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* For reasons of budgetary constraints, Annexes III to VIII remain untranslated.

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ANNEXES

1. OPENING

1 The meeting was opened at 10:00 hours on Wednesday June 23, by the Chairman, Dr. Angus McEwan, at the United Nation Educational, Scientific and Cultural Organization (UNESCO) Headquarters, Paris. He welcomed the delegates to Paris. He told them that this was a critical stage in the Global Ocean Observing System (GOOS) development and that I-GOOS had an important role to play in that development. He then called on the sponsors of GOOS to say a few words.

2 Patricio Bernal, Executive Secretary of the Intergovernmental Oceanographic Commission (IOC) said that there were strong signals that GOOS was now seen as realistic and achievable by national and international agencies. It represents an important next step in improving our knowledge about the oceans and the life support system of our planet. I-GOOS has a key and fundamental role to play in GOOS development, because it provided a means of relating GOOS to the societal needs of Member States. Indeed, GOOS had been initiated for this purpose by Member States. I-GOOS is the preferred mechanism through which Member States should describe what they would like GOOS to consider and to implement. GOOS is still very much in the planning stage, especially for the Coastal, Health of the Ocean (HOTO) and Living Marine Resources (LMR) Modules, although implementation is close for the Climate Module, and has begun to some extent through the formation of the GOOS Initial Observing System. The GOOS designers need the guidance and advice of Member States expressed through I-GOOS.

3 He noted that there was increasing support from many sources for major new operational elements like Argo, the proposed array of profiling floats, which was necessary to increase the rate of data capture and the area of data coverage from the upper ocean as the basis for understanding ocean processes and forecasting change.

4 He noted the development of a new initiative, the proposed Joint IOC-WMO Technical Commission for Oceanography and Marine Meteorology (JCOMM), which would provide a much needed and long overdue integration of the mechanisms for collecting and managing data from the upper ocean and overlying atmosphere. Ocean and atmospheric scientists have been working together increasingly over the last decade, recognizing the need to integrate their respective data sets so as to properly understand the behaviour of the ocean and the atmosphere in relation to one another. JCOMM offers a mechanism for consolidating that effort. It has been endorsed by the World Meteorological Organization (WMO) Congress and recommended to the IOC Assembly by the IOC Executive Council, and we hope that the Assembly will produce a similar outcome.

5 He noted that GOOS is now better balanced than it was at the time of I-GOOS-III, with strong efforts being made to bring the Coastal and Living Marine Resources Modules up to speed with the Climate and HOTO Modules, which started their developments earlier.

6 He remarked that having intergovernmental oversight of and support for GOOS from I-GOOS appeared to give GOOS an advantage over the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS), which had no similar mechanism, in terms of winning resources.

7 GOOS is coming to be the most important activity of the IOC, especially in terms of gaining attention and credibility. Implementing GOOS would be a true test of IOC's ability to take on a new and operational role.

8 Peter Dexter for WMO endorsed Dr. Bernal's remarks and congratulated the IOC on the considerable advance that has been made in GOOS in the 2 years since I-GOOS-III. GOOS is now firmly moving toward implementation, and WMO is willing to help as much as it can. WMO has fully endorsed support for the implementation of GOOS, as well as the establishment of JCOMM as a necessary implementational infrastructure mechanism. At the WMO Congress there was evidence of broad support for GOOS, not only at the international, but also at the national level.

9 He noted that the 4th Conference of the Parties (COP-4) to the Framework Convention on Climate Change (FCCC) in Buenos Aires, in November 1998, had made some significant decisions in favour of the establishment of GOOS, including a strong push for enhancement of ocean observing systems.

10 Arthur Dahl stated that the United Nations Environment Programme (UNEP) was impressed with the progress of GOOS under the leadership of the IOC and the GOOS Project Office (GPO). Governments now understand the need for the collection of long-time series of data so as to understand the evolution of environmental phenomena like climate and ecosystems. GOOS is an important element in this new equation, capable of providing the first signs of change and hence of providing early warnings needed by society. GOOS is one component of several needed to monitor the whole Earth system. UNEP is working to enhance the way in which these different components work together, through the Integrated Global Observing Strategy (IGOS), which should help to improve the timely delivery of data and information to policy makers, managers and Conventions. The land-sea interface was one important area where there was still much to be done, with its relevance to the Global Plan of Action (GPA) for the Protection of the Marine Environment from Land Based Activities, as was biology, with its relevance to the Biodiversity Convention. GOOS makes a potentially large contribution to the GPA, and to companion studies like the Global International Waters Assessment (GIWA), and the GESAMP assessment of the marine environment. I-GOOS is important because it can help to build support from governments to help manage the global environment in a sustainable way.

2. ADMINISTRATIVE ARRANGEMENTS

2.1 ADOPTION OF THE AGENDA

11 The agenda was adopted with no change and is given in Annex I.

2.2 DESIGNATION OF RAPPORTEUR

12 Ms. Muriel Cole of the United States of America was designated Rapporteur.

2.3 CONDUCT OF THE SESSION

13 Dr. C. Summerhayes, Director of the GPO, introduced the timetable and documentation for the session. The list of documents appears as Annex II; the list of participants appears as Annex III.

14 Two kinds of documents had been made available: working documents and Information and Reference Documents. Document I-GOOS-IV/14 was missing because it had been decided to make the presentation on infrastructure oral rather than written. Among the documents that needed consideration were I-GOOS-IV/Inf.1, Inf.2, and Inf.3, which conveyed references to GOOS in IOC documents.

15 Dr. Summerhayes noted that the submission of national reports (I-GOOS-IV/Inf.4) was incomplete and asked that new submissions be made to the Secretariat. In the interests of time national reports would not be presented orally; instead they would be available in paper copy at the meeting; would appear in Annex VII to the report of the meeting; and would appear on the GOOS Web page.

16 As an experiment, most of the documents had been made available on the Internet *via* the GOOS Web site. The Committee was generally satisfied with this new procedure but recommended in future (i) that adequate notice should be given to all Member States, and (ii) that the working documents should be accessible by coded access rather than available openly.

17 Dr. Summerhayes presented the apologies of Prof. Worth Nowlin, Chair of the GOOS Steering Committee, who planned to be present but who had recently been taken ill.

18 The Committee agreed that in future it would be desirable if possible to invite the immediate past Chair of I-GOOS to attend the I-GOOS meeting subsequent to his or her retirement, as one means of ensuring continuity.

19 It was announced that an exhibition of the Argo float programme, supported with examples of floats from different organizations was on display in the hallway outside the meeting room. The floats included: (i) the PROVOR neutrally buoy and float of MARTEC, France; (ii) the Profiling Autonomous Lagrangian Circulation Explorer (PALACE) or APEX float of Webb Research Corporation, USA; (iii) two PALACE floats from the Scripps Institution of Oceanography, USA, one encased in Plexiglas for viewing the contents, and a float housing with temperature/conductivity sensor. Dr. S. Wilson of the USA provided an Argo brochure to accompany the exhibit.

3. REPORTS BY I-GOOS CHAIRMAN AND DIRECTOR OF THE GOOS PROJECT OFFICE

3.1 REPORT BY I-GOOS CHAIRMAN

20 The Chairman presented his report (I-GOOS-IV/6). GOOS has now moved from a concept to an implementable reality, especially as far as open ocean observations in support of weather and climate forecasting are concerned. GOOS is now seen throughout the intergovernmental system as the prime means for implementing ocean observations. Nevertheless, the vision of a truly global, integrated and fully comprehensive ocean observing system is far from reality. Although it will take decades to develop, the first bricks are now in place.

21 GOOS has also become part of the larger IGOS, where it is connected with other global observing systems. The arrival of global co-ordination of observations through IGOS marks the development of a new scientific paradigm. No longer is the world of ocean observation dominated by the initiative of the individual investigator. Individual ownership of data is subordinated to collective ownership to the benefit of society as a whole. Territorial and parochial boundaries are beginning to fade away.

22 Much of the success of GOOS since I-GOOS-III is due to the energy of the GOOS Project Office (GPO) and the focus of the new GOOS Steering Committee (GSC) on design for implementation. Progress has been documented in some landmark publications, notably of *The GOOS Strategy and Principles* and of *The GOOS 1998 Prospectus*, which set out the scope and case for GOOS in a clear and inviting way.

23 The main vehicles for the development of implementation designs are the GOOS advisory panels for the 4 GOOS Modules: Climate, Coastal, Living Marine Resources (LMR), and Health of the Ocean (HOTO).

In the near future we hope to obtain a much needed implementation infrastructure for GOOS in the form of the proposed JCOMM. It is important that I-GOOS persuades the IOC Assembly of the importance of endorsement for JCOMM, or GOOS progress would be impeded by lack of an appropriate implementation infrastructure. JCOMM represents an important integration of the activities and approaches of IOC and WMO, enabling them to exploit their mutual interests and skills and to make delivery of results more effective by eliminating duplicating activity.

24 A conference on the observations needed to implement the Climate Module has been organized in concert with the World Climate Research Programme (WCRP), to further guide and refine the requirements for ocean observations for climate.

25 Coastal GOOS has been very active since its inception after I-GOOS-III, so as to make up for lost time. It should produce its implementation design early in 2000, and later that year discussions would begin with the object of considering a merger between it and the LMR and HOTO Modules to form an integrated Coastal GOOS Module addressing all aspects of coastal seas.

26 GOOS is also involved with the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS) in cross-cutting panels addressing common issues in the areas of remote sensing from space, and data and information management.

27 The Global Ocean Data Assimilation Experiment (GODAE) is now being developed to demonstrate the feasibility of GOOS. If GODAE cannot deliver assimilated data in near real-time for operational purposes, then we are not ready for GOOS.

28 GOOS is also being taken forward through regional pilot projects serving specific purposes, like the Pilot Research Array in the Tropical Atlantic (PIRATA). Regional GOOS programmes seem to provide a very useful mechanism for engaging Member States in the development and implementation of GOOS. A subject for debate may be how we draw the lines between them, and how they relate to the overall GOOS structure. Clearly, as GOOS grows and evolves, more attention will have to be paid to its structure. The question is, when, and how much?, and opinions are divided on this point.

29 To give strength to the development and implementation of GOOS, it is important that it be endorsed strongly at the highest level, which is why an Agreements Meeting was proposed. It is now proposed to obtain this endorsement from governments through the mechanism of a Resolution by the IOC Assembly, which is the competent body to provide intergovernmental agreement by Member States on ocean issues.

30 A companion meeting is the non-governmental First GOOS Commitments meeting, at which agencies will be invited to declare their national contributions to GOOS as another means of ensuring the growth of GOOS. The Chairman encouraged Member States attending I-GOOS to participate in the Commitments Meeting, which it was anticipated would be the first of several.

31 The GPO's activities have expanded considerably during the period since I-GOOS-III. This reflects the growing scope of GOOS. The challenge of GOOS is vast, and the scale of the task defines much of the activity. Recognizing this expansion of scope, the GSC has begun to examine the organizational structure of GOOS and has commissioned inter-sessional work on this topic.

32 Although the activity is large, the allocation for it is not, requiring the GPO to work hard to solicit the necessary extra-budgetary funds to make things happen. In spite of the wide interest in GOOS among Member States, and their in-kind contributions, not many are supporting the GPO directly.

33 Dr. McEwan then drew attention to a list of key issues that he felt needed addressing during the meeting:

(i) The call for balanced development of GOOS at the IOC Executive Council in November 1998 indicates widespread interest in and support for Coastal GOOS, reflecting the considerable interest of Member States in their coastal seas. Have we got the balance right?

(ii) A working party has been appointed by the IOC Executive Council to look into the resourcing needed for the international co-ordination of GOOS by the GPO. Due to illness, the work has progressed more slowly than anticipated, but a preliminary report will be presented to the Assembly. What more can be done to increase the resources for GOOS?

(iii) Support for JCOMM is needed at the IOC Assembly;

(iv) I-GOOS is asked to endorse participation in the IGOS Partners Forum;

(v) The GLOSS Group of Experts has recommended that the call for a sea-level panel for climate be met by forming a subgroup of GLOSS to work in conjunction with CLIVAR, IAPSO, OOPC and other appropriate groups. Guidance on this initiative is needed for the Assembly;

(vi) An expert review is proposed for the IOC's Ocean Science and Living Resources (OSLR) programme, which is responsible among other things for support of the LMR Panel and for management of another part of the GOOS Initial Observing System, the Global Coral Reef Monitoring (GCRMN) programme. Can we provide guidance for the Assembly on the future of OSLR in the GOOS context?

(vii) The IOC has been asked to provide an inventory of coastal data collecting systems. Can I-GOOS members help with the development of this inventory?

(viii) The IOC's capacity building programme, TEMA (Training, Education and Mutual Assistance), has now been integrated with the science programmes, including GOOS. Do we have any advice to offer the IOC and/or the GPO in developing TEMA activities within the GOOS programme?

(ix) The IOC is part of UNESCO's overall programme on El Niño. Promotion of GOOS as a critical means of providing observations for forecasting El Niño is needed in order for additional resources to be obtained for the further development of GOOS in the El Niño context.

34 In discussion, the Committee considered that it was timely for the GOOS advisory panels to form strong links with the appropriate Convention Secretariats, for instance OOPC with the Framework Convention on Climate Change, LMR with the Biodiversity Convention, and Coastal GOOS and HOTO with the GPA.

35 The Committee noted that with the reorganization of UNEP, there were prospects for a revitalization of UNEP's Regional Seas programme, which itself is governed by regional intergovernmental Conventions or Action Plans that GOOS could capitalize upon during GOOS implementation. With regard to links to UNEP's Regional Seas programme, Dr. Summerhayes pointed out that a representative of one of the programmes, Tim Kasten, from UNEP's Jamaica office, was a regular attendee at Coastal GOOS meetings. Dr. Summerhayes also told the Committee that links were already being built to specific Regional Seas programmes in certain areas, as well as to IOC's regional programmes:

(i) MedGOOS maps onto the Mediterranean Action Plan area, as well as onto the IOC's developing integrated Mediterranean programme;
(ii) NEAR-GOOS maps onto the NOWPAP Regional Seas programme, and is a programme of the IOC's WESTPAC region;
(iii) The newly developing Caribbean GOOS programme maps onto UNEP's Caribbean regional seas programme and onto the IOC's IOCARIBE programme area;
(iv) PacificGOOS maps onto the regional seas programme managed by SPREP, but is outside the IOC's WESTPAC regional programme;
(v) WIOMAP in the western Indian Ocean maps onto the IOC's IOCINCWIO, and overlaps with some Regional Seas activities.

36 Finally, he noted that in July there would be meeting in Holland of all UNEP's Regional Seas programmes, at which GOOS would be represented by Umit Unluata, the Technical Secretary of the HOTO Panel. At this meeting, efforts would be made to build further links with these programmes. UNEP cautioned that the recent reorganization of UNEP actually made it more difficult to get to the Regional Seas programmes through any central mechanism, and advised contacting each such programme individually on an as-needed basis in future.

37 The Committee fully endorsed the attempts to link regional GOOS developments to other regional activities, particularly those of the IOC and UNEP, and wondered about the possibility for linking to other significant programmes like those of FAO. It was noted that GOOS bodies were also linked to or actively involved in seeking linkages with major research programmes, like GLOBEC for LMR, LOICZ for Coastal GOOS, and CLIVAR for the Climate Module. The Committee also applauded the recent strengthening of links with the other main observing systems, GCOS and GTOS.

3.2 REPORT OF DIRECTOR GPO

38 Colin Summerhayes presented the report on the activities of the GOOS Project Office (I-GOOS-IV/7). There have been several changes in staff, with three staff returning to the United States (Bill Erb, John Withrow and George Grice). George Grice had been replaced by a secondee from NOAA, Dr. Ned Cyr. Naoko Ichiyama, seconded by Japan, had returned to Japan and been replaced by Rimi Nakano. The secondment of Janice Trotte, by Brazil, had been extended for a further year. The IOC is most grateful to the USA, Japan and Brazil for their support of the GPO through secondments. In addition, Thorkild Aarup, from Denmark though recently working in the USA, had been recruited as Technical Secretary for the GLOSS and Coastal GOOS Panels, and in August the IOC will begin a year-long contract with Maria Hood, of the USA, who will work on data and information and be shared between IODE and the GPO. The success of the office in supporting GOOS is due to the hard work and dedication of this well-knit team, which includes the GPO secretarial staff.

39 Since I-GOOS-III, many reports had been written documenting the activities of GOOS bodies, and several articles had been written for various journals to spread the word about GOOS. The delegate from Japan reported that one of these had been translated into Japanese and reproduced in the Technical Bulletin of the Japanese Meteorological Agency. As required by I-GOOS-III Resolutions 1, 2, and 3, two key documents providing guidance on the development of GOOS and describing its character had been published during the period: (i) *The Strategic Plan and Principles*, and (ii) *The GOOS 1998 Prospectus*. The Strategic Plan is already available on the GOOS Web site, and a contract has been placed to put *The GOOS 1998* on the Web site.

40 The Web site had been updated and considerably improved by the valiant efforts of Mr. Yves Tréglos, the GOOS Webmaster. His records show that the site gets around 100 hits *per* week, which is something we must aim to improve upon.

41 Dr. Summerhayes made available a copy of the latest issue (No.7) of *the GOOS News*, pointing out that this too was also available on the Web, where it could be read well before the hard copy version was available.

42 With the help of Mario Ruivo, the GPO had been able to prepare a GOOS exhibit for display in the Pavilion of the Future at EXPO 98 in Portugal, as a contribution to the International Year of the Ocean.

43 Attention was drawn to the extensive programme of GOOS activities attended by the GPO during 1998 and 1999. Maintaining such an extensive programme costs far more that the IOC Regular Programme funds can support, so requires extensive proposal writing to solicit funds from a wide range of agencies for the support of particular meetings. He thanked the Member States who had provided extra-budgetary support for the activities of the office, and noted that it came from just a handful of Member States.

44 The Committee congratulated the GPO on the high level of activity it had been able to sustain since I-GOOS-III, and on its success in raising extra-budgetary funds to support planning and co-ordinating activities. It was noted that the successful growth of GOOS was also a function of the growing interest in and enthusiasm for the GOOS concept by Member States, which are the prime agents of implementation.

45 In discussion, the delegate for Portugal considered there was a need to find mechanisms to gain more commitment to the development and implementation of GOOS from Member States so that development could be sustained for the long term. While it was pleasing that the means had been found to sustain the programme through voluntary extra-budgetary contributions, some more formal and perhaps non-voluntary mechanism may be required in the future to sustain GOOS as it grows yet further. Initiating a search for mechanisms might first require some review of the institutional arrangements for GOOS.

46 Patricio Bernal agreed that as GOOS grows and develops, it would be necessary for us to develop institutional arrangements. Using a biological analogy, he saw this as recognizing that GOOS was evolving from an amoeba-like state into a structured organism. WMO has binding conventions governing its activities. That is because it has had operational meteorology, for which such conventions were necessary, for some considerable time. Operational oceanography however is in its infancy. As it grows into adolescence and adulthood we will have to tackle to complex political issues of institutional arrangements. We should take on this challenge, but not yet.

47 UNEP pointed out that there are institutional challenges in meeting the requirement to collect time series of measurements that had time spans far longer than the lives of governments (or even funding agencies).

48 The Committee agreed that a detailed examination of institutional structures would be premature at this time while GOOS is still to a large extent in the design phase. It was felt that a sense of Member States commitment to GOOS for the longer term would begin to emerge at the 1st GOOS Commitments Meeting planned for July 5th and 6th in Paris.

49 The Director of the GPO then reviewed the Actions on I-GOOS-III decisions, resolutions and recommendations, noting that all had been either accomplished, or were the subject of ongoing activity.

4. STATUS OF GOOS DEVELOPMENT

4.1 GENERAL OVERVIEW OF THE WORK OF THE GOOS STEERING COMMITTEE (GSC)

50 On behalf of Prof. Nowlin, Dr. Summerhayes gave a presentation drafted by Professor Nowlin on the work of the GSC. The GSC was formed by the decree of the GOOS sponsors, endorsed by I-GOOS-III in Resolution I-GOOS-III.4, and its terms of reference were approved at I-GOOS-III (Annex to Resolution I-GOOS-III.4). It started its life formally at the beginning of 1998 after the signing of a Memorandum of Understanding between the sponsors late in 1997, and held its first meeting in Paris in April 1998. At that meeting it decided that it needed to be in contact with thinking in the regions, and that every other one of its meetings should be outside Paris. Accepting a kind offer from the State Oceanic Administration of China, its second meeting was held in Beijing in April 1999, with the able assistance of the Local Organizing Committee led by Mr. Haiqing Li, the delegate of China to I-GOOS-IV.

51 The membership of the GSC is given in Annex IV. The MOU on the GSC dictates that the core committee of 12 should evolve so that 50% of its members have substantial operational experience. To bring operational experience to bear on its deliberations in Beijing, the GSC invited along Dr. Howard Cattle of the UK Meteorological Office (UKMO) and Dr. Ralph Rayner, Managing Director of an international oceanographic service company, GEOS.

52 At its meeting in Beijing, the GSC developed a policy of rotating membership, starting by retiring the four longest standing members, who served on J-GOOS since its inception in 1994, and subsequently on J-GOOS's successor the GSC. One of these individuals is Neville Smith, Chair of the OOPC, who will still serve on the GSC, but outside the core group, in his capacity as chair of an advisory panel. The other three have been asked to consult their communities and to suggest appropriate replacements, preferably with operational experience. The GSC is looking for experts from operational agencies, not for representatives of operational agencies.

53 Dr. Summerhayes showed a structural diagram which explained in simple terms how GOOS was now organized, and which had initially been produced by Dr. Neville Smith at the GSC-II meeting. A comprehensive version of this diagram, provided by the I-GOOS chairman, is given in Annex V, Figure 1. The first element comprises scientific guidance, as provided by the specialist panels, including those shared with GCOS and GTOS (the cross-cutting panels). The second element comprises actual implementation and its oversight. Here there are two subsections: (i) regional GOOS bodies, and (ii) existing global systems like GLOSS, SOOP, VOS, DBCP and so on, which will in due course be subsumed within the proposed JCOMM. The third element comprises liaison and integration. The final element comprises outreach, communication and capacity building. Figure 2 of Annex V shows a different view of the structure indicating where the main GOOS bodies sit in relation to the sponsors, the Member States, allied global programmes, and the research and service community. The GOOS Project Office is a key element of the infrastructure.

