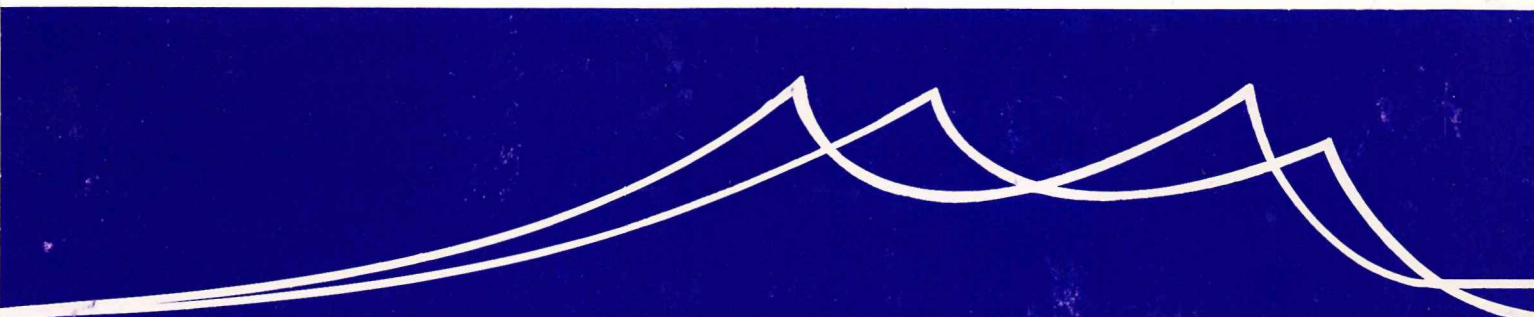


SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH



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INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

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**INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS**

**PROCEEDINGS**

**OF THE**

**SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH**

**May, 1988**

**Halifax, Nova Scotia, Canada**

SCOR Proceedings, Volume 23

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## REPORT OF THE TWENTY-EIGHTH MEETING OF THE SCOR EXECUTIVE COMMITTEE

Zurich, Switzerland

October 19 and 20, 1987

The twenty-eighth meeting of the Executive Committee of SCOR was held in the Zunfthaus zur Saffran (Spice Merchants' Guildhall) in Zurich on October 19 and 20, 1987. The meeting was held at the invitation of the Swiss Committee for SCOR and was hosted by Professor K. Hsu, of the Geological Institute of the Eidgenossische Technische Hochschule, Chairman of CMG and an ex-officio member of the SCOR Executive Committee. The President of SCOR, Professor Gerold Siedler, chaired the meeting. A list of participants is given in Annex I.

The President opened the meeting with a special welcome to two new members of the Executive Committee: Dr. A. Ayala-Castanares (Mexico), co-opted member with special responsibilities for the Joint Oceanographic Assembly, and Professor J. O'Brien (USA), newly elected President of IAPSO. On behalf of the entire Executive Committee, he expressed regrets at the absence of one of the Vice-Presidents, Dr. R. Chesselet, due to a lengthy illness. It was agreed that the best wishes of the participants for a speedy recovery would be conveyed to Dr. Chesselet.

The Secretary of IOC, Dr. M. Ruivo, responded to the welcoming remarks of the President, that he was happy that he and some of his colleagues were able to attend a SCOR meeting for the first time in a number of years.

Finally, Professor Siedler noted the recent deaths of Dr. A. Bayoumi (Egypt) and Dr. M. Menache (France). Dr. Bayoumi had been instrumental in the establishment of an Egyptian Committee for SCOR in 1983, while Dr. Menache played a leading role in the activities of WG 10, later known as JPOTS. A moment of silence was observed in their honour.

The agenda was approved with minor changes and additions.

A list of acronyms appears at the end of this report.

## 1.0 ORGANIZATION AND FINANCE

### 1.1 Membership

The Executive Secretary noted that both IAPSO and IAMAP had elected new officers at their meetings during the IUGG Assembly in August 1987. The Presidents of these two organizations, Professor J. O'Brien (IAPSO) and Dr. G.B. Tucker (IAMAP) hereby became ex officio members of the SCOR Executive Committee, while the two new Secretaries, Dr. R.E. Stevenson and Professor M. Kuhn became members of SCOR.

The Committee for SCOR in the USSR had informed the Secretariat that Professor A.P. Kuznetsov had replaced Dr. K.N. Fedorov as one of the Nominated Members from the USSR.

The meeting was informed that following the instructions of the XVIII General Meeting, the Executive Secretary had continued to correspond with the Vice President of the Consejo Superior de Investigaciones Cientificas in Spain about the re-establishment of a SCOR Committee in that country. Spanish membership in SCOR had lapsed some years ago as a result of non-payment of membership contributions. SCOR wished to be assured that the new Spanish Committee would be representative of the various institutions in the country. A formal letter of application for membership in SCOR had been received for the Executive Committee Meeting, although the establishment of the Spanish Committee had not yet been completed. The Executive Committee agreed that this application should be accepted by the President as soon as final information on the composition of the Spanish Committee for SCOR is available.

In accordance with the decision of the XVIII General Meeting of SCOR, the Executive Secretary had written to the two Invited Members, Dr. M. Branica (Yugoslavia) and Dr. G. Reyes-Vasques (Venezuela). They were reminded that the purpose of this category of membership is to provide a means of involving individuals from countries which are not SCOR members. It was the intent, however, that these individuals should encourage the eventual establishment of Committees for SCOR in their countries. The current Invited Members were asked to consider their roles in SCOR, to explore the interest in SCOR membership in their countries and to make suggestions as to how this category of membership might be better utilized by SCOR. Since no replies had been received, the Executive Committee was inclined to consider the termination of these memberships. However, several participants urged that Dr. Branica be contacted again since they knew him to be an active scientist who could well represent the Yugoslavian oceanographic community. The representatives of IOC and the UNESCO Division of Marine Sciences offered assistance to SCOR in making contact with newly-established oceanographic commissions in both of these countries. The Executive Secretary was urged to pursue this matter with the assistance of Dr. Krause and Dr. Ruivo.

### 1.2 Publications

The Executive Secretary presented the following list of publications which have arisen from SCOR activities since the XVIII General Meeting in November 1986

#### UNESCO Technical Papers in Marine Science:

- No. 48 Coastal-Offshore Ecosystems Relationships. Final Report of SCOR/IABO/UNESCO, Working Group 65, Texel, Netherlands, September 1983.
- No. 50 Progress on Oceanographic Tables and Standards 1983-1986: Work and recommendations of the UNESCO/SCOR/ICES/IAPSO Joint Panel.

BIOMASS Publications: BIOMASS Report Series

- No. 50 Meeting of the BIOMASS Executive, San Diego, California, U.S.A., 11-13 June 1986.
- No. 51 Report of the BIOMASS Workshop on Krill Physiology, Rimouski, Quebec, Canada, 15-17 September 1986.
- No. 52 Post-SIBEX Fish Data Evaluation Workshop:Phase 1, Validation, Cambridge, U.K., 6-17 October 1986.

SCOR/IOC CCCO Publications

Report of the Sixth Session of the JSC/CCCO Scientific Steering Group for WOCE. Wormley, April 21-24, 1986. Available from WOCE International Planning Office.

Report of the Seventh Session of the JSC/CCCO Steering Group for WOCE, Washington, November 17-19, 1986. Available from the WOCE Planning Office.

WOCE Core Project 2 Planning Meeting, The Southern Ocean, Bremerhaven, F.R.G., 20-23 May 1986. WCP 138.

1987 TOGA International Implementation Plan. Second Edition. ITPO-No. 1.

Report of the Fourth Session of the JSC/CCCO Working Group on Satellite Observing Systems for Climate Research. Tokyo, 20-24 October 1986. WCP 124.

Report of the Fifth Session of the JSC/CCCO TOGA Scientific Steering Group. Abingdon, 1-5 September 1986. WCP 130.

Miscellaneous SCOR Publications

SCOR Proceedings, Vol. 22, Report of the XVIII General Meeting, Hobart, November 1986.

1987 SCOR Handbook, June 1987.

The Joint Global Ocean Flux Study (JGOFS). Report of the International Scientific and Coordination Meeting for Global Ocean Flux Studies, ICSU Headquarters, Paris, France, February 17-19, 1987.

The Publications Officer, Professor Fournier reminded the participants of the discussion of the XVIII General Meeting in which some concerns were expressed about publications arising from SCOR activities. These related to inadequate recognition of SCOR as a sponsor of some activities, to negotiation of publishing contracts without reference to the Executive Committee, and so on. Professor Fournier reported that advice on these issues was sought from the Chairman of ICSU Press who had responded with a large number of suggestions. It was agreed that more precise instructions should be given to working groups, possibly by specifying in the terms of reference, as to the nature of the final product or publication expected by SCOR to result from the activities of each group. The Publications Officer will undertake to ensure that every publication adequately identifies SCOR as its sponsor. Several other suggestions were made including the production of a standard cover for SCOR reports, the acquisition of ISSN and/or ISBN numbers, the establishment of a SCOR Report Series and so on. Professor Fournier agreed to look further into the implications of these suggestions and to prepare a document for consideration for the Executive Committee in the next few months.

### 1.3 Finance

The Executive Secretary briefly reviewed the final financial statement for the 1986 SCOR accounts (see Annex II). These showed more income received than anticipated in the budget for the year, while expenses were less than expected, except for one or two items, notably the XVIII General Meeting. In summary, at the end of 1986, SCOR was in a healthy financial position with an unexpectedly large balance of about \$100,000.00. The budget for 1987 and interim financial status, were also reviewed. It was noted that four working group meetings had been postponed to 1988 and that funds allocated for these activities would have to be carried forward. It was pointed out that while the projected year-end balance for 1987 was again expected to be large, it would include a substantial amount of funds already committed to specific activities.

In accordance with the usual SCOR practice, an ad hoc Finance Committee consisting of Professor K. Voigt and Professor J. Field was appointed to review these documents in detail, to draw up a budget for 1988 and to make a recommendation regarding the levels of membership contributions in 1989. The Finance Committee worked in consultation with the Executive Secretary and its report was presented by Professor Voigt.

He reported that the financial resources available to SCOR in 1988 would be nearly \$400,000.00, including income and the balance which would be carried forward from 1987. The budget which was presented for 1988 included a commitment of \$219,000.00 to the activities of SCOR's subsidiary bodies, \$89,000.00 for related scientific activities (publications, JOA planning, etc.) and \$55,000.00 for administrative expenses. It was noted with considerable concern, that this budget would only leave a balance of \$33,000.00 at the end of 1988, less than the usual amount of \$55,000.00 which is expected to begin a new fiscal year. However, the Executive Committee, in accepting the report of the Finance Committee hoped that the projected balance might increase due to the postponement of activities for which plans were only tentative. Two or three such postponements can usually be expected each year.

Finally, the Executive Committee accepted the recommendation that membership contributions must be increased in 1989. It was agreed that this increase should be no larger than that accepted by ICSU for 1989, namely seven per cent. The suggestion was made that the President should urge certain SCOR Committees to reconsider their category of membership in SCOR with the hope that these would be increased to more adequately reflect the size and scope of the oceanographic communities in these countries. A special effort must also be made to increase SCOR income in order to support JGOFS activities (see item 3.5). Those countries which have actively participated in the preliminary JGOFS planning activities, and which have relevant national programmes, will be invited to assist SCOR with financial support for the international effort.

### 1.4 Preparation for Election of Officers in 1988

The election of SCOR Officers will take place during the XIX General Meeting in 1988. In order to prepare for this, a Nominations Committee was appointed consisting of Professors' Hsu, Voigt, Lasserre and O'Brien. The terms of office of the President, Secretary and Vice-Presidents will all expire at the 1988 General Meeting. The President will not be eligible for re-election having served the single four year term permitted by the Constitution. Similarly, Dr. Chesselet has served three terms as Vice-President and may not be re-elected. The Committee will seek nominations from SCOR Committees and will report to the XIX General Meeting.



## 1.5 Review of SCOR Constitution

The XVIII General Meeting instructed the Secretary and Executive Secretary to conduct a preliminary review of the SCOR Constitution and to make a recommendation to the Executive Committee as to whether a detailed review was needed and how it should be conducted. Professor Fournier noted that the existing Constitution may be perceived as lacking in detail in certain areas, however, no serious organizational problems had ever arisen which could not be resolved in an ad hoc manner. There was unanimous agreement that the traditional flexibility of SCOR is a most desirable quality which ought not to be jeopardized by the creation of a unnecessarily detailed and rigid Constitution. Instead, Professor Fournier recommended that only minor changes of an administrative nature were required (for example, the current Constitution calls for the Executive Committee to meet at eight month intervals, although this has not been done for several years). He agreed to prepare a proposal, incorporating these small changes, for consideration at the XIX General Meeting.

## 2.0 JOINT OCEANOGRAPHIC ASSEMBLY

### 2.1 Mexican Organizing Committee

The Chairman of the Mexican Organizing Committee for JOA-88 presented a detailed report on the status of planning for the Assembly which will take place at the Acapulco Convention Center from 23 to 31 August 1988. The SCOR Executive Committee welcomed his report and briefly discussed only a few related issues.

A letter received from the Ministry of Foreign Affairs of Mexico established that Mexican visas would be granted to all individual scientists wishing to attend the JOA. However, the citizens of three countries in particular will be required to make their applications earlier than others. The SCOR Committees in these countries will be informed of the procedures to be followed. The Executive Committee expressed its pleasure that a means had been found to ensure that the ICSU rules regarding free circulation of scientists would be followed for the JOA.

The question of the availability of travel funds for JOA participants, speakers and convenors, was of considerable concern. Both IOC and UNESCO have contributed substantially through the ICSPRO Logistics Committee for JOA. These funds are to be used principally to provide travel grants to participants from developing countries. It was recognized, however, that the research funding situation, even in many developed countries, will make it difficult for many other scientists to provide the full costs of their travel to Acapulco, even if they are speakers or convenors. In summary, there exists a need for commitments of travel funds from a variety of sources if a broadly-based participation in JOA is to be achieved. It was agreed that the President of SCOR should make a special appeal to SCOR Committees, and that the Secretary of IOC would make a similar appeal to IOC Member States, to establish national programmes of travel grants to encourage attendance by their own scientists, and to consider making special contributions to SCOR of funds to augment the inadequate amounts available from international sources. In addition, approaches will be made to appropriate funding agencies and foundations for the same purposes.

### 2.2 JOA Scientific Programme Committee

The President reviewed a written report which had been received from the Chairman of the JOA Scientific Programme Committee, Professor W. Wooster.

The Scientific Programme Committee met in Seattle on 11-12 May 1987. Agreement was reached on topics for General and Special Symposia, on a procedure for completing the list of invited co-convenors, on the schedule for Assembly sessions, and on the procedure for selecting papers for General, Special, and Association sessions. In accord with an agreed schedule, the Call for Papers was issued in June and has since been given wide distribution, especially through the International Marine Science Newsletter of UNESCO. Since the May meeting, the programme and the list of convenors has been essentially completed and is as follows:

Four General Symposia of invited papers with the following topics of broad, interdisciplinary interests:

- G1 New developments  
G. Siedler (FRG)
- G2 Ocean and climate  
J.C. Duplessy (France), R.W. Stewart (Canada)
- G3 Hydrothermal processes  
D. Desbruyeres (France), L.I. Moskalev (USSR), E. Suess (USA)
- G4 Summary critique  
K.N. Fedorov (USSR), W.S. Wooster (USA)

Twelve Special Symposia on the following interdisciplinary topics:

- S1 Oceanography in Mexico  
J. Adem, A. Ayala (Mexico)
- S2 Physical and ecosystem models  
J.C.J. Nihoul (Belgium), T. Platt (Canada), J. Pope (UK)
- S3 New Observation methods and associated data problems  
W. Alpers (FRG), R. Hekinian (France), M.J. Perry (USA)
- S4 Large-scale changes from human activity  
G. Saetersdal (Norway), A.D. McIntrye (UK), Zhou Jiayi (China)
- S5 Life strategies in extreme environmental conditions  
T. Fenchel (Denmark), P.W. Hochachka (Canada), I.A. Melnikov (USSR)
- S6 Small-scale processes in the surface layer  
K. Denman (Canada), V. Smetacek (FRG), Y. Toba (Japan)
- S7 Tropical Coastal Systems  
E. Jordan (Mexico), L. Martins (Brazil), A.N. Rao (Singapore)
- S8 Global ocean storage and fluxes  
P. Brewer (USA), E. Degens (FRG), M. Whitfield (UK)
- S9 Deep sea floor  
K. Hsu (Switzerland), S. Ohta (Japan), S.A. Thorpe (UK)
- S10 Ocean variability and biological change  
R. Dickson (UK), A.P. Kuznetov (USSR), A. Herbland (France)
- S11 Global sealevel change  
H. Postma (Netherlands), S. Snedaker (USA)
- S12 Scientific basis for ocean resource use  
T. Balkas (Turkey), S. Krishnaswami (India), J.P. Troadec (France)

Professor James McCarthy, Convenor of the Special Committee on the International Geosphere-Biosphere Programme, has agreed to discuss the scientific basis of that programme at the opening session.

The deadline for submission of abstracts is 30 November, with selection of papers for Special Symposia to be completed by 31 January. As of mid-October, few abstracts have been received, and it may be necessary to extend the deadline. Abstracts received to date tend to be specialized and thus not appropriate for the interdisciplinary symposia

contemplated. A letter to convenors will ask their help in soliciting more appropriate papers.

Many authors and convenors indicate their need for financial support. It is hoped that SCOR National Committees will make a special effort to assist convenors and selected speakers when they have been identified.

It should not be necessary for the Scientific Programme Committee to meet again before Acapulco. Attendance in Acapulco is essential for the SPC Chairman and the four Association representatives, and it is hoped that SCOR will provide the funds to make this possible.

### 3.0 SUBSIDIARY BODIES

#### 3.1 Arising from Former Working Groups

##### WG 46 River Inputs to Ocean Systems (with UNESCO)

The Executive Secretary informed the meeting that the Chairman of WG 46, Professor Burton, has agreed to submit the manuscript of the final report of his working group to UNESCO for publication by mid 1988 in the Technical Papers in Marine Science Series.

##### WG 51 Evaluation of CTD Data (with UNESCO)

In accordance with the instructions of the XVIII General Meeting, Professor Charnock had collaborated with Dr. J. Crease, the Chairman of WG 51 in completing the "Guide to the Acquisition and Analysis of High Quality CTD Data". The final draft of this volume had been circulated to all WG 51 members for last corrections, and was to be submitted by the end of 1987 to UNESCO for publication in the UNESCO Technical Papers in Marine Science.

