SCAR Executive Committee Meeting 2023

Trieste, Italy, 15-16 September 2023

INSTANT

2022-23 Report

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SRP updates since 2022 Delegates Meeting

Here we provide an update to our report delivered to the XXXVII SCAR Delegates Meeting in August, 2022. While we are very pleased with the range of activities we have highlighted and progress to date, here we also direct the attention of SCAR EXCOMM to the section on **Challenges.** We will raise a discussion on these at the meeting during SRP reporting.

Background reminder of INSTANT mission

INStabilities & Thresholds in ANTarctica (INSTANT) strategic research programme addresses - *the question of Antarctica's uncertain contribution to sea-level change*, by using a multidisciplinary Earth systems approach combining geoscience, physical sciences, biological and social sciences to improve understanding of the interactions between the ocean, atmosphere, solid Earth and the Antarctic Ice Sheet (AIS). It aims at ensuring effective communication on this topic with stakeholders. Therefore, it is sponsored by all 3 Science Standing Groups and works closely with SC-ATS and SC-HASS.

To achieve its goals, INSTANT with its internal SCAR and external partners in the World Climate Research Programme (e.g. CLiC[1], CLiVAR[2]), focuses on the poorly understood processes and feedbacks that influenced ice-sheets in the past, are influencing observed ice sheet changes, and will influence Antarctica's contribution to future global sea-level change. The key outcomes are reconstructions of past and projections of future ice mass changes, with reduced uncertainties due to an improved knowledge of rate-determining instabilities and irreversible thresholds. These are shared with various stakeholder groups. The ice sheet projections are being integrated into probabilistic sea-level projection frameworks for Intergovernmental Panel on Climate Change (IPCC) Assessment Report 7 (AR7) shared socioeconomic pathways (SSPs)

[1] Cryosphere in a Changing Climate core research programme of WCRP (World Climate Research Programme)
[2] Climate Variability core research programme of WCRP (World Climate Research Programme)

INSTANT is at the interface of science and policy, and involve engagement between earth system scientists, social scientists, practitioners, decision-makers, planners and publics. Stakeholder engagement and science communication plays an important role in this SRP, especially in converting science data into usable climate information that helps understanding of risk and uncertainty. INSTANT is providing scientific evidence to assess the effectiveness of, and risks associated with, climate change mitigation pathways (e.g., UNFCC[3] Paris Agreement). This evidence is also guiding adaptation approaches required to avoid the worst impacts, such as coastal flooding and erosion, groundwater inundation and salinization, habitat loss and large-scale human migration. The impacts of sea-level and ice sheet change around Antarctica are also of critical interest to CCAMLR[4], COMNAP[5] and Antarctic Treaty System parties, as they will have profound implications for key Antarctic stakeholder groups including national programme operations, tourism and fisheries.

[3] UNFCCC = United Nations Framework Convention on Climate Change
[4] CCAMLR = Commission for the Conservation of Antarctic Marine Living Resource
[5] COMNAP = Council of Managers of National Antarctic Programs

Activities, achievements and highlights 2022-2023

1. **INSTANT Conference.** At the time of writing, INSTANT is in full preparation for its international conference in Trieste, Italy, 11th-14th September. Organising and preparing this conference has dominated INSTANT members time and energy. Particularly the Co-Chief Officers and Theme Leaders. Florence Colleoni and the local organising committee have done an outstanding/herculean job in pulling together a stimulating week of presentations, panel discussions, workshops, side meetings and social events. It should not be understated just how challenging and expensive international conferences are in the post-Covid world. Nevertheless, we are in an excellent position as you can see from the following highlights: 270 registrations from 40 countries, multidisciplinary conference to be held in plenary, 35% ECRs, 20 keynotes, 40 oral presentations, 250 posters, 5 side meetings and 18 workshops, 3 public events and 3 field excursions. PRAMSO[6], MARICE[10], ICEPRO[11], RINGS, SCAR EXCOM[12], and IODP[13] EXP 378 will hold meetings either side of the the Conference. Then during the Conference three days of thematic presentations on specialist topics will lead up to the highlight - the "Melting Ice and Rising Seas" Symposium on Thursday, which will address the challenge of dealing with uncertain ice sheet and sea-level projections and their impacts. We will hear perspectives from the stakeholder and practitioner communities, and we will discuss the best practices in communication and engagement with the public and decision makers. Afternoons will be dedicated to thematic panel discussions posters and workshops. Workshops include: SOPAS[14], CLIPANT[15], RINGS[16], ADMAP[17], ECRS (two), REACT[18], ICEOLA[19], CLIVASH2K[20], SOACEP[21], HASS[22], ISMASS[23], ISMIP[24], GHF[25] as well as other Theme and Subcommittee meetings. The large number of internal INSTANT, SCAR and external WCRP-CLIC groups having workshops shows just how complex this research ecosystem is, but more importantly highlights the key role INSTANT is playing as an co-ordinating hub enabling resource and capacity is brought to address this very important issue for humanity.