54 Important new developments include:

(i) A mechanism for implementation in the form of the proposed JCOMM, which is anticipated by the activities of an Interim Implementation Advisory Committee chaired by Angus McEwan;
(ii) A GOOS Data and Information Management Plan which is under development;
(iii) A G3OS Information Centre, which provides access to metadata about GOOS, and which is in the pilot project phase;
(iv) A growing network of regional GOOS programmes;
(v) A growing network of National GOOS Coordinating Committees.

55 The development in particular of the national and regional networks demonstrates that GOOS is influencing national plans. It is also worth noting that the European Commission (EC) in its Fifth Framework

programme is setting aside funds for investment in research that will aid the development of global observing systems.

56 The development of GOOS may also be helped by a new body, the Partnership for Observations of the Global Ocean (POGO), recently formed by a consortium of research institutions led initially by Scripps, Woods Hole, and the Southampton Oceanography Centre. POGO provides a mechanism through which major academic and other institutions can work together to aid the development and implementation of GOOS. Its first meeting was hosted by the IOC, in Paris, where its deliberations were helped by presentations from the Executive Secretary of the IOC, the Director of the GPO and the Chair of the OOPC. It is an organization that is presently taking shape, and its next development will be a meeting at Scripps in December 1999.

57 GOOS communications have expanded. In addition to the examples reported in section 3.2, the GPO has continued the production of Annual Status reports on GOOS. Plans for production of a brochure in 1998 were set aside because it was considered that the production of *The GOOS 1998 Prospectus* met the same purpose. A brochure was produced explaining how the three observing systems were working together under the guidance of the sponsors. GOOS is also profiled in a brochure at the production stage explaining the Integrated Global Observing Strategy. Plans were made at GSC-II in Beijing to produce a GOOS Products and Services Bulletin, which would give concrete examples of what GOOS is doing or would be likely to do in the future that would be useful to decision makers and users.

58 Finally, Dr. Summerhayes drew attention to the fact that at I-GOOS-III, in Resolution I-GOOS-III.4, and its Annex, members had endorsed the terms of reference for the GSC, but in doing so, had not examined how the development of those terms of reference in turn required a change to their own, which had been established by the IOC Executive Council at its meeting in March 1992 (IOC Resolution EC-XXV.3). A sessional working party was formed under the chairmanship of one of the I-GOOS Vice Chairs, François Gérard, to consider a revision to the I-GOOS terms of reference in the light of the terms of reference for the GSC and of the proposed terms of reference for JCOMM. The revised terms of reference as endorsed by the Committee are given in *Draft Resolution 1* (Annex VI).

4.2 THE GOOS MODULES

4.2.1 Design and implementation of coastal GOOS Module (C-GOOS)

59 The Coastal GOOS Module Panel (Coastal GOOS or C-GOOS for short) was formed in 1998 in response to Recommendation I-GOOS-II.2. It is chaired by Dr. Tom Malone of the Horn Point Laboratory in Maryland. Three meetings have been held: (i) Paris, France (March 1998), (ii) Curitiba, Brazil (October 1998), and (iii) Accra, Ghana (April 1999). The future schedule includes meetings in October (China) and spring 2000 (venue to be decided). This accelerated pace of meetings reflects the determination of the GSC to bring C-GOOS quickly up to speed, bearing in mind the extensive interests of Member States in coastal seas, and contributes directly to improving the balance of GOOS activities.

60 In order to find out what users are interested in seeing produced by a coastal GOOS operation, C-GOOS meetings are being held deliberately in different regions, primarily in developing countries. Stakeholders meetings have been held in association with the C-GOOS Panel meetings to promote user input to the planning process and to determine their capacity building needs.

61 C-GOOS's priorities are: (i) preserving healthy coastal environments (which includes consideration for example of habitat loss, nutrient over-enrichment, harmful algae blooms, etc.); (ii) promoting sustainable use of marine resources; (iii) mitigating coastal hazards (which involves consideration for example of storm surges, tropical storms, erosion and sea-level rise, etc.); and (iv) ensuring safe and efficient marine operations.

62 C-GOOS is making strides in developing a design strategy centred on an Initial Global Network that will include as core elements: (i) satellite remote sensing; (ii) an enhanced global network of tide gauges (GLOSS +); (iii) enhanced arrays of instrumented moorings and fixed platforms, as well as ships, to obtain for example basic hydrographic and other environmental information; (iv) instrumented voluntary observing ships

(VOSs), like ferries; and (v) Coastal Ocean Watch, a network of coastal laboratories for making a broad range of observations on the shore and in near-shore regions.

63 Pilot projects are being developed to test C-GOOS concepts or demonstrate how the C-GOOS design works. These include for instance: (i) south-east Pacific coastal oceanography in relation to far-field forcing; (ii) a hazard warning system for the south-west Atlantic coast; (iii) an environmental pollution and forecasting project in the Adriatic.

64 C-GOOS is forming links to the main global coastal research programme, the Land-Ocean Interaction in the Coastal Zone Study (LOICZ) of the International Geosphere-Biosphere Programme (IGBP), and to the UNEP Regional Seas programme. It needs a link to the Secretariat for the GPA.

65 C-GOOS has commissioned a global inventory of coastal monitoring systems, which will be developed by the IOC using the officers of the GPO and the services of a consultant who would start work in August 1999. The inventory will be used to identify gaps and weaknesses in global coastal sea coverage, as a means of helping C-GOOS to focus its attention on areas of greatest need.

66 The GSC is keen to explore the possibility of a merger of the plans of C-GOOS, and the LMR and HOTO Modules of GOOS, to produce a comprehensive and integrated design for GOOS activities in coastal seas. It is expected that the implementation designs by C-GOOS and the LMR Panel will be ready by spring 2000, permitting a meeting of the three panels in fall 2000.

4.2.2 Design and Implementation of LMR GOOS Module

67 Like C-GOOS, the LMR Module Panel is the product of Resolution I-GOOS-III.2. It has held two meetings in France: (i) Paris (March 1998), and (ii) Montpellier (March 1999). FAO co-sponsors the Panel, and a FAO representative is a member of the Panel.

68 The Panel has developed a design strategy for a generic operational monitoring system which blends an ecosystem and a fisheries approach in a sensible way; the design is informed by an excellent regional operational example from Chile, provided by the Chilean Co-Chair, Dr. Dagoberto Arcos, who partners Dr. Warren Wooster of the USA.

69 The Panel is now considering the adaptation of existing systems as a means of building the LMR component of GOOS, as well as the development of pilot projects.

70 Like C-GOOS, it is developing links to the major relevant global research programmes, in this case GLOBEC (Global Ecosystems Study).

71 In due course the Panel will develop links to the Biodiversity Secretariat and the office dealing with the Straddling Stocks agreement within the UN Convention on the Law of the Sea (UNCLOS). Links have already been made to the Diversitas programme. The LMR Panel wishes to emulate the efforts of C-GOOS in contacting users, and proposes a meeting in Chile to this effect. The GSC has agreed to increase the number of Panel meetings to bring the LMR up to speed with C-GOOS, and the next LMR Panel meetings will likely take place in November or December 1999 and spring 2000, prior to the tripartite panel meeting in fall 2000.

4.2.3 Design and Implementation of HOTO GOOS Module

72 The HOTO Module Panel was formed in February 1993 and published its design strategy in May 1996. It held its fourth meeting in Singapore in October 1997, where it reviewed and made slight modifications to the design. Activity slowed somewhat in 1998 with the resignation of Dr. Neil Andersen, who had ably carried out the functions of Chair and Technical Secretary. A new Chair, Dr. Tony Knap of the Bermuda Biological Research Stations, was appointed in 1998, along with a new Technical Secretary, Dr. Umit Unluata.

73 HOTO has one active demonstrator pilot project, RAMP (Rapid Assessment of Marine Pollution), which is on trial in Brazil, and will soon be used in other areas. Several regional pilot projects are under consideration for the Black Sea, East Asian Seas, Red Sea, Arctic, Caribbean and Adriatic, and will probably be planned in very close cooperation, if not jointly, with the C-GOOS Panel, as well as with regional partners.

74 To address the growing interest in finding appropriate indicators of sustainability, a HOTO workshop is planned in Bermuda later in 1999, with substantial extra-budgetary support.

75 HOTO plans to develop links to the Secretariat for the Global Plan of Action, and already has strong links to GIPME.

4.2.4 Design and Implementation of Climate Module

76 The work of the Climate Module is carried out by the Ocean Observations Panel for Climate (OOPC) chaired by Dr. Neville Smith, which is attempting to develop the recommendations of the Ocean Observing System Development Panel (OOSDP) into requirements and a design for implementation. The OOPC is sponsored by GOOS, GCOS and the WCRP (especially with the interests of CLIVAR in mind).

77 The OOPC has had a keen interest and involvement in the development of an Action Plan for Implementation of Physical Observations for GOOS/GCOS (see agenda item 5). It was also much involved with GCOS in writing the report to COP-4 on adequacy of observing systems, which led to the recommendation by COP-4 for an increase in ocean observations. COP-4 also requires nations to plan and undertake programmes of systematic observation, and to enable free and unrestricted exchange of climate data. It calls for national and GEF (World Bank) support for capacity building to enable developing nations to make climate observations. This amounts to a deepening of government support for GOOS, since the government departments represented at the COP meetings are not usually the same as those represented in the IOC Assembly or the WMO Congress.

78 Currently, the OOPC is busy planning an international Conference on an Ocean Observation System for Climate (St Raphaël, France, 18-22 October 1999). The conference will bring together representatives of the research and operational community to discuss and reach consensus on the design for GOOS from the point of view of the climate community.

79 In the lead up to the Conference, the OOPC is planning workshops among other things to discuss: (i) improvements to the upper ocean thermal network, which will refine the SOOP plan, and (ii) renovation of the SST network.

80 The OOPC's major effort is spent on the development of its primary pilot project, GODAE (Global Ocean Data Assimilation Experiment), within which is an essential pilot project: Argo. GODAE and Argo are dealt with in agenda item 4.4.

81 The Chairman of the OOPC sees the prospects of implementing many of the recommended enhancements to GOOS and GCOS as being very good. This is an opportunity that has been provided by many different events and developments. It is an unprecedented opportunity and one which we should endeavour to exploit in such a way that we put in place an observing system that will stand the test of time. In this context, the OOPC sees the proposed JCOMM as being an effective means of meeting published requirements of the OOSDP, OOPC and GCOS.

4.2.5 Discussion on Agenda Items 4.1 and 4.2

82 In discussion on agenda items 4.1 and 4.2, the Committee appreciated clarification of the developing structure of GOOS as defined in Figure 1 of Annex V.

83 The Committee was pleased to see GOOS moving in the right direction, and with its considerable progress, and fully endorsed the balanced development of GOOS in the way it was happening, with the increased emphasis on C-GOOS and LMR and an eventual coming together of C-GOOS, LMR and HOTO to

form a comprehensive and integrated approach to coastal seas. The Committee is looking forward to seeing the final C-GOOS design emerge for the benefit of Member States, especially those in developing countries, and agreed that C-GOOS is making good progress in a difficult and complex area. The representative from EuroGOOS noted that C-GOOS is proving valuable as an intensive think-tank, even for developed regions. The representative from SOPAC noted that the requirements for small island States might be rather different from those of large coastal States, and asked that this matter be given some consideration in developing the C-GOOS design.

84 Portugal recommended that HOTO should not be neglected in this development, and in addition, that the approaches to the coastal zone be clarified. The Committee recognized that not all modules would move at the same speed. It had taken ten years of effort to get the climate panel to where it was today, but the payoff is coming, for instance in forecast products for water managers and agriculture in developed and developing countries. In due course it is expected that comprehensive observational programmes for the coastal zone will emerge from joint work between GOOS and GTOS. While there are plans to bring these two together, the rate of progress in the GTOS coastal group is extremely slow.

85 The Committee agreed that while the panels would come up with designs or strategies for implementation, the actual implementation would be done at the local or regional level by Member States. At I-GOOS-V there should be a more extended examination of implementation.

86 The Committee approved the steps taken by C-GOOS to get in touch with users, and recommended that the other panels follow similar courses of action. More work needs to be done to ascertain users' needs. The Committee recognized that the advisory panels would not be in a position to develop links to the farmer at his gate, but expected user interests to be ascertained through contact with intermediate agents acting as proxy users, like service companies, for instance, or government departments. India noted that it had recently completed a survey of users' needs and offered to make this available to the GPO. EuroGOOS noted that it had recently published a survey of user requirements, which might well be found to apply to many other regions. It was agreed that the Member States present at I-GOOS-IV would advise the GPO on possible users and user groups that might be contacted.

87 The links between the panels and research activities like GLOBEC, JGOFS, LOICZ, WOCE and CLIVAR was applauded, but there is also a need for the panels to connect more closely across interfaces with other parts of the UN community. The proposed linkage to the Convention Secretariats was applauded as one such step.

88 The Committee noted that rather few of IOC's Member States attended I-GOOS meetings. More work is needed to attract more Member States, especially developing ones, into GOOS.

4.3 THE GOOS INITIAL OBSERVING SYSTEM (GOOS-IOS)

89 Dr. Summerhayes noted that the GOOS Steering Committee had proposed the formation of a GOOS Initial Observing System, as an initial demonstration of what GOOS was all about (I-GOOS-IV/8). This was consistent with the creation of an Initial Operational System for GCOS and GTOS, and was regarded by the sponsors as meeting an important requirement in the dialogue with governments and potential funders who wanted a simple picture of what we were actually doing now, rather than what we were planning to do eventually.

90 The GOOS Initial Observing System recognizes that GOOS is meant to develop initially by capitalizing on existing observing systems. The practical implementation of GOOS began in 1998 with the creation of the GOOS-IOS from a number of pre-existing observing systems. Some of these are exclusively contributions to GOOS; others evolved for different purposes, but also address, are compatible with, and satisfy GOOS requirements. In principle the latter can provide contributions to GOOS as well as to the original group of clients for whom they were initiated. The present largely global components are those which, whatever else they may contribute to, include elements that are clearly contributions to GOOS. Other more regional and national components can be included later. The present components include:

- The operational ENSO Observing System in the tropical Pacific, including the Tropical Atmosphere Ocean (TAO) and TRITON array of buoys;
- Meteorological measurements from the Voluntary Observing Ship (VOS) network of the WMO;
- Upper ocean measurements of the Ship of Opportunity Programme (SOOP);
- Fixed and drifting buoys coordinated by the Data Buoy Cooperation Panel (DBCP);
- Sea level measurements from the Global Sea Level Observing System (GLOSS);
- Global Temperature and Salinity Profile Programme (GTSPP);
- Global Coral Reef Monitoring Network (GCRMN);
- Global Telecommunications System (GTS) of WMO;
- The Global Data Centre of the US National Oceanic and Atmospheric Administration (NOAA);
- Ocean observations from the operational satellites of NOAA and other entities;
- The Continuous Plankton Recorder (CPR) programme;
- The ICES International Bottom Trawl Survey (IBTS) of the North Sea (awaiting confirmation from ICES Council);
- Time Series Stations 'S' (Bermuda), and BRAVO (Labrador Sea).

91 As discussions and negotiations continue with the operators of other systems that meet the GOOS Principles, more elements will be added to the GOOS-IOS. For instance, several national systems are expected to be added to the GOOS-IOS at the GOOS Commitments Meeting on July 5-6, 1999, in Paris.

92 In discussion the Committee observed that there were likely to be a great many local (national) operational activities around the world that already met the GOOS Principles. However, unless and until these are brought to the attention of, and evaluated by, GOOS management bodies they cannot be included in the GOOS Initial Observing System.

93 In the case of time series stations, CLIVAR has identified eight that it regards as key sites, and which could eventually be part of the GOOS-IOS; however, the OOPC has not yet evaluated them. The two time series sites that are included in the GOOS-IOS are there because they were recommended as critical for GOOS/GCOS by the Ocean Climate Time Series Workshop sponsored by GCOS, GOOS, SCOR/JGOFS and WCRP in Baltimore (March 1997). One of the constraints is that such stations should be sustained for the long term. Eventually it may be that the ESTOC site off the Canary Islands (and other sites in the global ocean) will be included, but it has only been going for 4-5 years; the case for its inclusion in the GOOS-IOS has yet to be made and evaluated.

94 Some members of the Committee felt that if the GOOS-IOS were exclusive there is a danger that some GOOS-like activities that are not included may be disadvantaged in the search for further funding. However, the GOOS-IOS is not intended to be exclusive. The delegate from the Netherlands requested that repeat hydrography should be included in future versions of the GOOS-IOS, consideration being given to the continuation of key WOCE hydrographic survey lines.

95 Some members questioned whether all of the items in all of the elements of the GOOS-IOS were consistent with the Principles of GOOS. This question needs consideration by the GSC. However, the Committee recognized that many of the items on the list are in fact parts of the declared ongoing operational observing programmes of the IOC and the WMO, which justifies their inclusion as parts of the GOOS-IOS.

96 Japan asked that its TRITON buoys at the western end of the TAO array be identified as part of the GOOS-IOS. Dr. Summerhayes noted that he thought they were part of the ENSO observing system and therefore automatically included, but they would be explicitly noted in the future.

97 In summarizing the discussion, the Chairman noted that:

(i) the GOOS-IOS is useful as a means of demonstrating that GOOS is not working from scratch, but developing incrementally based on the cost-effective incorporation of existing systems;
(ii) we need a mechanism for potential local/national or regional elements to apply for inclusion;
(iii) we need a mechanism for defining what is and what is not in the GOOS-IOS;

(iv) at some time in the future it will be necessary for a defined GOOS observing system to be formally approved by appropriate intergovernmental bodies.

98 It is worth noting that, in classifying GOOS operational observations, there are two extreme end members. At one end are real-time oceanic and global climate and forecasting related data which are only valuable if contributed immediately to the global public domain; at the other extreme are near-shore, coastal and estuarine chemical, sedimentary and biological data which have hardly any direct interest more than 100 km away from the observation. Many observations at the regional, semi-enclosed sea, and continental shelf scale fall between these extremes. The criteria which should be set for inclusion of these observations in GOOS are not identical. Local data can and should be recognized by GOOS without being put immediately into the global domain.

4.4 SPECIFIC GOOS ELEMENTS

4.4.1 The Global Ocean Data Assimilation Experiment (GODAE) and its *Argo* Pilot Project

4.4.1.1 GODAE

99 Dr. Summerhayes reviewed progress in GODAE, which is a GOOS pilot project of the OOPC (reference I-GOOS-IV/9). The overall objectives of GODAE are:

(i) the application of state-of-the-art ocean models and assimilation methods for: (a) short-range open-ocean forecasts; (b) boundary conditions to extend predictability of coastal and regional sub-systems; and (c) initial conditions of climate forecast models;
(ii) to provide global ocean analyses and re-analyses for: (a) developing improved understanding of the oceans; (b) improved assessments of the predictability of ocean systems; and (c) as a basis for improving the design and effectiveness of GOOS.

100 Examples of specific objectives and their drivers/users include:

- Extending predictability of coastal and regional subsystems, to support coastal forecast systems, and regional monitoring and prediction;
- Providing several >20-day high-resolution, upper open-ocean forecasts and now-casts, to support ship routing, transport, safety at sea, and naval applications;
- Integrated analyses for research and development, and re-analysis, to support CLIVAR, GLOBEC and allied research programmes, hypothesis testing, and process studies;
- Providing initial conditions for climate forecasts, e.g. Kuroshio, NAO, ENSO, to support western boundary current prediction, seasonal prediction, and climate change prediction;
- Sustaining and designing a permanent GOOS, supporting GOOS, GCOS, operational oceanography, and multi-purpose applications.

101 Ocean data inputs to GODAE should be global, complementary, available in real time, and integrated. Remote sensing would provide information especially on SST, sea surface height (altimetry) and surface wind stress (scatterometry). *In situ* measurements would provide complementary surface and subsurface data, and provide for the calibration and validation of the satellite data.

102 Fundamental requirements include:

- Wind products, including estimates of error, are a fundamental requirement. Decisions are needed on spatial resolution, temporal resolution, merging data from different platforms, and the number of scatterometers required. Partnership with the satellite community has helped to define what is required;
- High resolution SST, including both bulk and surface skin products. Decisions are needed on spatial and temporal resolution, merging data from different platforms, and methods for filling space/time gaps (e.g. by models of by other instruments);

- Sea-surface height by altimetry and from tide gauges. Decisions are needed on the data sets to use, on techniques for merging data sets, on the numbers of altimeters required and on continuity (operational support);
- Surface radiation field. We can complete surface thermal "forcing" if the net short wave plus long wave radiation is known. Can it be determined in real time?; if so, to what accuracy and on what time scales? How do we validate open ocean estimates?
- Other relevant remote data sets. These may include (i) ocean colour (a proxy for transparency); (ii) sea-ice extent; (iii) open ocean precipitation; (iv) salinity; (v) ocean state (from SAR and ALT, etc.).

103 Pilot Projects are necessary to develop the capacity to do GODAE. A GODAE Pilot Project will develop capacity by engaging a section of the community in an activity which contributes significantly to GODAE development, e.g. the *Argo* project (see 4.4.1.2 below).

104 A Data Team will be established for GODAE, to: (i) help determine data requirements from a centralized data server; (ii) identify and gather resources to design and implement data servers, archives, pathways and so on; and (iii) identify resources to develop products and derived products for GODAE.

105 A GODAE Linkages Action Team will be established to ensure GODAE products are defined to meet the needs of meso-scale, regional, coastal and other non-global users.

106 A modelling and assimilation-working group will focus on generic issues raised by inter-comparison among results from the global set of regional activities (e.g. like the North Atlantic project).

107 GODAE now has a well-developed structure involving a set of scientific and technical "partners" funded by a set of "patrons". The partners are part of the GODAE Scientific Steering Team, which interacts closely with the OOPC, and through it with GOOS, GCOS and the WCRP including CLIVAR and WOCE. The activities are managed/coordinated through the newly established GODAE Office in the Bureau of Meteorology in Melbourne, under the direction of Neville Smith.

108 Already national efforts are contributing significantly to the achievement of GODAE objectives, especially in Australia, France (*via* the MERCATOR project), Japan, the UK (Meteorological Office), and the USA. International efforts include the European Shelf Seas Data Assimilation and Forecast Experiment (ESODAE) funded as a Concerted Action in 1998 by the European Commission (EC).

109 Finalization of a GODAE Plan is in hand, pending the outcome of the Climate Conference in Saint-Raphaël. A GODAE brochure should be available in July 1999.