##### WG 54 Southern Ocean Ecosystems and Their Living Resources (with SCAR, IABO, ACMRR and IOC)

While WG 54 was disbanded by the XVIII General Meeting in 1986, SCOR had agreed to continue support for the BIOMASS follow-up activities, especially for a series of post-BIOMASS data workshops which will take place in the period leading up to a final BIOMASS Evaluation Meeting in 1989. In particular, SCOR has assisted SCAR (and will continue to do so) in providing input from physical or chemical oceanographers by naming representatives to these workshops as appropriate.

##### WG 56 Equatorial Upwelling Processes (with IOC and UNESCO)

The Executive Secretary reported on the status of the special volume of Oceanologica Acta arising from the 1985 symposium on "Vertical Motion in the Equatorial Ocean and its Effects upon the Living Resources and the Atmosphere" which was organized by WG 56. While all of the papers submitted had been reviewed and edited, and the volume was believed to be in press, no precise publication to date had been received from the editor, Dr. J. Boutler. It was felt, however, that the volume could be expected to appear in the near future.

##### WG 65 Coastal-Offshore Ecosystems Relationships (with UNESCO)

Professor Stromberg reported that he had been in contact with Dr. B. Jansson who (with Dr. M. Pamatmat) had convened the final WG 65 workshop in April 1986. Dr. Jansson

was in the final stages of editing the volume arising from this workshop and expected to send the final manuscript within one month to Springer-Verlag for publication in early 1988.

#### WG 73 Ecological Theory in Relation to Biological Oceanography (with UNESCO)

A member of WG 73, Professor J. Field reviewed the final report of the group which had been submitted to SCOR earlier in 1987 and is reproduced as Annex IV. The group had undertaken two separate activities in the two year period prior to its final meeting which took place in December 1986. These included the organization of a workshop on flow analysis, and the promotion of cooperation between biological and physical oceanographers in the study of productivity at marine interfaces.

The Executive Committee approved the establishment of a small editorial group (Mann, Field, Wulff) which should meet in 1988 to complete the preparation of the volume arising from the Flow Analysis Workshop. It was agreed that the implementation of WG 73's recommendation regarding the use of analytical techniques in the design of observational programmes should await the publication of this volume. It was also agreed that Professor Legendre should be thanked for having initiated a lively debate on the topic of enhanced productivity at interfaces, although no conclusion had been reached as to whether a generalized explanation could be found for this phenomenon.

### **3.2 Current Subsidiary Bodies**

#### WG 69 Small-scale Turbulence and Mixing in the Ocean (with IOC)

Professor Siedler in his capacity as Executive Committee Reporter for WG 69, reviewed the report which had been submitted by the group's Chairman, Dr. K. Fedorov (see Annex III). During the period since the last meeting of SCOR, WG 69 had concentrated on two tasks; the completion of a glossary of terms and definition for use in turbulence studies and the organization of the scientific programme of the Liege Colloquium which took place in May 1987 and discussed the topic of small-scale turbulence and mixing.

The Colloquium attracted some eighty scientists and had a representative programme of talks which covered a wide variety of aspects of oceanic turbulence and mixing. WG 69 held its final meeting at the end of the Colloquium and agreed to procedures and a schedule for publication of the proceedings of the Colloquium in the Elsevier "Progress in Oceanography" series in May 1988. In addition, the group planned to submit its final report to SCOR in late 1987. This will include the Glossary referred to above, a summary of the scientific results of the Colloquium and a full report of the activities of WG 69. Since the completion of these two publications would fulfill the intended functions of WG 69, it was agreed to recommend to the XIX General Meeting that the group be disbanded.

#### WG 71 Particulate Biogeochemical Processes (with UNESCO)

The Chairman of WG 71, Dr. S. Krishnaswami had provided a brief written report to supplement a more extensive one which had been considered by SCOR following the meeting of WG 71 in April 1986. In accordance with a recommendation of that meeting, the Executive Committee approved Dr. Krishnaswami's request for a third and final meeting of WG 71 in 1988. The purpose of this meeting will be (1) to discuss the relationships between particulate transport processes and the profiles of dissolved trace elements and nutrients in the ocean, and (2) to prepare a final report. The group may also discuss the status of scientific planning for JGOFS and offer suggestions on this topic. It was agreed that the final meeting of WG 71 could be held either in France (Paris or Gif-sur-Yvette) or at Dr. Krishnaswami's Institute in India.

WG 72 The Ocean as a Source and Sink for Atmospheric Constituents (with IOC)

The President reminded the Executive Committee that, following the General Meeting of SCOR in 1986, Dr. M. Andreae had been invited to assume the Chairmanship for WG 72 and several changes had been made to the membership of the group. In accordance with the agreement of the General Meeting, WG 72 planned to meet in November 1987. The agenda for this meeting included consideration of the four topics identified by the group and endorsed by the General Meeting:

- The improvement and development of techniques for measuring transfer velocities at the air-sea interface.
- Studies on the role of atmospheric input of nutrients on marine productivity and ocean fluxes.
- Studies on the role of photochemical processes in the air-sea exchange of chemical species.
- Studies on the role of biological activities in the exchange of trace constituents between the ocean and the atmosphere.

The report from Dr. Andreae to the Executive Committee meeting included a request for approval for a WG 72 meeting in 1988 and for the group to organize or cosponsor an international symposium in 1989. The Executive Committee agreed, however, that WG 72 had already been in existence for more than the usual six year period, and that since the future activities proposed by the group were so closely related to JGOFS, they should be deferred until the plans for JGOFS are in a more advanced stage. It was concluded that WG 72 should be asked to complete its assigned tasks and to prepare a final report to SCOR following the forthcoming meeting. This report will be considered at the XIX General Meeting in August 1988 and should contain precise recommendations for future activities which take into account the results of the first one or two meetings of the SCOR Committee for JGOFS.

WG 75 Methodology for Oceanic CO<sub>2</sub> Measurements (with UNESCO)

A brief report from the Chairman of WG 75, Dr. C.S. Wong, noted that in order to combine the expertise of JPOTS on pH and alkalinity with that of SCOR WG 75 on total CO<sub>2</sub> and pCO<sub>2</sub>, a JPOTS Sub-panel on Standards for CO<sub>2</sub> Measurements had been established and that this group had held its first meeting in August 1987. The group discussed the concepts of standards and requirements of parameters to define the CO<sub>2</sub> system in sea water. The desirable characteristics of the reference sea water should be certified to 0.003 pH unit, 1  $\mu$ equivalent for total alkalinity, 1  $\mu$ mol kg<sup>-1</sup> for total CO<sub>2</sub> and 0.3 x 10<sup>-6</sup> atmosphere for pCO<sub>2</sub>. The group considered these to be achievable with existing capability in the scientific community. A review of the state-of-the-art of the models to determine these parameters was made. Progress in various national or individual efforts was reported. Dr. A. Poisson reported the organization of an intercalibration exercise for total alkalinity and total CO<sub>2</sub>, as recommended by both SCOR WG 75 and ICES Marine Chemistry WG and the utilization of the Standard Sea Water facilities at Wormley under Dr. F. Culkin to prepare sea water samples for distribution. The group endorsed the intercalibration effort and requested the coordinator, A. Poisson, to prepare a review of the methods in use, through a collation of the methods to be submitted with the analytical results in the exercise.

The meeting of WG 75 which had been approved by the XVIII General Meeting had not taken place in 1987 and Dr. Wong's report noted that the group now hopes to hold its final meeting in 1988, although the exact dates and venue had not yet been established. The following items will be considered at this meeting:

Results of the JPOTS/SCOR intercalibration exercise and other CO<sub>2</sub> intercalibrations.

<sup>13</sup>C, <sup>14</sup>C isotopes, not fully discussed in last SCOR WG meeting.

Options of strategy to carry out CO<sub>2</sub> measurements as documented in the Les Houches 1985 meeting: JGOFS, CCCO-CO<sub>2</sub> Panel, GTCP, IGBP, WOCE frameworks.

Identification of potential topics suitable for evolution of future new WG related to current WG 75 interests.

Preparation of final report and Symposium Proceedings.

The Executive Committee reiterated that this must be the final meeting of WG 75.

#### WG 76 Ecology of the Deep-Sea Floor (with IOC)

Professor Stromberg reviewed an extensive report which had been submitted to the Executive Committee by Dr. A. Rice, the Chairman of WG 76. The group had been conducting its business in correspondence since its final meeting in 1985 and two proposals for future activities have emerged:

1) Despite the existence of various national and international listings of marine scientists, the group felt that an annotated directory of biologists currently interested in, and working on, deep-sea problems would be useful to scientists, government agencies and industry. Accordingly, a simple questionnaire has been included in the Deep-Sea Newsletter and the replies will be collated at IOSDL, Wormley.

2) In an attempt to begin to address the key questions identified in the 1986 report, it was suggested that a paper be prepared jointly by the WG membership outlining the type of information on deep-sea communities which would be required to recognize and to forecast the results of perturbations, particularly anthropogenic ones. Accordingly, a proposed outline of such a paper was produced:

Introduction: To emphasize the importance of being able to forecast, or at least detect, the consequences of man's activities on deep sea communities, and to point out the practical problems of using classical taxonomic techniques in ecosystem description. To suggest that studies of communities can be considered under the following broad categories.

Structural aspects: Concerned with such topics as classical taxonomy, diversity indices, numerical abundance and biomass, size spectra, spatial distributions and demography.

Functional aspects: Concerned with fluxes of materials and energy, including respiration, growth and reproductive rates, productivity, transport by migratory organisms and coupling between the benthic and pelagic communities.

Ecological aspects: Concerned with interactions between organisms and their biotic and abiotic environments, including trophic relations, competition for space and other resource and biologically induced modifications to the environment such as bioturbation. In each of these sections the available and/or desirable techniques for obtaining and treating samples would be discussed. Finally, the significance of the resulting data in answering the questions addressed would be assessed critically, taking into account both the ability to obtain the data and the relative effort involved in doing so.

Conclusion: This section would attempt to establish the minimum information needed to answer the questions posed and to assess our ability with current technology, manpower and knowledge to obtain the required data. Specific areas where extra effort is required would be considered.

The Executive Committee noted that the proposed compilation of a directory did not fall within the terms of reference assigned to the group, but noted that this would probably not be a time consuming task. The proposal to prepare a report along the lines given above was approved. The Executive Committee agreed that this should be the final report of WG 76 and approved Dr. Rice's request for a meeting of the group to be held in association with the Fifth Deep-Sea Biology Symposium in Brest in late June 1988.

#### WG 77 Laboratory Tests Related to Basic Physical Measurements at Sea (with UNESCO)

The report from the Chairman of WG 77, Dr. Striggow, provided information on a three-week CTD intercalibration workshop which would take place at the Institute of Applied Physics of the University of Kiel in February 1988 (not 1987 as originally planned). The institutes which send instruments for use in the workshop are also expected to provide technicians and to cover the cost of their travel, shipping of the instruments and so on. Dr. Striggow sought financial support from SCOR for certain costs associated with the workshop and proposed that the working group itself should meet twice in 1988 in order to consider the results of the intercalibration experiment.

The Executive Committee recommended that WG 77 should meet once following the workshop. A second meeting would only be approved on the basis of a detailed report and request to the XIX General Meeting in Acapulco. While the meeting agreed to provide substantial financial support to WG 77 in 1988, the allocation was insufficient to meet the request of Dr. Striggow, in particular for the salary of a technician to assist in the experiment. The President of SCOR agreed to explore alternative sources of support for the intercalibration workshop with the local organizer and officials of the University of Kiel.

#### WG 78 Determination of Photosynthetic Pigments in Seawater (with UNESCO)

Professor Fournier, Executive Committee Reporter for WG 78, reviewed the group's report. He noted that the members of WG 78 are at an advanced state of completing the compilations of reviews which would be presented to SCOR for publication. The reviews will cover recent developments on the analytical chemistry of pigment determination in seawater, with emphasis on advantages and disadvantages of traditional versus modern techniques. New chlorophylls and carotenoids, pigments which have been recently identified will be included in a chemotaxonomic review of the pigments in marine biology. The application of chlorophyll pigment data to marine biology, satellite imagery, organic geochemistry and analytical flow cytometry will be also covered in component sections.

Professor Fournier reported that the experimental workshop which had been planned by WG 78 to take place in late 1987, had been deferred until 1988. The Executive Committee expressed its disappointment at this delay, especially since it felt that HPLC intercalibrations were of importance for JGOFS as is the standardization of procedures so as to allow the production of a reasonable pigment data set although WG 78 had extensive discussions on the structure resources and objectives of the experimental workshop to be held in Dr. S. Jeffrey's laboratories in Hobart, it had been unable to fix a date in 1987 suitable for all WG participants. Dr. Jeffrey has assured the WG of an October 1988 venue, but other alternatives were being considered so as to allow the preparation of WG 78 recommendations in time to integrate these into the first series of JGOFS 1989 cruises in the North Atlantic.

The objectives of the workshop will be: (1) to quantitatively intercompare existing spectrophotometric and fluorometric procedures with modern high performance liquid chromatographic (HPLC) and high performance thin layer chromatographic techniques for the determination of chlorophylls A, B, and C, together with major carotenoids in cultured and seawater samples of phytoplankton, in samples of phytodetritus from faecal and sedimenting particulates and in synthetic mixtures of pigments and their breakdown products. (2) Optimal methods of sample preservation, filtration and extraction will also be considered. (3) The provision of pigment standards, their quality control and stability will also be considered together with specification of optimal method for their purification and identification. (4) Finally, a simple isocratic HPLC system will be tested out at Hobart with a view to recommending a hardware/chemware configuration suitable for routine shipboard use by the non-specialist oceanographer. Several HPLC manufacturers have been in contact with Dr. Mantoura offering us the opportunity of testing their HPLC hardware and this will be pursued in advance of the Hobart workshop. The intention here is to actually field and laboratory prove a simple commercially available HPLC system for use by the marine community.

Immediately following the Hobart workshop, the data, recommendations and final report will be prepared by the WG and its chairman, and submitted to SCOR and UNESCO in late 1988 for publication.

The Executive Committee agreed that WG 78 should be urged to hold its workshop at an earlier date if possible.

#### WG 79 Geological Variations in Carbon Dioxide and the Carbon Cycle (with IOC)

Working Group 79 sponsored a symposium on "The Global Carbon Cycle: Palaeoclimate Perspectives" at the XIIth Congress of the International Union for Quaternary Research in Ottawa on July 31, 1987. The session was organized and chaired by Alan Hecht, Director of the U.S. National Climate Programme and WG 79 Chairman, Dr. E. Sundquist. Authors and titles were as follows:

- N.J. Shackleton, "Deep sea sediment evidence for changing atmospheric carbon dioxide levels".
- E.T. Sundquist, "Quaternary climate, atmospheric CO<sub>2</sub>, and marine carbonate sediments".
- J.T. Overpeck, E.R. Cook, "A Quaternary perspective on how trace-gas-induced climate change might affect natural vegetation: Data and methods".
- H. Faure, "An amplifying mechanism for the climatic cycle: the 'sea ice lid effect' controls the changes in atmospheric carbon dioxide".
- E.A. Boyle, "Comparison of carbon isotopes and cadmium as tracers of oceanic chemistry and circulation".

Several of these papers will soon be submitted for publication by the Journal of Palaeoclimatology.

At the SCOR General Meeting last year in Hobart, it was suggested that WG 79 should "consider revisions to its terms of reference which would more clearly define the important questions to be addressed and the way in which this can be best achieved". A meeting of WG 79 was scheduled in conjunction with the above symposium to discuss initiation of new terms of reference. Unfortunately less than half of the members could attend the WG meeting, and the Chairman chose to cancel it. The following recommendations were based on his communications with WG members since that time.



If WG 79 is to contribute to progress in understanding geologic variations in the carbon cycle, it must do so in a more focused way. The two meetings have been poorly attended, and the bibliography project has been suspended for lack of interest on the part of members. WG 79's terms of reference are very general, and the group is not affiliated with any ongoing international research programme. Further contributions require initiation of specific new activities, and perhaps addition of new members who are committed to those activities.

WG 79 therefore proposed a significant new project to be completed over the next two years. It proposed to initiate a project to stimulate development of time-dependent carbon-cycle models appropriate to time scales of thousands to a few million years.

The need for such models was felt to be conspicuous. Modelling of such geologic records as marine carbon isotopes and ice core CO<sub>2</sub> is almost exclusively limited to steady-state scenarios. The CO<sub>2</sub> and climate modelling communities are focusing on coupled ocean-atmosphere general circulation models (GCM's) which will be difficult to extend to transients as long as a year, let alone millennia. Both the steady-state and short-term GCM approaches are inherently unable to examine the dynamic interactions among the long-term processes that are reflected in the geologic record of carbon-cycle and climate change. Although geologic analogs are frequently cited as powerful tests of climate and carbon-cycle models, these tests require an understanding of the long-term processes that brought about "analog" conditions. Appropriate time-dependent models are essential to acquiring this understanding.

The problem does not appear to be a lack of data; after 7 years since the first suggestion that CO<sub>2</sub> was low during the last glacial period, we still have almost no time-dependent simulations of the Pleistocene/Holocene CO<sub>2</sub> increase. With the new Vostock CO<sub>2</sub> record showing a close correlation with climate over the last 160,000 years, and with steady improvements in our understanding of marine carbon isotope systematics, we have plenty of data to ponder. The problem seems to be a lack of focus on the need for a new generation of time-dependent models appropriate to geologic time scales. This is the problem WG 79 hopes to address.

Dr. Sundquist proposed two specific activities in his report to the Executive Committee:

(1) A symposium on "Palaeoceanographic implications of the Vostok CO<sub>2</sub> record" at the December 1988 AGU meeting in San Francisco. The Vostok data are certainly important enough to warrant such a focus (see enclosed preprints and News and Views article which will be published in Nature in early October). The meeting, which would naturally emphasize the very important time-dependent questions posed by the data, would be jointly sponsored and organized by SCOR WG's 79 and 81. Working group meetings held in conjunction with this symposium would assess progress toward completion of WG 79's new goals.

(2) A data-modelling workshop in approximately two years focusing on particular problems of time-dependent modelling appropriate to time scales of thousands to a few million years. Specific topics might include ocean mixing, organic carbon sedimentation, marine and terrestrial productivity, carbonate dissolution, and sea level change. Because the carbon cycle and climate system are so closely interactive, climate modelling topics (such as ice sheets and ocean heat fluxes) should be included in the workshop. We would propose that the climate modelling aspects of this effort might be sponsored by the Committee on Climate Changes in the Ocean. Proceedings of the workshop would be published in a special volume of an appropriate journal.

Finally, in accord with these new activities, the following additions to WG 79's terms of reference were proposed:

To plan and carry out a symposium on the palaeoceanographic implications of the Vostok ice core CO<sub>2</sub> record.

