International Council of Scientific Unions

SCAR report

No. 11
February 1996

Contents

SCAR Group of Specialists on Global Change and the Antarctic (GoS/GLOCHANT)
SCAR Group of Specialists on Southern Ocean Ecology (GoSSOE)

Published by the

SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH

at the

Scott Polar Research Institute, Cambridge, United Kingdom

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS
SCIENTIFIC COMMITTEE ON ANTARCTIC RESEARCH

SCAR Report No. 11 February 1996

Part A

EXECUTIVE SUMMARY OF GLOCHANT ACTIVITIES From 1990 to 1995

INTRODUCTION

The SCAR interest in global change research was formalised in 1991 with the establishment of the SCAR Steering Committee for the IGBP, who completed a regional research programme of global change research in the Antarctic, under the chairmanship of Professor Gunter Weller. This plan was published by SCAR in 1993 under the title *The Role of the Antarctic in Global Change.* It will be referred to as SCAR (1993) in the following text.

The SCAR science plan comprised six thematic areas:

- The Antarctic sea-ice zone: interactions and feedbacks within the global geosphere-biosphere system;
- Global palaeoenvironmental records from the Antarctic ice sheet and marine and land sediments;
- The mass balance of the Antarctic ice sheet and sea-level;
- Antarctic stratospheric ozone, tropospheric chemistry, and the effect of ultra-violet radiation on the biosphere;
- The role of the Antarctic in biogeochemical cycles and exchanges: atmosphere and ocean; and
- Environmental monitoring and detection of global change in the Antarctic.

In order to coordinate this research, the Group of Specialists on Global Change and the Antarctic (GoS/ GLOCHANT) was set up by the SCAR Delegates at XXII SCAR at Bariloche, Argentina, in 1992 (See SCAR Bulletin No 108, pages 5-6, Section 8.2.2), with the following terms of reference:

- To provide linkages and communication within SCAR.
- To provide liaison between SCAR and the major international programmes on global change.
- To plan and implement a regional programme of global change research in the Antarctic.
- To recommend a management structure to implement a coordinated programme on global change research in Antarctic.

The Group of Specialists (GoS) had their first meeting, known as GLOCHANT I, at the British Antarctic Survey, Cambridge, United Kingdom, on the 3-6 February, 1993. Copies of the GLOCHANT I minutes are available from the GLOCHANT Project Office in Hobart. The main business of the meeting was first to review ongoing and planned activities of the many international programmes and projects that involve Antarctic research, particularly those of the International Geosphere-Biosphere Project (IGBP) and World Climate Research Project (WCRP), and then to produce a plan for furthering research in the Antarctic (the continent and the surrounding ocean) on subjects important to understanding and predicting global change. Individual GLOCHANT members were assigned responsibility for liaison with the various programmes. At this meeting the GoS also formulated proposals to form SCAR/GLOCHANT subgroups to undertake the terms of reference and plan future actions. These were:

- Planning Group 1 - Sea Ice (Chairman: Dr I. F. Allison);
- Planning Group 2 - Global Palaeoenvironmental Records from the Antarctic Ice Sheet and Marine and Land Sediments (Chairman: Dr D. Raynaud);
- Planning Group 3 - Antarctic Mass Balance and Sea-Level (Co-chairmen: Prof. C. R. Bentley, Dr F. Nishio);
- Planning Group 4 - Trace Gases, Aerosol Particles, and UV Radiation in the Antarctic Atmosphere (Chairman: Prof. P. Artaxo);
- Planning Group 5 - Biogeochemical Cycles (Co-chairmen: Prof. P. Treguer, Dr G. Hubold);
- Data Coordination Group (Chairman: Mr M. Thorley);
- Numerical Modelling Coordination Group (Chairman: Dr H. Cattle).

The Planning Groups were established to develop research plans that would have strong logistic implications for field work. In order to facilitate the logistic support it was planned to include at least one representative of COMNAP in each Planning Group. The Coordination Groups do not have a logistic demand.

The GLOCHANT group investigated opportunities for the development of a Regional Research Coordinating Centre (RRCC) similar to that established under the START programme of the IGBP. The RRCC would act as a clearing house for information about and from, global change related research in Antarctica. In addition, the GoS determined the need for a full-time GLOCHANT Project Coordinator who would also run the RRCC. This was proposed to the SCAR Executive and accepted in April 1993.

The second annual meeting of the GoS, known as GLOCHANT II, was held at Col de Porte, France, on the 21-23 February, 1994. Copies of the GLOCHANT II minutes are available from the GLOCHANT Project Office in Hobart. This meeting focused on the proposed development of the RRCC and its integration with the IGBP START programme. The Deputy Executive Director of IGBP attended the meeting to provide active liaison between GLOCHANT and IGBP. The GoS also recommended to the SCAR Executive that the proposal from the Australian Antarctic Cooperative Research Centre (Antarctic CRC) in Hobart, to host and fund the SCAR/ GLOCHANT Project Office should be accepted. The proposal was accepted by the Delegates at XXIII SCAR. The membership of the GLOCHANT planning groups was resolved at this meeting.

The members of the Planning Group 1 on the Sea-Ice Zone, and the Planning Group 2 on Palaeoenvironmental Records held their first meeting in Cambridge on the 4-5 September, 1993. The second meeting of PG-2 was held in Col de Porte, France on the 24-25 February, 1994, immediately following the GLOCHANT II meeting. It was also attended by representatives of IGBP and PAGES. The meeting focused on deep ice-core drilling in Antarctica. It was recommended that as SCAR/GLOCHANT and PAGES have similar scientific objectives, they should form a joint planning group. Planning Group 3 on Antarctic Mass Balance and Sea-Level held their first meeting at Cambridge in conjunction with the Fifth International Symposium on Antarctic Glaciology (VISAG) conference, in 1993 and held their second meeting at the Byrd Polar Research Centre in Columbus, Ohio, U.S.A. on 9 August, 1994. This was an open meeting, held in conjunction with the International Glaciological Society's Symposium on the Role of the Cryosphere in Global Change. The theme of the meeting was the determination of the present-day mass balance of the Antarctic ice sheet. The planning group agreed to focus the international effort on the determination of the present accumulation rate over the entire ice sheet, together with the measurement of the ice thickness and ice velocities at the grounding zone of the ice sheet and glaciers. A comprehensive discussion on the state of the art of satellite remote sensing in polar science and glaciology also occurred. The group recommended that the international glaciological community should strongly support the application of laser altimetry in NASA's EOS programme. Satellite altimetry of the ice sheet is providing comprehensive coverage of surface elevation, and geodetic measurements from satellite image pairs are significantly increasing the coverage of ice velocity measurements. It was recommended to encourage satellite remote sensing research, because it had great potential to provide the necessary input to Antarctic mass balance and sea-level contributions.

CHANGE OF DIRECTION FOR GLOCHANT AT XXIII SCAR MEETING

The Rome (XXIII SCAR) meeting resulted in a significant change in the concept for GLOCHANT that had emerged two years earlier from XXII SCAR in Bariloche, Argentina. The general impression was that the Delegates now thought that GLOCHANT was attempting to do too much and that it was now advisable to reduce the scope of the programme. Two of the Delegates were national programme managers and thought that the plans for GLOCHANT were too broad and expensive and that SCAR was being committed to too much. Curiously, this opinion did not emerge from the Council of Managers of National Antarctic Programmes (COMNAP) which also met in Rome. At XXIII SCAR, some Delegates also expressed the opinion that GLOCHANT was undertaking aspects that were already covered by the International Geosphere-Biosphere Programme (IGBP) and the World Climate Research Programme (WCRP).

While commending the SCAR book as an excellent plan, Delegates had various views about the scope and focus of the programme and suggested that the research should be more focused than currently planned. Some Delegates felt that SCAR should concentrate on those parts of the plan which it is able to do best, rather than attempt to cover all aspects at the same time. SCAR should not be trying to run global programmes but should be contributing data to them. There was some criticism about the number of subgroups that had been established and a suggestion that the more active groups should continue with their programmes while others might be developed later, following a review of progress in 1996. Other Delegates were concerned that the approach to the whole programme being advocated was so contrary to the enthusiasm with which it was greeted when the Group of Specialists was established two years earlier at XXII SCAR.

Extensive discussions followed and a subgroup of Delegates developed the following principal points and recommendations.

"Since the establishment of the Group of Specialists on Global Change and the Antarctic (GLOCHANT) at XXII SCAR, there had been a growth of activities in global change research in the Antarctic, both from SCAR programmes and other international programmes, such as those of IGBP and WCRP. This had included the production of the SCAR Report *The Role of the Antarctic*

in Global Change: An International Plan for a Regional Research Programme which resulted from the workshop activities in Bremerhaven, Germany (September 1991), and it set out a substantial and challenging agenda for global change research in the Antarctic, elements of which were being actively adopted by national programmes. Concurrently over the last few years, the activities and plans of various international programmes have grown rapidly in scope and national programmes face the necessity of setting priorities and focusing projects. Mindful of these developments since at least its last meeting in Bariloche, Argentina (XXII SCAR), SCAR has, in response to Delegates' wishes decided to simplify and restructure the GLOCHANT activity; the details of the changes are set out below. This action is intended to focus the initial priorities within the SCAR Global Change Programme according to resources available; it does not negate or diminish the overall contribution of the Group of Specialists and the identified Planning Groups. The intention is to move forward step by step, as has been implicitly recognized, with progress and need, including the need for a Special Fund, being reviewed at successive meetings of SCAR, commencing at XXIV SCAR in Cambridge during August 1996.

1. Because of the development of a well-thought-out CS-EASIZ programme that largely covers the Antarctic aspects of sea-ice biology and biogeochemical exchanges across the ocean-atmosphere boundary and the advance plans in WCRP relating to the physical aspects of sea ice, it was considered that Planning Groups 1 (Sea Ice) and 5 (Biogeochemical Cycles) are not needed at present. However, it is recommended that the members of those Planning Groups and of the Steering Committee for CS-EASIZ meet jointly for one time only, to implement coordination between CS-EASIZ and GLOCHANT and to ensure that no important aspects of their fields are overlooked.

2. Ozone studies and tropospheric chemistry are well-covered by IGBP and other programmes, and it is proposed to establish a joint working group between SCAR and IASC to consider the effects of enhanced UV-B on the biosphere. Planning Group 4 (Atmospheric Chemistry, etc.) will be asked to evaluate the need for a meeting in the light of the modified emphasis in the SCAR/GLOCHANT programme and in consideration of other ongoing and planned international activities. If the Planning Group feels that it will be productive to meet, it will be supported to do so.

3. The work of the proposed Coordination Group 2, on Antarctic aspects of numerical modelling, can better be carried out in the relevant subject areas and by close coordination with IGBP/GAIM. Therefore, the Coordination Group will not meet. The Group will be asked to evaluate by correspondence the situation with regard to Antarctic aspects of modelling.

4. Planning Groups 2 (Palaeoenvironments) and 3 (Mass Balance) have well-focused purposes that fill clear needs in Antarctic research; they will continue their work.

5. The Group of Specialists itself will continue but with an increased emphasis on coordination of activities, information exchange, and planning of future strategy, as well as oversight of Planning Groups 2 and 3."

SCAR GLOBAL CHANGE PROJECT OFFICE

Delegates welcomed the acceptance by the SCAR Executive of the generous Australian offer to host the Global Change Project Office at the Cooperative Research Centre at the University of Tasmania, in Hobart, Australia. The President also told the Delegates that the advertisement for a Project Coordinator had produced several applicants for the post and that a review panel was evaluating these with a view to holding interviews in the near future. A starting date for the coordinator would be negotiated with the successful candidate but it would be as soon as possible.

It is envisaged that the Project Coordinator will have a full-time job in developing a newsletter and providing other modes of information exchange, organizing and staffing meetings of the Group of Specialists and its two remaining Planning Groups (and also GoSSOE and CS-EASIZ, if desired by this Group and its programmes), coordinating training of scientists from third-world countries and countries with young Antarctic programmes, helping to develop a bipolar approach to global change research, etc.

GLOBAL CHANGE SPECIAL FUND

A paper on the proposed Special Fund for the Global Change programme was tabled. In view of the diminished financial implications of the restructured programme, no Special Fund will be established at this time, but the Group of Specialists will be free to raise funds independently to support its work. It was accepted that such a fund could be re-proposed in the future if this was thought desirable.

RELATIONS WITH IGBP/START

Delegates agreed that it was important to maintain close contact with START. A paper appended to the report of the Group of Specialists discussed the mutual advantages of close links with START and proposed that a first step would be to seek approval from START for a procedure that would involve negotiations between SCAR and START over the next two years to develop the most effective mode of integration of SCAR activities within the START program. The Delegates accepted this paper and the recommendation that this course should be adopted. The meeting of the START Standing Committee in Brussels, Belgium, was taking place concurrently with the SCAR Delegates meeting and a member of

GLOCHANT attended and tabled the SCAR proposal there, where it was accepted.

GLOCHANT ACTIVITIES DURING 1995

The GoS/GLOCHANT held their third annual meeting (GLOCHANT III) at the National Institute of Polar Research in Tokyo, from April 17-19 and April 21, 1995. The joint meeting between the GoS/GLOCHANT Planning Groups 1 and 5, and the Group of Specialists on Southern Ocean Ecology (GoSSOE) and the Coastal and Shelf Ecology of the Antarctic Sea-Ice Zone (CS-EASIZ) recommended by XXIII SCAR was also held in Tokyo, on April 19-21, 1995. The minutes and recommendations from these meetings will be published in a SCAR Report in early 1996. The GoS at these meetings made plans for the future directions of GLOCHANT, including the development of a Planning/Task Group on Antarctic Sea-Ice Processes, Ecosystems and Climate (ASPECT), which if approved at XXIV SCAR, will replace the previous GLOCHANT Planning Groups 1 and 5. Planning Group 4 was disbanded, as were the Coordination Groups.

There was general agreement at the Tokyo meetings that the terms of reference that had been approved in Bariloche would have to be changed to reflect the new situation after the changes to the structure of GLOCHANT (which were determined by the XXIII SCAR meeting in Rome). Following discussions amongst the GoS and other participants in Tokyo, the following modifications to the terms of reference were approved for submission to the SCAR Executive:

1. To provide SCAR Working Groups, Groups of Specialists and national programmes with the best available multidisciplinary advice regarding ongoing Antarctic global change research.
2. To provide liaison between SCAR and the other major international programmes on global change and to promote the applicable Antarctic component within those international programmes.(See Table 1).
3. To identify research needs in Antarctic process studies, monitoring and modelling related to global change.
4. To plan, promote and monitor specific projects on problems of global change research in the Antarctic.

The GLOCHANT project office has been established at the Antarctic CRC in Hobart and the Project Coordinator, Dr Ian Goodwin, commenced in the position in August, 1995. A coherent and comprehensive science plan for GLOCHANT is currently in preparation. This plan will be submitted to the Delegates at the XXIV SCAR, in August, 1996. The first issue of the GLOCHANT newsletter is scheduled for distribution in early 1996.

The Planning Group 2 on Palaeoenvironments from ice cores (now known as PICE) also met between the 15 to 16 September, 1995, in Boston, together with members of PAGES sub-programmes on ice cores, for a Bipolar meeting. The meeting resolved a Bipolar approach to reducing the uncertainty in global environmental change, and determined an international strategy for ice-core drilling in Antarctica. A priority of the strategy is to obtain high resolution records from Antarctica which can complement the new records from central Greenland. The Planning Group 3 on Antarctic mass balance and sea-level (now known as ISMASS) met at Chamonix, on the 17 September, 1995, in conjunction with the EISMINT Symposium on Ice Sheet Modelling. The group determined a plan for a coordinated international research effort to measure the ice thickness by airborne radio-echo sounding (RES) around the perimeter or grounding zone of the Antarctic Ice Sheet. Whilst a significant portion of the grounding zone has been surveyed with RES, large segments which are remote from existing bases and logistic support have been identified and assigned to Australia, U.S.A, U.K., Germany, Sweden/Norway, Italy and Japan.

Table 1

GLOCHANT members identified for liaison with other programmes.

PROGRAMME OR GROUP	GLOCHANT Member
1. SCAR	
A. National programmes	All members
B. Working Groups	
Biology	G.Hubold
Geodesy and Geographic Information	M.R.Thorley
Geology	C.R.Bentley
Glaciology	I.F.Allison
Human Biology and Medicine	P.D.Clarkson
Physics and Chemistry of the Atmosphere	P.Artaxo
Solar-Terrestrial and Astrophysical Research	P.Artaxo
Solid-Earth Geophysics	C.R.Bentley

Table 1 (Contd.)

C. Groups of Specialists	
Evolution of Cenozoic Palaeoenvironments of High Southern Latitudes	I.D.Goodwin
Seals	G.Hubold
Southern Ocean Ecology	G.Hubold
Structure and Evolution of the Antarctic Lithosphere	C.R.Bentley
Environmental Affairs and Conservation	P.D.Clarkson
D. SCAR/COMNAP	
Ad hoc Planning Group on Antarctic Data Management	M.R.Thorley
2. INTERNATIONAL PROGRAMMES	
A. International Geosphere-Biosphere Programme (IGBP)	
IGBP Scientific Advisory Committee (IGBP-SAC)	C.R.Bentley
IGBP Core Projects	
Joint Global Ocean Flux Study (JGOFS)	P.Treguer
Past Global Changes (PAGES)	D.Raynaud
International Global Atmospheric Chemistry (IGAC)	P.Artaxo
Global Analysis, Interpretation and Modelling (GAIM)	H.Cattle
Land-Ocean Interactions in the Coastal Zone (LOICZ)	I.D.Goodwin
IGBP Data and Information System (IGBP-DIS)	M.R.Thorley
B. World Climate Research Programme (WCRP	
World Ocean Circulation Experiment (WOCE)	A.Foldvik
Climate Variability and Prediction Research (CLIVAR)	I.F.Allison
International Programme for Antarctic Buoys (IPAB)	I.F.Allison
Antarctic Ice Thickness Monitoring Programme (AnITMP)	I.F.Allison
Global Energy and Water-Cycle Experiment (GEWEX)	I.F.Allison
International Satellite Cloud Climatology Project (ISCCP)	I.F.Allison
Stratospheric Processes and their Role in Climate Change (SPARC)	P.Artaxo
Global Surface Baseline radiation Network (GSBRN)	I.F.Allison
Arctic Climate System Study (ACSYS)	H.Cattle
C. Other	
International Association of Geodesy (IAG). *Ad hoc* group on sea-level and ice-sheet volume changes	C.R.Bentley/ I.D.Goodwin
International Antarctic Science Committee (IASC)	C.R.Bentley
Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR)	G.Hubold
Scientific Committee on Problems of the Environment (SCOPE)	P.Treguer
Scientific Committee for Oceanic Research (SCOR)	A.Foldvik
Southern Ocean Global Ecosystem Dynamics (SO-GLOBEC)	G.Hubold
Intergovernmental Panel on Climate Change (IPCC)	H.Cattle
Global Ocean Observing System (GOOS)	I.F.Allison
Global Climate Observing System (GCOS)	H.Cattle
Global Terrestrial Observing System (GTOS)	H.Cattle
International Coordination of Oceanographic research within the Antarctic Zone(AnZONE)	I.F.Allison
International Geographical Union (IUG) Commission on Coastal Systems (CCS)	I.D.Goodwin
Acoustic Thermometry of Ocean Climate (ATOC)	C.R.Bentley

Part B

SCAR Group of Specialists on Global Change and the Antarctic (GLOCHANT)

Report of the third meeting of the Group of Specialists (GLOCHANT III) National Institute of Polar Research, Tokyo April 17-19 and April 21, 1995

Members of the Group of Specialists and the Planning/Coordinating Groups in attendance: S.Ackely (PG-1), I.F.Allison (GoS, PG-1), P.Artaxo (GoS, PG-4), U.Bathmann (PG-5), C.R.Bentley (GoS, Convenor and PG-3), H.Cattle (GoS, CG-2), G.Dieckmann (PG-1), M.Fukuchi (PG-1 and PG-5), G.Hubold (GoS), H.Marchant (PG-5), F.Nishio (GoS, PG-3), J.Priddle (PG-5), D.Raynaud (GoS, PG-2), G.Rosenberg (Coordinator, now resigned), M.R.Thorley (GoS,CG-1), P.Treguer (GoS, PG-5), P.Wadhams (PG-1), O.Watanabe (PG-2).
Other participants: G.di Prisco, Y.Fujii, T.Furukawa, D.Miller, M.Moskalevsky, H.Motoyama, M.Naganobu, M.Nakawo, S.Takahashi, A.Taniguchi, S.Ushio, K.Watanabe, T.Yamanouchi, K.Yamazaki
Members of the Group of Specialists who were unable to attend: A.Foldvik (GoS), Christian Schlüchter (Coopted Member GoS).
(See Appendix 1 for a list of acronyms and abbreviations and Appendix 2 for a list of participants and their addresses.)

