ISSN 0253-2808

INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

PROCEEDINGS OF THE SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

August 1999
Baltimore, MD, USA

Support for SCOR activities in 1998 came from the membership contributions of national committees, the United States National Science Foundation, the International Council of Scientific Unions, the International Geosphere-Biosphere Program, the United Nations Educational, Scientific and Cultural Organization, the Intergovernmental Oceanographie Commission of UNESCO, the Norwegian Research Council, the University of Bergen, the National Oceanic and Atmospheric Administration of the USA, the European Space Agency, the National Aeronautics and Space Agency of the USA, and the National Space Development Agency of Japan.

Additional copies of this publication are available from:
Ms. E. Gross
Executive Director, SCOR
Department of Earth and Planetary Sciences
The Johns Hopkins University
Baltimore, MD 21218 USA

Tel: 410-516-4070, Fax: 410-516-4019, Internet: scor@jhu.edu
http://www.jhu.edu/~scor

SCOR Proceedings, Volume 34

REPORT OF THE 24th GENERAL MEETING OF SCOR

Table of Contents

REPORT OF THE 24th GENERAL MEETING OF SCOR

Amsterdam, The Netherlands
November 1-5 1998

1.0 INTRODUCTION

1.1 Opening Remarks and Administrative Arrangements

The 24th General Meeting of the Scientific Committee on Oceanic Research (SCOR) took place at the Royal Netherlands Academy of Arts and Sciences in Amsterdam from November 1 to 5 1998. The meeting was hosted by the Dutch SCOR Committee and was held in conjunction with a scientific symposium on the Biogeochemistry of Iron in Seawater which was organized by the SCOR Working Group on the same topic (WG 109). The list of participants in the SCOR General Meeting is given in Annex 1 and the symposium program is given in Annex 2. Finally, an explanation of all acronyms and abbreviations used is given at the end of this report.

The meeting was chaired by Professor J.G. Field, the President of SCOR, who welcomed the participants to the meeting. Dr. Hein de Baar, Chair of The Netherlands Committee for SCOR, noted that it was five hundred years since the first discovery of a sea route to the Indies by Vasco da Gama of Portugal and that the Dutch and English explorers soon followed, laying the foundations of the Dutch overseas trading empire. The history of Amsterdam, and of the Trippenhuis, the historic building which is the home of the Royal Netherlands Academy of Arts and Sciences, is inextricably linked to this period of exploration of the seas.

At the opening of the General Meeting, the President informed the participants of the death of Professor Henry Charnock in November 1997 after a short struggle with cancer. He had a very long affiliation with SCOR, attending its meetings as a UK representative from 1973 until 1992. In faet, Henry was a member of SCOR WG 1, established in 1957 on the topic of Radioactivity in the Ocean. Coincidentally, at the time of his death, forty years later, he was also a member of SCOR WG 101 on the Influence of Sea State on the Atmospheric Drag Coefficient. In addition to his membership on SCOR's scientific groups, he served on the Executive Committee as Secretary, Vice President and Publications Officer from 1978 to 1986. A moment of silence was observed in memory of Henry Charnock.

1.2 Approval of the Agenda

The Agenda for the General Meeting was approved as distributed without any changes. It appears in Annex 3.

1.3 Report of the President of SCOR

The President briefly reviewed activities since the 33rd Executive Committee meeting (September 1997). The International Year of the Ocean, observed throughout 1998, and the large El Niño event had focused a great deal of attention on the role of the oceans in climate and on the importance of a much better understanding of the oceans in order to respond to societal needs.

During 1998, the statutes of SCOR's parent body, the International Council of Scientific Unions (ICSU) were substantially revised. Some of these changes will have an impact on the interdisciplinary bodies of what is now called the International Council for Science (acronym unchanged - ICSU). For example, ICSU will now formally review each Scientific Committee every six years and will monitor their responses to recommendations for change, disbanding committees that fail to comply within a three year period. It was the view of SCOR that such reviews should be less frequent for long-standing committees, and that other aspects of the changes in the ICSU statutes would be detrimental to the interdisciplinary bodies in general. However, this view did not prevail at the ICSU General Assembly.

Turning to SCOR's scientific programs, Field made special mention of a few highlights of the past year. Among them was the well attended first Open Science Meeting of the program on Global Ocean Ecosystem Dynamics (GLOBEC) at which the draft Implementation Plan for GLOBEC was presented and discussed by the

230 participants. The Joint Global Ocean Flux Study (JGOFS) is now in its synthesis phase when the results of ten years of field studies will be analyzed, integrated, used in models and synthesized to produce the improved global view of oceanic carbon fluxes which was the original JGOFS goal. The first JGOFS synthesis workshop had just taken place in Southampton, and the initial synthesis results were to be presented at the second Congress of the International Geosphere-Biosphere Program (IGBP) in Japan in May 1999. Both JGOFS and GLOBEC are important elements of the IGBP.

Several other significant SCOR activities and new initiatives have been developing during the past year. These include SCOR's participation with the Scientific Committee on the Problems of the Environment (SCOPE) in providing scientific input to the Assessment of the State of Marine Science and its Contribution to Sustainable Development being carried out by the Intergovernmental Oceanographic Commission (IOC). At its meeting in 1997, SCOR endorsed a plan to hold an international workshop on the Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB). This took place in October 1998 and its recommendation for an internationally coordinated GEOHAB program will be an important topic for discussion by the General Meeting. The initiative on enhancing graduate education in the marine sciences in developing countries, which was discussed in detail at the 1997 SCOR Executive Committee meeting in Rio, received support from the Rockefeller Foundation for a small workshop to be held at its international study center in Bellagio, Italy. Again, the outcome of this meeting would be presented for consideration by the General Meeting.

In closing his report, the President thanked the members of the Executive Committee and the Executive Director for their support during the past year.

1.4 Appointment of an *ad hoc* Finance Committee

In accordance with the SCOR Constitution, the General Meeting appointed an *ad hoc* Finance Committee to review the administration of SCOR finances during the previous fiscal year and the current year. It was also charged to propose a budget for 1999 activities based on the decisions taken during the meeting. The Committee members were Peter Burkill (UK), Wolfgang Fennel (Germany), Roberto Purini (Italy) and Friedrich Herms (Brazil), with Burkill as Chair. The report of the Finance Committee to the General Meeting was made under agenda item 4.3.

2.0 WORKING GROUPS

2.1 Arising from Former Working Groups

2.1.1 WG 80 Role of Phase Transfer Processes in the Cycling of Trace Metals in Estuaries

The Chair of WG 80, Michael Whitfield (UK) reported that, although many of draft papers had been provided by the WG members several years ago, little progress had been made in incorporating them into a final publication and that this would now require the updating and revision of the original submissions. He proposed that the results from WG 80 activities should be taken up in some joint activity with the International Union of Pure and Applied Chemistry (IUPAC). The General Meeting agreed that WG 80 should be disbanded and that future interactions with IUPAC on this topic should be discussed with the IUPAC representative, David Turner..

2.2 Current Working Groups

The President reminded the participants that the SCOR Constitution and the Objectives and Procedures for SCOR Working Groups specify that the tenure of SCOR subsidiary bodies automatically expires at each General Meeting. Their reports must demonstrate adequate justification for their reinstatement for an additional two years. The Executive Committee Reporter for each working group was called upon to present the relevant report and to make recommendations to the General Meeting on the actions to be taken.

2.2.1 WG 86 Ecology of Sea Ice

The activities of WG 86 culminated in a successful Gordon Research Conference which it organized in 1997. Since a GRC rule prohibits the publication of conference proceedings, the group had discussed whether it

should prepare some form of publications independently These plans have not advanced, however, and the Executive Committee Reporter, Fred Grassle, will discuss them with the Chair of WG 86, Steve Ackley. The General Meeting agreed not to disband WG 86 until this matter was clarified.

2.2.2 WG 89 Sea Level and Erosion of the World's Coastlines

The General Meeting agreed that the Executive Committee Reporter, Professor McCave, should urge the Chair of WG 89, Paul Komar, to complete the final report of the group before the next SCOR meeting.

2.2.3 WG 93 Pelagic Biogeography

The Chair of WG 93, Professor Annalies Pierrot-Bults (Netherlands) reported that the final report of the group had been published by the IOC. This document contains the proceedings of the International Pelagic Biogeography Congress organized by the WG, as well as its final report. Although one of its recommendations is for SCOR to consider establishing a new working group on the relationships between biodiversity and ecosystem function, a proposal was not yet ready for consideration. Two other activities arising from the WG were approaching completion. These include a glossary of taxonomic terms which will be available in several languages and in digital form, and an inventory of taxonomic collections. The General Meeting thanked Pierrot-Bults and agreed to disband WG 93.

2.2.4 WG 97 Physiological Ecology of Harmful Algal Blooms

The Report of a NATO Advanced Study Institute held at the Bermuda Biological Station in 1996 was published in May 1998. This was the final activity of WG 97. A final report was submitted to SCOR in 1996. The General Meeting formally disbanded WG 97 with appreciation.

2.2.5 WG 98 Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations

John Field presented the final report of WG 98 (see Annex 4). A paper summarizing the findings of WG 98 will be published in the *South African Journal of Marine Science*. Noting that this working group was influential in the development of GLOBEC's project on Small Pelagic Fishes and Climate Change (SPACC), the General Meeting agreed to disband WG 98 with thanks to its Co-Chairs and all members..

2.2.6 WG 99 Linked Mass and Energy Fluxes at Ridge Crests

No report was available on the final meeting of WG 99 which was held in January 1998. The group had plans to publish a brochure on ridge crest research and a paper in the *Reviews of Geophysics*. The Executive Director was asked to ensure that a report would be available for the next SCOR meeting.

2.2.7 WG 101 Influence of Sea State on the Atmospheric Drag Coefficient

The Executive Committee Reporter (Bob Duce) and the Chair of WG 101 (Ian Jones) both spoke on this agenda item. The final product of WG 103 is a book which is to be published by Cambridge University Press in 1999. The General Meeting approved the recommendation by Jones that SCOR should purchase some copies at a reduced price for distribution to WG members and to institutions in developing countries which are members of SCOR. WG 101 was formally disbanded by the meeting.

2.2.8 WG 102 Comparative Salinity and Density of the Atlantic and Pacific Ocean Basins

The Executive Committee Reporter, Vere Shannon, reported on the review and revision of manuscript prepared by WG 102 and the implementation of its recommendations. In his view the concerns of the review panel were addressed in the revised version presented to the General Meeting. However, the implementation of the necessary procedures to correct conductivity measurements to account for small differences in the chemistry between different ocean basins is a more complex problem. During the General Meeting, Shannon consulted with Frank Millero (USA), the Chair of WG 102 and Patricio Bernal, the Executive Secretary of IOC and proposed that a small task team be established to decide on how to implement to recommendations of WG 102, and to draft a report suitable for publication in the *UNESCO Technical Papers in Marine Science* which would incorporate the implementation aspects and the report from the working group. The task team would work primarily through electronic correspondence, with one short meeting if necessary. Millero agreed to convene this task team and to invite not more than two or three other specialists to join him, including a WOCE representative. The Executive

Secretary of IOC agreed that the Commission would publish the report. The General Meeting agreed that the original task of the group had been completed and that it should be disbanded.

2.2.9 WG 103 The Role of Wave Breaking on Upper Ocean Dynamics

In accordance with the request of the last SCOR Executive Committee meeting, the Chair submitted a request for a revision of the terms of reference of WG 103 which was presented by the Executive Committee Reporter, Ian Jones. The General Meeting accepted the new terms of reference for the WG as follows:

- To hold a workshop in January 1999 in conjunction with the Air-Sea Interface (ASI) Symposium to be held in Sydney, Australia in January 11-15, 1999. Invited participants in this special session will be the Working Group members and interested ASI Symposium participants. The goals of this workshop are to:
  - (a) review the present status of our knowledge of wave breaking on the wind driven sea surface in the light of very significant recent advances in theoretical and observational techniques, particularly the quantification of its dynamical and interfacial flux implications for air-sea interaction.
  - (b) discuss the formulation of strategies for future modeling and experiments arising from these recent significant theoretical and instrumentation developments.
  - (c) highlight the contributions made to larger scale atmosphere and ocean modeling from research on wave breaking and the outstanding needs of the larger scale atmosphere and ocean modelers for more realistic parameterization of physical processes in which interfacial wave breaking plays a significant role.

- The overall goal is to prepare an authoritative paper for publication in the open literature under the SCOR umbrella encapsulating the issues (a), (b) and (c), to be submitted within twelve months following the meeting.

The General Meeting confirmed the decision, which the Executive Committee had reached in correspondence due to the short time before the planned workshop, to allocate funds from the 1999 budget to support the meeting of WG 103 in conjunction with the Air-Sea Interface Symposium.

2.2.10 WG 104 Coral Reefs Responses to Global Change: The Role of Adaptation

A report from the Chair of WG 104, Bob Buddemeier (USA) was presented by Bjorn Sundby. The highlight of the past year was the organization of the symposium on "Coral Reefs and Environmental Change: Adaptation, Acclimation or Extinction" held in Boston in January 1998. This meeting attracted a great deal of attention in the scientific press, and an informative report of the symposium is presented in Annex 5.

The General Meeting noted that the proceedings of the symposium would be published in *American Zoologist,* and that this was already well advanced. Sine the report of the Chair constituted a final report to SCOR from the WG the General Meeting decide to disband WG 104 with appreciation to its Chair and members for the timely way in which its task was completed.

2.2.11 WG 105 The Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems

The Executive Director reported that the second meeting of the WG held in January 1998 concentrated on the development of the detailed plans for an international ICES/SCOR symposium on "Ecosystem Effects of Fishing" in Montpellier in March 1999. The first announcement of the symposium has received an enthusiastic response and more than 300 participants are expected.

The aim of Working Group 105 is to provide a global synthesis of the impacts of fishing on the marine ecosystem, to report on new methods for quantifying these impacts at the ecosystem level, and to discuss how objectives related to nature conservation can be integrated in future fisheries management. Teams have been established to prepare synthesis papers within three themes in preparation for the Montpellier symposium.

The first theme, *Ecosystem synthesis,* will provide a global overview of the effects of fishing on different

marine ecosystems and on specific species groups. The focus will be on differences and similarities in the responses in various parts of the world. The ecosystems covered will include coastal and estuarine systems, semi-enclosed seas, continental shelves, upwelling systems, boreal ecosystems, the deep seas, and the Antarctic. The species groups will include benthos, demersal fish, large pelagics, sharks and rays, seabirds, marine mammals, and turtles. The evidence for cascading effects on primary production and zooplankton will also be reviewed.

The second theme, *Quantification of fisheries impacts on ecosystems,* will present methods for quantifying fisheries impacts at the species and ecosystem levels. How can overfishing be defined in an ecosystem perspective? At the species level, the quantification of species vulnerability to fishing, the loss of genetic diversity, and the risks of species extinction will be discussed. At the community or ecosystem level, the usefulness of trophodynamic models, multispecies models, and indices of community structure will be summarized. Experience in the use of sustainability indicators and measures of ecosystem "health" for monitoring marine and freshwater environments will be reviewed.

The third theme addresses *Integrating fisheries and environmental management.* The elaboration of ecosystem management objectives will necessitate a selection of indices of ecosystem change, which are perceived to be scientifically sound, important to society, and operational in a management context. After a short review of management objectives and expectations from the respective points of view of representatives of the fishing industry, NGOs, and fisheries and environmental managers, a framework for designing operational ecosystem management strategies will be presented.

The synthesis papers within the above three themes will be presented at the ICES/SCOR Symposium hosted by ORSTOM to be held in Montpellier, France, 16-19 March, 1999. The report of the Working Group, which will comprise the invited papers, will be published in the year 2000 in the *ICES Journal of Marine Science.*

The written report from WG 105 included responses from the group to the comments of the Executive Committee reporter following the 1997 SCOR meeting and these were accepted by the General Meeting. The Montpellier meeting will be the final activity of WG 105 and it was anticipated that a brief final report would be sent to the Executive Committee meeting in 1999.

2.2.12 WG 106 Relative Sea Level and Muddy Coasts of the World

In the absence of Professor McCave, the reporter for WG 106, Bjorn Sundby reviewed the progress made by the group towards to completion of its final report, which will be a book in the *Elsevier Oceanography Series.* Over the past year, since the 2nd meeting in Wilhelmshaven in 1997, some 20 manuscripts have been submitted addressing the terms of reference of the WG. These have all been reviewed by the editors, and returned to the authors for revision, and been resubmitted. The schedule for the completion of the project was reviewed and accepted by the General Meeting. The final MS for the bok should be submitted to Elsevier in February 1999.

Arising from the 1997 Wilhelmshaven Conference which involved members of WG 106, Professor B. Flemming is editing a sister volume of manuscripts on aspects of muddy coasts, supplementary to the work of WG 106, which is also to be published in the Elsevier series.

The General Meeting decided that WG 106 should not be disbanded until the publication has been completed.

2.2.13 WG 107 Improved Global Bathymetry

The final meeting of WG 107 was hosted by the SCOR Secretariat in November 1997 and a detailed report of the meeting was reviewed by Vere Shannon. There has been good progress with the production of the final report and no further financial support is required from SCOR. The WG requested approval for some formal membership changes in order to reflect the actual contributions of participants in the WG activities. Accordingly, the General Meeting approved the following changes:

- Robin Tokmakian (USA), changes to Full Member, having attended both meetings and having made

considerable contributions to the program. Bert Semtner (USA) changes from Full to Associate Member, having worked closely with Tokmakian, but not having attended any meetings.

- Hugh Young is made Associate Member, having attended a meeting and submitted a paper.
- Chris Johnston and Bob Fisher have resigned from the WG.

2.2.14 WG 108 Double Diffusion

Ian Jones reported that a meeting of WG 108 planned for 1998 did not take place, although some members met informally during the Fedorov memorial symposium in Moscow in May. A formal meeting has now been arranged to take place in Tempe, Arizona in early 1999. These plans were approved and the General Meeting urged to group not to allow additional delays in its program.

2.2.15 WG 109 Biogeochemistry of Iron in Seawater (with IUPAC)

The WG and the Dutch SCOR Committee organized a symposium on the Biogeochemistry of Iron in Seawater in conjunction with the General Meeting, with one joint overview session for participants in the General Meeting. The program for the symposium is in Annex 2. This is a major step towards the fulfilment of the group's task to conduct a critical view of the current state of knowledge in this field. The WG planned to meet for two days in Amsterdam to review that draft chapters for the book which had been submitted by the members. The book will be published by the International Union of Pure and Applied Chemistry (IUPAC), which cosponsors the working group, in its series on *Analytical and Physical Chemistry of Environmental Systems.*

The Co-Chair of WG 109, David Turner, raised a new scientific issue which has arisen from the iron studies being conducted in JGOFS and elsewhere, namely the need to develop standard materials for the measurement of low concentrations of iron in seawater. Hein de Baar was to convene a small group to consider this topic during the symposium and there may be a need for support by SCOR for a workshop in 1999.

2.2.16 WG 110 Intercomparison and Validation of Ocean-Atmosphere Flux Fields (with WCRP)

A report from the WG Co-Chairs included an account of the WG's first meeting in October 1997 and is given in Annex 6. With the approval of the Executive Committee, Dr. K. Kutsuwada (Japan) was invited to join the WG following a recommendation from the 1997 SCOR meeting.

Future plans include a meeting of the WG in 1999 for which support was approved by the General Meeting. It was noted that the expenses of this working group are shared equally with the World Climate Research Program.

2.2.17 WG 111 Coupling Winds, Waves and Currents in Coastal Models

Working Group 111 was created in 1997. Its over all goal is to study the critical problems of a coupled coastal dynamics model; i.e., coupled wave and circulation models. Presently, few coastal ocean circulation models take into account the effects of surface wave dynamics, which may be an important source of flaws in their surface and bottom boundary layer dynamics. Similarly, few wave models take into account the effects of strongly sheared coastal currents.

Ian Jones noted that, since the last meeting of SCOR 1997, the Executive Committee in correspondence agreed to appoint a Co-Chair of WG 111 following a request from the Chair, Norden Huang, for assistance. Professor Chris Mooers (USA) has assumed this responsibility and plans were in place for the inaugural meeting of the group. It will be held in conjunction with the International Conference on Coastal Ocean Modeling (ICCOM) in Malta, on November 12 to 14. As the Conference will bring together modelers from different parts of the world to discuss recent advances in coastal modeling, the Conference will serve as a review of the current research efforts in the world coastal ocean modeling community. One of the goals of the Conference is to identify new challenges and establish new directions for future modeling efforts which coincides very well with the terms of reference of WG 111.

The report from SCOR WG 111 requested support for a workshop in 1999, to be held in conjunction with a Gordon Research Conference (June) to be held in New Hampshire on Coastal Ocean Modeling, which Prof.

Mooers chairs. These two meetings of WG 111 have been planned to further advance its objectives in reviewing the present status of our knowledge on each component of coastal dynamics: coastal wave models, coastal circulation models, and the coastal atmospheric boundary layer models; in examining the existing coastal circulation and wave data from both conventional and remotely sensing sources to detect possible weaknesses of uncoupled models, and to address the issues of a coupled model; and, finally, in building and strengthening collaborative research team effort, among members of the Working Group and with other existing groups, on coupled coastal dynamics model among wave, circulation and coastal meteorology modelers.

2.2.18 WG 112 Magnitude of Submarine Groundwater Discharge and its Influence on Coastal Oceanographic Processes

The General Meeting reviewed the first report from WG 112 which included a report of its first meeting in Taipei, July 1998, information on plans for a meeting in Birmingham in 1999 and a more detailed work plan for the approach of the group to its terms of reference. This report is given in Annex 7.

The Chair of WG 112, Bill Burnett (USA) made a brief presentation on the widely varying scientific estimates of the importance of submarine groundwater discharge which have been derived using different measurement techniques. The goal of the WG is to resolve these differences and to come up with a more reliable estimate of the magnitude of the flow of groundwater into the coastal ocean. The General Meeting approved the request of WG 112 to hold its second meeting in 1999, possibly in association with the IUGG Assembly.

2.2.19 WG 113 Evolution of the Asian Monsoon in Marine Records: Comparison between Indian and East Asian Subsystems

Pinxian Wang, the Chair of WG 113, reviewed the report of the first meeting of his group which took place in Shanghai in May 1998. Each member of the group presented scientific results of research relevant to the Asian and Indian monsoon systems. Each presentation was accompanied by in-depth discussions. These presentations served to familiarize the members with (1) the meteorological-, terrestrial-, and marine-based studies currently underway, (2) the broad array of chemical, physical, and biological proxies being applied to monsoon studies and (3) the timescale for which monsoon studies are currently underway (tectonic, Milankovitch, and sub-Milankovitch, annual).

Scientific discussions focused on a few key aspects including, the interhemispheric and related nature of the Asian monsoon systems, the need for further proxy evaluation and calibration, and the utility of continued AGCM and AOGCM modeling efforts. Several of the scientific presentations illustrated the interhemispheric scale and interrelated nature of the Indian, East Asian, and Australian subsystems. In addition, these systems were shown to be closely tied to climate variability associated with abrupt, high-latitude climate change as well as with variability in the western Pacific warm pool and the El Nino system. A full understanding of these complex relationships will require continued climate modeling efforts and more focused data-model comparison efforts. In light of this, much discussion focused on proxy development, evaluation and calibration. It was suggested that modern to recent process studies (e.g. sediment trap and spatial core-top analyses) are fundamental in terms of understanding the response of various paleoclimate proxies to monsoon-related forcing and variability on all timescale. Also discussed was the need for the development of common sample analysis protocol among different international laboratories.

The WG requested approval for a series of three annual meetings to address the following topics:

- 1999 - Proxies for Seasonal and Interannual Variability of the Monsoon System - an extended WG meeting
- 2000 - Asian Monsoons and Global Linkages on Milankovitch and Sub Milankovitch Timescale - a symposium of 50-60 participants, to be held immediately following an Ocean Drilling Program cruise
- 2001 - Asian Monsoons and Long-Term Tectonic Forcing (provisional) - a symposium

Each of the meetings will produce a review paper(s) for publication. Although this appeared to be a very ambitious plan, Wang was optimistic that supplementary funding would be available from other sources (IMAGES and the Ocean Drilling Program, for example). On these grounds, the General Meeting approved the proposed

schedule of meetings. The General Meeting also agreed to invite Steve Calvert (China) and Kuo-Yen Wei (Taiwan, China) to join the WG as Associate Members. Jarl Stromberg also nominated Eve Arnold (Sweden) in this capacity. If J. Kutzbach (USA) does not respond to the invitation to join the group, Pascale Braconnot (France), nominated by IMAGES, should become a full member, having participated in the first meeting as an alternate for Kutzbach.

2.3 Proposals for New Working Groups

Prior to the discussion of specific proposals for new working groups, the Meeting discussed the general issue, raised by Ian Jones (Australia), of the manner in which these proposals are generated. Since they come from national SCOR Committees, they reflect the interests of individual committees and do not necessarily take into account the need for an overall balance of scientific topics within SCOR's activities. The suggestion was made that the SCOR Executive Committee should take the lead in generating a slate of topics on which national committees could consider submitting proposals. Some participants felt that this might be a top heavy approach and many endorsed the idea that while SCOR should be pro-active in stimulating ideas from the national committees, this should not be the only approach. The Chairman of the Canadian SCOR Committee, Ken Lee, expressed the need for communication with the oceanographie community about the advantages of having a SCOR Working Group addressing a particular topic. The participants agreed that this topic of improving the working group proposal process should be discussed at the 1999 meeting of the Executive Committee.

By the deadline in August, the following three proposals for new Working Groups were received by the SCOR Secretariat and circulated to national committees for comments.

2.3.1 Mediterranean Sea Climate Study Project

The concern behind this proposal is the fact that the Mediterranean Sea is a semi-enclosed sea with more than three hundred million people living in the near its coasts. An understanding of the long term evolution of the Mediterranean Sea, the so-called Mediterranean Sea climate, for periods ranging from the decade up to the millennial, with air sea coupled models is required. The aim of this proposal is to define the best strategy for studying the variability of the climate of the Mediterranean region. In order to do this, it is necessary to improve our understanding of the variability of air-sea fluxes which are essential ingredients of an accurate model of the circulation of the Mediterranean sea and to improve our knowledge of the hydrological cycle on the Mediterranean basin leading to a better determination of the precipitation which influences the fresh water resources, agriculture and the buoyancy forcing of the sea.

The proposal called for an investigation of the interactions between the interannual variability of the Mediterranean SST and atmospheric variables such as precipitation anomalies throughout the Mediterranean basin. Several studies have shown that, on interannual time scales, the variations of precipitation in Northern Europe and Mediterranean region are closely linked, but with opposite phases. Recent studies show that the Mediterranean SST and transport through the strait of Corsica might be related to the North Atlantic oscillation. It is therefore important to study the European-Mediterranean climate variability problem as an interactive ocean-atmosphere problem, and to develop adequate modeling approaches.

Another motivation behind the proposal was the need for climate change detection and forecasting over Europe and the Mediterranean area. Is the deep temperature of the Mediterranean Sea an indicator of climate change? Finally, there is a need to develop global climate change scenarios over this particular region. More focused climate change simulations would provide a stronger basis for specific impact studies.

The major concern of the General Meeting related to the regional focus of the proposal and whether it met the SCOR criteria for a globally significant topic. It was also noted that many of the suggested members already have an active collaboration and would not need the mechanism of a SCOR Working Group to foster this. Several European participants referred to existing EU programs and the potential for duplication of effort.

At the same time, it was recognized that the broader topic of processes in semi-enclosed seas (including, for example, the Baltic and the Great Lakes), and their role in global climate and circulation might be one which

would be suitable for a SCOR Working Group. The General Meeting did not approve the proposal.

2.3.2 Standards for CPR (Continuous Plankton Recorder) Survey and Analysis

Fred Grassle introduced this proposal which was received from the UK SCOR committee. The topic was suggested as a response to the enhanced international recognition of the value of long-term Continuous Plankton Recording (CPR), particularly in relation to climate change There is a growing number of centers or organizations involved in CPR collection around the world. Problems have been found in maintaining consistent sampling through time so that records give an accurate indication of changes in plankton abundance. There is, therefore, a need to establish standards of careful collection, of quality-controlled analysis of collected material, of curation and archiving, of the development of associated instrumentation (particularly accurate measures of the flow through the recorders), and of the intercomparison of methods of collection and analysis, to ensure that data or data products are reliable, properly quantified, preserved and intercomparable.

The General Meeting noted that it was only the intention of the UK SCOR committee to submit this as a preliminary proposal, seeking feedback so that it could be revised for more detailed consideration in 1999. The consensus was that this topic was rather specialized and could be broadened to include methods, other than the CPR, for long-term measurements of plankton and newer methods, such as acoustics. There was a lengthy discussion of this suggestion.

Some participants noted that, while the CPR is a very old approach and has been in use since 1931, primarily in the North Sea and North Atlantic, it is now being used or considered for implementation in many other areas of the world ocean. The CPR record provides a long time series which could be important for global climate change studies. At the same time, there was concern that the Sir Alistair Hardy Foundation for Ocean Science, which operates the CPR survey and charges for the data from it, could support its own international working group to consider the issues raised in the proposal. For SCOR to sponsor such a working group, it would be more appropriate to include the consideration of topics such as other methods of plankton sampling and analysis, the problem of zooplankton (e.g. gelatinous plankton) which is not trapped by the CPR, or is destroyed by it, new technologies for plankton sampling and the identification of key areas of the ocean which might be especially sensitive to global change and where plankton surveys should be recommended.

2.3.3 Transport and Reaction in Permeable Marine Sediments

This proposal from the Canadian SCOR Committee was introduced by Bjorn Sundby. He defined permeable marine sediments as those sediments that are sufficiently coarse-grained as to allow measurable porewater flows when natural pressure gradients are applied. For various reasons, this term can only be applied to relatively clay-free sands and coarser sediments. These are generally the dominant type of sediments on continental shelves and are certainly equal to clays in abundance in coastal areas. In addition sandy sediments commonly constitute our beaches which represent one of our most exploited but dynamic and fragile environments.

What limited geochemical sampling exists has suggested that permeable sediments are characterized by low concentrations of organic matter. This latter point has led to a general impression amongst marine and coastal scientists, and particularly those interested in carbon cycling, that such sediments are almost biogeochemically inactive and do not participate importantly in cycling of carbon and other elements. Some recent studies have now shown that this view must be in error. For example, oxygen penetration depths appear to be as shallow in North Sea sands as in muds. Implied fluxes of nutrients seem to be in line with those observed for muddy sediments. In addition, the complex transport (advection and dispersion) associated with even simple surface structures on permeable sediments, e.g. ripples and biologically-produced mounds, can substantially modify the distribution of diagenetically reactive species, including metals. How this lack of understanding impacts our current view of global geochemical cycles and balances is as yet undetermined; however, the effects are unlikely to be trivial. While humans happily exploit sand environments, our actual knowledge of their biogeochemistry and physico-chemical processes remains meager indeed.

While muddy sediments are relatively well studied using a variety of advanced techniques, the study of sands and coarser sediments has none of these advantages, the database on porewaters in coarse sediment is

exceedingly small and the technologies for sampling them, and the relevant modeling approaches, are poorly developed. The proposed Working Group would promote the scientific investigation of the transport and reaction processes that occur in permeable sediments with the aim of establishing their importance to local and global biogeochemical cycling and their influence on surrounding environments.

The General Meeting responded favorably to this proposal, noting the potential for links to WG 112 (Submarine Groundwater Discharge) with respect to some of the technological problems to be addressed. The need for biological issues to be considered was mentioned with the recommendation that the WG should include a meiofaunal specialist. Several participants, including the Chairman of IGBP, noted the importance of close ties between this WG and the IGBP program on Land-Ocean Interactions in the Coastal Zone (LOICZ).

The proposal was accepted, with two minor changes to the terms of reference, and an agreement to finalize the membership in consultation with the proposed Chair, Professor Bernard Boudreau (Canada). This will be WG 114, and the General Meeting approved funds for its first meeting to take place in 1999. The final terms of reference and membership of WG 114 are:

- Attempt to identify the rates of reactions and transport phenomena likely to be important in the different marine environments that contain permeable sediments, i.e. beach, inter-tidal, subtidal, and shelf environments.
- Review the available methods and suggest sampling schemes and devices for the measurement of both biogeochemical variables (e.g. solute and suspended matter concentrations and fluxes) and flow velocities and their patterns in permeable sediments from different environments.
- Explore the development of models for the description of reaction and transport in permeable sediments and their implementation into standardized "user-friendly" codes.
- Encourage the participation of the marine science community in research on permeable sediments by organizing a special meeting/symposium or a special session at one of the front-line international scientific conferences. Publish the best of the submitted papers, along with review articles by the WG members, in a broadly-read journal.
- Determine if the study of reaction and transport in permeable sediments would be significantly enhanced by the development of a coordinated international research program (as has been done for carbon cycling with JGOFS), or if this goal would be better served by an enhanced presence in an existing program, such as LOICZ.

Chair:	Bernard P. Boudreau	Canada
Members:	Markus Huettel	Germany
	Peter Nielsen	Australia
	Wim Van Raaphorst	The Netherlands
	Ian Webster	Australia
	Gary Taghon	USA
	Aton McLachlan	Sultanate of Oman
	Pat Wiberg	USA
	Jan Marcin Weslawski	Poland
Associate Members:		
	Stefan Forster	Germany
	Frank Sansone	USA
	Richard A. Jahnke	USA
	Jack J. Middelburg	The Netherlands

Finally, since the following proposal was received after the deadline for circulation to national committees, the General Meeting could only give it preliminary consideration.

2.3.4 Terminal Millennial Synthesis of Decadal-to millennial-scale Climate Records of the Last 80ky.

This late proposal was presented by Gerald Ganssen (The Netherlands) on behalf of Michael Sarnthein and the IMAGES Scientific Committee. Its basic objective is to obtain a more reliable time scale for ice core studies at the millennial/centennial scale; in particular for studies of short-term and abrupt climate changes. One participant recommended that the membership of the WG should include a radioisotope expert and the meeting agreed that not only IMAGES, but also PAGES, should be asked to sponsor such a WG, partly because of the emphasis on dating. The Chairman of IGBP, Berrien Moore, referred to the second proposed objective ("to tie the ultrahigh-resolution marine climate records to ice core and other varved records of climate change measured on the calendar-year time scale") as an "extraordinarily important challenge". The General Meeting encouraged the proponents of this topic to expand and revise the WG proposal and to resubmit it for consideration by SCOR.

