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ATCM XXVIII

XXVIII ANTARCTIC TREATY
CONSULTATIVE MEETING

XXVIII TRAITÉ SUR L'ANTARCTIQUE
RÉUNION CONSULTATIVE

XXVIII TRATADO ANTÁRTICO
REUNION CONSULTIVA

XXVIII ДОГОВОР ОБ АНТАРКТИКЕ
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SCAR REPORT TO XXVIII ATCM
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2005

XXVIII ANTARCTIC TREATY CONSULTATIVE MEETING
Stockholm, Sweden, 6–17 June 2005

SCAR Report to XXVIII ATCM

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REPORT UNDER RECOMMENDATION XIII-2

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1. SCAR and its Role in Relation to the Antarctic Treaty

SCAR, the Scientific Committee on Antarctic Research, is the principal organization dealing with Antarctic scientific research (see <http://www.scar.org>). It is the authoritative voice on Antarctic scientific research from the ionosphere to the mantle, from bacteria to seals, from the ice sheet to the deep sea floor, on the role of Antarctica in the Earth System, and on astronomy from Antarctica.

SCAR is an interdisciplinary committee of the International Council for Science (ICSU). Formed in 1958, SCAR was charged with *“furthering the coordination of scientific activity in Antarctica, with a view to framing a scientific programme of circumpolar scope and significance”*. In this role SCAR inherited the mantle of the Antarctic component of the International Geophysical Year for 1957-58 (IGY).

SCAR’s area of interest includes Antarctica, its offshore islands, and the surrounding Southern Ocean including the Antarctic Circumpolar Current, the northern boundary of which is the Subantarctic Front. Subantarctic islands that lie north of the Subantarctic Front and yet fall into SCAR’s area of interest include: Ile Amsterdam, Ile St Paul, Macquarie Island and Gough Island.

SCAR’s has Observer status within the Antarctic Treaty System, and provides advice and responds to requests in the form of Information Papers and Working Papers to the annual Antarctic Treaty Consultative Meeting (ATCM) and the Committee for Environmental Protection (CEP).

SCAR’s remit has evolved in part because of the development of the Antarctic Treaty System. When the Antarctic Treaty came into force in 1961, SCAR accepted the task of being the primary source of objective, independent scientific advice to the Antarctic Treaty Parties through the biennial Antarctic Treaty Consultative Meeting (ATCM), and was granted the status of Observer to the ATCM. Subsequently, some of the tasks formerly addressed by SCAR were taken up by organizations of the Antarctic Treaty System. For instance, in 1982, under the Convention on the Conservation of Antarctic Marine Living Resources (CCAMLR), the Antarctic Treaty Consultative Parties created a commission and a Scientific Committee to oversee the development of an ecosystem-wide approach to management of the waters south of the Antarctic Convergence. In 1991, the Protocol on Environmental Protection to the Antarctic Treaty was concluded to apply environmental protection principles to human activities in Antarctica. The Protocol required the formation of a Committee for Environmental Protection (CEP) to advise the ATCM on the implementation of the Protocol.

A change in SCAR’s remit took place in 1988, when the newly created Council of Managers of National Antarctic Programmes (COMNAP) took over the coordination of the management and logistics of the National Antarctic Research Programmes operating there, a task formerly carried out by the SCAR Working Group on Logistics.

SCAR’s Members are representatives of national organizations adhering to ICSU, or nominated by national organizations adhering to ICSU. SCAR’s membership has changed from the original 12 countries to 28 Full Members and 4 Associate Members (nations with an interest in becoming full members).

Despite the changes over the years, there is still an essential requirement for the international coordination of science in the Antarctic region and the provision of

objective state-of-the-art scientific advice from an independent organization. SCAR continues to play a unique and crucial role in contributing to the scientific understanding of the south polar region of the planet. Under SCAR's leadership, and within the framework of SCAR Scientific Research Programmes, SCAR Members and their national scientific communities increase scientific knowledge about Antarctica and understanding of the processes taking place there on and under the land surface, in the atmosphere and the ocean, in the ice and in outer space. Studies by SCAR scientists increasingly show how Antarctic processes contribute to the working of the Earth System, and *vice versa*, and of how the south polar environment is influenced by human activities originating both within and outside the region. They also indicate what needs to be done to safeguard the environment. In addition, through the provision of relevant information, assessments and advice to the ATCM, SCAR helps policy makers meet international commitments in the Antarctic. SCAR continues its leading role in international efforts to monitor and protect the environment, by providing critical information on the role of Antarctica in global warming, climate change and sea-level rise, and on the effects of climate change on living organisms. It is axiomatic that improved scientific understanding demands free and unrestricted geographic access to the region, and the free and unrestricted exchange of scientific data and information.

2. Delivering Science in the 21st Century

At its 28th session, in Bremerhaven, during October 2004, SCAR completed the restructuring that began with an independent review commissioned in April 1999. The principal changes are as follows (roman numerals (i) through (x), below):

- i. SCAR has converted its Secretariat to an Executive Office run by an Executive Director, Dr C Summerhayes, formerly of UNESCO;
- ii. SCAR has adopted a new Constitution and Rules of Procedure, which embrace a new vision, mission and objectives.

The Vision is

"To establish through scientific research and international cooperation a broad understanding of the nature of Antarctica, the role of Antarctica in the Earth System, and the effects of global change on Antarctica."

The Mission is

"To be the leading independent organization for facilitating and coordinating Antarctic research, and for identifying issues emerging from greater scientific understanding of the region that should be brought to the attention of policy makers".

Five Main Objectives provide a new focus on achieving this mission:

- to initiate, develop, and co-ordinate high quality international scientific research in the Antarctic region, and on the role of the Antarctic region in the Earth system;
- to provide objective and independent scientific advice to the Antarctic Treaty Consultative Meetings and other organizations on issues of science and conservation affecting the management of Antarctica and the Southern Ocean.

- to facilitate free and unrestricted access to Antarctic scientific data and information;
- to develop scientific capacity in all SCAR Members, especially with respect to younger scientists, and to promote the incorporation of Antarctic science in education at all levels;
- to communicate scientific information about the Antarctic region to the public.

