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OF THE
SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH**

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REPORT OF THE TWENTY-FIRST GENERAL MEETING OF SCOR

Göteborg, Sweden
September 15 to 17, 1992

The Twenty-first General Meeting of SCOR was hosted by the Royal Swedish Academy of Sciences, the University of Göteborg and the Chalmers Technical University. It took place at the Conference Centre of the Chalmers Technical University from September 15 to 17, 1992. The President of SCOR, Professor Jarl-Ove Strömberg, chaired the meeting. A complete list of participants is given in Annex I. The meeting was followed, on September 18, by a scientific symposium on "Marine Hydrothermal Systems and the Origin of Life" which was organized and presented as the final meeting of SCOR Working Group 91. The program for this symposium appears as Annex II. A list of the acronyms and abbreviations used in the report may be found on the last page.

1.0 OPENING

1.1 Welcoming Remarks

The President welcomed the participants to Göteborg and expressed the best wishes of the Rectors of the University of Göteborg, the Chalmers Technical University and of the Permanent Secretary of the Royal Swedish Academy of Sciences. He introduced Professor Inger Wallentinus, Director of the newly-established Institute of Marine Science at the University of Göteborg.

Professor Strömberg noted that this General Meeting would mark the thirty-fifth anniversary of the establishment of SCOR in 1957. It was at a meeting in Göteborg during the International Geophysical Year in January 1957 at which the need for a new international organization in marine science was first discussed. This meeting, which was hosted by Professor Börje Kullenberg, involved such leading oceanographers as Professor Anton Brunn, Dr. Roger Revelle and others. As a result of these discussions in Göteborg, the founding meeting of SCOR took place in Woods Hole in August 1957.

1.2 Approval of the Agenda

The Agenda for the meeting was reviewed and approved as distributed with the addition of a report on former WG 54 under item 2.1, a presentation on TOGA COARE in item 2.3.1 and the addition of item 5.5, Other Organizations, in order to permit the introduction of information on the Commission for Marine Geography. The Agenda as approved is given in Annex III.

1.3 Report of the President

"I am very pleased to see at this meeting such a large number of nominated members of SCOR as well as representatives of organizations closely linked with SCOR activities. Thus I would especially like to welcome Dr. Wolfgang Fennel, now a German Nominated Member of SCOR, who so capably arranged our last General Meeting in Warnemünde two years ago. I also see some familiar friends and members of SCOR like Professor Henry Charnock of the U.K. and Dr. Robert Stewart, Canada, who is here this time as a representative of ICSU. Further, we have with us Dr. Phillip Williamson of the IGBP, Dr. Gunnar Kullenberg, the Secretary of IOC, and Dr. Ray Godin, Secretary of the CCCO. Dr. Kullenberg's father took an active part in SCOR's early years as the professor of the Department of Oceanography of this University, where an important meeting was held in 1957, leading to the formal creation of SCOR later that year. We also have an observer here, Dr. Gennady Korotaev from Sevastopol, the Ukraine. This country is looking into the possibility of becoming a member of SCOR and is in the process of arranging with its marine scientific community an infrastructure to meet with the specific regulations of SCOR.

I wish you all a warm welcome to Göteborg and this General Meeting.

I have already mentioned that this year we have the 35th anniversary of SCOR. It is very opportune to have this General Meeting in Göteborg, since in January 1957 a meeting was held at the Oceanographic Institution of the University of Göteborg where the final discussions of setting up a global, marine scientific organization were held. This was done in conjunction with a meeting of the IGY working group on oceanography and some 50 scientists participated. The founding meeting of SCOR was then held at Woods Hole in the U.S. on August 28-30, 1957. Dr. Torben Wolff will give an account of the early years of our organization later during this General Meeting.

Coming to the activities of SCOR since our last General Meeting, I would first of all like to refer you to the SCOR Proceedings from our Hamilton Meeting with the Executive Committee last November. Therein you can find what took place between 1990 and 1991. Since that meeting only 10 months have elapsed and this obviously restricts the number of activities that we have had.

We have had no change in memberships since the XXth General Meeting in Warnemünde, nor have we had any changes in category level of member countries. This means that we still have 37 members. Most members are paying their yearly contributions to SCOR in good time, but some countries are lagging behind. Despite letters of encouragement to live up to their responsibilities under the SCOR Constitution, we have had no success or, in some cases, not even an answer. This is, of course, disturbing, and we should analyze the possible reasons for this. There is no doubt that in some of the cases domestic economic problems are the prime reasons for the missing payment. In other cases this does not seem to be the major problem, and we do not seem to have the most appropriate contacts with the scientific community in these countries. We are, however,

continuing our efforts both to increase the number of member states and to encourage a rise in category levels among existing members.

Thanks to special contributions from the US, UK and Canada as well as through grants and contracts with national and international organizations, the financial situation looks somewhat brighter today than when I reported last year to the Executive Committee in Hamilton. Even so, we have to consider very carefully how to use SCOR funds in the best way to promote oceanic research. In other words, we have to set priorities. I emphasized this strongly in Hamilton and again I would like to refer you to the Proceedings from that meeting. A mix of what has traditionally been the strong part of SCOR's activity - i.e. relative short-lived working groups - and involvement in large-scale and long-term projects is, in my view, a healthy and scientifically justifiable development.

I believe, however, that our long-term activities must also be subject to scrutiny so they do not continue for a longer time than is scientifically motivated - in other words there should always be a "sunset clause" for every activity (see discussion at end of item 2.0).

When we are to consider the establishment of new working groups I would like to repeat the criteria I listed during our meeting in Hamilton. Although they are not exclusive, they emphasize some of the important points:

- How urgent is the project?
- Does the project overlap or duplicate already ongoing activities?
- Is there a real need for SCOR's involvement and is the project relevant to many nations - not only a few?
- Is the project ready to be taken on by SCOR?
- How well is SCOR covering the various marine scientific disciplines? (We need both a balance and in many cases an integration between the disciplines.) And finally and foremost,
- Is the science of the project good and viable?

With this as a background, your consideration of the proposals for new working groups during this Meeting may result in the acceptance of 2-3 new groups on scientifically "hot" issues. At this point I would also like to stress the need for a good national spread of working group members and ask you to keep this in mind when new groups are established. The use of corresponding members, who sometimes believe they are considered secondary, may have to be reconsidered.

As to other activities the biggest change is with the CCCO and what will develop in the realm of physical oceanography and climate in the future. Discussions have taken place between WMO, IOC and ICSU and we will look into the problems arising when we come to this point in the agenda.

The JGOFS SSC has not met during the last year but will do so in Taiwan this

October. I note with particular pleasure that the JGOFS Implementation Plan is now in press. This is a big step forward.

A first international GLOBEC Workshop held at Solomons, MD, USA was reported on at Hamilton and as you can see in the Proceedings the Executive Council accepted GLOBEC as a SCOR Programme. Since then another meeting (called "GLOBEC-0") was held in Ravello, Italy, on March 31-April 2 this year. The report is in your Meeting files. With the further steps taken this year and plans for several working groups GLOBEC is well on track.

Besides participating in the GLOBEC meeting I represented SCOR at the IOC Executive Council meeting last March in Paris. It should be noted that this was the first time of which I am aware that there has been a particular Agenda item dealing with SCOR. I take this as a sign of healthy relations between the two organizations. SCOR was well represented at the IOC meeting by our Executive Director and Secretary besides myself.

I note that a number of SCOR publications are either published, in press or ready to go to print. Published is the GLOBEC Workshop Report (Solomons), and in press are a number of reports (JGOFS North Atlantic Bloom Experiment papers, JGOFS Implementation Plan, BIOMASS Final Colloquium Proceedings, report of WG 91). At last I would like to mention that Working Groups 75, 76 and 80 have presented their final reports. This means that nearly all of our old groups have finished their work.

Since we last met, the SCOR Secretariat and the Executive Director have moved from Halifax to The Johns Hopkins University in Baltimore. I wish to express SCOR's gratitude to Canada for hosting the Secretariat at Dalhousie University from 1980 to 1992 and to the US SCOR Committee, the Ocean Studies Board of the National Academy of Sciences, for its assistance and support in this relocation.

I must finally take this opportunity to tell you that some well known and highly esteemed oceanographers and friends of SCOR have died since our last General Meeting. In Hamilton we paid respect to Professor Roger Revelle. Since then Professor Börje Kullenberg died in December 1991 and Professor Henry Stommel in January 1992. I would like you to join me in honouring these distinguished scientists, colleagues and friends with a minute of silence."

1.4 Appointment of an *ad hoc* Finance Committee

In accordance with the Constitution of SCOR, the General Meeting appointed a Finance Committee to review the state of SCOR finances and to draw up a budget for 1993. The members of the Committee were Brian Rothschild (Chairman), Ian Jones, Jeffrey Thompson and Gerold Wefer. The Finance Committee report was presented under agenda item 3.3.

2.0 SUBSIDIARY BODIES

Many SCOR Working Groups are cosponsored by the Intergovernmental Oceanographic Commission of UNESCO. SCOR gratefully acknowledges the support for some of the activities described here from the IOC, the International Council of Scientific Unions, the Royal Society, the Government of Canada and the US National Science Foundation.

2.1 Arising from Former Working Groups

WG 54 Southern Ocean Ecosystems and their Living Resources

The Chairman of WG 54 had informed the SCOR Secretariat that the Proceedings of the BIOMASS Colloquium would be published by Cambridge University Press in early 1993. BIOMASS (Biological Investigations of Antarctic Marine Systems and Stocks) was an international effort of SCAR, cosponsored by SCOR, with field programs in the early and mid-1980s which focused on the stocks of phytoplankton, zooplankton, frill, fish and birds of the Southern Ocean as well as the physical oceanography of the region.

WG 75 Methodology for Oceanic CO₂ Measurements

Terry Healy reported that the final report of WG 75 has now been sent to UNESCO for publication in the series *Technical Papers in Marine Science*. Many of the recommendations of WG 75 are being considered by the JGOFS/CCCO CO₂ Advisory Panel. As Executive Committee Reporter for former WG 75, he expressed thanks to the group for completing a task made more difficult by the renewed controversy surrounding the measurement of dissolved organic carbon.

WG 76 Ecology of the Deep-sea Floor

The Chairman of WG 76 had just sent the MS for the group's final report to the Executive Director. It was introduced by Jarl Strömberg who explained that one reason for the long delay in its production was probably the lack of clarity in the terms of reference originally given to WG 76. He drew attention to the conclusions and recommendations which include a call for a new emphasis on modelling of deep-sea benthic ecosystems, standardization of the sampling equipment and analytical procedures (such as standard sieve sizes), a focus on understanding of processes such as ingestion, excretion, respiration, nutrient and gas fluxes, etc. WG 76 also recommended a series of deep-sea benthic sampling program ("large-scale disturbance experiments") requiring international collaboration and oversight by an organization such as SCOR. The General Meeting felt that more detailed proposals for such a program would have to come from the scientific community itself.

The General Meeting considered a number of options for the publication of this report and it was agreed that this question should be resolved by the Executive Committee.

WG 77 Laboratory Tests Related to Basic Physical Measurements at Sea

The Executive Committee Reporter for former WG 77, Professor Siedler, recalled that the XX General Meeting had agreed to disband WG 77 pending receipt of its final report and had established a small editorial group to assist the Chairman with this task. The Chairman has since retired earlier than expected, without completing the report. Unfortunately, the data set from the CTD intercomparison experiments conducted by WG 77 is in a format which would be extremely difficult for other scientists to use. In addition, more recent *in situ* CTD intercomparisons conducted by major institutions, as well as technological developments, render the WG 77 results out-of-date. The General Meeting agreed, with regret, that further efforts to produce a WG 77 final report were probably not scientifically justified.

WG 78 Determination of Photosynthetic Pigments in Seawater

This WG was also disbanded by the XX General Meeting pending submission of its final report. Following some delay, the editorial group established by SCOR has made substantial progress with this effort and a firm schedule for its completion has been established in consultation between the Chairman of WG 78, the SCOR Executive Director, the Executive Committee Reporter, Professor Fournier, and the UNESCO staff who will be responsible for the final production of the report.

It has been agreed that the results of the three pigment methodological workshops conducted by WG 78 will be combined in one volume, a monograph which will serve as a practical handbook for pigment analysis, including explicit guidelines for modern methods, a literature review and a comprehensive compilation of pigment data. It is expected that the camera-ready manuscript would be delivered to UNESCO in mid-1993 for publication in the oceanographic monograph series under the title "Phytoplankton Pigments in Oceanography: Guidelines to Advanced Methods".

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

At its meeting in late 1991, the Executive Committee recommended that WG 80 be disbanded pending the publication of two reports; a summary report which would appear as a special issue of *Marine Chemistry*, and a more detailed document with technical annexes for publication by UNESCO. The Chairman, Dr. Whitfield, reported to the General Meeting that the plans to publish the summary report in *Marine Chemistry* had not been successful, however the more complete report should be available for submission to UNESCO by the end of 1992. The Chairman and members of WG 80 are continuing to investigate ways of providing a wider publication for the summary report and key recommendations of the working group.

SCOR/ICES/UNESCO/LAPSO Joint Panel on Oceanographic Tables and Standards

Although the XX General Meeting of SCOR agreed that SCOR sponsorship of the Panel should be discontinued, the Chairman of JPOTS had requested support for a meeting to address problems arising from the introduction of the T_{90} temperature scale. The Executive Committee suggested in late 1991 that this might be a topic for a SCOR Working

Group, however, no further action had been taken. The report from ICES to the General Meeting noted that this topic was also under consideration by its Working Group on Oceanic Hydrography.

During the General Meeting, a group of interested individuals (Charnock, Stewart, Siedler and Muench) discussed the matter and agreed that the T_{90} expression for temperature should be properly incorporated into the various marine algorithms, but that this task does not require the reconstitution of JPOTS. It was suggested that Dr. Gieskes arrange for the results of ongoing work on this problem to be reviewed and endorsed by the appropriate members of the former Panel prior to their dissemination by IOC (as was done for earlier JPOTS products). Again, following earlier precedents, an announcement should be placed in relevant oceanographic journals.

The President of IAPSO, which also sponsored JPOTS, expressed his support for this approach.

2.2 Current Working Groups

Participants were reminded by the President 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 presented the relevant report for discussion by the Meeting.

WG 83 Wave Modelling

Dr. Asai recalled that WG 83 was established in 1986 and has held annual meetings since then, culminating in a final meeting held in Sintra, Portugal in May 1992. The group consists of ten members who form an international oversight group for a European group of wave modellers (WAM) and has always met in conjunction with WAM meetings. The Chairman of WG 83, Dr. Komen, provided a WG 83 progress report as well as a summary of the latest WAM meeting.

The General Meeting agreed with Dr. Asai that WG 83 succeeded admirably in meeting its goals of developing and implementing a third generation wave model, organizing a strong group for the utilization of ERS-1 satellite data, promoting research needed for the development of the model and the assimilation of ERS-1 data in the wave models.

The final report of WG 83 will come out as a book which will describe the state-of-the-art of wave forecasting (satellites, medium-range forecasting and climate) with the main themes of waves as part of the global climate system, the links between microscale physics and medium-range forecasting and the use of satellites. It was expected that the book would be published in early 1993.

In closing, Dr. Asai offered his congratulations to the Chairman and members of WG 83 and recommended that the group could be disbanded, pending publication of the final report. It was noted that although the WAM group was also expected to be terminated, discussions were already taking place among its members about the creation of continuing task groups on topics such as coupled models, data assimilation, inverse modelling, coastal applications and WAM maintenance.

WG 86 Ecology of Sea Ice

Professor Strömberg reported that two publications of WG 86 are currently in press with *Polar Biology*. These are:

- Horner, R., et al. 1992. Ecology of sea ice biota. 1. Habitat, terminology and methodology. *Polar Biology*
- Legendre, L., et al. 1992. Ecology of sea ice biota. 2. Global significance. *Polar Biology*.

The report from the Chairman of WG 86, Dr. Sullivan, focused on the plans of the group for an international Symposium on the Ecology of Sea Ice Biota to be held in 1994. As yet, the dates and venue for this meeting have not been established and a number of possibilities were discussed. The size of the meeting planned would require additional funding and it was felt that the format of the NATO Advanced Research Workshops was appropriate. This mechanism will be explored by the Chairman and Executive Director.

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

Terry Healy reported that WG 89 had met in Delft (The Netherlands) in 1990 and, as a result of that meeting, a peer-reviewed publication had appeared in the *Journal of Coastal Research*.

The working group was to meet again in Venice in early October, 1992 and has planned a more substantial publication in book form with a chapter outline as presented in the WG 89 report. While IOC had expressed interest in publishing this report, some WG members felt that a commercial publisher would be more appropriate.

Dr. Stewart urged that the WG 89 report should clarify its relationship to the analyses of sea level change being conducted by the Intergovernmental Panel on Climate Change and that the second chapter on Sea Level and Related Changes in Water Levels should be especially carefully reviewed because of the intense interest of policy makers in this issue. The scientific community should ensure that it reaches a consensus on the trends of sea level rise since its findings will be grasped as statements of fact by governments seeking a basis for policy decisions.

In response, Terry Healy noted that the WG saw the problem of sea level predictions as a given parameter, the main issue defined in its terms of reference being the response of

the shorelines. He agreed to convey the comments from the General Meeting to the forthcoming meeting of WG 89.

The Secretary of IOC expressed IOC interest in WG 89 and its willingness to assist in the publication of the report.

WG 91 Chemical Evolution and Origin of Life in Marine Hydrothermal Systems

Alexei Kuznetsov reported that WG 91 had completed a set of papers to be published as a special volume of *Origins of Life and Evolution of the Biosphere*, the journal of the International Society for the Study of the Evolution of Life. Advance copies of this volume were available at the General Meeting, and its publication was to be followed by the appearance of a book. The papers contained in these publications had been prepared by the members of WG 91 for presentation at the symposium held in conjunction with the General Meeting (see Annex II). The proceedings are expected to constitute the final report of WG 91.

The General Meeting agreed with the recommendation of the Chairman, Nils Holm, that WG 91 should be disbanded. Work in this field is continuing and WG 91 has helped to foster collaboration between researchers.

WG 92 Ocean/Atmosphere Paleochemistry

Nick McCave reviewed plans of WG 92 to organize a series of three workshops in conjunction with the SCOR General Meeting and the International Paleoceanography Conference in Kiel which had not materialized, in part because of a lack of adequate financial support. Instead, it was hoped that an international symposium could be held in association with a US National Academy of Sciences meeting on the carbon cycle in Woods Hole in January, 1993. [This Academy meeting did not materialize and at the time of writing this report, the Chairman hoped to organize the WG 92 symposium in conjunction with the 4th International Conference on CO₂ in Carqueiranne, France in September 1993.]

The General Meeting expressed concern at the lack of substantial progress and urged the Chairman and WG 92 members to finalize the organization of the planned symposium as quickly as possible. The Executive Committee should carefully re-assess the status of WG 92 at its meeting in 1993.

WG 93 Pelagic Biogeography

Funding for a meeting of WG 93 in 1992 was allocated following a mid-year review of the 1992 SCOR budget. It proved impossible, however, to organize a formal WG 93 meeting in conjunction with the Kiel Paleoceanography Conference as originally planned. Some WG 93 members made presentations at a workshop in Kiel, however. Jarl Strömberg, the Executive Committee Reporter for WG 93 drew attention to the report of the Chairman which outlined plans and requested approval for a meeting in April/May 1993 and for the addition of D. Krause (USA) and A. Sournia (France) to the list of Corresponding Members of WG 93. These were approved.

The Chairman of WG 93, Annalies Pierrot-Bults, noted that the activities of the group are complementary to GLOBEC. Following the meeting in 1993, the final task of WG 93 will be to serve as the scientific program committee for the 2nd International Conference of Biogeography in 1995.

WG 94 Altimeter Data and in situ Current Observations

Gerold Siedler noted with pleasure the progress of WG 94 and reviewed its activities which are closely linked to the new ERS-1 and TOPEX/Poseidon satellites. At the time of the General Meeting, most members of the WG were either waiting for the TOPEX/Poseidon launch, or for the accurate geophysical data record from ERS-1 to be delivered, before further comparisons of altimetric and *in situ* currents. Several experiments to help understand this issue were planned in association with the new satellites.

A report from WG 94 is presented in Annex IV and gave rise to a question as to whether more pressure was required in order to further work on obtaining a good geoid. This problem was referred to WG 94 for consideration. Participants were also concerned about the magnitude of the task of assimilating altimeter data in circulation models with no real chance of resolving the eddy scale in this context given the present computing power.

The General Meeting approved the request of the Chairman for a second meeting of the group in mid/late 1993. Lastly, the Chairman of WG 94, Victor Zlotnicki, recommended that the Chairmanship of the group be rotated and that Joel Picaut (France) be invited to take his place. The General Meeting also approved this suggestion.

WG 95 Sediment Suspension and Sea Bed Properties

The first meeting of WG 95 was taking place in Kiel at the same time as the General Meeting, therefore, no detailed report from the group was yet available. The group had worked in correspondence, reviewing and exchanging literature. Interest in near-bottom particle transport processes has increased strongly due to its relevance to applied problems such as pollutant transport. Recent literature presents some new sampling devices and *in situ* equipment for the study of processes in the nepheloid layer, new model approaches and stresses the importance of this particle transport for biological budgets. The aim of the first meeting was to discuss the collected literature, identify gaps in the understanding of the topic and to discuss approaches to fill these gaps.

WG 96 Acoustic Monitoring of the World Ocean

The report and recommendations of the first formal meeting of WG 96 (La Jolla, June 1992) were reviewed by Su Jilan and are given in Annex V. He noted that the first term of reference (to study the existing methods of large-scale acoustic tomography of the ocean and identify those which can benefit from international collaboration) has been addressed at the La Jolla meeting and that an important start had been made on the second (to evaluate the opportunities for international collaboration in the use of acoustic techniques for monitoring global climate change in the ocean). The opportunities for international collaboration depend, among other things, on the existence of appropriate

acoustic paths, for example between Australia and North America or across the Arctic Ocean. In connection with its third term of reference (to assess other methods and theories relating to investigation of the ocean by means of observations of sound propagation over long distances), WG 96 has discussed approaches using drifting acoustic systems, but a number of issues on this topic remain to be addressed.

WG 96 reviewed the Heard Island Feasibility Test which had taken place in late 1991 and is providing a forum for expanding the international effort in a larger acoustic thermometry program, ATOC, whose goal is to implement a global acoustic monitoring system sensitive enough to detect climatic changes in the world's oceans over basin scales.

The General Meeting approved the request that Prof. N. Dubrovskii and Dr. M. Slavinsky be appointed Corresponding Members of WG 96. WG 96 will meet, in conjunction with a larger ATOC group, in Brest in June 1992. In a letter to Su Jilan, David Farmer, the Co-Chairman of WG 96 emphasized "the importance we attach to SCOR's continued support of this program. More than most other oceanographic studies it depends on a high degree of international scientific collaboration. SCOR has played a critical role in helping to get the collaboration started. SCOR's continued support is now required to ensure success as we work towards the design of a truly global program." He also noted that in a program where acoustic sources are in one country and the receivers in another, the international and non-political support of SCOR is particularly important.

WG 97 Physiological Ecology of Harmful Algal Blooms (with IOC)

The report from the Chairman, Don Anderson, focused on future plans for this newly-established working group. The membership has been finalized and includes the following individuals:

Dr. Donald Anderson	USA	Chairman	
Dr. Allan D. Cembella	Canada	Dr. G. Hallegraeff	Australia
Dr. John Cullen	Canada	Dr. S. Maestrini	France
Dr. Malte Elbraechter	FRG	Dr. E. Paasche	Norway
Dr. Marta Estrada	Spain	Dr. Qi Yu-Zao	China
Dr. Yasuwo Fukuyo	Japan	Dr. Theodore J. Smayda	USA
Dr. E. Graneli	Sweden	Dr. F. J. R. Taylor	Canada

Corresponding Members:

Dr. S. Bates	Canada	Dr. H. Chang	New Zealand
Dr. G. Pitcher	South Africa	Dr. W. Gieskes	Netherlands

The support of IOC made it possible to expand the original group by two members.

The group will work in correspondence and will hold its first meeting in La Rochelle,

France immediately after the Sixth International Conference on Toxic Marine Phytoplankton in Nantes. The Secretary of IOC noted the work of the IOC Intergovernmental Panel on Harmful Algal Blooms, to which WG 97 is expected to provide scientific input. He also encouraged the use of the IOC Harmful Algal Blooms Newsletter as a mechanism for communication in this field.