4.4.1.2 The *Argo* Project

110 The data essential for assimilation into global models of the ocean and coupled ocean-atmosphere models includes a continual stream of real-time data from the upper ocean on a global basis as an essential counterpart to the data stream on SST and sea-surface elevation provided by ocean observing satellites. It is proposed that the missing upper ocean data should be provided by a global array of profiling floats in a GODAE Pilot Project named *Argo* (representing the partner project to the proposed satellite altimetry project, Jason). The *Argo* project represents a major new increment in direct observations to support and enhance existing elements of GOOS and GCOS, and will go some way towards meeting the requirements of COP-4 that ocean observations be increased to fill major gaps in coverage.

111 The Argo project is seen as a key technology for CLIVAR. Consequently, an *Argo* Science Team was formed and drafted a plan which was presented at the CLIVAR Conference at UNESCO, Paris, in December 1998. The goal is 3000 profiling floats on a 300-kilometre grid, taking one profile every 10-14 days for a period of 4 years or more. The cost *per* profile is estimated as around $100, which compares favourably with the cost of $75/profile for XBTs. An implementation plan is now being prepared.

112 There is substantial commitment already to a major profiling float deployment, with likely contributions from Australia, Canada, the European Union (EU), France, Germany, the UK, Japan, and the USA. It appears reasonable to expect 600 deployments *per* year by around 2001. A high priority is placed on full global coverage, especially including the Southern Ocean.

113 Several technical issues are receiving attention. Long-life salinity sensors are now being developed and tested at sea, the longest tests with a 2-year duration. New satellite communications systems with high band width and allowing 2-way communications (including Argos, Orbcomm, and Iridium) will enable floats to spend shorter times at surface, minimizing energy loss and fouling. Power efficiency is continually improving, allowing deep profiles without impact on power supply. The combination of VOSs and aircraft offers an inexpensive means of wide deployment. The parking depth is an option which can be specified prior to deployment; 2000m is preferred by most, as it reduces the clustering to which floats would be susceptible at shallow depths.

114 Argo project data will be provided in real-time through centres modelled on the WOCE data centres and GTSPP. At present, there are floats in the North Atlantic and off Japan providing data in real time on the GTS, where they appear in TESAC format after collection by the Argos communication satellite system. The Web sites with the Atlantic data are listed in the *Argo* brochure provided at the meeting by the delegate from the USA.

4.4.1.3 Discussion on GODAE and the *Argo* Project

115 The Committee applauded the developments taking place within GODAE and the *Argo* project, and noted the widespread support from individual countries as well as the endorsement from the thirteenth WMO Congress. The Committee considered that the *Argo* project is a vital next step in the development of an operational GOOS.

116 Recognizing that there was some concern about *Argo* floats entering national exclusive economic zones (EEZs), a sessional working group was asked to draft a resolution for consideration by the IOC Assembly. *Draft Resolution 2* appears in Annex VI.

4.4.2 Pilot Research Array in the Tropical Atlantic (PIRATA)

117 Ms. Janice Trotte introduced the PIRATA project. PIRATA (Pilot Research Array in the Tropical Atlantic) is a GOOS pilot project which extends into the Atlantic the successful methodologies developed and applied in the TOGA project and its successor the TAO buoy array in the tropical Pacific. PIRATA will improve ocean and weather forecasting capabilities for eastern Brazil and western and central Africa, including the Sahel.

118 PIRATA is led by Brazil, with the USA and France as partners. Support from other States is increasing. PIRATA comprises 12 buoys. Deployment began in 1997 and ends in 1999. The buoys are ATLAS moorings measuring meteorological properties (surface winds, temperature, and rainfall) and subsurface properties (temperature and salinity). The data are available *via* Service Argos in real time on Internet, through PIRATA Web sites and PMEL. Several countries are already accessing the data.

119 At the 6th PIRATA meeting, in May 1999 in Miami, it was agreed that PIRATA should be the building block for operational observations of the tropical Atlantic. The system trial is scheduled for 1997-2001; the transition to an operational system is planned for 2001-2005. The operational phase should begin in 2005, following evaluation. A Resource Board has been created to solicit resources.

120 Ms. Trotte noted that vandalism of buoys at the ends of the tropical Pacific and Atlantic arrays is a problem, and that the IOC Executive Council had made a resolution on Vandalism (IOC/EC-XXXI.4), which it was hoped I-GOOS members would support at the Assembly.

4.4.3 Regional Elements, Strategies and Plans

121 Dr. Summerhayes introduced this item, noting that since I-GOOS-III, when the main regional GOOS activities were EuroGOOS and NEAR-GOOS, GOOS had grown to include MedGOOS in the Mediterranean, PacificGOOS in the Pacific islands, and IOCARIBE-GOOS in the Caribbean. In addition, a GOOS-AFRICA Coordinating Committee had been formed to help the development of regional GOOS activities in Africa.

122 Some potential regional GOOS activities remain on the drawing board. These include: (i) SEACAMP (South East Asia Centre for Atmospheric and Marine Prediction), a joint IOC/WMO initiative; (ii) WIOMAP (Western Indian Ocean Marine Applications Project) another IOC/WMO initiative; (iii) SEA-GOOS (south-east Asia GOOS). SEACAMP and WIOMAP are both at the proposal stage where funding is still being sought. SEA-GOOS is the subject of discussion, for instance at the WESTPAC International Scientific Symposium in February 1998.

123 Future prospects include: (i) ICES-GOOS elements; (ii) an Eastern Indian Ocean GOOS; and (iii) the equivalent in the equatorial Indian Ocean of the tropical array of buoys in the Pacific and the PIRATA array in the Atlantic.

124 The GSC is concerned about the need to work to better define formal requirements for and recognition of regional GOOS organizations and how they can best be coordinated.

4.4.3.1 IOCARIBE-GOOS

125 Ms. Janice Trotte introduced this item (I-GOOS-IV/11). I-GOOS-III had requested an awareness raising capacity building workshop in the Caribbean. This took place in April 1999 in San José, Costa Rica, under the Chairmanship of Dr. Jan Stel. There were 24 participants from 18 countries, together with representatives from LOICZ, UNEP, CARICOMP and other appropriate organizations. The workshop participants (representing the users) identified their capacity building needs. They agreed that it was desirable to implement GOOS in the region. They drew up a GOOS agenda, and created an Advisory Group charged with writing a strategic plan and devising steps to implementation.

126 Dr. Guillermo Garcia took the floor to present the results of the 1st national GOOS workshop in Cuba, which took place at about the same time as the IOCARIBE-GOOS workshop, and whose goal was to stimulate the development of GOOS, to agree on tasks and needs for planning and implementation. A national GOOS co-ordinating committee is needed to establish norms for data exchange, and to enhance cooperation nationally and internationally. Support is required for technology transfer and capacity building. Science and technology teams were formed to take these matters forward, but ultimately what is required is a regional approach. Various national actions were agreed: to form a steering committee; to form a body for examining costs and benefits of GOOS; to develop a national strategy on data exchange; to establish a National Ocean Data Centre (NODC); and to identify training needs.

127 The first priority is coasts and sustainable tourism. Some measuring systems are already in place, including 11 tide gauges and 5 VOS lines, together with those making observations on living marine resources, pollution, and erosion, and supporting ship routing services.

4.4.3.2 EuroGOOS

128 Dr. Nic Flemming, Director of EuroGOOS, made a presentation on EuroGOOS (I-GOOS-IV/10). EuroGOOS, which now has 31 members from 16 countries, is presently an inter-agency association. Over the next few years it aims to become an intergovernmental organization. EuroGOOS's planning activities are funded by its member agencies. It has been successful in attracting funds for EuroGOOS Pilot Projects from the MAST (Marine Science and Technology) programme of the EC (European Commission), and is now preparing project proposals for the EC's Fifth Framework Programme.

129 EuroGOOS has an Atlantic Pilot Project which is its contribution to GODAE and the Argo project, and which involves designing an operational system to monitor the North Atlantic on the basis of real-time

observations, modelling and data assimilation. EuroGOOS is actively working to develop partners outside Europe for this initiative. In this context, it is encouraging the development of numerical forecasting, particularly through two major efforts: the French-led MERCATOR project, and the UK-led FOAM Project (Forecast Ocean Atmosphere Model), which is now operational.

130 There already is a great deal of operational activity on the N.W. Shelf. EuroGOOS can add value to this activity by integrating data into models, for example through ESODAE (European Shelf Seas Data Assimilation and Forecast Experiment), which will provide a practical demonstration of the overall capabilities of ocean analysis and assimilation and of forecasting models for the region, and which is another link to GODAE.

131 In the Mediterranean, EuroGOOS has the Mediterranean Forecasting System Pilot Project (MFSPP), to develop a strategy for implementing a Mediterranean Forecasting System (involving observation, modelling and data assimilation), to predict marine ecosystem variability in coastal areas.

132 To identify customers and their requirements, EuroGOOS has done a Data Requirement Survey showing what kinds of products different users require. The results of this survey, published as EuroGOOS Publication No.12 *Operational Oceanography: Data Requirements Survey*, show that there are many common European requirements and will aid in the design of the observing systems to meet the stated needs.

133 To identify technology requirements, EuroGOOS has carried out a survey the results of which have recently been published as EuroGOOS Publication No. 13. The objective of the exercise was to determine what technologies could produce a reliable, accurate, long-term data stream with the minimum of sea-going requirement. There is an emphasis on remote sensing by satellite and on extended use of unmanned technologies such as floats, coastal buoys, long-range coastal radar, autonomous underwater vehicles (AUVs), and acoustic tomography. Already operational on the technology front is a chain of deep-water meteorological moorings west of the UK, and a programme of drifting buoys. For the future there is considerable interest in extending life for sensors measuring biogeochemical variables for long periods on unmanned platforms. A EuroGOOS Panel on sensors and biofouling is considering this issue. The French MAREL buoys eliminate biofouling by pumping sea water up into a laboratory on each platform.

134 As an example of a recent technology, N. Flemming cited the UKMO's MAWS (Marine Automatic Weather Station) network of buoys from Spain to the Faeroes, which collects meteorological data. Negotiations are underway to add oceanographic instruments to the MAWS buoys.

135 Another technological example was the Ferrybox project to develop a ship-borne instrument package for routine operational monitoring of surface water parameters from ships of opportunity in general and ferries in particular. If successful, this could be deployed on up to 800 routes around Europe, to provide a key element of the observing system.

136 EuroGOOS's goal is to encourage not only the collection of observations, but their use in numerical models to make appropriate forecasts and produce a range of products. There is a need to couple physical models to pelagic ecological models, and both of these to benthic ecological models, and this will be addressed at a workshop in Sweden in September 1999.

137 Gerbrand Komen gave a brief presentation on EuroCLIVAR. EuroCLIVAR was set up in 1995 to help implement CLIVAR in Europe. CLIVAR is an important element of the World Climate Research Programme. Its objective is to understand and predict climate variations on seasonal to centennial time scales. EuroCLIVAR organized 8 specialized workshops (with topics such as Scale Interaction in the Tropics; Atlantic Climate Variability; Clouds; Anthropogenic Climate Change; Data Assimilation in Ocean Models; etc). The recommendations of these workshops are summarized in a document entitled *Climate Variability and Predictability Research in Europe, 1999 - 2004*. They address observational (past and present) and modelling issues, and both natural and anthropogenic climate variations. For the Atlantic an upper ocean network, deep ocean observations and process studies are recommended. EuroCLIVAR intends to foster the implementation of its recommendations with funding from the European Commission. For the ocean observations it keeps close contact with EuroGOOS.

4.4.3.3 NEAR-GOOS

138 Comments on NEAR-GOOS (N.E. Asian Regional GOOS) were made by Colin Summerhayes and Dr. Keisuke Taira. NEAR-GOOS is making good progress. Highlights for the year include a doubling of its data holdings, a significant increase in contributors, and a significant increase in data exchange. NEAR-GOOS is now considering widening the spectrum of observations beyond the physical to include biological and chemical parameters. In this regard coordination is needed with the representatives of NOWPAP (Northwest Pacific Action Plan), which is a UNEP Regional Seas programme, to see how HOTO interests can be dovetailed with the traditional interests of the NEAR-GOOS community. Experts from NOWPAP and the NEAR-HOTO community will be invited to the next NEAR-GOOS Co-ordinating Committee meeting to be held in Tokyo in September 1999. There is also a need to see how the interests of the LMR Panel can be dovetailed with those of NEAR-GOOS. This may be most easily achieved first through development of the Yellow Sea LME project.

4.4.3.4 MedGOOS

139 I-GOOS-III had requested a capacity building meeting for the Mediterranean, in Malta. This meeting took place in November 1997, and led to the initiation of MedGOOS to provide a means of looking at the problems of establishing GOOS in the Mediterranean. Subsequently, the members developed a Memorandum of Understanding which was signed during the EuroGOOS Conference in Rome in March 1999. A substantial workshop is planned for Rabat, in November 1999, to address the benefits and costs of implementing GOOS in the Mediterranean Sea.

4.4.3.5 PacificGOOS

140 I-GOOS-III had also requested a capacity building meeting for the Pacific islands, in Fiji (I-GOOS-IV/Inf.5). This meeting took place in February 1998, and led to the initiation of PacificGOOS. Since then, there has been little progress, but a PacificGOOS Workshop is planned for spring 2000 in Noumea, to initiate planning for long-term monitoring and observing in the region's coastal seas. One of the tasks of the new Perth Office of the IOC will be to help PacificGOOS to develop their strategy, attract funding and build capacity.

4.4.3.6 GOOS-AFRICA

141 At the Pan-African Conference on Sustainable Integrated Coastal Management (PACSICOM), at Maputo, Mozambique, in July 1998, a GOOS workshop was held focussing on GOOS and the needs of the African user community. At that workshop, it was decided to assist the development of GOOS in Africa by forming a GOOS-AFRICA Co-ordinating Committee, to foster the development of regional developments of GOOS like MedGOOS, for example in west Africa, east Africa, and the Red Sea region. The idea is to build on present regional projects, like the Large Marine Ecosystem (LME) activity in the Gulf of Guinea in the west, like the Western Indian Ocean Marine Applications Project (WIOMAP) in the east, like the IOC's growing data and information project ODINAFRICA, which is now developing in both east and west Africa. In addition there is potential to capitalize on the interest in coastal tourism and the coral reefs of east Africa and the offshore islands.

142 Generic priorities identified by the GOOS-AFRICA Workshop at PACSICOM for future funding include:

(i) Building up the IODE network of National Ocean Data Centres (NODCs) in Africa;
(ii) Building up the network of tide gauges around the African coast;
(iii) Facilitating ready access by African scientists to remotely sensed data from the African region, and training them in the use and application of those data;
(iv) Improving access to-state-of-the-art electronic communication to facilitate data storage, manipulation and exchange.

143 Proposals for these initiatives will be developed during 1999 and 2000 as part of the post-PACSICOM process.

144 GOOS-AFRICA identified the need for the establishment of National GOOS Co-ordinating Committees (NGCCs) to develop and strengthen the effectiveness of the national institutional infrastructures in support of operational oceanography and marine meteorology for all purposes, which will stimulate the development of GOOS on a national and regional basis. Such bodies should entrain all interested stakeholders. As modified by GSC-II, the NGCCs will be expected to:

(i) Determine user needs and specify the data and products required to satisfy those needs;
(ii) Identify and work to improve existing national capabilities, including human skills and available technology;
(iii) Identify gaps in those capabilities, including inadequacies in present observing and data management systems, and work to correct them, focussing (a) on training and practical assistance related to meeting users' needs in the coastal zone and elsewhere, and (b) on formulating plans to fill gaps;
(iv) Pay special attention to exploiting the opportunities offered by the increasing number and variety of observations of the coastal zone and open ocean from space satellites;
(v) Promote communication between marine scientists and coastal managers and other potential users of GOOS data and information through the development of national, regional and global electronic networking;
(vi) Promote the design and implementation of regionally coordinated strategies for data acquisition, integration, synthesis and dissemination of products to improve coastal zone assessment, the assessment of other environments, and the forecasting and prediction of environmental change;
(vii) Develop regional pilot projects to demonstrate the usefulness of the GOOS system in the coastal zones and surrounding oceans, and encourage participation in ongoing GOOS pilot projects;
(viii) Evaluate costs and benefits as the basis for persuading governments, donor agencies and the private sector to support a data acquisition programme and associated capacity building.
(ix) Promote GOOS development and expansion through appropriate communication.

4.4.3.7 ICES and GOOS

145 ICES formed a Steering Group for GOOS to consider how ICES can contribute to and benefit from GOOS. The group met in Bergen in March 1999, with EuroGOOS and the GPO in attendance. At the meeting it was agreed that the ICES International Bottom Trawl Survey of the North Sea might be a suitable regional LMR contribution to the GOOS Initial Observing System. This suggestion was endorsed by the LMR Panel and by GSC-II, and awaits a decision from the ICES Council. The ICES database is another potential GOOS resource.

146 ICES is prepared to work with EuroGOOS to establish integrated operational oceanographic monitoring systems that would form GOOS components in the North Sea to address ecosystem and fisheries requirements. It is also prepared to work with GOOS and EuroGOOS to explore the feasibility of a similar approach in Barents Sea, Nordic Seas and Labrador Sea. ICES is also willing to nominate ICES representatives to provide operational advice on living marine resources to appropriate GOOS Panels.

147 At the conclusion of the meeting, ICES asked the IOC to consider co-sponsoring the ICES Steering Group for GOOS, and to nominate GOOS representatives to work with it to identify potential GOOS operational elements or pre-operational R&D GOOS Pilot Projects. This group would also include representatives of regional GOOS bodies (e. g. EuroGOOS, US GOOS).

4.4.3.8 Discussion on Regional Elements

148 As part of the discussion on regional items, the Chairman reminded the Committee that guidance regarding the formation of regional groups already exists in the GOOS Strategic Plan, especially in sections 7.1 and 7.3.(GOOS Report No. 41 or IOC/INF-1091, UNESCO 1998).

149 To aid discussion on regional strategy, Nic Flemming presented the following points:

(i) Total number and size of regions: do we expect complete global coverage? Do we expect all sea areas to be in GOOS regions?
(ii) Relationships of GOOS regional boundaries to IOC regions and other UN organizational boundaries (e. g. UNEP, WMO, FAO, etc.). Boundaries should relate to GOOS objectives;
(iii) Some regions unite adjacent countries on a land mass with a common interest; other regions unite countries across a water mass with a common interest in managing that sea area. Some countries may belong to more than one region;
(iv) Regional organizations may have different structures and different local objectives, depending on local and regional needs, consistent with the GOOS Strategy and Principles. Regions can learn from each other, may ask for help from the GOOS Module Panels, and may need a learning period to identify their best structure and plans. Regions should provide regular reports on their activities and development;
(v) The Module Panels of GOOS may provide assistance or advice to regional organizations, and regions may collaborate directly, especially when there it a common interest in a sea area;
(vi) Regions can share experience on identifying the benefits of GOOS and transfer experience between regions where relevant;
(vii) Because of regional differences in the development of infrastructure, pre-existing regional bodies, and local levels of scientific and operational systems, regions may concentrate on different components of marine science, observational strategy, operational systems services, and value added.

150 The Committee welcomed the fact that regional development is taking place, but with the growth of regional components more attention should naturally now be given to their consistency with the Strategic Plan. It would be fruitful at I-GOOS-V to have a comprehensive debate on regional strategy, and to that end, the GPO was asked to prepare an appropriate paper in consultation with the GSC.

151 The Committee took the guidelines on the formation of National GOOS Co-ordinating Committees as useful. The delegate for Portugal noted that we must take care that this initiative does not cut across the IOC's promotion of the formation of National Oceanographic Committees. Colin Summerhayes noted that several nations have already developed NGCCs, and that it was not difficult to imagine National Oceanographic Committees taking on this additional task, say through a subgroup, provided that all interested stakeholders were entrained. The strategy for the development of GOOS is threefold: (i) to encourage national awareness and activity, (ii) regional awareness and activity, and (iii) international awareness and activity.

152 The delegate from Russia noted that a Black Sea GOOS is in the planning stage, and also that developments on storm surge modelling in Viet Nam suggest that it will soon be ready to be part of GOOS.

153 The delegate from Russia also suggested that, as in WMO, regional rapporteurs might be appointed to speak for the regions. The Committee agreed it would be useful for I-GOOS to interact with regional representatives in future, much as it had done with EuroGOOS at this meeting.

154 The delegate from the USA mentioned the proposal to form the Sea Keepers' Association which would equip 300 ocean-going yachts with equipment to make high quality oceanographic measurements that would be available in real-time and would follow the GOOS Principles. The Committee agreed this initiative should be referred to the GSC for scientific evaluation and to the proposed JCOMM for technical evaluation.

155 The Committee agreed that a Draft Resolution should be made to the IOC Assembly regarding IOC co-sponsorship of the ICES Steering group for GOOS (*Draft Resolution 3*) (Annex VI).

4.5 SHARED G3OS TECHNICAL PANELS

4.5.1 Joint GOOS-GCOS-GTOS Data and Information Management Panel (J-DIMP)

156 J-DIMP held its 4th meeting in Hawaii in May 1998, under its Chair, Tom Karl. One of its main products to date is the J-DIMP Data and Information Management Plan, which is undergoing final revision.

This plan is an umbrella document that provides overarching guidance for the development of plans with higher levels of detail by GOOS, GCOS, and GTOS. A GCOS DIM plan was published in 1995, and now needs updating. A GTOS DIM Plan was just published. The first draft of a GOOS DIM Plan was presented to GSC-II, and is now being revised.

157 Another key product of J-DIMP is the G3OS Information Centre, headed by Ferris Webster at the University of Delaware. Its objective is to provide a single point of entry for access to information on the data requirements and data collection programmes of the G3OS, and access to the resulting data and products. It is being designed with a user-friendly, Web-based interface, and can already be accessed on the Internet.

158 The main GOOS input to the Information Centre to date is the GTSPP, which will be followed by other elements of the GOOS-IOS. In the future a complete suite of marine *in situ* data systems will be included, along with marine satellite data.

159 A demonstration of the Information Centre was given at GSC-II, and attendees were very impressed by what the system is capable of. There was strong support for continuance and expansion.

160 The Information Centre is a pilot project funded by NASA and NOAA for 3 years (2 to go). Member States will need to consider how the costs of its extension will be shared between them.