To plan and carry out a data-modelling workshop that will focus on the development of time-dependent carbon-cycle models appropriate to geologic time scales.

Further discussion of these proposals was deferred until consideration of the report of WG 81 (see below) since joint activities had been suggested by both Chairmen.

WG 80 The Role of Phase Transfer Processes in the Cycling of Trace Metals in Estuaries  
(with UNESCO)

The Executive Committee Reporter for WG 80, Professor Heath noted that the work of this group is still continuing by correspondence. All of the group members have been assigned a topic for review within the terms of reference provided and these reports were beginning to be sent to the Chairman. He was preparing an overview report on the basis of the information received. This interim report was expected to be available by the end of 1987. The Chairman, Dr. Whitfield requested a two or three day meeting at the Marine Biological Association in Plymouth in the spring or autumn of 1988 to discuss the written submissions and the overview report and to draft WG 80's final recommendations.

The Executive Committee approved this request.

WG 81 Deep-Water Palaeoceanography (with IOC)

The report submitted by the Chairman of WG 81 noted that while WG 81 has not met as a group since September 1986, members have been in contact and the exchange of data, samples and ideas between members in different countries has been gratifying.

Manuscripts arising from the WG 81-sponsored session at the Second International Palaeoceanography Conference in September 1986 came in slowly but a good group of manuscripts has emerged. These should appear together in the Journal of Palaeoceanography.

The scientific results of the past year's activities by the group were summarized as follows:

- 1) Deep-water temperatures. The temperature of the ocean deep water masses was about 1.5°C lower in glacial times than today. This conclusion has been established by three essentially independent means by members of the WG (Labeyrie, Duplessy and Blanc in Nature Vol. 327 pp 477-482; Chappell and Shackleton in Nature Vol. 324 pp 137-140; Shackleton in Quaternary Science Reviews Vol. 6 pp 183-190).
- 2) Organic carbon flux to deep water. The deep-waters must have received the impact of globally increased surface productivity in glacial times, as established by WG member Sarnthein (MS arising from WG 81 session in 1986).
- 3) Deep water dissolved oxygen concentration. In the East Pacific substantially increased accumulation of organic carbon in glacial-age sediments arose from higher productivity, deep water dissolved oxygen was not significantly less than today (MS by WG member Pedersen).
- 4) Radiocarbon age of ocean deep water. The radiocarbon age of ocean deep-water in glacial times was not less than, but probably more than today (unpublished data from WG members Shackleton and Duplessy, still in progress).

These conclusions did not appear to point to an immediate solution. Simple modelling efforts are in hand and it is to be expected that there will be considerable attention given to these results in the next year. However, it is apparent that the deep ocean has demonstrated its capacity for major change on glacial-interglacial time scales, as one would wish if the deep ocean has been responsible for the changes in atmospheric carbon dioxide concentration that have been observed in air bubbles from ice cores in particular in the 160,000 year long record recently published for the Vostok ice core.

Funds were requested for a WG meeting in association with an appropriate gathering where a session of talks on deep-water circulation and ventilation over the past glacial cycle can be given and a proper discussion period organized. This could probably very fruitfully be cosponsored by SCOR WG 79, since the results will certainly have bearing on atmospheric carbon dioxide levels. A suitable venue would be AGU in late 1988.

The Executive Committee then turned to consider the reports of WG 79 and WG 81 together. The meeting agreed that the interests of the two groups appeared to be converging now that the preliminary phases of their activities had been completed. It was concluded that the scientific objectives of the two WG's, as defined in their terms of reference, could be better achieved by constituting a new group which would combine the efforts of the existing WG's 79 and 81. It was noted, for example, that both groups had expressed an interest in the Vostok ice core CO<sub>2</sub> record and in modelling activities, and that a joint meeting had been proposed for 1988.

It was agreed that the Chairman of the two groups should consult one another and consider these suggestions. In particular, it was suggested that they might wish to initiate a project which would stimulate the development of time-dependent carbonate cycle models, appropriate to time scales of 10<sup>3</sup> to 10<sup>6</sup> years using data from the Vostok CO<sub>2</sub> record and from the oxygen and carbon isotope record in marine sediments. If a proposal for a new working group can be formulated with clearly defined terms of reference, it should be submitted to SCOR in time for consideration by the XIX General Meeting in 1988.

#### WG 82 Polar Deep-Sea Palaeoenvironments (with IOC)

The Executive Committee Reporter for WG 82, Professor Hsu, introduced the report from the working group which summarized its recent activities. The papers presented at the WG 82 session on the geology of polar seas at the Second International Palaeoceanography Conference have been submitted to Palaeoceanography for publication.

In December 1986, WG 82 together with CMG and ICL, organized a workshop on the feasibility of Arctic deep-sea drilling at the Bedford Institute of Oceanography. The main conclusion of this meeting was that deep-sea drilling is feasible in the high Arctic and is only constrained by questions of logistics and financing. The workshop report was summarized in Geotimes, and will be published in full by the Geological Survey of Canada. The Executive Committee agreed that the report of WG 82 did not state clearly enough what the group expected to achieve in relation to its terms of reference. Approval was given for a meeting of WG 82 to be held in conjunction with the JOA, however, it was expected that the group would use this opportunity to produce a work plan leading to the production of a final report in the foreseeable future.

#### WG 83 Wave Modelling (with IOC)

Professor Siedler, in his capacity as Executive Committee Reporter for WG 83, reviewed the report of the first meeting of the group (see Annex V) and more recent correspondence from the Chairman. He noted that while the first term of reference calls upon WG 83 to develop a third generation wave model, several other groups were already doing this and WG 83 might best be asked to monitor these activities rather than starting afresh. He also noted that the group had been charged to implement a global version of the

wave model and to test its usefulness for medium range forecasting.

The President of IAPSO, Professor O'Brien, noted that the development of remote sensing has stimulated a rapid growth of activities in the field of wave modelling. He felt, however, that WG 83 has special expertise to address problems of medium range forecasting and that the group should focus on this aspect of its charge.

It was agreed that WG 83 should be asked to provide SCOR with a brief report on the present status of activities in surface wave research. This document should clarify the relationships between the various groups currently active in this field. It should focus on the topic of medium-range forecasting and should establish a plan of work for WG 83 which leads to some final product.

The Executive Committee approved several changes in the membership of WG 83 which had been requested by the Chairman, Dr. Komen, following the group's first meeting in May 1987. Dr. Yuan Yeli (China) and Dr. V. Zakharov (USSR) will be invited to join the group and several individuals will become Corresponding Members. The Executive Committee gave approval for a meeting of WG 83 in March 1988 in conjunction with a meeting of the European WAM (Wave Modelling) group. It did not agree with Dr. Komen's suggestion that WG 83 serve as a steering group for the larger WAM group since this would involve a long-term commitment which was not felt to be appropriate for a SCOR working group.

The representative of WMO reported that his organization was especially interested in WG 83 in view of the existence of a WMO group on wave modelling. This group has a primarily operational role, however, and Dr. Dexter expressed the hope that the SCOR group would be oriented to questions of physics and the assimilation of data into wave models.

#### WG 84 Hydrothermal Emanations at Plate Boundaries (with IOC)

A report from the Chairman of WG 84, Professor E. Suess, recalled that the group had been established after the XVIII General Meeting in late 1986 and that the following individuals had accepted invitations to join the group:

E. Suess	Chairman	U.S.A.
J. Boulegue		France
E.E. Davis		Canada
J.R. Delaney		U.S.A.
H.W. Jannasch		U.S.A.
C.I. Measures		U.S.A.
R.O. Hallberg		Sweden
H. Sakai		Japan

It was agreed by the Executive Committee that Working Group 84 will meet at the Joint Oceanographic Assembly in Acapulco/Mexico, 30 August, 1988 following the General Session G3 on 29 August "Hydrothermal Processes". The scientific content of this session should provide a basis for the work of WG 84. The Chairman is co-convenor of the JOA General Session on hydrothermal processes. Coordination between WG 84 and this JOA session is envisioned.

The focus of WG 84 is thermally and tectonically-induced fluid circulation and mass transport. Plate boundaries as well as tectonically inactive settings are the sites where significant, recent scientific advances are being made. Mid-ocean ridge crests and flanks, accretionary complexes, back- and fore-arcs, and passive margins are the specific settings for fluid venting. It was hoped that WG 84 would use the opportunity of its first meeting to clarify its goals and to define the form of its final product.

#### WG 85 Experimental Ecosystems (with UNESCO)

The Executive Committee was informed that since the Chairman and Vice-Chairman of WG 85 had expressed a strong desire to include Professor Lasserre in the membership of their group, his responsibilities as Executive Committee Reporter for WG 85 had been assumed by Professor Fournier. Professor Fournier advised the Executive Committee that WG 85 appeared to have made a good approach to its task by beginning to work in correspondence. In particular, he noted that the group had formulated a set of assignments for its first meeting which would satisfy the first term of reference of WG 85 which calls for a state-of-the-art review of the use of experimental ecosystems. Accordingly, the Executive Committee approved the plans for a first meeting of WG 85 in Hamburg in mid-1988. This meeting will include presentations on the following topics:

- Classification of different types of ecosystem experiments.
- Scientific results from pelagic mesocosms.
- Scientific results from benthic mesocosms.
- Specific application of mesocosms for solving problems in fisheries research.
- Specific application of mesocosms for solving problems in pollution research.
- Computer models of mesocosm ecology.
- Microcosm research.
- Macrocosm research.
- Statistical considerations of mesocosm research.

It was felt that this meeting would be most useful in providing the basis for WG 85's activities and the importance of WG 85 for other activities such as JGOFS, IGBP and GIPME was noted. The group will be urged to make its results available to these organizations.

The following individuals have agreed to serve as members of WG 85 since its establishment was approved at the last general meeting of SCOR:

Li Guanguo	Chairman	China
T.R. Parsons	Vice-Chairman	Canada
P. de Wilde		Netherlands
U. Brockmann		FRG
M. Takahashi		Japan
V. Oiestad		Norway
J. Gamble		UK
S. Nixon		USA
P. Lasserre		France
T. Bakke		Norway
S. Schulz	Corresponding Member	GDR

#### WG 86 Sea Ice Ecology (with SCAR, AOSB and IOC)

The decision to establish WG 86 was taken at the XVIII General Meeting of SCOR in late 1986, however, it had been agreed that the original membership proposal should be revised in consultation with the Chairman of the Arctic Ocean Sciences Board and with SCAR, as a cosponsor of the group. This had taken longer than expected, however, Professor Siedler was able to report that Professor C. Sullivan (USA) had agreed to chair the working group and that a revised membership list had been submitted to him for consideration. Accordingly, invitations were about to be issued to the following individuals:

C.W. Sullivan	Chairman	USA
S. Ackley		USA
G. Dieckmann		FRG
B. Gulliksen		Norway
B. Horner		USA
T. Hoshiai		Japan
L. Legendre		Canada
M. Spindler		FRG
nominee expected		USSR

WG 87 Fine-scale Distribution of Gelatinous Planktonic Animals (with UNESCO)

Professor Stromberg informed the meeting that WG 87 had been established as recommended by the General Meeting in 1986, and that the following individuals had accepted invitations to join the group:

G.R. Harbison	Chairman	USA
M. Spindler		FRG
P. Laval		France
M. Omori		Japan
A. Alldredge		USA
W. Hamner		USA
N.E. Swanberg		Norway
P.R. Pugh		UK
L.P. Madin		USA

A very brief report had been received from the Chairman of WG 87, Dr. Harbison, in which he proposed that the group should not hold its first meeting until 1989 due to commitments of several members to field work. This proposal was of some concern to the Executive Committee, and to the Director of the Marine Sciences Division of UNESCO, Dr. Krause, who noted the special relevance of this group to the activities of the Division.

The Executive Committee agreed that WG 87 should be urged to begin its work in correspondence in 1988 and that the Chairman should provide a more detailed report to the XIX General Meeting in Acapulco. This report should include a description of the approach to be taken by WG 87 in addressing its terms of reference.

WG 88 Intercalibration of Drifting Buoys (with IOC)

At the XVIII General Meeting, it was agreed that WG 66 (Oceanographic Applications of Drifting Buoys) should be reconstituted so as to address problems related to the use of data acquired from different types of drifting buoys. WG 88 was established with the following members (some of whom had served on WG 66:

D. Hansen	Chairman	USA
G. Cresswell		Australia
R. Kase		FRG
C. Stavropoulos		South Africa
R.E. Davis		USA
P. Niiler		USA
G. Reverdin		France
H. Nishida		Japan
W. Krauss		FRG

WG 88 held its first meeting in Vancouver in conjunction with the IUGG Assembly in August 1987. A report of this meeting is given in Annex VI. Professor O'Brien, the

Executive Committee Reporter for WG 88, was of the opinion that WG 88 had made significant progress at this meeting. The request by the Chairman of WG 88 for a second meeting in 1988 was not supported, however, unless more information on an agenda, location, etc. could be provided.

The representative of the IOC, Dr. Kullenberg, reiterated the interest of IOC and WMO in this working group, in view of the recent establishment of the IOC/WMO Drifting Buoy Cooperation Panel. Dr. Dexter of WMO felt that some of the questions raised in the report of WG 88, especially in reference to the activities of drifting buoy data centers and to their documentation, ought to be referred to the intergovernmental Panel. He noted that the anticipated publication of a drifting buoy newsletter by the Panel will be of interest to WG 88.

### 3.3 Committees and Panels

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

Professor Siedler introduced the report of CCCO which is given in full in Annex VII. He noted in particular, the election of Dr. A. McEwan (Australia) to replace Dr. R. Stewart (Canada) as Chairman, the departure of the CCCO Secretary, Mr. B. Thompson, and the appointment of his replacement, Mr. R. Godin. It was expected that Mr. Godin would take up his duties in December 1987. The Acting Secretary, Mr. A. Alexiou, presented the CCCO report, focusing on the decisions arising from the eighth session of CCCO which had taken place in Kiel in May 1987.

A review of the study of the Tropical Ocean and Global Atmosphere (TOGA), following more than two years of implementation, was a major agenda item at the CCCO session. The Committee concluded that TOGA was progressing well and that the programme has been a "remarkable achievement". In particular, the reported assimilation of TOGA data into models for use in testing hypotheses, modifying the observational programme design and verifying predictive models was noted as a major success of TOGA. The TOGA SSG, at its sixth session in August 1987, reported that observing systems in the Atlantic and Pacific Oceans have been improved substantially, but that serious concerns remained about observation programmes and the availability of data for the Indian Ocean region.

The Scientific Steering Group for the World Ocean Circulation Experiment (WOCE) met in May, 1987. The working groups for each of the three WOCE Core Projects (1- the Global Description; 2- the Southern Ocean; and 3- the Gyre Dynamics Experiment) reported to the SSG. Planning for the first two of these CORE Projects is well advanced with major elements having been defined. The focus of The Gyre Dynamics Experiment is evolving from an emphasis on the North Atlantic Ocean as a test basin, to include a deep circulation experiment in the Brazil basin. These plans for Core Project 3 will be further developed at a working group meeting in early 1988.

The WOCE SSG will concentrate its efforts in late 1987 to mid-1988 on the preparation of the Implementation Plan for WOCE. This document will complement the Scientific Plan for WOCE and will be presented to the International WOCE Scientific Conference in late 1988 (November 28 - December 2). This Conference, which will be cosponsored by IOC, SCOR, WMO and ICSU is intended as a forum for the formal presentation of the plans for WOCE, the identification of ways in which countries can contribute to WOCE, and the encouragement of national commitments of resources to WOCE.

Mr. Alexiou also reported that plans for an oceanic CO<sub>2</sub> programme had been prepared by CCCO's CO<sub>2</sub> Advisory Panel and that a Panel report to be published by CCCO would include details. The plans for this programme call for an inventory of present levels of dissolved organic carbon in the ocean, studies of the fluxes of CO<sub>2</sub> at the sea surface including their seasonal and interannual variability, measurements of carbon fluxes through the

water column to the sediments, estimates of productivity and the rates of disappearance of phytoplankton obtained by satellite measurements of ocean colour. At its meeting, CCCO took note of the emerging plans for JGOFS (see item 3.5) and agreed that its CO<sub>2</sub> programme would be incorporated as an integral part of JGOFS. The programme will be developed in close cooperation with WOCE, whose planners have agreed to make space available for CO<sub>2</sub> work on WOCE research vessels.

Both the Acting Secretary of CCCO and the representative of WMO discussed the initiation of a joint CCCO/WCRP effort to improve the quality of the data sets from Voluntary Observing Ships, beginning with a pilot study in the North Atlantic. This was encouraged by Professor O'Brien and other members of the Executive Committee as a necessary step to complement satellite and other types of data sets for the WCRP and CCCO.

The President of SCOR noted that CCCO was moving quickly into a different stage of its activities, the actual realization of the scientific plans developed since its establishment in 1979. He expressed his strong support as Executive Committee Reporter for CCCO for the programme as described in the CCCO report and presentation by Mr. Alexiou.

The Secretary of IOC, Dr. Ruivo, informed the meeting of IOC's similar view of the CCCO programme, but did note some concerns. In particular, he had strong reservations about a proposal for a management structure for the WOCE Hydrographic Programme which had been considered by CCCO. It was agreed, that while this proposal and alternatives are still in preliminary stages of development, it will be necessary to consider the relationships with intergovernmental organizations at all stages of the process. Professor Siedler reiterated the need for frequent consultations between SCOR and IOC as cosponsors of CCCO.

He noted that a meeting of the Officers of SCOR and representatives of IOC had taken place just prior to the Executive Committee meeting (see also item 4.1). It was agreed to carry out a review of CCCO structures and procedures within six months of the arrival of the new CCCO Secretary. The Memorandum of Understanding on CCCO signed by SCOR and IOC in early 1984 would be due for review by the signatories in early 1988.

In summarizing the discussion on CCCO, the President of SCOR, speaking on behalf of the full Executive Committee, gave SCOR's approval to the report of CCCO.

#### UNESCO/SCOR/ICES/IAPSO Joint Panel on Oceanographic Tables and Standards

The report from Dr. J. Gieskes, Chairman of JPOTS provided information on several recent activities of the Panel. They included the publication of Table 4 of the Oceanographic Tables by UNESCO as number 44 in the UNESCO Technical Papers in Marine Science. In addition, the final report of the JPOTS sub-panel on CO<sub>2</sub> will be published in the same series in early 1988 under the title "Thermodynamics of the Carbon Dioxide System in Seawater". As noted elsewhere, a new JPOTS sub-panel on standards and reference materials for CO<sub>2</sub> measurements met during the IUGG Assembly in Vancouver. Finally, the JPOTS Editorial Panel on the Oceanographic Manual was expected to meet in Copenhagen in October 1987. A report from the Chairman of the Editorial Panel is given in Annex VIII. It was expected that this methodological manual on the processing of oceanographic data would be completed following a final meeting of the editorial panel in 1988.