2.3.5 Limits to Predictability

Finally, a proposal was discussed in 1997 for which there seems to be growing interest in the scientific community. The 1997 SCOR meeting requested revisions to the original proposal, but these were not received. Nevertheless, the General Meeting agreed that this topic warranted action by SCOR and a lengthy discussion ensued.

Roberto Purini (Italy) remarked that we have less knowledge about the time scales of predictability in the ocean than we have for weather and climate. Since eddy resolving models are now available, issues of predictability of ocean processes are becoming important. Berrien Moore (IGBP) raised three important areas which a working group might address: the chaotic dynamical characteristics of the ocean system, the impact of limits to predictability on the development of operational observing systems, and the observational strategies that may be needed to enhance predictability.

The President summarized the discussion by suggesting that SCOR itself should develop this proposal further and that David Prandle (UK) be asked to take the lead in consultation with Ian Jones (Australia).

3.0 LARGE-SCALE SCIENTIFIC PROGRAMS

3.1 SCOR Committees

3.1.1 Joint Global Ocean Flux Study Scientific Steering Committee

John Field turned over the chairmanship of the General Meeting to Vice-President S. Krishnaswami so that he (Field) could present a detailed report on JGOFS in his capacity as Past-Chair of the JGOFS Scientific Steering Committee (SSC). The complete written report received from JGOFS is given in Annex 8.

He noted that the JGOFS Executive had met in Southampton in conjunction with an important JGOFS Synthesis Workshop during the week preceding the General Meeting. The restructuring of the JGOFS SSC to deal with the synthesis phase of the program has been completed, and all of the former regional planning groups (North Atlantic, Equatorial Pacific, Southern Ocean, Indian Ocean) for the various JGOFS process studies have now become regional synthesis groups, responsible for the analysis, interpretation, modeling and synthesis of JGOFS results from the field programs. The JGOFS Global Synthesis and Modeling Task Team was disbanded when the SSC decided that it should take the responsibility for the global synthesis of JGOFS, integrating the efforts of the regional synthesis groups. The SSC will produce a produce a glossy brochure about the JGOFS program and its contributions to an improved understanding of the global ocean carbon cycle, and will organize a series of synthesis workshops (the one in Southampton being the first) which will result in a major book.

Field reviewed the recent scientific highlights from the JGOFS program. The interpretation of results from the Equatorial Pacific Ocean Process Study has improved our knowledge of carbon fluxes and their control in that region of the ocean (see Annex 8). A final JGOFS field study, the North Pacific Process Study, began. During the next four years, it will include extensive and intensive shipboard surveys, time-series observations and strong remote sensing and modeling components. Studies include CO_2 uptake and its relationship to biological activity in

this very seasonally variable ocean. In addition to JGOFS core measurements, plans include deployment of moored sediment traps, a shallow optical buoy and free-drifting sediment traps. Historical data from long-term data on interannual variability of vertical water structure, seasonal changes in CO_2 exchange, and mixed-layer depth will supplement field observations.

The report from JGOFS also included notes on the progress being made by all of the regional planning/synthesis groups and scientific task teams. The Remote Sensing Task Team has been disbanded and related issues will be handled by the addition of a representative of the International Ocean Colour Coordinating Group (IOCCG) to the JGOFS SSC. The Photosynthesis Measurement Task Tam has completed its assignment and has been disbanded. The Deep Ocean Flux Task Team is Field noted some changes in the leadership of these groups following decisions by the JGOFS Executive at the Southampton meeting:

- North Atlantic Synthesis Group — Veronique Garcon
- Equatorial Pacific Synthesis Group — Robert Leborgne
- Continental Margins Task Team — K.K. Liu and Liana McManus

Returning to the question of the synthesis phase of the JGOFS program, Field referred participants to the detailed "Synthesis Plan and Implementation" which is appended to the JGOFS report (Annex 8). This plan was developed and approved by the JGOFS SSC at its meeting in April 1998. The overall goal of this important, final stage of the JGOFS program is:

> *To develop an integrated, quantitative view of the biogeochemical cycle of carbon in the ocean, indicating the roles of biota, physical transport, air-sea exchange and particle settling and remineralization, and including estimates of uncertainties.*

This goal will be achieved through the following products that serve as JGOFS synthesis objectives:

- Ensure that all JGOFS observations are lodged with organizations, which can guarantee long-term stewardship. Provide web-based information on the availability and access mechanisms to all JGOFS data. Encourage the development of Web-based data delivery systems.
- Create a new synthesis of ocean biogeochemical regimes from the major JGOFS Regional Process, Time Series and Global Survey studies, with special emphasis on biogeochemical processes and ecological community structure, and including the mechanisms controlling primary production, carbon, macro- and micronutrient cycling, and carbon export from the upper ocean.
- Develop a hierarchy of coupled, biogeochemical-physical circulation models of varying ecosystem complexity, and use them to enhance understanding of natural variability and anthropogenic changes in the carbon cycle over dec-cen time scales.
- Building on Objective III, assess the capability of 3-dimensional ocean carbon cycle models with biogeochemistry to simulate observed global inventories, seasonal cycles and fluxes of carbon, nutrients and functional groups, and to evaluate current rates of carbon remineralization and ocean forcing over time scales. The models will be constrained, calibrated and validated using JGOFS and other pertinent global and regional data sets (e.g., JGOFS/WOCE global survey of CO_2 and tracers, pCO_2, ocean color, particle fluxes and deep ocean cores).
- Assess the contribution of continental margins and seas to CO_2 sequestration and the horizontal flux of carbon across the ocean - continental margin boundary.
- Utilize ocean color observations from satellites, aircraft, moorings, and towed vehicles to provide a global picture of the seasonal cycles of phytoplankton biomass, primary and new production.
- Make recommendations on the development and implementation of future global ocean observing systems for detection of changes in the ocean carbon cycle and impacts on marine ecosystems, as one aspect of global change.

The timetable for the JGOFS synthesis phase calls for activities to be completed at the end of 2001 and includes a major JGOFS Science Conference in Bergen in April 2000 and the publication of the book referred to above. The

early draft outline for the synthesis book includes chapters on topics such as the following:

- Ocean biogeochemical regimes,
- Regional primary and new production,
- Role of community structure and function,
- Water column remineralization,
- Air-sea carbon dioxide exchange,
- Feedback processes in regulating production and exchange,
- Role of continental margins,
- Role of deep-ocean fluxes,
- Ocean biogeochemical models,
- Future ocean biogeochemistry challenges,
- Integrated understanding of carbon cycling in the ocean.

A major administrative concern for the JGOFS SSC in 1999 will be the need to ensure that the Norwegian support for the International Project Office in Bergen is renewed. SCOR will be asked to support the proposal that will be presented to the Norwegian authorities. Field reviewed the membership of the SSC, noting that several members (Field, Willebrand, Ducklow, Murray and Tilbrook) were due to rotate off the committee. He proposed the following slate of new, or renewed, membership nominations, which the General Meeting endorsed:

Robert Anderson	USA
Paul Falkowski	USA
Robert Leborgne	France
Bronte Tilbrook	Australia (second term)
Douglas Wallace	Germany

In the discussion which followed Field's presentation, the Chairman and Deputy Executive Director of IGBP referred to the overall IGBP program synthesis effort. As part of this, IGBP is undertaking to produce a more comprehensive view of the global carbon cycles and is working with the World Climate Program (WCRP) and the International Human Dimensions of Global Change Program (IHDP) to achieve this. IGBP expects to call upon both JGOFS and the WOCE program (World Ocean Circulation Experiment) to contribute to this.

3.1.2 SCOR/IGBP/IOC Committee on Global Ocean Ecosystems Dynamics

The Chair of the GLOBEC SSC, Roger Harris, made a presentation which supplemented the written report (Annex 9. He began by reviewing the activities of 1998. A major milestone for GLOBEC was its first Open Science Meeting which was hosted by the IOC and took place at UNESCO Headquarters in Paris in March. Over 230 scientists from more than 30 countries participated in the meeting and there were over 100 contributed oral and poster papers. These were expected to appear in a special issue of *Fisheries Oceanography* within a month of the General Meeting. They covered all aspects of the research and regional components of GLOBEC.

A primary objective of the Open Science Meeting was for it to be a forum for the presentation of the draft Implementation Plan for GLOBEC to a wider audience. The preparation of this draft was the main preoccupation of the SSC during 1997 and early 1998. A substantial amount of feedback was received from the participants at the Open Science Meeting and the final draft of the Implementation Plan was then prepared for submission to the three international sponsors of GLOBEC (SCOR, IOC and IGBP).

Harris discussed the structure of the Implementation Plan which is given in some detail in Annex 9. There are four major scientific foci, 3 cross-cutting or framework activities, four regional programs through which the science effort will be implemented and an integrating effort to encourage the synthesis of GLOBEC results. The final draft of the Implementation Plan was reviewed on behalf of SCOR by a small panel chaired by Vere Shannon; several members of the panel were present at the General Meeting and provided their comments. In general the Plan was felt to be a good complement to the earlier GLOBEC Science Plan. The GLOBEC SSC was requested to expand the section dealing with process studies and to give more emphasis to the links to physical processes.

Shannon recommended that SCOR accept the Implementation Plan and the General Meeting agreed. The Implementation Plan will also be presented to the other two international sponsors of GLOBEC (IOC and IGBP) for their endorsement. [This was done in the three months following the General Meeting.]

The Chair of GLOBEC also reviewed the other activities of the past year, especially those of the Southern Ocean Working Group and the project on Small Pelagics and Climate Change (SPACC). The March 1998 SSC meeting agreed that the working groups on Numerical Modeling and on Sampling and Observation Systems should be reconstituted and given new terms of reference in light of the needs of the regional components of the program. Lastly, the SSC is considering the need for working groups on Retrospective Data Analysis and Process Studies since these topics form two of the major science foci of the GLOBEC program.

The General Meeting was pleased to learn from the GLOBEC Chairman that arrangements to establish an International Project Office (IPO) at the Plymouth Marine Laboratory had finally been concluded. This should greatly accelerate the progress in the implementation of the GLOBEC program, once the posts of GLOBEC Executive Officer and Assistant Executive Officer have been filled.

Noting the departures of Brian Rothschild (USA) and Svein Sundby (Norway) from the GLOBEC SSC at the end of 1998 and an existing vacancy on the SSC, the General Meeting endorsed the nominations of Celia Marrase (Spain), Ramiro Sanchez (Argentina) and Tim Baumgartner (Mexico) as new SSC members, effective January 1, 1999. These nominations were previously approved by the other GLOBEC sponsors.

3.2 Scientific Programs under Development

3.2.1 Development of a SCOR/IGBP/WCRP Surface Ocean Lower Atmosphere Study (SOLAS)

A status report on plans for SOLAS was given by Andrew Watson (UK) and Robert Duce (USA). Watson noted that, for the time being, SOLAS is a concept, not a formal program. A proposal may arise for a program in the early years of the next century, which would integrate the studies begun under programs such as JGOFS, IGAC and parts of WOCE. There is a need for studies of the interactions of the surface ocean system, including its biogeochemistry, and the lower atmosphere, especially of those processes which are changed by, or will change, climate. These major programs have given rise to certain critical hypotheses during the last decade and SOLAS is an approach to addressing them.

In 1997, Watson chaired a small workshop that gave rise to a SOLAS prospectus, which was published by IGBP and by SCOR (see *SCOR Proceedings* vol. 33, Annex 8). During 1998, with the support of SCOR and IGBP, Duce, Watson and Peter Liss (UK) have been promoting the SOLAS ideas and raising interests in the community at appropriate meetings. The goal of this activity was to build the links between the atmospheric, oceanic and climate science communities that will be required for the success of SOLAS.

The next step in this process was to be a meeting of an expanded SOLAS Working Group in Norwich in December 1998 in order to plan an international workshop in late 99/early 00 at which the SOLAS ideas should become sufficiently focused and synthesized to develop a Science Plan.

Duce added that the individuals involved in SOLAS planning to date feel that it is critical to involve all of the science specialities. As yet there have been no successful efforts that have integrated atmospheric and ocean scientists in all disciplines. With programs like JGOFS and IGAC in their synthesis phases, this is an ideal time to be initiate planning for SOLAS.

Krishnaswami noted that both SCOR and IGBP had found the physical oceanographic content of the earlier SOLAS prospectus to be inadequate. Duce responded that this was one reason for seeking the formal input of WCRP through a representative to the larger planning group and that there would be a special effort to involve physical oceanographers in the SOLAS conference.

The Deputy Executive Director of the IGBP, Neil Swanberg, thanked those involved in SOLAS thus far for their patience. The sponsors have insisted on a deliberate pace of planning in order to ensure that the synthesis of JGOFS and IGAC results would be well underway. The current plans seem likely to ensure the development of a much more broadly-based workshop. He noted that with IGBP in a phase of synthesis and evolution, it was not yet clear to the sponsors whether SOLAS will be a free-standing project between others or some cooperative effort between existing programs.

The Executive Secretary of IOC, Patricio Bernal, admired the cautious approach to program development. All international organizations need to be careful about their resource and management capacities. He agreed that the results of major endeavors must be assessed before new ones are initiated and he hoped to see IOC involved in this process. The Chairman of IGBP emphasized the importance of the process. In the next decade there will be a greater focus on the interfaces between the components of programs like IGBP and WCRP. While he agreed with these views. Watson also recognized the need to mobilize the enthusiasm generated in the SOLAS planning process; he felt that the current timetable is a desirable one.

Field thanked Watson, Duce and Liss for their leadership of SOLAS planning during the last two years. The General Meeting supported the plans for a larger SOLAS workshop or conference in late 1999 or early 2000 [later established as February 2000] as a means of exposing these plans to a much wider audience.

*3.2.2 **SCOR/IOC initiative on Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB)***

In accordance with the decision of the 1997 Executive Committee meeting, a SCOR-IOC planning workshop was convened in Copenhagen just before the General Meeting with 37 participants from 21 countries. The goal was to develop goals, objectives and a detailed outline for a Science Plan for a new international scientific program on harmful algal blooms. This workshop was chaired by John Cullen (Canada) who, under severe time constraints, had ensured that a full report was available for presentation to the General Meeting. The Executive Summary of this report appears in Annex 10, and the full report is available from the SCOR Secretariat.

The results of the GEOHAB workshop were presented by Patrick Gentien (France) who began by extending his gratitude to John Cullen for the rapid completion of the report. He noted that harmful algal blooms cause huge economic losses in addition to human health issues and mortalities. "Harmful" is not a scientifically accurate term - these blooms involve a large variety of species with differing modes of action, life cycles, toxins, impacts and ecological and hydrographic contexts. This diversity requires a species-specific approach which must also be multidisciplinary.

The Copenhagen workshop recommended that SCOR and IOC should initiate a coordinated international program on the Global Ecology and Oceanography of Harmful Algal Blooms (GEOHAB) and that a Scientific Steering Committee should be jointly established as soon as possible. Its first task should be to develop a more detailed Science Plan for GEOHAB. Gentien commented that such an international program will provide the diversity in expertise needed to tackle the complex problems presented by HABs.

He noted that other international organizations are addressing HAB issue, but are generally rather narrowly focused scientifically or geographically. The IOC has a mature HAB program which has made progress in areas of training and education and, to some extent in monitoring. A partnership with SCOR will bring the skills of both organizations to bear on the problem.

The workshop agreed that the central scientific question relating to HABs: to understand the critical features and mechanisms underlying the population dynamics of HAB species. GEOHAB, as conceived a the workshop, should foster international co-operative research on harmful algal blooms in the context of their ecological systems and the oceanographic processes which influence them. The workshop defined the scientific goal of GEOHAB as follows:

Determine ecological and oceanographic mechanisms underlying the population dynamics of harmful algae, by the integration of biological and ecological studies with chemical and physical oceanography, supported by improved observation systems.

The benefits of this program will be better methodologies for predicting the occurrence, distributions, toxicity, and environmental effects of HABs. The scientific goal of GEOHAB will be approached by addressing these major research questions:

- What are the unique adaptations of HAB species that determine when and where they occur and the extent to which they produce harmful effects?
- How do HAB species and their community interactions respond to environmental forcings?
- What are the effects of human activities (e.g., eutrophication) and interannual and decadal climate variability (e.g., El Niño, North Atlantic Oscillation) on the occurrence of HABs?

Gentien concluded by requesting that SCOR and IOC should accept the recommendations of the workshop report and he urged them to establish a Scientific Steering Committee for GEOHAB as soon as possible.

A lengthy discussion followed this presentation. It was overwhelmingly supportive of the need for a program of the type described in the GEOHAB workshop report. Patricio Bernal, Executive Secretary of the IOC pointed out that such a program will focus on the search for understanding of the causes of harmful blooms while other efforts consider the mechanisms of action of the toxins produced by the algae. The results of both efforts will underpin advice that must be given to governments and to society in general. IOC, being intergovernmental in nature, and SCOR, being primarily scientific, will together provide an good mechanism for this action.

Bjorn Sundby, who had represented the SCOR Executive Committee in the organization of the workshop, expressed his pleasure with the narrow scientific focus of the proposed program on ecology and oceanography, rather than one which could have included public health, engineering and many other topics. GEOHAB responds to an existing need in many countries such as his own (Canada) where a national program in under consideration.

Many other participants spoke in support of the proposal. In response to one question about whether studies of freshwater cyanobacteria would be included in GEOHAB, Gentien said that they would not. The inclusion of the freshwater environment would have broadened the scope of GEOHAB to an unmanageable point, however, there are already strong links between marine and freshwater scientists concerned with HABs.

The General Meeting approved the establishment of a SCOR/IOC program on the Global Ecology and Oceanography of Harmful Algal Blooms and requested the workshop organizing committee to assist Bjorn Sundby in the process of defining the terms of reference and membership for a GEOHAB SSC, for approval by SCOR and the IOC.

3.2.3 The Sloan Foundation Global Marine Census

The Alfred P. Sloan Foundation has been developing plans for a "A Global Marine Census" with workshops in the US and an international workshop in April 1998 in Southampton. The Executive Director participated in this workshop and she provided some information on the progress of this activity to date. A decision as to whether the Sloan Foundation will continue to develop this program would be taken by the Foundation's board in late 1998. Fred Grassle who participated in some of the preliminary workshops noted that the project began from the concern that in spite of many meetings on marine biodiversity, no program had emerged. Jesse Ausubel of the Sloan Foundation was motivated by the question "How much life can the ocean sustain?" He produced a discussion paper and organized a series of workshops . The foci which have emerged are on the biomass present in the higher trophic levels, especially in the open ocean, and the patterns of species and

geographic distributions. If this program goes forward, it will need to develop a relationship with GLOBEC.

One issue of special relevance to GLOBEC is the Sloan Foundation's interest in technology development. The Census of Marine Life would require new biological sampling technologies, and large numbers of instruments, which would be useful for GLOBEC. Ausubel made a presentation to the GLOBEC SSC at its 1998 meeting and agreed that links should be established. He has also made contact with IOC and several other international organizations.

Several participants stated that the Sloan Foundation will only provide "seed money" for a potential project which must then generate much more funding support in the broader community . With the exception of one international workshop, all scientific discussion thus far has been in the US. It was generally felt that a global census of marine life, if well-planned scientifically, might provide a valuable assessment of the status of marine ecosystems. The General Meeting agreed that SCOR should maintain contact with this activity and should monitor its progress.

3.2.4 Graduate Education in Oceanography and Environmental Marine Sciences in Developing Countries as a Means to Understand Global Environmental Problems

Following the decision of the 33rd SCOR Executive Committee meeting in 1997 (see *SCOR Proceedings*, vol 33, pg. 30), Ian Jones (Australia) and José Stuardo (Chile), with the assistance of the Executive Director, submitted a successful proposal to the Rockefeller Foundation for a small meeting to be held at their International Study Center in Bellagio, Italy. The purpose of this "team residency" was to develop the concept of a regional approach to graduate education in marine science in developing countries. Jones presented the report of this meeting; the Executive Summary appears in Annex 11, and the entire report is available from the Executive Director.

Jones stated that efforts to solve marine environmental problems in developing countries could only be successful if they are linked to leadership in marine science by individuals resident in those countries. The United Nations Conference on Environment and Development ("Rio '92) agreed that there is a significant lack of educational opportunities for talented students people which would allow them to play leadership roles in solving the environmental problems of their own regions. There is often a significant loss of the best people who leave to study abroad and may not return to carry on their scientific careers at home. Few institutions in developing countries have the necessary critical mass to develop excellence and the lack of good graduate students may be a disincentive to faculty members who might otherwise remain to develop research programs relevant to regional problems. The regions represented in the Bellagio meeting included South America, the Indian sub-continent, South-east Asia, sub-Saharan Africa. The size of the meeting was limited by the terms of the financial support from the Rockefeller Foundation, and future efforts will seek to gain input from other regions such as North Africa, Central America and the Caribbean and the eastern Mediterranean.

Stuardo presented information on the program at the University of Concepcion, emphasizing the importance of the international faculty members who visit to give intensive, specialized courses. He presented data on the number of applicants, success rate, financial resources required and so on. He stated that one of the biggest needs is to search for funding to satisfy the demand for student scholarships. The conclusion of the workshop was that the sum of $300,000 to $500,000 *per annum* would be needed to adequately fund a regional graduate school of marine science.

He proposed that SCOR should accept the workshop recommendation to apply to the Rockefeller Foundation's Innovation Fund for support for 2 follow-up activities. One would be a survey of potential sources of funding for regional schools, the second to be a survey of textbooks and teaching materials which would be appropriate for use in a regional context. He also described the scheme for evaluation of such regional schools, by

an international committee involving individuals nominated by SCOR.

Jones and Stuardo requested SCOR to endorse the Bellagio report and to send it to the IOC for transmittal to IOC Member States and regional sub-commissions.

There was an extensive discussion of this report and several participants told of their personal experience in educational initiatives in developing countries. The Executive Secretary of IOC reported that the effectiveness of the Training, Education and Mutual Assistance (TEMA) program is under review. TEMA activities are primarily short-term (e.g. training courses, but, in order to make real improvements in graduate education systems, a long-term commitment is required. Thus, he saw the Bellagio initiative as very complementary to TEMA and indicated that IOC will be interested in participating further in its development. Global science issues and problems impose demands on developing countries to contribute to their solutions and to participate in programs. The Chairman of IGBP, Berrien Moore, noted that a recent IGBP meeting in Nairobi exposed many of the same issues. He felt that the key successes have been where there is a long-term regional site around which science activities coalesce.

The President concluded the discussion, noting that many excellent ideas had been raised and should be taken into account in the next steps of this activity. He made a personal plea that a strong local leader will be required to ensure the success of each regional school when it is established. The General Meeting agreed to endorse the report of the Bellagio workshop, to transmit it to the IOC for information and possible action, and the principle that SCOR should be involved in the process of evaluation of such schools as may eventually be established was accepted.

3.3 Affiliated Programs

The 1998 General Meeting was the first occasion at which these international programs were to be formally reviewed by SCOR. The main points for consider are whether the quality of the scientific program remains excellent, and is sufficiently international in scope and membership, to justify SCOR's continuing sponsorship.

3.3.1 Acoustic Thermometry of Ocean Climate (ATOC)

Vere Shannon presented the ATOC report received from its Chair, Andrew Forbes (Australia). The Affiliated Group on Acoustic Monitoring of the Global Ocean was formed in 1996 to continue the excellent work initiated by WG 96, of the same name. It has essentially the same membership and focus, with the goal of exploring and proliferating acoustic techniques to monitor large scale phenomena in the World's oceans. In the first instance, the Group has taken a particular interest in ATOC, the Acoustic Thermometry of Ocean Climate program in the Pacific. The outstanding scientific and engineering achievement of the past two years has been the establishment of an acoustic thermometry network in the North Pacific. Two special purpose underwater low frequency acoustic sources were installed, one off California and the other off Hawaii, which routinely transmit signals to a number of acoustic receivers scattered throughout the North Pacific. Members of the Group have recently published the results of analysis of an entire year's travel time data from this network, "Ocean Climate Change by Acoustic Tomography, Satellite Altimetry and Modeling", in *Science* (Vol 281, pp 1327-1332, 28 August, 1998). The acoustic data have been used to do more than simply validate a General Circulation Model of the ocean – they have been assimilated into the model to significantly improve its ability to hindcast heat content of the North Pacific. This unique combination of observations and model will improve our understanding of ocean processes and climate change scenarios, ultimately leading to better predictions.

The Group will meet in February in Tokyo, at the invitation of JAMSTEC (Japanese Ministry of Science and Technology). It plans to review the progress of developments in acoustic receiver technology, particularly simple, inexpensive types, and provide guidance concerning their further development or refinement. A prime

motivation for advancing this technology is to expand the number of nations that can participate in basin scale ocean acoustics like acoustic thermometry. A low cost, high capacity receiver would enable developing nations around the rim of the Indian Ocean, for example, to become active partners in an international ocean climate monitoring program. A number of Group members will participate in an oceanographic research cruise on an Australian ship late in 1999, whose goal is to locate and survey a suitable site for an Indian Ocean acoustic thermometry source. This is a major step towards creating an Indian Ocean network that builds on the Pacific ATOC experience.

The General Meeting welcomed the report from Andrew Forbes and commended the Group on Acoustic Monitoring of the Global Ocean on its activities.

3.3.2 PAGES/SCOR International Marine Global Changes Study (IMAGES)

The General Meeting welcomed a progress report from the IMAGES program from which the following material is taken. The program is now in its third year and some growth in the budget has allowed initiation of the activities IMAGES was designed for: coordination of international coring cruises, organizing technical meetings and scientific symposia, and providing for the integration and distribution of the data to the Global Change community. The strategy of focusing on a much higher temporal resolution to sample the main modes of ocean and climate variability (especially the centennial to millennial scale) has been very fruitful. A large number of coring cruises (IMAGES, ODP, or others) have been geared toward that objective, new imaging tools (continuous records) have been, and are being, developed, and important results have begun to appear in the primary literature. In particular the existence of the close relationships between changes in thermohaline circulation and climate which were implied by models has been demonstrated, as has the evidence for recurrent instabilities in the coupled system, both in times of large and small ice sheets. Even more surprising, annually-resolved series covering 10 kyrs or more have been obtained in reducing environments (fjords and tectonic basins on the continental margins). These are allowing global CLIVAR-like reconstruction of the decadal variability of climate, with interactions between regional and global systems (ENSO-NAO, for example). Further studies are necessary to understand how the different components of the thermohaline and wind driven circulation interact in these changes, to determine how much both the continental system and green house gases are affected, and to identify the main feedback mechanisms).

IMAGES' future priorities have two main thrusts. First, to continue to acquire high-quality sediment cores in critical locations. Second, we must expand communication and cooperation within the international paleoceanographic community so as to foster integration of the local, regional and global scales of observations. Such collaboration should yield an integrated data set that will illustrate the variability of the global climate and environment (as seen from the ocean sediments) over the last 10^4-5.10^5 years. It is intended that this will be available for widespread assimilation in climate and global change studies.

Access to the *Marion Dufresne* giant coring facilities is one of the main attractions of the IMAGES program, and certainly the part which has developed the fastest. The evolution of paleoceanographic research in recent years, towards higher and higher sedimentation rates, attracts much interest based on the need to understand the mechanisms that govern rapid climatic changes. The *Marion Dufresne*, with her capacity for 20-50 meter-long continuous cores in sediments as shallow as a few tens of meters, occupies a unique slot in the international research fleet. The *JOIDES Resolution* (ODP) perfectly complements this tool, with her capacity for hundreds of meters of drilling, even at shallow depths, but her availability (both in time and cost) is too limited to allow her to fill the needs of the community.

IMAGES now includes 22 members: Australia, Canada, China, Denmark, France, Germany, Iceland, Indonesia, Japan, Mexico, the Netherlands, New Zealand, Norway, Portugal, Russia, South Africa, Spain, Sweden, Taiwan, Tunisia, UK, and the USA. In accordance with the original plans for the program, the IMAGES Secretariat will be re-located from France to another location for the three year period, 2000-2002. IMAGES

cosponsors and supports activities of the SCOR-IMAGES paleomonsoon WG (WG 113 on Evolution of the Asian Monsoon), and endorsed the proposal for a new WG on terminal millennial synthesis of decadal to millennial climate records which was considered by the General Meeting (see item 2.3.4). The IMAGES report noted the absence of formal links to SCOR at the national level and requested assistance in developing these contacts. More information will be sought on IMAGES' needs.

3.3.3 InterRidge - International, Interdisciplinary Ridge Studies

A written report was submitted for the General Meeting and was reviewed briefly by S. Krishnaswami. The membership of InterRidge now includes the representatives of 23 countries and several changes were noted. There was quite detailed information provided on the nine InterRidge scientific projects which are based on three themes: global studies, meso-scale studies and active processes. Detailed Information on these projects was given and is available on the InterRidge web site (http://www.lgs.jussieu.fr/~intridge). The report also describes two InterRidge workshops Mapping and Sampling the Arctic Ridges, and Long-term Monitoring of the Mid-Atlantic Ridge. The General Meeting agreed to continue SCOR's affiliation with InterRidge.

3.3.4 International Antarctic Zone (iAnZone)

The first iAnZone meeting as an affiliated program of SCOR was held at the Biosphere-2 facility in Arizona in December 1997. In view of the shared research interests, the iAnZone meeting was held in combination with the SCAR ASPeCt program. The forty-nine participants represented fourteen countries with activities in the Southern Ocean. A report of this meeting was issued by Lamont-Doherty Earth Observatory (Tech Rept #98-2) and is available upon request. It contains an account of national Southern Ocean programs related to iAnZone objectives and a summary of the iAnZone experiment #2 (AnzFlux) and experiment #3 (DOVETAIL).

The main achievement of this meeting was the development of plans for a fourth iAnZone experiment. The first three iAnZone programs involved just a few nations and occurred in the Weddell Gyre. With the enlarged scope of iAnZone resulting from the SCOR affiliation, it was agreed that an iAnZone program requires broader involvement, and must consider the full circumpolar Antarctic Zone. A theme for iAnZone experiment #4 that fully addresses the iAnZone goals, that can be met at a variety of sites around Antarctica, and for which there is wide interest deals with the convection, a thrust which is fully endorsed within the southern ocean component (D5) of the CLIVAR draft Implementation Plan. A preliminary name for iAnZone Exp. #4 is CONVECTION.

While much research has been directed at the formation and spreading of Antarctic Bottom Water (AABW) in all of its varied forms, we still do not have a firm assessment of the total, circumpolar production of AABW, and even less of an understanding of varied processes that sustain production.

The Objective of CONVECTION is:

> *To obtain a quantitative estimate of the effect of Antarctic zone water mass modification on the global thermohaline circulation and to establish the basis of an observational system which allows to improve and validate the representation of Southern Ocean convection in large scale models.*

It is anticipated that there will be a series of CONVECTION field programs during the period 2000 to 2004 that address these components. Field operations may occur at the same time, but difference sectors of the Antarctic Zone. To quality as an iAnZone program the field program must involve more than one national program and be subject to discussion at iAnZone meetings. Three components of CONVECTION are considered, which involve furthering aspects of the previous three iAnZone experiments. These will be further developed by small working groups before the next iAnZone meeting in May 1999.

1. Continental Margin Convection: This component is directed at the formation of the 'parent' shelf water masses

contributing to deep reaching convection, mixing within the continental margin frontal structures, and the plume convection feeding the deep and bottom water ventilation. Regions of potential field measurements are Weddell Sea, Ross Sea, Prydz Bay, Adelie coast. What are the common threads of these regions that make them sites of slope convection?

2. Open Ocean Convection: Of interest in this component are the vertical transfer processes within the Antarctic Zone thermohaline stratification and their response to wind, buoyancy forcing and polynyas. The perturbation of the regional stratification and vertical fluxes by the processes imposed by topography, such as Maud Rise.

3. Monitoring the convective products: Coupled to the two process oriented components of CONVECTION is the establishment of a time series measurement program of the outflow of deep and bottom water masses formed within the Antarctic Zone which ventilate the global ocean.

iAnZone Weddell Polynya Quick Response Program (WQRP):

The Weddell Polynya event of the mid-1970s stands out as a major perturbation of ocean - atmosphere coupling and presumably of the climate system. Might it represent another mode of operation for the Southern Ocean? Might it become the climatic norm, or perhaps was, now is being suppressed by anthropogenic climate response? Clearly the Weddell Polynya represents a different way of ventilating the deep ocean, perhaps more akin to NADW (Labrador) convection. The Weddell Polynya must be properly simulated in global climate models if they are to be useful in predicting climate change.

The 1997 iAnZone meeting reaffirmed the recommendation of the 4th iAnZone meeting in March 1996 in Barcelona, for a Weddell Polynya quick response program (WQRP). WQRP involves the deployment of a research vessel into the Weddell Polynya, should a large persistent polynya similar to that of the mid-1970s again occur. The Weddell deep water has warmed progressively (to 1.0°C, as warm as observed in the 1930s) since the polynya event of the mid-1970s. Might we be susceptible to a repeat of the 1970s event? iAnZone will coordinate the international response to a Weddell Polynya event. Procedures for the identification of a significant polynya (early alert) and measurement program were discussed at the iAnZone meeting. The co-chairs (A. Gordon and E. Fahrbach) will over see the coordination.

The SCOR General Meeting reviewed the current iAnZone membership and approved the nomination of Zhaoqian Dong (China) and of Hyungmoh Yih (Korea) as new members. Efforts to find a member from South Africa have been unsuccessful to date.

3.3.5 International Ocean Color Coordinating Group (IOCCG)

John Field introduced the first formal report submitted to SCOR since the 1997 SCOR Executive Committee meeting agreed that IOCCG should be given Affiliate status. The IOCCG report outlines scientific accomplishments, major program milestones and the establishment of an IOCCG report series. See Annex 12 for the complete report from IOCCG. A color brochure describing its activities was distributed to all participants

The mandate of IOCCG includes activities in several spheres: advancement of the science of ocean color remote sensing, coordination of national efforts, training, dissemination of information to the ocean color community, and contributing to the Integrated Global Observing Strategy of the international Committee on Earth Observing Satellites.