2.3 Committees and Panels

Joint SCOR/IOC Committee on Climatic Changes and the Ocean

The discussion of CCCO was introduced by Gerold Siedler and the CCCO Secretary, Ray Godin. The complete written report from CCCO is in Annex VI.

Professor Siedler reminded the General Meeting that since 1990 membership changes in CCCO had given it a more interdisciplinary focus and that it had been concentrating on topics such as interdecadal climate variability, the CO₂ survey and associated problems, the development of the ocean climate component of the ocean observing system (through OOSDP) and the promotion of the regional panels as a forum for interdisciplinary discussions. At the SCOR Executive Committee meeting in 1991, it was clear that organizational changes associated with the IOC's cosponsorship of the World Climate Research Program (WCRP) would have an impact on the CCCO. In the past the Joint Scientific Committee for the WCRP and the CCCO had cosponsored the Scientific Steering Groups for both WOCE and TOGA. With the signature of a Memorandum of Understanding (MOU) between ICSU, WMO and IOC which added the IOC as a cosponsor of the WCRP, it was agreed to expand the JSC by adding six oceanographers to its membership and to have the WCRP take over the sole responsibility for the oversight of WOCE and TOGA.

As a result of these negotiations and the conditions of the MOU, and of the increasing involvement of the IOC in the development of the Global Ocean Observing System (GOOS), the IOC agreed at its Executive Council meeting in March 1992, that its sponsorship of the CCCO would be terminated on December 31, 1992. It was expected that the CCCO might be reconstituted as a scientific and technical committee for GOOS, following discussions with ICSU and SCOR. In the meantime, the Chairman of CCCO, Dr. Jim O'Brien, resigned and the 1992 meeting of the Committee was cancelled (see below, however, for a report on other activities which were completed in 1992).

Professor Siedler reported that discussions had already taken place between representatives of SCOR and IOC as to the continuation of certain CCCO activities. It was agreed at a SCOR/IOC consultation in September 1992 that the Memorandum of Understanding on the CCCO signed by IOC and SCOR in 1984 should be formally terminated and that the CCCO will be considered to be disbanded as of December 31, 1992. Some activities and groups which were established by the CCCO, either alone or jointly with other organizations, must be continued, however. These were reviewed and decisions were made as shown below:

- **CCCO/JSC Sea Ice Working Group** - should be referred to the JSC
- **CCCO/JSC Air-Sea Fluxes Working Group** - should be referred to the JSC
- **CCCO/JSC WOCE SSG** - as a result of the MOU on WCRP, this body now reports to the JSC.
- **CCCO/JSC TOGA SSG** - as a result of the MOU on WCRP, this body now reports to the JSC.
- **CCCO/JGOFS CO₂ Advisory Panel** - this group is crucial to success of global oceanic CO₂ survey being conducted in collaboration between WOCE and JGOFS. It should continue as a joint SCOR/IOC body.
- **CCCO/JSC OOSDP** - as the main body responsible for providing the scientific input on the climate module of GOOS, this group must be maintained with strong sponsorship. It was suggested that it be sponsored by J-GOOS (see below) and JSC. J-GOOS sponsorship implies involvement of both SCOR and IOC.
- **CCCO/JSC Regional Panels** - differing views were expressed as to the utility of keeping these bodies and particularly as to their effectiveness in relation to existing scientific programs such as JGOFS. They could be used more effectively to provide scientific advice to the IOC Regional Sub-Commissions and might also provide a regional focus for GOOS. It was agreed that this matter should be referred to the J-GOOS and the other relevant IOC bodies.
- **CCCO ad hoc Working Group on Interdecadal Variability** - it was agreed that a good start had been made on this topic and that it should be continued for another year as a joint IOC/SCOR effort to organize an international workshop.

In summary, it was agreed that SCOR and IOC will jointly sponsor three activities arising from the former CCCO: the CO₂ Panel, OOSDP and Interdecadal Variability WG. SCOR will make every effort to maintain its support for these activities at the traditional level of support which was provided for CCCO. Professor Siedler recommended that these recommendations be approved by the SCOR General Meeting.

The importance of SCOR's involvement in the discussions leading to a Memorandum of Understanding between IOC, WMO and ICSU on the scientific and technical issues related to the Global Ocean Observing System (GOOS) was also emphasized by Professor Siedler because of the interdisciplinary nature of the issues to be addressed (see also item 4.1). The Secretary of IOC reiterated the importance he attached to the scientific input of groups like to CCCO to the intergovernmental agencies. He expressed the need for a similar mechanism to be developed for GOOS and that the MOU under discussion required the involvement of SCOR.

Several participants expressed concern that without CCCO there would be no body to provide the necessary linkages and communication between the physical climate program (e.g. WOCE and TOGA) now located within the WCRP and the biological and biogeochemical programs such as GLOBEC and WOCE. It was hoped that the proposed Joint Scientific and Technical Committee for GOOS would meet some of these needs. The SCOR Executive was urged to ensure that these problems are considered as the framework for the development of GOOS is put into place.

Readers are referred to Annex VI for detailed information on specific activities of CCCO.

The CCCO Ad Hoc Study Group on Interdecadal Variability met in Honolulu, 18-20 Feb 92. Evidence of Interdecadal Climate Variability within the global climate system was documented and two recent examples relating to large scale shifts in atmospheric circulation, ocean temperature distribution, and fisheries in the Pacific and North Atlantic regions were highlighted. The group recommended that an international workshop with be organized to review decadal/interdecadal scale variability and to design an appropriate observing, modelling and research strategy for development of an international interdisciplinary interdecadal climate variability science program.

Three meetings of the CCCO-JSC Ocean Observing System Development Panel (OOSDP) will have taken place during 1992. The OOSDP is responsible for the design of the climate module of the Global Ocean Observing System (GOOS) which will contribute directly to the Global Climate Observing System (GCOS). The OOSDP is preparing a series of Background Reports to stimulate interest and participation in the work of the OOSDP by the broader community of ocean scientists. "The Role of Models in the Ocean Observing System" was completed in December 1991 and widely distributed. A second background paper entitled "Scientific Rationale for Defining a Global Observing System to Monitor the Uptake of CO₂ by the Ocean and Its Evolution in the Future" was completed and distributed in 1992. Other background reports on air-sea fluxes, water mass renewal, and enabling technologies are in various stages of completion. The preliminary design of OOSDP for the ocean component of the Global Climate Observing System (GCOS) will be presented to the JSTC-GCOS at its second session (January 1993) and the conceptual design is to be completed by December 1994.

At its third session (Monterey, 6-10 April), the JGOFS-CCCO CO₂ Advisory Panel reviewed progress in completing the global CO₂ data set and on measurement practices, calibration exercises, and flux correction calculations. A manual on the protocols and the use of standards is in preparation. The Panel considered that the present status regarding the measurement of total dissolved inorganic carbon was very encouraging. Ever since Quay *et al.* demonstrated how the ¹³C/¹²C ratio can be used in a model-independent method to estimate oceanic uptake of fossil fuel CO₂, the approach has gained increasing acceptance. The Panel decided to place a high priority on making a global set of precise isotopic measurements and to urge that JGOFS include ¹³C in future plans for characterizing the

carbon cycle. The Panel discussed an incipient problem with regard to standards for measurement of the $^{13}\text{C}/^{12}\text{C}$ ratio since the natural limestone source used for the present standard is nearly exhausted. The panel concluded that to maintain long-term compatibility between laboratories on decadal time scales, a properly funded organization must be persuaded to take up the responsibility. The matter of CO_2 measurement coordination emerged again as an urgent and serious issue and various means of providing a coordinator for the global CO_2 survey are being explored.

Joint Global Ocean Flux Study Scientific Steering Committee

The Vice-Chairman of JGOFS, Professor John Field, introduced the report of JGOFS (see Annex VII). A major milestone for JGOFS was achieved in 1992 with the publication of its international Implementation Plan. Serving both to complement and to update JGOFS Science Plan (SCOR, 1990), the JGOFS Implementation Plan describes how the internationally coordinated parts of JGOFS will actually be accomplished and the resources which will be needed to do this. Revisions to the Implementation Plan will be required as the program develops. The Plan concentrates on the synthetic, integrative nature of JGOFS, and on the steps needed to make sure it eventually produces a global flux assessment. It provides a brief overview of the scientific questions related to carbon fluxes, the goals and objectives of JGOFS and the strategies it has proposed to address these problems. In more detail, it discusses modelling activities for global synthesis, the components of large-scale surveys required for JGOFS, the various process studies under way and planned, the operation of the established and planned time series stations, and the studies of the sedimentary record and continental margin boundary fluxes for which detailed planning is just beginning. In each section the requirements for personnel, facilities, ship-time, equipment, etc. are discussed as appropriate and a contact name and address is given for further information. Although the Implementation Plan concentrates on the parts of JGOFS which demand international planning, coordination and oversight by the JGOFS SSC, it also recognizes the essential information contributed by the associated activities of individual nations.

JGOFS Process Studies: A special volume of *Deep Sea Research* containing papers arising from the JGOFS North Atlantic Bloom Experiment (NABE) was expected to be published in January 1993. Many of these papers were originally presented at the international NABE symposium in late 1990, although they have been supplemented by additional articles and more recent results and analysis. The North Atlantic Planning Group met at IOS, Wormley in January to discuss the scientific objectives for a program to take place late in JGOFS (1996-7) which will follow on from NABE. The group is organizing a larger meeting of about 30 individuals in Warnemünde, Germany in the spring of 1993 for the purpose of producing a more detailed planning document. The goals of this study derive from the special character of the North Atlantic with strong latitudinal gradients in the depth of winter mixing, large seasonal variations and the large horizontal transport of carbon and nutrients by the Gulf Stream. The Indian Ocean Planning Group met on board the Dutch research vessel "Tyro" in May as she passed through the Mediterranean on her way to the Indian Ocean. Plans for the intensive period of the Arabian Sea process study in 1994-1996

were substantially advanced during this meeting. The Northern Indian Ocean region is important to JGOFS because of its high, seasonally variable chlorophyll concentration. It contains about half as much total chlorophyll as the entire North Atlantic and the seasonal variability is greater due to the monsoon-driven circulation. The Equatorial Pacific Ocean process study began early in 1992 with US cruises to the eastern part of the region with process study work and sediment trap moorings complementing earlier French, Australian and Japanese survey work further to the west. The region is likely the largest source of CO₂ from the ocean to the atmosphere and the interannual variability associated with the ENSO phenomenon is greater than seasonal variability. Another defining characteristic of the Equatorial Pacific is its large pool of unused nutrients. Why is it not more productive? This study, involving the USA, Japan, Australia, France and Canada, will continue through 1995. A German cruise inaugurated the Southern Ocean Process Study which will take place in two phases. The first (1992-94) consists of programs and cruises with objectives defined before JGOFS plans were developed. Some of these are being refined to take JGOFS goals into account. The second phase is being explicitly planned for JGOFS by the Southern Ocean planning group and will take place in 1996-98 following the analysis of the results of phase 1 and model development. A workshop at Cambridge (UK) discussed existing models and requirements for modelling related to the Southern Ocean. SCAR has agreed to co-sponsor this part of the JGOFS program which will involve research ships from seven nations and participants from a number of others.

Other JGOFS Activities: A NATO Advanced Research Workshop entitled "Towards a model of ocean biogeochemical processes" was organized by JGOFS at Chateau de Bonas near Toulouse in May. About forty-five participants discussed the requirements and possibilities for building the simulation models needed by JGOFS. A publication will be forthcoming from this workshop. A Global Synthesis and Modelling Task Team has been established to make more detailed recommendations, to coordinate modelling activities and to cooperate with the regional planning groups on experimental design. Another NATO Advanced Research Workshop on "Biogeochemical Ocean-Atmosphere Transfers" was organized and cosponsored by IGAC and JGOFS. It took place in Bermuda in January and was designed to bring together the marine and atmospheric scientists with interests in fluxes of carbon and other substances at the air-sea interface. Plans were formulated for a number of joint activities on the impact of atmospheric deposition on new production, production and cycling of trace gases in the oceans, processes controlling gas exchange rates, marine boundary layer chemistry and modelling. The workshop papers will be published as a special issue of *Global Biogeochemical Cycles* and a joint IGAC/JGOFS group is being established. Cooperation with another IGBP Core Project (Land-Ocean Interactions in the Coastal Zone) has been advanced by the recent establishment of a joint LOICZ/JGOFS Continental Margins Task Team which held its first meeting in Taipei in October. Studies in this complex and variable zone will give many coastal nations an opportunity to contribute to the global objectives of JGOFS. The relevance of the European OMEX (Ocean Margins Exchange) program to this component of JGOFS was noted.

Since the JGOFS SSC had not yet met during 1992, it was agreed that its proposals

for membership changes at the end of the year should be considered by the SCOR Officers in correspondence and in consultation with the IGBP Committee. This would be done immediately after the JGOFS SSC meeting in Taipei in October. The President of SCOR urged that the SSC strengthen its expertise in the topic of the sedimentary record of past biogeochemical cycles.

SCOR/IOC Committee on Global Ocean Ecosystems Dynamics

GLOBEC (Global Ocean Ecosystem Dynamics) is an international program jointly sponsored by SCOR, IOC, ICES and PICES, dedicated to understanding the effects of physical processes on predator-prey interactions and population dynamics of zooplankton, and their relation to ocean ecosystems in the context of the global climate system and anthropogenic change.

The Chairman of GLOBEC, Professor Rothschild, reported on the establishment of the GLOBEC Scientific Steering Committee and its preliminary activities following the 30th meeting of the SCOR Executive Committee. IOC cosponsorship was approved by the IOC Executive Council in March. ICES has also agreed to cosponsor GLOBEC, in particular through its Cod and Climate Change program in the North Atlantic Ocean, and PICES will likely be involved through its activities in the North Pacific. The terms of reference and membership of the GLOBEC SSC are unchanged from those given in *SCOR Proceedings Volume 27*.

A preliminary meeting of the GLOBEC SSC was held in Ravello, Italy from March 31 to April 2, 1992. The Ravello meeting was the first effort to generate plans for an international GLOBEC program. The report which was published by the SCOR Secretariat as No. 1 in a new *GLOBEC Report Series*, summarizes the discussions among a small group of individuals and recommends the establishment of working groups to develop the GLOBEC Core Program in much more detail.

The GLOBEC SSC has partitioned the development phase of the GCP into four problem-oriented working groups and two regional specific studies. The science and science-support elements involve a) population dynamics of zooplankton and physical variability b) numerical modelling c) GLOBEC Prudence (exploration and analysis of existing data sets) and, d) sampling and observation systems. In addition to the science and science-support elements, two regional studies are contemplated. These address the Southern Ocean and the North Atlantic (Cod and Climate Change).

Each of these science and science-support elements and regional initiatives will be developed in more detail by a Working Group. Professor Rothschild reviewed the terms of reference, membership and preliminary plans for each of these groups. In summary, each of them will meet during the first half of 1993. Their reports will form the basis for an international GLOBEC Science Plan to be reviewed by the SSC at its meeting in late 1993.

He also noted that there are already a number of national and regional programs that

are working on issues very relevant to GLOBEC. Close ties are being developed with these programs. Several participants in the General Meeting provided information on activities in their countries.

The GLOBEC SSC wishes to establish formal links with the IGBP, and expects to pursue this once the Science Plan is completed. Dr. Phillip Williamson of the IGBP Secretariat commented on the existing strong linkages between JGOFS and GLOBEC which have a number of members in common.

IGBP/SCOR Working Group for the Global Ocean Euphotic Zone Study

In accordance with an agreement with the ICSU Scientific Committee for the International Geosphere-Biosphere Program, SCOR is committed to cooperate in the planning of oceanic research for IGBP. The Executive Committee, in 1991, approved the establishment of a joint working group to develop the scientific rationale for a "potential Core Project" of the IGBP which had previously been discussed only in a very preliminary way.

This group met for the first time in Victoria, Canada, in May 1992, under the Chairmanship of Dr. Ken Denman (Canada). The other members of the group are:

M. Abbott	(USA)	T. Platt	(Canada)
K. Banse	(USA)	R. Pollard	(UK)
P. Holligan	(UK)	N. Smith	(Australia)
E. Maier-Reimer	(FRG)	R. Stewart	(IGBP)
L. Merlivat	(France)		

The report of the Victoria meeting is reprinted in Annex VIII.

GOEZO is planned as an IGBP-SCOR project on multidisciplinary aspects of the upper ocean that affect global change. Field work will follow on from WOCE and JGOFS, but planning and modelling are envisioned in the meantime. The working group defined two major goals for GOEZO, emphasizing its interdisciplinary nature and its concern with extrapolations from the small to the large scale and with atmosphere-ocean exchanges:

- To understand small scale changes in the structure and function of the connected physics, chemistry and biology of the upper ocean system and how these changes interact with larger scale changes in physical forcing (air-sea fluxes)
- To improve predictive capability of large scale change at interannual and larger timescales.

The following definitions regarding scales are required:

- large scale (space) - basin to global scales
- large scale (time) - seasonal and longer

The group also considered a planning schedule for GOEZS, including a second meeting in 1993 and a major symposium in 1994. In the ensuing three years a detailed science plan would be developed while intensive modelling, technology development and data synthesis activities took place. This latter will involve analysis and assessment of the JGOFS and WOCE data sets. No field work was envisioned before 1997 or 1998 when both JGOFS and WOCE will be completed.

While some participants in the General Meeting felt that planning for GOEZS was slightly, premature, others felt that it would be desirable to begin now when the need to plan field work is not urgent and there is ample time for "long lead-time" activities such as modelling and technology development.

It was agreed that SCOR support of the GOEZS working group should be continued, and that its close links to JGOFS (through three of its members) should be retained. The General Meeting noted the recommendations of the WG, including the proposed emphasis for its second meeting on a review of parameterizations now used in the upper ocean components of contemporary physical, chemical and biological models that address seasonal and longer time scales.

Editorial Panel for the Ocean Modelling Newsletter

The General Meeting wished to record formally its support for the Ocean Modelling Newsletter which continues to serve a valuable function as a venue for the rapid dissemination of ideas in the modelling community.

General Discussion of SCOR Committees:

In closing the discussion of Agenda Item 2.3 on Committees and Panels, the General Meeting agreed that each of these longer-term SCOR subsidiary bodies should have a "sunset clause" or specified termination date, as is the case for Working Groups. These should be chosen separately in each case, and each such body should be reviewed periodically in cooperation with the cosponsoring organizations as appropriate. In the case of JGOFS, John Field suggested that an external review in 1995/1996 would be beneficial to all concerned. This should be completed in time for a report to the General Meeting in 1996 and should include recommendations relating to the size of the SSC needed in the later stages of the program, plans for the post-field work stages, data analysis and management, etc. For GLOBEC, it was suggested that such a review should take place four years after the establishment of the SSC (i.e. in 1996).

2.4 Proposals for New Working Groups

The following proposals were tabled at the 30th Executive Committee meeting due to a lack of sufficient funds to support new activities. In some cases the proposals required revisions and these were requested. They were all circulated to SCOR Committees for comments prior to the General Meeting.

Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations

The proposal was submitted by the South African, Mexican and Japanese SCOR Committees and was reviewed by Professor John Field. There is clear evidence that there have been large fluctuations of sardine *Sardinops sagax* and anchovy *Engraulis spp.* populations worldwide over the last 60 or more years. Several hundred years of information on Japanese catches, as well as varved sediment data and surrogate indices from other systems, indicate the populations have been subject to a high degree of variability for centuries. The longest detailed catch records show that fluctuations off Japan and along the west coast of North America consistently occurred at more or less the same time. Shorter records from the west coasts of South America and southern Africa indicate that all major changes in these two systems observed to date were also nearly simultaneous with the changes in the two north Pacific systems. Empirical evidence for the coincidental changes has been explored in recent published papers, and in two informal workshops at La Paz, Mexico, involving seven of the proposed members of the working group. However, the causes of the dramatic changes, which occur over relatively short time periods but persist for decades, have not been established.

The fluctuations have dramatic socio-economic repercussions in countries where the fisheries are located and, since fisheries on the resources harvest many millions of tons annually, a profound influence on the World fish production and markets. The fluctuations also have major repercussions for ecosystems in which the sardines and anchovies occur, because these two fish are the major food of many higher predators. Some data suggest that fluctuations of sardine and anchovy may be associated with major structural changes in the ecosystems.

The proposal noted the need for international cooperation in studying available data in order to understand the natural causes of change. The proposal was intended to bring together senior researchers from the five regions where *Sardinops sagax* and *Engraulis spp.* co-occur. The terms of reference proposed for the WG were adopted as follows:

- Collate historical information from the five regions of the world where *S. sagax* has been fished (Japan, west coast of North America, west coast of South America, west coast of southern Africa, Australasia) that is pertinent to understanding the large ecosystem changes that have occurred in these regions. This includes catch records, abundance estimates, varved sediment records and other historical information such as records of guano harvests. It also includes various worldwide or large-scale atmospheric, physical oceanographic, planktonic and other biological data.
- Use historical information to evaluate the sequence of events occurring at times of major change, to develop hypotheses regarding causes of the large changes (of sardine and anchovy populations and other abundant resources with which they are associated) in each region, to identify mechanisms that may sustain large shifts in abundance over long periods, and to examine evidence for a worldwide cause of the major fluctuations.

- Prepare a report to SCOR on what appears to cause the worldwide, large-scale fluctuations of sardine and anchovy populations, on expected implications for fisheries and ecosystems associated with them of possible future climate change, and on key interactions between sardine and anchovy populations and their environment that require further study.

Dr. R. Stewart (ICSU) suggested that the term of reference involving the expected implications for fisheries and ecosystems of possible future climate change was speculative and might distract the group from its main tasks. Questions regarding the possible overlap with GLOBEC and ICES were discussed. The proposal was to relate long-term (decadal), large-scale (basin to global) population changes to environmental records whereas GLOBEC tends to be more concerned with fine-scale physical-plankton interactions. Professor Rothschild stated that the proposal was therefore complementary to other programs. The Secretary of IOC noted that it also complemented the OSLR Sardine and Anchovy Recruitment Project.

The proposal was accepted and the group will be WG 98. The Chairman should consider including a Brazilian member, possibly to replace Dr. Sanchez and it was suggested that FAO be approached to co-sponsor WG 98. The membership will be finalized in consultation with the Chairman, Dr. Daniel Lluç Belda (Mexico) and Dr. R. Crawford (South Africa).

Coral Reefs and Global Change

This proposal was tabled at the 30th Executive Committee meeting in order to allow a revision of the terms of reference and to take advantage of discussions which would take place among scientists active in the field during the International Coral Reef Symposium (Guam, June 1992) and associated events. The Executive Committee had urged Dr. Buddemeier and Dr. d'Elia, who had submitted the proposal, to take note of two ongoing activities: the UNEP/IOC/WMO program on "Climate, Sea Level Rise and the Coastal Zone - Management and Planning for Global Change; and the IGBP Core Project on Land-Ocean Interactions in the Coastal Zone (LOICZ), both of which address coral reef issues.

The General Meeting considered a revised proposal and agreed that the terms of reference were much improved (more focused). Many participants, however noted that they had not been aware of the existence of an IOC/UNEP Global Task Team on the Potential Impacts of Climate Change and Sea Level Rise on Coral Reefs which also held its first meeting which also took place in Guam. Noting that there were some differences between the approach of this Task Team and the WG proposal (the IOC/UNEP activity being oriented towards monitoring and the WG proposal being more interdisciplinary), the General Meeting was also informed of an IUBS/SCOPE/IABO effort to monitor reefs as part of the "Biodiversitas" program. The Secretary of IOC stated that the topic is politically important and that a SCOR WG could serve a useful function by providing authoritative scientific advice. At the same time, he noted, a number of the members proposed for the SCOR WG are already involved in the IOC/UNEP effort. The number of seemingly similar

activities already under way was a concern and the consensus of the General Meeting was that SCOR should await more information on their plans before proceeding further with the proposed working group.

The Impact of World Fisheries Harvest on the Stability and Biodiversity of Marine Ecosystems

The consideration of this proposal was postponed by the 30th Executive Committee meeting until the report of the ICES Study Group on Ecosystem Effects of Fishing Activities has been received. It was expected shortly after the General Meeting and will be forwarded to the Canadian SCOR Committee which will undertake a revision of the proposal, taking the recommendations of the ICES report into account.

Linked Mass and Energy Fluxes at Ridge Crests

This proposal, which was introduced by Professor McCave was revision of a proposal entitled *Quantification of Mass and Energy Fluxes through the Mid-Ocean Ridge System* which was considered in 1991. It arises from an activity known as InterRidge (International Ridge Interdisciplinary Global Experiments) involving the USA, UK and FRG and constitutes a request for SCOR to become involved as a cosponsor in order to broaden the international participation in InterRidge. Professor McCave noted that there is already considerable momentum and some financial support available for the InterRidge activity and that the topic is an important area of marine geoscience in which SCOR has not previously been involved.

