calculation is based on the photosynthetic activity pattern in the satellite images, the phytoplankton can also be mapped as vegetation and information such as air temperature will also be collected over the ocean if we do not use a proper vector file to mask the ocean areas. Due to its small cartographic scale (low detail levels), the Antarctica vector database used to mask the land/ocean areas doesn't match the real land borders. For this reason, a land/ocean mask also needs to be generated using the Sentinel-2 images, based on the water reflectance patterns in the infrared bands to retrieve information only over the vegetated areas.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

HUMANITIES & SOCIAL SCIENCES

**The changing face of
Antarctic tourism**

CONVENORS

Daniela Liggett, Daniela Cajiao, Karen Alexander,
Marisol Vereda, Hanne Nielsen, Yu-Fai Leung,
Gabriela Roldan

Accepted as: E-poster Presentation

Abstract No : 26

A survey on the status of Antarctic tourism resources and suggestions for China's participation in Antarctic tourism development

Xuefeng LI, National Ocean Technology Center

In recent years, the Antarctic region has attracted more and more attention for its unique tourism resources. With the overall tourism industry showing steady growth, a record number of 74,401 tourists to the region was shown in 2019. The International Association of Antarctica Tour Operators (IAATO) has been working on the development of standards, specifications and guidelines for Antarctic tourism, providing logistical support for the operation of scientific expeditions to Antarctica, and protecting Antarctica's fragile ecosystem. However, due to various types of Antarctic tourism resources, uneven spatial distribution, and huge difference in global engagement, it is necessary to carry out the systemic research on classification, characteristics and spatial distribution of Antarctic tourism. Then according to the characteristics of different resource types, corresponding Antarctic tourism code of conduct can be formulated, so as to better participate in the Antarctic tourism resources development and better protect the Antarctic fragile ecological environment. In addition, as an emerging market for Antarctic tourism, the number of tourists in China has risen to the second in the world in recent years. However, China has not played a matching role in the governance of the Antarctic tourism industry. By strengthening the research on the environmental impact, improving the policy management system and actively participating in the commercial operation of Antarctic tourism, China can effectively promote the development of Antarctic tourism, the participation in the formulation of Antarctic tourism rules, and jointly promote the sustainable development of Antarctic tourism with other countries in the world.

Accepted as: Oral Presentation

Abstract No : 815

The Antarctic Tourism “Anthropause”: What’s Next?

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Pablo Tejado, Universidad Autónoma de Madrid

Daniela Cajiao, Universidad Autónoma de Madrid

Javier Benayas, Universidad Autónoma de Madrid

Antarctic tourism had experienced continuing growth and diversification during the pre-COVID-19 pandemic time, reaching 74,000 visitors in the 2019–2020 season. This is comparable with global trends of tourism in protected areas where the over-tourism issues were featured as an example of human impacts on the natural world in the Anthropocene Epoch. In this context, the sustainability of tourism in the Last Frontier was called to question, with more focused deliberation on tourism governance and management emerging at recent ATCM/CEP meetings. Like global tourism and other industries, Antarctic tourism came to almost a complete halt in the 2020–2021 season following the onset of COVID-19 global pandemic and outbreaks in the final tourist expedition of the preceding season. The temporary halt of tourism and human activities in nature, include Antarctica, was termed the Anthropause, which appeared to afford natural ecosystems to recover from the continuous and encroaching human impacts. The drastic difference in tourism footprint between the pre-pandemic (2019–20) and the first pandemic (2020–21) seasons is revealing from the tourist vessel traffic images generated from GPS tracking data showing extreme reductions in number of routes and visitor sites visited. This presentation aims to connect the concepts of Anthropocene and Anthropause in the context of Antarctic tourism as illustrated by the satellite-generated images, discuss what post-pandemic Antarctic tourism patterns might appear in future images, and suggest a greater use of vessel GPS tracking data for the footprint analysis of Antarctic tourism.

Accepted as: Oral Presentation

Abstract No : 870

Antarctic Tourism from a Maritime Safety Perspective

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Özgün OKTAR, Polar Research Institute, TUBITAK MRC & İstanbul Technical University

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Hasan Hakan YAVAŞOĞLU, Polar Research Institute, TUBITAK MRC & İstanbul Technical University

Antarctic tourism has been increasing in the last decade with an average of approximately 9%. Also, at least 1 new activity was recorded each year, since the 2014 – 2015 season. Thus, SCAR Antarctic Tourism Action Group (Ant-TAG) is focused on the diversification and growth of Antarctic tourism with the aim of scientific research during the XLIV ATCM while presenting IP75. Risk management and education are two mentioned topics in IP75. The importance of safety precautions and training is getting much more valuable since the total number of tourists reached 74.381 during the 2019 – 2020 season. Also, IAATO allocates safety chapters in its guidelines. Vessels are the main transportation method to Antarctica. Therefore, Antarctica is the area of interest of the International Maritime Organization (IMO). IMO, as a rule-maker of the maritime industry, defines key requirements for cruise ships from safety issues to navigation, while issuing regulations such as the International Code for Ships Operating in Arctic Waters (Polar Code) or the International Convention on the Standards of Training, Certification, and Watchkeeping for Seafarers (STCW). Finally, tourist safety regulations should be one of the main agenda items on the basis of ship safety training, since Antarctica is one of the most isolated places on Earth. In this way, future possible accidents may be prevented, before they will happen. This preparation process needs to have research and outreach, and communication with other related parties as defined in part of IP75 of the next steps of the "publication, and operations workshop" headlines.

Accepted as: E-poster Presentation

Abstract No : 485

Proactively Managing Diversification of Antarctic Tourism

Yousra Makanse, Wageningen University

This research aims to explore and map tourism diversification in the Antarctic, considering the magnitude of integration of less tangible concepts of the ATS fundamental principles and values in the development of new tourism activities in the continent. It aims to provide knowledge for the development of a framework for conducting pre-assessments relating to new, novel, or particularly concerning activities. These would be derived from an exploration of the socio-economic drivers of tourism diversification and its desirability, as well as the ability to find legal tools to regulate undesirable aspects. Research questions: 1. Which types of Antarctic tourist activities have been conducted in the Antarctic? 2. What policy options have been suggested for addressing concerns relating to the diversification of tourism in Antarctica, and what arguments have been used in support of or against these options? 3. How do tour operators in the Antarctic perceive the existing and future demands, and to what extent/how do they foresee responding to such demands? 3.1. In light of the answer to the previous question, what developments in relation to the diversification of tourism do tour operators foresee for the next 20 years? 4. How may less tangible concepts of the ATS fundamental principles and values such as "natural reserve", "wilderness values," and "focus on the enrichment and education" receive recognition in a framework for conducting pre-assessments relating to new, novel, or particularly concerning activities?

Accepted as: Oral Presentation

Abstract No : 284

Polar Impact: Utilising Self-Determination Theory to maximise the proenvironmental potential of youth expeditions

Christy Hehir, University of Surrey

Emma Stewart, Lincoln University

Patrick Maher, Nipissing University

Youth-based educational expeditions to the Polar Regions, have been offered for at least the last two decades. Common across all these programmes is a desire to immerse participants in the Polar Regions in order to help them foster a new understanding of, and respect for the polar environment, share their experiences and enthusiasm with others, grow awareness of the Polar Regions, and take action more broadly on environmental issues. This presentation reports on a case study of the Students on Ice (SOI) Programme, a Canadian-based charitable organisation that leads educational expeditions to the Polar Regions for international high school and university students. The research explores how adventurous education programmes can act as a stimulus to career and pro-environmental behaviours, up to 18 years after their polar voyage. Participants were recruited from the 3,200+ alumni of Students on Ice (SOI) Programme. The overall study included mixed-methods and was co-designed in collaboration with SOI with data collected via an online survey (n=217) utilising both open and closed questions. Framed by 'self-determination theory', this presentation explores the qualitative results, focusing on the key components of self-determination (including autonomy, competence and relatedness), and how they created meaningful experiences and post-travel impacts. Initial analysis indicates a nexus of place-people-nature creates a lasting impact on participants' self-determination to make positive change in their own lives and in their wider communities. A key contribution of this study is that it documented actual long-term behaviour change which is rare in the literature to date.

Accepted as: Oral Presentation

Abstract No : 193

Adaptive Management of Sustainable Tourism in Antarctica: A Rhetoric or Working Progress?

Daniela Cajiao, Universidad Autonoma de Madrid

Javier Benayas, Universidad Autonoma de Madrid

Pablo Tejedo, Universidad Autonoma de Madrid

Yu-Fai Leung, North Carolina State University

Antarctic tourism growth and diversification constitute an increasing concern for policymakers and the scientific community. While a substantial number of tourism management strategies and recommendations have been proposed to the Antarctic Treaty Parties, little progress on policies and regulations has been achieved. Recognizing that the Adaptive Management approach has shown positive experiences in the management of tourism in protected areas, we examine the extent to which this approach has been incorporated into Antarctic tourism research and management and what has limited its implementation. We conducted an appraisal of 72 peer-reviewed journal articles from 1992 to 2020 and examined management documents archived in the Antarctic Treaty database for the period 1969 to 2020. From a scientific perspective, researchers applied different elements of the adaptive management approach, in particular ecological assessments, design of management measures, and monitoring. From a policymaking perspective, recommendations and management proposals have been made to comprehensively manage Antarctic leisure industry using this approach. However, very few contributions have been translated into legally binding policies and regulations. The Antarctic governance regime, different national laws, and, divergent political perspectives, challenged the full implementation of the Adaptive Management approach. However, regional, and site-specific adaptive management models could be applied as a first step toward more systematic implementation. This incremental approach could enhance stakeholder participation and improve decision-making processes, ultimately leading to more proactive and effective management of Antarctic tourism, essential for the conservation of the continent.

Accepted as: Oral Presentation

Abstract No : 382

The Curated Continent: Mediating the Antarctic Tourist Experience

Elizabeth Leane, University of Tasmania

Can Seng Ooi, University of Tasmania

Anne Hardy, University of Tasmania

Carolyn Philpott, University of Tasmania

Hanne Nielsen, University of Tasmania

Katie Marx, University of Tasmania

Unlike most destinations, the Antarctic is not a place tourists can encounter independently. This means that tourism in Antarctica is more closely mediated than perhaps anywhere else in the world. Almost all leisured visitors travel with an operator and hence experience the continent in a carefully curated way, with onboard lectures and activities as well as guided excursions framing their encounters with the environment. Despite increasing scholarly attention to polar tourism, the nature of this mediation and its role in tourists' experience of Antarctica has yet to be systematically examined; and we are only at the beginning of understanding how cultural and national background interacts with this mediation. In this presentation, we outline a collaborative project examining how cruise-ship tourism can foster a positive and culturally informed relationship with Antarctica among diverse groups of visitors. Funded by the Australian Research Council over two years, and in partnership with established Australian adventure tourism company Intrepid Travel, the project brings together approaches from mediated tourism, cross-cultural tourism, and Antarctic studies. Through in situ fieldwork, including interviews and participant observation, we will examine how the typical Antarctic tourist journey, with its interpretive activities as well as its multisensory experiences, shapes the experience of people of different national and cultural backgrounds. With the first fieldwork scheduled for early 2023, this presentation provides a preliminary outline of the project's aims, approaches and methods. Its ultimate goal is to develop ways for operators to foster strong connections with the continent across an increasingly diverse customer base.

Accepted as: Oral Presentation

Abstract No : 192

Behavioral responses of two penguin species to human presence at a popular tourist site in the Antarctic Peninsula Region

Daniela C Cajiao, Universidad Autonoma de Madrid

Yu-Fai Leung, North Carolina State University

Pablo Tejedo, Universidad Autonoma de Madrid

Andres Barbosa, Museo de Ciencias Naturales

Gunter Reck, Universidad San Francisco de Quito

Javier Benayas, Universidad Autonoma de Madrid

Visitor Site Guidelines, issued by the Antarctic Treaty Parties and implemented by the International Association of Antarctica Tour Operators (IAATO), constitute the principal guidance for tour operators, guides, and tourists on how visits should be conducted. The aim of these instruments is to minimize tourist impacts on Antarctic values, especially wildlife. However, some recommendations still need to be reinforced by empirical research. While penguins have enjoyed considerable research attention, a knowledge gap still exists regarding penguins' behavioral responses to realistic tourist activities, including talking sound, viewing distance and movement speed. To fill this gap, we conducted a series of experiments to simulate these activities on chinstrap (*Pygoscelis antarcticus*) and gentoo (*Pygoscelis papua*) penguins breeding at an intensively visited site. Experiments were conducted during late December and early January, coinciding with the most vulnerable part of the breeding season. We conducted 106 replicates of passive and active human presence treatments. Responses varied between species, but active human presence consistently triggered significantly higher responses of strong vigilance behavior. Our results reinforce Visitor Site Guidelines' recommendations of keeping quiet, moving slowly, and increasing viewing distance if changes in behaviors are observed. We also recommend the adoption of specific temporal and spatial measures at the early breeding season. More management-orientated empirical studies are needed on different species, sites, and stages of the breeding season to further strengthen visitor site guidelines, evaluate the efficacy of management measures, and contribute to the sustainable management of Antarctic tourism informed by science.

Accepted as: Oral Presentation

Abstract No : 835

A horizon scan for Antarctic tourism research: Current progress

Yu-Fai Leung, North Carolina State University

Daniela Liggett, University of Canterbury

Daniela Cajiao, Universidad Autónoma de Madrid

Pablo Tejedo, Universidad Autónoma de Madrid

Hanne Nielsen, University of Tasmania

Kees Bastmeijer, Tilburg University

Javier Benayas, Universidad Autónoma de Madrid

Gabriela Roldan, Antarctic Heritage Trust

Chengzhao Wu, Tongji University

Karen Alexander, Heriot Watt University

Gunter Reck, Universidad San Francisco de Quito

Antarctica is increasingly threatened by global and regional pressures. The growth and diversification of Antarctic tourism has been adding to these pressures. Despite a temporary COVID-19 halt of tourism in the past two seasons, Antarctic visitation is expected to return at the unprecedented level of over 100,000 in the 2022-23 season (IAATO, 2022). While proliferating ecological footprints of Antarctic tourism constitute a major concern, positive impacts of tourism can also expand, such as building a larger constituency in favor of Antarctic's sustainable future and facilitating Antarctic science through logistical support and direct tourists' engagement in citizen science projects. To identify research needs and priorities for Antarctic tourism in this critical juncture, a two-stage Horizon Scan (Sutherland et al., 2020) is being conducted by a team of researchers from four continents to develop a proposed research agenda with support from the Academic Consortium for the 21st Century (AC21). This two-stage approach is designed to integrate conceptual models generated by the project team with independent input on research needs from the broader community, including tourism researchers, National Antarctic Programs scientists, tourism practitioners, and other stakeholders. This presentation reports the current progress of this AC21 Horizon Scan, now in its final stage. We will summarize the conceptual models developed, highlight results from a research needs survey and an associated community engagement workshop, and present the method being used in the second community survey to prioritize the identified research needs and finalize the proposed research agenda.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

HUMANITIES & SOCIAL SCIENCES

Antarctic heritage

CONVENORS

Lize-Marié Hansen van der Watt,
Rebecca Hingley

Accepted as: Oral Presentation

Abstract No : 756

Antarctic heritage and visitors: theoretical reflections on narratives, ruins and natural processes of decay

Maria Ximena Senatore, INAPH Universidad de Alicante and CONICET-UNPA

Cornelia Lüdecke, University of Hamburg

Ruins, as intertwined cultural and natural entities, have linked the human past and present as part of cultural-natural landscapes around the world. In Antarctica, historic ruins are meant to disappear in the near future due to a mixture of environmental protection policies and heritage conservation practices working to reinforce the dominant image of Antarctica as a pristine landscape and presenting natural and cultural realms as a binary opposition. In this paper, we explore how these dominant images and narratives are challenged by the presence of decaying historic ruins that still persist in the Antarctic landscape without protection mechanisms under the Antarctic Treaty. Specifically, we study the ways in which these ruinous materials are currently becoming meaningful and acquiring heritage values through tourism. Tourists have regularly visited some ruins for decades, giving us an opportunity to explore visitors' attitudes toward them. The results of our surveys drawn on questionnaires show that cruise ship passengers value ruins despite their decaying state. Visitors offer a wide variety of generally positive responses and suggest their protection, "leaving them as they are". Based on our study, we argue that ruins have the power to diversify the ways of telling stories as they embody the processes in which time, nature and culture act as intertwined agents producing constant transformation and physical change. Consequently, they represent a valuable instrument to articulate Antarctic narratives, encouraging some theoretical reflections on heritage sites protection under their natural processes of decay.

Accepted as: Oral Presentation

Abstract No : 113

Polish Antarctic Station Dobrowolski: history, present and future perspective in brief.

Marek Lewandowski, Institute of Geophysics, P.A.S.

Monika A. Kusiak, Institute of Geophysics, P.A.S.

Wojciech Miloch, University in Oslo

Adam Nawrot, Institute of Geophysics, P.A.S.

It has been over 60 years since the Polish Antarctic Station Dobrowolski (Bunger Hills, East Antarctica) was built and handed over to Poland from the USSR. The 2021/22 4th Polish Antarctic Research Expedition (PARE) was the first one in 42 years. This presentation tells about the history of Dobrowolski station and results of the 4th PARE, which was organized to revitalize the station. A team of four Polish researchers spent 37 days, restoring and organizing the station's huts. Historical artefacts were preserved and packed for return to Poland. Almost 400 kg of rubbish and scrap was collected and disposed of in Cape Town. The area around the station was cleaned up as much as possible. New equipment replaced the old in the huts, including a power generator, oil-heated stove and incinerating toilet. A broadband seismometer, magnetometer, ionospheric scintillation receiver and other instruments were temporarily installed to perform test measurements. Geological and environmental samples were also collected over the vast area of the Bunger Hills, the environmental report is under preparation. For the time being, the station is ready for seasonal expeditions and year-round geophysical research.

Accepted as: Oral Presentation

Abstract No : 692

Interpreting the human histories of Antarctica: a UK Antarctic Heritage Trust case study

Ruth Mullett, UK Antarctic Heritage Trust

The UK Antarctic Heritage Trust (UKAHT) is responsible for the care and conservation of six designated historic sites on the Antarctic Peninsula, all of which are open to visitors. Dating between 1944 and 1973, it was at our sites that some of the earliest climate research took place, and where a formal scientific programme for Antarctica was established. They include a WWII base turned atmospheric science base, an air transit shelter, and sledding survey bases. Combined with the buildings themselves, the artefacts preserved at each site – clothes, scientific equipment, food tins, kitchenware, etc. – tell fascinating stories of early human history in Antarctica. UKAHT is currently in the process of redeveloping our Interpretation Strategy. We seek to identify what makes each of our sites unique and important, and how we can best communicate this to our audiences. Not only do we need to understand how visitors ‘on the ground’ can get the most from their experience, but also how we can share the stories of our sites digitally with the majority who will never visit. In this presentation, I explore how the process of preparing an Interpretation Strategy is helping UKAHT better understand our own sites and heritage, and clarify the challenges and opportunities presented by their interpretation.

Accepted as: Oral Presentation

Abstract No : 598

Heroic Networks: objects, museums and Antarctic explorers

Henrietta Hammant, University of Reading

My research considers the representation of explorers of the 'Heroic Age' of Antarctic exploration (broadly the late 19th to early 20th century) in museum collections. I am particularly interested in how certain British figures from this time period – particularly Sir Ernest Shackleton and Captain Robert Falcon Scott – have come to be thought of as 'heroes' thanks, in part, to the work of museum professionals. I ask how the actions of curators, conservators, exhibition and interpretation specialists and education staff may perpetuate traditional 'heroic' narratives, at the expense of a broader cast of actors involved in these expeditions. Using object biography, I aim to show the diverse network of both human and non-human actors that were critical to these expeditions, and their subsequent memorialisation in the museum context. Ultimately, by questioning traditional ideas of the 'hero', I aim to highlight a diverse network of both human and non-human actors that were critical to these expeditions, and their subsequent memorialisation in museums. This will be set in the context of my fieldwork at the Polar Museum at the Scott Polar Research Institute, Cambridge and comparative work at the RSS Discovery, Dundee.

Accepted as: Oral Presentation

Abstract No : 407

Preserving South African's Polar Heritage; creating a timeline of human impact in our polar heritage with information obtained from the Antarctic Legacy Archive.

Ria Olivier, Antarctic Legacy of SA, Stellenbosch University

South Africa is involved in the Antarctic region since the heroic age, although the first South African only reach the South Pole in 1959. Cape Town has been a port and gateway for vessels to the Antarctic Continent as early as 1739. The sealing industry also made use of South Africa to sub-Antarctic Islands. Since 2009 material has been collected for a digital archive. Especially in the South Africa context ALSA has the responsibility to establish the correct history timeline of involvement. A study of documentation and images was done to create a timeline since before the heroic age. The timeline started form a low impact for an exhibition and pan out to be part of the digital museum, posters for established museums, public lectures to specific groups. These timelines will be an important input an addition to establishing Capet Town as gateway city within the global gateway city project. In this presentation a timeline of South Africa's involvement in the Antarctic, Marion and Gough Island as well as vessels to the Antarctic will be shown that will include humans, infrastructures and research programmes. In creating these timelines it once again show the rich history of South Africa in the Antarctic region and a polar heritage to be proud of.

Accepted as: Oral Presentation

Abstract No : 138

Imagination, games, fun, 3D technologies and the Antarctic archaeological heritage

Alex Martire, UFMG

Andrés Zarankin, UFMG

The Laboratory of Antarctic Studies in Human Sciences – LEACH of the Federal University of Minas Gerais (Brazil) has been conducted a long international archaeological study about the relation of Antarctica and humans through time, with special focus in the first human occupation related with sealers. For more than 12 years, the "White landscapes" project has been building alternative stories from those told by official documents (centered on renowned explorers) about human occupations in the region. One of the aspects of scientific study and dissemination of LEACH is based on the use of new digital technologies. In this presentation, we will address its uses, mainly focused on the acquisition of three-dimensional data from scans and its uses in Virtual and Augmented Reality environments, as well as the development of the first archaeological video game about Antarctica ever made.

Accepted as: E-poster Presentation

Abstract No : 522

HISTORICAL NOTES ON STATIONS CONSTRUCTED ON THE KELLER PENINSULA, ADMIRALTY BAY, KING GEORGE ISLAND

Paulo Camara, University of Brasilia

Haynnee Souza, Brazilian Navy

Peter Convey, British Antarctic Survey

Kevin Roberts, British Antarctic Survey

The Falkland Islands Dependencies Survey established 'Base G' in 1947 on the Keller Peninsula, which operated until its closure in 1961. It was dismantled and removed in 1995/96 by Brazilian personnel from the adjacent Comandante Ferraz Antarctic Station, with the agreement of the British Antarctic Survey. The ruins of the site, including hut foundations and a cemetery, have become known colloquially as the "ruins of the old whaling station". However, no shore whaling station ever operated in Admiralty Bay and Base G served primarily as a meteorological station. Scientific data collected there contributed to important datasets still in use to the present, enabling comparisons and complementing data now collected at Ferraz Station. When Ferraz Station was initially constructed (1984), four abandoned buildings remained, all in poor condition. The remains of the Base G's foundations can still be seen along with artefacts such fishing hooks, coal and bullets. As no plaque or memorial marks the history of the site, and it is not designated a Historic Site under the Antarctic Treaty, information is hard to obtain. The site's importance and history have been fading, while the fictitious concept of the remains of a whaling station have increasingly taken hold. Our aim is to reveal the accurate history and importance of the first human research settlement on King George Island and its relevance to current and ongoing Antarctic science.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

HUMANITIES & SOCIAL SCIENCES

**The ATS, international law, and
governance**

CONVENORS

Alejandra Mancilla, Patrick Flamm

Accepted as: Oral Presentation

Abstract No : 901

Cold play and hot talk: Could the dynamics of Antarctic Treaty system change with the moves of non-original signatory states and new entrants?

HYOUNG CHUL SHIN, Korea Polar Research Institute

WONSANG SEO, Korea Polar Research Institute

JIHOON JEONG, Korea Polar Research Institute

CHAERIN JUNG, Korea Polar Research Institute

YEONGJUN CHOI, Korea Polar Research Institute

Deliberation and decision making of the Antarctic Treaty system have been prevailed by the traditional conservation-focused stances often driven by original signatory states. This is probably a correct portrayal of the whole scene since the founding and institutional settlement of the Environmental Protocol. The Treaty and Environmental Protocol welcomed a number of new acceding states and also granted some of them the consultative status in the last decade or so. In recent years, some fundamental questions are also being asked in a skeptical manner to the current practices and frameworks. These are initiated and supported by relatively a small portion of the Parties, however, the disagreement and tension created might be sufficient to disturb the atmosphere for cooperative dialogue. Divergent points of view will be illustrated using cases from the documents and interventions at the Antarctic Treaty system meetings. If the partnership, either bilateral or multilateral, as promoted in the text of the Treaty is affected and impaired in any way, that would be the greatest loss and in no Parties' interests.

Accepted as: Oral Presentation

Abstract No : 54

What are Stakeholders' Interests in the Weddell Sea? An Analysis with Focus on the CCAMLR Marine Protected Area Proposal

Sharlene Fechter, Helmholtz Institute for Functional Marine Biodiversity

In 2018, almost 87% of the world's oceans have been damaged by human activities, i.e. commercial and recreational fishing, tourism and recreational use and exploitation of mineral resources. The goal of so-called 'conservation tools' such as Marine Protected Areas (MPA) is to help marine ecosystems to be resilient to environmental change such as climate change and to minimise additional pressure due to human activities. Increasing human impacts are also starting to harm the Antarctic continent and the Southern Ocean. The icy continent and the Southern Ocean seemed to be "empty" and out of any human interests. Yet, in reality there are growing human interests, making it crucial for international governance to act. In particular, different stakeholder groups are interested in the Weddell Sea area for different reasons. Because of these interests and varying degrees of influences, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) failed to implement the Weddell Sea Marine Protected Area (WSMPA) for conservation since its development in 2016. This research project aims to identify key stakeholder groups with their different interests in the Weddell Sea as well as their engagement and degree of power in the implementation process of the WSMPA. The project will address the following objectives: Outlining the current situation of policy and governance regarding the MPA management in Antarctica; identifying key stakeholders in the Weddell Sea; analysing stakeholders' different interests and their influence on the MPA implementation; and determining the way to success of the WSMPA.

Accepted as: Oral Presentation

Abstract No : 355

Evaluation of the effectiveness of the Antarctic Treaty System for the environmental issue: a case study of the Madrid Protocol

Hugo Moraes, Federal University of Pernambuco

Andrea Steiner, Federal University of Pernambuco

Antartica is a strategic region due to political, economic and environmental aspects, and due to this reason, it requires adequate international tools for its management – especially for environmental purposes. The Antarctic Treaty Sytem (ATS) is made up of four international agreements that deal with issues that are directly linked to the Antartic region, including the Environmental Protection Protocol of the Antarctic Treaty, also known as the Madrid Protocol. This research was based on a single case study, in which the Madrid Protocol represented one case within one unit (the ATS as an umbrella treaty that comprises several agreements). Three groups of independent variables were evaluated (considering effectiveness as the dependent variable): problem type and structure, political context and problem solving capacity. Data was collected through interviews with experts and documental analysis. Process tracing and contrafactuals were the main techniques used for data analysis. Based on the variables analyzed and the contrafactuals constructed, the Protocol was classified as having mixed performance, due to a combination of well evaluated and badly evaluated variables.

Accepted as: Oral Presentation

Abstract No : 445

Antarctic science under unprecedented pressure: the first common efforts to counter Russia's aggression against Ukraine under the polar legal regimes

Andriy Fedchuk, Thd National Antarctic Scientific Center of Ukraine

Dmytro Cheberkus, The national Antarctic Scientific Center of Ukraine

Sophia Zherebchuk, The national Antarctic Scientific Center of Ukraine

The Antarctic Treaty has long been seen as an example of successful international cooperation for peace, research and environmental protection for the benefit of humanity. However, the military aggression of one Treaty's Party against another have a destructive effect on its National Antarctic Program, and requires a consolidated response from the Antarctic community. This peace of research examines how this issue was widely discussed at the 44th Antarctic Treaty Consultative Meeting (Berlin, 2022) and what consequences should be anticipated. The Consultative Parties condemned in the strongest possible terms Russia's unjustifiable, unprovoked and illegal invasion of Ukraine and its flagrant violation of the core principles of sovereignty and territorial integrity, based on international law. The overwhelming majority of the Parties expressed their support for Ukraine and aligned themselves with the demarche to the Russian delegation demanding Russia to stop the war against Ukraine, noting that this breach of international law was also contrary to the spirit of the Antarctic Treaty. This reaction appeared to be the first step towards taking isolation measures to the aggressor Party such as boycott of its initiatives, its chairmanships during intersessional contact groups, nomination of its representatives to the governing bodies of working groups. It is also expected, that if the aggression will continue the isolation measures will be extended also on research and logistics. Therefore, it should be taken into account that future research and logistic projects in collaboration with partners from Russia, could take very high risks in near future.

Accepted as: Oral Presentation

Abstract No : 998

Canada's evolving interests in Antarctica

Anita Dey Nuttall, University of Alberta

Canada operates as a non-consultative party member outside the decision-making machinery of the Antarctic Treaty System (ATS). That may soon change, as it has recently applied for consultative party status. A unique characteristic of Canada's connection to the Antarctic is that it has had the longest history of being closely involved in Antarctic matters of any of the non-consultative parties. Much of Canada's involvement in Antarctica has been driven by individual scientists and commercial interests, especially tourism, rather than a national Antarctic science agenda. In the context of the United Nations Decade of Ocean Science for Sustainable Development (2021-2030), the marine component of the Antarctic gathers further significance. Canada has a major role to play, given that it has much at stake in protecting its own oceans and coasts. As a polar nation, Canada's increased involvement in the Antarctic will be important. This paper examines Canada's recent approach to Antarctica and what consultative party status would mean not just for Canada as a polar nation, but for the ATS more generally, and especially for Antarctic governance. In discussing Canada's efforts toward the development of an Antarctic science program, it will ask whether Canada will need to implement and sustain a national program if it has consultative party status, or whether working in cooperation with other states with established programs will be sufficient for Canada to maintain a research presence in Antarctica, even if this supports individual scientists rather than establishing a nationally-funded initiative.

Accepted as: Oral Presentation

Abstract No : 974

Protecting the Antarctic biodiversity through an environmental liability regime: Where we are?

Luis Valentín Ferrada, Universidad de Chile

The Antarctic Treaty did not consider biodiversity protection properly. Still, it established that one of the topics to be discussed in the ATCM would be the “preservation and conservation of living resources in Antarctica”. In the subsequent ATS instruments, the concern about the Antarctic ecosystem protection and its exceptional biodiversity will progressively increase in importance. However, what happens if someone fails to fulfil the standards agreed to reach that protection? From the legal perspective, a liability regimen indirectly promotes the fulfilment of the obligations and directly creates the duty of compensating for any breach of the rules, punishing that non-compliance. This presentation will reflect on the Antarctic liability regimen development related to environmental protection and biodiversity safeguard. It will consider the analysis of Annex VI of the Environmental Protocol but also the situation of activities under the CAMLR Convention or the Convention on the Conservation of the Antarctic Seals. The present political and legal status will be described, and the main challenges will be highlighted and discussed.

Accepted as: Oral Presentation

Abstract No : 700

Red Herrings: The Negotiation of the Antarctic Treaty and the Soviet Union

Elias Angele, University of Bremen

This paper examines the role of the Soviet delegations in negotiating the Antarctic Treaty. While the claimant nations initially focused on keeping the USSR out of the continent, it soon became clear through the tremendous scientific effort of the Soviets during the International Geophysical Year that they intended to stay. Subsequently, a new strategy was adopted which aimed at containing the Soviets through integrating them in the treaty negotiations. During the preparatory meetings, however, the Soviet delegation pursued an obstructive tactic aimed at slowing down the progress by throwing in several “red herrings” as the British biologist and diplomat Brian Birley Roberts called it. When the Soviets all of a sudden changed their attitude, it became possible to decide issues of substance and ultimately agree on a treaty. In order to explain Soviet Antarctic diplomacy, it is argued here that it was fundamentally shaped by ideas of “ideological struggle and international law” and the Antarctic Treaty is a splendid example of it. By analysing the influence of the USSR on the treaty negotiations in the broader historical context of the Cold War, it will become possible to understand why the treaty eventually came into being – against all odds.

Accepted as: Oral Presentation

Abstract No : 222

Implications for CCAMLR: Is it a tipping point?

Lynda Goldsworthy, IMAS, UTAS

The Convention on the Conservation of Antarctic Marine Living Resources was negotiated to ensure that any fishing activity recognised and maintained the values of peace, scientific collaboration and environmental protection enshrined in the Antarctic Treaty. Its objective was set as 'the conservation of Antarctic marine living resources' which allowed for but is not restricted to fishing activity when such activity is undertaken according to strict principles of conservation. Forty years on, two conflicting views around the interpretation of that objective have emerged. One accepts that the conservation obligation extends beyond species of commercial fishing interest and requires the adoption of measures for protecting species and areas for scientific study and biodiversity. This acknowledges rational use as a legitimate activity but does not consider it to be the primary focus of the objective. The second assumes that management of harvesting is the focus of the Convention and that the objective is met through effective regulation of such activities. This polarisation has led to an inability of the CAMLR Commission to progress measures that extend direct fisheries management. This paper explores the implications of this trajectory toward a fisheries management focus, and considers three other possible futures for CCAMLR: the abandonment of the Convention; reaffirmation of a collectively-agreed objective that reflects the intent of the negotiations; and a 'Madrid Protocol Moment' where Commission Members agree to become custodians of the Southern Ocean to conserve and maintain its global values, particularly in mitigating global environmental threats.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

HUMANITIES & SOCIAL SCIENCES

Understanding
‘The Ice’ through the humanities,
arts and social sciences

CONVENORS

Klaus Dodds, Charne Lavery

Accepted as: Oral Presentation

Abstract No : 529

Writing Broken Ice in Two Contemporary Novels

Hanne Nielsen, IMAS UTAS

Elizabeth Leane, UTAS

The ice of Antarctica is richly storied. These stories range across scales, from the lone explorers of the “Heroic Era” of polar exploration to those of the scientific equipment that facilitates modern day science via satellite technology and implicates Antarctica in global systems of human communication. Despite this, few literary authors have addressed the challenges associated with depicting Antarctica – the so-called “continent for science” – in the age of the Anthropocene. With a handful of notable exceptions, the corpus of Antarctic texts has been dominated by genre fiction: adventure stories, science fiction, and thrillers. Yet literary fiction is well placed to respond to the conceptual challenges of understanding ice in the Anthropocene, at a time when what happens in Antarctica has global implications. Taking Ilija Trojanow’s *The Lamentations of Zeno* (2011) and Jon McGregor’s *Lean Fall Stand* (2021) as case studies, this paper examines how the language of literary fiction can be used to grapple with disruption on different scales, from the personal devastation of a stroke to the global implications of melting Antarctic ice. We argue that both novels employ experimental techniques to offer new and contrasting ways of framing human conceptions of and interaction with ‘the Ice’. However, they take different approaches to the idea of the Antarctic hero, with *Lamentations of Zeno* reinscribing a model of individual (white male) heroic rescue that *Lean Fall Stand* rejects.

Accepted as: Oral Presentation

Abstract No : 220

On edge: A more than human history of Antarctica's sea ice

Joy McCann, Australian National University

Antarctic sea ice is neither land nor sea, but something else entirely. The Southern Ocean's seasonal freeze and thaw represents the seasonal heartbeat of our Earth's life support systems, driving deep, powerful currents of ocean circulation and nourishing one of Earth's largest ecosystems. All living things that inhabit the cold polar waters around the Antarctic continent rely on its seasonal ebb and flow. For humans, the sea ice has long served as an evocative canvas for artists and writers, a formidable setting for heroic narratives of exploration and survival, and an intriguing scientific conundrum. In this paper, Joy examines the more than human history of Antarctic sea ice – above and below the surface – revealing the powerful agency of this fragile, dynamic environment and the creatures that inhabit it. This paper emerges from Joy's research for a new book about the natural and cultural histories of Antarctica's glacial and sea ice in the Anthropocene, to be published in 2024. She will discuss key themes and questions that frame her research and consider some of the insights and challenges that such research presents for environmental historians of the polar regions.

Accepted as: Oral Presentation

Abstract No : 909

Ice in the Southern imagination

Sophy Kohler, None

The relationship between humans and ice is newly urgent in the twenty-first century, our enmeshed future with ice having become a central aspect of climate-change discourse. Environmental historian Sverker Sörlin, for example, describes our current moment as ‘cryo-historical’ , and notes that ‘The fate of ice as a sign of the fate of our societies invites new readings and interpretations of ice that can be provided by the social, cultural and historical sciences – the humanities.’ Answering Sörlin’s call for the humanities to provide new readings and interpretations of ice, and influenced by Francis Spufford’s *I May Be Some Time: Ice and the English Imagination*, in which he outlines the aesthetic and cultural pull of ice in bringing British explorers to the poles, this presentation will think through what it means to talk about ice instead from the perspective of the Global South, and the African continent in particular. In doing so, it searches for a Southern version of what Spufford describes as the ‘intangible history of assumptions, responses to landscape, cultural fascinations, aesthetic attraction to the cold regions’ that runs alongside the technical and scientific history of the polar regions.

Accepted as: Oral Presentation

Abstract No : 716

Narrative Cartographies: 'The Ice' as storied volume.

Elizabeth Lewis Williams, University of East Anglia

Maps tell stories – about the world they represent, and the people who make them. Maps of 'The Ice' have evolved from speculative depiction, through accurate topographical representation, to works which look like abstract art. In the archives of the British Antarctic Survey are documents which help us to recreate the journeys of the mapmakers and enable us to discover the human dimension of the world in which the maps were made. The narratives generated by this archival exploration help us to understand human and non-human engagement with 'The Ice'. 'The Ice' is a metonym, referring not just to the material continent, and the substance which defines it, but to human and non-human engagement with it. Understanding 'The Ice', and conveying that understanding to others, requires us to perceive ice as volume, in both senses of the word, as derived from its Latin root volumen, a roll (of parchment). Ice cores (shaped like those rolls) contain bubbles of trapped air which tell the story of earth's climatological history. Stephen Pyne's book 'The Ice' is a volume in which studies of the continent's different kinds of ice types are layered with the cultural and political history of the continent. Peter Fretwell's 'Antarctic Atlas' combines various different kinds of cartographical representations to explore the interconnectivity of physical geography and the stories of the creatures and the people who live and work there. This paper will show that 'The Ice', like the maps by which it is represented, is a densely storied volume.

Accepted as: Oral Presentation

Abstract No : 653

Antarctic(a) Encounters: Navigating and Inhabiting the Ice

Miranda Nieboer, University of Tasmania / Institute for Marine and Antarctic Studies

While Antarctic stations are predominantly fixed point facilities in coastal ice-free areas, field camps are, as temporary modes of inhabitation, mainly dotted across the continent's glacial surface. In contrast, the Antarctic scientific and logistical traverses trace lines across the continent. Investigations into these traverses as distinct modes of human inhabitation in Antarctica, offer new perspectives on human relationships with the ice. Drawing from Jackman and Squire's 'Forging Volumetric Methods' (2021), this paper contributes to a volumetric approach to Antarctica's ice mass as it attends to the everyday encounters with the ice. It presents a case study of the French Italian logistical traverse RAID63 between Dumont d'Urville and Concordia Station. As a participant observer on this traverse, I developed a first-hand and experiential knowledge of navigating and inhabiting the ice. My embodied research, from an architectural/spatial perspective, is informed by video ethnographic studies and critical spatial writing as immersive forms of exploration. Foregrounding practices of navigation and inhabitation, this paper attends to the dynamics between ice, machines and humans and the complex entanglements of materialities and spatialities on, below, and above the traverse track. In the context of the logistical traverse, the tracing of a line on the surface, this paper argues, becomes a moving through and with the dynamic ice mass of Antarctica. The architectural/spatial perspective and the volumetric approach to the traverse reveals that the ice, understood as an active agent, allows for reconsidering ideas of inhabitation which are commonly grounded on a land based thinking.