161 In discussion, the Committee expressed concern about the continuing lack of a specified data policy for GOOS. There is an urgent need for this now that we have a GOOS-IOS and are working on finalizing a data and information management plan. Recognizing the complexity of the issue, the Chairman appointed a sessional group to draft a Resolution for consideration by the IOC Assembly (*Draft Resolution 4*) (Annex VI).

162 Some members of the Committee pointed out that individual researchers are accustomed to keeping their data until they have worked it up, making it difficult to see how one could get them to contribute to an observing system requiring data in real-time. In reply, the Chairman noted that in the past ocean observations have indeed depended on the enterprise of many individual researchers who needed to protect their interests by treating data in this way. However, GOOS is different and represented the arrival of a new paradigm in which all data was automatically provided in real time, as was happening now with the present floats programme. In the new paradigm there is more to be gained from sharing data, and having immediate access to the data of others, than there is in keeping data hidden away. Undoubtedly the realization of the new paradigm would require a substantial change in mind set, but we are already seeing a large amount of progress in this direction.

163 It was noted that there is an apparently increasing trend to privatize some sources of data. In addition the activities of the World Intellectual Property Organization (WIPO) may possibly increase the level of difficulty in accessing data. A careful eye needs to be kept on these developments, which some saw as "allowing the human race to be held to ransom".

4.5.2 Global Observing Systems Space Panel (GOSSP)

164 GOSSP held its 4th meeting in October 1998 in Maryland, USA, under its new Chair, Dr. Francis Bretherton. GOSSP is a vehicle for feeding a coordinated view of GOOS requirements to the space agencies, and provides a primary input to CEOS (Committee on Earth Observation Satellites) on user requirements. GOSSP aims to establish clarity and transparency about needs and plans. It is currently revisiting previous lists of requirements in the WMO database, for consistency internally and with the stated and evolving requirements of advisory panels.

165 Some of the advice on ocean colour has been provided by the IOCCG (International Ocean Colour Coordinating Group) of SCOR. It is important that in future this be dovetailed with the requirements identified by C-GOOS and LMR.

166 One of GOSSP's responsibilities is to identify priority measurements from space. Priorities include:

- Surface topography/altimetry: Precision altimetry of the kind offered by TOPEX/Poseidon or Jason is essential. A high resolution altimeter like ENVISAT is required. A third altimeter is desirable;
- Sea-surface irradiance (SST): At least one scatterometer (or an equivalent) is essential, and a strong case is emerging for a second one;
- Surface-wind vectors: essential as defined by GODAE;
- Ocean colour: agreed to be a priority measurement for ocean biology and carbon dioxide.

4.6 THE G3OS SPONSORS AND THE INTEGRATED GLOBAL OBSERVING STRATEGY (IGOS)

4.6.1 G3OS Sponsors' Group (FAO, ICSU, IOC, UNESCO, UNEP, WMO)

167 The Sponsors Group was formed in 1997 to enhance synergy and information exchange between GOOS, GCOS and GTOS, which make up the G3OS. The sponsors did not wish to see the three observing systems in competition, and realized that it was possible that governments might see them that way. Therefore they wished to develop a common strategy toward implementation and application. To this end a strategy document was written showing how the three are supposed to work together in an integrated and coherent way, and a G3OS brochure with this message was issued in 1998.

168 The 4th meeting of the Sponsors' Group was hosted by GTOS, at FAO HQ in Rome in June 1999. There, the sponsors decided that they needed to:

(i) Build links to an additional potential sponsor, the UN's International Atomic Energy Agency (IAEA);
(ii) Develop a common educational/marketing document showing costs and benefits and based on a core set of products;
(iii) Put joint outputs and products on display at the CSD Meeting on Agenda 21 Chapter 40, in 2001;
(iv) Engage the councils of FAO and UNEP more in discussion about and decision on the elements of the G3OS;
(v) Clarify the future role of J-DIMP and the reporting relationship of GOSSP to CEOS;
(vi) Present a collective case for global observing at COP-5 (FCCC);
(vii) Make a collective approach to the GEF and the Turner Fund with a simple clear message and a joint strategy, so as to bring new large funds into the G3OS;
(viii) Help G3OS panels to engage stakeholders and Conventions more.

169 Clearly then the question of engaging the user community more closely is not simply one for GOOS - it is generic across the G3OS.

4.6.2 The Integrated Global Observing Strategy (IGOS)

170 The concept of integration between different observing systems to add value and avoid duplication is not unique to the G3OS sponsors. It also developed independently within the CEOS community. Recently the G3OS and CEOS communities have come to agree on an Integrated Global Observing Strategy (IGOS), and the two communities now form the IGOS Partners, which consists of the G3OS sponsors, CEOS, IGBP, WCRP, and IGFA. It meets twice yearly in an IGOS Forum, in the margins of the G3OS Sponsors' Group or the CEOS Plenary meetings.

171 IGOS is a concept that unites major satellite and *in situ* observing systems in a framework designed to add value by delivering maximum effectiveness and benefit. It is a strategic planning process linking research and operations, and data producers and users. It also enables data suppliers to respond to requirements set by users. GOSSP is a key link.

172 IGOS is designed to promote awareness of nations to the value of global observations and the need for resources to ensure the arrival of associated benefits.

173 The major thrusts of IGOS are:

- strengthening space-based/*in situ* linkages;
- encouraging the transition from research to operational environmental observations;
- improving data policies and facilitating data access and exchange;
- stimulating better archiving of data to build time series needed to monitor climate change;
- increasing attention to harmonization, quality assurance and calibration/validation.

174 IGOS will work through themes, the first of which is the Oceans Theme. Each theme will contain projects: the Oceans Theme includes GODAE, for example.

175 In discussion, the Chairman reminded members that the IOC Executive Council Resolution EC-XXXI.8 recommends that IOC become a partner in the IGOS Partners' Forum. The Committee endorsed that Resolution.

5. GOOS IMPLEMENTATION PLANNING

176 Dr. Peter Dexter introduced item 5.

5.1 THE WORKSHOP ON THE IMPLEMENTATION OF GLOBAL OCEAN OBSERVATIONS FOR GOOS-GCOS

177 Following I-GOOS-III and realizing that the work of the OOPC has now made it possible to identify specific ocean requirements for a climate observing system, IOC and WMO decided that it was timely to look at implementation issues. Following the rule that GOOS should be built first from existing systems, the implementation process started by entraining those which seemed most appropriate as potential implementation mechanisms, such as VOS, SOOP, DBCP and so on, which were the subject of intergovernmental agreement and which therefore should be the natural initial components of a GOOS/GCOS Initial Observing System. As a first step, an Action Plan for Implementation was drafted based on these existing mechanisms. An updated version of the Action Plan was provided as Working Document I-GOOS-IV.12. The next step was to get the GOOS and GCOS planners together with the managers of the existing implementation mechanisms relevant to the climate module. The meeting took place in Sydney, Australia, in March 1998, and was attended by managers from or representatives of IGOSS, SOOP, DBCP, GLOSS, CMM, VOS, TAO, PIRATA, GTSPP, CLIVAR, OOPC, I-GOOS, GSC, GPO, WMO, NEAR-GOOS, GCOS and, bearing in mind the data requirements of GOOS, IODE (see GOOS Report No. 64). The participants assessed the draft Action Plan and agreed on modifications to it. They agreed on involvement in the implementation, analyzed the existing systems, identified cross-cutting issues, identified responsibilities for implementation actions, and developed a co-ordination and management mechanism in the form of an Interim Implementation Advisory Group (IIAG), chaired by Angus McEwan.

5.2 THE INTERIM IMPLEMENTATION ADVISORY GROUP (IIAG)

178 The IIAG was designated Interim because it was recognized that eventually the various implementation bodies involved would come together in some way under the proposed JCOMM, but that planning for implementation could not wait until the formation of JCOMM. Its task was to finalize the Action Plan, develop integrated strategies for the various bodies, and suggest changes to improve the system and its products. The IIAG met in Paris in November 1998, reviewed progress against actions, the status of the networks, and the Action Plan. It recommended an expanded review of existing mechanisms, and of cross-cutting issues, as the basis for eventual presentation to GSC-II and I-GOOS-IV.

179 The Action Plan is a substantial document. It states the requirements; describes the mechanisms for observation and for data management and exchange; assesses their strengths and weaknesses; describes the Initial Observing System based on these existing components; and sets the requirements in the context of the newly defined recommendations of COP-4. Annexes include user scenarios; observational requirements to meet users' needs; the decisions of COP-4; the capabilities of existing systems; the status of existing ocean

elements of GOOS/GCOS in the climate domain; the initial implementation action lists for existing mechanisms; the JCOMM plan and terms of reference.

180 The Action Plan will form the basis for the decisions of JCOMM, starting at the interim planning meeting for JCOMM scheduled for July 19-15 in St. Petersburg, Russia, which would be attended by representatives of the IIAG and CMM.

5.3 THE JOINT TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY (JCOMM)

181 At the Sydney workshop, it became quite clear that an overall co-ordination and management mechanism would be needed for the implementation of GOOS/GCOS and a range of other operational oceanographic and marine meteorological activities.

182 The process of searching for such a mechanism began in 1996 when the IOC and WMO agreed on the need to facilitate closer cooperation in oceanography to streamline the approach to operational oceanography, streamline existing mechanisms, and eventually regulate and manage operational oceanographic systems. Consultants were engaged to consider the possibilities, and proposed the merger of the WMO's CMM (responsible for marine meteorology) with the joint IOC/WMO IGOSS (responsible for upper ocean measurements, primarily physical), into a Joint Technical Commission for Oceanography and Marine Meteorology. The proposal was endorsed by the CMM and IGOSS in 1997, and formally recommended by the Executive Councils of the IOC and WMO in 1998. Dr. Dexter referred to Information Document I-GOOS-IV/Inf.3, which contained the text of the IOC Executive Council Resolution on this matter (IOC/EC-XXXI.13). At its thirteenth session, the WMO Congress had endorsed the recommendation of its Executive Council, and it was hoped that the IOC Assembly would endorse IOC/EX-XXXI.13.

183 JCOMM's terms of reference are to: (i) further develop the observing networks; (ii) implement data management systems; (iii) deliver products and services; (iv) provide capacity building to Member States; and (v) assist in the documentation and management of the data in international systems.

184 It is envisaged that JCOMM will have 50% of its members from meteorology and 50% from oceanography. Reporting to it will be specialist advisory panels, probably including in the first instance panels on (i) the ocean surface (SST and marine meteorology); (ii) the upper ocean (temperature, salinity, carbon dioxide); and (iii) sea level (GLOSS). JCOMM will be advised by GOOS bodies (GSC and I-GOOS), by GCOS and by the World Weather Watch (WWW) of the WMO. In turn it will report to the sponsors: IOC and WMO. The IODE will not be within JCOMM but will be strongly linked to it.

185 Dr. Summerhayes gave a brief presentation on the potential value of JCOMM to the IOC and GOOS. The concept of JCOMM had arisen because increasingly oceanographers need meteorological data while meteorologists are increasing interested in operational oceanography. Indeed, climate modelling requires oceanographers and meteorologists to work together with coupled ocean-atmosphere models. Furthermore, both communities need to collect their data at the same time and place to determine the fluxes across the air-sea interface. So it seems sensible to envisage one voluntary observing ship programme for combined meteorological and ocean data, not two as at present (VOS and SOOP).

186 It makes common sense to unify the mechanism by which we control the observations. There has been a long and satisfactory collaboration between IOC and WMO, which form entirely natural partners, through IGOSS and DBCP. JCOMM forms a natural home also for several existing groups: TAO, DBCP, GLOSS, etc. JCOMM will enable these groups to benefit from the potential synergies between them, through regrouping into thematic subgroups (ocean surface; upper ocean; and sea level).

187 Although both CMM and IGOSS are currently concerned primarily with physical parameters, at present, meteorologists increasingly need to consider biology (plankton) and its control of gases (chemistry), recognizing the role of (a) CO_2 in climate studies, and (b) DMS in acid rain studies. In future it will be natural to report to JCOMM on ocean plankton and chemistry, possibly through a separate subgroup, which would be expected to cover ocean colour measurements.

188 It makes sense to apply the JCOMM model of integration between atmosphere and ocean to many other aspects of IOC data collection in the future, which is what GOOS envisages. In future there is the potential for specific JCOMM subgroups to be formed to deal with different areas of GOOS data (e.g. pollution; living resources).

189 GOOS and JCOMM planning will address the broadening of the JCOMM remit as JCOMM and GOOS develop beyond addressing just the climate area for which we are most ready. The IOC will be a beneficiary of this improved infrastructure for data collection and management. The fact that we are not ready with this yet is not a show stopper. It is not a case of missing the roof off the house; it is a case of planning extensions as the family grows.

5.4 DISCUSSION ON AGENDA ITEM 5

190 In discussion on item 5, the Committee strongly endorsed the formation of JCOMM as a mechanism essential for the efficient and effective implementation initially of the climate module of GOOS and the ocean component of GCOS, and asked that this endorsement be made plain at the IOC Assembly.

191 The Committee recognized that JCOMM would bring other benefits too. Customers wish to see a coordinated approach by the IOC and WMO to meeting their needs, and JCOMM will be far more appropriate to customers' future needs than either of the systems that it replaces. JCOMM will also serve a very useful function in encouraging the improvement of co-ordination between meteorology and oceanography at the national level, which could lead to common national positions being brought to different UN organizations. The IOC would undoubtedly gain much from CMM, for instance in giving IOC access to a more extensive capacity building programme.

192 In developing JCOMM, there will be a need to preserve the balance between the different components of GOOS, though it is recognized that the non-climate elements are not yet ready for implementation. The development of JCOMM should recognize the broad requirements of the IOC. It should be reviewed after a few years to see that it is meeting IOC's requirements.

193 The Committee would like information in due course on the make-up of membership of JCOMM and its specialist working groups, to facilitate the delegation of experts to JCOMM by national agencies, to assist in the smooth transfer to the new arrangements.

6. CAPACITY BUILDING STRATEGY

194 Dr. Jan Stel was not able to be present, so Dr. Summerhayes introduced this item, which is informed by I-GOOS-IV/13 and 13add. In May 1996, I-GOOS established an *ad hoc* Capacity Building Panel, which was chaired by Jan Stel. The GPO was highly appreciative of his efforts and for the Dutch Government's financial support of the GOOS Capacity Building programme that he had led.

195 Until now the Capacity Building programme has been focussed on awareness raising workshops, which have taken place in:

- Goa (11/96);
- Mombasa (03/97): led to 5-year-science plan for E. Africa;
- Malta (11/97): led to formation of MedGOOS;
- Fiji (02/98): led to formation of PacificGOOS;
- Costa Rica (05/99): led to formation of IOCARIBE-GOOS.

196 I-GOOS-III had also recommended that there be a similar workshop in Latin America, but this had not yet taken place.

197 The GOOS capacity building activities also include technical training, which currently takes place in two ways:

(i) Annual NEAR-GOOS data management training workshops (Tokyo);
(ii) Annual GLOSS training workshops (Bidston, 06/97 for Mediterranean and Black Sea countries; Cape Town 11/98 for African countries).

198 The capacity building programme has successfully brought GOOS to the attention of particular regions, and resulted in the formation of regional GOOS groups dedicated to establishing GOOS in those regions.

199 Until now we have lacked a comprehensive strategy and principles for GOOS capacity building. These are now being developed by the GSC, and a copy of the draft strategy and principles was available as a working document (I-GOOS-IV/13). The strategy involves: (i) seeking regional involvement, for example by helping regions to develop GOOS and by helping to establish regional GOOS pilot projects; (ii) finding ways to help to build institutional infrastructure, for instance through forming National GOOS Co-ordinating Committees (see agenda item 4.4.3.6); (iii) calling for the development of inventories of capabilities and needs; (iv) a move away from awareness building to meeting specific technical training needs, for example in data and information management, which would involve a joint approach with IODE; (v) attempting to ensure sustainability for the long term; (vi) encouraging assessments of costs and benefits as a means of persuading governments of the value of joining GOOS; and (vii) working with donors to solicit funding.

200 These various developments clearly call for a revamping of the previous *ad hoc* Capacity Building Panel to meet the new requirements, and supplying it with new ToRs, which are currently being developed. It is intended that the new panel will be a standing body of GOOS, rather than an a*d hoc* body, and that its members will include representatives of the GOOS Advisory Panels as well as representatives of donor agencies.

201 The Panel will be the GOOS mechanism for implementing the GOOS component of the IOC's TEMA (Training, Education and Mutual Assistance) programme. The GOOS component will be developed in consultation with the other IOC components in the TEMA programme, to ensure maximum synergy within the IOC.

202 Future provisional plans approved by the GSC include the following:

(i) Help to establish regional GOOS activities (1999-2001):
- MedGOOS Costs/Benefits Workshop, Rabat (11/99);
- MedGOOS Pilot Project Meeting (summer/2000);
- PacificGOOS meeting, Noumea (spring 2000);
- Latin America Capacity Building Workshop (e.g. S.W. Atlantic area; S.E. Pacific area; and/or Caribbean);
- GOOS-AFRICA Meeting (follow up to PACSICOM);

(ii) Continue technical training:
- NEAR-GOOS Training Workshop, Tokyo (01/2000);
- GLOSS Training Workshop, Sao Paulo (09/99);

(iii) Identify new technical training requirements;

(iv) Possibly hold additional awareness raising meetings:
- southeast Asia, to help launch SEA-GOOS;
- northern Indian Ocean (this is a suggestion from Jan Stel and has not yet been approved by the GSC).

203 Priorities will be largely dependent on regional motivation, and on raising the necessary extra-budgetary resources.

204 Part of the new strategy is the establishment of regional centres to aid regional GOOS development and capacity building. The first of these, thanks to the generous financial support of the Government of Western Australia, and the in-kind assistance of the Australian Bureau of Meteorology, is an office in Perth, Western Australia. The Perth office will provide a southern hemisphere focus for GOOS, helping to form, maintain and develop GOOS in the eastern Indian Ocean, S.E. Asia (as an aid to the Bangkok Office of WESTPAC), and in the Pacific islands (helping PacificGOOS). The office will:

(i) Develop an outreach programme for capacity building: provide training in observations, data quality control, data transmission and archiving, production of products, and interpretation of products/information;
(ii) Organize conferences, workshops, and awareness-raising activities;
(iii) Strengthen links between GOOS and Australian programmes and industry; encourage development of products and services;
(iv) Obtain such additional resources as are necessary to carry out GOOS activities;
(v) Provide information about GOOS;
(vi) Promote transfer of *in situ* and remotely-sensed data to and from users and suppliers.

205 The office was established in December 1998 through a Memorandum of Understanding between the IOC, the Government of Western Australia and the Commonwealth of Australia. The Bureau of Meteorology has made an office available on its premises in Perth, and has seconded Brian Sadler to occupy the post temporarily while the IOC recruits a candidate.

206 In discussion of this agenda item, the Committee was pleased with progress to date and with the evolution of a comprehensive capacity building strategy and associated principles.

207 The Committee approved the proposed plan, but asked that efforts be made to build capacity also in especially disadvantaged areas, with an initial focus on Africa, in consultation with GOOS-AFRICA, and on the Pacific islands, in consultation with PacificGOOS.

208 The Director of the GPO noted that GOOS had not been inactive in Africa. Under the general GOOS flag the following activities had taken place there recently: (i) a TAO-PIRATA workshop in Abidjan (11/98); (ii) the GOOS-AFRICA workshop at the PACSICOM meeting in Maputo (07/98), which had led to the formation of a GOOS-AFRICA committee to help build GOOS in Africa; (iii) the involvement of North African countries in the Malta workshop (11/97) and their participation in MedGOOS; (iv) the holding of the first MedGOOS workshop in Rabat in November 1999; (v) the holding of the GLOSS training workshop for African countries in Cape Town (11/98); and (vi) the holding of C-GOOS-III and its associated stakeholders' meeting in Accra, Ghana (04/99).

209 The Committee noted that the IOC regional bodies with responsibilities for Africa (IOCINCWIO for the western Indian Ocean and IOCEA for the eastern Atlantic) might be able to help to develop GOOS capacity building programmes in those regions. It also noted that the IOC Assembly was a useful forum for ascertaining the training requirements of the regions.

210 The Committee observed that improvements in capacity in the Pacific were needed along the western coast of South America, not just in the Pacific Islands. In this context, Dr. Summerhayes noted that C-GOOS was working to develop a pilot project on S.E. Pacific coastal oceanography in relation to external forcing from the equatorial Pacific, and to build capacity through the establishment of that project. Already discussions have begun with the authorities of the GEF about funding for a related project, a meeting on which will take place in Concepcion in August, attended by a representative of the GPO (Ms. Janice Trotte) and the Executive secretary of the IOC.

211 The Committee agreed that the CPPS (Permanent Commission for the South Pacific) could be a useful vehicle for GOOS capacity building activities along the western coast of South America, and prepared a Draft Resolution for the IOC Assembly on this topic (*Draft Resolution 5*) (Annex VI).

212 Geoff Holland, the Chairman of IOC, noted that the IOC does not have all the resources needed to meet the requirements of Member States for capacity building. It needs to be clearly recognized that the only way forward is to work in partnership with donor agencies of various kinds to acquire the resources needed. Here the IOC would welcome in particular the help of developed countries and their overseas aid programmes. In the case of the GEF it is up to individual countries to put marine affairs high on their list of priorities if they want to attract GEF funds for building oceanographic capacity. The IOC can help them design the proposals. Early in 2001 there will be a conference on partnerships in coastal and ocean management, at which it is hoped that GOOS initiatives can be translated into governmental requirements.

213 The Director of EuroGOOS noted that EuroGOOS will try to assist in capacity building. It is doing so in one way by putting all of its documents on the Internet. EuroGOOS has developed some skill in explaining to governments how GOOS can be useful, and other countries can avail themselves of this skill by accessing the appropriate EuroGOOS documents. He reported that he is working with the GSC to develop a workshop in Brazil for South Atlantic countries on how GOOS can help users. The Committee appreciated the generous and unselfish attitude of EuroGOOS.

214 The representative of SOPAC appreciated the help of the GPO in establishing PacificGOOS, but noted that he felt in the position of someone who has been enabled to join a club but can't afford the drinks or the meals. He also noted that "we cannot feed the hungry of the world by telling them there are recipes on the Internet". He hoped the Perth office might help to take things forward, and would appreciate the help of the GPO and the Perth Office in identifying and acquiring the resources needed for the proposed PacificGOOS workshop in Noumea. The Chairman indicated that Australia would do what it could to help with this initiative.