The proposal which included a scientific rationale for the WG and proposed terms of reference is given in Annex IX. The participants in the General Meeting provided a number of comments on the proposed membership which, it was agreed, should be forwarded to the Chairman, Dr. Martin Sinha (UK) for consideration before the group is formally established. In general, it was felt that this topic is one which SCOR should support and that this proposal should be accepted. The group will be WG 99.

Laboratory Modelling of Oceanic Processes

This proposal was received in a preliminary form from the Russian SCOR Committee. It was discussed in conjunction with another proposal (see item 2.4.7) since the Meeting felt that there was a possibility to combine some aspects of the two topics. However, the consensus of the General Meeting was that this proposal was too broad and that the proposal needed considerable modification before it could provide a suitable basis for a new SCOR WG. It was recognized, however, that the proposal was an attempt to address a very old problem in physical oceanography; the extrapolation of laboratory results to the real ocean. Some specific recommendations were developed by an *ad hoc* group (Muench, Siedler, Stewart) and were transmitted to the Russian SCOR Committee following the General Meeting. Among these were that the scientific focus of the revised proposal should be on double diffusion, its modelling and the extrapolation of laboratory results to the real ocean and that membership of the proposed WG should be revised to broaden its international participation. It was expected that a revised proposal would be received for consideration at the meeting of the Executive Committee in 1993.

Sediment Coring for International Research on Global Change

This proposal was submitted by the UK, French and US SCOR Committees and arose from the emerging MESH program (Marine Aspects of Earth System History). Readers are referred to the complete proposal as presented in Annex X. It was reviewed by Professor McCave who explained the current situation in which cores are randomly collected and there is no coordination of their curation, techniques for preservation, sampling and sharing of information.

The participants agreed that this ideal topic is a very timely one and most suitable for the SCOR Working Group mechanism. The strong support of JGOFS for the proposal was noted; the JGOFS Implementation Plan includes statements about the types of cores and their collection and storage needed for JGOFS Sedimentary Record studies.

It was agreed that this proposal be accepted and the group established as WG 100. The President of SCOR agreed to discuss the various comments about membership with the Chairman-designate Professor N. Pias (USA) at the forthcoming Paleoceanography Conference. The membership was confirmed as follows:

Chairman:	Prof. N. Pias	(USA)		
Members:	B. Curry	(USA)	T. Oba	(Japan)
	R. Carter	(Australia)	T. Pederson	(Canada)
	E. Jansen	(Norway)	N. Shackleton	(UK)
	L. Labeyrie	(France)	Wang Pinxian	(China)
	L. Mayer	(Canada)	G. Wefer	(FRG)
Corresponding Members:				
	R. Fairbanks	(USA)	A. Mix	(USA)
	J. Thiede	(FRG)	P. Weaver	(UK)

Influence of Sea State on the Atmospheric Drag Coefficient

This topic was introduced at the 30th Executive Committee meeting and a formal proposal was later submitted by the Australian SCOR Committee and circulated to all SCOR Committees for consideration.

Dr. Ian Jones presented the proposal, noting that a workshop was held in Vienna on 23 August 1991 to discuss the current state of knowledge of the influence of sea state on the aerodynamic drag coefficient between the atmosphere and the ocean. About twenty people attended and concluded that the influence of swell and wind waves on the drag coefficient was uncertain and that further critical experiments were required. The coefficient of drag over the sea surface, which is related to the sea state, couples the momentum of the atmosphere and the sea water and is important for an understanding of air-sea fluxes. There remains controversy about the value of the sea surface momentum flux (drag) under extreme, steady state conditions and under unsteady atmospheric conditions. Surface drag

values are important in numerical atmosphere-ocean models and momentum flux is used in scaling many oceanic phenomena such as microwave backscatter, whitecap coverage or gas transfer. The flux of momentum is important in air sea models used both for climate studies and operational forecasts. The advent of wave sensing satellites will make the forecasting of sea state more exact. Our understanding of the flux of other quantities across the air sea boundary, such as heat or carbon dioxide are expected to be enhanced by knowing the nature of the momentum transfer.

The proposal was endorsed by the Japanese SCOR Committee, which some participants in the General Meeting felt was an ideal, narrowly defined topic for a SCOR Working Group. Accordingly, the Meeting agreed to establish WG 101 with the following terms of reference:

- To hold a workshop on the relationship between momentum flux to the sea and the sea state.
- To encourage the execution of critical experiments.
- To prepare a report to SCOR on the most likely expression relating momentum flux to sea state.

The membership of WG 101 was finalized at the General Meeting as follows:

Co-Chairmen:

Ian S. F. Jones	(Australia)	Yoshiaki Toba	(Japan)
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Members:

N. E. Huang	(USA)	Yu A. Volkov	(Russia)
M. A. Donelan	(Canada)	S. E. Larsen	(Denmark)

Corresponding Members:

E. F. Bradley	C. A. Friehe	K. Katsaros
H. Charnock	L. Gernaert	E. Plate
G. T. Csanady	K. Hasselman	P. K. Taylor

Effects of Direct CO₂ Disposal into the Oceans

A proposal had been received from the Chairman of former SCOR WG 75, Dr. C.S. Wong, but there was inadequate time to circulate it to SCOR Committees prior to the General Meeting. This topic was first introduced at the 1991 SCOR meeting and this proposal provided more detailed information. In accordance with the instructions of the Executive Committee meeting, comments were sought from some members of the CCCO/JGOFS CO₂ Advisory Panel.

The justification for the working group was that Japan and European Community countries such as Germany, the UK and The Netherlands are intensifying studies on direct

ocean disposal of fossil-fuel CO₂ from thermal power plants, as an option for enhancing CO₂ storage in the oceans to minimize the continuing rise in atmospheric CO₂ causing global warming. Japan has initiated experimental CO₂ dumping experiments. The possible environmental effects on the ocean environment, varying from local to regional to global scale are poorly known. The chemical, biological and physical interactions of different forms of CO₂ as solid, liquid or a saturated CO₂ solution in seawater are uncertain. The WG proposed would review existing knowledge of the possible modes of interaction and their consequences on the ocean environment, and identify gaps of knowledge required to make a sound assessment as to whether direct CO₂ disposal is a viable option or not.

Some participants in the General Meeting were aware of the Japanese activities in this topic and wished the proposal to be clarified to state that what is involved is direct disposal of CO₂ to the deep ocean, as opposed to surface or coastal disposal. Dr. Asai informed the meeting of an international workshop on this topic which would take place in Japan in 1993 and suggested that action on the proposal should be deferred until the results of this workshop could be taken into account.

Executive Committee Reporters for SCOR Subsidiary Bodies:

Following the General Meeting, the following assignments of Executive Committee Reporters were made for each of the continuing and new Working Groups:

WG 86	Ecology of Sea Ice	Strömberg
WG 92	Ocean/Atmosphere Paleochemistry	McCave
WG 93	Pelagic Biogeography	Rothschild
WG 94	Altimeter Data and <i>in situ</i> Current Observations	Muench
WG 95	Sediment Suspension and Sea Bed Properties	Kuznetsov
WG 96	Acoustic Monitoring of the World Ocean	Muench
WG 97	Physiological Ecology of Harmful Algal Blooms	Strömberg
WG 98	Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations	Rothschild
WG 99	Linked Mass and Energy Fluxes at Ridge Crests	McCave
WG 100	Sediment Coring for International Global Change Research	Lancelot
WG 101	Influence of Sea State on the Atmospheric Drag Coefficient	Asai
JGOFS	Scientific Steering Committee for the Joint Global Ocean Flux Study	Strömberg
GLOBEC	Scientific Steering Committee for the Global Ocean Ecosystem Dynamics Program	Muench

3.0 ORGANIZATION AND FINANCE

3.1 Membership

The Executive Director reported that she had been notified of the following changes in SCOR membership since the 30th Executive Committee meeting:

China (Taipei)

The Committee on Oceanic Research located in Taipei has nominated Dr. K.H. Chang and Dr. C.T. Wang, replacing Professor Hung and Dr. Juan.

France

Professor Laurent Labeyrie has been appointed Secretary of the French SCOR Committee which is Chaired by Professor Pierre Lasserre. Clarification has been requested as to the status of the French Nominated Members.

Federal Republic of Germany

The three Nominated Members are now Professor G. Siedler, Dr. G. Wefer and Dr. W. Fennel.

India

Dr. S. Krishnaswami, Professor N.R. Menon and Dr. D.P. Rao have been appointed as the Nominated Members of SCOR by the Indian SCOR Committee.

Japan

Professor Y. Aruga has assumed the chairmanship of the Japanese SCOR Committee following the retirement of Professor Marumo. The other Nominated Members are Professor Tomio Asai and Professor S. Tsunogai.

The Netherlands

Professor M. Mook has been appointed to fill a vacancy for a Dutch Nominated Member. He is also Chairman of the SCOR Committee in the Netherlands.

Poland

The three Nominated Members are now Professor A. Zielinski (unchanged), Dr. R. Bojanowski and Professor K. Korzeniewski.

South Africa

A vacancy exists for a Nominated Member following the resignation of Professor Lord.

United Kingdom

Dr. C. Summerhayes has replaced Sir Anthony Laughton and Professor I.N. McCave has been appointed to fill a vacancy created by the retirement of Professor Henry Charnock as a UK Nominated Member of SCOR.

United States of America

Professor Brian Rothschild has been appointed Nominated member of SCOR to fill the vacancy left by the retirement of Dr. E. Hofmann from the Ocean Studies Board.

Representative Members:

IUGS will be represented in SCOR by Professor I.N. McCave and Dr. Y. Lancelot. The former IUGS representative was Dr. H. Biersdorf.

The newly-elected President of the Commission for Marine Geology is Yves Lancelot (France). He will be an *ex officio* member of the SCOR Executive Committee.

Other Membership Matters:

The General Meeting agreed, with regret, that the memberships of Portugal and the Philippines should be terminated due to non-payment of their membership contributions. The Executive Director informed the meeting that while all efforts to re-activate the SCOR Committee in Portugal had failed, it did appear that a new Committee was likely to be established in the Philippines.

The Membership Officer, Su Jilan, reported on his efforts to increase the numbers of countries belonging to SCOR. Expressions of interest have been received from several of them, including Viet Nam and the Ukraine.

Dr. Gennady Korataev, representing both the Marine Hydrophysical Institute and the Institute of Biology of the Southern Seas in Sevastopol, the two major institutions of oceanography in the Ukraine, made a presentation on the status of the science in his country. He concluded by stating that he expected that a Ukrainian Committee for SCOR would be established in the near future and that a formal application for membership in SCOR would be forthcoming. The General Meeting agreed in principle that the President should approve this application when it is received.

3.2 Publications Arising from SCOR Activities

The Executive Director presented a report on publications arising from SCOR activities since the 30th Executive Committee meeting:

UNESCO Technical Papers in Marine Science

No. 63 Coastal Systems Studies and Sustainable Development. Report of the COMAR Interregional Scientific Conference. UNESCO, Paris. 21-25 May 1991. Co-sponsored by UNESCO, UNEP, SCOR, IABO.

IOC Workshop Report Series

No. 75 IOC-SCOR Workshop on Global Ocean Ecosystem Dynamics. Solomons, Maryland, USA. 29 April - 2 May 1991.

BIOMASS Publications

BIOMASS Newsletter, Volume 13, No. 2. Farewell Issue. December 1991.

Non-Acoustic Krill Data Analysis Workshop. Cambridge, UK. 29 May - 5 June 1991. BIOMASS Report Series No. 66.

SCOR/IOC CCCO Publications (including WOCE and TOGA)

Report of the Tenth Session of the JSC/CCCO TOGA Scientific Steering Group. Gmunden, Austria. 26-29 August 1991. WMO/TD No. 441.

WMO/IOC Inter-Governmental TOGA Board. Report of the Fifth Session. Paris, 14-16 January 1992. WMO/TD No. 476.

Report of the Second Session of the Joint JGOFS-CCCO Panel on Carbon Dioxide. Paris, France. 22 - 26 April 1991.

The Role of Models in an Ocean Observing System. OOSDP Background Report Number 1. Prepared by Neville Smith for the Joint CCCO-JSC Ocean Observing System Development Panel.

Report of the Third Session of the Joint CCCO-JSC Ocean Observing System Development Panel. Boston, USA. 2-4 October, 1991.

Report of the Ninth Meeting of the CCCO Pacific Ocean Climate Studies Panel. Sydney, Australia. 4-7 February 1991.

SCOR/IOC CCCO, Summary Report of the Twelfth Session. Woods Hole, USA. 4-8 June 1991.

IOC-WMO Intergovernmental WOCE Panel. Report of the Second Session. Paris. 3-4 March 1992.

World Ocean Circulation Experiment. A brochure describing WOCE.

Report of the Seventeenth Meeting of the WOCE SSG. IOS, Wormley. 20-22 November 1991. WOCE Report No. 78/92.

The WOCE Handbook (3rd Edition). Woce Report No. 79/92.

WOCE. Summary and Assessment of Resource Commitments. WOCE Report No. 80/92

WOCE Hydrographic Programme. report of the Ninth Meeting. Scripps Institution of Oceanography. 21-23 October 1991. WOCE Report No. 81/92

WOCE Data Management Committee. Report of the Fourth Meeting. Japan Oceanographic Data Center, Tokyo. 28-31 October 1991. WOCE Report No. 82/92.

WOCE Chlorofluorocarbon Intercomparison Cruise. WOCE Report 83/92.

WOCE Numerical Experimentation Group. Report of the Sixth Meeting. GFDL, Princeton. 9-10 September 1991. WOCE Report No 84/92.

TOGA/WOCE XBT/XCTD Programme Planning Committee. Report of the First Meeting. US National Academy of Sciences, Washington. 8-10 October 1991. WOCE Report No. 85/92.

WOCE Core Project 3. Report of the Fifth Meeting. IOS, Wormley. 1-3 April 1992. WOCE Report No. 90/92.

Scientific and Technical Review of the WOCE Drifter Programme. WOCE Surface Layer Scientific Panel. Reading, UK. 25 October 1991. WOCE Report No. 92/92.

JGOFS Publications

The JGOFS North Atlantic Bloom Experiment. A collection of papers in press as a Special Volume of *Deep Sea Research*. Pergamon Press. In press.

The JGOFS Implementation Plan. JGOFS Report Series No. 9. In press as a joint publication of JGOFS and IGBP.

Publications Arising from other SCOR Subsidiary Bodies

JPOTS Processing of Oceanographic Station Data. Published by UNESCO for the UNESCO/ICES/SCOR/IAPSO JPOTS Editorial Panel.

WG 96 First International Meeting on Global Acoustic Monitoring of the Ocean. Scripps Institution of Oceanography, June 8-10 1992. Abstracts.

Publications Arising from Other SCOR Activities

Ocean Sciences: Their History and Relation to Man. Proceedings of the 4th International Congress on the History of Oceanography. Hamburg, Germany. 23-29 September 1987. Co-sponsored by SCOR. W. Lenz and M. Deacon (Eds.). Dt. hydrogr. Z. Erg.-H. B, Nr. 22, 1990.

SCOR Proceedings, Volume 27. Report of the 30th Executive Committee Meeting of SCOR. Hamilton, New Zealand. November 11-13 1991.

A SCOR brochure was published in July 1992. It was prepared by Professor Terry Healy.

3.3 Finance

The Chairman of the *ad hoc* Finance Committee, Brian Rothschild, presented its report. He reviewed the state of SCOR finances for the past and current fiscal years. He recalled that the Executive Committee meeting in 1991 had been confronted with a serious financial situation, that it had only been possible to create one new working group, and a year of careful financial restraint was proposed for 1992. The Finance Committee examined the current state of SCOR finances and found it to be considerably more healthy, although this was at the expense of somewhat restricted activities and reduced support for working groups. The final financial statement for the previous year (1991) is presented in Annex XI.

The Finance Committee report also included a proposed budget for 1993. It projected a cash balance at the beginning of the 1993 fiscal year of \$80,000 and additional income of \$540,000. Allocations to Working Groups, Committees and other scientific activities were proposed for a total of \$473,000 and administrative expenses were expected to be \$138,000. This left an unacceptably small year end cash balance of \$9,000, an inadequate amount with which to begin activities in the next year. The General Meeting wished to formally record its concern over this situation and urged SCOR Committees to seriously consider increasing their categories of membership in order to increase income to SCOR. The budget proposed for 1993 included modest amounts for possible meeting of newly-established Working Groups; it was likely that not all of these would take place within one year. It was also suggested that support for GOEZS be found within the budget for JGOFS since several of the SCOR members of the GOEZS WG are also members of the JGOFS SSC and there are many common areas of interest between the two programs. Looking one year ahead, the Finance Committee recommended an increase in the levels of SCOR membership contributions for 1994 equivalent to that already approved by ICSU, namely 5%.

The remainder of Professor Rothschild's report dwelt primarily with future funding for SCOR and the Finance Committee's primary recommendation which was that an *ad hoc* Strategic Planning Committee be established to explore new sources of financial support for SCOR such as private foundations. This recommendation was approved and the Committee will include I.N. McCave, I. Jones, J-O. Strömberg, T. Asai and B.J. Rothschild.

The report of the *ad hoc* Finance Committee was approved by the General Meeting with thanks to its members for their work.

3.4 Report of the Nominations Committee and Elections

The chairman of the Nominations Committee established at the 30th Executive Committee meeting, Professor Siedler, presented his report and proposed a slate of officers for election. He explained that the terms of the President and Secretary were both due to expire and that Professors Strömberg and Fournier were ineligible to be re-elected. The terms of the three Vice-Presidents expire at each General Meeting. The incumbents were all eligible to be re-elected and all had agreed to serve an additional two year term. SCOR

Committees were invited to submit nominations for the vacant positions. Professor Siedler proposed that Professor I.N. McCave (UK) be elected President, that Professor Brian J. Rothschild be elected Secretary and that the three Vice-Presidents all be re-elected. This proposal was accepted by the General Meeting.

Following the General Meeting, the Executive Committee agreed to co-opt two members for specific tasks. One position was already vacant and Dr. Su Jilan (China) had completed his term of eligibility to serve in the second. Dr. S. Krishnaswami (India) agreed to join the Committee, accepting the responsibility for membership issues, and Dr. Allyn Clarke (Canada) was invited to undertake the responsibility for advising SCOR on issues related to climate change.

4.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS

4.1 Intergovernmental Oceanographic Commission / Marine-Related Issues (UNESCO)

The Secretary of IOC, Dr. Gunnar Kullenberg, reviewed the "Report on Co-operation between IOC and SCOR during 1991/1992" which was provided to the participants and appears in Annex XII. This consisted, in large part, of a report of an informal meeting between representative of SCOR and the IOC Secretariat held in Paris on September 3, 1992. This meeting reviewed the mutual activities and interests of the two organizations, issues related to CCCO (see item 2.3 above), the Global Ocean Observing System, GLOBEC, etc.

Issues related to the Global Ocean Observing System had been discussed in some detail in connection with CCCO (see item 2.3). Dr. Kullenberg wished to emphasize its importance for the future, noting that recommendations relating to GOOS and the IOC leadership in its development were made by the Second World Climate Conference and UNCED. He reiterated that the IOC would look primarily to SCOR for scientific advice in relation to the establishment of the joint scientific and technical body for GOOS. The General Meeting welcomed this position since it felt that the influence of the scientific community will be very important in the design of GOOS.

With regard to GLOBEC (see item 2.3), Dr. Kullenberg noted his pleasure in the partnership between IOC and SCOR on this program. He also referred to IOC's intention to look to SCOR WG 97 (Physiological Ecology of Harmful Algal Blooms) for scientific advice in the context of the IOC program on Harmful Algal Blooms. The cooperation between IOC and JGOFS, especially in the areas of the development of standard reference materials and methodological training workshops has been especially fruitful

The Secretary of IOC specifically sought the assistance of ICSU and SCOR in its follow-up to UNCED and in the implementation of the legal agreements signed in Rio. In his opinion it is necessary for the scientific community to reach consensus on a variety of

issues so that governments and policy makers receive consistent advice. The General Meeting was of the opinion that it would not always be possible for the scientific community to agree on a common attitude, but it wished to formally encourage the continuation of meetings between the IOC and SCOR officers when necessary to discuss and develop consensus on appropriate issues.

4.2 World Meteorological Organization

The attention of the participants was drawn to the written report from WMO which reviewed several items of mutual interest including drifting buoys, marine climatological data, ocean services, cooperation between IOC and WMO on UNCED and GOOS in particular, and the TOGA program.

In response to a formal request from WMO, the General Meeting approved SCOR cosponsorship of the WMO/IOC Technical Conference on Space-based Ocean Observation (Bergen, September 6-10 1993). SCOR support will take the form of travel grants for oceanographers from developing countries.

Professor Healy made special reference to the TOGA Coupled Ocean-Atmosphere Response Experiment (TOGA-COARE), reminding the Meeting that TOGA's parent was the CCCO, a SCOR body.

The General Meeting instructed the Executive Director that, in view of the pending disbanding of the SCOR/IOC CCCO, for future SCOR meetings reports should be requested from the WMO/ICSU Joint Scientific Committee for the World Climate Research Program. This would be the appropriate channel for information on the progress of WOCE and TOGA.

4.3 International Council for the Exploration of the Sea

Professor Rothschild reviewed ICES activities of interest to SCOR in his capacity as ICES representative to the General Meeting.

One current initiative of ICES entitled "Cod and Climate Change" relates to an understanding of cod stock fluctuations in response to climatic processes. A number of ICES member countries have plans for regional experimental work on this topic, especially in the Northwest Atlantic and in the Nordic region. An ICES Steering Group has been established for this activity and a symposium on the topic will take place in Reykjavik in August 1993. Professor Rothschild expressed ICES' interest in cosponsoring the GLOBEC program, especially through its Cod and Climate activity. ICES will, to the extent possible, ensure that its relevant activities are consistent with the objectives of GLOBEC.

The ICES report referred to the successful Symposium on Measurement of Primary Production from the Molecular to the Global Scale" which took place with SCOR

cosponsorship in La Rochelle, France in April 1992.

The ICES Hydrography Committee noted the earlier decision of SCOR to withdraw its support for the UNESCO/IAPSO/SCOR/ICES Joint Panel on Oceanographic Tables and Standards (JPOTS). ICES has also decided to suspend its support for the Panel until its proposal for future work can be assessed by the relevant bodies. In particular, it was considered that some work may be necessary to incorporate the 1990 temperature scale into modified algorithms on physical state variables. The JPOTS Manual on Oceanographic Station Data Processing was published earlier this year by UNESCO and ICES is providing some technical assistance to UNESCO for the production of Russian and Chinese versions.

ICES has been promoting the use of oceanographic and other marine data by means of purpose-built PC software packages. The ICES Biological Oceanography Committee has encouraged the establishment of a data base on fish. Interactive digital atlases have been developed to support the interpretation of data collected by recent oceanographic cruises in the Baltic. PC-based data management software developed and used by the ICES Oceanographic Data Center has been adopted for use by the IOC for a prototype version of OCEAN-PC which is designed to stimulate the use and submission of data in the World Data Center system.

4.4 North Pacific Marine Science Organization (PICES)

The Executive Director reviewed information she had received about this new intergovernmental organization which was established by a convention signed by Canada, the USA and Japan in March 1992. China has since signed the convention and Russia is expected to join. PICES is concerned with marine scientific research in the North Pacific and adjacent seas, especially north of 30°N. Its purposes are:

- to promote and coordinate marine scientific research in order to advance scientific knowledge of the area concerned and of its living resources, including, but not necessarily limited to research with respect to the ocean environment and its interactions with the land and atmosphere, its role in and response to global weather and climate change, its flora, fauna and ecosystems, its uses and resources, and impacts upon it from human activities, and
- to promote the collection and exchange of information and data related to marine scientific research in the area concerned.

SCOR was expected to be represented at the First PICES meeting in October 1992 by Professor Brian Rothschild. PICES was expected to become a cosponsor of the GLOBEC program due to its interests in North Pacific fisheries and related scientific issues.

5.0 RELATIONS WITH NON-GOVERNMENTAL ORGANIZATIONS

5.1 International Council of Scientific Unions

Professor Olof Tandberg extended greetings from the Officers of ICSU. He presented a preliminary report from the panel which he had chaired and which had been established by ICSU to review SCOR. Such periodic reviews of the interdisciplinary Scientific Committee of ICSU are part of a routine ICSU process. The final report of the panel was to be presented to the ICSU Executive Board shortly after the SCOR General Meeting.