2. **ATCM[26]-CEP[27]**. INSTANT members made significant contributions through papers presented by SCAR/SCATS and the WMO to the ATCM XLV and CEP XXV held in Helsinki, Finland in May-June. Tim Naish formally represented the WMO[28], but also informally worked with the SCAR delegation led by our president Yeadong Kim, with Susie Grant (SCATs) and Steven Chown (ACCE Report update in plenary to ATCM/CEP Climate Day) and the rest of the team. INSTANT members contributed to the following Meeting papers that presented by SCAR and WMO (https://www.ats.aq/devAS/Meetings/Past/95).

a. WP042, ATCM 6d. CEP 7a SCAR updates on Antarctic Climate Change and the Environment (influential on setting climate action agenda and wording of the Helsinki Declaration.)

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[6] PRAMSO = Paleolcimate Records of the Antarctic Margin and Southern Ocean (SCAR Action Group)
[10] MARICE = MARine and ICE Core Reconstructions of East Antarctic Sea Ice Variability Over the Past 2,000 Years
[11] ICEPRO = International Collaboration Effort for Improving Paleoclimate Research in the Southern Ocean
[12] SCAR EXCOM = SCAR Executive Committee
[13] IODP = International Ocean Discovery Program
[14] SOAS = Southern Ocean Antarctic Syntheses (Subcommittee Theme 1)
[15] CLIPANT = Coupling Earth System & Ice Sheet Models Paleoclimate Reconstructions of Antarctica (Subcommittee Theme 1)
[16] RINGS = Focussed on large scale acquisition of observations around teh margin of Antarctica's marine based ic sheets (SCAR Action Group)
[17] ADMAP = SCAR Digital Magnetic Anomaly Project (SCAR Action Group)
[18] REACT = new Wilkes-Aurora EAIS initiative (Australian-led)
[19] ICEOLIA = new Wilkes-Aurora EAIS initiative (European-led)
[20] CLIVASH2K = improve understanding of large scale modes of climate variability and the mechanisms and drivers of climate change in Antarctica (PAGES initiative but also Subcommittee Theme 1)
[21] SOACEP = Southern Ocean Antarctic Chronology and Environmental Proxies (Subcommitte Theme 1)
[22] HASS = SCAR Hummanities and Social Sciences (Subcommittee Them3 3)
[23] ISMASS = SCAR/IASC/CliC Ice Sheet Mass Balance and Sea Level (ISMASS) Project
[24] ISMIP = WCRP-CliC Ice Sheet Model Intercomparisson Project
[25] GHF = Geothermal Heat Flux (Subcommittee Theme 2)
[26] ATCM = Anatrctic Treaty Consulatative Meeting
[27] CEP = Committee on Environmental Protection
[28] WMO = World Meterological Organisation of the United Nations (co-sponsors WCRP)

b. WP039, ATCM 6d. Norway-SCAR. DML-RINGS and Enderby Land RINGS – opening extensive international collaboration to close critical data gaps for understand AIS dynamics and implications sea-level projections. (An INSTANT supported initiative).
c. IP095, ATCM 6d, CEP 7a. Understanding Future Sea-level Change Around Antarctica The paper outlined: (a) the challenges in accurately predicting location-specific sea-level change for Antarctica's coastline; (b) Risks that future sea-level change represents for operations including science support and tourism, coastal infrastructure and assets, heritage sites, specially protected and managed areas, and bioregions; and (c) Future research requirements and recommendations for actions to mitigate the identified risks. (This is an INSTANT-led initiative co-sponsored by SCAR-COMNAP-WCRP/WMO and is endorsed by both CEP and ATCM. SCAR will deliver working paper on progress to ATCM 46. INSTANT will Theme 3 will have completed sea-level projections).
d. IP016, ATCM 4, CEP 5. WMO. Annual Report of the World Meteorological Organization (WMO) (Naish and Sparrow helped develop slides and report for WMO Secretary General Peteris Tallais' presentation to ATCM Climate Change Day).
e. IP093, ATCM 6d, CEP 7a. WMO. Antarctica 2300 (ISMIP6) Projections (report on the WCRP-CLiC project to improve Antarctic contributions to sea-level projections collaborative with INSTANT).
f. IP094, ATCM 6d. CEP 7a. WMO. The Climate and Cryosphere (CliC) Project of the World Climate Research Programme (WCRP) (co-authored by Naish/Sparrow), as there are many INSTANT-CLiC collaborations.

