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REPORT FROM THE SCIENTIFIC COMMITTEE ON OCEANIC RESEARCH (SCOR) TO THE TWENTY-SEVENTH SESSION OF THE IOC EXECUTIVE COUNCIL

The IOC has requested a progress report on a number of current activities of SCOR of interest to the Commission, to be presented at the 27th Session of the IOC Executive Council.

Coastal Oceanography:

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

The Working Group has held its final meeting and is the process of preparing its final report which will be published with the assistance of the Commission. SCOR is grateful to the IOC for its commitment to support this activity. In many respects, the sequence of chapters planned parallels the sections of an article published by WG 89 in the *Journal of Coastal Research* in 1991, expanding them with more detailed considerations and reviews of each topic. In addition, the WG has decided to add a series of invited contributions in order to make the overall report more complete. It is expected that this activity will be completed by late 1994 and that the SCOR General Meeting in October will disband WG 89 pending publication of its final report.

The 1991 paper presented a review of models that have been proposed to predict beach-profile changes that result from a rise in water level, and include predictions of the resulting shoreline recession rates. The best known model is that of Bruun, while more recently developed models include an entire barrier-island system or focus on the erosion responses of beaches and dunes to the brief elevation of water levels associated with storm surges. Testing and application of the models for beach responses to a long-term rise in sea level have been hampered by the significant lag times of beach changes, amounting to months or years, and the importance of sediment budget balances that can produce shoreline erosion or accretion regardless of any sea level rise. Profile changes assumed by the models have been reasonably well verified by laboratory and field studies, but the predictive equations are found to yield poor results when the effects of profile lag times and complete sediment budgets are not included in the analyses. WG 89 made recommendations concerning the need for additional field and laboratory studies in order to improve our understanding of the responses of beaches to elevated water levels. They include surveys of beach profiles at selected sites and laboratory wave flume tank studies.

The conclusion of WG 89 is that "Coastal erosion in response to elevated water levels is already a significant problem and could become substantially greater if predictions of accelerated sea level rise due to greenhouse warming are correct. Unfortunately, the status of models for the beach responses to such elevated levels is far from satisfactory, and predictions of the associated shoreline recessions rates yield uncertain results. There is a clear need for substantial research efforts in this area."

Sea Level and Muddy Coasts of the World

At its General Meeting in October, SCOR will consider a proposal for a new Working Group which will complement the work of WG 89.

Many areas of muddy coastal seas, formerly mangroves, have become or are becoming heavily developed or established for aquaculture and dykes, for example, in the Philippines and China. Often such coastal areas are subsiding and subject to storm surge, e.g. in Bangladesh. Generally, muddy coasts are tide-dominated; so there are implications if sea level rises. WG 89 focused on sandy coasts, and purposefully excluded muddy coasts, while WG 61 focused on sedimentation at coastal margins. Thus there are many issues of muddy coasts that are not well known, especially in relation to IPCC potential sea level scenarios.

Muddy coastal plains, especially if clay deposits alternate with coarser sediments as in chenier plains, provide a sensitive record of environmental changes, in particular, sea level changes. The analysis and interpretation of the sedimentary structures in clayey deposits lags behind as compared with coarser sediments, due to the difficult and time-consuming sample preparation.

The following terms of reference have been proposed for the new working group; they are in the process of being circulated in the SCOR community for comments in advance of the General Meeting. Input

from the IOC would also be useful to SCOR. If the WG is established, SCOR would welcome IOC's participation.

- To review the nature of oceanographic, geomorphologic and sedimentary dynamics of muddy coasts.
- To examine the possibilities to improve the techniques to visualize, recognize and describe the sedimentary structures in clayey deposits, allowing more detailed interpretations.
- To assess the impact of seal level rise on the sedimentary evolution of muddy coasts, with emphasis on mangrove forests and salt marshes.
- To assess the impact of sea level rise on the utilization of shallow muddy coasts and to give recommendations for the future management of muddy coastal zones.
- To study the impact of the cohesive properties of fine grained sediments on the behavior of (estuarine) tidal flats, subject to sea level rise.