The review was largely positive. A cautionary recommendation suggested that SCOR should be careful about its involvement in large-scale, long-term programs if these jeopardized the support for the traditional working group mechanism. Another recommendation was that SCOR consider reducing the number of times the Vice-Presidents may be re-elected Committee in order to encourage more rapid rotation on the Executive Committee. Lastly, the review panel noted a lack of disciplinary balance among the current Working Groups; the General Meeting felt, however, that this had been redressed through the establishment of the new WGs which it had just approved.

5.2 ICSU Unions and Committees

Reports were requested from all ICSU bodies which have representatives to SCOR, or with which SCOR has joint activities.

Scientific Committee for the International Geosphere-Biosphere Programme

Dr. Phillip Williamson, Deputy Executive Director of IGBP, gave an account of the activities of the International Geosphere-Biosphere Programme (IGBP), with emphasis on the aspects most relevant to JGOFS. Like SCOR, IGBP is an interdisciplinary body of ICSU; however, the two organizations have different histories. IGBP was established to develop and coordinate a worldwide research effort on the dynamic interplay between living and non-living systems. Priority interactions are those that: affect the biosphere on a global scale; are likely to show significant change on the decadal to century timescale; are most susceptible to human perturbation; and are likely to lead to practical, predictive capability. Whilst the links between biogeochemical processes and climate change are of great importance to IGBP, non-climatic issues are also of interest; eg a project is being developed on the relationship between socio-economic factors, land use and land cover (and hence surface properties).

In addition to JGOFS - a joint project between SCOR and IGBP - there are four other established IGBP studies: International Global Atmospheric Chemistry project (IGAC), Global Change and Terrestrial Ecosystems (GCTE), Biospheric Aspects of the Hydrological Cycle (BAHC), and Past Global Changes (PAGES). A project soon likely to be established - Land Ocean Interactions in the Coastal Zone (LOICZ) - should assist

JGOFS in quantifying lateral fluxes at the continental margin, whilst IGAC and PAGES should similarly complement JGOFS at the air-sea boundary and with regard to the sedimentary record.

The integration of IGBP is assisted by three cross-cutting activities. Thus Global Analysis, Interpretation and Modelling (GAIM) has recently started to bring together different models, to test their interactive behaviour; the Data and Information System (DIS) addresses generic data management issues (with emphasis to date on land surface remote sensing); and the System for Analysis, Research and Training (START) aims to strengthen regional capabilities for global change science. Within the next decade, the suite of IGBP projects should make impressive progress in reducing uncertainties in global change.

Scientific Committee on Antarctic Research

The General Meeting was informed that SCAR has responded positively to the invitation from SCOR to become a cosponsor of the Southern Ocean programs of both JGOFS and GLOBEC. Unfortunately, SCAR was not in a position to provide financial support for these activities, but a representative of SCAR will attend future meetings of the JGOFS and GLOBEC Southern Ocean planning groups.

Committee on Space Research

The report from COSPAR noted that SCOR had cosponsored a number of scientific sessions at its recent Plenary Meetings, held in conjunction with the World Space Congress in Washington. Support from SCOR was used to provide travel grants to several scientists from developing countries.

COSPAR and SCOR will jointly sponsor a scientific workshop on early TOPEX/Poseidon results which will be held in France in late 1993.

Participants in the General Meeting expressed a desire for closer interaction with COSPAR, perhaps through the activities of WG 94.

Scientific Committee on Problems of the Environment

The General Meeting noted that SCOPE was considering the establishment of a program entitled "Interaction of Main Element Cycles in Marginal and Intercontinental Seas". At the request of the SCOPE Executive Director, documentation regarding this proposed program had been sent to individuals involved in JGOFS and LOICZ for comment. SCOPE was urged to maintain very close liaison with both JGOFS and LOICZ if the program is established, since there appeared to be substantial overlap between these various activities.

5.3 Affiliated Organizations

International Association for Biological Oceanography

The President of IABO, Professor Pierre Lasserre, reported that on the next IABO General Meeting would take place on the occasion of the international symposium on "Marine Biodiversity in Estuaries, Lagoons and Near-shore Coastal Ecosystems" which would take place in Guadeloupe in late February 1992. Elections would be held to fill the positions of IABO President, Secretary and two other members of the IABO Executive.

IABO and its parent organization, IUBS, along with UNESCO, have a joint task force on Marine Biodiversity. A proposal linking marine biodiversity and ecosystem function was accepted as part of the IUBS/SCOPE/UNESCO "Diversitas" program. A report has been produced which sets out a plan for the implementation of an integrated program on marine biodiversity, including theoretical and experimental research, as well as educational and training objectives. It identifies appropriate ecosystems and proposed a network of study sites in selected regions around the world, as well as proposing programs of monitoring and inventory development.

The General Meeting urged Professor Lasserre to ensure that SCOR is appropriately involved in the marine aspects of the "Diversitas" program.

International Association for Meteorology and Atmospheric Physics

The Executive Director had received a letter from the President of IAMAP, Professor Brian Hoskins, which questioned the need for the affiliation between IAMAP and SCOR. The General Meeting took strong exception to this and Dr. Muench and others agreed to provide the names of meteorologists with interests in air-sea interactions who could provide IAMAP representation to SCOR. It was also suggested that IAMAP be invited to co-sponsor the newly-created WG 101 on the Influence of Sea State on the Atmospheric Drag Coefficient. Professor Hoskin's letter also included reference to several symposia to be cosponsored by IAMAP during its joint assembly with the International Association of Hydrological Sciences in Japan in July 1993. These included two symposia of direct relevance to ocean-atmosphere sciences.

International Association for the Physical Sciences of the Ocean

The President of IAPSO, Dr. Robin Muench, discussed the structure of his Association, reviewing the new membership of its Executive Committee and of its various commissions. These include Commissions on: Mean Sea Level and Tides, Natural Marine Hazards; Oceanographic Cooperation with Developing Countries; Sea Ice, Space Oceanography and the Subcommittee on Optics and Remote Sensing of the Ocean; and Programs and Assembly Planning. IAPSO also operates the Permanent Service for the Mean Sea Level and the IAPSO Standard Seawater Service. His report also included a review of the meetings being organized or cosponsored by IAPSO - those of direct interest to SCOR are included in the list given in item 6.0 of this report.

Commission for Marine Geology

The outgoing President of CMG, Professor McCave, noted that the General Meeting of IUGS was taking place and that a new President of CMG would be elected. [Professor Yves Lancelot was confirmed in this position and thereby became an *ex officio* member of the SCOR Executive Committee.]

Professor McCave stated that work in marine geology covers virtually all subdiscipline of geology and is massively supported in several areas, especially the Ocean Drilling Program, but also through developing initiatives concerned with mid-ocean ridges, the use of the sea floor, continental margins and the polar oceans. These studies involve sedimentology, geochemistry, micropalaeontology, stratigraphy, igneous petrology, tectonics and geophysics. The recent activities of CMG include sponsorship of the Third and Fourth International Conferences on Paleoceanography (Cambridge, 1989; Kiel, 1993) which resulted in several publications; the organization of the Dahlem Conferences on Ocean Margin Processes in Global Change and on the Use and Misuse of the Seafloor; contributing to the scientific plan for the Nansen Arctic Drilling Program; cosponsorship of several symposia at the 13th International Sedimentological Congress; promotion of paleoceanography in JGOFS; sponsorship of symposia on paleoceanography and quaternary paleoceanography during the 13th INQUA Congress in Beijing; cosponsorship of relevant SCOR WGs; and, involvement in the development of the InterRidge program. This last activity will continue during the next few years, as will CMG's efforts to ensure a continuing voice for marine geology in IGBP programs like JGOFS and PAGES, and the organization of a workshop to survey the current state of the field of marine geology.

5.4 Corresponding Organizations

Arctic Ocean Sciences Board

The report from the AOSB drew attention to the progress in the International Arctic Polynya Program which involves studies of polynyas (permanently ice-free areas) in several areas of the Arctic Ocean, and the Greenland Sea Project which was entering its second intensive field phase in 1993. A Symposium on Oceanography and Marine Ecology of the Nordic Seas to be held in Hamburg in November 1992 was expected to feature the Greenland Sea Project. The Board has agreed to explore through IOC and its Committee on International Oceanographic Data Exchange the possibility of designating a Responsible National Oceanographic Data Centre for the Arctic region. The AOSB has also developed a statement of its long-term mission and strategy as follows:

The mission of the AOSB is to facilitate Arctic Ocean research by the support of multi-national and multidisciplinary natural science and engineering programs.

The AOSB long-term strategy is to achieve its mission and provide additional value through AOSB involvement by:

- encouraging and supporting science-led programs by offering planning, coordination, and access to funding and logistics;
- ensuring that information on Arctic Ocean research is exchanged between nationals and disseminated to Arctic Ocean scientists in each nation;
- providing networks for Arctic Ocean scientists, for example, on access to facilities/logistics and access to data;
- establishing means of initiating and maintaining long-term data capture systems (via moorings, buoys, satellites, etc.); and
- ensuring that there is interaction, where appropriate, between the international Arctic Ocean Science community and those concerned with Arctic policies.

Engineering Committee on Oceanic Resources

Mr. Brian Nicholls presented recent information on ECOR including several of its working groups of potential interest to SCOR:

- Marine Robotics - is preparing a discussion paper entitled "A Review of Technologies and Applications for Autonomous Underwater Vehicles."
- Large-scale Cleansing of Polluted Seabeds - is searching for funds to support a field study.
- Marine Oil Pollution - focuses on oil-spill trajectory modelling and clean up technologies.
- Ocean Engineering Education and Training - this WG is working with IOC to establish a training program involving experience on an oceanographic cruise or at a research institute for a candidate(s) from China, India or Korea.

The ECOR Council was due to meet shortly after the General Meeting and was to consider the establishment of working groups on Numerical Modelling Tools for Storm Surge Prediction in the Coastal Zone; and Application of Underwater Acoustic Methods to Measure Sediment Movement.

Confederation Mondiale des Activités Subaquatiques (Scientific Committee)

A note from the President of the CMAS (SC) stated that a sub-commission is working on a second edition of the manual for scientific diving which was originally produced by CMAS and published by UNESCO. Compilation of a directory of scientific and technical divers is continuing and readers wishing to be included should contact Professor P.D. Ryan.

5.5 Other Organizations

Following up from a discussion of the Commission for Marine Geography which had taken place during the SCOR Executive Committee meeting in 1991, Professor Healy had investigated the interests of this organization which had indicated an interest in establishing a formal relationship with SCOR. The Commission had not responded to an invitation to be represented at the General Meeting and since it appeared that its main interests relate to human impacts on the ocean and socio-economics, the Meeting did not feel that it was appropriate to pursue the matter further at this time.

6.0 FUTURE MEETINGS

6.1 Meetings of SCOR

The General Meeting accepted, with gratitude, an invitation from the Chinese SCOR Committee for the Executive Committee to hold its next meeting in Qingdao in late September or early October 1993. It was agreed that the detailed arrangements would be made in correspondence between the Executive Director and the Chinese SCOR Committee.

The Chairman of the Canadian Committee for SCOR, Dr. J.A.J. Thompson extended a preliminary offer to host the XXII General Meeting of SCOR at the Institute of Ocean Sciences in Sidney, British Columbia in September/October 1994.

6.2 Meetings of interest to SCOR

The Executive Director presented a list of meetings for which SCOR cosponsorship had been requested. The General Meeting agreed that these events were appropriate for SCOR involvement. While financial constraints did not permit the allocation of funds for organizational support of these meetings, it was agreed that SCOR should provide travel awards to scientists from developing countries as appropriate and as the funds available for this purpose would allow. Accordingly, SCOR sponsorship was endorsed for the following meetings:

The Oceanography Society, Third Scientific Meeting. Seattle, USA. April 13-16 1993.

IAPSO/IUGG Symposium on Optical Oceanography. Villefranche, France. May/June 1993.

Air-Sea Interaction Symposium. Marseilles, France. June 24-30 1993.

Fifth International Congress on the History of Oceanography. Scripps Institution of Oceanography, La Jolla, USA. July 7-14 1993.

WMO/IOC Technical Conference of Space-based Ocean Observation. Bergen, Norway. September 5-10 1993.

Fourth International CO₂ Conference. Carqueiranne, France. September 13-17 1993

The South Atlantic: Present and Past Circulation. Bremen University, Germany. August 15-19 1994.

The following meetings may be of interest to SCOR Members; additional information about any of them is available from the SCOR Secretariat:

Arctic Ocean Sciences Board. International Workshop on Arctic Polynyas. Seattle, USA, January 11-13 1993.

ICSU Forum on Earth System Research. Ensenada, Mexico. January 24 1993.

Third Meeting of the IGBP Scientific Advisory Council. Ensenada, Mexico. January 25-29 1993.

SCOPE/IUBS Ecosystem Function of Marine Biodiversity in Estuaries, Lagoons and near-shore Coastal Ecosystems. Pointe-à-Pitre, Guadeloupe. February 1993.

25th International Symposium on Remote Sensing and Global Environmental Change: Tools for Sustainable Development. Graz, Austria. April 4-8 1993.

Data Assimilation in Marine Science. The 25th International Liège Colloquium on Ocean Hydrodynamics. Liège, Belgium. May 3-7 1993.

Nansen Centennial Symposium on The role of the Polar Oceans in Shaping Global Environment. Bergen, Norway. June 1993.

SCOPE/IUBS Biodiversity in Coral Reef Ecosystem Function. St. Petersburg, USA. Summer 1993.

IAMAP/LAHS Symposium on Global Monitoring and Advanced Observing Techniques in the Atmosphere and Hydrosphere. Yokohama, Japan. July 11-23 1993.

IAMAP/LAPSO Symposium on Atmosphere/Ocean Interaction. Yokohama, Japan. July 11-23 1993.

IAMAP/IAPSO Symposium on Global Climate Models. Yokohama, Japan. July 11-23 1993.

Chapman Conference on Fractals, Chaos and Predictability in the Oceans and Atmosphere. Galway, Ireland. September 1993.

Inter-Ocean Exchange of Heat, Water and Particulates. Capetown, South Africa. Jan/Feb 1994.

IAPSO Summer School on Physics of Ice Covered Seas. Helsinki, Finland. June 1994.

7.0 OTHER BUSINESS

The President extended the thanks of all members of SCOR to Professor Gerold Siedler whose term as Past-President expired at the end of this General Meeting. He noted that Professor Siedler had been a participant in many SCOR activities for more than twenty years, as a member of WGs 21 on Continuous Current Velocity Measurements and 34 on Internal Dynamics of the Ocean, in the GARP Atlantic Tropical Experiment, and as a member of the SCOR Executive Committee since 1980. He welcomed the new President and Secretary of SCOR to the Executive Committee. Professor Strömberg also thanked the Swedish Academy of Sciences, the University of Göteborg and the Chalmers Technical University for their support and sponsorship of the General Meeting.

The incoming President, Professor McCave, took the chair briefly to express the appreciation of SCOR to Professor Charnock. His retirement as a Nominated Member of SCOR from the United Kingdom marked the end of his formal involvement in SCOR since its establishment when he was a member of WG 1 on Radioactivity in the Ocean and later as Secretary and Vice-President. The meeting was pleased to note that Professor Charnock would still have a link to SCOR since he had been nominated as a Corresponding Member of the newly established WG 101.

Finally, speaking on behalf of all of the members of SCOR, Professor Charnock thanked Professor Strömberg for his service as President of SCOR since his election in 1988.

There being no other business, the President adjourned the meeting.

ANNEX I - LIST OF PARTICIPANTS

XXI GENERAL MEETING OF SCOR
Göteborg, Sweden - September 15-18 1992

September 9, 1992

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ANNEX II - SYMPOSIUM PROGRAM

Marine Hydrothermal Systems and the Origin of Life"

Chalmers Part Conference Center
Göteborg, Sweden - September 18, 1992
Nils G. Holm, Convenor

- | | |
|------------------------------------|--|
| Nils Holm | Why are hydrothermal systems proposed as Plausible Environments for the origin of life? |
| Remy Hennet | Hydrothermal systems: their varieties, dynamics and suitability for prebiotic chemistry. |
| Roy Daniel | Modern life at high temperatures. |
| Bernd Simoneit | High temperature/high pressure organic geochemistry. |
| Everett Shock | Chemical environments of submarine hydrothermal systems. |
| James Ferris | Chemical markers of prebiotic chemistry in hydrothermal systems. |
| Everett Shock | Hydrothermal organic synthesis experiments. |
| Hiroshi Yanagawa | An experimental approach to chemical evolution in submarine hydrothermal systems. |
| Michael Russell | Mineral theories of the origin of life and iron sulphide example. |
| Roy Daniel,
Remy Hennet | Future research. |

The symposium was sponsored by the Anna-Greta and Holger Crafoord Foundation and the Wenner-Gren Center Foundation.

ANNEX III - AGENDA

TWENTY-FIRST GENERAL MEETING OF SCOR

1.0 OPENING

The General Meeting will open at 9:00 AM on Tuesday, September 15.

- 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 XX General Meeting (October 1990).
- 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 also works with the Executive Director to draw up a budget for the next year's activities based on the decisions taken during the meeting. The Committee will report under agenda item 3.3.

2.0 SUBSIDIARY BODIES

2.1 Arising from Former Working Groups

WG 54 Southern Ocean Ecosystems and their Living Resources - added at opening of General Meeting

2.1.1 WG 75 Methodology for Oceanic CO₂ Measurements

This WG was disbanded by the XX General Meeting pending submission of its final report, which has now been received by the Secretariat and forwarded to UNESCO for publication in the series *Technical Papers in Marine Science*.

2.1.2 WG 76 Ecology of the Deep-sea Floor

This WG was disbanded by the XX General Meeting pending completion of its final report which has now been received. Procedures for its publication/dissemination will be discussed.

2.1.3 WG 77 Laboratory Tests Related to Basic Physical Measurements at Sea

This WG was disbanded by the XX General Meeting pending submission of its final report. The unexpected retirement of the Chairman makes it unlikely that this report

will be received and recent CTD technology developments may render it obsolete in any case. The Executive Committee Reporter suggest that WG 77 be formally discharged.

2.1.4 WG 78 Determination of Photosynthetic Pigments in Seawater

This WG was disbanded by the XX General Meeting pending submission of its final report. Information on progress with this effort and a firm schedule for its completion will be presented.

2.1.5 WG 80 Role of Phase Transfer Processes in the Cycling of Trace metals in Estuaries

The Executive Committee recommended that WG 80 be disbanded pending the publication of two reports; a summary report which will appear as a special issue of *Marine Chemistry*, and a more detailed document with technical annexes for publication by UNESCO. Progress with these will be discussed.

2.1.6 Joint Panel on Oceanographic Tables and Standards

The former Chairman of JPOTS requested support of a meeting to address problems arising from the introduction of the T-90 temperature scale. The Executive Committee suggested that this might be a topic for a SCOR Working Group. No further action has been taken; the views of the other co-sponsors of JPOTS will be sought before the General Meeting.

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 83 Wave Modelling

Report of the final meeting held in May 1992. Plans for publication and distribution of final report. Recommendation for formation of task teams for continuation of the work of WG 83.

2.2.2 WG 86 Ecology of Sea Ice

Progress with planning for an international symposium on "The Ecology of Sea Ice Biota" in 1994. Publications of WG 86.

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

The final meeting of WG 89 will take place during the week of October 4, 1992. Plans for final report which will be an expansion of previous publication in the *Journal of Coastal Research*. An outline for this report will be presented.

2.2.4 WG 91 Chemical Evolution and Origin of Life in Marine Hydrothermal Systems
The Chairman will present his report. WG 91 will present a symposium in conjunction with the General Meeting. The proceedings are expected to constitute the final report of WG 91.

2.2.5 WG 92 Ocean/Atmosphere Paleochemistry

Plans to organize a series of three workshops in conjunction with the SCOR General Meeting and the International Paleoceanography Conference in Kiel have not materialized, in part because of a lack of adequate financial support. Plans are now being made for an international symposium to be held in association with a US National Academy of Sciences meeting on the carbon cycle in Woods Hole in January, 1993.

2.2.6 WG 93 Pelagic Biogeography

Funding for a meeting of WG 93 in 1992 was reinstated following a mid-year review of the 1992 SCOR budget. It proved impossible, however, to organize a formal WG 93 meeting in conjunction with the Kiel Paleoceanography Conference as originally planned. Some members will be making presentations at a workshop in Kiel. The Chairman will request approval for a meeting in April/May 1993 and for additions to the list of Corresponding Members of WG 93.

2.2.7 WG 94 Altimeter Data and in situ Current Observations

Report on activities, including plans for a meeting in mid/late 1993 at which time there will have been an opportunity to analyze data from both ERS-1 and TOPEX/Poseidon. Recommendation for rotation of the Chairmanship.

2.2.8 WG 95 Sediment Suspension and Sea Bed Properties

Report on the plans for the first meeting of WG 95, October 1992.

2.2.9 WG 96 Acoustic Monitoring of the World Ocean

Report and recommendations of first formal meeting, La Jolla, June 1992. Membership proposals. Plans for a meeting in Brest in June 1993. Statement from the Co-Chairman regarding the value of SCOR sponsorship of WG 96.

2.2.10 WG 97 Physiological Ecology of Harmful Algal Blooms

Report on the establishment and final membership of WG 97. Preliminary plans.

2.3 Committees and Panels

2.3.1 Joint SCOR/IOC Committee on Climatic Changes and the Ocean

CCCCO activities in 1992. The General Meeting will be informed of issues regarding the IOC cosponsorship of the WCRP and the establishment of two IOC committees for the development of the Global Ocean Observing System. One of these is expected

to be cosponsored by SCOR. These developments seem to make the continuation of CCCO in its present form with IOC sponsorship and support impractical. The General Meeting will be invited to consider alternatives which would provide an international forum for the discussion of interdisciplinary oceanographic topics. The continued SCOR sponsorship of certain CCCO subsidiary bodies, such as the regional ocean panels and the CCCO/JGOFS CO₂ Advisory Panel will also be discussed. Report of the CCCO meeting on Ocean Interdecadal Climate Variability. Proposal by the CO₂ Advisory Panel for a two week workshop on the design of equilibrators for pCO₂ measurements to be held in 1993/94.

2.3.2 Joint Global Ocean Flux Study Scientific Steering Committee

The Vice-Chairman of JGOFS, Professor Field, will introduce this report. Highlights of JGOFS activities since the 30th SCOR Executive Committee meeting. These include the initiation of the Equatorial Pacific Ocean Process Study, advanced planning for the Arabian Sea Process Study, a major modelling workshop, a joint workshop on ocean-atmosphere exchanges with the International Global Atmospheric Chemistry Program, preliminary discussion of the scientific objectives of a process study in the North Atlantic late in the JGOFS program. Publication of the JGOFS Implementation Plan has been a major priority in 1992. Plans for future activities including a formal meeting of the SSC in October 1992, inclusion of continental margins studies in JGOFS, to be planned jointly with the IGBP Land-Ocean Interactions in the Coastal Zone program. Membership changes. Other JGOFS issues.

2.3.3 SCOR/IOC Committee on Global Ocean Ecosystems Dynamics

Report by the Chairman of GLOBEC, Professor Rothschild, on the establishment of the GLOBEC Scientific Steering Committee following the 30th meeting of the SCOR Executive Committee. IOC cosponsorship was approved by the IOC Executive Council in March. ICES has also expressed an interest in cosponsoring GLOBEC. Report of the first meeting of the GLOBEC SSC, development of the Core Program and plans for initial activities to be carried out through a series of Working Groups. Membership. Other GLOBEC issues.

2.3.4 SCOR/IGBP ad hoc Planning Committee for the Global Ocean Euphotic Zone Study

In accordance with an agreement with the ICSU Scientific Committee for the International Geosphere-Biosphere Program, SCOR is committed to cooperate in the planning of oceanic research for IGBP. The Executive Committee, in 1991, approved the establishment of an *ad hoc* joint group to develop the scientific rationale for a "potential Core Project" of the IGBP which had previously been discussed only in a very preliminary way. Report on the establishment and membership of the GOEZO planning committee and of its first meeting, Victoria, BC., May 1992. Recommendations for formalization of this working group, a meeting in 1993, and for a scientific symposium in September 1994.

2.3.5 Editorial Panel for the Ocean Modelling Newsletter

2.4 Proposals for New Working Groups

The following proposals were tabled at the 30th Executive Committee meeting due to a lack of sufficient funds to support new activities. In some cases the proposals required revision. They have all been circulated to SCOR Committees for comments.

