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Contents

Executive Summary

The Scientific Committee on Antarctic Research (SCAR) is the foremost, non-governmental organisation for initiating, developing, and coordinating high quality international scientific research in the Antarctic region including the study of Antarctica's role in the Earth System.

During 2009, SCAR's research continued focusing on five themes:

(i) the modern ocean-atmosphere-ice system;
(ii) the evolution of climate over the past 34 million years since glaciation began;
(iii) the response of life to change;
(iv) preparations to study subglacial lakes and their environs; and
(v) the response of the Earth's outer atmosphere to the changing impact of the solar wind at both poles.

Highlights of recent scientific discoveries include:

1) SCAR published a major 560-page interdisciplinary review of "Antarctic Climate Change and the Environment (ACCE)" (*http://www.scar.org/publications/occasionals/acce.html*) showing how the climate has changed in the past and is likely to change in the future, with probable effects on the biota, notably declines in reproductive success with ocean warming and declining sea ice off the Antarctic Peninsula.

2) Increased growth in Antarctic sea ice during the past three decades is a result of the strengthening of surface winds around Antarctica caused by development of the ozone hole; these winds have limited the impact of global warming on Antarctic climate. When ozone levels recover, towards 2070, sea ice is likely to retreat considerably.

3) ICESTAR scientists present in Nature images of the aurora taken simultaneously in the Northern and the Southern hemispheres. These images reveal indisputable evidence that the auroras in the two hemispheres can be totally asymmetric. These findings contradict the commonly made assumption of aurora being mirror images of each other. See Nature 460, 491-493 (2009).

4) An international scientific consortium that includes ICESTAR team members successfully developed a series of autonomous observatories in Antarctica that for the first time provide critical year-round "space weather" data from the Earth's harshest environment. Data from these observatories were used in conjunction with the array of THEMIS satellites to reveal new information about magnetospheric substorms, the sudden release of energy that causes auroral displays. See J. Geophys. Res., doi: 10.1029 /2008JA013507.

5) Thanks to the impetus of the International Polar Year, some 620 scientists and students participated in SCAR-sanctioned IPY studies from over 25 countries. Over 8,600 species have been authenticated by taxonomic experts as living in the Antarctic.

6) The CAML-led barcoding campaign in collaboration with the CCDB Guelph, Canada and the marine EBA community extended the number of Antarctic DNA barcodes from 3,500 pre-2009 to over 10,000 to date. These data show clear evidence of a high numbers of cryptic species in the Antarctic benthos, especially in species previously thought to have circum-Antarctic distributions

7) Recent research shows that terrestrial, shelf and deeper water biotas all have components that survived repeated glaciations in what appear to be temporary and shifting refugia, which likely also contributed to substantial radiation in the marine biota (reviewed in Quaternary Science Reviews (vol. 28, 3035-3048).

8) The IPY Aliens in Antarctica project discovered that people involved in national programme activities in the Antarctic carried twice as many alien propagules on their clothing and equipment as did Antarctic tourists. These aliens were mainly vascular plant seeds, bryophytes and lichens. Most were found in packs and bags and on hiking footwear. This demonstrates the importance of designing measures to prevent introduction of foreign biota into the Antarctic and transfer within.

9) The ACE-supported ANDRILL Programme recovered >2400 metres of sediment from McMurdo Sound spanning more than 20 million years (Ma) of climate and ice sheet history, providing numerical modellers with new constraints on ice sheet behaviour and Ross Sea conditions. ANDRILL cores record obliquity-paced Pliocene cycles (60 glacial interglacial cycles, with 38 in the last 5Ma), with periodical collapse of the West Antarctic ice sheet (WAIS), resulting in a switch from grounded ice and ice shelves to open water environments in the Ross Sea Embayement (Naish et al., Nature 2009). These findings are consistent with a new ice sheet/ice shelf model, which simulates fluctuations of the WAIS, in response to ocean induced melting, that are capable of generating up to 7m of sea level change (and up to 3 m from the East Antarctic Ice Sheet).

10) The first SCAR Data and Information Strategy (DIMS) was published, defining the direction for SCAR data management activities over the next 5 years, emphasises the need to leverage established regional, global and thematic data-centric networks to improve data management capability within the Antarctic science community as a whole.

11) SCAR successfully ran the first year of the Martha T Muse Prize for Science and Policy in Antarctica, a $100,000 unrestricted yearly prize given to an early to mid-career individual who has demonstrated excellence and the potential or leadership in Antarctic science or policy. Dr Steven Chown was the inaugural recipient. Presentation of the award and a lecture by Dr Chown will take place at the Oslo IPY Conference in June 2010.

1. What is SCAR (for further details see www.scar.org)?

The Scientific Committee on Antarctic Research (SCAR) is the main non-governmental organization responsible for the international coordination of scientific research in the Antarctic region. SCAR is an Interdisciplinary Body of the International Council for Science (ICSU). ICSU formed SCAR in 1958 to continue coordinating the scientific research in Antarctica that began during the International Geophysical Year of 1957-58. The need for such coordination has grown as the role of Antarctica in the global system has become apparent, and continued unabated in the International Polar Year (IPY) ending in March 2009, in which SCAR played a leading role. SCAR's Members currently include 35 nations and 9 of ICSU's Scientific Unions, which link SCAR to a wide range of scientific activities.

SCAR aims to improve understanding of the nature and evolution of Antarctica, the role of Antarctica in the Earth System, and the effects of global change on Antarctica. It initiates, develops, and co-ordinates high quality international scientific research in the Antarctic region and on the role of Antarctica in the Earth system. SCAR carries out a comprehensive programme of coordinated scientific research that adds value to national research in the Antarctic by enabling national researchers to work together on large-scale scientific questions**.** Collectively, SCAR programmes can often accomplish research objectives that are not easily obtainable by any single country, research group, or researcher.

Through its biennial Open Science Conference, the next one of which will be in Buenos Aires (August 3-6, 2010), SCAR provides a forum for the community of polar scientists, researchers, and students to report on the latest science, exchange ideas and explore new opportunities. SCAR is also cosponsoring the 2nd IPY Open Science Conference, which takes place in Oslo (June 8-12, 2010). SCAR also supports research Fellows and young scientists and provides a broad range of data management and information products.

SCAR fosters strong links between its scientific programmes and global partners. For example, SCAR helps to coordinate polar scientific research through a network of the four main bodies of the International Council for Science (ICSU) concerned with polar and/or cryosphere research: SCAR, the World Climate Research Programme (WCRP), the International Arctic Science Committee (IASC), and the International Association for Cryospheric Sciences (IACS). SCAR also has partnerships with relevant components of the International Geosphere-Biosphere Programme (IGBP), the International Permafrost Association (IPA), the Global Ocean Observing System (GOOS), the Partnership for Observations of the Global Ocean (POGO), the Census of Marine Life (COML), the Global Biodiversity Information Facility (GBIF), and ICSU's Scientific Committee on Oceanic Research (SCOR), Scientific Committee on Solar Terrestrial Physics (SCOSTEP), and Committee on Data for Science and Technology.

SCAR also provides independent scientific advice on the knowledge and principles needed for wise management of the Antarctic environment by the Antarctic Treaty Parties (through Consultative Meetings); by the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR); by the Commission for the Conservation of Antarctic Seals (CCAS); and the Advisory Committee of the Agreement on Conservation of Albatrosses and Petrels (ACAP). In carrying out

research and providing advice SCAR works closely with the Council of Managers of National Antarctic Programmes (COMNAP).

2. SCAR Science

Everything SCAR does, and how SCAR is perceived as an organization, is rooted in the quality and timeliness of SCAR's scientific portfolio. Annual assessment of SCAR's scientific portfolio is assured by procedures for programme planning, proposing, implementation, reporting and review, which help to ensure continuous improvement. The performance of SCAR as a whole was reviewed by an external panel during 2009, with favourable results.

Renewal is essential to the continuing health of SCAR, and mechanisms are in place to ensure the generation of exiting new projects as old ones come to their end. SCAR's ICESTAR astrophysics programme will come to an end in August 2010 to be replaced by the new programme on Astronomy and Astrophysics from Antarctica (AAA). A regular Cross-Linkages workshop provides an incubator for the generation of new programme proposals. The Cross-Linkages group met at the University of Modena & Reggio Emilia, Modena, Italy, on 5-6 February 2009.

All SCAR's scientific planning, reporting and review is carried out by volunteers. The willingness of the community to participate in assuring success is another metric of the health of SCAR, especially when people have competing demands on their time.

2.1 Major Scientific Research Programmes

SCAR's current research continued to focus on five major Scientific Research Programmes (SRPs), each addressing key issues at the frontiers of science:

- Antarctica and the Global Climate System (AGCS), a study of the modern ocean-atmosphere-ice system;
- Antarctic Climate Evolution (ACE), a study of climate change over the past 34 million years since glaciation began;
- Evolution and Biodiversity in the Antarctic (EBA), a study of the response of life to change;
- Subglacial Antarctic Lake Environments (SALE), a study of lakes buried beneath the ice sheet;
- Interhemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research (ICESTAR), a study of how the Earth's outer atmosphere responds to the changing impact of the solar wind at both poles.

Project Implementation Plans are available at the SCAR web site. Advances in each programme in 2009-10 are summarized below. SCAR welcomes the involvement of scientists in these programmes (enquiries to info@scar.org).

2.1.1 Antarctica in the Global Climate System (AGCS)

Antarctica in the Global Climate System (AGCS) focuses on: (i) how does the modern climate system work in Antarctica and the Southern Ocean? (ii) how has it developed over roughly the last 10,000 years? and (iii) how may it evolve over

the next century? The results will be useful to the Intergovernmental Panel on Climate Change (IPCC) and others. For details see: http://www.antarctica.ac.uk/met/SCAR_ssg_ps/AGCS.htm. AGCS incorporates SCAR's International Trans-Antarctic Scientific Expedition (ITASE) and Antarctic Sea Ice Processes and Climate (ASPeCt) projects. AGCS and its sub-programmes are co-sponsored by SCAR and the World Climate Research Programme (WCRP). Members of AGCS have given public lectures, visited schools, prepared popular articles and made broadcasts on radio and television.

2.1.1.1 Progress

AGCS led the cross-SCAR development of a major review on Antarctic Climate Change and the Environment (ACCE), synthesizing knowledge on past present and possible future changes in Antarctica and the Southern Ocean and their impact on the biota. It was published in October 2009 and formally launched at a press conference in London on November 30. Copies are available at (http://www.scar.org/publications/occasionals/acce.html). Hard copies were provided ahead of time to the national delegations attending the UN Framework Convention on Climate Change conference held in Copenhagen in December 2009, which was attended by the SCAR Executive Director, who gave two talks there on ACCE. A review summarising the results of the ACCE work and with the same title was published in December 2009 in the journal "Antarctic Science" by Convey et al.

In addition to this major highlight, the AGCS community has led several other scientific breakthroughs. A paper in press to the Journal of Physical Oceanography presents unprecedented observational evidence of the way in which mesoscale eddies mix tracers across the Southern Ocean. An article submitted to Nature Geoscience shows, using a theory that fits those observations, that the overturning circulation of the Southern Ocean is sensitive to decadal-scale changes in the Southern Ocean westerlies, contrary to recent propositions. This has implications for the role of the Southern Ocean in the global carbon cycle. A paper published in Geophysical Research Letters shows that the increased growth in Antarctic sea ice during the past three decades is a result of the strengthening of surface winds around Antarctica associated with stratospheric ozone depletion. The presence of the ozone hole has delayed the impact of greenhouse gases on Antarctic climate, and the study predicts that Antarctic sea ice will retreat considerably by the end of the 21st century, as ozone levels recover. An article in press in Nature Geoscience presents evidence from an East Antarctic ice core indicating a link between drought conditions in Western Australia and increased snowfall in Antarctica. The link is established via evolving atmospheric circulation patterns off southern Australia, with the change in the last three decades appearing to be outside the range of natural variability. Papers in press in Deep-Sea Research II discuss the development of novel regional empirical relationships between ice thickness and satellite-derived snow freeboard, and their application to IceSAT altimetry. This development will allow the prompt determination, for the first time, of an adequate baseline of ice thickness distribution for future monitoring of climatic changes in the Antarctic sea ice cover.