Since becoming an affiliate of SCOR, IOCCG has been involved in one training course on remote sensing in Chile and will be actively involved in a second course on biogeochemical modeling to take place in Bangalore, India in January 1999. IOCCG organizes periodic technical workshops on issues such as the minimum

requirements for ocean color sensors, the strategies for global-scale, operational ocean color observing systems, the problems presented by "Case 2" (coastal or turbid) waters, and so on. There is now a detailed ocean color home page (http://www.ioccg.org) with information about the IOCCG, pointers to data sources, information on various ocean color sensors, meeting calendars, ocean color bibliography, etc. In addition to establishing its own technical report series, the IOCCG has produced regular technical and news articles for the quarterly publication *backscatter* and for the *CEOS Newsletter*.

The IOCCG has 19 members, some of whom represent the sponsoring space agencies, the rest being selected for their scientific expertise. There is now a rotational membership plan in place, in accordance with SCOR's requirements for its Affiliated Programs. The Executive Secretary of IOC, Patricio Bernal, expressed the hope that, following recent detailed discussions between himself and the Chair of IOCCG, Trevor Platt, a fruitful relationship between the two organizations could be established.

4.0 ORGANIZATION AND FINANCE

4.1 Membership

The participants were informed of the following changes in SCOR membership during the year since the 33rd SCOR Executive Committee meeting in September 1997:

ARGENTINA:	Professors S.R. Oliver and A. A. Yung have both retired from the Argentinian SCOR Committee, and information about their replacements is awaited.
AUSTRALIA:	Professors M. Banner and Ian Jones's successors as Nominated Members from Australia are Professors T. Done and A. McEwan.
BRAZIL:	Dr. F. Herms and Dr. I. Wainer succeed Drs. F. Brandini and I. Gurgel as Nominated Members of Brazil.
CHILE:	Dr. R. Mac-Kay replaces H. Gorziglia as one of Chile's Nominated Members.
CHINA-TAIPEI:	The three newly nominated members from Taipei are Drs. Min-Pin Chen, David P. Sheu and Kwang-Tsao Shao.
PHILIPPINES:	Professor Miguel D. Fortes is the one Nominated Member from the Philippines as Drs. R.B. Feir and G.S. Jacinto have stepped aside; the committee has been asked if it wished to appoint 2 new Nominated Members of SCOR.
UNITED KINGDOM:	Dr. C. Summerhayes has been replaced by Dr. Peter Burkill. He joins Professors R. Dickson and I.N. McCave as Nominated Members from the UK.
UNITED STATES:	Dr. J. Magnuson has stepped down as a Nominated Member from the US and his successor is Dr. E. Houde who joins Dr. Carl Friehe and Dr. Robert Knox as the US members of SCOR.
IUBS:	Professor J. F. Grassle replaced Professor P. Lasserre.
SCAR:	Dr. Julian Priddle has been appointed has the representative to SCOR.

Professor Krishnaswami, the Membership Officer reported that correspondence is ongoing with several countries about their interest in joining SCOR, but no formal applications had been received for consideration at this meeting.

4.2 Publications Arising from SCOR Activities

The Executive Director presented a report on publications arising from SCOR activities since the 1997 Executive Committee meeting:

JGOFS REPORTS AND PUBLICATIONS:

Southern Ocean JGOFS: The U.K., "Sterna" Study in the Bellingshausen Sea. Deep-Sea Research Part II, Vol. 42, 4-5, 1995. Eds.: D. Turner, N. Owens, and J. Priddle.

A U.S. JGOFS Process Study in the Equatorial Pacific. Part 2. Deep-Sea Research Part II, Vol. 43, No. 4-6, 1996. Ed., J.W. Murray.

Ecology and Biogeochemistry of the Antarctic Circumpolar Current during Austral spring: Southern Ocean JGOFS cruise ANT X/6 of R.V. Polarstern. Deep-Sea Research Part II, Vol 44, 1-2, 1997. Eds.: V. Smetacek, H.J.W. de Baar, U. V. Bathmann, K. Lochte and M.M. Rutgers van der Loeff.

ANTARES I: France JGOFS in the Indian Sector of the Southern Ocean; Benthic and Water Column Processes. Deep-Sea Research Part II, Vol. 44, No. 5, 1997. Eds.: J.-F. Gaillard and P. Tréguer.

Netherlands Indian Ocean Program 1992-1993: First Results. Deep-Sea Research Part II, Vol. 44, No. 6-7, 1997. Eds.: T.C.E. Van Weering, W. Helder and P. Schalk.

A JGOFS Process Study in the Equatorial Pacific. Deep-Sea Research Part II, Vol. 44, No. 9-10, 1997. Eds.: J. W. Murray, R. Le Borgne and Y. Dandonneau.

Sakshaug, E., Bricaud, A., Dandonneau, Y., Falkowski, P.G., Kiefer, D.A., Legendre, L. Morel, A., Parslow, J., and Takahashi, M., 1997. *Parameters of Photosynthesis: Definitions, Theory and Interpretation of Results.* Journal Plankton Research, vol. 19, 1637-1670.

Southern Ocean Planning Group reviews synthesis needs and plans for future projects, Vol. 8, Nr. 3, July 1997 (US JGOFS News);

What's Happening in Bergen: Update of the JGOFS IPO, Vol. 8, Nr. 4, November 1997 (US JGOFS News);.

JGOFS holds its first International Modeling Symposium, Vol. 8, Nr. 4, November *1997* (US JGOFS News);

Creating an International Data Management System for JGOFS, Vol. 9, Nr. 1, February 1998 (US JGOFS News);

The North Pacific Task Team Meets to Review Plans for Studies in North Pacific, Vol. 9, Nr. 1, February 1998 (US JGOFS News);

New Chair of JGOFS, No. 33, March 1998 (IGBP NewsLetter);

JGOFS Entering Its Next Project Phase, Vol. 9, Nr. 34, June 1998 (US JGOFS News);

JGOFS: The Synthesis Phase, Vol. 9, Nr. 2, June 1998 (US JGOFS News).

New Chairman Leads JGOFS SSC as Synthesis Work Begins, Vol. 9, Nr. 2, June 1998 (US JGOFS News).

JGOFS SSC Meets in Cape Town to Honour Former Chairman, Vol. 9, Nr. 2, June 1998 (US JGOFS News).

JGOFS Entering its Next Phase. By Roger B. Hanson and Michael J.R. Fasham. IGBP NewsLetter, No. 34. June 1998.

JGOFS Report No. 17: Parameters of Photosynthesis: Definitions, Theory and Interpretation of Results, August 1998.

JGOFS Report No. 24, *JGOFS Publications 1988-1996,* is a compilation of 1507 refereed articles and books that resulted from JGOFS activities from 1988 through 1996.

JGOFS Report No. 25: JGOFS/LOICZ Workshop on Non-Conservative Fluxes in the Continental Margins, October 1997.

JGOFS Report No. 26: Report of the JGOFS/LOICZ Continental Margins Task Team Meeting, No. 2, October 1997.

The Changing Ocean Carbon Cycle: A Midterm Synthesis of the Joint Global Ocean Flux Studies. Eds., R.B. Hanson, H.W. Ducklow & J.G. Field. Cambridge: Cambridge University Press (in press).

Note: JGOFS Reports are available directly from the JGOFS International Project Office or via the JGOFS Web-Site (http://ads.smr.uib.no/jgofs/jgofs.htm).

GLOBEC REPORTS AND PUBLICATIONS:

GLOBEC Report 7A. Report of the meeting of the Southern Ocean Planning Group. (Addendum to GLOBEC Report No. 7, Southern Ocean Implementation Plan).

GLOBEC Report 11. Small Pelagic Fishes and Climate Change Program: Implementation Plan.

GLOBEC Report 12. Report of the First SPACC Modeling Workshop (14-16 October 1996, JRC, Ispra, Italy).

Two issues of the GLOBEC Newsletter have been published and mailed to a mailing list of over 750 scientists worldwide.

GLOBEC International NewsLetter, Vol. 4, No. 1. June 1998.

Note: GLOBEC Reports are available directly from the Plymouth Office or via the GLOBEC Web-Site

(http:/www1.npm.ac.uk/globec). Additional copies of a number of reports, still being requested, have been reprinted.

Publications Arising from SCOR Working Groups

SCOR Working Group 93. *Pelagic Biogeography ICoPB II.* Proceedings of the 2nd International Conference. Final Report of SCOR/IOC Working Group 93. Noordwijkerhout, The Netherlands. 9-14 July 1995. UNESCO Publishing.

SCOR Working Group 97. *Physiological Ecology of Harmful Algal Blooms.* Proceedings of the NATO Advanced Study Institute on "The Physiological Ecology of Harmful Algal Blooms", held at the Bermuda Biological Station for Research, Bermuda, May 27-June 6, 1996. Eds.: D. M. Anderson, A.D. Cembella, G.M. Hallegraeff.

SCOR Working Group 98. Crawford, R.J.M. Seabird Responses to Long-Term Changes of Prey Resources Off Southern Africa. In: Adams, L. & Slotow, R. (Eds.), Proceedings of 22nd International Ornithological Congress. Durban, University of Natal. In press.

-- Crawford, R.J.M. Responses of African Penguins to regime changes of sardine and anchovy in the Benguela system. In *Benguela Dynamics: Impacts of Variability on Shelf-Sea Environments and their Living Resources.* Pillar, S.C., Moloney, C.L., Payne, A.I.L. and F. A. Shillington (Eds.). S. Afr. J. mar. Sci. 19. In press.

-- Maccall, A.D. 1996. *Patterns of Low-Frequency Variability in Fish Populations of the California Current.* CalCOFI Rep. 37: pp. 100-110.

Publications Arising from Other SCOR Activities:

GOOS Planning Workshop for Living Marine Resources. Intergovernmental Oceanographic Commission. Workshop Report No. 137. Center for Marine Science and Technology, University of Massachusetts, Dartmouth, MA, 1-5 March 1996.

GOOS Coastal Module Planning Workshop Report. Intergovernmental Oceanographic Commission Workshop Report No. 131. Prepared by the Scientific Committee on Oceanic Research of ICSU for J-GOOS. University of Miami, 24-28 February 1997.

Joint GCOS GOOS WCRP Ocean Observations Panel for Climate (OOPC). Report of the Ocean Climate Time-Series Workshop, Baltimore, Maryland, USA, 18-20 March 1997. Co-sponsored by GCOS GOOS SCOR/JGOFS WCRP. GCOS Report No. 41, GOOS Report No. 33. UNESCO Publishing.

Ocean Modeling NewsLetter. Issue 114. September 1997.

Ocean Modeling NewsLetter. Issue 115. December 1997.

Report of the 5th Coordination Meeting of iAnZone, International Antarctic Zone, A SCOR Affiliated Program. Columbia University's Biosphere 2 Center, Oracle, Arizona, December 1-5 1997. Prepared A.L. Gordon of the Lamont-Doherty Earth Observatory, Technical Report #98-2.

Gross, E. SCOR and International Year of the Ocean. ICSU Focus 11. Spring-Summer 1998.

Oceanography. Report of The Oceanography Society (TOS) 1997. Seattle, Washington. Vol. 10, No. 3.

The Sea: The Global Coastal Ocean, Processes and Methods. Volume 10. Edited by Kenneth H. Brink and Allan R. Robinson. John Wiley & Sons, Inc. 1998. Arising from the First COASTS International Workshop, Liege, Belgium, May 1994. Both the conference and the costs of publication were supported by SCOR.

The Sea: The Global Coastal Ocean, Regional Studies and Syntheses. Volume 11. Edited by Kenneth H. Brink and Allan R. Robinson. John Wiley & Sons, Inc. 1998.

4.3 Finance

The Chair of the *ad hoc* Finance Committee, Peter Burkill, presented the report from the Committee. He began by reviewing the finances of the prior year (1997), noting a substantial increase in the overall SCOR budget due to increased income and expenses resulting from IOCCG activities and from SCOR's involvement in the International Conference on Satellites, Oceanography and Society. The final auditor's report for the year showed a slight excess of income over expenses. Burkill noted that the accumulated balance of approximately $147,000 was a small relatively proportion of the annual budget. The final financial statement for 1997 is presented in Annex 13.

Turning to the current fiscal year, Burkill reviewed the original budget as approved by the 33rd Executive Committee meeting (September 1997), and he recommended revisions to it based on changing circumstances. The resultant budget for 1998 would predict a slight reduction of about $16,600 in the accumulated balance.

Noting that the increase in SCOR membership contributions for 1999 was agreed by the 1997 SCOR meeting, and was in accordance with ICSU guidelines which approximate inflation rates, Burkill reported that the Finance Committee determined to develop a balanced budget for 1999 with no further erosion of the accumulated balance. The Committee also wished to ensure that the salaries of the Secretariat staff were maintained in accordance with the guidelines of The Johns Hopkins University. The Committee's first attempt to formulate a budget for 1999 resulted in a large deficit. A balanced budget could only be achieved by reducing the allocations for some of the scientific activities. Burkill presented the budget proposed by the *ad hoc* Finance Committee.

In summary the Finance Committee recommended that: SCOR accept the audited accounts for 1997 and formally close the accounts for the year; that the proposed 1998 budget revisions be accepted; that the proposed budget for 1999 be accepted; that increases in the SCOR membership contributions for 2000 be based on ICSU's financial criteria. In addition, the Finance Committee recommended that the Executive Committee should assess the workload of the SCOR Secretariat and the resource requirements to meet them. If there is a budget surplus in 1999, a high priority should be given to maintaining the efficiency of the Secretariat. The Executive Committee should also carefully consider the question of unpaid membership dues and how this problem should be resolved before it becomes serious. A study of ways to increase SCOR membership should also be undertaken.

Several participants commented on the issue of unpaid membership dues. Traditional accounting practice assumes that all dues are paid in a timely fashion, but the economic uncertainties of many countries in a state of transition may make this policy inappropriate. This should be explored with the auditors. The SCOR budget should give top priority to maintaining support for the Working Groups and the Secretariat. The general consensus of the meeting was that seeking new members, who are likely to be in Category I and paying relatively small dues, will not produce a significant increase in SCOR's income.

The General Meeting approved the report of the *ad hoc* Finance Committee and its recommendations and urged the Executive Committee to set some formal financial priorities for SCOR.

4.4 Report of the Nominations Committee

Jarl Stromberg presented the report of the Nominations Committee. He reviewed the terms of the SCOR Constitution with respect to the terms of office of various members of the Executive Committee, noting that the terms of the Secretary and all three Vice Presidents were to expire at the General Meeting. However, the Secretary and one Vice-President (Lappo) were eligible for re-election.

The Executive Committee agreed that the nomination and election procedures drafted at its 1997 meeting should be tested for the 1998 elections. Accordingly, a call for nominations was issued six months before the General Meeting, and all voting members of SCOR were informed of the slate proposed by the Nominations Committee by letter on August 1 1998. Since no election was formally requested by October 16, slate of officers will be elected by acclamation.

The new SCOR Officers are:

President:	John Field	South Africa	1996-2000
Secretary:	Bjorn Sundby	Canada	1996-1998-2000
Vice-Presidents:	Sergei Lappo	Russia	1996-1998-2000
	Wolfgang Fennel	Germany	1998-2000, eligible for a 2nd term
	Shizuo Tsunogai	Japan	1998-2000, eligible for a 2nd term

4.5 Election Procedures

The General Meeting discussed whether the new nomination and election procedures had been satisfactory. In general, they were considered to be a significant improvement over the previous, less formal procedures. A few relatively minor changes were suggested and were incorporated into the draft procedures which were then approved by the General Meeting. They appear in Annex 14.

5.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS

5.1 Intergovernmental Oceanographic Commission

The President of SCOR reminded the participants that in late 1997, the IOC had called upon SCOR and SCOPE to assist the Commission by providing scientific input to an "assessment an analysis of the state of marine science, in particular regarding our scientific capability to understand ocean processes and to use such understanding for the sustainable development of Member States". The resolution calls upon SCOR and SCOPE to "contribute to this assessment in their respective fields of competence and to establish with IOC a joint advisory group of up to six members to assist in the assessment and analysis". This group was established and met in May and again in October 1998. Plans call for a major workshop to take place in 1999 and for several products including a book.

The Executive Secretary of IOC, Patricio Bernal, described the ocean assessment in more detail, noting that its purpose is to carry out an evaluation of the state of marine science and to identify issues for sustainable development and the capacities of governments and the scientific community to respond to these problems. The workshop planned for 1999 is to produce a book for the "Rio Plus 10" conference in 2002 and for the implementation on the United Nations Convention on the Law of the Sea in 2004.

Bob Duce noted that the organizing committee has decided to address only a certain number of issues and

their impacts on society. Five major scientific topics were identified for inclusion in the report: coastal areas and processes; climate; fisheries; ocean services; ocean studies for the advancement of basic understanding. Duce reviewed the draft book outline, noting that each chapter will have several case studies. Background papers will be prepared for the Potsdam meeting and the detailed book chapters will be developed there.

Field reminded that General Meeting that SCOR is the official scientific advisor to IOC. Bernal welcomed this relationship and stated that, in his opinion, it is a very strong one. SCOR has supported IOC by providing advice and developing partnerships which have led to many of the IOC programs. He expressed the need to understand the complementarity of intergovernmental organizations and their non-governmental counterparts.

Finally, Bernal reviewed recent progress in the development of the Global Ocean Observing System (GOOS), noting that panels for all four of the GOOS modules (climate, health of the ocean, coastal, and living marine resources) had met. The implementation of GOOS will rely upon regional arrangements. The effort will also be supported by a new committee for operational oceanography to be established jointly by the IOC and WMO.

5.2 World Meteorological Organization

A brief written report from the WMO provided information on two activities of interest to SCOR, the Data Buoy Cooperation Panel (DBCP) and the Integrated Global Ocean Services System (IGOSS). The work of the DBCP continues to be effected largely through technical coordinator, who works directly with both operational and research deployers of drifting and moored buoys. The total number of data reports from buoys distributed on the GTS in BUOY code has increased from less than 20,000 per month in mid-1987 to more than 200,000 per month in mid-1998. There are presently more than 80 individual deployment programs, in 18 countries, which have made data available for GTS distribution.

IGOSS is directly involved in implementation of the common GOOS/GCOS ocean climate module, in particular through the Ship-of-opportunity Program (SOOP). This program is now being coordinated and monitored as an on-going, operational ocean observing system component, and an operational SOOP implementation plan has been prepared. A data base of existing and projected SOOP resources is maintained. This resource data base is being used by the IGOSS Ship-of-opportunity Program Implementation Panel (SOOPIP) and the Ocean Observations Panel for Climate (OOPC) as part of an ongoing dialogue to determine the most scientifically effective way of using the available resources to monitor upper ocean heat content in support of global climate studies.

WMO and IOC are presently jointly studying the possibilities for an eventual merger of the WMO Commission for Marine Meteorology with the joint WMO/IOC Integrated Global Ocean Services System, to form a new joint WMO/IOC Commission for Oceanography and Marine Meteorology (JCOMM). The new body is intended to serve as the single intergovernmental technical body for coordinating and managing the implementation of an operational ocean observing system in support of GOOS and GCOS. As such, it will combine all existing functions of CMM and IGOSS, be the reporting and coordinating mechanism for other bodies such as the DBCP and GLOSS, and receive scientific advice from bodies such as the OOPC. A formal decision on the formation of JCOMM will be made by the WMO Congress and the IOC Assembly in mid-1999.

5.3 International Council for the Exploration of the Sea

The 1998 ICES Annual Science Conference was the first to be held with the new structure of seven Science Committees. The meetings and inter-sessional work of these Committees have focused on the development of their contribution to the ICES Initial Strategic Plan. It is expected that this plan will be launched to coincide with the ICES Centenary celebrations. These commence at the ICES Annual Science Conference in Stockholm 1999 when the 100th anniversary of the Stockholm Conference marking the birth of ICES will be celebrated. The Conference will include four special Centenary Lectures. These will be on "Otto Pettersson and the Birth of ICES" by Dr A Svansson, "On Oceanography" by Prof W Wooster, "On Fisheries (Theory and Advice)" by Dr J

Jakobsson and "On Environment". The complete program for this is not yet finalized but is expected to include up to 21 sessions on a variety of topics. These will include "Plans for Major International Programs in the North Atlantic Region over the Next Decade", "Nordic Seas Exchanges", "Application of Coupled Bio-physical Models in Studies of Zooplankton and Ichthyoplankton Advection and Dispersion", "Evaluation of Complete Fisheries Systems: Economic, Social, and Ecological Analyses" and "Ecosystem Management -Can We Make it Operational". Full details will be available before the end of 1998 on the ICES web site (www.ices.dk).

Plans for the ICES-SCOR Symposium on Ecosystem Effects of Fishing in March 1999 were reported to be progressing well. This meeting is being organized by SCOR WG 105 on the Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems. ICES has also agreed to a request from NOAA to co-sponsor (with NOAA, IOC and SCOR) the Symposium on "The Changing States of Large Marine Ecosystems of the North Atlantic and Global Environmental Trends", which is scheduled for Bergen, Norway in June 1999.

In 1998 the ICES Working Group on Ecosystem Effects of Fishing addressed questions related to the impact of fishing on age/size distribution of cod, herring, sole, mackerel and hake in the Northeast Atlantic. It has also prepared information on quantities of discards for commercially exploited stocks of fish and shellfish. Terms of reference for 1999 include the continuation of its long-term work program to develop basic concepts to evaluate direct and indirect effects of fishing on marine ecosystems.

The ICES/GLOBEC Office continues to support and co-ordinate the activities of ICES in the ICES/GLOBEC program on Cod and Climate Change. Dr K Brander remains in charge of the Office. The Office has now secured funding to ensure its operation for a further two years. In the coming year ICES will hold the fourth of its "Backward-facing" workshops in support of the Cod and Climate Change Program. This series of workshops have used a combination of retrospective analysis and new process studies and modeling in order to interpret the causes of past population events.

A request from ICES sought SCOR sponsorship and support for a special symposium entitled "100 Years of Science under ICES" to be held in Finland in August 2000. The General Meeting agreed in principle to cosponsor this meeting, but tabled the request for financial support for consideration by the Executive Committee meeting in 1999.

5.4 North Pacific Marine Science Organization (PICES)

The only item received from PICES was a request for SCOR sponsorship and support for a PICES conference, "El Niño and Beyond" to be held in February 2000. The very strong El Nino of 1997-1998 has stimulated interest in the effect of such events on longer term changes in the ocean and on the response of marine ecosystems and ultimately of marine fisheries. The Conference will look at interannual, decadal, and interdecadal scales of variability in the Pacific from the tropics north to the Arctic. In each case, it will review the evidence for variability, the consequences of such variability, the mechanisms of interaction with the ecosystems, and the implications for fishery production and management. Participation of scientists from countries around the Pacific Basin will be welcomed. The General Meeting agreed to cosponsor the meeting and to provide some support for participants from developing countries, contingent upon the availability of these funds at the time of the meeting.

Shizuo Tsunogai represented SCOR at the latest PICES meeting and reported that in response to his proposal, a new PICES WG on CO_2 in the North Pacific Ocean has now been established. He expressed his pleasure that PICES is now a more broadly interdisciplinary body. Tsunogai also noted that the JGOFS North Pacific Task Team met in Fairbanks during the PICES meeting.

6.0 RELATIONS WITH NON-GOVERNMENTAL ORGANIZATIONS

6.1 International Council of Scientific Unions

The Executive Director reported that ICSU and UNESCO are convening a "World Conference on Science" in Budapest in June 1999. The role for SCOR in this event was not yet clear, although the General Meeting is invited to consider the role of SCOR in providing input to ICSU from the ocean science community.

6.2 ICSU Unions, Committees and Programs

6.2.1 International Geosphere-Biosphere Program (IGBP)

The Chairman and Deputy Executive Director noted the strong links between SCOR and the IGBP through JGOFS and GLOBEC as well as through other co-sponsored activities. They reported that IGBP has initiated its first synthesis of scientific results in order to review the progress made in the last decade towards understanding the earth system and its susceptibility to global change.

6.2.2 World Climate Research Program (WCRP)

No report was available from the WCRP.

6.2.3 Scientific Committee on Problems of the Environment (SCOPE)

No report was available from SCOPE, but the close cooperation between SCOR and SCOPE on the ocean assessment (see item 5.1) was noted.

6.2.4 Scientific Committee on Antarctic Research (SCAR)

The Chairman of SCAR's Group of Specialists on Global Change (GLOCHANT), Julian Priddle, presented information on its activities, many of which have close ties to SCOR, as well providing a regional framework for the IGBP and WCRP. His written report appears in Annex 15. It has been formally agreed that SCAR should be a co-sponsor of the Southern Ocean components of the JGOFS and GLOBEC programs and representatives of these programs will be nominated to the GLOCHANT group.

Priddle specifically sought SCOR sponsorship for an International Workshop on Large-scale Variability in the Southern Ocean which is described in detail in Annex 15. Planned, for August 1999, it will be an interdisciplinary meeting with a focus on interannual and decadal time scales. This is the first in a series of SCAR-SCOR workshops on Southern Ocean science which was approved by SCOR in 1996.

The President welcomed the increased interaction between SCOR and SCAR, especially with the GLOCHANT activities. The General Meeting agreed that SCOR should cosponsor the Southern Ocean Variability workshop and should provide some financial support to it.

6.2.5 Committee on Space Research (COSPAR)

No report was available from COSPAR.

6.2.6 International Union of Pure and Applied Chemistry (IUPAC)

SCOR and IUPAC are co-sponsors of WG 109 on Iron Chemistry (see item 2.2.15), which was holding a symposium in conjunction with the General Meeting. A brief written report was supplemented by the IUPAC representative, David Turner.

He reported that several IUPAC Commissions have current projects of interest to SCOR. These are briefly summarized below.

Commissions V.2 (Microchemical Techniques), VI.1 (Fundamental Environmental Chemistry) and VII.C.2 (Toxicology). These three commissions are jointly developing guidelines for terms related to chemical speciation and fractionation of trace elements. A draft manuscript is now undergoing internal review within IUPAC:

Commission V.6 (Equilibrium Data). A project entitled "Influence of pressure on chemical equilibria in aqueous solutions - with particular reference to sea water" has resulted in a paper which is now undergoing internal review within IUPAC prior to publication.

Commission V.8 (Solubility data). The project "Solubilities of oceanic salt systems and related systems" is still in the planning stage. A report from the latest project group meeting held in August 1998 was not available at the time of the General Meeting. Turner noted that SCOR's advice has also been sought on this project and that the comments made at the 1996 General Meeting of SCOR and had not all been addressed yet.

Commission VI.1 (Fundamental Environmental Chemistry). This Commission is co-sponsor of SCOR WG 109, and has one other project relevant to SCOR: Volume 6 in the IUPAC series on Analytical and Physical Chemistry of Environmental Systems is entitled "In situ Analytical Techniques for Water and Sediments". This volume is currently in preparation: a workshop meeting to review draft chapters was held in July 1998. The book includes applications in both fresh and saline waters. The next book in this series will be one arising from the WG 109 symposium.

Turner and the Chair of former SCOR WG 80 (Role of Phase Transfer Processes in the Cycling of Trace Metals in Estuaries), Michael Whitfield met during the General Meeting to discuss how IUPAC might become involved in the updating and publication of the results of the WG's activities in the area of particle chemistry in estuarine systems. The complexity of the topic and the delays in obtaining all of the papers from the WG members had made it very difficult to synthesize the information. However, much of it would be valuable background information for a renewed joint SCOR-IUPAC project on the topic. This will be proposed to IUPAC.

6.2.7 Union Radio Scientifique Internationale (URSI)

A written report from URSI mentioned several activities of interest to SCOR. In general, these deal with remote sensing of the sea surface and include such topics as the use of scatterometers for the estimation of surface winds and sea state, advanced radar systems for the estimation of the 2D wavenumber spectrum, radiometers for SST measurements, synthetic aperture radar systems for studies of currents, and altimeters for wave studies. The report requested closer ties between SCOR and URSI's Commission F on Remote Sensing.

6.3 Affiliated Organizations

The Presidents of the Affiliated Organizations are *ex-officio* members of the SCOR Executive Committee. They presented brief verbal reports of the activities of their organizations.

6.3.1 International Association for Biological Oceanography (IABO)

Fred Grassle reported that IABO's main focus is currently on the issue of marine biodiversity. This has led to the formation of an international network of marine biological laboratories. DIVERSITAS is now a well-established program with sponsors including UNESCO, SCOPE and IUBS. There is an IABO initiative to develop a data base for marine biodiversity which should be very useful for systematists The year 2001 will be an international biodiversity observation year to which the marine laboratories will contribute, as will the international coral reef monitoring network and a German deep sea expedition.

6.3.2 International Association for Meteorology and Atmospheric Sciences (IAMAS)

The President of IAMAS, Bob Duce, reminded participants that the 1997 Executive Committee meeting agreed that SCOR should endorse a proposal being sent to ICSU by IAMAS for an Alliance for Capacity Transfer (ACT - see *SCOR Proceedings* vol 33, pg 26). This proposal was successful and ACT will be initiated in 1999. The goal of ACT is to stimulate and expand voluntary collaboration and exchange of information and data, within and across the boundaries between the National Meteorological and Hydrological Services (NMHSs), the university community, and the scientific community at large through the use of the Internet.

The next meeting of IAMAS will take place during the IUGG Assembly in Birmingham in July 1999. Duce's term as IAMAS President would expire at that meeting.

6.3.3 International Association for the Physical Sciences of the Ocean (IAPSO)

IAPSO will hold its next General Meeting at the IUGG General Assembly in Birmingham (UK) in July 1999. Vere Shannon noted that IAPSO is organizing a number of scientific sessions at the IUGG Assembly, both on its own and in cooperation with IAMAS. IAPSO and IABO are planning a joint assembly in Argentina in 2001. Several participants welcomed this innovative collaboration on a meeting to bring together the physical and biological oceanographic communities. In response to a question from Shizuo Tsunogai, Shannon said that IAPSO does include chemical oceanography within its mandate

6.4 Corresponding Organizations

6.4.1 Arctic Ocean Sciences Board (AOSB)

The representative of the AOSB, Louis Brown, reviewed the successful NATO Advanced Research Workshop on the Freshwater Budget of the Arctic Ocean which took place in Tallin, Estonia in May 1998 and was cosponsored by SCOR with significant staff support from the SCOR Secretariat. The discussions at the workshop indicated that "in both atmosphere and ocean, episodic event were important and therefore the processes involved, whether these were atmospheric cyclonic disturbances bringing in large quantities of moisture to the system, or the formation of deep ocean water, need to be better understood before the longer term changes can be appreciated. Kin terms of how the Arctic Ocean and its freshwater budget might be impacted by global change, or indeed how the arctic processes themselves contribute to the global situation, there are two issues which need understanding but have hitherto been neglected: (1) Coupling between the seasonal cycles (e.g. run-off vs ice formation) and (2) points of bifurcation (e.g. freshwater inputs from the Laptev entering the Canadian Basin or the Eurasian Basin; freshwater leaving the Archipelago vs. Fram Strait). The Arctic Ocean basin is still a data sparse area and existing monitoring programs need to be protected, but more extensive, and continuous networks need to be established. Finally, models are becoming available with finer resolution and these can be used, not only for forecasting longer term trends, but also to shed light on processes and to eventually replace some of the physical data networks through assimilation techniques."

Brown also noted that the AOSB Arctic polynya program is well underway and he mentioned other AOSB activities such as a study of paleo river discharges to the Arctic Ocean. At the AOSB meeting in March 1998, Dieter Futterer (Germany) was appointed Chairman of AOSB. Finally, Brown referred participants to the newly-established AOSB web site for additional information.

6.4.2 Engineering Committee on Oceanic Resources (ECOR)

Brian Nicholls reported that ECOR is continuing to try to expand its membership and is now seeking corporate members. ECOR has established a new journal which will be published biannually. The ECOR working group on Wave Energy Conversion (the topic was originally referred to ECOR by SCOR) is being supported by the Japanese Ministry of Science and Technology (JAMSTEC) and is publishing reports on the topic. ECOR continues to consider establishing a working group on the disposal of carbon dioxide in the deep ocean, another topic which

originated in a proposal to SCOR.

6.4.3 Confederation Mondiale des Activités Subaquatiques (CMAS - Scientific Committee)

No report was available from the CMAS-SC.

6.5 Other Organizations

The Oceanography Society (TOS)

Bob Duce, in his capacity as Past-President of TOS, reported that the next TOS Scientific Meeting would take place in Reno (USA) in April 1999. As usual, the meeting would be cosponsored by SCOR. The current President of TOS is Ken Brink (USA).

7.0 FUTURE MEETINGS

7.1 Future meetings of SCOR

As was agreed by the 33rd Executive Committee meeting, the Thirty-fourth Executive Committee Meeting of SCOR: will take place in Goa, India from October 25-29 1999. The General Meeting thanked the Indian SCOR Committee and the Indian National Science Academy for its invitation to SCOR to hold its first meeting at the National Institute of Oceanography in India.

Several national committees expressed an interest in hosting the 25th SCOR General Meeting which should take place in 2000, between September and early November. These included the Russian Academy of Sciences, the Chilean SCOR Committee and the US National Academy of Sciences. The General Meeting agreed that the Officers should consider the various options and decide where the next General Meeting should take place.

A possible venue for the Executive Committee meeting in 2001 would be the joint IABO/IAPSO scientific meeting to be held in Argentina in October of that year. This decision should be finalized at the Executive Committee meeting in 1999.

7.2 Other meetings of interest to SCOR

The Executive Director presented a list of international meetings of interest to SCOR which would take place during the next two years. For some of these meetings, SCOR sponsorship and/or support had been requested.

SCOR sponsorship was approved for the following meetings. Where such support had been requested, funds will be used to facilitate the participation of marine scientists from developing countries in these meetings.