The Liège Colloquium on the Coastal Ocean in a Global Change Perspective

SCOR co-sponsored this meeting, along with the IOC and several other organizations. SCOR provided funds for the travel and subsistence of eight scientists from developing and post-communist countries participating both in the Liège Colloquium and the subsequent *IOC/SCOR Workshop on Global Coastal Ocean Science and Technology Study (COASTS)*. Both meetings were successful with scientific audiences including representatives from a large number of countries. The papers presented in the Colloquium will appear in the *Journal of Marine Systems*, while those given at the COASTS Workshop will be edited and published as two volumes in "The Sea".

SCOR has long expressed its desire to be associated with the IOC coastal oceanography effort, and has been represented in various discussions or this program since 1989 by Dr. Ken Brink of Woods Hole. Dr. Brink was Co-Convener of the COASTS Workshop with Dr. Allan Robinson and Dr. Jacques Nihoul.

Two meetings of the COASTS organizing committee took place in Liège, one of which included a larger group for discussion purposes. While the report and recommendations of these meetings are not yet available, the Chair of the committee, Dr. Robinson, has advised the SCOR Secretariat of their general content.

1. COASTS should foster the standardization of the products of remote sensing, so that they are more easily used and applied to needs in the developing coastal states.

2. COASTS should encourage the development of community modelling and its application to problems in the coastal zones.

3. Training courses and two-way exchanges of scientists are necessary to develop the scientific expertise needed to carry out a well-founded scientific coastal program. COASTS recommends taking advantage of the programs of UNESCO and the Third World Academy of Sciences; if SCOR co-sponsors some of the scientific aspects of the COASTS program, it may be able to provide some travel awards to individuals attending training courses.

4. The COASTS program should be oriented to the study of coastal processes in the global context. One process which was suggested as a potential focus was erosion. SCOR urges the IOC to take into account the results of its WG 89 (see above) if this avenue of investigation is followed.

5. The next major COASTS workshop should be held in 5 years and should emphasize the understanding of the biological-physical interactions which is necessary for modelling for management applications. The synthesis of knowledge about these interactions should be the basis for management models.

6. In the meantime, the results of the Liège meeting should be used in a small workshop in Paris in one year's time. This workshop should identify "pan-coastal regions" - those regions which could be treated together in any scientific or management-oriented studies. The feasibility of implementing a COASTS program in each region will be assessed. The workshop, then, will determine how the future COASTS program would deal with different regions of the world''s coasts.

7. One region will be selected for a "demonstration of concept" project. A number of possibilities for such a pilot program were discussed in Liège, one being West Africa where there is a stated need to deal with the problem of coastal erosion. Many issues must be considered in more detail before a decision is made about the first COASTS field program, It was recommended that this be developed in consultation with SCOR.

SCOR welcomes these recommendations and awaits the detailed report of the Liège discussions. We urge the IOC to take advantage of the SCOR Working Group mechanism to address some scientific needs of the COASTS program, in particular WG 89 on beach erosion and the possible new WG on muddy coasts. The COASTS program should also be developed in close cooperation with the Land-Ocean Interactions in the Coastal Zone (LOICZ) Core Project of the IGBP.

Living Resources:

SCOR/IOC WG 97 - Physiological Ecology of Harmful Algal Blooms

At the first meeting of WG 97 in October 1993, the group laid plans and drafted a proposal for use in seeking support for a major workshop in 1995 or 96. This would supplement the usual SCOR support and, together with some support from the IOC, would permit a much more substantial meeting to be organized. It is expected that the larger meeting, and the resulting publication, will be the final activities of WG 97.

WG 97 works closely with the IOC HAB program and with the ICES Working Groups on Harmful Algal Bloom Dynamics and on Phytoplankton Ecology and close communication between the individuals involved has avoided duplication of effort. For example, it is clear that the final report of WG 97 - a book or special issue of a journal - will complement rather than overlap with the planned IOC/Unesco Manual on Harmful Marine Phytoplankton.

The terms of reference of WG 97 are:

- To review and analyze data on the physiological ecology and biochemical aspects of harmful algal blooms, especially those resulting in toxic episodes and paying particular attention to nutritional, environmental and physiological factors.
- To assemble within two years the Working Group's findings and submit for publication a report, summarizing the state of knowledge and identifying the areas of future research.