1.0 INTRODUCTION

1.1 Opening remarks

The third meeting of the Group of Specialists on Global Change and the Antarctic opened on 17 April 1995, with welcoming remarks by the host, Prof. F. Nishio, and the Convenor, Prof. C.Bentley. Prof.Bentley emphasized that the most important item on the agenda would be a discussion of the response of GLOCHANT to the new directions that emanated from the XXIII SCAR (1994) meeting in Rome.

Copies of the following documents were distributed:

- Draft meeting agenda.
- 'Thoughts on the Future Direction of SCAR/ GLOCHANT' by M.Thorley and H.Cattle (Appendix 3).
- Group of Specialists on Global Change and the Antarctic, Report to XXIII SCAR (Rome, 1994) compiled by C.Bentley.
- Approved minutes of the first meeting of the Group of Specialists held in Cambridge, England, on 3-6 February 1993.
- Draft of the minutes of the second (1994) GLOCHANT meeting in Col de Porte, France.
- Reports of GLOCHANT Planning Groups 1, 2, 3, & 5.
- 'An Antarctic Regional Network for Global Change Research and the Interface to International Global Change Programmes' (a proposal from SCAR/ GLOCHANT to SCAR, by M.Thorley and H.Cattle).
- Draft of 'A Proposal for an Antarctic Regional Research Network for Global Change Research' (a proposal from SCAR to START, by M.Thorley and H.Cattle).

The proposed agenda was approved with the addition of several items. At the beginning of the afternoon session, Prof. N. Ono, Deputy Director of the National Institute of Polar Research (NIPR), welcomed the meeting participants on behalf of the NIPR Director General, Dr. Hirasawa.

1.2 Minutes of the second meeting of the GLOCHANT Group of Specialists

C.Bentley reported that he had only recently received the draft of the minutes of the second (1994) GLOCHANT meeting in Col de Porte, France. Because there were important omissions, he requested that the members of the Group of Specialists send him their corrections so that he could prepare a revised draft that would be circulated for approval via e-mail. This proposal was accepted.

2.0 FUTURE DIRECTION OF SCAR/GLOCHANT

C.Bentley opened the discussion by reviewing the results of the September 1994 SCAR meeting in Rome (XXIII SCAR) as discussed previously in the executive summary.

C.Bentley felt that the idea was not to force a new programme on the national operators, but rather to promote coordination among programmes. GLOCHANT was not itself intended to be a research programme that would require implementation and its working groups were specifically termed "planning groups" only. Furthermore, there was minimal overlap with other international programmes because these programmes are not active in

the Antarctic. From communications with IGBP and its family of programmes, it is clear that the IGBP was counting on SCAR to organize the Antarctic components of these programmes, not vice versa. The purpose of the planning groups was to identify what was being done and not done in the Antarctic and to produce appropriate recommendations to fill the gaps.

Recommendations from XXIII SCAR

C.Bentley then reviewed the recommendations that were approved by the Delegates to XXIII SCAR (taken from the proceedings of the 'Twenty-third Meeting of SCAR, Rome, Italy, 4-9 September 1994'; the complete text of the part that deals with GLOCHANT is attached as Appendix 4):

C.Bentley concluded that GLOCHANT had not done a good job of informing SCAR about the activities of the Group of Specialists and the GLOCHANT Planning Groups and that this would be an important task of the new Project Coordinator. C.Bentley also commented that SCAR was not taking aim at multidisciplinarity *per se*. The existence of GoSSOE shows that SCAR is concerned with this aspect. D.Raynaud suggested that it would be a good idea for GLOCHANT planning groups to meet with other international groups (for example, PG-2 could meet with the Past Global Environmental Changes [PAGES] programme) to avoid any appearance of duplication of effort.

'Thoughts on the Future Direction of SCAR/GLOCHANT' (M.Thorley and H.Cattle)

Discussion of XXIII SCAR served to introduce the paper titled 'Thoughts on the Future Direction of SCAR/GLOCHANT' tabled by M.Thorley and H.Cattle (Appendix 3). M.Thorley felt that the SCAR Delegates had mistakenly seen GLOCHANT as a research project rather than as a communication/coordination project. It will nevertheless be necessary to respond to the implied criticism in Rome. He felt that the key to success was to formulate a mission and objectives to serve Antarctic science and SCAR. These would be accompanied by defined "deliverables" (products) with delivery dates. M.Thorley outlined the major recommendations of 'Thoughts...':

1. Review the restructuring of GLOCHANT at XXIII SCAR.
2. Define the scope of global change in the Antarctic.
3. Define the scope of GLOCHANT within Antarctic global change research.
4. Define the role of GLOCHANT.
5. Define how objectives are to be carried out.
6. Define the objectives and management structure for the GLOCHANT Project Coordinator.

M.Thorley felt that the SCAR Delegates did not have an accurate view of the function of GLOCHANT or of the actual scope of CS-EASIZ (much reduced from the original idea, according to G.Hubold), the Southern Ocean Joint Global Ocean Flux (SO-JGOFS), Southern Ocean Global Ocean Ecosystems Dynamics Research (SO-GLOBEC) and WCRP, which leave open many aspects covered by the GLOCHANT Planning Groups. Nevertheless, the restructuring of GLOCHANT could represent an opportunity if the Group of Specialists could provide an adequate response.

C.Bentley thanked M.Thorley and Cattle for the time and effort that went into preparing the document. There was a discussion of the type of "products" that GLOCHANT ought to deliver. G.Hubold suggested that the primary role of GLOCHANT could be to provide scientific advice (including evaluation of ongoing research) to SCAR and to the Antarctic Treaty System. D.Raynaud mentioned the additional role of ensuring that Antarctica is included in the plans of the major international global change research programmes. P.Treguer pointed out that the idea of producing science plans is ambiguous in as much as this implies producing an implementation plan. In his view, GLOCHANT would function to establish liaison among existing Antarctic research programmes and there would be no need for implementation plans. The "products" could include reports about advances in the scientific fields covered by the GLOCHANT Planning Groups.

I.Allison did not think that communication/liaison issues alone could justify the existence of GLOCHANT. Rather, there are issues in Antarctic science that are not being addressed by the currently existing programmes. GLOCHANT could at least develop a strategy for implementation. Allison pointed out that SCAR has a history of recommending international science plans that member nations then undertake in their own national programmes. One model for this is WCRP. WCRP has funded meetings, not actual research. Its projects, such as the World Ocean Circulation Experiment (WOCE), are being carried out through the national programmes. This shows that it is possible to do programme-building with limited funds. H.Cattle pointed out that the Antarctic sea-ice zone is not being studied by WCRP because this area was to be covered by SCAR. Allison added that the International Programme for Antarctic Buoys (IPAB) and the Antarctic Ice Thickness Monitoring Project (AnITMP) were originally promoted by WCRP, but are now largely undertaken by the SCAR national operators.

There was general agreement that, while SCAR 1993 had served to show the way, many of its recommendations were, in fact, being implemented by the various national and international programmes. G.Hubold suggested that one useful "product" of GLOCHANT could be a yearly evaluation of progress in Antarctic global change research that points out where scientific gaps still exist and makes appropriate recommendations to SCAR. This would take advantage of the multidisciplinary nature of GoS/GLOCHANT and would also be helpful in planning for

follow-on activities to the current international programmes. C.Bentley mentioned that, in the case of Antarctic Mass Balance (PG-3), for example, it would not be sufficient to summarize the current status of research. No work is being done to determine the outflow of ice across the grounding lines. There is a need to change the focus of current activities so that this will be measured. On the other hand, PG-2 can work closely with PAGES. The scientific needs are different in the different areas covered by the GLOCHANT Planning Groups. If GLOCHANT does not produce science implementation plans, there is still a need for very specific recommendations (for example, a polynya programme).

P.Artaxo pointed out that from the atmospheric standpoint (PG-4), there is no single national or international programme that covers Antarctica. Originally, PG-4 dealt with a number of different issues that were connected to the atmosphere, including ozone, UV-B, and snow-atmosphere chemistry. Although the International Global Atmospheric Chemistry (IGAC) programme deals with many of these problems, there is no focus on Antarctica. The work of PG-4 is now focused on UV-B effects.

H.Cattle cited the IGBP Global Analysis, Interpretation and Modelling (GAIM) programme as another example of an effort where there is no focus on Antarctica at the present time. The interpretation role of GAIM feeds into the Intergovernmental Panel on Climate Change (IPCC) process and it is possible that GLOCHANT may be able to put together a document for Antarctica in time for the third IPCC assessment. Any synthesis of information prepared by GLOCHANT needs to be specifically targeted.

Modification of the terms of reference for GLOCHANT

I.Allison said that, originally, GLOCHANT was to have the following roles:

- To develop a scientific plan for a regional programme of global change research for the Antarctic. This will be based on the key issues identified in SCAR 1993; it will be coordinated with the plans of other international programmes; and it will fit within the START framework.
- To coordinate implementation of this plan.
- To establish and oversee a Regional Research Centre (RRC) that will support implementation of Antarctic global change research and will become part of the IGBP System for Analysis, Research and Training (START).
- To promote relevant Antarctic issues within the international global change forum.
- To keep the Antarctic scientific community informed of developments in international global change research.
- To foster multidisciplinary links in Antarctic global change research.

C.Bentley reminded the participants of the terms of reference that came out of XXII SCAR in Bariloche, Argentina, in 1992:

- To provide linkages and communication within SCAR.
- To provide liaison between SCAR and the major international programmes on global change.
- To plan and implement a regional programme of global change research in the Antarctic.
- To recommend a management structure to implement a coordinated programme on global change research in the Antarctic.

The last term was considered as having been met with the establishment of a Project Office at the Antarctic CRC at the University of Tasmania and the appointment of a full-time GLOCHANT Coordinator. There was general agreement that the terms of reference that had been approved in Bariloche would have to be changed to reflect the new situation after XXIII SCAR in Rome. Following discussion, the following modifications were approved for submission to SCAR:

- To provide SCAR Working Groups, Groups of Specialists and national programmes with the best available multidisciplinary advice regarding ongoing Antarctic global change research.
- To provide liaison between SCAR and the other major international programmes on global change and to promote the applicable Antarctic component within those international programmes.
- To identify research needs in Antarctic process studies, monitoring and modelling related to global change.
- To plan, promote and monitor specific projects on problems of global change research in the Antarctic.

Role of GLOCHANT Planning Groups

It was reported that many of the SCAR Delegates in Rome felt that there were too many long-term groups being created. This led to a discussion of the advisability of adopting a structure of *ad hoc* groups to replace the present Planning Group structure as a way to address this perception. D.Raynaud favoured maintaining the flexibility to create the structures that GoS/GLOCHANT deems necessary. The general consensus was that once the Planning Groups have finished their work by recommending a few key projects and a plan for carrying them forward, they should move on to new problems or be replaced by task-oriented groups with a more limited lifespan.

H.Cattle said that it was important for the Planning Groups to deal with monitoring issues (detection of global change). D.Raynaud mentioned lakes (e.g. Lake Vostok) and modelling as important aspects that should also be covered by the Planning Groups. Each of the Planning Groups would need to propose only a few, very specific projects.

Conclusions on future direction of SCAR/ GLOCHANT

C.Bentley identified communication as the main problem of GLOCHANT. He then summarized the previous

discussions about the future direction of GLOCHANT under three headings: Planning, Communication and a Timetable. Following discussion, the following guidelines were approved:

Planning

SCAR 1993 provides an overall definition of Antarctic global change research. GLOCHANT should now identify the priority research needs from among those in SCAR 1993 and then plan and promote specific projects addressing outstanding key problems.

- Evaluate the research being done in the six Antarctic core projects.
- Identify any gaps in research coverage.
- From the two above, identify and describe any key projects required to fill the gaps and
- recommend the priority projects to SCAR and national committees.
- Produce a short, cogent, written justification of each recommended project.
- Recommend these projects for SCAR sponsorship; and propose a structure for coordination and monitoring their implementation and promotion within the wider scientific community.

Communication

The main weakness of GLOCHANT has been in communication. We should, in the future:

- Prepare a description of the aims and plans of GoS/ GLOCHANT in glossy format for SCAR Delegates, national committees and other interested parties.
- Regularly evaluate the progress of global change science in the Antarctic and report it to SCAR (and through SCAR, also to the Antarctic Treaty Consultative Parties).
- Produce promotional literature for national committees and international programmes on the needs for research that we have identified through the planning-group process.
- Co-sponsor symposia with published proceedings (e.g. the proposed IGS symposium scheduled to be held in Hobart, Tasmania in 1997).
- Produce a publication, regularly updated, on what is actually going on (as distinct from general plans) in the international and SCAR programmes that relates directly to Antarctic global change research. Each member of GLOCHANT is to submit to the Project Office by mid-August 1995 a paragraph on each of our assigned international programs and SCAR groups.
- Produce a newsletter to disseminate information about Antarctic global change research.

Timetable

The aim of our work is to have a coherent plan ready for XXIV SCAR in August 1996.

- Planning Groups 2 and 3 should write up statements on their identified projects by the end of 1995 (this allows for meetings of these groups during the year).
- Planning Groups 1 and 5 should identify projects during their meeting at the NIPR in Tokyo on 19-21 April 1995 and present a plan for action between now and XXIV SCAR. Progress toward the development of such a plan can be considered by the GLOCHANT Group of Specialists on 21 April 1995.
- Planning Group 4 should aim to meet at the International Union for Geodesy and Geophysics (IUGG) meeting in Boulder, Colorado, in July 1995 (if they think there is a need) to prepare their plan. It should be considered by GLOCHANT via correspondence.
- Coordination Group 2 should develop its recommendation by whatever means possible, also for GLOCHANT consideration by correspondence.
- GLOCHANT should hold a formal meeting during the northern spring of 1996 in time to approve a science plan for presentation at XXIV SCAR in August 1996.

C.Bentley volunteered to write a first draft of a statement about GLOCHANT and to send it to H.Cattle and M.Thorley so that they can make up a brochure. G.Rosenberg pointed out that such a brochure would have many uses and could be distributed through the GLOCHANT Project Office in Hobart. It will be helpful to write the brochure in such a way that it does not go out of date too quickly. Cattle suggested that an *ad hoc* meeting of three of four members of Coordinating Group 2 could take place by the northern fall.

STRATEGY FOR XXIV SCAR

It will be necessary to make a strong case for GLOCHANT to the Delegates at XXIV SCAR in Cambridge. D.Raynaud thought that what was needed was an integrated science plan for GLOCHANT. The plan would be based on the recommendations of the GLOCHANT Planning Groups, with emphasis on the interdisciplinary aspects that require concerted international action. He suggested the following foci: support for the buoy programme, Southern Ocean transects, Antarctic surface traverses, deep drilling coordination, intercomparison of climate models, and interdisciplinary sea ice-zone process studies.

Although specific projects were not approved, there was general agreement that a GLOCHANT science plan should be prepared for XXIV SCAR. Accordingly, the Convenor asked all of the GLOCHANT subgroups to prepare their recommendations by the end of 1995 so that a draft science plan could be available for consideration for the next GLOCHANT meeting in 1996, in advance of XXIV SCAR. C.Bentley reminded the members of the GoS that GLOCHANT can go back to SCAR in 1996 to ask for financial support for appropriate activities.

3.0 REPORTS FROM GLOCHANT PLANNING AND COORDINATING GROUPS: ACTIVITIES AND PLANS

3.1 PG-1: Sea-Ice Zone (I.Allison)

PG-1 has recommended three projects:

1. A study of the temporal and spatial variability of physical and biogeochemical characteristics within the sea-ice zone (North-South transects, sea ice, water column, sediments, etc).
2. A multidisciplinary process study of the development, maintenance and interactive role of coastal polynyas.
3. To encourage regular, coordinated contributions to IPAB and the Antarctic Ice Thickness Monitoring Project (AnITMP) from the SCAR national operators.

These projects are based on the recommendations in the SCAR 1993 and can be coordinated with CS-EASIZ at the joint meeting at NIPR later in the week. The group is thinking about putting together a polynya programme, under SCAR/GLOCHANT auspices, on the formation and functioning of coastal polynyas. The initial field work, possibly on the Filchner Ice Shelf beginning in 1998, would include a transect programme and would involve Australia and the U.S.

3.2 PG-2: Global Palaeoenvironmental Records from the Antarctic Ice Sheet and Marine and Land Sediments (D.Raynaud)

PG-2 last met at Col de Porte, France, in February 1994, following the second meeting of the GLOCHANT Group of Specialists. A report of this meeting was presented at XXIII SCAR in Rome. The main topics of this meeting were:

1. Ongoing and planned deep drilling activities in Antarctica.
2. ITASE
3. Addressing future drilling plans in Greenland in the context of current drilling plans in Antarctica.
4. A recommendation that SCAR and PAGES establish a joint planning group (a representative of PAGES was present at the meeting).

New developments have occurred since the Col de Porte meeting. Plans have been made for a joint GLOCHANT PG-2/PAGES/IASC workshop to discuss bipolar aspects of deep-ice drilling operations. This workshop will be held in Boston in September 1995. PG-2 and PAGES are also preparing a document titled 'An International Strategy for Ice-Core Drilling in Antarctica: a SCAR/GLOCHANT, PAGES/IGBP Initiative'. This document will be completed after the bipolar meeting in Boston.

The question arose of whether the overlap between PG-2 and PAGES was good for GLOCHANT. D.Raynaud replied that there is coordination, rather than overlap, because PAGES is concerned with palaeoclimate worldwide and has specifically tasked GLOCHANT with coordinating deep ice drilling in Antarctica. C.Bentley pointed out that the Boston meeting was actually a GLOCHANT initiative.

3.3 PG-3: Antarctic Mass Balance and Sea Level (C.Bentley)

The focus of PG-3 is Antarctic mass balance and sea level (the narrowest item mentioned in the SCAR 1993). Specifically, the aim is to evaluate the present-day mass balance of the ice. This is not predictive, but it is nevertheless critical. PG-3 would like to see the ITASE programme go ahead, especially if it includes measurements of surface mass balance. Satellite observations would also be involved, but this would not require coordination through SCAR. It is necessary to determine mass flux across the grounding line, so that measurements are needed of both velocity and ice thickness. Velocity can be determined from satellite observations, while ice thickness can be measured by the radar sounding method. COMNAP cooperation is needed in as much as this is a big job that would involve the participation of radar sounding aircraft from all of the national programmes. So far, PG-3 has not proposed to go beyond the present-day mass balance.

PG-3 met for the second time in August 1994 at the IGS Cryosphere and Global Change meeting in Columbus, Ohio. Twenty-five scientists from eleven countries are making velocity, ice thickness and other mass balance related measurements. The group recommended that satellite radar and laser altimetry be included in these measurements. F.Nishio emphasized the potential of synthetic aperture radar (SAR) for the determination of grounding lines.