March 7-12 1999 Ventura, California USA	Second Gordon Research Conference on Polar Marine Science: Controls and Significance of Carbon Fluxes in Polar Seas. This series of meetings arose from the activities of SCOR WG 86 on Sea Ice Ecology.
April 27-30 1999 Reno, Nevada, USA	Extreme and Unexpected Phenomena in the Ocean - TOS Scientific Meeting
May 3-7 1999 Liège, Belgium	Liège Colloquium on Three-Dimensional Ocean Circulation: Lagrangian Measurements and Diagnostic Analyses

April 24-28 2000 Rotorua New Zealand	6th International Coastal Symposium

The SCOR Secretariat had been notified of the following meetings which may be of interest to SCOR members. Information about any of them may be obtained from the Secretariat.

1998

December 1-4 Paris, France	CLIVAR Conference
December 3-4 Tokyo, Japan	XXI Symposium on Polar Biology

1999

January 26-28 Kaohsiung, Taiwan, China	Marine Environment, the Past, Present and Future
June 23-25 Moscow	PACON Regional Symposium on Humanity and the World Ocean
November 2-6 Antalya, Turkey	Land-Ocean Interactions: Managing Coastal Ecosystems

2000

June 5-9 Honolulu	The Ninth Pacific Congress on Marine Science and Technology

In 1998 SCOR agreed to support and co-sponsor the International Congress on the History of Oceanography in Qingdao, China, but no request was received for SCOR support for participants from developing countries. The organizers had now asked for a contribution to support the publication costs. The General Meeting decided that SCOR did not have funds available for this purpose, but should assist the ICHO organizers in negotiating a suitable publishing contract. Ian Jones agreed to undertake this responsibility.

Fred Herms, the representative of the Brazilian SCOR Committee, asked for SCOR support to assist one or two scientists from developed countries to participate in a national scientific meeting designed for undergraduate students from Brazil, Argentina and Uruguay. It was agreed that such action was appropriate and the means to undertake it should be explored within the existing budget for travel awards to scientists from developing countries which is made available through a grant to SCOR from the US National Science Foundation.

In response to a request from Vere Shannon, the General Meeting agreed that SCOR should provide support for a few participants in some of the sessions dealing with ocean science topics at the IUGG Assembly to be held in Birmingham in July 1999.

8.0 OTHER BUSINESS

Noting that the Ocean Drilling Program will come to an end in 2002, and that an international conference was being organized to explore future directions for the program, the participants discussed the question of whether SCOR should contribute to this discussion. There is already significant international interest in this debate and there are now expectations that there will be two new drilling vessels available by the middle of the next decade, one each from the US and Japan. While there is no international organization to represent marine geologists since the IUGS disbanded the Commission for Marine Geology, the IMAGES program will provide international input to the debate within its sphere of interest. The General Meeting agreed that the need for SCOR input should be explored further, that a SCOR representative should be sent to the international conference in Vancouver, if necessary, and that SCOR should offer to provide support to ensure that two or three scientists from developing countries with interests in ocean drilling could participate in the debate.

* * * * *

The President closed the General Meeting after expressing thanks on behalf of all the participants to Hein de Baar of the Netherlands SCOR Committee, and to Alice de Geir and Hedwig van der Zwaal of the Royal Netherlands Academy of Arts and Sciences for all their work in organizing the logistics of the meeting as well as the very enjoyable canal outing and reception at the Museum of the Dutch East India Company in Amsterdam. Field also extended the gratitude of SCOR to the departing members of the Executive Committee, Vice-Presidents S. Krishnaswami and Wang Pinxian, and ex-officio members Bob Duce and Vere Shannon. He thanked all participants for their many contributions to the discussions and wished them all a safe journey home.

ANNEX 1 - List of Participants
XXIV General Meeting of SCOR
Scientific Committee on Oceanic Research
Amsterdam, The Netherlands, November 1st- 6th 1998

EXECUTIVE COMMITTEE

President:

Professor John Field
Zoology Department
University of Cape Town
7701 Rondebosch
SOUTH AFRICA

Tel: 27-21-650-3612
Fax: 27-21-685-3937
E-mail: jgfield@pop.uct.ac.za

Secretary:

Professor Bjørn Sundby
INRS-Océanologie
Université du Québec
310 allée des Ursulines
Rimouski, PQ, CANADA G5L 3A1

Tel: 1-418-724-1767
Fax: 1-418-723-7234
E-mail: b.sundby@uquebec.ca

Vice-Presidents:

Professor S. Krishnaswami
Physical Research Laboratory
Navrangpura, Ahmedabad
380 009 INDIA

Tel: 91-79- 462-129
Fax: 91-79- 656-0502
E-mail: swami@prl.ernet.in

Professor S. S. Lappo, Director
P.P. Shirshov Institute of Oceanology
Russian Academy of Sciences
Krasikov St., 23
117218 Moscow, RUSSIA

Tel: +7-095-124-5996
Fax: +7-095-124-5983
E-mail: rocc@sovam.com

Professor Wang Pinxian
Tongji University
Department of Marine Geology
1239 Sipinglu
Shanghai 2000092, CHINA

Tel: 86-21-650-5080, ex. 3207
Fax: 86-21-6513-8808
E-mail: pxwang@online.sh.cn

Ex-Officio Members:

J. Frederick Grassle
Director, Institute of Marine and
Coastal Sciences
Rutgers University
New Brunswick, NJ 08903-0231 USA

Tel.: 732-932-6555, Ext. 540
Fax : 732-932-8578
E-mail: grassle@ahab.rutgers.edu

R. A. Duce
College of Geosciences and
Maritime Studies
Texas A & M University
College Station, TX 77843-3148, USA
Tel.: 409-845-5756
Fax: 409-845-8978
E-mail: rduce@ocean.tamu.edu

Vere Shannon
Oceanography Department
University of Cape Town
Private Bag
Rondebosch 7701, SOUTH AFRICA
Tel.: 27-21-650-3277
Fax: 27 21-650-3979
or 402-3106
E-mail: vshannon@physci.uct.ac.za

Co-Opted Member:
Ian S. F. Jones
Ocean Technology Group JØ5
University of Sydney
NSW 2006, AUSTRALIA
Tel.: 61 29 351-4586
Fax: 61 29 351 4584
E-mail: otg@otg.usyd.edu.au

SCOR SECRETARIAT:
Ms. Elizabeth Gross, Executive Director
Ms. Wesley Anne Ross, Executive Assistant
Department of Earth and Planetary Sciences
The Johns Hopkins University
Baltimore, MD 21218, USA
Tel.: 410-516-4070
Fax: 410-516-4019
E-mail: scor@jhu.edu
E-mail: wesley.ross@jhu.edu

Other Participants:

G.W. Bailey
Sea Fisheries Research Institute
Private Bag X2
Rogge Bay, 8012
SOUTH AFRICA
Tel.: 27-21-402-3306
Fax: 27-21-25-2920
E-mail: gwbailey@sfri.sfri.ac.za

Patricio Bernal
IOC / UNESCO
1 rue Miollis
75732 Paris cedex 15
FRANCE
Tel.: 33 1 4568 3983
Fax: 33 1 4568 5812
E-mail: P.Bernal@unesco.org

Patrick Buat-Menard
Département de Géologie et Océanographie
Université Bordeaux
351, ave des Facultiés, URP 197
F-33405, Talence, Cedex
FRANCE
Tel.: +33 5 5684 8870
Fax: +33 5 5684 0848
E-mail: buat@geocean.u.bordeaux.fr

Louis B. Brown
National Science Foundation
Division of Ocean Sciences
4201 Wilson Boulevard
Arlington, VA 22230, USA

Tel.: 1-703-306-1516
Fax: 1-703-306-0091
E-mail: lbrown@nsf.gov

Peter Burkill
Plymouth Marine Laboratory Prospect Place, West Hoe
Plymouth PL1 3DH, UK

Tel.: (44-1752) 633-422
Fax: (44-1752) 633 101
E-mail: p.burkill@pml.ac.uk

Bill Burnett
Department of Oceanography
Florida State University
Tallahassee FL 32306-3048, USA

Tel.: (850) 644-6703
Fax: (850) 644-2581
E-mail: burnett@ocean.fsu.edu

Min-Pen Chen
Deputy Director, National Center for Ocean Research (NCOR)
President, Republic of China National Committee on Oceanic Research
P.O.Box 23-13, Taipei. Taiwan, China

Tel.: 886-2-23914442, 23642424
Fax: 886-2-23644049, 23925294
E-mail: minpen@ccms.ntu.edu.tw

H. Lawrence Clark
National Science Foundation
4201 Wilson Blvd.
Arlington, VA 22230
USA

Tel.: 703-306-1584
Fax: 703-306-0390
E-mail: hclark@nsf.gov

Chris Crossland
LOICZ International Project Office
Netherlands Institute for Sea Research
PO Box 59
1790 AB Den Burg, Texel
THE NETHERLANDS

Tel.: 31-222-369404
Fax: 31-222-369430
E-mail: loicz@nioz.nl

Hein de Baar
NIOZ
P.O. Box 59
1790 AB Den Burg, Texel
THE NETHERLANDS

Tel.: 31-222-369465
Fax: 31-222-19674
E-mail: debaar@nioz.nl

Henrik Enevoldsen
IOC Science and Communication Centre
On Harmful Algae
Botanical Institute, Univ. Of Copenhagen
Oster Farimagsgade 2D
DK-1353 Copenhagen K, DENMARK
Tel.: +45 33 13 44 46
Fax: +45 33 13 44 47
E-mail: hab@bot.ku.dk

Wolfgang Fennel
Institut für Ostseeforschung Warnemuende (IOW) an der Universität Rostock
Seestrasse 15 D-18119
Rostock-Warnemünde, GERMANY
Tel.: 49 381 5197110
Fax: 49 381-5197480
E-mail: wolfgang.fennel@io-warnemuende.de

Michel Frankignoulle
Laboratoire d'Océanologie
Université de Liège (Bât;B6)
B4000 Sart Tilman (Belgique)
Tel.:
Fax: +32 4 3663325
E-mail: Michel.Frankignoulle@ulg.ac.be

Gerald M. Ganssen
Institute of Earth Sciences
Free University
De Boelelaan 1085
1081 HV Amsterdam
THE NETHERLANDS
Tel.: 31 20 4447369
31 20 4447308
Fax: 31 20 6462457
E-mail: gang@mailhost.geo.vu.nl

Patrick Gentien
IFREMER/DEL/
B.P. 70
29280 Plouzane, FRANCE
Tel.: +33-(0)2-98224324
Fax: +33-(0)2-98224548
E-mail: pgentien@ifremer.fr

Winfried W. C. Gieskes
Department of Marine Biology
University of Groningen
Kerklaam 30, P.B. 14
9750 A A Haren, THE NETHERLANDS
Tel: 31 50 3632021
Fax: 31 50 3635205
E-mail: w.w.c.gieskes@biol.rug.nl

Kurt Hanselmann
Institute of Plant Biology
University of Zurich, Zollikerstr. 107 CH-8008 Zurich, SWITZERLAND
Tel.: 41 1 385 42 84 (direct)
41 1 385 42 11 (office)
Fax: 41 1 385 42 04
E-mail: hanselma@botinst.unizh.ch

Roger Harris
Plymouth Marine Laboratory
Prospect Place, West Hoe
Plymouth PL1 3DH, UNITED KINGDOM
Tel.: 44-1752-633-400
Fax: 44 1752-633-101
E-mail: r.harris@pml.ac.uk

Carlo Heip
Center for Estuary and Marine Research
P.O. Box 140
NL-4400 AC Yerseke
THE NETHERLANDS
Tel: +31-112-577-445
Fax: +31-113-573-616
E-mail: heip@cemo.nioo.knaw.nl

W. Helder
NIOZ, P.O. Box 59
1790 AB Den Burg, Texel
THE NETHERLANDS
Tel.: +31 222 369 443
Fax: +31 222 319 674
E-mail: helder@nioz.nl

J.P. Henriet
Renard Centre of Marine Geology
University of Gent
Krijgslaan 281 s.8
B-9000 Gent, BELGIUM
Tel.: 32-9-2644585
Fax : 32-9-2644967
E-mail: jeanpierre.henriet@rug.ac.be

Friedrich Wilhelm Herms
Universidade do Estado do Rio de Janeiro
Departamento de Oceanografia
Rua São Francisco Xavier 524 - 4th floor
Rio de Janeiro - RJ
BRAZIL
Tel: 55-21-587-7689
Fax: 55-21-587-7466
E-mail: FREDWH@UERJ.BR

Birger Larsen
Secretary, DNO.
Danmarks og Grønlands Geologiske Undersogelse,
Thoravej 8 2400
København NV, DENMARK
Tel.: 45 38142368
Fax: 45 38142050
E-mail: bil@geus.dk

Kenneth Lee
Marine Environmental Sciences Div.
Bedford Institute of Oceanography
P.O. Box 1006
Dartmouth, Nova Scotia
B2Y 4A2, CANADA
Tel/Fax: (902) 426-7344
E-mail: Leek@dfo-mpo.gc.ca

Pentti Malkki
Finnish Institute of Marine Research P.O. Box 33
FIN-00931 Helsinki, FINLAND
Tel: 358-0-613 94 400
Fax: 358-0-613 94 494
E-mail: malkki@fimr.fi

Berrien Moore, III
Institute for the Study of Earth
Oceans, and Space
University of New Hampshire
39 College Road
Morse Hall, Durham, NH 03824-3524, USA
Tel.: (1-603) 862-1766
Fax: (1-603) 862-1915
E-mail: b.moore@unh.edu

C. Raj Murthy
National Water Research Institute
Canada Centre for Inland Waters
867 Lakeshore Boulevard
P.O. Box 5050
Burlington, Ontario, L7R 4A6
Tel.: (905) 336-4920
Fax: (905) 336-6230
E-mail: raj.murthy@cciw.ca

Brian Nicholls
1201, 9921-104 Street
Edmonton, Alberta T5K 2K3
CANADA
Tel.: 1-403-426-3278
Fax: 1-403-426-3278
E-mail: nicholls@telusplanet.net

Annelies C. Pierrot-Bults
Institute for Systematics and Population
Biology
University of Amsterdam
P.O. Box 94766
1090 GT Amsterdam
THE NETHERLANDS
Tel.: 31 20 525 7194 /525 5422
Fax: 31 20 525 5402
E-mail: pierrot@bio.uva.nl

Julian Priddle
British Antarctic Survey
High Cross, Madingley Road
Cambridge CB3 0ET
UNITED KINGDOM
Tel.: +44 1223 221 597
Fax: +44 1223 221 259
E-mail: j.priddle@bas.ac.uk

Roberto Purini
Istituto Talassografico,
CNR, viale R. Gessi 2
I-34123 Trieste, ITALY
Tel.: 39 40 305 312
Fax: 39 40 308 941
E-mail: purini@acqua.ifa.rm.cnr.it

Sally J. Stone
Ocean Sciences
Elsevier Science Lt.
Kidlington, Oxford OX5 1GB
UNITED KINGDOM
Tel.: +44 1856 843 866
Fax: +44 1856 843 960
E-mail: s.stone@elsevier.co.uk

Jarl-Ove Stromberg
Kristineberg Marine Research Station
S-450 34 Fiskebackskil, SWEDEN
Tel.: 46-523-18552
Fax: 46 523-18503
E-mail: j.stromberg@kmf.gu.se

Jose Stuardo
Universidad de Concepcion
Facultad de Ciencias Naturales y Oceanograficas
Casilla 2407, Aptdo. 10
Concapcion, CHILE
Tel.: 56-41-234985, Ext. 4502
Fax: 56-41-225400
E-mail: jstuardo@halcon.dpi.udec.cl

Neil Swanberg
IGBP Secretariat
The Royal Swedish Academy of Sciences
Box 50005
S-104 05 Stockholm, SWEDEN
Tel.: 46-8-1664 48
Fax: 46-8-1664 05
E-mail: neil@igbp.kva.se

Shizuo Tsunogai
Laboratory of Marine and Atmospheric, Geochemistry Lab (MAG) Graduate School of Environmental Earth Science
Hokkaido University
Sapporo 060, JAPAN
Tel.: 81-11-706-2368
Fax: 81-11-726-6234
E-mail: mag-hu@ees.hokudai.ac.jp

Ed Urban
Ocean Studies Board, HA-470
National Research Council
2101 Constitution Ave., N.W.
Washington, D.C. 20418, USA
Tel.: 1-202-334-3141
Fax: 1-202-334-2885
E-mail: eurban@nas.edu

C.H. van der Weijden
Department of Earth Sciences
University of Utrecht
P.O. Box 80021
3508 TA Utrecht
THE NETHERLANDS
Tel.: +31 30 253 5039
Fax: +31 30 253 5030
E-mail: chvdw@geo.uu.nl

ANNEX 2 - Symposium Program
Koninklijke Nederlandse Akademie van Wetenschappen

"Biogeochernistry of Iron in Seawater"

Sunday, November 1, 1998

13.00-13.30 Welcome, joint session SCOR General Meeting and WG 109.
14.00 Starting with program WG 109, Oude Vergaderzaal KNAW

14.00-14.30 *Iron-regulated photosynthesis: theory and observations.* R. Barber
14.30-15.00 *The solubility of Fe (OH), in NaCl and Seawater,* F.Millero and X. Liu
15.00-15.30 tea break
15.30-16.00 *The response of the photosynthetic apparatus of phytoplankton to iron limitation: assessing the effects of iron limitation on primary productivity in the sea.* R.J. Geider, M. Davey and J. La Roche.
16.00-16.30 Title to be announced, Alison Butler
17.00 Reception Royal Netherlands Academy of Ans and Sciences

Monday, November 2, 1998

8.30-9.00 *On the rate of diatom growth: Ecosystem-modeling of Blooms and Carbon dioxide drawdown in the Southern Ocean.* H.J.W. de Baar, C. Lancelot, E. Hannon, S. Becquevort and C. Veth.
9.00- 9.30 *Thermodynamics of iron in seawater:Photochemical transformations of iron in seawater.* T. D. Waite.
9.30-10.00 *Multiple levels of iron limitation in coastal upwelling regimes.* D.A. Hutchins and K.W. Bruland.
10.00-10.30 *Interrelated influence of light and cell size on the uptake and utilization of iron in phytoplankton.* B. Sunda.
10.30-11.00 coffee break

Subject of the following lectures: Open Ocean

11.00-11.20 *Iron in the North Pacific.* E.. Nakayama, H. Obata. K. Gamo. T. Kimoto and H. Karatani.
11.20-11.40 *Manipulating Fe availability in Nearshore Seawaters: A tool for ascertaining how subtle changes in Fe availability affect marine ecosystems.* M.L. Wells and C.G. Trick.
11.40-12.00 *Effect of iron enrichment on Si:N and Si:P consumption ratio of diatoms in the Southern Ocean.* S. Takeda.
12.00-12.20 *Iron limitation of phytoplankton growth affects nutrients drawdown ratios in the Southern Ocean: results from the recent Southern Ocean US JGOFS cruises.* K.H. Coale. S. E. Fitzwater, R.M. Gordon.

12.20-14.00 **lunch**

14.00-14.20 *Iron limitation of phytoplankton growth in natural oceanic waters versus artificial laboratory media with EDTA.* L.J.A. Gerringa, M. Boye, H.J.W. de Baar, e.a.

14.20-14.40 *Role of protozoan grazing in the fate and bioavailabiliry' of refractory Fe.* J.W. Moffen and K. Barbeau.

14.40-15.00 *Effects of iron on Chaetoceros calcitrans (Bacillariophyceae) grown in natural seawater without artificial chelators.* K.R. Timmermans, J.T.M. de Jong,

15.00-15.20 *Iron speciation in the Southern Ocean*, P. Croot.

15.20-16.00 tea break

16.00-18.00 Poster session **Chemistry**

Tuesday, November 3, 1998

8.30-9.00 *The influence of Fe supplv on oceanic biogeochemistry on short and long time scales.* P. Boyd, J. La Roche, J. Merrill. C.S. Wong and P.J. Harrison.

9.00-9.30 *Iron biogeochemistry in the Atlantic Ocean: Results from IOC expeditions.* W.M. Landing and Rodney T. Powell.

9.30-10.00 *Modeling the influence of reductases and siderophores on the availability of organically complexed iron to marine phytoplankton.* C. Vöelker and D. Gladrow.

10.00-10.30 *The role of iron in coastal upweiling regimes off Central Cahfornia*, K.W. Bruland

10.30-11.00 coffee break

Subject of the following lectures: Atmospheric/Solution chemistry

11.00-11.20 *Iron comes from above*, C. Saydam.

11.20-11.40 *Atmospheric inputs of iron to the Oceans.* T. Jickells and L. Spokes.

11.40- 12.00 *The biogeochemistry of iron in the epilimnion of freshwater systems.* B. Sulzberger L. Emmenegger.

12.00-12.20 *Mass culture plant of marine plants under enrichments with steel-making slag, sewage and CO : A preliminary report.* A. Taniguchi.

12.20-14.00 lunch

Subject of the following lectures: Solution chemistry/Speciation

14.00-14.20 *Colloid polymer interactions in Aquatic systems.* J. Buffle.

14.20-14.40 *The subtropical convergence: a natural laboratory.* K. Hunter and P. Boyd.

14.40-15.00 *Oxidation kinetics of iron (II) in Antarctic surface waters.* D. Turner, P. Croot, K. Andersson.

15.00-15.20 *Iron distributions along two Atlantic Meridional transects by flow injection - Chemiluminescence analysis.* A.R. Bowie.

15.20-16.00 teabreak

16.00- 18.00 Poster session Biology

Wednesday, November 4, 1998

Daytrip to NIOZ and IBN on the isle of Texel.

Thursday, November 5, 1998

Subject of the following lectures: Physiological responses

8.30-8.50	*Interactions of Fe,. Mn and Al with a Phaeocystis bloom in an Arctic fjord.* V. Schoemann, J.T.M. de Jong, C. Lancelot and H.J.W. de Baar.
8.50- 9.10	*Physiological alterations that influence iron acquisition in marine cyanobacteria.* S.W. Wilhelm.
9.10-9.30	*Competing for iron: marine cyanobacteria. siderophores and ligands.* C.G. Trick and M.L. Wells.
9.30-9.50	*Flavodoxin as an in situ marker for the detection of iron stress in marine phytoplankton from high nutrient low chlorophyll waters.* J. La Roche
9.50-10.15	coffeebreak

Plenary session key note lectures:

10.15- 10:45	***Geochemical consequences of iron and other co-limiting factors in HNLC regions.*** **A.J. Watson.**
10.45-11.15	***Possible responses of the food chain to Fe additions to the NE Subarctic Pacific: Episodic Fe inputs vs gradual long term increases.*** **P.J. Harrison and P.W. Boyd.**
11.15-11.45	***East Asia and West Pacific: Monsoon history in marginal seas.*** **P. Wang**
11.45-12.15	***The discovery of Antarctica as reflected in maps and charts.*** **W. Ligtendag.**

ANNEX 3 - Agenda

XXIV GENERAL MEETING OF SCOR
Amsterdam, The Netherlands

November 1-5 1998

1.0 OPENING

The meeting will open with a short session on Sunday afternoon, November 1, at which some of the more administrative issues (such as reports from other organizations, requests for SCOR sponsorship of international meetings, etc.) will be dealt with, in order to shorten the week and allow for the visit to the Netherlands Institute of Sea Research at Texel on Wednesday. The meeting will close at the end of the day on Thursday, allowing participants to depart on Friday.

1.1 Opening Remarks and Administrative Arrangements

1.2 Approval of the Agenda - additions or modifications to the Agenda as distributed may be suggested prior to approval of the final version.

1.3 Report of the President of SCOR - the President will briefly review activities since the 33rd Executive Committee meeting (September 1997)

1.4 Appointment of an ad hoc Finance Committee - the Constitution requires that a Finance Committee be appointed at every SCOR meeting. It reviews the administration of SCOR finances during the previous fiscal year and the current year. It will also propose a budget for 1997 activities based on the decisions taken during the meeting. The Committee will report to the General Meeting under agenda item 3.3.

2.0 WORKING GROUPS

2.1 Arising from Former Working Groups

2.1.1 WG 80 Role of Phase Transfer Processes in the Cycling of Trace Metals in Estuaries

Progress with the final report.

2.2 Current Working Groups

Participants are reminded that the SCOR Constitution and the Objectives and Procedures for SCOR Working Groups specify that the tenure of SCOR subsidiary bodies automatically expires at each General Meeting. Their reports must demonstrate adequate justification for their reinstatement for an additional two years. The Executive Committee Reporter for each working group will present the relevant report and will make recommendations to the General Meeting on the actions to be taken.

2.2.1 WG 86 Ecology of Sea Ice

Report from the Chair. The group is reconsidering its decision to publish a book. Its final meeting was the successful Gordon Research Conference which it organized in 1997, but a GRC rule prohibits the publication of conference proceedings. The General Meeting should consider whether it is appropriate to disband WG 86.

2.2.2 WG 89 Sea Level and Erosion of the World's Coastlines

Progress with final publication. Report from the Chair.

2.2.3 *WG 93 Pelagic Biogeography*

The final report of WG 93 was published by IOC in 1998.

2.2.4 *WG 97 Physiological Ecology of Harmful Algal Blooms*

The Report of a NATO Advanced Study Institute held at the Bermuda Biological Station in 1996 was published in May 1998. This was the final activity of WG 97. A final report was submitted to SCOR in 1996. The General Meeting should formally disband WG 97.

2.2.5 *WG 98 Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations*

The final report of WG 98 will be presented. A paper summarizing the findings of WG 98 has been submitted for publication in the *South African Journal of Marine Science*. The General Meeting should consider disbanding WG 98.

2.2.6 *WG 99 Linked Mass and Energy Fluxes at Ridge Crests*

Report on the final meeting, held in January 1998, and on the progress with preparation of a brochure and a publication in the *Reviews of Geophysics*. Is it timely to disband WG 99?

2.2.7 *WG 101 Influence of Sea State on the Atmospheric Drag Coefficient*

A publication contract has been arranged with Cambridge University Press and a draft MS for the WG 101 monograph has been submitted. SCOR funds for the purchase of up to 100 copies at a discount should be carried forward to 1999. The General Meeting should consider disbanding WG 101.

2.2.8 *WG 102 Comparative Salinity and Density of the Atlantic and Pacific Ocean Basins*

Vere Shannon will report on the review and revision of this manuscript and the implementation of its recommendations.

2.2.9 *WG 103 The Role of Wave Breaking on Upper Ocean Dynamics*

In accordance with the request of the last SCOR Executive Committee meeting, the Chair submitted a request for a revision of the terms of reference of WG 103. The Executive Committee also agreed that if the request were approved, then funds should be released for a meeting of WG 103 at the next available opportunity. These two items were approved in correspondence among the Executive Committee members. The annual report provides information on the future plans of the group, including the meeting which will take place in January 1999.

2.2.10 *WG 104 Coral Reefs Responses to Global Change: The Role of Adaptation*

Report on the final meeting of WG 104 and the symposium on "Coral Reefs and Environmental Change: Adaptation, Acclimation or Extinction" held in Boston in January 1998. Plans for publication of Proceedings in *American Zoologist*, and for a review article. The reports of the Chair constitute a final report to SCOR from the WG and include its conclusions; the General Meeting should decide whether to disband the group now.

2.2.11 *WG 105 The Impact of World Fisheries Harvests on the Stability and Diversity of Marine Ecosystems*

Report on second meeting in January 1998 and plans for an international ICES/SCOR symposium on "Ecosystem Effects of Fishing" in Montpellier, March 1999. The results of this symposium will be published in the *ICES Journal of Marine Science*. The report includes responses from the WG to the comments of the Executive Committee reporter following the 1997 SCOR meeting.

2.2.12 *WG 106 Relative Sea Level and Muddy Coasts of the World*

Progress with book publication. An agreement is under negotiation with Elsevier for publication of the book resulting from the deliberations of WG 106 and a schedule for its completion has been defined. A small amount of funding may be required for a purchase of copies by SCOR at a discount price.

2.2.13 *WG 107 Improved Global Bathymetry*

Report of the final meeting in November 1997 and progress with final report. No further financial support is required from SCOR. Approval is requested for some formal membership changes in order to reflect the actual contributions of participants in the WG activities.

2.2.14 *WG 108 Double Diffusion*

A meeting planned for 1998 did not take place, although some members met informally during the

Fedorov memorial symposium in Moscow in May. A formal meeting has now been arranged to take place in Tempe, Arizona in early 1999.

2.2.15 WG 109 Biogeochemistry of Iron in Seawater (with IUPAC)

The WG will hold a symposium in conjunction with the General Meeting, with one joint overview session for participants in the General Meeting. A meeting of the WG will follow to work on draft book chapters. Plans for a book to be published by IUPAC. No further SCOR support is anticipated.

2.2.16 WG 110 Intercomparison and Validation of Ocean-Atmosphere Flux Fields (with WCRP)

A report from the WG Co-Chairs includes a report of the WG's first meeting in October 1997. With the approval of the Executive, Dr. K. Kutsuwada (Japan) was invited to join the WG. Future plans include a meeting of the WG in 1999 for which support is requested from the two sponsors.

2.2.17 WG 111 Coupling Winds, Waves and Currents in Coastal Models

Report on final membership of the WG and appointment of a Co-Chair. Plans for first meeting, Malta, November 1998. Request for approval of a second meeting at a Gordon Research Conference on coastal ocean modelling, summer 1999.

2.2.18 WG 112 Magnitude of Submarine Groundwater Discharge and its Influence on Coastal Oceanographic Processes

This first report from WG 112 includes information on the final membership of the group and a report of its first meeting, Taipei, July 1998. Future plans include a meeting in Birmingham (UK) in conjunction with the IAHS and IUGG meetings – costs will be shared with LOICZ.

2.2.19 WG 113 Evolution of the Asian Monsoon in Marine Records: Comparison between Indian and East Asian Subsystems

Report on final membership. Report of first meeting - Shanghai, April 1998. Future plans call for a series of 3 annual meetings – this should be discussed and approved or modified by the General Meeting. IMAGES shares in the costs of WG 113.

2.3 Proposals for New Working Groups

By the deadline in August, the following proposals for new Working Groups were received by the SCOR Secretariat and circulated to national committees for comments.

2.3.1 Mediterranean Sea Climate Study Project

2.3.2 Standards for CPR (Continuous Plankton Recorder) Survey and Analysis

2.3.3 Transport and Reaction in Permeable Marine Sediments

In addition, the following proposal was received late. The authors have been informed that since there was not time to circulate it to national committees, the General Meeting could only give it preliminary consideration.

2.3.4 Terminal Millennial Synthesis of Decadal-to millennial-scale Climate Records of the Last 80ky.

Finally, a proposal was discussed in 1997 for which there seems to be growing interest in the scientific community. The 1997 SCOR meeting requested revisions to the original proposal, but the UK SCOR Committee did not wish to take the issue forward. The General Meeting may wish to consider whether it wishes to initiate a more detailed proposal on the topic of:

2.3.5 Limits to Predictability

3.0 LARGE-SCALE SCIENTIFIC PROGRAMS

3.1 SCOR Committees

3.1.1 Joint Global Ocean Flux Study Scientific Steering Committee

An extensive report from JGOFS will be presented. The program has formally begun its synthesis phase and is also contributing significantly to the overall IGBP synthesis. The report includes information on recent scientific highlights, the 1998 SSC meeting, the activities and plans of all JGOFS sub-groups, the current status if the International Project Office, JGOFS publications, meeting schedules and SSC

membership. The SCOR Officers will consult with representatives of the IGBP and a report will be given to the General Meeting on the proposed JGOFS SSC membership changes for 1999.

3.1.2 ***SCOR/IGBP/IOC Committee on Global Ocean Ecosystems Dynamics***

The Chair of the GLOBEC SSC will present and supplement the written report which includes information on the GLOBEC Open Science Meeting (March 1998), the SSC meeting held at the same time, the development of the International GLOBEC Implementation Plan, the status of the long-awaited International Project Office for GLOBEC, other GLOBEC activities and membership issues. The SCOR Officers will consult with representatives of the IGBP and a report will be given to the General Meeting on the proposed GLOBEC SSC membership changes for 1999. A panel of five reviewers has been asked to comment on the final draft version of the Implementation Plan and its report and advice will be presented by the Executive Committee Reporter for GLOBEC.

3.2 Scientific Programs under Development

3.2.1 ***Development of a SCOR/IGBP/WCRP Surface Ocean Lower Atmosphere Study***

Status report on SOLAS, the development of links to WCRP and the atmospheric sciences, and plans for an international workshop in 1999. Financial support is requested from SCOR.

3.2.2 ***SCOR/IOC initiative on Global Ecology and Oceanography of Harmful Algal Blooms***

A planning workshop will take place in Copenhagen just before the General Meeting with 37 participants from 21 countries. The goal is to develop goals and objectives and a detailed outline for a Science Plan for a new international program. A preliminary report will be presented. ICSU has committed funds to support the start up of this new initiative in 1999. The General Meeting should approve this new joint initiative with IOC, consider draft terms of reference for a new SSC and consider the process of establishing a new SSC.

3.2.3 ***The Sloan Foundation Global Marine Census*** - this private foundation has been developing plans for a Global Marine Census with workshops in the US and an international workshop in April 1998 in Southampton. Information will be provided on progress to date. A decision as to whether the Sloan Foundation will continue to develop this program will be taken in late 1998. Links to SCOR and GLOBEC are envisaged.

3.2.4 **Graduate Education in Oceanography and Environmental Marine Sciences in Developing Countries as a Means to Understand Global Environmental Problems** - the results of a Team Residency at the Rockefeller Foundation Bellagio Study Center, August 26 - September 1 1998. Future action by SCOR.

3.3 Affiliated Programs

The 1998 General Meeting will be the first occasion at which these international programs will be reviewed by SCOR. The main points to consider are whether the quality of the scientific program remains excellent, and is sufficiently international in scope and membership, to justify SCOR' continuing sponsorship.

3.3.1 ***Acoustic Thermometry of Ocean Climate (ATOC)***

In accordance with information submitted to the 1997 SCOR meeting, the ATOC steering group has been reconstituted.

3.3.2 ***PAGES/SCOR International Marine Global Changes Study (IMAGES)***

The IMAGES report notes the absence of formal links to SCOR at the national level, and seeks assistance from the General Meeting in developing these contacts.