The JPOTS report urged the sponsoring agencies to press for the use of SI units (UNESCO Technical Papers in Marine Science, No. 45) in Oceanography. After acceptance of the recommendation concerning the use of SI many oceanographers still persist in using old units, rather than SI units. The Joint Panel suggested that the following statement by SCOR and the other sponsoring agencies be published by various scientific journals in the field of marine science.



"In order to try to harmonize the vocabulary employed in oceanography to the one in use at the international level, the International Association for the Physical Sciences of the Ocean (IAPSO) decided to constitute a Working Group whose mission was to prepare and facilitate the introduction in oceanography of the International System of Units (SI). The recommendations of this Working Group have been adopted by the 18th General Assembly of the IAPSO in 1983 and published in July 1985 (UNESCO, 1985) to be effective from 1 January 1986.

This publication includes an explanation of the international rules for the implementation of the physical Quantities, Units and Symbols, indicating the main points of the International System of Units, as well as specific recommendations in the domain of the Physical Sciences of the Ocean. In addition this publication contains a number of tables dedicated to the most used quantities (fundamental quantities of sea water, physical properties of pure and sea water, dynamical oceanography, optical oceanography, marine geophysics, marine geochemistry, chemical oceanography). In each of these tables are given the principal quantities used with their symbol(s), a brief definition if necessary, the corresponding unit in the International System of Units, and its symbol. Finally, two tables give the conversion factors between certain earlier units and the corresponding units in the International System of Units.

We request all oceanographers to take into consideration the use of the SI in their work and to express the quantities they use with the corresponding units of the SI, and we urge the editors to ensure that scientific papers submitted to them are in conformity with the decision of the IAPSO".

Professor O'Brien offered to assist with the dissemination of this statement to appropriate journals.

In considering the JPOTS report, some participants were concerned about the apparent lack of vitality of the Panel itself. It was recognized that in recent years, SCOR had not identified new and challenging scientific tasks for the Panel. It was hoped that the establishment of the Joint Global Ocean Flux Study might stimulate new problems for the attention of JPOTS. Professor O'Brien and Dr. Brewer agreed to discuss this in more detail and to report to the XIX General Meeting in Acapulco.

#### Editorial Panel on the Ocean Modelling Newsletter

At the time of the Executive Committee meeting, seventy-four issues of the Ocean Modelling Newsletter had been published. A request for renewal of funding from the U.S. Office of Naval Research had been submitted although the results of this application were not yet known.

### 3.4 Proposals for New Working Groups

#### Methodologies Available for the Development of Biological Oceanographic Probes

This proposal was received from the Australian Committee for SCOR and had been circulated to all SCOR committees for comments before the Executive Committee Meeting. The proposal suggested that such a group could foster the development of systems and probes to obtain rapid measurements of biological activities in the ocean on similar time and space scales as can be achieved by physical oceanographic instruments such as CTD's. The comments received by SCOR were all supportive of the proposal. The Executive Committee was informed, however, that the initiator of the proposal, Dr. D. Smith had recently died. It was agreed to identify a replacement for him as likely Chairman of the proposed group and

to reconsider the matter in more detail at the 1988 General Meeting. In the meantime, the terms of reference proposed for the group should be refined in order to focus on the most promising technology which could benefit from the activity of an international group such as the one proposed.

#### Neo-Abiogenesis and Origin of Life in Hydrothermal Systems

Dr. N.G. Holm presented this proposal which had been submitted to SCOR by the Swedish Committee. He reviewed the scientific rationale for his proposal describing hydrothermal cells as dynamic systems in which strong gradients of temperature and pH may cause the polymerization of organic monomers into large molecules. The terms of reference suggested for the group called for the determination of the constituents required for neo-abiogenesis, the identification of observed and postulated organic monomers and polymers in hydrothermal systems, the differentiation of abiogenic and biogenic substances, the evaluation of the role of inorganic catalysts in the synthesis of organic compounds, the selection of suitable sampling sites and the development of sampling and analytical techniques.

The discussion which followed Dr. Holm's presentation raised a number of questions as to whether this proposal might be premature in view of the state of knowledge of hydrothermal systems, and whether the tasks were appropriate for a SCOR group since many of them were chemical rather than oceanographic. It was agreed that the proposal ought to be forwarded to IUPAC for consideration as a possible cosponsor, and that it could be revised, taking into account the comments of the Executive Committee, for a discussion at the XIX General Meeting.

#### Sea Level and Erosion of the World's Coastlines

Professor Heath reviewed this proposal which was originally discussed by the XVIII General Meeting in late 1986. He noted that the revised proposal responded adequately to the concerns expressed in Hobart and that it now focused on the question of the effects of sea level rise on the adjustment of beach profiles.

The establishment of this group (WG 89) was approved by the Executive Committee with the following terms of reference:

To evaluate the state of our knowledge of sea level rise and the potential impact on the coastline.

Examine the status of the existing models and formulate a programme of investigations for their verification or rejection.

To evaluate the role of short and long term sea level rises in beach erosion.

To recommend the best strategy for a monitoring programme in areas with lack of data.

To produce a report for SCOR which addresses these questions.

The Executive Committee agreed to invite Drs. P. Komar (USA) and N. Lanfredi (Argentina) to act as Chairman and Vice-Chairman of WG 89. Professor Heath agreed to assist Dr. Komar in determining the final membership for the WG since the proposed list did not include an adequate international representation. The representatives of IOC and UNESCO both expressed the interests of their organizations in cosponsoring WG 89. WG 89 will be urged to collaborate, as appropriate, with the SCOPE project on estuaries and

coastal embayments. Finally, Dr. Van der Land of the Netherlands SCOR Committee urged the group to stress problems of erosion since these are critically important for many developing countries.

#### Monitoring of the Ocean Chemical System for Climate

The Chairman of WG 75, in his report to the Executive Committee included a proposal for a new working group on the above topic which would develop and execute a strategy for monitoring changes in the oceanic chemical systems relevant to climate. It was agreed that this proposal would be referred to JGOFS (see item 3.5) for consideration in relation to the plans of several bodies (CCCO, JSC, IGBP etc.) for studies of greenhouse gases and CO<sub>2</sub> in particular.

#### **3.5 Proposal for a New SCOR Committee for the Joint Global Ocean Flux Study**

The President of SCOR reviewed the events which had led to the proposal that SCOR should sponsor the Joint Global Ocean Flux Study and that a SCOR Committee should be established to conduct the scientific planning for JGOFS. Dr. Peter Brewer, Chairman of the U.S. GOFS gave a presentation of the scientific rationale for JGOFS.

In February 1987, an international meeting was convened by the Scientific Committee on Oceanic Research (SCOR) which brought together scientists from a number of countries who are active in studies of major biogeochemical studies in order to discuss current and planned national and international research programmes in this field.

That meeting heard presentations about a number of existing programmes of ocean flux studies (USA, FRG, UK, France, Japan) and about relevant activities in other countries such as Canada, China and The Netherlands. It became clear that while these national programmes have different specific emphases (the European studies focus more strongly on coastal zones, for example), there are many common goals and elements to be found among them. The unanimous decision was taken that there should be an internationally coordinated Joint Global Ocean Flux Study whose goal was stated as follows:

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, the sea floor and continental boundaries.

The suggestion that this first international planning meeting be organized by SCOR was made by the Chairman of the IOC Working Committee on the Global Investigation of Pollution in the Marine Environment (GIPME), the Chairman of the Executive Committee of the U.S. Global Ocean Flux Study and the SCOR/IOC Committee on Climatic Changes and the Ocean (CCCO). This proposal was approved by the XVIII General Meeting of SCOR. In particular, the February meeting was asked to consider whether it would be appropriate to establish and develop an international coordinated programme of ocean flux studies which would provide a framework for cooperation between existing national programmes in the field of flux studies and with related international experiments such as the World Ocean Circulation Experiment (WOCE), the International Global Atmospheric Chemistry Programme (IGAC) and the International Geosphere-Biosphere Programme of ICSU.

As noted above, this International Scientific Planning and Coordination Meeting for Global Ocean Flux Studies was organized by SCOR and took place at the Headquarters of the International Council of Scientific Unions (ICSU) in Paris from 17 to 19 February, 1987. The report of this meeting was published and widely distributed by SCOR. The meeting recommended to SCOR that JGOFS be established with the primary goal stated above, and that SCOR should take the lead in the scientific planning and organizational aspects required for JGOFS.

In addition, the participants in the planning meeting considered that it should be a long-term goal of JGOFS to:

Establish strategies for observing, on long time scales, changes in ocean biogeochemical cycles in relation to climate change.

Some basic elements for JGOFS were established and it was agreed that a global oceanic CO<sub>2</sub> project which had been considered in the context of WOCE, should be planned and carried out instead by JGOFS in close association with WOCE. A statement was issued and sent to various satellite agencies stressing the importance of satellite ocean colour measurements for JGOFS.

In considering how JGOFS could best be planned and organized, it was agreed to propose that a Scientific Planning Committee be established under the auspices of SCOR. The meeting suggested that SCOR consider the following terms of reference for this committee:

To identify the fundamental scientific issues and detailed goals and objectives for an international Joint Global Ocean Flux Study.

To develop a scientific plan and to establish requirements for carrying it out.

To recommend the necessary actions to be taken to implement the plan and coordinate and manage the resulting activities.

To collaborate, as appropriate, with other related programmes and planning activities.

To report regularly to SCOR and related bodies on the state of planning and accomplishments of JGOFS.

The participants in the February 1987 planning meeting also wished to take advantage of the enthusiasm and momentum generated by their discussions. It was recognized that the North Atlantic is the best studied of the ocean basins and that this ocean is a priori the best possible place to develop process studies and document the variability of the carbon system. It was also recognized that several countries were already planning programmes in this basin. It was, therefore, decided to convene a workshop in order to consider the feasibility of coordinating these programmes in a scientifically beneficial manner. The offer of France to host this workshop in Paris was accepted.

Dr. Whitfield (UK) chaired the workshop in September 1987. The specific topics to be addressed by the workshop included:

Detailed information on national ship tracks, mooring plans and scientific programmes.

Advantages and disadvantages of combined national efforts.

Satellite data variability and interpretation.

Modelling, theory and data management.

Upper ocean programmes (water column studies).

Benthic flux studies.

It was expected that this workshop would provide an international perspective for the scheduling of individual national programmes of ocean flux studies in the North Atlantic and for an assessment of the proposed scientific objectives and geographical coverage of these programmes. Taking into account the goals for JGOFS as stated at the first international planning meeting, the workshop was also expected to see to what extent it

will be feasible and beneficial to coordinate national efforts in an international study of ocean fluxes in the North Atlantic Ocean.

Readers are referred to the reports of the February 1987 meeting and the North Atlantic Workshop for more detailed background information on JGOFS. Both have been published by SCOR and are available from the Executive Secretary.

In discussing the proposal that SCOR should establish a committee for JGOFS, the representative of IOC noted that an informal consultation had taken place in Paris involving representatives of IOC, GIPME and SCOR and of the JGOFS North Atlantic Planning Workshop. The suggestion of the first JGOFS planning meeting, that the necessary liaison with IOC should be provided through GIPME was reconfirmed. In particular, a technical expert should participate as an observer in all JGOFS activities.

The Executive Committee agreed that SCOR should sponsor JGOFS and should take the lead in its planning and execution. After some discussion, it was agreed that the time-scale and the scope of topics to be addressed within JGOFS are too broad to be covered by a traditional SCOR working group which would necessarily be confined to a narrow task and a limited life span. It was agreed that the planning for JGOFS required the establishment of a new SCOR Committee, similar in some ways, but not all to CCCO. Such a Committee would be able to establish sub-groups for specialized tasks, should consider the establishment of its own secretariat when necessary, and should have a rotational membership plan. A roster of fifteen members was approved; it was felt that this was the minimum size to ensure adequate representation of the scientific disciplines relevant to JGOFS and of the countries with established programmes of flux studies. The terms of reference as given above were approved by the Executive Committee. Finally, the meeting agreed that these decisions should be ratified by the XIX General Meeting of SCOR in 1988 and that the Committee for JGOFS should be subject to the usual biennial review process provided for in the SCOR Constitution, beginning in 1990.

Following the Executive Committee meeting, the membership of the Committee for JGOFS was finalized by the President in consultation with the SCOR Officers, as follows:

Chairman:	B. Zeitzschel	FRG
Vice-Chairman:	P. Brewer	USA
	H. de Baar	Netherlands
	O. Brown	USA
	S. Calvert	Canada
	K.L. Denman	Canada
	J.C. Duplessy	France
	H. Elderfield	UK
	R. Eppley	USA
	M. Fasham	UK
	I. Koike	Japan
	K. Kremling	FRG
	J.F. Minster	France
	T. Platt	Canada
	D. Hu	China
	(to be nominated)	USSR

For each meeting of the JGOFS Committee, an IOC/GIPME representative will be invited to ensure the liaison referred to above.

As a result of changes in the membership of the Executive Committee, it was necessary to reassign various responsibilities for the Executive Committee Reporters as follows:

Professor G. Siedler	WG 69, CCCO
Dr. K.N. Fedorov	WG 77, 83
Professor R.O. Fournier	WG 78, 85, 86
Dr. R. Chesselet	WG 71, 72, 75
Professor J.-O. Stromberg	WG 76, 87
Professor G.R. Heath	WG 80, 81, 84, JGOFS
Professor K. Hsu	WG 79, 82
Professor J. O'Brien	WG 88, 89, JPOTS

#### 4.0 RELATIONSHIPS WITH INTERGOVERNMENTAL ORGANIZATIONS

##### 4.1 Intergovernmental Oceanographic Commission

The President of SCOR, Professor Siedler reported on a half-day meeting between representatives of SCOR and IOC which had taken place in Zurich just before the Executive Committee meeting. The purpose of this meeting was to discuss both general and specific aspects of the relationship between SCOR and IOC. All participants agreed that the consultation had been useful and that such meetings ought to be held at regular intervals possibly annually. The main conclusions of this first meeting were that the IOC continues to look to SCOR as the most appropriate organization for scientific advice; SCOR expects the IOC to assist with communication and interaction at the intergovernmental level which may be required for the success of international experiments; that both organizations are interested in the promotion and development of marine science and that the responsibilities and roles of both organizations should be carefully defined in relation to the planning and implementation of large-scale international marine science programmes. More specific issues which were discussed included the JOA, CCCO, the WOCE International Scientific Conference and so on. Information on these items is provided elsewhere in this report.

In reviewing the resolutions of the fourteenth IOC Assembly which referred to SCOR, the Secretary of IOC agreed with the Executive Committee that Resolution XIV-2 required clarification before SCOR could respond. It "Invites SCOR to address problems of intercalibration, standardization and data formats for new ocean-observing technology as a matter of urgency". The final report of former SCOR WG 70 and the current activities of WG's 77 and 88 on intercalibration may be useful, but it was not clear what was expected by IOC.

Since the XVIII General Meeting SCOR had been represented at the meetings of a number of IOC subsidiary bodies including the Regional Committee for the Southern Ocean, the Guiding Group of Experts on Ocean Science in relation to Living Resources, the Guiding Committee for GEBCO and the Guiding Group of Experts on the Programme of Ocean Science in Relation to Non-Living Resources. The reports of the SCOR representatives to these meetings were reviewed briefly. The OSLR group expected to call upon SCOR for assistance in organizing a group to consider problems of the statistical analysis of time series data for recruitment studies. Plans of the IOCSOC committee for several research projects were noted. Action on the recommendations of those groups would be taken by the IOC Executive Council in March 1988.

##### 4.2 UNESCO Division of Marine Sciences

The Director of the Division of Marine Sciences of UNESCO, Dr. Dale Krause presented the report of his organization. Many items such as publications and the activities of SCOR subsidiary bodies had been covered earlier in the agenda before the Executive Committee.

Dr. Krause made special mention of the work of two joint SCOR/UNESCO bodies, the JPOTS Editorial Panel for the Oceanographic Manual and the Consultative Panel on Coastal Systems. The Consultative Panel met in late 1986 and recommended among other things, a close collaboration between the Division's COMAR Programme and SCOR WG 85 on Experimental Ecosystems.

#### 4.3 World Meteorological Organization

Mr. P. Dexter of WMO presented a brief report on the activities of his organization which relate to those of SCOR. The Tenth Congress of WMO gave continuing strong support to those oceanographic activities taking place within the WCRP, the Marine Meteorology Programme and the Integrated Global Ocean Services Programme. The WMO/IOC Drifting Buoy Cooperation Panel is now well established and the full time technical coordinator for the panel took up his appointment at CLS/Service Argos in Toulouse on 1 June 1987. His main immediate tasks include the monitoring of the flow and quality of buoy data on the GTS and the preparation of proposals for real-time quality control of such data, investigation of solutions to problems of LUT usage, establishment of a network of contacts with national and international buoy programmes, collection and distribution of information on buoy programmes, preparation of proposals for coordination of buoy deployments. The technical coordinator will also make early contact with the chairman of SCOR WG 88, to ensure mutual coordination, collaboration and assistance between the working group and the DBCP, where appropriate.

A two day technical conference on ocean waves is to be held in conjunction with the tenth session of the WMO Commission for Marine Meteorology scheduled for Paris in February 1989. The conference will be composed essentially of invited papers, with the core being provided by members of the WMO ad hoc Group of Rapporteurs on Numerical Wave Modelling, a number of whom are also members of SCOR WG 83. The conference will be open to all and a conference brochure will be prepared and distributed shortly.

### 5.0 RELATIONS WITH NON-GOVERNMENTAL ORGANIZATIONS

#### 5.1 Affiliated Organizations

##### Commission for Marine Geology

The Chairman of CMG, Professor Hsu presented a report in which the activities of CMG officers in a number of international activities were emphasized. These included participation in planning for JOA, the International Geological Congress and the Ocean Drilling Programme among others. He noted with regret that it had proved impossible to organize a third international workshop on the marine geosciences, however, he and the Secretary of CMG are involved in the organization of a Dahlem Conference on "Marine Geosciences and Human Use of the Global Sea Floor" in 1989 in Berlin. It is hoped that this meeting will bring together an interdisciplinary group of scientists who will identify the areas of most intense human influence on the sea floor and who can participate in the preparation of scientific guidelines for its protection. He requested the assistance of SCOR in identifying participants for this conference.