3. **Unprecedented Climate Change.** The slow-down of the Southern Ocean circulation (see notable paper by Li et al., 2023), a 40 year minimum in the winter extent of sea ice, ice shelves melting and heatwaves are all raising concerns that Antarctica may be approaching tipping points (see notable paper by Siegert et al., 2023). Once crossed, climate feedbacks and dynamic instabilities may lead to rapid and irreversible changes to the ice sheets with long-term consequences for ecosystems and humanity. The INSTANT programme was specifically designed to bring a multidisciplinary approach to improve our knowledge of the key rate determining processes, so that the impacts of sea-level rise can be more effectively anticipated and managed. Our work has never been more important and INSTANT members have been active in raising the alarm for urgent focus of resources to address these key science questions (see Outreach & Communication).

4. **INSTANT Fellowships.** The 5 very talented ECR researchers (Brazil, Sri Lanka, Australia, China, Germany) awarded USD $5K each for projects as the first recipients of INSTANT Fellowships have all completed their work and reports, and some will attend the INSTANT Conference. Unfortunately, because of the financial uncertainty associated with the conference we were unable to run the Fellowship Round in 2023. Depending on the final wash up it, we will run around in 2024.

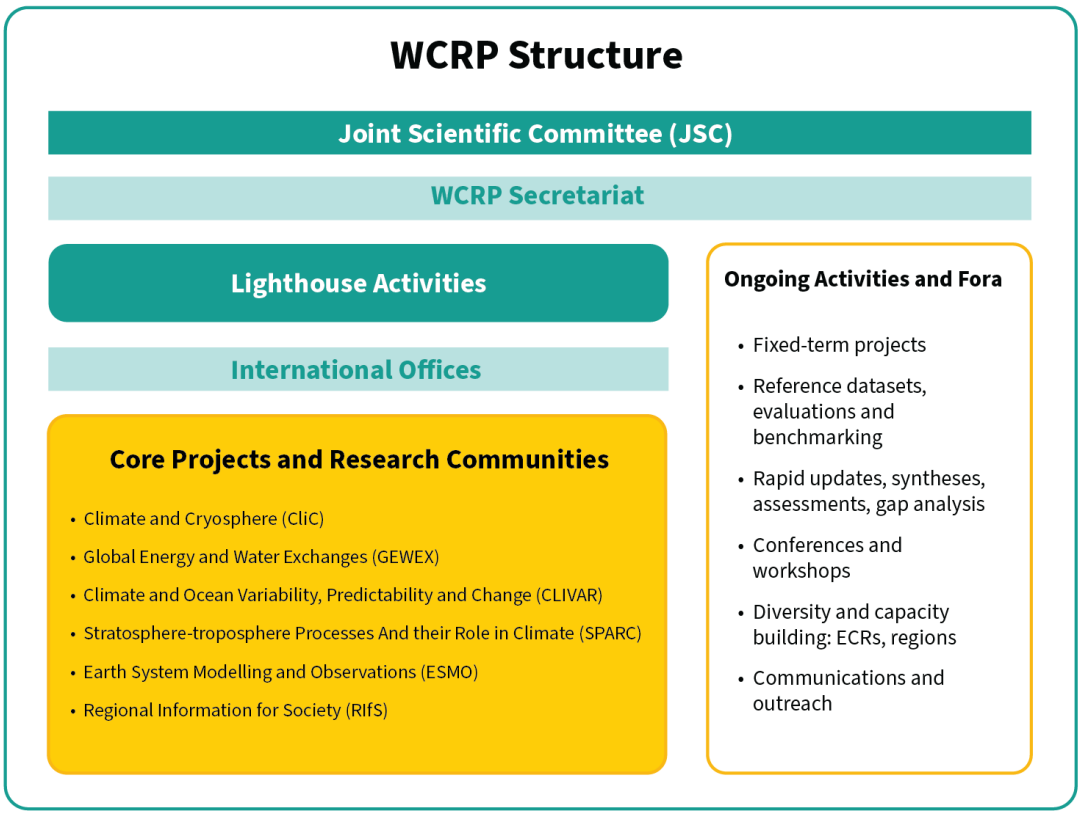
5. **INSTANT participation to COPs.** INSTANT took part in many side events to the COP 27 (and also COP 26) about sea level rise both in the past and in the future. Such events have been co-organised by SCAR and ICCI and have been very efficient in carrying message to policy makers about the reasons of the large uncertainties on the last IPCC report sea level projections up to 2100 and beyond. Such science to policy event is one of the main stream line of INSTANT and we hope to proceed our commitment to engage stakeholders, local populations and governments. We also hope to convince more INSTANT members to take part in such high-level outreach events. SCAR should definitely strengthens its participation to COPs side events. It is largely worthwhile.

