SCAR Cross-Linkages Workshop
22 – 24 November, 2005
Free University, Amsterdam,
The Netherlands

Version 20 December 2005 17:20

Attendees:

Sergey Bulat, Russia, member SALE SRP
Alessandro Capra, CO SSG Geosciences
Peter Convey, UK, co-chair EBA SRP
Taco de Bruin, the Netherlands, CO JCADM
Guido di Prisco, Italy, co-chair EBA SRP
Rob Dunbar, US, co-chair ACE SRP
Ad Huiskes, the Netherlands, CO SSG Life Sciences, member EBA SRP
Paul Mayewski, US, member AGCS SRP
Martin Siegert, UK, co-chair ACE SRP, member SALE SRP
Colin Summerhayes, UK, Executive Director SCAR
John Turner, UK, CO SSG Physical Sciences, chair AGCS SRP

Objectives

1. To explore or clarify the potential interdisciplinary linkages between SCAR's research programmes.
2. To establish what relevant data are already available.
3. To set out a plan for acquiring data needed to develop linkages.

Agenda

1. Opening
2. Goals, objectives, and implementation
   a. AGCS (John Turner)
   b. ACE (Martin Siegert)
   c. EBA (Ad Huiskes)
   d. SALE (Sergey Bulat)
3. Output and data produced, output and data requested
   a. AGCS (John Turner, Paul Mayewski)
   b. ACE (Martin Siegert, Rob Dunbar)
   c. EBA (Guido di Prisco, Pete Convey)
   d. SALE (Sergey Bulat)
4. Long-term monitoring and observatories as a basis for multidisciplinary measurements, data management and availability (Taco de Bruin (JCADM), Alessandro Capra)
5. Break-out groups will discuss items decided on Tuesday
6. Break-out groups report in plenary, discussion
7. Conclusions, commitments and report writing
8. Closure of the workshop

Opening

Ad Huiskes opened the workshop and welcomed the attendees. John Turner agreed to chair the workshop and he and Ad Huiskes took notes. Colin Summerhayes was invited to make some introductory remarks. He emphasised the following points:
(i) interdisciplinarity is important for SCAR in general and for the individual Special Research Programmes (SRPs) in particular. The Delegates' meeting stressed the need for interdiscipliarity, and for cross discipline linkages between the 5 SRPs, when adopting the five research programmes in October 2004.
(ii) SCAR will review the Special Research Programmes in a few years time, using an already accepted review procedure. It would also be necessary to develop a review process for the Standing Scientific Groups and their subsidiary bodies (Action and Expert Groups), and the first reviews should be identified at the SSG meetings in Hobart.
(iii) if there was time, the workshop should address the issue of the IPY, and especially how to deal with proposals from the Antarctic community that had been returned to the proposers for improvement.
(iv) if there was time the workshop should also consider the links of SCAR with science policy matters.
(v) there is a continuing need to ensure that to the extent possible there is geographical balance in the membership of each and every SCAR science group.
(vi) the workshop should also address (a) the question of the extent to which SCAR is (or could or should be) involved in chemical and biogeochemical research, and (b) how to give a higher profile to what we do in these areas.

Goals, objectives, and implementation of the Special Research Programmes

a. AGCS

John Turner presented the objectives and the science plan of the AGCS (Antarctica and the Global Climate System) programme. The programme comprises four themes:
1. Decadal time scale variability in the Antarctic climate system
2. Global and regional climate signals in ice cores
3. Natural and anthropogenic forcing on the Antarctic climate system
4. The export of Antarctic climate signals

In the discussion the point was made that the AGCS programme is able to provide other programmes with information on the likely development of the Antarctic climate in the next 100 years. In break-out groups the needs of the other programmes for this kind of data will be specified. As AGCS also includes oceanographic data, marine scientists as well as terrestrial scientists may benefit from the research of this programme. AGCS has established external links with groups such as the World Climate Research Programme's Climate and Cryosphere (CLiC) programme in the field of the cryosphere and the global climate system.

b. ACE

Martin Siegert presented the objectives and the science plan of the ACE (Antarctic Climate Evolution) programme. ACE has a long history, having begun life as ANTOSTRAT, but differs from ANTOSTRAT in having modelling as a focus. The programme attempts to understand the climate history of the Antarctic and tries to link climate history to climate modelling and ice sheet modelling. The programme focuses on the climatic evolution of the Tertiary and Quaternary, up to the end of the

Last Glacial Maximum. Five sub-groups of up to 10 people in each have been set up to coordinate research in the different time frames of the Tertiary, with a sixth group focusing on Radio-Echo Sounding. ACE is integrating programmes focusing on e.g. ice core research and geology. ACE can be helpful to SALE, by providing geological records. ACE and AGCS should collaborate, as the Last Glacial Maximum is an important feature for both programmes. ACE should collaborate with EBA, as the biologists may be helpful in the interpretation of paleontological data, while ACE may provide EBA with information on the development of the Antarctic climate on geological time scales, important for the interpretation of evolutionary processes.

c. EBA

Ad Huiskes presented the objectives and the science plan of the EBA (Evolution and Biodiversity in the Antarctic) programme. EBA has five research fields (work packages):

1. Evolutionary history of Antarctic organisms
2. Evolutionary adaptation to the Antarctic environment
3. Patterns of gene flow within, into and out of the Antarctic, and consequences for population dynamics: isolation as a driving force
4. Patterns and diversity of organisms, ecosystems and habitats in the Antarctic, and controlling processes.
5. Impact of past, current and predicted future environmental change on biodiversity, and the consequences for Antarctic marine, terrestrial and limnetic ecosystem function.