Accepted as: Oral Presentation

Abstract No : 349

"There's No Place Like Home!" Antarctica, the Blizzard of Oz

Ellen Frye, Wm. Pat. University of New Jersey

Springboarding off the world famous 1939 Academy Award winning movie, "The Wizard of Oz," Dorothy's quote, "There's no place like home," seems rather fitting for Antarctica. In many ways, this concept is applies to living in Antarctica! First, each principal character from "The Wizard of Oz" (Dorothy, Scarecrow, Lion, and Tinman) will be analyzed for what they are missing and in search of, in relation to life in Antarctica: home, brain, courage, and heart. Second, connecting the four characters to both the four elements (earth, air, fire, and water) and the four temperaments (David Keirsey's theory), what they represent will also be explored, particularly as pertaining to surviving in Antarctica. In a fun twist, each character will show their value in place and home-making, which links directly to the unique situation of life at an Antarctic Base: cooking, sewing, cleaning, and laundry, and the difficult aspects of carrying out these chores while living on the ice! As curious examples, images and stories ranging from early explorers' diaries (Scott, Shackleton, and others) to Gavin Francis's 2013 award-winning book, "Empire Antarctica: Ice, Silence and Emperor Penguins," will also be proffered. Sprinkled throughout will be other famous quotes about "home" and how their significance grows when the context is Antarctica, such as Maya Angelou's, "I long, as does every human being, to be at home wherever I find myself." In the end, I expect to prove that there's no place like Antarctica!



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

HUMANITIES & SOCIAL SCIENCES

Antarctica and the arts

CONVENORS

Elizabeth Leane, Carolyn Philpott, Adele Jackson

Accepted as: Oral Presentation

Abstract No : 204

WAIS Reliquary: 68,000 Years: an art installation informed by scientific research using West Antarctica ice core samples as a metaphor for deep time and Earth's frailty and resilience.

Anna McKee, independent artist

Visual artist Anna McKee will present WAIS Reliquary: 68,000 Years. This sculptural installation is comprised of 3405 glass ampules sewn to 678 silk panels suspended to create a subtly swaying wave form. The organizing structure is derived from isotope data. Shifting hues hint at untold levels of information and a deep measure of time. Though abstract, the installation's form suggests a graph, and is the expression of 68,000 years of temperature history from an ice sheet. The installation includes a multi-channel sound piece, created by Seattle composer/sound artist Steve Peters. In 2009, McKee visited the WAIS Divide Ice Core field camp in Antarctica through the U.S. National Science Foundation Artist and Writers program. In 2012, Eric Steig, professor of glaciology at the University of Washington, invited her to fabricate the glass ampules for the WAIS Reliquary at his research lab, using surplus water samples from over three kilometers of glacier ice. She employed the reliquary form to illuminate the mysterious qualities of glacial ice as well as the valuable science and feats of labor it took to obtain the ice core. Fabricating it provided an outlet to contemplate the vast scale of geologic time, and to grieve larger issues of environmental change. The water "relics" are the sacred elements of this piece. WAIS Divide Reliquary: 68,000 Years has been dismantled, and the ampules are now permanently installed in an "Urn" fabricated from a section of the ice drill. The installation is documented in a short video.

Accepted as: Oral Presentation

Abstract No : 383

Creative Antarctica: Australian Artists and Writers in the Far South

Carolyn Philpott, University of Tasmania

Elizabeth Leane, University of Tasmania

Adele Jackson, University of Canterbury

Philip Samartzis, RMIT University

Sean Williams, Flinders University

Martin Walch, University of Tasmania

William Fox, Center for Art + Environment, Nevada Museum of Art

Sachie Yasuda, Australian Antarctic Division

Most people will never travel to Antarctica, but rather form their idea of the continent vicariously, through the images, sounds, and stories created by those few who do visit. Creative outputs thus provide a crucial means through which perceptions of and attitudes toward Antarctica are built. Australia has a long history of facilitating creative arts practitioners of all kinds to experience the continent, through residencies with either the national program or tourist operators. Others have responded to the continent without ever having been there. However, among the research focussed on national Antarctic imaginaries, there is very little analysis of Australia's rich tradition of artistic engagement with Antarctica. At the same time, scholarship focussed on the arts in Antarctica, in a national context or otherwise, tends to separate out the literary, visual, and performing arts rather than identifying patterns and synergies across these forms. Moreover, to date there has been no platform for lifting artistic engagement with Antarctica to the level where it reaches large segments of the Australian population, and no in-depth analysis of the best models for residencies. This presentation focusses on a new Australian Research Council funded project that aims to be the first large-scale study addressing the ways the creative arts as a whole help shape the relationship between the two southern continents. We will outline the project's innovative combination of cultural analysis; curatorial and creative response; and qualitative investigation of artists' and writers' experiences and the impact of their work on those who encounter it.

Accepted as: Oral Presentation

Abstract No : 118

Mount Erebus in image, music and text

Adele Jackson, University of Canterbury

Mount Erebus occupies a prominent place in Antarctica's natural and human histories. Dominating the skyline of Ross Island, the southernmost active volcano has been the setting for triumphs and tragedies. Named in 1841 both for a warship and the passage to the underworld in Greek mythology, 'Erebus' conjures disturbing associations. Its evocative name and its appeal as both an earthly and an otherworldly spectacle have long captured the imagination of artists and writers. However, to date there has been no comprehensive account or assessment of artistic depictions and interpretations of this significant Antarctic volcano. In this paper I present findings from a literature review and from desk-based archival research. The resulting bibliography of visual art, music and literature, and a critical analysis of a selection of these works, provides a multi-faceted portrait of Mount Erebus. Importantly, an analysis of cultural representations complements both scientific enquiries and historic accounts to offer a more complete understanding of one of the most remarkable locations on the continent.

Accepted as: Oral Presentation

Abstract No : 492

Yard Weather

Jay Needham, Southern Illinois University Carbondale

Yard Weather Yard Weather is a live sound performance that evokes present-myth making in the telling of a tale of two territories, one near the forests of Southern Illinois and the other on the Antarctic Peninsula. As told in the myth, ancient ferns are transplanted for a new garden while past and present climates share a brief romance. Set across two epochs, in the Late Cretaceous and in the Holocene just a few days ago, Yard Weather's mythemes and sounds have been influenced by the author's own experiences alone on extended vigils in the wild and in his backyard, as well as eco-critical scholarship and science. This myth also includes the artist's recounting of Deep-time dreams, those moments of spacious learning when we are reminded of what lies under our feet. The online/virtual version of Yard Weather has been developed as a 20 min. performance. 1. Present-myth: influenced by old myths, important ideas from last year last and just a moment ago to compellingly address a present state through imaginative description and artistic means.

Accepted as: Oral Presentation

Abstract No : 958

On aftermaths and afterlives, afterimages and aftersounds: Mourning-as-witnessing ecological destruction in the southern ocean/s

Adrienne Van Eeden-Wharton, University of Pretoria

Water/Log' is an ongoing, site-responsive body of creative work in which I focus on the entangled histories of the 'harvesting' of whales, seals, seabirds and guano. I follow material and geopolitical flows in the enduring aftermaths of colonialism, extractivism, necro-capitalism and military-industrial expansion – from the mainland shores and islands along the southern African coast, to the South Atlantic, Indian and Southern oceans, the sub-Antarctic islands and, finally, to the frozen 'end/s of the earth': Antarctica. In an itinerant and associative presentation of still (moving) images and sound from 'Water/Log' – alongside extracts from diverse archival sources and an earlier project, 'Salt-Water-Bodies: From an Atlas of Loss' – I consider the work of art in terms of multispecies ethics of care and complicity, grappling with the unfinished labours of postmortem mourning-as-witnessing and a yearning towards more wake-full and just planetary futures. Unspectacular afterimages and aftersounds. Stories told in pieces, in parts.

Accepted as: Oral Presentation

Abstract No : 763

A Research on Representations of the Far South in Turkish Literature

Ebru Caymaz, Canakkale Onsekiz Mart University

Antarctica has long been a source of inspiration owing to its extensive spectrum of unique features. The concept of the “Far South”, which highlights both its remoteness and wilderness, also includes a variety of metaphors ranging from nature to space that stimulates the imagination around the world. Apart from the scientific studies, even the fictional works of the countries with no connection to polar regions have been affected by that concept. Accordingly, this study aims to examine representations of Antarctica in Turkish literature. It is found that the interest in polar regions dates back to the Ottoman period and fictional work pertaining to the Far South occupies a unique place within Turkish literature. Keywords: Antarctica, Antarctic Literature, Far South, Turkish Literature.

Accepted as: Oral Presentation

Abstract No : 148

Suffering and the Sublime in Antarctic Poetry and Verse

Ellen Frye, Wm. Pat. University of New Jersey

In the history, literature, and culture of Antarctica, poetry has always played an important role. "Suffering" itself is one of the key, or actually sacred, words uttered by probably every person who has ever visited Antarctica, including early and modern explorers, researchers and staff, adventurers, and tourists, too, who have suffered the turbulent waters crossing the Drake Passage. Many people have put into verse their thoughts and feelings about Antarctica, and these poems touch on suffering. Whether the earliest examples of Antarctic poetry from Wilson and others, or the most contemporary, we see the politics of Antarctica (the hybrid prose poems of Dennis James Sweeney, "In the Antarctic Circle," 2021); love found in Antarctica (multiple poets, "Love Songs for Antarctica," 2012); the religion of Antarctica (Luljeta Lleshanaku's "Homo Antarcticus," 2018, and "Antarctica," James Hoch, 2007); and the nature of Antarctica, incorporating the animals, stars, and ice (including Michael Leach's "The Plight of the Adélie Penguin," 2019, and Karla Linn Merrifield's "The Ice Decides: Poems of Antarctica," 2012). These poetic ventures incorporate suffering, directly or indirectly. Starting with Edmund Burke, 1757, contrasting with Hegel decades later, I use their work and others' as a springboard to analyze the sublime nature of Antarctic poetry, culminating with Joanna Price's seminal work. Upon analyzing selections of these poems, I demonstrate that indeed, there is an avalanche of agony to stumble upon, and to learn from, in the hauntingly beautiful poetry of Antarctica, which itself must be protected.

Accepted as: Oral Presentation

Abstract No : 78

Double Echo, art and science in Antarctica

Chris Drury, none

I went South in 2007 as a part of the Artist and Writers Program with The British Antarctic Survey. Art communicates at an emotional level so my presentation will be image based. I gave two presentations of my work on the boat down and at the main base. The resulting interest laid the foundation for collaboration. The met officer provided a daily weather and wind map, which produced the two works Albatross, now owned by BAS and the other by The Scot Polar Institute, and I was also first shown an echogram. At the remote base Sky Blu, I made most of the ephemeral works such as Wind Vortices – a vast drawing made with a Skidoo and a GPS on a fresh fall of snow. These works were recorded on film or video and were physically gone the next day. At Sky Blu and the Ellsworth Mountains, sitting in tents I was able to have extended conversations with climate scientists. I later worked with these people back in Cambridge on their echogram images of the 4 K of ice beneath our feet and the entombed mountains of Antarctica. These provided the bulk of the works produced as works on paper in the following 6 months; Double Echo, Lake Concordia, Everything Nothing etc. I am still working on them. One of these was presented in an issue of Nature. All of them are a deep blue colour and get to the heart of melting ice, Antarctica, and climate change

Accepted as: Oral Presentation

Abstract No : 369

The Ice Is Singing: Representing Antarctica through Music

Patrick Shepherd, University of Canterbury

When Earnest Shackleton talked of polar exploration, he summed it up as being not an outward journey but one within oneself . As a creative artist, my journey has been one of constant introspection, interpretation, reimagining and reflection, drawing together multiple threads in a portfolio of Antarctic-inspired works involving scientific, historic and natural phenomena. This phenomenological study, part action-research and part self-study, traces the creation of two large-scale dramatic vocal compositions—the chamber opera Poles Apart, and Cantata Antarctica for vocal soloists, choir and orchestra. Both draw on literary texts from the explorers themselves, as well as original material by myself and other contemporary artists who have travelled to Antarctica for inspiration. Examination of these compositions provides the referential touchpoints of an emergent artistic voice that resonates with Scott’s observation that “the ice is singing” .

Accepted as: Oral Presentation

Abstract No : 159

Polar Patterns: Mapping the eco acoustics of Eastern Antarctica

Philip Samartzis, RMIT University

Life on remote research stations is progressively resembling the broader contemporary experience, in which strict protocols are used to govern and preserve life. The resilient communities who live and work in these places have learnt how to co-exist with an increasingly hostile environment, along with its unknowns and necessity for hyper-vigilance. The way we live in Antarctica seems to reflect the way we now live on the rest of the planet. Rather than consider it as a place on the edge of elsewhere, Antarctica and its assemblage of durable, super modern colonies provides an archetype for an uncertain future in anticipation of increasing volatility and ecological dissonance. This presentation focusses on the work I have undertaken across the Australian Antarctic Territory recording natural, anthropogenic, and geophysical sound. The outcomes I have produced have provided immersive and affective experiences of the spaces, people, technologies, and conditions comprising the polar environment. Many of the recordings focus on the way the built environment is transformed through stress and fatigue caused by extreme climate and weather events including freezing temperatures and high velocity winds. In addition, the sounds of radar and scientific instrumentation used for upper atmospheric research and terrestrial communication offer further complexity to the acoustic environment through material activation. Projects like these remind us of the fundamentality of sound, its ability to express place and its attendant conditions, and the impermanence of nature. It is within this framework that Antarctica is offered as a space that has much to teach us.

Accepted as: Oral Presentation

Abstract No : 507

Bodies of Ice: Connecting Antarctic Ice to Our Bodies Through Dance

Christina Evans, Australian Antarctic Arts Fellow

"Our bodies are made up of pure water that at some point in time has been Antarctic ice. We are a part of the ice as well as its signs of a changing climate". 'Body of Ice' and 'Polarity' are dance works I created upon spending 6 weeks in Antarctica as a recipient of the Australian Antarctic Arts Fellowship. One focus of my work was the intrinsic connection we have to Antarctic ice - through our bodies. Our bodies are made up of pure water that at some point in time has been Antarctic ice. We are literally a part of Antarctic ice, it's cycles and processes, as well as its signs of a changing climate. When dancers are moving like the ice - layering, compressing, flowing, cracking, floating, crumbling, dissolving and melting - the fresh water in their bodies is recreating the time when it was ice. It also directly connects our actions to the Antarctic region. Expressing Antarctica and Antarctic ice through dance and the performing arts is critical in engaging an audience in a multi-sensory way, and physically impacts a viewers body and nervous system as they engage with live performance. It also demonstrates how we as humans are intrinsically connected to the Antarctic environment. This multi-sensory experience can create physical and emotional responses in viewers that can result in a deeper engagement with the region and potential solutions to climate change. *Can also present video footage of performances

Accepted as: Oral Presentation

Abstract No : 588

Antarctica, Africa and the Arts

Charne Lavery, University of Pretoria and University of the Witwatersrand

Adrienne Van Eeden-Wharton, University of Pretoria

Sophy Kohler, Independent

This paper provides an account of the first African Antarctic Arts and Humanities workshop which took place in May 2022, at the southern-most point of the continent of Africa, in Cape Agulhas National Park in South Africa. The focus was on Africa's relationship to its south-facing coastlines from the perspective of the arts and humanities, with the aim of navigating what it means to think Antarctica from Africa during the era of climate change. The workshop's location at the southernmost tip of continental Africa provided a unique vantage point for discussions that spanned from prehistory (the breaking up of the Gondwana landmass some 180 million years ago), via the history of colonial and Apartheid legacies linking Antarctica and southern Africa, to contemporary issues including migration and challenges facing local fishing communities. It was also future-oriented, reflecting – through presentations, film and poetry – on the reality of melting ice caps and rising sea levels for contemporary African coastlines. The paper describes the rationale for the workshop and provides an overview of the presentations, as well as an account of the developing network, both opportunities and challenges.

Accepted as: Oral Presentation

Abstract No : 384

From nuclear fiction in the 1950s to the bloody realities of South America in the 1970s. The life and Antarctic writings of Héctor G. Oesterheld

Pablo Wainschenker, University of Canterbury, Gateway Antarctica

This presentation focuses on the life and work of Héctor Germán Oesterheld, Argentina's most prolific Antarctic writer. Broadly absent from scholarly studies on Antarctic narratives, his stories about the South Polar regions demonstrate the challenges of creating an imaginary relationship with Antarctica from a South American perspective during the second half of the twentieth century. In the 1950s the government in Buenos Aires was promoting a patriotic territorial narrative established in the previous decade that focused on the idea of an "Antarctic consciousness". This official depiction presented Antarctica, and in particular the Antarctic Peninsula, in terms of territoriality. The archetypal story featured the military taking care of the far end of the homeland. However, while in Argentine popular culture the South Polar regions became a sensation during the Cold War, it was not for the reasons sought by the authorities. The Antarctica conjured in the popular imagination featured three-eyed monsters, aliens and German submarines. Created by Oesterheld, these stories not only diverted from the official discourse, but were also oblivious to another Argentine literary tradition in which the Southern Ocean constitutes a fluid space uniting the south of South America with Antarctica. The Antarctic work of Oesterheld evolved through time. His contribution to the engagement of South American popular fiction with Antarctica came abruptly to an end in 1978 when he was kidnapped and later killed by the military junta that ran the country at the time.

Accepted as: Oral Presentation

Abstract No : 715

Deception Island: A Portal to the South

Elizabeth Lewis Williams, University of East Anglia

Acts of imagination – and not always artistic ones – have formed part of Antarctic exploration since the idea of the continent was first conceived. Remote imaging has allowed the construction of detailed Antarctic topographies hidden from the human eye, and data collected this way requires an act of imagination to configure and interpret. The animation of the creation of Iceberg A68, as seen from a satellite, pulses like the ultrasound of a baby in the womb; the speeding up of glacial flow, shown in moving colour as a warming to red, signals the dangers of melting ice. This paper will look at the evolution of my poem and installation Deception Island, which aims to take the reader, or audience, on an Antarctic journey, asking whether the human imagination can act as its own remote sensing device, and whether the data it gathers can enable a different kind of virtual travel. The journey begins in the archives, with a translation of documentary and photographic material into poetic text. Explorations in poetic form and sound provide a way of engaging the senses in a textual experience of the island. Subsequent development of the text into an immersive experience in a replica Antarctic hut, through found sound, musical composition, and spoken word, engage the audience physically with the text. Audience feedback on their experience suggest that Deception Island really does provide a portal for travel through space and time, enabling a (partial) reconstruction of memory, and an intimate space for conversation and learning.

Accepted as: Oral Presentation

Abstract No : 544

Ilaia Further South

Paola Vezzani, Universidad de Magallanes

A short personal story where is shown how an artist can develop an idea during a trip that was meant not to be an artist's residence. Having the awareness of collaboration as a necessary value in Antarctica, this story shows how people can get involved in something when it is found to be meaningful. Also, the trip to Antarctica was life and art-making-changing experience. "It was December 2013 and I was working as regional director Ministry of Culture. From that platform, we developed the artist's residency program in Antarctica. As the local program had a national impact, I was invited to the Chilean Base in Union Glaciar to check the feasibility of inviting an artist there. The Base commander and the Architect were looking for a new name for the base. I proposed ilaia because is a yagan word that means "further south". Then, after a performance in which everyone in the base participates by lying on the snow to form the word ilaia, presents the new name to the authorities with a photo taken from above. The base name is not ilaia, but is the name Chilean Antarctic research publication of the INACH" After this experience, the value of collaboration emerges among the problems and concerns I work on as an artist. The importance of conservation in the current times is crucial for a possible future, and humanity is not able to be successful to achieve this goal without collaborating with each other.

Accepted as: Oral Presentation

Abstract No : 972

Jules Verne and Antarctica a way to explore futures for science and research in a world in metamorphosis

Emmanuelle Sultan, MNHN

Samuel Sadaune, Samsad Edition

More than any other writers, Jules Verne contributed to the elaboration of the polar myth. He created the type of the explorer of extreme places, Captain Hatteras, who persists in his quest in spite of everything. But he also created the ideal scientist in the person of Dr. Clawbonny, who discovers, contemplates, formulates hypotheses and also adapts to these territories. This took place in the Arctic. But very quickly, it is the legendary Antarctic that will hold the attention of the author. The South Pole becomes like a magnet that attracts his most famous characters: Nemo accosts it, Robur flies over it. Mistress Branican, the heroine of an eponymous novel, transposes to the southern seas the search for Lady Franklin, in search of her husband who disappeared in the Arctic. And above all, a true literary and mythical swan song, The Sphinx of the Ice, which combines the latest discoveries of real explorers (Dumont d'Urville) and Edgar Poe's unfinished novel, Adventures of Arthur Gordon Pym. These elements in the work of Jules Verne and the posture of the characters in it will serve as a point of support for thinking about the question of the posture of scientists and researchers in the light of global changes by calling on the history of science and technology, epistemology and ethics.



SCAR 2022

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HUMANITIES & SOCIAL SCIENCES

**New approaches to Antarctic and
Southern Ocean histories**

CONVENORS

Peder Roberts, Joy McCann, Nelson Llanos

Accepted as: Oral Presentation

Abstract No : 973

Architectural & Material History. An alternative to Antarctic master narratives.

Victoria Nuviala Antelo, CONICET – INAPL – Universidad de Buenos Aires

Violeta Nuviala Antelo, CEIHVAL – Universidad de Buenos Aires

Maria Ximena Senatore, INAPH/UA & CONICET/UNPA

Lucía Roitman, Universidad de Buenos Aires

Lucila Salvo, Universidad de Buenos Aires

Melina Lotarynski, Universidad de Buenos Aires

Emilia Oszlak, Universidad de Buenos Aires

Paz Fodde, Universidad de Buenos Aires

During recent decades, fundamental contributions by disciplines focused on material culture have proven their value in producing alternative Antarctic narratives. Furthermore, Subantarctic archaeology has helped to bring to the surface unknown stories and diversify the trajectories of Antarctic history outside the framework traced by the Master Narratives. Similarly, the History of Architecture has shown its capacity to produce new approaches to the history of the Antarctic and the Southern Ocean regions. Molding alternative stories built upon dimensions less explored as design trends, building techniques, and deployment strategies, taking architecture from its traditionally background-static role into an active and dynamic part. This lecture aims to present alternative trajectories of Antarctic history based on the architectural study of scientific facilities designed and built since the end of the 19th century. This lecture will map three moments within the Modern Antarctic history: first, a moment guided by the exploration of an unknown and isolated territory structured upon mobile and standardized architecture; second, a moment led by permanence and territorial claims, accompanied by solid and noticeable architecture with strategic deployment within the territory; and finally, a moment conducted by the ideal of a return to a pristine environment, materialized by minimalistic designs and sustainable buildings.

Accepted as: E-poster Presentation

Abstract No : 18

Politics Persisting: Britain and the Icebreaker Issue (1955–59)

Alice Oates, Scott Polar Research Institute

In the late 1950s Antarctic science and geopolitics were in a state of change, driven by the International Geophysical Year (1957 – 58), and soon to be cemented by the Antarctic Treaty. These developments would seemingly see Antarctic states dragged away from their nationalist, heroic-era pasts, into an enlightened future of 'peace and science'. Behind the headlines however, the old urge to hold tight to Antarctic claims was proving hard to shake. This poster explores how politics persisted after the IGY through the issue of Britain's lack of an ice-breaking ship. It draws on public narratives in press articles and speeches to understand the ways the elite men of British Antarctic science and politics framed the icebreaker issue. It makes an argument for the relevance of Star and Griesemer's (1989) concept of boundary objects for understanding how Antarctic stations and expeditions, specifically the Royal Society IGY base and Commonwealth Trans-Antarctic Expedition, were mobilised to suit particular agendas at this time of flux for Antarctic geopolitics.

Accepted as: Oral Presentation

Abstract No : 14

American Antarctic Policy Development during the Eisenhower presidency.

Bryan Lintott, University of Cambridge / University of Tromsø

The United States of America's National Security Council (NSC) was the centre of strategic policy development during Dwight D. Eisenhower's presidency, and the forum within which American Antarctic policy was developed. Eisenhower's experience as Supreme Allied Commander during World War II, and then NATO, informed the way in which the NSC operated with working groups, including on Antarctica, and subject experts providing a range of options to be discussed and debated at the NSC with the President making the final decision, or choosing not to make a decision at the time. In the context of Antarctic policy, there were strong debates within the NSC as to what actions – if any – the United States should take, with disagreement between the Department of State, Central Intelligence Agency and Department of Defence. The President's decisions on Antarctica, both decisive and deferred, were to result in ongoing internal tensions. Adding additional complexity to the 'Antarctic problem' was the Union of Socialist Soviet Republics' decision to establish an Antarctic presence during the International Geophysical Year, and developments in rocket technology. This presentation will provide an historical overview of how American Antarctic policy developed, and consider three illustrative proposals that did not eventuate: an American Antarctic territorial claim, a major mapping programme and an Antarctic Commission. In conclusion, the emerging consensus within the NSC for a treaty that resulted in the United States of America proposing an Antarctic Treaty and undertaking the necessary diplomatic endeavours will be discussed.

Accepted as: Oral Presentation

Abstract No : 728

Approaching sealing landscapes. A reflection on places, mobilities and tasks in nineteenth-century Antarctica

Melisa Salerno, Multidisciplinary Institute of History and Human Sciences, National Scientific and Technical Research Council –CONICET, Argentina

María Jimena Cruz, Multidisciplinary Institute of History and Human Sciences, National Scientific and Technical Research Council –CONICET, Argentina

The South Shetland Islands became the focus of commercial sealing in the nineteenth century. At that moment, the skins of fur seals were sought for the production of fashion goods, while the oil of elephant seals was used for lighting, and the production of machine lubricants, among other things. For fifteen years now, the 'Landscapes in White' research project – of which we are part– has conducted archaeological studies at multiples sealing sites in Livingston Island. While this work has shed light on different aspects of sealers' lives , the primary focus on the archaeological site as a unit of study has sometimes overshadowed a deeper consideration of sealing landscapes. In this presentation we will reflect on sealing landscapes as 'landscapes of production' intertwining places and movements, as well as multiple tasks. Tim Ingold's reflections on landscapes (including ideas on temporality, the dynamics of taskscapes, and the mutual relationships between human and non-human agents) provide relevant tools for analysis, along with other contributions from the "mobilities turn" in humanities and the studies of "chaîne opératoires". The presentation will resort to unpublished sealing logbooks describing nineteenth-century sealing voyages to the South Shetlands as the primary source for analysis. The results of the work will allow assessing the complex nature of sealing landscapes in the region. Furthermore, they will provide an interesting chance for discussing the impact of a landscape perspective in the archaeological research and heritage management of sealing material remains.

Accepted as: Oral Presentation

Abstract No : 868

The history of Cobalescou (Cobalcescu) Island in Antarctica transposed into art

Mariana Ioanitescu, Art Gallery „Galeria 15”, Bucharest, Romania

Florica Toparceanu, „St. S. Nicolau” Institute of Virology, National Commission for Antarctic Research of Romanian Academy

Iulia I. Nita , National Commission for Antarctic Research of Romanian Academy

Cobalescou Island (64°11'S, 61°39'W) was discovered on 27.01.1898 by the Belgian Antarctic Expedition. The expedition's naturalist, the Romanian Emil Racovita, named it in honor of his natural science teacher, the renowned European geologist Grigore Cobalcescu. Although the island is not in the way of current naval routes, there are accessible sources of information about it due to a group of Romanians who managed to get there in 2012. This paper illustrates these moments in a triptych as a time arc between 1898-2012. The left sequence of the triptych evokes the discovery of the island showing the moment in two poses: the ship "Belgica" image and Emil Racovita image in his laboratory on the ship looking through the porthole at the newly discovered island, with Grigore Cobalcescu's book in his hands. The central piece details the rocky relief of the island, populated by chinstrap penguins and has remained unchanged over time, as evidenced by the analysis of photographs taken in 1898 and 2012. The third part of the triptych depicts two surprisingly similar face-to-face profiles: of a slope of the island, inspired by the image captured and named "The Sphinx" by the Romanian photographer Helmut Ignat in 2012, and of Adrien de Gerlache. The triptych is an artistic homage to Adrien de Gerlache, commander of the "Belgica" Expedition, and to Emil Racovita, the expedition's naturalist, for their valuable contributions to the development of Antarctic science and the inscription on the Antarctic map of the name of a Romanian personality, Cobalcescu.

Accepted as: Oral Presentation

Abstract No : 977

History of the Chilean Antarctic Law: 200 years of Chilean policy and rule-making with an eye on the South

Luis Valentín Ferrada, Universidad de Chile

History of the law (or legal history) is often defined as the study of how the law has evolved and why it has changed. Although the historian's work is never finished, it is possible to affirm that the history of the international Antarctic law – the history of the Antarctic Treaty and the development of the ATS– has been broadly studied. On the contrary, the history of the domestic law about Antarctica has deserved less attention. This is problematic for at least two reasons. First, because the history of Antarctica did not begin in 1959, we need to know what happened before, including the relationship between domestic law and the Southern Continent. Second, even if we want only to consider the Antarctic Treaty era, we have to assume that international agreements need to be developed domestically to be enforceable. Considering itself as a State with sovereign rights over Antarctica at least since the times of General O'Higgins, the Chilean independence hero, and supported by the old colonial Spaniard titles, Chile has a very long history of ruling over the Sixth Continent and surrounding seas. Since the XIX century, the country has enacted more than 350 laws and by-laws about Antarctic matters. This rule-making process has its main milestone in the Chilean Antarctic Law (2020), but it has to be also considered some rules about Antarctica in the current new Constitution draft. This presentation is an advance of a forthcoming book and will make an overview of these 200 years' normative process.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

HUMANITIES & SOCIAL SCIENCES

**Values in Antarctica: identification and
vulnerability to anthropogenic impacts**

CONVENORS

Rupert Summerson, Shaun Brooks

Accepted as: Oral Presentation

Abstract No : 133

Rereading the Environmental Protocol

Alejandra Mancilla, University of Oslo

Since its inception, over thirty years ago, the Protocol on Environmental Protection of the Antarctic Treaty (EP) has been both hailed for securing tight environmental protection over a whole continent, and criticized for leaving too much power of decision and interpretation on individual states. In this article, I claim that the EP has a radical potential that, if realized, could make it into an avant-garde legal instrument to inspire global environmental governance. I focus on two points. First, given its overall objective towards “the comprehensive protection of the Antarctic environment and dependent and associated ecosystems”, I suggest that parties should commit themselves to action not just within the Antarctic Treaty Area but beyond it. Second, the claim that Antarctica has intrinsic value should be spelled out. To say that something has intrinsic value means that it is not just a means for something, but an end. It is thus worth asking what rights and correlated duties may be derived from the claim that a whole continent, or certain parts and/or entities within it, are intrinsically valuable. Different answers to this question will lead to very different practical prescriptions. I conclude that the EP may lead the way as an instrument for the effective protection of the Antarctic environment and beyond, so long as its parties are open to the possibility of reinterpreting some of its key passages, as well as correcting some fundamental inconsistencies between its goals and the measures proposed to fulfill them.

Accepted as: Oral Presentation

Abstract No : 596

Identification of potential candidates for designating Antarctic Specially Protected Areas (ASPAs)

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Fritz Hertel, German Environment Agency

The Antarctic Treaty Parties are currently endeavouring to establish a coherent network of protected areas in the Antarctic incorporating the existing protected areas. Germany wants to contribute to this network for the first time by identifying and proposing candidates for the designation as Antarctic Specially Protected Areas (ASPAs). To identify potential ASPAs, we conducted a search for suitable sites based on the following criteria: – Ecological, biological, geological or geomorphological features or peculiarities, – Classification as Important Bird Area, – Significance for seals and vegetation, – Scientific significance, – Potential threats As a result, we compiled a list of 13 appropriate areas. Supported by an advisory board of German polar institutions, we selected two candidates to be proposed for designation as an ASPA. The proposed area 'Danger Islands' comprises a set of seven islands off the northeastern coast of the Antarctic Peninsula while the proposed area 'Otto-von-Gruber-Gebirge' represents a continental high mountain oasis in the Wohlthat Massiv region of Dronning Maud Land. Since scientists from the USA have been working in both areas for some years, we developed the proposals jointly. According to the guidelines of the ATCM we prepared the Prior-assessments for these areas, which have been accepted by the Treaty Parties at CEP XXIV in Berlin 2022 as a first step towards the designation of an ASPA. In this presentation, we introduce the process of identifying the areas and discuss current constraints on the way to a more systematic and representative designation of new areas worthy of protection.

Accepted as: Oral Presentation

Abstract No : 141

Improving species-based area protection in Antarctica

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Area protection is a major mechanism deployed for environmental conservation in Antarctica. Yet, the Antarctic protected areas network is widely acknowledged as inadequate, in part because the criteria for area protection south of 60°S are not fully applied. The most poorly explored of these criteria is the type locality of species, which provides the primary legal means for Antarctic species-based area protection and a method for conserving species even if little is known about their habitat or distribution. The type locality criterion has not been systematically assessed since its incorporation into the Protocol on Environmental Protection to the Antarctic Treaty in 1991, so the extent to which the criterion is being met or might be useful for area protection is largely unknown. To address the matter, we created and analyzed a comprehensive database of Antarctic type localities of terrestrial and lacustrine lichens, plants, and animals. We compiled the database via a literature search of key taxonomic and geographic terms and then analyzed the distance between type localities identifiable to a $\leq 25\text{km}^2$ resolution and current Antarctic Specially Protected Areas (ASPAs) and human infrastructure. We used a distance-clustering approach for localities outside current ASPAs to determine candidate protected areas that could contain these unprotected localities. Of the 386 type localities analyzed, 108 were within or overlapped current ASPAs. Inclusion of the remaining 278 type localities in the ASPA network would require the designation of a further 105 protected areas. Twenty-four of these areas included human infrastructure disturbance. Given the slow rate of ASPA designation, growing pace of human impacts on the continent, and the management burden associated with ASPAs, we propose ways in which the type locality criterion might best be deployed. These include a comprehensive, systematic conservation planning approach and an alternative emphasis on the habitat of species, rather than on a single locality.

Accepted as: E-poster Presentation

Abstract No : 484

AGIVA – Intrinsic Value in Antarctica

Yousra Makanse, Wageningen University

Rupert Summerson, Independent scholar

Alfonso Donoso, Pontifical Catholic University of Chile

The 1991 Protocol on Environmental Protection to the Antarctic Treaty (the “Madrid Protocol”), which came into force in 1998, mandates the protection of the intrinsic value of Antarctica (Article 3, ‘Environmental Principles’, paragraph 1): The protection of the Antarctic environment and dependent and associated ecosystems and the intrinsic value of Antarctica, including its wilderness and aesthetic values and its value as an area for the conduct of scientific research, in particular research essential to understanding the global environment, shall be fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area. The position of intrinsic value in this context makes it a fundamental consideration for Antarctic governance. However, the Madrid Protocol provides no further guidance on how to define intrinsic value nor how it should be judged, and, to date, there has been little understanding or substantive debate about what intrinsic value means or how its protection can be effected. The Action Group on Intrinsic Value in Antarctica (AGIVA) was formed under the auspices of the SCAR Standing Committee on the Humanities and Social Sciences to develop and promote a better understanding of the concept of intrinsic value across multiple cultures and to model a framework for implementing the duty towards intrinsic value enshrined in the Madrid Protocol. In aiming to increase and consolidate understanding of what intrinsic value means in the Antarctic context, AGIVA intends to promote enhanced discourse and further the dialogue about the significance of the values and principles of the Antarctic Treaty System.

Accepted as: E-poster Presentation

Abstract No : 559

Proposed Antarctic Specially Protected Area at Danger Islands Archipelago (North-eastern Antarctic Peninsula)

Christian Pfeifer, THINK – Thuringian Institute of Sustainability and Climate Protection

Marie-Charlott Rümmler, THINK – Thuringian Institute of Sustainability and Climate Protection

Osama Mustafa, THINK – Thuringian Institute of Sustainability and Climate Protection

Germany and the United States of America have proposed the establishment of an Antarctic Specially Protected Area (ASPA) Danger Islands (North-eastern Antarctic Peninsula) at ATCM XLIV in Berlin. As a first step towards the designation of an ASPA the Prior-assessment has been accepted by the Treaty Parties. The proposed ASPA would be a multi-site ASPA intended primarily to protect important breeding sites for seabirds. The area is representative of the ecosystems of small rocky islands off the coasts of the northern Antarctic Peninsula containing most of the bird species typical for this region. With proof of at least 10 breeding species, avian diversity can hardly be higher in the Antarctic. What makes the area above all outstanding and distinctive from other areas is its enormous abundance of Adélie penguins, including the third and fourth largest colonies of this species globally on Heroína and Beagle Island. All colonies of the area sum up to about 750,000 breeding pairs, which is more than half of the Adélie Penguin breeding population of the Antarctic Peninsula region. Additional to its outstanding Adélie penguin population and its high avian diversity, the ecological importance of this area is complemented by a major colony of Antarctic shags, comprising 1.2 % of its global population. Monitoring the wildlife populations and analysing its role in the marine ecosystem has a high scientific potential. The management plan for the area is currently being developed by the proponents.

Accepted as: Oral Presentation

Abstract No : 536

Intrinsic value in Antarctica – what is intrinsically valuable?

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Rupert Summerson, Independent scholar

Yousra Makanse, Wageningen University & Research

The Protocol on Environmental Protection to the Antarctic Treaty (1991) lays out the environmental principles that govern human activity in Antarctica. In addition to expressing the conviction of the signatory states about “the need to enhance the protection of the Antarctic environment and dependent and associated ecosystems” (Preamble), the Protocol makes an explicit commitment to protect “the intrinsic value of Antarctica, including its wilderness and aesthetic values” (Art. 3). This is presented as one of the “fundamental considerations in the planning and conduct of all activities in the Antarctic Treaty area” (Art. 3). This paper focusses on the axiological dimension of the Protocol, defending the importance of including the idea of intrinsic value in the Madrid Protocol. The substantive challenge in the articulation of the concept of intrinsic value in the Protocol is the precise determination of what is intrinsically valuable in Antarctica. This paper will propose an answer to this issue, a matter which has been insufficiently studied by those interested in Antarctica and its environment.

Accepted as: E-poster Presentation

Abstract No : 560

Proposed Antarctic Specially Protected Area at Otto-von-Gruber-Gebirge (Dronning Maud Land, East Antarctica)

Marie-Charlott Rümmler, ThINK Jena

Christian Pfeifer, ThINK Jena

Osama Mustafa, ThINK Jena

Germany and the United States of America have proposed the establishment of an Antarctic Specially Protected Area (ASPA) Otto-von-Gruber-Gebirge (Dronning Maud Land, East Antarctica) at ATCM XLIV in Berlin. As a first step towards the designation of an ASPA, the P rior-assessment has been accepted by the Treaty Parties. The proposed ASPA is intended to protect a range of environmental, scientific, historic, aesthetic, and wilderness values. The environmental values to be protected in the area include two large ice-covered freshwater lakes with unique features like the only known large conical stromatolites in Antarctica, and one of the largest known breeding colonies of snow petrels (*Pagodroma nivea*). In general, the area represents an isolated polar desert oasis ecosystem with sparse vegetation. The scientific values of the area primarily build on those environmental values, including the ecology of the freshwater ecosystems and the snow petrel colony, but also on exobiology, geomorphology, paleoclimatology and geology. The management plan for the area is currently being developed by the proponents.