AGCS has been involved in numerous field campaigns contributing to IPY, including:

- Multi-national traverses across Antarctica as part of ITASE to measure ice layer thickness, ice and bedrock chemistry, snow accumulation rates and ice flow;

- Brazilian-Chilean-USA ice core drilling and airborne radar survey on the Detroit Plateau, Antarctic Peninsula, for the Climate of the Antarctic and South America (CASA) programme;
- Oceanographic transects across the Southern Ocean and the Antarctic margins as part of the Climate in Antarctica and the Southern Ocean (CASO); and Synoptic Antarctic Shelf-Slope Interactions Study (SASSI) programmes.
- The two first two cruises of the UK-USA Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean (DIMES), which seeks to test and, if necessary, redefine the present paradigm of Southern Ocean mixing and its grip on the ocean's overturning circulation.

AGCS recovers and archives Antarctic data, and has updated the Met-, Ice- and Southern Ocean- READER databases. AGCS now has a new portal for accessing information about data sets related to the programme - it is part of the Antarctic Master Directory and provides searchable information on projects and data associated with AGCS - http://gcmd.gsfc.nasa.gov/KeywordSearch/Home.do?Portal=agcs.

AGCS organized an International Workshop on Antarctic Sea Ice in IPY, held in Barga (Italy) with 47 participants (report available), and supported the organization of the 4th Malaysian International Seminar on Antarctica (Legacy of IPY to the Tropics), which focused on tropical-polar interactions. AGCS was also involved in leading a special issue of Deep-Sea Research on the results from the Sea Ice Physics and Ecosystem Experiment (SIPEX) and the Sea Ice Mass Balance in the Antarctic (SIMBA) projects conducted during IPY, with over 20 papers submitted. AGCS supported a range of activities of the Working Group on Southern Ocean Physical Oceanography and Cryosphere Linkages (SOPHOCLES), which focuses on understanding how well the current generation of models represents the interaction between the cryosphere and the Southern Ocean.

2.1.1.2 Plans for 2010

- Investigate Tropical-Polar Connections, with a section focusing on an array of ice cores from the Antarctic Peninsula and along southern South America.
- Obtain a deep ice core from the northern end of the Ross Ice Shelf to investigate the retreat velocity of the Ross Ice Shelf during the last deglaciation.
- Quantify Southern Ocean circulation, heat and freshwater fluxes, and investigate the processes controlling the circulation.
- Study variability in synoptic activity over Antarctica and the Southern Ocean.
- Establish an adequate baseline of ice thickness distribution for future monitoring of climatic changes in the Antarctic sea ice cover.
- Hold an International Conference on Antarctic Clouds at the Byrd Polar Research Center, 15-16 July 2010.
- Hold an Antarctic Sea Ice Workshop in Tromso, 30 May 2010.
- Hold an international workshop on 'Southern Ocean circulation and the carbon cycle' at the National Oceanography Centre, Southampton, 15-16 June 2010.
- Extend the Met-READER database, making meteorological observations available.

2.1.2 Antarctic Climate Evolution (ACE)

The purpose of ACE is to facilitate the study of Antarctic climate and glacial history through integration of numerical modelling with geophysical and geological data.

Antarctica has been glaciated for approximately 34 million years but its ice sheets have fluctuated considerably and the spatial scale and temporal pattern of these fluctuations is subject to considerable debate. Understanding the response of large ice masses to climatic forcing is relevant because ice-volume variations impact global sea level and also alter the capacity of ice sheets and sea ice to act as major heat sinks/insulators. ACE has links to the ice core community via the International Partnership in Ice Core Sciences (IPICS); to the palaeoclimate community via the past climate change (PAGES) programme of the International Geosphere Biosphere Programme (IGBP); to the IASC programme on Arctic Palaeoclimate and its Extremes (APEX); and to drilling programmes such as the Antarctic Geological Drilling programme (ANDRILL) and the Integrated Ocean Drilling Program (IODP). The ACE website is at www.ace.scar.org.

2.1.2.1 Progress:

In 2009, ACE held its First Antarctic Climate Evolution in Granada, Spain (7-11 September) (http://www.acegranada2009.com/). Nearly 200 international scientists from the fields of climate, ocean, and ice modelling joined geologists, geophysicists and geochemists for five days of intense interaction. A summary of the symposium and its outcomes is published in EOS (DeConto and Escutia, 2010).

In addition to providing co-funding for the First ACE Symposium, ACE financially supported the following workshops:

- First and Second Reconstruction of Antarctic Paleotopography (ANTscape) workshops, 15-17 April, Leeds (UK), and 10-11 September, Granada (Spain).
- Circum-Antarctic Stratigraphy and Palaeobathymetry (CASP) Project, 7-8 September, Granada, Spain.
- Antarctic Ice-Volume Proxies: High and Low Latitude Sequence and Seismic Stratigraphy and Deep-Sea Records, 9 September, Granada, Spain.
- Seismic Data Library System (SDLS) workshop, 9 September, Granada, Spain.
- Amundsen Sea Embayment: Tectonic and Climatic Evolution workshop, 9 September, Granada, Spain. Information and outcomes from this workshop are published in EOS (Larter, Gohl and Bentley, 2010).
- Developing an Integrated Strategy to Recover Paleoclimate Records from the Antarctic Margin and Southern Ocean, 12-13 September, Granada, Spain.

ACE has been also active in organizing special sessions, business meetings and Town Meetings in major scientific meetings such as the European Geophysical Union, Vienna; and AGU Fall Meeting, San Francisco.

ACE continues to be committed to the training of the next generation of Antarctic scientists. For this ACE funding provided travel expenses, student housing and low registration fees for students for the First ACE symposium. ACE also co-funded an Association of Polar Early Career Scientists (APECS) workshop, 7 September, Granada, Spain.

Key ACE peer reviewed publications include:

- Naish, T., et al., 2009, Obliquity-paced Pliocene West Antarctic Ice Sheet Oscillations. Nature 458, 322-328, doi:10.1038/nature07867.
- Pollard D. and DeConto R.M., 2009, Modelling West Antarctic Ice Sheet growth and collapse through the past five million years. Nature 458, 329-33, doi:10.1038/nature07809.

- Sun Bo, et al., 2009, The Gamburtsev Mountains and the origin and early evolution of the Antarctic Ice Sheet. Nature, 459,690-693
- Harwood, D., et al., 2009, Antarctic Drilling Recovers Stratigraphic Records from the Continental Margin. Eos Trans. AGU, 90(11), doi:10.1029/2009EO110002.
- Wilson, D.S. and Luyendyk, B.P., 2009. West Antarctic paleotopography at the Eocene-Oligocene climate transition. Geophysical Research Letters, 36, L16302, doi:10.1029/2009GL039297.

ACE has contributed through collaborative efforts with other communities (i.e., PAGES, AGCS, and EBA) to the following publications:

- Turner et al., 2009, Antarctic Climate Change and the Environment', available at: http://www.scar.org/publications/occasionals/acce.html
- Brigham-Grette, J., et al., (editors), 2009, Changing Poles: A Paleoscience Perspective. PAGES News, 17: 48pp.
- Brigham-Grette, J., and Powell R.D., 2009, Editorial: Changing Poles: A Paleoscience Perspective, in Brigham-Grette, J., et al., (editors), Changing Poles: A Paleoscience Perspective. PAGES News, 17: 2.
- Powell, R., et al., 2009, New Records of the Role of Antarctic Ice Sheets in Late Cenozoic Climate, in Brigham-Grette, J., et al., (editors), Changing Poles: A Paleoscience Perspective. PAGES News, 17: 32-34.

ACE continues to stimulate and be involved in geological drilling. The workshop on "Developing an Integrated Strategy to Recover Paleoclimate Records from the Antarctic Margin and Southern Ocean" (12-13 September, ACE, Granada, Spain) addressed knowledge gaps in the role of Antarctic Ice Sheets in climate change and outlined a sediment drilling strategy. This strategy was submitted to the IODP New Ventures in Exploring Scientific Targets (INVEST) meeting as a reference document for the planning of IODP beyond 2013. ACE also co-financed a meeting (12 September, Granada) for the scientific planning of the IODP Expedition 318 to the Wilkes Land margin (January-March 2010). The ACE-supported ANDRILL Programme, has advanced ACE objectives by recovering >2400 metres of sediment from McMurdo Sound spanning more than 20 million years (Ma) of climate and ice sheet history and provide numerical models with new constraints on ice sheet behaviour and Ross Sea conditions (see listed publications). Planning is underway for site surveys for the next ANDRILL Coulman-High Project.

The Whillans Ice Stream Subglacial Access Research Drilling (WISSARD) will be the first large-scale drilling project to examine subglacial ecosystems in a holistic context. This is a large-scale interdisciplinary approach to study the subglacial environments of a West Antarctic ice stream by using a range of new technologies. The programme connects 13 research groups in the US using specific scientific expertise in three integrated projects, LIZZARD: (Lake and Ice Stream Subglacial Access Research Drilling), RAGES: (Robotics Access to Grounding-zones for Exploration and Science), and GBASE: (Geomicrobiology of Antarctic Subglacial Environments). The overarching scientific objective is to examine the subglacial hydrological system of Whillans Ice Stream in glaciological, geological, microbiological, geochemical, and oceanographic contexts. Direct sampling will yield key information on these systems and contribute to understanding the history of the West Antarctic Ice Sheet. These unique environments exert major control on ice sheet dynamics and their history, and the study falls within the interests of ACE and will contribute to furthering ACE goals.

2009 saw the US-UK-Australian-French ICECAP team deployed twice in East

Antarctica. ICECAP aims to measure the ice and crustal evolution of the Central Antarctic Plate, using a DC3 airborne geophysics platform. In January 2009, ~30,000 km of geophysics data (radar, gravity, magnetics, altimetry, GPS) was acquired over the Aurora basin (flying from Casey Station), and a small amount over the Wilkes Basin (flying from McMurdo). In October 2009 ICECAP redeployed to McMurdo to continue data acquisition of the southern Wilkes basin, to Casey via Dome C for further Aurora transects, and to Durmont d'Urville for measurements of the Astrolabe basin and other outlets in the surrounding coast. Several ICESat II lines were flown in this second season, with an aim to bridge altimetric data from ICESat I. In total over 90,000 km of flight track have been acquired. 2010 will see the processing of these data, and the deployment for a third time of the DC3 later in the year.

2.1.2.2 Plans

- Special ACE publication by Elsevier, with selected review papers from the 1st ACE Symposium in 2009;
- Publication of the IODP Expedition 318 Wilkes Land Glacial History Preliminary Report;
- Contribution to the writing of the IODP Science Plan document for beyond 2013.
- ANDRILL science meeting in Erice, Italy (April 2010) focusing on results from the SMS Project;
- Special sessions, Town Meetings, and steering committee meetings at international meetings (EGU, IPY Oslo, SCAR OSC, AGU);
- Support for Urbino graduate summer school in paleoclimatology;
- Continue efforts to develop an European ANDRILL consortium (EuroANDRILL);
- Apply for a Chapman or Gordon conference on bi-polar paleoclimate records.

2.1.3 Evolution and Biodiversity in the Antarctic (EBA)

EBA aims to understand the evolution and diversity of life in the Antarctic, to determine how these have influenced the properties and dynamics of present Antarctic and Southern Ocean ecosystems, and to predict how organisms and communities will respond to environmental change. EBA integrates work on marine, terrestrial and lake ecosystems. By comparing the outcome of parallel evolutionary processes over the range of Antarctic environments, fundamental insights can be obtained into evolution and the ways in which life responds to change, from the molecular to the whole organism to the biome level. A wide range of national and multinational projects contribute to EBA, including CAML (Census of Antarctic Marine Life), MarBIN (Marine Biodiversity Information Network), Aliens, TARANTELLA, MERGE (Microbiological and Ecological Responses to Global Environmental Changes in Polar Regions), the Latitudinal Gradient Project, and ICED (Integrating Climate and Ecosystem Dynamics in the Southern Ocean). CAML, MarBIN and ICED are either SCAR activities or sponsored by SCAR. EBA is organised into 5 different Work Packages.