##### International Association for Biological Oceanography

Professor Lasserre noted that IABO is involved in planning for JOA and that the IABO Secretary, Professor McIntyre, is a member of the Scientific Programme Committee. He reported on the activities of two relevant IABO working groups. The first on High Diversity Marine Ecosystems has examined basic concepts of diversity and has planned field observations and experiments on this topic. The second, on Traditional Knowledge and Management of Coastal Systems has had several successful meetings and the proceedings of

its symposium have been published by UNESCO. IABO has been engaged in a reassessment of its general organization. This will be a major topic for discussion at the next General Assembly of IABO which will take place during JOA.

#### International Association for Meteorology and Atmospheric Physics

The next IAMAP Scientific Assembly will take place in Reading, (UK) in August 1989. IAHS and IAPSO have agreed to cosponsor relevant symposia. Major symposia will include global energy and water fluxes (IAHS and IAPSO), and atmospheric trace constituents and climate (some interest of IAHS and IAPSO). Specialized symposia will include boundary layer parameterization and larger-scale models (some interest to IAPSO), influence of polar regions on climate (possible IAPSO interest). There may also be a workshop on global data sets (for Global Change). It was agreed that SCOR should indicate its interest in cosponsoring appropriate sessions at the Reading Assembly.

The report from IAMAP noted that IAMAP is already underway on planning for the International Global Atmospheric Chemistry Programme (IGAC) and is maintaining appropriate liaison with SCOR Working Group 72. The IAMAP Commission on Atmospheric Chemistry and Global Pollution discussed IGAC further at its post-IUGG conference at Peterborough, Canada, and plans a major workshop in Melbourne, Australia in early 1988. It was agreed that IGAC is especially important in view of plans for JGOFs.

At XIX IUGG Vancouver, IUGG took actions to start quick-response planning of possible IUGG contributions to IGBP, some direct IUGG activities, some more appropriate to collaboration with ICSU special committee for Geosphere-Biosphere (SCGB). Projects under discussion include present and possible future changes in sea level highlighting ice and climate interactions; Magma-water interactions; palaeo environmental evolution of oceans and atmosphere; hydrological and nutrient pathways and biological responses.

#### International Association for the Physical Sciences of the Ocean

Professor O'Brien, the newly-elected President of IAPSO, reported on the Association's most recent meeting which took place during the IUGG Assembly in Vancouver in August 1987. In addition to his own election, Dr. R. Stevenson (USA) was elected Secretary-General of IAPSO. Professor O'Brien informed SCOR that this meeting initiated major changes in the goals and directions for IAPSO. The existing IAPSO Commissions had been terminated and a general re-structuring of the Association was under consideration. He also informed the meeting of IAPSO's interest in cosponsoring appropriate SCOR working groups. This possibility will be investigated further as such groups are established.

### 5.2 Corresponding Organizations

#### Engineering Committee on Oceanic Resources

A written report from the Executive Secretary of ECOR noted increased collaboration between ECOR and IOC. Specific involvement included (i) preparation of a report entitled "New Sources of Ocean Energy that would benefit from International Cooperation" (ii) provision of the names and institutions of specialists in the field of ocean engineering and technology for use as a case study in regard to updating and expanding the ASFIS (Aquatic Sciences and Fisheries Information System) register of marine scientists and institutions. (ii) providing background information for, and participating in, the Guiding Group of Experts on the programme of Ocean Science in relation to Non-Living Resources, providing advice on related aspects of Ocean technology. At the IOC Assembly in March 1987 the President of ECOR, Professor Ascensio Lara, presented a lecture entitled "Beneficial Symbiosis Oceanography and Ocean Engineering; New and Promising Horizons".



ECOR has three international working groups currently in operation, studying:

- (i) Ocean Engineering Education and Training, coordinated by Canadian ECOR
- (ii) Ocean Energy Systems, coordinated by Japanese ECOR
- (iii) Reliability Methods for Design and Operation of Offshore Installations, coordinated by Dutch ECOR.

A fourth working group was recently initiated studying Engineering Aspects of Marine Pollution to be coordinated by German ECOR.

The Sixth General Assembly of ECOR was to take place in London in October 1987. It was anticipated that the continuing support and enthusiasm of the members, together with a consolidation of the administration will ensure a constructive and successful future for the organization.

### 5.3 International Council of Scientific Unions

The Executive Secretary reviewed the decision of the ICSU General Assembly (Berne, September 1986) at which the formal decision was taken to launch the International Geosphere-Biosphere Programme - A study of Global Change. This programme had been the topic of discussions at several meetings of SCOR. Following the XVIII General Meeting, SCOR had responded to ICSU's request by submitting nominations for a Special Committee for the Geosphere-Biosphere (SCGB) which would be responsible for planning the IGBP. This Special Committee was established in early 1987 and held its first meeting in July. A report from SCOR for this meeting informed the SCGB of early plans for JGOFS and of the activities of CCCO and a number of working groups relevant to IGBP. The SCGB appointed four Coordinating Panels to develop objectives and plans for the core programme of IGBP. In particular, the panel on Marine Biosphere-Atmosphere Interactions will be of interest to SCOR. It noted that "the global aspects of marine ecosystems of primary concern to the IGBP are the interplay between physical, chemical and biological processes in the euphotic zone, the photo synthetically active upper layer of the ocean". The development of a research plan by this Panel will take into account SCOR's plans for JGOFS. In addition to the four Coordinating Panels, the SCGB established four Working Groups to address specific technical questions such as modelling, data management, the establishment of geo-biosphere observatories and techniques for analysis of the historical record of global change as found in ice cores, tree rings etc. The Chairman of IGBP is Professor J. McCarthy (USA) and the Executive Director, who has established a Secretariat at the Royal Swedish Academy of Sciences, is Professor T. Rosswall.

The Executive Committee was pleased to note that good communications had already been established between the IGBP and SCOR Secretariats and that two members of the SCGB would be invited to serve as Corresponding Members of the JGOFS Committee. It was agreed that it was especially important to establish close liaison between the JGOFS and IGBP programmes.

Notice has been received that the next General Assembly of ICSU would take place in Beijing in September 1988.

### 5.4 ICSU Unions and Committees

A number of ICSU bodies had provided written reports for the Executive Committee meeting. Items of particular importance to SCOR were drawn to the attention of the participants by the Executive Secretary.

#### Committee on Space Research

Following the instructions of the XVIII General Meeting, the Executive Secretary informed COSPAR of SCOR's interest in cosponsoring three scientific symposia at the COSPAR

Plenary Meetings which will take place in Espoo, Finland in July 1988. Accordingly, SCOR will assist with the organization of a symposium on "The Contributions of Space Observations to the WCRP and IGBP" through the participation of Dr. J. Gower (Canada). In addition, Topical Meetings on "Satellite Observations of Mesoscale Processes in the Atmosphere and Ocean" and "Latest Results in Space Observations for Meteorology and Oceanography" will be cosponsored by SCOR.

#### Scientific Committee on Antarctic Research

At the XVIII General Meeting it was agreed that SCOR should cosponsor the SCAR Group of Specialists on Southern Ocean Ecology. SCOR also responded to SCAR's request for nominations of a physical and chemical oceanographer to serve on this group.

SCAR, in turn, agreed to cosponsor WG 86 on the Ecology of Sea Ice, and, as noted elsewhere in this report assisted SCOR in the determination of the final membership of the working group.

#### Scientific Committee on Problems of the Environment

The report from SCOPE made special mention of a new working group on rising sea levels and subsiding deltas. This group held its first meeting in August 1987 and was expected to finalize a proposal for a programme of studies on this topic for presentation to the SCOPE Executive in November. The Executive Committee noted the relevance of this SCOPE project to the newly-established SCOR WG 89 and recommended that more information be sought from SCOPE.

The SCOPE report also noted that the initiative of the various SCOPE biogeochemical cycling projects in stimulating scientists to cooperate in providing information on individual cycles and their interactions has been very productive during the past decade. Ongoing projects now seek to a) present a more global picture of element cycling and provide information on interactions and linkages at global cycles, b) identify and address main gaps in knowledge, and c) contribute to the understanding of the effects of global change by developing new projects related to changing biogeochemical fluxes.

#### Union Radio Scientifique Internationale

Dr. G.R. Valenzuela, the URSI representative, submitted a report on the recent General Assembly of his organization. This meeting strongly endorsed ICSU's International Geosphere-Biosphere Programme (IGBP): A Study of Global Change. Also, as reported in a previous report to SCOR, the coordination of remote sensing within URSI will now be performed directly by Commission F.

The scientific programme of the General Assembly consisted of three General Lectures, nine Tutorial Lectures (one per Commission to review the field), a number of scientific sessions organized by one or more Commissions, and three Open Symposia. Of special interest to SCOR were the Tutorials on "Waves and Spectra" by L.B. Felsen of Commission B and "Present and Future of Research on Wave Propagation" by R.K. Crane of Commission F. This latter concentrated on remote sensing of precipitation while its written version deals with all aspects of remote sensing and its relation to wave propagation. Hence, remote sensing has clearly become one of the most important areas of research of URSI's Commission F. Two of the Open Symposia of interest to SCOR were "Reconstruction, Imaging, and Inverse Scattering" and "Millimeter-Wave Techniques in Telecommunications, Remote Sensing, and Radio Astronomy", One session of the latter was on Propagation and Remote Sensing. Among the scientific sessions organized by the Commissions, one was on "Wave Propagation in Random Media" (Commission B and F) and another on "Remote Sensing of the Ocean" (Commission F), this latter being of special interest to SCOR. As usual, Commission B had several sessions involving theory and numerical methods on scattering, diffraction,

and propagation of electromagnetic waves.

At the General Assembly it was decided that Commission F of URSI will cosponsor IGARSS-Remote Sensing symposia every year (they alternate from year to year between Europe and America) and the Commission will be involved in their planning.

#### International Union of Microbiological Societies

The Executive Secretary had received an inquiry as to whether the participation of IUMS in SCOR would be appropriate and mutually beneficial. The Executive Committee reviewed a recent report of IUMS activities and did not feel that there was sufficient overlap in the areas of interest of the two organizations to justify a formal relationship between them. The Executive Secretary will offer to exchange SCOR reports with the IUMS Secretary-General.

### 6.0 FUTURE MEETINGS

#### 6.1 Meetings of SCOR

The XIX General Meeting of SCOR will be held on August 27 and September 1 1988, in conjunction with the Joint Oceanographic Assembly in Acapulco, Mexico.

The twenty-ninth meeting of the SCOR Executive Committee should take place in September or October 1989. Professor O'Brien offered to host this meeting at Florida State University in Tallahassee. This offer was accepted, with gratitude by the President.

The Chairman of the GDR SCOR Committee, Professor K. Voigt, presented a formal invitation for SCOR to hold its XX General Meeting at the Institut fur Meereskunde of the Academy of Sciences of the GDR in Rostock-Warnemunde. He suggested that, in accordance with SCOR tradition, a scientific symposium could be organized in association with the General Meeting, possibly on the topic of patchiness or on the preliminary results of the JGOFS Pilot Study. It was agreed that the dates for the General Meeting should be chosen to compliment those of the ICES Statutory Meeting and that the most convenient dates may be 1-3 October 1990. Professor Voigt's invitation was accepted with appreciation.

#### 6.2 Other Meetings

The Executive Secretary informed the meeting of the following events of interest to SCOR:

International Symposium on Red Tides, 10-14 November, 1987. Takamatsu, Japan.

Tenth Symposium on Polar Biology, 24-26 November, 1987. National Institute of Polar Research, Tokyo.

Jacob Bjercknes Symposium on Air-Sea Interactions, 31 January - 5 February, 1988, Arnaheim, California.

5th Deep Sea Biology Symposium, Brest, France, 26 June - 1 July, 1988.

27th COSPAR Meeting, Espoo, Finland, 18-29 July, 1988. SCOR will cosponsor three scientific sessions:

The Contribution of Space Observations to the WCRP and IGBP  
Latest Results in Space Observations for Meteorology and Oceanography  
Satellite Observations of Mesoscale Processes in the Atmosphere and Oceans

6th International Coral Reef Symposium: 8-12 August, 1988 Townsville, Australia.

SCAR Fifth Symposium on Antarctic Biology, Hobart, Tasmania, Australia. 29 August - 3 September, 1988.

Meeting on University Curricula in the Marine Sciences, Ocean Engineering and Related Marine Study Fields, Acapulco, Mexico, August - in association with JOA.

Second International Liege Colloquium on Coupled Ocean Atmosphere Models. Liege, Belgium, May, 1989.

## 7.0 OTHER BUSINESS

Professor Stromberg reminded the meeting that at the XVIII General Meeting, he had been given the responsibility of keeping SCOR informed of developments in the field of marine pollution and for liaison between SCOR and other organizations involved in this field. He had attended the 17th session of GESAMP (the Group of Experts on the Scientific Aspects of Marine Pollution) on behalf of SCOR. GESAMP is cosponsored by IMO, FAO, UNESCO, WMO, WHO, IAEA, UN and UNEP. While there were no recommendations calling for action by SCOR, Professor Stromberg wished to draw attention to certain GESAMP activities. These included working groups dealing with the following activities:

- the transport of hazardous substances by ships
- carcinogenic substances in the marine environment
- interchange of pollutants between the atmosphere and the oceans
- river inputs of pollutants to the sea
- integrated global ocean monitoring
- coastal modelling
- effects of long-term low-level contamination of the marine environment

GESAMP is preparing an update of the state of the marine environment. This will include an assessment of the present situation in all major ocean areas. A chapter will be added dealing with our understanding of fluxes to the ocean of various contaminants and nutrients due to riverine and atmospheric transport.

Professor Siedler closed the twenty-eighth meeting of the SCOR Executive Committee by expressing his thanks, on behalf of the Committee, to Professor Hsu for having hosted the meeting and for his hospitality to the participants during their stay in Zurich. He made special mention of the enjoyable excursion to the mountains which had provided the oceanographers present with a special opportunity to view the remnants of the ancient sea of Tethys.

ANNEX I

EXECUTIVE COMMITTEE OF SCOR

Zurich, Switzerland, October 19 - 20 1987

LIST OF PARTICIPANTS

Members of the Executive Committee

*	Professor G. Siedler	Fed. Rep. of Germany	President
*	Professor R. Fournier	Canada	Secretary
*	Dr. G.R. Heath	U.S.A.	Vice-President
*	Professor J.-O. Stromberg	Sweden	Vice-President
*	Dr. A. Ayala Castanares	Mexico	Co-opted Member
*	Professor J. O'Brien	U.S.A.	Ex-Officio / IAPSO
*	Professor K. Hsu	Switzerland	Ex-Officio / CMG
*	Professor P. Lasserre	France	Ex-Officio / IABO

E. Tidmarsh

Executive Secretary

Other Participants

Mr. A.G. Alexiou	(CCCO)
Mr. N.R. Andersen	(U.S.A.)
Dr. P.G. Brewer	(U.S.A.)
Professor B. d'Anglejan	(Canada)
Mr. P. Dexter	(WMO)
*Professor J. Field	(South Africa)
Professor N. Holm	(Sweden)
Dr. D. Krause	(UNESCO)
Dr. G. Kullenberg	(IOC)
Dr. A. Preston	(U.K.)
Dr. M. Ruivo	(IOC)
*Dr. J. Van der Land	(Netherlands)
*Professor K. Voigt	(G.D.R.)

\* - SCOR members

## ANNEX II

## SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

Final Financial Statement, 1986  
(All figures in U.S. dollars)

BALANCE Jan. 1, 1986		139,429.40
INCOME		
Membership	114,509.75	
IOC Contracts	23,000.00	
UNESCO Contracts	28,000.00	
Grant from ICSU	40,000.00	
NSF Grant	48,452.46	
Can. gov't contract	9,113.35	
U.K. Subvention	12,948.34	
Misc., Interest, Loss on Exch.	4,630.33	
TOTAL INCOME	<u>280,654.23</u>	
TOTAL CASH PLUS INCOME		<u>420,083.63</u>
EXPENSES		
Subsidiary Bodies		
WG 42	1,056.29	
WG 54	12,000.00	
WG 65	15,489.93	
WG 69	4,000.00	
WG 71	9,455.68	
WG 72	5,321.98	
WG 73	24,684.90	
WG 77	7,040.13	
WG 78	7,670.80	
WG 79	7,084.68	
WG 81	5,429.08	
WG 82	6,800.00	
CCCO	52,000.00	
CCCO Chmn's. travel	8,682.48	
ports	<u>2,527.00</u>	
Total Subsidiary Bodies	169,242.95	
Related Scientific Activities		
Publications	4,494.82	
Representation	7,180.05	
JOA Planning	0.00	
NSF Travel grants	48,452.46	
General Meeting	35,470.07	
Conferences	<u>2,000.00</u>	
	97,597.40	
Total Scientific Expenses	<u>266,840.35</u>	
Administrative Expenses		
Salaries and benefits	38,400.47	
Communications	7,036.26	
Audit	927.16	
Misc. & bank charges	1,245.32	
Office equipment	<u>1,143.38</u>	
Total Admin. Exp.		48,752.59
TOTAL EXPENSES		<u>315,592.94</u>
BALANCE DEC. 31, 1986		104,490.69
TOTAL BALANCE PLUS EXPENSES		<u>420,083.63</u>

### ANNEX III

#### WORKING GROUP 69

#### SMALL-SCALE TURBULENCE AND MIXING IN THE OCEAN

This report sums up the major outcomes of activities over the years 1982-1987 of SCOR working group 69 on Small-Scale Turbulence and Mixing in the Ocean. The proposal to establish such a group came from the 11th International Liege Colloquium on Ocean Hydrodynamics which discussed the subject of Oceanic Turbulence in May 1979. More specifically, it was a small panel of scientists appointed by UNESCO, IOC and SCOR in the framework of IODE (the International Decade of Ocean Exploration) to work on the problems of oceanic turbulence after the Colloquium which came up with this recommendation. In 1981 the Executive Committee of SCOR formulated the terms of reference for the Group and determined its composition. With the formal approval of the SCOR XVIth General Meeting, the Group came to existence in 1982. Through a natural evolution and with the agreement of SCOR, the scientific goals of the Group and its membership finally settled as follows:

#### Terms of Reference:

To review the results of in situ measurements of small-scale oceanic turbulence in the light of the design and performance of the instruments used.

To review conjectures relating various characteristics of the space-time distribution of small-scale turbulence in the ocean interior to specific sources of energy available there under various typical conditions of stratifications and motion.

To consider the overall effects of small-scale turbulence on larger scale oceanic transports.

to design and encourage the implementation of experiments aimed at:

- a) comparing the performance of different instruments,
- b) finding ways to remove instrumental biases,
- c) providing statistically significant tests of the most plausible conjectures.

To organize in 1987 an international symposium on the small-scale turbulence in the interior of the ocean and to publish a carefully edited book containing its proceedings.