He explained that EBA needs to collaborate with AGCS in the field of climate modelling and the development of scenarios for the future of the ecosystems in the Antarctic biome. Especially in evolutionary studies, he sees close links with ACE in the field of the effects of climate processes on the evolutionary processes of organisms in the Antarctic. Collaborations with SALE are already in progress, e.g. in terms of expected unusual adaptation responses and evolutionary processes of microbiota likely thriving in the subglacial Antarctic lake environments.

Some aspects deserve further comments. For example, the impact of a climatic change often entails complex outcomes: shortage of precipitation or shrinking ice shelves would accelerate the rise in temperature due to the albedo change; by directly influencing the enzyme activity and gene activity/expression within cells, climate change can affect every aspect of an organism's biology, from cellular physiology to food web and habitat. The combination of isolation and climate change has led to a biota rich in endemic taxa, and to a strong contrast between marine and terrestrial/ limnetic biotas, from apparently simple ecosystems on land to highly diverse marine systems on the shelves and in the deep sea. In the marine realm the challenge is for organisms to function at the lowest seawater temperature on earth, but where seasonal variations are small. In contrast, on continental Antarctica, terrestrial and limnetic organisms must face enormous daily and seasonal fluctuations in temperature, extensive periods of freeze/thaw and of low water availability. Conditions on land fluctuated between cold and warm during the Tertiary, and terrestrial floras and faunas changed accordingly. After separation of Antarctica during the Cretaceous and Tertiary, the earliest cold-climate marine faunas are thought to be latest Eocene-Oligocene (c. 35 million years ago). Since then, the fauna has been subject to steady decrease in seawater temperature and increasing influence of sea-ice; nearly complete replacement of the fish fauna on the shelf occurred. On land, conditions have fluctuated between cold and warm periods, but superimposed by an overall cooling since the Mesozoic, and terrestrial and limnetic biota, ice-cover and land availability have changed accordingly. Areas supporting such biotas have been continuously available for periods ranging from several million to only a few thousand years. The continental shelves support a remarkably diverse fauna. In strong contrast, terrestrial communities are relatively impoverished, partly the result of eradication of almost all biota at previous glacial maxima. They also decrease in diversity with latitude. Thus, patterns of biological diversity are greatly different between land and sea.

An important feature of EBA is to seek an understanding of the reasons behind these differences. The study of biotic history is linked intimately to tectonic, climatic and palaeobiological studies and to biogeographic comparisons with other fragments of Gondwana. Integration with climate and tectonic history is essential, because feedback between the living and abiotic environments have modulated both.

On shorter time-scales, the Antarctic biota has also experienced cycles of global environmental change driven by periodic glaciations, on which recent anthropogenic global warming and increased UV radiation resulting from ozone depletion has been superimposed. Regional scale and short-term climatic variations appear to have been more frequent and intense in recent years.

Diversity along latitudinal gradients is also important.

Colin Summerhayes pointed out that the newly developing ICED programme (Integrated Analyses of Circumpolar Climate Interactions and Ecosystem Dynamics in the Southern Ocean) should provide a link between the ocean ecosystems part of EBA and the oceans part of AGCS. In discussion, the group noted the need to encourage research on psychrophilic bacteria.

d. SALE

Sergey Bulat presented the objectives and the science plan of SALE (Subglacial Antarctic Lake Enviroments). Although the Russian drilling towards the waters of Lake Vostok is the project most highlighted in the programme of this group, the group also makes inventories of other under-ice structures, develops clean sampling technologies for these structures, and develops plans for drilling projects to reach other subglacial lakes, like Lake Ellsworth (WAIS) and Lake Concordia (EAIS). He gave an overview of the state of the art of the Lake Vostok drilling project. It was noted that ACE and SALE could successfully collaborate on ice sheet history and paleoclimatic (in lake sediments) records, EBA could collaborate with SALE in the field of evolutionary and biogeochemical assessment of microrganisms revealed in these extreme subglacial Antarctic lake environments.

Output, data produced and data requested

The leaders of the four programmes outlined the kinds of data their programmes tend to collect, or the kinds of existing data that may be useful for reanalysis. JCADM can play an important role here in bringing together and identifying databases. In the various break-out groups the collaborations between the various programmes were discussed in more detail.

a. JCADM

The Joint SCAR/COMNAP Committee on Antarctic Data Management (JCADM) was established by SCAR and COMNAP together in 1997 to provide SCAR and

COMNAP with data management expertise and advice. Currently, 30 nations are represented in JCADM.

