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INTERNATIONAL COUNCIL OF SCIENTIFIC UNIONS

PROCEEDINGS
OF THE
SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH

September 1977
London, England
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Report of the Twentieth Meeting of the
SCOR EXECUTIVE COMMITTEE
Victoria, B.C. Canada — 18 to 21 May 1977

The Twentieth meeting of the SCOR Executive Committee was held in the new building of the Institute of Ocean Sciences of the Department of Fisheries and the Environment at Patricia Bay, Sidney, (Victoria) B.C. with the President, Dr K.N. Fedorov, in the chair. The Director-General of the Institute, Dr R.W. Stewart, welcomed the participants and a letter of welcome was received from Mr J.A. Neilson, the Chairman of the Environment and Land Use Committee of the province of British Columbia.

Before commencing the business of the meeting, the President invited the participants to stand in silence in memory of the late Professor I. Hela, Finland, who had been a member of SCOR since its formation and had contributed substantially to the work of SCOR, and to the late Dr F. Hermann who for many years had made major contributions to oceanography including the supervision of the Standard Seawater Service.

1.0 Organization and finance

1.1 Membership

National Membership:

Colombia — The Colombian National Committee had notified its intention to replace its three nominated members of SCOR.

1.2 Amendments to SCOR Constitution

At its meeting on 15 October, the ICSU Executive Committee had approved the changes to the SCOR constitution, given on page 8 of SCOR Proceedings, Vol. 12. It was agreed to invite ECOR to become a Corresponding Organization of SCOR, under article 6 (d) of the revised constitution.

1.3 Publications

a) UNESCO Technical Papers in Marine Science

No publications in this series had appeared since No. 27, reported at the SCOR General Meeting in September 1976. Because some concern had been expressed regarding the nature of some of the reports that had been published in this series, UNESCO had decided to create a sub-series — UNESCO Report in Marine Science which would carry titles of a less technical and scientific nature, such as reports of meetings organized by UNESCO and administrative or policy matters.

(b) UNESCO Monographs on Oceanographic Methodology

No. 5 Coral Reef Methods. The material for this volume was now ready for printing, subject to minor editorial corrections, and the publication was expected later in 1977. The text had been reviewed at the request of SCOR by Sir Eric Smith and Dr P. Spencer-Davies, who had offered comments on some of the contributions. They had noted that the volume consisted of a number of individual contributions which
hardly constituted a comprehensive handbook of methods and comparisons of different techniques. It was suggested that the actual title should convey the concept of contributions to coral reef methodology rather than aspire to being a comprehensive manual.

**No. 6 Phytoplankton Methods.** Dr Greta Hasle, Professor T. Parsons and Professor B. Zeitzschel had been invited to review the text for this manual when it became available.

In response to an enquiry from UNESCO, the SCOR Executive Committee advised against attempting translation of all manuals because of inaccuracies that might be introduced unless the translator was familiar with the subject. However, it was agreed that translation of some of the methodology manuals would be advantageous and SCOR would be willing to advise UNESCO, on request, concerning the possible value of translating specific volumes and would attempt to identify bilingual scientific reviewers.

The President invited members of the Executive Committee to submit to him any proposals for manuals which might arise from workshops or symposia during 1977 and 1978, it being noted that if a publication resulted from the recently established IOC group of experts on methods, standards and intercalibration in marine pollution, the monograph series might be an appropriate vehicle.

c) **International Directory of Marine Scientists**

The new international directory is now in press; a copy of the 'print-out' was available for examination. Each institute listed will receive copies of the final publication and SCOR will request FAO to send copies to each SCOR National Committee and to members of the SCOR Executive Committee. Mr Scott reported that it was intended to produce a supplement in 1978 to correct any errors or omissions which may be notified to FAO.

d) **SCOR/SCAR Polar Oceans Conference, May 1974**

A report from the editor, M.J. Dunbar, indicated that he expected authors' corrections by late May and that publication was expected in July. The publisher will be the Arctic Institute of North America, with financial support from the National Research Council of Canada, the U.S. National Science Foundation, SCOR and SCAR.

e) **BIOMASS**

The probable date for this SCOR/SCAR publication is mid-August 1977 (see item 22, under Working Group 54).

f) The SCOR Executive Committee again emphasized the need for all texts of publications arising from SCOR activities to be reviewed before being passed for printing. Professor H. Postma agreed to review the text of Professor Goldberg's volume resulting from the UNESCO/SCOR Symposium on Biogeochemistry of Estuarine Sediments and Professor Hempel accepted an invitation to act for SCOR in approving the revised text of the BIOMASS proposal.

It was agreed that SCOR needed to appoint an Executive Committee member to supervise all publications associated with SCOR and to recommend, where appropriate,
reviewers for individual volumes. It was decided that it would be desirable to coopt an additional member to the Executive Committee for this purpose under article 8 – of the revised constitution; Professor W.S. Wooster accepted an invitation to serve in this capacity.

1.4 Symposia and other meetings

The President drew attention to the difficulties experienced in some countries in enabling scientists to attend meetings called at short notice and also problems which were presented for National Committees and scientists because of the large number of organizations that arranged meetings with some interest to marine scientists. On the former problem it was agreed that announcements of symposia should normally be made at least fourteen months before the date of the meeting and formal Working Group meetings should be announced as far ahead as possible. It was not considered desirable to specify how long before a meeting of a Working Group it was necessary to make an announcement to all the members because such a ruling might destroy the flexibility which was most desirable, particularly for panel and *ad hoc* meetings.

On the question of meetings arranged by other bodies likely to be of interest to marine scientists, it was noted that the most comprehensive periodic listing of such meetings was that produced by IOC. It was suggested that National Committees might refer to those lists and if desirable bring relevant information to the attention of scientists in their country.

It was suggested that when scientists accepted membership of SCOR Working Groups their National Committees should do everything possible to facilitate their participation in meetings, even those called at short notice.

When other organizations approached SCOR for financial support for symposia, workshops, etc. organizers should be required to provide details of who had been invited and to give an assurance that adequate advance notice had been effectively distributed.

1.5 Finance

A statement of SCOR income and expenditure for the year 1976 is given as Annex II. It was noted that expenditure in 1976 was lower than usual because many activities of Working Groups had been associated with the JOA. However, it was envisaged that expenditure during 1977 would substantially exceed income but that reserve funds were adequate to cover the needs.

2.0 Subsidiary groups

Before considering the activities of existing groups, the President invited the Executive Committee to discuss procedures for considering new proposals to involve more of the national nominated members in SCOR affairs and to ensure that proposals have adequate international support before being adopted by SCOR. It was agreed that it was not possible to formulate precise criteria for SCOR activities but some general principles were agreed.

a) Although current working groups appeared to have overlapping terms of reference and some appeared to be concerned only with part of a broad subject area with which
other groups were also involved, the present system of restricting terms of reference to a topic on which some results could be produced within a few years should be retained.

b) Generally, new working groups should not be established if the only, or primary, task is to organize a symposium. This can be achieved by appointing a convenor and a steering committee. The objectives of working groups should be to generate innovative studies resulting in the production of reports and/or recommendations.

c) SCOR should only establish a working group when precise terms of reference have been agreed and names of interested scientists from at least three countries have been identified.

d) SCOR working groups normally have international and/or interdisciplinary objectives or are in direct support of affiliated organizations.

Proposals for new working groups can arise from any source. To facilitate meeting the criteria given in c) above where these were not provided by the proposer, the President would first consult with a few appropriate national SCOR members and others. Where proposals are first discussed at a SCOR Executive or General Meeting but not acted upon, they are reported in Proceedings and National Committee views are welcomed.

It was agreed that these principles be discussed further at the General Meeting in 1978.

2.1 Former groups

WG 25: Nutrient Intercalibration Experiment: The statistical analyses of the results from the 1969/70 intercalibration experiment, prepared by Dr F. Koroleff and Dr K.H. Palmork have been published by ICES as Cooperative Research Report No. 67. The report revealed wide variations between the different techniques but it was noted that many laboratories were now using auto-analysers.

Copies of the report of the 1969/70 experiment should be sent to all participating laboratories, to SCOR National Committees and to the World Data Centres.

WG 36: Coastal and Equatorial Upwelling Processes (with IABO, IAPSO and ACMRR): Dr K.N. Fedorov reported that so far he had not received from the members of the now disbanded group any commitments to write sections for the proposed comprehensive review of coastal upwelling. The only offer had been from a group of GDR scientists who proposed to write a series of papers on the west-African upwelling. The Executive Committee felt that the regional character of these proposed papers would make them more suitable for the ICES/FAO/IOC, CINECA Symposium on Canary Current Upwelling and Living Resources proposed for April 1978 rather than for the intended review. Professor G. Hempel, who was a member of Working Group 36, indicated that it would be difficult for marine biologists to write their contributions at this particular stage, and that some extended period of time would be needed for all the new ideas to take their final form. Professor T. Parsons supported this view and suggested that a section on marine biological aspects of coastal upwellings should be deferred until the contributions on physical oceanography became available. It was therefore recommended that Dr K.N. Fedorov continue his efforts to prepare a volume on physical oceanography of
coastal upwelling. The great need for such a publication was emphasized, both from the point of view of teaching and facilitating research in related disciplines.

WG 38: *Ocean Processes in the Antarctic* (with IAPSO, IAMAP and SCAR): A number of relevant documents were considered:

- Final Report of WG 38
- Report and recommendations of an informal workshop March 1977 to identify problems of the southern ocean
- Ocean Science in the Antarctic
- Proposal by Dr T. Foster concerning a Weddell Gyre project
- Summary of the International Weddell Sea Oceanographic Expedition by Dr T. Foster

In addition to the above papers, reference was made to the physical and biological oceanographic proposals contained in BIOMASS (see Working Group 54) and to the strong need for further geological and geophysical studies particularly in the area of the Weddell Gyre.

The SCOR Executive Committee recognized that there existed a number of international programmes in the southern oceans that required no assistance from SCOR but that there was a need for SCOR to take a continuing interest in this important region, and to promote specific process-oriented studies of the kind outlined in the above mentioned papers, particularly because scientific interest in the area was increasing.

It was agreed, therefore, to invite Dr T. Foster, USA to serve as convenor of an *ad hoc* review group with Dr J. Baker, USA and Professor G. Hempel, FRG and Professor P. Tchernia, France as reporter to the Executive Committee, to facilitate exchange between scientists interested in Antarctic oceanography. This would be done by correspondence and by arranging, in association with SCAR and IOC as appropriate, informal workshops to assist in joint planning of programmes and to advise SCOR from time-to-time on matters warranting SCOR attention. It was suggested that it would be useful if IOC were to compile a brief summary of on-going and planned research programmes in physical oceanography in the Antarctic.

### 2.2 Existing Working Groups

**WG 10: Oceanographic Tables and Standards** (with ICES and UNESCO)

It was agreed that, in recognition of his contributions to the activities of Working Group 10, Dr O. Mamayev, USSR, be invited to become a member of the group.

The President of IAPSO reported that following a proposal from Dr M. Menache, IAPSO had supported the use of SI Units and suggested that SCOR might consider whether or not it should issue a statement concerning the use of SI units. Some members of the Executive Committee pointed out some specific examples of difficulties which would
arise in physical and, more particularly, biological oceanography if some of the established units were abandoned but in general terms a transition to SI units was favoured. It was decided to suggest to IAPSO that Dr Menache might be invited to discuss this matter with Working Group 10 and with the President of IABO in order to clarify what statement by SCOR would be appropriate.

Arising in part from some discussions at a recent SCOPE meeting on the Global Carbon Cycle (see item 4.2 SCOPE), Professor Postma said that it was apparent that the problems of the carbonate chemistry of sea water were more complicated than had been thought. It was agreed to invite Working Group 10 to examine this problem and to consider the need for new carbon dioxide equilibrium tables.

It was noted that Working Group 10 would be meeting in Woods Hole, USA, the week following this SCOR Executive Committee meeting and that at that meeting the Chairman, Professor K. Grasshoff, would resign. The SCOR Executive Committee expressed its great appreciation to Professor Grasshoff for his work as Chairman over many years.

WG 34: Internal Dynamics of the Ocean (with IAPSO)

A report from the Chairman was received — Annex VI. It was noted that the members of the North East Atlantic Sub-group (Dr W.J. Gould, UK, Dr J. Gonella, France, Dr G. Needler, Canada and Professor G. Siedler, FRG) had become full members of the working group in 1976. Dr N.A. Phillips, USA had resigned and Professor H. Stommel, USA, had become a member.

The SCOR Executive Committee strongly supported the intention of WG 34 to undertake a study of the availability of XBT records and to investigate the possibility of WG 34 helping to organize and coordinate XBT programmes using ships of opportunity. Professor Stewart emphasized the value of XBT data in describing mesoscale phenomena, provided observational spacings were less than 100 km. The Executive Committee drew to the attention of National Committees the opportunities presented by such XBT programmes for gathering valuable data in an economic way. National Committees were asked to cooperate with Working Group 34 in utilizing FGGE research ships enroute to and from their observing areas for gathering XBT data from sparsely sampled areas of ocean. The Secretary of IOC reported that IOC was developing a Voluntary Assistance Programme (VAP) and it might be possible to arrange supply of XBTs for FGGE ships under that programme. Working Group 34 was asked to provide advice, as required, to IOC on the most effective distribution of these probes.

Working Group 34 has contributed to the preparations for the SCOR/JOC Study Conference on General Circulation Models of the Ocean and their Relation to Climate, Helsinki, May 1977, the programme for which is given in Annex VII.

WG 40: Paleo-Oceanography (with CMG)

A report from the Chairman, Professor Tj. van Andel was received. In accordance with the decisions of the XIII General Meeting of SCOR, the membership of this group had been reconstituted and was now as follows:

Tj. Van Andel (Chairman), USA; J.G. Sclater, USA; A.S. Monin, USSR; J.L. Reid, USA; K. Bryan, USA; E. Boltovskoy, Argentina; N.J. Shackleton, UK; W.H. Bé, USA; W.S. Broecker, USA; A.P. Lisitzin, USSR; and J. Imbrie, USA.
It was agreed to invite Working Group 40 to pay particular attention to three geological topics identified in Recommendation 8 of the Second International Workshop on Marine Geoscience viz

1. Marine geochronological methods
2. Cenozoic history of the ocean basins
3. Depth indicators in marine sediments

The group had not met since it had been reconstituted. Its primary task was to organize a symposium and preliminary ideas had been discussed by correspondence. As requested by the Chairman it was agreed that SCOR should support a meeting of 3 or 4 members between late 1977 and mid 1978 to discuss plans for the symposium.

WG 42: *Pollution of the Baltic* (with ICES, IAPSO and IABO):

A report of a meeting of the group, held in Charlottenlund, Denmark on 21 January 1977 in association with a workshop from 17 to 20 January on the Baltic investigations, had been distributed to National Committees on 5 April 1977. A revised version of the plans for the 1977 Baltic Open Sea Experiment (BOSEX-77) resulting from the workshop is given in Annex VIII.

A report on replies to a questionnaire to determine sources of input to the Baltic Sea and a report on the Baseline Study of the level of contaminating substances in living resources of the Baltic 1974/75 have been published in ICES Cooperative Research Report No. 63.

WG 43: *Oceanography related to GATE* (with IAMAP and IAPSO):

An international workshop on “The GATE Equatorial Experiment” was organized in consultation with IOC and WMO in Miami, U.S.A., from 28 February to 10 March 1977. The main purpose of the workshop was to review progress of work on results and manuscripts on hand, to foster the continued good relationship among the participants, and to receive additional papers that were presented. Subsequent discussions revealed many new facets of the equatorial circulation. In addition, it became evident that equatorial transient motions are far more complex than had been assumed at the time of SCOR’s last GATE Equatorial Experiment Workshop in August 1975 in Geneva. A report on the Miami Workshop will be printed by the GARP Activities Office of WMO.

The workshops participants had made recommendations regarding the publication in one journal of all papers on GATE oceanography and surface layer meteorology. Suggestions from the workshop regarding a GATE Oceanographic Atlas, together with suggestions from members of SCOR Working Group 43 and other GATE oceanographers, had formed the basis of a proposal by the Chairman of SCOR Working Group 43 which was submitted to the SCOR Executive Committee.

Professor W.S. Wooster, as SCOR Executive Committee reporter on publications, and Professor R.W. Stewart, as Executive Committee reporter for Working Group 43, were invited to review this proposal and to advise the President accordingly, especially in relation to advice to IOC concerning the GATE Oceanographic Atlas.

Members of SCOR Working Group 43 participated in informal discussions with members of the Steering Committee for the GATE Symposium on Oceanography and Surface Layer Meteorology, to be held in Kiel from 16 to 20 May 1978. A first circular announcing this
symposium will be available shortly. The steering committee expects to meet again in January 1978.

It is intended to have the last full meeting of SCOR Working Group 43 in Kiel in May 1978 during the time of the GATE Symposium.

It was noted that IOC had written a contract with SCOR for $10,000 to support GATE symposia activities in 1977.

WG 44: *Ocean Atmosphere Materials Exchanges* (OAMEX) (with IAMAP, IAPSO)

Dr R. Chesselet, France, has accepted an invitation from the President to serve as chairman of this new Working Group and the following have agreed to serve as members:

W. Broecker, USA; R. Duce, USA; J. Prospero, USA; E.D. Goldberg, USA; W. Seiler, FRG; S. Tsunogai, Japan; V. Korshz, USSR; D. Lal, India.

It is expected that the group will hold its first meeting early in 1978. The Chairman should be advised that when he requires a contribution from biological oceanographers he should communicate with IABO.

Mr Vetter reported that the background papers from the December 1975 workshop on Tropospheric Transport of Pollutants had recently been published by the US National Academy of Sciences and that the final report and recommendations from the Workshop had been subjected to review procedures and the final manuscript should be ready for printing within two or three months.

WG 46: *River inputs to Ocean Systems* (with ECOR, IAHS, ACMRR, UNESCO, CMG, IAPSO and IABO)

It was reported that UNEP had as yet made no decision on the IOC request for financial support for the proposed RIOS workshop. Having raised some questions regarding contributions to be made by IOC and other organizations, UNEP had recently indicated that the application would now be submitted to the approval committee for consideration. As a decision by UNEP could not now be expected before June 1977, the chairman of Working Group 46 and the workshop steering committee had decided to defer the workshop until May 1978.

Dr V.V. Gordeev, USSR, has been added to the membership of this group.

WG 47: *Oceanographic Programmes during FGGE* (with IAPSO and IAMAP)

The Chairman of Working Group 47, Professor H. Stommel, submitted a progress report (see Annex IX) on the activities of his working group indicating that by 15 September draft plans by all three Equatorial Panels will be combined into a single Draft Report. The Executive Committee did not share the view of the WMO EC Panel on FGGE “... that the rate at which the oceanographic programme is being developed is not commensurate with that of other elements of the Global Experiment”. In fact, the discussion demonstrated that there exists a very substantial difference in approach between modern physical oceanographers and meteorologists in formulating their respective observational programmes.
The Executive Committee of SCOR agreed to the change in terms of reference of Working Group 47 as proposed by the Chairman, so that these terms now read:

"to develop plans for comprehensive oceanographic programmes associated with FGGE and to advise other appropriate international and national bodies in the implementing of such programmes".

The group within these terms of reference will continue its activities under the chairmanship of Professor H. Stommel at least until the 14th General Meeting of SCOR. It was felt that some new ideas may result from POLYMODE and JASIN activities, and there may be a need for incorporating them in the FGGE oceanographic programmes.

The Executive Committee was informed by the Secretary of IOC that the Commission would be prepared to liaise with coastal states as needed, with a view to facilitating clearances for work in certain oceanic areas under national jurisdiction or for entering foreign ports, etc. He stressed however that action by the IOC Secretariat could not replace the normal applications for clearance made through diplomatic channels, but would be supplementary to these and would solely consist of an advisory service to coastal states to assist them in reaching decisions. He asked that for this purpose the Chairmen of the three Equatorial Panels be requested to keep the IOC Secretariat informed on a continuous basis of the planned ship movements in their areas of interest.

The IOC Secretary has already assigned the job of liaison with GAO to Mr G. Withee, and it was understood that he would be responsible later on for operational and coordination aspects of FGGE oceanographic programmes together with Dr W. Simmons, the new oceanographic programme liaison officer at GAO, Geneva. The IOC Secretary undertook to discuss the identification of primary responsibilities for these two officers with the Director of GAO, Professor B.R. Döös, and to discuss the matter further with SCOR.

It was decided to request IOC to investigate the problems of data exchange for the FGGE oceanographic programmes keeping in mind the diversity of scientific goals of the programmes' various components and the non-uniformity and individual character of data sets to be collected by different ships and institutions.

The Executive Committee noted with appreciation the effort which Professor Stommel, as chairman of the group, had devoted to the problem.