Challenges 2000-2023

SRP Project Management and Support. INSTANT is a very large and complex SRP. It has more than 300 members, an International Steering Committee, and 3 Themes and 15 subcommittees, all with leadership structure. It collaborates with and coordinates groups within SCAR and with organisations outside of SCAR (WCRP, PAGES), as well civil society and end user and practitioner communities.

INSTANT has developed a strong brand and reputation and is perceived as taking international leadership on the key issues of "understanding the Antarctic ice sheet contribution to future sea-level rise, communicating the uncertainties, and helping users and the public deal with risk". It has developed a holistic, multidisciplinary model that traverses the entire "science value chain" from fundamental science to applied science and useable climate information, bridging science with solutions for society. INSTANT is a response to a request from the past SCAR President and EXCOM to raise the societal relevance and impact of SCARs research groups. INSTANT has been a significant step up from the traditional roles of past SRPs (e.g. SERCE, PAIS, ANTCLIM), which have been more discipline focussed on facilitating collaborative science, workshops and opportunities for ECRs.

INSTANT is the equivalent size of a Core Project within the WCRP framework, and its role is now very similar. INTSANT co-chief Tim Naish his helped lead CLiC and is currently on the WCRP JSC (equivalent of SCARs EXCOM). This has helped INSTANT build close relationships with WCRP, and CLiC is indeed an essential partner helping INSTANT deliver on its mission, which is also a priority of CLiCs strategic plan.



In this report we raise the CLiC Core Project as a relevant example of a well-supported international science initiative, because INSTANT leadership needs more support than the SCAR Secretariat is resourced to offer. In comparison, as well as the WCRP Secretariat in Geneva, CLiC has 2 FTE of support in an International Project Office (IPO) hosted by the University of Massachusetts, Amherst. This includes a full-time Executive Director (e.g. Chandrika), a project officer (e.g. Hayley), and a communications specialist (e.g. Johanna). The WCRP model benefits from this, because the IPOs are usually funded by the host institution through government grants.

SCAR needs to move away from a "one size fits all model" for its science groups. If it wants to have highly visible and impactful programmes such as INSTANT, we will need to think more innovatively about funding models.

For INSTANT to be sustainable into the future, it can no longer rely on this level of goodwill of its chief officers, leaders and members who all have scientific "day jobs". SCAR will need to develop a support model that involves "real FTE support".

The work that has been done to date has been carried out largely by the Co-Chief Officers. Florence Colleoni's organisation, OGS, has supported her entire FTE for the last 12 months to work for INSTANT. In the initial two years of development both co-chiefs have spent an unsustainable amount of time on INSTANT Program.

The 3 Themes are operating sustainably at the moment and in many respects are similar to the previous SRPs in the their scale and the way they operate. However they are not adequately funded to carry out the range of activities they are planning.

The conference is very important for INSTANT. Standing up the INSTANT programme over the last 3 years has been challenging without being able to meet in person. This is especially because we are bringing new researchers and different disciplines and communities together. We are trying to facilitate an interdisciplinary approach. Following the conference we expect that the Themes and Subcommittees will have a much stronger idea of what they hope to achieve. They will need to continue to meet at smaller workshops and they will need support and funding.

Finally, we note that the current co-chiefs are committed to the future of INSTANT and putting it on a sustainable footing following the Conference, which includes developing successionI'm sure you will all have seen the value INSTANT brings to the community by the end of the Conference. We are committed to working with SCAR EXCOM to develop a suitable ongoing model, and have asked for time during the EXCOM Meeting SRP reports to discuss this.

Budget

Summary Budget 2021 to 2024

The INSTANT SRP was allocated budgets of USD$50,000 for 2021 and 2022, and requests the support for the SRP to be maintained at this level. Carry forward of funds remaining at the end of 2022 was also requested, with the main priority being support of the SCAR INSTANT Conference in September 2023. We anticipate the carry-forward to be USD$50-60,000. To date INSTANT expenditure has targeted support for ECRs through the INSTANT Fellowships and attendance at meetings of strategic importance, including representing the SRP. INSTANT leadership have also coordinated and approved the use of Legacy SRP funds, from the previous PAIS and SERCE SRPs, to enable support of ECRs at the GLASS Summer School and PSE Workshop in 2022 and a GIA Training School in 2023. In 2023 INSTANT expenditure will focus on supporting the cost of the Conference and ECRs to attend. The next round of INSTANT Fellowships will be deferred until 2024.

