The International Council for Science

ISSN 1998-0337

SCAR bulletin

No. 185 AUGUST 2013

SCAR Annual Report 2012-13

Published by the

SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH

at the

Scott Polar Research Institute, Cambridge, United Kingdom

SCAR Annual Report 2012-13

Table of Contents

SCAR Annual Report 2012-13

1. Background

The Scientific Committee on Antarctic Research (SCAR) is a non-governmental, Interdisciplinary Scientific Body of the International Council for Science (ICSU), and Observer to the Antarctic Treaty and the UNFCCC.

SCAR's Mission is (i) to be the leading, independent, non-governmental facilitator, coordinator, and advocate of excellence in Antarctic and Southern Ocean science and research and (ii) to provide independent, sound, scientifically-based advice to the Antarctic Treaty System and other policy-makers, including the use of science to identify emerging trends and bring these issues to the attention of policy-makers.

2. Introduction

SCAR's scientific research adds value to national efforts by enabling national researchers to collaborate on large-scale scientific programmes to accomplish objectives not easily obtainable by any single country. SCAR's members currently include 37 nations and 9 ICSU scientific unions.

SCAR's success depends on the quality and timeliness of its scientific outputs. Descriptions of SCAR's research programmes and scientific outputs are available at: www.scar.org. This paper summarises SCAR highlights since the last annual report and lists future SCAR meetings we believe will be of interest to Treaty Parties and others. Selected Antarctic and Southern Ocean science highlights for 2012/13 are listed in Appendix 1.

SCAR produces an electronic quarterly Newsletter highlighting relevant science and other SCAR related issues (http://www.scar.org/news/newsletters/). Please email info@scar.org if you wish to be added to the mailing list. As well as the web (www.scar.org), SCAR is also available on Facebook, LinkedIn, Google+ and Twitter.

3. SCAR Highlights (2012/13)

3.1 New SCAR Scientific Research Programmes

In July 2012, SCAR Delegates approved five new Scientific Research Programmes (SRPs). The new SRPs will continue the important scientific foci of SCAR, whilst expanding into newly identified high-priority areas for research, including a stronger emphasis on scientific advice to the Treaty. For further details, see http://www.scar.org/researchgroups/progplanning/. The new SRPs are:

State of the Antarctic Ecosystem (AntEco)

Biological diversity is the sum of all those organisms that are present in an ecosystem, that dictate how ecosystems function, and that underpin the life-support system of our planet. This programme has been designed to focus on patterns of biodiversity across terrestrial, limnological, glacial and marine environments within the Antarctic, sub-

Antarctic and Southern Ocean regions, and to provide the scientific knowledge on biodiversity that can be also used for conservation and management. In essence, SCAR proposes to explain what biodiversity is there, how it got there, what it does there, and what threatens it. A primary product of this programme will be recommendations for its management and conservation.

Antarctic Thresholds - Ecosystem Resilience and Adaptation (AnT-ERA)

AnT-ERA will examine the current biological processes in Antarctic ecosystems, to define their thresholds and thereby determine resistance and resilience to change. The extreme environment and marked difference in community complexity between the polar regions and much of the rest of the planet may mean that consequences of stress for ecosystem function and services, and their resistance and resilience, will differ from elsewhere. Polar ecosystem processes are therefore key to informing wider ecological debate about the nature of stability and change in ecosystems. The programme will attempt to determine the likelihood of cataclysmic shifts or "tipping points" in Antarctic ecosystems.

Antarctic Climate Change in the 21st Century (AntClim^{21})

The goals of AntClim^{21} are to deliver improved regional predictions of key elements of the Antarctic atmosphere, ocean and cryosphere for the next 20 to 200 years and to understand the responses of the physical and biological systems to natural and anthropogenic forcing factors. Primary forms of data that will be used by AntClim^{21} are the global coupled atmosphere-ocean model runs that form the basis of the Fifth Assessment Report (AR5) of the IPCC. Palaeo-reconstructions of selected time periods, recognised as past analogues for future climate predictions, will be used to validate model performances for the Antarctic region.