#### Chairman:

K.N. Fedorov                      USSR

#### Members:

T.R. Osborn	USA	C. Garrett	Canada
C.H. Gibson	USA	T.J. McDougall	Australia
J. Woods	FRG	R. Ozmidov	USSR
M. Gregg	USA	S. Panchev	Bulgaria
S. Thorpe	UK		

#### Corresponding Member:

C. Druet                              Poland

Since formulation of the terms of reference the need for a microstructure intercomparison experiment has decreased, comparisons are done routinely as part of larger observation programmes, providing scientific context as well as simultaneous observations with different institutions. A strong need remains, however, for publication of details of instrumentation and data processing bearing on the quality of the measurements.

It did not become immediately clear to the Group how to go about its major task of organizing an international symposium. Evidently, such a symposium would have to provide deeper insight into the problem of oceanic turbulence than it was possible to do in Liege in 1979. More research was needed in a number of important fields, and a number of important questions remained not only unresolved but also controversial even for the members of the Group. Work through correspondence was slow and took all 1982 and 1983, during which years it became obvious that no further progress was possible without a meeting of the Group where stock could be taken of the current state of research in the field. This meeting took place in May 1984 in Halifax. At that time only a short summary report of the Group was published announcing the decision to conduct the symposium as one of the series of the Liege International Colloquia in May 1987. The Group had also considered it necessary to prepare a glossary of terms used in dealing with the oceanic turbulence and mixing. It was felt that there should be a more uniform and correct usage of terms aimed at preventing as much as possible any designation of different numbers, scales quantities, characteristics and processes with the same term or, to the contrary, a use by different scientists of different terms for the same numbers, scales quantities, characteristics or processes. A small panel of group members consisting of T. McDougall (Chairman), S. Thorpe and C. Gibson had been charged with this work and by May 1987 has produced the third (revised) version of The Glossary which took into account most of the suggestions from other members of the Group.

The Group decided at its 1st meeting to pay more attention to mixing processes in the ocean on the understanding that one cannot equate the processes of turbulence and mixing, the degree of the latter being a function of the energetics of turbulence and of numerous specific conditions under which it occurs. A longer and more detailed report had been prepared by the Group on the actual state of research pointing to some important areas of progress and to a number of specific problems to be resolved and gaps in our knowledge to be filled. At that stage the Report was considered as being intended only for internal use by the group members. The Group felt that many of its statements in that Report should be further justified by additional research results. This was particularly true with regard to the assumed importance of various double diffusive effects or the relation between isopycnal and diapycnal mixing in the ocean.

To prepare the Colloquium on the Small-Scale Turbulence and Mixing in the Ocean the group created a Programme Committee under the chairmanship of S. Thorpe which also included K. Fedorov, C. Garrett, M. Gregg and J. Woods. The aim of this Committee was to prepare the announcement of the Colloquium to invite contributions, and to plan the scientific programme. The Committee worked in liaison with Professor J.C.J. Nihoul of the Liege University.

The Colloquium took place on 4-8 May 1987 with participation of some 80 scientists, including many young scientists from various countries, and with a fairly representative programme of talks which covered a wide variety of aspects of oceanic turbulence and mixing. In compliance with the Group's terms of reference the Colloquium focused on the relationships between small-scale mixing and large-scale features, and on the related problems of parameterizing small-scale mixing in models of larger-scale flows.

The Group met during and after the Colloquium on 12 and 13 May, reviewed its results and took a number of decisions with regard to: 1) the publication of the Colloquium Proceedings, 2) preparation of the Final Report to SCOR, and 3) future activities. Among other things it was decided:



that the papers presented as posters should be included in the Proceedings;

that all the papers submitted for publication by the participants of the Colloquium be referred by the members of the Group who will undertake to find second reviewers for additional independent reviewing.

that the established time-table should be strictly followed to ensure publishing the book by May 1988.

that the book of Proceedings should include an Introduction by the WG Chairman, K. Fedorov, the Summary of the scientific results presented at the Colloquium, as prepared by S. Thorpe, and the Glossary, the latter being once more revised by the Group in the light of the comments of the Colloquium participants, to whom the 3rd version had been distributed.

that the Final Report to SCOR should consist of:

- 1) Introduction by the Chairman giving an account of relevant details of the activities of the Group during 1982-1987;
- 2) The full scientific report of the 1st meeting;
- 3) Comments on the first report by the members of the group (to be submitted to C. Garrett by 15 August 1987) in the light of the scientific results reported at the Liege Colloquium;
- 4) Summary of the scientific results presented at the Colloquium, as prepared by S. Thorpe;
- 5) The Glossary.

The Group considered that with the submission of its Final Report to SCOR in September 1987 and the publication in May 1988 of the Colloquium Proceedings the functions of the Group would have been fulfilled in most of its major areas of responsibility. Therefore it was decided to suggest to the next general SCOR meeting in August 1988 that the Group be disbanded.

Nevertheless, all members of the Group agreed that the subject of ocean turbulence remains a matter of very great importance and recognize that in the coming years some particular questions may arise which can benefit from the establishment of a new SCOR Working Group.

## ANNEX IV

### WORKING GROUP 73

#### ECOLOGICAL THEORY IN RELATION TO BIOLOGICAL OCEANOGRAPHY

The meetings planned for 1986 took place on schedule.

##### 1. A FLOW ANALYSIS WORKSHOP

This was held at the University of Santa Cruz, Nov. 29-Dec.4. The Chairman was Dr. J.C. Field, South Africa. The following took part, and each brought ecosystem flow network data for analysis or contributed expertise in network analysis.

R. Costanza, Center for Wetland Resources, Baton Rouge, Louisiana, U.S.A.  
H. Ducklow, Horn Point Laboratory, University of Maryland, U.S.A.  
M.J.R. Fasham, Institute of Oceanographic Sciences, U.K.  
L.A. Graham, Institute of Ecology, University of Georgia, U.S.A.  
J.J. Kay, Dept. Environment and Resource Studies, University of Waterloo, Canada.  
J. Kremer, University of Southern California, Los Angeles, U.S.A.  
T. Malone, Horn Point Laboratory, University of Maryland, U.S.A.  
A. Michaels, Institute of Marine Sciences, Univ. of California, Santa Cruz, U.S.A.  
K.H. Mann, Bedford Institute of Oceanography, Dartmouth, Canada.  
H. McKellar, Dept. Environmental Health Sciences, University South Carolina, U.S.A.  
D. Mikulecky, Richmond, Virginia, U.S.A.  
T. Platt, Bedford Institute of Oceanography, Dartmouth, Canada.  
D.F. Smith, CSIRO Marine Laboratory, Marmion, Western Australia.  
J. Smitz, University of Liege, Belgium.  
R.M. Warwick, Institute for Marine Environmental Research, Plymouth, U.K.  
F. Wulff, Institute of Marine Ecology, University of Stockholm, Sweden.  
R.E. Ulanowicz, Chesapeake Biological Laboratory, Maryland, U.S.A.  
A. Vezina, Bedford Institute of Oceanography, Dartmouth, Canada.

A range of techniques of network analysis was applied to steady state ecosystem flow data from a variety of open ocean and shallow water habitats. It was found that some of the techniques could be modified and then used to analyze systems not in steady state. They will be used to analyze and compare time series in the form of simulation models of various marine ecosystems.

At the end of the workshop, the outline of the report suitable for publication in book form was agreed to (copy attached) and writing responsibility was assigned.

##### FINAL MEETING OF SCOR 73, DEC. 5 AND 6.

This meeting was attended by the following members: K.H. Mann (Chairman); T. Platt (Vice-Chairman), M.J. Fasham, J.G. Field, L. Legendre, J.J. O'Brien, D.F. Smith, R.E. Ulanowicz, F. Wulff. Apologies were received from P.A. Bernal and M.E. Vinogradov.

##### A. FLOW ANALYSIS

J.G. Field presented a report on the Flow Analysis Workshop. In general, the participants found the analytical techniques useful both as a way of deepening their own

understanding of each ecosystem and also as an objective method for comparing different ecosystems. As one member put it, simulation modelling of ecosystems provides an insight into the functioning of ecosystems and may form the basis of a "comparative physiology" of such systems, while network analysis provides a method for comparing the structure of ecosystems and may form the basis of a "comparative anatomy" of these systems. Just as comparative anatomy and comparative physiology of organisms provided intellectual depth to the study of plants and animals, it seems that we may now be at the threshold of a comparative science of ecosystems.

Dr. M.J. Bowman, who had been invited to the working group meeting in connection with another agenda item, informed us that he was a managing editor of the Springer-Verlag series "Lecture Notes on Coastal and Estuarine Studies". He invited the working group to submit a proposal to the full editorial board. This series is produced relatively inexpensively in soft cover from camera-ready material, and the working group thought that this would be an excellent medium for dissemination of the results of the workshop. (The SCOR publications officer later approved this course of action and the Springer Editorial Board has now accepted the book for publication.)

#### Recommendation 1.

WG 73 recommends to SCOR that some funding be made available for the editorial meeting of Wulff, Field and Mann, in the second half of 1987 when all manuscripts to be included in the book has been received.

The working group discussed the applicability of the results of the Flow Analysis Workshop to the design of field programmes in oceanography, and agreed to the following recommendation:

#### Recommendation 2.

The working group recommends to SCOR that Biological Oceanographers, before designing observational programmes, entertain the possibility of constructing a best-estimate flow network for the system they are working on, either by adapting existing models, or by starting from first principles. A suite of network analyses can be applied to this scheme to identify elements to which particular attention should be devoted in the observational programme. When the data have been collected, the original flow analysis can be updated. The suite of numerical analyses will provide indices of comparison (e.g. recycling index, average path length, trophic structure etc.) forming a relatively small set of numbers useful for comparing the dynamics of different systems or of one system at different times.

Implementation of this recommendation will, of course, await the publication of the workshop volume.

## B. Cooperation Between Biological and Physical Oceanographers

The working group recalled that part of its mandate was to explore ways of fostering cooperation between physical and biological oceanographers, and in the 1984 WG meeting attention had been focused on the possibility of encouraging joint work at physical interfaces in the ocean. Dr. Louis Legendre had arranged an informal workshop in Liege in May 1985 after the Colloquium on Ocean Hydrodynamics. At that meeting a substantial number of oceanographers had expressed interest in developing a cooperative programme on biological production at physical interfaces in the ocean (Given the acronym COPE, = Cooperative Oceanographic Project on Ergoclines, where an ergocline is a sharp gradation in physical energy).

A document was produced by Dr. Legendre which contained a statement of general hypothesis: "Enhanced biological production occurs at ergoclines as the consequence of the matching or resonance of physical (temporal or spatial) scales with biological scales". To clarify the views of SCOR WG 73 on this subject, three questions were framed for discussion at the December 1986 meeting.

1. Is there good evidence that marine biological productivity is normally enhanced at interfaces?
2. If so, what are the physical mechanisms leading to this enhancement at the various types of interfaces.
3. Are these mechanisms reducible to a single generalization and if so, what are the implications for the design of field programmes?

After a full day of listening to presentations and discussing the evidence, the consensus was that the answer to Question 1 is "Yes, productivity is normally enhanced at interfaces". In answer to Question 2, a long list of mechanisms was produced, and most members had difficulty in seeing that those mechanisms had much in common. Hence, in Answer to Question 3 the majority said "No, the mechanisms appear not to be reducible to a single generalization". Hence, WG 73 is not prepared to recommend to SCOR a particular programme of work such as COPE. This is not to say that interfaces are not useful places for cooperation between physical and biological oceanographers. The following formal statement and resolution is a consensus of the views of SCOR WG 73.

### Statement

Marine interfaces or gradients (e.g. fronts, pycnoclines, sediment-water and ice-water interfaces) often support enhanced biological production. The word ergocline has been used to describe these structures. There is presently a need for joint physical, chemical and biological study of processes at these interfaces and across them, as the coupling between processes leading to enhanced production at interfaces is generally poorly understood. Sampling design of these studies should take into account the temporal and spatial scales of the interacting processes. Comparison of various ergoclines may lead to useful generalization.

### Recommendation 3.

WG 73 therefore recommends that SCOR encourage cooperation between physical and biological oceanographers in the study of processes at physical interfaces in the ocean.

## ACKNOWLEDGEMENTS

At this, the last meeting of SCOR WG 73, warmest thanks were expressed to the following:

To Dr. Mary Silver, University of Santa Cruz, the local organizer, who, with the able assistance of a number of students did an outstanding job of arranging complex computer facilities, logistics for 20 people arriving and leaving at two different airports, travel between the university and hotels, meals, accommodation and financial arrangements. Everything worked extremely smoothly and she played a major part of the success of the workshop.

To the Executive of SCOR who have consistently supported a group of scientists with a common interest through two consecutive working groups (WG 59: Mathematical Models in Biological Oceanography and WG 73 Ecosystem Theory in Relation to Biological Oceanography), which together spanned a period of nine years, 1977-86. The opportunity for those people from many parts of the world to interact on a continuing basis is greatly valued and has been a lasting benefit to their development as scientists as well as permitting substantial contributions to the literature in the form of three volumes already published and a fourth in preparation.

### SCOR Flow Analysis Workshop Tentative Book Format

#### I. Methods and Theory

- A. Analysis of Networks (Ulanowicz, Lee, Kay)
  - 1. Total System Properties
    - a. Flow indices
    - b. Information indices
    - c. Network thermodynamics
  - 2. Cycle Analysis
  - 3. Trophic Analysis
  - 4. Bilateral Relationships
  - 5. Attributes of Compartments
- B. Construction of Networks
  - 1. Inverse Methods (Vezina)
  - 2. A priori Techniques of Sensitivity Analysis (Fasham)
  - 3. Commodities, Apples and Oranges (Costanza)

#### II. Open Ocean

- Single paper (Ducklow, Fasham, Vezina)

#### III Shallow Water and Benthos

- Chesapeake Bay, Baltic Sea comparison (Wulff, Ulanowicz)
- North Inlet (McKellar)
- North Sea (Smitz)
- Lynher (Warwick)

#### IV. Time Series

- Individual chapters (Field, Malone, Kremer, Constanza, Kay)

#### V. Synthesis Prospects, Conclusions (Platt)

ANNEX V  
WORKING GROUP 83  
WAVE MODELLING

Introduction

Research on ocean waves is in rapid evolution: for the first time in history understanding of physical processes responsible for ocean wave generation has reached a level, at which it can be used, and actually is being used to infer the larger scale response of the ocean surface to wind forcing. At the same time application of ocean wave modelling is going beyond traditional objectives (ship-routing, off-shore, coasts) as it is becoming increasingly clear that good global knowledge of the sea state can help understand weather and climate.

Traditional, numerical wave prediction models are based on a mix of theory, empiricism and ad hoc assumptions. In actual fact, wave growth is the result of a rather delicate balance between input from the atmosphere, dissipation to the underlying ocean and hydrodynamic non-linear redistribution of energy between different wave components. The usual distinction between wind sea and swell turned out to be highly artificial and arbitrary. As a result, models were not very accurate in complex or extreme situations, unless they had been tuned to reproduce observations under particular conditions. (See, for example, Robert Long's News and Views article in Nature 313, 182; 1985).

In 1984, on a suggestion by Klaus Hasselmann, an international group of wave researchers (about 40 people from 10 different countries), not satisfied with the state of the art, started to collaborate on the development and implementation of a model based on best known expressions for input, dissipation and nonlinear transfer. They now have a model (known as the 'WAM' model) which has run successfully on several large computers, notably on the CRAY-XMP/48 of the European Centre for Medium Range Weather Forecasting (ECMWF) in Reading, UK. Recently, the group met to discuss progress and work to be done.

The original prototype of the model has grown now into a flexible system of programmes which include all the necessary pre- and post-processing software (work by Susanne Hasselmann, Peter Groenewoud, Eva Bauer, Piero Lionello, Claire Bracher and many others). There are reasonably optimized versions for CRAY and CYBER-205 type machines, while further optimization is under way. The model has been tested in a large number of hindcasts: 6 storms on the Northwest European shelf (Janssen, Bertotti, Guillaume); a comprehensive North Sea study (v. Vledder, Bouwmeester, Kuik); 3 hurricanes in the Gulf of Mexico (Cardone, Greenwood, Reistad); several storms in the Mediterranean (Cavaleri with French and Spanish contributions) and an extended global hindcast. Results have been compared with observations. The outcome was satisfactory, although evidence was presented at the meeting that the model may be somewhat overpredicting at short fetch. It will be a challenge to relate this to the physics of the model. In addition, the model has been run in real time, to make actual forecasts, using wind forecasts of ECMWF as input. To this end a supervisor programme was written by Peter Janssen (following ideas of Liana Zambresky), which initiates the wave model jobstream every day, and automatically recovers results and restarts the operation in case of computer failure. After try out in a regional mode, the global model was batched in for the first time on March 7. From then on every day a wave analysis and a 5-day forecast were made.

Other work has focused on more general wave dynamical problems: a reanalysis of 'all' existing observations of fetch limited growth (Willem de Voogt), directional relaxation in turning winds (Holthuijsen) and shallow water aspects.

Last, but not least, the data assimilation problem was addressed. It is here that the relation with weather prediction appears most clearly. The general idea of data assimilation is to improve the initial model fields (resulting from earlier forecasts) by incorporating observations, with the hope of improving subsequent predictions. In weather forecasting this is common practice, as forecasting skill is known to rely heavily on having high quality initial fields. In ocean waves, data assimilation is rather new, but it receives increasing attention because remote sensing of waves has proven very useful, (Beal, Walsh) and satellite observations (Geosat, ERS-1) are or will be providing large amounts of wave data. As it happens ocean wave prediction is intimately related to wind prediction. If a computed wave height has to be modified, you may well have to change the computed winds as well. Therefore, the problem of data assimilation in numerical wave and atmospheric models is a coupled one. In addition, sea state influences the atmospheric boundary layer and the momentum flux to the ocean; also, it affects satellite observations of winds over sea. Ultimately, we hope to have real time data assimilation of all observations in combined wave and atmospheric models. This would also ensure that best possible use is made of satellites for the purpose of climate studies. Only by combining measurements and models can one hope to compile accurate global stress fields, which are essential in climate modelling.

To reach these goals, much more remains to be done. The WAM-model has to be optimized, refined and improved. Verification and archiving have to be organized. Several hindcasts are schedules. Interaction between physical studies and model development will be encouraged, and, finally, there is still a lot to be done on data-assimilation.