3.3.3 ***InterRidge - International, Interdisciplinary Ridge Studies***

A written report has been submitted for the General Meeting.

3.3.4 ***International Antarctic Zone (iAnZone)***

A written report has been submitted for the General Meeting. SCOR is requested to provide guidance on membership rotation and nominations for new members.

3.3.5 ***International Ocean Colour Coordinating Group (IOCCG)***

The 1997 SCOR Executive Committee meeting agreed that IOCCG should be given Affiliate status when a formal request was received by SCOR. This was received following the IOCCG meeting in January

1998. The IOCCG report outlines scientific accomplishments, major program milestones and the establishment of an IOCCG report series.

4.0 ORGANIZATION AND FINANCE

4.1 Membership

The Membership Officer and the Executive Director will report on changes in SCOR membership since September 1997. Other membership issues.

4.2 Publications Arising from SCOR Activities

The Executive Director will present a report on publications arising from SCOR activities since the 33rd Executive Committee meeting. Any other publications issues.

4.3 Finance

The *ad hoc* Finance Committee and the Executive Director will review the state of SCOR finances for the past and current fiscal years. The *ad hoc* Finance Committee will report to the General Meeting on this review and will present a budget for 1999 activities and recommendations regarding the levels of membership contributions to SCOR for 2000.

4.4 Report of the Nominations Committee

National Committees and all voting members of SCOR were informed of the slate proposed by the Nominations Committee by letter on August 1 1998. If no election is requested by October 16, in accordance with the proposed procedures distributed to all National Committees, this slate of officers will be elected by acclamation.

4.5 Election Procedures

The approval of the General Meeting will be sought for proposed election procedures which were sent to all National Committees in April 1998.

4.6 Other Organizational Issues

5.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS

Matters of interest to SCOR in the reports received from the following organizations will be brought to the attention of the General Meeting. If a representative of the organization is present, a verbal presentation will be welcomed.

5.1 Intergovernmental Oceanographie Commission

SCOR's role in the IOC Assessment of Ocean Science for Sustainable Development. Other IOC issues.

5.2 World Meteorological Organization

5.3 International Council for the Exploration of the Sea

A request from ICES seeks SCOR sponsorship and support for a special symposium entitled "100 Years of Science under ICES" to be held in Finland in August 2000.

5.4 North Pacific Marine Science Organization (PICES)

SCOR sponsorship an support is requested for a PICES conference, "El Nino and Beyond" to be held in February 2000.

5.5 Other Intergovernmental Organizations

6.0 RELATIONS WITH NON-GOVERNMENTAL ORGANIZATIONS

Matters of interest to SCOR in the reports received from the following organizations will be brought to the attention of the General Meeting. If a representative of the organization is present, a verbal presentation will be welcomed.

6.1 International Council of Scientific Unions

ICSU and UNESCO are convening a "World Conference on Science" in Budapest in 1999. The General Meeting is invited to consider the role of SCOR in providing input to ICSU from the ocean science community. A report from the ICSU representative on the GOOS Scientific Committee (selected in consultation with SCOR) on the first meeting of the re-structured GOOS Committee.

6.2 ICSU Unions, Committees and Programs

6.2.1 International Geosphere-Biosphere Program (IGBP)

6.2.2 World Climate Research Program

6.2.3 Scientific Committee on Problems of the Environment (SCOPE)

SCOR and SCOPE are collaborating in the provision of scientific expertise for the IOC's Assessment of the State of Ocean Science in Relation to Sustainable Development.

6.2.4 Scientific Committee on Antarctic Research (SCAR)

The Chairman of SCAR's Group of Specialists on Global Change (GLOCHANT) will present information on its activities, many of which have close ties to SCOR. It has been formally agreed that SCAR should be a co-sponsor of the Southern Ocean components of the JGOFS and GLOBEC programs.

6.2.5 Committee on Space Research (COSPAR)

6.2.6 International Union of Pure and Applied Chemistry (IUPAC)

SCOR and IUPAC are co-sponsors of WG 109 on Iron Chemistry. Advice has also been sought on an IUPAC project on the solubility of oceanic salts.

6.2.7 Union Radio Scientifique Internationale (URSI)

6.2.8 Others

6.3 Affiliated Organizations

The Presidents of the Affiliated Organizations are *ex-officio* members of the SCOR Executive Committee. They will present brief verbal reports of the activities of:

6.3.1 International Association for Biological Oceanography

6.3.2 International Association for Meteorology and Atmospheric Sciences

6.3.3 International Association for the Physical Sciences of the Ocean

6.4 Corresponding Organizations

6.4.1 Arctic Ocean Sciences Board

6.4.2 Engineering Committee on Oceanic Resources

6.4.3 Confederation Mondiale des Activités Subaquatiques (Scientific Committee)

6.5 Other Organizations

The Oceanography Society

7.0 FUTURE MEETINGS

7.1 Future meetings of SCOR

The *Thirty-fourth Executive Committee Meeting* of SCOR: will take place in Goa, India from October 25-29 1999.

The SCOR General Meeting should take place in 2000, between September and early November. An invitation has been received from the Russian Academy of Sciences to hold this meeting in Moscow.

A possible venue for the Executive Committee meeting in 2001 would be the joint IABO/IAPSO scientific meeting to be held in Argentina in October of that year. More information will be available at the General Meeting.

7.2 Other meetings of interest to SCOR

The Executive Director will present a list of international meetings of interest to SCOR during the next two years. In some cases the meeting will be asked to decide on requests for SCOR co-sponsorship and/or support of these

events.

In 1998 SCOR co-sponsored the International Congress on the History of Oceanography, but no request was received for SCOR support for participants from developing countries. The organizers have now asked for a contribution to support the publication costs.

8.0 OTHER BUSINESS

8.1 Should SCOR provide international input to the current discussion of the future of the Ocean Drilling Program? Would it be appropriate to assist some scientists from developing countries to attend the international conference in 1999?

CLOSURE OF MEETING

ANNEX 4 - Final Report - Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations SCOR Working Group 98

1. INTRODUCTION

In 1993, the Scientific Committee on Oceanic Research (SCOR) established Working Group 98 (WG 98) to investigate "Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations". The first meeting of WG 98 was at Centro de Investigaciones Biológicas del Noroeste, La Paz, Baja California Sur, Mexico, from 13-17 June 1994. WG 98 held its second and final meeting at Scripps Institution of Oceanography, La Jolla, USA, from 20-22 October 1997.

Prior to the establishment of WG 98, three workshops were held in La Paz, in 1988, 1990 and 1992 to consider regimes of high and low abundance of sardine *Sardinops sagax* and anchovy *Engraulis* spp., in regions where these species co-occur. Reports of the 1988 and 1990 workshops were published (Lluch-Belda *et al.* 1989, 1992). A paper summarizing the findings of WG 98 has been submitted to *South African Journal of Marine Science* for publication.

2. PARTICIPANTS

The following participated in one or both meetings of SCOR WG 98.

Participant	Country	1st meeting	2nd meeting
Alheit, J.	Germany	X	X
Bakun, A.	FAO	X	
Baumgartner, T.	Mexico	X	X
Carrasco, S.	Peru		X
Cloete, R.	Namibia		X
Cota-Villavicencio, A.	Mexico	X	
Crawford, R. J. M.	South Africa	X	X
Fletcher, W. J.	Australia	X	X
García-Franco, W.	Mexico	X	
González-Armas, R.	Mexico	X	
Hagen, E.	Germany	X	X
Kawasaki, T.	Japan	X	X
Lluch-Belda, D.	Mexico	X	X
Lluch-Cota, D.	Mexico	X	
Lluch-Cota, S.	Mexico	X	X
MacCall, A. D.	USA	X	X
Matsuura, Y.	Brazil	X	X
Nevárez-Martínez, M. O.	Mexico	X	
Parrish, R. H.	USA	X	X
Rodríguez-Sánchez, R.	Mexico	X	
Rothschild, B.	USA	X	
Roy, C.	France	X	X
Schwartzlose, R. A.	USA	X	X
Serra, R.	Chile	X	X
Shust, K. V.	Russia	X	
Vaske, B.	Namibia/Germany		X
Ward, N. M.	UK		X
Wooster, W.	USA	X	
Zuzunaga, J. Z	Peru	X	X

3. MAIN FINDINGS

Sardine *Sardinops sagax* and anchovy *Engraulis* spp. are found together in five of the world's large marine ecosystems - Northwestern Pacific (Japan, Korea and USSR), Northeastern Pacific (British Columbia, Washington, Oregon, California, Baja California and the Gulf of California), southern Australasia, Southeastern Pacific (Ecuador, Peru and Chile) and Southeastern Atlantic (Namibia and South Africa). They contribute a large proportion of the world's fish catch, but in no region have catches of the two species been at their highest simultaneously. Neither is there other recent evidence that sardine and anchovy have been simultaneously abundant for extended periods. Rather the two genera have tended to alternate with each other, being plentiful in turn for several years, even decades.

Off Australia, anchovy is mainly restricted to estuaries, whereas sardine is an open-ocean species, and the two are not thought to interact to any great extent. *Engraulis* occurs in some systems from which *Sardinops* is absent, for example in the Brazilian Bight, where it and *Sardinella* are segregated vertically in the water column.

In the Pacific Ocean, sardine shows great changes in its geographical distribution. Compared with its range when scarce, a population at a high level of biomass can extend 1000 to 1800 nautical miles farther along the coast and 400 to 1800 nautical miles farther out to sea. In different periods of high biomass, sardine does not necessarily have the same distribution. Such variable distribution makes population estimates based on sampling over a small area difficult to interpret. Further useful information on the co-occurrence of sardine and anchovy may be provided by expanding the sampling distribution, especially for historical records of scales in sediments.

In the 1930s and 1940s, near simultaneous fluctuations of sardine in the Northwestern and Northeastern Pacific were in phase. In the 1980s and 1990s, sardine in the Northwestern and Southeastern Pacific were fluctuating in phase. However, along the west coast of North America sardine started its most recent increase later than in other regions of the Pacific Ocean. This increase is continuing and by 1992 the range of sardine had expanded to include British Columbia. By contrast sardine populations in the Northwestern and Southeastern Pacific have decreased both in catch and geographic distribution since the late 1980s. Thus the Northeastern Pacific has moved out of phase with other major Pacific sardine populations. Catches in the Gulf of California decreased after 1989, similarly to Peru, but after 1992 increased, following the trend in the Northeastern Pacific. Sardine and anchovy in the Southeastern Atlantic have been out of phase with populations in the Pacific Ocean, especially those off Peru and Chile, probably since at least the late 1920s.

Information reviewed for other fisheries indicates that regimes of high and low abundance of resources are not limited to sardine and anchovy, but are characteristic of a number of ecosystems, and may occur at the same time as regimes of sardine and anchovy. For example, over the last three hundred years, episodic fisheries for Bohuslän herring *Clupea harengus* in Sweden, coincide with low abundance of sardines and high abundance of anchovies off California. This supports the view that pelagic fish populations may sometimes be influenced by climate operating at a global scale.

Further insight into the role of global climate can probably be obtained by fuller investigation of past data sets to more accurately determine the time of change, e.g. the start of resurgence of a population. This information is likely to be available for the four major *Sardinops-Engraulis* systems, and is a priority area for research aimed at understanding regimes of sardine and anchovy.

There is good information from Japan to show that, when sardine was abundant in the late 1980s, density-dependent factors came into play that resulted in low-quality eggs and weak year classes from 1988 to 1991. The possibility exists that sardine off the west coast of North America has moved out of phase with sardine off Japan and Peru/Chile because its abundance has not yet reached a level at which density-dependent effects exert a major influence. Sardine off California was exploited to an extremely low level of abundance, and it is still in the recovery phase.

In several instances, it seems clear that a species at a low level of abundance begins to increase when the then dominant species still had a high biomass. This happened off Japan and in the Northeastern Pacific in the last half of the 1930s

and off Japan during the last half of the 1980s. In the Gulf of California anchovy appeared in the catch before the sardine catch peaked. There was good recruitment of anchovy off Peru/Chile from 1983 to 1989, when sardine was still abundant, but falling. Similarly, off South Africa, anchovy started to increase in the early 1960s, when sardine was abundant. Later, sardine off South Africa collapsed, but after a strong 1983 year-class was formed, it commenced a sustained recovery although biomass of anchovy was high until 1988.

Anchovy off South Africa has recently decreased with wide fluctuations. Large fluctuations were also evident during the great decreases in the 1970s of sardine off Namibia and anchovy off Peru. Such fluctuations may mask a longer-term downward trend and lead to a wrong conclusion that a resource is recovering.

Off Peru/Chile, there was good recruitment of both anchovy and sardine in the 1980s. Off South Africa, acoustic estimates of recruitment strength of sardine and anchovy, available since the mid 1980s, also are positively correlated. In the Humboldt system, anchovy increased in the 1980s and sardine decreased; off South Africa there was the opposite tendency. This precludes conclusion that either sardine or anchovy will necessarily dominate when conditions for recruitment are favorable to both. In both these instances, it was the subdominant species that in the long-term benefited most from the good year-classes.

Sardine and anchovy share their habitat with other pelagic fish species. Off California there has been a succession of species: *Sardinops*, *Trachurus*, *Sarda*, *Engraulis*, *Scomber*, *Sardinops*. Similar successions have been evident off Japan (*Sardinops*, followed by a mix of *Trachurus* and *Cololabis*, then by *Scomber*, *Engraulis* and *Sardinops*) and off South Africa (*Trachurus*, *Sardinops*, *Scomber*, *Engraulis*, *Sardinops*). The ordering of the succession may be influenced by the physical environment and by biological interactions. For example, off California peaks in abundance of more predatory species (*Sarda*, *Scomber*) separate those of the planktivorous sardine and anchovy. Fishing policy also may influence the succession of small pelagic fish species; e.g. off Namibia it may have resulted in horse mackerel and pelagic goby rather than anchovy, which was heavily exploited, becoming the dominant forage fish after the collapse of the sardine.

The early growth of an expanding population seems crucial to its later assuming a dominant role in the ecosystem. There are instances when heavy exploitation of an increasing population probably impaired further growth, as with anchovy off Namibia in the 1970s and herring off Japan in the mid 1980s.

The succession of species influences the abundance of other animals in the ecosystems, especially those with limited ranges and depths of foraging such as seabirds.

A large mortality of sardine around Australia during autumn 1995 was probably caused by Herpes virus, indicating that biological factors as well as fishing have potential to reduce populations. In this instance only adults were affected and there was no long-term effect.

4. ACKNOWLEDGEMENTS

The SCOR secretariat, notably E. Gross and W. A. Ross, provided invaluable assistance in arranging the two meetings of WG 98. E. Gross reviewed the report sent to her from WG 98 and suggested avenues for its publication. B. J. Rothschild and W. Wooster attended the first meeting of WG 98, where they informed members on the functioning of SCOR and its working groups. D. Lluch-Belda arranged and hosted the first meeting of WG 98; R. A. Schwartzlose did this for the second meeting. Centro de Investigaciones Biológicas del Noroeste and Scripps Institution of Oceanography kindly provided venues for the meetings at no cost. R. A. Schwartzlose collated and edited the final report of WG 98.

5. PUBLICATIONS

Publications, to date, specifically noted to be a product of SCOR WG 98 are:

Crawford, R. J. M. in press. Seabird responses to long-term changes of prey resources off southern Africa. In: Adams, L. & Slotow, R (Eds), Proceedings of 22nd International Ornithological Congress. Durban; University of Natal.

Crawford, R. J. M. in press. Responses of African Penguins to regime changes of sardine and anchovy in the Benguela system. In *Benguela Dynamics. Impacts of Variability on Shelf-Sea Environments and their Living Resources.* Pillar, S. C., Moloney, C. L., Payne, A. I. L. and F. A. Shillington (Eds). *S. Afr. J. mar. Sci.* 19.

Maccall, A. D. 1996. Patterns of low-frequency variability in fish populations of the California Current. CalCOFI Rep. 37: 100-110.

ANNEX 5 - Final Report - Coral Reefs and Global Change: Adaptation, Acclimation or Extinction?
SCOR Working Group 104
INITIAL REPORT OF A SYMPOSIUM AND WORKSHOP
EXECUTIVE SUMMARY

Major revisions of concepts about corals and reef systems were developed by an international working group of scientific experts that met in conjunction with the Society for Integrative and Comparative Biology, the International Society for Reef Studies, and the Ecological Society of America (Boston, January 3-11, 1998) to evaluate the scientific basis for growing concerns about the survival of coral reef ecosystems facing global change and local stresses. The group, sponsored by the Scientific Committee on Oceanic Research (SCOR) and the Land-Ocean Interactions in the Coastal Zone (LOICZ) core project of the International Geosphere-Biosphere Programme (IGBP), and with the support of the NOAA Coastal Ocean Program, produced an interdisciplinary synthesis with important implications for research, assessment, and management. Key conclusions were:

The calcification rates of corals, coralline algae, and coral-algal communities depend on the calcium carbonate saturation state of surface seawater, and are expected to be reduced by rising atmospheric carbon dioxide. This represents a global, systemic, climate-related threat to the functioning of reef ecosystems that will interact with the more immediate anthropogenic local stresses.

Coral reefs and communities are products of processes operating over a wide range of interacting time and space scales, with fundamentally different controls operating at different scales. While short-term responses will be controlled by local environmental conditions and biotic responses, the longer-term sustainability of a reef system depends on the recruitment, dispersal, persistence, and interactions of populations at larger scales.

Corals, and to some extent reef communities, possess numerous mechanisms for acclimatization and adaptation -- diverse reproductive strategies, flexible symbiotic relationships, physiological acclimatization, habitat tolerance, and a range of community interactions. However, current understanding of these mechanisms, as well as of the critically important calcification mechanisms, is inadequate to explain the past success of corals and reefs or to ensure their conservation for the future.

Unlike many terrestrial ecosystems, coral reef ecosystems appear to be directly threatened by globally increasing atmospheric CO_2. Therefore, conservation or management strategies aimed at removing or mitigating only local, human-derived, or recently applied environmental stresses are likely to be inadequate. Corals and reefs are potentially robust and resilient, but realizing that potential requires the development of new approaches and greater integration of fundamental and applied research, conservation, and management.

SYMPOSIUM AND WORKSHOP OVERVIEW

INTRODUCTION

CORAL REEFS AND GLOBAL CHANGE: ADAPTATION, ACCLIMATION OR EXTINCTION? was the theme of a symposium and integrating workshop held in Boston, January 3-11, 1998, in conjunction with joint meetings of the Society for Integrative and Comparative Biology (SICB), the International Society for Reef Studies (ISRS), and the Ecological Society of America (ESA). The focus of the symposium and the subsequent workshop was on reports of Working Group 104 of the Scientific Committee on Oceanic Research (SCOR), co-sponsored by the Land-Ocean Interactions in the Coastal Zone (LOICZ) core project of the International Geosphere-Biosphere Programme (IGBP) and with the support of the NOAA Coastal Ocean Program. The reports of Working Group 104 members and invited contributors formed the basis for discussions.

This working group has been studying the topic "Coral reef responses to global change: the role of adaptation" for nearly four years, and the symposium provided opportunities to augment its findings with contributed and invited papers from other experts, to benefit from public review and discussion, and to integrate the output in a workshop. Proceedings will be published in a forthcoming issue of American Zoologist.

Both the symposium and the working group focused interactions within a highly interdisciplinary group -- biogeochemists, geologists, paleobiologists, climatologists, aquarists, geneticists, and organismal, ecological, and evolutionary biologists -- on the diverse lines of evidence concerning corals, reefs, and their responses to environmental change. The variety of expertise, the specific nature but global scale of the topic, and the opportunity to develop conclusions over time all contributed to the emergence of fundamentally new views of the nature and functioning of 'coral reef systems' that will have major implications for future research and management.

The conclusions below are based on major points of the Symposium and contributed papers, augmented by subsequent discussions and then integrated and interpreted during a post-meeting workshop. Although interdependent, they are presented under topical categories for convenience.

CLIMATE AND GLOBAL FORCING

One unique feature of the Symposium was a review of the general status of global climate change knowledge from a coral reef perspective, including results of a major regional climate-change modeling effort directed toward tropical marine environments. The focus of symposium and working group was on the biotic effects of climate, but review and analysis indicate the importance of carbon-cycle feedback. Coral reefs depend on calcification for production of the reef structure, but marine calcification is a net source of atmospheric CO_2, not a sink. The effects of coral reef and other calcifying communities on the global carbon cycle may be significant in the long term, but are very minor compared to present anthropogenic CO_2 emissions. However, direct effects of changes in atmospheric CO_2 on coral reef communities may be as great as or greater than the effects of climate change. The key coral and reef-related global climate and geochemistry points were:

Despite the Kyoto protocol, atmospheric CO_2 will continue to increase beyond 2100; it is projected to reach two times the preindustrial level of about 270 ppm by the year 2070, and approximately 700 ppm by 2100. These atmospheric changes will cause significant changes in the carbon chemistry of surface ocean water, especially decreases in pH and carbonate ion concentration, which will reduce the calcium carbonate saturation state.

Translation of the expected global warming (about 2 degrees C by 2100) into regional sea-surface temperature (SST) is difficult because of uncertainty about the physical controls on tropical SST, but probable outcomes include: (1) poleward movement of the isotherms currently associated with coral reef distributions; (2) some rise in mean SST within the present tropical-subtropical latitude ranges; and (3) some degradation of coral communities by local-to-regional episodes of higher temperature within the present warm-water zones.

Projected rates of sea-level rise (15-95 centimeters by 2100) are well within geologic ranges and measurements of accretion rates for unstressed reefs. However, interactions among decreased calcification rates and other stresses (discussed below) may diminish the ability of reefs to keep up with rising sea level.

Widespread increases in riverine flood frequency and magnitude will produce a greater incidence of high turbidity, nutrient loading, and other pollution episodes in coastal reef environments.

There will be possibly significant changes in ENSO and tropical cyclone climatology. Tropical cyclones may increase 10-20% in intensity by 2070, with a possible poleward extension of storm tracks. Effects on reefs of these

changes in climatic stress, especially extreme events, will vary regionally.

REEF PERSISTENCE -- PAST, PRESENT, AND FUTURE

Four earlier glacial periods over more than a billion years of earth history ended with mass extinctions of reef organisms, prolonged periods without reefs, and the eventual evolution of very different reef assemblages. These events may provide very general models for the potential effects of climate change on modern coral reefs. However, such comparisons must be tempered by the long time scales of these past events, and by understanding of the characteristics of the scleractinian corals that are the modern reef-builders. Within the Quaternary history of the earth, contemporary levels of anthropogenic stress are unique, and CO_2 concentration, temperature, and sea level are all at or near past maxima -- and projected to rise still further. The question of whether cumulative effects of human impacts have the potential to accelerate major changes in such processes, on global evolutionary as well as on local ecological scales, was addressed by considering aspects of coral reef history and science relevant to reef persistence.

While the distinctions among corals, coral communities, living coral reefs, and coral reef systems (or ecosystems) are both real and important, these categories are often confused. Their fates are intimately interconnected, but they are not the same, and an uncritical focus on 'coral reefs' may ignore vital aspects of the various interacting components that form coral reef ecosystems.

--Many reefal species also exist beyond the range of reefs and/or within non-reefal communities, where they may play important roles in preserving the resilience of reefal systems

-- Both evidence and inference suggest that coral reefs (as accreting coral communities living on calcium carbonate accumulations 'of their own construction') are not only difficult to define, but are also more vulnerable and more episodic in both space and time than are their component species and assemblages.

There is empirical evidence, at all scales and from a wide range of sources (geological and biological; field, laboratory and aquarium; theoretical and experimental), that corals as a group of organisms possess a wide range of adaptive and acclimative mechanisms, and that most of these mechanisms appear relatively robust and/or resilient in the face of stress. Coral community structure is dynamic on scales of years to centuries, and this dynamism may provide long-term resilience (or 'community adaptation') in response to stresses, including global environmental change. However, the unprecedented variety and magnitudes of chronic anthropogenic alterations of modern reef environments may undermine this resilience.

COMMUNITY AND POPULATION DYNAMICS

Consideration of global and large-scale regional distributions of reef organisms, populations, coral reef systems, and environmental variables yielded the following conclusions, some of which represent substantially new or different perspectives on corals and reefs. Some key points are described in terms of 'metapopulations,' which may be thought of as sets of spatially separated sub-populations linked by dispersal, or more simply as "populations of populations."

Distributions of reefs (certainly) and coral communities (probably) are correlated not only with sea-surface temperature, but also with available light and with calcium carbonate saturation state. Independent studies indicate that these additional variables may be important controls over coral and reef function and distribution. This is a significant change to the traditional view that temperature is the primary control on reef biogeography.

Limits of distribution and abundance of reefal species are not necessarily determined by the same processes that determine limits for reefs and reefal communities. Modern distribution patterns, as well as the ability of reefal species to adjust distributions in the face of climate change, can be modelled using metapopulation models in which patterns of abundance and distribution are functions of local population dynamics. These dynamics in turn determine persistence and dispersal, which controls the origination of populations. Both local population

dynamics and patterns of dispersal are sensitive to past and future climate change.

Ecological, genetic, and species diversities reflect history, including consequences of changes in patterns of dispersal within metapopulations..

-- Patterns determined during periods of intense disruption (e.g., low sea-level stands) may persist over temporal scales much longer than needed for their establishment, and may persist beyond subsequent disruptions.

-- Regional patterns also reflect persistent barriers to effective gene flow and dispersal over larger temporal and spatial scales; these barriers may constrain the development of reefs.

-- Regions with extreme isolation of reef communities, restricted gene flow, limited dispersal, and few refugia will be most vulnerable to major changes and least likely to respond resiliently, especially in geographically or ecologically marginal areas.

RESPONSES AND REACTIONS

Because coral reef 'systems' interact with each other and with global climate across a wide range of time and space scales, there are some fundamental limits on predictability. However general predictions can be made about the effects of global or large scale processes at scales of years to centuries.

Calcification of reef corals, coralline algae, and coral-algal communities is sensitive to the calcium carbonate saturation state of the water. While this is consistent with studies of foraminifera, geochemical expectations, and geological/paleontological evidence, it has not previously been recognized as a major factor in coral/reef biology.

-- There was consensus that the greatest global climate-related threat to corals and reef systems is the very real possibility that increased CO_2 will cause reduced rates of calcification.

-- Some, but not all, participants felt that a rough estimate of the magnitude of this effect was possible; and that an overall 10-20% decrease in reef-related calcification may follow from the projected doubling of preindustrial CO_2 levels within the coming century.

Mechanistic understanding of acclimitization and adaptation by corals is extremely limited.

-- Understanding of acclimative mechanisms is largely confined to photosynthetic responses to environmental irradiance.

-- In contrast, little is known about the cellular and biochemical pathways of acclimatization/adaptation to temperature change and other environmental variations, although recent studies of the symbiotic associations that sustain corals reveal that complexity and flexibility in host-symbiont partnerships may provide important and rapid mechanisms of acclimatization/adaptation to environmental change.

-- More importantly, because the mechanisms of coral calcification and their interactions with the photosynthesis of the symbiotic algae are largely unknown, corals' abilities to acclimatize or adapt to changes in seawater chemistry resulting from global increases in atmospheric CO_2 cannot be predicted.

-- Lack of knowledge about the ranges of reproductive behavior and their environmental relationships limits understanding not only of dispersal and recruitment, but also of whether hybridization and somatic mutation are critical adaptive mechanisms.

Sensitivity to saturation state, in conjunction with other influences operating over various scales, means that global climate-related change will apply significant stresses to coral reef systems.

-- This finding DOES NOT alter the assessment that the primary threat to reefs and coral communities is local and regional anthropogenic stresses, often of a chronic nature.

-- This finding DOES substantially alter the previously common view that the effects of global climate change are negligible, or indeed potentially positive, compared to local threats. Instead, global-scale changes are expected to significantly and progressively increase the vulnerability of many reefs to both acute and

chronic local stresses.

Resilience and/or robustness of modern assemblages may be "lost" as environmental changes exceed the adaptive and acclimative capacities established under previous rates and ranges of disturbance.

-- Globally, the issue of greatest concern is atmospheric CO_2, which is projected to exceed the estimated maxima for the Quaternary period during the coming century. This will both cause and interact with temperatures that also approach the maxima experienced by reef organisms over the past several million years.

-- Local and regional anthropogenic stresses are unprecedented in distribution, magnitude, rate of change, and, in some cases, nature. These will interact synergistically not only with each other, but also with global climate-related factors.

IMPLICATIONS

These findings and observations, resulting from focused interdisciplinary review and interpretation of many lines of evidence addressing corals and reefs, provide perspectives different from those obtained from discipline-based or local studies. The picture of coral reef ecosystem responses to the effects of global increases in CO_2 is fundamentally different from that of terrestrial ecosystems, for which it is widely accepted that increased primary productivity is advantageous. In contrast, the dominant global trend for coral reefs, a reduction in calcification, is fundamentally unfavorable for coral reef systems.

Widespread observations of intrinsic resilience and robustness in corals and reefs suggest that they need not necessarily disappear as a result of accumulating stresses. However, the recognition that global factors are likely to increase reef vulnerability to currently dominant anthropogenic stresses adds urgency, as well as new perspectives, to the need to develop new management, protection, and conservation measures on relevant spatial and temporal scales. Long-standing lack of knowledge about the mechanisms of calcification, the nature of symbioses, the physiology of acclimatization, reproductive biology (ranging from taxonomic and geographic inventories of behavior and success to mechanisms of adaptation), the nature and extent of biodiversity, and the long-term ecological structures and dynamics of coral reef communities hinder our ability to make decisions and useful predictions that address the issues raised by our rapidly developing understanding of large-scale processes. These uncertainties point toward research needs that will concurrently address both fundamental and applied problems.

Individual corals, communities, and living reefs are controlled by fundamental interactions among many environmental variables and biotic responses at local scales; this limits detailed or quantitative predictions in most situations. In addition, living reef communities are products of complex and dynamic interactions at all scales -- from dynamic, multicomponent symbiotic variations on scales of days or weeks, to gene flow involving metapopulations at millennial time scales. These are significant external factors determining the responses of individual reefs and communities to local conditions, and their probabilities of future change.

CONCLUSIONS

The Working Group's findings indicate the need for significant revision of our research, assessment, and management approaches to coral reef problems. Key issues include:

Calcium carbonate saturation state is potentially the most important control on calcification by reef organisms and communities. Increasing atmospheric CO_2 levels therefore represent a global and increasing threat to coral reef systems. This significantly changes our assessment of the importance of global climate change issues in contributing to reef system stresses.

Coral reef systems are the results of interacting processes and constraints operating at a variety of time and space scales, whereas the study, management, and protection of reef ecosystems are intrinsically local and regional

enterprises operating on human time scales. Effective local action must be informed by global understanding of controlling responses and interactions at a variety of scales -- simply reducing or mitigating local stresses may not be adequate to insure reef sustainability in the presence of large-scale constraints or systemic deterioration, and in the absence of mechanistic understanding.

Corals, and to some extent reef communities, possess diverse and impressive arrays of acclimative and adaptive mechanisms -- reproductive strategies, flexible symbiotic relationships, physiological acclimatization, habitat tolerance, and a range of community interactions. However, inadequate understanding of these phenomena, and of the critically important calcification mechanisms, severely limits our ability to predict and manage the future of reef systems.

Local anthropogenic threats remain the most immediate threat to coral reef systems, but responses to local stresses are now seen as being substantially conditioned by global environmental changes and by biological patterns and distributions established over much larger time and space scales. Consideration of the biological effects of reduced calcification and other stresses indicates that other environmental changes affecting tissue growth and metabolism, calcification, or demography (reproduction, recruitment, survival) of corals are all likely to reduce further the capacity of reef communities to maintain themselves, and increase the probabilities that thresholds to major disruptions -- such as ecosystem collapse or organism extinctions -- will be exceeded.

Symposium Participants:

BUDDEMEIER, R.W., Kansas Geological Survey, University of Kansas, Lawrence.
(WG-104 chair; Symposium co-organizer)

LASKER, H. R., SUNY, University at Buffalo. (Symposium co-organizer)

PITTOCK, A. B., CSIRO Division of Atmospheric Research, Aspendale, Australia

OPDYKE, B. N., Australian National University, Canberra

PANDOLFI, J. M., National Museum of Natural History, Washington

KINZIE, R. A. III, University of Hawaii, Honolulu.

GATES, R. D., University of California, Los Angeles.

YAMAZATO, K., Meio University, Okinawa, Japan (paper read; not present)

CARLSON, B. A., Waikiki Aquarium, Honolulu

BENZIE, J. A. H., Australian Institute of Marine Science, Townsville

POTTS, D. C., University of California, Santa Cruz

ROWAN, R., Marine Laboratory, University of Guam, Mangilao

BAK, R. P. M., Netherlands Institute of Sea Research, Texel.

DONE, T. J., Australian Institute of Marine Science, Townsville

KARLSON, R. H., University of Delaware, Newark.

KLEYPAS, J., National Center for Atmospheric Research, Boulder

GATTUSO, J.-P., CNRS Observatoire Océanologique, Villefranche-sur-mer, France

HATCHER, B. G., Dalhousie University, Halifax, Canada.

SMITH, S. V., University of Hawaii, Honolulu

ANNEX 6 - Intercomparison and Validation of Ocean-Atmosphere Energy Flux Fields (Joint JSC/SCOR Working Group on Air Sea Fluxes)

Current Status Report of SCOR Working Group 110:

(Prepared by co-chairs Serge Gulev and Peter K.Taylor for the 24th Meeting of SCOR, Amsterdam, 1st to 5th November)

1. Formation and Terms of Reference

The formation of Working Group 110 followed recommendations from the WCRP Workshop on Air-Sea Flux Fields for Forcing Ocean Models and Validating GCM's in October 1995 (WCRP, 1996) and a proposal to the 23rd General Meeting of SCOR. The terms of reference (TOR's) are:

TOR.1 - to review the requirements of different scientific disciplines for surface flux data sets;

TOR.2 - to compile a catalogue of available surface flux data and flux-related data sets, including those becoming available from the various reanalysis projects, and to review, in consultation with users and producers, the strengths and weaknesses of these data sets;

TOR.3 - to inform the scientific community of the work of the group by the use of the World Wide Web, by the publication of the final catalogue, and by convening, at a suitable time, a scientific workshop;

TOR.4 - to keep the JSC and SCOR informed of progress in the area and present recommendations for action as necessary.