- 2.4.1 *Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations* - Revised following the 30th Executive Committee meeting. Participants will be asked to take into account the development of the GLOBEC program in considering this proposal.
- 2.4.2 *Coral Reefs and Global Change* - Revised following the 30th Executive Committee meeting and further developed during discussions at the International Coral Reef Symposium (Guam, June 1992). The General Meeting will also be informed about the establishment of an IOC/UNEP Global Task Team on the Potential Impacts of Climate Change and Sea Level Rise on Coral Reefs and its first meeting which also took place in Guam.
- 2.4.3 *The Impact of World Fisheries Harvest on the Stability and Biodiversity of Marine Ecosystems* - The 30th Executive Committee meeting agreed to table this proposal until the report of the ICES Study Group on Ecosystem Effects of Fishing Activities has been received. This may be available for the General Meeting.
- 2.4.4 *Linked Mass and Energy Fluxes at Ridge Crests* - This is a replacement for a proposal entitled *Quantification of Mass and Energy Fluxes through the Mid-Ocean Ridge System* which was considered in 1991. It constitutes a request for SCOR to become an active cosponsor of the InterRidge program and to contribute to it through the activities of a SCOR WG.
- 2.4.5 *Laboratory Modelling of Oceanic Processes* - Received from the Russian SCOR Committee. Clarification of the proposal, especially the terms of reference, has been requested and it may be revised at the General Meeting.
- 2.4.6 *Sediment Coring for International Research on Global Change* - Submitted by the UK, French and US SCOR Committees, the establishment of this working group would provide a SCOR contribution to the emerging MESH program (Marine Aspects of Earth System History).
- 2.4.7 *Influence of Sea State on the Atmospheric Drag Coefficient* - This topic was introduced at the 30th Executive Committee meeting and a formal proposal

has been submitted by the Australian SCOR Committee.

The following proposal has not yet been circulated to SCOR Committees:

2.4.8 *Effects of Direct CO₂ Disposal into the Oceans* - This topic was introduced at the 1991 SCOR meeting. A more detailed proposal has been received from the Chairman of former WG 75 and comments have been sought from some members of the CCCO/JGOFS CO₂ Advisory Panel.

3.0 ORGANIZATION AND FINANCE

3.1 Membership

The Executive Director will report on changes in SCOR membership since 30th Executive Committee meeting. Dr. Su Jilan, Co-opted Member of the Executive Committee, will report on contacts with potential new members of SCOR. Other membership issues.

3.2 Publications Arising from SCOR Activities

The Executive Director will present a report on publications arising from SCOR activities since the 30th Executive Committee meeting. The Publications Office, Professor R.O. Fournier may wish to raise issues relating to SCOR publications.

3.3 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 1993 activities and recommendations regarding the levels of membership contributions to SCOR for 1993 and 1994.

3.4 Report of the Nominations Committee and Elections

The terms of the President and Secretary both expire and they are ineligible to be re-elected. The terms of the three Vice-Presidents expire at each General Meeting. The incumbents are all eligible to be re-elected for an additional two year term. SCOR Committees have been invited to submit nominations for these positions. The chairman of the Nominations Committee established at the 30th Executive Committee meeting, Professor Siedler, will present his report and will propose a slate of officers for election.

4.0 RELATIONS WITH INTERGOVERNMENTAL ORGANIZATIONS

4.1 Intergovernmental Oceanographic Commission / Marine-Related Issues (UNESCO)

The representative of IOC will inform the General Meeting about current activities of the Commission which may involve SCOR, in particular the establishment of mechanism(s) for the development of the Global Ocean Observing System (GOOS).

The IOC has become a formal cosponsor of the World Climate Research Programme (with ICSU and WMO) - implications for the non-governmental oceanographic community. The roles of SCOR and IOC as cosponsors of joint activities such as Global Ocean Ecosystem Dynamics (GLOBEC), harmful algal blooms, coastal oceanography, etc. Proposal for a joint coordinating body for interdisciplinary coastal ocean science. IOC follow-up to UNCED. Matters arising from the IOC Executive Council meeting (March 1992). Other IOC issues.

4.2 World Meteorological Organization

Items of mutual interest to WMO and SCOR will be brought to the attention of the General Meeting. SCOR sponsorship of the WMO/IOC Technical Conference on Space-based Ocean Observation (Bergen, September 6-10 1993) has been requested. TOGA-COARE.

4.3 International Council for the Exploration of the Sea

The report from ICES will cover activities of mutual interest such as the ICES Cod and Climate program which is a contribution to GLOBEC.

4.4 North Pacific Marine Science Organization (PICES)

This new organization will hold its First Annual Meeting in October. Information will be presented on its scientific objectives, membership, etc. The Chairman is Professor W.S. Wooster.

5.0 RELATIONS WITH NON-GOVERNMENTAL ORGANIZATIONS

5.1 International Council of Scientific Unions

The Chairman of the ICSU panel which is conducting a review of SCOR will give an interim report on its progress towards presentation of its findings to ICSU in October. ICSU participation in UNCED and the implications of UNCED for the scientific community. Other ICSU matters.

5.2 ICSU Unions and Committees

Reports have been requested from all ICSU bodies which have representatives to SCOR. Matters of interest will be brought to the attention of the General Meeting.

Scientific Committee for the International Geosphere-Biosphere Programme

Review of the relations between SCOR and IGBP with regard to the oceanic components of the IGBP.

Scientific Committee on Antarctic Research

Committee on Space Research

Scientific Committee on Problems of the Environment

5.3 Affiliated Organizations

Reports have been requested from the following organizations and matters of interest will be brought to the attention of the General Meeting. The Presidents may also present verbal reports as *ex officio* members of the Executive Committee.

International Association for Biological Oceanography

International Association for Meteorology and Atmospheric Physics

International Association for the Physical Sciences of the Ocean

Commission for Marine Geology

5.4 Corresponding Organizations

Reports have been requested from the following organizations and matters of interest will be brought to the attention of the General Meeting.

Arctic Ocean Sciences Board

Engineering Committee on Oceanic Resources

Confederation Mondiale des Activités Subaquatiques (Scientific Committee)

5.5 Other Organizations

Commission for Marine Geography - added at opening of General Meeting

6.0 FUTURE MEETINGS

6.1 Thirty-first Executive Committee Meeting of SCOR

Preliminary consideration should be given to the date and location. The Chinese SCOR Committee has indicated its interest in hosting this meeting in Qingdao in October 1993.

6.2 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 General Meeting will be asked to decide on requests for SCOR cosponsorship and/or support of these events.

7.0 OTHER BUSINESS

ANNEX IV - REPORT OF WG 94

Altimeter Data and *in situ* Current Measurements Dr. V. Zlotnicki, Chairman

SUMMARY

Past Activities: WG 94 (Comparison of Altimetric and in-situ current measurements) held its first meeting October 21 to 25, 1991 in Toulouse, France, co-located with the week-long meeting of the Topex/Poseidon Science Working team.

Current Activities: Most members of the WG are either waiting for Topex/Poseidon to launch, or waiting for the accurate Geophysical Data Records from ERS-1 to be delivered by the French PAF, before further comparisons between altimetric and in-situ currents. The reason for the wait is that almost no experiments to help understand this issue were planned for the past Geosat mission, but several such experiments have taken place for ERS-1 or will take place for T/P.

Current ERS-1 data available from NOAA-NOS does include orbits computed at Delft and water vapour corrections from the ECMWF model. Other data sets based on the Fast Delivery Product lack even those elementary corrections. The data from the French PAF (of which one tape was delivered over the last month) has many improvements over anything in existence: a) altimeter retracking; b) water vapour from the onboard radiometer (ATSR); c) precise orbit; d) timing error corrected (uncorrected in currently delivered tape).

As a consequence, this investigator believes that most results associated with ERS-1 that will be presented in Cannes later in 1992, will be associated with basic properties of the altimetric system, rather than oceanographic results or surface current estimates, and the ESA-sponsored meeting is sufficient.

Planned 1993 Activities: I propose one meeting of this WG in mid or late 1993. By then we will have had time to analyze the precise ERS-1 data, and early but accurate Topex/Poseidon data. I prefer to hold these meetings in association with either an ERS-1 or a Topex/Poseidon meeting, somewhere in Europe. This will give those members of the group who are not part of ERS-1 or T/P a broader exposure, will save money since those members who are part of T/P or ERS-1 can partly use other moneys to defray travelling costs, and it minimizes lost time spent on airplanes and airports.

Chairmanship: I suggest rotating the chair of this group to a European member. I suggest Dr. Picaut since in my personal opinion, the experiment he has planned around both ERS-1 and T/P is the most comprehensive yet, as is his published work on the subject.

COMPARISON OF ALTIMETRIC AND IN-SITU CURRENT MEASUREMENTS

REPORT OF WORKING GROUP 94 July 1992.

1. Meeting of October 1991.

The first meeting of SCOR WG 94, 'Comparison of Altimetric and in-situ current measurements', was held during October 21 to 25 in Toulouse, France, co-located with the week-long meeting of the Topex/Poseidon Science Working team, to which several members belong. Present were WG members Drs. John Church, Marten Grundlingh, Karen Heywood, Motoyoshi Ikeda, Shiro Imawaki, Oleg Mamayev, Jean-Francois Minster, Joel Picaut, Detlef Stammer, and Victor Zlotnicki (chair). Dr. Terrence Joyce could not attend but sent the chair a message with his thoughts and suggestions as well as reprints of relevant work.

Two specific dates (21 and 25) were reserved for SCOR WG 94 only activities. During the first meeting brief presentations both by members of the WG and by interested researchers attending the Topex/Poseidon meeting were heard. The group was fortunate to hear presentations by Sabine Arnault, Dudley Chelton, Robert Cheney, Gary Mitchum, Robert Stewart, and Ted Strub in addition to those of the group members. During the week, members attended the Topex/Poseidon sessions. On October 25 a second meeting was held to discuss the issues raised during the week and the preliminary report.

2) Summary of prior and recent results.

Rather than summarize each talk, a brief summary of work both published and in progress (reported at the meeting) follows, based on the presentations and

the written contributions of some members.

With the older Seasat data, Daniault and Menard (1985) had already shown that eddy kinetic energies derived from a short (3 month) Seasat altimetric data set matched extremely well the EKE derived from FGGE buoys in the Antarctic Circumpolar current region. However, no altimetric data set prior to Geosat was long enough or accurate enough to compare actual time series of current velocities.

Picaut et al. (1990) compared surface geostrophic currents derived from Geosat altimetry on and near the Equator with current meter data from depths up to 50 m. They used the meridional curvature of sea level on a beta plane, rather than its slope on an f-plane as is usual at higher latitudes, considered all altimetric data within a 4.5° longitudinal band as co-located, and smoothed the time series with both a median filter and a 31 day Hanning window. They found correlations between the two data sets ranging from 0.5 to 0.8, with a few as low as 0.2; the rms differences between the two methods ranged between 15 and 30 cm/s, relative to signals with 25 to 40 cm/s rms.

In the energetic Gulf Stream region, Joyce et al. (1990) compared absolute geostrophic velocities derived from Geosat in a 2 week period (using the method of Kelly and Gille, 1989) and those derived from ADCP (Doppler current profiler), smoothed with a filter whose half power point was 76 km, and no time smoothing. They found correlations of 0.87 and 0.57 between

the two data types on two particular days; they do not quote the rms difference between the two measurements. Similarly good correlations between altimetric velocities and those of drifting buoys in the Gulf Stream were found by Willebrand et al (1990) after low-pass filtering the drifter trajectories to match the smoothing of the altimetric objectively-mapped grids (~ 100 km). S. Imawaki reported on excellent agreement between Geosat altimetry in the Kuroshio region and GEK current meters in the same area, yielding also a very good description of the Kuroshio path.

In a much quieter regime in the Iberian basin, Stammer et al. (1991) also found agreement between altimetric and current meter velocities (their Figures 8 and 9). Zlotnicki et al. (1992), in the Cape Verde frontal area, compared the time varying components of altimetric velocities and those of current meters at about 200 m depth and found correlations ranging between 0.4 and 0.9. The rms discrepancies ranged between 39% and 134% of the rms of the current meter data (which was between 2.6 and 5.7 cm/s) when the current meters were smoothed over 30 days and the altimetric slopes computed over 140 km alongtrack. In the same Cape Verde - Azores area, and using essentially the same raw data but a different analysis scheme, Stammer reported that the correlation between geostrophic surface velocities derived from objective analysis of the GEOSAT composite SSH with subsurface current meter data are significant but not high (0.4). There are periods of reasonable good agreement followed by periods during which structures from both data sets do not agree, as is also clear in Zlotnicki et al. (1992). More confusing, the agreement is not uniform throughout the region: it is good close to the Azore front and north of it, but not further south.

Comparisons between altimetric sea level and hydrographic data, whether

from CTD stations or from XBT data, are abundant. Tai et al (1988) first showed the good correlation between XBTs and Geosat altimetric sea level, but only after the first EOF of both data sets was taken, which effectively applied a peculiar spatial low-pass filter over the equatorial Pacific. Arnault et al (1990) compared Geosat to historical monthly hydrography, to a small set of contemporaneous XBT data with a mean T-S relationship, and to contemporaneous inverted echo sounder data which in the equatorial region are strongly correlated with dynamic height. They found correlations between altimetric sea level changes and dynamic height changes better ($\rho=0.82$ to 0.94) around 3°N than on the Equator proper ($\rho=0.70$). Willebrand et al (1990) showed good visual agreement between the sum of climatological dynamic topography plus altimetric time residuals and instantaneous dynamic topography (50/1500 dbar) along three sections between Azores, the Grand Banks and Bermuda. Zlotnicki et al (1992), again in the quiet Cape Verde area, found that, when averaged over the box 14°N to 23°N , 27°W to 18°W , altimetric sea level during 11/87 was 4.5 cm higher than on 11/86 or 2/89, and that the dynamic height differences for the same region and time (to within one month) from hydrography in dyn-cm (50/1950 dbar from Meteor cruises 4,6,9) agree with altimetry within 0.1 or 2.0 cm. However, the rms discrepancy, representative of the point by point differences rather than the areal difference, is essentially 100% of the rms of the hydrographic differences (3.5 dyn-cm), which the authors attributed to ocean changes while the cruise is underway, mapped to a central time in the objective maps of dynamic topography. Grundlingh reported on 69 CTD stations executed to depths of 1000 - 3000 db between Durban (Africa) and Mauritius and compared to GEOSAT altimeter data, showing very good qualitative agreement between the positions of eddies, indicated by the ship's data and

located through altimetry. There was also fair quantitative agreement between the altimetric topography and the dynamic heights (disregarding the asynoptic coverage of the ship).

Comparisons between altimetry and tide gage data have now become a standard component of validating the altimeter data. Cheney and Miller (1990) showed rms differences between altimetric data averaged over 2° in longitude by 1° in latitude, and monthly tide gage data ranging between 3.7 and 6.5 cm, correlations ranging between 0.57 and 0.93 for 7 tide gages in the equatorial Pacific. Wyrski and Mitchum (1990), while also finding equally good correlations, pointed out the apparent change in 'datum' of the altimetric time series that can be identified with orbit error. G. Mitchum also pointed out the importance of the calibrating staff in tide gage stations, and its essential role in long term time series. Using tide gage sea level differences across straits constraining a current's path has been used for many years as a measure of surface transport by the current (e.g., Kawabe, 1989).

If altimetric data can yield surface currents with excellent spatial and temporal resolution, then altimetric sea level at crossovers can be used to compute eddy momentum flux, which Morrow et al (1992) did in the southern ocean, finding that their estimate cannot balance the eastward momentum input from the wind. Stewart (1992) also computed Reynolds stresses in the southern ocean from Geosat altimetry.

Ikeda discussed the assimilation of altimetric data into an eddy resolving QG model on a beta plane, with bottom friction and the ability of the model to predict incoming data (predictability) relative to the ability of data at the same location and prior time to predict future data (persistence). Most of the work in this area has been done with QG models and nudging as the assimilation scheme (Holland et al. (1991), Verron (1992),

Holland and Rizzoli (1990), White et al (1990), Verron (1992)). The weights used in nudging are almost never related to the expected errors of data and model prediction, hence the assimilation scheme has no ability to assess consistency between data types or between data and models, or to reject bad data, or to assess deficiencies in model physics. Recent progress has been gained in using rigorous L2 norm minimization schemes, such as adjoints (e.g., Tziperman and Thacker, 1989) or Kalman filters (e.g. Miller and Cane, 1989) which show the best potential to address many of the issues discussed by this WG.

3) Peculiarities of altimetric data.

Various problems unique to altimetric data were discussed.

The current lack of a geoid to subtract from the data restricts most current estimates to estimates of variability, as discussed by M. Grundlingh. The mean ocean circulation is either absent, or can be provided from historical hydrographic data, assuming that inhomogeneous long term average is the same as the 2-4 year average removed from the altimetry. This approach based on historical data has been widely used, including the work reported by Imawaki on Kuroshio meandering, Willebrand et al's (1990) work on the Gulf Stream, etc.

The only exception is the method of Kelly and Gille (1989) and Tai (1990) to estimate the total surface velocity only of meandering jet regions. Alternative approaches when a good climatology is available involve adding to the climatologic dynamic height the residuals from one or two years of altimetry data (e.g., Willebrand et al, 1990); this assumes the climatological and two year average are essentially the same. This issue is related to the one raised raised by O. Mamayev, who emphasized the classical difficulty of the level of no motion assumption and the

need to understand the density stratification.

The orbit error poses problems, but working directly with alongtrack sea level slopes, as discussed by T. Strub, has several advantages. As shown by Sandwell and Zhang (1989), most of the orbit error is attenuated in the alongtrack slope, avoiding a cumbersome adjustment process (although the longer wavelengths remain contaminated by error). Gordon and Haxby (1990) successfully used this approach while tracking Agulhas eddies into the S. Atlantic. Strub is using this approach in the NE Pacific.

Altimetric satellites travel at speeds of about 7 km/s, much faster than any ship. Nonetheless, their sampling scheme does leave holes in frequency-wavenumber space (see Wunsch, 1989). For example, Geosat aliases the M2 tide to about 317 days but neighbouring tracks show the aliased signal with a different phase that allows M2 to be separated from another oceanic signal with true 317 day period (Cartwright and Ray, 1991). However, this alias and the phase change appear as spurious traveling waves (Perigaud and Zlotnicki, 1992) that at certain latitudes can be mistaken for Rossby waves. Chelton discussed an alternative view of altimetric sampling, in the context of objective mapping: he transforms the error covariance function to analyze the filter imposed by the sampling scheme in frequency-wavenumber space. Minster reported work with Le Traon and Hernandez on the sampling properties of altimetric satellites using a numerical model to simulate ocean variability in the Azores front; he reported potential Topex errors of 70% of the variable mesoscale signal between tracks, due to Topex's large (2.8°) separation between neighbouring parallel tracks. G. Mitchum pointed out by example how sea level events can be totally missed by the altimetric sampling, while still leaving good matches to tide gage data. Stammer reported that not only in the energetic Gulf Stream have these

problems surfaced, but also in the quiet Iberian basin, where major changes (relative to the energy level in the region) can occur during a three week in-situ survey.

The issues of sampling also implies interpolation and smoothing. For example, surface velocities can be computed from alongtrack-track surface slopes, which is ideal for comparisons with current meters and for computing Reynolds stresses. But space-time objectively mapped (and smoothed in the process) altimetric SSH, differenced on its grid, can give a better areal estimate and also helps reduce some errors that remain correlated along tracks (for example, tidal aliasing). Normally interpolation will be done towards the space/time state vector of the data with lower space/time resolution.

The issue of water vapor corrections was briefly discussed by Cheney. For Geosat, the lack of onboard radiometer posed a huge problem that has been greatly alleviated with SSM/I-derived corrections after 7/87 and partially corrected with TOVS-derived corrections before that date (Emery et al., 1990). However, the coarse sampling of SSM/I implies that different interpolation schemes used to colocate the SSM/I and Geosat data in space and time yield different results (e.g., Jourdan et al., 1990).

4) Issues raised.

Several issues were raised during our discussions. They are summarized below.

When you do a cursory assessment about the different physics, noise, etc of altimeter and current meters, no such comparison should work. However, there is published work and we also heard of work in progress where it does work very well at all or at some times (literally, some time intervals in a long record). What does this mean about our assumptions about physics and noise?

The times of disagreement may be indicative of changing physical conditions or of changing environmental and other error terms.

The classical Oceanographic community was built on the accuracy of the geostrophic method. We seem to understand the accuracy of altimetry in relation to hydrography and current meters better than we understood the accuracy of geostrophy for many years

Four sources of discrepancy between altimetric and in situ data can be reasonably expected

a) physics (eg, surface geostrophic velocities vs. surface ekman+geostrophic vel .; sea level vs. dynamic height wrt 500 db)

b) synopticity (location of current meter vs. location of ALT track; duration of hydrographic survey vs interpolation of ALT to survey station lat-lon-time)

c) smoothing (time smoothing of current meter or tide gage or drifter vs. spatial smoothing of ALT)

d) signal to noise and systematic errors (of both altimeter and insitu; e.g., altimetric orbit error and drift of bottom pressure gages).

For a particular planned ALT-INSITU comparison in a particular region (equivalently, for a particular oceanographic process), one can identify the complement of instruments that will eliminate physics as a source of difference, plus redundancies necessary to decrease noise (Minster). E.g., as part of TOGA COARE there will be ADCP, XBT, CTD, Tide Gage, Rain Radar, ALT. Picaut and collaborators plan to add IES and bottom pressure gages. All the statements on how close altimetry and any in-situ data type should be are process dependent (equivalently, depend on the frequency-wavenumber spectrum of the signal).

Heights, velocities, Reynolds stresses must be shown to match separately. A good match of first moments does not guarantee a good match of second moments; neither does a good match of short scales imply one at large scales. For example, short arc orbit adjustments (e.g.. 6,000 km parabola) reduce noise much better than long ones (e.g. a handful of coefficients of analytic functions over 5 day arcs) which makes them better for mesoscale variability and for Reynolds stresses. However, such short arc adjustment kills most of the large scale ssea level signal

Alt-in situ comparisons, even with unexplained discrepancies, can help identify a better environmental correction, or processing technique for the altimetric system (non dynamic orbit error removal; blunder removal), since the mere reduction of the distance (rms difference) between the two data types can be reasonably interpreted as having removed one more source of error uncorrelated to the signals common to both measuring techniques.

The most challenging and most promising way to use satellite data is to combine the continuous and high resolution altimeter surface observations with dynamical ocean circulation models while using any other conventional information to construct a smooth and consistent three-dimensional ocean circulation field. This is precisely what atmospheric predictions centers, like ECMWF or NMC routinely do with atmospheric data. This offers great potential for ocean property flux studies (e.g. ocean heat transport from the lower latitudes towards the poles) by which future work on air-sea interaction and longterm weather forecast or climate predictability will be influenced. Numerical modelling plus a data assimilation scheme that accounts for errors in model and data is a most powerful approach to 'harmonize' different data types. The combination allows the model to dynamically interpolate between the instantaneous

observations of surface displacement, or any other in-situ observation, and to carry that information by its own dynamically consistent memory into data sparse areas, both horizontally (between the sub-satellite tracks or in data drop-out regions) and vertically from the surface to subsurface layers. Model assimilation allows one to identify suspicious data for detailed analysis, data whose values differ from the model/assimilation scheme's prediction by more than a specified threshold. It also allows to question quantitatively the model's physical or numerical simplifications, when the model/assimilation scheme fails to reproduce data within the expected errors of both data and model. The approach is also challenging, since the oceanographic community is still at an early stage of developing assimilation techniques given the constraints of being both optimal and practical with present day computer facilities (e.g., Derber and Rosati, 1989).

5. Future activities.

This group can make a contribution by listing what has been done with altimetry and with various in situ current data. Current data includes not just classical current meters but also sea level differences across selected locations, like Darwin (Australia) as a throughflow index, or current profilers (ADCP), and dynamic height differences.

The WG suggested the preparation of

- a) a short report of this meeting for SCOR (was faxed to rapporteur Prof. G. Siedler and Mrs. E. Gross on 10/91).
- b) a slightly longer one, with a comprehensive list of references, summarizing work to date and the main issues raised (this report).
- c) a review paper that discusses the technical issues in detail and can be used as an honest scientific publication for

wide discussion. If a review paper came out now (over next few months- it would add a useful dimension to the dialog. If we wait more than a year it will be overcome by events.