WG 48: *The Influence of the Ocean on Climate* (with IAPSO and IAMAP)

The group as a whole had not been activated, the intention being to wait and see what possible role this group might have in the light of recommendations from COG and in connection with the new WMO initiative on climate research (see p.17 on COG and p.19 item 3.1.iv on IOC). The Ocean Climate Panel of the group had continued its work and a brief report by its chairman on current activities and objectives was submitted. The final report of the panel was nearing completion and, when available, copies will be sent to members of the Executive Committee and their advice regarding publication will be sought.

WG 49: *Mathematical Modelling of Oceanic Processes* (with IAPSO)

Dr A.E. Gill, UK, had produced on behalf of Working Group 49 four issues of a modelling newsletter. The Executive Committee considered that the newsletter was of great value as an aid to communication and urged other working groups of SCOR and individual marine
scientists to make the maximum use of the newsletter by contributing notes on developments in ocean dynamics modelling.

The reconstituted Working Group 49 will hold its first meeting in Helsinki in association with the SCOR/JOC Study Conference in May 1977 at which time the panel on equatorial modelling, under the Chairmanship of Dr D. Moore (USA), will also meet.

WG 51: *Evaluation of CTD Data*

The membership of Working Group 51 has been established as follows:

J. Crease (Chairman), UK; W. Zenk, FRG; E.L. Lewis, Canada; E.A. Plakhin, USSR; P.L. Grose, USA; Dauphine, Canada; N.P. Fofonoff, USA and K. Striggow, GDR.

The Chairman has initiated the activities of this Working Group by asking his members to summarize their institute's practices regarding correction and conversion methods presently in use, has invited their views on the problems that have been encountered and has enquired regarding their willingness to participate in an intercalibration exercise should the need emerge. The Executive Committee advised that a meeting be arranged early in 1978.

WG 52: *Estimation of Micro-nekton Abundance* (with IABO, ICES, SCAR, ACMRR)

Professor W.G. Pearcy (USA) has agreed to serve as chairman of this group and the membership has now been agreed.

P.E. Smith, USA; CFE Roper, USA; T. Nemoto, Japan/SCAR; N.V. Parin, USSR; A. de C. Baker, UK; J. Porebski, Poland.

The first task will be to examine critically the various methods currently in use to sample the micro-nekton and to assess their value for biomass estimates; it will probably be necessary to set up specialist panels to examine net sampling and acoustic techniques.

WG 53: *Evolution of the South Atlantic* (with CMG):

It is now expected that the symposium being planned by Working Group 53 will be held during the International Geological Congress in Paris in 1980. W.B.F. Ryan, USA, and I. Premoli Silva, Italy, O.G. Sorohktin, USSR; B. Colette, Netherlands and P. Supko, South Africa have been added to the membership.

WG 54: *Living Resources of the Southern Oceans* (with SCAR, ACMRR and IABO)

Review of the BIOMASS proposal by IABO had led to the conclusion that while the factual part of the report was acceptable, and indeed commendable, some revision of the proposals for future work was desirable. In particular it was felt that the emphasis should lie on the study of processes rather than on the need for further survey work of the type conducted so successfully by the *Discovery* Expedition, the *Eltanin* cruises and the *Ob* etc. There was also a need to provide the IOC with an appraisal which could readily be translated into the various IOC working languages.

IABO agreed to draft an abbreviated report which could be used for this purpose and which would embody the contents of the revision of the main proposal. This would be considered by a SCOR/SCAR group of experts meeting in Cambridge (UK) in June to finalize the text...
of the BIOMASS proposal for publication. This paper, drafted initially by Professor Hempel with the assistance of Professor Parsons and Mr Currie, and subsequently amended and approved by an editorial group of Working Group 54, is given as Annex X.

WG 55: Prediction of El Niño (with IAMAP, IAPSO)

Dr J.J. O'Brien (USA) and Dr R. Parra (Colombia) had been added to the membership of the group and it was agreed to invite Professor R. Newell, USA, to become a member. A new Chairman for this group had not yet been appointed. However, Dr Ruttenberg agreed to pursue this problem further in conjunction with Dr Stewart.

The group met under the temporary Chairmanship of Dr J. Namias in San Francisco on 6 and 7 December 1976 and a report of that meeting (Annex XI) was submitted to the IOC ad hoc Intergovernmental Working Group on the Investigation of El Niño at its meeting in Callao, Peru, 13-17 December 1976. The report of the SCOR Working Group 55 meeting was discussed together with the recommendation from the IOC ad hoc Intergovernmental Working Group meeting that SCOR develops an investigation into biological indicators. Preliminary views on the recommendation from the IOC group had already been sought by correspondence from members of the SCOR Executive Committee.

It was agreed that the problem of biological indicators could best be met by inviting an experienced biologist to examine the available evidence and to advise SCOR on appropriate further action. It was proposed to invite Dr A. Longhurst to pursue this question and, if necessary, to arrange a visit by himself or another scientist to Peru and Ecuador. Regarding the request which had been contained in the IOC Resolution EC VIII.6, it was felt that the best way in which SCOR could assist in relation to the scientific content of the programme would be to make an appraisal of the existing programmes in the region and suggest kinds of projects that need to be carried out on a large scale. A physicist and a biologist would be invited to make such a review. IABO have advised that work on microheterotrophes was in progress at Kiel University and a microbiologist from Kiel will go to South America later in 1977. A meeting of Working Group 55 might be arranged later in 1977.

WG 56: Equatorial Upwelling Processes (with IAPSO, IAMAP and IABO)

Dr H. Rotschi, France, has accepted an invitation from the President to serve as chairman of this working group. Professors Hempel and Stewart have discussed with Dr Rotschi possible membership for a biological panel and a physical panel. They submitted their proposals to the President who, in consultation with the Chairman, will invite about five or six scientists to serve on each panel.

A report from the Chairman was received – Annex XII. The SCOR Executive Committee stressed the desirability of both panels meeting at the same time and place, with some joint sessions, and invited the Chairman to arrange such a meeting in 1978.

WG 57: Coastal and Estuarine Regimes (with IAPSO, ECOR and UNESCO)

With the agreement of IAPSO and the Chairman of Working Group 57, UNESCO and ECOR had been invited to cosponsor this Working Group. Both organizations had accepted the invitation; UNESCO had nominated Professor H. Postma, Netherlands as its representative and ECOR had nominated Ir H.A. Ferguson, Netherlands.

A report from the Chairman was received (Annex XIII) which included the membership of
the group. A meeting of Working Group 57 in Hamburg in November 1977 was approved. It was noted that the group was planning to join with the International Committee of Civil Engineers in sponsoring the sixteenth Coastal Engineering Conference in Hamburg in 1978 and was contemplating preparing a multi-discipline Estuarine and Coastal Conference in 1982.

It was agreed to advise Working Group 57 not to include ecological modelling in the topics for the 1978 conference but to maintain liaison with Working Group 59 with a view to arranging joint meetings at a later stage. Working Group 57 should also take note of the activities of Working Group 46.

WG 58: *Arctic Ocean Heat Budget* (with IAPSO)

SCOR had received twelve positive indications of support from National Committees and individual scientists who had been consulted about this proposal in February 1977.

It was agreed, therefore, to establish this working group with the following terms of reference:

To assess the present state of knowledge of the Arctic Ocean heat budget and the physical processes which control it.

To recommend a coordinated and international research effort to significantly improve the understanding of the heat budget and the controlling processes, taking into account the plans for the Polar sub-programme of the Global Atmospheric Research Programme.

The group will be established with an initial membership of eight, to be invited to serve by the President who will advise the group to maintain liaison with Working Group's 47, 48, 49 and COG, and may meet in late 1977.

WG 59: *Mathematical Models in Biological Oceanography* (with IABO)

Formation of this working group under the chairmanship of Dr Mann had now been accomplished. The need for close liaison with Working Group 49 and other relevant working groups was noted. Membership of Working Group 59 is as follows:

K.H. Mann, Canada, Chairman; T. Platt, Canada, Vice Chairman; J.M. Colebrook, UK; G. Radach, FRG; D. Smith, Australia; M.J. Fasham, UK; M. Vinogradov, USSR; V. Menshutkin, USSR; R. Ulanowicz, USA; F. Wulff, Sweden.

A proposal by the Chairman that an early meeting be arranged was approved.

WG 60: *Mangrove Ecosystems*

Following protracted discussions and also consultations with National Committees, IABO and others it was decided to establish this working group with the following terms of reference:

1. To produce a general scientific framework for mangrove ecosystem studies, including the need for research on structure, geographic range and ecosystem dynamics, and

2. To identify the subject content of a methodological handbook such as would be required to carry out the programme identified in item 1. above.
It was hoped that UNESCO would find ways by which an appraisal of man's impact on mangrove systems could parallel the work of the group and make it more comprehensive.

The membership of this new Working Group is to be established by the Executive Committee.

WG 61: *Sedimentation Processes at Continental Margins*

A new Working Group was established — see item 4.1 — CMG.

Other Proposals

A suggestion that a new Working Group be formed on Oceanic Fronts was deferred pending scientific discussions on this subject at the next General Meeting.

A suggestion arose during discussion — see item 4.2 — SCOPE — that a need may arise for a SCOR Working Group on the Carbon Budget of the Ocean.

A proposal for a SCOR Working Group on some aspect of coral reef studies may arise (see item 4.1 — IABO).

2.3 Committees

**Committee on Oceanography and GARP (COG)**

The SCOR Executive Committee took note of IOC resolution EC VIII.2, and the relevant recommendations from the second session of the IOC Scientific Advisory Board, April 1977. It was agreed to refer these to the first meeting of COG which will be held on 28 May 1977 in Helsinki, immediately following the SCOR/JOC Study Conference on General Circulation Models of the Ocean and Their Relation to Climate.

The Executive Committee of SCOR considered the outcome of the 3rd session of the WMO EC Panel of Experts on Climatic Change (Geneva, 21-25 February, 1977) and the proposed "World Technical Conference on Climate Change and Variability" to be held in early 1979. The Executive Committee requested the President of SCOR to draw the attention of the Secretary General of WMO to the importance of the ocean’s influence on climate and the grave implications of oceanic variability on climate changes. While changes in the ocean produced by changes of climate had already been included by the EC Panel of Experts in the scope of questions to be considered by the proposed world conference, the other side of the problem had not received enough attention from the Panel. The Executive Committee felt that both SCOR and IOC can contribute greatly to the development of research on climate changes and variability through promoting oceanographic studies which are of vital importance for climatologists. Therefore it would be appropriate for SCOR to collaborate in the preparation of the proposed World Conference on Climate Change and Variability if the scope of questions to be considered by it were enlarged in the sense indicated above. The President of SCOR should request that this matter be considered at the forthcoming 29th Session of the WMO Executive Committee.

In connection with the same subject the Executive Committee requested Dr S. Ruttenberg (IAMAP) to explore and to assess through COSPAR and relevant national authorities the availability of adequate sea surface temperature data sets on global scale which may be of potential use for climatologists (see also item 45 — COSPAR).
COG should be invited to clarify the tasks within the whole range of climate problems that were appropriate for its attention and to formulate recommendations to SCOR concerning actions which SCOR might take in relation to those aspects of the study of long term climatic change that were not considered to fall within the terms of reference of COG.

It was agreed to add Dr A. Rybnikov, USSR, to the membership of COG and to invite COG to review its membership to ensure that all relevant scientific fields were adequately represented.

2.4 Scientific rapporteur on marine pollution

Dr Dybern, the Scientific Rapporteur on pollution matters submitted a report on recent developments of interest to SCOR.

Bearing in mind that SCOR is more concerned with promoting research on fundamental oceanic processes than with applications such as pollution, there are, nevertheless, some bodies the activities of which SCOR should note and to which assistance may be given.

IOC is increasingly concerned with pollution problems. From SCOR's point of view the most important sub-group is the IOC Working Committee for GIPME, recently re-organized, which expected to play a major role in the future in coordinating and simplifying cooperative marine environmental pollution research and investigations all over the world.

Some items dealt with at the first sessions of the Working Committee for GIPME, Hamburg, 18-23 October 1976 relate more or less directly to SCOR.

FAO is engaged in some activities related to pollution interference with marine life and fisheries and is arranging training courses on aquatic pollution problems for participants from developing countries.

The Joint group GESAMP was set up ten years ago to provide scientific advice on marine pollution problems to several specialized UN agencies and the IOC. SCOR has helped by providing names of potential participants in one of its sub-groups (monitoring biological parameters of marine pollution). Since GESAMP plays a very central role in marine pollution questions SCOR should closely watch the outcome of its work.

SCOPE published last year “Environmental Issues 1976”. The book gives an account of global trends in environmental research as well as on some activities within ICSU and other bodies. Although SCOPE devotes only a small part of its work to marine environmental problems its general findings are of interest to SCOR.

The SCOR input into the ICES/SCOR Working Group on Pollution of the Baltic has been of very great importance for the aim and direction of the work of the group, which differs quite a lot from that of the parallel ICES groups on pollution of the North Sea and NEAFC area, the ICES/SCOR group having a much wider scope involving elements of basic research. For this working group to be able to complete its work, a continued SCOR input is desirable.

Dr Dybern made a number of recommendations regarding the input of SCOR to marine pollution matters. These were noted by the Executive Committee which expressed its appreciation of Dr Dybern’s assistance in these matters.
2.5 Scientific rapporteur on coastal research

Professor Postma, as rapporteur on coastal problems, was keeping all related programmes under review. He had no further proposals to offer at this stage; relevant work is being done by Working Groups 46 and 57.

3.0 Relations with Intergovernmental Organizations

3.1 IOC

i. The President of SCOR reported on the VIIIth Session of the IOC Executive Council and the 2nd Session of the IOC Scientific Advisory Board. He emphasized the requests to SCOR for scientific advice contained in IOC resolutions EC-VIII.2, EC-VIII.6 and EC-VIII.7.

ii. With regard to an offer made by SCOR to IOC to provide to the Commission scientific advice in the field of maritime meteorology, the Secretary of IOC stated that this offer had been considered together with a similar offer from WMO and the IOC EC decided that IOC preferred to remain free to seek meteorological advice from either of the bodies proposed (or from any other competent scientific organization).

iii. The President of SCOR indicated that there was clearly some duplication of effort between SCOR and the Scientific Advisory Board (SAB), by the reviewing of CINCWIO recommendations. Reviewers for these recommendations had been appointed by both SAB and SCOR. The latter had been requested to do so by the VIIth Session of the IOC Executive Council while the first acted on its own, within the broad mandate given to it by the Commission.

The President of SCOR also suggested that an important function for SAB might be to formulate more precisely the requests for scientific advice from IOC and its Executive Council. It was suggested that a more appropriate title for this Board might be Scientific Review Board.

The SCOR Executive noted that the SAB had felt that whilst problems in geophysics had been adequately identified by the Marine Geoscience Workshop, there was a need for further development in marine geology. It was pointed out that actions determined by CMG – see section 4.1 – included a number of geological elements.

iv. A request from the IOC Secretariat for scientific advice had been received by SCOR in connection with the WMO proposal to promote research on climate and to organize a World Technical Conference on Climatic Change and Variability in 1979. The substance of the advice given in response to that request is contained in the letter from the President of SCOR to the Secretary of IOC dated 1 April 1977 (see Annex XIV). In this connection another letter was written by the President of SCOR to the Secretary General of WMO (see p.17 on COG).

v. With regard to the requests to SCOR from the 1st Session of the IOC Working Committee for GIPME the Executive Committee of SCOR felt that:

a) A workshop on marine pollution in the Southern Oceans was not appropriate at the present time in view of the limited information now available.
b) The newly established IOC Group of Experts on methods, standards and intercalibration in the field of marine pollution (IOC resolution EC-VIII.3) would be an appropriate body to handle all problems related to the methodology of marine pollution research. SCOR would be willing to provide its advice on more specific requests.

c) SCOR WG’s 42, 46, 49, 57 and 59 should be invited to comment on the possible value of modelling in relation to marine pollution problems and the advice of Dr B. Dybern be sought.

vi. The President of SCOR reported on requests from the IOC Secretariat (dated 11 October 1976 and 7 February 1977) for advice in connection with the future of LEPOR. The President of SCOR summarized comments received from the members of the Executive Committee on the suggestions that a new “Ponza-type” activity be planned for either 1977 or 1978. These comments were essentially of these following three categories:

– If we knew the purpose of the suggested new “Ponza-type” activity we should know how to organize it best.

– Workshops within particular disciplines are more efficient in reviewing progress and formulating plans than any multi-disciplinary activities run for the same purpose.

– At present, money and qualified manpower in science are lacking, rather than scientific ideas and programmes. Therefore experts should spend their time doing science directly rather than organizing it.

The Executive Committee was informed by Professor W.S. Wooster than in the United States planning for post-IDOE programmes was presently underway and that reports could be made available to SCOR as they were published.

It was agreed that National Committees be invited to identify major fields of marine science which they felt should receive emphasis in the 1980s. To assist in this task it was agreed to refer them to the ‘Ponza’ report (Global Ocean Research) and the comprehensive outline of the scope of LEPOR [IOC Technical Series No. 7].

vii. The Executive Committee of SCOR, on the invitation of the Chairman of IOC, briefly discussed a number of problems related to the future role of IOC. Members of the Executive Committee were unanimous in recognizing that there exists in the world oceanographic community a definite need for an active and authoritative intergovernmental body like IOC. Specific functions today differ somewhat from those given to the IOC seventeen years ago, in particular, because of the implications of the growing interest of developing countries in the economic potential of the ocean and in connection with the Third UN Conference on the Law of the Sea. However, the principal statutory purpose of IOC, to promote oceanographic research through concerted action of its members, will undoubtedly remain unchanged.

The Executive Committee of SCOR was not prepared at this stage to offer any definite recommendation as to the best way for the IOC to adjust its activities and methods of operation to the changing scientific and political situation, but a number of suggestions were offered to the Chairman of IOC for his consideration.
viii. GEBCO - The Secretary of IOC distributed a brochure on the 5th edition of the General Bathymetric Chart of the Ocean, and Dr Simpson, Chairman of the Joint IOC-IHO Guiding Committee for GEBCO, described the present state of preparation and publication. Sixteen sheets on Mercator Projection covered the region 72°N to 72°S and two sheets on a polar stereographic projection covered the polar regions down to 64° latitude. Sir George Deacon pointed out that the Antarctic sheet, to be of any use to physical oceanographers and biologists, would need to extend to 35°S and while it might not be possible to achieve this at the moment it should be an ultimate objective and the strongest representations should be made to the GEBCO Guiding Committee.

ix. The Secretary of IOC reported that IOC had recently undertaken a review of availability of multi-lingual glossaries of marine science terminology and 93 such glossaries had been identified. This preliminary review had been discussed at the Eighth Session of the IOC Executive Council. The IOC Secretariat was now engaged in further work and expected to produce a revised version in due course.

The SCOR Executive suggested that it would be useful if a list of titles of the glossaries could be made available at an early date, and an improved and extended review be published subsequently, perhaps as an IOC Technical Paper.

x. Attention was drawn to the fact that preparations for the CCIR of ITU Conference in September 1977 on allocation of radio frequencies had not included any special group for oceanography. Matters concerning the use of radio frequencies for oceanographic purposes were the direct concern of a subcommittee of the IOC Working Committee for IGOSS. It was suggested that IOC might consider proposing to ITU the establishment of a Working Group for oceanography for the next CCIR Conference.

3.2 UNESCO

i. Biogeochemistry of Estuarine Sediments

This *ad hoc* panel, set up at the request of UNESCO, had been notably successful in organizing a workshop which had resulted in the preparation of a 400 page volume under the editorship of the convenor, Professor E. Goldberg. In the interests of having an independent appraisal, Professor Postma was asked to look over the volume prior to publication.

ii. Coastal Lagoons

Dr Steyaert reported on the results of the UNESCO enquiry on research activities in coastal lagoons. The response had been encouraging but few replies had been received from North America or the USSR. Dr Steyaert announced that UNESCO was planning to hold a conference on Coastal Lagoons in 1979.