In developing the processes and structures to reach these objectives there are two objectives that underpin the way forward:

- to improve the effectiveness, efficiency and flexibility of the structure, working mechanisms and practices of SCAR.
 - to increase funding to match requirements, and to maintain a healthy funding stream.
- iii. SCAR has created a modern science framework of Standing Scientific Groups on Geosciences, Life Sciences, and Physical Sciences, with interdisciplinary cross linkages between them;
 - iv. SCAR has focused its major scientific research on a limited number of major strategic scientific questions of global scientific interest, many of which also have considerable socio-economic significance;
 - v. SCAR has reorganized its meetings to give National Delegates greater contact with the science, and has introduced a major biennial open science conference;
 - vi. SCAR has expanded its geographical remit to include the Southern Ocean from the Antarctic coast north to the Subantarctic Front, to recognize the important role of the Antarctic Circumpolar Current;
 - vii. SCAR has published a Strategic Plan (2004–10) to specify how it proposes to achieve its new mission and objectives;
 - viii. SCAR has considerably improved its communications both internally and externally, with a new web page, a quarterly newsletter (starting in January 2005), posters and PowerPoint presentations; hits on the web site reached 62000 in March 2005, up from 16700 in January 2004.
 - ix. SCAR is changing, and will continue to change, in response to the changing demands of science and policy, and in the interests of efficiency and effectiveness.
 - x. SCAR is requesting a significant increase in contributions from Members, to compensate for inflation over the past decade, and to provide the support essential for the effective functioning of the Executive Office, the effective implementation of its new scientific research programmes, and effective interaction with the Antarctic Treaty System;

3. The International Polar Year (2007-2008)

SCAR will make a significant contribution to the proposed International Polar Year (IPY)(1 March 2007 – 1 March 2009). During 2004, SCAR made significant

contributions to the activities of ICSU's IPY Planning Group and its development of the "Framework for the IPY". Subsequently, the SCAR Executive Director has been appointed an *ex officio* member of the new ICSU/WMO Joint Committee on the IPY, which will steer the IPY process, and which will include several SCAR scientists. SCAR's five Scientific Research Programmes (SRPs), described below, prepared Expressions of Interest (EoIs) for submission to the IPY selection process by the end of 2004. At the first meeting of the Joint Committee (March 2005) the SCAR SRPs were designated lead projects for substantial subsets of the 850 EoIs submitted.

4. New Developments

SCAR held its first Open Science Conference on 26–28 July 2004, in Bremen, with the title "Antarctica and the Southern Ocean in the Global System". Around 1000 people registered for the meeting, which provided important opportunities to develop cross-disciplinary links.

The Conference was part of the XXVIII SCAR Meeting, which was held in two parts, in Bremen in July, and in Bremerhaven in October. The SCAR and COMNAP Executive Committees held a joint meeting in Bremen in July.

The SCAR Delegates, meeting in October, approved plans for a new set of five major Scientific Research Programmes (SRPs) that will be SCAR's scientific flagships for the next 5–10 years. They are:

- 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 Exploration (SALE) a study of the chemistry and biology of long buried lakes 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.

Brief descriptions of the programmes are given in Appendix 4. Most of the activities contributing to these programmes will be funded nationally. SCAR's international coordination will add value to national efforts. Scientists interested in participating in and contributing to the 5 scientific research programmes are invited to contact the SCAR Secretariat (info@scar.org).

SCAR also supports a variety of other scientific activities in which value is added to national efforts through international cooperation. These activities are coordinated by Action Groups operating for short periods, and Expert Groups where more time is needed to achieve success. Brief descriptions of these activities are given in Appendix 5.

SCAR's activities will make significant contributions to achieving the goals of the International Polar Year (IPY) (2007–09). During 2004 SCAR had considerable input into the IPY Science and Implementation Plans prepared by ICSU and WMO. From the end of 2004 onwards, SCAR will be a member *ex officio* of the Joint ICSU-WMO

Steering Committee for the IPY, and will work with partner organizations to influence the development of the IPY.

SCAR's Standing Committee on the Antarctic Treaty System will work closely with the Standing Scientific Groups and the Executive Committee to bring key scientific issues to the attention of the Antarctic Treaty Consultative Meeting.

5. Highlights of Scientific Coordination Activities

This report gives selected examples and is not exhaustive.

5.1 Scientific Research Programmes

During the year, SCAR's Standing Scientific Groups (SSGs) put considerable effort into developing the five new Scientific Research Programmes. All five programmes were evaluated by external reviews, on the basis of which they were approved by the Delegates for start up at the beginning of 2005.

Determining the extent of environment change across the Antarctic in recent decades is a high priority activity. The SSG on Physical Sciences (SSG-PS) contributed to this work through the creation of a number of new data sets of key environmental variables. Analyses of these data sets have resulted in assessments of climatic change over the Antarctic since the IGY in 1957–58. Details of some of these data sets are given below under the various Action and Expert Groups. A major conclusion is that there has been a complex pattern of change across the Antarctic over the last 50 years with the Antarctic Peninsula warming more than anywhere else on Earth while the rest of the continent has shown little change.

Recognizing that Southern Ocean biodiversity is an important and significant component of the World marine biodiversity, and that a large part of the Southern Ocean biodiversity remains unknown, in particular in the deep sea, the SSG on Life Sciences (SSG-LS) agreed to co-sponsor a Southern Ocean component of the global Census of Marine Life (CoML). To that end it formed a new Action Group on a Census on Antarctic Marine Life (CAML) to take this initiative forward as a contribution to EBA. The Group is led by Michael Stoddart of the Australian Antarctic Division, and has been awarded a start-up grant of US\$525,000 by the Alfred P Sloan Foundation.

The SSG-LS is also developing a Marine Biodiversity Information Network (MarBIN) that will contribute to the compilation, dissemination, and integration of fundamental information on the Antarctic marine biodiversity for scientific, monitoring, management and conservation purposes. This will be connected to the CoML's Ocean Biodiversity Information System (OBIS).

The evolution of climate is the focus of attention of the newly approved Antarctic Climate Evolution (ACE) programme within the SSG on Geosciences. Initial work by the ACE team has been published as a set of 13 papers in a Special Issue of *Global and Planetary Change* 45 (pages 1–332) in 2005, with an introduction on "Long-term changes in Southern high-latitude ice sheets and climate, the Cenozoic history" by the editors, F Florindo, D M Harwood and G S Wilson. ACE is placing a high priority on following up the work of the ANTIME project (part of the former GLOCHANT programme) that focused on the Antarctic environment during the Last Glacial Maximum.

Planning for exploration of a new scientific frontier, subglacial lakes, has continued under the aegis of the SSG on Geosciences through the newly approved Subglacial Antarctic Lake Environments (SALE) Scientific Research Programme, following the initial work of the Group of Specialists on Subglacial Antarctic Lake Exploration (SALEGOS). Much of the effort has been devoted to planning drilling activities that will avoid contaminating the lake environments. Plans are being made to start drilling into some of the smaller subglacial lakes during the forthcoming International Polar Year.