The future of this group

a) verification workshops will be held in spite of this group: they will be sponsored by Topex (early 93) and by ERS-1 (late 92). However, those workshops will concentrate on SEA LEVEL verification, not-CURRENT comparisons.

b) Modelling. Although this group does not include enough expertise to discuss the subject it is clear that the future combination of altimetry and other data must be done through numerical models with data assimilation.

c) The next meeting of this group should concentrate on

c1) results from the new Geosat data release, with gemt2, ssmi, etc.

c2) results over next 12 months or so of numerical assimilation exercises that include altimetry and one other current constraint.

c3) this group can act as a link between the classic verification activities and those using numerical model and assimilation. Perhaps we can help specify the MODEL REQUIREMENTS needed for alt-current comparisons.

c4) any next meeting should be attached to either of the planned meetings of the JASO modelling group, or the T/P or ERS-1 validation activities. There is no point in gathering a workshop not associated with those projects. Our next meeting should sometime in 1993, depending on these other activities.

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ANNEX V - REPORT OF WG 96

Acoustic Monitoring of the World Ocean

SUMMARY, PLANS AND RECOMMENDATIONS

Following the First International Meeting on Global Acoustic Monitoring of the Ocean, SCOR Working Group 96 met to review progress and make recommendations. The SCOR meeting was open to all participants of the Global Acoustic Monitoring meeting and had an attendance of 27 persons (Annex C). Professor Guan Dinghua chaired the meeting.

Below we summarize the results of the Heard Island Feasibility Test and identify the present status of relevant technical issues. This summary is followed by brief comments on plans for acoustic monitoring of different oceans. Our report concludes with a set of recommendations. Abstracts of the Global Acoustic Monitoring meeting (Annex A) and a copy of the Proof of Concept proposal (Annex B) are appended.

Guan Dinghua and David Farmer
Co-Chairmen, SCOR WG 96

REVIEW OF HEARD ISLAND FEASIBILITY TEST (HIFT)

There were three issues for the Heard Island Feasibility Test:

- (i) Can modulated sources provide sufficient power to be detected at trans-global ranges?
- (ii) Is the acoustic channel stable enough to use pulse compression techniques to resolve travel times to an accuracy required for monitoring global warming?
- (iii) Could the experiment be done without harming marine mammals?

These objectives were met. The signals were received at ranges up to 18,000km; the pulse compression worked for sequence lengths up to 180s; there were no discernible negative effects upon marine mammals. Since the experiment the data analysis has revealed several propagation phenomena important for acoustic monitoring of ocean warming and provided significant insight into the design of the global system.

STATUS OF RELEVANT TECHNOLOGIES

Sources

Sources are a critical technology for an Acoustic Thermometry of Ocean Climate (ATOC) program. Several potential sources are now available in both the United States and Russia; however, none at this time meets all the needs of the ATOC program. These are (i) 195 dB source level, (ii) 70 Hz carrier frequency, (iii) ± 10 Hz bandwidth ($Q = 4$), (iv) reliable for 10^{10} cycles and (v) maximum operating depth of 1500m. Japan and the EEC may also have useful sources which could be lowered to the ATOC frequency band. The technology exists for building the sources and a vigorous development program is needed.

Receivers

The technology exists for fabricating receivers consisting of single hydrophones, vertical line arrays and horizontal line arrays in either fixed or drifting configurations. The critical components are (i) reliable moorings, (ii) cable deployment for fixed receivers, (iii) data telemetry and (iv) energy supplies for autonomous or drifting receivers. Several sites in the Pacific including California, New Zealand, Tahiti and Kamchatka were identified for the initial ATOC effort. Additional sites in the Arctic, Atlantic and Indian Oceans were discussed for ATOC efforts in these oceans (see below).

Propagation Issues

ATOC involves an understanding of global acoustics, a discipline with its own set of (new) problems that have not been solved. The global forward problem (compute the acoustic propagation given the ocean parameters) has to be solved before tackling the inverse problem (derive ocean perturbations given the acoustic signal). In particular, HIFT has demonstrated that acoustic propagation across the antarctic circumpolar front is associated with strong mode coupling. Until this transition is better understood one should avoid propagation across strong frontal surfaces. There is also the problem of horizontal multipaths associated with refraction by mesoscale eddies.

Climate Issues

One of the principal problems is the separation of ambient variability from the greenhouse "signal". Ambient mesoscale variability is of relatively small scale and can be suppressed by integrating over large ranges. Ambient gyre scale and basin scale variabilities are of the same scale as the greenhouse signal, and the separation has to be based on the fact that their spacial structures differ. Thus the network of sources and receivers has to have adequate resolution to make the separation in both the space and time domain. (Atmospheric research on global warming has emphasized only the time domain.) The assimilation of the acoustic measurements into ongoing climate modeling research should commence with the very start of the measuring program.

Relation to other measurements

We recognize that the acoustic measurements are only one of a set of measurements to be assimilated. In particular, there is a nice complementarity between the satellite altimetry measurements and the ATOC program.

REVIEW OF ATOC PLANS BY GEOGRAPHIC REGION

Pacific Ocean

The Pacific Ocean was chosen for the Proof of Concept, a three year plan to develop the basic technologies and analytical approaches for global acoustic monitoring. The proposed plan calls for a source off Hawaii, a second source off California, and receivers as far south as New Zealand. The plan is set forth in Annex B.

Indian Ocean

Representatives from India, Australia and South Africa formed a sub-group to plan an acoustic monitoring program for the Indian Ocean. Opportunities exist for incorporating into the ATOC program plans for laying hydrophone cables off the southwest coast of Australia. India already has an active program of propagation studies that could provide a base for further work over greater ranges. A receiver off the east coast of South Africa is feasible. It is anticipated that a source could be deployed off the Australian coast, perhaps in 1995 or 1996.

Atlantic Ocean

There is strong interest among the Europeans in initiating an Atlantic ATOC program. A small committee of European and U.S. scientists will meet in Luxembourg in September this year to develop a plan, presently aiming to initiate a program after 1994. This timing is appropriate, since by this time the technological development under the Proof of Concept will be available for direct incorporation in the Atlantic program.

Southern Ocean

It was felt that the Southern Ocean presented peculiar problems that complicated interpretation due to mode coupling across the Antarctic circumpolar front. An interesting possibility exists, however for probing a potentially sensitive climatic signal: the transport of the circumpolar current. The measurement could be made by reciprocal transmission between appropriate locations. Notwithstanding the complications of cross-front propagation, paths through the Southern Ocean, for example between Australia and Antarctica, will likely be implemented as soon as an appropriate source is deployed. (A south west Australia source suitable for the Indian Ocean could also be used to probe parts of the Southern Ocean.)

Arctic Ocean

A sub-group with representatives from Russia, Canada, the U.S. and Norway met to plan a possible program in the Arctic Ocean. The scientific problem differs somewhat from the temperate oceans, since although water temperature is a factor, propagation effects arise

also from the ice cover, in particular its spatial distribution, thickness and roughness. Lower frequencies must be used to reduce attenuation by scattering from the ice. The accentuated sensitivity of the Arctic to global warming argues strongly in favour of an acoustic measurement program. Unique opportunities now exist due to the potential accessibility of a Russian hydrophone array off Franz Josef Land, a planned insertion of a Norwegian ship into the polar pack followed by a 2-3 year drift (1994-97), planned Canadian and U.S. icebreaker transits across the Arctic Ocean (one is planned for summer 1993), and a planned drifting ice camp for the US-funded Ice Mechanics Program.

Semi-Enclosed Seas

Although the primary goal of the meeting was to discuss monitoring of the global oceans, there was also discussion of acoustic monitoring of semi-enclosed seas both for climatic and other reasons. There are plans for an acoustic monitoring program in the Western Mediterranean where there is evidence of a progressive, though unexplained warming. There was informal discussion of the possibilities for acoustic monitoring of the Sea of Japan (Russia, Japan and Korea), and of the Tasman Sea (Australia and New Zealand). The Russians hope to develop an acoustic monitoring program in the severely threatened waters of the Black Sea with collaboration from Turkey, Bulgaria and Ukraine. Acoustic monitoring programs such as these will undoubtedly benefit from and may also contribute to technological developments underway for the global acoustic studies. It is to be hoped that data from such studies can be integrated into the archiving and distribution network planned for the global program so as to maximise scientific participation and interaction.

RECOMMENDATIONS

SCOR Working Group 96 makes the following recommendations:

1. a) That effort be focussed on the analytical task of separating ambient variability from global warming;
- b) That outstanding issues of acoustic propagation be addressed, including especially sound propagation through fronts;
- c) That outstanding technical issues concerning receiver and source development be addressed;
- d) That issues concerning the understanding and protection of marine mammals be addressed and that the opportunities provided by this program for learning more about the effects of noise on marine mammals be fully utilised.
2. That the concept of archiving and of free sharing of data with interested scientists be central to all planned global acoustic monitoring studies.
3. United States:

WG 96 discussed the proposed ATOC Proof of Concept and recommends that it proceed, recognising that it is an essential building block for further implementation of a global program.

4. **Japan:**

WG 96 recognises the important development of source technology that has been carried out in Japan, and strongly urges the Japanese development of a 70Hz source suitable for the ATOC program and its deployment together with a receiver off the Japanese coast. This technical development would be a particularly valuable contribution to the global program, and a deployment off the Japanese coast would play a significant role in the Pacific program.

5. **Australia:**

That the proposed deployment of hydrophone cables off the West Australian coast be carried out in such a way as to be appropriate for use with ATOC receivers;

6. **China:**

That collaboration between scientists at the Beijing and Taipei Institutes be encouraged with the purpose of deploying a suitable source and receiver off the East Taiwanese coast;

7. **Russia:**

(i) That support be found to allow Russian scientists to pursue development of ATOC sources and receivers;

(ii) That a Russian source and receiver be deployed off the southern Kamchatka coast;

8. **European Participation:**

WG 96 recognises the current European Community research development activities in the fields of Marine Science and Technology and encourages active support of (i) research projects in EC countries, and (ii) international collaboration, related to acoustic thermometry of the oceans, in particular in the seas around the EC;

9. **Countries bordering the Arctic Ocean:**

WG 96 recognises the particular sensitivity of high latitude regions to global warming and identifies the desirability of an early implementation of an Arctic acoustic

monitoring program. Countries bordering the Arctic Ocean, or with a particular interest in this region, including Russia, Canada, the United States, Norway and Britain, are urged to collaborate on such a program as soon as possible.

10. **New Zealand:**

WG 96 identifies the participation of New Zealand as being essential to implementation of a 10Mm path in the Pacific. Recognising New Zealand's strategic location from a global acoustic point of view, the Working Group recommends its incorporation in both the Proof of Concept and longer term global acoustic monitoring programs.

11. **Tahiti:**

That the potential incorporation of the Laboratoire de Détection de Géophysique at Rangiroa (Tahiti) into the Proof of Concept program, be taken up. The Working Group recognises that the important problem of coupling between the SOFAR channel and seismic signals can be explored if a hydrophone array is included in the Rangiroa deployment, to the mutual benefit of both seismic studies and the ATOC program.

12. **Oceanographic Sections, Integration with Satellite Altimetry:**

WG 96 identifies the need to conduct oceanographic sections in order to calibrate the acoustic array and urges co-ordination with other oceanographic programs wherever possible, including WOCE. When future oceanographic sections are being designed, consideration should be given to the mutual benefit to be derived by incorporating ATOC paths in the plan. The Canadian plan to conduct a north east Pacific calibration cruise is strongly encouraged, as is the potential use of Russian vessels for similar purposes. Ships of opportunity (i.e., New Zealand to California) could also be used if deeper and preferably more accurate XBTs could be designed; WG 96 encourages such future technical development.

Similarly, integration of ATOC paths into satellite altimetry analysis plans is encouraged, so as to maximize the mutual benefits of both measurement approaches.

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Following the suggestion of Academician Brekhoskikh, WG 96 recommended that Prof. Nikolai Dobrovsky and Dr Mark Slavinski be appointed Corresponding Members. The Committee decided to meet again June 20-22 1993 in Brest, France. There was general agreement that the 1994 meeting be held in the southern hemisphere to provide a focus for the planned transmissions in the southern oceans; Dr. Angus McEwan of CSRIO has kindly offered to host the 1994 meeting in Hobart, Tasmania.

In Attendance:

Guan Dinghua, China, Chair
David Farmer, Canada, Co-Chair

Viktor Akulichev, Russia
Ralph Alewine, USA
Arthur Baggerroer, USA
Leif Bjørnø, Denmark
Geoff Brundrit, South Africa
Warren Denner, USA
Yves Desaubies, France
Nikolai Dubrovskii, Russia
Andrew Forbes, Australia
Harley Hurlburt, USA
Ola Johannessen, Norway
Ann Kerr, USA
Zygmunt Klusek, Poland
Khosrow Lashkari, USA
Bernard Massinon, France
John Kay, New Zealand
Peter Mikhalevsky, USA
Walter Munk, USA
C. S. Murty, India
Iwao Nakano, Japan
Vladimir Shchurov, Russia
Mark Slavinsky, Russia
Chris Tindle, New Zealand
Alexander Voronovich, Russia
Zhang Renhe, China

ANNEX VI - REPORT OF THE SCOR/IOC CCCO

SCOR-IOC Committee on Climatic Changes and the Ocean

Prepared by: **Raymond H. Godin, Secretary, CCCO**

Since CCCO-XII, collaboration amongst the sponsors of international oceanographic and meteorological climate research has expanded to its full amplitude. In 1992, the World Meteorological Organization, Intergovernmental Oceanographic Commission, and the International Council of Scientific Unions signed a new agreement for co-sponsorship of the World Climate Research Programme (WCRP). Development and management of all the oceanographic and meteorological aspects of the WCRP will be centralized on 1 January 1993 with the Joint Scientific Committee (JSC) of the WCRP and its Joint Planning Staff (JPS) in Geneva. The agreement calls for the JSC to be expanded to eighteen members by the addition of six additional oceanographers as well as one additional oceanographer on the JPS. With the implementation of the Agreement, a transfer of the responsibility for planning the oceanographic component of the WCRP from the SCOR-IOC Committee on Climatic Changes and the Ocean (CCCO) to the JSC will take place. The CCCO will be disestablished on 31 December 1992.

Although the signing of this agreement was more rapid than expected the CCCO supported the efforts of the IOC to co-sponsor the WCRP, noting that the full and equal oceanographic representation on the JSC is essential for successful planning of the WCRP. Consequently the CCCO was encouraged over the past several years to direct its attention toward aspects of climate research which were not being handled by either WCRP or IGBP and the development of the Global Ocean Observing System (GOOS). The membership of the CCCO was changed over the past few years so that it could take on the broader role and responsibility of a multidisciplinary oceanographic committee (i.e. physical, biogeochemical, and biological) with a view to providing objective scientific advice to guide multidisciplinary climate research and the development of the Global Ocean Observing System (GOOS).

From discussions held during and subsequent to the Twenty Third Session of the IOC Executive Council, Paris, 10-18 March 92 the committee did not find adequate support for its perceived new role. The CCCO Officers felt that holding its thirteenth session without the full support and agreement of SCOR and IOC for the transition of the CCCO into a new direction would not be productive. The decision was made to cancel CCCO-XIII.

The implications of the disestablishment of the CCCO from the perspective of furthering international oceanographic scientific activity should be considered by the SCOR General Meeting. Among the important issues and discussion points which need to be addressed are:

- (1) The need for a long-term multidisciplinary ocean research committee to enhance international actions related to ocean climate research which are not being

adequately addressed by the JSC or IGBP?

- In losing the CCCO, the international ocean science community has lost an interdisciplinary committee who took responsibility for the ocean climate related coordination of both the physicists, who traditionally look only to the WCRP for physical climate type questions and the biologists, who look towards SCOR and the IGBP for climate response and impact type questions.
 - The twenty fifth session of the IOC Executive Council, Paris, 10-18 March 1992 supported the continued promotion and development of research into interdecadal ocean climate variability and the continuation within the transformed CCCO of activities involving multidisciplinary climate research which would not be under the purview of the JSC.
- (2) The need for a long-term scientific multidisciplinary ocean committee to provide objective scientific advice in the development of the Global Ocean Observing System (GOOS)?
- GOOS currently consists of five modules; (i) Climate Monitoring, Assessment and Prediction, (ii) Monitoring and Assessment of Marine Living Resources, (iii) Coastal Zone Management and Development, (iv) Assessment and Prediction of the Health of the Ocean, and (v) Marine Meteorological and Oceanographic Services.
 - At the twenty fifth session of the IOC Executive Council, Paris, 10-18 March 1992:
The IOC (i) approved the proposal to establish a GOOS Technical and Scientific Advisory Panel to advise the IOC Committee for GOOS on all scientific and technical aspects of GOOS and (ii) noted that these functions constitute a logical function for the transformed CCCO, particularly in view of the proposed transfer of many present functions to the joint WMO-IOC-ICSU Scientific Committee for the WCRP.
The President of SCOR supported the subsequent transformation of the CCCO into a technical and scientific advisory panel for GOOS.
- (3) Determination of which of the CCCO's subsidiary activities should be continued under the JSC, SCOR and/or IOC?

Activity	Recommendation
CCCO	Disestablished on 31 December 1992 as the new MOU for WCRP comes into force on 1 January 1993. Transform into a joint ICSU-SCOR-IOC Scientific and Technical Committee for GOOS (J-GOOS).

CCCO Executive	Disbanded as the new MOU for WCRP comes into force on 1 January 93.
CCCO-JSC OOSDP	Cosponsor by J-GOOS & JSC.
WOCE & TOGA SSG	JSC subsidiary bodies
Regional Panels	JSC for 1993 (by agreement between IOC & WMO WMO). Reviewed by JSC & J-GOOS in 93/94. Studies Panels
JGOFS-CCCO CO ₂ Panel	Cosponsor as a SCOR-IOC body
JSC-CCCO WG on Air-Sea Fluxes	JSC subsidiary body
JSC-CCCO WG on Sea Ice and Climate	JSC subsidiary body
CCCO Ad Hoc WG	SCOR & IOC support the group through the conclusion of an international workshop on Interdecadal Climate Variability.

Review of CCCO Subsidiary Activities

CCCO Ad Hoc Study Group on Interdecadal Variability

The CCCO Ad Hoc Study Group on Interdecadal Variability met in Honolulu, 18-20 Feb 92. Evidence of Interdecadal Climate Variability (ICV) within the global climate system was documented and two recent examples relating to large scale shifts in atmospheric circulation, ocean temperature distribution, and fisheries in the Pacific and North Atlantic regions were highlighted. The group recommended that an international workshop with be organized to review decadal/interdecadal scale variability and to design an appropriate observing, modelling and research strategy for development of an international interdisciplinary interdecadal climate variability science programme.

CCCO-JSC Ocean Observing System Development Panel (OOSDP)

The fourth session of the OOSDP, Southampton, U.K., 17-19 March 1992 reviewed satellite sensor technology, uses, limitations and potentials, as part of a future Ocean Observing System (OOS) for climate. Presentations were received on infrared, microwave, ocean color, scatterometer, sea surface and geoid (altimeter, gravimeter) measurements and on the U.K.'s National Environment Research Council (NERC) Autosub Project. Although remarkable advances are being made in the utilization of satellite data, two essential points

regarding the utility of satellite data were stressed: (1) the interpretation of satellite data depends on a reliable in situ observing program; and (2) action in a number of areas is needed now in order to ensure the existence of adequate systems for the late 1990s and beyond. The report of the fifth session of the OOSDP, Seattle (21-23 July 92) is not yet available. The sixth session of the OOSDP is scheduled for College Station, Texas

The OOSDP is preparing a series of Background Reports which will serve to stimulate interest and participation in the work of the OOSDP by the broader community of ocean scientists. "The Role of Models in the Ocean Observing System" was completed in December 91 and widely distributed. A second background paper entitled "Scientific Rationale for Defining a Global Observing System to Monitor the Uptake of CO₂ by the Ocean and Its Evolution in the Future" is completed and will be printed and distributed shortly. Other background reports on air-sea fluxes, water mass renewal, and enabling technologies are in various stages of completion. The OOSDP's meeting frequency is currently three times per year. It is developing a preliminary design for the ocean component of the Global Climate Observing System (GCOS) for presentation at its next session (January 1993) and is scheduled to complete its conceptual design for an Ocean Observing System by December 1994.

JGOFS-CCCO CO₂ Advisory Panel

At its third session, Monterey, 6-10 April 92 the panel reviewed progress in completing the global CO₂ data set and on measurement practices, calibration exercises, and flux correction calculations. A manual on the protocols and the use of standards is in preparation. The Panel considered that the present status regarding the measurement of total dissolved inorganic carbon was very encouraging. A written procedure exists and limited amounts of a sea-water-based reference material (RM) are now available. The closed cell titration approach to the measurement of total alkalinity has also been written. Though the same reference materials used for total CO₂ have been shown to have stable alkalinity values, the certification of an RM has not been finalized because agreement between laboratories is not good. The final manual awaits sections on f(CO₂) and pH which are scheduled to be completed later this year.

The desire to investigate the errors that the differing equilibrators in use might be contributing to the measurement error spread between laboratories prompted the Panel to plan an international inter-comparison test at a single location. Funds will be needed to conduct this test; SCOR probably will be asked to be a cosponsor.

Ever since Quay and his colleagues demonstrated how the 13C/12C ratio can be used in a model-independent method to estimate oceanic uptake of fossil fuel CO₂, the approach has gained increasing acceptance. The Panel decided to place a high priority on making a global set of precise isotopic measurements and to urge that JGOFS include 13C in future plans for characterizing the carbon cycle. The Panel discussed an incipient problem with regard to standards for measurement of the 13C/12C ratio. The natural limestone source

used for the present standard is nearly exhausted. The panel concluded that to maintain long-term compatibility between laboratories on decadal time scales, a properly funded organization must be persuaded to take up the responsibility.

The matter of CO₂ measurement coordination emerged again as an urgent and serious issue. Letters to the parent bodies for assistance in solving the problem on an international basis served to raise the conscious-consciousness level but produced no ready solution. The IODE has been prompted to undertake action to establish guides and standards to regularize international CO₂ data exchange while the Panel members themselves are pursuing potential leads that may provide a coordinator for immediate needs.

The impending changes in the administrative structure for the WCRP were cause for concern inasmuch as the CCCO was being disestablished. The members were unanimous in the view that the present Joint JGOFS-CCCO structure had been essential to implementing the current global observation effort. They saw the needs for international coordination on standards, data quality, and data exchange as growing and the Panel's responsibilities broadening. The Panel agreed to send a letter to its parent bodies expressing their concern and recommending that the Panel be continued under an ocean-allied structure.

CCCO Ocean Climate Studies Panels

Pacific Ocean Climate Studies Panel

The tenth session of the CCCO Pacific Ocean Climate Studies Panel was hosted by the Japan Meteorological Agency, 9-12 June 1992, in Tokyo. Fourteen papers were presented at a one-day symposium which focused on Pacific Ocean circulation variations and their impact on climate. The symposium was co-sponsored by the Panel, IOC/WESTPAC, Science Council of Japan, Oceanographic Society of Japan, Meteorological Society of Japan, University of Tokyo, and the Japan Marine Science and Technology Center (JAMSTEC). The Panel exchanged cruise planning information in the form of national reports, and updating of the inventory of the observing systems being implemented by WOCE, TOGA and other programs in the Pacific. An Indonesian participant, L. Wenno, Chief of the Indonesian Oceanographic Laboratory at Ambon agreed to finish the 137° E WOCE line in Indonesian waters which the Japanese have otherwise committed to. The Panel also discussed its future role in the development and implementation of GOOS. The Panel addressed means for better coordination of the various western boundary current activities, and the importance of the eastern South Pacific for climate change research. A start on the former was made at the last WESTPAC meeting at which a session on western boundary currents was organized through efforts by the Panel. The Panel decided to continue this effort by initiating a process of consultation among interested scientists which it is hoped will lead to the establishment of a co-ordination group for western boundary current studies. A first informal meeting is planned for the Western Pacific Geophysics Meeting in Hong Kong, August 1992.

Atlantic Climate Research Workshop, Moscow, 13-17 July 92

The CCCO and the State Oceanography Institute of Russia co-sponsored the Atlantic Climate Research Workshop. The scientific objective of the workshop was to address issues related to the oceanic conveyor belt and its variability on times scales from seasons to decades and longer. The CCCO also decided to use the workshop as a basis by which it would reorganize the Panel's membership to make it more to its basin scale responsibility. Over 50 presentations were given on what is known about the phenomenon, preliminary and recently concluded results from current studies, and the status of present and future programmes.

Indian Ocean Climate Studies Panel

The Seventh Session of the Panel was held in Bangalore, 24-28 August 92. A report of the session is not yet available.