A discussion ensued on the contribution which SCOR might make in the future. Reservations were expressed about the whole concept of identifying coastal lagoons as specific objectives for research, for one thing because of the difficulty of defining the limits of such a system. The relevant processes, which seemed the main area in which SCOR could usefully contribute, were in many ways relevant to a wide variety of coastal environments from lagoons to bays, estuaries, fjords, etc. It was suggested that UNESCO might define clearly what they meant by coastal lagoons or use some other, more precise, description. An *ad hoc* panel has been set up under the chairmanship of Dr Phleger to
advise SCOR on their future involvement. A particular topic being considered was the interaction between coastal waters and the adjacent seas with particular reference to fish and other animals which spent their early life in the region but contributed in the adult stage to commercial fisheries further offshore.

iii. Phytoplankton Pigments

Plans to undertake some intercomparisons of fluorimetric and spectrophotometric techniques by Dr K. Lorenzen and Dr S. Jeffrey had been delayed as a result of Dr Jeffrey's move to the laboratory at Cronulla. It was anticipated, however, that the work would go ahead later this year or in early 1978. A suggestion from Dr K.H. Szekielda that a chapter on the Determination of chlorophyll from space be included in any new manual had been conveyed to Dr Jeffrey.

iv. International C-14 Agency (Carbon-14 Centralen)

Following a request from the 13th General Meeting of SCOR, IABO had examined the needs of the agency. Professor Parsons reported that IABO strongly recommended continuing international support for, and interest in, the work of the agency. Danish charitable foundations had made grants to the agency which were adequate to support its regular operations, and IABO considered that requests for international funding should be limited to project/specific proposals, such as apparatus. The Agency was contemplating undertaking a comparison between their own ampoules and other ampoules, used on major expeditions and in other laboratories, for which there was a need for a suitable incubator. On advice from IABO, SCOR strongly supported this proposal and urged UNESCO to give favourable consideration to an application from the Agency for a grant of $5000.

3.3 FAO/ACMRR

ACMRR had been invited to cosponsor Working Group 56 but the invitation had not yet been accepted.

3.4 WMO

No matters were discussed, other than those reported under items 2.3 (COG) and 3.1 (IOC).

3.5 ICES

At its last Statutory Meeting, ICES had decided to undertake a review of its structure in order to ensure its continued effectiveness as a scientific organization under the changing situation in world marine affairs. Suggestions had been sought from ICES members and would be discussed further by the ICES Bureau at its meeting in June/July 1977. Professor Hempel reported that ICES was planning a symposium on the early life history of fish to be held in late 1979. It was agreed to accept an invitation from ICES that SCaR co-sponsor this symposium.

3.6 I.H.O.

The 11th International Hydrographic Conference had been held in Monaco from 18 to 30 April, 1977. SCOR's interest had been represented by IAPSO.
4.0 Relations with Non Governmental Organizations

4.1 Affiliated organizations

CMG

Dr R. Scrutton, UK, had been appointed secretary of the Commission on Marine Geology of IUGS.

Professor Simpson noted that large areas of the marine geological field were adequately covered by IUGS, IUGG, etc. but the role which SCOR could play in interdisciplinary aspects of marine geology was highly valued. CMG had further reviewed the recommendations from the Second International Workshop on Marine Geoscience, Mauritius, August 1976 and, taking into account suggestions from Professor E. Seibold, the following actions were noted or agreed:

Workshop recommendation 5.
CMG is organizing a symposium on Passive Margins of the Indian Ocean (convenor C. von der Borch) during the IUGG General Assembly, Canberra, December 1979. CMG and ICG WG8 were organizing a symposium on "The Continental–Oceanic Crustal Boundary at Passive Margins" in Halifax, Nova Scotia in June 1978 (Convenor C. Keen).

Workshop recommendation 7.
SCOR will appoint, in consultation with CMG and IAPSO, a steering committee to organize a symposium on Oceanic Crust and Seawater Interaction to be held during IUGG/IAPSO. A number of names were proposed.

SCOR, with CMG, will establish a working group (no. 61) on Sedimentation Processes at Continental Margins with the following terms of reference:

To review existing knowledge of sedimentation processes at continental slopes and margins; to recommend long-term measurement devices for current turbidity, accumulation rates and other relevant parameters; to recommend coordinated quantitative determinations of suspended and accumulated materials; to define a few experiments in key areas on both eastern and western sides of oceans.

Professor Postma and Professor Simpson were invited to discuss possible membership and to advise the SCOR Executive Committee accordingly. Professor Simpson will serve as Executive Committee Reporter for this new group. Professor Postma and Professor Simpson were invited to discuss further, in consultation with ECOR, the need for a symposium and/or a working group on High Energy Environment and Sediment Management Problems and to advise the SCOR Executive Committee on appropriate action for SCOR.

Workshop recommendation 8.
As reported earlier, Working Group 40 has been asked to pay particular attention to marine chronological methods, cenozoic history of the ocean basins and depth indicators in marine sediments.

CMG was invited to take note of the recommendation concerning marine geoscience from the IOC Scientific Advisory Board.
IABO

The President of IABO announced that plans were progressing satisfactorily for the Symposium on Coastal Problems which was being convened by Dr J. Costlow and would be held at Bahia, Brazil, in December 1977.

Enquiries about the desirability of holding a symposium on biological indicators had indicated some lack of enthusiasm but the issue was still being considered and it seemed that the Planktological Society of Japan might in fact arrange a national symposium.

The President of IABO invited SCOR to consider the formation of a working group on some aspects of coral reefs. The need for giving attention to this subject arose from the impact of man’s activities on reefs. It was hoped that further discussion on the occasion of the Third International Symposium on Coral Reefs might identify suitable terms of reference for a SCOR working group in which case IABO would inform the Secretary of SCOR who would circulate the proposal to national committees for comment before EX 21.

An IABO Standing Committee on Coral Reef under the chairmanship of Professor F. Talbot (Australia) had been formed to provide mechanisms for planning future coral reef symposia.

IAMAP

Dr S. Ruttenberg reported that the major activity of IAMAP in 1977 was in connection with the Joint IAGA/IAMAP Assembly which would be held in Seattle 22 August to 3 September. The GARP Air-Sea Interaction Sub-programme would feature and 23 papers on the AMTEX (Air Mass Transformation Experiment) had been contributed.

IAMAP was also joining with IAPSO in plans for the next IUGG Assembly at Canberra in December, 1979. Chemical evolution of the oceans, atmosphere and sedimentary shell during the earth’s history, and the mixed layers of the ocean and atmosphere were favoured topics.

The next IAMAP Assembly will take place in 1981, the site of the Assembly will probably be decided at the IAMAP Assembly, Seattle, August 1977.

A report on IAMAP activities of interest to SCOR is given as Annex XVII.

IAPSO

The report of IAPSO which unfortunately due to mailing delays could not be included in the Proceedings Volume 12, is now reproduced, updated, as Annex XVI.

SCOR had been invited to cosponsor with IAPSO, a Workshop on Oceanic Turbulence in April-May, 1979. About 30 invited experts would participate and the main theme would be on the interaction of oceanic motions on different scales in the range millimetres to megametres. Kiel seemed to be a likely location.

The Secretary of IOC had already been approached and had stated that provided the workshop met the criteria for IDOE programmes (see IOC Technical Series No. 13), and funds were available which he confidently expected, IOC would be able to give support. SCOR agreed to cosponsor the workshop and invited interested countries to designate it as an IDOE programme.
The President of IAPSO reported that he was not yet in a position to submit a detailed proposal concerning a workshop in 1978 on the Physics and Chemistry of Suspended Particles in the Ocean, although IAPSO continued to be willing to take the initiative when details had been elaborated. Professor Postma stated that Dr Gieskes and Dr Chesselet had conducted some preliminary correspondence with interested scientists and he was invited by the Executive Committee to pursue the matter with these two scientists.

4.2 ICSU

Attention had been drawn by ICSU to the preparations for the forthcoming United Nations Conference on Science and Technology for Development. It was understood that there would be a call for national papers through the UN system and it was apparent that whether or not marine science would be featured at the Conference would be dependent upon the content of the national papers. The SCOR Executive Committee was of the opinion that in the long term emphasis on marine science would be of benefit for development and drew the Conference to the attention of National Committees.

4.3 ICSU Committees

SCOPE

Professor Postma had attended the SCOPE workshop on the World Carbon Budget in Hamburg in March 1977. This had proved to be an interesting, informative and important discussion, the report of which should be sent to SCOR National Committees. Among issues which were highlighted, Professor Postma reported that concern had emerged about the validity of the currently accepted carbon dioxide equilibrium tables (see under Working Group 10).

Discussions were focussed on the fate of the excess CO$_2$ produced by man’s activities and it is evident that the ocean is the only major sink so that a good deal of attention was paid to this system. It was unfortunate that few oceanographers had been invited to the SCOPE meetings. If was agreed to inform SCOPE of SCOR’s interest in this subject and desire to be kept informed. If required, SCOR would consider establishing a working group on the carbon budget of the ocean.

SCOPE’s interest in the carbon budget is part of a wider study of biogeochemical cycles, studies of the total cycles of nitrogen, phosphorus and sulphur have already been published. Professor Goldberg continues to liaise with SCOPE in these matters.

An invitation had been received from SCOPE to participate in an open meetings of the SCOPE Executive Committee in London, 4-5 October, 1977 and it was agreed that SCOR should be adequately represented at the meeting.

COSPAR

In connection with an invitation to SCOR to be represented at the XXth Plenary Meeting and Associated Symposia of COSPAR (Tel-Aviv, Israel, 7-18 June 1977) a discussion took place on the desirability of SCOR’s greater involvement in promoting various uses of remote sensing techniques in oceanography. The Executive Committee felt that in future there should be more opportunities for satellite operators and interested oceanographers to get together and to explain to each other the constraints, requirements and opportunities involved. Information was received on a symposium on “Passive Radiometry of the Ocean and Atmosphere”
to be held in Victoria, B.C. Canada in May 1978, as a follow-up to the IUCRM Colloquium in Hamburg, 29 September-2 October, 1976. The topics for discussion at the proposed symposium will include:

- Infrared and microwave radiometry for sea surface temperature determination.
- Measurement of temperature and humidity profiles in the atmosphere by infrared or microwave radiometry (both up and down looking)
- Sea state, wind and salinity measurements by passive microwave radiometry
- Water colour measurements (optical radiometry) for chlorophyll determinations.

The Executive Committee hoped that Dr D.E. Cartwright, who represents SCaR interest in COSPAR, would attend this symposium. There may also be a need for greater involvement of SCaR in the preparatory work for it. This question may later on be resolved through correspondence.

The Secretary of IOC informed the Executive Committee that IOC had recently published “The Manual of Interpretation of Orbital Remote Sensing Satellite Photography and Imagery for Coastal and Offshore Environmental Features”. National Committees were asked to convey comments on this publication to Dr S. Ruttenberg (IAMAP) who undertook to review it in cooperation with Dr D.E. Cartwright and to submit a report to the next meeting of the Executive Committee on further steps needed to provide oceanographers with the necessary information on sources and availability of oceanographically useful satellite data and on the methodology of their interpretation. Dr Ruttenberg was also requested to look after SCOR interests at the XXth COSPAR General Meeting in Tel-Aviv, June 1977.

4.4. Other Organizations

ECOR

In his paper on Ocean Instrumentation, presented at the ECOR Technical Session on Ocean Engineering during the JOA, W.M. Nicholson had proposed that ECOR sponsor regular international workshops including both scientific and engineering groups involved, to address these problems. The first such meeting will be an international workshop on ocean instrumentation to be held in Washington, USA, from 1-3 May 1978.

The 3rd General Assembly of ECOR will take place in Washington, D.C. 3-6 May 1978. The theme of the Assembly will be “Critical Elements in the exchange of Ocean Engineering Technology”, with emphasis on three topics: the differing needs for ocean engineering technology exchange; training and educational aspects to encourage technology exchange; and national and international capabilities, limitations and problems in effecting technology exchange.

5.0 Joint Oceanographic Assembly 1976

Opinions on the organization and conduct of the JOA had been received from a number of national committees. By and large these were in agreement with the views already expressed by the Executive Committee (SCOR Proceedings, Volume 12) although in some aspects opinions diverged widely. There was unanimous support for the usefulness of the poster.
sessions, which were felt to be excellent and "here to stay", although a minority classed them “of limited interest”. There was some criticism of lead papers being too general and insufficiently innovative, qualities very difficult to avoid in such a broad meeting.

Perhaps the most serious criticism, however, concerned presentation. Many of the papers were unintelligible to non-English mother-tongue participants, others were illustrated by illegible slides. Such problems present the organizers of future assemblies with a serious challenge.

Suggestions from National Committees should be retained for consideration by the organizing committee for the next JOA. It was generally agreed that this should take place in another five or six years.

One of the greatest problems of JOA 1976 was the very large number of ancilliary meetings which were called during the two weeks. At future assemblies, such meetings should be kept to a minimum unless they are held before or after the programmed sessions. The other main complaint was that there was insufficient time for the poster sessions which should be in the main circulating area for future assemblies.

6.0 Future SCOR Meetings

6.2 Twenty-first meeting of the Executive Committee

An invitation had been received from Professor A.G. Ferri, Director of the Institute of Oceanography of the University of Sao Paulo, to hold the next meeting of the Executive Committee in Sao Paulo in January 1978. Professor Ferri's invitation was accepted by the committee.

6.2 14th General Meeting

A number of topics for the content of the scientific symposium at the 14th General Meeting had been proposed by National Committees. Of these, two topics, the Ocean and Climate, and Oceanic Fronts, were considered possibilities. After discussion, it was felt that more new and interesting material was likely to arise from an interdisciplinary discussion of Oceanic Fronts and this topic was selected.

Professor Tchernia undertook to explore the possibilities of holding the meeting in France, in early November 1978, and the President will prepare more detailed suggestions for the scientific programme for consideration at the next Executive Committee meeting.
## List of Participants

**Twentieth SCOR Executive Committee Meeting**

### Members of the Executive Committee

<table>
<thead>
<tr>
<th>Name</th>
<th>Nationality</th>
<th>Role</th>
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<tbody>
<tr>
<td>Dr K.N. Fedorov</td>
<td>USSR</td>
<td>President</td>
</tr>
<tr>
<td>Professor H. Postma</td>
<td>Netherlands</td>
<td>Past President</td>
</tr>
<tr>
<td>Professor G. Hempel</td>
<td>FRG</td>
<td>Vice President</td>
</tr>
<tr>
<td>Professor P. Tchernia</td>
<td>France</td>
<td>Vice President</td>
</tr>
<tr>
<td>Mr R.I. Currie</td>
<td>UK</td>
<td>Secretary</td>
</tr>
<tr>
<td>Professor E.S.W. Simpson</td>
<td>IUGS/CMG</td>
<td>Ex Officio</td>
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<tr>
<td>Professor T.R. Parsons</td>
<td>IUBS/IABO*</td>
<td>Ex Officio</td>
</tr>
<tr>
<td>Dr R.W. Stewart</td>
<td>IUGG/IAPSO</td>
<td>Ex Officio</td>
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<tr>
<td>Mr S. Ruttenberg</td>
<td>IUGG/IAMAP</td>
<td>Representing Professor</td>
</tr>
<tr>
<td>Mr G.E. Hemmen</td>
<td>UK/SCAR</td>
<td>Assistant Secretary</td>
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### Other participants

<table>
<thead>
<tr>
<th>Name</th>
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<tr>
<td>Sir George Deacon</td>
<td>UK</td>
<td></td>
</tr>
<tr>
<td>Dr W. Hay</td>
<td>USA</td>
<td>Chairman, IOC†</td>
</tr>
<tr>
<td>Dr G.F. Humphrey</td>
<td>USA</td>
<td>IOC</td>
</tr>
<tr>
<td>Mr D.P.D. Scott</td>
<td>USA</td>
<td>UNESCO</td>
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<tr>
<td>Dr M. Steyaert</td>
<td>USA</td>
<td></td>
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<tr>
<td>Mr R.C. Vetter</td>
<td>USA</td>
<td></td>
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<tr>
<td>Professor W.S. Wooster</td>
<td>USA</td>
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</table>

*Professor Parsons also represented the Canadian National Committee*

†Dr Humphrey also represented the Australian National Committee
### STATEMENT OF SCOR INCOME AND EXPENDITURE
(1 January – 31 December 1976)

#### Balances 1 January 1976

<table>
<thead>
<tr>
<th>Location</th>
<th>Reserve Fund</th>
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<th>London</th>
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<td>London</td>
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#### Income

- **National Contributions**: $36 900.00
- **Contracts**
  - UNESCO Regular Contract 1975 final: $2 000.00
  - IOC Regular Contract 1975 final: $2 000.00
  - UNESCO Regular Contract 1976 first: $7 000.00
  - IOC Regular Contract 1976 first: $10 000.00
- **Interest on deposit account**: $1 846.61

**Total Income**: $120 008.45

#### Expenditure

- **Scientific Activities**
  - Working Groups
    - 29: $10.07
    - 34: $3 051.30
    - 36: $567.61
    - 42: $833.74
    - 43 (including GATE meetings): $2 883.39
    - 46: $4 609.68
    - 54: $2 076.16
    - 55: $1 167.53
  - Estuarine Sediment Biogeochemistry workshop: $1 394.85
  - Recent & fossil marine diatoms: $205.54
  - Phytoplankton methods: $124.54

- **Representation at other meetings**
  - Radio Oceanography symposium (IUCRM): $390.81
  - IOC EC VII: $1 649.42
  - GIPME/Marine Pollution: $1 104.05
  - GARP/FGGE: $577.29
  - GEBCO: $130.45

- **Publications**
  - SCOR Proceedings: $1 780.06
  - IABO Proceedings: $1 260.00
  - Polar Ocean Conference: $2 500.00

- **SCOR Meetings**
  - Officers: $617.30
  - GEN XIII and JOA: $2 649.88

- **Administration**: $5 936.92

- **Loss on exchange/bank charges**: $154.12

**Balance 31 December 1976**

- Funds held by ICSU Paris: $8 823.62
- Funds held by SCOR London: $12 284.01

**Reserve fund**: $63 226.11

**Total**: $120 008.45
1. Introduction

The objectives of the SCOR Working Group 38 — Ocean processes in the Antarctic — are given in the terms of reference, i.e.:

"To recommend observational and theoretical studies to facilitate the design of a major study of the circulation of the Antarctic oceans. The group will take into account the findings of Working Groups 34 and 48 and integrate their recommendation with the plans of Working Group 47."

WG 34: Internal Dynamics of the Ocean.
WG 47: Oceanographic Programmes during FGGE.
WG 48: The Influence of the Ocean on Climate.

After the first brief meeting held in Buenos Aires (July 1974) the group members have expressed their ideas on pertinent programmes in letters which have been circulated among the group members. These documents formed the background for the discussion during the meeting held in Grenoble, 1 September 1975. A final meeting of the group was held at I.O.S. Wormley, 15-16 March 1977.

After considering the growing number of national and international plans for work in the southern oceans, the group felt that many problems remained, but the group was not able to comply satisfactorily with the terms of reference as given above. It seemed apparent that a comprehensive study of the circulation of the Antarctic oceans would not be possible in the foreseeable future because of the limitation of available resources.

The group agreed that the descriptive studies should be completed, but in the future more emphasis should be placed on theoretical and special problem-oriented programmes. It was furthermore recommended that all field programmes should be based on sound theory in order to ensure sampling on proper time and space scales.

Due to the large scales in space and time involved in the processes in the Antarctic oceans, it is convenient to list the recommended programmes under four different headings, with no priority to the sequence:

1. Antarctic Circulation
2. Frontal Zones
3. Water masses
4. Special processes

1.(a) There is already an existing programme to measure drift paths of icebergs which is a step towards understanding the coastal water transport on a large scale. The group recommends a continued and expanded programme, including measurements of air pressure, air temperature and if possible wind speed and direction. Both theory and observations are needed to
determine the response of icebergs to air and water movements. This programme should also be coordinated with programmes on katabatic wind investigation.

1.(b) Drifting buoys (preferably with drogues) have potential capacity to give information on water movements. Therefore considerable study should be made to determine both the behaviour of the buoys and the appropriate time and space scales for their deployment. More work is needed on interpretation of data from drifting buoys.

The following measurements from buoys are considered important:

1. Air pressure
2. Air temperature
3. Sea surface temperature
4. Subsurface temperatures
5. Salinities

1.(c) There are indications that the circulation in the area 30° – 60°E south of 50°S may be associated with or part of the Weddell Sea gyre. It is possibly also important to the distribution of krill.

The Antarctic Circumpolar Current has been the subject of many investigations and is currently being intensively studied in the Drake Passage region. The role of the gyres to the south of the Antarctic Circumpolar Current has not been thoroughly investigated. In particular, the large gyre in the Weddell Sea may play an important part in the Antarctic circulation and in bottom water formation. Two aspects of the Weddell Sea gyre are of particular interest: the total transport in the gyre, and the eastern extent of the gyre. It is suggested that a line of current meters across the Weddell Sea from the South Orkney Islands to Cape Norwegia be set out for a one-year period. These current measurements should be supplemented by hydrographic surveys along the section at both ends of this period. Hydrographic surveys and current measurements should also be made in the eastern end of the Weddell Sea gyre believed to extend to about 30° to 60°E south of about 50°S.

1.(d) Extensive monitoring programmes and plans exist for studies on the circumpolar current. The long term variability of the circumpolar current is considered to be of importance to the total global circulation. We therefore consider it important to continue the existing monitoring programmes and encourage long term monitoring of additional sections. This should be an appropriate supplement to the FGGE programme.