5.2 *Action and Expert Groups*

Recognizing the need to invest more effort in understanding the role of the Southern Ocean in climate and biodiversity, SCAR now co-sponsors much Southern Ocean research with global programmes having Antarctic interests, through recent joint agreements with the World Climate Research Programme and with the Global Ocean Ecosystem Dynamics programme (GLOBEC). As a further step in this direction, SCAR upgraded its Action Group on Oceanography to an Expert Group, which complements the activities of other groups active in the Southern Ocean. It will be managed in concert with SCOR and iAnZone.

SCAR is working with the space agencies and UN agencies through the Partnership for an Integrated Global Observing Strategy (IGOS) to devise a bi-polar programme to improve observations of the cryosphere.

The MOSAK Action Group carried out a modelling study that has produced a new, improved high resolution near surface wind field for the Antarctic. This will be of value in studies of blowing snow, sea ice advection and the investigation of katabatic winds.

The Expert Group of Operational Meteorology has worked with COMNAP to produce an International Antarctic Weather Forecasting Handbook. The WMO provided funding for a hardcopy version that is being distributed to all nations active in the Antarctic.

The READER Action Group has produced a new, improved database of mean, Antarctic tropospheric/stratospheric temperatures, winds and heights from surface observations and radiosonde ascents

(<http://www.antarctica.ac.uk/met/READER/>).

Significant new astronomical results have been obtained from the Amundsen-Scott South Pole Station, including measurements of the Cosmic Microwave Background Radiation (CMBR) and galactic/interstellar emission in a sub-millimetre diapason, as well as infrared observations of the Milky Way. More than 50 refereed papers have come from these data, and the cosmic microwave background polarization has been measured for the first time from the Antarctic.

The ASPECT Expert Group has continued to develop its database of sea ice parameters from in-situ ship observations. Data from 81 voyages were added over the last two years. The data archive has been used in a number of studies, including comparisons with satellite ice edge location to determine seasonal variability in the reliability in the satellite estimates, comparisons with sea ice-ocean models and the development of a circumpolar climatology of area-averaged albedo.

The ITASE Expert Group collected more than 240 firn cores (for a total of 7,000 m) and about 20,000 km of snow radar, resulting in numerous publications. In addition ITASE developed multi-centennial scale proxies for sea ice, regional temperature,

and major atmospheric circulation features plus new continental scale maps depicting the distribution of major chemical species over the ice sheet.

In the Life Sciences, the Expert Group on Human Biology and Medicine came to the conclusion that it would operate more effectively if it amalgamated with the COMNAP group MEDINET. Discussions on this merger are ongoing.

The research programme EVOLANTA published the proceedings of one of their workshops as a special issue of *Antarctic Science* (16, no. 1, March 2004).

The research programme RiSCC completed three successful field campaigns:

1. the three island study (Marion, Kerguelen, and Heard islands);
2. the Antarctic Peninsula transect (Netherlands – United Kingdom), and
3. the Latitudinal Gradient Project in Victoria Land (New Zealand – Italy – United States). The RiSCC community is also planning research in the Arctic, the Northern RiSCC, to be hosted by Canada.

The EASIZ programme was successfully terminated with a closing symposium in September 2004 in Croatia. The proceedings will be published in a special issue of *Deep Sea Research*.

The SSG Geosciences Action Group on Communication and Outreach (COG) plays an essential role in gathering, collating and disseminating geospatial and geoscientific information for the benefit of the entire Antarctic research community. This is achieved through the SSG on Geosciences website

(<http://www.geoscience.scar.org>)

and through *Georeach*, the geosciences newsletter which can be downloaded from the website. In addition, the SSG on Geosciences has a listserver with 134 subscribers and listservers have also been established for the Expert Groups on Geodetic Infrastructure in Antarctica (GIANT), on Antarctic Neotectonics (ANTEC), and on the Antarctic Digital Magnetic Anomaly Project (ADMALP).

A new Action Group on Marine Survey Coordination has been established to improve coordination of planned marine surveys within the Antarctic community.

The SSG on Geosciences has upgraded some of its short term Action Groups to longer term Expert Groups.

The Action Group on Permafrost has been up-graded to a longer-term Expert Group on Permafrost and Periglacial Environments that will address science questions pertaining to the age and history of Antarctic permafrost, landscape dynamics and evolution (including erosion, ground ice formation, patterned ground).

Similarly, the former Action Group on Geographic Information has been changed to an Expert Group that will create an Antarctic Spatial Data Infrastructure (ANTSDI) by integrating and coordinating Antarctic mapping and GIS programmes to provide a fundamental geographical base for all Antarctic research.

The former Action Group on Geodetic Infrastructure of Antarctica (GIANT) has also been converted to an Expert Group that will continue to define an accurate geodetic reference frame. This is essential for all scientists undertaking mapping application and geodynamics studies in Antarctica. The Expert Group will continue its activity for better planning of Geodetical and Geophysical Observatories, and to enhance continental and global data processing.

The Action Group on the Antarctic Digital Magnetic Anomaly Project (ADMAP) has also been up-graded to an Expert Group to maintain the database and make it a permanent tool available to the scientific community.

A new Expert Group on the International Bathymetric Chart of the Southern Ocean (IBCSO) will develop new compilations of bathymetric data for inclusion in the Chart.

The former Group of Specialists on Antarctic Neotectonics (ANTEC), established in 1998 to promote and coordinates multidisciplinary, multinational research relevant to Antarctic neotectonics, has been changed to an Expert Group. In conjunction with the ISMASS programme of the SSG on Physical Sciences, the Expert Group presented a thematic set of 21 papers on "Ice Sheets and Neotectonics" that was published in a Special Issue of *Global and Planetary Change* 42 (pages 1–326) in 2004, including an editorial by T S James, T H Jacka, A Morelli and R Dietrich.,

6. Future Plans

This report gives selected examples and is not exhaustive.

6.1 Scientific Coordination

The first priority is implementation of the five newly approved Scientific Research Programmes. The first task is to draft Implementation Plans for the five new programmes. These will be complete for the meeting of the SCAR Executive in July.

The Steering Committee for the AGCS SRP will meet in Cambridge, UK over 27 June – 1 July 2005.

The meeting of the SALE SRP will be held in Vienna, 22–23 April 2005, in association with the European Geophysical Union meeting.

The ACE SRP meeting will also be held in Vienna, on 25 April 2005.

The first ICESTAR workshop will be held in Spring 2005. This will focus on data portal/virtual-observatory specifications, identification and metadata description of all available Antarctic data on the Internet for ICESTAR and identification of available value-added products on- and off-line and prioritization of the data and products based on their science merit.

The Implementation Plan for the EBA SRP will be completed, following a draft, written during a workshop in Cambridge in March 2005, during the IX SCAR International Biology Symposium, which will be held in Curitiba, Brazil, 25 –29 July 2005. These highly successful symposia bring together over 75% of the biologists currently active in the Antarctic and Southern Ocean environment. Further information on this symposium can be found at:

<http://www.nioo.knaw.nl/projects/scarlsssg/>.