Accepted as: Oral Presentation

Abstract No : 589

Human-mediated dispersal of Antarctic invertebrates

Stanisław Cukier, Institute of Biochemistry and Biophysics PAS

Katarzyna Fudala, Institute of Biochemistry and Biophysics PAS

The increasing number of people visiting the Antarctic in recent years is a challenge in terms of preserving the original character of areas newly exposed from ice. Retreating glaciers are uncovering new landscapes that are particularly valuable scientifically, as they are peculiar laboratories for species succession and many other processes, focusing the attention of a wide range of disciplines. However, human presence in these remarkable parts of the Antarctic is also a huge threat to natural processes, the course of which can be irreversibly altered by unintended and often unconscious activity. We conducted an experiment demonstrating the potential for transfer on the field workers' footwear of Antarctic freshwater invertebrates. The record amount of sediment taken from one pair of footwear was 233.1 g, resulting in isolation of 29 Tardigrada, 15 Nematoda, 4 Rotifera individuals and 4474 Copepoda, 660 Anostraca cysts. We investigated the hatching ability of cysts isolated from footwear and subjected to a 27°C drying process. 15.15% of *Branchinecta gaini* and 2% of *B. poppei* eggs hatched in 15 days after flooding with tap water. The aim of our experiment was to stimulate discussion on the risk of human-mediated transfer of Antarctic native freshwater invertebrates to newly established freshwater ecosystems and thus the risk of disruption of natural succession processes as a result of anthropochory. We want to draw attention to the necessity of protecting the most valuable areas, where the human foot has not yet left its mark.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

HUMANITIES & SOCIAL SCIENCES

Living and working in Antarctica

CONVENORS

Pedro Marques-Quinteiro, Daniela Liggett,
Gabriela Roldan

Accepted as: Oral Presentation

Abstract No : 530

Profiling Antarctic Tour Guides

Hanne Nielsen, IMAS UTAS

Gabriela Roldan, University of Canterbury

For the 75,000+ tourists who head to Antarctica each season, the continent is a holiday destination. Yet for the Expedition Team who deliver the Antarctic product, the same location is a workplace. In order to work effectively and safely in this environment, guides require a range of skills. These range from boat driving to lecturing to crisis management. In recent years the Polar Tourism Guides Association (PTGA) has emerged to fill a gap in the market for assessing the competence of polar workers against a range of these areas, yet many guides also draw on extensive skillsets from parallel careers. The range of these skills, and the extent to which these are the result of formal or informal training, deserves closer attention as it is a key component when considering the training of the future polar guiding workforce. Drawing on interviews with 22 Antarctic tour guides, this paper presents a profile of the Antarctic tour guide. It considers aspects such as guide background and skillsets, formal qualifications, and the career trajectory that led to guiding in the far south. Guides also identified their perceived future challenges for the industry. Such insights into the capabilities of Antarctic tour guides are particularly valuable at this juncture, as tourism resumes post covid-19 pandemic and discussions around the professionalisation of the industry continue. By focussing on guides themselves, this paper foregrounds the experiences of the tour-guiding workforce in the Antarctic and the skilled contributions they make to delivering the lucrative polar product.

Accepted as: Oral Presentation

Abstract No : 766

France's Dumont d'Urville Antarctic station decarbonized by 2050. Presentation of the architectural and technical project by its design team. Study commissioned by the French Polar Institute Paul Emile Victor (IPEV)

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Studies for the expansion of French Antarctic station Dumont d'Urville anticipate its decarbonization by 2050. Combining low and high-tech approaches, the project experiments with innovative methods and constructive solutions. Aiming to reduce the environmental footprint of human activity, various points were examined: lifecycle analysis of materials, evaluation of the environmental impact of operating the facilities, reduction of energy consumption and particularly of grey energy. The options selected to meet these ambitions while simultaneously increasing the facility's capacity, were to maintain wherever possible the 20th-century architectural heritage, optimize performance of existing building envelopes, redistribute logistics flows and group together different activities, and where new build is necessary, to place these facilities above existing structures. The design focused on what was already there, densifying and reorganizing the existing to restore 3 hectares of Petrels Island to wildlife and science. The simplicity of the construction systems was prioritized to enable the possibility of self-renovation, relying on the skills of the team on site. This approach helps to limit the transport of materials from France and minimize the production of waste to be sent back. High levels of technical expertise (high tech) were required in the design of structures to meet the exacting performances required for extreme conditions (temperatures, katabatic winds), while also allowing for their maintenance and transformation by non-building specialist personnel (low tech). Finally, it was necessary to reduce use of and replace the energy-intensive transport systems (combustion engines), and to plan for the production of alternative energies in situ (wind, hydrogen).

Accepted as: Oral Presentation

Abstract No : 11

INDICATORS OF PSYCHOLOGICAL STATES OF PEOPLE DURING LONG ANTARCTIC EXPEDITIONS

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Larysa Bakhvutova, National Antarctic Scientific Center, Ministry of Education and Science of Ukraine

Extreme conditions of Antarctica and socio-spatial isolation of a small group of expeditioners significantly affect to physiological and psychological state of the members of team. Therefore, the monitoring of psychophysiological and psychological indicators is an important part of assessing the condition of winterers in extreme conditions in Antarctica. Identify the dynamics of expeditioners' psychological state indicators during yearly Antarctic expeditions as a significant factor in of the psychophysiological, mental and social health of people in extreme natural conditions and long-term isolation. Twelve peoples (all males, age from 29 to 60 years) were examined during the thirteen monthly stay on Ukrainian Antarctic Akademik Vernadsky Station. The modified methodology of the scaled psychological state self-assessment was applied for monthly monitoring. The states were assessed for the psycho-physiological (well-being, activity, mood, performance, health status) and social-psychological (satisfaction with relations with colleagues, satisfaction with the environment and work performed, life satisfaction) components. For statistical analysis were used Descriptive statistics (mean, standard deviation); One-Sample Kolmogorov-Smirnov Test and Paired Sample T-Test. In general, the self-assessed indicators of expeditioners' psychological states rise significantly during the first four months of the year-long expedition. Further, the self-assessments begin to decline gradually, reaching the lowest values in the last two months of staying at the Antarctic station. However, some indicators showed dynamics slightly different from the general tendency, and psychological states of some peoples remained quite stable during all expedition. Hence the long stay and work within an isolated group of people in Antarctica is a factor that affects the expeditioners' psychological health at the first place.

Accepted as: Oral Presentation

Abstract No : 771

Mental Health in the Antarctic Experience: Analysis of Mood and Feeling Monitoring Diaries

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The Antarctic experience involves extreme environmental conditions at different levels of confinement and isolation, but also brings positive factors for personal and professional fulfillment. However, there is a clear risk of negative impacts, including emotional, behavioral and cognitive changes. We applied mood and feelings diaries to a population of volunteer expeditionaries from the Brazilian Antarctic Program in 2019 and 2020 (N = 91). This tool, developed for the Antarctic Mental Health Booklet, a mental health monitoring instrument, was filled in for up to twelve weeks, by civilians and military personnel, men and women, on ships, polar stations and camps. Adequately filled in mood state and feelings diaries were included in the analysis (N = 61). Longitudinal affect graphs indicate coherence and suitability of this model for identifying different affective states over time, and lead to classification of the emotional experience of expeditionaries into empirical categories which constitute a unit of analysis comprising affectivity and their underlying psychological processes of resistance and submission. To better understand the underlying psychological process, we compared those empirical categories to the coping strategies of Utrecht Coping List. The results demonstrate the feasibility of this model for daily mood and feelings monitoring and research, and contribute to further knowledge concerning mental health in Antarctica.

Accepted as: Oral Presentation

Abstract No : 31

Who is in command? Hierarchy and leadership on historical Antarctic expeditions

Ursula Rack, Gateway Antarctica, School of Earth and Environment, University of Canterbury, New Zealand

In the extremes of Antarctica, historical leaders had to rise to the challenge of asserting their authority without any external support. The situation could become more complex when there were two formal leaders: the ship's captain, from the realm of nautical authority, and the scientific leader from academia or a research institution. Antarctic bases were also scenes of disputes and the breakdown of authority. Whilst successful Antarctic leadership, like that of Ernest Shackleton, can be informative and inspiring, there is merit in examining instances where leadership catastrophically failed. The Second German Antarctic expedition (1911–1912) sailed under the Imperial German flag. That set the frame of the hierarchical structure. The captain, Richard Vahsel, suffered from personal problems, and the scientist, Wilhelm Filchner*, an army officer, lacked the authority, experience, expertise, and character necessary to deal with the hierarchical and personal challenges that arose. When open conflict widely spread between the two and their respective camps, the results were both devastating to the individuals and dangerous for the expedition. This paper compares three different styles of leadership that historical Antarctic expeditions applied and highlights the importance of efficient leadership in extreme environments and unforeseen situations. Antarctic leadership continues to be an area of ongoing research, both in the context of the Arctic, the Antarctic, and planned missions to space. Reference: * Rack, U (2021), Wilhelm Filchner – hierarchy and insufficient leadership on the Second German Antarctic Expedition. *Polarforschung*, 89, 25–30 <https://doi.org/10.5194/pol-89-25-2021>

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Abstract No : 704

“Brotherhood of Men”. Soviet Masculinity and Solidarity in Antarctica

Elias Angele, University of Bremen

In Soviet propaganda, women’s liberation played an important role to distinguish the state from the capitalist West. In Antarctica, however, Soviet women were generally not involved in the expeditions. In the words of Mikhail Somov, first leader of the Soviet Antarctic Expedition, Antarctica was the only entirely male continent, “completely freed from restrictions on the part of the ladies” and, therefore, all men would work more effectively. The glaciologist Igor Zotikov even spoke of Antarctica as a “brotherhood of men”, evoking romantic images of a spiritual community of celibate male scientists. This paper focuses on the question why the imbalance between statements of emancipation on the one hand and an exclusionary practice in the Antarctic on the other hand came into being. By analysing a variety of speeches and memoirs, as well as psychological studies of Soviet participants of the expeditions, it is argued that the male gaze on Antarctica served as a motivation to overwinter there. For Soviet males in particular, the Antarctic became a resort to which they could escape from the problems of a deeply troubled masculinity in Soviet society.

Accepted as: Oral Presentation

Abstract No : 648

Team Challenges and Resilience in Isolated, Confined, and Extreme Environments

Andres Käösaar, University of Central Florida

Shawn Burke, University of Central Florida

Challenges encountered by teams operating in Isolated, Confined, and Extreme (ICE) environments are the core reason why these teams are considered different from traditional teams. Despite the existing literature focusing on trait resilience and adaptation processes in ICE, there is a lack of understanding of how different triggers affect teams in these environments. The current study aims to shed light on the dynamics of different challenges inducing the need for resilience in ICE contexts and the effect of other factors, e.g., team composition and processes, in dealing with the challenges. For this, weekly data from a 12-week Antarctic campaign was collected. The 8-person team consisted of two subteams, creating a multi-team system (MTS). Data was collected on different team processes (e.g., leadership and conflict) and emergent states (e.g., team cohesion and trust) together with resilience triggers and stressors. Qualitative data was collected via weekly journals and post-expedition interviews. The results reveal how even in a small station, compositional factors of the MTS (i.e., differences between the two subteams) and the character of individual task-related roles affect what kind of challenges the teams and their members encounter and to what extent the challenges affect their tasks and well-being. The dynamic nature of these mechanisms, their effect on team processes and emergent states, and the implications for stakeholders will be further elaborated upon in the presentation.

Accepted as: Oral Presentation

Abstract No : 60

Breaking the silence around blood: Managing menstruation during remote Antarctic fieldwork

Meredith Nash, Australian National University

Drawing on qualitative interviews with female expeditioners in the Australian Antarctic Program, this paper examines the additional labour involved in managing menstruation during remote Antarctic fieldwork. Unlike expeditioners working on a research station, fieldworkers rarely have consistent access to private toileting facilities or dedicated times/spaces to deal with their bodily excretions. However, being able to easily access toileting facilities can significantly impact how people who menstruate experience fieldwork. This is an overlooked but crucial corporeal challenge of working in Antarctica. Findings reveal that in male-dominated spaces, expeditioners must go to great lengths to make their menstruation invisible. A primary way that women do this is through menstrual suppression technologies. When these are not available or not preferred, women negotiate trying to keep their menstruation and gynaecological health issues hidden but often do so in field settings where there is little infrastructure or support. I argue that the lack of infrastructure to support menstrual health in the field is a form of sexism that maintains women's lower status in polar field environments. To conclude, I provide practical guidance for National Antarctic Programs to support people who menstruate.

Accepted as: Oral Presentation

Abstract No : 17

“It was a really peculiar place, but somehow it just felt like home”: the case for taking seriously the emotional lives of Antarctic winterers

Alice Oates, Scott Polar Research Institute

The factors shaping the life of an Antarctic research station are many and varied. Some are tangible, such as logistics and funding. Some are more complex or hidden but leave traceable, material tracks for the researcher: geopolitics, histories of Antarctic exploration, and changing scientific values. This paper makes a case for serious consideration of a more intangible element: the emotional lives of Antarctic winterers. The people who work in research stations have complicated experiences of their time in Antarctica. This paper will draw on interviews with winterers from Halley research station to explore the emotional dimension of those experiences, including relationships with other winterers, with their work, and with the place. It will argue that attention to the emotional dimension of Antarctic science can deepen our understanding of the past, present, and future of these unique places and the people who inhabit them.

Accepted as: Oral Presentation

Abstract No : 997

I used to dream in orange. Personal Experience of Architecture in the Antarctic

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Victoria Nuviala Antelo, CONICET – INAPL – Universidad de Buenos Aires

María Ximena Senatore, Universidad de Buenos Aires

Lucila Salvo, Universidad de Buenos Aires

Lucía Roitman, Universidad de Buenos Aires

Emilia Oszlak, Universidad de Buenos Aires

Guadalupe Tagliabue, Universidad de Buenos Aires

Abstract II: I used to dream in orange. Personal Experience of Architecture in the Antarctic. Architecture has been perceived traditionally as a material and static phenomenon. However, recent theoretical perspectives have introduced new dimensions to architectural studies. The Affective Turn (Eve Sedgwick) and the Performance Perspectives (Judith Butler) lead us to a more dynamic comprehension of architecture and its multidimensional perception. As a result of this theoretical turn, personal experiences have emerged as a rich field for research, revealing the necessity for documentary sources based on personal experience. In this sense, Archive SUR (Virtual Archive on Architecture and Habitat in Antarctica) has been structured based on two sections: institutional and private collections. This section encompasses aspects linked to an individual's personal experiences of architecture, such as a sense of belonging, material and spatial perceptions, and dwelling, recently incorporated into the Archive database and our current architectural studies. The presentation discusses the potential of this section of the Archive for architectural and historical studies of Antarctic facilities and dwelling practices.

Accepted as: E-poster Presentation

Abstract No : 1034

Long duration remote body composition monitoring using 3-dimensional optical scans: the ASTRO3DO project

Jonathan Bennett, University of Hawaii Cancer Center

John Shepherd, University of Hawaii Cancer Center

Michael Wong, University of Hawaii Cancer Center

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John Cherry, Australian Antarctic Division

Kate Kloza, Australian Antarctic Division

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Sandra Iuliano, University of Melbourne

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Jeff Ayton, Australian Antarctic Division

The remoteness of Antarctic expeditioners may be impact their diet and physical activity which may lead to increased fat and decreased muscle. The ability to remotely monitor changes in body composition remotely with accessible technologies is unknown. We asked what was the precision of remote body composition monitoring? Recruitment was open to all staff at Davis and Mawson bases to received paired 3D Optical (3DO) whole body scans and dietary questionnaires at monthly wellness visits. Images were acquired by onsite medical practitioners, after remote training, along with manual anthropometry. Scans were standardized using Meshscapade software. Body composition was assessed using in-house algorithms. Test-retest precision was evaluated to determine how frequent scans needed to be taken to monitor a 1 kg change in fat in a month. In total, 22 expeditioners (18 male, age = 43.9 ± 10.7 y, BMI = 27.8 ± 3.8 kg/m²) participated with monthly measures over a 3-5 month period, resulting in 148 total scans. The precision for fat mass was RMSE = 1.4 kg (%CV=5.15%), was worse than for similar experiments performed under laboratory conditions RMSE = 0.8 kg and when compared to clinical-grade 3DO scanners (RMSE = 0.4 kg). To monitor 1 kg changes in a month would require approximately 8 scans/week. Fat mass from 3DO scans could be monitored sensitively but improvement in the precision would decrease the number of scans needed. We plan to further evaluate ways to improve precision of 3DO scanning in remote environments.

Accepted as: Oral Presentation

Abstract No : 970

First year review of the « HABIT-ANT ? » project, some preliminary results.

Emmanuelle Sultan, MNHN

Elisa Dupuis, Sorbonne Université et Archives Nationales

Rachel Prat Lamy, EHESS

The Antarctic scientific research stations combine isolation and community life. The Antarctic situation is therefore truly unique, particularly because of its extreme nature. Since the installation of permanent French bases in Adelie Land, the continuity of the human presence on these lands has had multiple impacts on the way they have been occupied, lived and perceived. The aim is to explore certain aspects of this: – technical (analysis of the production of specific equipment) – sociological (analysis of the different modes of experience of these places, carried out in situ or ex situ) Thus, we also question the role of the conditions of access to the field in two distinct cultural processes: that of the construction of scientific knowledge through the acquisition of data produced on site, and that of the heritage involving both institutions and civil society. The aim is to present the first year of a multi-site fieldwork of the HABIT-ANT? programme, a research project in the humanities and social sciences with a methodological component in participatory action research, supported since 2020 by the French Polar Institute. The purpose of HABIT-ANT? is to study the diverse mode of inhabiting Antarctica. With this presentation, we propose to report on the methodological tools used for this long-term study, as well as on the first avenues of reflection on ways of inhabiting Antarctica and the French Southern Territories, based on the analysis of a corpus of documents made up of public and private archives and observations made in the field.

Accepted as: Oral Presentation

Abstract No : 852

Words on Ice: The Language of Antarctica

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When pressed for a definition of what language is, some people point to linguistics, which is a promising start. As a professor of languages, I am often asked what exactly language is, and now I am applying that question itself to Antarctica. Is there truly a language of Antarctica? For countless compelling reasons, in fact, there is! Based on the various branches and sub-specialities of linguistics, I propose to examine the words and expressions spoken and written, on and about, Antarctica. Beginning with phonology, I examine how certain sounds (phonemes) are innate to Antarctica and affect the language of Antarctica, as varying as ice, penguins, etc. Next, morphology leads us to the unique words specific to Antarctic life and work, including the multiple variations of certain morphemes, unknown and unused elsewhere (e.g., bagdrag, degomble, grumble bucket, hoosh, poppy, slotted, WTF0, etc., and even, "last call"). Pragmatics being context (such as being on Antarctica itself, for example, "slushy") and semantics being meaning (why a word or expression takes on an unusual definition "slot") will also both be analyzed. Bernadette Hince's seminal "Antarctic Dictionary," as well as other texts and websites with links to Antarctic jargon and slang, will be referred to and referenced. Finally, my hope is prove that unlike the other six continents, with indigenous people and proven philological origins of language, that indeed, the 7th continent, Antarctica, has developed its own unique, quantifiable, qualitative, and very cool language!!

Accepted as: Oral Presentation

Abstract No : 291

Antarctica: the final frontier? An exploration of the factors that has led to space age architecture in Antarctica

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Since the turn of the 21st century, the architectural landscape of Antarctica has seen a shift from functional pragmatic refuge to award-winning aesthetic shelter. This transition is rooted in a different approach to the station design process and aided in technological, material, & transportation improvements. These factors are not without challenges beyond the extreme environment, primarily around the parameters laid out in the Madrid Protocol. The identified design process primarily relies upon the use of architectural competition, a process that has historically and creatively fed upon the constraints such as those laid out in the Madrid Protocol to provide exciting and dynamic entries and results. It is then, the identified improvements, which permitted these concepts to become actual operational buildings, that not only become icons of their governing organization's presence but are more attuned to their users' needs and well-being. The methodology for this research builds upon existing case study analysis, with further data collection through interpretive-historical approaches.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS- DISCIPLINARY TOPICS

**Emerging technologies and their
applications from the depth of the ocean,
to the deep Antarctic field and space**

CONVENORS

Takashi Yamanouchi, Francis Bennet,
Wilson Wai Yin Cheung, Kimberlee Baldry

Accepted as: E-poster Presentation

Abstract No : 751

Applications in Borehole Geophysics: A Novel Modifiable Tilt Sensor for Measuring Ice Deformation, Temperature, and other Borehole Properties

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Robert Hawley, Dartmouth College

David Collins, Dartmouth College

We present a cost-effective tilt sensor for studying ice deformation that was developed at Dartmouth College as part of the Jarvis Glacier project, showcasing the development, deployment, and data collection processes. While the origins of this sensor were derived from applications to an Alaskan glacier, we present several use cases in a variety of glacier types including Athabasca glacier in Canada along with Antarctic regions with similar polythermal regimes like the ice streams and outlet glaciers. We will present a case study of installing our tilt sensor systems in two boreholes drilled close to the shear margin of Jarvis Glacier, and data retrieval after a ~1.5 year deployment period that yielded several core kinematic measurements. We computed borehole deformation by tracking the orientations of the sensors, which were lowered and frozen into the borehole, over time using gravity and magnetic data. Sensors installed in our tilt sensors are able to be added, removed, and modified to suit different needs, and the tilt sensor itself can also be modified for different boreholes and glacier environments. Through presenting our sensor development and successful application in the field, we aim to improve the accessibility of borehole geophysics, and also reach researchers who may have Antarctic research needs that our sensors can fulfill. We are looking for potential collaborations with researchers who are interested in using our sensors and might need assistance with its development, which can be time-consuming and expensive without the right tools and knowledge.

Accepted as: E-poster Presentation

Abstract No : 247

Design and Construction of a Man-Portable Hybrid Autonomous Underwater Vehicle for Antarctic Deep Sea Bed Exploration

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The Antarctic Deep Sea Bed near the South Shetland Islands is largely unexplored. Logistics are a key factor in Antarctic environment, usually an Oceanographic vessel with ROV system is employed to explore the Deep Sea Bed but this method might not be suitable at places with extreme weather conditions like Drake Passage. In order to face this exploration challenge a Hybrid Autonomous Underwater Vehicle (HAUV) has been developed. The vehicle combines the best characteristic of AUV and ROV, good hydrodynamics and stability in the water column to accomplish some tasks of a ROV like get close images of a scientific site of interest or collect samples from the sea bed without human intervention. The HAUV has a length less than 1 m, weight less than 30 Kg and depth capability of 1000 m, suitable for deployments using zodiac boat. The pressure housing to store the batteries and electronics are made of titanium grade 5 and aluminum alloy 6061 T6. The HAUV has got an Inertial Navigation system, Computer Vision and Artificial Intelligence routines running on ARM CPU, FPGA, TPU and coded by VHDL, C++ and Python. The HAUV has been successfully tested at Ecuadorian waters and is expected future deployments from the Ecuadorian Scientific Station Pedro Vicente Maldonado, Greenwich Island, Antarctica to make a Census of Antarctic Marine Life of the sea bed up to 1000 m of depth.

Accepted as: Oral Presentation

Abstract No : 77

Natural laboratories: Antarctic environment and the future of space and celestial activities. A perspective from Metageopolitics and space policy.

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The development of space technologies face huge challenges to be able to produce and disseminate high technology capable to sustain the human life in hostile environment such the lunar surface or even other celestial bodies. This, contextualized in the current new space race and the high uncertain levels on the International System – strongly pressurized due the renew of interstate conflict linked with geopolitical aspirations- make possible to prospect a new “space fever” for colonize celestial bodies, including the moon, in the coming years. This context of the space race increases the needs to find and exploit natural laboratories for the test of space related technologies, unfortunately due the very specifics requisites of land and environment aspects, there are just a few of land positions that are useful with this kind of purposes, being the Antarctic continent the most suitable place for this kind of activity. This presentation, will examine from a mix perspective of international studies the interaction between the ATS and Corpus Iuris Spatialis to find the principal gaps between the two international instruments and the principal trends on current international space interest, offering to international community a fresh perspective capable to anticipate future challenges for the harmonization of Antarctic international governance and space international governability answering the question if – in the coming future- Antarctic continent will face a new era of exploitation their condition of natural laboratories for the improvement of space missions and if it will represent a challenge for the ATS in terms of metageopolitics

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Abstract No : 615

Status of ocean observations in the Indian sector of the Southern Ocean

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The Indian Sector of the Southern Ocean, the region south of approximately 40°S, plays an important role in regulating the Earth's climate and supporting a diverse ecosystem. To understand how climate change affects oceanographic conditions and ecology in the Indian Sector, ocean observations are collected via various platforms, with conventional ship-based technologies, autonomous instruments (e.g. animal-borne sensors, AUVs, and profiling floats) as well as satellites and other remote methods. However, the harsh conditions and remoteness of the Southern Ocean and natural obstacles such as sea ice and clouds limit access to year-round ocean observations, and this sparse data coverage makes future predictions challenging. This review, led by the Regional Working Group for the Indian Sector of the Southern Ocean (SOIS RWG) as part of the Southern Ocean Observing System, examines the status of ocean observations in the Indian Sector with a focus on oceanography, lower, mid- and higher trophic levels in the water column, the benthic zone, as well as anthropogenic pressures. Seasonal and spatial gaps are discussed in addition to biases of the currently used observation platforms. Furthermore, we consider the synergies between modelling and ocean observations, where modelling can compensate for gaps in observations, and observations inform improved models in return. Finally, we will present priorities of future research campaigns and emerging technologies that would significantly improve our understanding of change in the Indian Sector of the Southern Ocean.

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Abstract No : 305

A comprehensive modelling of a stand alone power supply system for field equipment for the Antarctic region

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Field measurement systems are one of the most essential scientific tools used at Antarctic research facilities. The numerous areas of research activity in Antarctica define a vast variety of specific scientific equipment used in the field. The task of providing reliable power supply for such an equipment faces many challenges due to the extreme conditions in which it is usually deployed and used. Solar powered systems incorporating battery energy storage are widely used, but those type of systems face few main problems: prolonged periods with very low levels of solar irradiance which render photovoltaic panels inefficient during those periods; low temperatures which severely impact battery performance; strong winds and aggressive marine environment, which puts a lot of demand on the mechanical construction. We found the necessity to create a precise practical model of a stand alone solar powered system in order to accurately determine the power state of such system at any given moment throughout prolonged periods of operation. In order to do that we are using field data for the global solar irradiance, we take into account the specifics of the photovoltaic panels as an electronic devices, we model the charge controllers, power converters and the batteries including temperature and aging effects. By using the working model as a design tool we have largely facilitated building and adapting new field instrumentation systems for a vast variety of applications.

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Abstract No : 38

Antarctic field tests of RECAS autonomous thermal sonde begin a new chapter in subglacial lakes exploration

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Sealed from the Earth’s atmosphere for millions of years, the Antarctic subglacial aquatic environment may provide unique information about microbial evolution and the Earth’s climate in the past. In recent years, different approaches were taken to access and directly sample subglacial water environments. In 2014, Jilin University, China, put forward the

idea of using RECoverable Autonomous Sonde (RECAS) for subglacial lakes observations. It includes two electrically powered thermal drill bits located at the upper and lower ends of the sonde, heated body, control system, sampling chamber and coiling system. The thermal drill can melt a hole to ice sheet bottom, measure the physical and chemical parameters of lake water and sampling, and is able to move upwards. From 2016 to 2021, RECAS was designed, manufactured and tested in the laboratory of Jilin University, and all functions reached the expected indicators. During China's 38th Antarctic Scientific Expedition, field tests of RECAS were carried out on the flank of Dalk glacier near Zhongshan Station in East Antarctica, and three boreholes with depth 200.3 m, 183.2 m and 133.5 m were drilled, with an average downward penetration rate of 2.11 m/h and an average upward penetration rate of 3.6 m/h. About 600 ml of melting water sample was obtained from the bottom of each hole. During field tests, all systems of RECAS worked in expected ranges.

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Abstract No : 861

Instrumentation of multi-layer automated weather station for atmospheric temperature inversion monitoring and astronomical site testing at Dome A, Antarctica

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We have developed a multi-layer automated weather station (AWS) named Kunlun AWS (KLAWS) for temperature inversion (TI) monitoring and astronomical site testing at Dome A, Antarctica. KLAWS has a 15-meter-tall mast, upon which temperature sensors and anemometers were installed at seven heights. The main purpose of this instrument is to monitor the TI and atmospheric turbulence within the extremely thin atmospheric boundary layer at Dome A. We carefully chose and calibrated those sensors to guarantee they work correctly at an extremely low temperature ($< -80^{\circ}\text{C}$). Besides, we made a dedicated power-efficient electronic control box for data acquisition. Relying on a double-layer active heating design, KLAWS is able to work even when the ambient temperature is below -80°C . KLAWS was firstly installed in 2011 and then was renewed in 2015 and 2019. It collected more than 50 months of meteorological data showing steady, strong, and long-lasting temperature inversion at Dome A. Such phenomenon indicates the atmosphere is very stable and the atmospheric boundary layer is very thin, above which superb astronomical seeing could be obtained. KLAWS, along with other site testing devices, have proved the excellent conditions for astronomical observations at Dome A.

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Abstract No : 1022

A novel system for coring sub-ice platelet layers

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A key component of marine food webs in the Antarctic is the ecosystem that develops seasonally under sea ice, including within and supported by the complex matrix of platelet ice. Sub-ice platelet layers refer to loosely consolidated accumulations of disc-shaped ice crystals that form in supercooled water and which buoyantly accrete beneath sea ice. Platelet ice creates a unique habitat and protective environment for algae and bacteria, and offers a sheltered nursery for Antarctic fish eggs and hatchlings. The layers are fragile and will only form in very specific conditions, making them potentially vulnerable to small shifts in climate. Quantitative sampling of the sub-ice platelet layer is complicated by the fragile nature of the platelet matrix, and because any movement of water through it disassociates the incorporated biology from the sampled physical habitat. Our new sampling system allows the platelet ice structure to be captured along with the interstitial water, preventing the structure from collapsing. This approach also maintains the biological profile of the platelet layers, so that the algae, bacteria, crustacea, and fish that are living between the platelets can be captured along with their habitat. Here we will report on the initial test season of the new system, plus highlight plans for upcoming field work designed to identify causal links between the physical habitat and its dependent biology.

Accepted as: E-poster Presentation

Abstract No : 28

Obtaining energy from the Uruguayan national flower: an experience at the Antarctic Artigas Base

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The search for new strategies for obtaining energy constitutes an actual concern. Many approaches involve using renewable, but the application of Solar is lagging in comparison with other sources and remains still underutilized, especially in Antarctica. Dye-sensitized solar cells are widely reported as an alternative option for photovoltaics. They have experienced an increasing interest from the initial possibility of converting the light into electricity to the application in BIPV and greenhouses. DSSC offers two huge advantages: they remain functional even under diffuse light and are transparent to be used as power-generating building blocks. The present report intends to contribute to the field and place a question: could be used unutilized natural waste produce energy, at least in cold areas? Modules can be placed inside the buildings: protection against climate inclemency is assured. Here, we reported the power data generated from a small-sized panel made from cells sensitized with anthocyanins extracted from Uruguay's National flower: *Erythrina crista-galli*. The device was placed at the Artigas Antarctic Scientific Base for nineteen months. The panel showed good stability and maintained its efficiency conversion performance over the period. This device's output power and conversion efficiency mainly depended on irradiance and external factors such as light reflection due to snow or artificial bulbs near the area. A new prospect is raised here: the potential application of anthocyanins as sensitizers for indoor electricity generation in the Antarctic area with long term operability, where low temperatures are helpful considering the thermal stability of the dyes.

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Abstract No : 636

Science at the South Pole's Dark Sector and Potential for Interference from Emerging Communication Technologies

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The CMB-S4 Collaboration

The South Pole is an exceptional site for surveys of the cosmic microwave background (CMB), with a decades-long history of telescopes at the leading edge of the field. The CMB is a snapshot of the early universe, with faint features that encode information about the universe and its history. Precision measurements of the CMB require years of repeated observations to reach the sensitivity required, and careful analysis to disentangle the CMB from other sources of microwave radiation. The telescopes making these measurements must observe a wide area of the sky across a broad range of microwave frequencies, and can only observe from extremely dry, high-altitude sites, like the South Pole. CMB surveys will continue and expand over the next decade, including the upcoming CMB-S4 project, a priority of the Astro2020 decadal report for its great potential for discovery in cosmology and astrophysics. As these CMB instruments achieve greater levels of sensitivity, they also become more and more vulnerable to interference at radio and microwave frequencies. To avoid interference, these instruments observe from remote sites that have restrictions on local electromagnetic emissions, including the Dark Sector at the South Pole. However, increasing utilization of microwave frequencies for terrestrial and satellite transmissions, along with the dramatically increasing populations of communications satellites, could drastically transform the environment even at extremely remote sites like the South Pole. Planning and coordination are necessary to ensure that the benefits of these technological developments can be realized without jeopardizing significant scientific investments.

Accepted as: Oral Presentation

Abstract No : 27

Free-Space Optical Communication for Antarctica

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Scientific experiments on the Antarctic continent are requiring increasingly large bandwidths to transfer information off the continent. The insufficiency of existing radio frequency infrastructure will only be exacerbated with the new generation of scientific experiments and ever increasing data quantities. Without an optical fibre link to Antarctica, free space optical communication (FSO) may be the most viable solution for supporting Antarctica's communication needs. FSO ground terminals can be deployed at coastal or inland bases to provide bi-directional links to polar orbiting satellites with gigabit speeds, significantly more than what is offered by next generation low Earth orbit radio constellations. Current optical satellites in polar orbit could demonstrate the feasibility of FSO for Antarctica using existing optical astronomy telescopes or with new and compact ground stations dedicated to FSO. Additionally, the low cloud coverage of inland sites eliminates a severe obstacle for FSO at more typical sites. Due to the immense distances between Antarctica and the global optic fibre network, an optical fibre link is prohibitively expensive, so remote FSO terminals situated at key bases may be the future for supporting big data at Antarctica in the coming decades.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS- DISCIPLINARY TOPICS

**Predicting and
detecting tipping points and
regime shifts in Antarctic and
Southern Ocean systems**

CONVENORS

Delphi Ward, Nick Golledge

Accepted as: Oral Presentation

Abstract No : 335

Warm Deep Water intrusions in Filchner Trough, Antarctica, in CMIP6 simulations with the AWI Climate Model

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The Filchner Trough in the Weddell Sea is an important location for water mass exchange between the open ocean and the Filchner Ronne Ice Shelf cavity. Pulses of modified Warm Deep Water have been observed and provide additional heat to the cavity. Numerical studies suggest more frequent pulses in a warming climate and even the possibility of an irreversible regime shift to a substantially warmer state in Filchner Trough with strongly increased ice-shelf basal melt rates. In this study, we evaluate the temporal evolution of the intrusion of warm water into Filchner Trough in four climate scenarios defined for CMIP6. We show that for the high-emission scenarios SSP3-7.0 and SSP5-8.5, temperature in Filchner Trough will rise by 2°C until 2100. This regime shift is governed by open-ocean processes, in particular sea ice formation. A regime shift can be avoided by reaching the 1.5°C (SSP1-2.6) or the 2°C climate goals (SSP2-4.5).

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Abstract No : 535

Regime shifts in central Ross Ice Shelf cavity ocean processes between mid-1970s and contemporary observations

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Direct measurements of the water column beneath the central Ross Ice Shelf are limited. Here we compare data from the Ross Ice Shelf Project J9 borehole work in the mid-1970s with a new borehole (HWD2 borehole) from late 2017. The new borehole data include conductivity–temperature–depth (CTD) profiles and a hydrographic timeseries mooring. Although these two boreholes are the only access to direct measurements of water column structures beneath central Ross Ice Shelf, distinctive regime shift patterns were found. First of all, the temporal adjustment for salinity observed at the J9 borehole was fresher than the observed higher part of the HWD2 mid water column. This could be a signal that the recent observed salinity rebound in Ross Sea could reach out to central Ross Ice Shelf. Another apparent difference is that the Gade lines reveal a much stronger variation in the higher part of the HWD2 mid water column than the J9 borehole. Mooring data at the HWD2 suggested different circulation patterns bringing adjacent meltwater with different salinities to this location. Understanding the regime shifts over time in central Ross Ice Shelf cavity is critical for improving our predictions of Ross Ice Shelf evolution.

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Abstract No : 469

Short-term glacier area changes since 1988 and Transient Snow Line altitude for the 2020 year in King George Island, Antarctica.

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Jefferson Cardia Simões, Universidade Federal do Rio Grande do Sul

This work investigates the Snow Line Altitude (2020) and the glacial area loss of the King George icefields in the period of 1988– 2020 using remote sensing data. The Sentinel-2 and LANDSAT satellite images were applied in glacier mapping and index (NDSI and NDWI) to determine the glacier area variations in the period. The radar zones and Transient Snow Line (TSL) altitude were identified using Sentinel-1 IW (2020 summer) and the digital elevation model data. 300 m was determined to TSL altitude. 55% of glacial coverage is located above the TSL altitude in summer 2020. Eastern, Central and Arctowski icefields have more dimensions and the highest values of the glacier coverage located above the TSL altitude. Glacial area for 2020 is 999.95 km², and losses in the period represent 104.9 km² (error <1%) – a retreat of 3.17 km² / year. The Keller Peninsula glaciers and Bellingshausen Dome had a more significant loss (28% and 17%) and did not have TSL in 2020. The Warszawa, Kraków and Eastern icefields had 15.6%, 13% and 10.4% of the loss. The Kraków, Warszawa and Bellingshausen Dome icefields had the highest area loss in the 150m elevation range in this period. The area loss values (%) increased with decrease of the dimensions, total area above TSL and lower values for maximum elevation of the icefields. The calving glaciers with ice-flow toward deeper and steeper submarine sectors (associated to Bransfield Strait) had the highest area loss. The shrinkage in some Eastern icefield glaciers has been

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Abstract No : 580

Current and projected patterns of warming and marine heatwaves in the Southern Indian Ocean

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The Southern Indian Ocean (20:120°E, 70: 30°S) is a region of ecological interest, host to several endemic species and to an exceptional biodiversity that contributed to the inscription of the French and Australian natural reserves on the UNESCO World Heritage List. This region is expected to undergo important warming but, until now, warming patterns have been mainly provided at the basin-scale (~1000km). This information however is too coarse grained for supporting regional managing and conservation policies as well as for estimating possible impacts onto local marine ecosystems. There has currently been no spatialisation of temperature-related climate impact drivers over the Southern Indian Ocean, at scales relevant for conservation, or any investigation on how these spatial patterns may differ depending on scenarios' trajectories. Here, we present a regional analysis of ocean warming and marine heatwaves (MHW) based on the analyses of historical observational data and CMIP6 climate projections, including from high resolution models, comparing two plausible scenarios: SSP1-2.6 and SSP2-4.5. We find 1) an intensification of temperature-related climate impact drivers between 40°S and 55°S within the Antarctic Circumpolar Current region 2) an increasing difference between surface (0-200 m) and mesopelagic (200-1000 m) climate velocities and 3) that SSP1-2.6 and SSP2-4.5 patterns differ mostly at the end of the 21st century. This study points out the importance of climate impact drivers' regionalisation and the need to consider a 3D environment that may evolve at different paces when designing efficient conservation measures.