215 Peter Dexter (WMO) reminded the Committee that the creation of JCOMM would provide an additional capacity building mechanism for specific technical training in the GOOS context.

7. SUPPORT FOR GOOS INFRASTRUCTURE

216 The Chairman presented this item, using Figure 1 from Annex V. He noted that this structure seems to be working well, and that its functioning would be greatly enhanced with the formation of JCOMM. The individual elements must be allowed to function in a more or less autonomous way, subject to the appropriate co-ordination, which is provided largely on behalf of I-GOOS by the GSC and the GPO.

217 He showed a histogram prepared as part of his work as Chair of the inter-sessional Working Party on GOOS Resources created by IOC Resolution EC-XXXI.10, indicating the way in which the different elements on the structural diagram were financed. It showed that the bulk of the funds go into (i) science guidance panels; (ii) global oversight; (iii) outreach and capacity building; and (iv) outreach and infrastructure. The IOC comes up with somewhat less than half of the total cost, with the remainder coming from extra-budgetary resources. The picture is much the same in the year 2000 as it is for 1999.

218 The Committee found the structural diagram very useful. As far as future resourcing is concerned, Japan noted its intention to continue sending an Associate Expert to the IOC for the GPO, and Brazil noted that it had extended Ms. Trotte's secondment from 1999 to 2000.

219 In gross terms, the GOOS funds represent around 10% of the total budget of IOC. The Chairman noted that this seems rather modest given that GOOS is the IOC's flagship project. However, he would not expect considerable change from the IOC recognizing that like GOOS too it has to have a balanced programme.

220 The Committee recognized that much depended on the willingness of individual Member States to contribute to the operation of the GOOS programme, and urged all parties to consider increases in their contribution to the operation of the infrastructure.

8. THE DRAFT RESOLUTION ON GOOS AGREEMENT

221 At I-GOOS-III the Committee recommended the convening of a "First GOOS Agreements meeting" to:

(i) Obtain agreement from governments to the concepts and principles of GOOS as defined in the planning documents; and

(ii) Obtain commitments from national agencies to contribute to the implementation of GOOS (Recommendation I-GOOS-III.4).

222 At GSC-I the GSC reviewed this recommendation, and eventually came to the conclusion that, as a first step, the agreement of governments to GOOS concepts and principles could and should be obtained through a Resolution adopted by the IOC Assembly, the main intergovernmental body responsible for ocean affairs, since that body is accredited by governments to make such decisions. Subsequently a commitments meeting might be organized where national agencies would be invited to indicate specific contributions to GOOS implementation.

8.1 REVIEW OF THE DRAFT RESOLUTION

223 A Draft Resolution on GOOS implementation was prepared and forwarded to Member States under IOC Circular Letter 1577 dated June 29, 1998. Member States were asked to study the draft, comment, and propose amendments as necessary, and eventually decide in the IOC Assembly on its adoption.

224 The Committee was presented with the Draft Resolution amended in accordance with comments received (document I-GOOS-IV/15).

225 In the discussion, four modifications suggested by France were accepted in the final version of the Draft Resolution (Draft Resolution 6) (Annex VI).

226 In the discussion, Japan noted the severe loss of life caused by tsunamis, which raised a question about how coastal geomorphology should be treated in GOOS. The Committee agreed that the movements of sediments was important in the coastal zone, as was the shape for the seabed for modelling tidal currents, tsunami run up and the like. The Committee accepted, however, that it had never been intended that GOOS should be a geological programme, and that there are international mechanisms for the monitoring and forecasting of tsunamis. Indeed, the IOC's Ocean Science and Non-Living Resources (OSNLR) programme deals with the geological aspects of coastal seas, and IOC also has programmes dealing with bathymetry and tsunamis. GOOS should not duplicate these other activities. It was agreed it would not be proper to introduce new items such as coastal geomorphology to the Draft Resolution before they had been discussed by appropriate GOOS technical advisory bodies. It was agreed that C-GOOS should be asked by the GPO how it might propose to attend to monitoring in these matters, and that the IOC Assembly should be asked how its other programmes should be dealing with this issue.

8.2 ARRANGEMENTS FOR A COMMITMENTS MEETING

227 The Chairman introduced this item noting that arrangements had been made to hold an international 1st GOOS Commitments Meeting on July 5-6, 1999, in parallel with the meeting of the IOC Assembly, and after the debate on the GOOS Agreement Resolution (document I-GOOS-IV/16). He felt confident that the Resolution would be agreed to, and noted that already a number of Member States had indicated their willingness to participate in the Commitments Meeting, which was yet another mechanism for helping GOOS grow, this time by the addition of national contributions.

228 Having examined the programme for the meeting, and its goals and objectives the Committee endorsed the plan for the meeting.

9. REVIEW OF ACTIONS FOR 1999-2001

229 The Director of the GPO introduced this item, referring to working document I-GOOS-IV/17, which presented the proposed schedule of activities organized according to the GOOS structure as presented in Figure 1 of Annex V. He noted that the C-GOOS-IV meeting would take place in China, not as indicated in the document.

230 The Committee endorsed the programme, with the proviso that the capacity building requirements identified in agenda item 6 should be taken into consideration.

231 The committee agreed that mechanisms need to be found to bring more funds into GOOS, perhaps in due course on a non-voluntary basis.

10. ELECTION OF CHAIRMAN AND VICE-CHAIRMEN

232 Dr Angus McEwan (Australia) was re-elected as Chairman, and Drs François Gérard (France) and Vladimir Ryabinin (Russia) were re-elected as Vice-Chairmen.

11. NEXT SESSION OF I-GOOS

233 The next session of I-GOOS will be in Paris immediately before the IOC Assembly in 2001.

12. ADOPTION OF THE REPORT

234 The Committee adopted the list of Resolutions, Recommendations and Action Items proposed by the GPO. The GPO agreed to circulate the draft report to the attendees of I-GOOS-IV for comment and modification as appropriate.

13. CLOSURE OF THE SESSION

235 The session closed at 17:30 hours on Friday June 25th, 1999.

ANNEX I

AGENDA

1. **OPENING**

2. **ADMINISTRATIVE ARRANGEMENTS**

   2.1 ADOPTION OF THE AGENDA
   2.2 DESIGNATION OF A RAPPORTEUR
   2.3 CONDUCT OF THE SESSION

3. **REPORTS BY I-GOOS CHAIRMAN AND DIRECTOR OF THE GOOS PROJECT OFFICE**

4. **STATUS OF GOOS DEVELOPMENT**

   4.1 GENERAL OVERVIEW OF THE WORK OF THE GOOS STEERING COMMITTEE (GSC-I & GSC-II)
   4.2 THE GOOS MODULES
   4.3 THE GOOS INITIAL OBSERVING SYSTEM (IOS)
   4.4 SPECIFIC GOOS ELEMENTS (GODAE [including ARGO], PIRATA, Regional Projects)
   4.5 SHARED TECHNICAL PANELS
   4.6 THE INTEGRATED GLOBAL OBSERVING STRATEGY (IGOS)

5. **GOOS IMPLEMENTATION PLANNING**

   5.1 THE WORKSHOP ON THE IMPLEMENTATION OF GLOBAL OCEAN OBSERVATIONS FOR GOOS-GCOS (Sydney, Australia, March 1998)
   5.2 THE INTERIM IMPLEMENTATION ADVISORY GROUP (IIAG)
   5.3 THE JOINT TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY (JCOMM)

6. **THE CAPACITY BUILDING STRATEGY**

7. **SUPPORT FOR GOOS INFRASTRUCTURE**

8. **THE DRAFT RESOLUTION ON GOOS AGREEMENT**

   8.1 REVIEW OF THE DRAFT RESOLUTION
   8.2 ARRANGEMENTS FOR A COMMITMENTS MEETING

9. **REVIEW OF ACTIONS FOR 1999-2001**

10. **ELECTION OF CHAIRMAN AND VICE-CHAIRMEN**

11. **NEXT SESSION OF THE IOC-WMO-UNEP COMMITTEE FOR GOOS (I-GOOS)**

12. **CLOSURE OF THE SESSION**

ANNEX II

LIST OF DOCUMENTS*

Document Code	Title	Agenda Items	Lang.
WORKING DOCUMENTS			
I-GOOS-IV/1 prov.	Provisional Agenda	2.1	E F S R
I-GOOS-IV/1 Add.prov.	Provisional Timetable	--	E only
I-GOOS-IV/ 2	Annotated Provisional Agenda	--	E F S R
I-GOOS-IV/ 3 Ex.prov.	Draft Executive Summary Report *(to be issued shortly after the Session)*	--	E F S R
I-GOOS-IV/ 3	Summary Report of the Session *(to be prepared during or after the Session)*	--	
I-GOOS-IV/ 4 prov.	Provisional List of Documents *(this document)*	2.3	
I-GOOS-IV/ 5 prov.	Provisional List of Participants *(to be issued early during the Session)*	--	
I-GOOS-IV/ 6	Report by the Chairman I-GOOS	3	E only
I-GOOS-IV/ 7	Report by the Director GPO	3	E only
I-GOOS-IV/ 8	The GOOS Initial Observing System	4.3	E only
I-GOOS-IV/ 9	The Global Ocean Data Assimilation Experiment	4.4	E only
I-GOOS-IV/10	EuroGOOS	4.4	E only
I-GOOS-IV/11	CariGOOS	4.4	E only
I-GOOS-IV/12	The GOOS Implementation Action Plan	5	E only
I-GOOS-IV/13	The GOOS Capacity Building Strategy	6	E only
I-GOOS-IV/14	Future GOOS Infrastructure	7	E only
I-GOOS-IV/15	Draft Resolution on GOOS Agreement	8.1	E only
I-GOOS-IV/16	The GOOS Commitments meeting	8.2	E only
I-GOOS-IV/17	Draft Action Plan 1999-2001	9	E only
INFORMATION AND OTHER REFERENCE DOCUMENTS			
I-GOOS-IV/Inf.1	Relevant Excerpts of the Action Paper for IOC-XX	--	E only
I-GOOS-IV/Inf.2	Relevant Excertps of the IOC Annual Report	3	E only
I-GOOS-IV/Inf.3	Relevant IOC-EC Resolutions	--	E only
I-GOOS-IV/Inf.4	National reports		E only

*This list is for reference only. No stocks of these documents are maintained.

Document Code	Title	Agenda Items	Lang.
I-GOOS-IV/Inf.5	Report on Pacific GOOS	4.4	E only
IOC/INF-1123	Relevant Excerpts of the Fourth Conference of the Parties (CP.4) to the Framework Convention on Climate Change (FCCC)	3,4.6	E only
	Third Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System (I-GOOS-III)	all	E/F/S/R
GOOS Report No. 41 (IOC/INF-1091)	The GOOS Strategic Plan	3	E only
GOOS Report No. 42	The GOOS 1998	3	E only
GOOS Report No. 59	Status Report on Existing Ocean Elements and Related Systems (April 1998)	3	E only
GOOS Report No. 61	Report of the third session of the Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC)	4.2	E only
GOOS Report No. 54	Report of the first session of the GOOS Living Marine Resources (LMR) Panel	4.2	E only
GOOS Report No. 63	Report of the second session of the GOOS Coastal Panel (CP)	4.2	E only
GOOS Report No. 40	Report of the fourth session of the GOOS Health of the Oceans (HOTO) Panel	4.2	E only
	The Array for Real-time Geostrophic Oceanography (ARGO)	4.4	E only
GOOS Report No. 68	The Tropical Atmosphere Ocean Array (TAO)	4.4	E only
	The Pilot Research Moored Array in the Tropical Atlantic (PIRATA) - Executive Summary	4.4	E only
GOOS Report No. 60	Report of the third session of the NEAR-GOOS Co-ordinating Committee	4.4	E only
GOOS Report No. 53 (IOC/WR No. 144)	Report of the IOC-SOPAC Workshop Report on Pacific Regional Global Ocean Observing System	4.4	E only
IOC/WR No.140	Report of the GOOS Capacity Building Workshop for the Mediterranean Region	4.4	E only
GOOS Report No. (IOC/WR No. 158)	Report of the IOCARIBE users and the Global Ocean Observing System (GOOS) Capacity Building Workshop	4.4	E only
IOC-XX/Inf. 2	The Memorandum of Understanding on MedGOOS	4.4	E only
GOOS Report No. 62 (IOC/WR No. 152)	GOOS Africa (draft)	4.4	E only
GOOS Report No. 58	Report of the Preliminary Meeting of the fourth session of GOSSP	4.5	E only
	J-DIMP Data and Information Management Plan	4.5	E only
	The IGOS Partnership	4.6	E only

Document Code	Title	Agenda Items	Lang.
	The IGOS Partnership - Exchange of letters	4.6	E only
	The proposed Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM)	5	E only
I-GOOS-IV/Inf.5	Report on Pacific GOOS	4.4	E only
GOOS Report No. 64	Report of the workshop to develop an Implementation Action Plan for Global Ocean Observations for GOOS/GCOS (the "Sydney Workshop")	5	E only
GOOS Report No. 65	Report of the second workshop to develop an Implementation Action Plan for Global Ocean Observations for GOOS/GCOS	5	E only
GOOS Report No. 66	The Action Plan for Global Ocean Observations for GOOS/GCOS	5	E only
	The GOOS Capacity Building Strategy	6	E only

ANNEX III

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ANNEX IV

GSC MEMBERSHIP

Name	Organization	Country	Category of membership
Core Members			
I. Asanuma	JAMSTEC	JAPAN	core*
G. Brundrit	UCT	SOUTH AFRICA	core
K. Denman	IOS	CANADA	core
E. Desa	NIO	INDIA	core*
M. Fogarty	U.Maryland	USA	core
J. Hall	NIWA	NEW ZEALAND	core
L. Merlivat	LODYC	FRANCE	core
W. Nowlin	Texas A&M	USA (chairman)	core
F. Schott	U.Kiel	GERMANY	core
N. Smith	BoM	AUSTRALIA	core*
J. Su	SOA	CHINA	core*
I. Wainer	U. Sao Paulo	BRAZIL	core
Advisory Panel Representatives			
A. Knap	BBSR	BERMUDA	HOTO chair
T. Malone	U.Maryland	USA	C-GOOS chair
D. Arcos	IIP	CHILE	LMR co-chair
W. Wooster	U.Washington	USA	LMR co-chair
T. Karl	NOAA	USA	J-DIMP chair
F. Bretherton	U.Michigan	USA	GOSSP chair
A. McEwan	BoM	AUSTRALIA	I-GOOS chair
Sponsors Representatives			
A. Clarke	BIO	CANADA	ICSU
N. Flemming	SOC	UK	IOC
J. Guddal	NMI	NORWAY	WMO
A. Dahl	UNEP	SWITZERLAND	UNEP
Technical Secretary			
C. Summerhayes	IOC	FRANCE	IOC

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* J-GOOS/GSC member since 1994, now due for rotation. Operational replacements being sought so as to recognize the ideal balance of core = 50% operational. Operational advice at GSC-II came from invited guests, R. Rayner (GEOS) and H. Cattle (UKMO).

ANNEX V

GOOS STRUCTURAL DIAGRAMS

Fig 1. GOOS ACTIVITY STRUCTURE

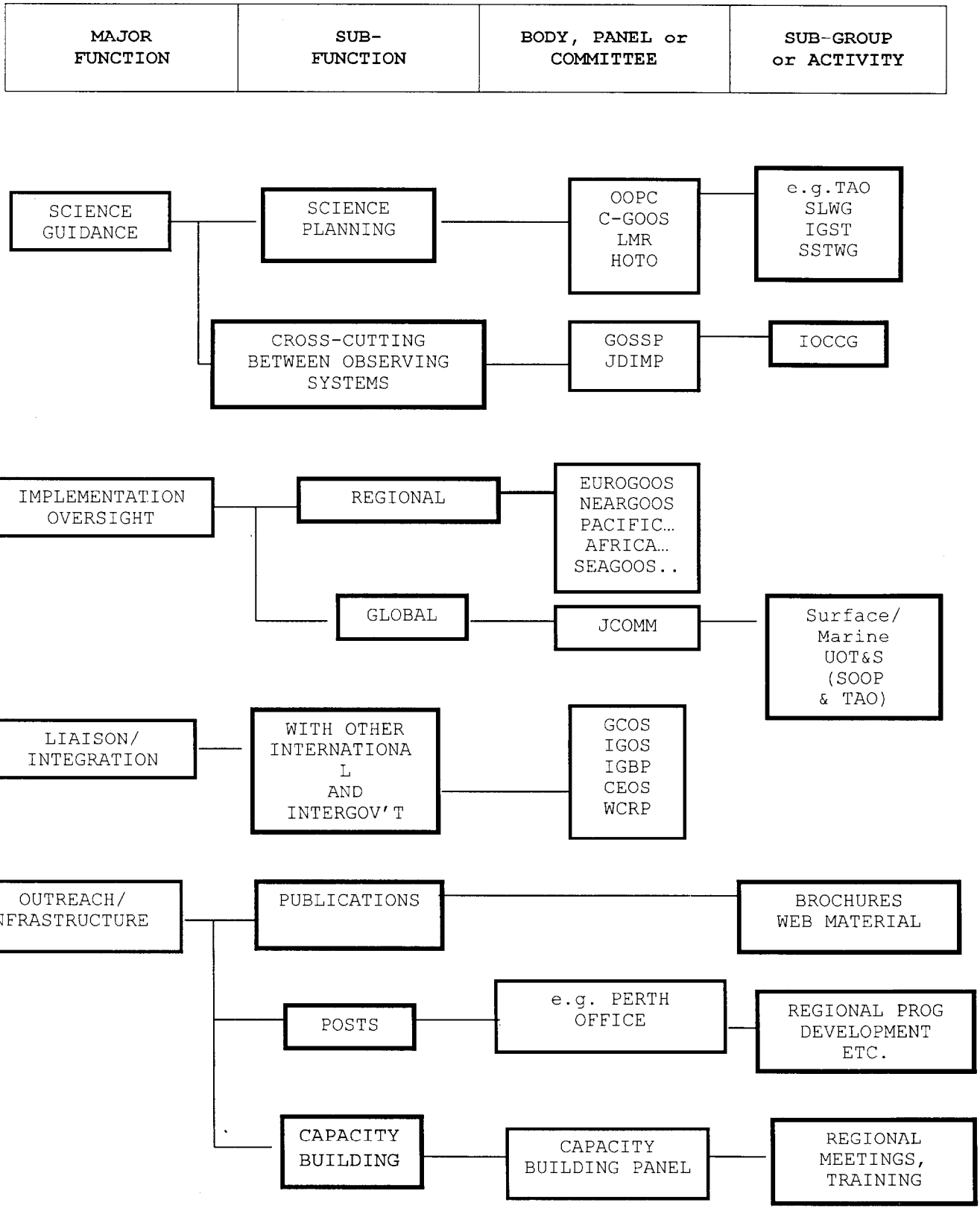
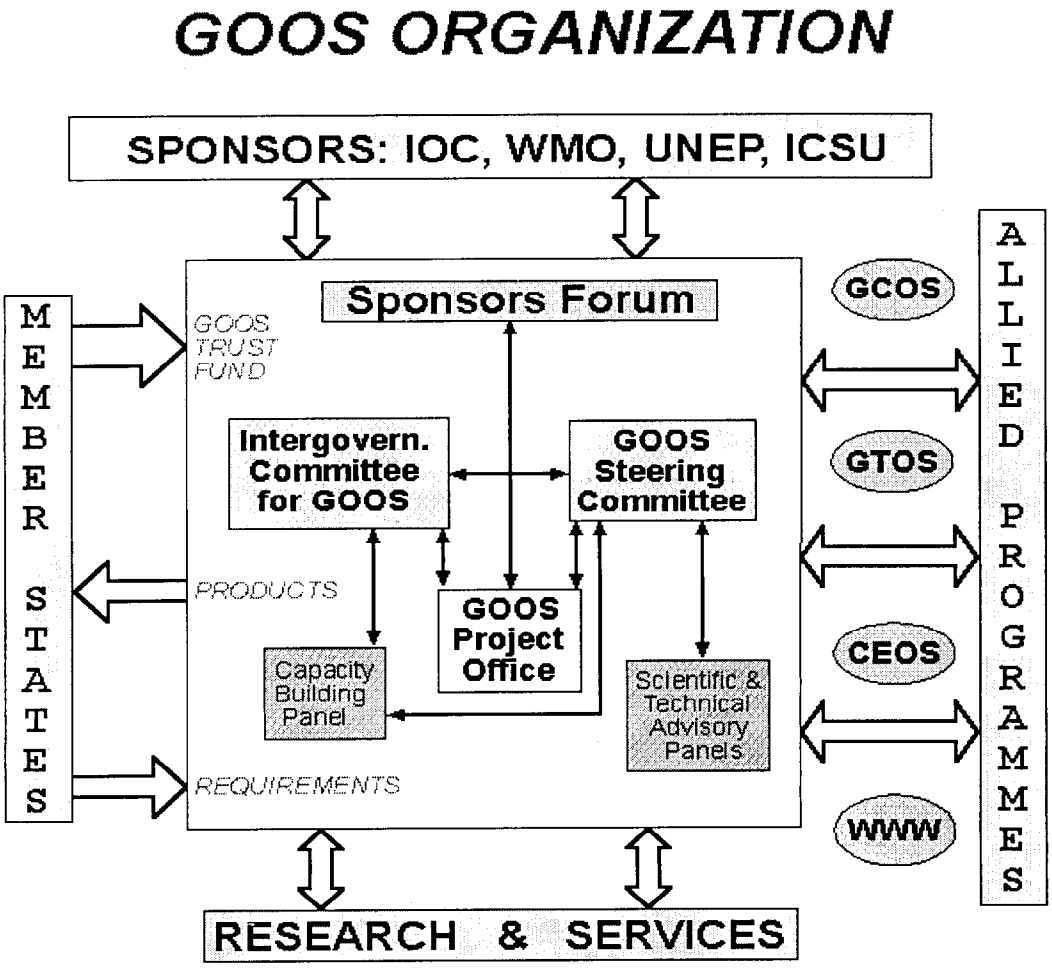


Fig. 2 GOOS ORGANIZATION

The diagram below represents the new international structure of the Global Ocean Observing System (GOOS), as adopted by the GOOS sponsors and the Intergovernmental IOC-WMO-UNEP Committee for GOOS.