The work described above received recognition recently when SCOR (the Scientific Committee on Oceanic Research) decided to establish a working group (involving several WAM representatives) in order to promote wave modelling activities on a global scale. Success of the WAM group may be related in part to the way in which it organized itself. On the one hand 'tasks' have been identified, on the other hand there were participating groups. The overall work plan then evolved in an interactive way as a result of a series of meetings in which presentation of individual plans, was followed by a presentation of tasks, to be followed by a presentation of individual plans, etc. etc. In this way a variety of interests and abilities (both personally and institutionally) could be bundled, without any strong structure, but with a lot of success.

The WAM (= Wave Modelling) group met at Woods Hole Oceanographic Institution, May 2-5, 1987. The group consists of about 40 scientists, mainly, but not exclusively, European, collaborating on the development of a so-called 3rd generation wave model. Their main sponsors have been NATO and the European Community. Computer time was provided in part by the European Centre for Medium Range Weather Forecasts (ECMWF) under a 'special project' arrangement.

First Informal Meeting of SCOR WG 83 - Woods Hole, May 4, 1987.

Present: Lars Behrendt, Vince Cardone, Luigi Cavaleri, Mark Donelan, Peter Francis, Hans Graber, Heinz Guenther (on behalf of Wolfgang Rosenthal), Klaus Hasselmann, Leo Holthuijsen, Gerbrand Komen (Chairman) and Willem de Voegt.

The first informal meeting of SCOR WG 83 was held in conjunction with a WAM meeting at Woods Hole Oceanographic Institution. The WAM meeting reviewed scientific progress in wave modelling and progress with the development of a third-generation ocean wave model.

The WG meeting was opened by the Chairman, who spoke a word of welcome and reviewed the events leading to the establishment of the new working group. The proposed agenda was adopted.

### 1. Terms of Reference

After a review of the terms of reference assigned to WG 83, they were accepted.

### 2. Membership

Membership has to be restricted to a maximum of 10, including the Chairman. So far, the SCOR Executive Committee has invited 9 members. Eight of these are present or represented (Uji could not attend)., and they express their willingness to accept. After some discussion it is recommended that;

- Mr. Guddal from Norway be invited to become a member
- Lars Behrendt and Anne Guillaume be invited to become corresponding members.

Mr. Yuan from Qingdao, present at the WAM meeting, has informed the chairman that he has been nominated as a WG member by his national SGOR Committee. Subsequently, he was invited to attend the WG meeting as an observer. It is decided that a Chinese reinforcement of the WG would be welcome. The matter will be taken up with the SCOR Executive Secretary. If necessary, Professor Hasselmann is willing to make a place by assuming corresponding membership.

### 3. Activities

#### (i) Steering WAM

It is agreed that the WG should pursue its aims with the help of the WAM group. This international group is not extremely well defined, but there is a core of about 20 to 30 individuals interacting on wave modelling problems, mainly from Europe and North America. Meetings are open to interested observers, however, WG 83 should operate by monitoring and steering WAM.

#### (ii) Realization of Objectives

Realization of the first objective (development of a third generation model) is well underway. Work is carried out by many individuals. Coordination is achieved through ad hoc meetings, whenever needed, and through longer term work visits.

The third objective (implementation of a global version of the model) should be promoted by all appropriate means. Presently, contracts have been laid with the National Meteorological Center (NMC) in Washington, and with the European Centre for Medium Range Weather Forecasts (ECMWF) in Reading. All present, support the idea of running the 3rd generation model at these centers, in so far as this is consistent with national policies.

For the time being, the second objective (nesting regional models) has a relatively low priority. Technically, it is a straight forward thing to do. In practice, it becomes useful only, when boundary conditions will be available from the global version.

The fourth objective (physical studies of wave dynamics) was discussed at some length. It was felt that the WG should not undertake experimental work itself. Instead it should rather concentrate on numerical experiments to identify weaknesses in our knowledge. Where needed, and if possible, gaps should be filled by reanalyzing existing data. If this is not sufficient, possible experiments may be suggested.



Data assimilation (fifth objective) is relatively new. Therefore, it is neither possible nor desirable to formulate a detailed work plan. Different routes should be explored. Nevertheless, it is clear already that attention should focus on the following issues:

- how can one optimally update a first guess wave spectrum (with its many degrees of freedom) when only one or two degrees of freedom are observed?
- how can one assess the reliability of wave observations from different sources?
- how can one dynamically estimate spatial correlation scales?

At a later stage, the issue of coupled assimilation schemes for wind and wave observations in numerical atmosphere and wave models is expected to become centrally important.

#### (iii) WAM Meetings

In order to achieve its aims, the WG will use all appropriate means. One activity which seems essential is the organization of an annual scientific WAM meeting. The format of these meetings was discussed, and it was concluded that the present set up is quite satisfactory. In this set up the meeting lasts four days. A local organizer is selected by the WG. The meeting is split up into six plenary sessions: model implementation, growth curve analysis, directional aspects, shallow water defects, data assimilation and special lectures. The meeting is announced to those who are on the WAM mailing list. Active researchers other than those wishing to attend, are welcome, in principle. In order to avoid having too large a group, they should ask for an invitation from the local organizer or the WG Chairman, who will decide jointly. The scientific programme has to be flexible, so as to allow people to speak on their latest work. A call for presentations is sent out with the announcement of the meeting. On the basis of the response, a preliminary programme is drawn up by the WG Chairman in consultation with each session chairman. When deciding on the programme, the terms of reference of the WG should be kept in mind. This may imply that some presentations have to be rejected. Each session starts with an introductory lecture by the session chairman, summarizing state of the art and reviewing progress. If necessary, invited lectures should complete the programme.

SCOR WG 83 decided to have the next WAM meeting in March 1988 in France or Spain, and to appoint the following persons as session chairmen.

P. Janssen	(model implementation)
W. de Voogt	(growth curves)
L. Holthuijsen	(directional aspects)
W. Rosenthal	(shallow water)
P. Francis	(data assimilation)

The special lectures session will be chaired by the local organizer.

In addition to organizing and chairing their session, session chairmen are asked to help coordinate research on their subjects.

#### 4. Funding

WAM needs funding for occasional ad hoc meetings between two or more members, and for mutual work visits. Present funds will dry up in 1988. All WG members will look for sponsors, and, where possible, proposals will be submitted in consultation with the WG chairman.

5. Other Matters

The WAM newsletter should be used as a SCOR WG newsletter. It is an important means of communication. Its use should be encouraged.

Dr. Komen provided information about a course on 'Ocean Waves and Tides' to be organized by himself and Dr. Cavaleri at ICTP, Trieste, 26 September - 28 October 1988. The WG is willing to endorse the programme of the course, although it does not feel responsible for this kind of activity.

It is hoped that the next WG meeting can be held in conjunction with the 1988 WAM meeting.

## ANNEX VI

### WORKING GROUP 88

#### INTERCALIBRATION OF DRIFTING BUOYS

An initial meeting of this new working group was convened on the campus of the University of British Columbia on 11 August, 1987. The meeting was attended by members from Australia, France, Germany, South Africa, and the USA. Mr. John Withrow attended on behalf of the IOC and WMO.

Initial discussions focused on the terms of reference for the WG. Succinctly, these might be interpreted as either to conduct a "drift-off" from which the performance of a variety of buoys of different design can be compared, or to define a test procedure that could be used by various investigators to quantify the performance of buoys of any particular design. The consensus was that it is not appropriate at this time to focus on a singular field project. The range of buoy designs, strategies and objectives of drifter measurements, and range of environmental conditions is too broad to permit a definitive result on a singular basis. Rather it appears to be more promising to encourage efforts to develop procedures and guidelines for buoy performance in the context of specific kinds of desired measurements.

One such kind of measurement is that of surface drift, especially in the tropical oceans, such as is needed for the TOGA and WOCE Programmes. Important factors include surface wind, waves, and current shear. Several attempts made to evaluate slippage of drogued buoys in the surface mixed layer indicate that ratio of the drag area of the drogue element to that of the surface float and attaching line is a critical design parameter. Empirical data suggest a functional relationship of the general form:

$$\text{slippage} = \text{constant} \times \text{wind speed} \times (\text{power of drag area ratio}).$$

in which K and p are constants and  $D_r$  is the drag area ratio. To hold slippage to 2 cm/s or less as is required for measurement of mean meridional velocities in the tropics, it appears that the drag area ratio must be in the range of 20 to 50. Further work is scheduled to refine these concepts and values.

Another kind of measurement objective to which significant attention is being directed is the determination of the geostrophic current below the surface wind driven layer in the mid-latitudes. Relatively weaker current shear at the desired level of measurement might make quantification and interpretation of these measurements somewhat easier. Much of the effort on quantification of this measurement has been dedicated to search for a method by which loss of drogue can be inferred from change of behavior of a buoy. In general, such inferences are unreliable. A conclusion is that a reliable drogue sensor as well as a competent drogue is required of drifting buoys from which high quality current data are sought.

New measurements of the performance of surface current drifters are planned for completion during the next several months as part of the TOGA programme. Most of these measurements are likely to be at wind speeds of less than 10 m/s however. The WG encourages additional work also on quantification of geostrophic flow (100 m) drifters. The essential measurements are the surface wind and waves, and subsurface shear, in addition to precise location of drifters. Experience has shown that comparing drift between buoys within the ARGOS System parameters yields results very slowly. Due to the inherent variability of the ocean, identical buoys can appear to behave as differently as

dissimilar buoys. A large number of such observations would be required to obtain definitive results.

There was a very limited discussion of numerical modelling of drifter performance. Although quite elaborate engineering models have been constructed, they have not yet found general acceptance of their ability to simulate drifting buoy response to the great variety of environmental forces acting. Well documented measurements of drifter performance in actual ocean conditions can be used to test models as well as to develop empirical design guidelines.

Two issues arose in the discussions that, although peripheral to the terms of reference for WG 88, nonetheless merit attention: First, one of the issues considered by the now terminated WG 66 was whether coordination was needed to provide for collection of data from buoys that have left the region of interest to the project for which they were released, but might become of value to others. During its period of existence, WG 66 was not able to document a real problem of this nature, but now it has emerged. Data collection is being cut off from drifters operating in the North Pacific Subtropical gyre. This problem now seems to merit the attention of the IOC drifting buoy coordinator. The second issue is that some present activities of data centers for archival of drifting buoy data are perceived as certain to fall short of their potential of collecting drifting buoy data for secondary users. In particular, there appears to be insufficient documentation as to the nature, depth, and continued presence of absence of subsurface drogue assemblies. Without this documentation, such data are likely to be of little more than anecdotal use to future oceanographers. All such data will necessarily be reduced to the lowest common data quality denominator - little better than flotsam. The GF-3 format (IOC Manuals and Guides No. 9, Annex 1, Parts 1 and 2) is available, and should be used systematically.

In view of calibration exercises already being planned during the coming year, and involving several members of the WG, no immediate activities were planned for the WG. It is thought useful to convene another meeting in the Summer or Fall of 1988, to review the progress made, and consider again appropriate contributions of the WG as a body.

## ANNEX VII

### REPORT OF THE COMMITTEE ON CLIMATIC CHANGES AND THE OCEAN (CCCO) FOR THE SCOR 28TH EXECUTIVE COMMITTEE MEETING September 1987

The Eighth Session of the Joint Committee on Climatic Changes and the Ocean was held at the University of Kiel, Federal Republic of Germany (25-29 May 1987). The major agenda item was an assessment of the study of the Tropical Ocean and Global Atmosphere (TOGA) which has now been underway for two and one-half years. Chairman Stewart summed up the Committee's general appraisal of TOGA progress thus far as a remarkable achievement. Networks for the acquisition and rapid distribution of oceanographic data are now in place. Modellers and other theoreticians are seizing on these data in order to test and modify their hypotheses. Those designing observational programmes are doing so with these hypotheses in mind. Moreover, the degree to which current theories match the observations is unprecedented. For example, the predicted teleconnections between the Pacific and Atlantic, via the atmosphere, have been demonstrated. More findings of this kind will inevitably take place as the observing system continues to be improved.

A number of other topics were discussed during the Session, including WOCE, the proposed Carbon Dioxide Programme, the proposal for a Joint Global Ocean Flux Study Group under SCOR, and the interrelatedness of these activities. Other subsidiary groups of CCCO also reported on their activities.

#### TROPICAL OCEAN GLOBAL ATMOSPHERE (TOGA)

The Sixth Session of the TOGA Scientific Steering Group (SSG) was held in Sidney, British Columbia, Canada, 3-7 August 1987. Excellent progress was reported in developing the observing system in the Atlantic and Pacific Ocean although serious gaps remain and frequency of sampling still needs improvement. During the last two years, microstructure measurements in the equatorial Pacific (TROPIC HEAT PROJECT) has revealed the strong diurnal character of mixing that extends into the top of the thermocline. The Atlantic programme during the next two years, is aimed at verifying the hypothesis that essentially relates changes in the position of the ITCZ to changes in the heat content of the equatorial zone.

Although lack of full cooperation by certain countries remains a problem, nevertheless, there are encouraging signs that progress is also being made in improving the density of observations in the Indian Ocean. Of major importance is the fact that the Indian Ocean stress-field product from O'Brien will become available next year. This will allow, for the first time, modelling of the circulation of the Indian Ocean basin to begin. However, the continuing governmental difficulties in getting data from the region convinced the SSG it would have to consider amending the TOGA Implementation Plan to reflect this problem. Noting the demonstrated potential of GEOSAT to complement and produce large scale sea-level fields at 5-day intervals over the Pacific Ocean, the SSG invited the U.S. TOGA Panel to assess the feasibility of making GEOSAT products available over the Indian Ocean.

TOGA Modelling (TOGA-NEG). The nature of modelling has changed with the advent of TOGA. Before this programme, models with only a few degrees of freedom in the vertical were actively used. Now primitive equation models have shown a remarkable ability to assimilate most of the features of the tropical circulations. The TOGA-NEG Group reports that comparisons of the model simulations in the Pacific, with in situ data from current

meter and temperature moorings, sea level gauges, and the XBT sets, show good agreement for sea level, subsurface thermal structure and velocities in the equatorial zone for time scales of a month and longer. Much of the variability observed in the equatorial zone, however, is of a higher frequency. More reliable estimates of surface wind stress on both monthly, and shorter time scales, will be required to improve upon the present simulations.

There remains much room for improvement in the simulation of sea surface temperature (SST). Problems have been encountered in the development of realistic mixed-layer structures. Present estimates of the atmospheric heat fluxes are inadequate and need to be improved if simulations of SST are to be improved. The effect of precipitation on salinity variations is another factor that needs investigation.

Intercomparison experiments of four different models have been run to simulate the 1982-1983 ENSO event. The results show all the models to be very sensitive to heat flux, irrespective of the wind fields used in the tests. Results with the Hooke Institute coupled model, show that large values of the net surface heat flux from the atmospheric model ( $50\text{W/m}^2$ ) produce an overheating in the west Pacific and then an El Niño-like event develops. The temporal evolution of the event looks very realistic and encouraging, but further work to overcome inconsistencies in the climatologies of the atmosphere and ocean is needed. Experiments with assimilation models using the successive correction technique show that models are capable of assimilating XBT data with apparently beneficial results.

The next intercomparison experiment will be aimed at reproduction of the normal annual cycle. It is hoped that results from other models (e.g., Cane and Zebiak, O'Brien) can also be included in the intercomparison. It is clear now, however, that the primary requirement to achieve improved hindcast skill is improved surface stress data. The scatterometer data will help but some analyses indicate that the inability of scatterometers to sample winds below 4 m/sec may seriously hamper their utilization for TOGA objectives.

#### WORLD OCEAN CIRCULATION EXPERIMENT

The Eighth Session of the WOCE Scientific Steering Group was held in Wormley, UK, (18-21 May, 1987). The purpose of the meeting was to assess the progress in the formulation of the WOCE implementation plan, taking into consideration results from the Core Project working groups which had met during the year.

The major programmatic components now envisaged for WOCE Core Project 1 and 2 are: surface fluxes, boundary currents, basin-scale circulation and variability (mass flux), heat flux, equatorial exchanges, and marginal seas exchanges. With respect to the latter, at least in the early stages, WOCE will not mount specific programmes within individual marginal seas, but will measure the transformation of water properties between entrance and exit.

Core Project 3 includes most of the process-oriented part of WOCE, i.e., those processes at the surface, mid, and deep layers which need to be studied if WOCE is to develop models for decadal climate prediction. In the deep ocean, form drag by eddies is seen as an important mechanism in an isolated deep basin that needs clarification for models. Of overall interest is the possibility of using purposeful tracers for the measurement of the diapycnal diffusion which is a major uncertainty in ocean models.

An organizational structure has been proposed by the WOCE SSG for the WOCE Hydrographic Programme (WHP). The heart of the concept is a Planning Committee which would provide stewardship for the WHP. It would also define resource needs, and, after

obtaining commitments from a Resources Committee made up of participating nations, coordinate the allocation of these resources and report to the WOCE SSG and the Resources Committee on the results of the WHP.

WOCE scientists conducted a workshop in South America in July 1987, hosted by Brazil, to explain WOCE activities, determine how regional programmes apply to WOCE and to hold a general dialogue on the participation of scientists of the region in WOCE. Scientists attended from most South American countries. Based on the success of this one, a second regional workshop, probably in east Asia, is now being considered.

International WOCE Scientific Conference. An international quasi scientific/governmental conference is being planned for October 17-21 1988. Its purpose is to explain the purposes of WOCE and to engender cooperation by scientists and contributions to the programme from the IOC and WMO Member States. The Conference, to be sponsored by IOC, WMO, SCOR and ICSU, will be held at UNESCO in Paris.

#### OCEAN CARBON DIOXIDE PROGRAMME

The CO<sub>2</sub> Advisory Panel proposed that a largely observational programme of ocean carbon dioxide studies be undertaken in the world's oceans during the next ten years. This programme would have four components:

- (i) an inventory of the present levels of dissolved carbon in the oceans;
- (ii) measurements of the partial pressure of CO<sub>2</sub> between the air and the near-surface ocean waters to obtain the net flux of CO<sub>2</sub> between the sea and the air throughout the world's oceans on a seasonal and interannual basis;
- (iii) measurements of the fluxes and rates of dissolution of organic carbon particles as they settle through the water column and on to the bottom sediments. Study of the spatial and temporal variations of this "biological pump" is one of the principal objectives of the proposed JGOFS programme;
- (iv) satellite observations of ocean colour aimed at quantitative estimates of organic productivity and rates of disappearance.

The observational programme will, of course, require development of standard reference materials, improvement and cross-testing of analytical methods, and a major modelling effort. Measurements of dissolved carbon dioxide would be carried out in a non-intrusive mode, primarily on hydrographic research vessels to be operated under WOCE, but also on the already approved South Atlantic Ventilation Experiment (SAVE), and on other research ships, such as the "POLARSTERN" of the Federal Republic of Germany.