Prior to the symposium, several workshops will be held including, among others, on Antarctic Conservation matters.

SCAR will also maintain the key activities of its Action and Expert Groups. A detailed record of the activities of these groups during 2005 can be found under EVENTS on the SCAR web page. The efforts of the Action Group on Marine Acoustics, which is investigating the relationship between noise in the ocean and the

behaviour of cetaceans, and which resulted in a report to the XXVII ATCM, is continuing, as a means of providing scientific advice to the ATCM.

Several activities are planned as part of the European Geophysical Union (EGU) meeting in Vienna in April, or as part of the American Geophysical Union (AGU) Assembly in New Orleans (23–27 May 2005) or the AGU fall meeting in San Francisco (December 2005).

SCAR will continue to provide inputs to the IPY process through its membership of the ICSU/WMO Joint Committee for the IPY. In addition, its Scientific Research Programmes will plan their leadership of subsets of the Expressions of Interest received by the IPY planners, and by the end of June 2005 will convert these EoIs into full proposals for IPY endorsement.

Key meetings in 2005 include:

1. SCAR–COMNAP Workshop on Practical Biological Indicators of Human Impacts in Antarctica, 16–18 March 2005, College Station, USA; to assess biological indicators of human impact and advise on implementing meaningful monitoring programmes in Antarctica.
2. Continental drilling 2005: A Decade of Progress and Opportunities for the Future; 30 March – 1 April 2005, Potsdam, Germany.
3. Climate and Cryosphere (CliC) 1st Science Conference; 11–15 April 2005, Beijing, China.
4. SCAR Workshop on Antarctic Conservation in the 21st Century, 23–25 May 2005, Stellenbosch, South Africa.
5. Southern Ocean Implementation Panel Meeting; 27–30 June 2005 Cambridge, UK; to discuss modes of variability and the IPY.
6. SCAR IX International Biology Symposium; 25–29 July 2005, Curitiba, Brazil.
7. International Association of Meteorology and Atmospheric Sciences Meeting; 2–11 August 2005, Beijing, China; to discuss Climate 7.Variability and Change in the Polar Regions: Causality and Prediction.
8. SCAR will co-sponsor special IAG/IAPSO sessions on “Oceanography and geodesy in polar regions” and on “Ocean interactions with sea ice, polynyas, ice shelves, and icebergs” as part 8.of the IAPSO/IABO Symposium, 22–26 August 2005, Cairns, Australia.
9. International Conference on Glacial Sedimentary Processes and Products; August 2005, Aberystwyth, UK.
10. Sixth International Conference on Geomorphology; 7–11 September 2005, Zaragoza, Spain; to discuss Antarctic Geomorphology.
11. Third International Conference on the Oceanography of the Ross Sea; 10–14 October 2005, Venice, Italy.
12. International Symposium on Sea Ice; 4–9 December 2005, Dunedin, New Zealand

6.2 *Developing Scientific Capacity*

The Antarctic research programmes of SCAR Member nations vary greatly in their size and capacity. Some have scientific communities that are large, scientifically advanced and long standing. Others have relatively small and new Antarctic science communities that are still developing. To enable all in the SCAR family to participate in, contribute to and benefit from SCAR's activities, it is incumbent on SCAR to work with appropriate national agencies to help to enhance the research capacity of all of its Members and Associate Members. This requirement has become more pressing with the significant increase in SCAR Membership in recent years. SCAR is in the process of developing a strategy for capacity building. One aspect of the potential capacity building programme that is already active is the SCAR Fellowship Programme, which provides a small number of annual awards. SCAR also arranges training workshops. For example, the MOSAK Action Group proposes to hold a workshop on the Antarctic wind field in early 2006 in Kuala Lumpur, Malaysia.

SCAR hopes that the nations participating in the ATCM will work actively with SCAR to support this scientific capacity building programme as it develops in the coming years.

7. Concluding Remarks

SCAR continues to play a central role in the development of scientific understanding in the Antarctic region. This role will be enhanced in future by SCAR's involvement at the heart of the planning process for the International Polar Year. SCAR's five new Scientific Research Programmes will make a major contribution to, and will help to lead the development of, the International Polar Year in the region. SCAR is keen to continue to play a major role as the scientific partner to the ATCM, and the driver for scientific research performed to acceptable scientific standards.

Appendix 1

MEMBERSHIP OF SCAR

<i>Full members:</i>	<i>Date of admission to Associate Membership</i>	<i>Date of admission to Full Membership</i>
Argentina		3 February 1958
Australia		3 February 1958
Belgium		3 February 1958
Chile		3 February 1958
France		3 February 1958
Japan		3 February 1958
New Zealand		3 February 1958
Norway		3 February 1958
South Africa		3 February 1958
Russia (formerly Union of Soviet Socialist Republics)		3 February 1958
United Kingdom		3 February 1958
United States of America		3 February 1958
Germany (including former German Democratic Republic)		22 May 1978
Poland		22 May 1978
India		1 October 1984
Brazil		1 October 1984
China		23 June 1986
Sweden	(24 March 1987)	12 September 1988
Italy	(19 May 1987)	12 September 1988
Uruguay	(29 July 1987)	12 September 1988
Spain	(15 January 1987)	23 July 1990
Netherlands	(20 May 1987)	23 July 1990
Korea, Republic of	(18 December 1987)	23 July 1990
Finland	(1 July 1988)	23 July 1990
Ecuador	(12 September 1988)	15 June 1992
Canada	(5 September 1994)	27 July 1999
Peru	(14 April 1987)	22 July 2002
Switzerland	(16 June 1987)	3 October 2004
 <i>Associate Members:</i>		
Pakistan	15 June 1992	
Ukraine	5 September 1994	
Bulgaria	5 March 1995	
Malaysia	3 October 2004	

ICSU Union Members

IGU	International Geographical Union
IUBS	International Union of Biological Sciences
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
IUPAC	International Union of Pure and Applied Chemistry
IUPS	International Union of Physiological Sciences
URSI	Union Radio Scientifique Internationale

Appendix 2

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SCAR–COMNAP Joint Committee on Antarctic Data Management