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Abstract No : 364

Using self-organization of Antarctic ice sheet velocities to infer past and future changes in flow regime

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Natural systems in steady state often display a characteristic known as scale invariance, in which a power-law relationship describes the size-frequency distribution of a population of samples from within that system. Furthermore, in fields ranging from solid Earth geophysics to population ecology, both sustained and transient deviations in the otherwise straight line log-log size-frequency relationship of scale-invariant systems have been interpreted as representing perturbations in the described system. In Antarctica, satellite-derived surface velocities exhibit a broadly scale-invariant relationship, with binned order-of-magnitude velocity increments corresponding to approximately an order-of-magnitude change in the sample size within each bin. Here we show that the continent-wide statistical properties of Antarctic ice flow can be used as a benchmark for evaluating idealized ice sheet model simulations. We propose that the model parameterizations producing size-frequency distributions most similar to that observed from Antarctica can be used to gain insights into the mechanisms governing ice flow there. Deviations from this general trend do exist, however. We propose that kinks or inflections in the distribution may reflect past or ongoing perturbations to a steady flow state, perhaps in response to external environmental forcing. By identifying the nature of these deviations at the scale of individual ice sheet catchments we suggest that this approach may be able to differentiate temporary shifts in ice flow regime from those that represent longer-lasting changes arising from tipping points or threshold-controlled behaviours.

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Abstract No : 483

Exploring the timing of past Antarctic tipping points

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Future abrupt climate shifts or 'tipping points' will have profound impacts on Earth and human systems. Examples include the irreversible loss of major ice sheets, the reorganisation of oceanic and atmospheric circulation patterns, and ecosystem regime changes. Major uncertainties exist not just in their future likelihood and magnitude, but also in the speed and mechanisms by which these abrupt changes and their complex chain of interactions will propagate regionally and globally. An accurate record of past shifts can help to constrain uncertainties in the sequence of events and their impacts, providing valuable insights into possible future changes. Here we focus on two time periods, the Last Interglacial period (129-116 ky) and the last deglaciation (20-12 ky), and present data reconstructing the magnitude and timing of past changes. A blue ice record of ice sheet and environmental change from the Weddell Sea Embayment provides direct evidence of West Antarctic ice mass loss early in the last interglacial, and an iceberg-rafted debris record from the Scotia Sea allows tipping point analysis shows the timescale of response to ice sheet retreat during the last deglaciation. Finally, a synthesis of high latitude 'tipping elements' demonstrates rapid and abrupt change occurred within 1-2 millennia of each other during the Last Interglacial which likely amplified polar and global change during this time.

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Abstract No : 19

Multiple Antarctic tipping points during the last glacial termination

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Emerging ice-sheet modeling suggests once initiated, retreat of the Antarctic Ice Sheet (AIS) can continue for centuries. Unfortunately, the short observational record cannot resolve the tipping points, rate of change, and timescale of responses. Iceberg-rafted debris data from Iceberg Alley identify eight retreat phases after the Last Glacial Maximum that each destabilized the AIS within a decade, contributing to global sea-level rise for centuries to a millennium, which subsequently re-stabilized equally rapidly. This dynamic response of the AIS is supported by (i) a West Antarctic blue ice record of ice-elevation drawdown >600 m during three such retreat events related to globally recognized deglacial meltwater pulses, (ii) step-wise retreat up to 400 km across the Ross Sea shelf, (iii) independent ice sheet modeling, and (iv) tipping point analysis. Our findings are consistent with a growing body of evidence suggesting the recent acceleration of AIS mass loss may mark the beginning of a prolonged period of ice sheet retreat and substantial global sea level rise.

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Abstract No : 1028

An Assessment of the Oceanic Physical and Biogeochemical Components of CMIP5 and CMIP6 Models for the Ross Sea Region

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The physical and biogeochemical performance of 16 CMIP5 and 16 CMIP6 Earth System models (ESM) are examined relative to present day (1976 to 2005) observational data sets for a Ross Sea Region (RSR) containing the Ross Gyre (RG) and the Ross Sea Continental Shelf, Antarctica. A relative ranking scheme using error metrics and published ESM properties (including climate sensitivity parameters and anomalous deep ocean convection statistics) enables identification of a “best” ensemble of models for the RSR. Over the RSR the CMIP6 models are generally found to have improved physical representations compared to the CMIP5 set, but the CMIP5 and CMIP6 biogeochemical representations remain similar. Examination of mean properties for the period 2018 to 2100 for RCP8.5 and SSP585 for CMIP5 and CMIP6, respectively, shows significant surface temperature increases, with significant decreases in sea surface salinity, sea ice concentration, and mixed layer depth across the RSR. Biogeochemically, there are generally small increases in surface values for chlorophyll, integrated primary production, zooplankton carbon concentrations, and iron. The projections also have robust reductions in surface nitrate, phosphate, and silicate across the RSR. For that part of the RG circulation to the east of 180°E which we refer to as the “inner Ross Gyre” significant increases in surface strength and barotropic transport are found by the end of century.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS- DISCIPLINARY TOPICS

**Air-sea interaction and
its linkages with ecosystem response in
the Southern Ocean**

CONVENORS

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Abstract No : 520

Lipid biomarkers of marine phytoplankton variability in modern snow and marine sediments from the southwestern Ross Sea, Antarctica

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Phytoplankton play an essential role in ocean-atmosphere systems by forming the base of the marine food web and are crucial to the global carbon cycle, acting as a significant carbon sink. The Ross Sea, Antarctica has high primary production rates influencing atmospheric carbon dioxide drawdown into the ocean. However, our understanding of how phytoplankton in the Ross Sea may respond to future climate change is limited by short observational records. Molecular fossils (lipid biomarkers) of phytoplankton can extend observational records of primary production. Biomarkers are found in snow and marine sediment samples providing a unique opportunity to compare across archives. Here we present new results of lipid biomarkers in Ross Sea paleoclimate archives: a spatial array of snow/ice samples and marine core tops from McMurdo Sound to Terra Nova Bay, as well as filtered Ross Sea oceanwater. We have investigated the spatial variability of phytoplankton biomarker concentration and composition across the different archives. Preliminary results from snow on top of sea ice from McMurdo Sound demonstrate the presence of phytoplankton biomarkers in the southwestern Ross Sea. The multi-archive comparison will provide new information relating to the spatial distribution and community composition of primary production in the Ross Sea and how concentrations of biomarkers relate to primary production rates. Overall, it will help validate biomarkers as a proxy to interpret longer palaeobiology records in Antarctica and help inform the impact climate change might have on biodiversity and the global climate system.

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Abstract No : 965

Analysis of Rainfall and Sea Surface Temperature over India during past years 1901–2021

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India is a vast montane forest ecosystem known for its biodiversity and endemism. The decadal variability of sst and summer monsoon rainfall is higher than most of the regions of India. Spatial and temporal analysis shows the variability over past years. Correlation analysis of rainfall with Indian Ocean sea surface temperature (SST) examine a significant relationship. The analysis associated with decadal rainfall variability will be studying. This study is important for decadal variability rainfall is robust and the forcing mechanisms are essentially maintained by the Indian Ocean. SST and rainfall relationship is necessary to understand the evolution of rainfall. Statistical analysis required to enhance the better result for this study.

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Abstract No : 664

ANALYSIS OF CO₂ FLUXES VARIABILITY IN THE DRAKE PASSAGE

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The Eddy Covariance method was used to quantify the fluxes of CO₂ at the ocean-atmosphere interface and, from this, to analyze the variability of the fluxes. This method uses data collected by the ship “Almirante Maximiano”, through the Brazilian Antarctic Program, by the Antarctic Observation and Modeling System project, on November 28 and 29, 2021 and January 31, 2022, at the Drake Passage. To quantify the CO₂ fluxes, it is necessary to correct the wind speed data due to the ship's movement. We also used salinity from NASA's SMOS satellite, sea surface temperature (SST) and geostrophic surface currents from COPERNICUS. The stability parameter (SST-T_{air}) showed that the Marine Atmospheric Boundary Layer was stable in most of the study region, and unstable only when close to the Antarctic continent, where thus there was an increase in the flux to the atmosphere. Overall, the Drake Passage behaved as a CO₂ sink. Where, on a regional scale, the CO₂ flux had a positive relationship with variations in atmospheric pressure at sea level. Moreover, this region presented fresh and cold water, increasing the solubility of CO₂. However, in some specific locations, it was related to the wind intensity, as in the data measured at 57.1° S and 64.2° W on the 28th, which, due to the higher wind speed, reduced the CO₂ sink capacity by the ocean.

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Abstract No : 547

Physical drivers on high chlorophyll-a in the vicinity of the Polar Front of the Indian Ocean sector of the Southern Ocean during austral summer

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The Southern Ocean is generally considered a High Nutrient-Low Chlorophyll (HN-LC) region. Even though, high chlorophyll (Chl)-a is common in several regions of the Southern Ocean including marginal ice zones, shallow coastal and shelf waters, across various fronts of the Antarctic Circumpolar Current, near polynyas, and in areas of upwelling associated with the shallow bathymetric features. The Southern Ocean consists of several quasi-zonal front systems such as Agulhas Front, Subtropical Front, Subantarctic Front, and Polar Front. Among these fronts, Polar Front is an important front due to its variety of physical features. In the present study, an attempt has been made to understand various physical drivers that influence the high Chl-a in the vicinity of the Polar Front using the in-situ data collected along a meridional section (57°30'E) during the Indian expeditions to the Southern Ocean in austral summers of 2017 and 2018 as well as the satellite data. High Chl-a was noticed in the vicinity of the Polar Front during both the years, however, its magnitude was lesser in 2018 than in 2017. It was noticed that mixed layer variability associated with the local winds played a major role in the high Chl-a observed in this region. The role of mesoscale eddies, frontal process, the influence of meltwater, and Southern Annular Mode (SAM) on the observed high Chl-a was also discussed. Keywords: Mixed layer depth, eddies, Polar front, Chlorophyll, Southern Annular Mode, Southern Ocean

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Abstract No : 443

Atmospheric iodine chemistry in the Southern Ocean marine boundary layer

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Air-sea exchange of reactive iodine-containing organic and inorganic compounds remains an open question with uncertainty regarding its the sources. Observations of atmospheric iodine oxide (IO) along with sea surface iodide (SSI) were recently obtained during the Indian Scientific Expeditions to the Southern Ocean (ISESO). The SSI observations were compared with existing parametric equations that are used in global models. A new region-specific parameterisation was designed for the Southern Ocean region. The observed and calculated SSI values were used to obtain fluxes of inorganic iodine species such as hypoiodous acid (HOI) and molecular iodine (I₂), the main precursors of atmospheric iodine. A discrepancy was observed between the HOI and I₂ fluxes and IO mixing ratios. Model simulations of IO correlated well with the observed IO values (above the 99% confidence limit for data south ($R = 0.78$, $P = P < 0.001$, $n = 48$) and north ($R = 0.69$, $P = P < 0.001$, $n = 68$) of the polar front), with a large offset. A positive correlation of surface chlorophyll-a concentration with IO ($R = 0.70$, $P < 0.001$) to the north of the polar front highlights that oceanic fluxes of organic iodine precursors may play an important role.

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Abstract No : 167

Swapping of the Pacific and Atlantic Niño influences on north central India summer monsoon

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The highly populated north central India receives 90% of annual rainfall during June to September. The interannual variation of summer monsoon rainfall is less studied compared to central and western India, due to its weak signal with the El-Niño-Southern Oscillation (ENSO). Previous studies have reported a marked decadal variation in the ENSO influences on north India rainfall, but the teleconnections of this variation are not satisfactorily understood. A pathway of the changing ENSO influences on north central India rainfall is revealed from observational data analysis and numerical experiments. While La Niña-like conditions produce anomalous northeasterly wind over India and reduce the tropospheric wind shear, the emergence of the Atlantic Niño appears to overtake this ENSO influence. The Atlantic Niño intensifies the meridional stationary wave affecting pressure anomaly over northwest Europe. This excites the Eurasian Rossby wave train along the mid-latitude producing upper-troposphere high pressure anomaly, subsequently affecting north India. Future work should examine the extent to which these teleconnections are represented in climate forecast models to aid the seasonal prediction of north central India rainfall.

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Abstract No : 319

Understanding dimethyl sulfide and its flux from the Southern Ocean

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We updated the estimation of the bottom-up global surface seawater dimethyl sulfide (DMS) climatology to 'DMS-Rev3' (Hulswar et al., 2022). It is the third of its kind and includes five significant changes from the last climatology, 'L11' (Lana et al., 2011) that was released about a decade ago. The update includes a much larger input dataset and includes improvements in the data unification, filtering, and smoothing algorithm. The DMS-Rev3 climatology provides more realistic monthly estimates of DMS and shows significant regional differences compared to the past climatologies. The largest changes are observed in high concentration regions such as the polar oceans, although oceanic regions that were under-sampled in the past also show large differences between revisions of the climatology. DMS-Rev3 reduced the previously observed patchiness in high productivity regions. The annual average concentration of DMS over the Southern Ocean is 2.45 nM (2.39 nM without sea ice) comparable to the global average of 2.26 nM (2.39 nM without sea ice). The average annual DMS flux is the latitudinal average is reduced to 2.6 TgS yr⁻¹ from 2.8 TgS yr⁻¹ as calculated by L11 between the 40S to 50S band while it increased to 2.4 TgS yr⁻¹ from 2.1 TgS yr⁻¹ between 50S to 60S.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS-DISCIPLINARY TOPICS

Emerging frontiers in
Earth observation (EO) and
geoinformation (GI) science in
Antarctica

CONVENORS

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Accepted as: Oral Presentation

Abstract No : 293

Potential of Satellite Derived Bathymetry mapping in Antarctica using high-resolution multispectral imagery

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Continuous bathymetric data is essential to the mapping and conservation of the rich biodiversity found in shallow Antarctic waters, as well as enhancing safety of navigation and enabling marine scientific research. Despite variable vertical uncertainty, Satellite Derived Bathymetry (SDB) has emerged as an effective method of modelling bathymetry in optically shallow waters in temperate and tropical regions. It is particularly useful to produce bathymetry data in environments where remoteness, lack of safe vessel access, or the cost of traditional hydrographic surveying is prohibitive. There is a critical data gap in available bathymetry covering the shallow oceanic waters of Antarctica, and to date no attempts have been made to assess the potential of SDB to fill this gap. This is likely due to difficulties in acquiring suitable multispectral imagery during the brief summer period where the absence of sea ice allows the seafloor to be visible, as well as having suitable collection parameters and environmental conditions for SDB production. This pilot study assessed the feasibility of SDB as a surveying technique to map bathymetry in Antarctic coastal waters using available Empirical SDB models in conjunction with Worldview 2 Multispectral Imagery. Using Optimal Band Ratio Analysis (OBRA) and the Sample-specific Multiple Band Ratio Technique (SMART) model to produce SDB, we show that the ability to produce accurate high resolution SDB for the 0 – 5 meter depth-range is possible. The ability to produce SDB for these shallow depths has significant implications for environmental management, safety of navigation, and the planning of future hydrographic surveys.

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Abstract No : 194

SPATIO-TEMPORAL MORPHODYNAMICAL VARIATION IN THE GETZ ICE SHELF, WESTERN ANTARCTICA: ESTIMATION & PREDICTION USING STATISTICAL AND GEOSPATIAL APPROACH

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Sea ice dynamics and mass balance of the Getz ice shelf (GIS) plays a crucial role in global climate and sea level. To assess long-term variations in the GIS (505 km) morphology, multi-dated MODIS satellite data (2003–2019) of the austral summer months (JFM) were utilised. The GIS was subdivided into three sectors (I, II, III), and further into different transects (5 km) intervals. Past ice shelf extent (ISE) positions were reconstructed and future ice shelves positions are predicted for the next 5 and 10 years. The statistical methods (EPR, AR, LR) were used to estimate the rate of change in ISE, which was then cross-validated using the correlation coefficient and root-mean-square error (RMSE). We have determined that the extent of the GIS shrank at a rate of -42 m/year during the austral summer of 2003–2019. Over the 17 years, 60% of transects showed recession, while remaining 40% showed progradation. Based on estimated RMSE values, 45% of transects in Sectors II and III have RMSE values ± 200 m, indicating the estimated and satellite-based ice shelf positions. The GIS is losing mass (-37.1 ± 5.8 Gt yr $^{-1}$) having an impact on sea level. Additionally, the variations in ISE have been linked to understand the prevailing conditions, viz. ice-mass changes, wind speed, air temperature, sea surface temperature (SST), and Southern Annular Mode (SAM) index. GIS sectors observed a decline in ISE and mass, as well as a rise in SSTs. The present study revealed that combining satellite observations and statistical approaches can forecast long-term ice shelf morphological variability.

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Abstract No : 201

Monitoring terrestrial Walrus haulouts using multispectral Sentinel-2 satellite imagery

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As sea ice retreats in the Arctic, the future of walruses (*Odobenus rosmarus*) is uncertain. Due to their wide distribution, understanding how changing sea ice conditions will impact populations requires monitoring at a pan-Arctic scale. In general, walrus surveys are conducted over the summer and autumn months, when walrus gather on shore in large groups (terrestrial haulouts). However (i) accessing these remote locations for land, boat or aerial surveys is logistically challenging and (ii) as they leave shore to feed, the number of individuals present changes frequently day-to-day and over the course of the season. This means that single day surveys cannot accurately capture the population trend. In this research, we investigate the use of freely available Sentinel-2 satellite imagery to overcome these challenges. Recent research has shown that large terrestrial haulouts can be observed as red/brown areas in the 10m resolution imagery, offering a means of surveying these isolated coastlines remotely. With an average revisit time of 5 days, Sentinel-2 also allows us to monitor walruses with greater frequency, helping to inform our understanding of seasonal and spatial variability of haulouts. In this project we perform a spectral analysis of walrus haulouts using Sentinel-2's 13 spectral bands. We assess whether a unique spectral signature can be used to delineate walrus from background features, as a method for automatically monitoring haulouts across the Arctic in Sentinel-2 timeseries.

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Abstract No : 969

Sensitivity assessment of various satellite-based microwave parameters for surface melt detection based on in-situ measurements of snow properties over marginal ice sheet near Bharti, Antarctica

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Monitoring surface melt conditions is critical for evaluating the stability of polar ice sheets and ice shelves. Rapid surface melting over the ice shelf triggers the propagation of rift and hence can be the cause of rapid calving of ice shelves. Active and passive microwave sensors have been widely used for the detection of surface melt over polar ice sheets and ice shelves. Backscatters from microwave scatterometers and microwave brightness temperature are found to be sensitive to the presence of water content over ice surfaces and hence these have been generally used for surface melt detection, broadly, based on two types of algorithms, edge-detection-based and threshold-based. In this paper, we tried to investigate the sensitivity of various satellite-based microwave parameters from different sensors and at different polarizations for surface melt detection over the ice sheet and ice shelves. We have used in-situ measurements of the snow properties (such as density, wetness, and dielectric constant) over the ice sheet near Bharti, Antarctica using a portable snow fork instrument. Temporal observations have been taken for surface snow properties during the 39th Indian Scientific Expedition to Antarctica. The correlation of the dielectric constant, density, and wetness with the backscattering coefficients and brightness temperature from SCATSAT-1, ASCAT, and AMSR-2/AMSR-E, have been analyzed and discussed. Also, the sensitivity of different polarizations and the cross-polarization ratio has been investigated.

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Abstract No : 230

Spatiotemporal change analysis for snowmelt over the Antarctic shelves using Scatterometers during 2000–2018

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We use Scatterometer backscatter data to map the spatial and temporal melt dynamics of Antarctic shelves were monitored during the austral summers of 2000 to 2018. Melt onset and duration maps for all the Antarctic shelves were constructed using a pixel-based, adaptive threshold approach based on backscatter during the transition period between winter and summer. We explored the climatic influences on the spatial extent and timing of snowmelt using meteorological data from weather stations and investigate the climatic controls on the spatial extent and timing of snowmelt. Melt extent usually starts in the latter week of November, peaks in the end of December/January, and then vanishes in the first/second week of February on most shelves. On the Antarctic Peninsula, the average melt was 70 days, with the melt onset on 20 November for almost 50% of the region. In comparison to the Antarctic Peninsula, the Eastern Antarctic experiences less melt, with melt lasting 40–50 days. For the Larsen, Shackleton, Amery, and Fimbul ice shelf, there was a strong correlation between melt area and air temperature. A significant correlation was also found between increased temperature advection and high melt area for the Amery, Shackleton, and Larsen–C ice shelf. The teleconnections between melt area and the combined anomalies of SAM and SOI point to the high southern latitudes being coupled to the global climate system. The most persistent and extensive melt on the Antarctic Peninsula, West Ice Shelf, Shackleton Ice Shelf, and Amery Ice Shelf, which should be monitored constantly for stability.

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Abstract No : 299

Finding a needle in a haystack: Monitoring albatrosses from space using satellites and citizen science

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Monitoring the world's threatened albatross species is challenging due to their remote nesting locations, making ground or aerial surveys expensive, infrequent, and often incomplete. With rapid advancement of geospatial technologies, citizen science can contribute to accurate and reliable georeferenced wildlife data, while also raising public awareness of current conservation efforts. We implemented an online citizen science campaign on Maxar's GeoHive crowdsourcing platform to count breeding Wandering Albatrosses (*Diomedea exulans*) across South Georgia using 31 cm resolution satellite imagery. The campaign consisted of 47 satellite images (150 km²) dating from 2015–2022, which were divided into 6,589 image chips (160 m x 160 m each). From space, each albatross appears as a white-to-cream coloured dot. Participants were asked to place a marker on each albatross they could see in each image. Each image chip was given to 6 observers to assess confidence of detection. We propose that crowdsourced image counts may provide accurate data on population sizes, highlighting the utility of this approach as a long-term monitoring tool, with great potential for further expansion to other sites and seabird species. Future endeavours to employ crowdsourced image counts as a training tool for machine learning algorithms will enable automated extraction of data on the location and numbers of albatrosses at different breeding sites, and aid ecological monitoring through the detection of animal attendance patterns and habitat preferences.

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Abstract No : 947

Machine learning applied for Antarctic soils mapping: spatial prediction of soil texture in the South Shetland Islands and Northern Antarctic Peninsula

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Soil texture is one of the most important soil properties as it drives several physical, chemical, biological and hydrological soil processes. In Antarctica the soil texture controls different ecological processes, such as carbon stock formation, nutrient leaching and toxic metals retention. Thus, there is a pressing need for accurate and continuous soil texture information for the Antarctic ice-free areas, mainly under the pressures imposed by the climate changes and human disturbances on the continent. We predicted the distribution of sand, silt and clay of the main ice-free areas of South Shetland Islands and Northern Antarctic Peninsula, creating novel soil texture maps for Antarctica. We used legacy soil texture data mainly produced by the Brazilian Terrantar Group and tested different machine learning models. Random Forest presented the best performance to predict soil texture. The best predictors were associated to spatial position, climate, topography and soil development, attending well to the scorpan model factors. The highest accuracy was obtained on clay prediction, mainly in the topsoil (CCC of 0.40 and R^2 of 0.23). In the maps, sand contents presented higher values, leading to the predominance of the sandy loam texture, although clay contents are higher in some areas where the chemical weathering is stronger. The final maps presented great spatial consistency, with soil texture distributed according to factors such as geomorphology, parent material and pedogenic development. With our results, we goal to furnish subsidies about soil to decision-making in Antarctica, besides provide pioneer data that can be incorporated in global environmental models.

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Abstract No : 737

Detailed Glacier Bed Information Derived from Repeating Icequakes at the Grounding Line of Rutford Ice Stream, West Antarctica

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The basal microseisms, or icequakes, generated at the bottom of glaciers as the ice flows over the bed can grant us valuable insights about features and deformation processes that occur at the bed. In the 2018/19 austral summer, Penn State University and the British Antarctic Survey (BAS) collaborated and deployed several seismic arrays over 3 months in the Rutford Ice Stream in West Antarctica, to monitor natural source seismicity. We used the earthquake detection and location software QuakeMigrate to generate high-resolution icequake catalogs at the Rutford grounding line making use of unprecedented quantities of located events to resolve key topographical features and characteristics at the bed like sticky spots, and how they related to the loading plus slipping process as the ice slides over the bed. To handle the massive amount of seismic data incoming and subsequent located icequakes, we created a systematic data processing pipeline and event optimization routine. We also made use of machine learning clustering algorithms to resolve inter- & intra-clusters relations that include both spatial and temporal results. We present our pre-processing methods on handling similarly large datasets and present physical findings from our own seismic data combined with other data sources, like GPR and tidal gauge data, that improves our understanding of ice flow dynamics in the region. Apart from sharing our research, we hope our presentation will serve as a springboard for new ideas and big data processing.

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Abstract No : 711

Application of remotely sensed data and techniques to monitor terrestrial biodiversity within the northern Antarctic Peninsula region

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Terrestrial biodiversity in the northern Antarctic Peninsula region is especially concentrated within ice-free areas. They are relatively small extensions found mainly along the coast lines and influenced by glacial, periglacial and paraglacial processes. Rock outcrops, sediments, soils and water bodies are the dominant surface covers in which manifestations of permafrost presence is common. During the austral summer period, moderate temperatures give rise to an active hydrological cycle and an increased biological activity. Mosses and lichens have a broad presence as vegetation covers, and bird and seal colonies have their breeding grounds in these areas. Advanced remote sensing data and techniques are proving to be useful for characterizing and monitoring ice-free areas. The objective of this work was to use a spectral library to identify indicators of biodiversity and to monitor their distribution using remotely sensed data within the South Shetland Islands. Spectral measurements within the visible, near and short wave infrared were taken in the field and laboratory to create the Northern Antarctic Peninsula SPECTral library (NAPSPEC). This then served to identify and classify multispectral (Landsat-8 and Sentinel-2) and upcoming hyperspectral (PRISMA and EnMAP) satellite-borne data. During several field campaigns, different test sites were studied on Livingston Island and King George Island where in situ measurements and samples were taken. Combining spectral library information and using the multispectral spatial resolution, an improved characterisation of the biodiversity indicators could be made. This initial characterisation was then used to simulate the information obtained from the mentioned latest generation of hyperspectral satellite sensors.

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Abstract No : 199

Walrus from Space: Getting the crowd involved

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As sea ice retreats in the Arctic, the future of walruses (*Odobenus rosmarus*) is uncertain. Understanding how the alteration in their habitat is affecting them is essential to predict and safeguard their existence. Walrus monitoring needs to be at the pan-Arctic scale to reflect their wide distribution, and preferably annual to match the rapid changes in sea ice conditions. However, it is logistically challenging to access a region as vast and remote as the Arctic via boats or planes, limiting the areas where field surveys can be conducted, as well as restricting the regularity of such surveys. Satellite images could be a non-invasive solution to monitoring walrus across the Arctic annually and help to overcome constraints imposed by the Covid-19 pandemic. The Walrus from Space project, with partners around the Arctic, aims to monitor walrus across the Atlantic and Laptev Sea using very high resolution (VHR) satellite images and the crowd to help review the large amount of images, every year for 5 years. Having mapped all known terrestrial haul-out sites at a pan-Arctic scale, we acquired VHR satellite images (30 to 50 cm) from Maxar of all terrestrial Atlantic and Laptev walrus haul-outs for 2020 and 2021. We partnered with the crowdsourcing platform GeoHIVE to create a detection campaign, which will soon be followed by a counting campaign. The first detection campaign included the 2020 imagery and is now complete. More than 600,000 satellite image chips covering about 24,000km² were reviewed by more than 11,000 observers.

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Abstract No : 959

Machine learning for vegetation mapping in Antarctica

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Vegetation is a key component of virtually all terrestrial ecosystems. It provides a useful indicator of climate change consequences due to its sensitivity to carbon dioxide levels in the atmosphere, and it responds to changes in important environmental variables such as temperature, desiccation and water availability. Vegetation mapping of plant communities at fine spatial scales is increasingly becoming practicable using remote sensing technology in cryospheric regions. Effective monitoring of changes in the distribution of plant species and communities in these regions requires precise high-resolution baseline vegetation maps. However, mapping such change at sufficiently high resolution has often been problematic, particularly in remote cryosphere regions such as Antarctica, the Himalayas and the Arctic. In this study we used WorldView-2 (WV-2) satellite data to map cryospheric vegetation. We tested a range of machine learning methods including target detection, spectral processing/matching and pixel-wise supervised classification feature extraction techniques, for extracting cryospheric vegetation. We evaluated the resulting mapping obtained from machine learning methods for vegetation on Fisher Island and Stornes Peninsula in the Larsemann Hills, East Antarctica. Visual analysis indicated that the machine learning methods provided varying accuracy in their estimates of vegetation, and there is a strong need to validate these results in different parts of Antarctica, which are often typified by different vegetation types. The results of the various customized and standard multispectral information extraction techniques were validated using independent reference datasets, which indicated that the vegetation mapping results achieved using high-resolution imagery achieved around 92% overall accuracy.

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Abstract No : 422

The new Norwegian infrastructure initiative Troll Observing Network

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Antarctica and the Southern Ocean are critically important parts of the Earth system. The physical and biological properties here control and shape to a large degree other parts of the Earth through atmospheric, cryospheric and oceanic connections, including sea-level rise. To contribute to global research efforts and closing the data gaps in Antarctic environmental observations, the Norwegian Research Funding has used one of its most powerful tools to finance the Troll Observing Network infrastructure. The Troll Observing Network (TONE) will be a comprehensive distributed infrastructure centred around the Norwegian Troll Research Station in Dronning Maud Land. Through TONE we will develop a state-of-the-art observatory network for environmental observations and provide access to shared services to support collection of data suited for studying and monitoring the atmosphere, terrestrial and marine environment. The observatory network includes an ionospheric observatory, an atmosphere composition observatory, an integrated cloud observatory, an infrasound array, a seismic array, an ice-shelf observatory, a multidisciplinary open ocean moored observatory and a sea-bird monitoring observatory. The shared research services consist of a drone service. Over the next 5-years the Norwegian Polar Institute, five Norwegian and three international partners will establish and validate the observatories and service. The key aspect of TONE is to ensure wide and free access to all recorded data from the observatories and shared services to the entire national and international research community as a basis for new knowledge of societal importance and scientific cooperation.

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Abstract No : 306

Open-source software for the geostatistical simulation of ice sheet conditions

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Geostatistical simulation is a powerful means for modeling geologic phenomena while reproducing geologic heterogeneity and quantifying subsurface uncertainty. Geostatistical simulation is widely used in oil and mineral exploration and could be similarly effective for modeling subsurface ice sheet conditions such as topography or geology. The creation of multiple realizations of subglacial topography could play a particularly important role in quantifying uncertainty in ice sheet models. However, existing geostatistical algorithms and software were developed for industry applications and cannot accommodate the size and complexity of glaciers and ice sheets. Furthermore, many existing software are not open-source or easily integrated with other analyses. To address these issues, we have developed GlacierStats, an open-source geostatistical Python package that is specifically designed for cryosphere applications. This package features geostatistical modeling functions and tutorials for accommodating large datasets, non-linear trends, variability in measurement density, and non-stationarity. In its current state, the tools and tutorials focus on the geostatistical simulation of subglacial topography. Nonetheless, these protocols could be used to model a variety of phenomena in glaciology.

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Abstract No : 872

Observations of glacial meltwater in West Antarctica with the use of high-resolution Unoccupied Aerial Vehicle sensors.

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In response to the needs related to the transformation of polar marine ecosystems, we have conducted a series of observations on glacial meltwater in West Antarctica using both the Parrot Bluegrass and the DJI Inspire 2 unoccupied aerial vehicles (UAV) with the Parrot Sequoia + multispectral sensor and the Zenmuse X5S RGB sensor. The research was carried out from 2019 to 2022. Coves nearby glaciers flowing into the sea within the Admiralty Bay, King George Island - Ecology Glacier, Krak Glacier, Zalewski Glacier and Dera Icefall were observed. Additionally, in situ measurements were conducted to identify glacial influxes – turbidity of water surface with the use of a CTD probe, suspended sediment concentration (SSC) and mean particle diameter of suspended sediment (MPD). The conducted studies have shown that UAVs can be successfully used to observe glacial meltwater, especially within small coves, as evidenced by the high correlation coefficients obtained between turbidity and spectral reflectance in the red and near infrared (NIR) spectral bands ($R_{RED} = 0.68-0.85$, $R_{NIR} = 0.71-0.83$). In addition, studies have shown that the color of the suspension resulting from the chemical composition may have a greater impact on its spectral characteristics than other physical parameters of the suspension (turbidity, SSC, MPD). The obtained data allowed to create the Glacial Meltwater Turbidity Algorithm (GaMTA), which gives satisfactory results from the use of high-resolution data from UAV ($R = 0.96-0.97$, $RMSE = 5.75-7.57$), so that it can be a substitute for satellite imagery in the turbidity analysis.

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Abstract No : 140

The Southern Ocean Observing System: Supporting the Community with Networks and Tools

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The Southern Ocean is disproportionately important in its role in the Earth System, connecting the Earth's oceans basins, and impacting climatic, biogeochemical and ecological systems. The understanding of ongoing changes and our ability to project future changes are reliant on sustained observations. The Southern Ocean Observing System (SOOS) has the mission to facilitate the sustained collection and delivery of essential observations of the Southern Ocean to all stakeholders, through the design, advocacy, and implementation of cost-effective observing and data delivery systems. SOOS has been operating for 10 years, and during this time has built community networks, focussed task groups, and tools to support collaboration and data discovery – towards addressing gaps in the observing system. Here we articulate the community-agreed scientific priorities to focus SOOS efforts over the next five years (2021–2025); the mechanisms which SOOS will use to address these priorities; and highlight the ways that SOOS can support you in your research and data objectives. All of which is aimed to deliver the observations and data required to address uncertainties in estimates of the future state of Southern Ocean processes and the subsequent global consequences.

Accepted as: Oral Presentation

Abstract No : 824

Potential application of deep learning using multispectral satellite data for characterizing surface facies in Antarctica

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Mapping target features from an image scene usually entail a process of pattern recognition built on pre-defined algorithms. In the case of multispectral imagery, these patterns include spatial, textural, contextual, and spectral features. While identification of optimal patterns for training classification algorithms is important, the selection of appropriate algorithms is of equal importance. Advances in pattern recognition have led to the development of robust deep learning (DL) algorithms. DL for image classification is a subset of machine learning which incorporates vast iterations of training data in complex model structures to assign a thematic value to an entity. Here, we have tested three DL methods, (1) Random Forest (RF), (2) Convolutional Neural Net (NN), and (3) Support Vector Machine (SVM), using Landsat-8 imagery for mapping surface facies in Antarctica. Surface facies are glaciological facies derived using optical imagery. Preliminary results indicate that the RF classifier produces the most accurate (higher than 85%) thematic map with the most efficient processing speed. The current study will help improve semi-automated mapping procedures across data archives for long-term monitoring of facies in Antarctica.

Accepted as: Oral Presentation

Abstract No : 343

Remote Sensing of Sea Surface Glacial Meltwater Fraction in the Coastal Ocean Waters of the Antarctic Peninsula

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Glacial meltwater has been identified as an important environmental variable in the ecosystem of the Western Antarctic Peninsula (WAP). This biologically productive region is also experiencing rapid environmental change, resulting in an increase in glacial meltwater discharge. To better understand the WAP environment and aid ecosystem forecasting, additional methods are needed for monitoring and quantifying glacial meltwater. Prior studies showed that sea surface glacial meltwater (SSGM) has unique optical characteristics which may allow remote sensing detection via ocean color data. In this study, we present a robust first-generation model for quantifying SSGM that can be applied to both spaceborne and airborne ocean color platforms. In addition, the model was prepared and verified with one of the more comprehensive in-situ stable oxygen isotope datasets compiled for the WAP region. The SSGM model demonstrates robustness and relatively accurate predictions, thus offering an additional novel method for quantifying and studying glacial meltwater in the WAP region.

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Abstract No : 178

Surface snowmelt detect on the Buenos Aires glacier with Sentinel-1 images

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The monitoring of the phenomenon of surface melting and the characteristic surface zonation that this produces is highly desirable, especially for the Antarctic Peninsula region. With that, this work aims to investigate the surface snowmelt (SS) in Buenos Aires Glacier (BAG), Antarctic Peninsula, in the period 2019 to 2020, using Sentinel1 (C-band SAR) acquired in the Interferometric Wide (IW) and Level-1 Ground Range Detected (GRD) and HH polarization at the Google Earth Engine platform (GEE). The results evidence SS variability based on the backscattering coefficient related to the locations with the presence of wet snow on the glacier. Surface air temperature and humidity data provided by the meteorological station located at the Bahía Esperanza base will be used for the analysis of the influence of meteorological variables on the dynamics of glacier surface melting in the next step of this work. The response obtained by the radar image in GEE provides important results about surface snowmelt on the BAG and how the new technologies can help to detect that information in these areas for the future.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS- DISCIPLINARY TOPICS

**Sub-ice geology and
east Antarctic Ice Sheet (EAIS) stability**

CONVENORS

Stewart Jamieson, Mathieu Morlighem,
Emma Mackie, Mayuri Pandey

Accepted as: Oral Presentation

Abstract No : 368

Antarctic lithosphere density heterogeneity provides new insights for solid-earth and cryosphere interactions

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Knowledge of crust and mantle structure is essential for understanding subglacial geology, tectonic history and solid-earth influence on ice sheet stability in Antarctica. For instance, mantle temperature, crust thickness, and heat production are important for geothermal heat flow, which influences ice dynamics. However, 3D earth heterogeneity structure and physical properties are poorly resolved in Antarctica. Here, we use two types of 3D gravity inversion focusing on the Antarctic crust and mantle density structure. For the crust model, we use layered-earth gravity inversion constrained by seismic Moho depth to estimate crustal density, crust thickness and sedimentary basin thickness. For the mantle model, we constrain our 3D finite element inversion (Esys-escript) by seismic tomography model to resolve mantle density, from which we estimate temperature and composition. Results show East Antarctica is characterised by dense, thick and cold lithosphere in contrast with thin and hot lithosphere in West Antarctica. Our result highlights heterogeneity within East Antarctica with a highly depleted cratonic mantle in central East Antarctica. Along the coast region in Dronning Maud Land, Lambert rift and Wilkes Land, lithosphere is thinner and warmer with localised higher crust heat production. Our model also shows thicker sedimentary basins beneath Wilkes, Aurora, Recovery and Pensacola Subglacial Basins. These crust and mantle heterogeneities provide insight into basal boundary conditions including subglacial geology, subglacial hydrology and geothermal heat flow. These factors are essential to understanding the ice sheet flow and stability.

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Abstract No : 849

The sub-ice continent, and regional ice-ocean interactions in East Antarctica: selected initiatives of the Australian Centre of Excellence in Antarctic Science.

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Matt King, University of Tasmania

The Australian Centre of Excellence in Antarctic Science (ACEAS) is a research collaboration that aims to integrate knowledge of interacting Earth systems to inform climate risks emerging from East Antarctica and the Southern Ocean. This presentation outlines data analysis and modelling to inform our understanding of the nature of the sub-ice continent; and a planned field season in the vicinity of the Denman glacier to inform the interactions between the sub-glacial environment and this little-understood ice sheet outlet glacier. Data-driven initiatives make use of multivariate statistical inference, and machine learning and include improved predictions of geothermal heat flow, sub-ice tectonic segmentation and sub-ice sediment distribution. Research methodology draws on interoperable computational environments with transparent meta-data information, while research outputs are formatted for interdisciplinary usage including the needed uncertainty bounds for further use as (for example) ice sheet model boundary conditions. Field plans are under development for the 2023-24 Antarctic summer and comprise ice sampling, seismic and magnetotelluric installations, and gravity measurements. It is hoped that the field campaigns will inform existing aerogeophysical data in the vicinity of the deep Denman glacial trough and surrounding area. Paleo ice sheet change, the interaction between the ice sheet and ice shelf, and sub-ice shelf melt will also be investigated.