Past Antarctic Ice Sheet Dynamics (PAIS)

PAIS aims to improve our understanding of ice sheet dynamics during past warm world conditions by:

- targeting the study of vulnerable areas around the continent;
- linking ice-proximal records with coastal and offshore records including far field paleoceanographic and sea level records;
- integrating data into the latest generation of coupled Glacial Isostatic Adjustment (GIA)-Ice Sheet-Climate models.

Solid Earth Response and influence on Cryosphere Evolution (SERCE)

SERCE aims to improve understanding of the solid earth response to cryospheric and tectonic forcing. SERCE will:

- Identify and develop key disciplinary and interdisciplinary science components of a science programme aimed at advancing understanding of the interactions between the solid earth and the cryosphere;
- Coordinate with other groups investigating ice mass change, ice sheet contributions to global sea level rise, glacial isostatic adjustment models of ice caps, etc.;
- Work with groups and research programmes to promote interdisciplinary science using POLENET project data;

- Provide an international framework for maintaining, and potentially augmenting, the remote autonomous POLENET infrastructure.

3.2 The Southern Ocean Observing System (SOOS)

The Southern Ocean plays a key role in the climate and ecosystem functioning of the whole planet, but understanding has long been hampered by lack of data. A SOOS International Project Office, established in Australia and supported by the Institute for Marine and Antarctic Studies at the University of Tasmania in Hobart and Antarctica New Zealand, supports implementation of the SOOS. A new SOOS data portal has also been established: http://www.soos.aq/index.php/data/data-portal. Visit www.soos.aq or see the SOOS report to XXXVI ATCM (IP005 at http://www.scar.org/treaty/atcmxxxvi/).

3.3 The Antarctic Climate Change and the Environment (ACCE) Report Update

SCAR has published a major update to the 'key points' from the Antarctic Climate Change and the Environment (ACCE) report. In this update, we summarize subsequent advances in knowledge of how the climate of the Antarctic and Southern Ocean have changed in the past, how they might change in the future, and examine the associated impacts on the marine and terrestrial biota. For more information, see the ACCE papers to XXXVI ATCM (WP038 and BP021 at http://www.scar.org/treaty/atcmxxxvi/).

3.4 The SCAR Science Horizon SCAN

The 1st SCAR Antarctic and Southern Ocean Science Horizon Scan will assemble some of the world's leading Antarctic scientists, policy-makers, leaders and visionaries to identify the most important scientific questions that will or should be addressed by research in and from the southern polar regions over the next two decades. The Scan outcomes will assist in aligning international programmes, projects and resources to effectively facilitate Antarctic and Southern Ocean science in the coming years. See the Horizon Scan paper to XXXVI ATCM (IP019 at http://www.scar.org/treaty/atcmxxxvi/) or visit the SCAR Horizon Scan website (http://www.scar.org/horizonscanning/).

3.5 Antarctic Conservation in the 21st Century

SCAR, COMNAP, New Zealand and the IUCN, in collaboration with several partners, are developing a strategy entitled '*Antarctic Conservation for the 21st Century*'. The activity will actively encourage participation from all stakeholders in the region. The approach will be structured to align with both the Protocol on Environmental Protection to the Antarctic Treaty and the Five Year Work Plan of the Committee for Environmental Protection. The Antarctic Conservation Strategy links closely with the Environments Portal being developed by New Zealand, SCAR and Australia. For more information, see the Environments Portal paper to XXXVI ATCM (WP028 at http://www.scar.org:8080/treaty/atcmxxxvi/).

3.6 Fellowships and Prizes

In order to expand capacity in all its member countries, SCAR runs several fellowship and prize schemes, including:

- ***SCAR/COMNAP Fellowships*** (applications closed 4 June 2013). The Fellowships are designed to encourage the active involvement of early career scientists and engineers in Antarctic scientific research, and to build new connections and further strengthen international capacity and cooperation in Antarctic research. This year, the scheme has been launched in tandem with the ***CCAMLR Scholarships***. For further details see: http://www.scar.org/awards/fellowships/information.html.
- ***Martha T Muse Prize for Science and Policy in Antarctica*** (nominations closed 23 May 2013). Sponsored by the Tinker Foundation, this is a US$ 100,000 unrestricted award presented to an individual in the fields of Antarctic science or policy who has demonstrated potential for sustained and significant contributions that will enhance the understanding and/or preservation of Antarctica. For more information, see: www.museprize.org.
- ***SCAR Visiting Professor Scheme*** (nominations closed 16 August 2013). The Visiting Professorships are for mid- to late-career stage scientists and academics. It provides them the opportunity to undertake short-term visits to a facility in or operated by SCAR Member countries, to provide training and mentoring. See: http://www.scar.org/awards/.