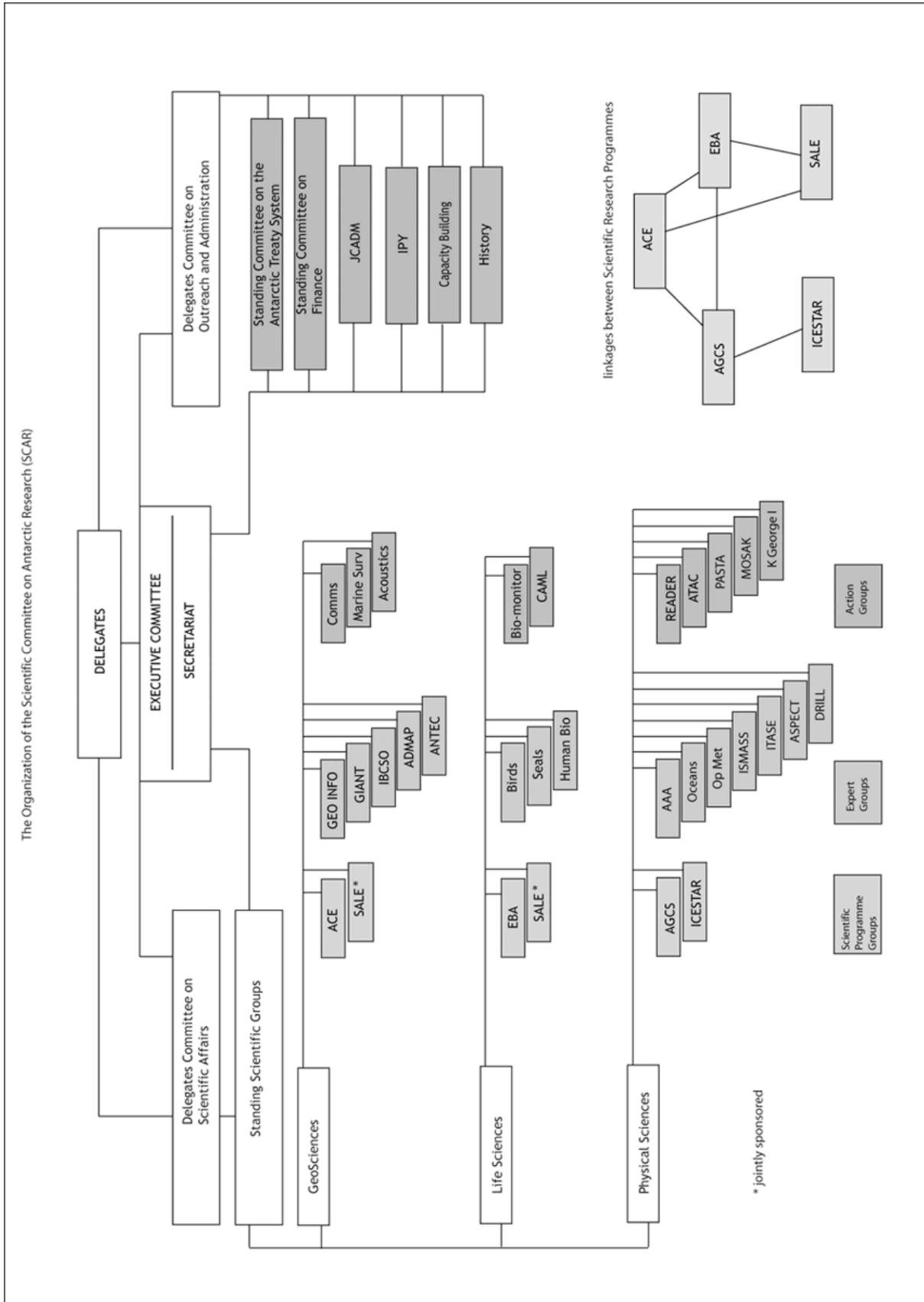
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Appendix 3:

New SCAR Structure



List of constituent sub-groups in the SCAR Organization

<p>Delegates Committee on Scientific Affairs</p> <p>Standing Scientific Group on Geosciences</p> <p>Expert Groups on: Geographic Information Geodetic Infrastructure for Antarctica International Bathymetric Chart of the Southern Ocean Antarctic Digital Magnetic Anomaly Project Antarctic Neotectonics</p> <p>Standing Scientific Group on Life Sciences</p> <p>Expert Groups on: Birds Seals Human Biology and Medicine</p> <p>Standing Scientific Group on Physical Sciences</p> <p>Expert Groups on: Antarctic and Astronomy and Astrophysics Oceanography of the Southern Ocean Operational Meteorology Ice Sheet Mass Balance and Sea Level International Trans-Antarctic Scientific Expedition Antarctic Sea-Ice Processes and Climate Ice drilling technology</p> <p>Scientific Research Programmes</p> <p>Antarctic Climate Evolution Antarctica and the Global Climate System Evolution and Biodiversity in the Antarctic</p> <p>Other sub-groups</p> <p>Standing Committee on the Antarctic Treaty System Standing Committee on Finance Joint Committee on Antarctic Data Management</p>	<p>Delegates Committee on Outreach and Administration</p> <p>Action Groups on: Communications and Outreach Marine geophysical surveying Marine Acoustic Technology</p> <p>Action Groups on: Bio-monitoring of Human Impacts Census of Antarctic Marine Life</p> <p>Action Groups on: Reference Antarctic Data for Environmental Research Antarctic Tropospheric Aerosols and their Role in Climate Plateau Astronomy Site Testing in Antarctica Modelling and Observational Studies of Antarctic Katabatics Scientific Coordination on King George Island</p> <p>Inter-hemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research Subglacial Antarctic Lake Environments</p> <p>Capacity Building International Polar Year 2007–09 History of Scientific Research in Antarctica</p>
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Appendix 4

The SCAR Scientific Research Programmes

Antarctic Climate Evolution (ACE)

ACE will use palaeoclimate and ice sheet-modelling investigations, integrated with terrestrial and marine geological and geophysical evidence, to study the climate and glacial history of Antarctica. Over the past 34 million years changes in climate have led to considerable spatial and temporal fluctuations in ice volume that have driven significant changes in global sea-level. Determining the scale and rapidity of the response of ice masses and associated sea ice to climate forcing is essential to understand the processes of climate change in the region, and to underpin estimates of the likely magnitudes and directions of future change.

ACE will promote the exchange of data and ideas between research groups focusing on the evolution of Antarctica's climate system and ice sheet. It will encourage scientific exchange between modellers and data gatherers, facilitating the development of relevant projects and the testing of hypotheses. The main function of the programme is to acquire and compile "ground truth" geoscience data and to use these to develop a suite of palaeoclimate models for significant periods of climate change throughout Cenozoic times up to and including the Holocene. Data access and data sharing will be encouraged to facilitate the data syntheses needed for enhancing palaeoclimate models. Numerical modelling is an essential component, and will address:

1. ice sheet modelling;
2. coupled ice-sheet, climate and ocean modelling; and
3. coupled ice sheet and sediment modelling to address the interaction between ice sheets, water and deformable sediment at the interface between ice and bedrock.