2. Frontal Zone studies

The frontal zones in the Antarctic regions have shown considerable variability in space and time. We encourage the continuation of the several pertinent existing and planned programmes. In addition we encourage development of observation programmes using aircraft, satellites and possibly supply ships. Using all these methods would provide information on a variety of time and space scales.

3. Water masses

The Working Group 38 encourages the existing and future programmes designed to study the following topics related to the water masses:

A. Processes leading to the formation of water masses.
B. The continuity and the variability in time and space of water mass formation and movement.
Very few oceanographic winter data from the Antarctic regions exist, mainly due to severe ice conditions which make these areas inaccessible for a large part of the year. In order to understand water mass formation a much broader based year round data base is required, especially from the regions assumed to be of importance to bottom water formation (such as Weddell Sea, Ross Sea and other shelf regions). We suggest that serious consideration should be given to the following techniques for obtaining winter data:

A. Manned drifting stations.
B. Telemetering ice station equipped with oceanographic sensors.
C. Aircraft, either to bring manned stations to the ice, or equipped with remote sensors.
D. Automatic stations moored under the ice cover.
E. Satellite imagery.

Plans and programmes exist which will provide information on the formation of deep water and bottom water in the Weddell Sea. It is recommended that a programme be developed to determine their formation rates. Studies on long time variability are important and measurements should be carried out over periods of years.

Bottom water is believed to form in the Weddell Sea in the region near the shelf break west of somewhere between 30°W and 40°W. In order to investigate the mixing processes leading to bottom water formation, it is proposed that a multi-ship expedition carry out detailed hydrographic surveys of this area in successive years and the currents and temperature fields should be monitored between surveys.

4. Special processes

4.(a) Ice shelf/seawater interaction

The Antarctic ice shelves provide unique thermodynamic conditions by acting as substantial heat sinks at water depths to about 500 m. There are studies on the effect of the ice shelves on the ambient water masses. It is furthermore believed that processes near the ice shelves are important to the vertical circulation. We therefore encourage the continuation of such studies.

4.(b) Mixing processes and dynamics near the continental margins

The processes at the continental slope region are thought to have an influence on water mass formation and deep circulation in general. We recommend the implementation of appropriate programmes in selected regions.

5. Conclusions

Although a number of important problems have been identified, dealing with ocean circulation, climate and living resources, none of them are likely to be tackled by existing SCOR Working Groups.

The group therefore recommends that SCOR should appoint a convenor and a small nucleus of scientists with wide interests in the Southern Ocean to organize periodic workshop meetings on different topics. This proposal is dealt with in the report of meeting 15-16 March 1977 at I.O.S. Wormley, UK.

T. Kvinge
Chairman WG 38
SCOR WORKSHOP ON
IDENTIFYING PROBLEMS OF THE SOUTHERN OCEANS
Wormley, UK
15-16 March 1977

Participants:

T. Kvinge (convenor), G.E.R. Deacon, T.D. Foster, P. Tchernia, P.M. David, A de C. Baker,
J.C. Swallow, V.T. Neal, P.D. Killworth

On 15-16 March 1977 a group of oceanographers, including members of the former
SCOR Working Group 38 met at the Institute of Oceanographic Sciences, Wormley, UK,
with the purpose to promote investigations of important aspects of Antarctic Oceanography.

Because of the importance of the Antarctic circulation to the other oceans and to world
climate, as well as to the marine living resources, and growing pressure for their exploitation,
the group recommends that SCOR should find the mechanism for keeping Antarctic prob-
lems permanently in mind.

It was felt that an efficient method would be to maintain a small group of scientists
with wide and active interests in the Southern oceans. This might best be done by appointing
a convener or small nucleus of scientists whose function would be to identify and recommend
important problems which would profit from SCOR attention.

During the meeting discussions of this type were initiated and the following emerged:

1) Studies of the Antarctic circulation by tracking icebergs by means of satellite trans-
ponders. This project requires studies of factors such as: geometry of the icebergs, wind,
current, pack ice and bathymetry which may determine the movements of the icebergs.

2) The Weddell Gyre project. This is a multidisciplinary approach to the problems of a
large part of the southern ocean between the eastern side of the Antarctic Peninsula and the
Kerguelen Plateau. Because of the large area involved the problems require international
cooperation.

3) Studies of the polar front region with the view to determine the meridional and
zonal transport and the mechanisms involved. This would necessitate both long term
monitoring of currents and water masses in a few selected locations and also short term
detailed studies of the exchange mechanisms.

The projects selected are representative of problems of interest in the Antarctic. We
believe that SCOR can contribute to their success.

These problems represent three different stages of progress, and therefore require
three different timescales of action.

Project No. 1 has been in progress since 1972, international cooperation is urgently
needed for continuation and expansion of this programme.
Project No. 2 Because of the long time needed to obtain logistic support an early meeting of a planning workshop to formulate the scientific programmes is a matter of urgency. We suggest that SCOR support such a workshop.

Project No. 3 This is an ongoing project and a large extension is desirable. We recommend an early meeting to discuss the feasibility of such an operation.

If SCOR finds that such suggestions are helpful, it may wish to continue to support informal meetings (such as this) in which Antarctic problems can be discussed.
OCEAN SCIENCE IN THE ANTARCTIC

Presented to SCOR by Sir George Deacon

The problems are wide ranging. Many of them are summarized in planning documents such as those of the National Academy of Sciences. The purpose of the present draft is to make out a case for some fairly approachable biological and physical problems likely to prove immediately rewarding, mainly to do with krill.

1. Krill

In spite of what is sometimes written, a good start has been made — sufficient to give direction and promise to new work. The principal features which distinguish the successive stages of krill, from egg to adult, have been described. We also have broad outlines of their distributions, and reasonable working hypotheses about how the population is maintained. The *Discovery* reports give a clear indication that krill reproduce most successfully in the east wind drift, along the Atlantic continental margin, but grow to largest size where they are carried northwards by branches of the current, particularly by the Weddell Sea current, but also near the Kerguelen-Gaussberg ridge and north of the Ross Sea. It has been suggested that the distribution of pack ice may determine that of the krill, but this may only be so because the ice distribution runs parallel to that of the cold water of the east-wind drift and its northward branches. In winter the main areas of krill distribution are frozen over, except for parts of the northern fringe, but later on the krill is left in open water. The ice may give some protection again predators: divers see krill sheltering in cavities in its under surface; a ship ploughing through pack, up-ending small floes, throws out krill, or makes them jump out, so that they land kicking on the ice, well above the water surface. They may also congregate below the ice to feed on the phytoplankton which seems to be concentrated there, possibly because there is a fairly stable environment and just enough light. The main phytoplankton outburst required to support growth and spawning seems to occur when the ice melts, letting in more light; the outburst must also be helped by stable surface layering promoted by the release of fresh water.

Full understanding of the spawning and hatching of the krill eggs, and development of the larval stages, is clearly essential to a general picture of the krill distribution and its apparent relationship to the currents and water masses. The comprehensive summary by Marr (1962) leaves little doubt that the gravid and spent females are found mostly near the surface, at least within the first 100 m or so, and that their eggs are laid there. The number of eggs collected is small in relation to the number of nets hauled, and remarkably small in relation to the astronomical abundance of krill, but collecting is not easy. The eggs appear to sink to great depth, developing as they go, so that the first nauplius, — the first larval stage — is hatched at great depths, perhaps 2,000 – 3,000 m if the water is deep enough. It took some time to realize this, and most of the *Discovery* nets were fished at shallower depths, usually down to 1,000 m and occasionally 1,500 m. The very few first nauplii, and most of the eggs, that have been collected were taken near the continental slope or in regions of upwelling, where the shallow sea floor, or upward water movement, kept them within range of the nets. Probably more would have been taken near the slope if the nets had been fished specially close to the bottom to sample possible concentrations, but the modern techniques, using acoustic telemetry to keep gear close to the bottom were not known, nor was the possibility that more eggs might be found there. The later stages of larval develop-
ment occur at higher and higher levels, till the transition from non-feeding to the first feeding stage, the first calyptopis, occurs in the Antarctic surface layer.

One of the most remarkable outcomes of the krill sampling is the strikingly small number of eggs taken in the well-sampled, krill-rich, area near South Georgia — only 11 from 880 *Discovery* net hauls. This may be because the eggs were mostly below the depths to which the nets were fished, but Marr (1962) found it difficult to avoid the conclusion that the eggs spawned near South Georgia fail to mature, and therefore contribute little or nothing to the annual recruitment of the population. Complete absence of the early larval stages — which can be expected to come within range of the nets — afforded further evidence that eggs did not hatch successfully. Such failure might result from the eggs sinking too deep to allow the usual development ascent to succeed; perhaps the water movements and densities also may be unfavourable. This is only surmise, but whatever the cause, it seems that the rich population near South Georgia, and possibly those in other northern areas of abundance, spring from incursions of larvae from higher latitudes rather than successful local hatching.

Such hypotheses linking krill distribution to water movements cannot be fully acceptable till we know more about the speeds and directions of transport in the surface layer, in the bottom current, which may influence the distribution of the early larval stages, and in the intervening warm deep layer, where there must be a general southward trend. Within the east wind drift such a trend might help to maintain the krill distribution near the continental slope, where there seem to be conditions favourable for reproduction. In the Atlantic sector, where there is a rich population in the Weddell Sea outflow, the southward movement might be instrumental in replenishing the east wind population from the apparently unfavourable northern region, though it seems fairly certain that once the larvae reach the surface layer they remain there. There is no evidence of a mass descent into the warm deep layer in winter like that demonstrated for some other species. Water movements in 20°E to 30°E may be of special interest because, while there is massing of the older larvae in the eastward flow of water from the Weddell Sea in about 55°S, there seem to be relatively few in the same latitude farther east. A strong southward movement near 20°E to 30°E might replenish the southern population, though from our present knowledge of the water movements and krill depths it seems unlikely. The absence, or virtual absence, of *Euphausia superba*, as distinct from *crystallorophias*, from extensive areas of shelf water — at the head of the Ross Sea, for example — was attributed by Marr to the failure of warm deep water to penetrate far on the shelf.

The swarming habits of krill (which seem to make them more vulnerable to the larger predators) are little understood. As far as we know they spring from a lifelong habit of the species. Analysis of net hauls and of the contents of whale stomachs show that a swarm generally contains individuals of much the same age, though sometimes they may be more mixed near the surface and augmented by younger stages. Marr found that deep, and east wind drift, swarms tend to be more homogenous than surface, west wind drift swarms, possibly because of wider time and space separation of the different stages. He thought that each swarm tends to keep together from hatching onwards. The movements of a swarm seem to depend on remarkable uniformity of individual action. There is clearly a lot to learn about variations in size, depth and density of swarms, and how they are affected by nets, ships, storms and varying light intensity. The physical processes that cause patchiness everywhere in the sea may also have some significance.
2. Water movements

To gain the information needed to further the krill studies needs some long-term basic studies of the water movements as well as those immediately related to plankton problems. It would, for example, be useful to know more about the basic physical processes that maintain the permanent surface, deep and bottom layers, and their meridional circulation — northwards in the surface and bottom layers and southwards in the intervening warm deep layer — that is superposed on their eastward and westward movements. Assessments of the northward and southward movements are based on budgetary estimates of the transports needed to maintain the observed temperatures and salinities in face of loss of heat, freezing, excess of precipitation and drainage from the continent. Averaged over the extent of each layer, and all round the continent, the speeds of the north and south movements seem likely to be of the order of 0.1 cm sec, though the activity of the meridional circulation must vary sufficiently from one sector to another to make 1.0 cm sec, and perhaps a little more, possible in some places.

The west and east wind drifts are better known, especially the west wind drift in the Drake Passage. The International Southern Ocean Studies programme, largely conducted by USA scientists, shows that it is not the broad, steady, flow we have imagined. It consists of bands of strong current separated by bands of little or no current, with variations over space and time scales of about 75 km and 15 days. It probably varies in much the same way everywhere else, though the bands of varying current may be wider in the less restricted ocean outside the relatively narrow Drake Passage. Much of our information from the rest of the ocean is based on ships’ observations, drift bottles, drift cards, and timing of the drift of a large quantity of pumice produced by an underwater disturbance near the South Sandwich Islands. The average surface speed is of the order of 10-15 km a day, about the same as in the Drake Passage. The wind that drives it is not a broad, continuous air flow, but a succession of changes, mainly between NW and SW, dependent on depressions travelling along tracks that usually lie farther south. The east wind drift, driven by the NE and SE winds that prevail south of the storm tracks, has been said to be somewhat faster than the west wind drift. We know something of its speed and variability from the work of Tchernia, who used the Eole satellite, and later the Nimbus 6, to follow the movements of icebergs fitted with transponders. Along the continental margin south of the Indian Ocean the average speed of the icebergs was 15 km a day with a maximum of 46 km, and with sometimes backward loops to the east. The iceberg movements indicate a strong northward branching of the current near the Kerguelen-Gaussberg ridge — where one of the northern krill-rich areas occurs. The deep and bottom currents appear to flow east and west like the surface currents, though the measurements made so far, in the Drake Passage, the Weddell Sea and south of Australia, suggest average speeds less than half the surface speeds.

Although, even in the early days, it was clear that water movements and current boundaries varied with the changing winds, it seemed reasonable to think of them — the sinking of Antarctic water into the lower part of the subantarctic water column, for example — as fairly steady processes. Newer, closely spaced, observations emphasize the variability, though it is remarkable how closely the zone across which the transition between the two water masses wavers, agrees with the old maps, and how there is always evidence of the lower salinity and temperature of sinking Antarctic water near the bottom of the well-mixed subantarctic water. Fuller understanding of what goes on in such transition areas, and special investigation of the exchange between surface, deep and bottom waters, near the continental shelf seem essential to further progress.
3. Immediate opportunities

While advantage should be taken of every opportunity to make new observations, it is clear that very good use can still be made of earlier work, particularly of existing plankton collections. Krill samples have probably been worked over thoroughly, though perhaps not exhaustively, and sufficient has been done with plankton species other than krill to gain useful information about their relationships with each other and with the water movements. There are some objections to putting young men beginning their careers on to such work unless they are able to go to sea to try out new ideas and methods, but time and effort will be lost unless the old collections, analysis sheets, unpublished studies and experience, are kept alive and used in conjunction with the new ideas and observations. Further study of earlier work would undoubtedly strengthen the biological and physical background and planning of new work.

The most pressing need for new observations is to confirm and extend our understanding of the krill's life history, distribution, abundance and swarming habits. A ship supplied with modern nets, water sampling instruments, current meters and acoustic equipment, and worked by a team strong enough to pick out the different stages and interpret the other measurements, could make substantial progress in a very short time. Remaining more or less stationary in one of the northern areas of krill abundance, east of South Georgia, for example, she could, at the right time of year, follow the development of the adult females, the spawning and subsequent history of the eggs, look for the first nauplius, and test the whole hypothesis of the non-productiveness of a northern area. At the same time enough physical observations could be made to further our understanding of the water movements, and acoustic measurements would help with the studies of the size, structure, movements and continuity of krill swarms. A single well-equipped research vessel would achieve a great deal, several would ensure success. If fuel is available in South Georgia the work could be done within a 3-month cruise from South Africa or South America. Fish studies might be added to the list.

A similar study in the neighbourhood of the continental slope would give further information about the processes of spawning, hatching and larval development. It would also allow measurements of size and growth rates for comparison with those found in warmer water farther north. Physical measurements would give useful information about exchanges and mixing between the surface, deep and bottom layers, and allow investigation of the possible effects of water movements, particularly the meridional circulation on the distribution of eggs, larvae and adults. Studies of the krill swarms made there would also allow useful comparison with similar observations made in one of the northern areas. The continental slope north of the Soviet Antarctic station at Mirny would be a promising site, especially if arrangements could be made for ships to re-fuel.

Another prominent requirement is for study of over-wintering populations in the east wind drift. The Discovery sometimes reached latitudes where krill were present, and was sometimes kept out by the ice and freezing extending too far north. An icebreaker could penetrate further into the krill habitat, but net hauls and physical measurements become very difficult in low temperatures and ice cover. It is also hard to see how, with our foreseeable resources, the problem could be attacked from the south, even where there are sometimes patches of open water close to the land.

The area between longitudes 20°E and 30°E is particularly interesting because of the sharp transition from the Weddell Sea current, well-populated with krill larvae, to the relatively barren conditions found in the same latitude farther east. It raises the question
whether the krill can migrate southwards, to help make up for the great outpouring from
the western part of the Weddell Sea, possibly assisted by a southward trend of the surface
current or by a particularly strong southward movement in the warm deep layer.

Physical studies are already being very effective in and near the Drake Passage, but
they may soon have to be supplemented by a long-term current measurements in wider parts
of the ocean where the meridional circulation is less likely to be constrained by a northern
as well as southern boundary. Much more information about the variability of surface
currents is likely to be obtained from satellite-monitored drifting buoys during the GARP
experiment in 1978-79, when there should also be unique meteorological coverage. To learn
more about northward transfer of water from the east wind drift may prove particularly
useful. Long-term deep-current measurements would be valuable everywhere; it should now
begin to be possible to get current meter moorings laid and recovered from the supply
vessels that make regular voyages to the continent.

Another topic deserving special study is the effect of increased stability of the near
surface water column due to surface inflow of fresh water on phytoplankton growth. Many
authors have suggested such a possibility near melting sea-ice and near land. The effect of
the fresh water, and some shelter by the ice or land is likely to lessen vertical mixing. Farther
from ice or land, wind action is likely to stir the water and circulate the phytoplankton to
much greater depths, so that it must spend some of its time at depths where the light
intensity is too weak to maintain active growth. The rich phytoplankton growth found at the
bottom of sea ice is probably due to porous ice providing a fairly stable environment with
just enough light.

4. Other problems

Studies of the effect of the ocean on world climate and on the weather of the neigh-
bouring continents require physical observations of much the same kind as those needed for
krill studies. Recent work indicates that in the North Atlantic Ocean northward transport of
heat is greater in the ocean than in the atmosphere. The Southern Ocean, a relatively narrow
zone between climatic extremes, seems likely to be of special importance.

Marine geophysical studies are providing new information about the processes that
have shaped and structured the Antarctic and neighbouring continents. The Antarctic
continental shelf, though little known, seems to have some unique features. It is abnormally
deep and often contains depressions that tend to run parallel to the coast. It has been
suggested that these depressions may be due to cracking of the crust during downwarping,
due to the heavy load of ice on the continent, but there is the further possibility that
morainic activity has been responsible, as with similar formations close to the coast of
Norway.

There is great scope for other studies, particularly the fish, squid and benthos, waves,
tides and other physical processes, and there can be no doubt that many problems basic to
marine science would be furthered by study in the Antarctic.
SCOR WORKING GROUP 34
INTERNAL DYNAMICS OF THE OCEAN

Report of Chairman: A.R. Robinson

The following information summarizes the activities of SCOR Working Group 34 (Internal Dynamics of the Ocean) for the period September 1976 to April 1977.

1. POLYMODE

A preliminary publication of the contributions in English to the Theoretical Institute held in Yalta in August, 1976 has been issued (March 1977) and is available from the US POLYMODE Executive Office, MIT. The final report, including contributions in Russian and English, will be issued in the near future in the USSR.

Scientific sessions during the US/USSR Joint POLYMODE Organizing Committee Meetings held in Cambridge, Massachusetts on 1-5 February 1977 were, in part, jointly sponsored by SCOR Working Group 34. Working Group members Gonella, Gould, Needler and Robinson attended. A Joint POLYMODE Programme and Plan was adapted and will be issued in final form in the near future.

2. NEADS (North East Atlantic Dynamics Studies subgroup)

The initial deployment of NEADS moorings (vid. SCOR Proceedings 12, p. 28) were deployed between November, 1976 and January, 1977.

3. Existing and Potential Data on Mesoscale Eddies in the World Ocean

A meeting sponsored by Working Group 34 was held in Cambridge, Massachusetts on 5 February 1977. It was attended by C. Collins, L. Dantzler, W.J. Gould, M. McCartney, G. Needler, A.R. Robinson and W. Simmons and assessed sources of mesoscale eddy information from the oceans of the world and discussed ways in which this data base might be improved and enlarged. It was recommended that (i) a list of existing or planned XBT ships-of-opportunity programmes be compiled; (ii) a bibliography of XBT reports be prepared; (iii) a catalogue of XBT data sets be compiled; (iv) a summary world map of mesoscale activity be produced; (v) the development of quantitative universal analysis techniques for mesoscale information on XBT sections be explored; and (vi) the possibility be examined of Working Group 34 helping to coordinate and organize XBT of opportunity programmes in order to obtain an efficient and expedient basis for world ocean mesoscale data. This could include FGGE ships en route from and to ports.