2.1.3.1 Progress:

EBA facilitates collaboration through workshops and conferences that maximize international and multidisciplinary involvement. In 2009 these included:

- Antarctic-South American Interactions in the Marine Environment (ASAI), VI Symposium in Ecology, November 2009, Rio de Janeiro, Brazil
- EBA participation in three Workshops of the European Union's "Coordination Action for Research Activities in Life in Extreme Environments" (CAREX):
  - Identification of model organisms in extreme environments, Sasbachwalden (Black Forest), Germany, June 2009
  - Laboratory Procedures Workshop, Univ of Tuscia, Viterbo, Italy, June 2009
  - Strategic Roadmap Workshop, November 2009, Ostend, Belgium
- Xth SCAR Biology Symposium in Sapporo, Japan, 27-31 July 2009.
- Latitudinal Gradient Project Workshop, Auckland, New Zealand, 1 July 2009.
- SCAR MarBIN Meeting, December 2009.

EBA participants have worked with SCAR glaciologists and geologists to assess interactions between organisms and their environment through time. In this context, many EBA participants have actively contributed to the ACCE report and associated review publication. Genes and proteins in polar fish and bacteria enable molecular studies of thermal adaptation, to understand their evolutionary adaptation to Antarctic conditions. The ability of cold-adapted organisms to survive implies that they have overcome constraints imposed by a permanent cold environment through biochemical and physiological adaptations, which preserve the flexibility of DNA, RNA and proteins. Similar to other bacteria, the genome of the cold-adapted bacterium *Pseudoalteromonas haloplanktis* contains multiple genes encoding three monomeric hemoglobins exhibiting a 2/2 α-helical fold. We have cloned, over-expressed and characterised one of these 2/2 hemoglobins. The ensemble of results indicates high protein structural flexibility, probably in response to the constraints of the cold environment. Papers have been published in e.g. *International Innovation, Biophys J, IUBMB Life, Marine Genomics, J Fish Biol.*

EBA, with SCAR's Antarctic Treaty System committee, is also funding terrestrial biodiversity analyses based on existing databases so as to provide information and advice for the 2010 ATCM. Scientific publications are also being developed from this work, emphasising the increasing synergy between science and policy input in some areas of EBA supported research. This is further illustrated by a recent publication analysing the efficacy of protection measures provided by the current system for Antarctic Specially Protected Areas (Hughes & Convey 2010, *Global Environmental Change* **20**, 96-112).

EBA contributes to the new SCAR Action Group on Prediction of Changes in the Physical and Biological Environments of the Antarctic, the 2nd workshop of which was held at AWI, Bremerhaven, Germany, in September 2009.

EBA has provided funding to assist the continuation of data analyses within the IPY-Aliens programme. Publications are expected to come online from that programme during 2010, with a major effort associated with its organising a session at the 2010 IPY conference in Oslo.

A compilation of EBA-related publications has not yet been completed for 2009, although EBA national programmes and individuals have continued publishing at the same rate as in recent years. For instance, the Italian IPB-CNR programme includes 16 publications directly acknowledging EBA, while the British Antarctic Survey's BIOFLAME and Ecosystems programmes list over 50 publications, although not all explicitly mention SCAR or EBA. A special issue of the journal Polar Science was

published arising from the EBA-sponsored workshop on polar microbiology held in Canada in 2008. The journal International Innovation (December 2009) published an interview on EBA-IPY by G di Prisco ("Multi-agency aims to beat problem to climate change") and an article by G di Prisco and C Verde ("Biodiversity's role in a sustainable world"). EBA Newsletters were distributed in March and October.

In part EBA's success rests on the extent to which biological data can be maintained, archived and exchanged, much of which is done through the Australian Antarctic Data Centre, which hosts and maintains a Biodiversity Database on Antarctic and sub-Antarctic flora and fauna (http://data.aad.gov.au/aadc/biodiversity/). EBA also relies on other databases such as SCAR-MarBIN (below), MERGE, and the Southern Ocean Continuous Plankton Recorder Programme (SO-CPR). EBA has a portal within the Antarctic Master Directory allowing access to metadata that contribute to EBA's aims. To view the portal – go to: http://gcmd.nasa.gov/KeywordSearch/Home.do?Portal=eba&MetadataType=0.

SCAR-MarBIN

The SCAR-Marine Biodiversity Information Network (www.scarmarbin.be), supports and develops a network of databases, institutes and people and gives open access to information on marine biodiversity for science, conservation and management. SCAR-MarBIN together with its sister project CAML (Census of Antarctic Marine Life) has started its activities in 2005 to build the first comprehensive assessment of Antarctic Marine Biodiversity and better understand the actual diversity and status of Antarctic marine life. Open access is made available through the first Register of Antarctic Marine Species (RAMS), the most comprehensive resource on the taxonomy of Antarctic marine species. RAMS offers authoritative information on over 16,000 taxa. This information is then also made available through the World Register of Marine Species (WoRMS; www.marinespecies.org), the Catalogue of Life (CoL; www.catalogueoflife.org) and the Encyclopedia of Life (EoL; www.eol.org), and a series of thematic portals. In parallel, biogeographic information is also being compiled, allowing users to access information on occurrence, abundance, and genetics of more than 5,200 taxa. The ANTOBIS geodatabase (forming the Antarctic node of the Ocean Biogeographic Information System, OBIS) has now reached 1,054,676 records from 145 distributed databases. This information is also accessible through other webportals such as the Ocean Biogeographic Information System (OBIS; www.iobis.org), or the Global Biodiversity Information Network (GBIF; www.gbif.org). Since its inception, the SCAR-MarBIN website has reached over 700,000 visitors, 5,000,000 hits, and a total of over 32,000,000 downloaded records.

Antarctica is a natural evolutionary laboratory for studying the impacts of climate change on molecular evolutionary rate, dispersal, speciation and to some extent, extinction. Together, SCAR-MarBIN and CAML (see below) meet the need to establish the current state of Antarctic marine communities and their diversity, so that we can understand the impact of future climate change, and the changes wrought by human activities such as overfishing and pollution. SCAR-MarBIN was funded by the Belgian Science Policy office (BELSPO) until September 2009, and is now supported by contributions from Australia, Germany, The Netherlands, the TOTAL Foundation and the ArcOD consortium; these contributions represent an important first step into making SCAR-MarBIN an internationally-supported initiative. Networking activities are ongoing thanks to a new BELSPO-funded project, the Antarctic Biodiversity Information Facility (ANTABIF, www.biodiversity.aq), which

will give access to all Antarctic Biodiversity information (marine, terrestrial and limnetic) on a single web portal, thanks to a tight collaboration with the Australian Antarctic Data Center.

Census of Antarctic Marine Life (CAML)

The Census of Antarctic Marine Life (CAML www.caml.aq) is a project of SCAR and EBA, and was also a major project of the International Polar Year (IPY). In addition to establishing a benchmark of over 16,000 taxa of biota in the Southern Ocean, CAML researchers have discovered new pathways of evolution, dispersal and colonization by Antarctic organisms. This broad scope was achievable only by collaboration among biologists, geoscientists and oceanographers from the outset. A comparison of the species in Antarctic and Arctic waters was possible for the first time, inspired by the IPY.

CAML is a regional project of the global Census of Marine Life (CoML), funded by the Sloan Foundation. When CAML ends in December 2010, a legacy will remain in the strong international network that has been fostered, with 350 participants from 33 countries, including a consortium of the seven South American countries with Antarctic programmes. Training the next generation of researchers has been a priority, implemented by funding young scientists to join voyages and attend conferences.

In the last five years, CAML has coordinated the largest-ever survey of biota in the Southern Ocean, including 18 major voyages to Antarctica (and as many minor voyages). The survey has contributed data to SCAR-MarBIN; coordinated intensive Continuous Plankton Recorder sampling, shown changes in zooplankton communities; discovered hundreds of new species; published barcodes for 2,500 species (from over 11,000 DNA sequences); posted web-based media from each voyage and three major international press events; and produced a video on YouTube with another in progress. Lasting legacies from CAML are the 30-year benthic dataset from Admiralty Bay; initiation of the Southern Ocean Observing System, with both physical and biological components; including biologger data from marine mammals; writing taxonomic monographs, Antarctic Field Guides and pages for the Encyclopaedia of Life; publication of over 1,000 scientific papers; and providing evidence for CCAMLR's bioregionalisation and declaration of two Vulnerable Marine Ecosystems. CAML has published a regional descriptive paper (Huw Griffiths) and a synthesis chapter (Julian Gutt) for the CoML. The main findings will be published in a special volume of *Deep-Sea Research II*, with guest editors Stefano Schiaparelli and Russ Hopcroft. These achievements during the IPY have provided a robust benchmark against which future change in the Antarctic marine ecosystems may be measured.

In late 2009, CAML hosted a workshop in Bremen for the synthesis and publication of the *R V Polarstern* SYSTCO voyage. In 2010, participants of the East Antarctic Census (CEAMARC) from three vessels and four nations, gathered at a synthesis workshop in Hobart. The CAML coordinators of barcoding (Rachel Grant), bipolar species (Louise Allcock), and LA-CAML in South America (Lucia Campos and Manuela Bassoi) will continue their work in 2010. The plans for the remainder of 2010, including a benthic biodiversity workshop, biogeography analysis, polychaete meeting and synthesis presentations are at http://www.caml.aq/documents/20091116calendar2009_10.pdf

In October 2010, CAML will be represented at the final meeting of the CoML at the Royal Society in London. By invitation, the Scientific Steering Committee (appointed by SCAR) will present the highlights of CAML.

2.1.3.2 EBA Plans for 2010

- Support the investigation of environmental gradients (major review in latter stages of development, arising from 2008 EBA targeted workshop);
- Support the collation of terrestrial biogeographical data, and its analysis in terms of Antarctic regionalisation (joint activity with SC-ATS);
- Provide advice to CEP on biodiversity and conservation within Antarctica;
- Support studies of the risks of transfer of non-native species into Antarctica;
- Support continuation of SCAR MarBIN database development, and its development into ANTABIF;
- Continue contributing to relevant IPY programmes (EBA-IPY, MERGE, CAML, Tarantella, Aliens in Antarctica, etc)
- Sponsor the workshop on "Polar Marine and Lacustrine Organisms: Gene and Protein Evolution in a Changing Environment", May 24th-25th, 2010), Institute of Protein Biochemistry, CNR, Naples, Italy.
- Contribute to the organisation of a SCAR-sponsored workshop in May 2010 to scope and develop proposals for future SCAR biological research programmes.
- Support participation by the biological science community in the SCAR Open Science Meeting to be held in Buenos Aires in August 2010
- Contribute articles of EBA participants to a 2010 special issue of Polar Science devoted to the SCAR Biology Symposium, Sapporo, Japan (2009).

2.1.4 Subglacial Antarctic Lake Environments (SALE)

The SALE programme promotes, facilitates and champions international cooperation to better understand subglacial aquatic environments in Antarctica. It also promotes and advances environmental stewardship in the exploration of these unique settings. SALE's members are funded through their national programmes to conduct SALE science; additional funding from SCAR allows for the convening of a yearly meeting. The SALE website contains details on the programme (http://scarsale.tamu.edu/). SALE produces a weekly email highlighting subglacial aquatic research and related topics to more than 150 scientists worldwide.

2.1.4.1 Progress

SALE has been instrumental in bringing ideas on subglacial research together since its inception. Through its efforts, the international scientific community now recognizes these environments as frontiers for scientific study across disciplines. SALE science has gone from a curiosity to a focus of scientific research with 3 national projects funded to sample subglacial lakes in both east and west Antarctica within the next 5 years.

Subglacial Lake Ellsworth: Geophysical exploration of Subglacial Lake Ellsworth took place over two Antarctic field seasons in 2007/08 and 2008/09, when small teams of scientists were deployed on the ice above the lake. Using seismic and radar surveys, they were able to map the outline of the lake, measure the depth of the water (150 m at its deepest) and establish that sediments suitable for coring, which could contain a record of ice sheet history, are present on the lake floor. Based on the results of the geophysical exploration, the UK's Natural Environment Research Council approved funding for direct

exploration of the lake in 2012/13 by members of the Lake Ellsworth Consortium. During this stage of the project scientists will use a hot water drill to melt through the overlying ice sheet into the lake water, before deploying a probe (to test for life in the lake) and a sediment corer (to recover sediment from the lake-floor).