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Abstract No : 760

Ice retreat fluvioglacial signatures from the exposed nunataks on the eastern flank of Amery Ice shelf: evidence from glacial tills/erratics and moraines

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The Lambert Glacier and Amery Ice Shelf (LG-AIS) is the largest glacial system in Antarctica which transports huge sediment piles from the interior of Princess Elizabeth Land (PEL). Detailed fieldwork carried out during the 41st ISEA was focused on the glacially transported material, ice-rafted debris, erratic and moraines deposited in and around the nunataks of PEL, expanding from Vestfold Hills in the east to Gillock Island of the AIS. Morainial deposits and glacial tillites in and around Reinbolt Hills, Vestknatten, Landing Bluff and Larsemann Hills were investigated. Landing Bluff and certain areas of Larsemann Hills are devoid of any glacial erratics/moraines. Vestfold Hills, Reinbolt Hills and Vestknatten nunatak were the prime locations for glacial inputs and represented an outwash plain. An east-west trending terminal moraine deposit comprising subglacial debris was found in active contact with the glacier between Stornes Peninsula and Publication Ice Shelf. The erratics in Reinbolt are round to subrounded and spherical suggesting a record of glaciofluvial-fluvial transport whereas tills found in Vestfold hills are dominantly angular denoting glacial transport. Local variability of melting in the LGAIS is indicated by the preliminary observations. The eastern flank of AIS is far more prone to melting compared to the coastal exposure possibly because of its proximity to the inner shelf-break of Prydz Bay. In this work, we discuss our field observations collated with the available geophysical-geothermal data to understand variable degrees of melting along the eastern AIS and delineate possible reasons contributing, both topographic as well as sub-glacial.

Accepted as: Oral Presentation

Abstract No : 397

Bedmap 3

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We present Bedmap3, a new geophysical data compilation and grids of Antarctic bed topography, ice thickness and surface elevation. The grids and all data used in the compilation are available for download from a bespoke interactive web map. To facilitate consistency and statistical robustness, all new data since Bedmap2 have been collated in a consistent fashion and the RES and seismic data from Bedmap3, Bedmap2 and Bedmap1 have been sub-sampled to the median value for each 500 m grid cell. The new grid of bed topography, based upon these data, is the most up-to-date and statistically robust grid of bed topography for ice sheet models and interpretation. New data coverage, since 2013, in East Antarctica, the recovery glacier area and many other areas fill almost all of the data voids in the Bedmap2 compilation and provide an alternative assessment to Bedmachine Antarctica. The new grid will be essential for assessing ice sheet instability, points of ice sheet weakness and for assessing and prioritizing the remaining gaps in RES and seismic data coverage. The freely available collection of geophysical data, both original collection and subsampled 500 m statistical data is the only place where all Antarctic geophysical data can be downloaded from and will encourage and expedite research on the Antarctic ice sheet.

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Abstract No : 858

Provenance and tectonic settings of offshore sediments of East Antarctica: comparative evaluation of geochemical signatures from Wilkes Land and Prydz Bay

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The geochemical signatures of marine sediments can provide insights into the provenance, the intensity of palaeoweathering of the source rocks and the tectonic setting in the source area. Marine-based sediment packages recovered during two separate ODP/IODP expeditions from Wilkes Land (WL) and Prydz Bay (PB), were investigated to understand their comparative geochemical behaviour. The chemical index of alteration (CIA), chemical index of weathering (CIW) and plagioclase index of alteration (PIA) calculated from major oxides are 41%, 60%, and 54% respectively for WL sediments and 63%, 74%, and 69% respectively for PB sediments suggesting a higher impact of the chemical weathering in the Princess Elizabeth Terrain. The Average index of compositional variability (ICV) is (>1) for Wilkes land and 1 for the PB sediments, suggesting predominance of reworking of sediments at the PB than in the WL sector possibly from the gyral movement of water flow in PB. Compositionally, the WL sector sediments and proximal sediments from PB show the presence of mafic terrain in the interior owing to the Large igneous province in the WL and Proterozoic massive dyke intrusions in Vestfold Hills for PB proximal site. Based on the trace element distribution tectonically, Prydz bay and Wilkes Land sediments suggest the presence of the Continental Island Arc in the interior. However certain sediment sample shows mixed signatures possibly due to the multiple provenance inputs suggesting complex tectonic settings in the whole East Antarctic Terrain.

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Abstract No : 147

Mapping subglacial landscapes in central East Antarctica from ice surface morphology.

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The imprint of the subglacial topography of Antarctica is recorded in ice sheet surface morphology, due to the influence of basal relief on ice flow. Satellite-derived datasets, including radar images and high-resolution elevation models, can therefore be used to map the planform geometry of the subglacial valley network. This information can be used to understand patterns of landform evolution, including glacial and fluvial erosion, and tectonics, and also to make inferences about past ice sheet history. We test the effectiveness of both automated and manual approaches to mapping ice surface morphology using these data in the Pole-Gamburtsev-Vostok region of East Antarctica, and use the best results to infer the planform geometry of the valley and ridge networks for this area with more consistency than is currently possible from relatively sparse survey data. By analysing these networks, we draw conclusions relating to the geological structure of the Gamburtsev mountains, the evolution of the landscape, the configuration of modern subglacial drainage, and potential locations for discovering ancient cold-based ice.

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Abstract No : 760

Ice retreat fluvioglacial signatures from the exposed nunataks on the eastern flank of Amery Ice shelf: evidence from glacial tills/erratics and moraines

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The Lambert Glacier and Amery Ice Shelf (LG-AIS) is the largest glacial system in Antarctica which transports huge sediment piles from the interior of Princess Elizabeth Land (PEL). Detailed fieldwork carried out during the 41st ISEA was focused on the glacially transported material, ice-rafted debris, erratic and moraines deposited in and around the nunataks of PEL, expanding from Vestfold Hills in the east to Gillock Island of the AIS. Morainial deposits and glacial tillites in and around Reinbolt Hills, Vestknatten, Landing Bluff and Larsemann Hills were investigated. Landing Bluff and certain areas of Larsemann Hills are devoid of any glacial erratics/moraines. Vestfold Hills, Reinbolt Hills and Vestknatten nunatak were the prime locations for glacial inputs and represented an outwash plain. An east-west trending terminal moraine deposit comprising subglacial debris was found in active contact with the glacier between Stornes Peninsula and Publication Ice Shelf. The erratics in Reinbolt are round to subrounded and spherical suggesting a record of glaciofluvial-fluvial transport whereas tills found in Vestfold hills are dominantly angular denoting glacial transport. Local variability of melting in the LGAIS is indicated by the preliminary observations. The eastern flank of AIS is far more prone to melting compared to the coastal exposure possibly because of its proximity to the inner shelf-break of Prydz Bay. In this work, we discuss our field observations collated with the available geophysical-geothermal data to understand variable degrees of melting along the eastern AIS and delineate possible reasons contributing, both topographic as well as sub-glacial.

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Abstract No : 606

Elevated heat flow beneath the northern Transantarctic Mountains imaged by spectral analyses of high-resolution aeromagnetic measurements.

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The Transantarctic Mountains (TAM) are the largest noncontractional mountain range on Earth, separating East Antarctica from the West Antarctic Rift system. They are ~4000 km long and up to 400 km wide, with a peak elevation of ~4000 m. Recent seismology studies imaged a low velocity zones beneath the TAM, interpreted as warm low density mantle material, helping support the mountain range. We test this hypothesis using spectral analyses of magnetic data to estimate the Curie depth point (CDP). The CDP describes the depth at which magnetic materials lose their ability to generate a magnetic field due to increasing temperature. This depth is assumed to correspond to a temperature of 580 °C and is known as the Curie isotherm. Geothermal heat flow can be derived from forward modelling using the CDP and assumption on the thermal conductivity of the crust. A shallow CDP and high heat flux would support the model of thermal support for the TAM. In this study we use high resolution airborne magnetic data and spectral analysis to map the CDP in the northern TAM and neighbouring Wilkes Subglacial Basin (WSB). Our results show elevated heat flow beneath the northern TAM and medium heat flow in the WSB. Locally high heat flow is seen in the WSB central basin and the Rennick Graben. Our results confirm the hypothesis of thermal support for the northern TAM utilizing an independent approach to characterise thermal properties within the lithosphere.

Accepted as: E-poster Presentation

Abstract No : 350

Passive Seismic Surveying in the Polar Regions: A Review and Forward Look

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Many geophysical surveying approaches now exist for subsurface investigation, with techniques such as passive seismology recently maturing into an attractive option due to low resource requirements and potential to interpret both the vertical structure and intermediary processes. This is exemplified in the high latitudes, where passive seismic applications have expanded to link ambient signals with cryogenic processes, characterize the ice-sheet fabric, and infer the presence of underlying sediments. Unique considerations in wavefield sensitivity, receiver installation and geometry, data processing, analysis and physical interpretation are essential for the successful employment of these techniques in the polar environs. The cumulative experiences and knowledge acquired from case studies across the Arctic and Antarctic can provide a valuable guide for future investigations looking to leverage the advantages of passive seismics for their own research questions. Here, we review key discoveries and previous experience to initiate a discussion on the strengths and limitations of passive seismic approaches for the polar subsurface. We focus on the horizontal-to-vertical spectral ratio (HVSr) method, receiver function (RF) analysis and ambient interferometric approaches, which have been employed in the polar areas, demonstrating contrasting capabilities in sensitivity, lateral coverage, and investigative depth. This contribution outlines how the broad scales afforded by continuous passive monitoring complement the high-resolution survey lines of airborne geophysics and active seismics. We highlight the value of translating novel solutions and enhancing interdisciplinary discussions between the Arctic and Antarctic geoscientific communities.

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Abstract No : 225

Princess Elizabeth Land, East Antarctica: insights on sub-ice geology and Proterozoic to Cambrian evolution

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Princess Elizabeth Land (PEL) preserves archives of Archean to Permian geological history. There appears to be a complex crustal framework with cross-cutting orogenic belts, the most prominent being the Indo Australo Antarctic Suture (IAAS or the Kuunga suture). Sub-glacially, the terrain morphology comprises a large system of interconnected canyons, water pathways, and lakes, flowing along speculated rift systems associated with the Lambert Graben (LG). The location and path of IAAS passing through PEL have been a matter of debate. The presence of zones of thinned crust (rifts and basins) and thickened but rheologically weak zones (orogenic belts) affect the geothermal heat flux of the terrane which in turn represents one of the main influences on the stability of the East Antarctic Ice Sheet (EAIS). This work unifies existing data on metamorphic and magmatic history, mesoscale structures, and geochronological data of exposed outcrops of East Antarctic Shield in coastal PEL, comprising of Rayner, Fisher, Ruker and Lambert terranes, Amery nunataks, Larsemenn Hills sector, and Rauer-Vestfold domain. The available geophysical and geothermal data is combined, to constrain the sub-ice geology of the region and to discuss the geological evolution of PEL. The path of IAAS and the extension of Pan-African signatures has been specifically addressed showing the extensive reworking along this suture at ~500Ma. Based on collation and interpretation of available data, an attempt is made to explain possible hypotheses for the geological evolution of the coastal PEL terrain, as well as highlighting the gaps in the knowledge.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS- DISCIPLINARY TOPICS

The resilience of
the Antarctic Treaty System in
the Anthropocene

CONVENORS

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Osamu Inagaki

Accepted as: Oral Presentation

Abstract No : 391

The Development of Concept “Cumulative Impacts” under the Antarctic Treaty System

Osamu Inagaki, Kobe University

Recently, the concept “cumulative impacts” has attracted academic interest in relation to the Environmental Impact Assessment (EIA) of a new legal binding instrument on BBNJ being negotiated under the United Nations as well as the Mining Code being drafted under the International Seabed Authority. This concept is also a important tool in implementing the ecosystem approach (EA) since the EA requires integrated management of different human activities. At the same time, however, assessment of cumulative impacts is generally understood to be scientifically and institutionally challenging. Here, it should be recalled that the Antarctic Treaty System (ATS) has been familiar with this concept since 1980s. Above all, the Madrid Protocol of 1991 identifies “cumulative impacts” as an item to be assessed under its EIA procedure. This paper thus aims to explore the development and lessons of the concept of “cumulative impacts” under the ATS and distill the institutional conditions in which cumulative impacts can be assessed effectively and successfully.

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Abstract No : 607

Ringfenced Equity, Diversity and Inclusion Internships

Geraldine Hough, British Antarctic Survey

Pilvi Muschitiello, British Antarctic Survey

Beth Rosier, Natural Environmental Research Council

Beatrix Schlarb-Ridley, British Antarctic Survey

Kate Hendry, British Antarctic Survey

x Diversity in UK Polar Science Steering committee, x

In the early days of the British Antarctic Survey (BAS) mostly young white, physically fit men went on expeditions to “the frozen continent”. It was not until the 1980s that the first British female scientists began working in Antarctica. While this has undoubtedly left an imprint on the organisation, a lot has changed culturally and structurally since then, and people have evolved their thinking. A recent turning point in the BAS journey towards being a more inclusive organisation was partnering with the Diversity in UK Polar Science Initiative (DiPSI), founded in September 2019. DiPSI community identified that a number of societal challenges remain, including accessibility of polar research for those at the intersection of groups that are still underrepresented in STEM subjects. New EDI internships, hosted by BAS in 2021-22, build on the activities developed by the DiPSI steering group to deliver a more diverse and inclusive future for UK polar science. Here, we will outline the successes and insights gained from the EDI internship programme funded through the Natural Environment Research Council. We want to paint a picture of the long-term investment of time and resources needed to support inclusion and propel progress within the UK Polar Community. These internships are ‘the tip of the iceberg’ built on the efforts started in September 2019. We will present results from our impact evaluation in the context of our long-term ambitions, highlighting both areas of success as well as prevailing challenges.

Accepted as: Oral Presentation

Abstract No : 900

Legal Implications of China's Proposal for an Antarctic Specially Managed Area (ASMA) at Kunlun Station at Dome A

Sakiko Hataya, Sasakawa Peace Foundation

China has become increasingly active in the Polar Regions in recent years. Since 2013, China has intended to establish an Antarctic Special Management Area in the vicinity of the Kunlun base near Dome A. The paper argues that the debate at the Antarctic Treaty Consultative Assembly regarding China's proposal is not a political matter; instead, the debate was simply prompted by the fact that the current Chinese proposal doesn't compile with the requirements of the provisions of the Antarctic Treaty Protocol on Environmental Protection.

Accepted as: Oral Presentation

Abstract No : 249

Current Development of Port State Measures in CCAMLR: Interaction with FAO Port State Measures Agreement

Maiko Raita, Osaka University of Economics and Law

As noted by the Sustainable Development Goals (SDGs) target 14.4, illegal, unreported and unregulated (IUU) fishing hinders implementation of scientific resource management plans by making it difficult to collect accurate catch data. For preventing, deterring and eliminating IUU fishing, Port State measures are focused on recently as one of powerful and cost-effective means in the international law of the seas. In the Southern Ocean, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) had been formulated Port State measures to tackle IUU fishing since the mid-1990s, ahead of other marine areas. Today, due to adoption and entry into force of the FAO Port State Measures Agreement, which affected by CCAMLR's works, Port State measures in CCAMLR have further remarkably innovated: they have not only elaborated on their procedures but also addressed to implement more effective regulatory mechanisms. This presentation would clarify how CCAMLR's Port State measures have evolved, focusing on its interaction with the FAO Port State Measures Agreement.

Accepted as: Oral Presentation

Abstract No : 391

The Development of Concept “Cumulative Impacts” under the Antarctic Treaty System

Osamu Inagaki, Kobe University

Recently, the concept “cumulative impacts” has attracted academic interest in relation to the Environmental Impact Assessment (EIA) of a new legal binding instrument on BBNJ being negotiated under the United Nations as well as the Mining Code being drafted under the International Seabed Authority. This concept is also a important tool in implementing the ecosystem approach (EA) since the EA requires integrated management of different human activities. At the same time, however, assessment of cumulative impacts is generally understood to be scientifically and institutionally challenging. Here, it should be recalled that the Antarctic Treaty System (ATS) has been familiar with this concept since 1980s. Above all, the Madrid Protocol of 1991 identifies “cumulative impacts” as an item to be assessed under its EIA procedure. This paper thus aims to explore the development and lessons of the concept of “cumulative impacts” under the ATS and distill the institutional conditions in which cumulative impacts can be assessed effectively and successfully.

Accepted as: Oral Presentation

Abstract No : 315

The Resilience of the Antarctic Treaty System in Light of Russian Invasion of Ukraine

Zia Madani, JSPS Postdoctoral Fellow, Kobe University

Russia's unprovoked and violent invasion of Ukraine with its horrendous human suffering has to a large extent changed the security landscape in the international arena. It also appears to have fundamentally altered the perception of the security situation in the Polar regions. From a scientific cooperation perspective, Russia's aggression has placed tremendous challenge to any attempts to friendly cooperation, including in the realm of science and research. Therefore, the assumption that Antarctica and the Southern Ocean remain an area of low political tension must be placed under re-scrutiny. Whether or not would the current reality suggest that security questions in the Antarctic need to be addressed, just as been put by politicians and decision makers in regards to the Arctic, is a question central within the Antarctic Treaty System resilience discussions. This is despite the fact that the pressing global issue pertaining to the Antarctic should tackle the impacts of climate change. These impacts are being overwhelmingly outspread throughout the globe with no apparent exceptions. These changes on the Antarctic and the Southern Ocean ecosystem are of high significance. In fact, the physical environment and conditions of the Antarctic and its surrounding waters today have become such integrated to the global environmental changes and conditions that the Antarctic environment and its dependent and associated ecosystems can no longer be identified both physically and legally as a discrete isolated object of protection. This paper seeks to examine how and to what extent the ongoing Russian invasion of Ukraine would impact....

Accepted as: Oral Presentation

Abstract No : 173

Examining the Regulatory Framework for the Protection of the Antarctic Marine Environment in the Anthropocene: The Case of Anthropogenic Underwater Noise

Maruf Maruf, Xiamen University

We live in the complex Anthropocene era in which human-dominated activities profoundly affect marine environmental changes and pressures, bringing into question the ocean's ability to support human well-being. Thus, anthropogenic underwater noise (AUN) posed by many human activities is an ongoing focus of governments worldwide and across several international fora. As an emerging issue, AUN would denote not only a rapid change in the marine environment but also several issues on the relevance and inadequacy of existing instruments in the Anthropocene era. Accordingly, there is an urgent need for further studies on the development of the law and policy to respond and enhance the protection of the marine environment in the current Anthropocene era. Such needs are highly significant in the Antarctic due to the increasing marine environmental pressures. This article critically examines relevant instruments for protecting the marine environment and their applicability to addressing the issue of AUN in the Antarctic. It also examines the functions of the institutions involved and their response to the issue of AUN. It is argued that several instruments are applicable to address this problem and concerns have been made by several bodies such as the Scientific Committee on Antarctic Research and the Commission for the Conservation of Antarctic Marine Living Resources. However, although significant concern has been made, it is clear that further actions are needed. Finally, this article proposes the application of environmental impact assessment as stipulated by the Madrid Protocol and the establishment of area-based management to address the problem.

Accepted as: Oral Presentation

Abstract No : 910

Interplay management in the Antarctic regime complex

Ayako Okubo, Tokai University

Managing institutional interaction within the 'Antarctic regime complex' (McGee and Haward 2019), which consists of the multiple governance regimes involved in Antarctic issues, is one of the important challenges for the resilience of the Antarctic Treaty System. This study assesses institutional interactions focusing on the causal pathway, its impact on effectiveness, and how related actors have managed overlap or inconsistency among different regimes. It utilizes analytical frameworks for institutional interaction and interplay management established in the existing literature (Stokke 2001, Oberthür and Gehring 2006, Oberthür 2009). The case study findings include the behavior of state actors to unilaterally manage the inconsistency between the ATS and the United Nations Law of the Sea. It also identified the process of cognitive interaction between the Antarctic Treaty Consultative Meeting and the International Maritime Organizations, facilitating mutual understanding of the regime's expertise and division of labor. This study aims to provide helpful insight to elaborate possible approaches to promote synergies and mitigate adverse effects among different regimes so that the Antarctic Regime Complex to effectively address the emerging issues in the Anthropocene, such as climate change.

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Abstract No : 548

Intensive observation campaign off Sabrina Coast, East Antarctica, to predict the future ice loss

Shigeru Aoki, Hokkaido University

Aurora Basin in East Antarctica is characteristic of its bed topography similar to that of West Antarctica. Totten Glacier off Sabrina Coast is the outlet glacier of the basin. Recent various researches have revealed Totten Glacier and nearby ocean-ice system are changing, which has some similarity with the situation in West Antarctica. Totten Glacier is now losing its ice mass and has a potential of contributing to a significant sea level rise in the future. Warm water of the ocean off Sabrina Coast, flowing through a deep channel underneath the glacier, is considered as the major driver of the rapid ice melting, but yet little is known about the oceanic role in melting the ice. Although this region has been attracting growing attention, in-situ observational evidence is insufficient because of its inaccessibility. Based on Icebreaker Shirase, we conducted oceanographic and geophysical observations off Sabrina Coast, East Antarctica, during Dec. 2019 and Feb.-Mar. 2020. Bathymetric survey with multi-narrow beam were effective and describes new and detailed topographic features. Hydrographic measurements revealed the ubiquitous presence of deep warm water in this region. Air-borne XCTD and XBT helped enhance the spatial sampling in difficult access area, and largely expand the distribution of water mass property. The sustained observation of this area is needed under the international cooperation. The Antarctic Treaty System provides the indispensable bases for this cooperative observational framework to work efficiently.

Accepted as: Oral Presentation

Abstract No : 385

Invasion of Ukraine and the Antarctic Treaty System: Legal challenges for its continuing resilience

Akiho Shibata, Kobe University PCRC

At the opening plenary of Berlin ATCM on 24 May 2022, exactly three months since the Russian invasion of Ukraine, State Secretary Morgan stated, while strongly condemning the Russian aggression, that "the Antarctic Treaty is widely seen as a prominent example of well functioning multilateralism. This is something we want to preserve – and this although the loss of confidence in the aggressor party in terms of its compliance with international obligations is evident. I call upon all Parties participating in this Meeting to bear the special history of the Antarctic Treaty in mind and to take responsibility for the protection of this unique and vulnerable ecosystem, and not to block important decisions for reasons unrelated to Antarctic interests". Her statement painstakingly tries to maintain the so-called "Antarctic exceptionalism" even "while one Consultative Party is waging war on another Consultative Party". This paper examines the legal nature in relation to the ATS of the Russian invasion of Ukraine to see whether and to what extent it has changed the legal foundation of the ATS. This examination will re-evaluate the often-quoted "Antarctic exceptionalism" in its legal terms.

Accepted as: Oral Presentation

Abstract No : 791

Basic research on the functioning of marine life in the Southern Ocean and its relationship to science policy

Naomi Harada, The University of Tokyo

Takuhei Shiozaki, The University of Tokyo

Akiho Shibata, Kobe University

The presence of previously unknown micro-organisms in the Southern Ocean and waters around Antarctica is beginning to be reported. For example, nitrogen-fixing bacteria, which were thought to be adapted to oligotrophic environments in the tropics and subtropics ocean, have been found living in eutrophic environments such as under sea ice around Antarctica (Shiozaki et al., 2020). In the other polar region, the Arctic Ocean, inhabiting phytoplankton were found to be capable of synthesizing a series of saturated hydrocarbons equivalent to fossil oil (Harada et al., 2021). Polar regions are a kind of extreme environment, and the discovery of marine organisms and their novel functions that defy conventional wisdom is expected to continue. Some of these organisms will be found to have a role as resources. Under the current Antarctic Treaty, there are no restrictions on research and surveys based on peaceful use and basic scientific exploration. This raises concerns about the devouring of polar marine life and its specific functions from a resource perspective, as the world's population explodes and countries vie for supremacy in scientific and technological innovation. Can the current Antarctic Treaty alone really sustain the rich Southern Ocean environment and marine ecosystem services into the future? There is a need to encourage natural and social sciences to work together in discussions to understand the limitations of the current Antarctic Treaty, to work together in discussions to understand the limitations of the current Antarctic Treaty, to propose ideas for concrete solutions.

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Abstract No : 169

The Antarctic Environments Portal

Keith Reid , SCAR

Johanna Grabow, SCAR

SCAR's Antarctic Environments Portal ("the Portal" www.environments.aq) provides a web-based source of independent and objective scientific information to support the work of decision makers in the Antarctic Treaty system. The Portal provides impartial and up-to-date information to meet the important need for reliable, policy-ready summaries on priority issues for Antarctic conservation and management. It also raises awareness of emerging scientific issues to support informed discussions and prioritisation of issues. Articles published on the Portal are all subject to peer-review and are grouped into thematic topics including marine, terrestrial, human activities, inland aquatic environments, atmosphere and cryosphere. As an interface between science and policy The Portal provides a route to impact for Antarctic research and is an effective mechanism to deliver added value to research outcomes.

Accepted as: Oral Presentation

Abstract No : 271

Structure and Dynamics of Antarctic Governance

Larissa Lubiana Botelho , Queensland University of Technology

Michael Bode , Queensland University of Technology

Kate Helmstedt, Queensland University of Technology

Kerrie Wilson, Queensland University of Technology

Governance decisions in Antarctica are made at the annual ATCM (Antarctic Treaty Consultative Meetings) and play out in the context of complex geopolitics. Understanding the dynamics of these international forums can help anticipate future decisions and guide them towards better stewardship of the Antarctic environment. Decisions are likely influenced by a combination of external factors – such as international conflicts and international relations – and internal factors – such as hierarchical structure inside the Treaty and language used in official documents. Working Papers are the main tool with which participants of the ATCM guide the discussions that will lead to the final decisions. Collaboration on these papers may reveal alignment between the values of participants, and coordination about priorities for the Antarctic continent. Using social network analysis, network structural and locational properties, and by analyzing the details of the participants (i.e., Parties, Observers and Experts), their role and rights at the ATCM and the processes by which they interact (e.g., through joint submission of official documents), we assess the influence of ATCM participants and elucidate the patterns of interactions between them. Drawing on decades of Working Papers submissions, I will explore the resulting collaboration networks aiming to reveal hierarchical organization inside the Antarctic Treaty System and indirect influence from non-Consultative Parties, Observers and Experts in the decision-making process. Elucidating these behavioral patterns can help us predict future collaborations and decisions about Antarctica's governance.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS- DISCIPLINARY TOPICS

**Inclusive collaborations in
Antarctic research**

CONVENORS

Adriana Gulisano, Donna Frater, Morgan Seag,
Renuka Badhe, Mariama Dryak

Accepted as: Oral Presentation

Abstract No : 406

Collaboration of South African researchers in an extreme cold environment.

Ria Olivier, Antarctic Legacy of SA, Stellenbosch University

Scientists and their research data is a matter of huge importance in the scientific world as this leads to data ownership. “The Antarctic is proof that great things can be achieved through collaboration”– Richard Fifiield. The International Geophysical Year(IGY) of 1957–158 set the scene for global collaboration in this unique research field that cut across many disciplines. This IGY did not just capture the attention of scientists but that of the public and the politicians as well. The mystique surrounding this most southern continent creates an atmosphere of exploration. Scientists would like to discover all the unknown of the last wilderness on earth and other just want to be part of this immense wilderness. South Africa already made a huge contribution to science in the Antarctic region since 1958, but with the accessibility of data that has been collected of more than five decades, our collaboration and contribution to research in this extreme wilderness is of utmost importance. The role of scientists and researchers and their collaboration with their counter part on a national and international cannot be emphasised enough. Collaboration in Antarctica comes from a joint passion for an unknown territory and the experience of the same hardships in a harsh environment. This discoveries leads to data and publishing scientific findings. That the outcome of these publications, findings and analysing of datasets can become knowledge for future generations of specifically South Africans, but to the greater continent of Africa as well as in a global world.

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Abstract No : 1016

Terrantar: 20 years of soil research in Antarctica

Marcio Rocha Francelino, Universidade Federal de Viçosa

Carlos Ernesto Schaefer, Universidade Federal de Viçosa

The Terrantar Research Group is composed of researchers from several institutions in Brazil and other countries, with coordination based at the Universidade Federal de Viçosa. He has been carrying out continuous studies with an emphasis on the antarctic soils since 2002. Upon completing 20 years, he has published 115 papers, 16 book chapters and 35 theses. It built a collection of soils from Antarctica that currently has almost 3,000 samples from more than 600 studied profiles. It has implemented a network of soil temperature and moisture monitoring sites, that record hourly data at 29 locations spread across the ice-free areas of the South Shetlands Islands and east of the Antarctic Peninsula. It has already mapped almost 20,000 hectares of soils in that region. In a survey carried out on the Web Science platform, considering the terms “soil” and “Antarctica”, from 2010 to 2020, the Terrantar was responsible for almost 40% of all publications, consequently the Universidade Federal de Viçosa was the institution with the highest scientific productivity in the world on this subject and contributes to Brazil presenting the greatest scientific contribution among all countries, accounting for 25% of all that is published on antarctic soils. This survey demonstrated the considerable contributions of the studies carried out by the Terrantar in understanding the antarctic soils.

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Abstract No : 738

Promoting Inclusivity, Diversity, Equity, and Accessibility within the International Thwaites Glacier Collaboration

Marianne Karplus, University of Texas at El Paso

Leilani Henry, Being & Living Enterprises

Asmara Lehrmann, University of Alabama

Erin Pettit, Oregon State University

Elizabeth Sheffield, University of Colorado at Boulder

Julia Wellner, University of Houston

Tun Jan Young, University of Cambridge

ITGC IDEA Council, International Thwaites Glacier Collaboration

The International Thwaites Glacier Collaboration (ITGC) is a large, multi-disciplinary program funded by the U.S. National Science Foundation and the U.K. Natural Environment Research Council to investigate Thwaites Glacier in West Antarctica. ITGC projects cross scientific disciplines to understand the glacier's flow dynamics and project its ice mass loss and potential contributions to sea level rise. The ITGC formed an Inclusivity, Diversity, Equity, and Accessibility (IDEA) Council of PIs, postdocs, students, contractors, and outreach specialists who meet twice monthly in order to foster IDEA within each project team, across the ITGC, and across the Antarctic Science community. Significant projects included creating "Community Norms and Values" and "Field and Ship Best Practices" guides; hiring a diversity consultant to lead inclusivity workshops, guide discussion, and share expertise; organizing screenings and introspective discussions of *Picture a Scientist*; conducting post-season surveys for field participants; and incorporating IDEA activities into meetings. Going forward, we aim to strengthen links with like-minded IDEA efforts. We will build on our experiences and data from surveys to further promote IDEA in ITGC and Antarctic Science. We plan to offer additional programming on effective mentoring practices and communicating to a non-science audience. We also aim to engage underrepresented groups by creating teaching material and presentations for undergraduates at minority-serving institutions and K-12 students. Given the complex problems of polar science and their global impact, we strive to foster a research environment that welcomes contributors from diverse backgrounds (ethnicity, race, and socioeconomic status) and engage with the broader community.

Accepted as: Oral Presentation

Abstract No : 607

Ringfenced Equity, Diversity and Inclusion Internships

Geraldine Hough, British Antarctic Survey

Pilvi Muschitiello, British Antarctic Survey

Beth Rosier, Natural Environment Research Council

Beatrix Schlarb-Ridley, British Antarctic Survey

Kate Hendry, British Antarctic Survey

x Diversity in UK Polar Science Steering committee, x

In the early days of the British Antarctic Survey (BAS) mostly young white, physically fit men went on expeditions to “the frozen continent”. It was not until the 1980s that the first British female scientists began working in Antarctica. While this has undoubtedly left an imprint on the organisation, a lot has changed culturally and structurally since then, and people have evolved their thinking. A recent turning point in the BAS journey towards being a more inclusive organisation was partnering with the Diversity in UK Polar Science Initiative (DiPSI), founded in September 2019. DiPSI community identified that a number of societal challenges remain, including accessibility of polar research for those at the intersection of groups that are still underrepresented in STEM subjects. New EDI internships, hosted by BAS in 2021-22, build on the activities developed by the DiPSI steering group to deliver a more diverse and inclusive future for UK polar science. Here, we will outline the successes and insights gained from the EDI internship programme funded through the Natural Environment Research Council. We want to paint a picture of the long-term investment of time and resources needed to support inclusion and propel progress within the UK Polar Community. These internships are ‘the tip of the iceberg’ built on the efforts started in September 2019. We will present results from our impact evaluation in the context of our long-term ambitions, highlighting both areas of success as well as prevailing challenges.

Accepted as: Oral Presentation

Abstract No : 61

Who should work in Antarctica? An exploration of the individual, social, and cultural aspects of expeditioner recruitment

Meredith Nash, Australian National University

Drawing on qualitative interview data, this paper explores past and current Australian Antarctic Program expeditioners' perceptions of the personal qualities of expeditioners alongside their views of Antarctic station culture and expeditioner recruitment procedures. Findings reveal study participants shared similar views about expeditioner personal qualities. However, findings also suggest that the current demographic similarity of expeditioners (e.g., the overrepresentation of white men) is perhaps much more important for assessing organisational fit than the program might be selecting for. Participants described the ways in which interpersonal interactions and the social environment can deeply affect an expeditioner's experience of the station culture. Women in this study pointed to the connection between the overrepresentation of men in the expeditioner population and a potential male bias in station culture. These results extend the existing literature on person-culture fit in Antarctica. To conclude, I provide recommendations for diversifying the expeditioner applicant pool in Antarctica and that can also be applied to the selection of other workforces in isolated, confined, and extreme work environments, including space missions.

Accepted as: Oral Presentation

Abstract No : 764

A Research on the Role of Science Diplomats in Polar Science Diplomacy

Ebru Caymaz, Canakkale Onsekiz Mart University

The global arena has been experiencing a more complicated and many-sided diplomatic system in which non-governmental organizations, scientific institutions, the network of regulators, media, and governments are involved. While disputes and conflicts have necessitated a new type of governance framework for polar regions, the new diplomatic system has renewed the interest in science diplomacy to address the major challenges threatening the global commons. On the other hand, as could be seen in the COVID-19 pandemic case, immediate multilateral responses may not be coordinated albeit the existence of intense international scientific collaboration. Therefore, by applying the methods of Track II diplomacy to unite scientists with political leaders, government officials, and diplomats, science diplomats can elicit communication between countries and enhance collaboration, especially during crises. Accordingly, based on the geopolitical tensions and recent developments, this article aims to examine the role of science diplomats in polar science diplomacy. Keywords: Antarctica, Global Commons, Science Diplomacy, Science Diplomat, Track II Diplomacy.

Accepted as: Oral Presentation

Abstract No : 696

Breaking Polar Boundaries; Access Polar's role in advocating change and representing researchers with disabilities.

Angus Aldis, Accessibility in Polar Research

Isabelle Cooper, Accessibility in Polar Research

Charlotte Cockram, Accessibility in Polar Research

Iain Sword, Accessibility in Polar Research

Navigating the field of polar research is tricky, especially for people with disabilities. Whilst the field has progressed, there are still accommodations that need to be made, and discussions that need to be had regarding inclusivity. Accessibility in Polar Research (APR) was founded during the pandemic by a small group of disabled researchers who have all faced adversities in the field due to their disabilities. In just under two months, we found ourselves with a platform exceeding 700 followers on Twitter (@accesspolar). APR's first initiative was to understand how the polar field is restricting disabled researchers. Through collating this information from fellow researchers who have experienced adversity, APR has identified key areas in need of improvement. Additionally, APR has hosted multiple speaking events, been invited to panels/podcasts, made some useful resources on quick-fix accessibility tips for science, and sparked lively debates on frequently avoided topics. From this work, the network has created an excellent platform to carry out some of its aims: (i) Highlight the positives of disabilities (ii) to help spread awareness of difficulties researchers face and, (iii) provide/distribute resources and suggestions to improve inclusivity. This talk will give you a taste of APR advocacy, a summary of the key issues identified, what APR's future goals are and why the polar field needs to become more inclusive (using our own experiences). You will also receive some of our top tips on how to make your research more accessible.

Accepted as: Oral Presentation

Abstract No : 610

Supporting and building inclusive behaviours in the UK Polar Community

Pilvi Muschitiello, British Antarctic Survey

Geraldine Hough, British Antarctic Survey

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Beatrix Schlarb-Ridley, British Antarctic Survey

Kate Hendry, British Antarctic Survey

The unique conditions of living and working with a small group of people in the remoteness of Antarctica has always required strong codes of conduct to govern behaviour. Insights gained from the activities of the Diversity in UK Polar Science Initiative (DiPSI), such as a race impact survey highlighting the importance of an anonymous reporting system, have indicated that it would be helpful and timely to review the code of conduct developed by the British Antarctic Survey (BAS) for those who use its logistics and infrastructure. This review has led to a stronger emphasis not only on reinforcing expected behaviours, but also on building a positive culture where everyone can belong, independent of their background and lived experience. Additional context and training are being provided pre-deployment through talks and a UK Polar Community booklet on inclusive behaviours. Here we share details of the approach taken and invite discussion on the most effective ways to build a fully inclusive culture across all levels of Antarctic communities.

Accepted as: Oral Presentation

Abstract No : 930

Be a Better Ally for LGBTQIA+ Students

Nicole Hellessey, Georgia Institute of Technology

Alex Thornton, Pride in Polar Research

Sasha Leiderman, Rutgers University

Inclusivity, equity, and diversity benefit scientific research, helping the community to realize its full potential by uplifting qualified individuals with unique perspectives from a wide range of backgrounds. Even so, LGBTQIA+ voices have historically been marginalized within the geosciences, particularly at the early career level. Pride in Polar Research (PiPR) is an international network welcoming all Sexual Orientation, Gender Identity, Gender Expression and Sex Characteristics identities (LGBTQIA+ and others); one of our core aims is to help polar professionals become better allies to LGBTQIA+ individuals in order to promote diversity and foster a more inclusive environment for marginalized individuals in our community. We welcome allies with all degrees of familiarity about this topic to join us on our mission. This talk will provide a information for researchers related to LGBTQIA+ identity and examples of how allies can create resources that attract, recruit, retain, and uplift students despite these different barriers. Examples on how to address diversity and inclusion within the feild as well as in STEM teaching will provide helpful tools allies can take back to their home institutions to help foster a more inclusive environment, from the classroom to the lab or field. This talk will also open to broader questions and discussion about ways to create impactful procedures, policies, and best practices that benefit LGBTQIA+ students facing discrimination.

Accepted as: E-poster Presentation

Abstract No : 734

THE BRAZILIAN ANTARCTIC PROGRAM AND ITS SCHOLARLY COMMUNICATION

Paula Carina de Araújo, Universidade Federal do Paraná

Roberto de Pinho, Ministério da Ciência, Tecnologia e Inovações, Brazil

Andrea Cancela da Cruz Kaled, Ministério da Ciência, Tecnologia e Inovações, Brazil

The Brazilian Antarctic Program aims to produce scientific knowledge about Antarctica and its relations with the earth system, including the cryosphere, the oceans, the atmosphere and the biosphere. Considering its 40 years uninterrupted contribution to Antarctic Science the investigation sought to analyze the bibliometric indicators of scientific production from scientists enrolled in research funded by the Program and found to be related to Antarctica. The data was collected from the databases Lens, Web of Science and Scopus. A set of 1,242 scientific documents were analyzed and the data shows that the scientific production grew through the years. The domain of Biology is the main area of publication. The majority of studies were published in the journals Polar Biology. The institution of affiliation that concentrates the most part of the publications is Universidade de São Paulo. The co authorship among two or more authors is preferred by the scientists which reveals a high scientific collaboration rate. The strongest institutional collaboration is between Universidade de São Paulo and Universidade Estadual Paulista Júlio de Mesquita Filho, followed by the one between Universidade de São Paulo and Universidade Federal do Rio Grande do Sul. When considering the connection among countries, the strongest country collaboration is between Brazil and the United States of America. The resulting corpus can be regularly updated to allow for longitudinal studies of the program. Furthermore, it represents strategic information to support the management and the definition of guidelines for Brazilian science in Antarctica.