ANNEX VI

DRAFT RESOLUTIONS FOR THE IOC ASSEMBLY

A number of resolutions were drafted for the consideration of the IOC Assembly, which met from June 29th to July 9th, 1999. For the sake of consistency the final texts of these resolutions as approved by the IOC Assembly is included here, rather than the initial text as submitted to the Assembly by I-GOOS-IV. The numbers at left refer to the draft resolutions as numbered in the text of the I-GOOS report; those at the right refer to the final resolutions as approved by the Assembly.

1. Revised Terms of Reference for I-GOOS (IOC Resolution XX-8)

2. The Intergovernmental Status of the *Argo* Project (IOC Resolution XX-6)

3. The International Council for the Exploration of the Sea (ICES) (IOC Resolution XX-9)

4. Oceanographic Data Exchange Policy (IOC Resolution XX-11)

5. The Permanent Commission for the South Pacific (CPPS) (IOC Resolution XX-10)

6. The Global Ocean Observing System (GOOS) (IOC Resolution XX-7)

1. IOC Resolution XX-8

REVISED TERMS OF REFERENCE FOR I-GOOS

The Intergovernmental Oceanographic Commission,

Noting:

Resolutions I-GOOS-III.1 and 2 endorsing GOOS principles and strategic plan respectively;
Resolution I-GOOS-III.4 endorsing the formation of the GOOS Steering Committee (GSC) and approving the Terms of Reference of the GSC provided in the Annex to the Resolution;

Approves the amended I-GOOS Terms of Reference as follows:

I-GOOS is the intergovernmental body taking overall responsibility for promotion, co-ordination, implementation and management of the Global Ocean Observing System (GOOS), according to the agreed principles and strategy. Therefore, I-GOOS will:

(i) regularly assess user requirements;
(ii) approve overall plans for the initiation and implementation stages of GOOS elements;
(iii) facilitate the development of such plans on the advice of the GOOS Steering Committee, its Scientific and Technical Advisory Panels and other scientific and technical groups as appropriate;
(iv) identify the resources needed for GOOS and the means for obtaining them:
(v) monitor the progress of GOOS and propose changes as required;
(vi) provide guidance to the Director of the GPO on priority needs for GOOS development and implementation;
(vii) be responsible for the representation of GOOS at intergovernmental meetings.

For implementing these activities, the Committee is invited to:

(i) develop and maintain a strategy for providing training and technical assistance within the TEMA framework;
(ii) develop and maintain working relations with relevant bodies of other UN organizations, with other intergovernmental and regional bodies such as ICES and non-governmental bodies, notably ICSU and its SCOR;
(iii) build upon bodies responsible for the various existing programmes and activities such as IGOSS, DBCP, GLOSS (subject to their eventual incorporation in JCOMM) and GIPME/MARPOLMON;
(iv) support and promote regional development of GOOS.

2. IOC Resolution XX-6

THE Argo PROJECT

The Intergovernmental Oceanographic Commission,

Considering that:

(i) the Global Data Assimilation Experiment (GODAE) is being planned as a pilot project in the context of the UN-sponsored programmes of GOOS, GCOS and CLIVAR, to contribute to short-term ocean forecasting, to provide boundary conditions for forecasting in coastal seas, and for provision of seasonal to inter-annual atmospheric forecasts,

(ii) GODAE will meet the pressing need for: (a) a vastly improved cooperation and integration of remote and *in situ* data streams; (b) improved ocean models and data assimilation techniques to exploit this information, to meet various kinds of users' requirements, such as the stated requirements of the Conference of Parties to the Framework Convention on Climate Change for observational data to support its needs for monitoring and assessing climate change and its impacts,

(iii) a major focus of the International GODAE Steering Team has been the development of a proposal for a global array of about 3000 profiling floats, now known as the *Argo* project, which will be deployed in open ocean waters and will cover the global ocean, and will measure temperature and salinity profiles in the upper 2000 metres of the water column,

(iv) the data and data products derived from those floats will be freely available in real-time and delayed mode through IOC and WMO data exchange systems, as well as other appropriate international mechanisms, and will support operational oceanography and marine meteorology,

(v) those profiling floats are measuring instruments using modern technology; they drift freely at depths as great as 2000 metres, rising to the surface every week or two to transmit data to shore *via* satellite,

Considering further that the *Argo* project shall be fully consistent with UNCLOS,

Noting the absence of a specific international legal instrument regulating profiling floats, drifting buoys, and other similar objects deployed in the oceans,

Recognizing that:

(i) just as with existing surface drifting buoys, some of these new instruments may drift into waters under national jurisdiction,

(ii) the *Argo* project is operational, is now being implemented, but is not yet global,

Supporting strongly the objectives and directions of GODAE which, as part of GOOS and GCOS, enjoys co-sponsorship by IOC, WMO, UNEP and ICSU,

Noting that the *Argo* project presents an excellent opportunity to improve ocean and climate forecasting, with consequent benefits for the protection of life and property and effective planning for the effects of seasonal to inter-annual climate variability,

Acknowledging paragraph 3.4.4.26 of the general summary of the thirteenth World Meteorological Congress, which specifically addresses and endorses the *Argo* project,

Recognizing the need to ensure that Member States gain maximum benefit from the data of the *Argo* project in real-time and at longer time scales, and that they have the possibility to participate in and contribute to the project,

Accepts the *Argo* project as an important contribution to the operational ocean observing system of GOOS and GCOS, as well as a major contribution to CLIVAR and other scientific research programmes;

Concludes that concerned coastal states must be informed in advance, through appropriate channels, of all deployments of profiling floats which might drift into waters under their jurisdiction, indicating the exact locations of such deployments;

Instructs the Executive Secretary IOC, in close collaboration with the Secretary-General of WMO and in consultation with the Executive Director of UNEP:

(i) to inform all Member States, the IHO, and appropriate UN agencies, including IMO and FAO, of the acceptance of the *Argo* project by IOC and WMO;

(ii) to inform all Member States of how to determine float locations and access float data;

(iii) to consider how all Member States might participate in and benefit from the *Argo* project, as well as propose options to that end; and

(iv) to appeal for international cooperation in making the *Argo* project a success;

Further instructs the Executive Secretary IOC to consult with the ABE-LOS and JCOMM on the legal and technical implications respectively of the deployment of profiling floats, drifting buoys, and other similar objects in the ocean, including the feasibility of drafting a legal instrument.

3. IOC Resolution XX-9

THE INTERNATIONAL COUNCIL FOR THE EXPLORATION OF THE SEA (ICES)

The Intergovernmental Oceanographic Commission,

Recognizing that

(i) the International Council for the Exploration of the Sea (ICES) has a Steering Group for GOOS,

(ii) cooperation between GOOS and ICES would be beneficial to both organizations,

Offers to co-sponsor the ICES Steering Group for GOOS, and to appoint representatives to it as appropriate;
Invites the Executive Secretary to convey this offer to the Secretary-General of ICES.

4. IOC Resolution XX-11

OCEANOGRAPHIC DATA EXCHANGE POLICY

The Intergovernmental Oceanographic Commission,

Noting

(i) the agreements on the broad principles of global data management already reached by the Sponsors Forum for the global observing systems, comprising IOC, UNESCO, UNEP, WMO, FAO and ICSU, and by the Integrated Global Observing Strategy (IGOS) Partners, which includes those same bodies plus CEOS, WCRP, IGBP and IGFA,

(ii) the existing data management and exchange agreements set forth by the conventions for the protection of the marine environment, such as OSPAR, HELCOM or the Barcelona Convention,

(iii) the existing broad agreements relating to data relevant to global change, climate change and data relevant to implementation of the international Conventions on Climate Change, Biodiversity and Sustainability,

(iv) WMO Resolution 40 (Cg-XII) which defines a policy and practice as far as the international exchange of meteorological and related data is concerned, and is intended to promote the free and unrestricted exchange of basic data,

(v) the "IOC statement on data management policy for global ocean programmes", as submitted by the Committee on IODE (Recommendation IODE-XIV.6, December 1992) and adopted by the Assembly at its Seventeenth Session (Paris, 25 February - 11 March 1993) (paragraph 220 of the Summary Report of the Session),

Noting also GOOS Design Principle D7, which calls for commitments by GOOS participants to establishing, maintaining, validating, making accessible, and distributing high quality, operational data which meet internationally agreed standards,

Considering the need for detailed technical arrangements regarding data and information to be developed in accordance with varying requirements in the different programmes, projects and regions of GOOS,

Instructs the Executive Secretary IOC to establish an *ad hoc* Working Group on Oceanographic Data Exchange Policy, including the two Co-Chairpersons of JCOMM and the Chairperson of IODE, and other experts to review existing agreements and practices, both within and outside IOC, with regard to the exchange of oceanographic and related environmental data and products, with a view to proposing to the next session of the Assembly:

(i) a restatement of the general IOC principles and policy with regard to oceanographic data exchange; and

(ii) a statement of recommended practices and the required institutional arrangements for the operational exchange of oceanographic data;

Invites interested Member States to nominate experts to join the *ad hoc* group and actively contribute to its work.

5. IOC Resolution XX-10

THE PERMANENT COMMISSION FOR THE SOUTH PACIFIC (CPPS)

The Intergovernmental Oceanographic Commission,

Recognising that:

(i) the Permanent Commission for the South Pacific (CPPS) has been identified by IOC and WMO as the central unit for co-ordinating South East Pacific observational activities,

(ii) increased cooperation between IOC and CPPS would be beneficial to both organizations, particularly within the scope of the GOOS programme,

Decides to explore the possibility that the CPPS agreement with IOC be complemented by a special arrangement, specifying the contribution of CPPS to GOOS development, including national CPPS contributions;

Instructs the Executive Secretary IOC to pursue the drafting of such an arrangement with the CPPS Secretariat

6. IOC Resolution XX-7

THE GLOBAL OCEAN OBSERVING SYSTEM (GOOS)

The Intergovernmental Oceanographic Commission,

Recalling:

(i) that the development of a Global Ocean Observing System (GOOS) was recommended by the Second World Climate Conference (Geneva, 1990), as a means of monitoring and forecasting global change, and by the United Nations Conference on Environment and Development (UNCED) (Rio, 1992), as a means of providing information on the state and future condition of the seas and oceans to support sustainable development, especially of Exclusive Economic Zones,

(ii) IOC Resolution XVI-8 of the Assembly and WMO Resolution 9 (Cg-11) of the Congress by which it was decided to undertake the development of a Global Ocean Observing System,

(iii) that the third Conference of the Parties to the Framework Convention on the Climate Change (FCCC) (Kyoto, 1997) re-confirmed the need for a long-term operational GOOS, stating:

(a) that continued unrestricted use of the ocean by mankind is inconsistent with long-term preservation of sustainability and quality of its resources,

(b) that the ocean processes that are critical to global changes are themselves subject to man-induced global climate change,

(c) that no significant decision addressing these realities in economically and politically beneficent ways for governments, industry, science and the general public can be achieved without a basic knowledge of ocean processes and variability,

(d) that scientific efforts (TOGA, WOCE, etc.) in the last two decades have fully demonstrated that this basic knowledge cannot be achieved, and therefore no applications developed, without systematic observations at global scale,

Noting the progress achieved in GOOS design and planning, expressed *inter alia* through the issuing of various publications such as "*Towards Operational Oceanography: the Global Ocean Observing System*", the "*Strategic Plan and Principles for the Global Ocean Observing System*", "*The Global Ocean Observing System 1998 - A Prospectus*", etc.,

Recognizing that, at this stage of development, the specification of GOOS has not been formally agreed by Governments,

Recognizing further that:

(i) specific implementation plans are now being developed for different components of GOOS,

(ii) the implementation and maintenance of GOOS, on the basis of these plans, can only be achieved through specific contributions from governments,

(iii) these contributions shall take advantage of existing *in situ* and space-based ocean observation systems, which are able to contribute to GOOS development;

Reiterates and reinforces its decision to establish, develop and maintain, through the concerted action of its Member States, an internationally coordinated Global Ocean Observing System;

Agrees that the concept of GOOS as defined in the aforementioned publications is a realistic and achievable means of combining and enhancing the marine observing systems of the world into an integrated, operationally functioning system;

Endorses the Principles of Design and Involvement defined in the "*Strategic Plan and Principles for the Global Ocean Observing System*" as an appropriate definition of the essential features of activities contributing to GOOS and the implications of participation;

Specifies in addition that GOOS shall provide the infrastructure necessary to assess the present and forecast the future states of seas and oceans and their living resources, in support of their sustainable use, as well as to contribute to the prediction of climate change and variability. In particular, it shall:

(i) specify in terms of space, time, quality and other relevant factors, the marine observational data needed on a continuing basis to meet the common and identifiable requirements of the user communities;

(ii) cover the global ocean and its coupling with the near surface atmosphere, polar ice and land boundaries;

(iii) encourage and support the development and application of now-casting and forecasting capabilities as a means of monitoring climate changes, preserving healthy coastal environments, promoting sustainable uses of coastal resources, mitigating coastal hazards, and ensuring safe and efficient marine operations;

(iv) encourage and support technical developments for long-term, low-cost, *in situ* ocean observing systems and products;

(v) coordinate international mechanisms for acquiring, integrating and distributing observations;

(vi) promote and support initiatives for generating and operationally disseminating analyses, forecasts and other products, as required by the user communities;

(vii) in particular, support the implementation and monitoring of the Conventions on Climate Change, Biodiversity and Desertification;

(viii) involve and integrate existing international and regional mechanisms already working on ocean observation;

(ix) facilitate means by which less-developed Member States can increase their capacity to acquire and use marine data according to the GOOS framework;

(x) be developed in accordance with the published GOOS *principles and strategy*;

(xi) coordinate its development with those similar systems already in place or under development, mainly the World Weather Watch (WWW) of WMO, the Global Climate Observing System (GCOS) and the Global Terrestrial Observing System (GTOS);

Encourages the numerous efforts that are being made, at the national, regional and global levels, towards implementing GOOS, including:

(i) those that are aimed at streamlining the activities of existing operational systems and/or bodies such as the WMO Commission for Marine Meteorology (CMM) and its Voluntary Observing Ships (VOS) scheme, the IOC-WMO Integrated Global Ocean Services System (IGOSS) and its Ship-of-Opportunity Programme (SOOP), the IGOSS-IODE Global Temperature and Salinity Profile Programme (GTSPP), the WMO-IOC Data Buoy Cooperation Panel (DBCP), the IOC Global Sea-Level Observing System (GLOSS), the Tropical Atmosphere Ocean (TAO) array in the Pacific Ocean;

(ii) those that contribute to understanding more precisely what are the GOOS requirements and possible output, such as the Pilot Research Moored Array in the Tropical Atlantic (PIRATA), the Global Ocean Data Assimilation Experiment (GODAE), etc.;

(iii) those that constitute direct regional contributions to GOOS, such as the European GOOS (EuroGOOS), the North-East Asian Regional GOOS (NEAR-GOOS), the Mediterranean GOOS (MedGOOS) and other similar initiatives that are being planned; and

(iv) the co-ordination of major space agencies for the development and operation of permanent space-based ocean observing systems;

Urges Member States to contribute to GOOS implementation within the context of available resources and government policies, and in particular to:

(i) make specific commitments to implement and maintain components of GOOS as defined in the GOOS implementation plans;

(ii) exchange data and products through available marine data, collection and management services of IOC and WMO wherever possible, account being taken of national regulations, in accordance with the policies and mechanisms of ocean data management and as agreed by the GOOS sponsoring organizations;

(iii) cooperate with and assist other Member States, both to implement and maintain GOOS and also to share in the benefits to be derived from GOOS;

(iv) contribute where possible to GOOS co-ordination and management through support for the work of the GOOS Project Office;

Invites WMO, UNEP and ICSU to continue and if possible expand their support for GOOS implementation, as well as FAO to consider assisting in GOOS development through relevant technical contributions and the eventual co-sponsorship of the System;

Instructs the Executive Secretary IOC, in consultation with the Secretary-General of WMO and the Executive Directors of UNEP and ICSU, with the assistance of I-GOOS and within the available budgetary resources, to:

(i) manage the co-ordination of GOOS implementation;

(ii) assist Member States in the implementation of this Resolution.

ANNEX VII

NATIONAL PROGRAMMES

A. CANADA

INTRODUCTION

Canada continues its support of GOOS as the principal international mechanism for obtaining long-term systematic observations of the marine environment, both regionally and globally, to meet a broad range of user requirements. In the past this support has primarily involved Canadian participation in the planning of GOOS through its panels, working groups, and I-GOOS, as well as through Canada's support of the infrastructure that is being used to implement GOOS. In the future, Canada will contribute more directly to GOOS through the designation of parts of its long-term monitoring effort as contributions to GOOS and do so in a manner that is consistent with the GOOS Principles. The extent of Canadian involvement in GOOS awaits further development of the detailed design of the GOOS observing system for all the GOOS modules, especially those which require observations in the Canadian EEZ and which are less developed than the climate module. Another obvious constraint will be the ability to commit long-term funding to GOOS in times of government cutbacks and assessment of priorities. However, given Canadian concerns regarding climate change and the marine environment, the opportunity exists to make a substantial contribution to GOOS.

CANADIAN GOOS ORGANIZATION AND PLANNING

Within Canada, the responsibility for the planning and implementation of ocean observing systems rests primarily with the Fisheries and Ocean Sciences Directorate, Department of Fisheries and Oceans (DFO). Collaborations are established with other departments and agencies to include those variables for which the responsibility falls outside DFO. Within this framework, ocean monitoring programmes have been developed for the ocean off both the Atlantic and Pacific coasts and to a lesser extent for the Arctic. They have been designed to meet a number of Canadian needs and have elements that span C-GOOS, LMR and HOTO concerns.

More recently, in the post-Kyoto spirit, Canada has been planning its potential contributions to GCOS, including all the ocean, terrestrial and atmospheric elements. In addition, requirements have been defined for the augmentation of the sparse GCOS global network to provide the climate observing system needed to meet Canadian national interests. While for the atmosphere and land this augmentation primarily increases the density of the observing network, for the ocean it includes climate observations on the continental shelves and the oceans directly off Canada's coasts. Long-term government support for Canadian climate observations for GCOS, and its Canadian augmentation, is being sought. Some elements are however presently being routinely carried out as part of existing monitoring or research programmes.

POTENTIAL CANADIAN CONTRIBUTIONS TO GOOS

As just mentioned, serious consideration has been given to what Canada could contribute to the GOOS/GCOS common climate module given adequate resources. First priority has been given to (i) five geocentrically positioned tide gauges (two on the east coast, of which one would be a new gauge on the coast of Labrador, two on the west coast and one in the Arctic, also a new gauge); (ii) continuation of the research-based time series on Line P and the site of OWS P in the Pacific, at the site of OWS Bravo, and on an annual section across the Labrador Sea; and (iii) a substantial contribution of profiling floats to the Argo programme that might eventually total about 5 percent of the global array. Regarding profiling floats, Canada would consider providing floats to the global array in regions other than off Canada's coasts should the contributions of other nations provide regional coverage in areas of particular Canadian interest. Slightly lower priority has been given to carrying out one transocean section off both the east and west coasts every eight years for the assessment of the inventories and transports of heat, fresh water and carbon.

This contribution to the global GOOS/GCOS physical ocean observing system would be augmented by (i) seasonal sampling using hydrographic sections and time series stations of the water properties on Canada's continental shelves and adjacent seas including the Arctic (roughly 12 sections and 8 time series stations on the east coast including the Gulf of St Lawrence, 9 sections on the west coast and a moored climate station and annual hydrographic survey in the Beaufort Sea region of the Arctic Ocean); (ii) an enhanced tide gauge network, some of which would be geocentrically positioned (roughly 6 gauges on the east coast, 4 gauges on the west coast and one in the Arctic, all of which would be in addition to those contributing to the climate module); (iii) direct observation of the transport on the Labrador shelf and through the Canadian Archipelago; (iv) observations of sea-ice concentrations, extent and velocity both off the coast of Labrador and in the Canadian Arctic. In the case of limited resources priority will be given to maintaining parts of the hydrographic and tide gauge networks as well as to observations of sea ice. How much of the above observational array would contribute to GOOS depends on the final design of the global C-GOOS observing system. In any event, Canada would be willing to contribute the observations it is taking to GOOS as the evolving GOOS plans indicate is appropriate. Data presently being obtained is already being archived in the international data management system.

Potential Canadian contributions to the HOTO and LMR modules are less clear, partly as the result of the less advanced state of both GOOS and Canadian planning in these areas. However, under the *Canada Oceans Act*, Canada has placed considerable emphasis in developing coastal zone management strategies and designating various ecologically sensitive areas as Marine Protected Areas. Furthermore, Canada does have operational programmes in these areas, especially as they relate to fisheries. In an effort to evaluate the effectiveness of current monitoring programmes to meet Canada's ecosystem objectives for integrated oceans management and conservation as well as the performance measures by which observational tools used to monitor the ocean ecosystem can be assessed, a Canadian workshop will be held in the fall of 1999. It is expected that in addition to addressing Canadian issues this will aid Canada's input to the design of the LMR module and better indicate how Canada could most effectively contribute to this aspect of GOOS.

Canada will also continue its contributions to the infrastructure supporting the implementation of GOOS. As in the past, Canada through the Marine Environmental Data Service, as a member of the IODE system, will continue to be the RNODC for both the present suite of data as well as those resulting from new technologies. GTSPP, drifting buoys, thermo-salinographs, Argo are a few examples of such data sets. In addition, Canada will continue collaborating with other countries to develop data management policies and guidelines, by providing expertise to the various implementation panels of GOOS modules.

SUMMARY

In general, Canada supports the development of GOOS as a planned observing system to meet specific needs and providing data and products of known quality to the global community. While the boundary between what Canada contributes to GOOS and what should remain in the Canadian context is still to be determined, Canada will support international efforts to make GOOS as broad as possible within the framework of the GOOS Principles of design and involvement. Canada views climate change and marine environmental matters in general as issues requiring an international approach and will support the contribution that GOOS can make to the extent possible taking into account the available resources.

National contact for GOOS:

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K1A 0E6

B. CHILE

(Comité Oceanográfico Nacional de Chile)

1. INTRODUCTION

During the last two years, the Chilean National Oceanographic Committee (Comité Oceanográfico Nacional de Chile - CONA) has been organizing several activities related to the planning and implementation of the GOOS observing system in Chile.

This document serves to describe the activities that are performed by the Marine Institutions and Universities that form part of CONA.