	2021	**2022**	**2023**	**2024**
	Spent	Allocated	Request	Request
(US$)	0	100000	50000	50000

Planned use of funds for 2022 to 2024

Year (YYYY)	Purpose/Activity	Amount (in USD)	Contact Name	Contact Email
2022	Meetings & workshops support	$10,000		
2022	INSTANT Fellows	$25,000		
2022	Carry fwd	$60,000		

2023	Internal costs (e.g. website, comms etc..)	$5,000		
2023	INSTANT Conference	~80 000$		
2024	Meetings & workshops support, Special issue (?)	$20,000		
2024	INSTANT Fellows	$25,000		
2024	Internal costs (e.g. website, comms etc..)	$5,000		

Changes to planned use of funds for 2023 and 2024

Note, that after the INSTANT conference and the financial wash-up, we may need to work with SCAR secretariat to adjust the budget for 2024, and find co-funding to support for an INSTANT programme office.

Year (YYYY)	Purpose/Activity	Amount (in USD)	Contact Name	Contact Email
Total				

Membership

Changes to SRP Leadership

No changes at this stage, but in the INSTANT SIP we suggested that leadership positions would be reassessed in 2024. We will start this process after the INSTANT Conference with a view to succession and ongoing sustainability of the SRP.

SCAR Fellowship Reviewers

First Name	Last Name	E-mail	Principal Expertise
Tim	Naish	See list above	geological paleoclimate
Florence	Colleoni		ice sheet and climate modelling
Richard	Levy		sea-level
Alex	Simms		solid Earth
Andrew	Lloyd		solid Earth
Alessandro	Silvano		oceanography

Significant Deviations from the Implementation Plan

N/A

Additional information (optional)

Outreach, communication and capacity-building activities (examples)

INSTANT members contributed as part of 50 international experts raising concern about the climate crisis and how close Antarctic and the Southern Ocean may be to tipping points and irreversibilities in this Guardian Article https://www.theguardian.com/environment/2023/aug/28/crazy-off-the-charts-records-has-humanity-finally-broken-the-climate?CMP=share_btn_link.

Tim Naish presented "Melting Ice, Rising Seas and the Paris Climate Agreement at reception on the eve of the first ATCM Climate Day, Helsinki, Finland. https://iccinet.org/atcmhelsinki2023/

Following the State of the Climate Announcement by WMO and the lack of real traction on climate change expressed at the ATCM 45 Climate Day by parties Tim Naish wrote a call to action in The Conversation https://theconversation.com/antarctic-tipping-points-the-irreversible-changes-to-come-if-we-fail-to-keep-warming-below-2-207410.

INSTANT and British Antarctic Survey members wrote a public facing summary of Antarctic tipping points for the ATCM 45 Climate Day. https://www.bas.ac.uk/data/our-data/publication/antarctic-tipping-points/

WCRP-SCAR joined forces in a public announcement of the dramatic loss of polar sea-ice and a call for action to understand the causes and projections. https://public.wmo.int/en/media/news/polar-scientists-call-urgent-action-view-of-rapid-arctic-and-antarctic-change

Flo Colleoni took part in COP 26 in Glasgow and COP 27 in Sharm-el-Sheik. She took part into the co-organised SCAR-ICCI side events for policy makers, stakeholders, journalists and governments about sea level rise in the future and why the past matters to our future commitment.

Eu-Polar Net invited Flo Colleoni to represent SCAR INSTANT at a policy briefing May 3rd 2023 in Bruxelles. The scope of the meeting was to raised awareness of Eu politicians on the importance of Antarctica. In fact, Europe mostly focuses on the fate of Greenland and of the Arctic ocean. https://www.youtube.com/watch?v=N_hDgGC5mEg

Notable Papers/Outputs.

Below, we profile a selection of papers that span the science value chain from fundamental understanding of ice sheet dynamics to ice mass projections and their incorporation into sea-level projections, to their use by planners and practitioners in adaptation. We also showcase two examples of science communication where science writers use literary platforms to reach the public on the importance of shrinking glaciers and ice sheets and sea-level rise. Due to the size of this programme, its breadth and the enthusiasm of our members we have listed 20 publications.

1. Siegert, M., Mike M.J., Atkinson A., Bracegirdle T., Convey P., Davies B., Downie R., Hogg A., Holmes C., Hughes K., Meredith M., Ross N., Rumble J., Wilkinson J.,

2023, Antarctic extreme events. *Frontiers in Environmental Science*, 1. 10.3389/fenvs.2023.1229283

This paper briefly examines evidence for extreme events in Antarctica and the Southern Ocean across a variety of environments and timescales. It shows how vulnerable natural Antarctic systems are to extreme events and highlights how governance and environmental protection of the continent must take them into account.

2. Levy, R., Naish, T., Lowry, D., Priestley, R., Winefield, R., Alevropolous-Borrill, A., et al. 2023 Melting ice and rising seas – connecting projected change in Antarctica's ice sheets to communities in Aotearoa New Zealand, *Journal of the Royal Society of New Zealand*, DOI: 10.1080/03036758.2023.2232743

This paper has a NZ and global focus. It highlights new research that is needed to reduce uncertainty in future Antarctic Ice Sheet contribution to sea level, links changes in sea surface height to dynamic land surface of coastlines and enhance communication approaches. While it provides several examples of the required research, it emphasizes ongoing efforts must refine the timing and magnitude of coastline change, better define coastal hazards and risks, and develop appropriate adaptation strategies for unavoidable climate change impacts. It is an example of how the work of the INSTANT programme can make a difference locally to people vulnerable to the impacts of sea-level rise.