2. Relevance to societal needs

The extent to which the earth's climate may be changing, either due to the actions of mankind or natural variability, is at present a major cause of societal concern. Numerical models of the earth's climate system are being used to quantify the possible effects of climate change. A vital test of such models is to verify that the present day climate is correctly simulated. An important aspect of that simulation is the transfer of energy between the ocean and atmosphere, the air-sea fluxes. Unfortunately observational data on these fluxes is limited and the various attempts to produce climatologies of the flux fields and to describe their climatic variability differ in significant aspects. The main task of Working Group 110 is to evaluate the various flux field climatologies and to develop parameterizations of sea-air energy fluxes for the benefit of climate research and other flux field users.

3. "Newsletter" summary of Working Group activities

The air-sea fluxes of heat, water vapour, and momentum represent one of the key-processes in the earth's climate system, which establish links and feedbacks between its main components, the ocean and the atmosphere. The main aims of SCOR Working Group 110: Intercomparison and Validation of Ocean-Atmosphere Energy Flux Fields (the Joint JSC/SCOR Working Group On Air Sea Fluxes) are to review the requirements of different scientific disciplines for surface flux data sets, to catalogue available surface flux data and flux-related data sets, and to review, in consultation with users and producers, the strengths and weaknesses of each. The WGs findings will be of use for those developing numerical climate models for research and forecasting purposes.

The WG first met in October 1997 in Silver Spring, Maryland. A preliminary discussion of the user requirements for surface flux fields led to a definition of the basic desirable characteristics for a flux product to be considered. Recommendations were made with respect to the availability of reanalysis products, the value of in-situ data, and the need for fully developed satellite flux field data sets. It was decided that, for a product to be listed in the flux

field catalogue it should be readily available to all scientists either routinely or on request, be a gridded (derived) surface flux or flux related field, cover major ocean basins, and be adequately documented. The WG considered the information to be included about each flux field product and discussed methods of determining the relative quality of the different products. The WG accepted an offer from Peter Glecker of Lawrence Livermore Laboratory to host the Working Group Web Site (http://www-pcmdi.llnl.gov/airseawg/).

Concerning more recent activities, Peter Taylor represented the WG at the nineteenth session of the Joint Scientific Committee of the WCRP, Cape Town, March, 1998. The JSC were happy with the WG's actions and agreed continued support. Serge Gulev organised a Session at the European Geophysical Assembly in Nice (April, 1998) on Intercomparison and Validation of the flux fields and a short discussion was held among the four WG members present. Serge Gulev also represented the WG on the WOCE/CLIVAR Modelling workshop in Boulder (August 1998) which was devoted in particular to the coming OMIP (Ocean Model Intercomparison Project). The specific requirements for forcing fields for such ocean modelling is directly relevant to the WG. Informal meetings of various WG members were also held at the WOCE Conference, Halifax, Nova Scotia (May, 1998) and the TOGA COARE meeting in Boulder, Colorado (July, 1998).

Based on a preliminary contents list agreed at the first WG meeting, production of an initial draft of the Working Group's final report has now begun. It is presently based on the individual contributions of the WG members at that meeting but significant revision and replacement of the text will occur before the report is finalised.

The next meeting of the WG is planned for a European venue during spring, 1999.

4. Recent progress initiated by WG members relevant to the WG's TOR's.

Joerg Schulz (with Volker Jost of MPI, Hamburg) has begun evaluation of their 10 year climatology (1987-1997) of flux fields based on data from the microwave radiometer (SSM/I) on the DSMP series of meteorological satellites for the period 1987-1997. This data set contains practically all the important flux fields and flux-related parameters for the globe and will be available by public ftp from DKRZ this autumn. The technique used for evaluation (comparison with surface buoy data) is the same that Peter Taylor's group has used in evaluating the Southampton Oceanography Centre (SOC) flux climatology. Thus the work will also allow comparison of the Hamburg and SOC products.

David Legler has continued the collection of high quality instrumental flux data derived under the WOCE programme. This data set has special value for the validation of the VOS and satellite products such as the Atlantic Ocean Flux Climatology recently finalised by Ralf Lindau. This covers a 100 year period from 1890 to 1990 and will appear as an Atlas with CD-ROMs (published by Springer Verlag). Ralph Lindau (with Hans-Joerg Isemer of GKSS, Geesthacht) has also evaluated heat and water balances for the Baltic Sea which, together with Mediterranean Sea, can now play an important role for testing sea-air fluxes in enclosed seas.

Bernard Barnier has evaluated a new climatology of river runoff which is considered as a forcing field for ocean modelling. Bernard Barnier and Serge Gulev undertook several numerical experiments with ocean general circulation model forced by NCEP/NCAR and ECMWF fluxes, directed in particular on the validation of the fluxes from the reanalyses. The work also included the use of an ocean general circulation model for the validation of different wind climatologies available from the ERS and NASA satellite scatterometers. Glenn White has also intercompared fluxes from the ECMWF, NASA and NCEP reanalyses with independent data such as the flux climatology of Arlindo da Silva.

Finally, Serge Gulev and Andreas Sterl (with David Cotton of SOC) have started a joint project for the comparison and intercalibration of ship, satellite altimeter and modelled wave products. By the end of 1998 a new global climatology of ocean waves for the 32-year period will be created.

Results from these various scientific activities will, together with flux evaluations being performed elsewhere, contribute to the WG's most difficult task, the comparative evaluation of the various flux products.

5. Working Group Membership

Dr. Kunio Kutsuwada of Tokai University has agreed to join the WG in order to expand the group's expertise

6. Future actions

The future activities will be devoted to the development of the flux fields catalogue, producing the final report of the Working Group, further development and maintenance of the WG Web Site, and organising the Scientific Workshop which will summarise the activity of the Working Group and any consider future requirements for flux field evaluation. In parallel, the WG will encourage actions designed to progress the evaluation of ocean-atmosphere flux fields.

The next meeting of the WG will revise the draft final report and consider the further actions needed to complete the WG's tasks. The proposal is to hold the meeting at the home institute of one of the European WG members (Southampton Oceanography Centre would be one possibility). The costs for a 5 day meeting (assuming one WG member does not have to travel and not including travel and subsistence costs for secretariat members) are estimated at 21600 US dollars. It is assumed that these costs would be shared between SCOR and WCRP.

ANNEX 7 - Magnitude of Submarine Groundwater Discharge and its Influence on Coastal Oceanographic Processes

SCOR Working Group 112

Co-Chairs: Bill Burnett & Evgeny Kontar LOICZ Liaison: Robert Buddemeier

Introduction and Objectives

The overall goal of WG 112 is to define more accurately and completely the magnitude of submarine groundwater discharge (SGD) and how it may influence chemical and biological processes in the coastal ocean. To this end, the members of the working group have organized themselves into three task-oriented units based on the following goals:

(1) Review and evaluate existing methods for assessment of SGD via modeling approaches. Identify needs and improvements in the field. This will be addressed by the **Calculation and Modeling** group headed by Igor Zektser (Russia).

(2) Define the existing methods and tools useful for direct measurement of groundwater fluxes to the coastal zone. The **Measurement, Sampling, and Experimental Design** subgroup, headed by Makoto Taniguchi (Japan) is taking the led on this task.

(3) Develop and refine a typological approach to assess SGD over broad areas. These activities will include selection of appropriate parameters, identification of type areas, recommendation of necessary studies for proper evaluation, extrapolation to other areas; and a direct tie in to the LOICZ typology data set. Robert Buddemeier (U.S.) and the **Typology, Integration and Globalization** group is addressing this issue.

Activities in 1998 and Plans for Future Work

This was the first year for WG 112 which was approved at the SCOR General Meeting in the Fall of 1997. LOICZ has also agreed to co-sponsor this working group. Our activities thus far this year have included establishing our full group of members and associates, drafting a working plan, organizing and conducting a planning workshop, and putting together a web page. Copies of our current membership and the 1998-99 work plan are enclosed with this report. The web page (still in progress) will be placed on either the SCOR or the LOICZ server with crosslinks to the other site as well as other appropriate sites. Much of the front part of the proposed web will be ready to post very shortly. Some of the other components (bibliography, searchable list of active researchers, etc.) will be developed as contributions from the group.

Our planning workshop was held July 20-24, 1998 in Taipei, Taiwan in conjunction with the Western Pacific Geophysical Meeting (WPGM). The working group members included Bill Burnett (USA), Evgeny Kontar (Russia), Robert Buddemeier (USA), Makoto Taniguchi (Japan), Maria Malmstrom (substituting for Georgia Destouni, Sweden), and Igor Zekster (Russia). Additional participants from the WPGM also sat in our some of our meetings. These included Chung-Ho Wang (Taiwan), Jeffrey Turner (Australia), Kee-Hyun Kim (South Korea), and Masao Kobayashi (Japan).

The members of the working group and other participants had considerable discussion and debate regarding the approach and deliverables expected from the group. The following summarizes the thoughts from these discussions by task:

(1) The members of task #1 (Modeling and Calculation) will communicate with each other via email and construct a short list of the most important issues facing modelers attempting to quantify submarine groundwater discharge. They will also present a strategy on how working group 112 can assist in resolving some of these issues.

There was also considerable discussion about potential publications (monographs, special issue of a

scientific journal, etc.) this group should strive for. The publication issue was not resolved but the group elected to revisit the question at a later date. Since considerable lead time is usually required in order to hold a special issue of an established journal, specific proposals will have to be developed and agreed upon by the 1999 meeting.

(2) The focal point of task #2 (Measurement, Sampling, and Experimental Design) is a desire to improve the methods for measurement of SGD. One possibility would be to assist in the design of an intercalibration/comparison exercise of different types of measurement tools for assessment of groundwater discharge to the coastal zone. Many different types of tools have been applied (e.g., seepage meters with various designs, remote sensing, geochemical tracers, etc.) without many attempts at calibration. Members of task #2 will design an experiment to compare some of these tools within the same environment. A listing of desirable features of an ideal field site for such an intercomparison is currently being developed. A search for one or more "flagship" field site(s) will then be initiated by soliciting suggestions from the scientific community. A first effort would be directed towards seepage meter comparisons with the understanding that other measurement tools will be included to the extent possible.

(3) The first outcome from task #3 (Typology, Integration, and Globalization) will be to hold a small dedicated workshop on coastal typology with significant emphasis on how it can be used to extrapolate and interpolate groundwater discharge data along type coastlines. This workshop will be held in October, 1998 at the University of Hawaii with funding provided by LOICZ. During the coming year, members of this task will continue to solicit information and data sets from researchers active in this field. Construction of a working example of a typological approach to SGD, hopefully with www access, will be a goal of task #3 for the coming year.

Plans and Estimated Costs for 1999: Birmingham

For several reasons including a late start and limited funding, the 1998 meeting was relatively small with only six group members attending. It was very useful, however, for purposes of getting organized and setting directions. We intend to organize a full group meeting next year.

The group discussed the pros and cons of different venues for such a meeting and decided that the best overall setting would be for a period of a few days in association with the International Association of Hydrological Sciences (IAHS) Meeting which will convene together with the International Union of Geodesy and Geophysics (IUGG) in Birmingham, UK during July 19-30, 1999. Three members of the small group meeting in Taiwan have already made commitments to attend this meeting and it is far enough in advance that we have sufficient time for completion of this year's tasks and planning for next year. Further details and a firm meeting time will be forthcoming.

Relevance to Societal Needs

The direct discharge of groundwater into coastal waters may have significant environmental consequences because groundwaters may be an important source of nutrients or other substances important for the local ecosystems. In addition, many areas are now characterized by groundwaters that have become contaminated with a variety of substances (e.g., metals, radionuclides, organics). Coastal areas adjacent to such contaminated areas are thus subject to environmental degradation via groundwater discharge either as submarine springs or disseminated seepage. Therefore, coastal planners and scientists interested in chemical and biological systems in the nearshore zone should be aware that this process may be important. Although recognized by the scientific community for many years, little progress has been made because of the difficulties in measuring the magnitude of submarine groundwater discharge. SCOR working group 112 is taking up the challenge of how to approach this problem.

ANNEX 8 - Joint Global Ocean Flux Study (JGOFS)

Contributed by: Roger B. Hanson, Executive Officer
JGOFS International Project Office
University of Bergen, Bergen, Norway

Introduction

This report reviews Joint Global Ocean Flux Study activities from July 1997 through June 1998. During this period, the Scientific Steering Committee showed foresight in developing an organisational structure in support of JGOFS Synthesis through the Year 2004. An international Synthesis Plan describes the timeline, activities and products. This report also summarises recent activities of the new Synthesis Groups, Task Teams and the International Project Office.

Scientific Highlights

The ***Equatorial Pacific Process Study*** has improved our knowledge of carbon fluxes and their control in Equatorial Pacific (special issues of Deep-Sea Research Part II Volumes 42, Nr. 1-2, 1995; Volume 43, Nr. 4-6, 1996; and Volume 44, Nr. 9-10, 1997). Initial estimates suggested that dissolved organic carbon was a major form of exported new production. As synthesis has proceeded, the estimates of the contribution due to dissolved organic carbon have decreased and the best estimates now are that export of dissolved organic carbon is less than half of the new production. Particulate organic carbon export correlates well with new production. Great progress has also been achieved in understanding the controls of carbon cycling and fluxes. One-dimensional models with iron limitation illustrates that iron supply controls the variability of primary production but that grazing balances primary production and controls phytoplankton biomass. In addition, two high frequency physical processes, Kelvin waves and tropical instability waves, which are difficult to measure from ships, have been found to influence phytoplankton variability by controlling the vertical transport of iron into surface waters. Future studies of biogeochemical cycles will require continuous high-resolution measurements of physical and bio-optical properties on moored arrays.

The ***North Pacific Process Study*** began. During the next four years, it will include extensive and intensive shipboard surveys, time-series observations and strong remote sensing and modelling components. A significant part of the fieldwork falls under the Japanese initiative entitled "Biogeochemical Study of the Northern North Pacific and its Adjacent Seas". In June 1998, observations began at the Kyodo North Pacific Ocean Time-series (KNOT) station in the subarctic gyre of the western North Pacific. Research vessels from JAMSTEC, Hokkaido University, University of Tokyo, Tokai University and the National Institute for Resources and Environment will participate. Studies include CO_2 uptake and its relationship to biological activity in the seasonally variable ocean. In addition to JGOFS core measurements, plans include deployment of moored sediment traps, a shallow optical buoy and free-drifting sediment traps. Historical data from long-term data on interannual variability of vertical water structure, seasonal changes in CO_2 exchange, and mixed-layer depth will supplement field observations.

Scientific Steering and Executive Committees Meetings

Executive Committee Meeting (October 1997). The 1997 Executive Committee met in Williamsburg, Virginia, USA. This meeting marked the transfer of the JGOFS Chair from John Field, as one of his last official duties, to the appointed-chair Michael J.R. Fasham, effective January 1, 1998. Field also announced the appointments of Liu and Lochte to second terms, and Quinones and Hong as new members of the Scientific Steering Committee. With JGOFS nearing completion of the field programmes, the meeting focused on planning groups, terms of reference, and organisation structure for synthesis. The EXEC chose the North Atlantic Planning Group being the farthest along with synthesis to be the model for other Planning Groups reorganisation. Fasham presented the North Atlantic synthesis plan, group reorganisation and terms of reference. After discussion, the EXEC charged Fasham to develop generic terms of reference for other synthesis groups. EXEC later distributed copies to each Planning Group for discussion and modification for their particular regional needs. Since then, the EXEC has approved the reorganisation of the North Atlantic Synthesis Group, Indian Ocean Synthesis Group and Equatorial Pacific Synthesis Group. Only the Southern Ocean Planning Group remains. The EXEC approved the site for the 1998

SSC meeting, which was held in Cape Town, South Africa in honour of John Field's 4-years of service to JGOFS. The EXEC also selected Bergen, Norway as the site for the Second JGOFS Scientific Conference in April 2000, in recognition of Norway's continuous support of the International Project Office from January 1996 through 1999. For further information, please visit the meetings' minutes on the homepage.

Scientific Steering Committee Meeting (April 1998). The Thirteenth JGOFS SSC (Appendix III) met in Cape Town, South Africa. The new Chair Michael Fasham presided and outlined his views on JGOFS Synthesis. In response to his views and the IGBP-wide synthesis challenge, the SSC honed its terms of reference and objectives to support, co-ordinate and integrate the efforts of the four regional Synthesis Groups. In the end, the SSC decided to participate directly in the integration of JGOFS observations and agreed to accept additional synthesis tasks. The efficacy of the restructure process ensures global integration of regional regimes. To meet this challenge, the SSC restructured its membership and overall responsibility for JGOFS synthesis. In the future, representatives from ocean carbon modelling will attend the SSC as well as representatives from international programs on ocean colour and global ocean observing systems. Thus, the SSC expanded point two of its Terms of Reference, i.e., to foster the integration of JGOFS activities in order to achieve the global synthesis required to meet JGOFS objectives. The SSC will now oversee the integration and modelling activities of the four regional Groups and all task teams with similar activities. In addition, it will liaise with other IGBP Program Elements and Framework Activities as well as with international ocean programs with extensive ocean data sets. It will also identify critical scientific gaps in our knowledge of ocean biogeochemistry that may significantly compromise carbon monitoring and modelling carbon in Earth's oceans. Finally, it will organise synthesis, modelling and training workshops and will publish synthesis books, glossy brochures and other data products. With these new efforts in mind, the 1998 SSC unanimously adopted an overarching Synthesis Goal with specific Objectives for synthesis (see Joint Global Ocean Flux Study Synthesis Plan and Implementation, Appendix I).

Reports on the Synthesis and Planning Groups

The last field projects are nearing completion, and in anticipation of synthesis, field planning groups have reorganised themselves for the next phase, Synthesis and Modelling. Several groups have new terms of reference and objectives, and are planning regional synthesis workshops. For more information, please visit the JGOFS web site. It lists the present members and the new Terms of Reference for these groups.

North Atlantic (NASG) (Chair Michael Fasham). The NASG met in May and its report is on the homepage. They reached several general conclusions:

(1) publish a special issue in Deep-Sea Research on JGOFS North Atlantic synthesis;
(2) produce data sets on a CD-ROM to be included with the special issue;
(3) present the North Atlantic synthesis at the Second IGBP Congress; and
(4) promote a joint JGOFS/WOCE meeting on CO_2 transport, inverse modelling of dissolved inorganic carbon and other data sets.

With the submission of that report and unanimous approval of the EXEC, Fasham has turned over the NASG Chair to Dr. Veronique Garcon (France), effective July 1, 1998.

Indian Ocean (IOSG) (Chair Peter Burkill). The IOPG met at the Ocean Science Meeting in San Diego last February. In May, the SSC approved the recommendations from that meeting including its new Terms of Reference, objectives, organisation structure and new members. The SSC encouraged the Synthesis Group to include not only JGOFS data from the Arabian Sea but also other relevant research from Indian Ocean. The first meeting of the IOSG is January 1999 alongside the Arabian Sea Biogeochemistry Symposium and Training Course in Bangalore. The homepage provides symposium and course information.

Equatorial Pacific (EqPSG) (Chair James Murray). The EqPSG meets this September in Seattle. The SSC approved its reorganisation structure and new members, but EXEC deferred its action on EqPSG Terms of Reference and synthesis plan until after their meeting. Murray has edited three special issues of Deep-Sea Research Part II (Topical studies in Oceanography) on JGOFS in the Equatorial Pacific (see Scientific Highlights).

Southern Ocean Planning Group (SOPG) (Chair Ulrich Bathmann). The SOPG meets this September in Bremerhaven. This group has not completed its fieldwork but proceeding along with synthesis. In the interim of reorganisation, the SOPG will nominate candidates for the Southern Ocean Synthesis Group and recommend new Terms of Reference, objectives and synthesis plans in 1999. Recently, following the US JGOFS Southern Ocean Workshop in Tennessee, the French offered to host a Second Brest Symposium on the Southern Ocean around July 2000.

Reports on the Task Teams

Global Synthesis and Modelling Task Team (GSMTT) (Chair Trevor Platt). Preparation continues for a combined Arabian Sea Symposium and Biogeochemical Modelling Training Course in Bangalore, India in January 1999. For more information, please visit the homepage. The SSC also reviewed GSMTT in light of the new JGOFS Synthesis Plan. The SSC confirmed that the Task Team has provided a valuable service. However, in view of the reorganisation and global synthesis plans, the SSC made two actions. First, the SSC moved to disband the GSMTT following the Symposium and Training Course, and second, they moved to solicit a representative from ocean carbon modelling group (e.g., OCMIP under GAIM) to sit on future JGOFS SSC. For more information about OCMIP, please visit their homepage http://www.ipsl.jussieu.fr/OCMIP/.

Data Management Task Team (DMTT) (Chair Roy Lowry). The DMTT meets this September in Bergen alongside the Data Management and Synthesis Workshop. The aim of the workshop is to establish a communication between national data managers and scientists actively working in synthesis and modelling. Seven scientists from Australia, Canada, France, Germany, Norway, UK and USA will provide science presentations. For information to this 'invited-only' workshop, please visit the homepage.

Continental Margin Task Team (CMTT) (co-Chairs J. Hall-JGOFS & S. Smith-LOICZ). The CMTT met last October before the LOICZ Open Science Meeting. The team will submit a synthesis paper in near final form from the OSM workshop soon. The workshop showed a good linkage between JGOFS and LOICZ elements. In Cape Town, Hall announced her intention to step down as co-Chair. The SSC then moved to approve K.K. Liu as the next co-Chair for CMTT. In the near future, Han Lindeboom will inform JGOFS of the new co-Chair for CMTT from LOICZ. In Cape Town, a group wrote new Terms of Reference for LOICZ and JGOFS approval.

Photosynthesis Measurement Task Team (PMTT) (Chair Egil Sakshaug). The task team has performed well and will soon complete their Terms of Reference. The PMTT has published their first article with limited reprinting in JGOFS Report Series (see Publications under International Project Office). Their last task is to finalise its Svalbard manuscript for publication. Following the publication of the second article, the SSC moved to disband the team.

Deep Ocean Flux Task Team (DOFTT) (co-Chairs Graham Schimmield & Karin Lochte). The co-Chairs attended the recent PAGES SSC Meeting and requested nominations from PAGES to join members of JGOFS on deep-ocean flux. However, there was not much interest as PAGES has strong terrestrial foci while the marine component has been slow to develop. This may change with the new Chair and broader approach to the PAGES Science Plan. The co-Chairs will present their Terms of Reference with a list of suggested members to PAGES and request approval, and return to the EXEC for approval.

Remote Sensing Task Team (RSTT) (Chair James Yoder). The RSTT has not met for several years while providing continuous technical support service. Meanwhile, SeaWiFS and other satellites are contributing routine ocean colour data to the public domain. In support of this activity and others, the International Ocean Colour Co-ordinating Group (IOCCG) was established, and it now provides the direction, liaison and communication channel between users, managers and agencies in ocean colour. For more information, please visit their homepage http://www.ioccg.org/. In view of this group and its membership, Platt as its Chair and Yoder as a standing member of the IOCCG, the SSC moved to disband the RSTT with the intentions of an IOCCG representative sitting on future JGOFS SSC.

North Pacific Task Team (NPTT) (co-Chairs Alexander Bychkov & Toshiro Saino). The NPTT meets this October in Fairbanks at the PICES Annual Meeting alongside of the PICES/JGOFS Session on Carbon Cycle in the North Pacific Ocean organised under Shizuo Tsunogai and C.S. Wong. For more information, please visit the homepage. In March 1999, a North Pacific and SEATS Workshop has been proposed for China-Taipei. The host organisation, Center for Oceanic Research (CORE), in Taipei approved it support and a venue has been reserved.

IOC-JGOFS CO_2 Panel (I-JCO_2P) (Chair Andrew Watson). The I-JCO_2P meets this January in Tsukuba, Japan alongside of the Second International Symposium on CO_2 in the Oceans. For more information, please visit the homepage. At the SSC in Cape Town, Watson provided an illuminating presentation on some problems, issues and future activities of the I-JCO_2P. The comments from the SSC emphasised a strong support for the Panel and the importance of the Panel in JGOFS Synthesis Plan. In particular, they support a restructure of the Panel membership and Terms of Reference towards synthesis with a focus on global CO_2 data sets and development of models.

International Project Office

The International Project Office falls under the auspices of the International Geosphere-Biosphere Programme (IGBP) and the Scientific Committee on Oceanic Research (SCOR). It receives full financial support for its operation from Norwegian Research Council, University of Bergen and the Meltzer Foundation in support of the administrative functions of the international JGOFS programme. Over the remaining 16 months of the contract, the staff has its calendar full with synthesis activities, meetings, symposiums and workshops, and data management (see Appendix II, and Appendix I, Table 1). One of the many important responsibilities will be the Second JGOFS Science Conference that is planned for Bergen, 13-18 April 2000. The Office recently contracted the Science Conference to PLUS Convention of Norway AS (Bergen). The Conference organisers expect over 300 participants presenting JGOFS research and synthesis.

Norwegian Research Council Contract. In Cape Town, the Scientific Steering Committee recognised with its highest esteem for the Norwegian contributions to the International Project Office. The Norwegian Research Council, the University of Bergen and the Meltzer Foundation has provided continuous and unhindered support over past two and half years. In addition, the SSC recognised the exceptionally high performance and professionalism of the Office and its staff in the executions of their duties at the University of Bergen. Because of the strong Norwegian support for the International Project Office, the Norwegian Research Council and the University of Bergen has received unprecedented visibility and high admiration from member nations of the Joint Global Ocean Flux Study. In the near future, Dr. Michael J.R. Fasham, JGOFS Scientific Steering Committee Chair, Professor Ulf Lie, Norwegian JGOFS Committee Chair and Dr. Roger Hanson plan to seek sponsors' interests in continuing the International Project Office contract at the University. Soon thereafter with support from the University, they plan to seek interest at the Norwegian Research Council. The purpose for continuation includes maintaining the continuity of the Office and staff through the international synthesis and modelling phase (see Synthesis Plan and Implementation, Appendix I) as well as to host the Science Conference 2000 in Bergen, Norway. The Scientific Steering Committee views the lost of the Office in Norway as serious and highly disruptive as it enters its final and most visible science phase since its 1989 inception.

National Program in Norway. The primary obligation of the International Project Office is to facilitate JGOFS goals and objectives across national and international programmes. In this vein, Office recognises a strong obligation to its host country and the Norwegian JGOFS (NGOFS) program. In this endeavour, Office staff have encouraged, assisted and participated in NGOFS activities in Norway. Two such activities are worth noting:

- *Norwegian JGOFS Data Center.* Representatives from the Institute of Marine Research (IMR), the NGOFS Committee and the International Project Office met in November 1997 for developing a strategy towards a Norwegian JGOFS Data Center. The group discussed the issue of future centralisation and exchange of all data acquired by NJGOFS research activities. Conclusions: The IMR proposed to build a database for NGOFS within their system based on their experience as a data management co-ordinator for an EU-financed research project. A one-year pilot project was proposed to (i) build a database and archive all ocean data acquired by NGOFS; (ii) develop an interface towards the internet in order to facilitate data

exchange and presentation of data via the WWW; and (iii) to gather all the NGOFS data on a CD-ROM as the final product of the project. Project leader is Harald Loeng, IMR, with the following partners: the Norwegian JGOFS committee, the University of Bergen and JGOFS International Project Office. IMR submitted the application to the Norwegian Research Council (NCR) for financial support in 1999.

- ***NGOFS Synthesis and Modelling Project.*** The NGOFS Committee and Office staff met in May 1998 to develop a strategy for NGOFS Synthesis and Modelling phase and a research project to produce a synthesis of the Nordic Seas biogeochemistry. The plan fixed a 4-year synthesis period, identified several research themes for individuals to seek funding from different national and international agencies and proposed several synthesis products through the organisations of workshops and symposiums. Five research proposals were proposed under the title: "*The synthesis and modelling of the variability in carbon and other biogenic elements in the Nordic Seas*", and submitted to the Norwegian Research Council for consideration. The Nordic Seas region represents a very important region for the North Atlantic Synthesis and potentially for the JGOFS-LOICZ Continental Margins programme.

Homepage (http://ads.smr.uib.no/jgofs/jgofs.htm). The JGOFS homepage is now the most organised and complete reference source on JGOFS History, Research, Organisation, Data Inventory, Contacts, Activities and Publications. Recently, the Office implemented a number of new items on the web site (i) the JGOFS International Library; (ii) Documents on-line, and (iii) a Catalogue of data sets published on CD-ROMs. The Library includes references on an array of publications, ranging from more than 2000 refereed articles, printed abstracts, national and international reports, to theses and dissertations resulting from JGOFS field programs. From this library, documents are being made available on-line, such as the JGOFS Core Measurement Protocols (JGOFS Report Nr. 19, which is out-of-print) and poster presentations. In addition, the Office plans to place all future JGOFS reports on the web site. On the Data Inventory page, there is a catalogue of JGOFS research cruises, data sets and related data sets, published on CD-ROMs, including summary information on relevant data sets and contacts for ordering. In the future, scientists from around the world will use this resource to locate biogeochemical and relevant ocean data sets within any ocean area or scale desired.

Link between JGOFS and IGBP-DIS. Dr. Beatriz Balino, Assistant Executive Officer, is the Data Co-ordinator of the Office and liaises with IGBP-DIS and the DMTT. Early this year, she was named a member of the Expert Group under IGBP-DIS Focus 2 activities (Data Management and Dissemination). The main task of this group is to build a web browser for the IGBP Data and Information System. The Expert Group met last May in Toulouse, France.

Other Publications. The Office submitted in June a book on the early midterm synthesis of JGOFS science and its achievements to Cambridge University Press for publication. The book will be a valuable resource on air-sea exchange of carbon driven by physico-chemical forces and photosynthesis-respiration processes. The combined biogeochemical and physical process has an important influence on atmospheric composition and variability in the ocean carbon cycle. The editors and contributors contend that the ocean exert significant response effects during conditions of climate change. The book's main appeal is expected to be to scientists seeking a recent overview of the role of ocean processes in Earth system science and their wider implications on climate change.

- *The Changing Ocean Carbon Cycle: A midterm synthesis of the Joint Global Ocean Flux Studies,* eds. R.B. Hanson, H.W. Ducklow & J.G. Field. Cambridge: Cambridge University Press.

The Photosynthesis Measurement Task Team published a paper on with P vs. E measurements conducted using the ^{14}C method, which will also appear in the JGOFS Report Series publication later this year. The authors stressed a consistent system for terms, symbols and units for the photosynthetic rate and the photosynthetic parameters (alpha, the maximum light utilisation index; Pm, the maximum photosynthetic rate, and Ek, the light saturation index). Moreover, the paper discussed the relationship between "traditional" P vs. E parameters and physiological parameters, and then described how and why all these parameters vary due to photoacclimation. The paper will be useful as an introduction and update for everyone who deals with photosynthetic measurements in JGOFS and elsewhere.

- Sakshaug, E., Bricaud, A., Dandonneau, Y., Falkowski, P.G., Kiefer, D.A., Legendre, L., Morel, A., Parslow, J. and Takahashi, M., 1997. *Parameters of photosynthesis: definitions, theory and interpretation of results.* Journal Plankton Research, vol. 19, 1637-1670.

The Office and Task Teams released several newsletter articles to US JGOFS News and IGBP NewsLetter on activities occurring within Joint Global Ocean Flux Study this past year.

- *Southern Ocean Planning Group reviews synthesis needs and plans for future projects*, Vol. 8, Nr. 3, July 1997 (US JGOFS News).
- *What's happening in Bergen: Update of the JGOFS IPO*, Vol. 8, Nr. 4, November 1997 (US JGOFS News);
- *JGOFS holds its first International Modelling Symposium*, Vol. 8, Nr. 4, November 1997 (US JGOFS News);
- *Creating an international data management system for JGOFS*, Vol. 9, Nr. 1, February 1998 (US JGOFS News);
- *The North Pacific Task Team meets to review plans for studies in North Pacific*, Volume 9, Nr. 1, February 1998 (US JGOFS News);
- *New Chair of JGOFS*, No. 33, March 1998 (IGBP NewsLetter);
- *JGOFS entering its next project phase*, No. 34, June 1998 (IGBP NewsLetter); and *(US JGOFS News)*
- *JGOFS: The Synthesis Phase*, Vol. 9, Nr 2, June 1998 (US JGOFS News).
- *New Chairman leads JGOFS SSC as synthesis work begins*, Vol. 9, Nr 2, June 1998 (US JGOFS News).
- *JGOFS SSC meets in Cape Town to honour former Chairman*, Vol. 9, Nr 2, June 1998 (US JGOFS News).

The Office maintains as part of its responsibilities a record of all JGOFS publications and publishes an updated report in the JGOFS Report Series every other year. The latest publication list is now available. JGOFS Report No. 24, *JGOFS Publications 1988-1996*, is a compilation of 1507 refereed articles and books that resulted from JGOFS activities from 1988 through 1996.

APPENDIX I
Joint Global Ocean Flux Study
Synthesis Plan and Implementation

Introduction. The Joint Global Ocean Flux Study has been, without doubt, the most successful interdisciplinary biogeochemical ocean project yet undertaken. It transcended cultures, politics and economic boundaries to bring together oceanographic talent, research ships and other resources from all parts of the world. The research elements of regional Process Studies and Time Series Studies are perhaps the most often associated with JGOFS. No less critical elements of the JGOFS strategy are the surface ocean surveys and the synoptic view of ocean colour made from satellites. The recent satellite data, in fact, promise to revolutionise our knowledge of ocean biological variability. With a successful completion of its observation phase, JGOFS promises to provide an unique data set on the status of the global ocean during 1990s. Along with the observations, significant advances in biogeochemical modelling have found important application in studies of carbon cycling and transport on regional and global scales.