In response to a question from G.Hubold concerning current thought about Antarctic mass balance, C.Bentley responded that most systems are thought to be balanced or to be in positive mass balance. Only one little system is negative. Today's measurements and sea level rise are influenced by what happened over the last tens of thousands of years.

3.4 PG-4: Trace Gases, Aerosol Particles and UV-B Radiation in the Antarctic Atmosphere (P.Artaxo)

The members of PG-4 are Paulo Artaxo (Chair; Brazil), D.Hofmann (NOAA/CMDL, USA), Marie-Lise Chanin (SPARC Chair, France), David Bromwich (USA), T.Ito (Japan) and a UV-B specialist still to be nominated.

The objectives that were set forth in the SCAR 1993 were:

1. To investigate changes in the composition and structure of the Antarctic atmosphere.
2. To determine the chemical composition of the Antarctic atmosphere.

3. To determine the effects of increased UV-B radiation on Antarctic aquatic and terrestrial ecosystems.

These objectives should be realised by carrying out:
1. *In situ* measurements of trace gases and aerosol particles.
2. Spectral measurements of ultraviolet radiation.
3. Stratospheric and tropospheric cloud and aerosol studies.
4. Biological effect studies.

Many international programmes are involved in this research, including NOAA/GMCC, PASE, PAGES, SPARC, GAIM, IGAC, SAGE, etc. The major priority of PG-4 will be monitoring and studying the effects of increased UV-B flux on the Antarctic ecosystem. This involves monitoring UV-B radiation; the study of physical and chemical processes; studying the links between ozone depletion and UV-B flux; and studying the biological effects (including the effects on human populations in Patagonia and the sub-Antarctic region).

H.Marchant stated that the IASC report on UV effects (item 5.2.3 below) was based mostly on the SCOPE report, neither of which incorporated any implementation plans. At present there is no integration of UV measurements from the various UV-monitoring stations. On the impact side, there are individual research programmes with no formal coordination. The impact studies also use different instruments from those used in monitoring. The laboratory simulations used for laboratory work differ from one another. J.Priddle stressed the need for PG-4 to prioritize the recommendations in the SCOPE and IASC reports. Close contacts will be maintained with SPARC, WMO and IASC UV-B activities.

N.B. With the establishment of the GLOCHANT Sea-Ice Zone Task Group that will be partly concerned with UV-B impacts on the biota, the work of PG-4 (should it decide to continue) will focus on other needs, including monitoring and the atmospheric aspects of UV radiation.

3.5 PG-5: Biogeochemical Cycles (P.Treguer)

P.Treguer distributed copies of the PG-5 planning document. The CO_2 flux measurements do not agree with the models and the frontal area of the Southern Ocean is thought to be a major sink for CO_2. It will be necessary to focus on selected topics. This document includes a review of activities of ongoing programmes (including IGAC, SO-JGOFS, SO-GLOBEC, WOCE and CS-EASIZ) and a summary of current knowledge of biochemical cycles in the Southern Ocean. The general idea is to assist ongoing programmes that are pertinent to GLOCHANT objectives and to reinforce links among those programmes. The specific aims are:

1. To increase liaison among ongoing (SO-JGOFS [Phase 2] and WOCE [Southern Ocean aspects] and PAGES) and new programmes (CS-EASIZ and SO-GLOBEC).
2. To develop biogeochemical models coupled to physical models for the different subsystems of the Southern Ocean (coastal zone, seasonal sea-ice zone, etc.); to extend local-scale models to the regional scale to study regional-scale budgets of key biogenic elements (C, N and Si).
3. To help define standard methods and strategies. Ideas about carbon cycling in the Southern Ocean will be tested by comparing the various methods used to estimate primary productivity, including direct measurement, *in situ* fluorescence techniques, insolation models, winter-summer nutrient deficits and production at higher trophic levels. A strategy will be developed to study the variability of frontal areas, with special emphasis on the Subtropical Convergence and related CO_2 sink areas.
4. To contribute to the organisation of the SO-JGOFS symposium 'Carbon fluxes and dynamic processes in the Southern Ocean: Present and Past' to be held in Brest, France, in August 1995.

Specifically, PG-5 should pursue a few initiatives to be carried out under the umbrella of GLOCHANT. These could include: Antarctic support for SO-JGOFS, a workshop on Antarctic meteorology in 1998 and joint Australia/France/Japan JEISSO expeditions to time-series Station N in Prydz Bay. Another activity could be a joint France/Australia cruise in the frontal zone south of Perth that has been proposed for Feb/March 1998.

G.Hubold asked whether the Antarctic seas play an important role in the global CO_2 deficit. Treguer replied that the seasonal ice zone and the coastal zone (except for the Weddell Sea) are not sinks for CO_2 as originally thought. D.Raynaud stated that the missing sink is now thought to be in the continental biosphere, while the role of the oceans is relatively well known. Thus, the missing CO_2 sink is not a strong argument to study the Southern Ocean; it is of greater interest to study ocean processes.

3.6 CG-1: Data Coordination (M.Thorley)

The purpose of CG-1 is:
1. To support the GLOCHANT Planning Groups by helping them to define data needs.
2. To improve access to data by supporting the use of the SCAR database (SCAR Antarctic Master Directory) and identifying and solving limitations caused by restricted access to data.
3. Data rescue. This involves identifying critical datasets at risk and sponsoring their rescue.

CG-1 met at XXIII SCAR in Rome (1994) where SCAR issued a call for proposals to host the Antarctic Master Directory (Antarctic Data Directory System). Only one proposal was received from the International Centre for Antarctic Information and Research (ICAIR) in New Zealand. Their proposal has been accepted in principle by SCAR so that the SCAR/COMNAP data management function will now be taken over by ICAIR. This still leaves

a need for data management within GLOCHANT itself. G.Rosenberg suggested that it would be a good idea to coordinate with ICAIR during preparation of the SCAR/ GLOCHANT proposal that will be submitted to START.

3.7 CG-2: Numerical modelling (H.Cattle)

With input from GAIM, CG-2 is carrying out a review of current efforts in Antarctic modelling. This includes reviewing the status of model simulations of Antarctic change under different scenarios. A future project is to model interactions between physical and biological processes in the Antarctic sea-ice zone. This is a need that was identified in SCAR 1993 and involves links with GLOCHANT Planning Groups 1 and 5. Another project aims to develop atmospheric datasets for models of surface forcing in the Antarctic region.
Within GLOCHANT itself, it is easier to link what CG-2 is doing to the modelling components of the projects that emerge from the Planning Group process. An example might be the modelling of the interactions of biology and the physics of sea ice. G.Hubold felt that the group should emphasize the multidisciplinary nature of GLOCHANT modelling efforts.

3.8 Regional Research Centre (RRC)

3.8.1 Activities and plans (G.Rosenberg)

The specific mention of a GLOCHANT newsletter in the recommendations from XXIII SCAR in Rome made this a high priority for the new GLOCHANT Coordinator. The newsletter would itself constitute a "product" that could be distributed to the SCAR Delegates. Other important activities (additional "products") would be Antarctic global change science symposia and publications. It would be worthwhile to look into arranging with a publisher for a SCAR/GLOCHANT book series, along the lines of the IGBP book series. The Coordinator would also work with M.Thorley and H.Cattle to pursue contacts with START with a view to establishing GLOCHANT as a RRC in the START framework. The Convenor asked the new Project Coordinator to prepare a prioritized list of what he proposes to do.

H.Cattle suggested producing a yearly update of the status report published in SCAR 1993. Publication could be in a loose-leaf format and this information could also be made available on the World Wide Web. Initially, the review would deal with international programmes only, and specifically with their Antarctic components. The material proposed for inclusion (as brief as a twenty-line paragraph) could be sent for review to the international programme managers (with a deadline).

3.8.2 Logo and Letterhead (C.Bentley)

A previous design for a GLOCHANT logo was rejected by the IGBP as too similar to their design. This is something that will be taken up by the new Project Office in Hobart.

3.8.3 Newsletter (G.Rosenberg)

The GLOCHANT newsletter will have an initial frequency of once every six months, possibly increasing in frequency to once every four months. It will be necessary to solicit articles from the Group of Specialists and from members of the Planning/Coordination Groups. It will also be important to control production and distribution costs. The newsletter could be a joint publication with CS-EASIZ and could include information about other national and international programmes of interest to SCAR. The newsletter could also be posted on a GLOCHANT home page on the World Wide Web, but a printed version would be essential. C.Bentley asked the chairs of the GLOCHANT Planning Groups to prepare write-ups of their activities for the first issue of the newsletter. U.Bathmann recommended that later issues should include data from GLOCHANT projects to show the scientific community what the Group of Specialists is doing.

3.9 Finances (C.Bentley)

The GLOCHANT Financial Statement for 1994 is attached as Appendix 5. The total expenditure amounted to US$27,405 including US$22,552 for the 1994 GLOCHANT II and PG-2 meetings in Col de Porte, France. The total budget for 1995 is US$72,000, of which US$37,000 has been allocated for the GLOCHANT III and joint GLOCHANT PG-1 and PG-5/ CS-EASIZ meetings in Tokyo. SCAR has also authorized meetings of PG-2, PG-3 and PG-4 in 1995. US$38,500 has been budgeted for 1996. The proposal to approve a GLOCHANT Special Fund was not approved at XXIII SCAR, although it was accepted that such a fund could be re-proposed in the future.

3.10 Membership

The present membership of the GLOCHANT Group of Specialists and GLOCHANT subgroups is given in Appendix 6. Any additions to the GoS itself would have to be coopted members, although it might be possible to request SCAR support for one additional member. The present membership of the GoS already includes a coopted member from Switzerland. Coopted members cannot come from a country that is already represented in the GoS, a restriction that does not apply to regular members.

C.Bentley identified a need for a marine biologist and a sedimentary palaeontologist or palaeoclimatologist. G.Hubold felt that the biologist should be an expert on sea-ice biota or carbon flux who also works at the species level. Suggested names included Warwick Vincent (Canada, limnology), Louis Legendre (Canada, biological oceanography) and Christiane Lancelot (Belgium, microbial modelling). An approach to SCAR to appoint a

new regular member was preferred to a new coopted member. D.Raynaud was not convinced that it would be good idea to increase the membership of the GoS as it would make discussions less efficient. Another strategy is for the members to maintain individual contacts with scientists in disciplines that are not represented in the GoS. It was decided to request the SCAR executive to add a new member to GoS/GLOCHANT in the field of marine biology. G.Hubold will recommend a specific person.

3.11 Interaction with IASC (C.Bentley)

SCAR and IASC have agreed that it is appropriate to take a bipolar approach to some research questions and that global change is an area that is particularly appropriate for cooperation. IASC has a Working Group on Global Change in the Arctic that is chaired by Gunter Weller. Weller also chaired the group that prepared SCAR 1993. Cooperation is envisaged in the areas of the palaeo-record, mass balance and sea level change and UV effects in the environment. At XXIII SCAR in Rome, the SCAR Delegates approved the establishment of a joint SCAR/ IASC Planning Group on UV-B effects. H. Zimmerman has suggested a joint workshop on bipolar deep drilling activities and SCAR, IASC and PAGES have discussed the development of a joint palaeoenvironment group. It has been suggested to have *ad hoc* joint groups on UV effects, glaciers and mass balance and the palaeoenvironmental record meet at the IASC conference in Hanover, New Hampshire, in December 1995.

3.11.1 Effects of Enhanced UV Radiation (P. Artaxo)

The most important aspects of IASC UV activities for GLOCHANT are the effects on aquatic ecosystems. So far, there is only one UV monitoring station in the Arctic while there are six to eight operating in the Antarctic. The IASC report on UV effects (see 5.2.3 below) includes recommendations for research, but we do not know how it will be implemented (except that WMO will run the monitoring stations).

In view of the need for bipolar coordination in research on UV monitoring and effects (see item 3.4, above), the GoS approved the designation of SCAR representatives to *an ad* hoc joint planning group with IASC. H. Marchant suggested the following names for this group: Polly Penhale, Susan Weiler, Barbara Prezelin, Ray Smith, Osmund Holm-Hansen, Deneb Karentz and Victor Smetacek. J.Priddle suggested approaching the BIOTAS programme for terrestrial expertise.

3.11.2 The Palaeoenvironmental Record (D.Raynaud)

Two factors favour more linkages with IASC in this area. First, in the Arctic, there are a wide variety of palaeoenvironmental records that provide proxy data. Second is the strong support from Gunter Weller. On the other hand, for work on ice cores, most of the experts are now working closely with PAGES and GLOCHANT and the activity of PAGES could easily be extended to the Arctic. Furthermore, palaeoclimate is not a main focus in IASC's 1994 action plan. D.Raynaud recommended that GLOCHANT postpone any formal action until after the GLOCHANT PG-2/PAGES/IASC workshop in Boston in September 1995 (see item 3.2, above).

O.Watanabe mentioned that the International Circum-polar Arctic Ice Drilling Project (ICAP) involves Japan, Canada, Russia and Germany under the auspices of the Glaciology Working Group of IASC. ICAP has begun to cooperate with PAGES. D.Raynaud plans further discussions among GLOCHANT/PG-2, G.Weller and a representative of ICAP at the Boston meeting.

3.11.3 Glaciers and mass balance (C.Bentley)

H.Zimmerman asked C.Bentley to organize a workshop titled 'Mass Balance of Arctic Glaciers and Ice Sheets'. A convenient venue would be at the IASC Conference for Arctic Research Planning in Hanover, New Hampshire in December 1995. The workshop will be jointly sponsored by GLOCHANT, IASC and PAGES. C.Bentley suggested himself, F.Nishio and M.Moskalevsky as workshop participants. Dr.Haeberli of the World Glacier Monitoring Service in Zurich was mentioned as another possible participant.

M.Moskalevsky mentioned Russian investigations on glaciers and mass balance in Franz Josef Land in cooperation with the Scott Polar Research Institute of the U.K. Similar Russian studies in the Antarctic offer the opportunity for bipolar comparisons. Russia is also carrying out deep drilling activities in the Russian Arctic as part of ICAP. Two of these projects will combine deep drilling with studies of mass balance. P.Wadhams mentioned that IASC has organised global change (biophysical impact) studies at the regional level in both the Barents and Bering regions. This experience may be of use to GLOCHANT.

4.0 REPORTS ON OTHER SCAR ACTIVITIES

4.1 SCAR Working Groups

4.1.1 Working Group on Biology (G.Hubold)

In 1994, the Working Group on Biology sponsored the Sixth SCAR Biology Symposium in Venice. The Science and Implementation Plans for the CS-EASIZ programme developed by SCAR/GoSSOE were approved. A programme on Antarctic Pack-Ice Seals (APIS) sponsored by this Working Group is now underway. The Working Group also approved reports from GoSSOE and from the Biological Investigations of Terrestrial Antarctic Ecosystems (BIOTAS) programme. Finally, the Working Group recommended that another biologist be added to the membership of GLOCHANT.

4.1.2 Working Group on Geology (C.Bentley)

The interest of this Working Group that is most relevant to GLOCHANT is the palaeoclimatic record obtained by marine drilling projects. The Cape Roberts Drilling Project, a joint effort involving the U.S., New Zealand, Germany and Italy, aims to drill strata recording climatic and tectonic history in the southwestern corner of the Ross Sea. Drilling will take place in 1996 and 1997. The Working Group urges that further marine coring and drilling be conducted on the Antarctic continental shelf, by the Ocean Drilling Project and through other efforts. Antarctica is particularly important in efforts to understand climate history and to extend the sedimentary record.

4.1.3 Working Group on Glaciology (I.Allison)

The last formal meeting of the Working Group on Glaciology took place in Cambridge in 1993, and an informal meeting took place in September 1993 in Columbus, Ohio. The Working Group reviewed the progress of a number of projects, including the Filchner-Ronne Ice Shelf Programme (FRISP), the European Ice Coring in Antarctica (EPICA) programme, IPAB, the iceberg observing project and plans for the International Trans-Antarctic Scientific Expedition (ITASE; the programme now has new officers). The Working Group also looked at Landsat data from the Antarctic.

4.1.4 Working Group on Physics and Chemistry of the Atmosphere (PACA) (P.Artaxo)

The most recent PACA Working Group meeting brought together about twelve researchers at XXIII SCAR in Rome (1994). In Rome there was also an informal meeting of a working group on atmospheric science and palaeoclimatic modelling. Fifteen papers were presented at a workshop on Antarctic atmospheric chemistry. Results were also presented from the first year of the First Regional Observing Study of the Troposphere (FROST) and plans for the second year of this study were discussed. The Working Group discussed an integrated Antarctic communication system to transmit synoptic data for Antarctica by satellite, using the Global Telecommunication System. The Working Group members felt that there was an urgent need for more communication between PACA and GLOCHANT.

Additional information about the FROST study was presented by I.Allison. FROST is a project of PACA to assess the quality of numerical weather analyses and predictions over Antarctica and the surrounding seas. FROST data have been collected for three Special Observing Periods (July 1994, October/November 1994 and January 1995). This data is being used to produce a series of independent weather analyses for the area south of latitude 50° S. The impact of these analyses on the performance of numerical weather prediction models will be tested. The first FROST workshop, to review the programme and to plan future activities, was held in Hobart, Tasmania, in March 1995 and the initial results have been encouraging.

4.1.5 Working Group on Solid-Earth Geophysics (C.Bentley)

The Working Group on Solid-Earth Geophysics continues to be concerned at the lack of consideration for the circum-Antarctic sedimentary record within GLOCHANT. This concern echoes similar concerns expressed by the SCAR Working Group on Geology.

4.2 Reports from SCAR Groups of Specialists

4.2.1 Group of Specialists on Cenozoic Palaeoenvironments (D.Raynaud)

This Group of Specialists focuses on the Pliocene and the Quaternary, but also looks further into the past. They would like to have a stronger interaction with GLOCHANT. The person to contact is Peter Webb at Ohio State University, who is the convenor of the GoS.

4.2.2 Group of Specialists on Antarctic Seals (G.Hubold)

The new APIS research programme is now underway. The programme is focusing on the population dynamics of crabeater seals and their dependence on the extent of sea ice.

4.2.3 Group of Specialists on Southern Ocean Ecology (GoSSOE) (G.Hubold)

The GoS met in Padua, Italy in the week before the Sixth Biology Symposium. The CS-EASIZ Science and Implementation Plans were finalized and a steering group of six scientists was established to coordinate CS-EASIZ in its three regional divisions: Atlantic sector (Wolf Arntz, Andrew Clarke), Ross Sea (Maria Cristina Gambi, Paul Dayton) and Indian Ocean sector (M.Fukuchi, H.Marchant). The CS-EASIZ Science and Implementation Plans were published in December 1994 as SCAR Report No.10. A.Clarke was elected as CS-EASIZ Coordinator. To effectively link CS-EASIZ with GoSSOE, the following changes in the group were recommended (and later approved by SCAR): A.Clarke, H.Marchant and M.Fukuchi became full members of GoSSOE. G.Hubold, P.Nichols and Sakshaug ceased to be full members, but continue as coopted members. D.Miller replaced G.Hubold as the Convenor. G.Dieckmann was added to the group to replace C.Sullivan. A joint meeting of GoSSOE and CS-EASIZ will take place later in 1995.

The aim of CS-EASIZ is to improve understanding of the structure and dynamics of the Antarctic coastal and shelf ecosystem. Particular attention will be focused on the biology and on understanding seasonal, inter-annual and long-term changes. The core of the programme consists

of measurements to be undertaken on the ice, water column and benthic subsystems. Field work under the auspices of CS-EASIZ will start in 1994-95 and run for ten years. A dedicated cruise will take place in 1996-97.

4.3 Reports on National Programmes

China (C.Bentley)

Dr.Qin Dahe has developed a proposal for a 'GLOCHANT study from the Antarctic Convergence to Dome A along 75° E longitude'. As the title implies, the proposal contains both oceanographic and glaciological (surface sampling) components. It is not known whether the proposal has been accepted by the Chinese National Committee.