The main task of JCADM is to coordinate the Antarctic Data Management System. Following the JCADM Terms of Reference, JCADM has been concentrating on

- recruiting new National Antarctic Data Centres (NADCs)
- assisting those new NADCs by all kind of capacity building activities
- advising SCAR and COMNAP on data issues
- developing a global inventory of Antarctic and Southern Ocean data set descriptions: the Antarctic Master Directory (AMD)

The AMD is housed within the Global Change Mater Directory (GCMD) managed by NASA. The AMD currently contains over 3800 dataset descriptions and this number is growing continuously. The AMD is also increasingly being used by scientists, as the number of dataset description retrievals (grown to ~500/month) clearly shows.

Building the Antarctic Data Management System and the Antarctic Master Directory for SCAR and COMNAP nevertheless meant that until now JCADM has concentrated its efforts at the national level. JCADM wishes to extend its activities to overarching SCAR projects, and was asked to do so by the SCAR Executive at the meeting in Sofia in July 2005.

The SCAR Executive requested JCADM to nominate data management experts for the Steering Committees of all SCAR Research Programmes (SRP).

JCADM, at its annual meeting in Buenos Aires in September 2005, has nominated

- Kim Finney (AUS – AADC) for EBA
- Helen Campbell (UK – BAS) for AGCS
- Rob Bauer (US – NSIDC) for ACE
- Claudio Rafanelli (IT – IFA/CNR) for ICESTAR
- The representative for SALE has yet to be determined

JCADM is actively developing partnerships with various organizations and groups, thereby establishing cross-linkages to help answer the data management needs of the SCAR SRPs.

- JCADM is on the Steering Committee of the SCAR-MarBIN project, the data and information component of the Census of Antarctic Marine Life (CAML), which is an EBA project.
- JCADM is collaborating with the International Oceanographic Data Exchange Committee (IODE) in the field of combining and harmonizing metadata directories.
- JCADM will assist in building Ocean-READER and Ice-READER databases for AGCS and has suggested building a similar Geo-READER database for ACE.
- JCADM is developing partnerships with various other organizations such as CliC, GBIF, ATS and IPY.
- JCADM will be making presentations to the three SSGs at their meetings in Hobart, and getting feedback from the scientists there about how JCADM may be made more useful for SCAR science.

b. Geographic Information Systems

It was recommended that the results obtained within SCAR activities on Place names, Map production and collection, and GIS systems implementation be made available to all SSGs and SRPs. This could help to establish cross-linkages between the SSGs and SRPs.

JCADM and the Geosciences Expert Group on Geographic Information (EGGI) were recommended to cooperate closely to provide the entire SCAR community with access to GI metadata and catalogues.

A two day EGGI meeting is planned for Hobart before the Open Science Conference. The JCADM Chief Officer is invited to attend in order to establish links and collaboration between EGGI and JCADM.

The SCAR Executive Director suggested that during the three SSG meetings the EGGI chair should explain to each of the three scientific communities the interdisciplinary aspects of the Expert Group activities.

c. Geodetic and Geophysical Observatories for Global Change

A knowledge of Earth and ice variations, in terms of movement and deformation (the dynamics of the Earth's surface and interior), is essential underpinning for studies of Global Change and Climate Change. That knowledge comes from geodetic and solid Earth geophysical observatories, data from which need to be integrated with all other Earth observing data and information to achieve best results .

Geodetic networks allow us to determine crustal deformation and surface kinematics. The integration of surface measurements and subsurface geophysical data, obtained through a seismological network, allows us to study the internal structure of the Earth, along with its seismicity and volcanism. GPS measurements can be used to derive the movements of glaciers, ice tongues and ice sheets.

GPS data can also be used to determine atmospheric parameters such as precipitable water. The use of a network of GPS observatories network allows us to control the quality of results, and the GPS network can even be used for meteorological data and weather forecasting.

In Antarctica there is a network of Observatories including GPS, VLBI, Doris, Tide gauge, Absolute Gravity, Seismometers, Magnetometers. Many of these observatories have operated for 20-15 years (see the SCAR web site under Geoscience SSG). Data from such observatories will find applications during the IPY of 2007-08. The GOIA (Geodetic Observatories In Antarctica) IPY proposal is specific to Antarctica. The programme is connected to POLENET (Polar Earth Observing Network for the International Polar Year); a more extended proposal that spans the Arctic and Antarctic.

d. Data and information management

SCAR Data and Information Management were discussed during one of the outbreak sessions. The group noted that

- there is an increasing need for data archiving and data access and exchange
- SCAR has no data policy
- most (if not all) SCAR science is funded at the national level
- data policies can only effectively be 'enforced' at a national level by funding agencies and/or national programmes

- careful thought needs to be applied to generate practicable definitions of "data" in this context, as the products and needs of different disciplines are not the same

The group concluded that SCAR needs a data policy based on the same principles as the data policies of similar organizations such as IOC, WMO and ICSU.