Subglacial Lake Whillians and its associated watershed: WISSARD (Whillans Ice Stream Subglacial Access Research Drilling) will be the first large scale US funded drilling project to examine subglacial ecosystems in a holistic context. The project will investigate the physical, chemical, and geobiological interactions in the subglacial environments poised at the interface of the Antarctic cryosphere, geosphere and global ocean. The WISSARD programme connects 9 institutions across the USA and includes 13 research groups using specific scientific expertise in three integrated projects, LIZZARD: (Lake and Ice Stream Subglacial Access Research Drilling), RAGES: (Robotics Access to Grounding-zones for Exploration and Science), and GBASE: (Geomicrobiology of Antarctic Subglacial Environments). This large-scale interdisciplinary approach to study the subglacial environments of a West Antarctic ice stream provides the unparalleled opportunity to highlight the process of science utilizing novel technology and the increasingly interdisciplinary nature of scientific discovery. The overarching scientific objective of WISSARD is to examine the subglacial hydrological system of Whillans Ice Stream in glaciological, geological, microbiological, geochemical, and oceanographic contexts. The project plans to test the cleanliness of its drill on the Ross Ice Shelf in 2011-2012, sample Lake Whillans in 2012-2013, and sample the lake's outflow at the grounding zone in 2013-2014.

Subglacial Lake Vostok: During the 2008-2009 drilling season the Russian crew made an unsuccessful attempt to recover from the borehole bottom at 3,367 metres a drill that had been damaged during an accident in October 2007. They deployed a new drill and deviated around the stuck drill exceeding the depth of the stuck drill. They now plan to enter the lake in the 2010-2011 drilling season. During 2008-09, radio-echo sounding was conducted beyond the lake limits and preparations were underway to conduct seismic measurements of the geological structure of the Earth's crust.

Japanese scientists continue their work at Dome Fuji and confirmed that liquid water was present at the base of the Dome Fuji ice core and that bacteria and other organic matter was present throughout the core. These biogenic particles were not correlated with the temperature or dust records in the core. They have begun examining the possible connection between subglacial water in the Dome Fuji region with coastal lakes.

Belgian scientists are focusing on developing numerical models of ice flow over subglacial lakes, and studying the force and mass balance of large Antarctic glaciers and ice streams in combination with satellite radar interferometry, the influence of basal conditions on the dynamic behaviour of Antarctic glaciers and ice streams, and the paleo-reconstruction of the glacial history of ice sheets. They will begin to work within the existing IceCube project at the South Pole to install additional inclinometers within IceCube to measure ice deformation. The neutrino detectors that are currently installed will be employed as well to infer ice deformation. They will establish new equations for ice flow (accurately determining Glen's index), and verify high-resolution higher-order and full Stokes models with the measured deformation rates in IceCube.

Italian scientists, working on rare earth elements (REE) in accreted ice from the Vostok core, showed that REE concentrations in the upper and lower accreted ice are lower than those in fresh water and seawater, respectively and are probably not representative of conditions within Lake Vostok, but instead reflect phase exclusion processes at the

ice/water interface.

During 2009 SALE has continued to develop workshops and promote sessions at scientific meetings; worked with a SCAR action group to develop a code of conduct for subglacial exploration (the code has been finalized for submission to the SCAR Delegates for approval); educated the public through extensive coverage of SALE science; and worked closely with APECS to bring earlier career scientists to SALE meetings.

2.1.4.2 Plans for SALE

- A Chapman Conference proposal on subglacial environments will take place on 15-17 March 2010 in Baltimore, Maryland, USA (http://www.agu.org/meetings/chapman/2010/ccall/index.php). The objectives are (1) to communicate to the wider community the most recent results, (2) to share expertise in planning subglacial aquatic environment (SAE) exploration programmes and (3) to bring together a diverse group of experts that might not otherwise collaborate or interact to broaden the interdisciplinary nature of all aspects of SAE research.
- Plans are in the making to terminate SALE as a Scientific Research Programme at the XXXI SCAR Meeting.

2.1.5 Inter-hemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research (ICESTAR)

ICESTAR is creating an integrated, quantitative description of the upper atmosphere over Antarctica and of its coupling to the global atmosphere and the geospace environment. The aim is to deliver a wide variety of products ranging from a better scientific understanding of the polar atmosphere to a data portal that will enable scientists to create a systems-view of the polar region.

2.1.5.1 Progress

Links between solar activity and surface temperature: ICESTAR scientists conducted a statistical study that revealed new information about the linkage between solar activity and surface temperatures in polar regions. During periods of enhanced geomagnetic activity the surface temperatures in certain high-latitude regions are on average 4-5°C higher or lower than during quiet conditions. It is thought that solar activity and consequent precipitation of energetic charged particles to upper and middle atmosphere can affect the ozone balance there, and in this way geospace variations can have an effect also on surface temperatures. Modelling efforts to test this concept are underway. For more information see J. Geophys. Res., doi:10.1029/2008JA014029, 2009.

Aurora Borealis/Australis Studies: It is commonly assumed that the aurora borealis (Northern Hemisphere) and aurora australis (Southern Hemisphere) are mirror images of each other, because the charged particles causing the aurora follow the magnetic field lines connecting the two hemispheres. The particles were believed to be evenly distributed between the two hemispheres, from the source region in the equatorial plane of the magnetosphere. Although it has been shown that similar auroral features in the opposite hemispheres can be displaced tens of degree in longitude and that seasonal effects can cause differences in global intensity, the overall auroral patterns were still similar. ICESTAR researchers K.M. Laundal and N. Østgaard, both at the University of Bergen, report in Nature observations that clearly contradict the common assumption about symmetric aurora: intense spots are seen at dawn in the

Northern Hemisphere summer, and at dusk in the Southern Hemisphere winter. The asymmetry is interpreted in terms of inter-hemispheric currents related to seasons, which have been predicted but not seen hitherto.

Interhemispheric Similarities and Asymmetries in Geospace Phenomena: The ICESTAR team convened a scientific session at the 2009 Fall American Geophysical meeting in San Francisco. Papers on high-latitude electromagnetic fields, currents, and auroras in the conjugate hemispheres revealed latitudinal, longitudinal and hemispheric asymmetries. Such global-scale coupling effects can be predicted by global models, yet many fundamental questions remain. For example, can asymmetries in auroral intensity and morphology be accounted for by tilt angle and the influence of the sun's magnetic field on the magnetosphere? Or is the energy input from the solar wind to the magnetosphere different in the two hemispheres? What is the role of seasonal conductivity differences and inter-hemispherical currents? ICESTAR will play an important role in answering these questions by organizing and helping to develop data portals, such as GAIA (see below).

GAIA Data Portal: The ICESTAR team continue to develop and refine the Global Auroral Imaging Access (GAIA) data portal; see http://gaia-vxo.org. GAIA is a virtual observatory for dealing with data from geospace optical and riometer systems. While these two instruments differ in observational technique, they both remotely sense auroral precipitation. GAIA is a network-based set of tools for browsing summary data from All-Sky Imagers (ASIs), Meridian Scanning Photometers (MSPs), and riometers worldwide. It provides indexes for direct access to data. Over 10,000,000 summary images are registered in the GAIA database. They and the associated metadata provide a link to hundreds of "imager years" of data from observational programmes in at least seven countries. This programme is the virtual observatory component of the IPY Auroral Optical Network (AON) and GLORIA projects, and falls under the ICESTAR IPY umbrella. Prof. Eric Donovan (Calgary), the lead on GAIA, recently joined the ICESTAR team as a Thematic Action Group (TAG) leader.

Heliosphere Impact on Geospace (IPY Project 63): ICESTAR scientist Dr. Kirsti Kauristie of the Finnish Meteorological Institute led this IPY Project, which included 29 international research groups and was jointly managed by ICESTAR and by the International Heliophysical Year (IHY) group. First results will be presented at the IPY Open Science Conference (Oslo, June 8-12 2010).

2.1.5.2 Plans for 2010

- Continued development of the GAIA data portal;
- Continued maintenance of the Arctic and Antarctic measurement networks for monitoring bipolar solar-terrestrial and aeronomy processes also during the forthcoming solar maximum years;
- Quantifying the role of seasonal differences in polar ionospheric conductance and the effects on magnetospheric, ionospheric, and thermospheric dynamics;
- Constraining models based on conjugate remote sensing of inner magnetospheric dynamics;
- Characterizing the basic state of the polar middle atmosphere;
- Organizing a session at the SCAR XXXI Open Science Conference, and at the IPY Open Science Conference in Oslo;

- Transitioning ICESTAR from a Scientific Research Programme to an Expert Group in August 2010.

2.2 Specific SCAR Research Areas

2.2.1 Life Sciences Group

The Standing Scientific Group for the Life Sciences (SSG-LS) is responsible for a number of activity areas aside from EBA and SALE (above).

(i) Expert Group on Birds and Marine Mammals (EG-B&MM)

The new group, formed by combining the former expert groups on birds and on seals, met in July 2009 at the 10th SCAR Biology Symposium (see below) and identified some long-term research objectives. The most relevant of these is the compilation of all existing bird and mammal tracking data. These data will form the basis of multi-species 'hot-spot' analysis as well as a gap analysis to indicate species and regions where tracking efforts should be focused in future. A long-term objective will be to build on this retrospective analysis to launch a new Southern Ocean predator community study.

(ii) Expert Group on Continuous Plankton Recorder Research (EG-CPR)

The Southern Ocean CPR Survey (SO-CPR) had a relatively quiet sampling season in 2008/09, following the extremely busy 2007/08 season for CAML and IPY. Forty-four tows were completed from 4 vessels compared with double that number the previous season. Nonetheless, the 2008/09 season and the year following was marked with a number of important milestones. Successful tows were conducted between New Zealand and the Ross Sea from a commercial toothfish vessel. This will continue each Antarctic summer, greatly improving the monitoring of plankton in the western Pacific region. The South American CAML consortium LA-CAML officially joined the SO-CPR Survey with tows across Drake Passage from Brazilian and Chilean vessels. This is an important region in relation to the krill fishery and also the proximity of the rapidly warming western Antarctic Peninsula. Tows will be conducted annually there. In preparation for the New Zealand and LA-CAML tows, CAML sponsored a training workshop at the AAD for Ms Karen Robinson (NZ plankton analyst) and Dr Manuela Bassoi (Brazil) who will coordinate the CPR work in South America. Dr Bassoi will also represent South America on the Expert Group. This workshop was followed by a more extensive CPR workshop in Rio de Janeiro in November 2009, to train 14 people from Brazil, Argentina, Chile, Peru, Ecuador and Venezuela. Other notable milestones include the completion of the first zooplankton atlas using the CPR data, and the submission of all data to SCAR-MarBIN collected during 2007/08 circum-Antarctic CPR. The atlas was presented at the SCAR Biology Symposium in Sapporo and will be published in the symposium's Polar Science special issue later in 2010. Preliminary results of the analysis of the 2007/08 data shows that while there is distinct north-south zonation of zooplankton assemblages across the Antarctic Circumpolar Current (ACC), the zooplankton species composition remained relatively consistent within the ACC around Antarctica suggesting there is just one community.

(iii) Cross-SSG Action Group on Prediction of Changes in the Physical and Biological Environments of the Antarctic

See the report under SSG-PS at 2.2.3(x), below.

(iv) ICED (Integrating Climate and Ecosystem Dynamics in the Southern Ocean)

ICED is co-sponsored by SCAR, and recently published its Science Plan (http://www.iced.ac.uk/). A key activity for 2009 was the Southern Ocean Sentinel Workshop (Hobart, 20-23 April 2009), to consider how to measure, assess and provide early-warning detection of climate change impacts on the Southern Ocean and how these could be used to signal future impacts on marine and other ecosystems elsewhere in the world. The Sentinel programme is developing as part of ICED and our members are involved in the development of the science plan, public outreach documents and a forthcoming special issue publication of the workshop. For further details please see the Sentinel website at ***http://www.aad.gov.au/default.asp?casid=35088***. The pdf report of the workshop can be downloaded from the site.