The broad outcomes will be:

1. a quantitative assessment of the climate and glacial history of Antarctica;
2. identification of the processes that govern Antarctic climate change and those that feed back around the globe;
3. improvements in the ability to model past climate changes in Antarctica; and
4. documented case studies of past changes against which models of future change can be tested.

ACE will promote new drilling programmes to expand the necessary database. These will include the activities of the Integrated Program for Ocean Drilling (IPOD) in deep water, the shallow drilling (SHALDRIL) programme on land, and the ANDRILL programme on the ice shelves. Among other things the programme will examine the terrestrial record of landscape evolution; the influence of tectonics on the behaviour of the ice sheet; and the influence of palaeo-seaways, such as the opening of the Drake Passage, on climate.

ACE and AGCS have complementary interests in Quaternary studies of Antarctica, so a joint Action Group manned by both programmes will be established to run a Quaternary sub-programme.

Antarctica and the Global Climate System (AGCS)

AGCS will investigate the nature of the atmospheric and oceanic linkages between the climate of the Antarctic and the rest of the Earth system. The linkages between the different elements of the Antarctic climate system are highly non-linear and it is necessary to understand the behaviour of and interactions between the atmospheric, oceanic and cryospheric elements of the system if past change is to be explained and we are to have confidence in future predictions. A study of this kind has only recently become feasible with the advent of sufficient high-resolution *in-situ* data and ice core records, and the development of numerical modeling tools to the point where they can represent realistically the closely coupled atmosphere-ocean processes that control long-term climate variability.

The work requires a combination of modern, instrumented records of atmospheric and oceanic conditions, and the climate signals held within ice cores, to understand fully past and future climate variability and change in the Antarctic as a result of natural and anthropogenic forcing. AGCS will focus on the last 6,000 years, since the mid-Holocene warm period, and will develop forecasts to 100 years in the future. Records that capture abrupt climate change over the past few glacial/interglacial cycles will also be studied, in association with the ACE programme (see below).

AGCS will use existing deep and shallow ice cores, satellite data, the output of global and regional coupled atmosphere-ocean climate models, and in-situ meteorological and oceanic data to understand how signals of tropical and mid-latitude climate variability reach the Antarctic, and high latitude climate signals are exported northwards. It will emphasize synthesis and integration of existing data sets and model outputs, although some new ice core and oceanographic data will be collected.

AGCS will contain four closely linked themes reflecting significant gaps in our knowledge:

1. *Decadal time scale variability in the Antarctic climate system*, to investigate ocean-atmosphere coupling and the role of the El Niño-Southern Oscillation in modulating the Antarctic climate;
2. *Global and regional climate signals in shallow and deep ice cores*, to establish better quantitative relationships between ice core data and measures of tropical, mid- and high latitude climate variability;
3. *Natural and anthropogenic forcing on the Antarctic climate system*, including the production of regional-scale estimates of expected climate change over Antarctica during the next 100 years, to be able to distinguish natural variability from anthropogenic activity and to understand how global climate change will be expressed in the Antarctic; and
4. *The export of Antarctic climate signals*, to examine how climate changes in the Antarctic can influence conditions at more northerly latitudes

The research will be carried out in an interdisciplinary way through a close collaboration between meteorologists, climatologists, glaciologists, oceanographers and ice chemists, who will integrate observational and modelling activities.

A key deliverable will be the production of regional and Antarctic-wide climate predictions covering the next 100 years.

Evolution and Biodiversity in the Antarctic (EBA): the response of life to change.

A major challenge facing humankind is the management of the Earth System to ensure a sustainable human future. Managing the environment requires understanding the functioning of all parts of the Earth System in the context of both natural and anthropogenic change. That understanding must encompass Antarctica and the Southern Ocean and their biota, including knowledge of the way in which life has evolved in those environments, and the ways in which it is likely to change, which in turn demands an integrated, interdisciplinary investigation of the structure and functioning of living systems in the region.

EBA will provide a platform for the kinds of interactions amongst disciplines and researchers that are essential to understand the evolution of biodiversity in the region and the responses and contributions of that biodiversity to the Earth System. By doing so, it will fill a major void in understanding of the role of biodiversity in the Earth System.

The overall aims of EBA are 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 make predictions on how organisms and communities will respond to current and future environmental change. EBA will integrate work on marine, terrestrial and limnetic ecosystems in a manner never before attempted, covering an entire biome. By comparing the outcomes of parallel evolutionary processes over a 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 level and ultimately to biome level. EBA will be complementary to many ongoing national programmes that cannot attempt an ambitious study individually.

Antarctic ecosystems offer unique examples of how both structure and function have evolved, and the likely responses of species and ecosystems to change induced by a wide variety of natural and anthropogenic processes, as well as the ways in which their responses feed back to influence these processes.

EBA will use a range of modern techniques and a multidisciplinary approach to explore the evolutionary history of the modern Antarctic biota, examine how modern biological diversity in Antarctica influences how present-day ecosystems function, and attempt to predict how the biota may respond to future environmental change. It will integrate the major realms of Antarctic biology into a cohesive picture for the first time, and contribute to evolutionary theory and understanding of global ecology and biological diversity. More specifically, EBA will examine:

1. The evolutionary history of the Antarctic biota.
2. Evolutionary adaptations to the Antarctic environment.
3. Patterns of gene flow within, into and out from the Antarctic, and their consequences for population dynamics.
4. Patterns and diversity of organisms, ecosystems and habitats in Antarctica, together with the ecological and evolutionary processes that control these.
5. The impact of past, current and predicted environmental change on biodiversity and the consequences for Antarctic marine, freshwater and terrestrial ecosystem function.

The programme will integrate research across a wide variety of fields, from functional genomics and molecular systematics to ecosystem science and modelling, and will draw on and contribute information to a wide range of related fields, such as climate modelling and tectonics.

Interhemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research (ICESTAR).

ICESTAR will address some key questions about the interaction of the solar wind with the Earth's outer atmosphere, so as to quantify the key mechanisms of indirect coupling between the Sun and the Earth at high latitudes; to determine how solar variability is amplified through those couplings; and to determine the temporal evolution of atmospheric change caused by solar coupling. Much remains to be learned about how the solar forcing can affect the atmosphere, especially at high latitudes where the solar wind-driven processes are most influential.

ICESTAR will also investigate possible influences of the changing Sun (i.e., its irradiance and magnetic moment) and the geospace environment on polar climate and weather. ICESTAR addresses the fact that important gaps remain in our understanding of the solar wind-magnetosphere-ionosphere interaction. We do not know enough about the changes and dynamics of the Earth's magnetosphere under extreme solar wind conditions, i.e., during strong geomagnetic storms and as a consequence of solar activity such as coronal mass ejections.