Work Programme and Resources

The IOC will transfer \$ 200,000 to the WMO Joint Climate Research Fund in 1993 to support the oceanographic activities of the JSC. Staffing support for the CCCO Secretariat is provided by the USA (2) through December 1992 for R. Godin, Secretary CCCO and Mr. A. Alexiou and by UNESCO/IOC (1) for a secretary, Mr. V. Leogardo.

ANNEX VII - REPORT OF JGOFS

THE JOINT GLOBAL OCEAN FLUX STUDY

By: E. Gross, JGOFS Executive Secretary

The JGOFS Scientific Steering Committee held its last full meeting in September/October 1991 and will again in Taipei from October 19-24. Thus, there has not been a formal SSC meeting since the last JGOFS report to SCOR. Nonetheless, this has been a busy period and there are a number of areas where important progress has been made.

JGOFS Implementation Plan

There has been a major effort to complete the JGOFS Implementation Plan in time for the JGOFS-7 meeting. It is now at the printers. The plan was drafted by the JGOFS Executive Scientist, Dr. G.T. Evans, using reports from JGOFS Task Teams, Regional Planning Groups, national JGOFS programs, etc. It was extensively reviewed and revised at a meeting of the JGOFS Executive at the Royal Society in March and has subsequently been reviewed by members of the SSC. The final version has been prepared with the assistance of Dr. Phillip Williamson of the IGBP Secretariat and will be printed and distributed by IGBP, with a financial contribution from the JGOFS budget. It will appear as a joint JGOFS/IGBP report.

Serving as both a complement to and an update of the JGOFS Science Plan (SCOR, 1990), the JGOFS Implementation Plan describes how the internationally coordinated parts of JGOFS will actually be accomplished and the resources which will be needed to do this. Revisions to the Implementation Plan will be required as the program develops. The Plan concentrates on the synthetic, integrative nature of JGOFS, and on the steps needed to make sure it eventually produces a global flux assessment. It provides a brief overview of the scientific questions related to carbon fluxes, the goals and objectives of JGOFS and the strategies it has proposed to address these problems. In more detail, it discusses modelling activities for global synthesis, the components of large-scale surveys required for JGOFS, the various process studies under way and planned, the operation of the established and planned time series stations, and the studies of the sedimentary record and continental margin boundary fluxes for which detailed planning is just beginning. In each section the requirements for personnel, facilities, ship-time, equipment, etc. are discussed as appropriate and a contact name and address is given for further information. Although the Implementation Plan concentrates on the parts of JGOFS which demand international planning, coordination and oversight by the JGOFS SSC, it also recognizes the essential information contributed by the associated activities of individual nations.

The Executive Summary of the JGOFS Implementation Plan appears at the end of this report.

JGOFS Process Studies

A special volume of *Deep Sea Research* containing papers arising from the JGOFS North Atlantic Bloom Experiment (NABE) is currently in press. Many of these papers were originally presented at the international NABE symposium in late 1990, although they have been supplemented by additional articles. The North Atlantic Planning Group met at IOS, Wormley in January to discuss the scientific objectives for a programme to take place late in JGOFS (1996-7) which will follow on from NABE. The group is organizing a larger meeting of about 30 individuals in Warnemünde, Germany in the spring of 1993 for the purpose of producing a more detailed planning document. The basic aims of this process study are set out in the Implementation Plan. They derive from the special character of the North Atlantic with strong latitudinal gradients in the depth of winter mixing, large seasonal variations and the large horizontal transport of carbon and nutrients by the Gulf Stream.

The Indian Ocean Planning Group met on board the Dutch research vessel "Tyro" in May as she passed through the Mediterranean on her way to the Indian Ocean. Plans for the intensive period of the Arabian Sea process study in 1994-1996 were substantially advanced during this meeting. The Northern Indian Ocean region is important to JGOFS because of its high, seasonally variable chlorophyll concentration. It contains about half as much total chlorophyll as the entire North Atlantic and the seasonal variability is greater due to the monsoon-driven circulation. The basin is also characterized by a layer of low oxygen content between 150 and 1500 m and an unusual planktonic food chain with high bacterial productivity during oligotrophic periods and intense grazing pressure on phytoplankton blooms during and following the monsoon by a single species of zooplankton. The group developed detailed operational plans which concentrate on the area of the Arabian Sea north of 6°N, with ancillary studies in the Somali upwelling, off the Kenyan coast and along a transect from 6°N, 65°E to 18°N, 58°E. Pakistan is already operating a Time Series Station in the northern Arabian Sea, Kenya is in the process of establishing one, and Oman is giving consideration to establishing a third. FRG, India, Pakistan and the USA will carry out a mooring program to quantify patterns of deep sedimentation processes. Shallow drifting sediment traps will be used during research cruises. Planning is under way for a series of training courses for scientists from the region, focusing on the agreed methods for the JGOFS Core Measurements. Finally, the planning group is taking steps to ensure compliance with the JGOFS Data Policy, to assist with the establishment of a regional data center and a specialized satellite receiving station/data facility, and to appoint a coordinator to help with logistics and training.

The Equatorial Pacific Ocean process study began early in 1992 with US cruises to the eastern part of the region with process study work and sediment trap moorings complementing earlier French, Australian and Japanese survey work further to the west. The region is likely the largest source of CO₂ from the ocean to the atmosphere and interannual variability associated with the ENSO phenomenon is greater than seasonal variability. Another defining characteristic of the Equatorial Pacific is its large pool of unused nutrients. Why is it not more productive? This study, involving the USA, Japan, Australia, France and Canada,

will continue through 1995.

A German cruise inaugurated the Southern Ocean Process Study which will take place in two phases. The first (1992-94) consists of programs and cruises with objectives defined before JGOFS plans were developed. Some of these are being refined to take JGOFS goals into account. The second phase is being explicitly planned for JGOFS by the Southern Ocean planning group and will take place in 1996-98 following the analysis of the results of phase 1 and model development. A workshop at Cambridge (UK) discussed existing models and requirements for modelling related to the Southern Ocean. SCAR has agreed to co-sponsor this part of the JGOFS program which will involve research ships from seven nations and participants from a number of others.

A joint project among scientists from Chile, Sweden, Germany and Denmark completed four cruises to the Eastern Boundary Current in the Pacific off the coast of Chile, and conducted its first data workshop in August 1992 in Sweden. Quarterly investigations of physics and biology in the region are planned for several years, to be supplemented by measurements of the carbonate system as soon as instruments are available. This project fills a gap in one of the ocean's most sparsely sampled regions.

Other JGOFS Activities

A NATO Advanced Research Workshop entitled "Towards a model of ocean biogeochemical processes" was organized by JGOFS at Chateau de Bonas near Toulouse in May. About forty-five participants discussed the requirements and possibilities for building the simulation models needed by JGOFS. A publication will be forthcoming from this workshop. A Global Synthesis and Modelling Task Team has been established to make more detailed recommendations, to coordinate modelling activities and to cooperate with the regional planning groups on experimental design.

Another NATO Advanced Research Workshop on "Biogeochemical Ocean-Atmosphere Transfers" was organized primarily by the International Global Atmospheric Chemistry program (IGAC) and cosponsored by JGOFS. It took place in Bermuda in January and was designed to bring together the marine and atmospheric scientists with interests in fluxes of carbon and other substances at the air-sea interface. Plans were formulated for a number of joint activities on the impact of atmospheric deposition on new production, production and cycling of trace gases in the oceans, processes controlling gas exchange rates, marine boundary layer chemistry and modelling. The workshop papers will be published as a special issue of *Global Biogeochemical Cycles* and the creation of a joint IGAC/JGOFS group is under consideration.

Cooperation with another IGBP Core Project (Land-Ocean Interactions in the Coastal Zone) has been advanced by the recent establishment of a joint LOICZ/JGOFS Continental Margins Task Team which will hold its first meeting in Taipei in October. Studies in this

complex and variable zone will give many coastal nations an opportunity to contribute to the global objectives of JGOFS.

Administrative Matters

The Agenda for the forthcoming JGOFS SSC meeting in Taipei includes a series of scientific lectures and a through program review. Some consideration of administrative matters is also necessary. For example, the secondment by Canada of Dr. G.T. Evans to the JGOFS-Büro in Kiel will come to an end in late 1992. Efforts are under way to identify a replacement, but have been unsuccessful to date. The lack of an Executive Scientist to direct the program on a day-to-day basis will be a serious impediment to its progress. SCOR Committees are urged to consider seconding an experienced scientist to fill this vacancy. Membership will also be discussed since five SSC members are due to rotate off the Committee at the end of 1992. In addition, Dr. Graham Harris has tendered his resignation from the SSC. Nominations are being sought for these six positions and will be discussed by the SSC. Suggestions from SCOR and the IGBP would be welcomed. Recommendations as to new membership will be sent to the Executive Committee of SCOR for consideration immediately after the Taipei meeting. New appointments should take effect on January 1, 1993. The current SSC membership is given in Annex 1.

Finally, the question of funding for JGOFS planning activities has not been such a serious concern in 1992. There have been a smaller number of Task Team and Planning Group meetings, due to the emphasis on completion of the Implementation Plan. The hosts of the SSC meeting in Taipei have generously assisted JGOFS by providing funds for the local expenses of the meeting. Support from IGBP for the production and distribution of the Implementation Plan has also provided some financial relief. The budget is tight, but manageable for this year. The pace of activities will increase again in 1993, however, and a careful review of the projected financial situation will be carried out at JGOFS-7.

JGOFS Implementation Plan EXECUTIVE SUMMARY

The oceans contain some 50 times as much carbon dioxide as the atmosphere, and a small change in the oceanic carbon cycle can have large atmospheric consequences. This has been important during transitions to and from ice ages, and it may be important during climatic change induced by the recent rapid increase in atmospheric CO₂. Models indicate that the oceans are currently taking up at least a third of the anthropogenic CO₂ by dissolving it in water that then loses contact with the atmosphere because of sinking or vertical mixing. Biological processes complicate the oceanic carbon cycle; although they probably do not affect the present uptake of anthropogenic CO₂, they are important (1) as a determinant of the natural background distribution of carbon, (2) because seasonal variation in biological processes complicates the effort to survey the background distribution, and (3) because biological feedbacks have the potential to amplify chemical and physical effects.

Many scientists worldwide are addressing aspects of the oceanic carbon cycle, but to determine overall net fluxes and the processes controlling them is beyond the capability of any one nation. Therefore the Joint Global Ocean Flux Study (JGOFS) has been established, under the auspices of the Scientific Committee on Oceanic Research and as a core project of the International Geosphere-Biosphere Programme, to plan and execute the research that requires international cooperation. Close to 20 countries are contributing to JGOFS planning or field work. The scientific goals of JGOFS were published in its Science Plan in 1990:

- To determine and understand on a global scale the processes controlling the time-varying fluxes of carbon and associated biogenic elements in the ocean, and to evaluate the related exchanges with the atmosphere, sea floor and continental boundaries.
- To develop a capacity to predict on a global scale the response of oceanic biogeochemical processes to anthropogenic perturbations, in particular those related to climate change.

The Science Plan describes how the goals can be attained through a combination of large scale surveys from satellites and ships, studies of key processes to help interpret and interpolate between surveyed quantities, series of monthly measurements for many years to determine how fluxes and processes vary, and studies of the record of the wide range of oceanic and climatic conditions preserved in Quaternary sediments. An overarching programme of synthesis and modelling will seek to ensure that observations are planned and interpreted with the goals of JGOFS in mind. JGOFS will create a high-quality data set by specifying measurement protocols and providing training in their use, and it will institute a data management system to make the data easily available to the scientific community.

Field work began in 1989, and will continue until about 1997, with a peak in 1994-95 as results from the next generation of satellite ocean colour sensors become available. Analysis and synthesis of data will continue for the rest of the decade.

This Implementation Plan describes how the internationally coordinated part of JGOFS will be accomplished and what resources it will need. Planning is a continuous process, and revisions to this document will appear periodically as JGOFS advances. The Plan mentions some possible activities that are not scheduled yet, although this Executive Summary refers only to research for which firm commitments have been made. The Implementation Plan also refers to scientific thought that has developed since the Science Plan was published, and can thus be regarded, in part, as a Science Plan update.

JGOFS will restrict itself to the most important tasks consistent with its lifetime and resources. CO₂ exchange between the atmosphere and ocean is its main focus; but for periods longer than a year, the main factor limiting this exchange may be the rate of exchange between the surface ocean and the ocean interior. JGOFS has therefore adopted the following "operational goal" for evaluating components of the program:

To assess more accurately, and understand better the processes controlling, regional to global and seasonal to interannual fluxes of carbon between the atmosphere, surface ocean and ocean interior, and their sensitivity to climate changes.

This goal is expressed in more detail in the following objectives:

- An assessment of large-scale carbon fluxes, obtained from a greatly increased network of observations
- A set of models that express our understanding of the processes controlling large-scale carbon fluxes
- A procedure for observing the ocean in a routine, synoptic manner to detect possible changes in the ocean carbon cycle in response to climate change
- A well-cared-for data set, comprising observations made according to standard protocols and a system for making subsets of these data easily available to researchers
- Knowledge and understanding of fluxes across the continental margins, to provide reliable boundary conditions for global models
- An increased number of countries with an interest and skill in planning JGOFS-type activities and making the appropriate measurements and global-scale inferences

The global synthesis will be carried out with the aid of a variety of models---both concept-driven models of the underlying processes tuned to the data collected during JGOFS and data-driven models designed to interpolate as best we can between JGOFS observations. Large-scale surveys will lead to maps of fluxes which can be integrated to produce global flux estimates. Surveys so far planned include ocean colour from satellites and carbon system measurements made on cruises of the World Ocean Circulation Experiment.

Some regions of the ocean must be studied in more detail, because large-scale surveys are likely to mislead, or because they are sensitive to changes in climate, or simply because they are major regions of carbon flow that needs to be better determined to get a global picture. The North Atlantic is a major area of deep water formation where dissolved CO₂ is carried away from the surface ocean, where a large seasonal biogenic signal complicates the interpretation of CO₂ surveys, and where the sedimentary record indicates a large sensitivity to past changes in climate. The Equatorial Pacific has a large area and a large pool of unused nutrients (representing a potential uptake of carbon that is not in fact occurring); inter-annual variability connected with the El Niño - Southern Oscillation complicates the interpretation of surveys. The Southern Ocean is a complicated region of large fluxes, which appear to be in rough balance now but may easily get out of balance in a changed climate. It also has a large pool of unused nutrients, and the influence of changes in sea ice cover needs special attention. The Arabian Sea is an area of extremely high average chlorophyll, and of extreme seasonal variation driven by monsoonal reversals; it also offers a wide range of physical forcing in an area where light does not vary much, i.e. a region of instructive contrasts.

Process studies are ongoing or planned for all of these regions. They will be designed to provide the sort of understanding that can be extended over a large area and used to make syntheses, especially understanding expressed in improved models and model parameterizations for the key processes. They will provide an inventory of key fluxes, a definition of control mechanisms, and an understanding of forcing at time scales ranging from a week to several years. Time series stations will be maintained for several years to observe and interpret seasonal and interannual variability of fluxes and processes over the whole water column, using a combination of shipboard observations at specific sites made monthly or more often and sediment trap moorings. Stations currently operate near Bermuda and Hawaii; others are planned for Kerguelen Island and the Canary Islands.

Sedimentary record studies are underway in many ocean basins to determine the relationship among ocean circulation, biological production and CO₂ content of the atmosphere over a wide range of past conditions.

A special effort will be made to determine horizontal boundary fluxes across the continental margins. This work, which offers the possibility to involve many coastal states in global change research in the ocean, will be coordinated jointly with the IGBP Core Project on Land-Ocean Interactions in the Coastal Zone.

Protocols will be published for measuring the most important variables. To encourage the use of these protocols by all investigators in all regions of the ocean, training workshops will be held in conjunction with JGOFS process studies. An international data management system, linking small topical (e.g.national) JGOFS data centres, will make it possible for researchers to find out about and access the data collected during JGOFS.

Although this Implementation Plan concentrates on the parts of JGOFS that demand international coordination, it recognizes the essential information contributed by associated activities of individual nations. Those associated national activities that are known to the international JGOFS Committee at the time of preparation of this first version are listed here.

Annexes provide information on the organization of JGOFS, including the subgroups that have contributed or are now contributing to the design of the study, addresses of people to contact for further information on its different parts, and other related international research into global change.

ANNEX 4.

JGOFS SSC Membership to December 1992

NAME	NAT.	1988	1989	1990	1991	1992	1993	1994
Brown	USA			E	---E---	---E---		
Buat Menard	France							
Chen	Taipei							
Dandonneau	France							
Denman	Canada				-----	-----		
Ducklow	USA							
Field	S. Afr.				V	V	V	
Harris	Austral.						Retired	
Krishnaswami	India							
Leinen	USA							
Lisitsyn	Russia							
Merlivat	France							
Piatt	Canada				C	C	C	P
Priddle	UK							
Shaffer	Nordic							
Siegenthaler	Switz.							
Smetacek	FRG							
Wefer	FRG							

C=Chairman V=Vice-Chairman P=Past-Chairman E=Executive ----=2nd term

Terms expire 12/31/92: Brown, Denman, Ducklow, Shaffer, Wefer. Unanticipated resignation of Harris leaves and additional vacancy.

ANNEX VIII - REPORT OF THE FIRST GOEZS MEETING

IGBP/SCOR Ad Hoc Working Group on the Global Ocean Euphotic Zone Study 29 April - 1 May 1992, Victoria Canada

PREAMBLE

The upper ocean is the reactive buffer between the atmosphere and the ocean interior, regulating and modifying the exchange of energy and materials between the atmosphere and the ocean interior. Global climate and the oceans interact principally through uptake, release, and horizontal transport by the sea of heat, maintenance of ice cover, net uptake of the radiatively-active CO₂, and release of radiatively-active N₂O, as well as of dimethylsulphide (DMS), whose oxidation in the air promotes cloud condensation nuclei and possibly affects the radiation balance of the earth. These gases are involved in or are produced by biological processes. Particularly, the interaction of the physical, chemical, and biological processes near the sea-air interface are poorly understood. These, in turn, are strongly influenced or determined by processes in the upper ocean, which responds to the atmosphere on a diurnal, weekly and seasonal basis, and where plant production takes place. Satellites, especially, have demonstrated the intensity, complexity, variability, and connected nature of the physical, chemical and biological processes taking place in the upper ocean. While the anticipated climate change caused by the radiatively-active gases acts in the decade-to-century timescale, we do not yet have the theory (especially in respect to the biota) to extrapolate from observable seasonal change or interannual variability to the larger time scale. We lack predictive capability even with respect to interannual variability.

MAJOR ISSUE

In the upper ocean, we do not understand the relation between the event-scale variance ("weather") of ecosystem properties and their larger scale means ("climate"), nor how the organisms might modify climate through their action or production or consumption of radiatively-active gases and atmospheric aerosols. Our ability is therefore limited to assess the response of the upper ocean to global change, and the role of the upper ocean in global change.

Thus, at the present time we recognize for the upper oceanic layer both priority and deficiency of scientific understanding. Therefore, it is timely to anticipate the new level of understanding that will evolve as WOCE, JGOFS and TOGA are completed, and to formulate the next generation project that will build upon the data and understanding obtained and that will also address fundamental questions regarding global change in atmosphere-ocean interactions. To address the major issue stated above, a Global Ocean Euphotic Zone Study (GOEZS) was proposed as a core IGBP project several years ago. It

was to involve a long planning and modelling phase running parallel with the field phases of WOCE and JGOFS, with a field phase after the completion of WOCE and JGOFS field phases around 1997. To review the need for a GOEZS, develop a scientific rationale, and plan the next steps, IGBP and SCOR struck a small ad hoc working group which met in Victoria, Canada on 29 April - 1 May 1992. This report summarizes the progress made at that meeting.

PREMISES & QUESTIONS

Discussions of the background of GOEZS were followed by several scientific presentations by the participants with much discussion between presentations on the needs, format, questions, goals, etc that a GOEZS should address. There was general agreement on several premises:

- atmosphere-ocean fluxes of energy and materials are poorly parameterized,
- these fluxes (and / or their "uncertainties") may be controlled by episodic events,
- we must develop the appropriate linkages between event scales and larger scales (scaling up, switching),
- these improved parameterizations will be required for improved global scale models of atmosphere-ocean transfers.

A general question that we must address is the following:

How well can we parameterize small event scale processes for application in basin-scale models that address interannual variations in the seasonal cycle and longer time scale change or variation in the structure and function of the linked biological, physical and chemical systems in the upper ocean?

Associated specific questions include:

- Would GOEZS focus on variability of parameterizations of atmosphere-ocean transfers?
- What would be the scales? Do they define the processes, organisms, etc. of interest?
- What criteria will we use to partition the ocean?
- What is the role of modelling and analysis of existing data in this definition process?

GOALS

Several goals for GOEZS were developed for IGBP Report 12: The Initial Core Projects (1990), but they tended to be operational rather than scientific and they did not imply time and space scales precise enough to facilitate further design of the actual elements that might comprise a GOEZS. After several iterations, the working group formulated the following goals that emphasize the connected disciplines, small to large scale extrapolation, and atmosphere-ocean transfers:

- To understand small scale changes in the structure and function of the connected physics, chemistry and biology of the upper ocean system and how these changes interact with larger scale changes in physical forcing (air-sea fluxes)
- To improve predictive capability of large scale change at interannual and larger timescales.

The following definitions regarding scales are required:

large scale (space) - basin to global scales
large scale (time) - greater than seasonal

STRATEGY

1992-1997 - Planning, Modelling and Data Synthesis

- 1992 - Review proceedings from the NATO/JGOFS Modelling symposium held in May 1992 (Geoff Evans and John Parslow, Coordinator) and from the WOCE Numerical Experimentation Group meeting scheduled for August 1992.
- 1993 - Meeting of this Working Group to analyze parameterizations of small-scale transfer processes in large scale models, and to prioritize scientific activities that might comprise GOEZS
- 1994 - September SCOR/IGBP symposium on multidisciplinary parameterizations of upper ocean processes.
- 1994-97 - Develop scientific plan, modelling and data synthesis

1994-1997 - Analysis and Assessment of SeaWIFS and JGOFS/WOCE Data Sets

1992-2007 - Developing New Technologies

- Improving on sensor systems developed for upper ocean components of JGOFS, TOGA, IGAC and WOCE
- Working closely with the design and implementation of the GCOS and GOOS ocean observing networks to see that the needs of GOEZS for remote observations of chemical and biological variables are incorporated into these networks.

1997-2007 - Operational phase of GOEZS

- Field work (revisit N. Atlantic?)
- New satellite sensors
- Modelling and data assimilation

COORDINATION WITH WCRP "CLIVAR"

At the March 1991 XIIth joint session of the WCRP Joint Scientific Committee (JSC) and the Executive Group of the SCOR/IOC Committee on Climatic Change and the Ocean (CCCO) "It was recognized that a new research initiative should combine the global aspect of WOCE with the TOGA concern of achieving a dynamical prediction of the behaviour of the coupled ocean-atmosphere (and land) system." A study group then reported to the XIIIth session in March 1992 recommending a WCRP climate variability and prediction research programme ("CLIVAR") emphasizing the global ocean and its interaction with the rest of the climate system. Quoting from the Report of the XIIIth Session: "The JSC

considered that the principal components of a WCRP climate variability research and prediction programme should consist of:

1. A retrospective data retrieval and analysis programme, aimed at reconstructing, inasmuch as feasible, homogeneous long time-series of atmospheric and oceanic data to provide a basis for assessing the natural variability of the climate system,
2. A numerical experimentation programme to explore the variability and predictability of the coupled global ocean-atmosphere system, including land surface and ice processes as appropriate, on time scales from seasons to a century,
3. A global upper-ocean observational programme and ocean- atmosphere data assimilation and modelling programme aimed at:
 - predicting climate anomalies on time-series of several months to a few years, when and where such anomalies are predictable (e.g. ENSO),
 - reducing uncertainties and minimizing discrepancies (ad hoc corrections) between air-sea fluxes and oceanic transport/storage of heat and fresh water, as required for estimating the forcing of the world ocean.
4. A global ocean observation, analysis and data assimilation programme aiming at characterizing inter- decadal variability and long-term changes."

Clearly, GOEZO shares many aspects with CLIVAR - similar scientific goals, similar time and space scales, probable overlapping time period, dependence on satellite sensors and a global ocean observing system, etc. However, the WCRP views its mandate as coordinating research into the physical aspects of the climate system, whereas GOEZO will be aimed at the connected multidisciplinary aspects of the upper ocean, in particular, improving the parameterizations of those processes for use in global models addressing seasonal to climatic scales. It will be necessary for GOEZO to coordinate its planning phase with that of CLIVAR for maximum scientific gain.