2. NATIONAL GOOS CO-ORDINATING COMMITTEE (Chilean-NGCC)

A National Co-ordinating Committee for GOOS has been established to develop, plan, coordinate and implement the necessary infrastructure to support operational oceanography and marine meteorology. The members of this Committe are:

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Concepción - Chile
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José Rutllant
Departamento de Geofísica
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3. SEA LEVEL NETWORK (GLOSS AND PACIFIC TSUNAMI WARNING SYSTEM)

The Chilean contribution to GLOSS and to the Pacific Tsunami Warning System, covers installation, operation and maintenance of 20 sea level stations located between latitude 18°S and the Antarctic peninsula (Base Prat).

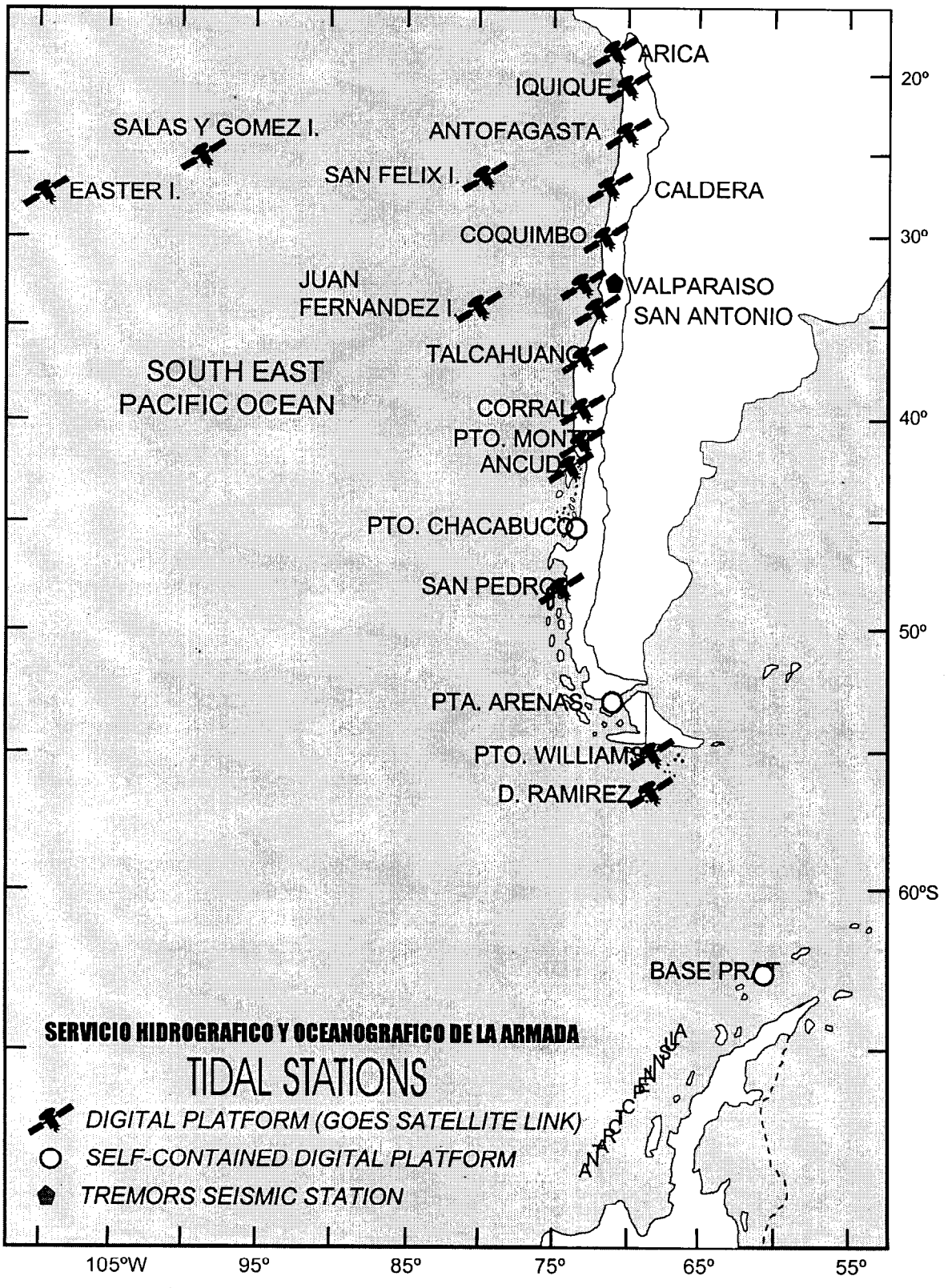
The network was recently updated from bubbler type gauges and digital platforms to one of the latest generations of digital collector platforms (DCPs) linked *via* satellite. The installation of all the platforms north of latitude 42°S was completed during May of 1999, leaving only four stations to be replaced. Near real-time data can be obtained downloading the data directly from the GOES-East satellite, from the University of Hawaii Sea Level Center (UHSLC) or from http://www.shoa.cl/oceano/sdc/Estaciones_marea/Estaciones.html (graphic displays of sea level, air temperature, water temperature and atmospheric pressure). Data in a delayed mode can be requested from the Centro Nacional de Datos Oceanograficos (CENDOC) at <rrojas@shoa.cl>.

Table 1 and Figure 1 show the geographic location of the sea level stations and transmitting codes for the GOES-East satellite.

Table 1: location and code identification of sea level stations

Station Code	Station Name	Latitude [South]	Longitude [West]
9320E016	Arica	18° 29'	070° 19'
ADC01548	Iquique	20° 13'	070° 10'
ADC020D2	Antofagasta	23° 39'	070° 25'
9321011E	Caldera	27° 04'	070° 50'
ADC033A4	Coquimbo	29° 56'	071° 21'
932127F2	Valparaiso	33° 02'	071° 38'
ADC0063E	San Antonio	33° 35'	071° 38'
ADC04534	Talcahuano	36° 41'	073° 06'
ADC05642	Corral	39° 52'	073° 26'
ADC063D8	Puerto Montt	41° 29'	072° 58'
ADC070AE	Ancud	41° 52'	073° 51'
ADC0935C	Puerto Williams	54° 56'	067° 37'
93214214	San Felix island	26° 16'	080° 07'
140F372	Salas y Gomez Island	26° 25'	105° 28'
93202BDA	Easter Island	27° 09'	109° 27'
93215162	Juan Fernandez island	33° 37'	078° 50'
ADC0802A	San Pedro island	47° 43'	074° 53'
DCP self-contained	Punta Arenas	53° 10'	070° 54'
DCP self-contained	Base Prat (Antarctica)		
DCP self-contained	Chacabuco	45° 28'	072° 50'

Figure 1: Geographic location of sea level stations



4. WOCE HIGH DENSITY WBT PROGRAMME

Chile is involved in the WOCE high density XBT programme, along line PX-50, from Valparaiso-Chile to Auckland-New Zealand and along line PX-25, from Valparaiso-Chile to Japan/Korea. Both lines are operated jointly by SCRIPPS and SHOA.

5. CAPACITY BUILDING

Within Chile, capacity building is mainly carried out by universities and a few marine science institutes. These academic centers provide undergraduate and graduate studies in oceanography, marine biology and atmospheric science. Universidad de Concepción, in the south of Chile, has an interdisciplinary Ph.D. programme in oceanography for students from Latin American countries.

6. OCEAN SOUTH EAST PACIFIC ARRAY (OSEPA)

The South East Pacific Ocean is one of the areas of the planet that has no systematic meteorological and oceanographic information. Only the coastal stations and a few islands (Easter island, Juan Fernandez island, San Felix island and Salas y Gomez island) provide information on the sea surface temperature and sea level. The actual knowledge on the oceanographic conditions of the area does not help understand the ocean phenomena occuring along the coastal zone, such as the upwelling processes and continental shelf wave propagation which impact fishing and coastal climate. The initial economic impact of ENSO 1997/1998 in Chile was close to US$ 655 million.

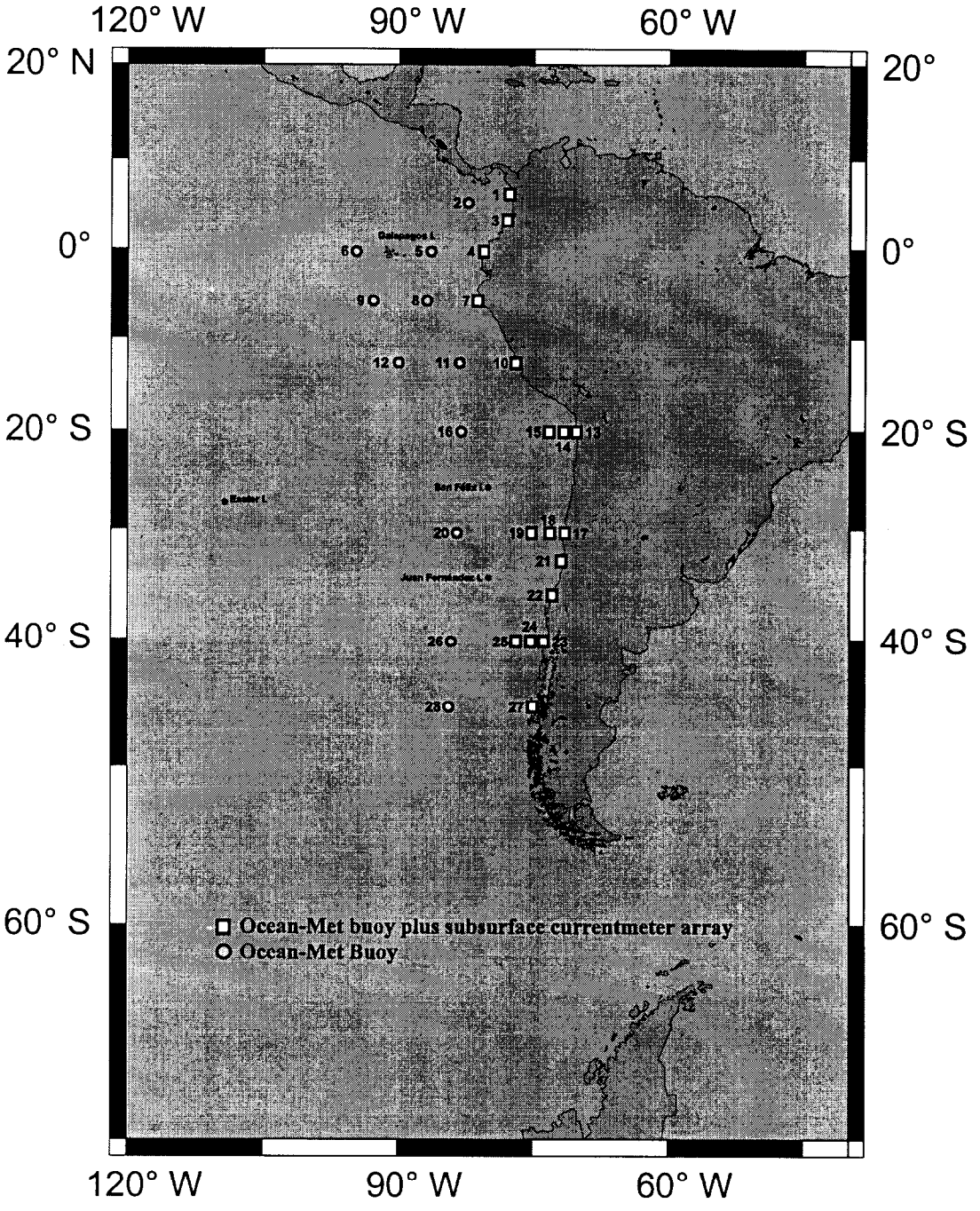
Chile is proposing to install an array of buoys that combine with the new upgraded tidal network to monitor the evolution of ENSO to provide inputs for the Regional Models presently being developed to mitigate the impacts on the phenomenon in the coastal area.

This array will consist of 16 buoys (similar to the ATLAS buoys used by the TOGA/TAO array) and 12 current meter arrays installed at 3, 20, 100 and 1000 miles offshore at 20°S, 30°S, 40°S and 45°S. The data collected with this array could be used by Chile, Perú and Argentina, as part of an advanced meteorological warning and monitoring system. *All data collected by this array and by the coastal stations will be freely shared among the scientific community to prevent and mitigate the social and economical impacts caused by El Niño in the Southeast Pacific Ocean.*

The proposed array (OSEPA) has been adopted and extended by the Permanent Commission for the South Pacific (Comisión Permanente del Pacífico Sur – CPPS) to cover the oceanic and coastal waters in front of Colombia, Ecuador, Peru and Chile and now consists of 27 buoys and 17 current meter arrays. A meeting to complete the proposal for this project will take place in Concepcion, Chile during August of 1999. The meeting is being sponsored by WMO, IOC and CPPS.

Figure 2 shows a schematic diagram of OSEPA.

Fig. 2 Schematic Diagram of the Ocean South East Pacific Array (OSEPA) as proposed by the Permanent Commission for the South Pacific (CPPS)



COLOMBIA

MAIN COLOMBIAN ACTIVITIES RELATED TO THE GOOS PROGRAMME[1]

Prepared by Mauricio González Espinosa
Advisor - Colombian Oceanographic Commission

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
Medellín EAFIT University - Marine Sciences covered by the Department of Geology. Lines of research	• Basic paleoceanographic research • Basic research on Models for the coastal evolution of the Colombian Pacific Coast • Applied research. Coastal erosion on the Pacific and Colombian Caribbean coasts	• Geomorphological, sedimentological and biological indicators of the San Juan River Delta in the Colombian Pacific Phase I, Phase II, COLCIENCIAS				X	
National University - Natural Sciences Institute - (Postgraduate studies in Biology - Marine Biology). Lines of research	• Systematics and taxonomy of invertebrates(sponges, crustaceans) and vertebrates (fish) • Fishery ecology • Inventory, use and ecology of marine natural products • Marine pollution • Ecology of marine communities with special reference to coral reefs	• Metabolites of marine sponges of pharmacological and chemo-taxonomic interest, COLCIENCIAS 1996-1998 • Chemical study of Colombian marine invertebrates (Phase III) and chemical study of marine sponges-structural relations, Activity (Stage I), 1992. COLCIENCIAS		X		X	

1 The information contained in the first three columns has been taken from the document "National Marine Science and Technology Country Profile of Colombia in 1999", prepared by Dr Jairo Escober, Adviser - Colombian Oceanographic Commission.

2 Ocean Observation Panel for Climate (PC); Ocean Safety Panel (SO); Living Marine Resources Panel (RMV); GOOS Coastal Panel (PGC); Marine and Oceanographic Meteorological Services and Products Panel (S y P).

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
National University - Natural Sciences Institute - (Postgraduate studies in Biology - Marine Biology). Lines of research	• Ecology of coastal communities	• Bio-ecological and environmental assessment of reef areas of the Colombian Caribbean, Phase II COLCIENCIAS*, INVEMAR, National University of Colombia, 1997-1999 • Fishery ecological study of the *Demersal* Resources of the Gulf of Salamanca in the Colombian Caribbean. Variability study of the biological components of the COLCIENCIAS* system. INVEMAR, National University (since 1998), 1995-1998.					

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
National Fishery and Aquaculture Institute (INPA)	• Research on fishery resources and technological development of fishing on the following lines: Research on the marine fishery resources of the Caribbean (population dynamics, crustaceans, fish and molluscs), exploration of new fishing grounds for artisanal fishing; research on the marine fishery resources of the Pacific (population dynamics, crustaceans, fish and molluscs), exploration of new fishing grounds for artisanal fishing. Applied fishing technology Assessment of non-traditional skills • Research, development and technical development of aquaculture on the following lines: Research and development of marine aquaculture on the Atlantic Coast (oyster farming, marine fish farming, prawn farming) Research and development of aquaculture in the Pacific (prawn farming) • Training, technology transfer and the promotion of peasant aquaculture and artisanal fishing • Management and inspection of fishing resources and aquaculture, Improvement of training for institutional management	• Adoption and adaptation of techniques for the cultivation of the mangrove oyster *Crassostrea rhizophorae* based on the technology developed in Cuba (1997-1999) • Reproduction in captivity of the mutton snapper *Lutjanus analis*, with a view to diversifying marine aquaculture in Colombia (1998-2001) • Exploration of the main shoals of fish in the Pacific			X		

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
"Benito Vives de Andreis" Marine and Coastal Research Institute INVEMAR	• Biodiversity and marine ecosystems with the following lines of research: Basic research and inventories, monitoring and biology of conservation, biology of ecosystems (coral reefs, mangrove swamps, basic studies, taxonomy and systematics of certain groups) • Appraisal and exploitation of Living Marine Resources, with research on fishing, aquaculture and natural products (fishing ecology, trophic models, phytoplankton), protection of the marine environment with research into the analysis and assessment of risks, the monitoring of effects and the rehabilitation of ecosystems. Marine environmental quality activities (Ecology of estuaries, pollution by heavy metals, pesticides and hydrocarbons) • Marine Environmental Information System (SINAM) working with the SIG Geographical Information System and the Documentation, Information and Reference Centre.	• Monitoring system for reef environments in Colombia and assessment of factors in the destruction of coral deposits, 1997-1999 • Characterization of the macrofauna of the Colombian Caribbean, Phase I: Epifauna of the upper fringe of the continental shelf (100-400m), 1997-2000 • Assessment of the biological, technical and economic feasibility of the experimental farming of markable bivalve molluscs in the Colombian Caribbean 1997-1998, COLCIENCIAS • Diagnosis of the chemical quality and salubriousness of Colombian marine waters 1996-2001		X	X		
Marine Museum - Jorge Tadeo Lozano University Foundation	• Inventories of living resources, biodiversity, functional and descriptive ecology • Coral reefs • Coastal zones - integrated coastal zone management			X	X		

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
Research Institute for Geosciences, Mining and Chemistry INGEOMINAS	• Coastal geomorphology • Coastal erosion problems • Risks and geological threats to coasts • Geological coastal evolution	• Geological problems associated with the Pacific coastline: geomorphology and geological risks • Geomorphology and erosive aspects of the Colombian Caribbean coast 1993-1995 • Digital Geological Atlas of Colombia: Charts of the maritime zones of the Colombian Caribbean and Pacific, 1995-1997				X	
Corporation for the Sustainable Development of the Archipelago of San Andrés, Providencia and Santa Catalina CORALINA	• Inventory of living resources • Functional and descriptive ecology • Coastal zone management (coastal planning) • Marine pollution • Aquaculture	• Monitoring system for reef environments in Colombia, Assessment of factors in the destruction of coral reefs • Zoning of the San Andrés seacoast (1998) • Characterization of the macrofauna associated with the mangrove swamp ecosystems in the Island of San Andrés (1996-1999) • Biological fishery study of *Ocyurus chrysurus* and *Balistes vetula* of San Andrés and Cayo Bolívar (1996-1998) • Supervision and monitoring of solid waste dumped at sea off San Andrés Island (1997-1999)		X	X	X	
CIOH Oceanographic and Hydrographic Research Institute (DIMAR)	• Marine pollution • Integrated coastal zone management • Oceanographic data service	• Opening of the National Naval Oceanographic and Meteorological Forecasting Centre, 1991	X	X	X	X	

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
CIOH Oceanographic and Hydrographic Research Institute (DIMAR)	• Marine topography, geodesy, hydrography • Physical oceanography, marine meteorology • Numerical modelling of coastal and ocean circulation and polluting processes • Nautical and electronic cartography, bathymetry and supervision of dredging	• Oceanographic and geological study of the Colombian Caribbean, Barranquilla-Juan de Acosta section (1996-1997) • Forecasting of meteorological and oceanographic conditions for naval operations and maritime activity in jurisdictional waters • Hydrographic survey of the San Bernardo Archipelago (1988) • Cartographic processing of nautical charts, 1995, COLCIENCIAS • Land survey of the Bajamar Caribbean coast (1991-2000)					
Agustín Codazzi Geographical Institute IGAC)	• Basic and thematic cartography • Soil studies • Physical environmental studies • Land-use planning and ecological zoning • Use of remote sensors, aerial photography, satellite images, radar • Spatial dynamics, production of thematic charts	• Study of land cover and land use in the Bahia Málaga region (1995-1997) • Analysis over different periods of mangrove swamps in the coastal region of the Department of Atlántico (1998) • Ecological zoning of the Colombian Pacific region, 1995-1998				X	
CCCP Pacific Pollution Monitoring Centre (DIMAR)	• Ocean zone oceanography • Coastal zone oceanography • Marine pollution • Quality of the environment • El Niño	• Mathematical model of marine dynamics in the Colombian Pacific, 1998 • Hydrological, oceanographic and phytoplanktonic study of the Colombian Pacific and its relation with the El Niño phenomenon (under way since 1989)					

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
CCCP Pacific Pollution Monitoring Centre (DIMAR)		• Development of a model of the quality of water in the Tumaco inlet (1997-1998) • Characterization and assessment of the Colombian Pacific coastal zone (1995-2001)					
NATURA Foundation	• Characterization of strategic systems • Inventory, structure and composition of coastal ecological environments • Actions and plans for land development and land-use planning	• Space and time patterns of recent environmental disturbances in the corals and coral reefs of the Colombian Pacific • Ecological zoning of the Utría inlet, 1993 • Chocó Norte - UTCH-NATURA Foundation Hydrobiological Resources Programme		X	X		
Yubarta Foundation	• Inventories of marine mammals (cetaceans) • Biology of marine mammals • Interaction and migration	• Study of the social structure of the yubarta or humpback whale *Megaptera novaeanglia* (Borowski, 1781), Gorgona Island, Colombian Pacific. COLCIENCIAS • Study of the yubarta whale *Megaptera novaeanglia* (Borowski, 1781), population aspects, social structure and conservation, Part II. COLCIENCIAS		X			

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
University of Cartagena	• Chemistry and biological activity of secondary metabolites of marine sponges • Hydrology and marine pollution	• Study of the chemistry and anti-microbic, anti-inflammatory and cardiovascular activity of certain species of sponges belonging to the *Xestospongia* genus in the Colombian Caribbean* • Assessment of physical-chemical parameters of mangrove swamps in the Bay of Cartagena, 1997.		X			
Regional Autonomous Cooperation of the Del Dique Canal (CARDIQUE)	• Mangrove swamps and coastal areas	• Diagnosis and zoning of mangrove swamp areas in the Department of Bolívar • Plan for the management and environmental monitoring of coastal and harbour zones under the jurisdiction of CARDIQUE • Microbiological and physical-chemical study of the Bay of Cartagena		X		X	
Seismological Laboratory of the Southwest (OSSO) (Del Valle University)	• Tsunami warning and reporting system • Coastal dynamics • Analysis and processing of satellite images and SIGs • Modelling of impending threats • Vulnerability and risks	• Plan for the digital simulation of the generation, propagation and impact of tsunami waves (Tumaco, Pacific). 1997 • Development of the National Tsunami Detection and Warning System				X	