WG 97 has agreed to narrow the definition of "Harmful" in its title to encompass only those marine algae which produce toxins. It has also decided that rather than addressing the transfer of toxins in the food web, it will focus on the cellular and population levels (extreme ends of the size spectrum) in order to find the common properties and processes regulating harmful blooms. As implied by its title, WG 97 agreed to concentrate on physiological ecology and to exclude toxicology, taxonomy, epidemiology, management issues, ballast water transport, etc.

With respect to the second task, the WG developed a detailed program for the proposed workshop and is engaged in the search for funding to support it. We are working closely with the IOC Technical Secretary, Dr. Enevoldsen, on this activity.

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

The first meeting of WG 98 has just taken place in La Paz, Mexico (June 1994). The group has been established to broaden the participation and formalize the activities of an *ad hoc* group of scientists who had been considering the climatic and oceanic processes which cause the simultaneous large variations in the stocks of sardines and anchovies in widely separated parts of the world ocean. These important fisheries have been observed to undergo large changes off the coasts of Japan, Australia, the west coasts of North and South America and the coast of southern Africa.

The terms of reference of WG 98 are to:

- Correlate historical information from the five regions of the world where S. sagax has been fished (Japan, west coast of North America, west coast of South America, west coast of southern Africa, Australasia) that is pertinent to understanding the large ecosystem changes that have occurred in these regions. This includes catch records, abundance estimates, varved sediment records and other historical information such as records of guano harvests. It also includes various worldwide or large-scale atmospheric, physical oceanographic, planktonic and other biological data.

- Use historical information to evaluate the sequence of events occurring at times of major change, to develop hypotheses regarding causes of the large changes (of sardine and anchovy populations and other abundant resources with which they are associated) in each region, to identify mechanisms that may sustain large shifts in abundance over long periods, and to examine evidence for a worldwide cause of the major fluctuations.

- Prepare a report to SCOR on what appears to cause the worldwide, large-scale fluctuations of sardine and anchovy populations, and on key interactions between sardine and anchovy populations and their environment that require further study.

The WG 98 meeting was just concluded as this report was written and no report is yet available. When it is received, the recommendations and plans for WG 98 will be communicated to the IOC

The SCOR/IOC /ICES/PICES Program on Global Ocean Ecosystem Dynamics (GLOBEC)

The GLOBEC program is one of two large-scale programs for which SCOR is currently taking the lead, organizationally and financially. It forms a major component of the IOC Program on Ocean Science and Living Resources. The cosponsorship of the IOC is gratefully acknowledged by the SCOR Executive; in particular this year the Commission is hosting the GLOBEC Strategic Planning Conference (see below) which will take place here at Unesco Headquarters just after this Executive Council Meeting.

The ocean plays a central role in modulating global climate. While this role has been understood in general for decades, the mechanisms by which global climate in turn influences ocean processes are only now being unravelled and studied in such programs as the World Ocean Circulation Experiment. Of particular interest to biological, chemical and fisheries oceanographers are the relationships between ocean circulation, biogeochemistry and ecosystem dynamics.

In April 1991, motivated by growing interest in a number of nations, SCOR and the IOC sponsored a workshop in Solomons, Maryland on the topic of Global Ocean Ecosystem Dynamics. The report of that workshop (IOC, 1991) notes that "Concerns for global climate change emphasize the need to understand how changes in the global environment will affect the abundance, diversity and production of animal populations comprising ocean ecosystems." The workshop emphasized that "among marine animal populations, zooplankton play a pivotal roles in shaping ecosystem structure and the cycling of biogenic elements."

The Solomons Workshop highlighted a new appreciation of zooplankton as a critical component of oceanic biogeochemical cycles (through grazing and its regulation of primary production) and, in particular of the significance of zooplankton population dynamics to the marine ecosystem; variations in zooplankton populations may affect the biomass of many fish and shellfish stocks. The links between the physical and biological variability of the ocean are, as yet, poorly understood and this was recognized to be a major topic which could only benefit from international collaboration. It recommended a coordinated international effort to address these questions of global change and marine ecosystems.