On 8-11 June 2009, at Princeton University, ICED held a workshop on New Frontiers in Southern Ocean Biogeochemistry and Ecosystem Research, in June 2009. The objective of this scoping workshop was to facilitate interaction between the physical, biogeochemical, and ecosystem research communities to develop research strategies to resolve current limitations, gaps and discrepancies in our understanding and prediction of the Southern Ocean ecosystems, biogeochemical cycles and carbon uptake. For more information, see the meeting website at http://www.whoi.edu/sbl/liteSite.do?litesiteid=32992.

A further ICED session will be held as part of the IPY Polar Conference in Oslo in June 2010.

(v) Southern Ocean Global Ocean Ecosystems Dynamics (SO-GLOBEC).

SCAR co-sponsors the Southern Ocean GLOBEC project of the IGBP. Results were reported at the third GLOBEC Open Science Meeting (22-26 June 2009, Victoria, BC, Canada), which summarized the integration and synthesis activities of the international GLOBEC programme by providing a new mechanistic understanding of the functioning of the marine ecosystem, in order to develop predictive capabilities and propose a framework for the management of marine ecosystems in the era of global change. Workshop papers from the meeting can be downloaded from http://web.pml.ac.uk/globec/products/OSM3/wa.htm, and include two specifically on the Southern Ocean.

(vi) Expert Group on Human Biology and Medicine (EG-HB&M)

The group met in Dundee in association with a conference on Antarctic medicine organised by the BAS medical unit. The EG was able to meet with colleagues from the Arctic and from other branches of Antarctic and remote healthcare. Fruitful discussions were held over the day prior to the conference, sharing current research and future ideas. The group then participated in the two-day conference where short presentations on numerous aspects of operational and academic medicine were discussed. It was agreed that a conference on research and applications for telemedicine in the Antarctic would be held next year. Professor Pillon offered to host this at CIRM, the telemedicine centre in Rome.

(vii) Action Group on Antarctic Fuel Spills (AGAFS)

In the wake of the sinking of the MV Explorer on 23 November 2007, SCAR created an Action Group on Antarctic Fuel Spills (AGAFS). AGAFS will address issues that might arise related to the fate and effects of fuel releases in Antarctica. The group will respond when specific advice is requested; none was requested in 2009.

(viii) SCAR Biology Symposium

The Xth SCAR Biology Symposium was organized by Mitsuo Fukuchi and his collaborators, and held at Hokkaido University, Sapporo, Japan on July 26-21, 2009. The symposium focussed on the early outcomes of the IPY and was opened by the Chair of the Census of Antarctic Marine Life, Michael Stoddart. The six subthemes were strongly related to the themes of EBA and its Work Packages. There were over 110 oral presentations and 130 posters, with 40% of the papers by early career scientists. Many of the presentations will be published in a special issue of Polar Science. New to the symposium was a special outreach event and awards for the best ten presentations by young researchers.

2.2.2 Geosciences Group

The Standing Scientific Group for the Geosciences (SSG-GS) contains several Expert and Action Groups aside from the Scientific Research Programmes ACE and SALE.

(i) The Expert Group on Geodetic Infrastructure of Antarctica (GIANT):

GIANT provides a common geodetic reference system for all Antarctic scientists and operators. This reference system underpins all spatial data and allows the integration of other scientific data sets in a uniform coordinate system. It also contributes to global geodesy for studying the physical processes of the Earth and the maintenance of the precise terrestrial reference frame, and provides information for monitoring the horizontal and vertical motion of Antarctica. GIANT also offers a forum for the exchange of data and research on topics of importance to Antarctic Geodesy. The SCAR GIANT team was a leader in the bipolar IPY POLENET (Polar Earth Observing Network) project, to which GIANT contributed the Antarctic GPS component.

(ii) Solid Earth Response and influences on Cryospheric Evolution (SERCE) Scientific Programme Planning Group:

This team is developing a scientific research programme that will capitalize on GIANT, on the former Antarctic Neotectonics (ANTEC) programme terminated in July 2008, and on developments made by the IPY POLENET programme in 2007-2009. SERCE aims to improve understanding of the solid Earth response to cryospheric and tectonic forcing by:

- Integrating and synthesizing geodetic observations obtained from the multinational POLENET geophysical network during IPY to obtain a vertical and horizontal velocity field across the continent.
- Integrating and synthesizing seismological data obtained from the POLENET geophysical network during IPY to map Antarctic lithospheric and upper mantle structure and rheological properties.
- Synthesizing available observations and carrying out glaciological modeling to improve understanding of Antarctic Ice Sheet (AIS) evolution since the Last Glacial Maximum (LGM).

- Developing improved models of glacial isostatic adjustment (GIA) constrained by vertical crustal motion observations (objective 1), improved earth structure (objective 2), and improved ice sheet history (objective 3).
- Improving the estimates of present-day ice mass balance obtained from satellite observations. [Provision of improved constraints on the rates of gravitational change and crustal uplift due to GIA will remove one of the largest uncertainties in analysis of satellite data for present-day change].
- Documenting ice sheet boundary conditions and subglacial processes from seismological and glacial surface motion observations.
- Determining seismicity levels in Antarctica and linking them to cryospheric and tectonic processes.
- Improving understanding of neotectonic processes through analysis of improved earthquake catalogues and horizontal crustal motion observations.
- Improving understanding of ionospheric and tropospheric processes through analysis of new POLENET space-geodetic observations.

(iii) Expert Group on the International Bathymetric Chart of the Southern Ocean (IBCSO)

IBCSO organized a one-day meeting in November 2009 at Alfred Wegener Institute for Polar and Marine Research (Bremerhaven, Germany), attended by 16 scientists from Spain, UK, USA, Russia and Germany. Discussions focused (1) on the status of the bathymetric database provided by numerous institutions, data centres and individuals, (2) on the need to enlarge the network for a continuous data exchange, and (3) on international collaboration addressed to research particularly at regions of high interest e.g. the Amundsen Sea and its related West-Antarctic Ice Sheet. To facilitate these processes, next steps will be (1) the provision of gridded products in conjunction with a draft version of the Technical Report for scientific communities, and the public from the IBCSO web site, and (2) the organization of special sessions and workshops at international meetings for dissemination and information, such as the XXXI SCAR in Buenos Aires. For more details see www.ibcso.org.

(iv) The Antarctic Digital Magnetic Anomaly Project (ADMAP)

ADMAP aims to map Antarctica's magnetic anomaly field to aid in understanding geological processes. It is managed jointly with IAGA (International Association of Geomagnetism and Aeronomy). ADMAP contributes data to the World Magnetic Anomaly Map (for details see: http://www.geology.ohio-state.edu/geophys/admap). During 2008, the release of a CD to the World Data Centres with the latest completed ADMAP compilation was approved, pending the inclusion of minor updates. This compilation is ADMAP-1999 to indicate the latest year of survey data that the compilation holds. Plans have been made to commemorate the CD release with a special issue of ADMAP papers in a peer-reviewed journal. Papers on Antarctic geomagnetism are being solicited as part of ADMAP's activities at the 2010 SCAR meeting. Work on the next compilation is underway. More than 2 million line kilometres of new aeromagnetic and ship survey data since 2000 are becoming available for inclusion in the database. In addition, a number of new surveys will be completed as part of the IPY. Furthermore, CHAMP satellite magnetic observations are now being collected at altitudes of about 300-325 km that provide important new constraints on Antarctic crustal anomalies. In view of these data developments, a new-generation ADMAP compilation will be made available soon. The new

compilation, tentatively entitled ADMAP-2011, will be a significant ADMAP contribution to the legacy of the IPY. ADMAP is cooperating with Antarctic Geoid Project http://tpg.geo.tudresden.de/antgp/antgp.htm), which aims to support gravity measurements in Antarctica to close the gaps in terrestrial gravity data coverage.

(v) Expert Group on Antarctic Permafrost and Periglacial Environments (EGAPPE):

The group aims to:

- develop a common web-accessible repository for permafrost and soils data;
- complete thematic maps on Antarctic permafrost and soils (Transantarctic Mountains, the Antarctic Peninsula, and other regions);
- establish a system of boreholes for providing data on permafrost and soil properties (GTN-P), records of past environmental change and recording permafrost responses to climate change;
- develop a system for monitoring active-layer dynamics and periglacial processes in response to climate change along selected environmental gradients;
- improve mobility and access to Antarctica by permafrost researchers through coordinated research.

To attain these goals, EGAPPE prepared and was awarded an IPY project, Antarctic Permafrost and Soils (ANTPAS), for coordinating national and individual research. The aim was to create a database for permafrost within the framework of the Thermal State of Permafrost (TSP) and the Global Terrestrial Network-Permafrost (GTN-P), and for active-layer monitoring within the framework of the Circumpolar Active Layer Monitoring-South (CALM-S) and a Geographic Information System (GIS) for storing and analyzing these data. Several members of the working group helped prepare the ACCE review. The EG wishes to establish a network of permafrost and active layer monitoring sites as a contribution to the Standing Committee for Data Information and Communication (SCDIC) of the International Permafrost Association (IPA), and to prepare a permafrost map of Antarctica for which some provisional results were presented at the Ninth International Conference on Permafrost (NICOP) in July 2008, Fairbanks, Alaska. Map upgrades will be presented in 2010 at:

- A Cryosol session at the World Soils Congress of the International Soil Science Society, Brisbane, Australia;
- A session on Permafrost and Periglacial Antarctic Environments at the Open Science SCAR meeting of Buenos Aires; and
- The IPY meeting in Oslo in June.

(vi) The Sub-Ice Geological Exploration (SIeGE) Action Group:

This group aims to further understand Antarctica's geological, ice sheet and climatic history from sub-ice sheet and sub-ice shelf data through on-going and future multidisciplinary, multinational geophysical surveys and geological sampling. Its goals are to: (i) evaluate and synthesize potential geological targets for subglacial sampling based on current information, (ii) determine areas of high scientific interest to define targets for future surveying for geological sampling, (iii) provide a forum to exchange ideas on potential geological targets and communicate plans of national and multinational initiatives for campaigns to achieve the surveying and sampling, and (iv) provide a forum for reviewing existing ice drilling and geological sampling

technology and to establish plans for developing new technologies required to achieve the surveying and sampling.

Various activities have been undertaken by the international community to further the objectives of SIeGE:

Workshop on Fast Access Drilling and Ice Sheet Bed Sampling: As reported last year, in 2008. US scientists held a workshop as a follow-on to the one held in 2002, termed FASTDRILL. Unfortunately, as of present the coiled tubing concept that was a prime focus of the meeting is moot, because the technology to use light-weight synthetic materials for the tubing has been stalled as petroleum companies have ceased their interest in supporting research and development in this area. That leaves only steel coiled tubing available, which is too heavy for the ice-drilling concept envisaged. Other outcomes from the meeting are being advanced such as "clean access" technology to enter subglacial environments following SCAR's guidelines.

WAISDivide Basal Science and Implementation Plan: The US ice-coring programme WAISDivide had aimed to recover basal debris-rich ice and subglacial material including water, sediment and bedrock. Results of that work have also been set back as it was deemed impractical to sample subglacial environments after using the ice drilling system (DISC drill) to recover the ice core.

Surveying for Subglacial Access Sites: Several initiatives have been or are currently being undertaken. Antarctica's Gamburtsev Province Project (AGAP) is a multi-national venture to explore one of the largest mountain ranges on Earth, the Gamburtsev Subglacial Mountains, through geophysical surveying to help determine what they are made of, how they formed, and what effect they have had on development and history of the ice sheet. In addition, as reported under ACE, above, surveying for other initiatives for subglacial studies involving geological recovery are being planned or have been conducted for the Subglacial Lake Ellsworth project in west Antarctica and the Whillans Ice Stream Subglacial Research Drilling project. Linked to these activities a subgroup of the ACE programme, ANTscape is developing a set of Antarctic palaeotopographic maps for key periods over the last ~70 million years, and is working collaboratively with the *Circum-Antarctic Stratigraphy and Bathymetry Project* (which includes *RossMap*) of the Seismic Data Library System. Maps of this sort are increasingly important for realistic palaeo-ice sheet and palaeoenvironmental modelling studies. These also further the goals of SIeGE in terms of its interests in geological and ice sheet history.