The SCAR data policy should include the following elements:

- It will be based on the Antarctic Treaty Article III-1c

  "Scientific observations and results from Antarctica shall be exchanged and made freely available"

- Existing national (and international) data policies will be quoted
- It will stress the importance of avoiding data (including specimen) loss and have procedures in place to manage/curate the data after the end of a project
- It will define data not only as digitally available but also as sample data
- All data should be available for free (although in principle realistic recognition needs to be included for resource demanding activities such as curation, storage and transport, in cases where "data" includes "specimens")
- In principle, by default, data should available for general use within the scientific community immediately after collection. A PI can exert an embargo on the use of the data for maximum period of 2 years after collection (however, differences between metadata and data were also discussed, as well as specific aspects linked to differences among research fields)
- Mechanisms are needed to acknowledge the country/scientist/funding agency who collected data and the country/organization which made the data available
- SCAR should be acknowledged where data are collected under a SCAR programme

The issue of intellectual property rights should not be addressed in the SCAR Data Policy, since this is an issue that should be addressed at a national level

SCAR is, through several members of the IPY Sub Committee on Data Policy and Management, involved in the development of the IPY data policy. It is foreseen that the IPY Data Policy may be used as the SCAR data policy with little or no alteration. The following timetable was suggested:

Feb. 2006:	First draft of IPY Data Policy
End Feb 2006:	Final version of IPY Data Policy
March 2006:	Acceptance of IPY Data Policy by IPY Joint Committee
July 2006:	Discussion of SCAR Data Policy (adapted from IPY Data Policy) by SCAR SSGs meeting in Hobart
July 2006:	Adoption of SCAR data policy by delegates meeting in Hobart.

The SCAR Data Policy will give an excellent example of best practice, which can be adapted for use at the national level. SCAR should encourage application of the SCAR Data Policy at all levels, including the SSGs and the SRPs.

SCAR should advocate the implementation of the data policy at a national level by addressing both the SCAR national committees and delegates and the National Antarctic Programmes/Funding agencies at the same time.

e. Requirements of the biologists for climate model output

A breakout group considered the fields from climate model simulations that would be of value to the biological community. These models would be run for up to 100 years in the future, with data being provided for each year. Among the ecological factors controlling distribution patterns and biodiversity of the modern Antarctic biota, the most important are temperature, water availability, ice cover, oxygen, light, UVB and wind. These factors are not constant, and vary over a range of temporal scales, from less than daily through seasonal to inter-annual. Besides fishing and introduction of alien species, the most important anthropogenic changes currently affecting the Antarctic are accelerated global warming and increased levels of UVB. Models of oceanic and atmospheric circulation can help to predict transport of propagules into (and out from) the Antarctic, establishing links between the physical environment and gene flow. In the marine environment, barriers include deep-water trenches between shelves, and isolating mechanisms include oceanographic fronts and gyres.

The requirements for the terrestrial, marine and limnological communities were considered separately. One potential problem would be the relatively coarse horizontal resolution of the current generation of global climate models, which is about 200 km. However, over the next few years regional climate models covering the Antarctic (and sub-regions of the continent) will be developed that have resolutions of tens of kilometres and possibly less than 10 km. An initial list of the model fields required is provided in Appendix 1. The first data from the coarse resolution models will be provided by July 2006. The Regional Climate Model will produce its first results with 2-3 years.

f. Requirements of the biologists for data from ice cores

A breakout group met to consider this topic. Key points raised were:

a) Ecosystem description. Ice coring in general (ie from surface snow layers, through shallow cores, to the deepest such as Vostok or Dome C) provides an opportunity for ecosystem description. This requires the inclusion of chemical/biochemical assays that may not be currently routine in the ice coring community, but are practicable. A range of nutrients and other biological indicators was drawn up that were considered practicable for analyses.
b) Does a viable biological community exist in the snow/ice (ie can it be regarded as an true ecosystem, as distinct from a reservoir, or a simple record of death)? There is clearly a spatial element to this question, as such ecosystems clearly exist in the form of snow algal and cryoconite communities at some locations in the Antarctic, and the potential spread of such communities from their current position is likely to be influenced by changing climatic/environmental parameters. This could be addressed (as with next section) by including biological filtering of snow/ice collected using suitable aseptic methodologies, followed by classical culture approaches and molecular

fingerprinting, though there still would remain a challenge to demonstrate activity as distinct from viability or mere presence.

c) Can biological material retrieved from snow or ice cores clarify patterns of dispersal, potential colonisation, across the entire Antarctic continent, or over time (ie through ice cores) be used as a proxy to identify changes in these patterns? The idea behind this would be to use the Antarctic snow/ice effectively as a giant integrated aerobiological sampler, and is a separate concept to (b), as it does not require an actual ice ecosystem to exist, only that it collects the biological material dispersed to it over time. Only very limited studies of this type have been attempted to date, generally at station locations, while to study these processes at isolated and generally inland terrestrial locations is generally beyond the scope of either logistic support, or the methodologies available. Such studies would ideally take advantage of traverse-type journeys to give transect sampling from coastal (likely relatively rich) locations to inland/high altitude ones (likely relatively poor). Aerobiological survey techniques, and the combination of both with meteorological back trajectory modelling, would clearly complement this approach.
d) Note that none of these studies are currently underway, hence we are talking about interdisciplinary potential here, and development would require new funding bids, which can be problematic for interdisciplinary approaches.

ACE – AGCS LGM/Holocene interactions

The ACE and AGCS research programmes have a common interest in climate variability and change on a range of timescales, and there was a discussion on this topic. It was agreed that a one-day workshop should be held on the theme of Atmospheric, Oceanic, Cryospheric and Biological Variability Over Decadal to Millennial Timescales. This would take place on Monday 10 July, just before the Open Science Conference. This would deal with the Last Glacial Maximum (around 20k yr before present) to the present. Topics dealt with would include a comparison of marine and ice core records. What was the state of the climate and ice sheet modelling during this period? How did the modes of variability change? Martin Siegert and Rob Dunbar agreed to find a convenor or convenors for this symposium.