Dr Gould will prepare a report based on the more readily available information relating to (i-v) to guide Working Group 34 towards possible activities along these lines.

I anticipate that the Working Group 34 may wish to pursue aspects of the coordination, collection and classification of world ocean mesoscale data and may request funds to sponsor a meeting involving representatives of other interested groups as a next step.


The Chairman of Working Group 34 has been active in planning this conference, and several Working Group members will participate.
JOC/SCOR STUDY CONFERENCE ON GENERAL CIRCULATION MODELS
OF THE OCEAN AND THEIR RELATION TO CLIMATE

(Helsinki, 23-27 May 1977)

1. Introductory Lectures

(i) The general circulation of the ocean and its modelling
Speaker: W. Holland

(ii) The effect of the ocean on the atmospheric general circulation
Speaker: W.L. Gates

(iii) The physical problem of climate and the role of atmosphere-ocean interaction
Speaker: A.S. Monin

2. Review of Recent Research on the Modelling of Oceanic Processes

(i) Mesoscale eddies
Speaker: A. Robinson

(ii) Boundary currents
Speaker: P. Niiler

(iii) Surface boundary layer
Speaker: S.A. Kitaigorodsky

(iv) Mixing in the oceanic interior
Speaker: C. Garrett

(v) Tropical and equatorial processes
Speaker: G. Philander

(vi) Coastal upwelling
Speaker: J. O’Brien

(vii) Sea-ice dynamics
Speaker: J. Doronin

(viii) Deep circulation processes
Speaker: A. Sarkisyan

(ix) Intercomparison of Primitive Equation and Quasi-Geostrophic Ocean Models
Speaker: A. Semtner

(x) High-latitude Processes – Modelling and Observations
Speaker: D.J. Baker, Jr.

3. Process Parameterization in Ocean General Circulation Modelling

(i) Global models of the oceanic general circulation (OGCM’s)
Speaker: K. Bryan

(ii) Discussion of process parameterization and the structure of OGCM’s
Speaker: J.S.A. Green

4. Deterministic Analysis of Large-scale Ocean Atmosphere Interaction

(i) Observational evidence and empirical studies
Speaker: R. Davis

(ii) Model simulation and sensitivity experiments with GCM’s
Speaker: J. Namias
(a) Oceanic responses (OGCM's)  G. Veronis  D. Anderson  
(b) Atmospheric responses (AGCM's)  P. Rowntree  S. Manabe  
(c) Responses in coupled GCM's  S. Manabe  M. Schlesinger  

5. **Statistical Models of Climate Variability**

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<th>Speaker / Discussant</th>
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<tr>
<td>Introductory Lecture: Observed Spectrum of Climatic Variability</td>
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<tr>
<td>(i) Low resolution of grid models</td>
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<td>(ii) Low resolution spectral models</td>
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<td>(iii) Time dependent SDM's</td>
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<td>(iv) Stochastic forcing models</td>
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<td>(v) Entropy concepts</td>
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<td>(vi) Linear statistical predictors</td>
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<td>(vii) Predictability</td>
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6. **Resume of Outstanding Scientific Problems and Outlook**

Panel:  

7. **Plan of Action**

A small ad-hoc working group will be convened 30-31 May 1977 in order to prepare specific action proposal to JOC and SCOR:  
SCOR WORKING GROUP 42 (WITH ICES)
STUDY OF POLLUTION OF THE BALTIC

Plan for Baltic Open Sea Experiment 1977 – BOSEX-77

1. Background

In ICES Cooperative Research Report, No. 42 (ICES 1974) the Working Group on the Study of Pollution of the Baltic, established jointly by the International Council for the Exploration of the Sea and the Scientific Committee on Oceanic Research, proposed a number of research tasks which were considered to be essential for increasing our understanding of the Baltic Sea system in relation to pollution problems. Seven tasks were specified which require interdisciplinary and international cooperation in order to be successfully accomplished. They focus on the study of processes, physical, chemical, and biological. The tasks are: (1) Exchange of water and dissolved materials with the North Sea, (2) Open Sea Experiment, (3) The Baltic Circulation Model, (4) The Coastal Water’s Dynamics Experiment, (5) The Open Sea, Multi-disciplinary Continuous Stations, (6) Year-round Biological Observations designed to optimize monitoring of future changes, and (7) Determination of Toxic Substances throughout the Food Chain.

Three to four years have passed since the formulation of these proposals and considerable progress can be reported in major fields of research related to the pollution problem. The exchange with the North Sea is being studied intensively in a five-year programme carried out mainly by Denmark. Vertical transport, mixing and advection have been studied in several joint experiments during 1975 and 1976. The effects of eutrophication, as well as coastal zone dynamics, are being investigated in several national experiments. The input of pollutants has been further assessed and the distribution and levels of certain pollutants in fish have been determined (Coop. Res. Rep., No. 63, ICES, 1977). Although much of this work has developed independently of the ICES/SCOR Working Group, some elements have been carried out directly by the Working Group.

At its meeting 5-7 May 1976 in Tallinn, the Working Group agreed that the time had now come when it would be appropriate to carry out a joint, inter-disciplinary open sea experiment in the Baltic. There all the Baltic States would participate, pooling their resources in order to achieve the necessary coverage of the various disciplines. The experiment would include elements of Tasks 2, 5, and 7, with emphasis on the biological and pollution parts. It was thus agreed to pool resources in the international experiment BOSEX-77, to be carried out during 3-4 weeks in September in the southern Gotland Basin.

Since the Working Group meeting, a Coordination Group proposed a framework for the experiment which was discussed during the ICES Statutory Meeting in 1976. This proposal was circulated to a large number of scientists, both within and outside the Baltic area. Comments were received, and, by the end of 1976, all the Baltic countries had sent proposals on their own contributions to the experiment. In order to integrate these proposals and carry out the detailed planning, a Workshop was held in Copenhagen, 17-20 January 1977, where about 20 participants discussed the experiment. The Workshop resulted in a complete programme with a fairly good coverage of all basic requirements.
2. Objectives

The objectives of BOSEX-77 can be summarised as follows.

**General:** to obtain simultaneous observations of physical, chemical, and biological parameters covering basic parts of the ecosystem, which will facilitate the interpretation of the biological observations in particular and which will make it possible to advance simulation modelling. In addition, observations at the same time of levels of pollutants in practically all compartments (water, plankton, fish, seston, sediments) will greatly advance our means to interpret and understand the distribution of pollutants in the ecosystem. The observations will be tied to the Baseline Study (Coop. Res. Rep., No. 63, ICES 1977) by analysing as far as possible samples from the same species (cod, sprat, herring) as used in the Baseline Study. The conditions in the BOSEX area will also be connected to coastal zones by hydrographic sections to be worked before, during and after the experiment. Such experiments as these form part of the studies required before a meaningful Baltic Sea monitoring programme can be established.

**Specific:** to study transfer between the various layers in the water column; to study small and medium scale dispersion simultaneously in different parts of the water column; to study aspects of the current structure, the coupling between the various layers, and the kinetic energy distribution; to study in some detail the conditions in and structure of the halocline layer; to study primary production in relation to composition of phytoplankton communities as well as to nutrients, light and turbulence; to study secondary production and grazing and other aspects of turn-over; to study decomposition and sedimentation rates of various kinds of particulate matter in the water column; to study some processes at the water/sediment interface; to study the transfer of certain pollutants in the ecosystem.

Recent studies in the Baltic, e.g., *Baltic 75*, have clearly shown that supporting physical and chemical observations are necessary for interpreting the biological, in particular, but also some of the chemical observations. The aim has, therefore, been to specify the programme according to the available resources and divide the tasks so that as good a coverage as possible is obtained of basic requirements in all disciplines. This will make it possible to interpret the observations within an ecosystem model.

3. Programme

The experiment will be carried out in September 1977 in the southern most part of the Gotland Basin at a depth of ca. 110 m. The studies will concentrate on a square area with 30 km side 'the box'.

a) Stationary ships positioned in center of the box: CTD profiling, oxygen, nutrients, chlorophyll, pH, alkalinity, particulate and dissolved organic carbon, primary production, light levels, transparency, scattering, plankton sampling, sedimentation rates, microbiological studies.

b) Environmental mapping of the conditions in the box and its immediate vicinity is carried out by 4 moving ships with similar observation programme as the stationary ships.

c) Special experiments are carried out by additional moving ships. The experiments include dispersion studies by dye tracing and drogue tracking, as well as special biological studies.
The meteorological conditions are recorded by standard meteorological observations on the ships and by a meteorological buoy for profile measurements.

The currents are observed by means of about 50 moored current meters distributed at 10 stations, with 5 meters at each, in the center, the corners of the box and along the diagonals so that scales in the range 3-50 km are covered.

The pollutant measurements include analysis for trace metals, petroleum and chlorinated hydrocarbons in water, plankton, fish and sediments.

In all, 12 ships will participate in BOSEX-77, representing all Baltic countries. The ship times are planned so that two stationary ships are always in the center of the box. The position of the box has been adjusted so that the International Baltic Year Station No. 9 (56°05’N, 19°10’E) is the easternmost corner station.

Provided the plans as now laid down are carried out, BOSEX-77 will be a major international exercise. The fact that all Baltic States are participating is very encouraging.

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<thead>
<tr>
<th>Country</th>
<th>Institution</th>
<th>Ship</th>
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<tbody>
<tr>
<td>Denmark</td>
<td>Danish Environment Protection Agency, Kampmannsgade 1, 1604 Copenhagen V.</td>
<td>Martin Knudsen</td>
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<tr>
<td></td>
<td>Institut f. Meereskunde an der Universität Kiel, Düsternbrook Weg 20, 23 Kiel.</td>
<td>Poseidon, Alkor Littorina</td>
</tr>
<tr>
<td>Finland</td>
<td>Institute of Marine Research, P.O. Box 166, 00141 Helsinki 14.</td>
<td>Aranda</td>
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<td>German Democratic Republic</td>
<td>Institute of Marine Research, Academy of Sciences of the GDR, Seestrasse 15, 253 Warnemünde.</td>
<td>Prof. A. Penck</td>
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<td>Poland</td>
<td>Institute of Meteorology and Water Management, Waszyngtona 42, Gdynia.</td>
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<td></td>
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<td>Birkut</td>
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Aju-Dag
SCOR WORKING GROUP 47
OCEANOGRAPHIC PROGRAMMES DURING FGGE

Report of Chairman: H. Stommel

May 1977

Achievements

1. Draft Report for September 15, 1977

I report that we are about to complete the first part of our terms of reference:

"To develop plans for comprehensive oceanographic programmes associated with FGGE ..."

During June and July 1977 all three Equatorial Panels* will meet to produce draft plans, and these will be combined into a single draft report dated September 15, 1977. This will represent the culmination of our planning efforts, begun February 2, 1974. As a foretaste of what SCOR may expect, the preliminary draft report of the Atlantic Panel Reunion held in Miami (February – March 1977) under the chairmanship of Ph. Hisard, dated 20 April, 1977, identified 26 ships for participation in the Atlantic equatorial region alone, among which there are already seven major research vessels clearly identified by name of vessel, principal scientist, specific research plans and ship tracks. This Atlantic draft report will be refined in Sao Paulo during July 1977. Panel Chairmen J. Swallow (Indian) and B. Taft (Pacific) will produce equivalent draft reports during June and July 1977 at La Jolla.

2. FINE** Workshop

The increase in interest in equatorial studies has encouraged theoreticians to hold a workshop during June and July 1977 in La Jolla on problems of equatorial dynamics in all three oceans, under the chairmanship of Dr Dennis Moore and general sponsorship of the US National Science Foundation. SCOR is funding the travel for some participants in this workshop. It is hoped that the theoretical results of this workshop will help stimulate the design of a major equatorial experiment during the 1980’s (see recommendation 3 below).

Constraints and Limitations

The planning of the oceanographic programme for FGGE has encountered certain constraints, about which it may be helpful to be explicit:

(i) There is no single unifying scientific oceanographic idea or theory that can be offered as overall basis for design of the oceanographic programme and that is compatible with a uniform grid of 5° spacing in the meteorological plans for FGGE.

(ii) Physical oceanographers in many nations must compete with scientists of other oceanographic disciplines for the use of their ships and do not have exclusive control of ship operations.

* The Equatorial Panel of the Indian Ocean includes a MONEX component.

** FINE means FGGE Index Norpax Equatorial Workshop.
(iii) FGGE is not the single most important experimental opportunity of the decade for oceanographers. It is simply a rather special interlude of a few months, but most oceanographic research programmes continue over many years. FGGE therefore does not dominate the attention of the international research community of oceanographers in the way that it does for meteorologists.

(iv) The decision making processes that determine what commitments of ships and scientists can be made differ from one country to another. This is reflected in the specific nature of the plans as defined in the reports, and to a large extent explains the looseness of the organization and unevenness in other respects of the reports. There is real difficulty of communication between individual scientists in academic institutions on one hand, and authorities in large ministries and naval establishments on the other, which have been almost unbridgeable within the informal framework of our Panels.

(v) In some cases proposed national commitments already appear to exceed the funds available, and it is uncertain how at the national level these dilemmas will be resolved and which parts of the programmes will be dropped for financial reasons.

(vi) The draft plans as yet do not make effective use of the TWOS. As we know research oceanographers have in the past made only little use of Weather Ships occupying certain stations for very long periods of time, and it perhaps is not to be expected that they will know how to make use of Weather Ships that are going to be in location for only a few months at most.

(vii) Some plans are contingent upon obtaining permission from coastal countries to work in their waters. An example is the MONEX programme for studying cooling of the Arabian Sea during the southwest monsoon. At present some of these permissions have not yet been obtained, and members of the Panels do not have any guidance or ideas about how to obtain the permission. This is a very serious constraint, the solution of which appears to be outside the competence of Working Group 47.

(viii) A volunteer group of scientists such as that which constitutes Working Group 47 and its Panels cannot adequately meet the demands of WMO for frequent reports, other paper work and providing representation at numerous meetings.

(ix) Oceanographers are unfamiliar with and unable to cope with requirements for data handling and processing to which meteorologists are accustomed.

Opportunities for IOC and GAO to render assistance

It appears to us that IOC and GAO/WMO may be able to assist in furthering the oceanographic programme for FGGE in many ways. The following are some suggestions of possibilities:

(i) In obtaining permission to work in territorial waters, clearance for port visits and customs.

(ii) In clarifying information about the possible oceanographic use of TWOS by providing details about possibilities for oceanographic use of TWOS and initiating correspondence between oceanographers and the TWOS operating authorities.
(iii) In intercepting and redirecting requests for reports, correspondence, attendance at meetings etc. which are inappropriate for SCOR WG 47 and its panels to undertake. This is simply an appeal to make efficient use of the scientists' time, so that they can direct their efforts toward the pressing scientific problems that they have in implementing their actual contributions to the field experiment.

(iv) In assuring a data exchange within time requirements that are consonant with oceanographic practice.

Requests and Recommendations

(i) The Chairman of WG 47 recommends that SCOR clarify the second part of the terms of reference:

"... and to assist other appropriate international and national bodies in the implementing of such programmes."

As explained in the letter of Stommel to Döös of March 26, following the issuance of the September 1977 Report, the oceanographic programme will enter into an operational or "implementing" phase. Clearly there will be great demands for many decisions, a great deal of management requirements, etc. during the operational phase. The equatorial experiments involved are much greater than the GATE experiment or the International Indian Ocean Expedition. If the terms of reference as they presently stand were to be interpreted broadly it would put an impossibly heavy responsibility on WG 47 — one that it cannot discharge satisfactorily as presently constituted. Already the EC Intergovernmental Panel on FGGE (14-18 February 1977; JOC-XIII Doc 5) has "expressed concern that the rate at which the oceanographic programme is being developed is not commensurate with that of other elements of the Global Experiment." WG 47 can only present its Panel Reports, and its coming September 1977 report as evidence of whether or not this concern is justified. Whatever the truth may be, at present WG 47 does not see any possible way in which it can accelerate the development of the programme beyond what it already plans to achieve.

Perhaps the wording of the second part of the terms of reference could be amended to read:

"... and to advise appropriate international and national bodies in the implementing of such programmes."

(ii) WG 47 requests SCOR, IOC and GAO/WMO to clarify the terms of reference of the responsibilities of IOC staff members and the new FGGE oceanographic programme liaison officer at Geneva, in particular to determine whether it will be possible for them to undertake some of the tasks mentioned under the preceding section.

(iii) WG 47 requests the new COG to consider plans for a major field experiment in Equatorial Dynamics in one (unspecified as yet) ocean, to extend over at least two years, during the 1980's as an opportunity for oceanographic research which is ripe for further development. Recent discoveries of deep layered current systems trapped on the equatorial wave guide, and rather short time series of current measurements that show evidence of waves moving along the equator, and the rapidly developing body of theoretical knowledge
of such systems suggest that a determined effort to understand Equatorial Dynamics may be the most significant immediate task that merits a large concerted effort in the near future. This proposed experiment is too long extended in time, and too restricted geographically to be compatible with FGGE plans, and so should be planned for following years. It may also be an opportunity for oceanographers to invite meteorologists to participate in a predominantly oceanographic experiment.
Within recent years, scientific and economical interest in the Antarctic waters has been steadily growing. Therefore the need was felt among those concerned with the study and conservation of the Antarctic oceans to develop a coordinated international programme for the study of the marine living resources of the southern oceans. A SCAR/SCOR Group of Specialists (SCOR Working Group 54) reviewed in 1975-1977 the present knowledge of the marine living resources of the Antarctic and developed a proposal for future cooperative studies in this area named 'Biological Investigations of Marine Antarctic Systems and Stocks 'BIOMASS' '. A detailed document was prepared by the Group of Specialists, containing the BIOMASS proposal together with background information on the living resources, their physical, chemical and biological interactions, as well as on the existing international organizations in the field of Antarctic research. It is being published jointly by SCAR and SCOR. The present brief document was prepared on the request of SCaR in response to the need by IOC for adequate information on the major scientific objectives of the BIOMASS proposal and its practical implementation.

1. General objectives

The need for a comprehensive international and interdisciplinary research programme in the southern oceans rests in science as well as in global food resources management. It stems from the fact that the circular current system of the southern oceans houses a food web which is very different from those of other parts of the World Ocean, individual weights of its key members being several orders of magnitude larger than comparable ones in other parts of the World Ocean. This gives an incentive to a unique mass exploitation of the southern oceans’ key herbivores, the krill.

The principal objective of the BIOMASS programme is to gain a deeper understanding of the structure and dynamic functioning of the Antarctic marine ecosystem as a basis for the future management of potential living resources. Thus, we are primarily concerned with: a) contributions to man’s understanding of the World Ocean and b) developing a sound ecological strategy for the exploitation of the living resources and for the conservation of the southern oceans’ ecosystems. To achieve these goals of basic marine science and wise ecosystem management we need to consider several objectives. The list given below emphasizes krill as the major potential food resource of the Antarctic waters and as a key element of the marine food web. On the other hand it is recognized that there are other important fields of marine studies in the Antarctic which warrant the attention of the scientific community. BIOMASS will evolve while it proceeds and will hopefully attract new scientists with new ideas in the course of its development into a comprehensive study of the Antarctic ecosystem, its exploitation and conservation.

a) study of the physico-chemical environment, influencing krill and its food base, namely:
i) study of vertical advective and diffusive processes, as driving force of primary production.

ii) study of micro- and meso-scale horizontal processes in relation to swarming of krill and patchiness of phytoplankton.

iii) study of the large scale meridional and zonal water transport at various depths in relation to the life cycle of krill

b) Study of the variability between years and regions in the quantity and composition of phytoplankton.

c) Autecological studies of key organisms of the Antarctic ecosystem such as whales, seals, penguins, fishes, squids, krill, some other crustaceans, salps; assessment of their standing stocks/biomass and production in selected areas of the southern oceans.

d) Description of the major food chains in Antarctic waters with emphasis on the flux of energy and material between the various trophic levels in selected small areas.

e) Development of models to improve our understanding of the quantitative interaction between different elements of the ecosystem and the effects of climate, whaling and krill fishing on the structure and efficiency of the food chain.

f) Compilation and analysis of data from exploratory and commercial fishing.

g) Provision of scientific information on the Antarctic ecosystem to the scientific community, governments, industries, and other concerned bodies.