The goal of GLOBEC as defined in Solomons, is "*To understand the effects of physical processes on predator-prey interactions and population dynamics of zooplankton, and their relation to ocean ecosystems and implications for fisheries in the context of the global climate system and anthropogenic change*". The Workshop recommended that SCOR establish an international GLOBEC program to provide coordination between and a focus for existing national programs.

This was done, and the SSC for GLOBEC met for the first time in early 1992. A series of 6 working groups met during the first half of 1993. Their reports have been published by SCOR in the GLOBEC Report Series as follows:

No. 1 - Towards the Development of the GLOBEC Core Program. Report of the first International GLOBEC Planning Meeting, Ravello, Italy, March 31 - April 2, 1992.

No. 2 - Report of the First Meeting of the International GLOBEC Working Group on Population Dynamics and Physical Variability, February 1-5, 1993, Cambridge, United Kingdom.

No. 3 - Report of the First Meeting of the International GLOBEC Working Group on Sampling and Observational Systems, March 29-April 3, 1993, Paris, France.

No. 4 - Report of the First Meeting of the ICES/GLOBEC Working Group on Cod and Climate Change, June 7-11, 1993, Lowestoft, United Kingdom.

No. 5 - Report of the First Meeting of the International GLOBEC Southern Ocean Working Group, June 15-17, 1993, Norfolk, Virginia, USA.

No. 6 - Report of the First Meeting of the International GLOBEC Working Group on Numerical Modelling, July 12-14, 1993, Villefranche, France.

These reports form the basis for the GLOBEC international Science Plan which describes the scientific problems to be addressed and the major gaps in our understanding of marine ecosystem dynamics. It identifies the critical processes to be studied and the scientific strategies or elements of the program by which its objectives can be achieved. The Science Plan is in press as this report is being prepared, and it will be presented to a broader audience for the first time at the GLOBEC Strategic Planning Conference in Paris, July 18-22, 1994. All IOC Members were invited to send experts to this Conference.

The GLOBEC Core Program provides a framework in which international, national and regional programs can be linked towards a common goal of understanding zooplankton dynamics in a physical and ecosystem setting. It is being developed along two lines. The general scientific approach is being generated by four working groups: Population Dynamics and Physical Variability, Numerical Modelling, Sampling and Observational Systems and Retrospective Data Analysis. The resulting scientific focus will be applied to specific ecosystems, the other line of GLOBEC investigation.

The Population Dynamics and Physical Variability Working Group is charged with problem definition and the development of population dynamic, behavioral, and trophodynamic mathematical and conceptual models. Recommendations for both biological and physical process studies were developed at the first working group meeting in February, 1993. The Numerical Modelling Working Group met in July, 1993 and has been charged with incorporating zooplankton population dynamics models into physical fields. The Sampling and Observation Systems Working Group will be expanding the use of modern technologies in estimation of parameters related to zooplankton population dynamics and physical processes. These estimates are critical to the success of both the Population Dynamics and Physical Variability and Numerical Modelling Working Groups. The Retrospective Data Analysis Working Group will be reviewing historical data for its applicability to GLOBEC problems and will be making previously unavailable data accessible through modern data management techniques. This is an essential part of determining the variability of ecosystems and assessing the impacts of global climate change on both biological and physical mechanisms.

The development of the scientific approach so far suggests that the direction of the GLOBEC mission will be achieved along two avenues. The first involves the population dynamics of zooplankton (including ichthyoplankton) and is fairly straight forward. The second involves the development of coupled numerical models and observation systems which will involve a significant planning effort and international cooperation.

The idea of coupled numerical physical/biological models and observation systems is associated with the ideas that originally motivated GLOBEC. These involve developing a capability to nowcast and forecast population dynamics of zooplankton in a physical setting in order to better understand the major ecosystem

types. These nowcasts and forecasts have important applications in global-change issues and fisheries. Such a system would be designed in the context of modern data assimilation and interpolation schemes. It would involve sampling theory considerations and evaluation of cost effectiveness in its design. It would rely heavily on advances which have been made in acoustic and optical sampling and image identification.