Key Antarctic geophysical fields

It was pointed out that many groups within SCAR required fields of key atmospheric, cryospheric, geophysical and oceanic parameters, such as mean sea ice thickness, average near-surface air temperature, sea surface temperatures etc. It was agreed that the SCAR web site, under its data section, would provide images and data on regular latitude-longitude grids for key fields of information. The fields agreed to be included initially are listed in Appendix 2. Action – SSGs to suggest fields and provide data.

This same section of the web site should include the main existing SCAR datasets and databases (such as BEDMAP etc); currently these are listed in Annex 7 to the SCAR Strategic Plan, and tend to be scattered through the SCAR web site.

This led to a question for the SSGs. Are all the SCAR databases up to date and properly maintained? This needs to be addressed at the SSG meetings in Hobart.

Other useful information currently appears on the Antarctic Information page on the SCAR web site. Some consolidation of these different routes into data is desirable.

An Antarctic Climate Impact Assessment

Following the production of the Arctic Climate Impact Assessment early in 2005, the SCAR Executive Committee agreed at its meeting in Sofia (July 11-13, 2005) that a comparable and complementary Antarctic Climate Impact Assessment should be produced for the guidance of policy makers in the Antarctic Treaty System and to inform the public. The Executive Director and the Chief Officers of the Standing Scientific Group on Physical Sciences and of the Standing Committee on the Antarctic Treaty System were charged with developing an appropriate document for presentation to the 2007 Antarctic Treaty Consultative Meeting.

During the Amsterdam workshop, a small working group comprising Paul Mayewski (ITASE and AGCS), Rob Dunbar (ACE) and Colin Summerhayes (Secretariat) outlined a plan for an assessment document. The outline plan was agreed and amended by the meeting attendees (see Appendic 3). It will comprise three main sections:

(i) from 10,000 years to the present;
(ii) the past 50 years;
(iii) the next 100 years.

The document will be interdisciplinary, including information on the atmosphere, ocean, earth history and ice systems, and on the interaction of these with Antarctic ecosystems. The document should be written by a wide-ranging team of experts on the appropriate fields, under the leadership of the Executive Director. To achieve maximum impact it should be short, concise and to the point, and submitted as a Review article to the journal, NATURE. Such articles are 6 pages long and may include up to 100 references and 3-5 figures. The multi-author writing team should aim to complete its task so that the article is published shortly before the 2007 ATCM. A preliminary list of possible co-authors was developed. It was agreed that the initial text could be longer than required, anticipating that it would be cut back in the review process.

Aside from providing information for policy makers and the public, the article should provide inputs to the ongoing activities of the Intergovernmental Panel on Climate Change (IPCC), which is currently preparing its next report, and to the planners of activities for the International Polar Year, which begins in March 2007.

ACE – EBA linkages

a) The main thrust of the discussions here was that both sides have to be alive to the findings of each, rather than to identify specific areas of joint work – from the ACE perspective, there remain significant questions about the pattern of evolution, extent, dynamism of the Antarctic ice sheet, while from the biological perspective, climate and ice are clearly fundamental drivers of evolution, selection and distribution. Current RiSCC and planned EBA related research has already identified that vicariance (the fragmentation of ancient distributions) plays a considerably greater role than generally thought in explaining the distributions of both West and East Antarctic terrestrial and possibly limnetic biota. While "relict" taxa have been known for some time from East Antarctica, where relict habitats can comfortably be surmised (eg nunataks, ablation regions), the same is not simply true for West Antarctica, where the majority of the biota is known from low altitude and coastal habitats, assumed to have been obliterated at glacial maxima. However, at the extreme, the most recent molecular studies in both regions have indicated that either speciation events or population separation events can be dated on timescales of millions to tens of millions of years, that are clearly not consistent with a wide preconception that Antarctic biodiversity patterns have been driven by Pleistocene/Pliocene glaciation and climate events. Such findings may also have implications for the glaciological stability vs dynamism debate. From a biological perspective, these studies are currently being advanced using a combination of classical biogeographical baseline survey (there remain very considerable gaps in knowledge across the continent), and advanced molecular phylogenetic studies. The latter can be used to elucidate both phylogenetic patterns and, with input from glaciology and/or geology of independent temporal control, clarify timescales of evolutionary events. From glaciological/icesheet and even geological perspectives, the point to bear in mind is to allow for the existence of terrestrial habitats in the general scheme of reconstruction models. This obviously assumes modelling at an appropriate physical scale but, and very simplistically expressed, the presence of a vicariant terrestrial biota, particularly at low altitude, presents a novel constraint to be considered when modelling the extent, depth (and hence flow rate or mass balance) of previous ice sheets, or when addressing the geological question of dating emergence above sea level. In the marine realm, palaeobiologists have established the broad history of cool-temperate and cold marine biotas that have evolved in a mid- to high-latitude setting. The high diversity of the marine continental shelf fauna has been explained in terms of a relatively homogenous physical environment, disturbance by icebergs and glacial history. Periodic extensions of the ice sheet as far as the shelf edge will have fragmented the habitat and also driven many species down the continental slope (a mechanism for driving speciation; this climate diversity pump, a variation of standard vicariance speciation models, has probably been a major evolutionary driver in the history of the Antarctic biota). Fluctuations in the size of the Antarctic ice sheet are first documented in the Eocene, and have continued through the Pleistocene to the present day. Extensions and contractions of the ice sheet will have also influenced speciation by modulating gene flow between isolated populations. Recently, powerful insights into the evolutionary history of the Antarctic biota have been gained from modern molecular techniques. These have allowed divergence times between taxa to be dated, radiations (e.g. of notothenioid fishes) to be related to climatic or tectonic events, and have also revealed a number of cryptic species hinting at a vast reservoir of undetected diversity. Combining these approaches with our increasing understanding of the tectonic, climatic and glacial evolution of Gondwana offers a unique opportunity to advance our understanding of how evolutionary processes are related to the physical setting. EBA cannot of itself undertake work on the tectonic, climatic or glacial history of the Antarctic. Key questions: when did the key radiations of Antarctic taxa take place? What are the evolutionary links between continental shelf and slope/deep-sea species? How is the Antarctic biota geographically structured and related to that elsewhere?