Planned Subglacial Drilling Efforts to Include Geological Sampling: Various ice coring and drilling initiatives are being planned in the very near future to recover geological materials, with links to ACE and SALE. These include *SLE* (Subglacial Lake Ellsworth lake sediment core), *WISSARD* (Subglacial Lake Whillans lake sediment core, Whillans Ice Stream till core, Ross Ice Shelf/WAIS grounding zone and glacimarine sediment core), *PIG* - Pine Island Glacier project (sub-ice-shelf sediment core), and *Dome A* (bedrock sample of the Gamburtsev Mountains). Efforts also include programmes designed to recover subglacial and sub-ice-shelf glacimarine sediment from below the Ross Ice Shelf by the international *ANDRILL* programme, also associated with ACE. As part of these efforts, both SLE and WISSARD need to develop "clean access" technologies to meet the guidelines established by SCAR for subglacial access. These are important developments on which to base future planning for subglacial geological sampling initiatives.

(vii) Seeps and Vents ANTarctica (SAVANT) Action Group

SAVANT prepared and presented a paper to the CCAMLR Workshop on Vulnerable Marine Ecosystems in La Jolla California in August 2009, entitled "Detection of Cold Seeps and Hydrothermal Vents" (CCAMLR paper WS-VME-09/9). The workshop accepted the paper, and the four-level classification of seep and vent indicators from Class 4 areas, which are geomorphic features associated with seeps and vents, to Class 1 areas where Vulnerable Marine Ecosystems living on a seep or vent, have been confirmed. The workshop also identified the need for a guide to vent and seep organisms so that fisheries observers are able to recognize them when they are part of by-catch. Two pilot studies examined echo-sounder and seismic data from the East Antarctic margin to determine if indicators of seepage were present. The echo-sounder data did not produce any possible indicators; however, some seismic lines did have signs of shallow gas and fluid escape.

2.2.3 Physical Sciences Group

The Standing Scientific Group for the Physical Sciences (SSG-PS) reported a number of highlights aside from those associated with AGCS and ICESTAR (above).

(i) International Partnership in Ice Coring Science (IPICS):

The main formal activity of IPICS in 2009 was a major workshop held in Oregon in July on "Science and Technology for the Next Generation of International Ice Coring". For the IPICS 2k and 40k networks, the workshop agreed on the production of initial synthesis products, and the definition of which sites should and will be drilled in the future. IPICS agreed to expand its last interglacial project to include Antarctica. For the oldest ice project, the attendance of external experts allowed progress towards defining a suitable site. IPICS agreed to organize a major ice core open science conference in 2012 – the venue is yet to be finalized.

(ii) Astronomy and Astrophysics from Antarctica (AAA) Scientific Research Programme Planning Group (SRPPG):

During 2009, the Planning Group held two meetings coinciding with major international astronomical meetings - the Third ARENA Conference in Frascati, Italy, in May, and the International Astronomical Union General Assembly in Rio de Janeiro, Brazil, in August. The group is in the process of establishing four working groups to cover: site testing, validation and data archiving; Arctic site testing; science goals; and major new facilities.

During 2009, China continued the construction of the permanent "Kunlun" station at Dome A. Site testing continued at Dome C and Dome A throughout the year, and astronomical science was conducted at both these stations and at the South Pole.

(iii) Operational Meteorology:

The Expert Group on Operational Meteorology in the Antarctic provides a point of contact between many groups undertaking meteorological work there. Through liaison with the World Meteorological Organisation (WMO) it has ensured that the amount of real-time data available from Antarctic sites has increased, with only two of the GCOS Surface Network (GSN) stations now not sending out a CLIMAT message on the WMO Global Telecommunications System (GTS). It continues to extend the Met-READER database. The Group's web pages provide news and information about Antarctic meteorological activities. The International Antarctic

Weather Forecasting Handbook has been converted into web pages and this can be accessed via a link from the Group's web pages. There is evidence that many ships operating in Antarctic waters do not make meteorological reports. SCAR and the International Maritime Organisation (IMO) should co-operate to improve the situation to the benefit of mariners, tourists and science.

(iv) Environmental Contamination in Antarctica (ECA) Action Group:

The 3rd ECA workshop was not held as planned, due to organizational problems; however the group decided to continue its action as programmed, following the priorities identified during the 2nd workshop:

- the integration of the ECA data base in the Antarctic Master Directory by construction of one dedicated portal is in progress;
- the subgroups defined during the 1st workshop are preparing reviews of significant publications on the subjectss identified during the first two years, in order to provide a report at the XXXI SCAR meeting. One review, focussing on the distribution of Persistent Organic Pollutants in Antarctica, was published by SCAR, others are presently in preparation.
- One priority identified during the 1st workshop held in Venice was to extend studies to the biological aspects of environmental contamination

Some preliminary results are emerging from data collected up to now. Although a lot of data have been collected in recent years, a coordinated approach is still lacking. Some emerging contaminants have already been taken into consideration in a few studies carried out in Antarctica. Studies have largely been restricted to the Antarctic Peninsula and the Ross Sea; circum-polar collaboration should be encouraged. In future the group recommends:

1. extending such studies to emerging contaminants in relation to the potential for change in diffusion and transport with climate change.
2. establishment of an internationally coordinated Antarctic Monitoring and Assessment Programme (AnMAP) (the equivalent of the Arctic Council's AMAP project).
3. making an inventory of all Antarctic Environmental Specimen Banks (AESBs), and setting up a suitable information system, including the availability of sample aliquots.
4. encouraging faster process from sampling to analysis and data processing, to ensure published data is rapid and up-to-date.

(v) Polar Atmospheric Chemistry at the Tropopause (PACT):

A workshop was held in August 17-22, 2009, Kyiv, Ukraine, in the framework of the 36th Annual European Meeting on Atmospheric Studies by Optical Methods, enabling PACT participants to agree on the PACT tasks and workplan. A session on "Processes at the Polar Tropopause and their Association with Climate Variations" has been proposed for the IPY Oslo Science Conference. The PACT Project website http://data.aad.gov.au/aadc/pact/ was created. A PACT database consists of the tropopause and ozone distribution information derived from existing high latitude ozone-sonde measurements.

(vi) The joint SCAR/SCOR Oceanography Expert Group:

The group met in Venice, Italy, on September 26th 2009, following the OceanObs09 meeting. The main aims of the Venice meeting were:

1. to identify the main gaps in the Southern Ocean Observing System (SOOS) Design Plan, and to identify people to fill these gaps within a specified timeline, and
2. to discuss implementation of the plan.

Since the meeting, following substantial additional input (particularly from the biology community, coordinated by John Gunn and Vicki Wadley), the SOOS plan is being redrafted ready to go out to the community for consultation. A proposal is being constructed for a SCAR Member nation to host a SOOS Secretariat to implement the plan. The Ocean Expert Group co-chair, Mike Meredith, agreed to act as the SCAR representative on the OceanObs09 Working Group on Ocean Observations.

(vii) CLIVAR/CliC/SCAR Southern Ocean Implementation Panel (SOIP) and the WCRP/SCAR International Programme for Antarctic Buoys (IPAB):

The 5th meeting of the CLIVAR/CLiC/SCAR SO Implementation Panel (SOIP) took place in Sydney on the 16-18 of February 2009 (see http://www.clivar.org/organization/southern/ SOP5_meet.php for agenda). The meeting aimed to evaluate progress with the design plan for SOOS (see vi, above), identify priority research questions in the region, and identify key gaps in Southern Ocean climate modelling and in atmosphere and ocean reanalysis and fluxes in the Southern Ocean/ice system. One of the SOIP's main achievements was the production of a vision document "A Vision for Climate Variability Research in the Southern Ocean-Ice-Atmosphere System", the results of which are feeding into the design of a Southern Ocean Observing System (the 'vision' is on the SOIP web site).

The panel for the International Programme for Antarctic Buoys (IPAB) last met in 2008 and plans to meet again in 2010. The main current plan is to use experience gained from work in the Arctic to implement an array of drifting buoys on the Antarctic sea-ice.

(viii) The SCAR Expert Group on Ice Sheet Mass Balance and Sea Level (ISMASS):

ISMASS aims to revitalize the approach towards assessing methods and uncertainties in estimating Antarctic Ice Sheet mass balance. The group ran a successful Summer School, in Portland, Oregon, in August 2009, with funding assistance from ICSU and NSF, to explore how to improve ice-sheet models used to predict sea level change, and to train young researchers (SCAR Report 36). The report of the ISMASS workshop from XXX SCAR in St Petersburg 2008 was written up and presented as a paper at the International Glaciological Conference on 27-31 July 2009, at Newcastle UK. This report is now being prepared as a SCAR Report.

(ix) GPS For Weather and Space Weather Forecast (joint with SSG-GS):

The Action Group organized a two days meeting in September 2009 at INGV (Rome, Italy), attended by scientists from UK, Poland, South Africa, Brazil, Finland, Canada, Slovenia, and Italy. Discussions focused on the need to establish a permanent network of GNSS receivers for a multi-purposes investigation over Arctic and

Antarctica (e.g. 3D water vapour reconstruction and ionospheric imaging), and on international collaboration addressed to bi-polar investigations particularly at conjugate regions. To facilitate these processes, next steps will be: (a) establishment of a common portal where data and products will be available for scientific communities, and (b) organization of special sessions at international meetings for dissemination and awareness activities.

(x) Prediction of Changes in the Physical and Biological Environment of the Antarctic (PCPBEA) (Cross SSGs Group):

This new group aims to:

- Assess our current ability to predict how the physical and biological environments of the Antarctic will evolve over the next century;
- Identify the extent to which the physical and biological approaches to prediction can be integrated;
- Determine the parameters needed from climate models to predict changes in the biosphere;
- Consider the issues involved in downscaling from the resolution of climate models to those required for prediction of biological systems;
- Investigate the means of improving prediction of selected physical parameters and their impacts on aspects of marine and terrestrial biota;
- Identify areas where future research is needed.

The group held its second meeting at the Alfred Wegener Institute from 30 September to 2 October 2009. Much of the meeting was given up to preparing a 10-point summary of the Antarctic Climate Change and the Environment (ACCE) review document. The group is proposing to make a significant contribution to the forthcoming 5th Assessment Report of the Intergovernmental Panel on Climate Change (IPCC). It intends to encourage: integration between biological and physical data gatherers and modellers; the development of long-term biological records that can be matched with long-term meteorological and oceanographic databases; and development of biological models that can be combined with physical models of the Antarctic environment. It aims to produce a comprehensive paper comparing climate variability with biological variability, and recognises the need to examine biological tolerance to change, and the effects of extreme events.

(xi) King George Island Cross SSG Action Group:

Following the XXX SCAR meeting (2008) the King George Island science group was reorganised under the leadership of S Marenssi (SCAR V-P for Science). It was decided that efforts should be focused on encouraging national operators and station managers working on KGI to work in such a way that their activities contributed as much as possible to the research activities of SCAR, such that KGI activities formed a useful subset of wider-ranging SCAR programmes. To draw this plan to the attention of national operators a paper was prepared for presentation to the COMNAP meeting in Punta Arenas in August 2009. The paper, entitled "King George Island and SCAR Science", was presented by S Marenssi to the COMNAP meeting on August 6, 2009. It can be downloaded from the SSG-PS web page at http://www.scar.org/researchgroups/physicalscience/, under the subheading King George Island Coordination Group. Additional support to this initiative was provided

by the SCAR President's visit to King George Island courtesy of the Uruguayan polar programme in February 2009.