The Joint Global Ocean Flux Study project is now rapidly approaching a closure of its intensive field observations, but the project will not end there. A continuing effort is needed to ensure that the observations are fully exploited to achieve JGOFS scientific goals. One of the many legacies that JGOFS bequeaths to future generations will be extensive biogeochemical and physical data sets collected during its high profile and successful 10-year field campaign that began in 1989. However, future generations will not judge JGOFS on its data sets and its interdisciplinary research alone. The real measure of success will rest entirely on its ability to synthesise its data sets in order to improve ocean carbon models and to be able to predict future ocean carbon cycling scenarios accurately.

Background. The Twelfth Scientific Steering Committee began restructuring discussions for a global synthesis-

modelling phase, which is expected to continue well past the end of its last field campaign. The SSC envisions that the final phase will require 5 to 6 years to successfully complete its two scientific goals and objectives. This phase intends to provide national researchers with the time and resources needed to complete the best possible descriptions and interpretations of JGOFS data sets. The cost of which is expected to be on par of a Process Study. The target date for completion is early 2004.

With the shift from fieldwork towards synthesis, the Thirteenth Scientific Steering Committee restructured the Planning Groups for synthesis, which includes modelling and data products and renamed them Synthesis Groups. In part, they are responsible for the international perspective of national activities over the respective regions. Their goals are

- (1) to enhance national synthesis efforts,
- (2) to identify JGOFS biogeochemical data and related data sets in the regions,
- (3) to assist the development and validation of regional models of ocean biogeochemistry, and
- (4) to report their efforts internationally.

Regional synthesis will provide snap shots of the temporal and spatial scales of the ocean's biogeochemical regimes and boundaries. Rigorous time and space descriptions of the biogeochemical regimes and their boundaries are needed to develop present one-dimensional models into three-dimensional models that can describe the biogeochemical state of the global ocean as it varies in time and space. Biogeochemical data from the fieldwork are being released to the community and appearing at national ocean data centres, on CD-ROMs and/or distributed data systems (see Takahashi, et al. 1997). This global CO_2 composite is just a "thumb-nail" picture of the available data sets from JGOFS and related research.

Restructuring the Scientific Steering Committee. The Thirteenth SSC decided that the SSC must participate directly in the integration of the Synthesis Groups and as such agreed to accept additional tasks. The efficacy of the restructure process ensures global integration of regional regimes. The restructured Fourteenth SSC will include ocean carbon and ecosystem modellers, and representatives from OCMIP and IOCCG. The Thirteenth SSC also modified Point 2 of its Terms of Reference, to include:

- 1--Oversee the integration and modelling activities of the four regional Groups and all task teams with similar activities, such as Data Management, CO_2 Advisory Panel, etc.;
- 2--Liaise with IGBP Program Elements and Framework Activities as well as with international ocean programs with extensive ocean data sets and global ocean-climate observing systems;
- 3--Identify critical scientific gaps in our knowledge of ocean biogeochemistry that may significantly compromise carbon monitoring and modelling carbon in Earth's oceans;
- 4--Organise synthesis, modelling and training workshops; and
- 5--Publish international book(s), glossy brochure(s) and other data products.

Synthesis Plan. With these new efforts, the Thirteenth SSC produced a Synthesis Plan with an overarching goal and specific objectives for synthesis that provides a practical guide for assessing success.

Goal

To develop an integrated, quantitative view of the biogeochemical cycle of carbon in the ocean, indicating the roles of biota, physical transport, air-sea exchange and particle settling and remineralisation, and including estimates of uncertainties.

This goal will be achieved through the following products that serve as JGOFS synthesis objectives:

- Ensure that all JGOFS observations are lodged with organizations which can guarantee long-term stewardship. Provide web-based information on the availability and access mechanisms to all JGOFS data. Encourage the development of Web-based data delivery systems.
- Create a new synthesis of ocean biogeochemical regimes from the major JGOFS Regional Process, Time Series and Global Survey studies, with special emphasis on biogeochemical processes and ecological

community structure, and including the mechanisms controlling primary production, carbon, macro- and micronutrient cycling, and carbon export from the upper ocean.

- Develop a hierarchy of coupled, biogeochemical-physical circulation models of varying ecosystem complexity, and use them to enhance understanding of natural variability and anthropogenic changes in the carbon cycle over dec-cen time scales.
- Building on Objective III, assess the capability of 3-dimensional ocean carbon cycle models with biogeochemistry to simulate observed global inventories, seasonal cycles and fluxes of carbon, nutrients and functional groups, and to evaluate current rates of carbon remineralization and ocean forcing over time scales. The models will be constrained, calibrated and validated using JGOFS and other pertinent global and regional data sets (e.g., JGOFS/WOCE global survey of CO_2 and tracers, pCO_2, ocean colour, particle fluxes and deep ocean cores).
- Assess the contribution of continental margins and seas to CO_2 sequestration and the horizontal flux of carbon across the ocean - continental margin boundary.
- Utilise ocean colour observations from satellites, aircraft, moorings, and towed vehicles to provide a global picture of the seasonal cycles of phytoplankton biomass, primary and new production.
- Make recommendations on the development and implementation of future global ocean observing systems for detection of changes in the ocean carbon cycle and impacts on marine ecosystems, as one aspect of global change.

Workplan and Timeline. At the Tenth IGBP meeting, the Officers recommended that mature Core Projects launch a concerted effort towards synthesis of scientific knowledge. To encourage IGBP-wide synthesis, they also invited specific projects to bid for Secretariat funds up to $40,000 per project to aid in the task. Products should be specifically targeted towards the Second IGBP Congress, the IGBP Book Series, the IGBP Science Series, and that culminate at the IGBP Millennium. Within JGOFS, such efforts have started: (1) SSC and Planning Groups restructured, (2) Synthesis Plan written, and Workplan and Timeline tentatively approved.

Table 1
JGOFS Workplan and Timeline
Thirteenth Scientific Steering Committee Meeting, Cape Town, South Africa.

Year 1998	
April 25-28	Thirteenth JGOFS SSC, Cape Town, South Africa. *Discuss, develop and approve JGOFS synthesis plan*
May 11-13	First Meeting of the North Atlantic Synthesis Group, Southampton, UK. *Plan chapter(s) for synthesis and presentation for IGBP congress.*
Sept 3-5	First Meeting of the Southern Ocean Synthesis Group, AWI, Bremerhaven, Germany. *Discuss/define all Southern Ocean biogeochemical regimes, plan chapter(s) for synthesis and presentations*
Sept 9-11	First Meeting of the Equatorial Pacific Synthesis Group, Seattle, USA. *Plan chapter(s) for synthesis book and presentation for IGBP congress*
Sept 24-25	JGOFS Data Management & Synthesis Workshop, Bergen. *Review data requirements for JGOFS synthesis and plan development of web-based data archive.*
Oct 23-24	JGOFS Executives, General Business Meeting, Southampton, UK.
Oct 25-29	First JGOFS SSC Synthesis Workshop, Southampton, UK. *Develop implementation of JGOFS synthesis plan. Produce a synthesis Brochure (1999), draft book (2001), plan presentations for IGBP congress and future meetings.*
Year 1999	
Jan 18-20	First Meeting of Indian Ocean Synthesis Group, Bangalore, India. *Plan chapter(s) for synthesis book and future presentations.*
Jan 18-20	Symposium on the Biogeochemistry of the Arabian Sea: Synthesis and Modelling, Bangalore, India.

Jan 21-29	Training Course of Biogeochemical Modelling of the Ocean. Bangalore, India.
May 6-13	Second IGBP Congress/JGOFS SSC meeting, Yokohama, Japan. *JGOFS will present papers on overall synthesis and progress reports on North Atlantic, Equatorial Pacific and Indian Ocean syntheses.*
TBA	Meetings of the Continental Margins, Deep Sea Flux, and North Pacific Task Teams. *Plan chapters for synthesis and presentations at future meetings*
TBA	Second JGOFS SSC Synthesis Workshop.
Year 2000	
April 13-18	Second JGOFS Science Conference, Bergen, Norway. Theme: Ocean Biogeochemistry and Climate Change: Synthesis. *Presentations on synthesis progress;* JGOFS SSC Annual Meeting
Year 2001	
TBA	IGBP Millennium Conference. *Keynote talks on JGOFS synthesis. Distribute Brochure.*
Summer	Publication of JGOFS Synthesis in IGBP Book Series (CUP Press)
Fall	Publication of JGOFS Synthesis in IGBP Science Series

Synthesis Workshops. In June, IGBP Secretariat approved funds for JGOFS Synthesis Workshops. The two workshops are dedicated to JGOFS synthesis and related research. The First Workshop is planned for 25-29 October 1998 in Southampton, UK. The two goals are to produce a glossy JGOFS Brochure (tentative title: *Ocean Biogeochemistry and Climate Change*), and draft chapters for a Cambridge University Press book (tentative titled: *JGOFS Synthesis and Related Research*) as part of the IGBP Book Series. This workshop will involve most SSC members and invited contributors. Workshop participants will come prepared with "white papers", figures and illustrations for the brochure and book (Table 2). The last chapter is on the theme of the global carbon cycle, i.e., integrated understanding of carbon cycling in the ocean.

Table 2
Tentative Brochure Topics and Book Chapters

- Ocean biogeochemical regimes,
- Regional primary and new production,
- Role of community structure and function,
- Water column remineralisation,
- Air-sea carbon dioxide exchange,
- Feedback processes in regulating production and exchange,
- Role of continental margins,
- Role of deep-ocean fluxes,
- Ocean biogeochemical models,
- Future ocean biogeochemistry challenges,
- Integrated understanding of carbon cycling in the ocean.

APPENDIX II
Meetings and Events (1998-2001): Summary

July 1 through December 13, 1998
Photosynthesis Measurement Task Team Meeting (Gainesville, August)
Southern Ocean Planning/Synthesis Group Meeting (Bremerhaven, September)
Equatorial Pacific Synthesis Group Meeting (Seattle, September)
Data Management Task Team Meeting (Bergen, September)
Data Management and Synthesis Workshop (Bergen, September)
Executive Committee Meeting (Southampton, October)

First SSC Synthesis Workshop (Southampton, October)
Third NPTT Meeting (Fairbanks, October)
Joint PICES-JGOFS Scientific Session on Carbon Cycle in the North Pacific Ocean (Fairbanks)

January 1 through December 13, 1999
Indian Ocean Synthesis Group Meeting (Bangalore, January)
Arabian Sea Symposium (Bangalore, January)
Biogeochemical Modelling Training Course (Bangalore, January)
IOC-JGOFS CO_2 Panel Meeting (Tsukuba, January)
Fourth North Pacific Task Team Meeting (Taipei, March)
Scientific Steering Committee Meeting (Yokohama, May)
Continental Margin Task Team Meeting (Yokohama, proposed for May)
Second SSC Synthesis Workshop (planned for late 1999)
Executive Committee Meeting (planned for late 1999)
JGOFS/WOCE CO_2 Transport Workshop (proposed for late 1999)
Equatorial Pacific Synthesis Group Meeting (proposed)

January 1 through December 13, 2000
JGOFS Science Conference (Bergen, planned for 31-81 April)
Scientific Steering Committee Meeting (Bergen, 11-21, 91 April)
Southern Ocean Symposium (Brest, proposed for July)
Executive Committee Meeting (planned for late 2000)

January 1 through December 13, 2001
IGBP Millennium (TBD)
Scientific Steering Committee Meeting
Executive Committee Meeting

APPENDIX III

SCIENTIFIC STEERING COMMITTEE FOR 1998

NAME	Country	Position	Function	Executives	End of Term	1996	1997	1998	1999	2000
Bathmann, Ulrich	Germany	Chair	SOPG		2000			Chair	Chair	Chair
Burkill, Peter	UK	Chair	IOSG		1998	Chair	Chair	Chair		
Bychkov, Alex	Russia	SSC, Co Chair	at-large, NPTT		1998	SSC	SSC	SSC		
Ducklow, Hugh	USA	SSC	at-large	Vice Chair	1998	SSC	SSC	SSC		
Fasham, Michael	UK	SSC	at-large	Chair	2000	Chair	Chair	SSC	SSC	SSC
Field, John	South Africa	SSC	Past Chair	PC	1998	SSC	SSC	SSC		
Hall, Julie	N. Zealand	Chair	CMTT		1998	SSC	Chair	Chair		
Hanson, Roger	Norway	Exec. Officer	JGOFS IPO	Executive	1999	EO	EO	EO	EO	
Hong, Huasheng	China-Beijing	SSC	at-large		2000			SSC	SSC	SSC
Liu, KK	China-Taipei	SSC-2nd	at-large		2000	SSC	SSC	SSC	SSC	SSC
Lochte, Karin	Germany	SSC-2nd	at-large, DOFTT	Executive	2000	SSC	SSC	SSC	SSC	SSC
Lowry, Roy	UK	Chair	DMTT		1998	Chair	Chair	Chair	Chair	
Murray, James	USA	SSC, Chair	at-large, EqPSG	Executive	1998	SSC	SSC	SSC		
Platt, Trevor	Canada	Chair	SMTT		1998	Chair	Chair	Chair		
Quiñones, Renato	Chile	SSC	at-large		2000			SSC	SSC	SSC
Saino, Toshiro	Japan	SSC, Co-Chair	at-large, NPTT		1999		SSC	SSC	SSC	
Sakshaug, Egil	Norway	SSC-2nd	at-large, PSTT	Executive	1999	SSC	SSC	SSC	SSC	
Shimmield, Graham	UK	Co-Chair	DOFTT		1998	SSC	SSC	Chair		
Tilbrook, Bronte	Australia	SSC	at-large		1998	SSC	SSC	SSC		
Watson, Andrew	UK	Chair	I-JCO2P		1998		Chair	Chair	Chair	
Willebrand, Jürgen	Germany	SSC-2nd	at-large		1998	SSC	SSC	SSC		
Yoder, James	USA	Chair	RSTT		1998	Chair	Chair	Chair		

ANNEX 9 - GLOBEC: Global Ocean Ecosystem Dynamics

Report of the SCOR/IOC/IGBP Scientific Steering Committee for 1998
Contributed by Roger Harris Chairman GLOBEC SSC

Open Science Meeting
major event in the year under review was the First Open Science Meeting of GLOBEC which served to present a draft of the GLOBEC Implementation Plan to the international science community and provide a forum for its discussion, and for feedback. The Open Science Meeting took place from 17-20 March 1998 at the Intergovernmental Oceanographic Commission of UNESCO, Paris.

The Open Science Meeting featured invited plenary keynote presentations on GLOBEC, its major subprojects and their implementation, in addition to contributed papers on the current scientific activities of GLOBEC. The overall structure of the meeting reflected the four GLOBEC research Foci: Focus 1., Retrospective analyses and time series studies; Focus 2. , Process studies; Focus 3. , Predictive and modelling capabilities; Focus 4. , Feedbacks from changes in marine ecosystem structure

In addition there were sessions on the four major GLOBEC Regional Programmes: The GLOBEC Southern Ocean Programme (SO-GLOBEC), Small Pelagic Fishes and Climate Change (SPACC), the ICES - GLOBEC Cod and Climate Change Programme (CCC) and the PICES-GLOBEC Climate Change and Carrying Capacity Programme (CCCC).

Over 230 scientists attended the meeting from more than 30 countries and over 100 contributed papers were submitted.

A special issue of the journal *Fisheries Oceanography* containing a collection of 24 papers presented at the first Open Science Meeting of GLOBEC will be published in November 1998. The papers in this volume reflect the wide range of contributions at the Open Science Meeting, and all elements of the programme, keynote talks, the four research foci, and the Regional Programmes, are represented.

Participation by a number of scientists in the Open Science Meeting was supported by travel funds provided by grants to the Scientific Committee for Oceanic Research (SCOR) from the US National Science Foundation, the International Council of Scientific Unions and UNESCO. Those supported in this way included participants from, Argentina, Cameroon, Chile, China, India, Mexico, Pakistan, Peru, Russia, South Africa, and Ukraine

Development of the GLOBEC Implementation Plan
Closely linked to the Open Science Meeting has been the timely development of the Implementation Plan for GLOBEC. This has been the key task for the GLOBEC SSC during 1998.

The broad structure for the Implementation Plan was identified at the 1997 Plymouth SSC as an outgrowth of the four Foci of the GLOBEC Science Plan. Draft texts have been developed subsequently. These were reviewed at the Paris SSC meeting and feedback sought from the SSC. The overall structure of the Implementation Plan is outlined below (a detailed draft has been submitted to SCOR):

GLOBEC RESEARCH FOCI

Focus 1: Retrospective analyses and time series studies

Activity 1.1 :	Preservation of existing long time series studies and data
Activity 1.2 :	Analyses of existing retrospective data
Activity 1.3 :	Creation of new, retrospective, data sets
Activity 1.4 :	Development of new data sets for future comparisons

Focus 2: Process studies

Activity 2.1 : Research on life histories and trophodynamics and their modelling in ecosystems
Activity 2.2 : Identification and understanding of multiscale physical-biological interactions
Activity 2.3 : Response of marine ecosystems to fishing and species introductions

Focus 3: Predictive and modelling capabilities,

Activity 3.1 : Design and testing of relevant sampling and observational system capabilities
Activity 3.2 : Develop relevant modelling capabilities
Activity 3.3 : Develop coupled modelling-observational capabilities and applications

Focus 4: Feedback from Changes in Marine Ecosystem Structure,

Activity 4.1 : The climate interaction on multiple scales and its consequences for basic biological processes through the food web
Activity 4.2 : The earth system impacts resulting from changes in marine ecosystems
Activity 4.3 : Social impacts of changes in marine ecosystems

FRAMEWORK ACTIVITIES

Sampling and models: protocols and intercomparisons

Task 5.1. Core sampling protocols and methods intercomparison

Subtask 5.1.1. Provide an updated account of sampling and observational technological capabilities and needs.

Subtask 5.1.2. Summarise existing/continuing/planned sampling networks and remote sensing platforms. Special attention should be given to means of obtaining a nearly continuous spectrum of sampled scales

Subtask 5.1.3. Explore new schemes for obtaining data utilising ships of opportunity.

Subtask 5.1.4. Expand the availability and application of relevant emerging sampling and observational technologies.

Task 5.2. Model intercomparision

Data Management

Scientific Networking

Task 7.1 Establishment of GLOBEC research networks

Task 7.2 Establishment of Focus Working Groups

Task 7.3 GLOBEC publications

Task 7.4 GLOBEC Open Science Meetings

Task 7.5 Interactions with other Global Change Research Programmes

Subtask 7.5.1. Interactions with the Global Environmental Change and Human Security (GECHS) Project to examine the human dimensions of changes in marine ecosystems

Subtask 7.5.2 Interactions with the World Climate Research Programme on Climate Variability and Predictability (CLIVAR) to examine the influence of global climate change on marine ecosystems.

Subtask 7.5.3 Interaction with other ecosystems and climate change programmes.

Capacity Building

Task 8.1 Scientific training

Task 8.2 Development of scientific infrastructure and enhancement of capacity building in developing countries.

Task 8.3 Interdisciplinary training of students and especially post-doctoral fellows in both observational and modelling methods.

GLOBEC REGIONAL PROGRAMMES

Southern Ocean GLOBEC (SO-GLOBEC),
Small Pelagic Fishes and Climate Change (SPACC),
ICES-GLOBEC Cod and Climate Change Programme (CCC),
PICES-GLOBEC Climate Change and Carrying Capacity Programme (CCCC)

INTEGRATING ACTIVITIES

Towards a GLOBEC synthesis: ecosystem comparisons
Task 9.1 Development of marine ecosystem typologies and classification of ecosystems.
Task 9.2 Identification and prediction of responses of marine ecosystem types to global changes

OPERATIONAL CONSIDERATIONS

Categorisation of Research
Benefits and Obligations of Participation in GLOBEC
The status of current major national and multi-national GLOBEC programmes,

This document has been prepared this year under the leadership of the GLOBEC SSC. A previous version was presented to the GLOBEC Open Science Meeting in March, which was attended by over 200 GLOBEC scientists from over 30 countries. The outcome of discussion working groups at the Open Science Meeting, together with over 40 responses to an individual questionnaire circulated to participants, has been incorporated into a subsequent revision. Copies of a previous draft of the Plan were sent in August to National and Regional GLOBEC programmes for comment. Copies of the present draft have been made available to each of the IGBP Core Projects, and Framework Activities, at the September IPO meeting in New Hampshire.

A final version of the Implementation Plan is being submitted to the co-sponsors, SCOR and IOC, during the autumn, and subsequently for consideration by the SC-IGBP in February 1999.

Scientific Steering Committee
The GLOBEC SSC met once during the year, at the Paris Open Science Meeting, 17-20 March, 1998. Agenda items discussed included: Progress on developing the Implementation Plan for GLOBEC, Plans for the Open Science Meeting, Report from the SC-IGBP meeting, Establishment of an International Project Office, Reports on and updates on plans of major GLOBEC field components, GLOBEC Modelling, Feedback to GLOBEC from the Open Science Meeting, Moving forward with the Implementation Plan, Meeting with National Chairs, Data Management for GLOBEC and Retrospective Data Analysis.

The full Minutes of the SSC meetings are available from the GLOBEC Web-Site (http:/www1.npm.ac.uk/globec/), or on request from the Plymouth Office. Selected issues are reported on under the appropriate headings below.

The current membership of the GLOBEC SSC is shown in the Table below. Nominations have been sought to fill the one vacancy, and to replace the two members whose terms end at the end of 1998.

The current membership of the GLOBEC SSC is:

		1998	1999	2000
Dr Jürgen Alheit	Germany			
Dr Francois Carlotti	France			
Dr Tommy Dickey	USA			
Dr Roger Harris*	UK			
Prof Eileen Hofmann	USA			
Dr Tsutomu Ikeda	Japan			
Dr Suam Kim	Korea			
Dr Ian Perry	Canada			
Dr Serge Poulet	France			
Dr Nadia Pinardi	Italy			
Prof Brian Rothschild	USA			
Dr Sergey Piontkovsky	Ukraine			
Dr Frank Shillington	South Africa			
Dr Svein Sundby	Norway			
Vacancy				

International Project Office
A bid to host the IPO in Plymouth was made to the UK Natural Environment Research Council originally in August 1996. After considerable discussion the outcome has been positive, and a funding package is now in place to set up the IPO at the Plymouth Marine Laboratory. This is expected to be on an equivalent scale to the JGOFS IPO in Bergen. The NERC thematic programme will support the Executive Officer position, CCMS/PML will provide office facilities and support the Secretarial Assistant, and the University of Plymouth has agreed to support an information scientist as Deputy Executive Officer. It is expected that the US NSF will provide funds for office running expenses. The Executive Officer post has been advertised, initially for a three-year period, and a shortlist of candidates has been drawn up.

GLOBEC Working Groups
At the Paris SSC meeting there was discussion of the status of, and plans for the existing GLOBEC WGs, and the need for new WGs to address new topics

Modelling and Sampling WG: The future of the "Sampling and Observational Systems" and "Numerical Modelling" Working Groups was discussed in detail. It was recognised that both groups had been influential in the development of GLOBEC to date, and that it was important to consider their future role and direction carefully. It was agreed that a new combined group should be formed with revised terms of reference, new membership, a rotation plan, and a new name as a "Modelling and Sampling Working Group". Chairmanship for the new group is being sought.

Data Management for GLOBEC It was agreed at the Plymouth SSC meeting that a Data Management Working Group should be set up. No further action has been taken. The SSC discussed the issue further. It was questioned whether, in light of the prior discussions during the meeting, a separate WG was needed. It was recognised that several regional programmes have data management groups, and that perhaps GLOBEC could organise a workshop to bring these together once. Subsequently the data function could be taken on by the IPO. This course of action was agreed, and that no WG should be set up at present.

Retrospective Data Analysis While retrospective data analysis is a central component of the Implementation Plan, the SSC has not yet put any mechanism in place to foster this activity. At the review of GLOBEC at the recent SC-IGBP it was suggested that this important component should have a special WG. There was further brief SSC discussion of this issue in Paris. It was generally considered that this topic is being addressed adequately within the various regional programs, and does not require a dedicated international working group to be established at this time.

The Major Components of GLOBEC
Four major field programs are currently being planned as part of international GLOBEC. Significant developments are briefly reviewed below.

Southern Ocean - GLOBEC: The SOPG met in August 1997 in La Jolla, and their report (GLOBEC Report 7A) has been published as an addendum to the SO Implementation Plan. This includes a recommendation for a SO-GLOBEC Co-ordination Office. The SOPG met again on the first day of the OSM, and prospects for the programme look good now. The geographical focus will be in two areas, 70° East (Japan and Australia), and the Peninsula Region (US, Korea, UK, Germany etc.). There was a need for a central co-ordination to ensure good coverage. The SOPG will set up a SO modelling WG and a data management WG. There would be 5-10 participants in each group to meet in 1999 after the austral field season. Otherwise the SOPG would try to meet with other events.

SPACC is developing actively, and the Implementation Plan has been published, together with the report of the first SPACC modelling workshop.

Cod and Climate Change: The funding status of the ICES North Atlantic office in Copenhagen is more secure. The CCC WG met in Woods Hole in April, and there was a CCC workshop on the application of climate date in stock assessment the week after the OSM. For CCC overall has been some reconsideration of the concept of cod alone as the target species; some would like to see more work on other stocks, for example the Baltic herring and the sardine stocks off the Iberian Peninsula. A five-year plan for the WG has been developed.

PICES CCCC: the MODEL, BASS and REX Task Teams are continuing. The last PICES meeting agreed to set up a "Monitoring Task Team", and there is also a new WG 14 on "Effective sampling of micronekton to estimate ecosystem carrying capacity". The 1998 PICES meeting takes place in October in Fairbanks. There will be a two-day symposium on climate effects on small pelagics.

National Programmes
China GLOBEC has the aim of identifying how the change in climate and anthropogenic influences will affect the dynamics of the coastal ecosystem. The field study is in the Bohai Sea and has 4 research teams concentrating on, Bohai prawn early life history, zooplankton population dynamics, trophodynamics of the food web, and Bohai Sea ecosystem dynamics modelling.

Japan GLOBEC is still waiting for funding for Monbu-sho GLOBEC (Universities). Suisan-sho (Fisheries Agency) GLOBEC is funded and is making a comprehensive study of the environmental variation influencing the fisheries resources in the North Pacific.

The Benguela Ecology Programme (BEP-IV) in South Africa links to other programs such as BENEFIT, LME, ENVIFISH, VIBES, and the NORAD modelling project.

Within US GLOBEC the NW Atlantic/ George's Bank program is in it's 4th year and is currently in midst of an active field season. The NE Pacific program has 15 funded projects. There is a transition to operational monitoring, with a move of the Georges Bank effort towards monitoring.

GLOBEC Canada is entering the third year of the funded program. Fieldwork and modelling are underway, and there was a Science meeting in Vancouver in January 1998.

In Chile funding has been secured for a GLOBEC programme in the Eastern Boundary Humboldt Current.

A proposal for a UK GLOBEC programme was successful, and there are plans to start an initial phase of the programme in late 1998.

An EU GLOBEC Science Plan was developed at a meeting in Warnemuende, in October 1997, and will be published

as a contribution to the development of EU-funding in this area.

In Germany a national GLOBEC programme is being planned for in a number of meetings. It is expected to have a focus on the Baltic and North Seas.

Reports and Publications
GLOBEC Reports are available directly from the Plymouth Office or via the GLOBEC Web-Site (http:/www1.npm.ac.uk/globec/). Additional copies of a number of reports, still being requested, have been reprinted.

Three GLOBEC Reports have been printed and circulated from Plymouth, they are:

Report 7A. Report of the meeting of the Southern Ocean Planning Group. (Addendum to GLOBEC report No. 7, Southern Ocean Implementation Plan).

Report 11. Small Pelagic Fishes and Climate Change Programme: Implementation Plan.

Report 12. Report of the First SPACC Modelling Workshop (14-16 October 1996, JRC, Ispra, Italy)

Two issues of the GLOBEC Newsletter have been published and mailed to a mailing list of over 750 scientists worldwide.

In conclusion, this has been a year of active development for GLOBEC, and the continued support of the co-sponsors, IGBP, SCOR and IOC has been valuable and is gratefully acknowledged.

ANNEX 10 - Global Ecology and Oceanography of Harmful Algal Blooms

A Plan for Co-ordinated Scientific Research and Co-operation to Develop International Capabilities for Assessment, Prediction and Mitigation

EXECUTIVE SUMMARY

Proliferations of microalgae in marine or brackish waters can cause massive fish kills, contaminate seafood with toxins, and alter ecosystems in ways that humans perceive as harmful. The scientific community refers to these events with a generic term, "Harmful Algal Bloom" (HAB), recognising that, because a wide range of organisms are involved and some species have toxic effects at low cell densities, not all HABs are "algal" and not all occur as "blooms." A broad classification of HABs distinguishes two groups of organisms: the toxin producers, which can contaminate seafood or kill fish, and the high-biomass producers, which can cause anoxia and indiscriminate kills of marine life after reaching dense concentrations. Some HABs have characteristics of both.

Although HABs occurred long before human activities began to transform coastal ecosystems, a survey of affected regions and of economic losses and human poisonings throughout the world demonstrates very well that there has been a dramatic increase in the impacts of HABs over the last few decades and that the HAB problem is now widespread, and serious. It must be remembered, however, that the harmful effects of HABs extend well beyond direct economic losses and impacts on human health. When HABs contaminate or destroy coastal resources, the livelihoods of local residents are threatened and the sustenance of human populations is compromised. Clearly, there is a pressing need to develop effective responses to the threat of HABs through management and mitigation. This requires knowledge of the factors that control the distributions and net growth rates (i.e., the population dynamics) of HAB species.

A great deal is known about harmful algae and HABs, but our abilities to describe the factors controlling the dynamics of individual species is limited by critical gaps in knowledge about how the physiological, behavioural and morphological characteristics of HAB species interact with environmental conditions to promote the selection for one species vs. another. For example, information about the environmental cues for encystment (formation of a resting stage) and germination, as well as the interactions of life cycles with hydrography, is generally inadequate to quantify the role of resting stages in the population dynamics of cyst-forming harmful algae. Also, it is often difficult to assess the role of nutrients and light in HAB dynamics and toxicity because some harmful algae can migrate vertically to exploit deep sources of nutrients at night and light near the surface during the day. Further, some harmful protists can exploit several forms of nutrition (including consumption of other micro-organisms), complicating models of growth or toxicity vs. nutrient concentration. The nutritional status of harmful algae could be assessed by measuring cellular bio-chemical composition, but this is presently impractical unless the harmful algae dominate the plankton. Compounding the problems, essentially all effects of physical forcing and nutrient supply on harmful algal populations also influence food-web/community interactions, which ultimately determine the selection for or against a particular species.

Successful research to date shows that the key to explaining HAB phenomena is to identify and quantify special adaptations of HAB species that lead to their selection in particular hydrodynamic and ecological conditions. Thus, **the central research problem is to understand the critical features and mechanisms underlying the population dynamics of HAB species**. This understanding can be used as a basis for monitoring and predicting the occurrence, movement, toxicity, and environmental effects of harmful algal blooms. In turn, these predictions are essential for management and mitigation of HABs.

Because HABs are globally distributed and are integral parts of marine and brackish-water ecosystems, the central research problem can be addressed comprehensively and effectively only through international, interdisciplinary, and comparative research on important questions about the dynamics of HABs within their oceanographic and ecological systems. Progress depends upon advancement through targeted studies and technological innovation in

biology, ecology, chemical and physical oceanography, modelling, and ocean observation.

To address the need for broad-based advancement in the understanding of HABs, we propose the establishment of GEOHAB (Global Ecology and Oceanography of Harmful Algal Blooms), a programme of scientific research. **The mission of GEOHAB is to foster international co-operative research on harmful algal blooms in the context of their ecological systems and the oceanographic processes which influence them.**

The scientific goal of GEOHAB is to:

Determine ecological and oceanographic mechanisms underlying the population dynamics of harmful algae, by the integration of biological and ecological studies with chemical and physical oceanography, supported by improved observation systems.

The benefits of this programme will be better methodologies for predicting the occurrence, distributions, toxicity, and environmental effects of HABs. The scientific goal of GEOHAB will be approached by addressing these major research questions:

1. **What are the unique adaptations of HAB species that determine when and where they occur and the extent to which they produce harmful effects?**
2. **How do HAB species and their community interactions respond to environmental forcings?**
3. **What are the effects of human activities (e.g., eutrophication) and interannual and decadal climate variability (e.g., El Niño, North Atlantic Oscillation) on the occurrence of HABs?**

A broad range of research is directly relevant to these questions, including: interdisciplinary process studies of HABs in comparable ecosystems; taxonomic and genetic surveys of HAB organisms from different locations, along with physiological characterisation of isolates and examination of possible dispersal mechanisms; studies of the influences of turbulence or variations in nutrient fluxes on community interactions (conducted in micro- or mesocosms, modelled, and compared with observations of natural communities); and examination of temporal and spatial trends in HABs, relative to human influence and climate variability, as inferred from existing sources and a developing Global Ocean Observing System.

Targeted studies and technological innovation are essential to the GEOHAB programme, and the list of opportunities for advancement is long indeed. For example, we need better tools for detecting harmful algae and their biologically active products, more sensitive approaches for studying the nutrition of HAB organisms, integrated techniques for observing physical, chemical, and biological variability on the scales relevant to physical forcing, improved representations of the physical processes that influence HAB dynamics, progress in physical-biological coupled models (including data assimilation models), and effective approaches for detecting and characterising HABs in the context of a Global Ocean Observing System. Rapid advances in bio-technology and instrumentation for measuring physical and bio-optical variability in the sea, along with more sensitive and selective methods for chemical analysis and stunning improvements in computational abilities, ensure that rapid progress can be made if efforts are focused and co-ordinated appropriately.

It is not our intention to specify or circumscribe the research directions for GEOHAB. Rather, we recommend that SCOR and IOC organise a Scientific Steering Committee (SSC), charged with identifying the scientific issues and detailed goals and objectives for an international study of the ecology and oceanography of harmful algal blooms. GEOHAB will foster scientific advancement in the understanding of HABs by encouraging and co-ordinating fundamental scientific research — multifaceted, international, and interdisciplinary, maintaining an ecological and oceanographic context consistent with the scientific goal of the programme. International, co-operative research on comparable ecosystems would be encouraged. In addition, GEOHAB will identify targeted studies on organisms, processes, methods, and observation technologies that are needed to support the interdisciplinary research. Improved

global observation systems will be required to resolve influences of environmental factors (anthropogenic and climate-related) on distributions and trends in HAB occurrence. This will be greatly facilitated through strong links between GEOHAB and the Global Ocean Observing System (GOOS).