3.7 New SCAR Executive Committee

Jerónimo López-Martínez, from the Universidad Autónoma of Madrid, Spain, was elected the new SCAR President. SCAR also has two new Vice-Presidents: Karin Lochte from the AWI in Germany and Bryan Storey from the University of Canterbury, New Zealand. They will join Yeadong Kim (Korea) and Sergio Marenssi (Argentina), as well as Mahlon "Chuck" Kennicutt (USA) who will remain on the Executive Committee until July 2014 as Past President.

3.8 Venezuela joins SCAR

Venezuela is the latest country to join SCAR as an Associate Member in 2012.

4. Future SCAR Meetings

There are several major SCAR Meetings coming up (http://www.scar.org/events/), including:

- **SCAR Biology Symposium**. 15-19 July 2013, Barcelona, Spain. See: http://www.icm.csic.es/XIthSCARBiologySymposium.
- **SCAR Executive Committee Meeting and cross linkages meeting of the chief officers of SCAR Standing Scientific Groups, Committees and Research Projects.** 20-23th July 2013, Barcelona, Spain.
- **SCAR Astronomy and Astrophysics from Antarctica (AAA) Workshop.** 24 - 26 July 2013, Siena, Italy. See: http://www.astronomy.scar.org/AAA2013.

- **XXXIII SCAR Meetings and Open Science Conference.** 22 August - 3 September 2014, Auckland, New Zealand. The SCAR Open Science Conference will be held on 25-29 August. See: http://www.scar2014.com.

Appendix 1

Selected Antarctic and Southern Ocean Science Highlights (2012/13)

Here we highlight some recent key science papers published over the past year. Although not highlighted below, the new ACCE update (published in *Polar Record* and submitted as a SCAR Background Paper to the XXXVI ATCM) was also a very important publication. It should also be noted that this is by no way a complete list (there have been many highly significant papers published over the last year) but represents a sample of key science papers highlighted by SCAR groups.

Climate Change:

a) Mayeswski et al (2012) show that the location and intensity of the austral westerlies strongly influence southern hemisphere precipitation and heat transport with consequences for human society and ecosystems. With future warming, global climate models project increased aridity in southern mid-latitudes related to continued poleward contraction of the austral westerlies. This manuscript shows that recent poleward migration of the westerlies coincident with increased emission of greenhouse gases and the Antarctic ozone hole has led to unprecedented penetration, compared with >100,000 years ago, of air masses bringing warmth, extra-Antarctic source dust and anthropogenic pollutants into West Antarctica:

Mayewski, P.A., Maasch, K.A., Dixon, D., Sneed, S.B., Oglesby, R., Korotkikh, E., Potocki, M., Grigholm, B., Kreutz, K., Kurbatov, A.V., Spaulding, N., Stager, J.C., Taylor, K. C, Steig, E.J., White, J., Bertler, N.A.N., Goodwin, I., Simoñes, J.C., Jaña, R., Kraus, S., Fastook, J. 2013. West Antarctica's sensitivity to natural and human-forced climate change over the Holocene. Journal of Quaternary Science, 28 (1), 40-48. DOI: 10.1002/jqs.2593

b) Sea ice extent in the Ross Sea region has increased since 1979 AD. Sinclair et al. (2012) discusses the results of a 125-yr seasonally resolved ice core record from northern Ross Sea Region. While reconstructed mean annual temperatures show no significant change between 1882 and 2006, a cooling of the autumn/winter seasons (April–September) temperatures of -1.56 ± 0.84C/decade is observed since 1979. This cooling trend is in contrast to a surface temperature record from Ross Island (Scott Base) where significant spring warming is observed. The authors argue that the observed cooling is forced through the strengthening of Westerly Winds (positive trend of the Southern Annular Mode), which causes stronger southerly winds and increased sea ice extent and duration in the western Ross Sea:

Sinclair, K.E., Bertler, N.A.N. and van Ommen, T.D. 2012. Twentieth century surface temperature trends in the western Ross Sea, Antarctica: Evidence from a high resolution ice core, Journal of Climate, 25 (10), 3629-3636, doi: 10.1175/JCLI-D-11-00496.1

c) Changes in atmospheric circulation over the past five decades have enhanced the wind-driven inflow of warm ocean water onto the Antarctic continental shelf, where it melts ice shelves from below. Atmospheric circulation changes have also caused rapid warming over the West Antarctic Ice Sheet, and contributed to declining sea-ice cover in the adjacent Amundsen–Bellingshausen seas. Steig et al. (2013) use water-isotope ($\delta^{18}O$) data from an array of ice-core records to place recent West Antarctic climate changes in the context of the past two millennia:

Steig E. J., Q. Ding, J. W. C. White, M. Küttel, S. B. Rupper, T. A. Neumann, P. D. Neff, A. J. E. Gallant, P. A. Mayewski, K. C. Taylor, G. Hoffmann, D. A. Dixon, S. W. Schoenemann, B. R. Markle, T. J. Fudge, D. P. Schneider, A. J. Schauer, R. P. Teel, B. H. Vaughn, L. Burgener, J. Williams, E. Korotkikh. Recent climate and ice-sheet changes in West Antarctica compared with the past 2,000 years. 2013. Nature Geoscience. doi:10.1038/ngeo1778

Past Climate:

a) The paper by Pross et al. (2012) provides information on the early Eocene (~52 million years ago) climate from lowland settings along the Antarctic Wilkes Land coast of East Antarctica. Early Eocene climate supported near-tropical forests including palms and Bombacoideae (equivalent to today's Baobabs). Winters were extremely mild (warmer than 10°C) and frost-free, despite polar darkness. These new findings provide new constraints for the validation of climate models, for understanding the response of high-latitude terrestrial ecosystems to increased carbon dioxide forcing, and therefore provide insights into the response of Earth's climate and biosphere to the high atmospheric carbon dioxide levels that are expected in the future:

Pross, J., Contreras, L., Bijl, P.K., Greenwood, D.R., Bohaty, S.M., Schouten, S., Bendle, J.A., Röhl, U.,Tauxe, L., Raine, J.I., Huck, C.E., van de Flierdt, T., Jamieson, S.S.R., Stickley, C.E., van de Schootbrugge, B., Escutia, C., Brinkhuis, H., and IODP Expedition 318 Scientists. Persistent near-tropical warmth on the Antarctic continent during the early Eocene epoch. Nature Vol 488, No. 7409: 73-77, doi:10.1038/nature11300.

b) Over the past 50 years, warming of the Antarctic Peninsula has been accompanied by accelerating glacier mass loss and the retreat and collapse of ice shelves. A key driver of ice loss is summer melting; however, it is not usually possible to specifically reconstruct the summer conditions that are critical for determining ice melt in Antarctic. Abram et al. (2013) reconstruct changes in ice-melt intensity and mean temperature on the northern Antarctic Peninsula since AD 1000 based on the identification of visible melt layers in the James Ross Island ice core and local mean annual temperature estimates from the deuterium content of the ice. They conclude that ice on the Antarctic Peninsula is now particularly susceptible to rapid increases in melting and loss in response to relatively small increases in mean temperature:

Abram N. J., Mulvaney, R., Wolff, E.W., Triest, J., Kipfstuhl, S., Trusel, L.D., Vimeux, F., Fleet, L. & Arrowsmith, C. 2013. Acceleration of snow melt in an Antarctic Peninsula ice core during the twentieth century. Nature Geoscience. doi:10.1038/ngeo1787

Ice Sheet Mass Balance:

The recent study of Shepherd et al. (2012) reconciled the various satellite-derived estimates of changes in the mass of the Antarctic ice sheet and also estimated the contribution to sea level rise. They found that over the period 1992–2011 the Antarctic Peninsula, West Antarctica and East Antarctica have respectively contributed +0.05±0.04, +0.18±0.07 and -0.04±0.12 mm per year to global sea level rise. Combined, this gives a contribution from the whole Antarctic ice sheet of +0.20±0.15 mm per year, which compares to +0.39±0.14 mm per year from the Greenland ice sheet:

Shepherd, A., Ivins, E. R., Geruo, A., Barletta, V. R., Bentley, M. J., Bettadpur, S., Briggs, K. H., Bromwich, D. H., Forsberg, R., Galin, N., Horwath, M., Jacobs, S., Joughin, I., King, M. A., Lenaerts, J. T. M., Li, J. L., Ligtenberg, S. R. M., Luckman, A., Luthcke, S. B., McMillan, M., Meister, R., Milne, G., Mouginot, J., Muir, A., Nicolas, J. P., Paden, J., Payne, A. J., Pritchard, H., Rignot, E., Rott, H., Sorensen, L. S., Scambos, T. A., Scheuchl, B., Schrama, E. J. O., Smith, B., Sundal, A. V., van Angelen, J. H., van de Berg, W. J., Van den Broeke, M. R., Vaughan, D. G., Velicogna, I., Wahr, J., Whitehouse, P. L., Wingham, D. J., Yi, D. H., Young, D., and Zwally, H. J. A Reconciled Estimate of Ice-Sheet Mass Balance. Science 338(6111), 1183-1189. 30-11-2012.

Mapping of the Antarctic Bedrock:

The recently published Bedmap2 paper (Fretwell et al., 2013) represents a significant contribution to Antarctic science mainly because, using a higher resolution and multiple data set, this work reports a nearly 5% increase in ice-volume from previous estimates. Similarly, there is a significant revision in the bed-rock level leading to an increased volume of ice below sea-level:

P. Fretwell, H. D. Pritchard, D. G. Vaughan, J. L. Bamber, N. E. Barrand, R. Bell, C. Bianchi, R. G. Bingham, D. D. Blankenship, G. Casassa, G. Catania, D. Callens, H. Conway, A. J. Cook, H. F. J. Corr, D. Damaske, V. Damm, F. Ferraccioli, R. Forsberg, S. Fujita, Y. Gim, P. Gogineni, J. A. Griggs, R. C. A. Hindmarsh, P. Holmlund, J. W. Holt, R. W. Jacobel, A. Jenkins, W. Jokat, T. Jordan, E. C. King, J. Kohler, W. Krabill, M. Riger-Kusk, K. A. Langley, G. Leitchenkov, C. Leuschen, B. P. Luyendy, K. Matsuoka, J. Mouginot, F. O. Nitsche, Y. Nogi, O. A. Nost, S. V. Popov, E. Rignot, D. M. Rippin, A. Rivera, J. Roberts, N. Ross, M. J. Siegert, A. M. Smith, D. Steinhage, M. Studinger, B. Sun, B. K.Tinto, B. C. Welch, D. Wilson, D. A. Young, C. Xiangbin, and A. Zirizzotti. 2013. Bedmap2: improved ice bed, surface and thickness datasets for Antarctica. The Cryosphere, 7, 375–393, 2013 www.the-cryosphere.net/7/375/2013/, doi:10.5194/tc-7-375-2013

The Southern Ocean:

(a) Bednaršek et al. (2012) represents a key paper on the effects of ocean acidification in the Southern Ocean. As deep-water upwelling and CO_2 absorption by surface waters is likely to increase as a result of human activities, they concluded that upper ocean regions where aragonite-shelled organisms are affected by dissolution are likely to expand:

Bednaršek, N., Tarling, G. A., Bakker, D. C. E., Fielding, S., Jones, E. M., Venables, H. J., Ward, P., Kuzirian, A., Lézé, B., Feely, R. A., Murphy, E.J. 2012 Extensive dissolution of live pteropods in the Southern Ocean. Nature Geoscience, 5 (12). 881-885. 10.1038/NGEO1635

(b) Costa et al. (2012) review the advances made in our ability to study highly pelagic large marine vertebrates. While the review is global, it highlights work being carried out in the Antarctic, especially the thriving field of using animals as ocean sensors. Studies enabled by new technologies now allow us to follow the movements of marine vertebrates over great distances and long time periods in great detail, providing detailed characteristics of the habitats they use and clues to their navigation abilities. Together these tools are providing critical insights into the ecology of highly pelagic marine vertebrates that are key for their conservation and management:

Costa, D.P., G. A. Breed, P. W. Robinson. 2012. Annual Review of Ecology, Evolution and Systematics. 43:7 3–96.