The modelling/observation system would be flexible and modular and therefore be deployable in the major ecosystem types (e.g. spring bloom, HNLC, upwelling, etc.). It would be aimed at estimating realistic physical and biological fields with mesoscale resolution because these are thought to be the most energetic (and hence, variable) physically and most demanding of density dependent compensatory processes biologically. The regional working groups of GLOBEC: ICES/GLOBEC Cod & Climate Change, Southern Ocean, PICES/GLOBEC Subarctic Pacific, and the recently formed group on Small Pelagic Fish and Climate Change (which will focus on coastal and upwelling systems) are developing scientific plans for their regions to which this modelling/observation system would be applied. It is expected that the system will also be used to address key areas of interest within the national programs.

The modelling/observation system description is, at this point, fairly general. This is because the configuration of this system and its components will require careful analysis; evaluation of feasible configurations; and cost effectiveness. It seems that there is broad scientific support for the development of such a coupled modelling/observational system.

Following the GLOBEC Strategic Planning Conference and the final publication of the Science Plan, it is expected that SCOR will ask the IGBP to consider accepting GLOBEC as a Core Project. This has been discussed in some detail with IGBP already and the advantage of links between such programs as JGOFS, LOICZ, GAIM, etc. and GLOBEC have been identified. Some aspects such as modelling and data management are particularly important for interactions with other programs.

Support for GLOBEC continues to be a source of concern to SCOR. Some future US funding for a small GLOBEC Secretariat at the University of Maryland is conditional upon increased support from the other cosponsors of the program (IOC, ICES and PICES) and from national GLOBEC programs. To date, nearly all of the funding for GLOBEC planning activities has come from the SCOR budget. In addition to the IOC support for the GLOBEC Strategic Planning Conference noted above, a small amount of direct financial support from IOC has been made available for two GLOBEC planning meetings in 1994. The Secretary of IOC participated in the GLOBEC SSC meeting in January. SCOR urgently requests those Member States of the IOC with special interests in this program to consider how they could contribute to its support, either through SCOR or the Commission.

A milestone for GLOBEC in 1995 will be an Implementation Conference. The dates and location of this meeting will be determined during the Strategic Planning Conference in Paris in July 1994.

GLOBEC - Small Pelagic Fish and Climate Change (SPACC)

This aspect of GLOBEC may be of special interest to many Member States of the IOC. The first meeting of the SPACC group has just been completed in conjunction with SCOR WG 98 in La Paz, Mexico. SCOR WG 98 is using historical information (see above), but the SPACC component of GLOBEC will involve a new program to address the problems of fluctuations in the stocks of small pelagic fish. While the report of the SPACC meeting is not yet available, it will be brought to the GLOBEC Strategic Planning Conference next week.

Mounting evidence from the dynamics of small pelagic fish populations, and other sources, indicate that climate variability alters the productivity of marine ecosystems. Nearly half the world's annual marine catch is small pelagic fishes. Their distribution is global (except Antarctica) occurring in the coastal waters of developed as well as developing countries, and in the southern as well as the northern hemisphere. Thus, they are well suited for an international comparative ecosystem program. Major swings in population size of small pelagic fishes are often accompanied by alternations in the dominate species in the ecosystem. Examples include, sardines and anchovies in the Humboldt and Benguela Current, herring and sprat in the North Sea, sardinella and anchovy off southern Brazil, and sardinella and juvenile triggerfish in the Gulf of Guinea.

These alternations in dominance between the major small pelagic fish stocks have been called "regime shifts" because they are believed to be linked to decadal-scale changes in ocean climate. Typically, they are correlated with changes in other components of the ecosystem, as abundance of plankton, primary production, abundance of other fish stocks, mammals or birds, as well as changes in physical events such as mean sea surface temperature. There are indications that these regime shifts might be recognized by changes in the zooplankton communities before they become obvious in the fishery. Thus, shifts in the composition of zooplankton communities might be useful early indicators of regime shifts caused by climate change.