3. Data and Information Management

3.1 Antarctic Data Management:

In 2009 EXCOM approved the SCAR Data and Information Management Strategy (DIMS). This Strategy sets the direction for SCAR data management activities over the next 5 years and emphasises the need to leverage established regional, global and thematic data-centric networks to improve data management capability within SCAR science programmes. As part of Strategy implementation, the Chief Officer of the SCAR Standing Committee on Antarctic Data Management (SCADM) became a member of the Polar Information Commons (PIC) Steering Committee (see http://www.polarcommons.org/). The PIC initiative, sponsored by ICSU, builds on the legacy of scientific activities associated with the IPY and seeks to develop a bipolar data access network. The launch of PIC will coincide with the IPY Conference to be held in Oslo, in 2010. Given that SCAR already has an identified data management community, governance structure and data systems, it is in a strong position to influence and contribute to PIC outcomes. The success of PIC and the value that can be derived from the SCAR DIMS will, however, be dependent upon the active participation of SCAR members. SCAR is also actively engaged at the committee level in the reform of the ICSU World Data Centre System through its membership of the ICSU Strategic Coordinating Committee on Data and Information (SCCID), established in 2009. For the first time, in 2009, SCADM and the SCAR Standing Committee on Geographic Information (SCAGI) met together for their annual meetings in Amsterdam (Netherlands) (http://www.scar.org/publications/reports/Report_37.pdf). This was an opportunity to discuss DIMS implementation and closer collaboration between SCADM and SCAGI. As a consequence of discussions, both groups agreed to use the establishment of a new Belgian Antarctic Biodiversity Portal (ANTABIF) as the basis for leveraging and showcasing many of SCAR's existing data products and services. SCADM also developed the data management component of the international Southern Ocean Observing System (SOOS) Plan and participated in the IPY data outreach conference, held in Ottawa (29 September to 1 October 2009).

3.2 Antarctic Geographic Information:

The third intersessional meeting of SCAGI was held at the Trippenhuis in Amsterdam from 7 to 9 of September 2009, in parallel with the Standing Committee on Antarctic Data Management (SCADM), with many of the sessions being held jointly. The main issues discussed were the hosting of the SCAGI web site and the King George Island GIS and the urgent need to move them somewhere other than the University of Freiburg, and the need to work with COMNAP on GISs and topographic surveys. Updates were given on the main SCAGI projects such as the SCAR Composite Gazetteer of Antarctica, the Map Catalogue and the Antarctic Digital Database as well as a host of national initiatives such as the Coastal Change project, Names projects and Aerial photography projects. For further details see http://www.scar.org/publications/reports/Report_37.pdf.

4. International Polar Year (IPY)

Although the IPY 2007-2008 formally ended on March 1 2009, several IPY activities have continued. C.G. Rapley (the immediate past SCAR President) and C. Summerhayes (SCAR Executive Director) continued as members of the Joint ICSU/WMO Committee for the IPY (the IPY-JC), which remains in being until summer 2010. They and other SCAR scientists are contributing to writing 'Understanding Earth's Polar Challenges: International Polar Year 2007-2008', which reviews the origins of the IPY and summarises progress to date and will be published in mid 2010. A major IPY science conference (the 2nd in a series of three) is scheduled to take place in Oslo from June 8-12, 2010, and SCAR and IASC have been much involved in planning for it. The SCAR and IASC Bipolar Action Group (BipAG) met on October 15-16 in Oslo to develop advice for the SCAR and IASC governing bodies on the roles SCAR and IASC might play in managing the IPY legacy. As mentioned above, as elements of the legacy SCAR continues to develop the Southern Ocean Observing System (SOOS), and has published a data and information management strategy. In addition, SCAR and IASC co-sponsor the Association of Polar Early Career Scientists (APECS), which is a product of the IPY, to facilitate the development of young polar researchers (see 6.3 below).

5. Scientific Advice to ATCM, CEP, CCAMLR and ACAP

Through its status as Observer, SCAR continues to be the primary source of independent scientific advice to the Antarctic Treaty Consultative Meeting (ATCM) and the Committee on Environmental Protection (CEP). SCAR's advice is provided through the Standing Committee on the Antarctic Treaty System (SC-ATS). SCAR participated in the XXXII ATCM and the XII meeting of the CEP in Baltimore in April 2009. Prof. Karin Lochte gave the SCAR Lecture, on "Marine Life and Change in the Southern Ocean" (available from http://www.scar.org/communications/). SCAR presented 1 Working Paper and 9 Information Papers (available at http://www.scar.org/treaty/atcmxxxii). The SCAR presentation on the IPY led to a Resolution on ensuring the legacy of the IPY, which recommended that Parties:

- Continue to focus attention on Antarctic research at the highest levels of national and international science organisations;
- Work with SCAR and COMNAP to implement Resolution 3 (2007) and maintain, extend and develop long-term scientific monitoring and scientific observations in Antarctica and the surrounding Southern Ocean;
- Develop integrated climate–ecosystem prediction capabilities for Antarctica and regional prediction capabilities for specific areas of the Antarctic;
- Identify stable long-term locations for the many networks and programmes established and strengthened during IPY;
- Provide attention and assistance to the recruitment and retention of young polar scientists within national Antarctic research programmes;
- Provide IPY data and outcomes from Antarctica as contributions to integrated climate change and environmental reviews and assessments; and
- Preserve, store and exchange reliable, accessible, long-term IPY data.

Parties were particularly pleased with SCAR's report on climate change, based on the ACCE review (see AGCS, above), appreciated the efforts that SCAR had made to provide a comprehensive review on the state of research on Persistent Organic Pollutants (POPs), and enjoyed the SCAR Lecture.

SCAR is also an Observer to the Commission for the Conservation of Antarctic Marine Living Resources (CCAMLR). Mark Hindell (Australia) - represented SCAR at the 28th annual CCAMLR meeting in Hobart (October 2009). SCAR's marine biology programmes provide strong links to CCAMLR's interests, especially SCAR's Census of Antarctic Marine Life (CAML) programme, the SCAR Continuous Plankton Recorder (CPR) programme, EBA, and SCAR's Marine Biodiversity Information Network (MarBIN). The work of SCAR's Ocean Expert Group is also relevant to CCAMLR, as is that of the Expert Group on Birds and Marine Mammals.

6. Other Developments

6.1 History:

The SCAR History Action Group held a successful 5th workshop, on "History of International Spaces", during the Antarctic Treaty Summit on December 3rd, 2009, in Washington DC with 12 speakers representing six nations. Two papers from the 4th history workshop, at the XXX SCAR meeting in St. Petersburg (2008), were published in Polar Record. The proceedings of the 3rd workshop (Columbus, 2007) will be published as an electronic version by the Byrd Polar Research Institute in 2010, and the Proceedings of the 2nd workshop (Santiago, 2006) were published by the Chilean Antarctic Institute in 2009, see *http://www.inach.cl/InachWebNeo/Controls/Neochannels/Neo_CH6231/deploy/boletin%20historico.pdf*. In 2010 the SCAR History Group is organizing sessions for the IPY Oslo science conference (June) and the SCAR Conference in Buenos Aires (August).

6.2 Capacity Building, Education and Training (CBET):

SCAR's main contributions to Capacity Building, Education and Training are through its Fellowship Programme and through working closely with the Association of Polar Early Career Scientists (APECS), which SCAR co-sponsors with IASC. In 2009/2010 SCAR funded 4 fellowships. Both India and Italy contributed an additional $5000 to the Fellowship programme for 2009/10. SCAR is committed to expanding its fellowship programme through both external as well as internal sources.

SCAR continues to work closely with APECS (6.3 below), acting both in an advisory manner and by co-sponsoring APECS initiatives of relevance to SCAR, such as a Polar Brochure for early career scientists and the support of several workshops. As approved by the Delegates in XXX SCAR, representatives of APECS have been invited to send an observer to XXXI SCAR as well as to nominate local representatives to SCAR science meetings where appropriate.

SCAR is an Associate Member of the International Antarctic Institute (IAI), which is a "virtual" university comprising the Antarctic science courses of a number of universities and institutes around the world, led by the University of Tasmania.

SCAR was awarded 30,000 Euros from ICSU in a joint bid with IASC, IACS and WCRP to fund a summer school on ice sheet modelling, which took place in Portland, Oregon, on 3-14 August 2009; NSF and the other partners also provided funds.

SCAR successfully ran the first year of the Martha T Muse Prize for Science and Policy in Antarctica, a $100,000 unrestricted yearly prize given to an individual who has demonstrated excellence in Antarctic science or policy (see highlights, above).

The CBET web pages (http://www.scar.org/about/capacitybuilding/) now include a large number of Antarctic Education Websites separated into different categories and languages.

The SCAR CBET committee has been revamped with new Terms of Reference. The committee will take on tasks such as the design of a Visiting Professor Scheme.

6.3 The Association of Polar Early Career Scientists (APECS)

APECS is a worldwide association for undergraduate and graduate students, postdoctoral researchers, early faculty members, educators and others with interests in Polar Regions and the wider cryosphere. APECS grew out of the IPY 2007-08, recognizing that the need to stimulate and nurture the next generation of researchers is crucial to achieving polar science goals. An important objective of IPY was to ensure a legacy of continued polar research and literacy by encouraging the development of the next generation of researchers and educators with interests in the Polar Regions and the broader cryosphere. APECS was founded as a response to these needs and as a legacy of IPY Project 168, the International Youth Steering Committee. The association represents people with a wide range of scientific expertise and interests including glaciology, geology, anthropology, sociology, atmospheric science, oceanography, polar biology, culture and heritage studies, linguistics, space studies, biogeochemistry, and paleontology. APECS' mission is to raise the profile of polar scientists by providing a continuum of leadership that is both internationally and interdisciplinary focused, and to stimulate collaborative projects.

These aims shall be achieved by:

- creating a network of polar researchers across disciplines and national boundaries to meet, share ideas and experiences, and develop new research directions and collaborations;
- providing the opportunity for career development for both traditional and alternative polar and cryosphere professions; and
- promoting education and outreach as an integral component of polar research to stimulate future generations of polar researchers.

Membership in APECS is free and open to all early career researchers interested in natural and social sciences of the polar regions, from undergraduates through assistant professors or equivalent for non-academic positions. Participation by engineers and those interested in the cryosphere in general is also being sought. APECS encourages senior researchers to register on the APECS website and serve as mentors for the organization as well as post job openings and events at their institutions.

The APECS website (http://apecs.is/) serves as the main contact point for APECS members and provides forums sharing news, connecting with other polar researchers, finding jobs, and announcing events relevant to polar research.

7. Administrative Developments

SCAR Executive Director Colin Summerhayes retires on April 9 2010, after 6 years service and will be replaced by the Executive Officer Dr. Michael Sparrow, after an exhaustive international search. He in turn will be replaced by Dr Renuka Badhe, a marine biologist and Indian citizen, who was selected from 44 international candidates.

An external group chaired by Dr Phil Smith reviewed SCAR's performance. Dr Smith had chaired the 2000 review of SCAR. The review group met in Cambridge on 2-3 February 2009, reported that it was pleased with SCAR's performance, that no major change in direction was required, and that efforts should continue to maintain momentum.

The SCAR Executive Committee met in Punta Arenas on 5-7 August 2009, following a meeting of the SCAR Chief Officers on 4 August. EXCOM also met with the Executive Committee of COMNAP (6 August 2009). EXCOM explored the issues of how to improve the management of SCAR meetings and how to engage Delegates more in thinking strategically about SCAR's future directions. The Committee agreed on the process required to renew the Strategic Plan, which expires in 2010, and decided on plans for the SCAR meeting and Open Science Conference scheduled for Buenos Aires (July 30-August 11, 2010). A Strategic Planning meeting involving EXCOM and the Chief Officers was planned for Cambridge on 14-15 January 2010. The new Strategic Plan (2011-2017) should be available in final draft form for the SCAR Delegates meeting in August.

SCAR's communications continued to be focused through the SCAR web site, and the SCAR quarterly Newsletter. There were on average 143,000 hits per month on the SCAR web site for 2009, continuing the pattern of year-on-year increases. That excludes the 547646 hits in December 2009 following the November 30 press launch of the ACCE review report.