Russia (M.Moskalevsky)

Russian scientists are involved in a study of glaciers on sub-Antarctic islands, including King George Island and the South Shetland Islands. The work involves the establishment of a mass balance network, radio-echo sounding and snow studies. There is a plan to broaden the study to include the northern part of the Antarctic Peninsula. The emphasis is on using glaciers as indicators of climate change. The programme invites international participation and is already cooperating with Brazil.

United Kingdom (H.Cattle)

The British Antarctic Survey is developing a strategic plan for the next five years. The plan will be based on the SCAR 1993, so this strategic plan is of obvious interest to GLOCHANT. A draft version of the plan has already been circulated. Once approved, the five-year plan will be published.

Australia (I.Allison)

The Australian strategic five-year plan for Antarctic research in the period from 1995 to 2000 is now complete. This plan emphasizes both global change and environmental protection. (The proposed research on global change closely parallels that outlined in SCAR 1993.) Specific projects are relevant to all of the GLOCHANT Planning Groups, except PG-4 (UV Radiation in the Antarctic Atmosphere). Projects completed or planned in 1994-95 include measurement of sea-ice characteristics (Indian Ocean sector), drifting buoys, upward looking sonar (ULS), algal growth, analyses of cores (DSS and DE08 cores and Prydz Bay sediments), glaciological/mass balance studies (Lambert Glacier Basin, Amery Ice Shelf, Law Dome) and JGOFS contributions along WOCE SR3.

Japan (Atmosphere - T.Yamanouchi, Biology - M.Fukuchi, Glaciology - Y.Fujii)

The emphasis in the Japanese programme has been on studies of the Antarctic atmosphere, glaciology/geology, and biology. Routine observations at Syowa Station include a suite of meteorological variables, including total ozone and UV fluxes and spectra. Observations are also made at Mizuho Station and during R/V Shirase cruises. Climate research has focused on inter-annual variation in the Antarctic atmosphere and on air/sea-ice interactions. Research on atmospheric chemistry has included measurements of greenhouse and other trace gases and aerosols, from the stratosphere to the troposphere and cryosphere. Plans for a new atmospheric monitoring scheme will be of interest to GLOCHANT PG-4.

Japanese biological investigations are being carried out under the umbrella of the Sea Ice Ecology and Flux Study (SIEFS) at Syowa Station and on repeated inter-annual cruise tracks of the R/V Shirase. SIEFS is a five-year programme that will conclude in 1998. Measurements include CO_2 nutrients, primary production and zooplankton in the water column, as well as studies of the ice biota (both seasonal and fast ice) and benthic communities. Studies of fish behaviour and analyses of sediment cores are also being carried out. SIEFS is linked with the APIS seals programme. Additional biological work is being carried out at Prydz Bay, Davis Station and Macquarie Island in cooperation with Australian scientists. Terrestrial biology (bacteria and algae in soils, mosses and lichens, penguins) is also a component of the Japanese programme.

From mid-1995 to 1996, Japanese scientists will carry out a deep ice core drilling project at Dome F to obtain an ice core record to 200,000 yr B.P. The aim is to study processes related to past global climate change. The parameters to be measured in the core include ice and gas chemistry, particles and physical properties. Atmospheric and snow chemistry will be studied at Dome F and additional studies, including snow chemistry, ice sheet dynamics and snow accumulation are planned along a transect from Dome F to the coast. In 1997 to 2000, there are plans for deep ice core drilling at Dome Fuji. These activities should be coordinated with GLOCHANT PG-2.

5.0 REPORTS ON OTHER INTERNATIONAL ACTIVITIES AND PROGRAMS

5.1 International Geosphere-Biosphere Programme IGBP)

C.Bentley pointed out that that coordination with IGBP will be particularly important for GLOCHANT. Chris Rapley has replaced Thomas Rosswall as the new IGBP Executive Director in Stockholm.

5.1.1 Southern Ocean - Joint Global Ocean Flux Study (SO-JGOFS) (P.Treguer)

The third meeting of the SO-JGOFS Planning Group was held in Cambridge, England on 15-16 September 1994. The Planning Group agreed to sponsor the symposium on

'Carbon Fluxes and Dynamic Processes in the Southern Ocean: Present and Past', to be held in Brest, France on 28-31 August 1995. Funding for this symposium is being provided by SCOR and SCAR. The group recommended that:

- A session at the Brest symposium should be used to compare methods used to measure primary production in the sea-ice zone.
- The Southern Ocean components of GLOBEC and JGOFS should establish their respective requirements for time-series studies with a view to assessing their mutual compatibility.
- SCAR and SCOR should consider joint funding of a liaison group for global change research in the Southern Ocean. A JGOFS scientific symposium and evaluation meeting will be held in Villefranche-sur-Mer on 8-12 May 1995. The presentations will include the results of iron (Fe) fertilization experiments in the Southern Ocean. U.Bathmann and P.Treguer will present syntheses of Phase I of SO-JGOFS activities as well as describing preliminary plans for Phase II. A joint Australian/French cruise to study the physics, chemistry and biology of the frontal area and the polar front has been proposed by John Parslow (Australia) and Michel Denis (France) for the austral summer of 1998. This expedition would involve two ships.

5.1.2 Past Global Environmental Changes (PAGES) (D.Raynaud)

One of the goals of PAGES is to obtain palaeodata for the validation of predictive climate models. PAGES now has a five-year plan for the period 1994-1998 that includes both marine and terrestrial work. Variability over the last 2,000 years and over the last two major climate cycles is of particular interest. There are four foci:

- Global palaeoclimate and environmental variability.
- Palaeoclimate and environmental variability in the polar regions.
- Human interactions in past environmental changes.
- Climate sensitivity and modelling.

Work in the polar regions will include both Arctic and Antarctic components. The Arctic programme emphasizes studies of palaeoclimate from Arctic lakes and estuaries and from the Nansen Arctic Drilling Project (GISP2 and GRIP cores). The Antarctic programme will be carried out in cooperation with GLOCHANT and includes ongoing and planned deep drilling projects. Nations that are involved in drilling projects include the U.S. (WAIS cores), Russia (Vostok), Japan (Dome Fuji) and France, Italy and Sweden (Dome Concordia and Queen Maud Land). Part of the future work will be under the umbrella of ITASE.

5.1.3 International Global Atmospheric Chemistry (IGAC) (P.Artaxo)

During an IGAC international conference in Fuji-Yoshida, Japan, in September 1994, there was a formal meeting of the Polar Air and Snow Chemistry (PASC) programme. Fourteen scientists attended this meeting chaired by Robert Delmas (France) and Len Barrie (Canada). Discussions concerned the French-led international Deep Drilling Programme in the Antarctic and results from the GRIP and GISP projects. In connection with the deep drilling activities, the group stressed the importance of understanding processes at the atmosphere-snow interface.

5.1.4 Global Analysis, Interpretation and Modelling (GAIM) (H.Cattle)

GAIM concentrates on modelling of biogeochemical processes with the aim of eventual coupling to physical models of climate. "Analysis" is carried out via workshops and has recently concentrated on wetlands, vegetation and climate. "Interpretation" aims to clarify specific (IPCC-related) issues via workshops and study teams. "Modelling" concentrates on the carbon cycle and vegetation and climate in four time frames: palaeo, fossil fuel era, contemporary and future. The first GAIM Scientific Conference will be held at Garmisch-Partenkirchen, Germany on 24-29 September 1995.

5.1.5 IGBP Data and Information System (IGBP-DIS) (M.Thorley)

M.Thorley maintains contact with IGBP-DIS, which is developing data directories and standard methods for data management and transfer. So far, little of this work concerns the Antarctic. However, a data centre has been established in Boulder, Colorado, to support the work of PAGES on ice cores.

5.1.6 Land-Ocean Interactions in the Coastal Zone (LOICZ) (G.Hubold)

LOICZ has recently added a 'Framework Activity 6 - Determination of the Rates, Causes and Impacts of Sea Level Change'. The descriptive language includes "state-of-the-art determinations of sea-level and ice-volume changes". LOICZ had previously indicated that they would consider only the effects of sea-level change, not the causes.

5.1.7 Global Change and Terrestrial Ecosystems (GCTE)(C.Bentley)

C.Bentley raised the question of possible linkages with the IGBP Global Change and Terrestrial Ecosystems (GCTE) programme. There was some interest in initiating such contacts, particularly related to terrestrial biology on the Antarctic peninsula.

5.1.8 IGBP System for Analysis, Research and Training (START) (M.Thorley)

On behalf of GLOCHANT, M.Thorley and H.Cattle were asked to develop a draft proposal to SCAR to implement an Antarctic Regional Research Centre (RRC) that would build on the global change components of the existing

SCAR-coordinated regional scientific network. This proposal grew out of a meeting among C.Rapley, T.Rosswall, M.Thorley, H.Cattle, J.Priddle and D.J.Drewry that was called to discuss coordination between SCAR and IGBP/START. XXIII SCAR accepted the proposal and agreed that SCAR/GLOCHANT and START should work together to produce a proposal for implementing an Antarctic Regional Research Network, for discussion at XXIV SCAR in Cambridge.

M.Thorley then tabled a draft proposal from SCAR to the eighth meeting of the START Steering Committee that took place in Brussels in September 1994. The START Steering Committee agreed that there are potentially large benefits to be realized from collaboration between START and SCAR and welcomed the strong lead taken by SCAR/ GLOCHANT in developing the proposal. Following a discussion on issues such as the need to include a capacity-building component (for example, training and a data and information system) and linkage to broad polar issues, the START Steering Committee encouraged SCAR/ GLOCHANT to forge ahead in consultation with the International START Secretariat to develop an Antarctic Regional Research Network based upon the timetable and steps proposed.

Some participants questioned the merits of GLOCHANT becoming a formal RRC within the START network due to their emphasis on developing countries and lack of specific interest in Antarctica. Potential benefits to SCAR/ GLOCHANT include the possibility for direct input into IGBP projects and a higher international profile. It is possible that IASC will eventually function as an RRC for the Arctic. After some discussion, there was general agreement to continue on the path recommended by M.Thorley. Both M.Thorley and Cattle would welcome more input from other members of GoS/GLOCHANT.

The International START Secretariat is located in Washington, DC. The START Director is Roland Fuchs; he is assisted by Deputy Director Hassan Virji.

5.2 Other international activities and programmes

5.2.1 World Climate Resarch Programme (WCRP)

5.2.1.1 World Ocean Circulation Experiment (WOCE) (H.Cattle)

A.Foldvik normally monitors this programme. WOCE is moving from the data-gathering phase to the analysis phase. It will be succeeded by a new programme, Climate Variability and Prediction Research (CLIVAR), with some of the WOCE measurements to be continued under CLIVAR.

5.2.1.2 International Programme for Antarctic Buoys (IPAB)(I.Allison)

IPAB was established under WCRP auspices at a meeting in Helsinki in June 1994. The programme objectives are to promote and coordinate the deployment of drifting data buoys, measuring air pressure and temperature and reporting via the Global Telecommunication System (GTS), within the Antarctic sea-ice zone. The programme will also maintain a research data base of data from all buoys contributing to the programme.

Six organizations had formally acceded to the programme as of February 1995 and further participants are expected. Nine drifting buoys were operating in the Antarctic in Jan/ Feb 1995 and at least nine new deployments were firmly planned during 1995.

5.2.1.3 Antarctic Ice Thickness Monitoring Project(AnITMP)(I.Allison)

AnITMP aims to monitor sea ice thickness in the Antarctic using bottom-moored upward looking sonar (ULS) buoys. During 1994, eleven ULS moorings were deployed in the Antarctic sea-ice zone. A workshop on ULS data processing was held in Oslo, Norway, in June 1994. The AnITMP Coordinator is Prof. Peter Lemke.

5.2.1.4 Global Energy and Water Cycle Experiment(GEWEX)(I.Allison)

GEWEX is a global study of the hydrological cycle and energy fluxes with a focus on the processes of the "fast climate system". GEWEX does not plan to include the CO_2 solid part (ice masses) of the hydrological cycle as part of the programme.

5.2.1.5 International Satellite Cloud Climatology Project (ISCCP)(I.Allison)

It has been proposed that ISCCP, due to conclude in mid1995, be continued until 2000. ISCCP uses the mean earth disk as a radiometric target to provide intercalibration between different spacecraft sensors. Hence, ISCCP data cannot be used to monitor global change, but do characterize regional, seasonal and diurnal cloud variability. Revised cloud detection algorithms now provide improved detection of polar clouds, particularly over sea ice.

5.2.1.6 Global Surface Baseline Radiation Network (GSBRN)(I.Allison)

GSBRN is establishing a high quality radiation monitoring network using standardised instruments and measurement protocols. Currently, South Pole is the only Antarctic station contributing to the network, but several other Antarctic stations have been proposed, including Neumayer (Germany) and Syowa (Japan) stations.

5.2.1.7 Climate Variability and Prediction Research (CLIVAR)(I.Allison)

The goal of CLIVAR is to determine the variability and predictability of the physical climate system on time-scales

of seasons to centuries. CLIVAR includes climate system modelling, a global scale upper-ocean observing programme, and a deep ocean observation programme. 'CLIVAR encompasses and builds on aspects of the Tropical Ocean and Global Atmosphere Experiment (TOGA) and WOCE. The study of deep water formation and other oceanic processes within the Antarctic sea ice zone will form an integral part of CLIVAR.

5.2.1.8 Arctic Climate System Study (ACSYS) (H.Cattle)

ACSYS is concerned with Arctic climate monitoring and modelling. The programme will concentrate on the Arctic basin region and will look only at the physical part of the climate system (including hydrology), not at the biology. Science and implementation plans for ACSYS are now available.

5.2.1.9 Stratospheric Processes and their Role in Climate (SPARC) (P.Artaxo)

SPARC is a programme of WCRP. The four principal foci are:

- Stratosphere-troposphere exchange
- Upper troposphere/ lower stratosphere chemistry
- Ozone trends assessment
- UV-B monitoring and modelling

The UV-B work is being done jointly with the WMO Global Atmospheric Watch Programme (GAW). SPARC has links with IGAC, JGOFS, GCTE, CIMD, the Scientific Committee on Problems of the Environment (SCOPE) and other international programmes. With regard to UV-B, SPARC has focused on the effects of increased UV-B radiation on terrestrial vegetation and aquatic ecosystems. SPARC is also sponsoring studies of UV-induced immune suppression and its relationship to stratospheric ozone depletion. Although SPARC is a worldwide programme, the Antarctic figures prominently in all four research foci. SPARC produces a newsletter and sponsors workshops.

Concern was expressed about overlap between SPARC and GLOCHANT/PG-4 in the area of UV-B effects on the biota. P.Artaxo plans to contact SPARC to find out about the status of their programme and to look into possibilities for cooperation. SCOPE and IASC have also produced reports on the effects of UV-B radiation in the Arctic.

5.2.2 International Association for Geodesy (IAG)(C.Bentley)

Recently, the principal activity of the IAG *ad hoc* Planning Group on Global Change of Sea Level and Ice Sheet Volume Changes has been to convince LOICZ of the importance of including determination of the causes of change in their programme.

5.2.3 International Antarctic Science Committee (IASC)(C.Bentley)

IASC will organize a Conference for Arctic Research Planning in Hanover, New Hampshire in December 1995. IASC recently produced a report (IASC Report No. 2) on the effects of UV-B radiation. A.Foldvik normally monitors IASC activities.

5.2.4 Southern Ocean - Global Ocean Ecosystems Dynamics Research (SO-GLOBEC) (G.Hubold)

A five-year implementation plan has been finalised and will be published as GLOBEC Report No.7. The programme consists of two field studies (winter and summer, six months each) and modelling activities that will be supported by strong data management. SO-GLOBEC will focus on zooplankton (krill, two copepod species and salps) and on top predators (crabeater seals, Adelie penguins, petrels, squid and fish). The programme has three regional components: Antarctic peninsula, eastern Weddell Sea and the Indian Ocean sector. Work will begin in 1996. SO-GLOBEC has links to both CS-EASIZ and the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR).

5.2.5 Convention for the Conservation of Antarctic Marine Living Resources(CCAMLR) (G.Hubold)

CCAMLR is part of the Antarctic Treaty System. Within CCAMLR, the programme that is relevant to GLOCHANT is the CCAMLR Ecosystem Monitoring Programme (CEMP). CEMP has now been running for several years and focuses on local effects of krill abundance on top predators (including penguins and seal colonies). Recently, CEMP started to add sea-ice data to its routine measurements. Initial results show a positive relation between the extent of winter sea ice and krill abundance in the following season.

5.2.6 Scientific Committee on Problems of the Environment (SCOPE)(H.Marchant)

SCOPE held meetings in Budapest and in Sardinia on the measurement and biological and medical impacts of increased UV-B radiation. Two SCOPE reports resulted from these meetings. The role of SCOPE is not to implement programmes, but rather to propose science plans.

5.2.7 Scientific Committee on Oceanic Research, Working Group 86 on Sea-Ice Ecology (SCOR/WG-86) (S. Ackley)

This Working Group has been concerned with the interactions of biology with sea-ice physics and chemistry, including the definition of sea-ice habitats and how sea ice participates in the carbon cycle. WG-86 has published three papers (two on Polar Biology and one on Deep Sea Research) on 'Sea Ice - Physical - Biological Habitats'; 'Global Significance'; and 'Terminology and Methods to be Used in Sea-Ice Ecology Studies'. The final task of the Working Group is to hold a workshop on Sea Ice Ecology

which is currently proposed as a Gordon Research Conference for the northern summer of 1996. The book that will result from this conference is intended for use by researchers and graduate students in Sea Ice Ecology.
Within SCOR, A.Gordon has proposed the creation of a committee on International Coordination of Oceanographic Research within the Antarctic Zone (AnZone). SCOR is also the operating agency for GLOBEC and JGOFS. A.Foldvik normally monitors SCOR activities.

5.2.8 Intergovernmental Panel on Climate Change (IPCC) (H.Cattle)

IPCC has now published its special report on 'Radiative Forcing, 1994'. Work on the second scientific assessment by IPCC Working Group 1 is well underway. Publication of the assessment is planned for March/April 1996. The primary Antarctic input will be in Chapter 7, 'Changes in Sea Level'.

5.2.9 Global Ocean Observing System (GOOS) (I.Allison)

GOOS is the designation for a long-term ocean observing system that is presently being developed. The GOOS Ocean Observing System Development Panel has commissioned a background report on long-term monitoring of sea ice as part of the global climate system. This report, with recommendations, will be published in 1995. GOOS will include the continuation of present observing systems as well as the application of new systems, such as synthetic aperture radar (SAR). The Global Climate Observing System (GCOS) is a climate analog to GOOS that is also being developed.

5.2.10 Acoustic Thermometry of Ocean Climate (ATOC) (C.Bentley)

ATOC started as an initiative of Walter Munk to use acoustic signals to determine ocean temperatures. However, the whole project has been delayed until ways are found to satisfy concerns that the high sound levels generated might be damaging to marine mammals. A decision by the U.S. National Marine Fisheries Service on whether to issue a permit is expected in May 1995. ATOC is of interest because of the possibility that a listening station might be established on the East Antarctic coast, which would allow monitoring of the mean temperature along a transect across the Southern Ocean. P.Wadhams pointed out that ice thickness may be another parameter to come out of this project.

5.2.11 Inter-American Institute for Global Change Research (IAI)(G.Rosenberg)

Sixteen nations in the Americas signed the agreement that created the IAI in 1992 and the agreement has now been ratified by eleven nations including Argentina, Brazil, Canada, Chile, Costa Rica, Cuba, Mexico, Panama, Peru, the United States and Uruguay. The IAI has defined seven foci for its scientific activities, including four of possible interest to GLOCHANT: High Latitude Processes; Comparative Studies of Oceanic, Coastal and Estuarine Processes in the Temperate Zones; ENSO and Interannual Climate Variability; and Impacts of Climate Change on Biodiversity. Workshops involving scientists from throughout the Americas have been held to develop the scientific agenda for each of the seven foci.