In order to obtain a deep understanding of the mechanisms responsible for energy transfer from the solar wind into the geospace environment, simultaneous consideration is needed of various geophysical phenomena occurring over both the northern and southern Polar Regions. ICESTAR will both enable and conduct focused scientific research on the upper atmosphere above the Antarctic and on how that region of space ties in with the global system. The programme will strive for international coordination of interhemispheric research in the areas of solar-terrestrial physics and polar aeronomy, promoting exchange of research ideas, and sharing experimental data from various arrays of geophysical instrumentation deployed over the Polar Regions and in near-Earth space.

ICESTAR aims

1. to identify and quantify various mechanisms that control interhemispheric regional differences and commonalities in the electrodynamics and plasma dynamics of the Earth's magnetosphere-ionosphere coupling system, and in the aeronomy of the upper atmosphere over the Arctic and Antarctic; and
2. to create a data portal that will link together a large number of geophysical databases including both data serving applications and visualization tools, so as to enable a systems view of the polar upper atmosphere. Creation of the ICESTAR data portal to facilitate the sharing and interpretation of global geospace datasets will encourage the collaboration of researchers by sharing data and the interpretation of the results.

Subglacial Antarctic Lake Environments (SALE)

SALE serves as the international focal point of SCAR's activities to promote, facilitate, and champion cooperation and collaboration in the exploration and study of subglacial environments in Antarctica.

The overarching scientific objectives of SALE are:

1. to understand the formation and evolution of subglacial lake processes and environments;
2. to determine the origins, evolution and maintenance of life in subglacial lake environments; and
3. to understand the limnology and palaeoclimate history recorded in subglacial lake sediments.

To explore the complex interplay of biological, geological, chemical, glaciological, and physical processes within subglacial lake environments an international, interdisciplinary plan for coordinated research and study is essential. The three objectives can only be accomplished by integrated and coordinated phases of discovery and hypotheses driven research over at least a ten-year period.

Major areas of research will be:

1. Functional Genomics and Phylogenetics (eg to determine the genetic diversity in the water columns and benthic sediments of subglacial lakes);
2. Limnology (eg to establish the geochemical and isotopic composition of selected lake water constituents to determine their role in biological processes, water column stability, and to establish the age of subglacial lake water);
3. Geophysics (eg to understand the tectonic and ice sheet setting of subglacial lakes through geological analysis of geophysical data);
4. Glaciology (eg to understand the interrelation between ice sheet processes and lake water circulation);
5. Geology and Cenozoic Palaeoclimate (eg to use palaeoenvironmental data to determine lake and ice sheet histories, and evaluate temporal changes in Cenozoic palaeoclimate relative to those histories determined from Antarctic marginal sequences and global Cenozoic proxy records).

The technological challenges and environmental stewardship issues of under ice drilling cannot be underestimated, so SALE will also advise the international community not only on scientific issues but also on technology issues relevant to subglacial lake exploration, including environmental concerns and safeguards.

Appendix 5

SCAR's Action and Expert Groups

Geosciences SSG

Action Group on "Communication and Outreach" (**COG**): to provide information on Antarctic geoscientific research to the scientific and community and the wider public.

Action Group on "Acoustics in the Marine Environment": to consider the effects on marine mammals of noise created by marine scientific activities (such as echo-sounding and airgun surveys).

Action Group (Cross-SSG) on "Antarctic Treaty and Committee for Environmental Protection (CEP)": to communicate with SCAR representative at the CEP and ATCM to bring matters of concern to the CEP and Treaty to the SSG-G for advice and to identify areas of concern in geosciences and geospatial information, raise them in Antarctic Treaty System (ATS) fora, and provide scientific advice.

Action Group on "Marine Survey Coordination": to develop mechanisms for improved communication about planned marine surveys within the Antarctic community.

Expert Group on "Geographical Information" (**EGGI**): to create an Antarctic Spatial Data Infrastructure (**ANTSDI**) by: providing Antarctic fundamental geographic information products and policies in support of all SCAR science programmes and operations management and the global user; integrating and coordinating Antarctic mapping and GIS programmes; promoting an open standards approach to support free and unrestricted data access; promoting capacity building towards sound Antarctic geographic data management within all SCAR nations; and promoting to COMNAP the data and products that the EGGI produces.

Expert Group on "Permafrost and Periglacial Environments" (**EGPPE**): to provide coordination, communication and exchange of data amongst Antarctic permafrost researchers within SCAR and IPA and promote interaction and collaboration with SCAR and IPA working groups; to collect and collate spatial data on permafrost and cryosols and contribute to databases for Antarctic soils, permafrost and ground ice conditions including the active layer; to develop and promote monitoring/observation protocols and networks; to promote international cooperation and facilitate collaborative field research; and to address key science questions pertaining to permafrost.

Expert Group on "Geodetic Infrastructure of Antarctica" (**GIANT**): to provide a common geodetic reference system for all Antarctic scientists and operators; to contribute to global geodesy for the study of the physical processes of the earth and the maintenance of the precise terrestrial reference frame; to provide information for monitoring the horizontal and vertical motion of the Antarctic.

Expert Group on "Antarctic Neotectonics" (**ANTEC**): to promote and coordinate multidisciplinary, multinational research relevant to Antarctic neotectonics; to identify 'target sites' where there is a need for deployment of geodetic and seismic stations and arrays, and airborne, marine and field campaigns; to encourage and coordinate the installation of instruments at permanent sites and in regional networks (GPS, gravity, seismic) for focused studies in target areas; and to promote and coordinate sharing of instrumentation, logistics, and data.

Expert Group on “Antarctic Digital Magnetic Anomaly Project “(**ADMAP**): to produce a coordinated effort for: compiling the existing magnetic data acquired by various institutions; coordinating protocols for data distribution; serving as a reference for future survey planning; archiving and maintaining the magnetic anomaly data base of Antarctica.

Expert Group on “International Bathymetric Chart of the Southern Ocean” (**IBCSO**): to act as the steering group for production of a revised chart of the bathymetry of the Southern Ocean, in conjunction with the IHO and GEBCO.

Life Sciences SSG

Action Group on “Global International Waters Assessment” (**GIWA**): to provide the information required for a Global Waters Assessment for Area 66: Antarctica.

Action Group on “Best Practices for Conservation”: to review and establish current best practices for conservation in an Antarctic context.

Action Group on Biological Monitoring: to organize a workshop on this topic, in order to produce a (set of) protocol(s) for biological monitoring activities for environmental management purposes.

Action Group for the “Census of Marine Life” (**CoML**): to act as a scientific steering committee for the Southern Ocean component of the global CoML programme.

Expert Group on: “Birds”: to provide long-term data on avian populations in the region; to encourage, coordinate and support research on seabirds; to contribute to their conservation; and to provide scientific advice to SCAR.