In some cases, fluctuations of similar species seem to be in phase with one another in distant regions of the world's oceans. For example, Japanese and Californian sardine populations grew in the 1920's and early 1930's and reached a peak in the mid to late 30's and both populations declined thereafter and remained depressed for decades. The sardine population in the Humboldt Current and the Japanese population began a phase of rapid growth in the mid-70's, reached a peak in the 80's and synchronously started to decline again in the late 1980's. These basin-wide, in phase, fluctuations of sardines in the Pacific Ocean may be forced by climate since the underlying teleconnections must be connected to atmospheric processes. The causal mechanisms need identification, however.

ENSO teleconnections affect marine ecosystems throughout the world. ENSO's are associated with worldanomalies. For example, droughts, unusual rainfall or flooding in Indonesia, China, India or Australia. In addition to short-term perturbations caused by ENSO, indications exist for trans-basin teleconnections acting on a decadal or multi-decadal scale and affecting long-term trends in small pelagic fish populations. For example, the fluctuations of the sardine population off southwestern Africa tend to be opposite in phase to those of the Pacific Ocean. Again, climate forcing is assumed to be the driving mechanism.

The small pelagic fishes are an ideal group of fishes for comparative studies of the effects of climate change on marine resources because of their economic importance, worldwide distribution, great swings in abundance, evidence for climatic teleconnections between populations, short food chains, and paleoecological time series of abundance.

The objective of SPACC program is to understand the effect of climate change on pelagic fish population dynamics through comparisons among ecosystems supporting these populations. The goals are:

- To describe the characteristics and variability of the physical environment, zooplankton population dynamics and their impact on small pelagic fish populations in each key ecosystem; and
- To improve understanding of the nature and causes of long-term changes in these ecosystems.

The SPACC program will use two general approaches to meet these goals. Retrospective studies, in which ecosystem histories are reconstructed using time series and paleoecological data and genetics data; and Process studies, where cause and effect linkages between fish population dynamics and ocean climate are inferred from comparisons of standard measurements made in different ecosystems.

A detailed Science Plan for SPACC is part of the overall GLOBEC Science Plan which will be available next week. Participants in the IOC Executive Council Meeting who wish to receive copies of the GLOBEC Science Plan are invited to contact the Executive Director of SCOR.

GOOS-related activities of SCOR:

SCOR WG 96 - Acoustic Monitoring of the World Ocean

This WG has received some support through the annual contracts between IOC and SCOR - this support from IOC is gratefully acknowledged.

The propagation of sound over very long distances in the ocean can be used to monitor small changes in ocean density and temperature. The successful Heard Island Experiment in 1991 was a feasibility study for a larger, international experiment known as Acoustic Thermometry of Ocean Climate (ATOC). WG 96 has

been serving successfully as a forum to broaden international participation in the ATOC project which originated in the USA. It meets to discuss strategies and evaluate opportunities for international collaboration. It has also provided a means for the involvement of theoretical oceanographers and modellers in ATOC. The second meeting of WG 96 was held in Brest in June 1993, once again in conjunction with an international symposium on ATOC. It was attended by the Director of the GOOS Support Office.

WG 96 will meet again in Hawaii in October 1994. It will consider how to complete the terms of reference assigned to it by SCOR:

- To study the existing methods of large-scale acoustic tomography of the ocean and identify those which can benefit from international collaboration.
- To evaluate the opportunities for international collaboration in the use of acoustic techniques for monitoring global climate change in the ocean.
- To assess other methods and theories relating to investigation of the ocean by means of observations of sound propagation over long distances.
- To prepare a report to SCOR on the scientific prospects for large-scale acoustic tomography.

The group will also address the international aspects of the ATOC experiment and, in particular the regulations involving sound and marine mammals in countries other than the US.

SCOR notes the needs of the Global Ocean Observing System and the Global Climate Observing System for ATOC has instructed WG 96 to forge links to these activities so that an ATOC system can be appropriately designed to respond to the requirements of GOOS and GCOS.

SCOR has encouraged the activities being carried out by WG 96. At the same time, there is some concern that the ATOC program will last longer than the normal lifetime of a SCOR WG. Accordingly, the 1994 General Meeting will discuss a new mechanism which will permit the continuing sponsorship and oversight by SCOR of a longer-term activity such as ATOC without the substantial financial and personnel commitment such as are required by programs like JGOFS and GLOBEC.