b) Note that both ACE and EBA participants include the separate elements of these types of studies in their existing programs.

Chemistry and Biogeochemistry

Chemistry is the one main field of scientific endeavour not to be identified explicitly in the new SCAR structure. Meeting attendees therefore addressed the question of whether or not SCAR's current programmes were paying sufficient attention to chemistry and biogeochemistry in developing research programmes to address the major issues of the day. For instance, SCAR has no significant programme on atmospheric chemistry dealing with the ozone hole. Nor is SCAR addressing directly the role of the Southern Ocean as a major global sink for carbon dioxide.

From the discussion it became clear that several SCAR programmes do involve chemical analyses as a means of answering key scientific questions:

(i) the newly developing international programme ICED (Integrated Analyses of Circumpolar Climate Interactions and Ecosystem Dynamics in the Southern Ocean), which is co-sponsored by SCAR, SCOR and IMBER (a part of IGBP), will be the successor to the recently completed Southern Ocean component of JGOFS (the Joint Global Ocean Flux Study). Among other things it will address the question: "How does ecosystem structure affect circumpolar ocean biogeochemical cycles?", This will naturally address the carbon cycle.

(ii) Trace element chemistry is routinely used in the analysis of the short ice cores collected by the ITASE programme, and also of the long ice cores collected to assess climate history through the ice age, to provide information on such matters as the influx of dust, the influx of pollutants, the deposition of sea salt by winds, and the deposition of methyl sulphides derived ultimately from plankton.

(iii) Isotope chemistry is routinely used to establish the stratigraphic and thermal history of long ice cores. This generally comes under the heading of ACE.

(iv) CO2 and CH4 are analysed in the bubbles of gas trapped in ice cores, to provide the history of atmospheric gases.

(v) Ecosystem investigations on land and at sea involve the determination of a variety of nutrients and of complex organic molecules (fatty acids and so on). These are made routinely by individual investigators, but tend not to be shared as part of any wide reaching effort.

(vi) Much biology is developing along molecular lines, including analyses of the genome. Many of these resultswill be pulled together within SCAR's EBA programme.

Given this analysis, it was felt that there was no need to make chemistry and biogeochemistry a new strand in SCAR's programme, though it would be useful to highlight the fact on the SCAR web page that chemical and biogeochemical approaches were being widely used to answer key scientific questions.

Participants observed that ozone measurements are made from many national stations in Antarctica, and suggested that SCAR might play a useful role in encouraging ozone intercomparisons as a means of ensuring that best practice was adhered to. At the same time they recognised that ozone measurements are largely the province of the International Ozone Commission, which addresses ozone depletion globally, not just over Antarctica. It was suggested that we seek the advice of John Shanklin (BAS) as to the extent to which SCAR might become involved in ozone measurements. It was also recommended that ozone be given a prominent position on the SCAR web site, with appropriate URL links, for instance to the European ozone secretariat.

Participants also noted that measurements of the chemistry of the lower atmosphere were made from several coastal stations in Antarctica. It was noted that that these measurements tended to be discontinuous and measured different things at different places. It was suggested (a) that SCAR might recommend that the same measurements were made at the same times and to the same standards at an agreed array of sites, so as to provide a coherent and integrated picture of atmospheric chemistry across Antarctica; and (b) that in any case the measuring stations might benefit from SCAR arranging an intercomparison project. This matter could be addressed either (i) by a new action group; or (ii) by the aerosol action group (Antarctic Tropospheric Aerosols and their Role in Climate – ATAC)(either in its present or some expanded form); or (iii) under the overall leadership of AGCS, through which there could be some kind of synthesis of atmospheric chemical data. It was suggested that Carlo Barbante (Venice) be approached to discuss possible ways forward, focusing initially on option (iii).