2. The research programme

The objectives of BIOMASS require actions along three lines:

a) Seagoing operations of research vessels. These include detailed multidisciplinary studies in limited areas of special interest (cooperative 'experiments') as well as some large scale surveys, building on the experience of the former survey work done by research vessels including Discovery, Ob and Eltanin and of recent exploratory cruises.

b) Other operations at sea. Exploratory and commercial fishing and whaling vessels, supply vessels and others are expected to be operating in the Antarctic during the BIOMASS period. Observations from these vessels will be used to supplement the work of the research vessels especially in relation to the harvestable resources. The seagoing operations should be supported by remote sensing work.

c) Shore-based studies. Investigations on feeding, growth and reproduction of krill and other key organisms at the established coastal stations should complement and add year round continuity to the offshore ship-based studies.

d) Data analysis. Arrangements will be made to ensure proper compilation, storage, dissemination and analysis of information arising from all relevant activities in the Antarctic.

e) Modelling. Stepwise development of models making immediate use of information from published and unpublished sources but augmenting it progressively with field and experimental data as they come in from a), b) and c).
2.1 Seagoing activities of research vessels

In the first operational stage culminating in the First International BIOMASS Experiment (FIBEX), 1980/81, these investigations would be concentrated in a suitable area such as the Scotia Sea or the Atlantic sector in general. It is in this sector where the resources appear most abundant and most likely to be harvested. Studies of other sectors must follow.

2.1.1 Macroscale studies of krill in relation to hydrography

The drift of krill during its 2-3 years life time is of the order of $10^3$ km. It is mainly governed by surface and deep currents. The assumed 'development ascent' may include the upper 2000 m of the water column and together with the larval development it takes $10^1 - 10^2$ days. The proposed Weddell Sea Gyre project, and the International Southern Ocean Studies (ISOS) of water circulation as well as remote sensing of the variability in oceanic fronts and ice movements are of the right scale to provide information on the transport mechanisms. The near surface distribution of krill in summer has been described in considerable detail by earlier expeditions. However, the transport of the various life history stages and the links between the various populations are not sufficiently known in space and time. Quantitative sampling of krill in the various depths should be carried out in various areas and seasons. The sampling programme should be guided by oceanographic observations and supported by echosurveys; at least two research vessels are needed for the physical and biological work in each of the selected large areas. There is a very urgent need for extending the life history studies of krill into autumn and winter and into the pack ice zone.

2.1.2 Microscale studies on the ecology of krill swarms

The interaction between phytoplankton composition and biomass and the swarming of the krill under the influence of oceanographic factors can be studied at scales of the order of 10 km and 10 days. Two to three ships are needed in a complete experiment of this type.

Measurements to provide information on vertical transport and stability and on advection. Sampling the spatial distribution and densities of swarms of krill in relation to the abundance and size spectra of phytoplankton, in order to understand the reactions of a krill swarm to its food base and the effects of grazing on the phytoplankton. Quantitative recordings and sampling for analyses of phytoplankton distribution and zooplankton abundance and composition in different depth layers and at different times of day and night will provide additional information on the spatial structure of the biotic environment of krill.

Echo-sounding and sonar observations should provide three-dimensional pictures of the changes in the zooplankton concentrations in time.

Those studies should be carried out at several selected places, mainly in different areas of high krill concentrations of the ice edge, in the neritic zone of the Antarctic Peninsula and of the Antarctic islands as well as in the open ocean of the west wind drift, the east wind drift and the upwelling zones. If possible they should be repeated at different seasons.

2.1.3 Microscale studies of food chain structures and functions

In order to learn more about possible future effects of krill fishing on the structure of the first and second trophic level, composition of phytoplankton and its productivity should be studied in places and seasons which differ in relative abundance of krill, salps or other herbivores. Those studies have to be based on quantitative plankton sampling in various depth
layers and can be considered as an extension of 2.1.2 beyond the krill swarms into areas and seasons where alternative grazing and predation strategies lead to changes in the quantitative composition of the herbivore level.

2.1.4 Macroscale studies of zooplankton, nekton and benthos

There is still a need for further quantitative sampling of zooplankton, pelagic squids and fish in various regions of the southern oceans. The Benthos of the Antarctic is very poorly known.

Beyond such faunistic surveying of the area, quantitative data are needed on the abundance of the dominant elements of plankton and benthos in the different regions. The position of the dominant species within the food chains should be ascertained by studies of stomach contents and feeding apparatus.

Benthos studies may be combined with observations on sedimentation and decomposition of fecal pellets, dead zooplankton, particularly krill, and diatoms.

The biological and sedimentological surveys are very time consuming. More than one research vessel is needed, even if one wants to cover one of the Ocean sectors within one summer.

2.2 Sea-going activities of other vessels

The sea-going research tasks require the cooperation of a number of oceanographic and other vessels in the southern oceans. The majority of the seagoing studies need fully equipped research vessels. This is particularly the case in the multidisciplinary studies on the relationship between krill and the environment. The success of the biological programmes would largely depend on a well designed coupling with observations on horizontal transport and vertical mixing. It would not be sufficient nor economical to add small biological programmes to physical expeditions and vice versa but rather to combine full scale programmes of both disciplines in large process-oriented exercises. (On the other hand, one should avoid to try to measure and sample ‘everything’.) International cooperation is essential in view of the large support needed for a multidisciplinary study which includes several vessels and a considerable number of specialists.

The work of the research vessels can be greatly assisted by coordinated survey efforts of exploratory and commercial trawlers, a few whaling vessels which are still in existence as well as by supply ships and icebreakers. A brief summary of the advantages and limitations of the different types of vessels with regard to the research objectives of BIOMASS is given in table 1. Given the ambitious objectives of BIOMASS, its success will depend on making the best use of all types of vessel.

In view of the importance given to resource management, special emphasis will be given to obtaining information from those vessels most directly concerned with the harvestable stocks, i.e. exploratory and commercial vessels, particularly those directed at krill. Information from them will include details of the catch, the distribution and, as far as possible, the relative abundance of the stock, and size, maturity, food etc of the animals caught. All of these are important in studying the population dynamics of the exploited stock. In addition, where opportunity offers, other biological observations using simple equipment e.g. plankton nets, will be made from these and other non-research vessels.

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Table 1. Summary of Research Opportunities and Constraints from Platforms available for Southern Oceans Studies

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Research Vessels</th>
<th>Shore Bases</th>
<th>Exploratory Trawlers</th>
<th>Commercial Trawlers and Whaling Ships</th>
<th>Supply Ships and Ice-Breakers</th>
<th>Satellites</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Limited (large scale) trawling capacity</td>
<td>Poor (large scale) trawling capacity</td>
<td>Limited spectrum of oceanographic opportunities</td>
<td>Uncontrolled operational area</td>
<td>Few station opportunities en route</td>
<td>Lack of &quot;Ground Truth&quot;</td>
</tr>
<tr>
<td></td>
<td>Limited access to open ocean</td>
<td>Limited geographic coverage</td>
<td>Limited trawling capacity</td>
<td>Fishing bias</td>
<td>Lack of trawling capability</td>
<td>Ice cover</td>
</tr>
<tr>
<td></td>
<td>Limited geographic coverage</td>
<td>Poor year-round coverage</td>
<td>Narrow spectrum of oceanographic opportunities</td>
<td>Poor year-round coverage</td>
<td>Poor year-round coverage</td>
<td>Cloud cover</td>
</tr>
<tr>
<td></td>
<td>Limited geographic coverage</td>
<td>Limited geographic coverage</td>
<td>Limited year-round coverage</td>
<td>Limited geographic coverage</td>
<td>Limited year-round coverage</td>
<td>Turbulent sea surface</td>
</tr>
<tr>
<td>Opportunities</td>
<td>Flexibility</td>
<td>Stable platforms</td>
<td>Acoustic survey for krill</td>
<td>Acoustic survey for krill</td>
<td>&quot;Ground Truth&quot; for satellite survey of surface temperature and chlorophyll</td>
<td>Remote sensing of surface temperature, chlorophyll, and krill swarms</td>
</tr>
<tr>
<td></td>
<td>Multiple sampling capability</td>
<td>Experimental studies</td>
<td>Efficient sampling for krill</td>
<td>Efficient sampling for krill</td>
<td>&quot;Ground Truth&quot; for acoustic survey of krill by other vessels</td>
<td>Deployment of drifting sensors in communication with satellites</td>
</tr>
<tr>
<td></td>
<td>Interdisciplinary research</td>
<td>Year-round coverage</td>
<td>&quot;Ground Truth&quot; for acoustic survey of krill by other vessels</td>
<td>&quot;Ground Truth&quot; for acoustic survey of krill by other vessels</td>
<td>&quot;Ground Truth&quot; for acoustic survey of krill by other vessels</td>
<td>Year-round coverage</td>
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<td></td>
<td>Water column studies</td>
<td>Time series studies</td>
<td>&quot;Ground Truth&quot; for remote sensing of krill</td>
<td>&quot;Ground Truth&quot; for remote sensing of krill</td>
<td>&quot;Ground Truth&quot; for remote sensing of krill</td>
<td>Remote sensing for macroalgae</td>
</tr>
<tr>
<td></td>
<td>Acoustic surveys for krill, squid, and fish</td>
<td>Inshore benthic sampling</td>
<td>Acoustic survey for squid and fish</td>
<td>Acoustic survey for squid and fish</td>
<td>Acoustic survey for squid and fish</td>
<td>Remote sensing for occurrence of seals and penguins</td>
</tr>
<tr>
<td></td>
<td>Benthic sampling</td>
<td>Larval surveys</td>
<td>Sampling predators of krill, fish and squid (seals, penguins, etc.)</td>
<td>Squid and fish sampling from sperm whaling operations</td>
<td>Squid and fish sampling from sperm whaling operations</td>
<td>Communication with unmanned buoys and sensors</td>
</tr>
<tr>
<td></td>
<td>Underwater photography</td>
<td>Sampling predators of krill, fish and squid (seals, penguins, etc.)</td>
<td>Population dynamics of seals, penguins, etc.</td>
<td>&quot;Ground Truth&quot; for remote sensing of intertidal macroalgae</td>
<td>&quot;Ground Truth&quot; for remote sensing of intertidal macroalgae</td>
<td></td>
</tr>
</tbody>
</table>


Information from fishing vessels is however no substitute for observations from research vessels. Indeed, to the extent that the number of the former increases i.e. exploitation intensifies, there will be a greater urgency for timely scientific advice on management. This will increase the need for some information only obtainable with well-equipped research vessels.

In view of the importance of the large area under the pack ice, there is an urgent need for icebreakers capable of conducting deep biological sampling under the pack ice.

An increasingly useful method of studying large areas is remote sensing by aircraft or satellite. Since remote sensing is only suitable for observations of surface or near-surface conditions, and the extent of cloud cover make even some of these observations difficult, the application of remote sensing to BIOMASS may be limited. Nevertheless, attention will be paid to making the best use of available facilities, especially the *Nimbus-G* satellite, for those observations that may help the BIOMASS programme of variations in ice cover.

2.3 Shore-based studies

So far only a few experiments were successful on krill and other Antarctic plankton organisms in captivity on board research vessels and in shore stations. Basic data on productivity — respiration, growth and reproduction — should be obtained together with data on rates of filtration, feedings, digestion and on metabolism under different controlled environmental conditions in tanks and aquaria. Attempts to culture krill experimentally should provide further information on the duration of various life history stages and on biochemistry and histology of moulting and sexual maturation. Pressure tanks might be needed for the eggs and early larvae. Research on enzyme kinetics and microbial activity is needed in parallel with studies on the energy budget and decomposition processes in large containers.

Recently considerable experience has been gathered on plankton experiments in various types of inshore and land-based enclosures. Studies in feeding and predation of krill under semi-natural and semi-controlled conditions might bridge the gap between the physiological laboratory studies and field observations. Experiments on shoaling, vertical migration and sonar target responses of marine organisms such as krill in enclosures would be complementary to field studies.

Year-round studies of the Antarctic fauna and flora are essential because most species have marked seasonal cycles. The shore station bases — although limited in their seagoing facilities — provide opportunities for continuous year-round observations of near shore communities in plankton and benthos as well as in magnitude and seasonal variation in predation by fishes, sea birds and seals. The great number of experimental studies and their methodological diversity require considerable international and interdisciplinary collaboration in more than one well equipped shore station with easy access to krill stocks.

Further information is required on the programmes, technical facilities and man-power of the various stations, in order to launch new internationally coordinated programmes as outlined above.

2.4 Data analysis

Much of the information arising from, or relevant to, BIOMASS requires some form of central compilation, storage, analysis and dissemination. The types of information include
oceanographic data; catalogues of biological data; biological samples for sorting and identification; statistics of harvest; and bibliographic information.

Different types of data will require different arrangements. Some can be handled by existing facilities. For example, oceanographic data by National and World Data Centres, and fishery statistics (at least in the first instance) by FAO. In other cases new arrangements may have to be set up, or existing facilities strengthened; for example, if a large volume of detailed biological and statistical data becomes available from large-scale krill exploitation.

2.5 Biological modelling for the Antarctic oceans

Expertise on the best form of biological models applicable to the Antarctic ecosystem should be sought from scientists in the field as well as from SCOR Working Group 59. It may be useful initially to divide the problems of modelling the Antarctic ecosystem into two parts.

a) In the first model one might consider physical/chemical parameters, such as the depth of mixing, the rate of upwelling, the input of radiation, nutrient levels etc, as forcing functions in generating different levels of primary production. If possible the model should not be confined to an output in terms of the quantity of photosynthetic carbon, but should include also at least two outputs showing the relative quantity of photosynthetic carbon fixed separately by nano-plankton and net-plankton. Ideally the computed primary production might be considered in a broader size spectrum, including a dozen or more different size categories of primary producers.

b) Using known extremes in seasonal and regional variations in primary production, a second model should be developed in which primary productivity is used as a forcing function on the growth and mortality of herbivore populations (particularly krill). Such a model should help to elucidate competitive grazing, life cycle and growth strategies of all major species of herbivores so as to create a scenario of factors affecting the relative abundance of the major filter feeding zooplankton in the Antarctic ecosystem including krill, salps, copepods and amphipods. Various predatory strategies of whales, seals, penguins and fish should be included in order to examine seasonal and regional differences in krill abundance, in as much as this abundance may be due to purely biological effects. A first step in this model should deal with the interaction between krill, whales, seals and penguins in order to provide a rationale for management decisions.

These two models on primary production and on filter feeders may be developed simultaneously. It is even possible to start with the filter feeders model by taking published figures on primary production. Although the final goal of both models is a description of the Antarctic waters in general, regional submodels may provide a useful starting point.

3. Time-table and coordination of BIOMASS (fig. 1)

The three major types of activities under BIOMASS (seagoing experiments and surveys; shore-based experiments and year round observations; data analysis and modelling), have to be adjusted to each other. Observations on krill swarms and on the ecological physiology of key organisms of the Antarctic ecosystem should be started immediately and continued both at sea and shore stations. Systems of data reporting and handling should be developed as soon as possible. The programmes by FAO as discussed and approved by its Committee on Fisheries includes the development of a statistical data base and of a collection of scientific reviews on the living resources and their present and potential exploitation. Some standardization with regard to sampling and sorting of plankton and nekton in the southern oceans are also required at an early stage of the BIOMASS programme.
Scientific planning
Technical preparation
Seagoing experiments and surveys
Other seagoing activities
Shore based studies
Data analysis
Synthesis and advice, (workshops and symposia)

Figure 1
The major implementation phase consists of at least two major international multiship experiments as well as of a number of loosely connected experiments at sea and ashore and of national macro-scale surveys.

A time-table for large scale seagoing operations has to take into account other large scale oceanographic activities such as FGGE but also the need for sufficient time for scientific planning, logistic preparation, and development of instrumentation. Austral summer 1980/81 was chosen for the “First Internation BIOMASS Experiment” (FIBEX) as a major multidisciplinary process-oriented study which should involve several vessels in microscale experiments and macroscale investigations of transport mechanisms and of ecosystem variability in space and time. It should concentrate on the Atlantic sector but include Drake Passage and its western approaches. On-going marine research activities — both sea going and landbased — in the Antarctic should be used as far as possible to prepare the ground for the international BIOMASS experiment 1980/81.

Data analysis will go parallel to the field work, laboratory studies and modelling. There will be a need for meetings of small groups of specialists for the planning of seagoing and shore-based experiments, for the development of methodology, data handling and concepts of modelling. An interim synthesis of data and results should be aimed at by specialized workshops from 1979 onwards and presented at a small symposium in 1982 and a major, concluding one about 1986.

Preparatory and coordinating arrangements for the implementation of BIOMASS will be needed at the scientific and administrative, non-governmental and governmental levels. The group felt that those tasks should largely be entrusted to the existing bodies of SCAR/SCOR and of IOC which should also be the principal sponsors of BIOMASS.

The group of specialists proposed the following system of coordination.

a) SCAR/SCOR scientific planning group. A group of scientists selected according to their individual expertise, who would recommend methods and techniques and draw up scientific programmes for cooperative field work and land based studies and for the analysis of data. Subgroups may be established for special technical tasks. The existing group of specialists on the Living Resources of the Southern Oceans (SCOR Working Group 54) could (with perhaps enlarged membership) undertake this task with its new terms of reference.

b) BIOMASS Coordinating Group as a subgroup of the existing IOC International Coordinating Group for the Southern Oceans (ICG/SOC) with the responsibility of implementation of the BIOMASS programme acting on the scientific advice of the SCOR/SCAR scientific planning group. Consideration might be given to the appointment of an International Coordinator. SCOR, SCAR and IABO should be invited to participate in the work of the BIOMASS coordinating groups. It is expected that FAO and the International Whaling Commission (IWC) will contribute to the efforts of the BIOMASS coordinating group.

The proposals on the coordination of BIOMASS and on exchange of information and data are summarised in the recommendations of the group, published in SCOR Proceedings, Vol. 12, Annex VI.
In late 1976 the SCOR Executive established this new Working Group with the following terms of reference:

“To examine possible prediction scheme and indices for El Niño and to recommend the research needed to define the processes that should be taken into account in such forecasting procedures.”

An organizational meeting of the members was held in San Francisco, 6-7 December 1976. The members of the group are Dr M. Kanamitsu, Tokyo, Dr P. Lagos, Lima, Dr J. Namias, La Jolla, Dr J. O’Brien, Tallahassee, Dr R. Parra, Cartagena and Dr K. Wyrtki, Honolulu. Drs Lagos, Namias, O’Brien and Wyrtki attended this first meeting. Dr W. Patzert, La Jolla, attended as an observer. Dr J. Namias was chosen by SCOR to be interim Chairman. The SCOR Executive has not chosen the Working Group Chairman. The Working Group plans its first formal meeting in summer 1977.

In order to address its terms of reference, Working Group 55 will investigate and encourage a broad base of research and data collection related to the problem. Some members of the Working Group believe that a concise and useful definition of ‘El Niño’ is required if prediction is to be useful. In other words, we must define the requirements for prediction schemes by first defining El Niño. The Working Group recognises the importance of regional studies like ERFEN (Estudio Regional del Fenómeno El Niño), and process experiments like CUEA JOINT II (Coastal Upwelling Ecosystems Analysis Programme).

However, El Niño is clearly a large-scale phenomena and the monitoring data required for any prediction model must be obtained in the atmosphere and in the ocean over the equatorial Pacific, and perhaps elsewhere.

It is apparent that present ideas, indices and prediction schemes are severely limited by the lack of adequate data to test usefulness, skill or suggest refinement of existing hypotheses. The Working Group will encourage scientific investigations of El Niño.

Carefully posed hypotheses must be developed and then tested if the proper design of appropriate monitoring programmes and subsequent prediction programmes are to be developed.

Since El Niño (still undefined) is not a periodic phenomena and its time and space scales are large, Working Group 55 envisages that research programmes will require many years of execution if success is to be achieved.

Working Group 55 recognises that the development of useful prediction schemes requires the collective input of both skilled meteorologists and oceanographers. Previous El Niño investigation have concentrated on either atmospheric mechanisms which might lead to anomalies or oceanographic descriptions of anomalies. El Niño is a large-scale
atmospheric and oceanographic climate fluctuation and it is to be expected that investiga-
tions by both disciplines will be desired. These investigations will be broad. They must
include large-scale atmospheric and oceanic descriptions, long term time-series of carefully
selected variables in the ocean and atmosphere and development of coupled air-sea numerical
models. Use of modern satellite-derived data will certainly be very useful in the investiga-
tions.

SCOR Working Group 55 will establish intellectual contacts with other SCOR Working
Groups in order to foster scientific inquiry on El Niño.

SCOR Working Group 49 on Mathematical Modelling of Oceanic Processes will be
asked to recommend specific research related to equatorial modelling. SCOR Working
Group 56 on Equatorial Upwelling will be asked to recommend field programmes which
could gather necessary data on El Niño phenomena. SCOR Working Group 47, GARP/FGGE,
will be requested to designate El Niño studies as a prime candidate for large-amplitude
climatic investigations.