RECOMMENDATIONS

1. Formalize the existence of this IGBP/SCOR Working Group. With the discontinuation of the CCCO, the group can take over the consideration of multidisciplinary research on upper ocean processes relevant to climate issues. The WG should have the clear charge of assessing the need for and developing plans for a GOEZO programme, according to the following action items (and the previous detailed STRATEGY section):
2. WG to meet in May/June 1993 (in Southampton?) to review parameterizations now used in the upper ocean components of contemporary physical, chemical and biological models that address seasonal and longer timescales.

3. WG to plan a scientific symposium tentatively scheduled for September 1994. The symposium will have as its focus the following questions:

How well can we parameterize small event scale biological, chemical and physical processes in the upper ocean for use in basin-scale models to address interannual variations in the seasonal cycle and longer time scale change or variation?

How robust are these parameterizations?

How do they vary?

What are their ranges of errors or uncertainties?

4. Based on 2 and 3 review the requirements for a GOEYS and enter planning phase.

5. Liaise with WOCE and JGOFS to assess their techniques and results. In particular, the second set of goals in the JGOFS Science Plan (SCOR, 1990) are open ended, and a more practical planned completion of the programme is still being determined in the draft Implementation Plan of JGOFS.

6. Coordinate planning with the WCRP programme CLIVAR and the ocean observing network aspects of GCOS and GOOS.

7. Sponsor modelling activities emerging from the 1994 symposium, coordinating with related efforts in WCRP, IGBP, WOCE and JGOFS.

ANNEX IX - WORKING GROUP PROPOSAL

Proposal for a SCOR Working Group on LINKED MASS AND ENERGY FLUXES AT RIDGE CRESTS

Submitted by John R. Delaney (USA) and H. David Needham (France)
on behalf of the InterRidge Steering Committee

More than 50% of the heat lost from the earth's interior flows through the 50,000km long spreading center network that extends through all of the ocean basins. Solidification of approximately 20 km³ of magma per year along this narrow band has created 60% of the earth's surface. Mass and energy fluxes associated with the formation and early aging of oceanic lithosphere couple the deep earth and surface environments through a complex array of interlinked, episodic and highly active processes. These processes include mantle upwelling and melting, solidification of ocean crust, volcanism, hydrothermal circulation, chemosynthetic microbial activity and volcano/hydrothermally-driven ecosystems.

However, the nature of the linkages, the time scales of episodicity, and the distribution of energy among the processes are either poorly understood or completely obscure. Three examples illustrate this point:

- Rigid plate tectonic theory does not furnish the constraints necessary to explain or predict the observed geometry of the ridge crest. We still cannot show in any systematic way how observed structure and petrology reflect the controlling mantle processes at different spatial and temporal scales.
- Chemical and thermal consequences of episodic hydrothermal venting for mixing of the deep ocean are not even approximately known.
- An unexpected connection between submarine eruption, earthquake activity, and biological response was dramatically demonstrated in April 1991 when, for the first time, scientists in *Alvin* observed the results of a very recent seafloor eruption at 9°48N on the East Pacific Rise. Microseismicity was intense and a massive, extensive microbial mat covered large areas where none had existed before. Nine months later, the mat had disappeared. These observations raise a series of questions: What triggered the eruption? How frequently do these phenomena occur? What is the link between the nutrient flux that supported the bacterial "bloom" and the volcanic/seismic activity?

These examples highlight the need to examine the system as a whole. Improved understanding of the nature and interactions of fundamental earth processes operative at ridge crests will require innovative approaches and sustained efforts over the coming decades. The international oceanographic community is rapidly developing the scientific and technological expertise to begin observing, measuring and modelling the interactive processes focused within this narrow zone. Multisensor mapping efforts at global, regional and local scales, with varying degrees of resolution, must be complemented by concurrent studies of

active processes, using a wide range of instrument arrays to document temporal covariation in system components.

The enclosed suggestions for membership of a SCOR Working Group deliberately includes several members of the present InterRidge Steering Committee to ensure continuity and appropriate interaction. This group would provide essential scientific and technological direction for a new generation of seafloor research. This expertise is necessary to take maximum advantage of the current opportunities in interdisciplinary ridge research described above.

The InterRidge program is designed around three thematic lines of research: global reconnaissance, meso-scale studies, and investigations of active processes. InterRidge Working Groups will be charged with proposing and developing specific corresponding actions. A SCOR Working Group is an important opportunity for integrating the more focused program elements designed by InterRidge action groups. It could also provide an independent opinion on how different approaches might be integrated in order to solve certain outstanding scientific problems. Finally, the SCOR Working Group we are proposing could be a mechanism allowing SCOR to act as a sponsor of the initiative, and hence to help strengthen InterRidge's international visibility.

Terms of Reference:

- To assess which portions of the global ridge system are particularly well suited for in-depth studies, through a review of information on both well known portions of the ridge and areas that are less well known by appear to have potential for future multidisciplinary work.
- To identify the approaches required to address quantitatively the interplay among the important variables involved in oceanic crustal accretion.
- To assess possible water column investigations aimed at evaluating the consequences of hydrothermal venting for ocean physics and chemistry.
- To consider the scientific, technological and organizational foundation necessary to accomplish the goals cited in the first three terms of reference.
- To prepare a report to SCOR on scientific prospects for a long-term program leading to quantification and modelling of the global spreading center system.
- To prepare and convene a SCOR symposium to present the Working Group's results and current research in the field.

ANNEX X - WORKING GROUP PROPOSAL

Proposal for a SCOR Working Group on SEDIMENT CORING FOR INTERNATIONAL GLOBAL CHANGE RESEARCH

The ocean plays a major role in global climatic changes, both through its own dynamics and through the derived distribution of dissolved CO₂. Paleoceanography has developed high quality tools for the reconstruction of past ocean characteristics (temperature, salinity, distribution of nutrients and dissolved CO₂, primary productivity, etc.) using mainly the distribution of foraminiferal species, isotopic ratios, geochemical analysis of foraminiferal shells, and other tracers such as the analysis of the residual organic matter. The effort has been concentrated over these last years on long term changes, as reconstructed from studies of sediment cores with 5-10 cm sediment depth resolution. The recent development of methods for continuous non-destructive analysis of the sediment cores (colour reflectance and magnetic susceptibility, for example) has opened up new possibilities: with care, meaningful information on an ocean basin scale may be resolved with sampling at 1-2 cm sediment depth intervals. With mean sedimentation rates of 5 to 10 cm kyr⁻¹, this typically limits the time resolution to 200 years, a time scale which is compatible with the dynamics of the main ocean circulation system.

Consequently, it is feasible to consider initiating a global collaborative effort in high quality sediment coring, to provide the basis for reconstructing changes in ocean dynamics over the last few 10³ to 10⁵ years. To link oceanic and atmospheric variability, this effort should be developed in parallel to the ice core drilling program, in close collaboration with PAGES, a component of IGBP.

Paleo-records offer the basis for studying climatic and oceanic responses to known changes in insolation forcing (mainly the changes in precession). Working on time scales of a few hundred thousand years helps to differentiate deterministic feedbacks derived from the insolation forcing from stochastic behaviour. Temperature, salinity, and the paleonutrient (tracer) profiles may be constructed within the ocean through the collection of sediment cores over a wide range of water depths. In order to spatially reconstruct the variability of these properties within the ocean, 20 to 50 cm sediment cores are needed covering the different ocean basins. A "vertical" water depth transect with sufficient resolution requires about 10 cores sampled at different depths in the same area along sea mounts and continental margins. A global study would require about 100 high quality, large diameter cores, to enable all the basic analytical techniques to be applied. The present core collections are far from being sufficient to provide the basis for a study.

Independent efforts have begun in different nations, but not all the programs use the modern high-resolution technology now available. An independent group has proposed a renewed involvement in ocean sediment coring for global change studies (Shackleton et al., Contributions from the oceanic record to the study of global change in three time scales, Interlaken 1989, report published in Global and Planetary Changes 1990, 82, 5-37), and an

ad hoc international committee has been created on the initiative of NSF and the support of several national science organizations, which has recommended the creation of a coordinated international effort to optimize sediment coring and analysis.

The aim of the proposed working group is to set the basis for the program over the next 2 years.

Terms of reference (as amended at the General Meeting):

- To coordinate international efforts to collect good quality piston cores, Kasten cores and Box cores from the world ocean suitable for collaborative studies of global change over the geologically recent past as required by the PAGES and JGOFS component of IGBP.
- To advise on the description, curation and sampling of these cores and on protocols for the distribution of samples for specialist analysis.
- To promote the construction of a data base of available deep sea core material providing enough information to promote the efficient use by the international scientific community of existing as well as new core material.
- To promote the increasing use of non-destructive tools for obtaining high resolution logs of deep-sediment cores.

Notes:

1. The international coordination described in the first term of reference involves both the diffusion of information on the best technologies and the preparation of specific international actions within key areas.
2. Although the Ocean Drilling Program is very successful in curating and distributing samples on an international basis, there is at present no analogous organization for other types of cores. It is becoming difficult to justify funding coring cruises while there is no mechanism for ensuring that the material collected is utilized efficiently other than to the extent of the techniques available to the proponent.
3. If core repositories become more efficient in disseminating information and samples, it will be easier to ascertain the priorities for new coring in a particular region.
4. There has been a recent growth in the development of non-destructive techniques that can provide very high resolution data; the usefulness of existing good quality cores will be greatly reduced unless an effort is made to perform routine logging of some of their properties (eg. colour reflectance, magnetic susceptibility).

ANNEX XI - FINAL FINANCIAL STATEMENT, 1991

Year Ended December 31, 1991

	Revised 1991 Budget	Actual to Dec. 31
INCOME		
BALANCE - Jan. 1, 1991	42,000.00	41,719.00
INCOME:		
Membership	150,000.00	163,750.00
ICSU Grants/CCCO	23,850.00	23,850.00
ICSU Grants/JGOFS	23,850.00	23,850.00
IOC Contract	31,000.00	31,000.00
IOC Contract re: GLOBEC	6,000.00	6,000.00
NSF Grant (travel)	75,000.00	70,149.00
NSF Grant (geoscience)	90,000.00	85,074.00
UK Subvention	20,500.00	20,499.00
JGOFS Special Fund	20,000.00	11,126.00
IGBP Support to JGOFS	15,000.00	15,000.00
Misc.	0.00	37.00
Total Income	<u>455,200.00</u>	<u>450,335.00</u>
TOTAL CASH PLUS INCOME	<u>497,200.00</u>	<u>492,054.00</u>
EXPENSES		
EXPENSES: Scientific		
WG 54 (SCAR)	5,000.00	5,000.00
WG 77	2,000.00	0.00
WG 80	10,000.00	15,491.00
WG 83	6,000.00	3,060.00
WG 89	0.00	645.00
WG 90	12,000.00	12,230.00
WG 91	10,000.00	8,673.00
WG 94	12,000.00	7,840.00
CCCO	50,000.00	50,000.00
JGOFS (not incl. admin.)	100,000.00	99,253.00
GLOBEC	12,000.00	10,309.00
Executive Meeting	20,000.00	18,271.00
Publications	10,000.00	14,424.00
Travel Awards	75,000.00	70,149.00
Representation	<u>15,000.00</u>	<u>15,896.00</u>
TOTAL SCIENTIFIC EXPENSE	<u>339,000.00</u>	<u>331,241.00</u>
EXPENSES: Administrative		
SCOR		
Salaries & FB	65,000.00	61,441.00
Communication	12,000.00	10,823.00
Audit	2,500.00	2,514.00
Office Equipment	0.00	522.00
Misc.	2,200.00	1,929.00
Bank Charges	<u>100.00</u>	<u>161.00</u>
TOTAL SCOR	<u>81,800.00</u>	<u>77,390.00</u>
JGOFS	<u>60,000.00</u>	<u>39,123.00</u>
TOTAL Admin. Exp.	<u>141,800.00</u>	<u>116,513.00</u>
TOTAL EXPENSES	<u>480,800.00</u>	<u>447,754.00</u>
Loss on exchange		1,340.00
BALANCE - Dec. 31, 1991	<u>16,400.00</u>	<u>42,960.00</u>
TOTAL CASH PLUS EXPENSES	<u>497,200.00</u>	<u>492,054.00</u>

ANNEX XII - THE INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION

REPORT ON CO-OPERATION BETWEEN IOC AND SCOR DURING 1991/1992

**Prepared by Gunnar Kullenberg, Secretary IOC
for the XXI General Meeting of SCOR**

1. Introduction

This report very briefly provides pertinent information on IOC-SCOR interactions, cooperation and specific interests of IOC in certain activities of SCOR. Since the common interests and potential interactions between IOC and SCOR cover in essence all our activities, this report can only deal with specific partnerships. Overviews of IOC programme activities and recent decisions of the Governing Bodies are provided in the Report of the Secretary on Intersessional Activities presented to the Twenty-Fifth Session of the IOC Executive Council (Paris, March 1992), and the reports of the Sixteenth Session of the IOC Assembly (Paris, March 1991) and the Twenty-Fifth Session of the Executive Council (Paris, March 1992).

2. Overview

Regular consultations are held between the Secretariats of IOC and SCOR and the coordination and flow of information is satisfactory. It is of great importance that we work in harmony and provide support to each others' objectives in order to help ensure that the international ocean research and related matters are properly supported.

The Executive Council discussions on specific co-operation between IOC and SCOR concerned the joint IOC-FAO Ocean Science in Relation to Living Resources (OSLR) programme; ocean dynamics and climate, and CCCO; developments of the Global Ocean Observing System (GOOS); matters related to JGOFS and IGBP; matters related to the UN Conference on Environment and Development.

The Executive Council decided to transform the IOC Committee on Ocean Processes and Climate into the IOC Committee for GOOS, providing an intergovernmental mechanism for the guidance, support and coordination of the further development of GOOS. It also decided to establish a scientific and technical advisory body to advise the intergovernmental committee. SCOR has been invited to provide advice towards the planning of the GOOS and has been invited to consider cooperating in its development.

The IOC is now co-sponsoring the WCRP with WMO and ICSU, and the development of the Global Climate Observing System (GCOS) with ICSU, WMO and UNEP. The IOC participated in the preparations for the United Nations Conference on Environment and Development (UNCED) and attended the Conference in its own right. The IOC in particular emphasized the need to obtain adequate knowledge and information about the ocean for its protection, sustainable development and management of its resources

and the coastal areas. This resulted, inter alia, in GOOS being included as a specific item in Agenda 21, with the IOC identified as the leading body for the implementation, cooperating with other bodies. SCOR is invited to participate in this endeavour. The IOC is providing a certain financial, as well as in kind, support to some SCOR activities. It is regrettably not possible for IOC to provide the substantial financial support which the value of the SCOR activities merits.

3. Specific items

An informal meeting between representatives of SCOR and the IOC Secretariat was held in Paris, 3 September 1992, which reviewed most of the activities of mutual concern. The following presents a summary of the discussions, prepared by the Executive Director of SCOR and the Secretary of IOC.

3.1 Issues relating to the SCOR/IOC Committee on Climatic Changes and the Ocean

It was agreed that the Memorandum of Understanding on the CCCO signed by IOC and SCOR in 1984 should be formally terminated and that the CCCO will be considered to be disbanded as of December 31, 1992.

Some activities and groups which were established by the CCCO, either alone or jointly with other organizations, must be continued, however. These were reviewed and decisions were made as shown below:

- **CCCO/JSC Sea Ice Working Group** - should be referred to the JSC
- **CCCO/JSC Air-Sea Fluxes Working Group** - should be referred to the JSC
- **CCCO/JSC WOCE SSG** - as a result of the MOU on WCRP, this body now reports to the JSC.
- **CCCO/JSC TOGA SSG** - as a result of the MOU on WCRP, this body now reports to the JSC.
- **CCCO/JGOFS CO₂ Advisory Panel** - this group is crucial to success of global oceanic CO₂ survey being conducted in collaboration between WOCE and JGOFS. It should continue as a joint SCOR/IOC body.
- **CCCO/JSC OOSDP** - as the main body responsible for providing the scientific input on the climate module of GOOS, this group must be maintained with strong sponsorship. It was suggested that it be sponsored by J-GOOS (see below) and JSC. J-GOOS sponsorship implies involvement of both SCOR and IOC.
- **CCCO/JSC Regional Panels** - differing views were expressed as to the utility of

keeping these bodies and particularly as to their effectiveness in relation to existing scientific programs such as JGOFS. They could be used more effectively to provide scientific advice to the IOC Regional Sub-Commissions and might also provide a regional focus for GOOS. It was agreed that this matter should be referred to the J-GOOS.

- **CCCO ad hoc Working Group on Interdecadal Variability** - it was agreed that a good start had been made on this topic and that it should be continued for another year as a joint IOC/SCOR effort to organize an international workshop on this topic.

In summary, it was agreed that SCOR and IOC will jointly sponsor three activities arising from the former CCCO: the CO₂ Panel, OOSDP and Interdecadal Variability WG. SCOR will make every effort to maintain its support for these activities at the traditional level of support which was provided for CCCO.

3.2 Issues relating to the Global Ocean Observing System

There was a detailed review of a Draft Memorandum of Understanding on the establishment of a Scientific and Technical Committee for GOOS. The results of this discussion are incorporated into the revised draft. This MOU outlines the concept of GOOS, agrees on joint sponsorship of a Joint Scientific and Technical Committee for GOOS, defines its terms of reference, membership, and the mechanisms for staff and financial support.

3.3 GLOBEC

The arrival of Geoff Lawrence at IOC in the near future should result in increased cooperation and communication between SCOR and IOC on GLOBEC. He will be able to assist specifically by providing staff assistance to the Chairman of the SCOR/IOC Committee for GLOBEC. It was agreed that a large portion of the annual IOC contractual support to SCOR will, in future, be used to support international GLOBEC planning activities.

3.4 Harmful Algal Blooms

The establishment of SCOR/IOC WG 97 on Physiological Ecology of Harmful Algal Blooms was briefly discussed. There is much interest in WG 97 and it has been necessary to limit the membership to ten individuals for financial reasons. Two additional scientists who have been made Corresponding Members, are considered vital to the scientific expertise of WG 97. It is hoped that IOC can provide some support specifically for travel of two members of WG 97 so that it could be expanded accordingly.

3.5 Coordination of interdisciplinary coastal oceanography

It was agreed that it would be useful to have a communication mechanism between the many activities in this field (IGBP/LOICZ, JGOFS, CoOP, GIPME, IOC regional activities, etc.), but that this could be achieved informally. Ken Brink will be asked to take the lead in this activity which would be conducted via telemail. IOC and SCOR should assist him in identifying the various components for which this communication or coordination is needed.

3.6 SCOR Working Groups

The Secretary IOC identified existing WGs 89, 94 and 96 as being of special interest to IOC in view of ongoing IOC programme actions. In future SCOR documents these will be so designated. Of the proposals to be considered at the forthcoming SCOR General Meeting, those on Worldwide Fluctuations in Sardine and Anchovy Populations and on Coral Reefs and Global Change are of interest to IOC, also in view of activities with OSLR (SARP) and the coastal GOOS pilot development.

3.7 Miscellaneous

IOC contractual financial support to SCOR will be partitioned between fewer activities in the future. These should be primarily the formal joint activities (e.g. GLOBEC, HAB).

The Secretary described the IOC involvement in the Committee on Earth Observing Satellites (CEOS) and noted the importance of input from the scientific community. A request from IOC should be received in the near future.

4. Conclusions

It can be concluded that SCOR and IOC have a healthy interaction. This must aim at supporting marine research and related capacity building. Through this, the cooperation between SCOR and the whole UNESCO-IOC marine science programme and its training activities is also continuing.

It is important that the scientific community help at national levels to convince decision makers, national resource institutions and governmental departments of the necessity of increasing our knowledge about the ocean and the equal necessity of establishing adequate infrastructures and human resources and maintain these so as to obtain the scientific results and the information for proper management and use of the ocean, the coastal zone and the marine resources.

ACRONYMS AND ABBREVIATIONS

ADCP	Acoustic Doppler Current Profiler
ALT	Altimeter
AOSB	Arctic Ocean Sciences Board
ATOC	Acoustic Thermometry of Ocean Climate
BAHC	Biospheric Aspects of the Hydrological Cycle
BIOMASS	Biological Investigations of Marine Antarctic Systems and Stocks
CCC	Cod and Climate Change
CCCO	Joint SCOR/IOC Committee on Climatic Changes and the Ocean
CLIVAR	Climate Variability and Prediction program (WCRP)
CMAS	Confederation Mondiale des Activites Subaquatiques
CMG	Commission for Marine Geology
COARE	Coupled Ocean-Atmosphere Response Experiment (TOGA)
CoOP	Coastal Ocean Processes
COSPAR	Committee on Space Research
CSIRO	Commonwealth Scientific and Industrial Research Organization (Australia)
CTD	Conductivity, Temperature, Depth (Profiler)
DIS	Data and Information Systems (IGBP)
ECMWF	European Centre for Medium Range Weather Forecasting
ECOR	Engineering Committee on Oceanic Resources
ENSO	El Niño-Southern Oscillation
ERS-1	Earth Resources Satellite - 1 (of ESA)
ESA	European Space Agency
FAO	Food and Agriculture Organization (UN)
FGGE	First GARP Global Experiment
GAIM	Global Analysis, Interpretation and Modelling
GARP	Global Atmospheric Research Program
GATE	GARP Atlantic Tropical Experiment
GCOS	Global Climate Observing System (WMO, IOC, ICSU, UNEP)
GCTE	Global Change and Terrestrial Ecology (IGBP)
GEOSAT	Geodetic Satellite (launched March 1985 USA)
GIPME	Global Investigation of Pollution in the Marine Environment (IOC)
GLOBEC	Global Ocean Ecosystem Dynamics (SCOR/IOC)
GOEZS	Global Ocean Euphotic Zone Study (IGBP/SCOR)
GOOS	Global Ocean Observing System (IOC, WMO, UNEP, ICSU)
GSP	Greenland Sea Project
HAB	Harmful Algal Blooms
HIFT	Heard Island Feasibility Test
LABO	International Association for Biological Oceanography
IAHS	International Association for Hydrological Sciences
IAMAP	International Association for Meteorology and Atmospheric Physics
IAPSO	International Association for the Physical Sciences of the Ocean
ICES	International Council for the Exploration of the Sea

ICSU	International Council of Scientific Unions
IGAC	International Global Atmospheric Chemistry Programme (IGBP)
IGBP	International Geosphere-Biosphere Programme (ICSU)
IGY	International Geophysical Year (1957)
INQUA	International Union for Quaternary Research
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IODE	IOC Committee on International Oceanographic Data Exchange
IUBS	International Union of Biological Sciences of ICSU
IUGG	International Union of Geodesy and Geophysics
IUGS	International Union of Geological Sciences
JGOFS	Joint Global Ocean Flux Study
JPOTS	Joint Panel on Oceanographic Tables and Standards
JSC	Joint Scientific Committee for the WCRP (ICSU/WMO)
JSTC	Joint Scientific and Technical Committee for GCOS
LOICZ	Land Ocean Interactions in the Coastal Zone (IGBP)
MESH	Marine Aspects of Earth System History
MOU	Memorandum of Understanding
NABE	North Atlantic Bloom Experiment (JGOFS)
NOAA	National Oceanic and Atmospheric Administration (USA)
NOS	National Ocean Service
OMEX	Ocean Margins Exchange (EEC)
OOSDP	Ocean Observing System Development Panel (CCCO/JSC)
OSLR	Ocean Science in Relation to Living Resources (IOC)
PAGES	Past Global Changes (IGBP)
PICES	North Pacific Marine Sciences Organization ("Pacific ICES")
SCAR	Scientific Committee on Antarctic Research (ICSU)
SCOPE	Scientific Committee on Problems of the Environment (ICSU)
SCOR	Scientific Committee on Oceanic Research
SSC	Scientific Steering Committee
START	Global Change System for Analysis, Research and Training (IGBP)
TOGA	Tropical Oceans and Global Atmosphere (WCRP)
TOPEX	Ocean Topography Experiment - TOPEX/Poseidon satellite
UNCED	United Nations Conference on Environment and Development
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific, and Cultural Organization
WAM	Wave Modelling Group
WCRP	World Climate Research Programme (WMO/ICSU)
WESTPAC	IOC Regional Sub-Commission for the Western Pacific
WG	Working Group
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment (WCRP)
XBT	Expendable Bathythermograph