The group also agreed that it would be useful to create a Southern Ocean chlorophyll database by compiling records from ocean colour satellites such as SeaWifs. This would facilitate studies of seasonal and interannual change in Southern Ocean biology and biogeochemistry. The question could be discussed as a topic at the forthcoming SSG-LS meeting in Hobart, but might also be addressed by the new SCAR/SCOR Oceanography Expert Group (EG Ocean). The EG-Ocean group should be encouraged among other things to compile multidisciplinary datasets of use to ICED and CCAMLR.

It was agreed that it would be ideal for the ACE Steering Committee to have as one of its members an expert in long ice core studies, and the Executive Director was asked to approach Eric Wolff about this.

The SCAR Web site

The SCAR Secretariat will take over the management of the three SSG web sites over the coming months, as staff effort becomes available. The five SRPs will continue to maintain their own web sites.

The Hobart Open Science Conference and related SCAR meetings

It is understood that meeting rooms will become available at the Grand Chancellor hotel from 11 AM on Saturday 8 July. In the preceding week some SCAR-related workshops (such as the ASPECT sea ice thickness workshop) will take place at other locations.

Recommendations and actions

Action	Person(s) responsible	Deadline
Develop a SCAR data policy	De Bruin with others as necessary	July 2006
Provide climate model data for the next century to the biologists	Turner	July 2006
Arrange workshop on Atmospheric, Oceanic, Cryospheric and Biological Variability Over Decadal to Millennial Timescales	Siegert and Dunbar	Find convenor(s). Contact LOC. Issue invitations. By end 2005
Write The Antarctic Climate Impact Assessment paper for nature	Summerhayes and others	Submit before March 2007
Highlight SCAR chemical and biogeochemical activities on the SCAR web site	Secretariat	Spring 2006
Ask Jon Shanklin how SCAR might become involved in ozone measurements	Secretariat	End of 2005
Consider the way forward on chemical measurements in the Antarctic	Turner and aerosol WG	July 2006
Create a Southern Ocean chlorophyll database	SSG-LS	July 2006
The ACE Steering Committee to have as one of its members an expert in long ice core studies, and the Executive Director was asked to approach Eric Wolff about this.	Summerhayes	End 2005
Suggest was should be included in the Key Fields data base	Turner and other members of the SSGs	July 2006

Close of meeting

The meeting closed at lunchtime on Thursday 24 November 2005

Appendix 1

EBA Needs for Climate Model Output

Three groups need data:

Terrestrial

Period – next 100 years with data for every year
Temporal resolution – monthly data.

Spatial resolution – models are about 200 km at present.
5-10 km would be useful for resolving most areas of ice-free ground
Areas of interest – ICE-FREE AREAS, Antarctic Peninsula, McMurdo incl. Dry Valley, Victoria land, Cape Hallett, Cape Adare; Syowa area, Davis Area, sub-Antarctic islands

Implementation period – Next year 200 km data.
2-3 years for regional climate model.

Parameters:

Near-surface air temperature (2 m)
Skin temperature if possible.
Precipitation – m water equivalent
Precipitation days
Split of precipitation into rain and snow
Cloud fraction
Wind speed and direction
Snow cover
The diurnal temperature cycle

Additional information – inter-annual variability of the above quantities
Extreme events - temperature

Marine

Period – next 100 years with data for every year
Temporal resolution – monthly data.

Spatial resolution – models are about 200 km at present.
5-10 km or higher
Areas of interest – well north of the entire Antarctic coast to include the continental shelf. Should extent north to cover the (ACC) Antarctic Polar Front Zone if possible. Areas such as the Falkland Islands are also of interest, plus other sub-Antarctic islands.

Implementation period – Next year 200 km data.
2-3 years for regional climate model.

Parameters:

Sea surface temperature
Temperatures at various levels in the ocean – 1 m …
Salinity at various levels
Conductivity?
Nutrient data
Light penetration depth
Ocean currents

Sea ice extent and thickness

Cloud fraction

Near-surface wind speed and direction

Additional information – inter-annual variability of the above quantities

Limnological (of lakes and ponds)

Period – next 100 years with data for every year
Temporal resolution – monthly data.

Spatial resolution – models are about 200 km at present.
5-10 km or better. The largest lake in the Antarctic is Ablation Lake, Alexander Island (approx. 5 x 3 km).
Areas of interest – All ice free areas, e.g. Antarctic Peninsula, sub-Antarctic Islands, Victoria Land, Dry Valley, East Antarctic oasis

Implementation period – Next year 200 km data.
2-3 years for regional climate model.