Joint Global Ocean Flux Study (JGOFS)

Details of the JGOFS program have been given at several IOC meetings in the past few years. JGOFS is now well-advanced, with ongoing process studies in the Equatorial Pacific Ocean, Arabian Sea and the Southern Ocean. The Executive Director of SCOR will be pleased to supply JGOFS Reports and other information to participants in the IOC Executive Council meeting.

The assistance and support of the IOC in organizing a training course on the methods for making the JGOFS Core Measurements, which took place in Mombasa, Kenya last November, was much appreciated by SCOR. This workshop providd training to about 18 scientists who will participate in the JGOFS Arabian Sea program.

In relation to GOOS, the existence of a number of JGOFS Time Series Stations should be taken into account. JGOFS time series studies provide full seasonal coverage over several years for measurements of key properties and processes. Since research cruises for intensive study are generally limited to a few weeks, time series observations are essential to give flux estimates free of seasonal bias - and to reveal other patterns of long-term variability. Thus the time series data sets play a vital role in assisting model development, by constraining parameter values and providing data for model testing and validation. JGOFS time series stations off Hawaii and Bermuda were both established in 1988, with monthly sampling according to internationally agreed protocols. Data reports are published annually, and those observations will be continued until at least 1998 (with some upgrading; e.g., with regard to increased use of automated sensors for continuous measurement of pCO_2, nutrients and other variables).

Additional JGOFS time series stations off Kerguelen Island (South Indian Ocean/Southern Ocean) and the Canary Islands are currently being initiated, and are expected to be fully operational this year. Observations at the Kerguelen site will build on a background of WOCE measurements (since 1990), sediment trap deployments (since 1992) and other relevant studies in the region. Time series stations provide ideal sites for sampling the marine atmosphere and thus interaction with IGAC. This has already been initiated at Bermuda.

SCOR urges the planners of GOOS to look at the feasibility of ensuring the continuing maintenance of the time series stations after the end of the JGOFS program late in this decade.

Other SCOR activities:

A full list of the current SCOR subsidiary bodies is given below:

WG 86	Ecology of Sea Ice (with SCAR and AOSB)
WG 89	Sea Level Rise and Erosion of the World's Coastlines (with IOC)
WG 93	Pelagic Biogeography (with IOC and ICES)
WG 95	Sediment Suspension and Sea Bed Properties
WG 96	Acoustic Monitoring of the World Ocean (with IOC)
WG 97	Physiological Ecology of Harmful Algal Blooms (with IOC)
WG 98	Worldwide Large-scale Fluctuations of Sardine and Anchovy Populations (with IOC)
WG 99	Linked Mass and Energy Fluxes at Ridge Crests
WG 100	Sediment Coring for International Global Change Research
WG 101	Influence of Sea State on the Atmospheric Drag Coefficient (with IOC)
WG 102	Comparative Salinity and Density of the Atlantic and Pacific Ocean Basins
WG 103	The Role of Wave Breaking on Upper Ocean Dynamics
JGOFS	Joint Global Ocean Flux Study, Scientific Steering Committee
GLOBEC	Global Ocean Ecosystem Dynamics - Scientific Steering Committee (with IOC, ICES and PICES)
GOEZS	*ad hoc* Working Group on the Global Ocean Euphotic Zone Study (with IGBP and WCRP)

Finally, participants are reminded that SCOR has a long-standing program of providing travel grants to marine scientists from developing countries who wish to participate in scientific meetings which are either organized by or cosponsored by SCOR. This program is made possible by a grant to SCOR from the US National Science Foundation. Since the last IOC Assembly, more than 50 oceanographers from nearly 30 countries have received full or partial travel grants.

Additional information on any SCOR activities is available from Elizabeth Gross, the Executive Director. The SCOR Secretariat is in the Department of Earth and Planetary Science, The Johns Hopkins University, Baltimore, MD 21218, USA. Tel: 410-516-4070. Fax: 410-516-4019. OMNET: E.Gross.SCOR InterNet: e.gross.scor@gateway.omnet.com