#### AIR/SEA FLUXES

Following the JSC meeting (23-27 March 1987), it was agreed to establish a JSC/CCCO Working Group on Air-Sea Fluxes to specifically address the problem of inferring fluxes from satellite data. The motivation for producing global gridded flux fields is primarily for climate research and ocean circulation studies (WOCE, TOGA). A kick-off meeting was held in January 1987. A second meeting was held 23-24 June 1987, at which sub-groups were formed. These sub-groups will focus on coupled wind/wave data assimilation tests, incorporation of sensor algorithms in the data assimilation system and ocean circulation response studies.

Current activities include the preparation for TOGA of continuous surface flux analyses beginning with 1985 data (ECMWF), and assimilation (SEASAT data) by the wave modelling sub-group.

The improvement of boundary layer packages in atmospheric models is considered beyond the scope of this group and is the responsibility of WGNE and operational weather forecasting centers. Process studies in relation to calibration of sensors are also not the responsibility of the Group, although the process studies are seen as needed and should be undertaken by some group.

#### TRAINING AND ACCESS TO EEZ's AND LOCAL DATA

The issue regarding access by research ships to ports and exclusive economic zones (EEZ's) for WCRP experiments remains unresolved. Developing countries cannot be considered as a homogeneous group when looking at the problems of access to local data, access to EEZ's or, more generally, participation in the global programmes (e.g., TOGA and WOCE). A range of actions coupled to training opportunities is being considered to promote national participation of a wider range of countries as one solution to the problem. These would involve special arrangements with individual countries. Scientific training through active participation might be regarded as an attractive quid pro quo for access to regional waters with the added benefit of seeding future contact and cooperation.

#### DATA EXCHANGE

WOCE has yet to develop policies for data exchange, but preliminary indications are that they will suggest submission of data within one month of transfer of the data from satellites or from in situ collection systems to the laboratory. The data centers would be bound to protect the data for a period of two years from exploitation by other groups, without the explicit permission of the originating scientist.

While standard formats are defined for TOGA, standard media of exchange are not. This was foreseen as a potential major problem as data sets become more widely available. It was suggested that oceanographers capitalize on the WCDP network of Personal Computers being established to allow experts in developing countries to receive and provide data. The TOGA and WOCE offices (ITPO and WOCE IPO) should investigate with the WCP office in Geneva the possibility of using this network and the need for establishing standards for exchange media. Another problem needing consideration is that the standard exchange formats are meant for exchanges between TOGA centers and WDC's and that no standard formats have been suggested for the scientist to scientist, laboratory to laboratory, or TOGA centre to individual exchanges.

#### OCEAN OBSERVING SYSTEM DEVELOPMENT PROGRAMME (OOSDP)

The OOSDP Group met in December 1986 and reviewed the OOSDP publication IOC Technical Series No. 27 to determine whether an updated version was required. It was concluded that this should be considered sometime in 1989 subsequent to the International WOCE Scientific Conference and that such a task would require special resources (for example an editor/author).

The Group identified two issues requiring continuing consideration by the CCCO. One concerned satellite system, planning and coordination, especially regarding long-term calibration and validation of remotely sensed data. The group will assess the adequacy of existing measures for this purpose. The second issue was the long-dormant proposal for a Pilot Study on the improvement of the meteorological data from the Voluntary Observing Ships. Implementation of that Pilot Study finally began with the first coordination meeting in De Bilt, Netherlands (21-23 September 1987). The CCCO is represented on the Pilot Study Management Group by a member of the OOSDP group.



#### CCCO MEMBERS

Several changes in the membership of CCCO have taken place or will take place in the next several months. Invitations have been sent to individuals to fill the current four vacancies created due to normal rotation. All membership selections are being made in consultation with the Secretary of IOC and the President of SCOR. A. McEwan was elected as chairman replacing R. Stewart. R. Chesselet was elected as one of the two vice-chairmen with J. Barberan continuing as the second vice-chairman.

#### WORK PROGRAMME AND RESOURCES

The planned CCCO Programme of work for 1988 will require a minimum of \$200,000. This estimate is based on the assumption that some forty per cent of the participants in CCCO activities provide their own support. The CCCO Secretariat is staffed by the USA (Godin [Nov. 1987] and Alexiou) and France (Molcard); the WOCE office by Canada (G. Needler), FRG (P. Koltermann) and UK (1). Full staffing of the TOGA office, by the UK (J. Marsh), USA (V. Lee), and France (M. Martinet), will be completed by December 1987. The TOGA office, currently manned by one person, was moved to Geneva in July.

## ANNEX VIII

### SECOND REPORT OF THE JOINT PANEL ON OCEANOGRAPHIC TABLES AND STANDARDS EDITORIAL PANEL ON THE OCEANOGRAPHIC MANUAL

Report by the Chairman of UNESCO/SCOR/ICES/IAPSO Joint Editorial Panel on the "Manual on Processing of Oceanographic Station Data" to the Scientific Committee on Oceanic Research. The report of the first meeting of the Panel was published in SCOR Proceedings, Vol. 22, Hobart, November 1986 (Halifax, Canada, 1987), Annex XIV.

The second meeting of the Joint Editorial Panel was held in the ICES Secretariat in Copenhagen from 21 to 27 October 1987; all the members of the Panel were present, as well as Dr. S. Morcos, UNESCO coordinator. The meeting was chaired by Professor O. Mamayev, and Dr. H. Dooley acted as rapporteur.

The agenda of the meeting, refined during its course, contained the following topics:

review of the work during the intersessional (between the first and the second meetings) period;

consideration of the contents of the Manual with an aim to specify as much as possible the outline of each section;

consideration of already prepared (draft) parts of the Manual and of sample calculations, graphs and tables;

planning the intersessional (before the third meeting) work to be done.

According to this outline of the conduct of the meeting the following text of this report is arranged as contents of the Manual, i.e. in three parts.

#### Part I. - Scientific Background

The section on standard sea water was prepared in advance by Dr. F. Culkin; it was decided that this will be supplemented by the description of variability in batches of standard sea water and also on "sub-standard" sea waters in some countries. The drafts on the sections on computation of properties from CTD stations, description of PSS-78 and EOS-80 and conversion of existing data into PSS-78, EOS-80 - dependent data were prepared during the course of the meeting. These parts will be sent for review and comments to invited experts (particularly Drs. N. Fofonoff and R. Perkin) and finalized during the intersessional period.

No progress has been achieved prior to the meeting in preparation of the section on thermometry. A joint contribution from Dr. K. Taira and ICES with an assistance from Dr. K. Koltermann of the WOCE Office at Wormley, England, is expected in the near future. Finally, an introduction to Part I is still to be prepared by the Chairman and Dr. S. Morcos.

#### Part II. - Processing Procedures

The three deep-water oceanographic stations to be used throughout the Manual as a basis for demonstration of processing procedures, selected during the intersessional period, were adopted at the second meeting. These are two neighboring stations in the Gulf Stream area (RV "Endeavour" Cruise 88, Stations Nos. 61 and 64) and a station RV "Hakohu Maru" (Cruise KH-87-I) in Japan Trench area. The first pair is in the region of high

geostrophic shear and are very appropriate for dynamic calculations, the third one, (worked down to 6500 dbar depth) provides excellent information on adiabatic conditions in the ocean.

Considerable attention was paid at the meeting to the problem of pressure averaging of the modern CTD data and achieving conformity between the water bottle station and their CTD-equivalent data, both being brought to standard horizons. The findings of SCOR WG 51 were fully taken into account during the discussions, and a draft text of the section on pressure averaging was prepared. This section will also contain description of procedure of interpolation of water bottle data to standard depths.

The three selected sample oceanographic stations will be reconsidered and brought to standard pressures according to the criteria decided in course of described above discussion. They will be reworked at the Woods Hole Oceanographic Institution by Dr. R. Millard in a short time and then sent to Panel members for preparation of hand computations intersessionally.

These processing procedures, as they were once more discussed and confirmed at the second meeting, will include adiabatic lapse rate and potential temperatures, speed of sound, specific volume and their derivatives, vertical stability, dynamic depths, available potential energy, geostrophic currents and potential vorticity.

Manual (hand) calculations and simultaneous machine test calculations, together with formulae, descriptions etc. will be made by Panel members and/or invited experts (as laid down in the report). Particularly, Dr. M. McCartney, Woods Hole, will be approached to contribute on the potential vorticity concept and its computation (also density ratio).

### Part III. - Oceanographic Tables and Graphs

First of all, table of depth as a function of pressure in the ocean was prepared by Dr. R. Millard and will be included into the Manual as accompanying the reverse table given in Volume 4 of "International Oceanographic Tables". Secondly, a short set of tables covering the salinity ranges of the Red Sea waters will be included into the Manual, extending appropriate tables of Volume 4. Some other very short tables may also be envisaged.

The following graphs will be included into the Manual to facilitate hand calculations: sound speed as function of T, S and pressure; coefficients of thermal expansion and saline contraction at atmospheric pressure with their pressure corrections; form of these were reviewed at the meeting.

### Conclusion

It was noted that no principal deviations from the decisions of the Moscow meeting were observed and that the Panel's approach is consistent with an idea of long term usage of the Manual for education.

The plan for intersessional work was discussed, some actions needing high priority so that the Manual be finalized at least by 90 per cent of its contents before the next meeting. Dr. S. Morcos informed the Panel that the Manual will be published in the UNESCO series "Monographs on Oceanographic Methodology".

Upon the invitation of Dr. Taira, it was proposed to request the agreement of the sponsoring bodies to hold the next meeting of the Panel in Tokyo from 14 to 20 September 1988.

## ANNEX IX

### SEA LEVEL AND EROSION OF THE WORLD'S COASTLINE

(Proposal for a new Working Group)

#### Terms of Reference

To evaluate the state of our knowledge of the sea level rise and the potential impact on the coastline

Examine the status of the existing models and formulate a programme of investigations for their verification or rejection.

To evaluate the role of short and long term sea level rises in beach erosions.

To recommend the best strategy for a monitoring programme in areas with lack of data.

To collaborate, as appropriate, with the SCOPE project on estuaries and coastal embayments.

There has been considerable scientific, economic and political interest in the question of whether slow post-glacial rise of sea level is now beginning to increase at more rapid rates. Sea level changes is of current interest because of its possible sensitivity to climate change. Coastal geologists and geomorphologists have reported that shore erosion dominates over shore accretion on a world wide basis (Bird, 1980), and many of these investigators believe that the rate of erosion has increased in recent decades or centuries. This concern was raised when K.O. Emery in 1980 and V. Gornitz in 1982 published analyses of tide-gauge records which suggested accelerating rates of sea-level rise. Many processes affect the sea level position measured on shorelines. The increased water levels were attributed to greenhouse warming of the earth which produces greater melting of glaciers, and isostatic adjustments of the earth's crust caused mainly by ice sheet growth and the associated change in the ocean water mass, tectonic and river sedimentation.

However, analyses of tide-gauge records are difficult, the eustatic rise in sea level being partly obscured by tectonic activity that alters elevation of the gauges. Due to such problems in the analyses, some scientists have questioned the conclusions concerning accelerated rates of sea-level rise (Barnett, 1983). On the other hand, investigations by the Environmental Protection Agency and the National Academy of Sciences in the United States have attempted to project the impact of greenhouse warming into the future, predicting rises of 60 to 300 cm by the year 2100; this range of estimated values results from assumptions about rates of deforestation, the burning of fossil fuels, and concerning such factors as ocean-mixing processes.

There is little doubt that, even at its present rate, the progressive rise in sea level is a major factor in causing erosion along much of the world's coastline. In 1971 the US Army Corps of Engineers inventoried the stability of the coasts of the United States, concluding in their final summary, "A Report on the National Shoreline Study", that of the 135,000 km of coastline, some 33,000 km were "seriously eroding". More recently, R. Dolan and co-workers assembled the existing data on shoreline changes, reaffirming the magnitude of this problem.

It is apparent that if sea levels are increasing at accelerated rates, then considerable impact on our coasts can be expected in the next century. Some indication of

the potential erosion is provided by the problems now being experienced in the Great Lakes of North America. Roughly every ten to fifteen years water levels in these lakes peak due to increased rainfall, but at present the water levels have reached historic highs. The resulting erosion and loss of property has been devastating.

Short-term increases in local sea levels are also known to result in major coastal erosion. In 1982-83 an El Nino event released water that is normally set up in the western Pacific by the trade winds. The released water created a "wave" of sea-level rise, which first propagated eastward along the equator and then poleward along the eastern ocean margin. The increased water levels were measured by tide gauges along the west coast of South America, Mexico and the United States, and were found to range 20 to 60 cm over normal levels. Extensive erosion occurred during the several months of elevated water levels, especially in California and Oregon where intensified storm systems were also associated with El Nino.

In view of this possibility for increased sea levels within the next century, a review of the state of our understanding as to the potential effects on the world's coastlines. Such an examination should include both scientific and engineering aspects of the problem. In 1962 Per Bruun proposed a model relating shoreline erosion to a sea-level rise. Although more sophisticated models have been developed in the intervening years, only a few attempts have been made to test them with laboratory wave-basin experiments and with field measurements. It is important to examine the status of these models, and to formulate a programme of investigations for their verification or rejection. For example, one might consider the types of studies that could be undertaken on the Great Lakes, using that erosion as a prototype "experiment" for the impact of high-water levels. Other experiments might be conducted at a series of ocean sites having a range of local water-level changes brought about by different rates of land subsidence. The engineering aspects would include examination of structures and their effectiveness in the face of high water levels. Many designs have been used in the Great Lakes with varying degrees of success. There is also the danger of our coasts becoming fortified bastions in opposition to the erosion problem, with a loss of the coast's natural character and beauty. Because of this potential, special consideration should be given to restructures such as offshore submerged breakwaters, structures which could provide a satisfactory defence for coastal communities without having a major visual impact.

It is proposed that a SCOR Working Group be organized to review our scientific and engineering understanding of the processes related to coastal erosion, especially those associated with increased ocean-water levels. This already is a significant problem, and has the potential for considerable environmental, economical and political impacts in the coming century.

## ANNEX X

### ACRONYMS AND ABBREVIATIONS

AGU	American Geophysical Union
ARGOS	Satellite Location and Data Collection System (CNES and NOAA)
ASFIS	Aquatic Sciences and Fisheries Information Systems
CCCO	Committee on Climatic Changes and the Ocean (Joint SCOR/IOC)
CLS	Collecte Localisation Satellites (Service ARGOS)
CMG	Commission for Marine Geology (IUGS)
CNES	Centre National d'Etudes Spatiales (France)
COMAR	Coastal Marine Research (UNESCO)
COPE	Cooperative Oceanographic Project on Ergoclines
COSPAR	Committee on Space Research
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTD	Conductivity/Temperature/Depth
DBCP	Drifting Buoy Cooperation Panel (WMO/IOC)
ECMWF	European Centre for Medium Range Weather Forecasting
ECOR	Engineering Committee on Oceanic Research
EEZ	Exclusive Economic Zones
ENSO	El Nino - Southern Oscillation
EOS-88	International Equation of State of Seawater 1980
ERS-1	ESA's Earth Remote Sensing Satellite - 1
ESA	European Space Agency
FAO	Food and Agricultural Organization
GCM	General Circulation Model
GEBCO	General Bathymetric Chart of the Ocean
GEOSAT	A U.S. Navy Satellite
GESAMP	Group of Experts on the Scientific Aspects of Marine pollution
GF-3	IOC General Format Number 3
GIPME	Global Investigation of Pollution in the Marine Environment (IOC)
GTCP	Global Tropospheric Chemistry Program (now IGAC)
GTS	Global Telecommunication System
HPLC	High Performance Liquid Chromatography
IABO	International Association for Biological Oceanography
IAEA	International Atomic Energy Agency
IAHS	International Association of 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
ICL	Inter-Union Commission on the Lithosphere
ICSPRO	Inter-secretariat Committee on Scientific Programmes Relating to Oceanography
ICSU	International Council of Scientific Unions
ICTP	International Centre for Theoretical Physics
IGAC	International Global Atmospheric Chemistry Programme (formerly GTCP)
IGBP	International Geosphere-Biosphere Programme (ICSU)
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
IOCSOC	IOC Programme Group for the Southern Ocean
IODE	International Oceanographic Data Exchange (IOC)
IOSDL	Institute of Oceanographic Sciences Deacon Laboratory
IPO	International Planning Office (WOCE)
ISBN	International Standard Book Number
ISC	International Scientific Conference (WOCE)
ISSN	International Standard Serial Number

ITCZ Inter Tropical Convergence Zone (TOGA)  
 ITPO International TOGA Project Office  
 IUGG International Union of Geodesy and Geophysics  
 IUMS International Union of Microbiological Societies  
 IUPAC International Union of Pure and Applied Chemistry  
 JGOFS Joint Global Ocean Flux Study  
 JOA Joint Oceanographic Assembly  
 JPOTS Joint Panel on Oceanographic Tables and Standards  
 JSC Joint Scientific Committee (for WCRP - ICSU/WMO)  
 LUT Local User Terminal  
 MS Mass Spectrophotometry  
 NEG Numerical Experimental Group (TOGA)  
 NMC National Meteorological Centre  
 NOAA National Oceanic and Atmospheric Administration (of USA)  
 NSF National Science Foundation  
 OOSDP Ocean Observing System Development Programme  
 OSLR Ocean Science in Relation to Living Resources (IOC)  
 PSS-78 Practical Salinity Scale 1978  
 RNME Royal Netherlands Meteorological Institute  
 RV Research Vessel  
 SAVE South Atlantic Ventilation Experiment  
 SCAR Scientific Committee on Antarctic Research  
 SCGB Special Committee for the Geosphere-Biosphere  
 SCOPE Scientific Committee on Problems of the Environment  
 SCOR Scientific Committee of Oceanic Research  
 SEASAT Oceanographic Satellite  
 SI International System of Units  
 SPC Scientific Programme Committee (JOA)  
 SSG Scientific Steering Group (WOCE, TOGA)  
 TC Technical Committee (IOC-Ocean Processes and Climate)  
 TOGA Tropical Oceans and Global Atmosphere  
 UN United Nations  
 UNEP United Nations Environment Programme  
 UNESCO United Nations Educational, Scientific and Cultural Organization  
 URSI Union Radio Scientifique Internationale  
 WAM Wave Modelling Group  
 WCDP World Climate Data Programme  
 WCP World Climate Programme  
 WCRP World Climate Research Programme (WMO/ICSU)  
 WDC World Data Centre  
 WG Working Group  
 WGNE Working Group Numerical Experimentation (WMO/JSC)  
 WHO World Health Organization  
 WHP WOCE Hydrography Programme  
 WMO World Meteorological Organization  
 WOCE World Ocean Circulation Experiment  
 XBT Expendable Bathythermograph