Accepted as: Oral Presentation

Abstract No : 346

PEI & JEDI – from aspiration to inclusion – working towards an inclusive polar educators network

Betsy Wilkening , PEI

Members of the PEI JEDI Working Group share our initial planning and progress, lessons learned and hopes for the next stages of development.

Accepted as: E-poster Presentation

Abstract No : 30

PSECCO: A New Community Office for Supporting Early Career Scientists and Advancing Equity and Inclusion in the Polar Sciences

Mariama Dryak, Polar Science Early Career Community Office

Rebecca Batchelor, CIRES Education & Outreach, University of Colorado Boulder

Bradley Markle, INSTAAR, University of Colorado Boulder

Anne Gold, CIRES Education & Outreach, University of Colorado Boulder

While the polar sciences offer unique opportunities for international, transdisciplinary research as well as connections with Indigenous knowledge systems, the US polar science community remains unrepresentative of the diversity of the country itself. While there are many reasons for this, including those familiar throughout STEM as well as the explicit historical exclusion of certain groups in polar science specifically, early career scientists in the polar community are driving efforts to broaden participation in polar research. The newly launched Polar Science Early Career Community Office (PSECCO) seeks to empower, elevate and give agency to the early career polar scientists who are leading the charge to make the polar sciences more welcoming, inclusive and diverse. The office will foster community among early career polar scientists, provide funding, training and travel opportunities, partner with other organizations to share opportunities, resources and support leadership development, while working together towards a more just, inclusive, diverse, equitable and accessible polar science environment. Launching in 2022, we invite all current and future polar scientists to join PSECCO in building community together.

Accepted as: Oral Presentation

Abstract No : 419

#100polarwomen: Reflections on the first half of a yearlong project to showcase the work of women in Arctic and Antarctic

Andrea Herbert, University of Canterbury, Gateway Antarctica

Renuka Badhe, European Polar Board

Women in Polar Science (WiPS) is a network that aims to connect and support women working in science and support positions across both polar regions. Its #100polarwomen project is a yearlong effort to highlight and showcase diverse women engaged in Arctic or Antarctic work across all disciplines, age groups, and geographic locations. In this presentation, we discuss the outcomes and insights of the first six months of the project (1 December 2021-31 May 2022), including reflections on representation, recruitment, and challenges. We also look ahead at the second half of the project and invite discussions on future collaborations and follow-up projects.

Accepted as: E-poster Presentation

Abstract No : 750

DEPLOYMENT OF AN ANTARCTICA RESEARCH GROUP

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Debora Espírito Santo , Centro Universitário Celso Lisboa

CAROLINE CARVALHO DE ARAÚJO, Centro Universitário Celso Lisboa

Paulo Eduardo Aguiar Saraiva Câmara, Universidade de Brasília

The geographic isolation of the Antarctic continent associated with the low temperatures of the Southern Hemisphere, resulting from the albedo and the Circumpolar Current, guarantees an authority in the regulation of the global climate and the planet's ecosystems. The identification of the pattern of trajectories between the Antarctic Continent and South America associated with the Continent has contributed significantly to the deposition of particulate matter in the Region. Despite the lack of available data on pollen deposition in the shipping medium. The present work presents the process of creation of the First Antarctic Research Center in a private university located in the metropolitan region of Rio de Janeiro. The establishment of the group allows undergraduate students to initiate research in Antarctica and consists of submitting the proposal by the academic direction of the constitution, the selection process of scholarship holders, evaluation and delimitation of research lines and the necessary methodological design. group composed of a professor at the University of Brasília, a professor at the Centro Universitário Celso Lisboa, a graduate student and four undergraduate students was created in March 2020. Among the activities developed are: scientific dissemination actions and research projects in the area of Atmospheric Sciences. NPA students followed the scientific activities in different institutions and recipients of discount scholarships. To date, the NPA has already held 2 regional events with the development of a master's thesis and three development monographs. Keywords: Cryosphere, NPA, Antarctic Research

Accepted as: Oral Presentation

Abstract No : 348

Diversity, equity and inclusivity – core principals for Securing Antarctica's Environmental Future (SAEF)

Diana King, SAEF, University of Wollongong

Ilva Sporne, SAEF, Queensland University of Technology

Kerrie Wilson, SAEF, Queensland University of Technology

There is a growing movement towards greater diversity, equity and inclusivity in Antarctic research. Securing Antarctica's Environmental Future (SAEF) is an ARC Special Research Initiative (SRI) in Excellence in Antarctic Science that brings together 30 organisations, both national and international, to deliver its program. Aiming to develop the future Antarctic research workforce, SAEF has a fundamental commitment to equity, diversity and inclusion. In this presentation we share our experience in planning and implementation of a range of initiatives within the program that contribute to providing equal opportunities to all participants and equitable access to groups who are currently underrepresented in the STEM disciplines.

Accepted as: E-poster Presentation

Abstract No : 55

Podcast production about black people's participation in the polar sciences

Ana Carolina Silva Gonçalves, Federal University of ABC

Silvia Dotta, Federal University of ABC

Black people made up 54% of the Brazilian population. Despite this, they are underrepresented in numerous spheres of society, including universities. In this context, we raise the following questions: Does Antarctica reach black students? Are there black researchers in Brazilian Antarctic research groups? Are there opportunities for study, work and research for blacks in the polar sciences? This work aims to produce a podcast that contributes to the reflection on the black in polar science. We researched the condition of black people in society, racism, social movements and black participation in science. We invite groups researching Antarctica to participate in a podcast, indicating their black members. The interviews were recorded online by Streamyard, edited with Audacity and broadcast on PolarCast. The search result for black people in the polar sciences for the podcast's production suggests a low representation of this population in the sciences. Only three scientists declared themselves to be black and granted interviews. Even though a black majority forms Brazilian society, few Afro-descendants work in polar science. The interviewees claimed to have been inspired by other people from the academy to follow a scientific career. However, they found that science in general and access to university are very distant from the black population. The podcast made it possible to learn about the problem of the insertion of black people in polar science, disseminated Antarctica to the black and Afro-descendant Brazilian population and attracted the attention of this audience to the search for opportunities in a scientific career.

Accepted as: Oral Presentation

Abstract No : 611

Value of cross-organisational collaboration for inclusivity initiatives

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Beatrix Schlarb-Ridley, British Antarctic Survey

Donna Frater, Natural Environmental Research Council

x Diversity in UK Polar Science Steering committee, x

In 2019, to mark the 200th anniversary of the discovery of Antarctica, the UK Foreign, Commonwealth and Development Office provided funding to start a Diversity in UK Polar Science Initiative (DiPSI). The initiative aims to provide baseline data on the current composition of the UK Polar Community regarding diversity and protected characteristics, and to work proactively towards increasing diversity, equity and inclusivity (DEI) in the community. The DiPSI Steering Committee has greatly benefitted from the breadth of organisations that are represented, which include members of (i) the UK-university-based polar research community representing the UK Arctic and Antarctic Partnership and the UK National Committee for Antarctic Research, (ii) the UK's National Antarctic Operator (British Antarctic Survey), (iii) the Polar Regions Department of the UK Foreign, Commonwealth and Development Office, (iv) DEI teams from the UK research funding bodies (Natural Environment Research Council and its parent, UK Research and Innovation), (v) the Early-Career-Researcher-focused UK Polar Network, as well as (vi) a BAME in STEM Consultant, and representatives of international bodies such as (vii) SCAR, (viii) the International Arctic Science Committee and (ix) the European Polar Board. This paper highlights the importance and value of working across a broad organisational landscape to address DEI issues in a holistic way, encompassing the entire pipeline from education through to senior leadership. Connecting with those organisations engaged in providing funding helps to set project targets that will interlock with the goals of those organisations, can facilitate funding opportunities, and reward targeted efforts.

Accepted as: E-poster Presentation

Abstract No : 605

International Collaborations on Antarctic Research by Türkiye

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Nasih Sarp Ergüven, Ankara University, Faculty of Law

Zeynep Bilge Esen, TUBITAK MAM Polar Research Institute

Özgün Oktar, TUBITAK MAM Polar Research Institute

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Hasan Hakan Yavaşoğlu, TUBITAK MAM Polar Research Institute

Burcu Özsoy, TUBITAK MAM Polar Research Institute

TÜBİTAK MAM Polar Research Institute (PRI) is the responsible body of Türkiye to coordinate polar scientific & logistic operations and the National Competent Authority in Antarctic Treaty System since 2020. Within the national polar science program, PRI primarily conducts scientific expeditions to Polar Regions, funds annual polar research project calls, organizes education & outreach activities and represents Türkiye in various international meetings and associations. Meanwhile, Türkiye also aims to increase international collaborations in polar research with bilateral agreements, as promoted in Antarctic Treaty. Since 1960s, many Turkish researchers were hosted by several National Antarctic Programs. Similarly, scientists from various nations were supported by Turkish Antarctic Expeditions since 2017. Türkiye signed memorandums of understandings and letters of intent on scientific and logistic cooperation in Antarctica with many countries and aims to expand this list to conduct high quality and multi-national polar research projects, as well as efficient logistics. As mentioned in research and news articles, Türkiye carries out more effective activities to undertake polar research annually. Additionally, Türkiye intends to increase science diplomacy actions with Antarctic Treaty parties. This study aims to showcase the development of Turkish national polar program with a special focus to international collaboration. An overview of international collaboration of Türkiye in Antarctica will be presented including a review on Türkiye's increasing polar activities.

Accepted as: Oral Presentation

Abstract No : 601

Staring Down Adversity in the Polar Community: A black woman's challenge to overcome

Kimberly Aiken, Research and Policy Associate, Antarctic and Southern Ocean Coalition and PhD Candidate, Antarctic and Southern Ocean Coalition, Institute for Marine and Antarctic Science

The impact of being a black person and a woman in a predominately all-white space is distressing, to say the least. Colonization, its past and present effects on generations across STEMM fields are incredibly messy. Repeated acts of dismissal, invalidation, and disrespect threaten one's emotional well-being. An onset of unworthiness, a plethora of questions, and the imaginary fact that one does not belong are illuminated. Misery and loneliness become your reality. Experiences with microaggression and marginalization inescapably have shown up in interactions with white colleagues, reinforcing the struggle to experience a professional environment free of oppression and covert discrimination. Driven to contribute to the Arctic and Antarctic environmental protection as a passion of mine quickly became to others something to be tolerated, invisible or inconsequential. At the lowest point, a strong desire to walk away and leave polar work behind was appealing, as the overwhelming doubt that something must be wrong with me took hold. Within the suspension of epistemology, something is inherently wrong with the way society sees and acknowledges black, brown, and Indigenous people in the world, making the challenge to overcome adversity all the more severe. Surviving an undiversified and non-inclusive space never goes unchallenged when you are an anomaly and do not fit the cultural profile. A solution-oriented approach requires full commitment to engaging in sincere ways of respect for, acknowledging, and understanding all forms of discrimination that reinforce inequality, and applying actions that foster belonging and the building of diverse spaces in the polar community.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS-DISCIPLINARY TOPICS

**Public engagement with
Antarctica in a changing climate**

CONVENORS

Rebecca Priestley, Rhian Salmon, Heidi Roop,
José Xavier

Accepted as: E-poster Presentation

Abstract No : 49

Education and Outreach Perspective of Polar Research Institute in Turkey

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The national polar expeditions of the Republic of Turkey were carried out under the coordination of the Scientific and Technological Research Council of Turkey (TUBITAK), Marmara Research Center (MAM), Polar Research Institute (PRI) in both Arctic and Antarctic Regions to shed light on to the past, present and the future of the planet with scientific researches. In addition to polar expeditions, PRI aims to raise awareness on the polar regions and global climate change among younger generations since 2019. Onward the establishment of the PRI, thousands of students and teachers have been reached during various education and outreach (E&O) activities by the experts in the institute. In 2021, the 2nd Polar Science Festival was held on Antarctica Day, December 1st with the participation of more than 10,000 visitors. Additionally TUBITAK is organizing to encourage high school students in polar sciences, the “High School Students Polar Research Projects Competition” which it's first in 2020 and received more than 700 submissions. “Educators Supporting Collaboration on Polar Regions Project (ESCoP)” was created to bring teachers to polar regions along with scientists, and then to disseminate the experience in schools with interaction. TUBITAK MAM PRI has been carrying out numerous E&O activities since its establishment and continues with more activities about polar regions, polar research, and global climate change. For this purpose, the PRI organizes festivals, seminars, presentations, prepares documentaries, etc. and contributes to the related publications. In this study, a review of these E&O activities will be presented in details.

Accepted as: Oral Presentation

Abstract No : 116

A Long-Distance relationship: strategies for fostering indirect Antarctic place attachment

Katie Marx, University of Tasmania

Place attachment, a concept employed in human geography to refer to the bonds between people and places, is useful for promoting environmental public engagement. Individuals who feel attached to a place experience increased wellbeing and are more likely to take action to protect that place. As Antarctica faces increased environmental challenges in the coming decades, an understanding of place attachment could assist the polar sector in garnering public support for the southern continent. The majority of place attachment scholarship to date, however, has focused on people who have lived in, or at least directly experienced, the place concerned. Given that most people will never visit Antarctica, this raises the question of whether there are ways to foster attachment based on indirect experience. This paper will present the results of a mixed methods case study on Antarctic place attachment situated in Hobart, the Australian gateway city. Drawing on in-depth interviews and a community survey, this study has found that some Hobart residents who have not been to Antarctica do experience a type of indirect place attachment. This attachment is facilitated, or “mediated,” by a number of factors, including a person’s social and political capital within the Antarctic sector; their access to Antarctic information and events; and the availability of sensory experiences that mimic Antarctica in terms of ice, cold, and isolation. Engagement strategies that focus on these mediators will, therefore, help to strengthen the public’s sense of attachment to Antarctica.

Accepted as: E-poster Presentation

Abstract No : 321

The imaginary legend – The reality to all.

Coral Tulloch, Illustrator, Hobart, Australia

Our stories past and present create the legend that is Antarctica. This enormous, raw environment, where winds are born and oceans cooled – demands our humility and inspires our cooperation. Our collective voices hold the honest values born here to define the future path for our world.

Accepted as: E-poster Presentation

Abstract No : 47

Antarctic Expedition 2.0 – the scientist's role in the development team of an educational digital RPG

Silvia Dotta, Federal University of ABC

Sandra Freiburger Affonso, Federal University of ABC

Flavia Sant´ Anna Rios, Federal University of Paraná

Juliana Braga, Federal University of ABC

Edson Pimentel, Federal University of ABC

The development of educational digital RPG (Role-Playing Game) learning objects (LO) requires gathering skills from several areas of knowledge: computer science, game design, illustration, and project management, among others. This work aims to develop an RPG guided by pedagogical approaches since its conception and describe the Antarctic scientist's role in creating an LO for disseminating Antarctic sciences. We adopted the Intera methodology (Braga et al., 2015) for LO development, which provides for the distribution of roles according to the technical demands of LO production. An expert in Antarctic Sciences acted as curator and coordinator of the team of scientists. During the development of the LO, a scientific consultant was responsible for validating content, helping to ensure conceptual accuracy in scenarios, dialogues and other interactions. The game allows the player to simulate field research in different research areas and locations in Antarctica, with specific methodologies and materials consistent with their object of study. LO of this type often have conceptual errors. In this work, the participation of different scientists contributed to avoiding these problems. Ensuring that an LO achieves its pedagogical goals is one of the challenges multidisciplinary teams face. In the process described above, the valorization of the role of Scientific Consultant, as proposed by the Intera methodology, was crucial to guarantee adequate treatment of scientific and educational contents. The game will be evaluated in the classroom in future works, seeking to understand its contribution to education.

Accepted as: Oral Presentation

Abstract No : 999

The Effect of Education and Outreach Studies on Polar Regions and Climate Change Adaptation

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Earth's recent history has been dominated by dramatically growing human activities since the 19th century. Due to fossil fuel burning, the anthropogenic effect has brought a critical reflection regarding positive feedback mechanisms on ecosystems. As a consequence of human activities, the number of events, like the warming of the Arctic, permafrost thawing, riverbanks crumbling, and melting of polar ice shields, significantly increased. Despite these impacts expected to intensify in the coming decades, general knowledge about polar regions is relatively low due to the level of education, and social and demographic features that may influence the formation of legislative solutions concerning polar regions. Notably, the dissemination of scientific knowledge and awareness, which are formed through education, outreach, and effective communication, are key instruments that can help environmental conservation and sustainability in polar regions. Within this scope, the Turkish Polar Research Institute has established a team of dedicated students to conduct awareness-raising activities on climate change and its impact on polar regions. Over the last 7 years, 100,000 people are reached out across Turkey during seminars, festivals, and other activities for schools and partner organizations. Besides, activities held are not only on a national but also international scale to increase collaboration among polar enthusiasts. This gaining capacity brought a unique understanding and engagement where especially students started taking action on how to tackle the climate crisis. This study will showcase some analyses that might be used as background to design educational and social plans promoting environmental responsibility by also considering polar regions.

Accepted as: Oral Presentation

Abstract No : 666

Public Attitudes towards Australia's Activities in the Antarctic Region: Preliminary Results from a National Survey

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Claire Konkes, University of Tasmania

Linda Hunt, University of Tasmania

Elizabeth Leane, University of Tasmania

Hanne Nielsen, University of Tasmania

In the last two decades researchers have increasingly turned their attention to public perceptions, knowledge and attitudes in relation to Antarctica. Surveys and interviews with a range of different focuses have been conducted in several national (and sometimes comparative) contexts, including the Netherlands, Malaysia, the US, Spain, Chile and New Zealand. This presentation reports the early findings of surveys of public attitudes towards, support for and knowledge of Australia's activities in the Antarctic. We collected data via the Australian Survey of Social Attitudes (AuSSA), a national sample of adults randomly selected from the Australian Electoral Roll, which can be generalised to the Australian population. In 2021-22, we asked a set of questions focussed on public support for Australian Antarctic Division activities in Antarctica, including the (now abandoned) Davis runway project; krill research; ice-core research; and the new icebreaker, Nuyina. Our presentation reports on these data, noting significant difference in terms of gender, age, views on climate change, and other factors. We followed this research with a longer set of questions aiming to determine Australians' broader attitudes towards Australia's Antarctic activities as well as to obtain a baseline of citizens' general knowledge of the region. Our presentation will also give a preliminary report on these data, which are still in the process of collection. Our results suggest that, if Australians are to have informed opinions about their nation's involvement in the region to its south, evidence-based and carefully considered public engagement is required.

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Abstract No : 43

Approaching Antarctica in Brazilian Geography textbooks aimed at the 8th grade of Brazilian Elementary School

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Diego Cieni, Federal University of ABC

Flavia Sant'Anna Rios, Federal University of Paraná

Sandra Freiburger Affonso, Federal University of ABC

The approach to Antarctica in the Brazilian school curriculum is still incipient. The National Curricular Common Base (Brazil, 2018) defines essential learning for all students. Despite proposing a study on climate, climate change, and the greenhouse effect, Antarctica only appears in the Geography curriculum for the 8th year of Elementary School. That leads to the question: Is Antarctica an essential topic for Brazilian people? Is there enough educational material? What do teachers know about Antarctica? What disciplines could address the subject? We analysed if and how the Continent appears in 8th-grade Geography textbooks. We have compiled six Geography books (B1 to B6) from the official national catalogue. We analyse summaries and content dedicated to discussing Antarctica's environmental and territorial role in the geopolitical context, its relevance to South America, and its value as an area for research and understanding of the global environment (Brasil, 2018). The pages dedicated to Antarctica are: B1: 6; B2: 15; B3:7; B4: 3; B5:8; and B6: 8 pages. The topics covered are [i] geographic data; [ii] climate data, [iii] historical information, [iv] fauna and flora, [v] climatic importance, [vi] global warming, [vii] preservation, [viii] research, [ix] Antarctic Treaty and [x] Brazilian Antarctic Station. The small space gives a superficial view of the contents. The curriculum neglects the study of Antarctica in the other subjects. Urgent actions are needed to expand the presence of Antarctica at schools and for teacher training.

Accepted as: Oral Presentation

Abstract No : 433

Formation of environmental education teachers in Brazil: the role of Antarctica in the local climate

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Lúcia Sanguino Canteri, UFPR

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Sandra Freiburger Affonso, UFABC

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Brazil is mostly located in the Tropical Region, and the marked influence of Antarctica on climatic conditions is not always evident to the population, probably due the absence of typical components of the cryosphere in the country. In order to contribute to the insertion of the theme “Earth as a System” in elementary school, a workshop was conducted with teachers. Investigative activities were applied based in problematization and hypotheses, which were tested with laboratory experiments: (i) formation and buoyancy of icebergs, using different forms and size of ice; and (ii) oceanic and atmospheric circulation, inducing the formation of a convection cell in a container with water with different temperature (ice representing Southern Ocean and hot water representing Tropical Region. The applicability of the activities and understanding of the concepts were evaluated by a form. Everyone understood how icebergs arise and how they float. Most teachers (84.6%) assimilated that the planet acts as an interconnected system, with the polar regions being great climate coolers. They were inspired by new ways of teaching. The activities were considered applicable by the majority (69.2%). Some of them would apply the iceberg activity (30.8%) or the ocean circulation experiment (7.7%) with students aged 6 to 10 years. Although the experiments clearly aroused the interest of teachers during the workshop, the concepts are possibly complex for the age group of students they work with. All teachers said that they feel fully motivated to attend the next workshops on polar regions and climate change.

Accepted as: E-poster Presentation

Abstract No : 329

POLAR REGION & SUSTAINABLE DEVELOPMENT: ROLE OF PUBLIC PARTICIPATION IN CLIMATE CHANGE & ENVIRONMENTAL MANAGEMENT

Droupti Yadav, ASSISTANT PROFESSOR

India is a fast-growing nation with biodiversity-rich natural & cultural outstanding universal values (OUV). In the current frame time countries like India facing multiple challenges related to environmental issues due to overpopulation, pollution, global warming, ozone depletion, climate change, and mismanagement of the natural resources like water, forest, minerals, biodiversity, wildlife, and various ecosystem services, etc. In the era of digital technology world's scientific community, academicians, industrialists, corporative communities, government and non government organizations (NGOs) and self help groups (SHGs), and individuals are worried about the adverse impact on the environment due to global climate shifts. In this era of science and technology, everyone continuously works together and tries to find some possible solutions for achieving sustainable development goals in 2030, and "Zero Emissions" by 2070. The technocratic youth with innovative, creative, productive ideas and positive energy is engaged in research and development (R&D) to resolve the various climatic and environmental-related issues. In this regard, public participation became a boon for reducing the adverse impacts of environmental changes on the Polar Regions like Antarctica (South Pole) and Arctic (North Pole). Emerging trends of the current digital world play a significant role in our lives and in every stream like arts and commerce. Space-based technology (Remote sensing & Geographical Information System) save time, money, life, and the environment in inaccessible areas and support us through satellite data mapping, monitoring, and management of natural

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Abstract No : 505

Antarctic Education must include diversity, inclusion and equity: Portuguese efforts and actions

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There is increasing evidence that the Antarctic Treaty Parties, observers and experts recognize the value of education and outreach, with various examples of resources put into developing educational activities and collaborations. In the last Antarctic Treaty Consultative Meeting, in Berlin May-June 2022, the first papers have been addressing the issues of diversity, inclusion and equity. Working with other countries, as well as with the contribution of Polar Educators International (PEI) and the Association of Polar Early Career Scientists (APECS), Portuguese scientists and educators are highly committed to education and outreach related to these issues. In this presentation, we review the most recent and relevant educational activities developed in collaboration with APECS and PEI, in connection with other organizations (e.g. Portuguese Polar Program – PROPOLAR, Antarctic Treaty System, Scientific Committee on Antarctic Research Capacity Building and Training). These activities engaging scientists and educators contribute to define a common and effectively strategy to communicate polar knowledge. By qualitative examples in Portugal with > 10 countries, we show the steps to bring the Polar Science to the Portuguese Curriculum, developing didactic activities with students, and keep highly in long-term events, such as POLAR WEEKS and PEI national/International Workshops, under a diversity, inclusion and equity perspective. This way, we aim to demonstrate our efforts to change this culture and conduct activities that help to boost polar science-educational links outside the polar communities

Accepted as: E-poster Presentation

Abstract No : 717

A platform of education and entertainment to spread knowledge about Antarctica collapse through social media

FRANCYNE ELIAS-PIERA, Gelo na Bagagem Institute

Physical disturbance like sudden ice-sheet collapses and the fast retreat of glaciers impacts the spatial distribution and diversity of benthic communities and the Antarctic environment. Benthic organisms are a sink of carbon and nitrogen, and an essential part of the recycling material is relevant to the environment. The study of benthic communities from Admiralty Bay, Maxell Bay, Marian Cove and Larsen contributes to showing what can happen to the ocean with increased climate change and people have the right to know how the changes in the Antarctic and its communities affect human life. Raising awareness of the public about the need to protect the planet and spreading knowledge about Antarctica becomes more than necessary. The best way to teach the population is through educational programs and/or media programs. The “Gelo na Bagagem” Institute (Ice in the Luggage), the first platform of Antarctic education and entertainment, exists to create that environmental awareness. The institute offers free content available on Instagram, Facebook and YouTube with a playful and fun language reaching audiences from 5 to 90 years old and providing understanding and reflections about how human actions interfere with the environment. Based on the free content, high school and undergraduate students, elementary and higher education teachers who want to learn more about the topic can take part in the online course, available on an informal education platform. The material produced by the institute has been used in schools from Brazil and Portugal. Girls and women are the main audiences of social media.

Accepted as: E-poster Presentation

Abstract No : 44

ANTARTICANDO – DISSEMINATING ANTARCTIC SCIENCES THROUGH PODCASTS

Paula Marchiante Polignone da Silva, Federal University of São Paulo

Silvia Dotta, Federal University of ABC

Fernanda Quaglio, Federal University of São Paulo

Communicating science to the non-specialized public can bring scientists closer to society. However, informing scientific content is not an easy task. It is influenced by factors such as the complex nature of scientific information, how people process such information, and social influences. Most of the scientific dissemination content about Antarctica is in English, making its dissemination impossible for many Portuguese speakers, such as the Brazilians. This work aims to disseminate the Antarctic sciences to young Brazilian adults by creating and producing a podcast: Antarticando. We selected Antarctic scientists for interviews, drafted scripts, and recorded, edited, disseminated, and released six episodes. We use the free Anchor® platform for distribution on Spotify, Deezer, Facebook, YouTube and Instagram. The podcast reached approximately 1000 people, an audience predominantly from Brazil, with 83% of listeners using the Spotify platform, 10% on the Anchor platform, 3% on Google Podcasts and 3% on others. The most heard episodes were: Scientific dissemination of Antarctica, Living Marine Invertebrates and fossils, Antarctic Flora, Living Marine Mammals. The primary audience was between 18 and 34 years old. The production of podcasts requires low resources and investments. The resources available for the Antarticando channel allowed programming with scientists who contributed to Antarctic knowledge. The results showed the importance of expanding funds and disseminating podcasts to become widespread.

Accepted as: Oral Presentation

Abstract No : 417

Initiatives of India to Socialize Polar Science

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Avinash Kumar, National Centre for Polar and Ocean Research

Rahul Mohan, National Centre for Polar and Ocean Research

The scientific community is well acquainted with the far-reaching effect of climate change. Therefore, there is an urgent need to disseminate this information clearly and concisely to the general public and policymakers. The government of India unveiled a Scientific Social Responsibility (SSR) Policy that fosters synergy between science and society. National Centre for Polar and Ocean Research (NCPOR) is the nodal agency for the Indian Polar Programs (Antarctic, Arctic, and the Southern Ocean). For more than 15-year, NCPOR has been striving to popularize and socialize the significance of polar research and climate change in India, in light of the social responsibility of the scientific community to connect people to the poles. We organize scientific conferences, workshops, and other events. National Conference on Polar Sciences is a biennial event that provides researchers and academics with a platform to share their knowledge and science. During 2021-2022, the number of interactions under SSR exceeded 13000. Out of this, about 58% constitute the age group 8-17 years (schools students), 28% is under 18-25 years age group while 14% are above 25 years. The World Environment Day 2021 online quiz competition drew 3000 participants of all ages, and the India International Science Festival hosted by NCPOR in December 2021 attracted 5000 visitors. NCPOR has recently introduced a Virtual Reality tour of the polar and ocean regions that provides viewers with an immersive experience. This enthralling experience helps viewers to realize Antarctica's beauty and the global climate change crisis.

Accepted as: Oral Presentation

Abstract No : 710

Certifying institutions that develop the Antarctic mindset: Antarctic Accreditation Stamp

Francyne Elias-Piera, Gelo na Bagagem Institute

Silvia Dotta, Federal Univerity of ABC – InterAntar

Alfredo Sotto, University of Magallanes – Gaia Antarctica Research Center

The importance of the Antarctic continent to our planet is still unknown by society. In this work, we present the Antarctic Accreditation Stamp as a dissemination strategy for the polar sciences. This certification demonstrates the institution's performance and concern with the knowledge of the antarctic theme. The Antarctic Accreditation Stamp was created by Gaia Antarctica Research Center in 2013. In Brazil, it was implemented in 2021 by Gelo na Bagagem Institute and InterAntar/UFABC. They promote and coordinate the certification of schools, museums, and other institutions from Brazil or other countries. Gelo na Bagagem and InterAntar also offer materials such as videos, books, games, and podcasts to support activities like basic training courses on Antarctica, application of polar projects, participation in international polar weeks, activities on Antarctica Day, etc. There are five certification categories, and the institution will receive one of them according to the number of activities done over a year. In Chile, the educational activities are made for two years. The certification consolidates day-to-day activities with the Antarctic theme and recognizes the activities of the pedagogical staff in the implementation of polar science projects. In Chile, fifteen institutions have been awarded the certification, among them one in Spain, one in Portugal and the first one in Brasil. In 2021, seven Brazilian institutions and one Portuguese had received the Brazilian Accreditation. In 2022, more than 100 schools applying from Brazil, Portugal and Greece. Hopefully, this science dissemination action can contribute to the formation of the Antarctic mentality in society.

Accepted as: Oral Presentation

Abstract No : 207

Science in Antarctica: Producing media about science in the white continent

John Weller, Sea Legacy

“Science in Antarctica” is an ongoing series of short films that attempts to bridge the gap between scientists and the public by highlighting cutting-edge research, providing the in-depth context necessary to understand the importance of Antarctica to crucial global systems, and demonstrating its relevance to people around the globe. We have completed four films thus far, including “Tipping Point,” “Retreat of the Penguins,” “Sanctuaries at Sea,” and “Peace and Science.” Combined, these films tell a rich story of the fast-changing Antarctic, and the importance of Antarctic science and science diplomacy. Narratives for these films are derived entirely from interviews with the relevant scientists, and the series is being produced in collaboration with SCAR. In this presentation, we will show a 5-minute film, discuss the filmmaking process and tools for reaching the right audience, and report on the initial public release of these films at the ATCM and online.

Accepted as: Oral Presentation

Abstract No : 467

Polar Literacy: evaluation form to measure the knowledge of high school students about the Polar Regions

Priscila Correa, Universidade de São Paulo

The development of Science, environmental sustainability and scientific literacy are areas that will always be connected, maintaining the need for an interdependence between science produced in universities and the information that reaches society. As a result, the ocean literacy was created in the early 2000s and, based on it, there was a need to develop the polar culture from the international program Polar Interdisciplinary Coordinated Education (Polar-ICE), established in 2019 to connect scientists, educators and students and spread polar science through data and research in the Arctic and Antarctic. From this program, in 2020, seven principles were developed that support the polar scientific culture and the population, based on the engagement of society on how the polar regions influence people's daily lives under interdisciplinary aspects regarding the expansion of scientific knowledge about changes in polar regions and the global climate system. In this context, an evaluation form was produced containing 28 questions written based on polar principles and on the existing form on ocean literacy (International Ocean Literacy Survey) and 11 more questions for sociocultural data collection. This form will be widely distributed to high school students from schools throughout Brazil, covering the capitals of the five Brazilian regions. This investigation will generate unprecedented data for the country and help to foster national and global initiatives that seek to consolidate the importance of the Arctic and Antarctic in our lives and their influence on society.

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Abstract No : 432

Books about the polar regions and their inhabitants: arousing interest of the juvenile public for these themes

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Polar bears and penguins are symbolic animals of the North and South polar regions. However, although thousands of kilometers separate them in their natural habitats, these two animals are often represented side by side in films, books, advertisements and other materials that depict the icy environments characteristic of the Arctic and Antarctic. This misconception is added to the scarcity of teaching material and children's literature aimed at approaching polar themes at school. In order to fill this gap, books were written for children and adolescents with the aim of transmitting more accurate information, without conceptual errors, and that arouse interest in the polar regions and what happens there. In a playful way, the fable "The adventures of the Great Papu" addresses many concepts from the natural sciences, including the life cycle of penguins, the Antarctic food web and the impact of human activities on tourism, fishing and scientific research on the dynamics of the environment. In the book entitled "Polar bear eats penguin?", this intriguing question is answered by professionals from different areas, such as biologists, geographers, paleontologists, oceanographers, meteorologists, bringing a broad view on the subject. The digital version of the books in Portuguese can be accessed free of charge at <https://www.interantar.com/livros>. In addition to contributing to the dissemination of science, these books meet the need to offer teachers pedagogical support material with scientific rigor to address various aspects of the polar regions and their influences on the planet in the classroom.

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Abstract No : 646

A mysterious disease in Antarctic fish – A scientific graphic novel

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Researchers studying the Antarctic region and the Southern Ocean produce large amount of knowledge that they publish in scientific journals. These discoveries are, however, rarely popularized and provided in formats appealing and accessible to a general audience consisting of adults, teachers, and younger generations eager to learn more about science without delving into the complex scientific literature. To promote a wider understanding, appreciation, and protection of Antarctica, alongside a scientific abstract proposed to the Life Sciences session Management implications of Southern Ocean ecosystem dynamics and biodiversity thresholds, we present here “A mysterious disease in Antarctic fish”, a short scientific graphic novel resulting from the collaboration of scientists and a student artist. In this free graphic novel, we take readers on a scientific expedition to Antarctica aboard the US Antarctic Research Vessel Laurence M. Gould during which we captured many specimens of fish affected by massive skin tumors, set sail to the isolated Palmer Station to sample them, then back to the laboratory in the States to identify the origin of this mysterious disease and its effects on the fish. This non-fiction visual art format allows us to reach audiences beyond the scientific realm and invites readers to learn more about science in the South Polar region by engaging them into the initial discovery, building and testing of hypotheses, interpreting results, and developing new questions. Furthermore, to reach even broader audience, with the help of international collaborators, we now provide the graphic novel in five languages.

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Abstract No : 46

Scientific dissemination through transmedia: 101 Questions About the Polar Regions

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The role of the Antarctic and Arctic regions in maintaining the Earth's heat balance and living conditions is not fully recognized by the general public. We hypothesise that expanding the media universe of the polar regions makes it possible to favour the perception of its importance in the conceptual horizon of non-specialised audiences. This work aims to create a transmedia system to facilitate knowledge and awareness about the polar regions, expanding the potential for education and scientific dissemination of Antarctic themes. A transmedia system is a narrative context distributed on various media platforms such as comics, movies, books, games, etc. The languages that we use are diverse and adapted to different media. We've created the media franchise 101 questions about the polar regions: Antarctica, the Arctic and Climate Change and within it is production of a printed book, an e-book, a video channel (Tik Tok), and an audiobook distribution channel. Access to scientific information in an accessible language can lead citizens to better understand this information and how it is applied to their well-being (directly or indirectly), making them participate more effectively in decision-making. Therefore, it is necessary to promote a comprehensive and accessible language about scientific information and critical capacity through different dissemination forms, serving different audiences. Expanding different languages to access polar themes made it possible to reach different audiences, deepening their knowledge of Antarctica. In addition, the offer of varying media materials boosted the interest of teachers in dealing with the topic in the school curriculum.

Accepted as: Oral Presentation

Abstract No : 219

The impact of citizen science on attitudes to Antarctica: a collaborative investigation

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Citizen science (CS) has become an increasingly popular activity over the last couple of decades, involving thousands of projects and millions of people. Within polar tourism, where ship-board voyages are regularly presented as “expedition cruises” involving educational and environmental components, CS has a strong appeal – to the extent that a “Polar Citizen Science Collective” has been formed to promote and facilitate this activity. In the specific context of Antarctica, the appeal of CS aligns with the notion of a “continent for science.” CS activities within Antarctic tourism are many and varied, from commercial operators regularly offering CS options to scientific expeditions partly funded by citizen-scientists. Strong evidence exists for the useful scientific outcomes of CS, and there is emerging evidence of its potential to positively influence those who take part in it. At the same time, researchers have raised concerns that CS can act as a form of greenwashing – a sop to the conscience of tourists eager to justify their own impact on the environments they visit. These opposing views point to the need for more empirical evidence of the effect of citizen science not only on science but on tourists themselves. This presentation outlines a project, undertaken in partnership with Hurtigruten Expeditions, to examine the impact of CS on visitors’ attitudes towards Antarctica and their experiences of the journey, with a view to determining how CS activities can be implemented to maximise positive change. With fieldwork scheduled for the 2022–23 season, this presentation explains the project’s objectives

Accepted as: E-poster Presentation

Abstract No : 435

Where are the polar regions? Concrete and digital educational materials for elementary school

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The geoid shape of the Earth, when represented as a flat map, causes distortions. The typical representation of the continents makes it hard to understand the actual shape and size of polar regions in particular. This aspect contributes to the fact that the continent in the extreme south is little known. Unfamiliarity with polar geography makes it difficult to understand the importance of polar regions in global environmental dynamics. Terrestrial globes are certainly the best ways to represent the planet. However, they are not always available and students need to interpret images in textbooks and maps. Thus, didactic activities that allow the visualization of the Earth from different perspectives can help in locating the polar regions. Conical, cylindrical or azimuthal cartographic projections are flat representations that can help to minimize some specific distortions. In this work we present interactive activities for elementary school developed with WordWall® tools, representing different types of cartographic projection. We also propose to make paper globes from planispheres by the students themselves, facilitating the association of 2D representation with 3D. Additionally, the use of digital 3D simulation representing the Earth is an interactive way that shows the globe realistically and allows precision measurements. All activities can contribute to understanding form, location and size of the polar regions in relation to self-location, making learning more dynamic and interactive.

Accepted as: Oral Presentation

Abstract No : 436

Antarctic animals and the climate changes: card games for elementary school

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Human activities can affect the environmental balance of the planet, being particularly noticed in the polar regions of the Earth: Antarctica and Arctic. The fauna of these regions is rich in biomass and is composed of many endemic animals. Some representatives of this very particular fauna are seriously threatened with extinction and some have recently become extinct. Would Climate Change be responsible for accelerating this process? We present two educational games that engage students to answer this and other questions. The games expose elementary school students to polar fauna and many of their adaptations and extinction risks. In a playful way, the game “Desafio Ambiental” (Environmental Challenge) addresses some ecological interactions and geographic distribution of polar animals, highlighting their trophic level, allowing the interpretation of the role of each organism in the food web, as well as the environmental consequences of the eventual extinction of each one of them. To play “Dominó Mudanças Climáticas: Adapta ou Extingue” (Domino Climate Change: Adapts or Extinguish), it is necessary to relate the animals of Antarctica or Arctic with adaptive and evolutionary aspects that allow these polar animals to survive in hostile and extreme environments. The rules are similar to a traditional domino game, however, players are invited to deepen their reflection on the consequences of climate change on the adaptability of these organisms. Therefore, both games stimulate learning through investigative teaching, putting the students as protagonists of the process while also having fun. All the games are freely available for download and printing.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS- DISCIPLINARY TOPICS

**Rethinking Antarctic
environments and conservation**

CONVENORS

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Steve Chignell, Jilda Caccavo, Neil Gilbert,
Natasha Gardiner, Hyoungh Chul Shin

Accepted as: Oral Presentation

Abstract No : 115

Towards a biocultural paradigm shift in Antarctic conservation

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Daniela Liggett, University of Canterbury

As the only continent without an indigenous human population, Antarctica is often viewed as a pristine wilderness to be protected from human impact. While this approach to conservation has done much to promote an appreciation for the intrinsic values of Antarctica, it can also perpetuate a human-nature binary that sees people as separate from the natural world. Recent scholarship in the humanities, arts and social sciences has demonstrated that humans have played a role in the history of the continent, continue to do so today, and will likely do so into the future. If future human engagement in the Antarctic is to be equitable and sustainable, it will require fundamental changes in the way we approach conservation, to account for a plurality of worldviews and human-environment interactions. Building on innovative scholarship in other parts of the world, we propose a biocultural approach to Antarctic conservation, trading idealistic notions of pristine wilderness for a focus on the inextricable socio-ecological linkages among human cultures, material landscapes and diverse ecosystems. To do so, we examine how, where and by whom knowledge about the Antarctic has been produced in the past and present. We then identify points of intersection among these periods and explore how a biocultural approach could produce a more sustainable future. A biocultural paradigm shift has the potential to integrate insights from across the humanities, arts and sciences to offer a robust framework for interacting with each other and the Antarctic environment and for valuing complex socio-ecological systems in the Anthropocene.