A better understanding of the factors that regulate the dynamics of HABs in the context of physical and chemical forcing, ecosystem dynamics, and human influences will be used to improve strategies for monitoring and prediction of HABs. However, this is not the only benefit of GEOHAB. Through links to national agencies and international organisations responsible for protecting coastal resources and public health, the knowledge gained from GEOHAB will be used to develop international capabilities for more effective management and mitigation of HAB problems. This linking of basic scientific research directly to societal needs should result in an effective contribution of science to the protection of the intrinsic and economic value of coastal marine ecosystems.

ANNEX 11 - Graduate Education in Oceanography in Developing Countries as a Means to Understand Global Environmental Problems

Report of a Team Residency held at the Rockefeller Foundation's International Study Center, Bellagio, Italy
August 26-September 1 1998.

EXECUTIVE SUMMARY

A Team Residency at the Bellagio Study Center of the Rockefeller Foundation took place from August 26 to September 1 to carry out a workshop with the following general objective:

> *To develop a format for international graduate programs in the field of Ocean and Marine Environmental Sciences for a number of regions of developing countries and prepare proposals to appropriate aid agencies and foundations with the goal of implementing such programs, as an urgent requisite to support the international studies and research on global environment.*

Eleven highly reputed specialists took part in the workshop. Nine came from Australia (2), Argentina, Chile, Germany, India, Malaysia, South Africa and Thailand; two belonged to the following international scientific organizations: the Scientific Committee for Oceanic Research (SCOR), and the Intergovernmental Oceanographic Commission (IOC), respectively.

The five days of residence were largely devoted to the analysis of the information available on the subject. More than ten original documents and first hand oral contributions were presented and discussed. An attached list of the papers presented is included.

It was concluded that to reduce the gap between developing and industrialized countries regarding the ocean and marine environmental sciences, a proposal should be made to develop regionally graduate education programs in different parts of the world.

Building on the capacities of already existing institutions, the following four regions were selected to develop, enhance and upgrade graduate training programs on ocean and marine environmental sciences: Central and South America, Africa (south of the Sahara); South Asia (combining India, Bangladesh, Mauritius, Pakistan and Sri Lanka), and South East Asia (including Brunei, Cambodia, Indonesia, Laos, Malaysia, Myanmar, Philippines, Singapore, Thailand and Vietnam).

The program on graduate education in Oceanography established at the University of Concepcion, Chile has already set the pace for national and regional higher training in Central and South America, and it is recommended to follow at least some of its successful characteristics. Two of them are: a) the establishment of an International Faculty to support the program; and b) an annual input of fellowships for students of the region conveying funds from the international and bilateral assistance (UNESCO/IOC; SCOR; Germany's DAAD; ad hoc governmental agencies and universities from South Africa, Japan, France, Canada, USA and Australia), plus local support from Foundations and the National Research Council.

According to the model envisaged, the proposed Regional Graduate Schools should be supported with resources directed to organize manpower (including fellowships), ship time, library facilities and research funding. Although differences exist between the selected centers, it was considered that an annual total of US$ 300,000 – 500,000 requested from various international funding agencies was necessary to launch each program, not including funds for research.

It was recommended that the Team Leader applies to the Innovation Fund in order to finance a study of the funding agencies and grants available to start the new Regional Graduate Schools and help to consolidate the network existing in Latin America coordinated by the University of Concepcion.

An open rigorous procedure for periodic assessment should be established by an Internationally Advisory Panel of five to six scientists of the highest possible standing in each discipline of oceanography and the marine environmental sciences. The members of the Panel should be nominated by the Regional School and proposed to SCOR and IOC for suggestions and approval before they are formally appointed. In some cases it may be appropriate to include a representative of the interests of the major financial supporting organizations. The initial reviews may be biennial and later at some years interval. The process should not take more than six months for the submission of the final report.

A complementary Team Residency involving participants of the four Regional Graduate Programs here presented plus representatives of the developing countries of the Mediterranean and the Red Sea (Arab sub-region) and Central America and the Caribbean sub-region should be proposed to take place during 1999 or the year 2000.

ANNEX 12 - International Ocean Colour Coordinating Group (IOCCG)

The International Ocean Colour Coordinating Group (IOCCG) was established in 1996, initially under the auspices of the Intergovernmental Oceanographic Commission (IOC) of UNESCO. The group is now an Affiliated Program of the Scientific Committee on Oceanic Research (SCOR), which also provides infrastructure support.

Major Scientific Highlights:

Over the past two years, the IOCCG has been involved in a wide range of activities to meet the objectives of the group. These include the planning of scientific workshops, the provision of training opportunities, the dissemination of technical and scientific information in the field of ocean colour remote sensing and coordination with other relevant scientific programs such as those of CEOS and the various global observing systems.

In November, 1997, the IOCCG helped organize and sponsor an advanced training course on Remote Sensing of the Oceans, in Olmué, Chile. The IOCCG funded the participation of 6 scientists from outside South America, as well as provided two instructors for the course (Drs. Platt and Kawamura). The course was an outstanding success and did a great deal to mobilize, stimulate and coordinate marine remote sensing capability in Latin America.

The IOCCG has also been instrumental in organizing a number of technical workshops to address key issues in the development of ocean-colour technology and its applications and to provide appropriate advice to space agencies. The first of these workshops took place in October, 1997, in France, under the chairmanship of Prof. Morel. Members of the working group explored the feasibility of including a minimum set of common spectral channels on all future ocean-colour sensors. The working group produced a comprehensive report entitled "Minimum Requirements for an Operational Ocean-Colour Sensor for the Open Ocean" (IOCCG Report Number 1). This report should be printed within the next few weeks, and will be sent to various Space Agencies and Scientific Institutes.

The second of these workshops took place in June, 1998, Halifax, and dealt with the technical requirements for global-scale, operational, remote sensing of ocean colour in both Case 1 and Case 2 waters. Members of the working group also addressed the issues of complementarity that arise when more than one sensor with similar capabilities is in orbit at the same time. A draft report has been compiled by members of the working group (IOCCG Report Number 2), and is in the process of being reviewed. It is hoped that this report will be available by November this year, in time for the CEOS Plenary Session in Bangalore.

In order to advocate the importance of ocean-colour data to the global community, the IOCCG has developed a comprehensive homepage (www.ioccg.org), as well as published a series of scientific articles in the *backscatter* magazine (produced by the Alliance of Marine Remote Sensing). Articles cover a variety of topics ranging from information on ocean-colour sensors or their data products (MOS, OCTS, SeaWiFS) to information on national ocean-colour related programs (NASA SIMBIOS Program, Atlantic Meridional Transect).

Plans for the next year

The IOCCG will continue to coordinate and sponsor advanced training courses on remote sensing of ocean colour, particularly in developing countries. The first of these courses will take place in January, 1999, in Bangalore, India, as a component of a broader JGOFS training course on Biogeochemical Modeling of the Ocean. The second IOCCG-sponsored training course will take place in the summer of 1999, in Bangkok, Thailand. This remote sensing training course will be integrated with a summer school organized by the International Space University of Strasbourg. NASDA have already indicated that they are willing to co-sponsor the course, and the

Joint Research Center in Italy have agreed to help with the coordination.

The IOCCG also plans to convene a number of additional technical workshops in 1999, each of which should result in the publication of an IOCCG Report. These workshops include:

Calibration of ocean-colour sensors to common standards - chaired by Dr. Neumann

Establishing a standard validation data set - chaired by Dr. Ishizaka

Algorithms for Case 2 waters - chaired by Dr. Campbell

In addition, the IOCCG will continue its support for the CEOS initiative for an Integrated Global Observing Strategy (IGOS), through implementation of the Ocean-Biology Project. One of the recent initiatives of CEOS is the establishment of the Strategic Implementation Team (SIT) to examine the long-term applications of ocean colour data. The SIT was also instrumental in developing and executing the Integrated Global Observing Strategy (IGOS) using six demonstration projects that reflect and incorporate the principals of an IGOS. One of these projects was the Long-term Ocean Biology Measurements, which was handed over to the IOCCG to implement since its aims were entirely met by the activities of the IOCCG.

Lastly, the IOCCG has considered the problem of data merging at a global scale. The IOCCG recognizes that it should take responsibility for ensuring a long-term data series and that there should be some liaison with CEOS regarding this issue. While the IOCCG does not have the resources to produce a large, merged, data set, it could implement a strategy to achieve this. The IOCCG plans to make recommendations to CEOS promoting the idea of data merging, which would help funding agencies allocate their funds.

Major Milestones in the Program

One of the major milestones of the IOCCG has been the establishment of an IOCCG series of technical reports. These reports are written by members of specialized working groups established by the IOCCG to investigate various aspects of ocean colour technology and its applications. The reports will be made available to major international libraries, research institutes and space agencies and an ISSN assignment (International Standard Serials Number) will facilitate citation.

The first of these reports, IOCCG Report Number 1 (Minimum Requirements for an Operational Ocean-Colour Sensor for the Open Ocean), has already been well received by the scientific community and forms the basis for many recommendations to space agencies regarding the design of future sensors.

The second report, dealing with the technical requirements for global-scale, operational, remote sensing of ocean colour in both Case 1 and Case 2 waters, should available by the end of the year.

Benefits of the Affiliation to SCOR

The IOCCG has greatly benefited from the efficient and professional manner in which its funds have been managed by SCOR. In addition, the IOCCG has been strengthened by having visible links with one of the major international and intergovernmental organizations in the marine sphere. The affiliation of the IOCCG with SCOR also ensures an efficient mechanism for coordination with other SCOR programs, such as JGOFS or GLOBEC, or with intergovernmental organizations such as the International Council for the Exploration of the Sea (ICES), as well as non-governmental organizations such as the International Geosphere-Biosphere Program (IGBP).

Current Membership of the IOCCG

The IOCCG Committee consists of 19 members drawn from space agencies and ocean colour communities, selected to reflect a balance of both providers and users of ocean colour data as well as geographical

location. There are two types of committee members:

- scientific members, appointed in their personal capacities, who fill the needs of the IOCCG for specific expertise, and
- members representing various space agencies and other organizations which have an interest in ocean colour remote sensing and in providing support for the activities of the IOCCG.

The term of service is usually three years except where the member's participation is governed by a space agency nomination.

IOCCG Committee Members (1998)

Dr. J. Aiken	-	Plymouth Marine Laboratory, United Kingdom
Dr. J. Campbell	-	NASA HQ, Washington, USA
Dr. R. Frouin	-	Scripps Institution of Oceanography, USA
Dr. J. Ishizaka	-	Nagasaki University, Japan
Dr. O. Kopelevich	-	P.P. Shirshov Institute of Oceanography, Russia
Dr. A. Lifermann	-	CNES, France
Dr. C. McClain	-	NASA /GSFC, USA
Prof. A. Morel	-	Laboratoire de Physique et Chimie Marines, France
Dr. R. Navalgund	-	Indian Space Research Organization, India
Dr. A. Neumann	-	German Aerospace Research Establishment, Germany
Dr. J. Parslow	-	CSIRO Division of Fisheries, Tasmania, Australia
Dr. T. Platt	-	Bedford Institute of Oceanography, Nova Scotia, Canada
Dr. M. Rast	-	ESA/ESTEC, Netherlands
Mr. P. Schlittenhardt	-	Joint Research Center, Ispra, Italy
Dr. F. Shillington	-	University of Cape Town, South Africa
Mr. T. Tanaka	-	EORC/NASDA, Tokyo, Japan
Dr. O. Ulloa	-	Universidad de Concepción, Chile
Dr. J. Yoder	-	University of Rhode Island, USA
Dr. S. Yoo	-	Korea Ocean Research and Development Institute

Relevance of Ocean Colour to Societal Needs

Measurements of ocean colour from space allow oceanographers to view the global distribution and concentration of chlorophyll pigments (an index of phytoplankton biomass) in the oceans. There are three broad applications of this data. Firstly, since phytoplankton fix carbon dioxide during photosynthesis, ocean colour data can be used to help understand and quantify the ocean-atmosphere fluxes of carbon. This is of major importance in climate change research. Secondly, ocean colour data may be used in the general area of coastal zone management, such as monitoring toxic algal blooms or coastal pollution, as well as in fisheries management. Ocean-colour maps of pigment distribution may be used directly to help predict the presence of fish shoals for operational fishing fleets, or they may be used to provide long-term data for analysis of decadal trends in exploited fish stocks. Lastly, since phytoplankton control the optical turbidity in most parts of the ocean they also control the manner in which the mixed layer heats up under the influence of the sun. The transmissibility of visible light through the ocean is an important element in physical models that calculate the depth and temperature of the mixed layer, which is critical for weather forecasting in maritime areas.

About the IOCCG

The International Ocean Colour Coordinating Group (IOCCG) is composed of a committee of experts in the field of satellite ocean colour, which acts as a liaison and communication channel between users, managers and agencies in the ocean colour arena. The IOCCG promotes international cooperation and coordination in the acquisition, calibration, validation, distribution and utilization of ocean colour data and also aims to broaden the user community for ocean-colour data, particularly in developing countries, through advanced training courses.

Remotely-sensed images of ocean colour, calibrated as chlorophyll concentration, (an index of phytoplankton biomass) provides the only window into the ocean ecosystem on synoptic scales. Chlorophyll concentration is the single most important property of the marine ecosystem and is central to understanding in fields such as ocean biogeochemistry, coastal zone management, fisheries, harmful algal blooms and mixed-layer dynamics.

In the past two years, three satellites carrying ocean-colour sensors have been launched by various nations (one of these has since ceased to function), with a further four sensors scheduled for launch in the next year. Many of these missions have different technical and hardware requirements and not all provide global coverage. For this reason, the IOCCG established a task force to examine the requirements for global-scale, operational, remote-sensing of the oceans at a desirable time scale. The specialized working group recommended that at least three global satellite ocean-colour sensors should be in orbit at one time. Clearly, there is a need for coordination of these satellites as well as for the acquisition, distribution and calibration of the data.

ANNEX 13 - 1997 Final Financial Statement and Budget Comparison

	BUDGET	ACTUAL
INCOME		
Membership	200,000	209,695
ICSU Grant / JGOFS	21,000	21,000
ICSU Grant / GLObEC	21,000	21,000
IGBP Grant / GLOBEC	10,000	9,530
START Fellowship	4,471	4,471
IOC Contract to SCOR	38,000	36,000
ICSU Support / GOOS activities	25,000	23,167
NSF Grant / Travel Awards	70,000	52,653
NSF Grant / Science Activities	180,000	208,276
Funds received in trust for IOCCG		52,280
IOC Contract for IOCCG		20,000
Miscellaneous	50	-
Total SCOR Income	**569,521**	**658,072**
SCIENTIFIC EXPENSES		
Sea Ice Ecology WG	15,000	15,000
Sea Level / Coastal Erosion WG	1,000	-
Sardine and Anchovy WG	10,000	8,050
Fish Harvest Impacts WG	400	408
Sea Level / Muddy Coasts WG	15,000	30,354
Bathymetry WG	12,000	8,809
Double Diffusion WG	4,500	4,352
Air-Sea Fluxes WG	10,000	6,190
JGOFS	120,000	110,431
GLOBEC	120,000	100,146
SOLAS	3,500	3,466
Total SCOR Subsidiary Bodies	**311,400**	**287,206**
Other Scientific Activities		
iAnZone	1,500	1,563
GOOS Coastal Workshop	25,000	23,167
AOSB Symposium	5,000	5,000
Travel Awards	70,000	52,653
START Fellowship	4,471	4,471
IOCCG Activities		72,280
ICSOS planning expenses		10,000
Miscellaneous NSF-funded activities	-	2,451
Total	**105,971**	**171,585**
TOTAL SCIENTIFIC EXPENSES	**417,371**	**458,791**

continued

RELATED SCOR EXPENSES		
Strategie Review Meeting	8,000	9,366
Representation	6,000	5,380
Publications	10,000	10,738
Executive Committee Meeting	28,000	30,243
Total	**52,000**	**55,727**
TOTAL NON-ADMIN. EXPENSE	**469,371**	**514,518**
	BUDGET	**ACTUAL**
SCOR SECRETARIAT EXPENSES		
Salaries and Benefits	118,000	116,319
less allocated to programs		30,000
		86,319
Communications	7,000	5,422
less allocated to programs		2,000
		3,422
Office Equipment	5,500	5,824
Audit and Accounting Services	6,000	6,800
JHU overhead charges	19,000	18,765
Bank charges	50	45
Miscellaneous	4,500	4,689
TOTAL SECRETARIAT EXPENSES	**160,050**	**125,864**
TOTAL SCOR EXPENSES	**629,421**	**640,382**
Excess of Income over Expenses		17,690
Accumulated Balance 1/1/97		129,254
Accumulated Balance 12/31/97		**146,944**

ANNEX 14 - Nomination and Election Procedures

PROCEDURES FOR THE NOMINATION AND ELECTION OF SCOR OFFICERS

1. A call for nominations from national committees and affiliated organizations must be issued more than 6 months before the General Meeting Nominations should include a suggestion of the position for which the candidate is being proposed, and a brief *curriculum vitae*. Candidates proposed must be Nominated Members of SCOR (see Constitution 8a). National committee may propose candidates from their own or any other member country.

2. A Nominating Committee of three SCOR members will be appointed by the Executive Committee meeting prior to each General Meeting at which an election will take place. The Nominating Committee will normally include the Past-President as its Chairperson. The role of the Nominating Committee is to provide an Executive Committee for SCOR that is balanced in terms of disciplinary and geographic distribution.

3. Nominations will not be accepted later than 4 months before the General Meeting except as provided for in clause 4.

4. Between 2 and 4 months before the General Meeting, the Nominating Committee, after scrutinizing the nominations received, may seek additional nominations for specific positions through direct consultations with national committees and/or affiliated organizations. This process may be needed in order to maintain the appropriate disciplinary and geographic balance on the Executive Committee.

5. The Nominating Committee will prepare a final slate of candidates, one per position, and will confirm that the members of this slate are willing to serve.

6. Two months before the General Meeting the Nominating Committee will announce its proposed slate and send it, along with all nominations received, to all voting members of SCOR as defined in Clause 21 of the SCOR Constitution (Nominated Members and Representative Members of Affiliated Organizations). Nominations received as a result of action taken under clause 4 will be identified.

7. Clause 22 of the SCOR Constitution states that when elections are held "only one Nominated Member from each Committee for Oceanic Research shall have a vote. One Representative Member from each Affiliated Organization may also vote."

8. No further nominations be allowed after the Nominations Committee has announced its slate of candidates.

9. If three or more national committees do not agree with the proposed slate of the Nominations Committee, they may request that a formal election be held and that all nominations received be included on the ballot. Notice of a request must be received not less than 2 weeks before the start of the General Meeting and the election will be held on the last day of the General Meeting.

10. If no vote is requested the slate proposed by the Nominating Committee will be declared elected at the end of the General Meeting.

11. This procedure has been approved by the 24th General Meeting of SCOR (Amsterdam 1998) and may only be modified by a majority decision taken at a General Meeting.

ANNEX 15 - Scientific Committee on Antarctic Research

Southern Ocean Studies - Information document for SCOR, November 1998

Summary: This document outlines the current oceanographic activities undertaken within SCAR, especially through its global change programme (GLOCHANT). It examines in particular the existing links to other organizations with active and developing research programmes in the Southern Ocean, and identifies possible ways of promoting shared interests in the region.

1. SCAR oceanographic activities

SCAR sets its scientific priorities and establishes some focussed multinational programmes through discipline-based working groups and through shorter-lived specialist groups. At present, there is no working group on oceanography. Oceanographic research is supported largely through the Group of Specialists on Global Change and the Antarctic (GLOCHANT), together with programmes under the Working Groups on Biology and Glaciology. Four programmes are reviewed briefly below.

1.1 Programmes within GLOCHANT

GLOCHANT was established by SCAR to identify the priority areas for Antarctic and Southern Ocean global change research. The group established several programmes to address specific problems, but also sought collaboration with existing global change activities. GLOCHANT now includes nine projects (listed at the end of this document), representing most of the global change programmes active in the region.

1.1.1 ASPeCt

The ASPeCt programme is concerned with sea-ice physics in relation to climate. It has an ambitious fieldwork programme aimed at producing a circum-Antarctic sea ice climatology as well as studying key processes. The programme has also undertaken the processing of archive sea-ice data to make them compatible with the new climatological data. Scientists in ASPeCt have produced a manual for ice observation, including data entry software and a CD-ROM of example images to improve the quality of data records.

1.1.2 ANTIME

The ANTIME programme is designed to resolve the glacial history from the continental shelf, particularly the glacial extent, and the determination of palaeo ice sheet and ice stream morphology. It will examine the relationship between ice sheets and continental shelf banks, and similarly between ice streams and shelf troughs. It will also develop a chronological control between continental shelf and onshore records; and the interpretation of high resolution event stratigraphy for the Holocene, from sedimentary investigations in lake, coastal zone, fjord, and shelf sequences.

ANTIME is focussed on twelve priority regions which characterise the range of ice morphologies and climatologies that exist in the circum-Antarctic. These priority regions will also be used to plan future fieldwork and data correlation, and involve the linking of onshore glacial and coastal projects with marine projects on the continental shelf and slope, together with deep ocean coring projects administered through the IMAGES programme . Extensive data sets have already been collected in many of these regions and future research is planned with national and/or international logistic support for each of these regions over the period 1998 to 2003.

1.2 Other programmes

1.2.1 EASIZ (WG Biology)

The EASIZ programme is concerned with the ecology of organisms in the sea-ice zone. It already has an active field programme, including both research cruises and studies of the nearshore system from research stations.

1.2.2 IMASS (WG Glaciology)

The ISMASS programme is concerned with the mass balance of the Antarctic ice sheet. Interaction between the floating ice shelves and the ocean forms a potential element of this developing programme.

2. Links to non SCAR activities

2.1 SCOR and IGBP

2.1.1 GLOBEC and JGOFS

In addition to SCAR-based programmes, GLOCHANT is also attended by representatives of programmes sponsored by other bodies. SCAR has now indicated that it wishes to strengthen its relationship with GLOBEC and JGOFS by nominal co-sponsorship of the Southern Ocean regional studies in these two programmes.

2.1.2 ANTIME potential relationship to IMAGES

ANTIME has a formal linkage to IMAGES which was developed at the initial meeting of ANTIME. Three members of the ANTIME SSC represent the three key zones of IMAGES activities, and also interface with ODP. A key area of collaboration is in the understanding of sea-ice extent and characteristics during the glacial and transition periods, and the correlation of proxy climate records from the shelf to the deep ocean.

2.2 WCRP

2.2.1 ASPeCt as a potential CLIC component

WCRP is developing a new activity which will link together studies of cryosphere systems in global climate. The CLIC (Climate and Cryosphere) initiative may include the ASPeCt programme.

3. A SCAR focus on oceanography

3.1 Overview of current Southern Ocean issues

The current emphasis on global-scale processes has increased the importance of oceanographie studies in the contexts of present and past climate, and of the potential impacts of future environmental change. SCAR recognizes the need to continue to support cross-disciplinary studies, and to ensure that key scientific problems are addressed in the most appropriate manner. Amongst these problems are

Contemporary Antarctic processes with impacts on the Earth climate system

- Antarctic Bottom Water formation and its effect on global thermohaline circulation
- Ocean-atmosphere teleconnections - interannual and subdecadal variation
- Oxygen utilization rates in the Southern Ocean (water mass renewal rates)
- Antarctic land- and sea-ice and feedback to global climate and oceanic interaction with ice-shelves
- Sea ice: volume and coverage, air-sea heat, momentum and water vapour exchange and tracer input processes
- Ice-sheet mass balance and sea-level - effects on the global hydrological cycle
- Oceanic and atmospheric carbon, nitrogen and sulphur cycles - understanding biogeochemical cycles, especially micronutrient control on productivity

Present and potential impacts

- Effects of documented local warming on physical and biological systems
- Loss of ice shelves
- Consequences of changes in sea ice extent and thickness

Past environments - understanding the Earth's climate history

- Sediment records of changes in climate, especially understanding palaeo-proxies

3.2 Cross-programme workshops promoted through GLOCHANT

GLOCHANT acts as a forum for interaction between programmes. The group is actively stimulating collaborative activities in order to address cross-disciplinary problems such as the links between the palaeoenvironmental record and contemporary processes, and the links between physical forcing and biological response. Interaction is through shared expeditions and research cruises, and collaborative workshops and symposia. Three such workshops with oceanographic foci are planned.

3.2.1 Interannual variability in the Southern Ocean

This will be held in the UK in August 1999, and will address the pattern of interannual variability from both physical and biological perspectives. Sponsorship for the meeting is sought from several bodies, including SCOR.

3.2.2. Coupling biology and physics in sea-ice systems (ASPeCt and GLOBEC)

3.2.3 Overwintering strategies of Antarctic marine organisms (EASIZ and GLOBEC)

3.3 SCAR Task Group on Oceanography

At their meeting in Chile in July 1998, SCAR national delegates agreed to examine the status of research in the Southern Ocean. A small Task Group was established to assess whether further effort is needed to sustain or coordinate oceanographic research. This group has not yet completed its task, but an initial survey indicates that the combined scope of all of the SCAR and non-SCAR programmes is very broad. Few topics which could be viewed as being of key importance did not already have a 'home' in one of these programmes. There may, however, be some areas where strengthened interaction between programmes could be effective.

Appendix. The participating programmes in SCAR GLOCHANT

The projects which participate in **GLOCHANT** are listed below. **GLOCHANT** also has representation from WCRP and IASC, and liaises through project representation with SCOR and IGBP where appropriate.

Polar climate system

- **ASPeCt** (SCAR GLOCHANT - potential WCRP) - sea ice physics and climate
- **ISMASS** (SCAR WG-Glaciology) - ice-sheet mass-balance

Palaeoenvironmental studies

- **PICE** (SCAR GLOCHANT-PAGES) - long-term climate change records in ice cores
- **ITASE** (SCAR GLOCHANT-PAGES) - recent history of climate change
- **ANTIME** (SCAR GLOCHANT-PAGES) - history of the Antarctic continental margin

Ecological and biogeochemical studies in the Antarctic and Southern Ocean

- **EASIZ** (SCAR WG-Biology) - marine coastal ecology
- **SO-JGOFS** (IGBP, SCOR) - ocean biogeochemistry
- **SO-GLOBEC** (IGBP, SCOR, IOC) - marine plankton dynamics
- **BIOTAS** (SCAR WG-Biology) - terrestrial ecology

Request from SCAR for SCOR sponsorship of an International Workshop on Large-scale variability in the Southern Ocean - patterns, mechanisms and impacts

from: Julian Priddle, Chair of SCAR GLOCHANT

SCOR is invited to co-sponsor a workshop on Large-scale variability in the Southern Ocean - patterns, mechanisms and impacts. The workshop will be broadly multidisciplinary and will be designed to consolidate and advance our knowledge of Southern Ocean interannual and decadal variability. Participation in the workshop will be predominantly by invitation, and all those taking part will be expected to contribute both during the course of the workshop and to the resulting publication.

The workshop will be held at the British Antarctic Survey (Cambridge, UK) from 2-7 August 1999. Local contacts are Julian Priddle, a biological oceanographer (j.priddle @bas.ac.uk), and John King, a meteorologist (j.c.king@bas.ac.uk).

Funding from SCAR has been obtained, and WCRP has also indicated that it will support the workshop. A Scientific Steering Committee has been established; it includes Roger Harris and representatives of SO-GLOBEC and SO-JGOFS (together with CLIVAR and others).

I am aware that SCOR often provides support for delegates whose countries would not normally be able to fund their participation. I would anticipate that both Russian (and other ex-Soviet bloc) and South American scientists could make a valuable contribution.

Background:

Study of long-term change in the Southern Ocean must acknowledge natural variability at interannual and decadal scales. Such variability has been documented using a wide range of records, but interpretation remains equivocal.

The workshop will examine a wide range of data sets and their interpretation, and compile a synthesis of Southern Ocean large-scale variability. The workshop is intended to be broadly multidisciplinary, and will examine three aspects of large-scale variability:

The nature of interannual and decadal change in the physical environment

There is now a wide range of data on interannual to decadal change in the Southern Ocean. Information derived from satellites provides information on sea ice distribution, sea-surface temperature and other variables, with synoptic coverage of the entire Southern Ocean over about 25 years. At the same time, there are more local records and proxies which, if placed in the context of the larger-scale data, may allow description of change over longer time scales, with some data being available from the beginning of the century. There is some evidence that the pattern of change may have been more complex than suggested by recent interpretations of satellite data.

Potential underlying mechanisms: consideration of teleconnections with external forcing

Although the character of large-scale variability has been know in some detail for some time, there remains considerable uncertainty over the extent to which the variability is coherent around Antarctica, and how much is due to intrinsic behaviour of the Southern Ocean system as opposed to external forcing

Use of a comprehensive coupled data series and models, extending temporal coverage with validated local records, should allow further interpretation of the links between Southern Ocean phenomena and potential forcing from lower latitude features.

The implications of large-scale variability in the Southern Ocean

An understanding of large-scale variability has considerable importance in both physical and biological contexts. These include the determination of the coupling between the Southern Ocean and the global climate system, the interpretation of secular environmental change, possible variation in the biogeochemical role of the Southern Ocean, and the exploitation of marine living resources in the context of a comprehensive conservation framework.

ANNEX 16 - Acronyms and Abbreviations used in SCOR Documents

AABW	Antarctic Bottom Water
AGCM	Atmospheric Global Circulation Model
ANTIME	Antarctic Ice Margin Evolution
AOGCM	Atmosphere-Ocean Global Circulation Model
AOSB	Arctic Ocean Science Board
ASI	Air-Sea Interface
ASPECt	Antarctic Sea Ice Processes, Ecosystems and Climate (SCAR-GLOCHANT)
ATOC	Acoustic Thermometry of Ocean Climate
CCC	Cod and Climate Change Program (ICES-GLOBEC)
CCCC	Climate Change and Carrying Capacity (PICES-GLOBEC)
CEOS	Committee on Earth Observing Satellites
CLIVAR	Climate Variability and Prediction program (WCRP)
CMAS	Confederation Mondiale des Activites Subaquatiques
CMM	Commission for Marine Meteorology
COSPAR	Committee on Space Research (ICSU)
CPR	Continuous Plankton Recorder
DBCP	Drifting Buoy Cooperation Panel (IOC-WMO)
DOVETAIL	Deep Ocean Ventilation Through Antarctic Intermediate Layers (iAnZone)
ECOR	Engineering Committee on Oceanic Resources
ENSO	El Niño-Southern Oscillation
GCOS	Global Climate Observing System (WMO, IOC, ICSU, UNEP)
GLOBEC	Global Ocean Ecosystem Dynamics (SCOR, IGBP)
GLOCHANT	Group of Experts on Global Change in Antarctica (SCAR)
GLOSS	Global Sea Level Observing System (of IOC)
GOOS	Global Ocean Observing System (IOC, WMO, UNEP, ICSU)
GPS	Global Positioning System
GSP	Greenland Sea Project
HAB	Harmful Algal Blooms
IABO	International Association of Biological Oceanography (IUBS)
IAMAS	International Association for Meteorology and Atmospheric Sciences (IUGG)
iAnZone	International Antarctic Zone
IAPSO	International Association for the Physical Sciences of the Ocean (IUGG)
ICES	International Council for the Exploration of the Sea
ICSOS	International Conference on Satellites, Oceanography and Society
ICSU	International Council for Science
IGAC	International Global Atmospheric Chemistry Programme (IGBP)
IGBP	International Geosphere-Biosphere Programme (ICSU)
IGOSS	IOC/WMO Integrated Global Ocean Services System
IMAGES	International Marine Aspects of Global Change program (IGBP/PAGES, SCOR)
InterRidge	International RIDGE studies
IOC	Intergovernmental Oceanographic Commission (of UNESCO)

IOCCG	International Ocean Colour Coordinating Group
IPHAB	IOC Intergovernmental Panel on Harmful Algal Blooms
IPO	International Project Office
IUBS	International Union of Biological Sciences
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
IUPAC	International Union of Pure and Applied Chemistry
JAMSTEC	Japanese Ministry of Science and Technology
JGOFS	Joint Global Ocean Flux Study (SCOR, IGBP)
JOIDES	Joint Oceanographic Institutions for Deep Ocean Sampling
LOICZ	Land Ocean Interactions in the Coastal Zone (IGBP)
NADW	North Atlantic Deep Water
NAO	North Atlantic Oscillation
NATO	North Atlantic Treaty Organization
ODP	Ocean Drilling Program
OOPC	Ocean Observations Panel for Climate (GCOS)
PACON	Pacific Science Congress on Marine Science and Technology
PAGES	Past Global Changes (IGBP)
PICES	North Pacific Marine Sciences Organization ("Pacific ICES")
SAR	Synthetic Aperture Radar (Satellite)
SCAR	Scientific Committee on Antarctic Research (ICSU)
SCOPE	Scientific Committee on Problems of the Environment (ICSU)
SCOR	Scientific Committee on Oceanic Research (ICSU)
SOLAS	Surface Ocean - Lower Atmosphere Study (IGBP, SCOR)
SOOP	Ship of Opportunity Program
SPACC	Small Pelagic Fishes and Climate Change (GLOBEC)
SSC	Scientific Steering Committee
SST	Sea Surface Temperature
TEMA	Training, Education and Mutual Assistance
TOS	The Oceanography Society
UNESCO	United Nations Educational, Scientific, and Cultural Organization
URSI	Union Radio Scientifique Internationale
WCRP	World Climate Research Programme (WMO, IOC, ICSU)
WG	Working Group
WGASF	JSC-CCCO Working Group on Air-Sea Fluxes
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment (WCRP)
WQRP	Weddell Polynya Quick Response Program (iAnZone)
WWW	World Wide Web