3. Kopp, R.E., Oppenheimer, M., O'Reilly, J.L. *et al.* 2023. Communicating future sea-level rise uncertainty and ambiguity to assessment users. *Nature Climate Change* 13, 648–660 (2023). https://doi.org/10.1038/s41558-023-01691-8

This paper was an outcome from the Sea-Level Chapter in IPCC WG1 Report (2021). A number of INSTANT members are co-authors, including its leader Bob Kopp. This paper provides insights and best practice advice for how to translate uncertainty and ambiguity on Antarctic ice mass projections, and sea-level, projections to the user community.

4. Li, Q., England, M.H., Hogg, A.M. *et al.* 2023. Abyssal ocean overturning slowdown and warming driven by Antarctic meltwater. *Nature* 615, 841–847 (2023). https://doi.org/10.1038/s41586-023-05762-w

In this paper, co-authored by INSTANT members, a transient forced high-resolution coupled ocean–sea-ice model shows that under a high-emissions scenario, abyssal warming is set to accelerate over the next 30 years. The meltwater input around Antarctica drives a contraction of Antarctic Bottom Water (AABW), opening a pathway that allows warm Circumpolar Deep Water greater access to the continental shelf. The reduction in AABW formation results in warming and ageing of the abyssal ocean, consistent with recent measurements, with consequences for melt rates at the grounding line of the marine based sectors of the Antarctic Ice Sheet.

5. Priestley, R., 2022. Coming soon to a beach near you – The incoming tide of Meltwater. *Griffith Review*. https://www.griffithreview.com/articles/coming-soon-to-a-beach-near-you/**.**

This is a non-fiction article written by Rebecca Priestly, Theme 3 SCAR-HASS representative. She is a science communicator, science writer and historian. The article is published in one of the world's leading literary journals and brings a personal human face to scientists working on melting ice sheets and glaciers and their implications. She weaves her personal encounters with scientists such as Rob DeConto and Nick Golledge and her own experiences, both living on the coast and visiting Antarctica.

6. van de Wal, R. S. W., Nicholls, R. J., Behar, D., McInnes, K., Stammer, D., Lowe, J. A., et al. (2022). A high-end estimate of sea level rise for practitioners. *Earth's Future*, 10, e2022EF002751. https://doi.org/10.1029/2022EF002751

Taking a co-production approach between scientists and practioners, this paper provides high-end sea level rise (SLR) estimates for practitioner application based on an expert evaluation of physical evidence and approaches currently used in policy environments to understand high end risk. This is done for two global warming scenarios, a modest and a strong one, for two time slices 2100 and 2300. The large and growing differences between the scenarios beyond 2100 emphasize the long-term benefits of mitigation.
The paper cautions, that even a modest warming may cause multi-meter SLR on centennial time scales with profound consequences for coastal areas. The paper emphasizes the importance of the timing of ice shelf collapse around Antarctica as well as how practitioners use high end projections to frame risk. It stresses that both emission scenario and limited physical understanding will control the outcome.

7. Reading, A.M., Stål, T., Halpin, J.A. *et al.* 2022. Antarctic geothermal heat flow and its implications for tectonics and ice sheets. *Nature Reviews Earth Environment* **3**, 814–831. https://doi.org/10.1038/s43017-022-00348-y.

In Antarctica, GHF has consequences in predicting the response of ice sheets to climate change. IThis paper shows that the inferred GHF at continental scale for West Antarctica (up to 119 mW m−2, 95th percentile) points to numerous contributing influences, including non-steady state neotectonic processes. Combined influences cause especially high values in the vicinity of the Thwaites Glacier, a location critical for the accurate prediction of accelerated loss of Antarctic ice mass. The paper provides GHF maps comprising central values with these fine- scale anomalies captured within uncertainty bounds that enable enable improved boundary conditions for ensemble- based ice sheet model predictions of Antarctic ice loss.

8. Orr, A., Deb, P., Clem, K., Gilbert E., Bromwich, D., et al. 2023: Characteristics of Surface “Melt Potential” over Antarctic Ice Shelves based on Regional Atmospheric Model Simulations of Summer Air Temperature Extremes from 1979/80 to 2018/19. *J. Climate*, **36**, 3357–3383, https://doi.org/10.1175/JCLI-D-22-0386.1.