Accepted as: E-poster Presentation

Abstract No : 25

The Status, Problems and Proposals of Antarctic Specially Protected Areas System

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With the Antarctic warming, sea ice melting, changes in ecosystem, and the increase of human demand for natural resources, the protection of the Antarctic ecological environment is facing great challenges. Under the active promotion of the international community, Antarctic Specially Protected Areas (ASPAs) have developed from a single reserve to a system of multiple types of reserve. At present, there are more than 75 ASPAs designated by 16 countries among which United States, United Kingdom, New Zealand, Australia, and Chile play a leading role. ASPAs system mainly covers the regions of Antarctic Peninsula and Ross Sea Victoria Land, and establishes the Antarctic Conservation Biogeographic Regions (ACBRs) as dynamic model for reserve recognition. However, there are still a series of problems in the ASPAs system, such as slow progress of development, disordered information management, low coverage rate of the areas, and insufficient representation of the reserve. To solve above-mentioned problems, it is important to fulfil each Party's duty of the Antarctic environment protection as the premise, strengthen scientific cooperation as an effective way, cope with the Antarctic climate change as the primary challenge, conduct ecosystem-based Antarctic Marine Spatial Planning (MSP) as the development direction, and eventually promote the further development of ASPAs system, and fully implement the effective protection for the Antarctic environment and ecosystem.

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Abstract No : 895

Conservation values in the Argentine Islands – Kyiv Peninsula region in the Antarctic Peninsula

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Multiple recent studies have identified inadequacies in the system of Antarctic Specially Protected Areas (ASPAs) as currently applied. Key limitations include the generally small extent and lack of resilience of ASPAs, the overall small proportion of terrestrial area under protection, and the lack of (bio)geographical or ecosystem representation. The urgent need for the ASPA network to be developed to become properly representative and resilient is widely recognised. An example of an area that could deliver these aims is provided by the region of the Argentine Islands – Kyiv Peninsula in the central Antarctic Peninsula. At present, formal protection in this highly biodiverse region is limited to the small Green Island (ASPA 108), which cannot represent the full range of ecosystems and biodiversity present. Founded on appropriate baseline survey data, definition and adoption of a larger ASPA in this region would enable effective protection of a wider range of these biological values. The region also includes important non-scientific values, in particular aesthetic, and includes a number of popular visitor sites, factors also important to include in the development of any future ASPA proposal. Here, we compare terrestrial biodiversity that would receive protection under any newly proposed ASPA in this region with those of existing ASPAs in the Antarctic Peninsula for which comparative biodiversity data are available. The available data demonstrate the exceptional ecosystem and biodiversity values of this region, satisfying the well-established grounds applied within the mechanisms of the Environmental Protocol in consideration of proposals for ASPA designation.

Accepted as: Oral Presentation

Abstract No : 519

Evaluating the effectiveness of the Ross Sea region Marine Protected Area: overcoming challenges of scale, cost, complexity and time

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When the Ross Sea region Marine Protected Area (MPA) came into effect in 2017 it was the world's largest marine reserve. It was also time-limited, in that it was established for a period of 35 years, after which, unanimous approval from CCAMLR members is needed to continue. The MPA provides an unprecedented opportunity to study the extent to which high seas MPAs (1) conserve representative ecological structure and function; (2) mitigate threats to ecosystems from fishing; and (3) provide a reference area to better gauge the effects of fishing and climate change. However, at over 1.55 million km² in size, tracking change and evaluating the conservation value of the Ross Sea region MPA is a highly complex, technical and unprecedented scientific challenge. The region is enormous, remote, inhospitable, complex (both physically and biologically), spatially heterogeneous, and varies on time-scales of days to decades. This presentation will discuss New Zealand research associated with the Ross Sea region MPA during its first 5 years. We summarise our baseline understanding of the ecosystems of the marine Ross Sea region and highlight key knowledge gaps. This taking stock is used to suggest future directions for ongoing monitoring of the region to understand the role of spatial protection: how can we ascertain the conservation value of a large, high-seas MPA in the Southern Ocean given oceanographic variability, complex food-webs, global change and mobile species?

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Abstract No : 936

Marine Ecosystem Assessment for the Southern Ocean (MEASO): outcomes, updates, and next steps

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Antarctic and Southern Ocean ecosystems are under increasing pressure from climate change and human impacts, which have already caused significant changes in these ecosystems. The first Marine Ecosystem Assessment for the Southern Ocean (MEASO) harmonised data on status and changes in Southern Ocean ecosystems to inform policy makers at the local and global scale, representing a truly international collaboration of over 200 researchers from 19 countries, with strong engagement from Early Career Researchers. MEASO highlighted the importance of key species and groups in structuring Southern Ocean ecosystems and performing key functions including carbon and nutrient cycling, and the transfer of energy to support vast biological populations, fisheries, and wildlife tourism. MEASO assessed the potential for future changes in water temperatures, ocean chemistry and sea ice, to generate major shifts in ecosystems over the coming decades. MEASO outputs emphasised Southern Ocean ecosystems' integral connection to the global ocean and human systems across the planet – only by mitigating climate change, alongside effective local conservation and management can we safeguard these vulnerable ecosystems and their societal benefits now and into the future. This presentation will highlight MEASO outcomes and recent fora in which these messages were shared (e.g. COP26). MEASO syntheses are intended to be repeated at regular time intervals to assess and quantify ongoing changes in the system and underpin effective decision-making around climate change mitigation, conservation and management of environmental change in this climate-sensitive region. We welcome continued and diverse engagement from the community to contribute to future MEASOs.

Accepted as: Oral Presentation

Abstract No : 747

Data to marine ecosystem assessments of the Southern Ocean: an integrated approach to Antarctic and Southern Ocean Management

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Ecosystems in the Southern Ocean offer a range of benefits to human society, dubbed Ecosystem Services. Upholding these Ecosystem Services requires well-informed and effective ecosystem-based management. This requires up to date and accurate information not only on the status of species, communities, habitats, and ecosystems, but also on the impacts of fisheries, tourism and climate change. This information can be used to generate indicators and undertake assessments to advise decision-makers. Currently, most marine assessments are derivative: reliant on the review of published peer-reviewed literature. Well-timed and accurate information for decision making requires an integrated Marine Biological Observing and Informatics System that combines and distributes data and allow the development of informative data Products. For such a system to work, data needs to be shared according to the FAIR principles (Findable, Accessible, Interoperable and Reusable), use transparent and reproducible science, adhere to the principle of action ecology and complement global initiatives. Here we aim to provide an overview of the components of such a system that are currently in place for the Southern Ocean, the existing gaps and a framework for a way forward.

Accepted as: Oral Presentation

Abstract No : 897

Towards two-way information flow between research and policy for area-based management in the Antarctic

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Southern Ocean delivers a range of ecological functions for the planet and the inhabitants, and is a source of harvestable resources. Area based management is one of the key mechanisms deployed for ecosystem conservation in the Antarctic. Science has been sought as and is mostly the basis for decision making in this regard for the Antarctic Treaty system. Ideally, correctly identified questions might be asked and answered by appropriate science for the designation. The benefits of having such management in place, then, is gauged in a reproducible and justifiable fashion, which should help to design the relevant monitoring and research. This might well be an iterative process and some inevitable gaps might be filled with precautionary reasoning. Some real-life cases will be compiled and reviewed in this presentation, and attempts will be made to study the examples of inadequacies. Developing effectiveness metrics with a protocol for stakeholder engagement is warranted. When the consensus for more complete measures takes time, building an interim arrangement that can generate part of the intended effects and still be evaluated for feedback will be worthwhile.

Accepted as: Oral Presentation

Abstract No : 158

Building representative MPA networks: MPA planning in the Southern Ocean

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Establishing representative Marine Protected Area (MPA) networks in Areas Beyond National Jurisdiction (ABNJ) is a priority for the conservation of marine biodiversity. In the Southern Ocean, the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR) is in the process of designating a representative network of MPAs using a bioregional planning approach. Globally, bioregional planning approaches have informed successful MPA network design in national waters, however the suitability of the approach to capture the broad scale characteristics of offshore ecosystems and support MPA planning in international waters is untested. We review the effectiveness of bioregional planning to achieve systematic conservation planning objectives (in particular the CARE principles) for a network of Southern Ocean MPAs. Using a Systematic Conservation Planning (SCP) framework, we test four planning scenarios and show that established and proposed CCAMLR MPAs underrepresent important region-specific conservation features, particularly for pelagic environments. We identify that under the current CCAMLR MPA planning approach, improved representation of targets will require establishing very large MPAs within the remaining planning domains, adapting existing and planned protection through revisiting previously planned-for domains, or a mix there-of. We recommend a) additional areas for protection to build a representative network of MPAs for the Southern Ocean and b) priorities for regional level plans to recognise and represent the relative importance of network level targets. Our research insights presented here are specific to the Southern Ocean but have broader applicability for other ABNJ.

Accepted as: Oral Presentation

Abstract No : 80

Evaluating the conservation impact of Antarctica's protected areas

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Antarctic Specially Protected Areas (ASPAs) are the primary regulatory mechanism for protecting Antarctic environments, which are increasingly threatened by the impacts of local activities. Evaluations of the effectiveness of ASPAs in the literature to date have been limited to their sampling and design characteristics, and these present a compelling rationale for the network's revision and expansion. However, while systematically expanding the ASPA network will increase the representation of outstanding values within ASPAs, representation is not automatically synonymous with genuine protection in terms of the improvement or avoided loss of those values. Consequently, an important question remains unresolved: do ASPAs work? This is not a question of the effectiveness of ASPA design and associated outputs, but rather ASPA management and outcomes. Without knowing how effective current ASPAs are in terms of the quality of protection they offer, we cannot fully quantify the potential benefits of expanding the ASPA network. This information gap falls short of the Antarctic Treaty Consultative Parties' and CEP's 'best available science' standard that guides Antarctic environmental management. In this presentation, we discuss approaches and challenges for evaluating the conservation impact of ASPAs and propose a research and management agenda to enable the comprehensive evaluation of the effectiveness of the ASPA network.

Accepted as: Oral Presentation

Abstract No : 625

The science-policy link in practice: how to propose an ASPA?

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The BELSPO projects ANTAR-IMPACT, BELDIVA and MICROBIAN and literature data concerning the biodiversity in the inland biotopes of the Western Sør Rondane Mountains (Dronning Maud Land) indicated a very rich and unique terrestrial biodiversity on the nunataks in the surroundings of Princess Elisabeth Station, including biofilms and Biological Soil Crusts. However, there is potential for negative impacts due to visits and (human) disturbances, mainly driven by the presence of infrastructures in the vicinity. Therefore, the involved scientists initiated the process of creating an ASPA in collaboration with the relevant ministries (Foreign Affairs, Environment and Science Policy). The first step was the submission of a Working Paper (WP42) at CEP XX (2017) with a Preliminary assessment of the values to be protected, using the template of Appendix 4 to the CEP XX report. Other countries scrutinized the document and raised useful comments and questions. The Information Paper (IP42) submitted at CEP XXI (2018) contained the answers to these questions. The next step was the writing of a Management Plan, based on a Guide that includes all the elements to describe (annex to Resolution 2 (2011)). Several versions were discussed, also with the station operator. The WPI5 was finally presented to CEP XXIV that forwarded it to the Subsidiary Group on Management Plan, where it will be further improved during the intersessional period. The process was a learning experience for the scientists, from creating the maps to developing management options, and lastly communicating the importance of the area to policy- and decision-makers.

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Abstract No : 270

Patterns of humans' preferences for choosing a place to survey biodiversity in terrestrial Antarctica

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Incomplete and biased biodiversity data hinders conservation science and management. Human preferences for choosing places to collect biodiversity data is one of the main contributors to this challenge. To fill data gaps and correct biases, we need to first understand these preferences. This information can then be used to correct for bias in modelled datasets and inform the prioritisation of future surveys. In other regions, studies find that these patterns are driven by accessibility, travel costs, curiosity, security, geopolitics, distance to populated areas, etc. However, such studies have not been carried out in Antarctica. We analyse patterns of human preferences for surveying Antarctic biodiversity and identified associated biases in existing Antarctic biodiversity datasets. We then predict the probability of a biodiversity survey being undertaken anywhere in the ice-free area of terrestrial Antarctica, where biodiversity is concentrated. We discuss the implications of our analyses for future biodiversity survey planning and conservation management in terrestrial Antarctica. Two exemplar implications of this research are (1) identification of high-resolution surveys that are a priority for future survey work; (2) coordinated effort to mobilise resources amongst National Antarctic Programmes (leveraging ground personnel, station access and field capabilities) to further the goals of the Antarctic Treaty System.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

CROSS- DISCIPLINARY TOPICS

Human impacts on Antarctica

CONVENORS

Kevin Hughes, Jasmine Lee,
Andrew Lowther

Accepted as: Oral Presentation

Abstract No : 239

Unveiling the real and potential environmental impacts of Antarctic tourism through a comprehensive meta-analysis of the published research

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The COVID-19 pandemic had a significant effect on Antarctic tourism operations, reducing the presence of visitors to practically zero during the 2020–21 season. However, the easing of travel restrictions during the 2021/22 season resulted in a reactivation of tourism as the largest commercial activity interacting with the Antarctic continent. It is expected that in the coming years pre-pandemic visitor numbers will be reached again, and the observed trends of growth and diversification will likely resume. The presence of visitors can generate unwanted negative effects, both real and potential, which have been compiled through a comprehensive meta-analysis of academic publications. 233 scientific papers on environmental impacts associated with Antarctic tourism were subjected to a bibliometric and content analysis. Following this, 75 key publications were identified and examined in detail to assess whether the presence of tourists at different Antarctic sites generated significant environmental impacts. Almost a third of these papers did not detect a direct relationship between the presence of tourists and significant negative impact. In most cases where impacts were found, they were classified as minor or transitory, not considered as posing a serious problem for Antarctic ecosystems. However, the application of lessons learnt from these publications to the management of Antarctic tourist sites is in many cases too weak, or even non-existent. To inform the effective conservation of Antarctica, rigorous and systematic monitoring of tourism activities is essential. Our study offers important insights on what we already know and why steadfast support for further monitoring of impacts is needed.

Accepted as: Oral Presentation

Abstract No : 29

The Southern Ocean contribution to the UN Ocean Decade

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In 2017, the United Nations proclaimed a Decade of Ocean Science for Sustainable Development (2021–2030) to support efforts to reverse the cycle of decline in ocean health. The initiative strives to strengthen the international cooperation needed to develop the scientific research and innovative technologies that can connect ocean science with the needs of society at the global scale. Based on the recommendations in the Ocean Decade Implementation Plan, the Southern Ocean community engaged in a stakeholder-oriented process to develop the Southern Ocean Action Plan. The process engaged a broad community, which includes the scientific research community, the business and industry sector, and governance and management bodies. As part of this global effort, the Southern Ocean Task Force identified the needs of the Southern Ocean community to address the challenges related to the unique environmental characteristics and governance structure of the Southern Ocean. Through this community-driven process, we identified synergies within the Southern Ocean community and beyond in order to elaborate an Action Plan that provides a framework for Southern Ocean stakeholders to formulate and develop tangible actions and deliverables that support the UN Ocean Decade vision. The Southern Ocean contribution to the Ocean Decade culminated in the publication of the Southern Ocean

Action Plan. Through the publication of the Southern Ocean Action Plan, the Southern Ocean Task Force aims to mobilise the Southern Ocean community and inspire all stakeholders to seek engagement and leverage opportunities to deliver innovative solutions that maintain and foster the unique conditions of the Southern Ocean.

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Abstract No : 951

Microplastics in beach sediments of two Antarctic Specially Protected Areas (ASPAs)

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Microplastics (MPs) are small plastic particles (0.001 to 5 mm) that have been detected as ubiquitous contaminants in oceans around the globe. Even geographically isolated and with environmental regulations in force, the Antarctic continent is not free from contamination by MPs. Recent studies have reported MPs in the Southern Ocean, marine sediments, sea ice, freshwater and associated with Antarctic biota. In coastal areas, the distribution of MPs is influenced by the energetic dynamics acting in the sedimentary environment. This study investigated the presence of MPs in surface sediments from beach environments of ASPA 126 and ASPA 128, seeking to trace relationships with sedimentological parameters to better understand MPs distribution in Antarctic beaches. Only 4 MPs (fibers excluded) were identified, one in each of 4 of the 15 samples collected. Raman spectroscopy was efficient in identifying the polymeric composition of particles such as PP, PE, PET (polypropylene, polyethylene and polyethylene terephthalate, respectively) and thermoplastic resin, but the low numbers limited comparison between the sampled environments. Significant differences in grain sorting and particle density occur between sampled environments, suggesting different sedimentary dynamics. However, the sediment is dominantly coarse and poorly sorted, reflecting a very energetic sedimentary environment that may explain the low numbers of MPs. Despite the low numbers, contamination by MPs is present even in ASPAs, and it is suggested to reinforce compliance with norms that regulate management of solid waste and liquid effluents in Antarctica.

Accepted as: Oral Presentation

Abstract No : 620

Ant-ICON State of the Antarctic Environment Project

Jasmine Lee, British Antarctic Survey

Kevin Hughes, British Antarctic Survey

State of the Environment reporting (SOE) is a popular framework for assessing environmental status in various regions worldwide. In the Antarctic, the Committee for Environmental Protection (CEP) has identified monitoring and SOE reporting as a Priority 2 issue in their 5-Year Work Plan. However, there have been limited efforts to undertake comprehensive SOE reporting for the Antarctic, though some nations have compiled regional assessments including Australia and New Zealand for East Antarctica and the Ross Sea Region, respectively. Ant-ICON Theme 2 is proposing a community-led initiative to develop a framework for, and undertake, a comprehensive assessment of the state of the Antarctic environment. This assessment could include themes for each of the primary threats to the environment, including non-native species, pollution from local and global sources, disturbance and habitat destruction associated with human activities, as well as an integrative theme on existing use of management tools. Climate change will be an important consideration in this work, but will not be the main focus as this issue is being reported through other SCAR initiatives. In this talk we will (i) provide background and context on Antarctic SOE reporting and (ii) identify possible pathways for a community-led initiative to deliver a product, via the SCAR Standing Committee for the Antarctic Treaty System (SC-ATS), that is useful for both policymakers and environmental managers.

Accepted as: Oral Presentation

Abstract No : 537

Geological diversity and heritage in Dronning Maud Land

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Geological diversity is the variety of rocks, minerals, fossils, landforms and unconsolidated deposits, and the processes that shaped them. Geological heritage, as part of the natural heritage, is special places and object that have key role in our understanding of the history of the Earth. Geosites are key localities of intrinsic interest. A value assessment of geosites will clarify the need of management. Antarctica is the continent dedicated to peace, research and conservation of the environment with its vulnerable nature. Geology is one of the elements in the Antarctica nature environment which undergoes mapping and research. Most parts of Antarctica are covered by ice, but nunataks expose rocks and unconsolidated deposits without vegetation. Hence, Antarctica provides unique information on geology. During geological expeditions to Dronning Maud Land (DML) we have registered geosites of intrinsic nature value. The localities are assessed as unique for scientific value, education, outreach, and the understanding of nature and landscape. Geosites of intrinsic value in DML encompass bedrock, unconsolidated deposits, geomorphology and landscape forms. In Antarctica the geological diversity interacts with ice streams and influences the development of the landscape. Our experience from geological field work in DML shows that there is a requirement for registration, descriptions and value assessment of important geosites. This should be run in accordance with SCARs pursuance of geoheritage. A good understanding of the geodiversity and geoheritage is important in a holistic management of the nature and environment, and can contribute to all ecosystem services; regulation, supporting provisioning and cultural services.

Accepted as: Oral Presentation

Abstract No : 620

Ant-ICON State of the Antarctic Environment Project

Jasmine Lee, British Antarctic Survey

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State of the Environment reporting (SOE) is a popular framework for assessing environmental status in various regions worldwide. In the Antarctic, the Committee for Environmental Protection (CEP) has identified monitoring and SOE reporting as a Priority 2 issue in their 5-Year Work Plan. However, there have been limited efforts to undertake comprehensive SOE reporting for the Antarctic, though some nations have compiled regional assessments including Australia and New Zealand for East Antarctica and the Ross Sea Region, respectively. Ant-ICON Theme 2 is proposing a community-led initiative to develop a framework for, and undertake, a comprehensive assessment of the state of the Antarctic environment. This assessment could include themes for each of the primary threats to the environment, including non-native species, pollution from local and global sources, disturbance and habitat destruction associated with human activities, as well as an integrative theme on existing use of management tools. Climate change will be an important consideration in this work, but will not be the main focus as this issue is being reported through other SCAR initiatives. In this talk we will (i) provide background and context on Antarctic SOE reporting and (ii) identify possible pathways for a community-led initiative to deliver a product, via the SCAR Standing Committee for the Antarctic Treaty System (SC-ATS), that is useful for both policymakers and environmental managers.

Accepted as: E-poster Presentation

Abstract No : 73

Retrospective assessment of air impacts in Antarctica: a case study

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In the late 19th and early 20th centuries, construction of the first stations in Antarctica has been started. This process accelerated during the International Geophysical Year (1957/1958) and since then, it is believed, that the intensity and scale of human activity in Antarctica have continued to grow. But quantitative assessment of trends of anthropogenic impact levels due to operations in Antarctica are scarce. The presentation is devoted to the assessment of trends of atmospheric air pollution and atmospheric impacts on the environment in the oases of the Thala Hills, Enderby Land, East Antarctica. The performed retrospective analysis for the first time allowed to construct time series of anthropogenic impacts on the atmospheric air in the Antarctic (on an example of Thala Hills) over half a century period. Estimates of annual emission of SO₂, NO_x, PM₁₀ and CO and their dynamics over the entire period of Thala Hills exploration and development as well as levels of surface air concentrations of SO₂, NO_x, PM₁₀ and PM₁₀ atmospheric deposition using air dispersion modeling are given. Modeled air concentrations and depositions are compared with the available measurement data. Sources of uncertainties in the estimates of emissions, ground-level concentrations and depositions are described. Proposed approaches can be used to assess the cumulative impacts of ongoing and planned activities on atmospheric air as well as on other components of the environment in the Antarctic Treaty area.

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Abstract No : 955

Potentially toxic elements (PTEs) in soils adjacent to an Antarctic research station

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The increase of anthropic activities in Antarctica has attracted attention to the environmental impacts associated with them. Historically, fossil fuels are used for power generation in Antarctica, and impacts associated with their management and storage are commonly reported. PTEs occur naturally on the earth's surface, but high concentrations confer toxicity to organisms. Anomalous levels of these elements have been related to contamination by fuel and oil spills. Soil plays a key role in the dynamics of these contaminants in the environment, and is fundamental for monitoring ice-free areas where human activities are concentrated. In this study, the levels of PTEs (Cd, Cr, Cu, Mn, Ni, Pb, V and Zn) in soils in the vicinity of the Henryk Arctowski Antarctic Research Station were investigated. Enrichment factors were used to verify potential anthropogenic effects on the geochemical variability of these soils. Low variability was observed in Cr, Ni and V levels, but high variability occurs for Mn, Zn and Pb. All samples presented Pb levels (5.1-165.9 mg kg⁻¹) above those observed in control sites. Transects successively distanced from an old fuel tank revealed decreasing levels of Pb, suggesting a point source of contamination. Pb and Zn pollution levels ranged from moderate to high by enrichment factor rating and geoaccumulation index. Results of this study contribute to the environmental monitoring of ice-free areas, preconized by the Protocol on Environmental Protection to the Antarctic Treaty, and highlights that fossil fuel facilities can act as point sources of PTEs.

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Abstract No : 314

First evidence of atmospheric nuclear weapons testing fallout on a Southern Ocean Island

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Efforts to monitor, manage and remediate our “visible” footprint in Antarctica have increased in recent years, but our “invisible” footprint, including contaminants transported atmospherically from geographically distant sources, has received far less attention. Although only 10% of all atmospheric nuclear weapons tests were conducted in the Southern Hemisphere, the fallout inventory was about 30% of that in the Northern Hemisphere, and there have been limited studies on the temporal and spatial variations of fallout in the Antarctic region. Lake sediment records provide unique archives for investigating these. We present the first nuclear weapons testing fallout history from a sub-Antarctic island. Fallout radionuclides ^{239}Pu , ^{240}Pu , ^{241}Pu and ^{236}U were measured in a lake sediment core from Macquarie Island (54°S , 158°E) and independently dated using ^{210}Pb . The $^{240}/^{239}\text{Pu}$ atom ratio during the onset of nuclear weapons testing in the late 1940's/early 1950's was 0.24, showing the influence of fallout from US atmospheric tests in the Pacific Proving Grounds, which was the major source of global fallout at the time. A lower $^{240}/^{239}\text{Pu}$ atom ratio of 0.17 in the late 1950's/early 1960's coincides with atmospheric testing by the former Soviet Union dominating global fallout. Concentrations of all radionuclides peaked ca. 1962–3, just prior to the signing of the Partial Test Ban Treaty, after which all declined. Records from other sub-Antarctic islands are being analysed to trace changing spatial and temporal patterns of anthropogenic radionuclides across the region, providing a baseline of currently unaccounted for contaminants.

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Abstract No : 975

Blue War in Antarctica's Water and Open Space

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The huge unmanned territory in the Antarctica and an ocean where no country has national jurisdiction is no more representing a fragile environment and the icy territory. The technology, increasing temperature and global order all have caused several threats in the Antarctica region. The term blue war definitely indicate a bloody war yet blue economy sector, probably the ocean territory including surface of oceans and beneath the water and outer space which involves blue water and blue sky including outer space. These three 'blue' are really offering a seed bed for geo - economic, geo-political and geo-strategy. The increasing human reach in Antarctica for economic lust has given birth to competition for the tourism, fishing, whaling leading to depletion of fishes and whales. Increasing tourism is a direct threat to the Antarctic environment. After approval of deep sea -bed mining the whole Antarctica is now vulnerable as no slice would remain immune to human lust causing devastating impact on the submarine biodiversity and geographical features under the ocean. The increasing tensions in the international relations and emerging multipolar global order and especially emergence of China has been indicating that the knowledge economies like China is able to create war infra structure in any place in its reach. The use of artificial intelligence, probabilities for space war has already made the Antarctica vulnerable for blue war (water and space). The paper explores the how Antarctica region is caught is in a blue war.

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Abstract No : 360

Total phosphorus records in coastal Antarctic sediments: burial and evidence of anthropogenic influence on recent input

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Total phosphorus (TP) records reflect variations in input and burial of organic matter (OM) in coastal and shelf sediments. At Antarctic regions, TP levels are often derived from natural sources; however, with emergent human pressure at these regions, anthropogenic sources of TP may play an important role. At the Antarctic Peninsula, Admiralty Bay attracts great scientific and touristic interest, especially during austral summer months, thus being vulnerable to human activities. Currently, only scarce spatial distributions of TP are available for this key region, whereas no vertical distributions have been determined. To fill this gap, we investigated short (< 20 cm) sediment cores in ten areas along Admiralty Bay for TP contents. We produced the first TP vertical distributions and established site-specific background values (from 492 ± 13 to 932 ± 17 µg g⁻¹), which are related to hydrodynamics, sedimentology, and natural inputs of P. We observed a gradual surface TP enrichment at all sites, mainly due to input of fresh OM. Benefiting from our background values, we employ the Phosphorus Pollution Index (PPI) to assess possible human impacts. Generally, the increase of PPI suggests natural inputs of P. However, PPI ≥ 1.3 found at the nearby Comandante Ferraz Research Station (Brazil) can be linked to recent (past 2–3 decades) treated sewage inputs in Martel Inlet. We suggest PPI as a proxy for preliminary assessments of anthropogenic impacts in coastal Antarctic regions experiencing increased human pressure. Full text: <https://doi.org/10.1016/j.marchem.2021.104037>

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Abstract No : 568

Interaction of seabirds with anthropogenic material in the Maritime Antarctic

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Antarctic marine and terrestrial ecosystems are under increasing pressure from human impact. The adverse impact of anthropogenic material on animals has been widely documented. The Fildes Region, King George Island, Maritime Antarctic, is characterised by a relatively long presence and high concentration of manifold human activities. Therefore, there is a lot of anthropogenic material in the surrounding of the stations or even scattered in more remote areas. At the same time, thirteen seabird species breed in the area. To investigate the impact of anthropogenic material on seabirds in the Fildes Region, a wide range of materials were collected, including freshly dead animals, faecal samples, regurgitates and pellets of skuas were examined for anthropogenic material. Thus, 84% of the storm petrel chicks found dead in the nesting cave and 36% of skua pellets with indigestible remains from storm petrels contained plastic particles, including plastic polymer granules. Besides, anthropogenic material was found in 10% and 20% of brown and south polar skua pellets, respectively. In regurgitates and faeces from skuas, anthropogenic material was registered in 1% and 6% of the samples, respectively. Microplastic particles were found in 4% of the gentoo penguin faeces samples. Furthermore, the use of anthropogenic material as nest material of Antarctic terns was reported for the first time. Other findings of anthropogenic material, such as long lining hooks or parts of fishing ropes at southern giant petrel nests underline the impact of anthropogenic material on seabirds in the Fildes Region, both from regional as well as marine sources.

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Abstract No : 29

The Southern Ocean contribution to the UN Ocean Decade

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In 2017, the United Nations proclaimed a Decade of Ocean Science for Sustainable Development (2021–2030) to support efforts to reverse the cycle of decline in ocean health. The initiative strives to strengthen the international cooperation needed to develop the scientific research and innovative technologies that can connect ocean science with the needs of society at the global scale. Based on the recommendations in the Ocean Decade Implementation Plan, the Southern Ocean community engaged in a stakeholder-oriented process to develop the Southern Ocean Action Plan. The process engaged a broad community, which includes the scientific research community, the business and industry sector, and governance and management bodies. As part of this global effort, the Southern Ocean Task Force identified the needs of the Southern Ocean community to address the challenges related to the unique environmental characteristics and governance structure of the Southern Ocean. Through this community-driven process, we identified synergies within the Southern Ocean community and beyond in order to elaborate an Action Plan that provides a framework for Southern Ocean stakeholders to formulate and develop tangible actions and deliverables that support the UN Ocean Decade vision. The Southern Ocean contribution to the Ocean Decade culminated in the publication of the Southern Ocean

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Abstract No : 344

Anthropogenic Litter found in Antarctic seals from the Western Antarctic Peninsula

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To assess the presence of marine debris in Antarctic seals, 29 feces samples were collected at Cierva Cove at the WAP (*Lobodon carcinophaga* (n=5), *Leptonichotes weddellii* (n=11) and *Hydrurga leptonyx* (n=13)). Feces were digested with KOH at 10% and observed under a binocular microscope. Approximately 400 debris items were isolated from the whole scat samples. Fragments and fibers of different colors were the main items found. We used Raman and FTIR microscopes to determine their composition, with 20% of the items analyzed so far. Black, green and blue fragments were characterized by μ -Raman spectroscopy, and spectra were consistent with black carbon (black fragments), blue and green copper phthalocyanine pigments (blue and green fragments, respectively), confirming their anthropogenic origins. The preliminary results for fibers characterized from μ -FTIR indicate the presence of semi-synthetic cellulose. Main sources of black carbon are associated with industrial activity, such as fuel fossil combustion, and burning of vegetation. Although previous reports were inconclusive about the source of this pollutant in Antarctica, potential sources such as electrical power plants and shipping are present in the region. On the other hand, copper phthalocyanine pigments are widely used in plastic polymers synthesis and industrial paints, indicating microplastic contamination in Antarctic seals. These results alert about the impact of these contaminants in this remote region and its ecologically important biota.

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Abstract No : 722

Presence of polyamide in stomach contents of a gentoo penguin at STRANGER POINT (25 DE MAYO/KING GEORGE ISLAND, ANTARCTICA)

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The diet of 15 gentoo penguins (*Pygoscelis papua*) was analyzed during the chick-rearing period at Stranger Point (25 de Mayo/King George Island, Antarctica), during the austral summer 2020/2021. Consistent with previous studies, Antarctic krill (*Euphausia superba*) dominated the diet and fish were secondary prey. However, a strange orange anthropic debris was found in one of the stomach content analyzed. The morphologic characterization was performed through the ocular inspection and using the stereoscopic microscope. The founded fragment seems to be a paint scrap, and its ingestion could have been accidental. With the aim of determinate the chemical composition and its possible anthropic origin, different regions of the fragment were analyzed using Attenuated Total Reflectance Fourier Transform Infrared Spectroscopy (ATR-FTIR). ATR-FTIR spectra were collected over the 4000–580 cm⁻¹ spectral region using a Nexus Nicolet spectrometer coupled with an ATR accessory containing a ZnSe crystal. The spectra are consistent with a polymeric composition of polyamide structure. This chemical species has a wide distribution in its use, even for polyamide epoxy paints. These epoxy coatings are prevalent in residential, industrial, transportation and marine applications, as it is highly resistant to corrosion. In addition, in the study area there are tourist, scientific and fishing activities, so it is not possible to elucidate the origin of this debris. This work highlights the importance of further investigating the extent of anthropogenic pollution in the Antarctic Peninsula, as well as the potential effect on top and meso-predators predators and evaluating the improvement of waste management in Antarctica.

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Abstract No : 151

Legacy and emerging contaminants in surface sediments from Admiralty Bay, King George Island, Antarctica

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The Antarctic continent is one of the most remote and protected areas of the planet. Nonetheless, anthropogenic pressures are increasing in the continent. Whereas legacy contaminants (e.g., Persistent Organic Pollutants- POPs and Polycyclic Aromatic Hydrocarbons- PAHs) have been detected in different environmental matrices in Antarctica, current knowledge on the presence of emerging contaminants (ECs) is still scarce in the region. This work aims to analyze the occurrence and levels of POPs, PAHs, and ECs recently deposited in Admiralty Bay. Surface sediment samples (n=17) were extracted using an accelerated solvent extraction system and quantified using gas chromatography coupled to a triple-quadrupole mass spectrometer. PAHs presented the highest concentration among the analyzed samples ($\Sigma 16$ PAHs ranging from 5 to 617 ng g⁻¹) followed by the UV filters HMS (0.35 to 251.3 ng g⁻¹) and octocrylene (0.68 to 93.8 ng g⁻¹), organophosphate flame retardant TCPP (0.1 to 87.4 ng g⁻¹), and the fragrance galaxolide (0.16 to 55 ng g⁻¹). PCBs presented the lowest concentrations ($\Sigma 5$ PCBs:

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Abstract No : 555

Monitoring of Emperor Penguins with drones – Feasibility and sensitivity.

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Like many other (Antarctic) species, emperor penguins are assumed to face severe challenges with ongoing climate change in the next centuries. As a fast ice-obligate species, they have to cope with possible habitat loss or instability due to the observed and projected changes in Antarctic fast ice. Other risks include loss of food resources or changes in weather patterns. As of now, the actual population status of the species is uncertain, since population data like exact breeding pair numbers are not available Antarctic wide. Many colonies are only known through satellite imagery, on which actual colony sizes can only be estimated. Drones present a promising tool to get more detailed insights into even remote emperor penguin colonies. During the field season of 2019/20, we tested the feasibility of drones as a monitoring tool over the emperor penguin colony of Atka Bay. We found that, when considering some technical difficulties due to Antarctic conditions, drones provide a useful tool for rapid gathering of population data. We also tested the behavioural reaction of the penguins to drones in different flight activities as well as in comparison to direct human approaches. Emperor penguins showed an observable, but short and not so intense (regarding proportion of individuals as well as severeness of behaviour) reaction. While chicks reacted most to direct drone approaches, adults showed stronger reactions to humans on ground than to any drone activity.



SCAR 2022

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CONVENORS

Petra ten Hoopen, Taco de Bruin,
Frank Nitsche

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Abstract No : 106

Data Discovery and Mobilization through POLDER's Polar Federated Search

Chantelle Verhey, WDS-International Technology Office

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A federated search enables users to utilize a single interface and through one query, search for data from multiple metadata catalogs. The system sends the search out to multiple data providers and waits for a response, then compiles and organizes the results for review by the user. Polar Data Discovery Enhancement Research (POLDER) is a collaboration between the Southern Ocean Observing System, Arctic Data Committee, and Standing Committee on Antarctic Data Management. With its community, POLDER has been working towards a federated search system for the last 5+ years. For many data types, there is no realistic prospect of standardizing and aggregating the data itself at this time; therefore, federated metadata search is the only viable way to make these datasets easily discoverable, and so maximize their value. The Polar Pilot Federated Search tool has moved into its first year of production. It harvests schema.org mark-up to expose various repository metadata in a single user interface. This shift marks a major milestone in the Polar data management community as we continue to work to ensure data adheres to the FAIR principles. This session explores the technologies used in the tool, the best practices documentation, and impacts/benefits to the wider Antarctic scientific community.

Accepted as: E-poster Presentation

Abstract No : 101

Data and metadata management for Antarctic sciences as the NADC in Japan

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The Polar Environmental Data Science Center (PEDSC) of the Joint Support-Center for Data Science Research (DS), the Research Organization of Information and Systems (ROIS) has a responsibility to manage and publish the data involving Japanese research activities as one of a National Antarctic Data Center (NADC). The data policy of PEDSC was established in February 2007, based on the requirements of the Standing Committee on Antarctic Data Management (SCADM) of the Scientific Committee on Antarctic Research (SCAR). At the International Polar Year (IPY2007-2008), a significant number of multi-disciplinary data have been compiled. These collected data/metadata have a tight collaboration with the Global Change Master Directory (GCMD), the Polar Information Commons (PIC), as well as several data centers belonging to the World Data System (WDS). In terms of data activities in polar communities of the Scientific Committee on Antarctic Research (SCAR) and the International Arctic Science Committee (IASC), tighter linkages of data/metadata sharing within the Asian Forum for Polar Sciences (AFoPS) countries has been discussed and should be further promoted by the involved Asian countries, in particular China, India, South Korea, Malaysia and Japan. In this presentation, a decade of history of polar data management is demonstrated, in particular focusing on data/metadata sharing, international collaboration among global data bodies and initiatives, data publication and citation, as well as data journal issues (Polar Data Journal).