The report of the Workshop on High Latitude Processes (Buenos Aires, Argentina, December 1994), the area most relevant to GLOCHANT, was published in April 1995. GLOCHANT was represented by P.Artaxo. The broad areas proposed for future research are ozone and UV-B radiation, present and past cryospheric processes, and climatology and atmospheric processes. The IAI is providing US$50,000 start-up grants to multinational groups to support the development of detailed science and implementation plans for each of the seven scientific foci, including High Latitude Processes. US$2 million has been approved to fund an Initial Science Programme until the first set of long-term programmes is established in 1997.

The Office of the Director of the IAI is being established at the National Institute for Space Research (INPE) in Sao Jose dos Campos, Brazil. The new Director is Uruguayan, Armando Rabuffetti.

5.2.12 Joint Expeditions in the Indian Ocean Sector of the Southern Ocean (JEISSO) (P.Treguer)

JEISSO is a new international programme involving Australia, France and Japan. Its principal investigators include P.Treguer (France) and M.Fukuchi (Japan). The research programme is concerned with the variability of physical, chemical and biological parameters in the seasonal ice zone. Chemical measurements include pCO_2 and inorganic nutrients; biological parameters include chlorophyll, primary production and export production (from sediment traps). This work is being carried out at a station north of Prydz Bay, away from the influence of the coastal zone. A total of five expeditions are planned to this station, at different seasons. Research began in 1994-95. JIESSO is a longer-term programme that will continue past the scheduled end of JGOFS. P.Treguer suggested that JIESSO might be carried out under the auspices of GLOCHANT. The most appropriate umbrella for JIESSO activities will be a topic of discussion at the SO-JGOFS symposium in Brest in August 1995.

5.2.13 MAST (U.Bathmann)

U.Bathmann mentioned the MAST proposal for deep-sea research that has been developed for funding by the European Union. Carbon and Silica deposition, microbial communities, bioturbation, boundary layer transport, deep-sea troughs, water convection and waste disposal are some of the areas that would be studied. The first phase of this project covers three years.

6.0 RESPONSE OF GoS/GLOCHANT TO THE JOINT MEETING OF GLOCHANT PG-1 AND PG-5 WITH GoSSOE/CS-EASIZ

The Group of Specialists reconvened on 21 April 1995 and approved the following statement:

"GLOCHANT is encouraged by the accomplishments of the joint meeting and encourages the group to continue in its work. GLOCHANT supports the principle of the Antarctic Sea-Ice Processes, Ecosystems and Climate (ASPECT) project and looks forward to receiving a science plan for further consideration by GLOCHANT."

The Group of Specialists also decided to change its emphasis from disciplinary Planning Groups to task-oriented groups of more limited lifespan. Accordingly, PG-2 will now be known as the Ice Coring Task Group, PG-3 as the Mass Balance Task Group, PG-4 as the Atmospheric Task Group (if it decides to continue its work), and the new group that will replace PG-1 and PG-5 will be known as the Sea Ice-Zone Task Group.

Some concern was expressed that the new structure and the goal of producing a science plan fails to take into account the liaison function that is prominently featured in the terms of reference. The most important liaison function would be to advise SCAR and the most important coordination would be between GLOCHANT projects and other projects to see how they impact on the GLOCHANT effort. G.Rosenberg reminded the meeting that liaison would be part of the function of the project office in Hobart and, eventually, of a GLOCHANT/START Antarctic RRC. In addition, individual members of GoS/GLOCHANT have already been assigned as liaisons with particular international programmes. U.Bathmann suggested that each of the new Task Groups should designate a member who would be responsible for liaison.

C.Bentley noted that the proposed ASPECT programme still leaves out work in the frontal zone that is partly covered by JGOFS. C.Bentley proposed that SCAR send a recommendation to JGOFS emphasizing the importance of research in the frontal zone and requested that P.Treguer prepare an appropriate statement for final approval by SCAR. This suggestion was supported by J.Priddle.

The Convenor expressed the appreciation of all of the participants for the hospitality of the Japanese hosts, including F.Nishio and the staff of the NIPR. The meeting was closed on 21 April 1995.

7.0 FUTURE GoS/GLOCHANT MEETINGS

7.1 Next formal meeting (C.Bentley)

The Convenor invited GoS/GLOCHANT to meet in the northern spring of 1996 at the University of Wisconsin in Madison. C.Bentley's offer was welcomed by the members of the GoS and it was decided to meet from Wednesday, April 10, to Saturday, April 13, 1996.

At the 1994 meeting of GoS/GLOCHANT in Col de Porte, France, the group committed itself to gathering the input of SCAR officers before the annual GLOCHANT meeting and this should be done before the 1996 meeting. New programs and their GoS/GLOCHANT liaisons are: ACSYS (H.Cattle), ICAP (F. Nishio), JEISSO (P.Treguer), and Global Data Archive Rescue (GLODAR)(M.Thorley). Members of the GoS were also asked to notify the Convenor or the Project Office of the meetings that they plan to attend.

7.2 Informal meeting at XXIV SCAR

Members of GoS/GLOCHANT will be at XXIV SCAR to meet informally and to discuss GLOCHANT activities with SCAR Working Groups and Groups of Specialists meeting there.
The Group of Specialists decided to reconvene at the NIPR on 21 April 1995, to take action on the results of the joint meeting of GLOCHANT PG-1 and PG-5 with GoSSOE/CS-EASIZ that was scheduled for April 19-21.

Part C

SCAR Group of Specialists on Global Change and the Antarctic (GoS/GLOCHANT)

SCAR Group of Specialists on Southern Ocean Ecology (GoSSOE)

Report of the joint meeting of GLOCHANT Planning Groups 1 and 5 and GoSSOE/ CS-EASIZ

National Institute of Polar Research, Tokyo, Japan, April 19-21, 1995

The principal product of this meeting will be a science plan for the study of Antarctic Sea-Ice Processes, Ecosystems and Climate (ASPECT).

Attendees: S.Ackley (PG-1), I.Allison (GoS/GLOCHANT, PG-1), P. Artaxo (GoS/GLOCHANT, PG-4), U.Bathmann (PG-5), C.R.Bentley (GoS/GLOCHANT, Convenor and PG-3), H.Cattle (GoS/GLOCHANT, CG-2), G.Dieckmann (PG-1, GoSSOE), M.Fukuchi (PG-1, PG-5, GoSSOE, CS-EASIZ), G.Hubold (GoS/GLOCHANT, GoSSOE), H.Marchant (PG-5, GoSSOE, CS-EASIZ), D.Miller (GoSSOE, Convenor), G.di Prisco (GoSSOE), J.Priddle (PG-5), F.Nishio (GoS/GLOCHANT, PG-3), D.Raynaud (GoS/GLOCHANT, PG-2), G.Rosenberg (GLOCHANT Coordinator, now resigned), M.R.Thorley (GoS/GLOCHANT, CG-1), P.Treguer (GoS/GLOCHANT, PG-5), P.Wadhams (PG-1), O.Watanabe (PG-2). Other participants: Y.Fujii, T.Furukawa, M.Moskalevsky, H.Motoyama, M.Naganobu, M.Nakawo, S.Takahashi, A.Taniguchi, S.Ushio, K.Watanabe, T.Yamanouchi, K.Yamazaki

(See Appendix 1 for a list of acronyms and abbreviations used in this report. See Appendix 2 for a list of participants and their addresses.)

1. INTRODUCTION

The meeting was opened on 19 April 1995, by C.Bentley, Convenor of GoS/GLOCHANT. The revised agenda was approved and copies were distributed to the participants.

1.1 Background (C.Bentley)

By late 1994, both GLOCHANT Planning Groups 1 (Sea Ice) and 5 (Biogeochemical Cycles) had produced preliminary recommendations for their work on global change in the Antarctic under the auspices of GLOCHANT. The GLOCHANT Convenor tabled a report on GLOCHANT activities at XXIII SCAR in Rome in September 1994. Bentley recalled the recommendations of the SCAR delegates that came out of this meeting:

"Because of the development of a well-thought-out Coastal and Shelf Ecology of the Antarctic Sea-Ice Zone (CS-EASIZ) programme that largely covers the Antarctic aspects of sea-ice biology and biogeochemical exchanges across the ocean-atmosphere boundary and the advance plans in WCRP relating to the physical aspects of sea ice, it was considered that GLOCHANT Planning Groups 1 (Sea Ice) and 5 (Biogeochemical Cycles) are not needed at present. However, it is recommended that the members of those Planning Groups and of the Steering Committee for CS-EASIZ meet jointly for one time only, to implement coordination between CS-EASIZ and GLOCHANT and to ensure that no important aspects of their fields are overlooked".

CS-EASIZ was accordingly invited to meet with GLOCHANT/PG-1/PG-5 following the third meeting of GoS/GLOCHANT to take place at NIPR in Tokyo in April 1995. Although the Chair of CS-EASIZ, Andrew Clarke, could not be present in Tokyo, he prepared and transmitted a document titled 'The Relationship between the SCAR/ GLOCHANT and EASIZ Programmes' for discussion at the meeting. This document is attached as Appendix 7. Clarke concluded that:

"Whilst scientific work to have been undertaken under the auspices of the now-disbanded GLOCHANT PG-1 might contribute significantly to the aims of CS-EASIZ, this is unlikely to the case for the similarly disbanded PG-5, whose area of interest is broadly confined to the surface

waters away from the continental shelf. Unfortunately, neither the management structure nor the limited funding of CS-EASIZ allow for the resurrection of either PG-1 or PG-5 within this programme. Whilst we in no way wish to discourage the contribution that any Antarctic scientists might make to the aims of CS-EASIZ, there unfortunately exist no mechanisms for transferring the roles of either PG-1 or PG-5 to this programme".

C.Bentley expressed the appreciation of GLOCHANT for Dr. Clarke's thoughtful paper. XXIII SCAR and Clarke's paper have set the stage for the development of recommendations concerning what is being overlooked in other programmes and for a re-evaluation of the roles of GLOCHANT PG-1 and PG-5.

C.Bentley invited the meeting participants to consider possible research deficiencies that require concerted international actions in Antarctica with an interdisciplinary aspect. Discussions earlier in the week at the third meeting of GoS/GLOCHANT had identified lacunae in the areas of UV-B effects and the coupling between physics and biology in the sea-ice zone.

1.2 Status of PG-1 (I.Allison)

I.Allison recalled that the deficiencies in sea-ice research had been pointed out in *The Role of Antarctica in Global Change* (SCAR, 1993). In fact, since that time, several international programmes have been established or have developed interests in this area, including the World Ocean Circulation Experiment (WOCE), the international Antarctic Zone project (AnZone) (coordinated oceanographic research in the Antarctic), CS-EASIZ, the Antarctic Ice Thickness Monitoring Project (AnITMP), the International Programme for Antarctic Buoys (IPAB), and others. In September 1993, PG-1 met to refine the list of priorities from SCAR 1993. The group identified several deficiencies and recommended some process studies, including a project on coastal polynyas. The report from this meeting is attached as Appendix 8.

1.3 Status of PG-5 (P.Treguer)

P.Treguer distributed copies of the report of PG-5 that came out of their February 1994 meeting in Col de Porte, France. The report reviewed the activities of the Southern Ocean Joint Global Ocean Flux Study (SO-JGOFS) and WOCE and recommended links with these programmes, as well as with the emerging programmes of CS-EASIZ and Southern Ocean Global Ocean Ecosystems Dynamics Research (SO-GLOBEC). The major recommendations were: to develop biogeochemical models coupled to physical models for the different subsystems of the Southern Ocean; to define standard methods for the study of carbon cycling and strategies for the study of frontal areas. UV-B effects on the biota were also mentioned. Excerpts from the report of PG-5 are attached as Appendix 9.

2.0 OVERLAPPING ACTIVITIES

2.1 SCAR/CS-EASIZ (G.Hubold)

G.Hubold presented the history of EASIZ, now CS-EASIZ. The programme originated in Trondheim, Norway, in 1990, where the idea was to develop a successor to the SCAR Biological Investigations of Marine Antarctic Systems and Stocks (BIOMASS) programme. The meeting produced a broad research plan concerned with Antarctic biology that was similar to SCAR 1993. After 1990, new programmes were coming into existence. In 1994, another meeting in Padua, Italy, came up with a more focused plan that reduced the scope of EASIZ to the ecology of the coastal sea-ice zone. The overall aim of CS-EASIZ is to understand the structure and dynamics of the Antarctic coastal and shelf ecosystem. Because shallow-water communities are especially sensitive to global change, particular attention will be paid to the biology and to understanding seasonal, inter-annual and long-term changes. During the planning stages of CS-EASIZ, a major role was played by benthic ecologists. The idea is to link processes that are occurring in sea ice, in the water column and in the benthos. The science plan also includes modelling, diversity studies, physiological work and molecular genetics. The landward limit of CS-EASIZ is the coast (even onto the land margin for mammals and birds); the seaward limit is rather ill-defined. The focus is on the fast ice and the inner pack ice. The six key scientific questions identified by CS-EASIZ are:

- What is the role of ice in the Antarctic coastal marine ecosystem?
- How do communities of Antarctic marine organisms differ from those elsewhere?
- What physical, chemical and biological factors determine patterns of production, sedimentation and recycling, and the major elemental budgets of the Antarctic coastal and shelf ecosystem?
- How are marine organisms adapted to the low temperature and seasonal changes in the physico-chemical parameters characteristic of the Antarctic coastal and shelf ecosystem?
- What is the nature and importance of the interaction between land (including shelf ice) and sea in the Antarctic coastal zone?
- How are the biological communities of the Antarctic coastal and shelf ecosystem directly affected by human activities?

The CS-EASIZ Steering Committee includes regional coordinators for the Atlantic sector (Wolf Arntz, Andrew Clarke), the Ross Sea (Maria Cristina Gambi, Paul Dayton) and the Indian Ocean sector (M.Fukuchi, H.Marchant). There is both a core monitoring programme involving coastal stations and shipboard work and a wider programme for nations with appropriate logistical capability. Field work will commence in 1994-95 and the

programme will run for ten years. A dedicated cruise has been scheduled for 1996-97. The CS-EASIZ Science and Implementation Plans were approved by the delegates to XXIII SCAR in Rome in September 1994 and were published as SCAR Report No.10 in December of 1994.

The approach of CS-EASIZ, which includes the study of benthic communities (to SCUBA diving depth), was judged by the participants to be quite different from SO-JGOFS, which focuses on physics and primary production, and geographically distinct from SO-GLOBEC which focuses only on water column processes. The indicator species are different and, in many cases, the scale of the planned observations also differs. The cross representation of researchers in the different programmes ensures that there is, in fact, a good deal of awareness of what the others are doing. I.Allison felt that the CS-EASIZ sea-ice measurements were rather scant and would benefit from the activities of PG-1.

2.2 World Climate Research Programme (WCRP)(I.Allison)

WCRP is sponsoring two programmes that are concerned with physical processes in the Antarctic sea-ice zone: the Antarctic Ice Thickness Monitoring Project (AnITMP) and the International Programme for Antarctic Buoys (IPAB). In as much as WCRP considers the Antarctic as an area that is covered by SCAR, there are no plans for other WCRP programmes. In particular, the WCRP programmes do not study biogeochemical cycles. P.Wadhams suggested that there is a need for an Antarctic climate system study, similar to ACSYS in the Arctic.

2.2.1 International Programme for Antarctic Buoys (IPAB)

IPAB was established at a meeting in Helsinki in June 1994. The objectives are to promote and coordinate the deployment of drifting data buoys, measuring air pressure and temperature and reporting via the Global Telecommunication System (GTS). As of Jan/Feb 1995, nine drifting buoys were operating in the Antarctic sea ice and at least nine new deployments are planned during 1995. Areas that are still in need of coverage include the Ross Sea, the Bellingshausen Sea and the Eastern Weddell Sea. I.Allison is the Coordinator of IPAB and recommends that GLOCHANT promote the buoy programme rather than taking it up as a GLOCHANT project.

2.2.2 Antarctic Ice Thickness Monitoring Project (AnITMP)

The purpose of AnITMP is to monitor sea-ice thickness in the Antarctic using bottom-moored Upward Looking Sonar (ULS) buoys. During 1994, eleven ULS moorings were deployed in the Antarctic sea-ice zone, three moorings off the Filchner Ice Shelf, six in the northern Weddell Sea, and two off East Antarctica.

2.3 Southern Ocean Joint Global Ocean Flux Study (SO-JGOFS)(J.Priddle)

JGOFS is one of the core projects of the IGBP, and was the first IGBP project to implement a field programme. The JGOFS Science and Implementation Plans included the Southern Ocean because it represented an oceanic enigma in the carbon cycle. There is a nutrient surplus (i.e. the phytoplankton do not use up the nutrients) and this creates the potential to increase the carbon flux into the ocean. The first JGOFS cruises took place in 1990. SO-JGOFS was adopted by JGOFS as a regional programme. The field work combines a subsystem approach with larger-scale monitoring. Several volumes of *Deep Sea Research* deal with SO-JGOFS. The next major events are a JGOFS Scientific Meeting in Villefranche-sur-Mer, France, in May 1995, and the SO-JGOFS 'Symposium on Carbon Fluxes and Dynamic Processes in the Southern Ocean: Present and Past' to take place in Brest, France, in August, 1995.

The seasonal ice zone figures in JGOFS in process studies of the phytoplankton blooms associated with the ice edge. Some work is also planned in coastal regions, with linkages to CS-EASIZ. There are also efforts to understand what limits phytoplankton production in the open ocean and fronts. Unlike the rest of JGOFS, SO-JGOFS includes the export of carbon and its accumulation in the sediments. Planned time-series studies may provide opportunities for shared cruises and linkages with SO-GLOBEC. The development of coupled physical-biological models for different "biogeochemical provinces" in the Southern Ocean is another important goal of SO-JGOFS activities.

2.4 Southern Ocean Global Ocean Ecosystems Dynamics Research (GLOBEC) (U.Bathmann)

The SO-GLOBEC Science and Implementation Plans have now been published as SCOR Report No.7. Although GLOBEC has been formally accepted as a SCOR project, it has not yet been accepted by IGBP. The SO-GLOBEC plan came out of a 1994 meeting in Bremerhaven, Germany. The plan outlines the key questions, the target species and the scientific approaches. Two groups of species will be studied: zooplankton (copepods and krill) and top predators (seals and penguins). The main aim is to understand the linkages between physics and biology on different scales, from ocean scales to meters and decimeters. SO-GLOBEC will concentrate on three areas: the Antarctic peninsula, the eastern Weddell Sea and the Indian Ocean sector. There will be three modes of observation: interannual time-series surveys of the physics and biology of the target species, process studies at different scales and hydroacoustic studies. There will also be three permanent stations for the biological work on reproduction and species interactions. These stations will be occupied at six-to eight-week intervals through a

complete annual cycle. A suite of physical factors will also be measured.

SO-GLOBEC field work will begin with a British-German cruise in 1996. Most of the research will be in the period 1998-2000. Unlike CS-EASIZ, SO-GLOBEC will limit its attention to the water column and the sea ice. In addition, the indicator species are different and the ocean dynamics occur on a different scale. GLOBEC will integrate on a scale of weeks while EASIZ will also integrate on a scale of years. SO-GLOBEC, with its focus on higher trophic levels, was developed to complement SO-JGOFS, with its focus on CO_2 and primary production. There is some overlap between SO-JGOFS and SO-GLOBEC when one considers, for example, what happens to the sea-ice diatom bloom. Does it sink out or is it consumed and recycled by zooplankton? There is perhaps more overlap between SO-GLOBEC and the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR), in as much as they are monitoring the same species. The objectives of these two programmes are quite different, however.

2.5 International Global Atmospheric Chemistry Programme (IGAC)(P. Artaxo)

There is no IGAC activity related to sea ice. The Polar Air and Snow Chemistry (PASC) experiment does not deal with interactions of snow and sea ice.