Parameters:

Near-surface air temperature (2 m)
Lake surface temperature
Precipitation – m water equivalent
Precipitation days
Split of precipitation into rain and snow
Cloud fraction
Nutrient data
Near-surface (2 m) wind speed and direction
Ice extent and thickness on the lakes
Snow extent and thickness on the ice
Diurnal near-surface air temperature cycle

Additional information – inter-annual variability of the above quantities
Extreme events - temperature

Annex 2

Key Fields to be included in the SCAR web site data section

Over the continent

Annual mean near-surface temperature (from 10 m temperatures)
Annual mean net surface mass balance (from cores, pits etc)
Seasonal mean near-surface wind speed/direction (from models)
Mean winter depth of the temperature inversion (from radiosondes)
Mean winter strength of the temperature inversion (from radiosondes)
Surface chemistry (from ITASE data)
Surface stable isotopes
RADARSAT fields
Proxy climate fields, including calibration data

Over the ocean

Monthly mean sea surface temperature (from satellite and ship data)
Monthly mean sea ice extent (from satellite data)
Monthly mean sea ice concentration (from satellite data)
Monthly mean surface ocean currents (from model and ship data)
Monthly mean ocean currents at various depths (from model and ship data)
Monthly mean mean sea level pressure (from ECMWF re-analysis)
Monthly mean near-surface temperature (from ECMWF re-analysis)
Productivity
Chemistry

Non-varying fields (on short time scales)

Orography of the continent (from digital elevation model)
BEDMAP
Map of ice/snow free areas in summer

Non-field data

Climate indices – SAM, SAO, TPI, SOI
Solar emission series

Annex 3

Antarctic Climate Impact Assessment: Outline Plan

(Amsterdam November 15-17, 2005)

Note that names suggested below are purely provisional, and reflect potential contributions only.

Subtext:- Antarctica and the Southern Ocean - The Next 100 Years in the Context of the Past 10,000 Years

Publication: as Nature Review paper; pre-IPY, pre-IPCC, pre ATCM 2007.

Published as a "SCAR" paper with many possible authors, led (coordinated) by Executive Director

Nature Review = 6 pages, max 100 refs, 3-5 figs.

Contact the Nature Review editor first

Three main sections:-
evolution since –10,000 yrs
the past 50 years
the next 100 years

Evolution since -10,000 yrs (organizer Paul Mayewski)

a) Ice core data (e.g. Taylor Dome, Siple Dome)(**Mayewski**)
b) Marine sediment data (Amy **Leventer, Rob Dunbar, Crosta, Pike)**
c) Glacial geology data (**Hall**, **Conway** for the Ross Sea hinge)
d) Lake sediments data (**Hodgson,** BAS; **Gibson**, Utas Peninsula, Signy, coastal continental location and clime - take home message: last 1000 years cooler, stormier)
e) Past sea level data (**Hodgson**, BAS; Domack)
f) Atmospheric chemistry data (acidity, trace elements, dust) (**Hong, Boutron, Mayewski**)
g) Biological evolution (**Eastman, Crame, di Prisco, Verde, Lecointre, Parisi**)

Current (last 50 yrs) (organizer Colin Summerhayes)

a) Atmospheric circulation (**John Turner**, SAM etc; radiosondes; modes of variability; READER database

b) Atmospheric chemistry (ozone, trace elements, Thompson/Solomon strato/tropo circulation impact) (**D. Thompson**)

c) Southern Ocean: (i) warming (**Gille**, Science); (ii) circulation (Steve **Rintoul**, AUS; Karen **Heywood; Mike Meredith**); (iii) Ross Sea (**Spezie**); (iv) Weddell Sea (under ice) (Eberhard **Fahrbach**)

d) Teleconnections (**Turner; Rintoul; Meredith**)

e) Peninsula warming and glacier retreat (**Vaughn**)

f) Sea ice retreat (**Worby**; others)

g) Ice shelf retreat (Antarctic Peninsula vs. Ross Sea) – Ted **Scambos**, Doug MacAyeal?

h) East Ant and West Ant temp (stable, cooling) (thickening/thinning?) – e.g. **Davis in Science?; Siegert?)**

i) Ocean ecosystems and biogeochemistry (Julie **Hall**; **DeBaar**; GLOBEC/ICED connections (Eileen **Hofmann**; Eugene **Murphy**); decline in krill (due to temp or increased seal activity)

j) Terrestrial Animals and plants response to change (**Bergstrom, Peck?, Convey);**

k) Biological evolution: adaptations in marine vertebrates (**Eastman, di Prisco, Verde**)

(perhaps i, j and k may be pasted together in a single item ?)

l) Lakes and islands (who??)

<u>+ 100</u> (organizer John Turner)

a) IPCC Scenarios (**Turner**)

b) Models such as HadCM3 (**Turner**)
c) Sea ice
d) Atmospheric circulation
e) Precipitation,
f) Sea level and Sea level response (continuing but not dramatic until +500yrs? (check Alley Nature Review paper)

g) Ocean models such as OCCAM, thermohaline, coastal seas (**Turner/Meredith**)

h) Changes in ice shelves and ice streams (**Siegert, WAIS community**)

i) Atmospheric + Biogeochmical Teleconnections (e.g. Ocean, **Sarmiento**)

j) Biological response (**E. Hoffman** – SOGLOBEC, E. **Fanta**); coastal seas response – primary production (**Arrigo**?)

k) Adaptive evolution in action in marine vertebrates (**di Prisco, Verde)**

(perhaps j, k and l may be pasted together in a single item ?)

l) Terrestrial response (Life history changes, physiological stress/upper limits/marine stenothermy, changes in primary production and decomposition, dispersal and colonization) (**Convey, Huiskes, Peck, Frenot, Chown**)

m) Human impact on ecosystems – non-indigenous species and transfer (**Frenot, Convey, Bergstrom**)

n) Nearshore marine disturbance (icebergs, other forms of sea ice) (**Peck, Barnes**)