This paper calculates a regional surface “melt potential” index (MPI) over Antarctic ice shelves that is used to determine which ice shelves are vulnerable to melt-induced hydrofracture. MPI is highest for Antarctic Peninsula ice shelves and lowest for Ross Ice Shelf, with a number West and East Antarctic ice shelves with MPI hotspots. The paper emphasizes the growing importance of surface melt on ice sheet dynamics.

9. Li, R., Cheng, Y., Chang, T. *et al.* 2023. Satellite record reveals 1960s acceleration of Totten Ice Shelf in East Antarctica. *Nature Communications* 14, 4061 (2023). https://doi.org/10.1038/s41467-023-39588-x.

This paper uses satellite observations and outlines persistent long term ice discharge and an acceleration from 1963 to 2018 at the Totten Glacier groundling line. This makes the TG the greatest contributor to global sea level rise in East Antarctica. They attribute the long-term acceleration near grounding line from 1963 to 2018 to basal melting likely induced by warm modified Circumpolar Deep Water.

10. Lecavalier, B. S., Tarasov, L., Balco, G., Spector, P., Hillenbrand, C.-D., Buizert, C., Ritz, C., Leduc-Leballeur, M., Mulvaney, R., Whitehouse, P. L., Bentley, M. J., and Bamber, J.: Antarctic Ice Sheet paleo-constraint database, Earth Systems Scientific Data, 15, 3573–3596, https://doi.org/10.5194/essd-15-3573-2023, 2023.

This paper, provides an new and updated database - version 2 (AntICE2) – which consists of a large variety of observations that constrain the evolution of the Antarctic Ice Sheet over the last glacial cycle. This includes observations of past ice sheet extent, past ice thickness, past relative sea level, borehole temperature profiles, and present-day bedrock displacement rates. The database is intended to improve our understanding of past Antarctic changes and for ice sheet model calibrations and intercomparisons.

11. Iizuka, M., Seki, O., Wilson, D.J. *et al.* Multiple episodes of ice loss from the Wilkes Subglacial Basin during the Last Interglacial. *Nature Communications* 14, 2129 (2023). https://doi.org/10.1038/s41467-023-37325-y

This paper presents a high-resolution record constraining ice-sheet changes in the Wilkes Subglacial Basin (WSB) of East Antarctica during the Last Interglacial period, based on analysis of sediment provenance and an ice melt proxy in a marine sediment core retrieved from the Wilkes Land margin. The sedimentary records, together with existing ice core records, reveal dynamic fluctuations of the ice sheet in the WSB, with thinning, melting, and potentially retreat leading to ice loss during both early and late stages of the LIG. We suggest that such changes along the East Antarctic Ice Sheet margin may have contributed to fluctuating global sea levels during the LIG. This is an important potential meltwater source needed to reconcile AIS contributions to LIG sea-levels which could have been between 3-9m based on geological records.

12. Duncan, B., McKay, R., Levy, R., Naish, T. *et al.* 2022 Climatic and tectonic drivers of late Oligocene Antarctic ice volume. *Nature. Geoscience.* 15, 819–825 (2022). https://doi.org/10.1038/s41561-022-01025-x.

This paper presents an Antarctic compilation of Cenozoic upper-ocean temperature for the Ross Sea and offshore Wilkes Land, generated by membrane lipid distributions from archaea, and is an important record of SST from the southern high-latitudes bottom water formation regions, that is independent of the deep marine oxygen isotope records.

13. Crotti, I., Quiquet, A., Landais, A. *et al.* 2022. Wilkes subglacial basin ice sheet response to Southern Ocean warming during late Pleistocene interglacials. *Nature Communications* **13**, 5328 (2022). https://doi.org/10.1038/s41467-022-32847-3.

This paper (along with contribution 11) reinforces the potential contribution of meltwater from the Wilkes Subglacial Basin (WSB) to sea-level changes during Pleistocene interglacials. The key finding here, is the WSB may have experienced significant ice retreat 400ka, but not so much at 125 ka, the last interglacial.

14. Aitken, A. R. A., Li, L., Kulessa, B., Schroeder, D., Jordan, T. A., Whittaker, J. et al. 2023. Antarctic sedimentary basins and their influence on ice-sheet dynamics. *Reviews of Geophysics*, 61, e2021RG000767. https://doi.org/10.1029/2021RG000767

This comprehensive review discusses how sedimentary basins beneath the ice sheet interact with the ice sheet above and can potentially contribute to rapid ice-sheet changes that impact global sea level and climate. The paper reviews technical progress toward the understanding of sedimentary basins in the subglacial environment, and maps out the sedimentary basins beneath Antarctica's ice. It explores how improved knowledge of Antarctica's basins helps to (a) understand important tectonic events in the continent, (b) unravel the evolution of the landscape and the ice sheet, and (c) contribute to improved predictions of future ice-sheet change.