Expert Group on “Seals”: to provide information on the status of seal stocks as required by the Convention for the Conservation of Antarctic Seals (CCAS); to encourage research and information exchange on this group of animals; and to provide advice to SCAR.

Expert Group on “Human Biology and Medicine”: to provide a forum for medical, physiopathological, behavioural, clinical, and biological scientists; to promote high quality research in polar human biology in association with appropriate international scientific organizations; to encourage cooperation in the continued evolution of high quality healthcare and the prevention of injury and disease in the Antarctic; and to promote the full use of the unique environment of the Antarctic to allow understanding of major health problems in extreme environments in particular, and in mankind in general.

Physical Sciences SSG

Action Group on: “Plateau Astronomy Site Testing in Antarctica” (**PASTA**): to coordinate the efforts to properly characterize the conditions available at various sites on the Antarctic plateau, delivering and compiling the required site testing data.

Action Group on “Modelling and Observational Studies of Antarctic Katabatic Winds” (**MOSAK**): to analyze, understand and model katabatic wind events, and to develop a new map of katabatic wind distribution and strength over the Antarctic ice sheet.

Action Group (Cross-SSG) on Coordination of Scientific Activities on King George Island: to encourage different national groups on King Gorge Island to share information about their research plans, so as to avoid unnecessary duplication of costly activities.

Expert Group on "SCAR and Oceanography": - to facilitate coordination between the physical oceanographic research groups currently active and those planning research in the Southern Ocean; to encourage an inter-disciplinary approach to Southern Ocean observations, modelling and research, recognizing the inter-dependence of physical, chemical and biological processes in the ocean at present and in the past; to identify historical and reference data set of value to researchers, focusing initially on physical oceanography data; to encourage the exchange of information with operational agencies.

Expert Group on "Antarctic and Astronomy and Astrophysics" (AAA): to coordinate efforts to explore the potential for astronomical observations in the Antarctic.

Expert Group on "Operational Meteorology in the Antarctic": to liaise with WMO over observing standards, the use of new data/model fields and weather forecasting in the Antarctic; to maintains links with COMNAP/SCALOP; and to provide scientific advice to WMO on Antarctic meteorology.

Expert Group on "Ice Sheet Mass Balance and Sea Level" (ISMASS): to understand the relationship between Ice Sheet Mass Balance and Sea Level, by determining the present accumulation rate over the entire ice sheet and measuring ice thickness and velocities at the grounding zone of the ice sheet and glaciers.

Expert Group on Ice Drilling Technology: to facilitate communication among international ice drilling communities; to create an international forum for strategic development of new ice drilling and borehole testing concepts and technologies and continued improvement of existing technologies; to provide a pool of expertise to address SCAR issues related to ice drilling and coring; and to enhance international cooperation and communication on large- and small-scale ice core recovery projects.

Appendix 6

List of Acronyms

AAA	Antarctic and Astronomy and Astrophysics
ACE	Antarctic Climate Evolution
ADMAP	Antarctic Digital Magnetic Anomaly Project
AGCS	Antarctica in the Global Climate System
AGU	American Geophysical Union
ANDRILL	Antarctic Geological Drilling Project
ANTEC	Antarctic Neotectonics
ANTIME	Late Quaternary Sedimentary Record of Antarctic Ice Margin Evolution
ANTSIDI	Antarctic Spatial Data Infrastructure
APTIC	Antarctic Peninsula Tropospheric-Ionospheric Coupling
ASPeCT	Antarctic Sea-Ice Processes and Climate
ATAC	Antarctic Tropospheric Aerosols and their Role in Climate
ATCM	Antarctic Treaty Consultative Meeting
CAML	Census of Antarctic Marine Life
CEP	Committee for Environmental Protection
CLiC	Climate and Cryosphere Programme
CMBR	Cosmic Microwave Background Radiation
COG	Communication and Outreach
CoML	Census of Marine Life
COMNAP	Council of Managers of National Antarctic Programmes
EASIZ	Ecology of the Antarctic Sea-Ice Zone
EBA	Evolution and Biodiversity in the Antarctic
EGGI	Expert Group on Geographical Information
EGGPE	Expert Group on Permafrost and Periglacial Environments
EGU	European Geophysical Union
EoI	Expression of Interest
EVOLANTA	Evolutionary Biology of Antarctic Organisms
GIANT	Geodetic Infrastructure for Antarctica
GIS	Geographic Information Systems
GIWA	Global International Waters Assessment
GLOBEC	Global Ocean Ecosystems Dynamics
GLOCHANT	Group of Specialists on Global Change and the Antarctic
GPS	Global Positioning System
IABO	International Association of Biological Oceanography
IAG	International Association of Geodesy
IAnZone	International (Coordination of Oceanographic Research within the) Antarctic Zone
IAPSO	International Association for the Physical Sciences of the Ocean
IBCSO	International Bathymetric Chart of the Southern Ocean
ICESTAR	Inter-hemispheric Conjugacy Effects in Solar-Terrestrial and Aeronomy Research
ICSU	International Council for Science
IGOS	Integrated Global Observing Strategy
IGU	International Geographical Union
IGY	International Geophysical Year
IPA	International Permafrost Association
IPOD	Integrated Program for Ocean Drilling

IPY	International Polar Year
ISMASS	Ice Sheet Mass Balance and Sea-Level
ITASE	International Trans-Antarctic Scientific Expedition
IUBS	International Union of Biological Sciences
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
IUPAC	International Union of Pure and Applied Chemistry
IUPS	International Union of Physiological Sciences
JCADM	Joint Committee on Antarctic Data Management
MADREP	Middle Atmosphere Dynamics and Relativistic Electron Precipitation
MarBIN	Marine Biodiversity Information Network
MEDINET	Medical Network
MOSAK	Modelling and Observational Studies of Antarctic Katabatic Winds
OBIS	Ocean Biodiversity Information System
PASTA	Plateau Astronomy Site Testing in Antarctica
PPE	Permafrost and Periglacial Environments
READER	Reference Antarctic Data for Environmental Research
RiSCC	Regional Sensitivity to Climate Change in Antarctic Terrestrial and Limnetic Ecosystems
SALE	Subglacial Antarctic Lake Environments
SALEGOS	Subglacial Antarctic Lake Exploration Group of Specialists
SCALOP	Standing Committee on Antarctic Logistics and Operations
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanic Research
SHALDRIL	Shallow Drilling
SRP	Scientific Research Programme
SSG	Standing Scientific Group
SSG-G	SSG on Geosciences
SSG-LS	SSG on Life Sciences
SSG-PS	SSG on Physical Sciences
UN	United Nations
UNESCO	United Nations Educational, Scientific and Cultural Organization
URSI	Union Radio Scientifique Internationale
WMO	World Meteorological Organization