2.6 Joint Expeditions in the Indian Ocean Sector of the Southern Ocean (JEISSO)(P.Treguer)

JEISSO is a new multinational programme involving Australia, France and Japan. This programme is concerned with the variability of the physical, chemical and biological parameters in the seasonal ice zone and the frontal area. Chemical measurements include pCO_2 and inorganic nutrients; biological parameters include chlorophyll, primary production and export production from sediment traps. This work is being carried out at a station north of Prydz Bay, away from the influence of the coastal zone. Research began in 1994-95.

2.7 Convention for the Conservation of Antarctic Marine Living Resources (CCMLR)(G.Hubold)

The CCMLR Ecosystem Monitoring Programme (CEMP) has now been running for several years and focuses on local effects of krill abundance on top predators (including penguins and seal colonies). Recently, CEMP started to add sea-ice data to its routine measurements.

SUMMARY

The discussion of overlaps among the Antarctic programmes was summarised in a Venn diagram prepared by H.Marchant(Figure 1). JGOFS is concerned with off-shelf (water column) processes, physics, measurements of CO_2 and dissolved and particulate inorganic carbon (DIC and PIC), dissolved and particulate organic carbon (DOC and POC), single-celled organisms (including phytoplankton and protists), primary production and its export. GLOBEC is concerned with off-shelf (water column) processes, invertebrate and vertebrate indicator species, as well as the physics that influences the population dynamics of animals and predator/prey interactions. CCAMLR is concerned with off-shelf populations of invertebrates and vertebrates and has a management focus. Antarctic Pack-Ice Seals (APIS) is an ongoing research programme under the auspices of the SCAR Working Group on Biology. APIS is concerned with populations of crabeater seals that live at the ice edge. CS-EASIZ covers the sea-ice zone from the coast to the shelf break and is concerned with both benthic and pelagic indicator species (their population structure and dynamics) as influenced by sea ice. CS-EASIZ also places special emphasis on the community level.

The general consensus of the meeting participants was that present and planned programmes fail to provide adequate coverage of the sea-ice zone.

3.0 IDENTIFYING THE DEFICIENCIES (CHAIR: P.TREGUER)

3.1 Sea ice and sea-ice processes (S.Ackley)

S.Ackley presented a brief review of the dynamics of sea ice and the ecology of sea-ice-associated biota. According to climate models, polar regions should respond more strongly than other ecosystems to a doubling of atmospheric CO_2. However, the models do not include all of the sea-ice processes that are important and many important parameters are not available. For example, sea-ice thickness distribution is available for only three areas in the Antarctic. U.S. JGOFS does not include the sea-ice zone. Ackley concluded that there is a special role for GLOCHANT in the shelf to ice-edge area (pack ice) that is not being adequately covered by other programmes, including IPAB and AnITMP. In response to some participants who felt that the pack-ice zone was still overly broad, I.Allison pointed out that biological considerations were mainly responsible for narrowing the focus of CS-EASIZ. Physical scientists need to cover a larger area because of their interest in the larger climate system. CS-EASIZ does not focus on sea ice *per se*, but sea-ice data are desired by the programme for the rest of its work. There is also a need to develop special tools and techniques to study biological communities under sea ice. GLOCHANT could play a role in coordinating between the biological and physical studies.

3.2 Marine ecosystems (G.di Prisco)

G.di Prisco suggested that GLOCHANT promote studies of benthic indicator species that have distinct stages (such

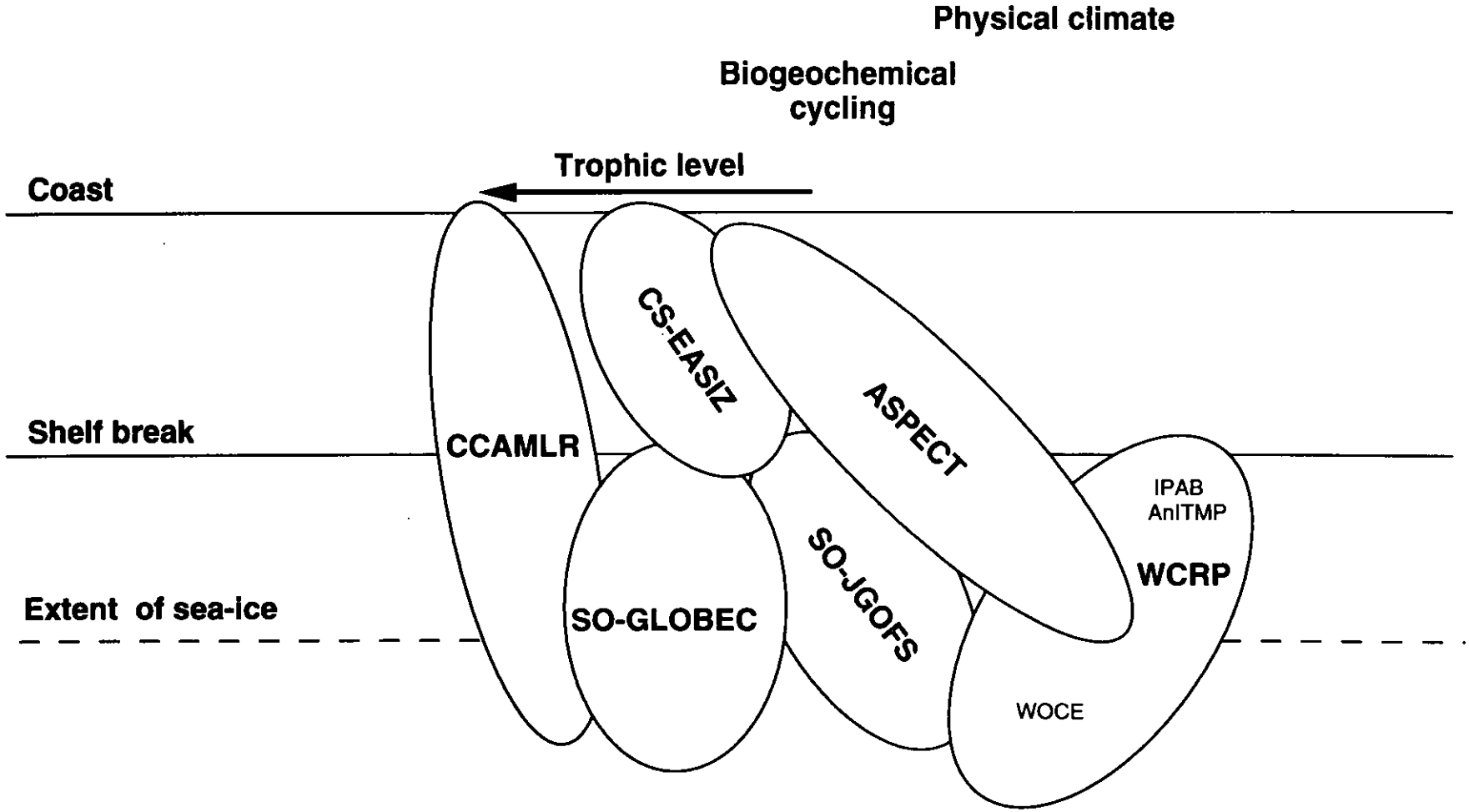

Figure 1. Cartoon depicting some of the interactions between, and area of operation of, selected Southern Ocean programs.

as pelagic larvae) in their life cycles. As an example, he mentioned UV-B effects on early life-history stages.

G.Hubold felt that CS-EASIZ is lacking in large-scale connections and that a synoptic approach, including the relationship between local and regional variability, could be developed by GLOCHANT.

U.Bathmann mentioned that the European Union has identified deep-sea processes and ecosystems, including Antarctica, for special funding.

3.3 Biogeochemical cycles (J.Priddle)

SO-JGOFS has a comprehensive remit for biogeochemical cycling. Planning is already proceeding for a second four-year field campaign, including collaboration with SO-GLOBEC and CS-EASIZ. The deficiencies that are not covered adequately by other programmes include (possible GLOCHANT linkages in parentheses):

1 The sediment record (contemporary and past changes). (GLOCHANT PG-2)
2 Inadequate understanding of the sea-ice system, including polynyas, gas exchanges and export (particularly when the ice melts). This deficiency requires an ecosystem, dynamic approach. (PG-1 and CS-EASIZ)
3 Science logistics and mechanisms for inter-programme liaison.
4 UV impacts as a forcing factor. (PG-4 and PG-5)
5 Southern Ocean remote sensing applications, including special problems that are unique to polar regions (ice contamination, ground truthing and physical aspects). (PG-1)
6 Physical export of carbon through deep water formation (covered to some extent by Atlantic Deep Ocean Exchange (ADOX)). (PG-5)
7 Biochemical cycles, especially the sulphur cycle (production of dimethyl sulphide DMS, etc.). (PG-4 and PG-5)
8 Horizontal exchanges between the shelf and the deep sea (exchanges across the shelf break). (PG-5)
9 Modelling (CG-2)

According to Priddle, the most important item on this list is #2(the sea-ice system) because this information is required for coupled models. Next in importance are items #5(remote sensing) and #8(exchanges across the shelf break).

P.Treguer suggested three additional items:

- Long-term variability of the ecosystems
- Methodology and core parameters. One role for GLOCHANT would be to evaluate the methods that are in use.
- The frontal zone as a key CO_2 sink (inadequately covered by JGOFS). Frontal zones also play an important role in heat exchange.

3.4 UV-B and marine biota (H.Marchant)

H.Marchant identified a number of deficiencies in this area, including UV-B monitoring and intercalibration between different national UV-B programmes. UV-B climatology in Antarctica will require coordination between different national research activities. For studies of UV-B impacts, much work has been done on marine phytoplankton. Some of this work has used laboratory simulations and some work has been done under ambient conditions. Short-term experiments that measure UV-B protection (pigments, etc) are quite different from long-term experiments that look at UV-B damage and survival. Some organisms even show UV-B enhancement. Phytoplankton are important because of their role as primary producers and their production of trace gases, especially DMS. Organisms other than phytoplankton have attracted less attention, although there has been some work on bacteria and heterotrophic dinoflagellates (but not other protozoa). Bacteria and protozoa are DMS users and control its ventilation to the atmosphere. Although there has been some work on UV-B effects on metazoa from temperate waters, there has been little work in Antarctica. Furthermore, the effects of UV-B on DOC and POC have not received much study. Unlike some other global change parameters, UV-B impacts also have a political dimension.

The effects of UV-B on the terrestrial biota of Antarctica are included in the Biological Investigations of Terrestrial Antarctic Systems (BIOTAS) programme. For the Antarctic marine biota, some work is planned by CS-EASIZ and there is some discussion of including UV-B work in SO-JGOFS and SO-GLOBEC. Marchant nevertheless felt that the only clear way ahead would be through GLOCHANT.

3.5 Modelling (H.Cattle)

For modelling, one needs forcing data, data to initialise the model and data to verify the model (independent data). Both SO-JGOFS and SO-GLOBEC include strong modelling components. One aim of SO-JGOFS is to model the carbon cycle. Modelling of the impact of sea ice on the development of phytoplankton is being done by a German/Dutch/British team at the Alfred Wegener Institute for Polar and Marine Research (AWI). Ice/ocean-coupled modelling is also going on elsewhere. PG-5 has identified model development as a priority (see item 1.3, above). J.Priddle felt that small-scale models address the concerns of local studies, whilst JGOFS is especially concerned with developing regional and large-scale models. The role of sea ice (including albedo feedback, ice thickness, flux correction and ice dynamics) has not been well addressed and sea ice should be incorporated into climate models. SO-JGOFS would welcome GLOCHANT development of models that include sea ice.

3.6 Data requirements (M. Thorley)

Each programme has its own data management policy (centralised or distributed systems). It is important to identify any needs for data exchange among programmes and problems with restricted access to data. GLOCHANT could sponsor key Antarctic datasets or promote the establishment of long-term datasets. M.Thorley mentioned some examples, including 'World Ocean Atlas 1994' and 'Operation Oceanic Data Rescue'. Data and modelling are linked and there is a need for long-term data on environmental variability. Finally, some data (e.g. from remote sensing) are available but are presently underutilized. U.Bathmann mentioned that JGOFS and GLOBEC decided to establish their own databases to ensure that the scientists actually look after their data. He suggested that GLOCHANT could identify a set of core parameters (for intercalibration and large-scale modelling) to be measured across the programmes.

3.7 Relevant SCAR and SCAR-related projects and proposals

Joint Expeditions in the Indian Ocean Sector of the Southern Ocean (JEISSO)(P.Treguer)

A total of five expeditions at different seasons are planned to the north of Prydz Bay. JEISSO is seeking a long-term organisational umbrella for its activities.

Antarctic Coastal Polyna Study (ACoPS)(P.Wadhams)

P.Wadhams reviewed the formation and role of coastal polynyas as "ice factories". He then discussed the research and logistical needs for a proposed United Kingdom/ Australia ACoPS study of coastal polynyas. A small number of coastal polynyas would be studied at different seasons. If this programme were to be sponsored by SCAR, it would become multinational. New research tools that could be used include Automatic Underwater Vehicles (AUVs) that could be launched under the ice to measure ice thickness, passive and active microwave satellites, synthetic aperture radar (SAR), and the Sea Viewing Wide-Field-of-View Sensor satellite (SeaWIFS). Acoustic tomography could be used to determine the underwater temperature and salinity structure. There was a discussion of the technical capabilities of SAR. G.Hubold emphasized the link between coastal polynyas and marine biology, from primary productivity to penguins and whales. The proposed polynya programme would be complementary to CS-EASIZ.

Seasonal ice transects (I.Allison)

U.S. and Australian scientists have proposed a programme of transects within the sea ice using standardised ship-based observations to fill some of the gaps in knowledge about Antarctic sea ice, including ice thickness distribution, snow thickness and the proportion of water to ice coverage. The transects would be perpendicular to the Antarctic coast and spaced at intervals of about 20-30° of longitude. The programme would include research on sea ice and snow, hydrology, meteorology, water column biology, sea-ice biology and vertebrates. Biological measurements would be made using the protocols recommended by the CS-EASIZ programme.

Australia/France frontal area cruise (P.Treguer)

A cruise to study the physics, chemistry and biology of the frontal area and the polar front has been proposed by John Parslow (CSIRO, Australia) and Michel Denis (CNRS, France) for the austral summer of 1998. The expedition would involve two ships and would take place under the JGOFS umbrella. This project is complementary to a South African effort.

4.0 ADDRESSING THE DEFICIENCIES (CHAIR: I.ALLISON)

A number of options were considered including: disband PG-1 and PG-5; recommend science plans to relevant programmes within and outside SCAR; reinstate PG-1 and PG-5 and continue outside SCAR; amalgamate PG-1 and PG-5; appoint an *ad hoc* team to redefine the science plan. Ultimately, it was the last option that prevailed.

I.Allison opened the discussion by considering the revised terms of reference that had been approved at the third meeting of the GoS/GLOCHANT in Tokyo earlier in the week. These are:

- To provide SCAR Working Groups, Groups of Specialists and national programmes with the best available multidisciplinary advice regarding ongoing Antarctic global change research.
- To provide liaison between SCAR and the other major international programmes on global change and to promote the applicable Antarctic component within those international programmes.
- To identify research needs in Antarctic process studies, monitoring and modelling related to global change.
- To plan, promote and monitor specific projects on problems of global change research in the Antarctic.

I.Allison then presented the following list of important problems, derived from SCAR 1993 that are not being adequately covered by existing Antarctic research programmes:

- Broad climatology of sea-ice physical characteristics.
- Sea-ice ecology.
- Processes (polynyas, ice formation, water masses and Antarctic Bottom Water, frontal zone, gas exchange, air-sea interaction).
- UV-B impacts.
- Modelling sea-ice processes (physics and ecology) in

coupled upper-ocean models. Linking scales (local scale to regional scale models).
- Identification of core data access projects for model initiation, forcing and validation.
- Remote sensing methodology and validation.

H.Marchant suggested that one distinguish between questions (more important) and approaches (such as modelling and remote sensing). After some discussion, it was decided to focus on the first four problems in the sea-ice zone. The participants then agreed that the best way to proceed was to appoint an *ad hoc* task group to prepare a science and implementation plan that would be complementary to the plans for CS-EASIZ. Many participants felt that a strong statement of specific objectives for the different components was still lacking. Two subgroups met to prepare the following sets of ecosystem and physical science objectives that were approved after some discussion:

Objective I

To understand processes that affect the coupled ice-ocean-atmosphere-biota system in the Antarctic and the role of this system in the global environment. These are:

- The nature of ice formation and modification processes in determining the ultimate thickness distribution of Antarctic sea ice.
- The factors controlling the biology and ecology of the sea-ice-associated biota; and the effects of that biota on the sea-ice characteristics.
- The role of dynamic regions, such as coastal polynyas, the coastal current front and ice-edge fronts in affecting ice production and distribution; biological and biogeochemical processes; water mass modification; and air-sea-exchange.
- The impact of sea ice and its associated biota on the ocean-atmosphere exchange of climatically active gases.
- The response of key sea-ice-associated organisms to elevated levels of UV-B.

This objective can be achieved by process studies undertaken as components of the transect programme and proposed multidisciplinary field studies of coastal polynyas and the coastal current front.

Objective II

To establish the seasonal and regional properties of Antarctic sea ice important to air-sea interaction, biogeochemical cycles, and ice growth and decay within the Antarctic sea-ice zone.

Broad-scale surveys are required to define a climatology of the time-varying state of the ice thickness distribution and snow cover; structural, chemical and thermal properties of the snow and ice; floe, lead and ridge distribution; upper-ocean hydrography; and the sea-ice and water-column biota.

This will be achieved by standardised ship-based observations along a series of systematic transects, building on ongoing national efforts.

N.B. Some of the above objectives were condensed from the following list of general and specific objectives presented by I.Allison.

General objectives:

- To establish the distribution of basic properties important to air-sea interaction and ice growth and decay within the Antarctic sea-ice zone in order to derive forcing and validation fields for models (ice thickness distribution and snow cover; structural, chemical and thermal properties of the snow and ice; upper-ocean hydrography; floe size and lead distribution).
- To understand key sea-ice zone processes in order to improve parameterization of these processes in coupled models.

Specific objectives:

- To understand the special processes of ice formation and modification in the Antarctic that determine the ultimate ice thickness distribution. These include the frazil-pancake mechanism at the ice edge, ice formation within the pack, the snow-ice mechanism (effect of snow load) and underwater ice formation. (SCAR 1993, 1.2.1)
- To understand the role of coastal polynyas in ice production and water-mass modification on shelves (leading to bottom-water formation). (SCAR 1993, 1.2.5)
- To understand and determine the role of the coastal current front in affecting biological and biogeochemical cycles and in determining the ice distribution in coastal regions. (SCAR 1993, 1.2.2)
- To determine how UV-B affects biological processes within and under ice. (SCAR 1993, 1.2.2)
- To understand how ice/water distribution affects gas exchange. (SCAR 1993, 1.2.6)

There was a discussion of whether or not the new programme should look at Antarctic Bottom Water formation, but this issue was left unresolved.

It was also agreed that the two specific projects (i.e. the transect study and the coastal polynya study), as presented, will answer only some of the questions that are being asked. The transect study will provide information about large-scale distributions while polynyas are a system of interest in the context of some of these questions. Ecosystem and process studies will also be necessary on the ice itself (and not only in the polynyas). S.Ackley

suggested adding a time-series study to the transects and lengthening the transects to begin before the ice edge. Time-series stations could be established in different sea-ice environments and the fast ice could be studied from the Antarctic stations. Core-data requirements would need to be established for the transects. The general consensus was that it would be possible to address all of the proposed objectives in the context of a polynya programme and in a suitably modified transect programme.