15. Gales, J.A., McKay, R.M., De Santis, L. *et al.* 2023. Climate-controlled submarine landslides on the Antarctic continental margin. *Nature Communications* 14, 2714 (2023). https://doi.org/10.1038/s41467-023-38240-y.

This paper presents a multidisciplinary study of a major submarine landslide complex along the eastern Ross Sea continental slope (Antarctica) that identifies preconditioning factors and failure mechanisms. These recurrent Antarctic submarine landslides were likely triggered by seismicity associated with glacioisostatic readjustment. Ongoing climate warming and ice retreat may increase regional glacioisostatic seismicity, triggering Antarctic submarine landslides, with implications for Tsunami hazard in Antarctica and the Southern Hemisphere.

16. Armbrecht, L., Weber, M.E., Raymo, M.E. *et al.* 2022. Ancient marine sediment DNA reveals diatom transition in Antarctica. *Nature Communications* 13, 5787 (2022). https://doi.org/10.1038/s41467-022-33494-4.

This paper presents authenticated metagenomic marine eukaryote sedaDNA from the Scotia Sea region acquired during IODP Expedition 382. It also provides a marine eukaryote sedaDNA record of ~1 Mio. years and diatom and chlorophyte sedaDNA dating back to ~540 ka. This novel study demonstrates that sedaDNA tools can be expanded to hundreds of thousands of years, opening the pathway to the study of ecosystem-wide marine shifts and paleo-productivity phases throughout multiple glacial-interglacial cycles.

17. Baldacchino, F., Morlighem, M., Golledge, N. R., Horgan, H., and Malyarenko, A. 2022. Sensitivity of the Ross Ice Shelf to environmental and glaciological controls, *The Cryosphere*, 16, 3723–3738, https://doi.org/10.5194/tc-16-3723-2022, 2022.

Understanding how the Ross Ice Shelf will evolve in a warming world is important to the future stability of Antarctica. It remains unclear what changes could drive the largest mass loss in the future and where places are most likely to trigger larger mass losses. Sensitivity maps are modelled showing that the RIS is sensitive to changes in environmental and glaciological controls at regions which are currently experiencing changes. These regions need to be monitored in a warming world.

18. Elizabeth. L. 2022. 'Cryonarratives for warming times: icebergs as planetary travellers.' In Klaus Dodds and Sverker Sörlin, ed. *Ice Humanities: Living, working and thinking in a warming world*. Manchester UP, 2022 (Aug). pp250-265.

Ice humanities is a pioneering collection of essays that tackles the existential crisis posed by the planet's diminishing ice reserves. The ramifications of such change are not simply geophysical and biochemical. They are societal and cultural, and they are about value and loss. Where does this change leave our inherited ideas, knowledge and experiences of ice, snow, frost and frozen ground? How will human, animal and plant communities superbly adapted to cold and high places cope with less ice, or even none at all? The ecological services provided by ice are breath-taking, providing mobility, water and food security for hundreds of millions of people around the world, often Indigenous and vulnerable communities. Drawing on sources ranging from oral testimony to technical scientific expertise, this collection sets out a highly compelling claim for the emerging field of ice humanities, convincingly demonstrating that the centrality of ice in human and non-human life is now impossible to ignore.

19. Chorley, H., Levy, R., Naish, T., Lewis, A., Cox, S., Hemming, S et al. 2022. East Antarctic Ice Sheet variability during the middle Miocene Climate Transition captured in drill cores from the Friis Hills, Transantarctic Mountains. *GSA Bulletin* 2022; 135 (5-6): 1503–1529. doi: https://doi.org/10.1130/B36531.1

This paper presents a unique glaci-lacustrine-fluvial continuously cored record of ice cemented sedimentray facies representing progressively larger oscillations of the EAIS leading into the Middle Miocene Climate Transition when continental scale glaciation of Antarctica occurred. It contains two well-dated volcanic ashes and a chronology that helps reconcile historical interpretations of teh Miocene glacial history of Antarctica – a time when Antarctica last supported higher plants.

20. Uenzelmann-Neben, G., Gohl, K., Hochmuth, K. *et al.* Deep water inflow slowed offshore expansion of the West Antarctic Ice Sheet at the Eocene-Oligocene transition. *Communications Earth Environment* 3, 36 (2022). https://doi.org/10.1038/s43247-022-00369-x

This paper uses seismic reflection profiles to investigate the architecture of a sediment body on the shelf of the Amundsen Sea Embayment to conclude that the West Antarctic Ice Sheet has likely experienced a strong oceanic influence on its dynamics since its initial formation, preventing it from extending beyond the coastline at the Oligocene-Miocene boundary 34 Ma. This has implications for the stability of teh present marine-based sectors of Antarctica.

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