The Working Group will consider encouraging GARP, the equatorial theoretical panel
of Working Group 49, the NORPAX investigations, the ERFEN project and other interested
scientific groups to concentrate on studies related to El Niño. The Working Group will
consider recommending the formation of a scientific centre for intensive investigations of
El Niño. These and other scientific concerns will be considered in the next year. SCOR
Working Group 55 will also consider recommending that studies be done of the socio-
economical consequences of El Niño.
1. **Formation of the Working Group**

Letters have been exchanged with Professors Hempel and Stewart on the possible membership for the Biological Panel and the Physical Panel of the Working Group. Having in mind the FINE workshop to be held at La Jolla in June-August it has been suggested that the formation of the Working Group be urged.

2. **Future activities**

According to the terms of reference, it seems that two priority tasks are waiting the Working Group. The first is an inventory of the observational evidences on temporal and spatial variability of the equatorial upwelling in the three oceans and of the production mechanisms which are bound to it. From this point of view a critical listing of all the major cruises devoted to the study of the equatorial region in the three oceans might be established and circulated to serve as a basis for general information. In this line, two Soviet works deserve special attention; they are *Productive zone of the equatorial Atlantic, conditions of its formation* issued by Atlanto NIRO and published at Kaliningrad in 1971 and volume 102 of the *Transactions of the Institute of Oceanology of the USSR Academy of Sciences* "Pelagic ecosystems of the Pacific Ocean", Moscow 1975. Both are being translated into French at CRO, Abidjan and they might be largely diffused among non-Russian speaking interested scientists. Another pertinent book is *Functioning of Pelagic Communities in the Tropical Region of the Ocean*, M.E. Vinogradov Ed., Moscow 1971, which has already been translated into English.

The second priority question is the planning of the possible participation of FGGE. Little can be done until the Working Group is formed. Nevertheless, it is hoped that one member of its Physical Panel will participate in the SCOR/JOC Study Conference on General Circulation Models of the Ocean to be held at Helsinki in May 1977 and particularly at the first meeting of the Panel on equatorial modelling of WG 49. The Chairman will probably be present at La Jolla for the meeting of the Pacific Penal of WG 47 and for the first week of the workshop on Dynamics of Equatorial Ocean Currents. Further, it should be provided for the participation to the CINECA symposium of Dakar in 1978 and to the GATE symposium of Kiel also in 1978.

All the above refers practically only to the dynamical aspect of the upwelling and the biological implications of the latter are let aside. Progress in this field will depend to a certain degree on progress of the work of WG 59 on Mathematical Models in Biological Oceanography with which contacts should be established. Of particularly great interest will be the review of coastal upwelling processes of the former WG 36.

As far as "the coupling of equatorial upwelling processes with the coastal upwelling in the adjacent areas along eastern boundaries of the oceans" is concerned, it is actually difficult to forecast any action until the first meeting of the panel on equatorial modelling.
of WG 49. Nevertheless, close cooperation should be sought with the WG 55 on Prediction of El Niño, and the WG 56 should be active in helping the former to select the biological indicators to be studied in conjunction with El Niño.

The fourth term of reference will be approached after the formation of the Working Group.

To conclude I would like to suggest that a possible date and place for the first meeting of the Physical Panel of WG 56 would be the GATE Symposium of Kiel in June 1978 and that the Biological Panel could hold its first meeting during the CINECA symposium of Dakar in early 1978.
Because this is the first official report to the SCOR Executive a brief description of the group and its goals will be given before reporting on its activities.

1. History and terms of reference

Working Group 57, Coastal and Estuarine Regimes was originally sponsored by IAPSO and is now co-sponsored by IAPSO, SCOR, ECOR and UNESCO. A sub-Working Group on Numerical Models of Estuaries and Coastal Seas has been formed and is considered part of the full Working Group.

The terms of reference of the Group are:—

To promote the co-ordination of the physical aspects of research on estuaries, coastal areas and shelf seas. In particular, special efforts should be made:

a) to encourage liaison between physical oceanographers and those studying sediment transport phenomenon, and
b) to relate numerical models with observational programmes.

2. Membership

The members of the Working Group are:—

Chairman, Dr J.B. Matthews, USA; Professor Ain Aitsam, USSR; Professor Herman G. Gade, Norway; Dr Christopher N.K. Mooers, USA; Dr Jorg Imberger, USA; Ir H.A. Ferguson, Netherlands (ECOR representative); Professor H. Postma, Netherlands, (UNESCO representative); Dr N.S. Heaps, UK (Chairman of the Sub-Working Group on Numerical Models).

SCOR Executive Committee Reporter, Professor H. Postma.

The members of the sub-Working Group on Numerical Models on coastal seas and estuaries are:—

Dr N.S. Heaps, Chairman; Dr J.B. Matthews; Dr J.J. Voogt, Netherlands; Dr Taivo Laevastu, USA; Professor W. Hansen, FRG; Dr B.J. Noye, Australia.

3. Overall Programme

The Working Group has met only once at the organizational meeting at the IUGG General Assembly in Grenoble in September 1975. Chairman Heaps reports that his sub-Working Group has been unsuccessful in attempting to hold a meeting in conjunction with the 1976 Joint Oceanographic Assembly in Edinburgh but has conducted business by correspondence. The full Working Group and the sub group have not yet met together. All members of both groups have expressed the need to meet together and this report includes a formal request for funds to support the first full meeting of the group.
Activities of the group have been conducted by correspondence and during chance meetings of two or more group members. It has been decided that the best way to achieve our objectives is via the sponsorship or co-sponsorship of conferences on topics related to our goals. To date three conferences or sessions at conferences have been proposed. These are:

(i) Co-sponsorship of the Sixteenth Coastal Engineering Conference in Hamburg, Germany, 28 August – 1 September 1978.

(ii) Sessions at the IUGG General Assembly in Canberra, Australia, December 1979.

(iii) Co-sponsorship of a multi-disciplinary conference on estuaries and coastal seas in 1982, possibly as part of the proposed Joint Oceanographic Assembly.


Planning for the co-sponsorship of the Coastal Engineering Conference is in the advanced stages. Co-sponsorship of the conference is believed to satisfy both major goals listed in our terms of reference. The major organization of the sessions is being undertaken by the German Organising Committee. Our role is to suggest names of chairmen for sessions on subjects identified as being of special interest to our group, to review the abstracts of papers submitted to these sessions, and to run the sessions.

Topics of particular interest to the CER Working Group have been identified as follows:
(i) Three dimensional modeling in estuaries and seas
(ii) Sediment transport processes
(iii) Exchange processes in estuaries and seas
(iv) Transient circulation over variable topography in density stratified waters
(v) Role of fronts
(vi) Instrumentation
(vii) Air-sea interaction
(viii) Wave-current interaction
(ix) Estuarine and shelf interaction
(x) Ecological modelling

Abstracts of papers for presentation at the conference, submitted by 15 October 1977, will be reviewed by our reviewers and selected papers will be printed in the proceedings of the conference. An announcement has been accepted for publication in the June issue of EOS, Transactions of the American Geophysical Union in which our co-sponsorship is announced and a call for papers issued. It is believed that EOS reaches a large audience world-wide. Final details of the meeting sessions will be worked out with the German Organizing Committee at the proposed meeting of the Working Group.

5. IUGG General Assembly, Canberra, Australia, December 1979

The group has had considerable discussion as to the overlap of the IUGG meeting with the Hamburg meeting. It is generally agreed that the two meetings serve different purposes and are linked by our overall strategy. The Hamburg meeting is designed to bring physical oceanographers into the coastal engineering community and is a step toward the IUGG General Assembly. It is unfortunate that details of the sessions for the General Assembly need to be finalized before the Hamburg meeting is completed but IAPSO have informed us that details of the proposed symposia, the number of sessions and the names of the convenor must be submitted to IUGG by 1 June 1977.
We have identified the programme for IUGG as follows:

Symposium on Estuaries, coastal areas and shelf areas

Session 1. Numerical models relating to observational programmes.
Session 2. Current structure: space and time variability, sediment transport phenomena.
Poster Session  Topics included in sessions 1. and 2.

Convenors for these suggested sessions have not been finalized at this time but will probably be provided from within the Working Group.

6. Estuarine and Coastal Conference 1982

It has been proposed that the SCOR Executive be approached to consider the merits and feasibility of holding a multi-disciplinary assembly on estuaries and coastal seas. This has been proposed because the group, being well aware of the interdisciplinary nature of estuarine and coastal processes, has perceived the tendency for estuarine and coastal problems to be considered as ecological entities. It is believed that by 1982 it will be opportune to bring together in one assembly the physical oceanographers, aquatic biologists, coastal engineers, sedimentologists, chemical oceanographers, meteorologists and numerical modellers who are working on estuarine and coastal problems.

This type of multi-disciplinary meeting will need very careful planning and the cooperation of the international bodies which represent the various disciplines. To be successful in such a venture will be largely dependent upon getting the experts involved. Our group recognizes that this is not a trivial problem. It will also be necessary to limit the range of topics to be discussed so that, while stressing the interdisciplinary nature of the work, one will avoid diluting the specialist contributions.

Our group will be willing to provide the physical oceanographic (including numerical modelling) expertise. We would also expect to share in the responsibility for organizing the meeting and in editing contributions if it is decided to publish proceedings. It is hoped that through SCOR and UNESCO enquiries can be made of the appropriate international bodies.

Because of the extensive amount of expertise resident there in all aspects of coastal and estuarine topics, it is tentatively suggested that the proposed conference be held in the Netherlands. However, it has also been suggested that such a symposium be held in conjunction with the next Joint Oceanographic Assembly. We do not at this time know the proposed venue for the Assembly but our group would be very happy to contribute to the next JOA. This matter is respectfully submitted for consideration by the SCOR Executive.

7. Funding for the Working Group Meeting

It is proposed to call a full meeting of the Working Group and subgroup in the fall of 1977. We have been looking for conferences which some of our group members were planning to attend so that we might append our meeting and thereby reduce costs. We have had no success in finding a meeting to which more than one of our members are planning to contribute. Consequently the request for funds must cover almost the total anticipated travel and subsistence cost for our Working Group.
The following meetings have been considered as possible vehicles for our group meeting:


The Liege Conference is too early for us and only one group member indicated planned attendance.

The POAC Conference would only be attractive to North American group members and only one member has indicated possible attendance. However in a poll of the group the weeks around the POAC Conference 19 – 22 September or 3 – 7 October are generally agreeable for a meeting in Hamburg with the German Organizing Committee. A small preference for the later date was indicated.

The Baden Baden Conference is attractive because the German Organizing Committee plans to meet there and because the conference will be attended by many ocean engineers. Only one of our group has indicated planned attendance. This Conference has only just been brought to our attention and there has been no time to poll the group for opinions. It is known that at least two group members have field programmes which might be in conflict with this meeting.
Letter from the President of SCOR (Dr K.N. Fedorov) to the Secretary of IOC (Mr D.P.D. Scott)
1 April 1977

In response to your multiple letter ICO/2/4 PGC/4 of 23 March 1977, it is clearly most important that IOC should play a prominent role with WMO in establishing any international programme to study climatic change and variability. I trust IOC will remain well to the fore in promoting the relevant oceanographic research activities.

To answer your specific question about how the Commission should become involved is, perhaps, not so easy. Obviously it would be desirable for IOC to be clearly identified as co-sponsor of the proposed Technical Conference in early 1979, but I do think that any discussion of an integrated international programme for the 1980s is so complex that the Assembly in September 1977 should not be expected to do more than declare its interest in the concept and offer to co-sponsor further discussions on the subject.

Whilst the second objective of GARP is concerned with understanding the physical basis of climate, for which it is essential to think in terms of the interacting general circulation of ocean and atmosphere, from item 1 of the abstract report which states the necessity for examining the historical record over much longer periods than 100 years, it is clearly necessary first to consider how this might be achieved and whether it is within the capability of the present GARP organizational structure. As is recognised in the abstract report the problems to be studied will require a wider research expertise than meteorology and this may necessitate a new structure involving a greater number of international organizations than are presently represented in IOC and the GARP Activities Office, who already have a large task on hand anyway.

You will recall, of course, the meeting that was organized in ICSU Headquarters in January 1975 with WMO and UNESCO which discussed the need for an integrated approach to studies of climate and climatic change. It seems to me that the suggestion made at that meeting by Mr Fournier d’Albe of a forum of WMO, ICSU and UNESCO should be followed up at an early date and that the three organizations should be equally involved in planning the conference and discussing a future organizational structure for a programme. If such a structure is evolved I would expect UNESCO to ensure that IOC was represented on a planning group and from that the precise future role for IOC would emerge. Similarly, I would hope that ICSU would ensure representation of the interests of its relevant bodies e.g. SCOR, IAMAP, IAPSO, CMG, SCOPE, SCAR, COSPAR, ICSI, SCOSTEP, INQUA, IUBS etc.

Only when there have been full consultations with all the relevant interests will it be possible to plan a truly comprehensive World Conference at which, presumably, the foundations of a programme of study could be laid taking into account the actual programmes of all the organizations, such as the SCOPE project on carbon cycling and SCOR WG 40 on Paleo-Oceanography.

I should like to further point out that the reported findings of the 3rd session of the WMO EC Panel of Experts on Climatic Changes are somewhat one-sided in their part dealing with Coastal and Ocean Activities. The Panel of Experts considered only impact of climatic
changes on the ocean and did not touch upon the most important aspects of the oceanic variability causing climatic changes.

From the IOC point of view your present close contacts with the planning of GARP-related activities seem satisfactory. For considering the wider implications of climatic change, I suggest that further consultations are an important first step.

I propose to send a copy of your letter and this reply to the members of the SCOR Executive Committee and to the Chairman of SCOR WG 48 with a suggestion that we might discuss this at our Executive Committee meeting in May, with a view to SCOR offering you more carefully considered suggestions than this personal, first response. I am copying this reply to Professor Döös and to Mr Fournier d’Albe.
1. Re-examination of the Terms of Reference of the Panel

The Terms of Reference are laid down in resolution 10 (WMO/EC-XXVII). The Panel had been requested to concentrate on phenomena on time scales from a few months up to 100 years, this would necessitate examining the historical record over much longer periods. The Panel suggested a more appropriate name: Panel on Climate Change and Variability.

2. WMO Statement on Climatic Change

WMO issued a statement on "Climatic Change" on 18 June 1976 (WMO Press Release, 14 pages). The Panel stated, "that the degree of certainty with respect to a likely amount of such a change and its interaction with naturally occurring changes is such that a more positive statement on this matter is not warranted at this time".

However the Panel emphasized that this does not mean that there is any lack of urgency in improving our knowledge on the impact of man on climate and taking action to arrange an integrated international effort to study this and associated problems.

3. Review of National Programmes

WMO issued a questionnaire and received replies from 54 countries of which 21 indicated activities in the field of climate change and variability. Oceanographic climate research and impact was only indicated in the replies by Australia, Canada and the USA. Only one (Canada) indicated "impact studies on fisheries".

The Panel recommended further inquiries to ensure that information is obtained from all institutes (not only WMO contacts). The Panel further suggested a preparation of a selected annotated bibliography of this subject which would form a useful background document for the world conference (see paragraph 6).

4. Workshop on CO₂ Increase in the Atmosphere

The Panel reviewed the workshop report (Washington, 28 November – 3 December 1976) and noted ongoing activities in other organization in this subject, especially those of SCOPE and SCOR. There was general consensus that the report gave a well-balanced account of our present state of knowledge. The increasing use of fossil fuels for combustion, as far as can be judged, represents the most significant impact on climate. Other emissions into the atmosphere and changes of the albedo of the earth's surface may also have pronounced effects. Although there is general consensus that most of the above effects would lead to a warming of the atmosphere, there are still considerable uncertainties about the magnitude of the global impact and about the regional distribution of these effects. In view of the possible far-reaching consequences of such man-induced climatic changes, the Panel considered it most important to give highest priority to activities leading to improved knowledge in this
field (e.g., SCOR Working Group 44 Ocean-Atmosphere Materials Exchange), transport of CO₂ or carbonates down to the large reserves in the deep oceans is insufficiently known, a concerted effort using tracers is needed to describe and parameterize these internal ocean transfers, etc.

The Panel suggested:

a) The development of alternative scenarios of future likely increase of the use of fossil fuels for energy production;

b) The establishment of the best possible model of the carbon cycle including the role of biota, the oceans and sediments to permit an assessment of the most likely future rise of the carbon dioxide in the atmosphere;

c) Climate model development and validation.

The Panel emphasized that in particular item (b) above requires the contribution from many other fields of science than meteorology and items (a) and (b) will necessitate co-operation with many other international governmental and non-governmental organizations.

5. Integrated International Effort related to Studies of Climatic Change and Variability

A draft outline plan for an integrated international programme *International Programme for Study of Climate and Man (IPSCAM)* (see appendix) was recommended. The Panel noted that the scope of such an effort was likely to be greater than that of the first GARP objective and that each of the four main components

a) modelling of the atmosphere-ocean-land-cryosphere climatic system
b) study of the impact of man on climate
c) study of the impact of climate on man
d) study and implementation of data base

could well need an arrangement similar to that established for GARP

Among the suggested activities regarding the impact of changes in climate and its variability on man there are listed among others:

*Coastal and Ocean Climate Conditions*

- Study on Sea Ice conditions, their impact on fishery, marine transport, etc.
- Study on rise or decrease of water level of the sea (possible inundations, etc.)
- Study of the change of ocean circulation (coupled to change of atmospheric circulation) with the corresponding change of local advection in the atmosphere
- Study of occurrence (probability) of extreme phenomena such as hurricanes and storms.

6. Proposed World Conference on Climatic Change and Variability

The panel strongly supported the idea of a preparatory world concerence. Only after the results of this conference have been assessed should a decision be taken about the ‘political’ conference, proposed by an informal meeting in January 1977 to the WMO Secretary General.
Suggestions on the main themes of the proposed preparatory conference and on the organization of the conference (Planning Committee with representatives of organizations directly interested) are as follows:

a) Concise review of knowledge of past Climate Change and Variability
   (i) in pre-instrumental times
   (ii) in recent times
together with an analysis of their possible causes and some examples of their impact on social and economic activities.

b) Assessment of possible future climatic change and variability up to and beyond the year 2000 A.D.

c) Assessment of the sensitivity of contemporary agriculture and land-use to climatic variations.

d) *Assessment of the sensitivity of pelagic and coastal fisheries and of other maritime activities to climatic change and variability.*

e) Assessment of the effects of climatic change and variability on energy demand and production noting possible feedback effects (CO₂, air pollution, release of thermal energy, etc.).

f) Assessment of the impact of climatic change and variability on the availability and use of water.

g) The impact of climatic change and variability on health.

h) Analysis of the overall impact of climatic change and variability on social and economic activities.

This “World Technical Conference on Climate Change and Variability” is planned to be held before the next WMO Congress (May 1979). The first meeting of the Planning Committee is envisaged for late summer or fall 1977.

7. *Funding of future work on Climatic Change*

Continued support is expected from UNEP, however other international organizations concerned also should make adequate provisions to finance their contributions to the integrated international effort on climatic change and variability. The WMO Secretary-General should discuss the matter with appropriate authorities in these organization. The formal adoption of an international effort on climatic change and variability would assist in some countries in obtaining Government approval for the national expenditures. Donor agencies also were encouraged to provide support.
APPENDIX

Draft Proposals for Plan for an Integrated International Programme for Study of Climate and Man (IPSCAM)

1. The Panel was requested by EC-XXVIII to complete a detailed plan for the integrated international effort related to studies of climatic change before the next session of the Committee. The Panel has prepared tentative lists of activities necessary in four main areas — see attachments 1-4. These lists, which are based on information provided to the Panel, are by no means exhaustive and are meant only to give a general indication of the scope of activity within each component.

2. It should be noted that many of the activities in each component are not readily identified with any one organization or institution. For instance, activities related to modelling, whilst largely involving those conducted under the auspices of the JOC, will also include many activities of other WMO bodies, related international agencies and national efforts. Similarly, activities related to the data base will include data relating to modelling activities, studies of the impact of man on climate and of climate on man. The last named component of the effort will involve a wide spectrum of activities so that the data base will need to cover a correspondingly wide range including conventional meteorological data, data from special observing systems, data from palaeoclimatological records and historical records, statistics of fossil fuel consumption, data relating to the oceans, ice masses and data related to the biosphere.

3. The activities relating to the data base component will involve a statement of requirements for data from the other three components of the effort. The activities will also involve a study of availability, quality and homogeneity of data. It will also be necessary to determine what further collection and storage is required and to ensure that necessary data will be readily available for the activities of the three other components of the effort.

4. With the resources available to the Panel it has not been possible to prepare a detailed plan of action for the effort (IPSCAM) but the following outline of an action plan is suggested.

Modelling of climatic change and variability

5. Presently available models need further development and integration to meet the needs of IPSCAM. A family of models is needed to deal with the two kinds of prediction. First is the prediction of climate with the initial and boundary conditions prevailing at present. The second is the prediction of changes in climate and its variability resulting from changes in the chemical composition of the atmosphere, particulate matter therein, changes in the biosphere, sea-ice, ice masses, ocean and land use.