8. SCAR's Products

For the benefit of the wider community SCAR provides several products underpinning the work SCAR scientists do. These can be useful to other communities too (CCAMLR or COMNAP, for instance). Many of these products do not (yet) have particularly high visibility (even on the SCAR web page). The list includes:

Antarctic Data Directory System (ADDS) (part of SCADM and therefore the responsibility of Taco de Bruin, Netherlands)

REference Antarctic Data for Environmental Research (READER) (part of AGCS under the responsibility of Steve Colwell, UK)

Antarctic Digital Database (ADD) (part of SC-AGI and under the responsibility of Paul Cooper, UK)

Antarctic Biodiversity Database (managed for SSG-LS by the Australian Antarctic Division, under the responsibility of Dave Watts)

Marine Biodiversity Information Network (MarBIN) (under SSG-LS and the responsibility of Bruno Danis, Belgium)

Composite Gazetteer of Antarctica (an element of SC-AGI and now managed by the Australian Antarctic Division by Henk Brolsma)

Seismic Data Library System (SDLS) (managed for SSG-GS at the US Geological Survey under the responsibility of Alan Cooper, USA)

Geodetic Data including: Master index for Antarctic positional control; Geophysical and geodetic observatories; and Geodectic Control Database; (managed for SSG-GS by Reinhard Dietrich, Germany)

Antarctic Map Catalogue (managed by the Australian Antarctic Division, under the responsibility of Henk Brolsma)

Antarctic Bedrock Mapping (BEDMAP) (managed for SSG-GS/SSG-PS by David Vaughan, BAS, UK**)**

Tide gauge data (managed at the Proudman Oceanographic Laboratory, under the responsibility of Phil Woodworth, UK)

International Bathymetric Chart of the Southern Ocean (**IBCSO)** (managed for SSG-GS under the responsibility of Norbert Ott, Germany)

Antarctic Digital Magnetic Anomaly Project (ADMAP) (managed for SSG-GS under the responsibility of Marta Ghidella, Argentina)

The SCAR King George Island Geographical Information System (KGIS) (managed for SC-AGI under the responsibility of Steffen Vogt, Germany)

The Continuous Plankton Recorder database (CPS) (managed for SSG-LS under the responsibility of Graham Hosie, Australia)

The Feature Catalogue (managed by SC-AGI, through Henk Brolsma, Australia)

The Ocean READER database (part of AGCS under the responsibility of Mike Meredith, UK)

The Ice READER database (part of AGCS under the responsibility of Paul Mayewski, USA)

Sea Ice Database (part of AGCS and ASPeCt, and the responsibility of Tony Worby, Australia).

Appendix - List of acronyms

AAA	Astronomy and Astrophysics from Antarctica
AAD	Australian Antarctic Division
ACAP	Advisory Committee on Albatrosses and Petrels
ACC	Antarctic Circumpolar Current
ACCE	Antarctic Climate Change and the Environment
ACE	Antarctic Climate Evolution
ADD	Antarctic Digital Database
ADDS	Antarctic Data Directory System
ADMAP	Antarctic Digital Magnetic Anomaly Project
AESB	Antarctic Environmental Specimen Bank
AG	Action Group
AGAFS	Action Group on Antarctic Fuel Spills
AGAP	Antarctica's Gamburtsev Provinces Project
AGCS	Antarctica and the Global Climate System
AGU	American Geophysical Union
AIS	Antarctic Ice Sheet
AMAP	Arctic Monitoring and Assessment Programme (Arctic Council programme)
AMD	Antarctic Master Directory
ANDEEP	ANtarctic benthic DEEP-sea biodiversity: colonisation history and recent community patterns
ANDRILL	Antarctic Geological Drilling Project
AnMAP	Antarctic Monitoring and Assessment Programme
ANTABIF	Antarctic Biodiversity Information Facility
ANTEC	Antarctic Neotectonics
ANTOBIS	Antarctic node of the Ocean Biogeographic Information System (OBIS)
ANTPAS	Antarctic Permafrost and Soils
ANTscape	Reconstruction of Antarctic Paleotopography
AON	Auroral Optical Network
APECS	Association for Polar Early Career Scientists
APEX	Arctic Palaeoclimate and its Extremes (an IASC programme)
ArcOD	Arctic Ocean Diversity programme
ARENA	Antarctic Research, a European Network for Astrophysics
ASAI	Antarctic-South American Interactions in the Marine Environment
ASI	All-Sky Imager
ASPeCt	Antarctic Sea ice Processes and Climate
ATCM	Antarctic Treaty Consultative Meeting
ATS	Antarctic Treaty System
AWI	Alfred Wegener Institute for Polar and Marine Research
BAMM	Birds and Marine Mammals Expert Group
BAS	British Antarctic Survey
BEDMAP	Antarctic Bedrock Mapping
BELSPO	Belgian Science Policy Office
BipAG	Bipolar Action Group (joint with IASC)
CALM-S	Circumpolar Active Layer Monitoring - South
CAML	Census of Antarctic Marine Life
CAREX	Coordination Action for Research Activities in Life in Extreme Environments

CASA	Climate of the Antarctic and South America programme
CASO	Climate in Antarctica and the Southern Ocean
CASP	Circum-Antarctic Stratigraphy and Palaeobathymetry
CBET	Capacity Building, Education and Training
CCAMLR	Commission for the Conservation of Antarctic Marine Living Resources
CCAS	Commission for the Conservation of Antarctic Seals
CCDB	Canadian Centre for DNA Barcoding
CEAMARC	Collaborative East Antarctic Marine Census
CEP	Committee for Environmental Protection
CGA	Composite Gazetteer of Antarctica
CHAMP	CHAllenging Minisatellite Payload
CIRM	Centro Internazionale RadioMedico, Italy
CliC	Climate and Cryosphere programme
CLIVAR	Climate Variability and Predictability project (a WCRP project)
CNR	Italian National Research Council (il Consiglio Nazionale delle Ricerche)
CO	Chief Officer
CoL	Catalogue of Life
CoML	Census of Marine Life
COMNAP	Council of Managers of National Antarctic Programmes
CPR	Continuous Plankton Recorder
DNA	Deoxyribonucleic acid
DIMES	UK-USA Diapycnal and Isopycnal Mixing Experiment in the Southern Ocean
DIMS	Data and Information Management Strategy
EBA	Evolution and Biodiversity in the Antarctic
ECA	Environmental Contamination in Antarctica (Action Group)
EG	Expert Group
EGAPPE	Expert Group on Antarctic Permafrost and Periglacial Environments
EG-B&MM	Expert Group on Birds and Marine Mammals
EG-CPR	Expert Group on Continuous Plankton Recorder Research
EG-HB&M	Expert Group on Human Biology and Medicine
EGU	European Geophysical Union
EoL	Encyclopedia of Life
Eos	Newspaper of the AGU
EXCOM	SCAR Executive Committee
FASTDRILL	Fast Access Drilling and Ice Sheet Bed Sampling
GAIA	Global Auroral Imaging Access
GBASE	Geomicrobiology of Antarctic Subglacial Environments
GBIF	Global Biodiversity Information Facility
GCOS	Global Climate Observing System
GIA	glacial isostatic adjustment
GIANT	Geodetic Infrastructure of Antarctica (Expert Group)
GIS	Geographic Information System
GLOBEC	Global Ocean Ecosystem Dynamics
GLORIA	GLObal RIometer Array
GNSS	Global Navigation Satellite System
GOOS	Global Ocean Observing System

GPS	Global Positioning System
GS	Geosciences
GTN-P	Global Terrestrial Network for Permafrost
GSN	GCOS Surface Network
GTS	Global Telecommunications System
IACS	International Association of Cryospheric Sciences
IAGA	International Association of Geomagnetism and Aeronomy
IAI	International Antarctic Institute
IASC	International Arctic Science Committee
IAU	International Astronomical Union
IBCSO	International Bathymetric Chart of the Southern Ocean (Expert Group)
ICECAP	Investigating the Cryospheric Evolution of the Central Antarctic Plate project
ICED	Integrating Climate and Ecosystem Dynamics in the Southern Ocean
IceSAT	satellite equipped with laser altimeter
ICESTAR	Inter-hemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research
ICSU	International Council for Science
IGBP	International Geosphere–Biosphere Programme
IHY	International Heliophysical Year
IMO	International Maritime Organisation
INACH	Instituto Antártico Chileno (Chilean Antarctic Institute)
INVEST	IODP New Ventures in Exploring Scientific Targets
IODP	Integrated Ocean Drilling Program
IPA	International Permafrost Association
IPAB	International Programme for Antarctic Buoys (joint WCRP/SCAR)
IPCC	Intergovernmental Panel on Climate Change
IPICS	International Partnerships in Ice Core Sciences
IPY	International Polar Year
IPY-JC	IPY Joint Committee
IPY Oslo	IPY Oslo Science Conference
ISMASS	Ice Sheet Mass Balance and Sea Level (Expert Group)
ITASE	International Trans Antarctic Scientific Expedition
KGI	King George Island
KGIS	King George Island Geographical Information System
LA-CAML	South American Consortium for the Census of Antarctic Marine Life
LGM	Last Glacial Maximum
LIZZARD	Lake and Ice Stream Subglacial Access Research Drilling
LS	Life Sciences
MarBIN	Marine Biodiversity Information Network
MERGE	Microbiological and Ecological Responses to Global Environmental Changes in Polar Regions
MSPs	Meridian Scanning Photometers
NEEM	North Greenland Eemian Ice Drilling
NICOP	Ninth International Conference on Permafrost
NSF	National Science Foundation
OBIS	Ocean Biogeographic Information System
OceanObs09	Ocean Observation Conference, held in Venice, Italy, September 2009

OpMet	Operational Meterology in Antarctica (Expert Group)
OSC	Open Science Conference
PACT	Polar Atmospheric Chemistry at the Tropopause (Action Group)
PAGES	Past Global Environmental Changes
PCPBEA	Prediction of Changes in the Physical and Biological Environment of the Antarctic (Action Group)
PDFs	Portable Document Format
PIG	Pine Island Glacier project
PIC	Polar Information Commons
POGO	Partnership for Observations of the Global Ocean
POLENET	Polar Earth Observing Network
POPs	Persistent Organic Pollutants
PS	Physical Sciences
RAGES	Robotics Access to Grounding-zones for Exploration and Science
RAMS	Register of Antarctic Marine Species
READER	REference Antarctic Data for Environmental Research
REE	Rare earth elements
RNA	Ribonucleic acid
SAE	Subglacial aquatic environment
SALE	Subglacial Antarctic Lake Exploration
SASSI	Synoptic Antarctic Shelf-Slope Interactions Study
SAVANT	Seeps And Vents ANTarctica (Action Group)
SCADM	Standing Committee on Antarctic Data Management
SCAGI	Standing Committee on Antarctic Geographic Information
SCAR	Scientific Committee on Antarctic Research
SC-ATS	Standing Committee on Antarctic Treaty System
SCCID	Strategic Coordinating Committee on Data and Information
SCDIC	Standing Committee for Data Information and Communication
SCOR	Scientific Committee on Oceanic Research
SDLS	Seismic Data Library System
SERCE	Solid Earth Responses and influences on Cryospheric Evolution
SIeGE	Sub-Ice Geological Exploration (Action Group)
SIMBA	Sea Ice Mass Balance in the Antarctic
SIPEX	Sea Ice Physics and Ecosystem Experiment
SLE	Subglacial Lake Ellsworth lake sediment core
SMS Project	Southern McMurdo Sound Project
SO-CPR	Southern Ocean Continuous Plankton Recorder
SO-GLOBEC	Southern Ocean Global Ocean Ecosystems Dynamics
SOIP	Southern Ocean Implementation Panel (joint CLIVAR/CliC/SCAR)
SOOS	Southern Ocean Observing System
SOPHOCLES	Southern Ocean Physical Oceanography and Cryosphere Linkages
SRP	Scientific Research Programme
SRPPG	Scientific Research Programme Planning Group
SSG	Standing Scientific Group
SSG-GS	Standing Scientific Group on GeoSciences
SSG-LS	Standing Scientific Group on Life Sciences
SSG-PS	Standing Scientific Group on Physical Sciences

SYSTCO	SYSTem COupling (part of ANDEEP - ANtarctic benthic DEEP-sea biodiversity: colonization history and recent community patterns)
Tarantella	Terrestrial Ecosystems in Arctic and Antarctic
THEMIS	Time History of Events and Macroscale Interactions in Substorms
TSP	Thermal State of Permafrost
V-P	Vice President
WAIS	West Antarctic Ice Sheet
WAISDivide	West Antarctic Ice Sheet Divide Ice Core Project
WCRP	World Climate Research Programme
WISSARD	Whillans Ice Stream Subglacial Access Research Drilling
WMO	World Meteorological Organisation
WoRMS	World Register of Marine Species