(c) The paper by Murphy et al. (2012) considers the main ecological and modelling challenges in predicting the responses of Southern Ocean ecosystems to change, and proposes three interlinked focus areas that will advance the development of integrated models for Southern Ocean ecosystems:

E.J. Murphy, R.D. Cavanagh, E.E. Hofmann, S.L. Hill, A.J. Constable, D.P. Costa, M.H. Pinkerton, N.M. Johnston, P.N. Trathan, J.M. Klinck, D.A. Wolf-Gladrow, K.L. Daly, O. Maury, S.C. Doney. 2012. Developing integrated models of Southern Ocean food webs: Including ecological complexity, accounting for uncertainty and the importance of scale. Progress in Oceanography, 2012, 102 (SI), p. 74-92.

Terrestrial Ecosystems:

The polar regions are experiencing rapid climate change with implications for terrestrial ecosystems. This paper makes some important early predictions on soil invertebrate community responses to predicted 21st century climate change. It suggests that climate amelioration is likely to allow a greater influx of non-native species into both the Arctic and Antarctic, promoting landscape scale biodiversity change:

U. N. Nielsen and D. H.Wall. 2012. The future of soil invertebrate communities in polar regions: different climate change responses in the Arctic and Antarctic? Ecology Letters, 16: 409–419 doi: 10.1111/ele.12058

Conservation in the Antarctic:

A major highlight in the Antarctic conservation literature has been the conservation and governance horizon scanning exercise reported in the Chown et al. (2012) *Science* paper. This is an authoritative attempt to identify future challenges to the Antarctic Treaty System and continental governance in advance of them actually happening:

Chown, S. L., J. E. Lee, K. A. Hughes, J. Barnes, P. J. Barrett, D. M. Bergstrom, P. Convey, D. A. Cowan, K. Crosbie, G. Dyer, Y. Frenot, S. M. Grant, D. Herr, M. C. Kennicutt, II, M. Lamers, A. Murray, H. P. Possingham, K. Reid, M. J.

Riddle, P. G. Ryan, L. Sanson, J. D. Shaw, M. D. Sparrow, C. Summerhayes, A. Terauds, D. H. Wall, Challenges to the Future Conservation of the Antarctic, Science, Vol 337, 13 July 2012

Astronomy and Astrophysics:

The origin of ultra high-energy cosmic rays is one of the great, unsolved mysteries of modern astrophysics. Gamma-Ray Burst (GRB) sources currently offer the leading explanation; if they are indeed responsible then significant numbers of TeV neutrinos should also be produced. However, analyses of two years of data from the IceCube detector at South Pole Station have produced no evidence of this neutrino flux - further deepening the mystery:

IceCube Collaboration (R. Abbasi et al.). 2012.An absence of neutrinos associated with cosmic-ray acceleration in γ-ray bursts, Apr 2012. 6 pp. Nature 484. 351-353 DOI: 10.1038/nature11068. e-Print: arXiv:1204.4219

Appendix 2

List of Acronyms

AAA	Astronomy & Astrophysics from Antarctica
ACCE	Antarctic Climate Change and the Environment
AntClim[21]	Antarctic Climate Change in the 21st Century
AntEco	State of the Antarctic Ecosystem
AnT-ERA	Antarctic Thresholds - Ecosystem Resilience and Adaptation
AR5	Fifth Assessment Report (IPCC)
ATCM	Antarctic Treaty Consultative Meeting
ATS	Antarctic Treaty System
Bedmap2	Antarctic Bedrock Mapping
GIA	glacial isostatic adjustment
GRB	Gamma-Ray Burst
IceCube	the South Pole Neutrino Observatory
ICSU	International Council for Science
IPCC	Intergovernmental Panel on Climate Change
IUCN	International Union for Conservation of Nature
PAIS	Past Antarctic Ice Sheet dynamics
SERCE	Solid Earth Response and influence on Cryosphere Evolution
SOOS	Southern Ocean Observing System
SRP	Scientific Research Programme
UNFCCC	United National Framework Convention on Climate Change