Accepted as: Oral Presentation

Abstract No : 597

SCAR Antarctic Biodiversity Portal GBIF Hosted Portal

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The SCAR Antarctic Biodiversity portal (www.biodiversity.aq) is a community of researchers, data custodians and developers from around the world that supports the mobilisation publication, retrieval and analysis of Antarctic and Southern Ocean biodiversity data in a free and open manner in line with the Antarctic treaty and the FAIR data Principles (Findable, Accessible, Interoperable, Reusable). It is also the regional thematic node for both OBIS (Ocean Biodiversity Information System) and GBIF (Global Biodiversity Information Facility). To further support their engagement across national, institutional, regional and thematic levels, the GBIF Secretariat has developed a fully hosted service that provides simple, customizable biodiversity data portals to GBIF Participant nodes and their partners Each hosted portal is a simple website hosted and maintained on the GBIF infrastructure. The programme complements other tools available through the network by lowering the technical threshold for maintaining a branded web presence displaying a targeted subset of the data and information already available through GBIF.org. Here we present the latest developments relevant for the GBIF-hosted portal for biodiversity.aq.

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Abstract No : 491

Bedmap3: Data Standardisation and FAIR Publishing

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From 2020, the Antarctic geophysics community and data managers have worked together to produce Bedmap3, a new geophysical data compilation and grids of Antarctic bed topography, ice thickness and surface elevation. For consistency and statistical robustness, all new ice-thickness survey data since Bedmap2 have been collated in a consistent fashion. Survey data from Bedmap3, Bedmap2 and Bedmap1 have been standardised following the Findable, Accessible, Interoperable and Re-usable (FAIR) data principles, and we report standardised statistics on average and distribution for each 500 m grid cell. New survey data since 2013 in East Antarctica, the Recovery Glacier and many other areas fill almost all of the major data voids in the Bedmap2 compilation. In addition, recently available grounding-line, surface-topography and bathymetry mapping mean that the Bedmap3 gridded products provide an updated, model-independent alternative to Bedmachine Antarctica. Such grids are essential for identifying and prioritizing the remaining survey data gaps, understanding the long-term evolution of the Antarctic continental landscape, assessing ice sheet stability and predicting future sea level rise. Importantly, all original and summarized 500 m statistical data used in the compilation will be freely available for download from a bespoke interactive web map. As the only single source for all such Antarctic geophysical data, this represents a key resource for all future model- and data-driven assessments of the Antarctic Ice Sheet. The presentation will focus on the lessons learnt and show how the collaboration between data managers and scientists has been beneficial for the project.

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Abstract No : 463

Who's going where and how? What can they do there? Towards an integrated database for polar logistics and infrastructures: Polardex

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As polar research, infrastructure and observing systems come of age, there is increasing interest in sharing information about logistical resources, which in turn makes it possible for the resources themselves to be shared across institutions and nations, facilitating multi-agency collaboration. To support this, Polardex is new online discovery and planning tool for polar infrastructure and logistics. Led by the European Polar Board (EPB), Polardex has been developed by a wide team of partners and with data and information provided by many organisations and projects. Polardex is an evolution of the European Polar Infrastructure Database, combining it with the Southern Ocean Observing System (SOOS) DueSouth database to be an integrated platform for physical infrastructure (field facilities, vessels, aircraft and other assets) and logistics (planned routes, cruises, transects, etc.). Polardex's modern, cloud-based, serverless technology provides high availability and high performance, with a scalable platform to be made available to the polar communities. This facilitates easy access to search and discovery of polar logistics and infrastructure resources and information, helping to maximise use and international collaboration in Arctic and Antarctic research. This presentation, on behalf of the EPB Action Group on Infrastructure, will introduce Polardex and its features, and outline the process by which it was built and continues to develop.

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Abstract No : 458

A geospatial database for the sub-Antarctic Prince Edward Islands

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Research projects at the sub-Antarctic Prince Edward Islands are increasingly considering geospatial data as an essential component in answering scientific questions. A need exists for high resolution geospatial data in both multi- and trans-disciplinary research to better analyse fine-scale biotic-abiotic interactions of the islands' landscape and ecosystems within the context of climate change and the impacts of invasive species. However, much of the geospatial data that currently exist either have limitations in spatial coverage and/or resolution, are outdated or not readily available. To address these issues, we present an online geospatial database for the Prince Edward Islands (both islands) produced from a high-resolution digital surface model and satellite imagery. This database contains vector files, raster datasets, and maps of topographical and hydrological parameters. It is freely available to download from figshare – an open access data repository. With this database we answer the call to improved data sharing and encourage other sub-Antarctic terrestrial scientists to make use of similar practices.

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Abstract No : 191

Getting Southern Ocean data ‘on the map’

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The Southern Ocean connects the world’s ocean basins and acts as a sensitive indicator of oceans’ health. Researchers and data professionals from more than 40 countries are part of the Southern Ocean Observing System (SOOS), which facilitates the collection and delivery of essential observations on dynamics of Southern Ocean systems. This collaborative community aims to develop an interoperable data ecosystem that serves a multitude of scientific disciplines and, with a minimum of centralised funding, depends on the generosity and cooperation of a broad community. At the centre of the Southern Ocean data system is SOOSmap – a portal for well curated and standardised datasets of key circumpolar interest, which draws on the infrastructure of EMODnet Physics. It provides not just access to datasets but also a very visible way to identify gaps in observing and data sharing efforts in the Southern Ocean. SOOS is also working with international colleagues to develop a federated metadata search based on Schema.org, as an attempt to bridge the seemingly intractable differences in metadata standards across scientific communities, to enable access to data coming from the wide variety of process studies that cannot be made available in a unified way. Here we present a new version of the portal, SOOSmap version 2, developed by the EMODnet Physics and supported by the SO-CHIC project. We will highlight key features designed for better discoverability of datasets and for improved usability of this tool that strives to get research data ‘on the map’.

Accepted as: Oral Presentation

Abstract No : 300

ISOBATA bathymetric data acquired during R/V Laura Bassi Southern Ocean transits, data sharing and collaboration among other onboard projects.

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ISOBatA (Italian Southern Ocean Bathymetry for the exploitation of opportunistic seafloor dataset in the Antarctic water and surrounding areas) is a 3-year PNRA (Italian National Antarctic Research Program) Project. Project partners (OGS, CNR-IGAG and University of Milano-Bicocca) designed and planned R/V Laura Bassi data acquisition along preferred corridors back and forth New Zealand and Mario Zucchelli Station during transit time, in order to improve the Southern Ocean (SO) bathymetric coverage. An extended case study area along the Pacific-Antarctic plate boundary (i.e.: Emerald Fracture Zone – EMZ – and Macquarie Triple Junction – MTJ), (Choi et al. 2017, Lodolo et al. 2013) was chosen to test the acquisition potential during transit time in remote areas. The project's emphasis is on acoustic data, although magnetometer data are also taken into account. According to SCAR, one of the project's expected outcomes is the compilation of a structured "Antarctic Data Storage Repository" that can be shared internationally, along with best practices, workflows and procedures used to implement QA in multi-beam transit acquisition, processing, analysis and archiving of data and metadata. The first oceanographic expedition took place in 2021-2022, the investigation went beyond the limits of the predefined plan engaging interesting interactions and collaborations with other onboard projects and making us aware that onboard data sharing can be a powerful driver of change. Our experience has highlighted the need to open a discussion to address a supranational strategy in SO data acquisition during transit times, in accordance with the geomorphic/geographical nature and existing coverage of the working areas.

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Abstract No : 318

Development of the AMIDER system: a database application for open science

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AMIDER project aims at promoting open science by providing an integrated database application to explore scientific datasets. The AMIDER system is planned to start operation in 2023 focusing on the fields related to polar science. One of its unique features is the visualization in a uniform format regardless of dataset types. Scientific data in various fields, such as geospace science, atmospheric science, geoscience, and life science, are inclusively displayed with a thumbnail image and snippet for each dataset. This catalog view is designed so that the contents of each dataset can be imagined at a glance, inducing access from a user who is not familiar with the dataset. Each dataset has a uniform design page composed of five sections: main images, a data-download interface, data plots, related dataset links, and a metadata table. The data-download interface not only accesses data repositories but also provides a function to convert data files to the ASCII format from dedicated formats such as Common Data Format (CDF) and Network Common Data Form (NetCDF) in space science. The related dataset section is one of the unique functions of our system; we calculate and register a correlation score between each dataset or data file, and several datasets with relatively high scores are displayed. This function provides users with a cross-disciplinary “walk-around” experience between datasets. These applications are optimized to promote open science and are realized by our careful data curation. Many datasets are ready for publication, and the final preparation of the system is underway.

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Abstract No : 604

Handling diverse (long-tail) data Antarctic domain data at the US Antarctic Program Data Center (USAP-DC)

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The U.S. Antarctic Program Data Center (USAP-DC) is funded by the National Science Foundation (NSF) and provides services to help NSF-funded scientists document, preserve, and disseminate their research data and assists with fulfilling NSF data management obligations. As result USAP-DC handles a wide and diverse range of data, especially those that do not fit into other, discipline repository. These diverse datasets include many that are unique in methods, instruments and data structure and present challenges to ensure that they can be easily found and incorporated into the workflows of other researchers. We use an online web form that data providers can use to submit their data and metadata information. The form contains structured and unstructured fields for metadata including free text fields to describe the instruments, data acquisition and processing methods as well data structure to allow for unique character of the data. The submitted data and metadata are reviewed by a curator who will provide feedback and guidance if critical information is missing, insufficient, or the data could be provided in a more suitable form. To make the data more findable we provide DOIs through DataCite and share metadata information by including schema.org information to the dataset page and through DataOne, the Antarctic Metadata Directory, PolarData Search, and our own data search browser. The metadata can also be harvested and searched through an API. We guide the providers to choose a data license that will enable reuse of the data.

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Abstract No : 35

Antarctic Meteorological Research and Data Center: An Antarctic Meteorological Data Repository for the Community

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The Antarctic Meteorological Research and Data Center (AMRDC) has developed a formal data repository in service to the entire Antarctic meteorological and broader community. Built on the Comprehensive Knowledge Archive Network (CKAN) open-source data repository software system, the AMRDC repository aims to host meteorological datasets from a variety of sources including many that have historically been a part of the AMRDC’s 30-year archive. This project will expand beyond well-known Wisconsin datasets such as Antarctic satellite composite imagery and Automatic Weather Station (AWS) observations to host unique datasets such as United States Antarctic Program (USAP) field camp observations and USAP main station observations from South Pole, McMurdo, and Palmer Stations. This project seeks to build in links to external data holdings found in other repositories (e.g. Pangea, Zenodo, etc.) thanks to support from SCAR’s AntClimNow project. This enables the AMRDC repository to provide a “one-stop shop” experience for forecasters, researchers, educators, and others who seek Antarctic meteorological data. The repository will take in investigator provided datasets, meeting USAP data expectations and requirements. All repository holdings offer a formal entry including the issuing of a Digital Object Identifier (DOI), proper metadata information, and follow all FAIR principles (Findable, Accessible, Interoperable, and Reusable). The AMRDC will provide additional capabilities that offer basic visualization of archive datasets in the service to the community. These efforts complement ongoing project activities with the continued building of Antarctic satellite composite imagery, climatological analysis, and case study projects, where many of these involve students.

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Abstract No : 189

Sharing ionospheric data in polar areas: advances on the SWIT-eSWua system

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The Upper Atmosphere Physics and Radiopropagation group at the Istituto Nazionale di Geofisica e Vulcanologia (INGV, Italy) has a long tradition in acquiring ionospheric data in the Polar areas, privileged natural laboratories for the investigations in this research field. The group currently operates, among others, Ionospheric Scintillation Monitor Receivers (ISMRS) in Antarctica (Mario Zucchelli, Concordia and SANAE IV stations) as well as in the Arctic region (Svalbard and Greenland) and developed the SWIT (Space Weather Information Technology) system and the new eSWua (electronic Space Weather upper atmosphere: <http://eswua.ingv.it>) website for the management and dissemination of this data and for the integration into the network of the data from other international scientific Institutions. Even though long-lasting initiatives are ongoing in this field (in Polar areas, for example, the GNSS Research and Application for Polar Environment SCAR expert group: <http://www.grape.scar.org>), only recently the ionospheric scientific community has undertaken initiative towards federated portals (i.e. the PITHIA EU project: <https://pithia-nrf.eu/>) with the aim to facilitate access to the data and to foster interdisciplinary research collaborations. Within this framework, also the INGV SWIT-eSWua system is currently implementing technological solutions to promote the FAIRness and to enable the interoperability with other infrastructures such as the Italian NADC (National Antarctic Data Center). The state of the art and the latest advances of the system, especially with regards to the Polar areas, will be presented in this work.



SCAR 2022

Antarctica in a Changing World

PARALLEL SESSIONS

OTHER POSTERS

Accepted as: E-poster Presentation

Abstract No : 254

The Doctrine of Effective Occupation and the Question of Sovereignty in Antarctica

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In international law, traditional territorial acquisition methods are enumerated as occupation, prescription, accretion, cession, conquest. Among these methods, occupation is closely related with the sovereignty question in Antarctica. Occupation is the fundamental method of acquiring title over terra nullius. Terra nullius means the territories which are not under sovereignty of any state, but are capable of territorial acquisition. For valid acquisition of terra nullius, the territory must be effectively occupied. It was argued that polar regions cannot be subject to territorial claims as they are uninhabitable, actual settlement is required for effective occupation. Island of Palmas, Eastern Greenland, Clipperton Island cases opened the discussion that the requirements of effective occupation differ according to the circumstances of the territory and in remote or sparsely populated areas, actual occupation may not be required. According to first case, if a claim is based on continuous and peaceful display of state authority, such display must be shown precisely; establishment of special administration within territory is not required. Pursuant to second case, if a claim is based on a continued display of authority, then, two elements are sought: the intention and will to act as sovereign and some actual exercise or display of such authority. According to third case, if the territory is entirely uninhabited, a state may acquire sovereignty by showing its full and undisputed disposal. The main of this study is to explain the doctrine of effective occupation in light of the judicial decisions and discussions on the Antarctic claims in this regard.

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Abstract No : 393

Analysis of the Novel The Brief History of The Death through the Lens of Eco criticism for Better Understanding of the Issues of Antarctica Region

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Humans have brought devastating threat on the planet Earth. Global warming and climate change are the defining issues of our time. Past few years have been recorded the hottest in the history. Ice caps are melting, sea levels are rising, we are experiencing fractured rain cycles and damage in ozone layer. Over the last few decades, the west coast of the Antarctic Peninsula is warming very rapidly. During last 50 years, the annual temperature of the Antarctica is increased by 3°C . The issue of Antarctica melting is dominating as a main theme of current various arts like poetry, fictions, paintings, music videos etc. The Brief History of The Dead is a 2006 fantasy by Kevin John Brockmeier with one of the settings in Antarctica. It talks about how anthropocene has brought ruin in Antarctica. The novel also talks about bio terrorism. The present paper aims to examine some eco critical aspects like anthropocene and bio terrorism reflected in the novel and particularly in the region of Antarctica. The paper will help in promoting understanding of issues of Antarctica and inspire us to think about our relationship with the Antarctica.

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Abstract No : 931

Climate Change and Polar Regions: Implications of the Arctic Geopolitics for Antarctica Treaty System

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Physical and political geography of both poles present interesting example of similarity and contrast. The Arctic region countries are big powers and Cold War leaders former USSR and US are the closest neighbors here whereas, the South Pole is located in isolation. Despite these stark differences these two regions have similar climate and environment. Their unique physiography designed interesting geopolitics in governing these two regions. Both Super Powers the United States and Russia were already controlling the Arctic but geographically distant from the South Pole. Seven other countries were claiming their sovereignty over the Antarctica. To keep sovereignty claimer outside the Superpowers Powers were prompted to draft the Antarctica Treaty System (ATS). ATS suspended sovereignty claims, prohibited human settlement, militarization, mining and declared Antarctica a nuclear free zone but the Arctic was exempted from such multilateral arrangement despite severe militarization, revealed the Super Powers' wish for privileges and exemptions. The ATS fitted in future's ambitious vision of the Super Powers keeping sovereignty claimers outside and maintaining their presence in Antarctica. The situation shaped exclusively different type of maritime domain- an ocean completely exempted from jurisdictional claim gave advantage to the Super Powers to choreograph Antarctica politics yet current changes in the Arctic also looped into the Antarctic and now the world is gazing Antarctica for its resource potential and tourism activities and emerging sovereignty claims and similar environmental issues like the Arctic region. The paper intends to discuss the connectivity of happenings in the Antarctica with geopolitical scenario in the Arctic region.

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Abstract No : 339

Mapping carbon dioxide soil diffuse emissions and temperature at Deception Island volcano, South Shetlands, Antarctica

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Deception Island is amongst the most active volcanoes in Antarctica. Located in the southeast margin of the South Shetlands archipelago in the Bransfield Strait, this volcano has erupted at least twenty times in the last two centuries. The volcanic edifice emerges forming a horseshoe-shaped island with several hydrothermal sites and monogenetic cones scattered around its surface. In this work, we report the results of a carbon dioxide (CO₂) soil diffuse degassing survey carried out in February – March, 2022. In total, we took 857 CO₂ soil diffuse flux and 1011 soil temperature measurements in seven hydrothermal sites: Primero de Mayo Bay, Whalers Bay, Pendulum Cove, Carlos Salvador –a previously unnamed beach between Cross Hill and Wensleydale Beacon–, Cerro Caliente, Mount Pond, and a site located on the outer slope of Stonethrow Ridge. Soil CO₂ fluxes and temperatures were obtained by means of a West Systems portable flow-meter and a Hanna HI 935005N thermometer, respectively. All surveyed sites presented anomalous CO₂ fluxes and/or soil temperatures. Measurements of CO₂ soil diffuse flux show values up to 13400 g m⁻²d⁻¹. Soil temperatures range between -3 and 50°C. A preliminary statistical analysis suggests soil CO₂ is fed by a combination of sources. Most hydrothermal sites present well defined diffuse degassing structures that release as much as 1.3 t/day of volcanic CO₂ into the atmosphere. The findings of this survey will allow discriminating different sources of CO₂, estimating the total output of CO₂ and calculating the thermal energy release of Deception Island.

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Abstract No : 123

Gas hydrate system of the South Shetland Islands Continental Margin: a potential contributor to Southern Ocean methane emissions?

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Gas hydrates (GHs) are susceptible to climate-induced perturbations such as changes in sea level and temperature and may provide feedback to such perturbations. The occurrence of GHs in the Pacific margin of the Antarctic Peninsula (PAP) is well known from seismic data, including a Bottom Simulating Reflector (BSR). Such BSR is widespread between Elephant and King George Is in water depths between 1000–3000 m. Previous studies in the area assessed the geothermal gradient from the BSR depth ($\sim 31^{\circ}\text{C}/\text{km} \pm 3.15 \text{ MAD}$) assuming the GH is in equilibrium. However, nearby heat flow determinations suggest that GHs are not in equilibrium, as the derived geothermal gradient is significantly higher ($\sim 97^{\circ}\text{C}/\text{km} \pm 36.4 \text{ MAD}$). Thus, the BSR is 100–400 m deeper than the theoretical Base of the GH Stability Zone (BGHSZ) in the area. Overpressure resulting from rapid sedimentation or tectonic stresses cannot explain alone the observed depth of the BSR, as it cannot balance for the thermal conditions at such depths. Vertical movements of tectonic and/or glacial-isostatic origin could be only partially responsible for the mismatch between observed BSR and theoretical BGHSZ depths. Hence, a better knowledge of the thermal regime of the PAP is needed to assess the dynamics of the GH system. A research cruise in 2024 aims to constrain better the dynamics of the GH system of the PAP using geophysical imaging and heat flow measurements. The cruise will also assess the potential export of methane into the ocean using a suite of geochemical indicators in sediments, pore waters and the water column.

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Abstract No : 87

Atmosphere–Cryosphere coupling processes – a closer look into High Mountain Hydrology

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Snow and Ice (glaciers) play a complex role in the hydrological cycle. Post depositional modification of these components brought about by macro and micro-scale phenomena introduces a significant departure from expected stable isotopic signatures. This leads to erroneous interpretations of paleoaltimetry, paleotemperatures, moisture source identification, and hydrological budget. While most studies characterize mountain meteorology by employing an empirical calibration to field data, they fail to include any temporal or spatial integration of the regional climatic signal. Monitoring the hydrological cycle via remote sensing techniques gives a good estimate of bulk transitions within the cycle. Here, we present the isotopic composition of snowpack, glacial melt, and stream and river water from the 6 Hindukush Himalayas river basins ranging at altitudes between 2.5 and 6 km. Stable isotopic signatures derived from atmospheric and geomorphic variables were simulated and compared with field data with minimal residuals. Integrating field and satellite data has enabled us to identify local processes and quantify the degree of modification brought upon meteoric water reservoirs.

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Abstract No : 508

Antarctic bacterial bioplastic producer?

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Environmental problems from synthetic polyester products have a strong and negative effect in natural ecosystems. Development of polymers based on organic polyesters have been established as a viable alternative to replace plastic derived from petroleum. Polyhydroxyalkanoates (PHAs) are a type of biopolymer composed of more than 160 monomers with similar properties to synthetic polyesters which can be synthesized by microorganisms. In this research, 45 antarctic soil bacterial strains isolated from Barrientos Island (Aitcho Islands) were assessed to identify possible granules of PHAs by specific cell dyes. Only 7 Gram-positive strains demonstrated the presence of this organic polyester, therefore they were selected for a PHAs production stage at laboratory scale in a specific culture media. Preliminary yields achieved amounts of 41%, 20.62% and 23.28% (% w/w) for ANT1-T31, ANT1-T10 and ANT1-T48 strains, respectively. Further analysis in the bacterial polyester extracts through crotonic acid assay and FT/IR confirmed the presence of polyhydroxybutyrate (PHB) monomers. ANT1-T31 antarctic strain reached the highest PHAs yield production compared to other strains. This result becomes as the first report of Gram-positive PHA producer bacteria from Antarctic turning it as a potential biopolymer cell factory for commercial purposes.

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Abstract No : 820

Zooplankton functional dynamics – assessing energy flow along major foodweb pathways

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Zooplankton, including copepods, euphausiids and salps, provide pathways through which energy flows from primary producers to higher trophic levels. The relative dominance of these pathways is determined by latitude, primary production and environmental variability, and is expected to change as the Southern Ocean environment changes. While we have developed qualitative descriptions of the key links in these foodwebs and can model how biomass is transferred between trophic levels, we have far less understanding of how energy is transferred. It is hypothesised that there are three major foodweb pathways through zooplankton. Of these, the krill pathway is best understood and is known to be an efficient route for the transfer of carbon and energy to higher predators. Conversely, the salp pathway is little understood and it has only recently become apparent, largely via DNA and stable isotope analyses, that salps are present in the diets of over 200 predators. The third pathway, copepod-fish, contains more trophic links (>5) than the other two (~3 links) and therefore has the potential to be less energy-efficient. This talk will summarise what we know about how energy is transferred through the planktonic components of food webs in the Southern Ocean from the open ocean to the ice edge.

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Abstract No : 164

Development of Ice Drilling by using Thermal Drilling methods (Plasma and Laser Drilling) to reduce the contamination and energy of mechanical drilling in Antarctica.

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Drilling the ice core in Antarctica is a challenging task. To acquire the oldest ice, ice cores must be drilled in the center of the ice sheet, near the ice split. Mechanical drilling methods are running for more than a century. However, as much as the bedrocks are firmer, the amount of weight to press down on the drill to penetrate is higher, and the bits should take out and changes frequently. Therefore, these types of drilling not only consume more energy and produce more contamination in consequence but also need more equipment for the transportation and overall can make it uneconomical for many potential geothermal energy sites or for Antarctica bedrocks. Thermal Drilling methods such as Laser and Plasma Drilling that are implemented in oil and gas fields, can be substituted by these techniques for ice-coring processes. Laser and Plasma drilling can reduce the energy power requirement dramatically, facilitate ice core breaking, and prevent more unwanted pollution in Antarctica and sub-glacial lake sediments.

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Abstract No : 1052

Study of water temperatura in Deception and Livingston Islands in the period 2015–2021 (Antarctica).

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Deception and Livingston Islands are part of the South Shetland Island chain, this archipelago form the northern boundary of the Bransfield Strait and the Antarctic Peninsula forms the southern bourandy. Deception Island is one of the active volcanoes in this subduction zone, so Livingston Island is taken as a reference to volcanic studies. The underwater temperature records in Antarctica are rare and most of them correspond to the Antarctic summer due to the weather conditions during the rest of the year and the formation of the ice sheet. Long continuous records were obtained in both islands from 2012 until today. The series of both islands were studied for about 7 consecutive years. Temperature records range from -2 to 2°C , highest temperatures occur during the austral summer or during periods of volcanic activity in the case of Deception Island, on the other hand, lowest temperatures recorded during the austral winter. During the austral winter, sometimes because of the low temperatures, ice sheet is formed. To study the differences between the two islands, that may be caused by the influence of volcanic activity, are used statistical and analytical techniques for time series analysis. The maximum and minimum temperatures are similar on both islands, although on Deception Island the maximum temperatures are more variable due to its volcanic nature. As for minimum temperatures, all seasons start earlier on Livingston Island.

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Abstract No : 837

Concentration and distribution of Cu, Zn, Pb, and Cd in the Ocellated icefish, *Chionodraco rastrospinosus*, in the northern Antarctic Peninsula, Antarctic

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Antarctic icefish belonging to the family Channichthyidae have the unusual physiological trait of lacking hemoglobin, in which Ocellated icefish (*Chionodraco rastrospinosus*) distributes in a very limited area at the south Scotia Sea. Understanding the distribution of trace elements in this species will help understand their physiological composition and conserve this vulnerable population; however, information on this topic is extremely limited. This study examines trace elements (two essential elements, i.e., copper [Cu] and zinc [Zn], and two non-essential elements, i.e., cadmium [Cd] and lead [Pb]) in *C. rastrospinosus* and provides for the first time baseline data on elemental distribution in four tissues of *C. rastrospinosus* in the northern Antarctic Peninsula. The element concentrations showed the following trends: Zn > Cu > Pb > Cd in muscle and stomach and Zn > Cu > Cd > Pb in intestine and liver. Among all tissues, muscle had the lowest element concentrations. The concentration of Zn was the highest, followed by Cu. Zn and Cd concentrations in the stomach and intestines were significantly positively correlated.

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Abstract No : 577

Remote influence of Northwest–Northcentral Pacific SST on monsoon Low level Jet over the Arabian Sea

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Nuncio Murukesh, ESSO– NCPOR

Indian summer monsoon (ISM) is an important phenomenon on earth due to its intensity and spatial extent. We have examined the variability of monsoon Low-Level Jet (LLJ), a vital component of ISM, along the Arabian Sea during June–July–August (JJA), using reanalysis data for the past four decades (1979–2019). A significant positive trend (0.04 ms⁻¹yr⁻¹) in the intensity of LLJ is observed, and there exists considerable interannual variability in the speed of the LLJ during JJA. Using linear regression analysis, we examined the relationship between LLJ and Sea Surface Temperature (SST) anomalies over the Northern hemisphere. Significant relationship between SST anomalies and LLJ intensity anomalies is prominent in the equatorial Pacific Ocean and are associated with El Niño–Southern Oscillation (ENSO) events. When the ENSO effects were removed, a strong co-variability is observed between LLJ intensity and SST anomalies over the Northwest–Northcentral Pacific. Our analysis suggests that SST over this region is correlated with the upper-tropospheric geopotential height anomalies. These geopotential anomalies were favourable for easterlies in the upper troposphere, intensifying the low-level westerlies and hence LLJ. The present analysis suggest a new pathway of remote influence on LLJ. The mechanism startss with Atlantic Multidecadal Oscillation that warms up the Northwest–Northcentral Pacific SST which in turn induce circulation anomalies that accelerate the upper tropospheric easterlies conducive for strong LLJ.

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Abstract No : 708

Warming exacerbates the negative effects of ocean acidification on the immune system of thick shell mussels (*Mytilus coruscus*)

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Ocean acidification and warming has become a global problem that is seriously affecting the survival and physiology of marine life. This study investigated the effect of the combination of temperature (20°C and 30°C) and pH (pH 8.1 and pH 7.7) on the immune response capacity of thick shell mussels (*Mytilus coruscus*) after 14 and 21 days of combined action. The experimental results showed that ocean acidification and warming had a significant interactive effect on various immune parameters. Specifically, ocean acidification and warming led to an increase in HM, ROS, while LYS, PHA, EST and THC were significantly reduced, indicating that ocean acidification and warming can negatively affect hemolymph indicators. In addition, ocean acidification and warming caused an increase in TNF- α (Tumor necrosis factor- α), IL-17 (Interleukin 17), Caspase-8 and apoptotic cells, and a decrease in TGF- β (Transforming growth factor- β), and both had a synergistic effect on the immune system. It is suggested that ocean acidification and warming cause immune inflammatory responses in mussels and that warming can intensify the stimulation of the shellfish immune system by ocean acidification. In addition, ocean acidification and warming can affect the immune system through TNF- α induced endogenous and ROS induced exogenous apoptosis. This study highlights that ocean acidification and warming can influence the immune capacity of bivalves such as apoptosis, laying the foundation for studying the effects of the immune system of bivalves under changing climatic conditions.

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Abstract No : 12

Passive Seismic Subsurface Imaging

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Passive seismic imaging is employed for glaciology glacier quake study. Seismological data analysis is done by wavelet transform –spectral decomposition, singular spectrum analysis, nonlinear nonstationary signal processing by empirical mode decomposition Hilbert Huang transform, etc. Wavelet transform suffers from spectral leakage smearing of signal. For removing spectral leakage Synchrosqueezed wavelet transform empirical mode decomposition is employed for passive seismic attributes analysis. Passive seismic imaging earthquake data (based exploration technique is employed for extractive industry geosciences hydrocarbon, minerals, coal geothermal energy resources exploration, lithosphere subsurface imaging earth crust sounding, faults imaging tectonics, sediments thickness measurements, glaciology, dam safety investigation, near surface study, etc. Passive seismic imaging is efficient for ocean bottom seismometer deepwater hydrocarbon exploration,. Seismic wave at low frequency around one hertz are often drowned out by earth noisy seismic hum, which is useful to delineate deeper subsurface geological structures. Seismic site effect H/V horizontal to vertical spectral ratio HVSR– Fourier amplitude spectra of the horizontal and vertical component of microtremors, V/H spectral ratio VH SR, etc calculated for passive seismic imaging. Passive seismic tomography is used for precise lithosphere high resolution imaging. Active faults delineation probing , carbon dioxide geological storage site monitoring, are applications of passive seismic imaging. passive seismic multiscale subsurface imaging is efficient technique.

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Abstract No : 693

Governing of Global Commons: The Case of Antarctica?

elçin doruk, researcher expert

Antarctica doesn't belong to anyone and is governed by an international partnership. The territorial claims over the continent, however, do not comply with the concept of an international regime encompassing all nations. Existing legal structure to regulate scientific research, utilization, conservation and governance of Antarctic resources has not been competent enough in surpassing the claims and current threats as the rise of tourism. This study aims to analyze the governing of global commons under the scope of international cooperation and international regime in the case of Antarctica. Self-interested actors in Antarctic affairs have shaped the politics of Antarctica in the form of international cooperation through science. In this regard, this research also aims to examine the science-policy interaction in Antarctic affairs. The methodology is mainly based on interviews with the national Antarctic research institutions/centers of the claimant states and concerned non-governmental organizations. Under the frame of this notice, this study evaluates the functioning of the Antarctic Treaty System by reference to international law and the benefit of future generations. The overall structure demonstrates the fact that the sustainable future of Antarctica is in need of a comprehensive regime under the frame of common heritage of mankind and free from national interests. Key Words: Common heritage of mankind, international cooperation, Antarctic affairs, theories of international regimes, politics of Antarctica

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Abstract No : 358

In vivo pathogenicity using BALB/c mice of fungal species *Aspergillus thermomutatus* and *Rhodotorula mucilaginosa* recovered from Antarctic Peninsula permafrost

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The genus *Aspergillus* is ubiquitous and some species present in different Antarctic substrates. The yeast *Rhodotorula mucilaginosa* is a cosmopolitan species also present in Antarctica. Both fungi are recognized as opportunistic pathogens emerging from humans and animals. In our study, the fungal isolates *Aspergillus thermomutatus* UFMGCB 17415, *Rhodotorula mucilaginosa* UFMGCB 17448 and *R. mucilaginosa* UFMGCB 17473, recovered from Antarctic permafrost, were submitted to in vivo assays using immunosuppressed BALB/c mice. All fungal isolates caused biological impact leading to illness and fluctuations in weight, motor behavior, sensory and reflex function and significant changes in the psychiatric status of the animals. On histopathology, the lung showed an intense inflammatory process, mainly close to the bronchioles, with a large amount of neutrophils and macrophages, and intense hyperemia and moderate pulmonary edema. Our results indicated significant pathogenicity of all fungal isolates against immunosuppressed BALB/c mice. The set of these results generates great concern about the possible spread of these isolates in the face of global warming. This is the first report of potential virulence in vivo using BALB/c mice immunosuppressed in *R. mucilaginosa* and *A. thermomutatus* in Antarctica. Support: CNPq, FAPEMIG, CAPES

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Abstract No : 274

Permafrost landforms from Jhelum basin, Kashmir Himalaya, India

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Preliminary inventory of Jhelum basin based on freely available fine spatial resolution satellite data accessible through Google Earth platform and Sentinel-2a show that the Jhelum basin has more than 231 permafrost landforms (rock glaciers) covering an area of 48.26 km², which is 0.3 % of total area of the Kashmir valley (16000 km²). The majority (89%) permafrost landforms have a northerly aspect (N, NE, and NW). The study shows that these permafrost landforms are mostly active rock glaciers and situated between 3019 and 4633 m a.s.l. The visible characteristic features through which active permafrost landforms were mapped are; flow-like ropy lava type texture reflecting their visco-plastic properties; spatially organised longitudinal or transverse ridge-and-furrow assemblages, steep ($\sim > 30-35^\circ$) and sharp-crested front and lateral slopes that typically rise 15–70m above adjacent terrain, light-colored (less weathered debris) frontal slope in contrast to the dark-colored rock-varnished (highly weathered) uppermost surface, a swollen, noticeably longitudinally convex appearance of a permafrost body, and an absence of vegetation and/or lichen cover on the active part of landform. The permafrost constitutes a significant portion of cryospheric reserves in the Jhelum basin which till date has been neglected. The present work represents an initial step towards understanding the spatial distribution, rock glacier characteristics and reporting of rock glaciers (active permafrost) from the study area for the first time as majority of rock glaciers in this study area are transitional forms formed from the retreat, mass loss and increase of debris cover in former shrinking glaciers.

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Abstract No : 162

Seasonal-variability and radiative forcing of black carbon over of central Himalaya glaciers (Dokriani and Gangotri), India

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The monitoring of BC aerosols is important due to its vital role on climate change, BC monitoring stations at Dokriani and Gangotri Glacier valleys of central Himalaya, India are established in spite of harsh weather conditions and difficult accessibility of glacierized region. In the present study, a comparative investigation on BC mass concentration, radiative forcing and atmospheric heating due to BC aerosols at the glacier valleys is carried out. During most of the days of the study period, BC is found low in Gangotri than Dokriani Glacier valley which might be due to the forest fire, increased anthropogenic activities and vehicles' movement in the nearby localized areas of Dokriani Glacier valley. Monthly mean BC mass concentration at Dokriani is found 777 ng/m³ whereas at Gangotri, it is 691 ng/m³. Highest daily average BC mass concentration was found in May, 2016 at both the valleys with the values of 1694 ng/m³ (Dokriani) and 1180 ng/m³ (Gangotri). On the other hand, lowest BC mass concentration of 350 ng/m³ and 270 ng/m³ is noticed during the month of December, 2015 at Dokriani and Gangotri respectively. The seasonal radiative forcing (surface, TOA, atmosphere) due to black carbon has been estimated for Dokriani and Gangotri Glacier valleys of central Himalaya. The atmospheric radiative forcing which is the difference between TOA and surface forcing is found between 6.7 W/m² and 11.9 W/m² (Dokriani: 6.7 -11.9 W/m²; Gangotri: 6.7 to 10.9 W/m²). Highest radiative forcing is observed during pre-monsoon months similar to trend of

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Abstract No : 359

In vivo pathogenicity potential of Antarctic *Pseudogymnoascus* spp.

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Present in different islands of Antarctica, *Pseudogymnoascus* genera is recognized as psychrophilic, including *P. destructans* recognized as pathogenic for bats through White Nose Syndrome (WNS). Our study focused on the in vitro and in vivo potential pathogenic properties of different *Pseudogymnoascus* isolates from Antarctica. Eldon, aqui inserir os resultados in vitro dos isolados. From the 11 *Pseudogymnoascus* spp. isolates assayed in vitro, *Pseudogymnoascus* sp. UFMGCB 8532 displayed hemolytic activity, growth at different pH, production of hydrolytic enzymes (phospholipase and esterase) and tine spores capable of arriving in pulmonary alveoli. *Pseudogymnoascus* sp. UFMGCB 8532 was selected to evaluate the pathogenic potential in vivo, which killed 100% of *Tenebrio molitor* larvae. In addition, against immunosuppressed BALB/c mice, in one day the fungus caused a biological impact leading to illness in mice with oscillations in weight, motor behavior, function and sensory reflex and finally significant changes in the state psychiatric of all animals. On histopathology, the mice lung showed an intense inflammatory process, mainly around the bronchioles, with a large amount of neutrophils and a slight number of macrophages, in addition to moderate pulmonary edema with intense hyperemia. Despite the use as model immunosuppressed mice, our results indicate significant pathogenicity of the Antarctic *Pseudogymnoascus* spp. Support: CNPq, FAPEMIG, CAPES

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Evolution and status of melt ponds over Amery and Nivilson Ice Shelves, East Antarctica

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Surface melting induced percolated water through hydro-fractures directly impacts the ice shelf stability, which accelerates the rapid breakdown of ice shelves. We have studied these processes over Amery ice shelf (68°15'S, 74°30'E) and Nivilson Iceshelf (70°29' S, 110°22'E) located in East Antarctica for the period from 2017–2020. Here we use Sentinel-1 SAR data for identification of melt pond. Daily assessment of surface melt was carried out using SCATSAT-1 scatterometer derived surface melt product. Landsat 8 OLI data was used to estimate the depth of lake to estimate storage volume capacity based on empirical relation. Seasonal and inter-annual evolution of melt ponds studied to assess the rate of surface melt. During melt season the melt water flows through various melt channels and feeds several vast melt ponds which are up to 80 km long in Nivilson Iceshelf. Increase in melt pond area and distribution was also observed over Amery ice shelf, specifically at grounding line between glaciers and iceshelf. A comparative analysis of onset of melting and refreezing of melt ponds was also carried out based on the time series analysis of derived products. Appearance/disappearance and stored volume capacity of melt water ponds could lead to understand the energy exchange processes and local subsurface dynamics of the iceshelf. Key Words: Melt pond, Surface melt, Nivilson Iceshelf, Amery ice shelf

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Detection of infrasound sources using the three-years array data in 2019–2021 deployed at the Lützow–Holm Bay region, Antarctica

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Time-space variations of infrasound source locations for three years in 2019–2021 were studied by using a combination of two local arrays in the Lützow–Holm Bay region (LHB), Antarctica. The local arrays deployed at two outcrops clearly detected temporal variations in frequency content as well as propagating directions during the three years. A large number of infrasound sources were detected and many of them located between northward and north-westward directions from the arrays. These source events are generated within the Southern Indian Ocean to the northern part of LHB with frequency content of few seconds; that is the microbaroms originated from oceanic swells. From austral summer to fall season, many infrasound sources orientation are determined to be north-eastward direction. These sources might be related to the effect of katabatic winds of the continental coastal area. Furthermore, several sporadic infrasound events during wintering seasons had predominant frequency content of few Hz, which are clearly higher than microbaroms. On the basis of a comparison with sea-ice and glacier distribution from MODIS satellite images, these high-frequency sources were considered to be cryo-seismic signals associated with cryosphere dynamics. In these regards, infrasound could be an useful tool for monitoring surface environment involving climate change in the coastal area of Antarctica.

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