5.0 CONCLUSIONS

A name and acronym for the proposed new programme was suggested by J.Priddle and approved by the group: Antarctic Sea-Ice Processes, Ecosystems and Climate (ASPECT). An *ad hoc* planning/writing group was identified to prepare a draft of a science and implementation plan for ASPECT. This group included S.Ackley, I.Allison (Co-chair for physics), P.Artaxo, G.Dieckmann (Co-chair for biology), M.Fukuchi, H.Marchant, D.Miller, J.Priddle, P.Treguer and P.Wadhams. It was emphasized that this planning/writing group is not necessarily the same as an eventual scientific steering group. There was a brief discussion of whether a member of the Council of Managers of National Antarctic Programmes (COMNAP) should be included in a scientific steering group. It was agreed to invite a representative of COMNAP to future GLOCHANT scientific planning meetings. It was recognised that the programme would need to include modelers to couple what is happening in the sea-ice zone and global change. D.Miller proposed the following names of modelers who could be added to the group: Ilene Hoffman, Gary Schaffer, Colin Atwood, Chris Gant, Mark Abbott and Coleen Maloney. To this list, U.Bathmann added the names of Eilers and Lemke, two modellers at AWI. ASPECT-related modelling could be carried out in collaboration with the Global Analysis, Interpretation and Modelling (GAIM) effort of IGBP, which otherwise could not be expected to promote the models that are needed for Antarctic systems.

I.Allison reviewed the requirements for the preparation of the ASPECT science plan. The plan should have an Introduction that refers to *The Role of Antarctica in Global Change* (SCAR, 1993). The Introduction should also mention the recommendations from XXIII SCAR in Rome, from the third meeting of GoS/GLOCHANT in Tokyo and from the joint meeting of GLOCHANT/PG-1/PG-5 with CS-EASIZ. The scientific aims should include the key scientific issues. The status of current knowledge and investigations should be summarized, including the aims and limitations of SO-JGOFS, SO-GLOBEC, CS-EASIZ, WCRP, etc. This summary should identify the existing deficiencies. The science plan should include specific objectives and recommendations. Presentations of the transect programme and the polynya programme (an international development of ACoPS) should include explanations of their rationale and a science outline. This document should also include recommendations for implementation and management, a timetable, and a section on interaction with other programmes.

Recommendations to GLOCHANT and SCAR

The specific response to XXIII SCAR should not be included in the ASPECT Science Plan, but rather in a cover letter that will serve as a report to SCAR. This letter will be the responsibility of the chairmen of PG-1 and PG-5. The scientific plan and justification should constitute a stand-alone document. Initial work on the ASPECT Science Plan will be done by e-mail and a draft should be ready in time for the SO-JGOFS meeting in Brest at the end of August 1995. Following approval by SCAR, the ASPECT Science Plan could be published in the SCAR Report series. Support will be provided by the GLOCHANT Project Office in Hobart and it will be necessary to maintain contact with SO-JGOFS, SO-GLOBEC, CS-EASIZ and WCRP.

The meeting concluded with a discussion of whether it would be better to recommend disbanding GLOCHANT PG-1 and PG-5 or maintaining them in a dormant state until JGOFS field work ends in 1998. The general consensus was that it would be better to disband these groups and reconstitute them as necessary. Although UV-B impacts on the biota are now included in the proposed ASPECT programme, P.Artaxo, the Chair of GLOCHANT PG-4, was of the opinion that this still leaves plenty of work for PG-4 on problems of monitoring and atmospheric aspects. PG-4 will decide what to do by July 1995.

Transmission of relevant proposals to other programmes

The proposed ASPECT programme would be carried out under the sponsorship of SCAR, rather than by other international programmes. On behalf of SCAR, C.Bentley thanked the meeting participants for taking an unfortunate situation and making a constructive event out of it. The meeting closed on April 21, 1995.

Appendix 1

List of Acronyms and Abbreviations

ACoPS	Antarctic Coastal Polynya Study
ACSYS	Arctic Climate System Study
ADOX	Atlantic Deep Ocean Exchange
AnITMP	Antarctic Ice Thickness Monitoring Project
AnZone	International Coordination of Oceanographic Research within the Antarctic Zone
APIS	Antarctic Pack-Ice Seals programme
ASPECT	Antarctic Sea-Ice Processes, Ecosystems and Climate (GLOCHANT)
ATOC	Acoustic Thermometry of Ocean Climate
AUV	Automatic Underwater Vehicle
AWI	Alfred Wegener Institute for Polar and Marine Research(Germany)
BAS	British Antarctic Survey
BIOMASS	Biological Investigations of Marine Antarctic Systems and Stocks
BIOTAS	Biological Investigations of Terrestrial Antarctic Systems
CCAMLR	Convention for the Conservation of Antarctic Marine Living Resources (Antarctic Treaty System)
CEMP	CCAMLR Ecosystem Monitoring Programme
CG	Coordinating Group (GLOCHANT)
CG-1	Coordinating Group 1 on Data Management (GLOCHANT)
CG-2	Coordinating Group 2 on Numerical Modelling (GLOCHANT)
CLIVAR	Climate Variability and Prediction Research (WCRP)
CNRS	National Centre for Scientific Research (France)
COMNAP	Council of Managers of National Antarctic Programmes
CS-EASIZ	Coastal and Shelf Ecology of the Antarctic Sea-Ice Zone (GoSSOE)
DIC	Dissolved inorganic carbon
DIS	Data and Information System
DOC	Dissolved organic carbon
ENSO	El Nino - Southern Oscillation
EPICA	European Ice Coring in Antarctica
FRISP	Filchner-Ronne Ice Shelf Programme
FROST	First Regional Observing Study of the Troposphere
GAIM	Global Analysis, Interpretation and Modelling (IGBP)
GAW	Global Atmosphere Watch
GCOS	Global Climate Observing System
GCTE	Global Change and Terrestrial Ecosystems (IGBP)
GEWEX	Global Energy and Water Cycle Experiment
GLOBEC	Global Ocean Ecosystems Dynamics Research
GLOCHANT	Group of Specialists on Global Change and the Antarctic (SCAR)
GLODAR	Global Data Archive Rescue
GOOS	Global Ocean Observing System
GoS	Group of Specialists (SCAR)
GoSSOE	Group of Specialists on Southern Ocean Ecology (SCAR)
GRIP	Greenland Research Ice Core Project
GSBRN	Global Surface Baseline Radiation Network (GEWEX)
GTS	Global Telecommunication System
IAG	International Association for Geodesy
IAMAP	International Association for Meteorology and Atmospheric Physics
IAPSO	International Association for the Physical Sciences of the Ocean
IASC	International Arctic Science Committee
ICAIR	International Centre for Antarctic Information and Research (New Zealand)
ICAP	International Circum-polar Arctic Ice Drilling Project
ICSU	International Council of Scientific Unions

List of Acronyms and Abbreviations (Contd).

IGAC	International Global Atmospheric Chemistry Programme (IGBP)
IGBP	International Geosphere-Biosphere Programme
IGBP-DIS	IGBP - Data and Information System
IGS	International Glaciological Society
IPAB	International Programme for Antarctic Buoys
IPCC	Intergovernmental Panel on Climate Change
ISCCP	International Satellite Cloud Climatology Project (GEWEX)
ITASE	International Trans-Antarctic Scientific Expedition
IUGG	International Union of Geodesy and Geophysics
JEISSO	Joint Expeditions in the Indian Ocean Sector of the Southern Ocean
JGOFS	Joint Global Ocean Flux Study (SCOR and IGBP)
LOICZ	Land-Ocean Interactions in the Coastal Zone (IGBP)
MAST	Marine Scientific Technology
NATO	North Atlantic Treaty Organization
NIPR	National Institute of Polar Research (Japan)
NOAA	National Oceanic and Atmospheric Administration (USA)
PACA	Working Group on Physics and Chemistry of the Atmosphere (SCAR)
PAGES	Past Global Environmental Changes Programme (IGBP)
PASC	Polar Air and Snow Chemistry Programme
PASE	Polar Air-Snow Experiment
PIC	Particulate inorganic carbon
POC	Particulate organic carbon
PG	Planning Group (GLOCHANT)
PG-1	Planning Group 1 on Sea Ice (GLOCHANT)
PG-2	Planning Group 2 on Global Palaeoenvironmental Records from the Antarctic Ice Sheet and Marine and Land Sediments (GLOCHANT)
PG-3	Planning Group 3 on Antarctic Mass Balance and Sea Level (GLOCHANT)
PG-4	Planning Group 4 on Trace Gases, Aerosol Particles, and UV Radiation in the Antarctic Atmosphere (GLOCHANT)
PG-5	Planning Group 5 on Biogeochemical Cycles (GLOCHANT)
RRC	Regional Research Centre (START)
RRN	Regional Research Network (START)
SAGE	Stratospheric Aerosol and Gas Experiment
SAR	Synthetic Aperture Radar
SCALOP	Standing Committee on Antarctic Logistic Operations
SCAR	Scientific Committee on Antarctic Research
SCOPE	Scientific Committee on Problems of the Environment (ICSU)
SCOR	Scientific Committee on Oceanic Research
SeaWIFS	Sea Viewing Wide Field-of-View Sensor
SIEFS	Sea Ice Ecology and Flux Study
SO-GLOBEC	Southern Ocean - GLOBEC
SO-JGOFS	Southern Ocean - JGOFS
SPARC	Stratospheric Processes and their Role in Climate (WCRP)
START	System for Analysis, Research and Training (IGBP)
TOGA	Tropical Ocean and Global Atmosphere Experiment
ULS	Upward-Looking Sonar
UV	Ultraviolet Radiation
WG	Working Group
WAIS	West Antarctic Ice Sheet Initiative
WOCE	World Ocean Circulation Experiment (WCRP)
WCRP	World Climate Research Programme
WMO	World Meteorological Organization
WWW	World Wide Web

APPENDIX 2

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APPENDIX 3

'Thoughts on the Future Direction of SCAR/GLOCHANT'

Changes in the focus and structure of GLOCHANT were made at XXIII SCAR (September 1994), after concerns were raised over its role and the scope of its proposed activities. As a result, we ourselves have a concern that GLOCHANT has yet to demonstrate a clear and credible reason for its existence and to formulate its mission and objectives, so as to provide a service of value both to the Antarctic scientific community and to SCAR. With this in mind, we would like to propose that the following issues are discussed, as a matter of some urgency, at the third meeting of GLOCHANT.

The main objective of this exercise is to ensure that GLOCHANT responds to the criticism of its actions implied by the restructuring at XXIII SCAR and to produce an agreed and workable set of objectives for GLOCHANT and for the newly appointed Project Coordinator.

1. Review of the restructuring of GLOCHANT at XXIII SCAR

Issues for discussion include:

- What had GLOCHANT done, or not done, which caused SCAR Delegates to do what they did?
- Is a formal response needed to the restructuring? The report of the SCAR Delegates meeting showed that Delegates had a misperception of the role and scope of some of the other related programmes, for example CS-EASIZ and those planned by WCRP.
- What opportunities does the restructuring present?

2. Define the scope of global change in the Antarctic.

SCAR has a regional research agenda, outlining what are the scientific issues that should be incorporated into an Antarctic global change research programme. Issues for discussion include:

- What does GLOCHANT see as the key areas of global change research in the Antarctic? When we talk of global change research in the Antarctic, what do we mean?

3. Define the scope of GLOCHANT within Antarctic global change research.

Once GLOCHANT has defined what it means by global change in the Antarctic, it needs to define what GLOCHANT's scope should be within this. Issues for discussion include:

- The key topics that GLOCHANT should focus on need to be decided. GLOCHANT may be better served by restricting its focus to a small number of key topics, rather than by trying to cover the majority of the areas outlined in SCAR's regional research agenda.

4. Define the role of GLOCHANT

Stages 2 and 3, above, will have produced a definition of Antarctic global change research and of the scope of GLOCHANT within this. With this information, we now need to decide exactly what GLOCHANT should be doing. Issues for discussion include:

- A review of the Terms of Reference for GLOCHANT, both the original and the revised, is required and should include such basic questions as: What is the best role for GLOCHANT - what does the Antarctic scientific community need in terms of the services that GLOCHANT could provide? Is there a role for the planning and coordination group structure as it currently exists within GLOCHANT?
- The output of this process should be a definition of GLOCHANT's mission and major objectives, with a draft schedule running up to and beyond XXIV SCAR (September 1996). GLOCHANT needs to say what it is going to do and when it hopes to do it.

5. Define how objectives are to be carried out.

Once GLOCHANT's objectives have been agreed upon, we will then need to decide on how best they are to be carried out and what revised structure will be needed to do this. Issues for discussion include:

- What structures are required? Instead of a formal structure of Planning and Coordination groups, the IPCC group or JGOFS Task-Team structure might be a useful analogue to consider. IPCC groups or JGOFS Task Teams are set up for a specific purpose and have a limited lifespan. Once their task is complete, they are disbanded.
- How will achievement of objectives be measured? What will be the outputs that GLOCHANT can be judged on? For example, reports and workshops on specific subject areas or the development of databases of information.

6. Define the objectives and management structure for the GLOCHANT Project Coordinator.

Once GLOCHANT is clear in its own mind exactly what it is doing, it will need to further define the role of the Project Coordinator. The role of the Project Coordinator is pivotal to the success of GLOCHANT. Issues for discussion include:

- A clear set of objectives need to be developed for the Project Coordinator as does a management and reporting structure. This has to be done in consultation with the Antarctic CRC in Hobart.
- The mechanism to enable SCAR/GLOCHANT to give the Project Coordinator the support that he requires must also be set up.

Other points that need thinking about.

These are points that we should consider, but are not included in the issues outlined above:

- There is a need to carry out a detailed review of the Antarctic components of other international research programmes, for example WCRP. This should be carried out in conjunction with these programmes, to ensure there is an agreement on coverage. This could be started at GLOCHANT III, but could be a major first task for the Project Coordinator. GLOCHANT should issue a report of its findings.
- Once this information has been collated, the gaps and missing research areas can be defined.
- SCAR/GLOCHANT's major function should be in bringing different scientific areas together to address the key issues of Antarctic global change research that it has identified. This synthesising role could be of great value to the Antarctic scientific community.
- The role of GLOCHANT as coordinator for an Antarctic Regional Research Network within the START framework and the implementation of an Antarctic Regional Research Centre.

Mark Thorley and Howard Cattle SCAR/GLOCHANT
April 10, 1995

APPENDIX 4

Twenty-third Meeting of SCAR

Rome, Italy, 4-9 September 1994

SCAR Global Change Programme

Report of the Group of Specialists

C.R. Bentley (Convenor) tabled and spoke to a report of the activities of the Group of Specialists and its several sub-groups. He said that the SCAR Report *The Role of the Antarctic in Global Change: An International Plan for a Regional Research Programme,* published in 1993, served as a guide for the activities of the Group whose principal aims are:

1. To provide linkages and communication within SCAR;
2. To provide liaison between SCAR and the major international programmes on global change;
3. To plan and implement a regional programme of global change research in the Antarctic; and
4. To recommend a management structure to implement a coordinated programme on global change research in the Antarctic.

Seven sub-groups to plan future actions on particular areas had been or were being established: Planning Group 1: The Sea-Ice Zone; PG-2: Global Palaeoenvironmental Records from the Antarctic Ice Sheet and Marine and Land Sediments; PG-3: Antarctic Mass Balance and Sea Level; PG-4: Trace Gases, Aerosol Particles, and UV Radiation in the Antarctic Atmosphere; PG-5: Biogeochemical Cycles; Coordination Group 1: Data; CG-2: Numerical Modelling. The Planning Groups are concerned with Antarctic field activities whereas the Coordinating Groups are not field-based activities. Reports of activities of Planning Groups 1, 2 and 3 are appended to the main report; Planning Groups 4 and 5 have still to meet.

While commending the SCAR book as an excellent plan, Delegates had various views about the scope and focus of the programme and suggested that the research should be more focused than currently planned. Some Delegates felt that SCAR should concentrate on those parts of the plan which it is able to do best, rather than attempt to cover all aspects at the same time. SCAR should not be trying to run global programmes but should be contributing data to them. There was some criticism about the number of sub-groups that had been established and a suggestion that the more active groups should continue with their programmes while others might be developed later, following a review of progress in 1996. Other Delegates were concerned that the approach to the whole programme being advocated was so contrary to the enthusiasm with which it was greeted when the Group of Specialists was established two years earlier at XXII SCAR.

Extensive discussions followed and the following principal points were developed by a sub-group of Delegates. Since the establishment of the Group of Specialists on Global Change and the Antarctic (GLOCHANT) at XXII SCAR, there had been a growth of activities in global change research in the Antarctic, both from SCAR programmes and other international programmes, such as those of IGBP and WCRP. This had included the production of the SCAR Report *The Role of the Antarctic in Global Change: An International Plan for a Regional Research Programme,* which resulted from the workshop activities in Bremerhaven, Germany (September 1991), and it set out a substantial and challenging agenda for global change research in the Antarctic, elements of which were being

actively adopted by national programmes. Concurrently over the last few years, the activities and plans of various international programmes have grown rapidly in scope and national programmes face the necessity of setting priorities and focusing projects. Mindful of these developments since at least its last meeting in Bariloche, Argentina (XXII SCAR), SCAR has, in response to Delegates' wishes decided to simplify and restructure the GLOCHANT activity; the details of the changes are set out below. This action is intended to focus the initial priorities within the SCAR Global Change Programme according to resources available; it does not negate or diminish the overall contribution of the Group of Specialists and the identified Planning Groups. The intention is to move forward step by step, as has been implicitly recognized, with progress and need, including the need for a Special Fund, being reviewed at successive meetings of SCAR, commencing at XXIV SCAR in Cambridge during August 1996.

1. Because of the development of a well-thought-out CS-EASIZ programme that largely covers the Antarctic aspects of sea-ice biology and biogeochemical exchanges across the ocean-atmosphere boundary and the advance plans in WCRP relating to the physical aspects of sea ice, it was considered that Planning Groups 1 (Sea Ice) and 5 (Biogeochemical Cycles) are not needed at present. However, it is recommended that the members of those Planning Groups and of the Steering Committee for CS-EASIZ meet jointly for one time only, to implement coordination between CS-EASIZ and GLOCHANT and to ensure that no important aspects of their fields are overlooked.
2. Ozone studies and tropospheric chemistry are well-covered by IGBP and other programmes, and it is proposed to establish a joint working group between SCAR and IASC to consider the effects of enhanced UV-B on the biosphere. Planning Group 4 (Atmospheric Chemistry, etc.) will be asked to evaluate the need for a meeting in the light of the modified emphasis in the SCAR/GLOCHANT programme and in consideration of other ongoing and planned international activities. If the Planning Group feels that it will be productive to meet, it will be supported to do so.
3. The work of the proposed Coordination Group 2, on Antarctic aspects of numerical modelling, can better be carried out in the relevant subject areas and by close coordination with IGBP/GAIM. Therefore, the Coordination Group will not meet. The Group will be asked to evaluate by correspondence the situation with regard to Antarctic aspects of modelling.
4. Planning Groups 2 (Palaeoenvironments) and 3 (Mass Balance) have well-focused purposes that fill clear needs in Antarctic research; they will continue their work.
5. The Group of Specialists itself will continue but with an increased emphasis on coordination of activities, information exchange, and planning of future strategy, as well as oversight of Planning Groups 2 and 3.
6. The Project Office will remain in place with a full-time Project Coordinator, as currently planned. It is envisaged that the Project Coordinator will have a full-time job in developing a newsletter and providing other modes of information exchange, organizing and staffing meetings of the Group of Specialists and its two remaining Planning Groups (and also GoSSOE and CS-EASIZ, if desired by this Group and its programmes), coordinating training of scientists from third-world countries and countries with young Antarctic programmes, helping to develop a bipolar approach to global change research, etc.
7. Because of the diminished financial implications of the restructured programme, no Special Fund will be established at this time, but the Group of Specialists will be free to raise funds independently to support its work.