6. Although considerable progress has been made as the result of initiatives by JOC and other bodies a very considerably expanded effort is required before an adequate input to other components of IPSCAM will be available. The JOC, SCOPE, SCOR, CAS and other bodies are the logical bodies to initiate these efforts.

Study of impact of man on inducing climatic change and variability

7. The Panel regarded the intensification of efforts in this field as having the highest priority. Progress would depend on the development of an adequate family of models referred to in paragraph 5 above but of equal importance was an improvement of our knowledge of the carbon cycle including the role of the oceans, the biosphere and land-use.

8. Organizations concerned, including WMO, UNEP, FAO, Unesco and ICSU, should work closely together to ensure a co-ordinated study of these problems, interacting intimately with JOC.

9. The Panel stressed the importance of combining these studies with those relating to population growth and energy consumption, especially with regard to meeting world needs for energy, food, fibres, etc., according to alternative scenarios of future climatic change.

10. The Panel also emphasized the need to extend and improve activities for monitoring chemical composition of the atmosphere, particulate matter, the biosphere, land-use, ocean characteristics, including pollution and meteorological indicators of changes in climate and its variability induced by man. The Panel noted in this context the intention of UNEP to organize within the next year in relation to GEMS and in close co-operation with WMO, an intergovernmental group of experts to consider various aspects of climate-related monitoring.

11. The Panel believed that world leaders should be alerted to the need for increased effort to assess more accurately the effects on climate of changes in the chemical composition of the atmosphere, the biosphere, the use of land and the ocean characteristics by pollution and other means.

Study of impact of changes in climate and its variability on man

12. To obtain an integrated assessment of the impact of changes in climate and its variability on man, the Panel emphasized the need for a family of models to give a better knowledge of the impact of changes in climate and its variability in world food production, human settlements, energy requirements and human welfare generally. It recognized that there are substantial studies in some fields of planning to take climatic factors into account but saw a need for more co-ordination of these efforts in the overall context of this segment of IPSCAM.
13. The Panel stressed that the development of an integrated set of models relating the atmosphere-oceans-biosphere and human utilization of resources was a task of great magnitude and considerable urgency.

14. Preparation of a detailed plan for this effort would involve WMO, ICSU, UNEP, FAO, Unesco (IOC) and other agencies.

**Data base required for IPSCAM**

15. The scope and variety of information required for the data base was very great. It was not envisaged that the data base would be collected in one central point but a detailed plan was necessary to delineate the requirements, identify and catalogue existing resources and specify action to remedy deficiencies. Preparation of such a plan would require close consultation between WMO, ICSU, UNEP, FAO and Unesco (IOC).

**Identification of targets**

16. The Panel was attracted by the idea advanced by Dr G. Paltridge that objectives should be identified as achievable in the short, medium and long term. It believed that the proposed technical conference on climatic change should have this as one of its primary goals.

**Attachment 1**

**ACTIVITIES RELATED TO MODELLING OF THE CLIMATE SYSTEM**

1. **Development of Models of the Climate System**
   - Empirical/statistical models
   - Thermodynamic energy balance models
   - Physical/dynamical modelling of the atmosphere
   - Stochastic-dynamic models
   - Laboratory analogue models

2. **Climate Theory and Modelling Methodology**
   - Modelling/Parameterization of Elements and Processes within the Climate System
     - Cloudiness and radiation fields
     - Aerosols — natural, anthropogenic, and man-triggered
     - Sea ice and ice sheets
     - Biological processes on land, hydrological processes, and land surface albedo
     - Carbon dioxide, ozone, and other radiatively significant minor constituents

3. **Model Validation and Intercomparison**
   - Comparative climate simulations between models
   - Validation of climate models and parameterizations

4. **Climate Sensitivity and Predictability Studies**
   - Estimation of the response of climate to small perturbations through model experiments and empirical studies
   - Climate predictability experiments using both physical-dynamic and empirical-statistical models

5. **Diagnostic Studies**
   - Empirical Determination of the Structure of Observed Climate Variability

**Attachment 2**

**ACTIVITIES RELATED TO EFFECT OF MAN ON CHANGES IN CLIMATE AND ITS VARIABILITY**

1. Collection and evaluation of available information on atmospheric carbon dioxide concentrations, study of transport between the stratosphere, troposphere and hydrosphere and effect on climate (this is reflected in proposed project on CO₂ submitted in Appendix B to ECPCC-III/Doc. 4);

2. Collection and evaluation of available information on other atmospheric gases (e.g. chlorofluoromethanes, N₂O, CH₄, etc.), study of their transport between the stratosphere, troposphere and hydrosphere, and their effect on climate;

3. Collection and evaluation of available information relevant to atmospheric ozone, study of the consequences on global climate of any reduction in the atmospheric ozone content (this is included in the Global Ozone Research and Monitoring Project approved in Resolution 8 (WMO EC-XXVIII);

4. Study of the character, optical properties and distribution of particulate matter in the atmosphere and of their direct radiative effects on the heat balance under clear and cloudy skies;

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5. Study of the effects of modification of land-use (including irrigation and water storage);
6. Study of large-scale effects of heat emissions due to production and use of energy;
7. Study of small-scale effects of human activities;
8. Study of effects of human activities on physical, biological and oceanic processes (including marine pollution).
9. Monitoring chemical composition of and particulate matter in the atmosphere and characteristics of the ocean, land-use, ice masses, sea ice, etc.

Attachment 3

ACTIVITIES REGARDING THE IMPACT OF CHANGES IN CLIMATE AND ITS VARIABILITY ON MAN

The variability of climatic conditions and its possible integrated effect on the environment and national economy in various parts of the world, should be kept in mind at the level of responsible national and international authorities, in particular when considering the planning of various sectors important for human society.

In addition to the relevant projection of climatic conditions in various scenarios, it may be useful to develop some studies to indicate the degree of sensitivity to climate in connexion with some activities. For instance, it would be relevant to promote studies on potential consequences for activities related to agriculture, energy and hydro-power potential in specific geographical areas particularly sensitive to climate.

In this connexion, to facilitate the above referred considerations, a list of examples from various fields has been prepared and is given here below.

General development of plan of action related to monitoring of climate

Agriculture
a) Potential impact of climatic variability on land-use especially in the marginal areas adjacent to cold and arid regions
b) Study of climatic variability in relation to plant and animal diseases, e.g. assessing their increase or decrease
c) Development of methodology for assessing the potential impact of climatic variability on the distribution of crops especially those contributing to world food production
d) Developing methodology for assessing effects of climatic variability on agriculture areas and production
e) Conduct case studies of yields of major crops during recent climatic extremes
f) Studies based on systematic and comprehensive observations of crop trials and simultaneous environmental conditions
g) Development of plan of action related to international climate alert system.

Energy
a) To develop methodology for assessing energy consumption in relation to possible change of temperature and other relevant meteorological elements
b) In connexion with (a), to intensify studies in the field of meteorology and energy conservation and production. In this relation there is a need to develop guidelines for applications of reference temperature for heating and cooling purposes
c) To further promote studies on the utilization of solar radiation and wind as well as other new energy sources with a special regard to possible change of temperature, i.e. to the variability of climate.

Transport
Study the impact of climatic variability on transport with a particular emphasis on safety and economy.

Recreation
Study of impact of climate variability on economy in resort areas and relevant planning.

Land-use planning and planning with regard to housing and human settlements
a) Application of meteorology to planning of rational use of land for human settlements in view of possible change of climatic conditions
b) Studies of the best possible use of meteorological knowledge including climate variability in urban planning and building design
c) Meteorology and climate variability aspects of desertification processes.

Human biometeorology
a) Criteria for establishing comfort zones and critical limits of extreme conditions in different climates based on review and the evaluation of existing knowledge;
b) Study of illumination (space and time variations in various climates) and man;
c) Study of human heat exchange in particular in cold climatic conditions;
d) Study of the relationships atmospheric environment/human health (presentation of data, correlation methods, mathematical models);

e) Study of the seasonal rhythm in human physiology;

f) Study of the importance for human health of the natural biometeorological factors in urban and industrialized areas;

g) Study of the effects of weather changes on the human body;

h) Control of the health conditions in urban and rural areas affected by air pollution.

Water resource development

To study, on the basis of the situations known from the past (e.g. possible change of the geographical patterns as effects of climate change), which kind of possible consequences should be envisaged for relevant scenarios.

Coastal and ocean climatic conditions

a) Study on sea-ice conditions, their impact on fishery, marine transport, etc.

b) Study on rise or decrease of water-level of the sea (possible inundations, etc.)

c) Study of the change of ocean circulation (coupled to change of atmospheric circulation) with the corresponding change of heat advection in the atmosphere

d) Study of occurrence (probability) of extreme phenomena, such as hurricanes and storms.

Attachment 4

ACTIVITIES RELATING TO DEVELOPMENT OF DATA BASE FOR STUDIES OF EFFECTS OF
CHANGES IN CLIMATE AND ITS VARIABILITY

1) Identify requirements

2) Identify data sources

3) Identify deficiencies

4) Plan action to remedy deficiencies in the following fields:

Data for model development and validation

(i) Global data sets for recent periods
(ii) Regional data sets for selected areas and periods
(iii) Long records for individual locations
(iv) Paleoclimatic data sets for significant periods, e.g. the early Holocene climatic optimum
(v) Observation/collection of complete global data sets for future
(vi) Phenomenological/case study data sets.

Data for studies of effect of man on climate

(i) and (ii) above

(vii) Observations of chemical constituents of ocean, atmosphere and biosphere

(viii) Observations of particulate matter

(ix) Observations of thermal emissions

(x) Observations of changes in land-use

(xi) Observations of burning of fossil fuels

Data for studies of effect of climate on man

(i) and (vi) above

(xii) Agricultural productivity

(xiii) Econometric data

(xiv) Sociological/demographic data

(xv) Fisheries data
IAPSO held its General Assembly in Grenoble, France, 25 August to 6 September 1975. The proceedings of the meetings have been published as IAPSO Procès-Verbaux No. 14 and are on sale at the IUGG Publications Office, 39ter Rue Gay-Lussac, 75005 Paris, France.

At the IAPSO business meetings in Grenoble, new members of the Executive Committee were elected. They are Dr R.W. Stewart (President), Professor J.S. Turner and G. Siedler (Vice-Presidents), Dr E.C. LaFond (Secretary), Dr J.M. Gieskes (Deputy Secretary), Admiral P. DaSilva, Professor E.S.W. Simpson, Professor B.L.K. Somayajulu and Dr S. Uyeda (members). The first meeting of the Executive Committee was held in Edinburgh, Scotland, 21 September 1976.

IAPSO has co-sponsored a number of scientific meetings on:

- "Structure and Tectonics of the Eastern Mediterranean, Jordan Rift Valley and the Red Sea", 30 August to 4 September 1976 in Haifa, Israel;
- "Structural History of the Mediterranean Basins", 25 to 30 October 1976 in Split, Yugoslavia;
- Symposia at 25th International Geological Congress, 16 to 25 August 1976 in Sydney, Australia; and
- Symposia at Joint Oceanographic Assembly, 14 to 23 September 1976 in Edinburgh, Scotland.

IAPSO is planning future scientific meetings:

1. IAPSO will co-sponsor an IUTAM/IUGG symposium on Monsoon Dynamics, to be held in New Delhi, India, 5-9 December 1977. Dr A.V.R. Murty is IAPSO representative to this meeting which includes:

   a. Global processes and global atmospheric models, in their relation to monsoon dynamics.
   b. Interaction between the monsoon winds and the general circulation of the Indian Ocean.
   c. Monsoon climatology and variability; monsoon depressions.
   d. Theory and numerical modelling of meso-scale, orographic and local processes in monsoon meteorology.
   e. Monsoon hydrology, flood prediction and storm-surge prediction.
(2) IAPSO plans to sponsor an Ocean Turbulence Workshop, tentatively scheduled for Kiel, Germany, in the spring of 1979. Professor J.D. Woods is coordinating the workshop.

(3) IAPSO is planning for its next General Assembly, tentatively scheduled to be held at the Australian National University in Canberra, Australia, from 2-15 December 1979. Considerable interest has been expressed in this meeting, and 65 symposia topics have been proposed. These are being reviewed for possible joint sponsorship with other IUGG Associations.
THE INTERNATIONAL ASSOCIATION FOR METEOROLOGY AND ATMOSPHERIC PHYSICS

Activities related to SCOR during 1976-77

By Mr S. Ruttenberg, Secretary

The major IAMAP activity in this period of interest to SCOR concerns the Air-Sea Interaction series of sessions now arranged for the Joint IAGA/IAMAP Assembly, Seattle, August 1977. Three days will be devoted to air-sea interaction topics, including an extensive review of scientific results of the Air Mass Transformation Experiment (AMTEX) organized by Japanese colleagues with international participation for GARP. Additional reports will be heard on JASIN, organized by the UK; and Typhoon-75, organized by the USSR, as well as some general papers on the subject.

Other sessions at the Seattle Assembly will include some papers on exchange of materials between the atmosphere and ocean, in particular carbon dioxide, and the release to the atmosphere from the sea of materials important to tropospheric and stratospheric chemistry, e.g., N₂O.

IAMAP expects to join with IAPSO and IAHS in organizing several symposia with implications to oceanography at the next IUGG Assembly, scheduled for Canberra, December 1979.
## FUTURE MEETINGS OF SCOR

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<tr>
<th>Date</th>
<th>Place</th>
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<tr>
<td>June</td>
<td>La Jolla</td>
<td>1977 Indian and Pacific Ocean Panel of WG 47</td>
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<td>September/October</td>
<td>Sao Paulo</td>
<td>Atlantic Ocean Panel of WG 47</td>
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<td>17-19 October</td>
<td>Halifax, N.S.</td>
<td>WG 58</td>
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<td>3-5 November</td>
<td>Hamburg</td>
<td>WG 57</td>
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<td>6-9 December</td>
<td>Wormley</td>
<td>WG 59</td>
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<td><strong>Other probable meetings in late 1977</strong></td>
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<tr>
<td>January</td>
<td>Sao Paulo</td>
<td>1978 21st SCOR Executive Committee</td>
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<td>March</td>
<td>Kiel</td>
<td>Organizing Group for Paleo-oceanography Symposium</td>
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<td>16-20 May</td>
<td>Kiel</td>
<td>Editorial Group, Coastal Upwelling</td>
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<td>May</td>
<td>Kiel</td>
<td>GATE Oceanography and Surface Layer Meteorology Symposium</td>
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<td>19-23 June</td>
<td>Halifax, N.S.</td>
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<td>28 August – 1 September</td>
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<td>CMG Symposium, Crustal properties across passive margins</td>
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<td>early November</td>
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<td>WG 57 (during Coastal Engineering Conference)</td>
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<td><strong>Other probable meetings in 1978</strong></td>
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<td>1979</td>
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<td>late 1979</td>
<td>ICES/SCOR symposium on Early life History of fish</td>
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<td>December</td>
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<td>SCOR/CMG/IAPSO symposium on Continental Margins of the Indian Ocean</td>
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<td>(at IUGG GA)</td>
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<td>1980</td>
<td>Paris</td>
<td>SCOR/CMG symposium on evolution of the South Atlantic</td>
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**Dates not yet arranged**

- SCOR/IAPSO Symposium, Suspended particles in the Ocean
- SCOR/CMG Symposium on Oceanic Crust and Seawater Interaction
- SCOR/CMG Symposium on High Energy Environment and Sediment Management Problems
- SCOR/CMG Paleo-oceanography symposium
- UNESCO Conference on Coastal Lagoons (with SCOR advisory panel)
<table>
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<tr>
<th>Abbreviation</th>
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<tr>
<td>ACMRR</td>
<td>Advisory Committee on Marine Resources Research (of FAO)</td>
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<tr>
<td>AGCM</td>
<td>Atmospheric general circulation models</td>
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<td>AIDJEX</td>
<td>Arctic Ice Dynamics Joint Experiment</td>
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<td>AMTEX</td>
<td>Air Mass Transformation Experiment (GARP)</td>
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<td>ASFIS</td>
<td>Aquatic Science and Fisheries Information System (FAO/IQC)</td>
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<td>BIOMASS</td>
<td>Biological Investigations of Antarctic Systems and Stocks</td>
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<td>BOSEX-77</td>
<td>Baltic Open Sea Experiment – 1977 (WG 42)</td>
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<td>CAS</td>
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<td>CICIR</td>
<td>International Radio Consultative Committee (of ITU)</td>
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<td>CGMW</td>
<td>Commission for the Geological Map of the World (of IUGG)</td>
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<td>CER</td>
<td>Coastal and Estuarine Regimes (WG 57)</td>
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<td>Cooperative Investigation on the North and Central Western Indian Ocean (IOC)</td>
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<td>CINECA</td>
<td>Cooperative Investigation of the Northern Part of the Eastern Central Atlantic</td>
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<td>CMG</td>
<td>Commission on Marine Geology (of IUGS)</td>
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<td>Committee on Oceanography and GARP (of SCOR)</td>
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<td>COSPAR</td>
<td>Committee on Space Research (of ICSU)</td>
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<td>CRO</td>
<td>Centre de Recherches Océanographiques (Abidjan)</td>
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<td>CTD</td>
<td>Conductivity Temperature Depth</td>
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<td>CUEA</td>
<td>Coastal Upwelling Ecosystems Analysis</td>
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<td>Engineering Committee on Oceanic Resources</td>
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<td>ERFEN</td>
<td>Estudio Regional del Fenómena ‘El Niño’</td>
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<td>FAO</td>
<td>Food and Agriculture Organization of the UN</td>
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<td>FGGE</td>
<td>First GARP Global Experiment</td>
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<td>First BIOMASS Experiment (WG 54)</td>
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<tr>
<td>GAO</td>
<td>GARP Activities Office (at WMO)</td>
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<tr>
<td>GARP</td>
<td>Global Atmospheric Research Programme (of WMO/ICSU)</td>
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<td>GATE</td>
<td>GARP Atlantic Tropical Experiment</td>
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<tr>
<td>GCM</td>
<td>General Circulation Model</td>
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<tr>
<td>GEBCO</td>
<td>General Bathymetric Chart of the Ocean</td>
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<tr>
<td>GEMS</td>
<td>Global Environmental Monitoring System (of UNEP)</td>
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<tr>
<td>GESAMP</td>
<td>Group of Experts on Scientific Aspects of Marine Pollution</td>
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<tr>
<td>GIPME</td>
<td>Global Investigation of Pollution in the Marine Environment</td>
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<tr>
<td>IABO</td>
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<td>IAGA</td>
<td>International Association of Geomagnetism and Aeronomy (of IUGG)</td>
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<td>IAHS</td>
<td>International Association of Hydrological Sciences (of IUGG)</td>
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<td>International Association of Meteorology and Atmospheric Physics (of IUGG)</td>
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<td>IAPSO</td>
<td>International Association for the Physical Sciences of the Ocean (of IUGG)</td>
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<tr>
<td>ICES</td>
<td>International Council for the Exploration of the Sea</td>
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<tr>
<td>ICG</td>
<td>Inter-Union Commission on Geodynamics (of IUGG/IUGS) and also used with reference to International Coordination Groups of IOC</td>
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<td>ICSI</td>
<td>International Commission for Snow and Ice (of IAHS)</td>
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<td>IDOE</td>
<td>International Decade of Ocean Exploration</td>
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<td>IGCP</td>
<td>International Geological Correlation Programme (UNESCO/IUGS)</td>
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<td>IGOS</td>
<td>Integrated Global Ocean Station System (of IOC)</td>
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<td>IHO</td>
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<td>Intergovernmental Maritime Consultative Organization</td>
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Indian Ocean Experiment (GARP)
International Union for Quaternary Research
Intergovernmental Oceanographic Commission
IOC Association for the Caribbean and Adjacent Regions
International Oceanographic Data Exchange (Working Group of IOC)
Institute of Oceanographic Sciences (UK)
International Programme for Study of Climate and Man
International Southern Ocean Studies
International Telecommunications Union
International Union of Biological Sciences (of ICSU)
Inter-Union of Theoretical and Applied Mechanics
International Union of Geodesy and Geophysics (of ICSU)
International Union of Geological Sciences (of ICSU)
International Union of Pure and Applied Chemistry (of ICSU)
International Union of Theoretical and Applied Mechanics
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(Conference September 1977)
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Special Committee on Solar Terrestrial Physics (of ICSU)
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Salinity Temperature Depth recorder
Tropical Wind Observing Ships (FGGE)
United Nations Development Programme
United Nations Environment Programme
United Nations Educational, Scientific and Cultural Organization
Voluntary Assistance Programme (IOC)
World Data Centre
World Health Organization
World Meteorological Organization
Expendable BathyThermograph