Relations with IGBP/START

Delegates agreed that it was important to maintain close contact with START. A paper appended to the report of the Group of Specialists discussed the mutual advantages of close links with START and proposed that a first step would be to seek approval for the SCAR network of Antarctic stations and national research institutes to be adopted as a START RRN (Regional Research Network). The Delegates accepted this paper and the recommendation that this course should be adopted. It was noted that the START meeting in Brussels, Belgium, was taking place concurrently with the SCAR Delegates meeting and that a member of GLOCHANT would be attending and would table the SCAR proposal there.

SCAR Global Change Project Office

Delegates welcomed the acceptance by the SCAR Executive of the generous Australian offer to host the Global Change Project Office at the Cooperative Research Centre at the University of Tasmania, in Hobart, Australia. The President also told the Delegates that the advertisement for a Project Coordinator had produced several applicants for the post and that a review panel was evaluating these with a view to holding interviews in the near future. A starting date for the coordinator would be negotiated with the successful candidate but it would be as soon as possible.

Global Change Special Fund

A paper on the proposed Special Fund for the Global Change programme was tabled. However, in view of the changes made to the programme, it was agreed that the Special Fund would not be required at the present time. It was accepted that such a fund could be re-proposed in the future if this was thought desirable.

APPENDIX 5

SCAR/GLOCHANT Financial Statement, Calendar Year 1994

Income

ICSU Grant	US$ 5,800.00
SCAR budget	US$ 12,000.00
PAGES	US$ 885.87
Total income	US$ 18,685.87

Expenditure

GLOCHANT II and PG-2 meetings	US$ 22,551.65
SCAR/START meeting at BAS	US$117.39
M. Thorley at START meeting	US$ 769.06
Project Coordinator advertisement	US$ 1,446.10
Interview expenses	US$ 2,520.78
Total expenditure	US$ 27,404.98

Excess of Expenditure over Income	US$ -8,719.11
Excess funds from SCAR	US$ 8,719.11
Final Balance	US$0.00

P.D. Clarkson
Executive Secretary, SCAR

1995 and 1996 Budget for GLOCHANT

Calendar Year 1995	US$ 72,000.00
Calendar Year 1996	US$ 38,500.00

APPENDIX 6

GLOCHANT Membership (as of April 21, 1995)

GoS/GLOCHANT

Name	Country	Expertise
I. Allison	Australia	Glaciology/ sea ice
P. Artaxo	Brazil	Atmospheric chemistry
C. Bentley*	United States	Glaciology/ ice sheet
H. Cattle	United Kingdom	Numerical modelling
A. Foldvik	Norway	Physical oceanography
G. Hubold	Germany	Marine biology
M. Moskalevsky**	Russia	Glaciology
F. Nishio	Japan	Remote sensing
D. Raynaud	France	Ice sheet chemistry
C. Schluchter**	Switzerland	Glacial geology
M. Thorley	United Kingdom	Data management
P. Treguer	France	Marine chemistry

* = Convenor
** = Coopted member

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I.Hofmann (U.S.)
T.Ito (Japan)
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M.Huntley (U.S.)
H.Marchant (Australia)
J.Priddle (U.K.)
P.Treguer (Chair, France)

CG-2 (Modelling)

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H.Cattle (Chair, U.K.)
Fasham (U.K.)
P.Lemke (Germany)
W.Peltier (Canada)
Ocean modeller (to be added)

Sea-Ice Zone Task Group
(succeeds PG-1 and PG-5)

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I.Allison (Co-chair, Australia)
P.Artaxo (Brazil)
G.Dieckmann (Co-chair, Germany)
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H.Marchant (Australia)
D.Miller (South Africa)
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APPENDIX 7

The Relationship between the SCAR/GLOCHANT and EASIZ Programmes

A document for the meeting of SCAR/GLOCHANT
NIPR, Tokyo, April 1995

The SCAR programme on Coastal and Shelf Ecology of the Antarctic Sea-ice Zone (CS-EASIZ) was developed at a series of workshops held under the auspices of the SCAR Group of Specialists on Southern Ocean Ecology (GoSSOE) in Cambridge (September 1992), Bremerhaven (September 1993) and Padua (May 1994). SCAR Delegates formally approved the Science and Implementation Plans for CS-EASIZ during XXIII SCAR in Rome, 5-9 September, 1994, and these were published as SCAR Report 10 (November 1994). CS-EASIZ has no funding for implementation, although bids have been made for small amounts of support for workshops. CS-EASIZ will be run by a small Steering Committee comprising Andrew Clarke (Chair, British Antarctic Survey, Cambridge), Wolf Arntz (Alfred-Wegener-Institute, Bremerhaven), Paul Dayton (Scripps Institution of Oceanography, La Jolla, California), Mitsuo Fukuchi (National Institute for Polar Research, Tokyo), Maria Cristina Gambi (Stazione Zoologica di Napoli, Italy) and Harvey Marchant (Antarctic Division, Hobart, Australia).

Also at SCAR XXIII, delegates expressed some concerns regarding the scope and focus of GLOCHANT, and recommended specifically that GLOCHANT Planning Groups (PGs) 1 (Sea Ice) and 5 (Biogeochemical Cycles) be disbanded. It was also proposed that at least part of the role of PG-1 and PG-5 be taken up by either CS-EASIZ or developing WCRP programmes, and that there should be a joint meeting of CS-EASIZ and GLOCHANT at NIPR in Tokyo to "implement coordination between CS-EASIZ and GLOCHANT and to ensure that no important aspects of their fields are overlooked".

Unfortunately, only a few members of GoSSOE and the CS-EASIZ Steering Committee can be present at the Tokyo meeting, and this briefing document is intended to outline possible routes for enhanced cooperation between CS-EASIZ, GLOCHANT and other international programmes.

Science and Implementation Plans of CS-EASIZ

The aim of the CS-EASIZ programme is to improve our understanding of the structure and dynamics of the Antarctic coastal and shelf ecosystem. Particular attention will be paid to those features which make the biology of this ice-dominated ecosystem so distinctive, and to understanding seasonal, inter-annual and long-term changes. Six key scientific questions have been identified, and for each of these between two and seven research topics recommended.

The heart of the CS-EASIZ programme will be the Core Programme, a series of basic measurements to be undertaken on the ice, water-column and benthic subsystems of the Antarctic coastal and shelf ecosystem. These measurements have been carefully designed to be both simple and relevant, and to encourage participation by a maximum number of the coastal marine stations around Antarctica. For those nations wishing to undertake more extensive work, a Wider Programme has been devised as a guide to those areas of coastal marine ecology most in need of attention.

The CS-EASIZ programme is distinctive in its attention to the Antarctic coastal and shelf ecosystem as a whole, linking ice, primary production, the water column, higher predators, vertical flux processes, and the benthos. It has essentially no funding for implementation and, consequently, a simple management structure.

Relationship with other programmes

In designing the Core Programme and Wider Programme, CS-EASIZ took care to avoid duplication of research being undertaken or planned by other international programmes concerned with Southern Ocean global change. In particular, the concentration on the coastal seas meant that CS-EASIZ is complementary with the aims of SO-JGOFS, but does not overlap to any significant extent. There are, however, areas of significant potential interaction with SO-GLOBEC and the SCAR/APIS (Antarctic Pack-Ice Seals) programme.

Relationship between CS-EASIZ and GLOCHANT

As has already been recognised, CS-EASIZ will make a significant contribution to our understanding of ecological processes in the coastal and shelf zone of Antarctica. The science undertaken through CS-EASIZ will therefore fall within the sphere of interest of GLOCHANT and we will keep the appropriate Planning Groups fully appraised of progress.

Whilst scientific work to have been undertaken under the auspices of the now disbanded GLOCHANT PG-1 might contribute significantly to the aims of CS-EASIZ, this is unlikely to be the case for the similarly disbanded PG-5,

whose area of interest is broadly confined to the surface waters away from the continental shelf. Unfortunately, neither the management structure nor the limited funding of CS-EASIZ allow for the resurrection of either PG-1 or PG-5 within this programme. The scientific remit of CS-EASIZ is so broad that the decision was taken early on not to set up either regional steering groups or science discipline-based planning groups. Whilst we in no way wish to discourage the contribution that any Antarctic scientists might make to the aims of CS-EASIZ, there unfortunately exist no mechanisms for transferring the roles of either PG-1 or PG-5 to this programme.

Andrew Clarke. Cambridge, 23rd March 1995

APPENDIX 8

Report of GLOCHANT Planning Group 1: The Antarctic Sea-Ice Zone

1.0 INTRODUCTION

The Antarctic sea-ice zone is predominantly characterized by a seasonal ice cover, and there are a number of physical, chemical and biological processes involved in the seasonal cycle of ice growth and decay with the potential to have global-scale impact through feedback effects. The Antarctic sea-ice zone, however, remains one of the least observed regions of the world. Additionally, many of the atmosphere/sea-ice/ocean/biota processes that occur there are not adequately represented in current climate or geo-biochemical models.

The WCRP, recognizing the importance of sea-ice zone processes to global climate, has initiated a number of Antarctic sea ice programmes. In particular the WCRP International Programme for Antarctic Buoys (IPAB) aims to establish and maintain an array of instrumented buoys within the southern sea-ice zone, and the WCRP Antarctic Ice Thickness Monitoring Programme (AnITMP) plans a network of upward looking sonars to monitor sea-ice draft. Both of these programmes are in their infancy.

Several IGBP and WCRP core projects (e.g. WOCE, JGOFS, GLOBEC), while recognizing the importance of the Antarctic sea-ice zone, tend to de-emphasize the direct role of ice processes. This is partly because of the logistical difficulty of year-round sampling and measurement. Some Antarctic sea-ice zone research projects have also been conducted or are planned under the umbrella of AnZone, originally an informal group of marine scientists, which has initiated programmes through bilateral agreement. At present AnZone has no affiliation with any international body.

It is the aim of the SCAR GLOCHANT Planning Group 1 to better develop an overall scientific programme of sea-ice zone research in the Antarctic. This will include providing liaison and supporting collaboration between SCAR and the major international programmes on global change; as well as planning, promoting and coordinating new research objectives, observations and logistic arrangements.

2.0 First meeting of Planning Group 1

Members of the Sea-Ice Zone Planning Group held their first meeting in Cambridge, U.K. on 4-5 September 1993. All current members of the group (I.Allison, S.F.Ackley, G.Dieckmann, G.Hubold and P.Wadhams) attended the meeting. P.Clarkson (SCAR Executive Secretary) and several visitors also participated in the discussions.
At this meeting, the members reported on relevant Antarctic sea-ice research within national and multi-national programmes. The Group reviewed the objectives of an Antarctic Sea-Ice Zone programme that were defined at the first meeting of GLOCHANT (Cambridge, February 1993) and recommended a number of preliminary steps toward implementing these. These are outlined below and are detailed in the report from that meeting.

3.0 Objectives

The Group defined the overview objective of Antarctic sea-ice research as "understanding and modelling the role of sea ice in the coupled atmosphere-ice-biota-ocean system". Sub-objectives within this involve understanding key processes, and determination of physical, chemical and biological properties of the sea-ice zone, including:

- the ice thickness distribution, and the processes of ice growth, deformation and decay that produce spatial and temporal variations;
- the distribution of snow thickness (and density) and the effect of the snow cover on the energetics and mass budget of the sea-ice system;
- the processes maintaining persistent open water polynyas and the role of the polynyas for the ecosystem and in determining heat balance, total ice production and salt flux;

- the relationship between large-scale synoptic fields of atmospheric and oceanic variables, the ice thickness distribution, and the surface energy and mass fluxes;
- the role of sea ice in oceanographic processes such as large-scale water mass modification and vertical circulation;
- the role of the biota on sea ice and, inversely, the role of sea ice on marine ecosystems and in the control of global biogeochemical exchange;
- the relationship between sea ice and cloud cover variabilities, and the effect of clouds on radiation fluxes and ice-albedo feedback;
- the effect of sea ice on the spatial and temporal variability of ocean-atmosphere exchange of CO_2

It was noted that there is an inadequate observational base to define present ice characteristics, and their regional and seasonal variation, within the Antarctic sea-ice zone. Data are required, among other purposes, to validate numerical models. Satellite-derived data provide large-scale estimates of ice extent and concentration, but not of the thickness of ice and snow, which are the primary variables affecting many physical and biological processes.

4.0 Recommendations

A number of actions were recommended as a start to achieving the above objectives. These include support for ongoing or planned international and multinational programmes, and coordination of observational opportunities using existing logistic support capabilities of SCAR nations.

4.1 Support for, and participation in, existing programmes:

AnZone
The Planning Group will participate in the development of AnZone scientific objectives in concert with those of SCAR, and encourages affiliation of AnZone to an international body.

IPAB and AnITMP
SCAR nations will be urged to contribute to these WCRP projects and to continue and extend the networks of drifting-buoy and ice-thickness sonars in the Antarctic.

EASIZ, SO-JGOFS and SO-GLOBEC
The biological aspects of the GLOCHANT sea-ice initiative will adopt the observation guidelines and protocols developed by the SCAR-EASIZ programme (for the coastal and shelf areas) and in the SO-JGOFS and SO-GLOBEC biological programmes (for the open sea-ice zone).

4.2 Coordination of existing data and implementation of new observational programmes

Routine and standardised ice observations
The Planning Group will develop a format and code for standardised ice observations in the sea-ice zone, and will recommend through SCAR, that all vessels in Antarctic waters make regular observations using this code and submit data to a central management point.

Fast ice thickness monitoring
The Group urges collation and dissemination of the existing near-coastal fast ice and snow thickness data sets (many of which are of decades duration) from Antarctic stations, and recommends continuation and extension of these simple measurements.

4.3 Planning and development of new techniques and programmes.

Sophisticated techniques for synoptic scale monitoring
Enhancement of sea-ice zone observational techniques should include a quantitative and qualitative improvement in the use of existing techniques; development and use of innovative ice thickness measuring techniques, particularly the application of techniques now being developed for the Arctic; and the development and application of integrated techniques whereby directly measured data are merged with data from satellite sensors.

Comprehensive seasonal and spatial climatology of Antarctic sea ice
Development of an observational programme is proposed to broadly define the present conditions within the sea-ice zone, and to provide data to validate models. This will require a series of north-south ship transects, spaced at about 30o longitude or better, for at least each season of the year, with a core of standardised measurements.

Process studies
The Group recommends planning of multi-ship and multi-disciplinary studies aimed at understanding such important processes as the development, maintenance and role of coastal polynyas; and the spatial and temporal synoptic variability of biological processes.

5.0 Membership and next meeting of the Planning Group

A suitable additional member is to be sought to increase the sea-ice biota expertise within the Planning Group. A decision on time and venue for a next meeting of the Group was deferred until after the second meeting of the parent Group of Specialists.

I. Allison, University of Tasmania, Hobart, Australia.

APPENDIX 9

GLOCHANT Planning Group 5 Biogeochemical Cycles

Grenoble (Col de Porte), France, 21-23 February 1994

PG-5 Members: Paul Treguer (Chair), Mark Huntley (Scripps, La Jolla, California, USA), Julian Priddle (BAS, Cambridge, U.K.), Mitsuo Fukuchi (NIPR, Tokyo, Japan), Harvey Marchant (Australian Antarctic Division, Hobart), Uli Bathmann (Alfred Wegener Institute, Bremerhaven, Germany).

Abstract

During the last two years, several activities (at least 12 JGOFS-related cruises were reported) have been undertaken in the Southern Ocean to understand and to model the biogeochemical cycles of carbon and of related biogenic elements. Those studies covered a large range of regions, including the Atlantic sector (e.g. Germany/South Africa ANT X/3 and Germany/The Netherlands ANT X/6 cruises aboard the *Polarstern*, autumn and spring 1992, respectively), the Pacific sector (e.g. a U.K. cruise aboard the *James Clark Ross* and aboard the *Discovery* in the Bellingshausen Sea, spring 1992; continuation of the U.S. effort in the Ross Sea, aboard the *Polar Duke*, summer 1992), and the Indian sector (e.g. France: MINERVE surveys aboard the *Marion-Dufresne* for PCO_2 determination in surface waters; ANTARFIX/time-series station, south of Kerguelen; ANTARES 1 cruise aboard the *Marion-Dufresne*, autumn 1993; e.g. Australia: CSIRO/AAD 4 cruises from October 1992 to August 1993 between Australia and Antarctica). Plans are also in progress in SO-GLOBEC and in IGAC to study biogeochemical cycles of the Southern Ocean and the cycles of elements in the atmosphere of the Southern Hemisphere.

Although their conclusions are still preliminary, the JGOFS-related activities provide support to answer major questions dealing with the CO_2 and biogeochemical cycles in the Southern Ocean. In contrast to the Frontal Zone, where permanent CO_2 sinks have been evidenced, the surface waters south of the Polar Front can be either a source or a sink of atmospheric CO_2, at least during the austral summer and autumn. The best estimates for primary production of the Antarctic Ocean are 100-120 Tmol yr^{-1} and 11-32 Tmol yr^{-1}, for carbon and for silica, respectively. As far as the cycle of silicon is concerned, this means that the rate of preservation of opal in Antarctic abyssal sediments is exceptionally high, compared to the rest of the world ocean. Several lines of evidence now indicate that the primary production, reconstructed from the sediment record, was not higher during the last glacial maximum than at present.

What GLOCHANT Planning Group 5 will have to do in the immediate future

It is necessary to focus on selected topics. The ideas are:

1. To give help to ongoing programmes that are pertinent to the SCAR/GLOCHANT objectives.
2. To reinforce links between those programmes.

Our objectives for the next few years are to organise liaisons with the ongoing programmes such as SO-JGOFS and WOCE (Southern Ocean activities). We will focus our attention on helping to organize Phase 2 of SO-JGOFS in an international context and on developing liaisons with palaeo-oceanographic programmes (PAGES). We will contribute to the new programmes CS-EASIZ and SO-GLOBEC.

The group needs to assist in the development of biogeochemical models coupled to physical models for the different subsystems of the Southern Ocean. Also to help develop extension from local-scale models to regional-scale models and regional-scale budgets of key biogenic elements (C, N, Si).

The group needs to define standard methods and strategies to:

- Test our ideas about Southern Ocean carbon cycling by comparing the various means of estimating primary productivity (production *per se*, insolation-driven models, winter-summer nutrient deficits, production at higher trophic levels).
- Study frontal areas and their variability (with particular attention to the Subtropical Convergence and related CO_2 sink areas).

The group will contribute to the organisation of the SO-JGOFS symposium on 'Carbon fluxes and dynamic processes in the Southern Ocean: Present and Past', to be held in Brest, France, in the August, 1995.

It is important to note that the UV-B/biota interactions will be covered by and in cooperation with Planning Group 5 (cf. Harvey Marchant), and that the aspects of chemical cycles related to ocean exchanges (cf. IGAC/ACE) will be covered by Planning Group 5.

P. Treguer, CNRS, University of Western Brittany, Brest, France.

SCAR Report

SCAR Report is an irregular series of publications, started in 1986 to complement *SCAR Bulletin*. Its purpose is to provide SCAR National Committees and other directly involved in the work of SCAR with the full texts of reports of SCAR Working Group and Group of Specialists meetings, thathad become too extensive to be published in the *Bulletin*, and with more comprehensive material from Antarctic Treaty meetings.

SCAR Bulletin

SCAR Bulletin, a quarterly publication of the Scientific Committee on Antarctic Researach, is published on behalf of SCAR by Polar Publications, at the Scott Polar Research Institute, Cambridge. It carries reports of SCAR meetings, short summaries of SCAR Working Group and Group of Specialists meetings, notes, reviews, and articles, and material from Antarctic Treaty Consultative Meetings, considered to be of interest to a wide readership. Selections are reprinted as part of *Polar Record*, the journal of SPRI, and a Spanish translation is published by Instituto Antártico Argentino, Buenos Aires, Argentina.

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Printed by The Chameleon Press Limited, 5–25 Burr Road, London SW18 4SG, United Kingdom