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
Chocó Technological University (Fishery Engineering Programme)	• Ecological and fishery research on fish of marketable or other fishery interest • Research on the effectiveness and selectivity of fishing skills and methods • Research on marine product technology (fishing) and the processing of marine products	• UTCH - Chocó Norte-NATURA Foundation Hydrobiological Resources Programme			X		
Special Administrative Unit of the National Nature Reserve System - Ministry of the Environment	• UAESPNN now receives proposals from different sources for the conduct of research in the protected areas. These proposals reflect the interests of the proposing institutions. Other research activities are linked with the management of areas of interest for conservation purposes. Lines of research of interest to UAESPNN are now being defined.	• Rearing of male fish for reproduction and experimental monitoring of the grouper (*Ephinephelus itjara*) in the Corales del Rosario PNN (see CEINER projects) • Assessment of the epifaunal communities of *Thalasia testudinum* prairies in the Tayrona PNN (UAESPNN) • Monitoring system for reef environments in Colombia and assessment of factors in the destruction of coral reefs COLCIENCIAS-INVEMAR. National University (1998-2000) • Study of the chemistry and anti-microbic, anti-inflammatory and cardiovascular activity of certain species of sponges belonging to the *Xestospongia* genus in the Colombian Caribbean. University of Cartagena, Faculty of Chemical and Pharmaceutical Sciences and National University, 1999-2001.		X	X	X	

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
Institute of Hydrology, Meteorology and Environmental Studies (IDEAM)	• Marine meteorology • Mareography • Coastal and soil geomorphology • Global change (ocean-atmosphere interaction) • Marine ecosystems	• Study of the El Niño regional phenomenon (national meteorology, follow-up and monitoring) • Ocean-atmosphere interchange of carbon dioxide • Analysis of marine processes and productivity with colour images of the ocean • Creation of an oceanographic database (1998-2000) • Geomorphological study of the Caribbean and Colombian Pacific coasts (1997-1998) • Mareographic forecasts (1998-2000) • Marine meteorological forecasts	X			X	X
Institute of Caribbean Studies - National University	• Coastal and marine biodiversity • Coral reefs, *Thalasia* prairies and Caribbean mangrove swamps • Integrated ecosystem management	• Assessment of biodiversity in the mangrove areas in San Andrés and Providencia in the Colombian Caribbean (PNN Old Providence McBeen Lagoon) (see projects of the Caribbean Studies Institute, National University)		X	X		
Jorge Tadeo Lozano University. Cartagena Section	• Marine environmental management	• Proposed methodology for environmental diagnosis of island areas as a basis for land-use planning. Case study: Archipelago of the Rosario Islands • Zoning of the Bay of Barbacoas Cartagena (Bolívar), Proposal for its environmental management				X	

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
Jorge Tadeo Lozano University. Cartagena Section		• Environmental management system for the industrial zone of Mamonal, Cartagena					
Ministry of the Environment - MINAMBIENTE	• Marine coastal biodiversity • Integrated ecosystem management	• Diagnosis and preliminary zoning of the mangrove swamps of the Colombian Pacific, 1997 • Conservation and sustainable use of the Colombian Caribbean mangrove swamps, 1998 • Main lines of a national policy for the integrated management of the CNA coastal zone, 1997		X		X	
National Planning Department	• Environmental indicators	• Studies of environmental indicators, marine coastal areas, and coastal zone integrated management (1997-2000) • Institutional survey of the extent of application of item 17 of Agenda 21				X	
Jorge T. Lozano University* - Faculty of Marine Sciences		• Growth, reproduction and survival after transplanting of the coral species *Montastrea annularis, Diploria labyrirthiformis* and *Porites astreoides* in the Rosario National Coral Reserve. COLCIENCIAS		X	X		

INSTITUTION	LINE OF RESEARCH	ACTIVITIES	INSTITUTIONAL RELATION TO GOOS[2] MODULE				
			PC	SO	RMV	PGC	S y P
Jorge T. Lozano University* - Faculty of Marine Sciences	• Research on marine ecosystems	• Growth & regeneration of *Acropora palmata, A. Cervicornis, Rhizophara mangle* & *Thalassia testudinum* & their relation with the oceanographic characteristics of the water & sediment in the Rosario National Coral Reserve, Marine Museum. COLCIENCIAS.					

The Colombian Oceanographic Commission (CCO) has been nominated as the Colombian National Oceanographic Data Centre (CNDO) to the Intergovernmental Oceanographic Commission (IOC). The CCO objective for 1999 is to consolidate and operate the GOOS System to the extent that the activities listed in this document are activities which are "related" but not linked to the System.

C. FRANCE

1. GENERAL OVERVIEW

During the last two years, French activities in relation to GOOS have been focused on the definition of a coherent development for operational oceanography, associating ocean modelling, ocean observation and ocean products. This covers not only the MERCATOR programme within the perspective of GODAE, but also the regular contribution to the already existing parts of the Initial GOOS observing system. Descriptions given below illustrate key points of these activities, with the ambition to illustrate the way French agencies are envisaging development of operational oceanography within the International GOOS framework.

2. TOWARDS GODAE

The perspective of the GODAE experiment, starting in 2003, is a structuring element for the development of operational oceanography in France. This associates an operational analysis and forecasting system, MERCATOR, to both space and *in situ* based observing systems, JASON and CORIOLIS. This effort, recognised at ministerial level, associates seven national agencies, CERFACS, CNES, CNRS, IFREMER, IRD, Météo-France, SHOM, in conjunction with some international partners. It is likely to be the core of the French contribution to GOOS in the coming years.

2.1 MERCATOR

MERCATOR is the major French contribution to GODAE, in addition to satellite remote-sensing and *in situ* observational programmes. The programme started formally in 1997 and is planned to reach its full implementation in 2003, in time to be a component of GODAE. The output will be a system for the simulation of the global ocean at high-resolution with primitive equations assimilating both satellite and *in situ* data. It will be useful to end users by:

- being fully operational;
- contributing to advanced seasonal forecasting using coupled ocean-atmosphere models;
- providing products for developing applications and services for defence and commercial needs;
- supporting the research community through, e.g., analyses and access to numerical modelling facilities.

MERCATOR is proposed to the international community as a GODAE Centre, ready to exchange experience and outputs with the other ones. It will contribute to inter comparison exercises, validation studies, exchange of modules, etc.

Six French institutions support MERCATOR: two research organizations, CNRS and IRD, two agencies responsible for developing observing systems, CNES for the space segment and IFREMER for the *in situ* oceanic systems, and two organizations interested in using oceanic products, Météo-France and SHOM (the French Navy). CERFACS (Centre Européen de Recherche et de Formation Avancée en Calcul Scientifique) is used as the focal point for the main software developments. MERCATOR is organized along two main streams:

- a global, medium resolution model and assimilation scheme, with particular attention being paid to its application to climate seasonal forecasting. This global approach is also of particular interest for scientific research, in support of global programmes such as WOCE and CLIVAR. It is developed in close relationship with ECMWF (European Centre for Medium Range Weather Forecasting);

- a regional high-resolution modelling and assimilation scheme for the North-Atlantic and the Mediterranean, aimed at serving all the needs related to mesoscale forecasting, as well as supporting the research dealing with oceanic processes. It is also proposed as a contribution to EuroGOOS, and is developed in close European collaboration, amongst others with the United Kingdom Meteorological Office.

Both streams are addressed with the same approach and similar tools for ocean modelling, coupling with the atmosphere, and data assimilation, using presently developed tools. The oceanic model OPA, developed by LODYC, has been chosen after careful intercomparison by the scientific community. It is coupled, when necessary, to an atmospheric model through a coupling developed by CERFACS (OASIS) and the first data assimilation will be through the optimal interpolation scheme developed by LEGOS (SOFA).

MERCATOR's feasibility phase has been successfully completed in mid-1998, and the prototyping phase is now underway, scheduled to be finished in the second half of 2000. The full-size system will be developed starting in late 2000 and delivered in time for the beginning of GODAE in 2003.

2.2 JASON

JASON, the successor of TOPEX/Poseidon is a CNES/NASA project, whose objective is the continuation of high accuracy measurement of mesoscale ocean circulation, by the use of its main instrument, the Poseidon-2 radar altimeter. The launch of Jason is expected for 18 May 2000.

2.3 CORIOLIS

The same six French institutions as for MERCATOR have started defining a strategy for observing the Atlantic Ocean, with a view to a contribution to global projects like *Argo*. This was the work of a group chaired by IFREMER, whose output is the CORIOLIS proposal.

It takes account of recent development in automatic instrumentation like the French profiler floats PROVOR (Fig. 1), to propose the implementation of long term near real-time observation of the internal state of the ocean aimed at catching climate signals at seasonal and decennal scales. This is especially tailored within the perspective of the development of forecasting systems based on global and regional models like MERCATOR. Therefore, the CORIOLIS proposal includes two main streams of actions.

Figure 1: 2 temperature PROVOR profilers on board LA THALASSA before launching. One profiler is linked to a reference CTD for metrological comparisons (photo S. Le Reste - IFREMER).

The first stream addresses the maintenance and development of activities led by French agencies in the Atlantic Ocean within existing or already developing programmes, mainly:

- contribution to PIRATA tropical mooring array, both in the development and in the operational phase;
- the continuation of operation of Atlantic XBT lines under the framework of SOOP;
- the maintenance and development of drifting and moored buoys programmes already implemented within the framework of DBCP

The second stream, which may be considered as the heart of the proposal is to deploy and maintain an operational network for the observation of temperature and salinity profiles within the Atlantic. It would include:

- some 500 profilers of the PROVOR type, deployed at an average of 5°x5°; to be considered as a contribution to the Argo project;
- some profiling stations of the EMMA type, based on the sea bottom, able to launch one expandable sonde per month.

CORIOLIS relies on a compromise between lagrangian and eulerian approaches for ocean observation. Part of it is a contribution to Argo, in relation to GODAE. Some of its elements, like EMMA, require some development and tests. Such an endeavour is considered as a typical example of what shall be GOOS in the Atlantic, requiring for implementation to establish new international cooperation schemes, mainly at regional scale (EuroGOOS), having in the mind the potential of existing frameworks, like DBCP and its action groups and SOOP.

3. IODE

The core of the French contribution to IODE is the NODC operated in Brest by IFREMER, collecting national oceanic data prior to exchanges with other IODE centres. It also includes participation to GTSPP and GODAR.

In 1997-1998 the Mediterranean Data Archaeology and Rescue (MEDAR) project, also supported by EEC, has been prepared and started for a duration of three years until 2001. It follows the pilot project MEDATLAS whose results have been published in 1997. It includes a temperature and salinity database and an hydrological atlas (Fig. 2), both made available on CD-ROM.

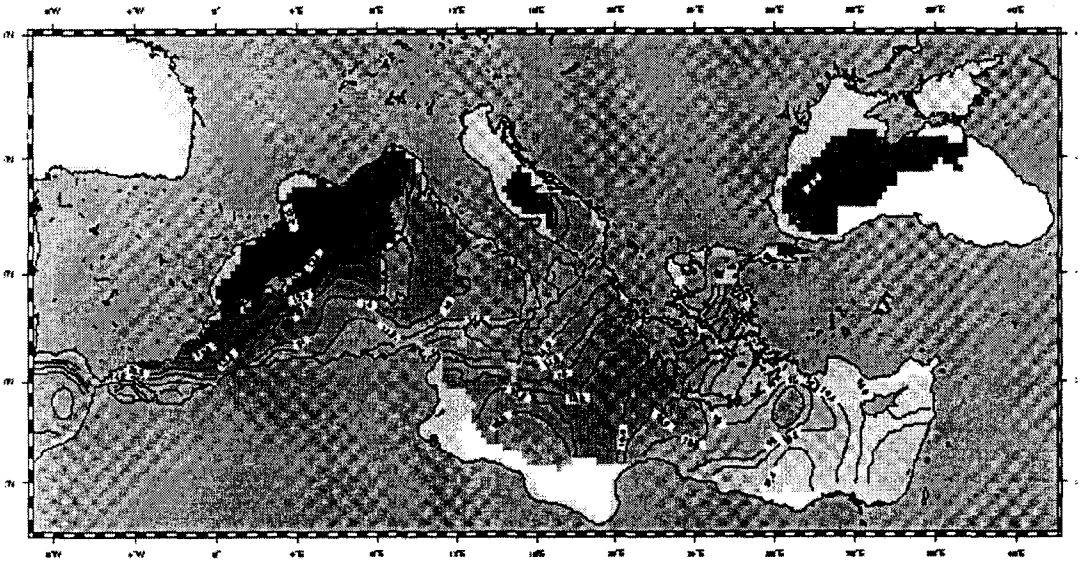


Figure 2: Climatological mean temperature in June at 100 dbar from de MEDATLAS Database. The computation was made by SHOM (D. Jourdan).

The new MEDAR project has been initiated by an IOC/IODE workshop held in Istanbul (Turkey) in 1997. In this workshop, the most important programmes in relation to data management in the Mediterranean area were reviewed, and needs for the future were identified, mainly with respect to operational oceanography. It was noted that all countries regularly acquire oceanic data from their EEZ, even in poor economic conditions. A work programme for three years has been established, with the specific goal to increase the availability of existing physico-chemical data and of some biological parameters and to publish an integrated database. MEDAR officially started in December 1998, in the frame of an European MAST/INCO concerted action, linked with the international GODAR programme, coordinated by IFREMER and involving 20 agencies from 17 countries.

4. GLOSS

The French contribution to GLOSS covers installation, operation and maintenance of 15 tide gauges at various locations in the World ocean. Presently 12 of these stations, listed in the table below are fully operational. This contribution is part of the scientific programme of CLIVAR and of the GOOS initial observing system. It is also a support to the present (TOPEX, ERS) and future (JASON, ENVISAT) altimetric satellite missions. It necessitates cooperation of seven national agencies.

Nr	Name	Ocean
242	Brest (France)	Atlantic
205	Marseille (France)	Mediterranean
17	Poinre des Galets (Réunion Is)	Indian
123	Nouméa (New Caledonia)	Pacific
202	Cayenne (French Guyana)	Atlantic
142	Nuku Hiva (Marquises Is)	Pacific
138	Rikitea (Gambier Isl)	Pacific
140	Matavaï (Tahiti)	Pacific
23	Kerguelen Is	South Indian
24	Amsterdam St Paul Is	South Indian
21	Crozet Is	South Indian
131	Dumont d'Urville	Antarctic

The most recent achievement to be noted is the completion of the network in the Southern Indian and Antarctic Oceans (Kerguelen, Crozet, Amsterdam islands and Terre Adélie) known as ROSAME. Data from these four stations are collected through ARGOS and transferred within 15 days to the Hawaii data centre after validation (Fig. 3). This is an important part of GLOSS in the sense it allows to monitor the circumpolar Antarctic current and contributes to the calibration of the satellites in the southern hemisphere. Its maintenance in hard environmental conditions has to be considered as a challenge.

Figure 3: the GLOSS tide gauge in Crozet island, showing the ARGOS antenna.

Campaigns to monitor the geodetic markers associated with these tide gauges using GPS are regularly undertaken. In addition, 6 of the operational stations have been equipped with permanent GPS or DORIS beacons, for continuous geodetic monitoring.

5. IGOSS

5.1 SOOP

France maintains an effort of oceanic monitoring relying on ships of opportunity (SOOP), under the framework of SOOPIP. Around 15 ships are equipped with XBT devices, operating primarily in the tropical Atlantic and in the Western Pacific. This programme is operated by IRD, with the support of NOAA for the provision of probes. Nearly 4000 profiles per year are collected in real time through the ARGOS system, the data being inserted into the GTS at the Toulouse hub. These data are transmitted to the data centres under the framework of GTSPP. The national effort related to XBT will be continued and technical developments are planned, mainly with a view to increase the efficiency of the telecommunication system, and to implement a performing on-line information system. All data are collected within the TOGA/COCE database located in Brest (Fig. 4).

A specific effort has been dedicated to the operation of 12 ships equipped with thermosalinographs for monitoring surface salinity. Data are presently collected in delayed mode, but real-time transmission is planned for the near future. This system is also managed by IRD.

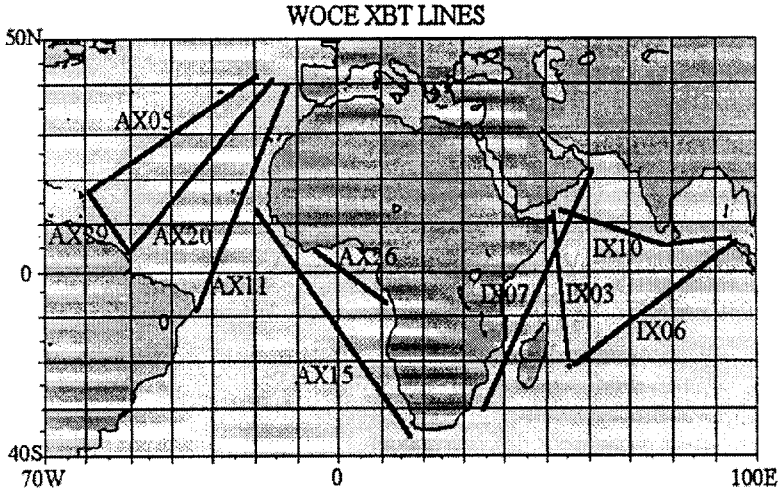


Figure 4: WOCE XBT lines operated under responsibility of IRD

5.2 SPECIAL OCEANIC CENTRE

A special oceanic data centre is operated by Météo-France in Toulouse within the framework of IGOSS. This centre archives all real time oceanic data available in real time on the GTS, mainly BATHY, TESSAC and BUOY messages. These data are made available to GTSPP. The centre is also responsible for the insertion into the GTS of data coming from the ARGOS processing centre in Toulouse. An information bulletin is published and distributed on a monthly basis (Fig. 5). An upgrade of the system is underway, aimed at better data quality control and an efficient access to the data by users.

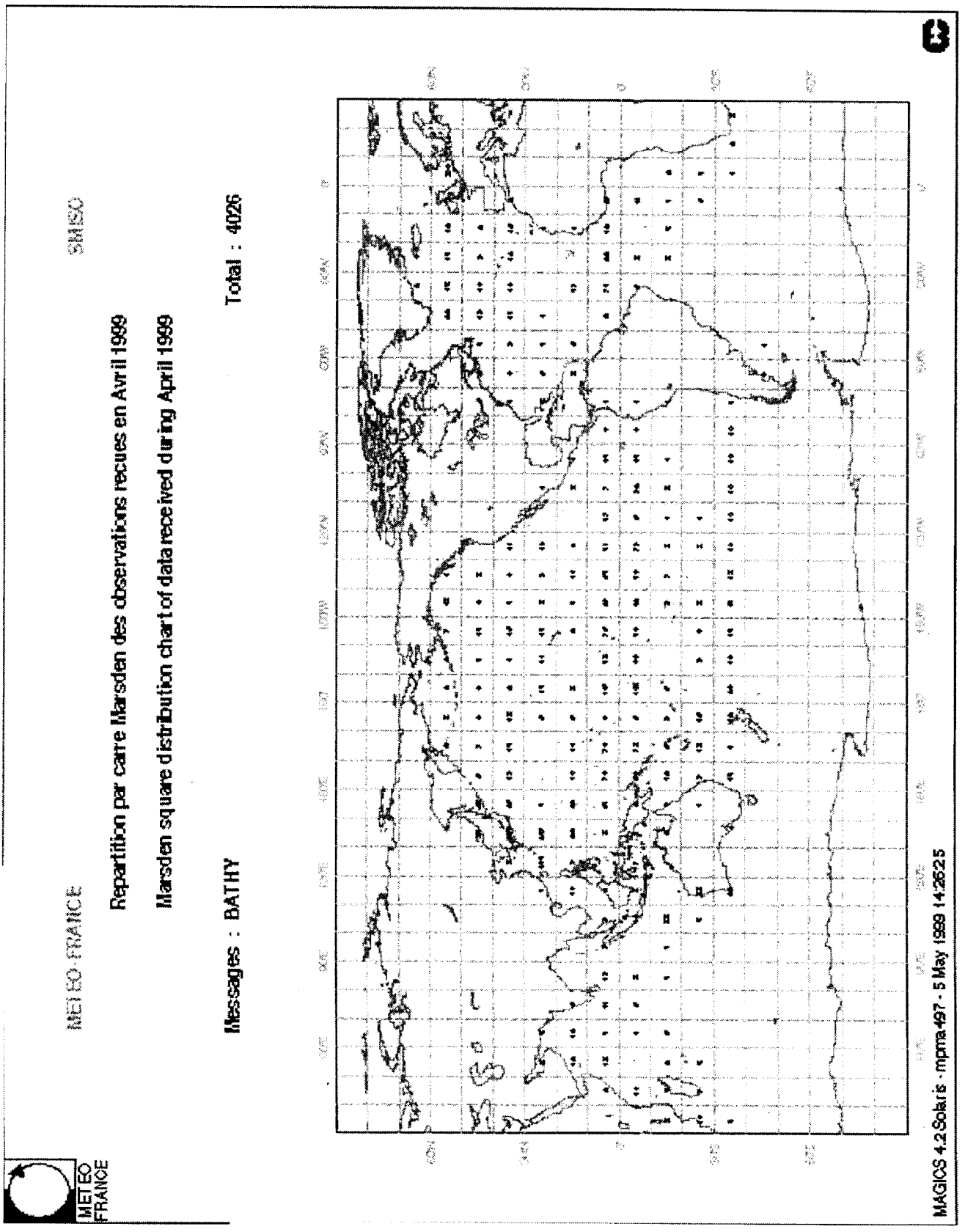


Figure 5: Map operationally produced and by the French SOC (Monthly availability of BATHY messages).

6. DBCP

6.1 GENERAL

France is active in the baseline DBCP activities, namely through the contribution of Météo-France to the action groups EGOS (European Group for Ocean Stations) and IBPIO (International Buoy Programme for the Indian Ocean, Fig. 6) and through the availability of the technical co-ordinator for DBCP, Etienne Charpentier.

An important achievement of the last period has been the extension of the network of fixed buoys, not only in European waters, but also off the French West Indies. Part of this achievement in the Bay of Biscay has come from a cooperation with the UK Meteorological Office.

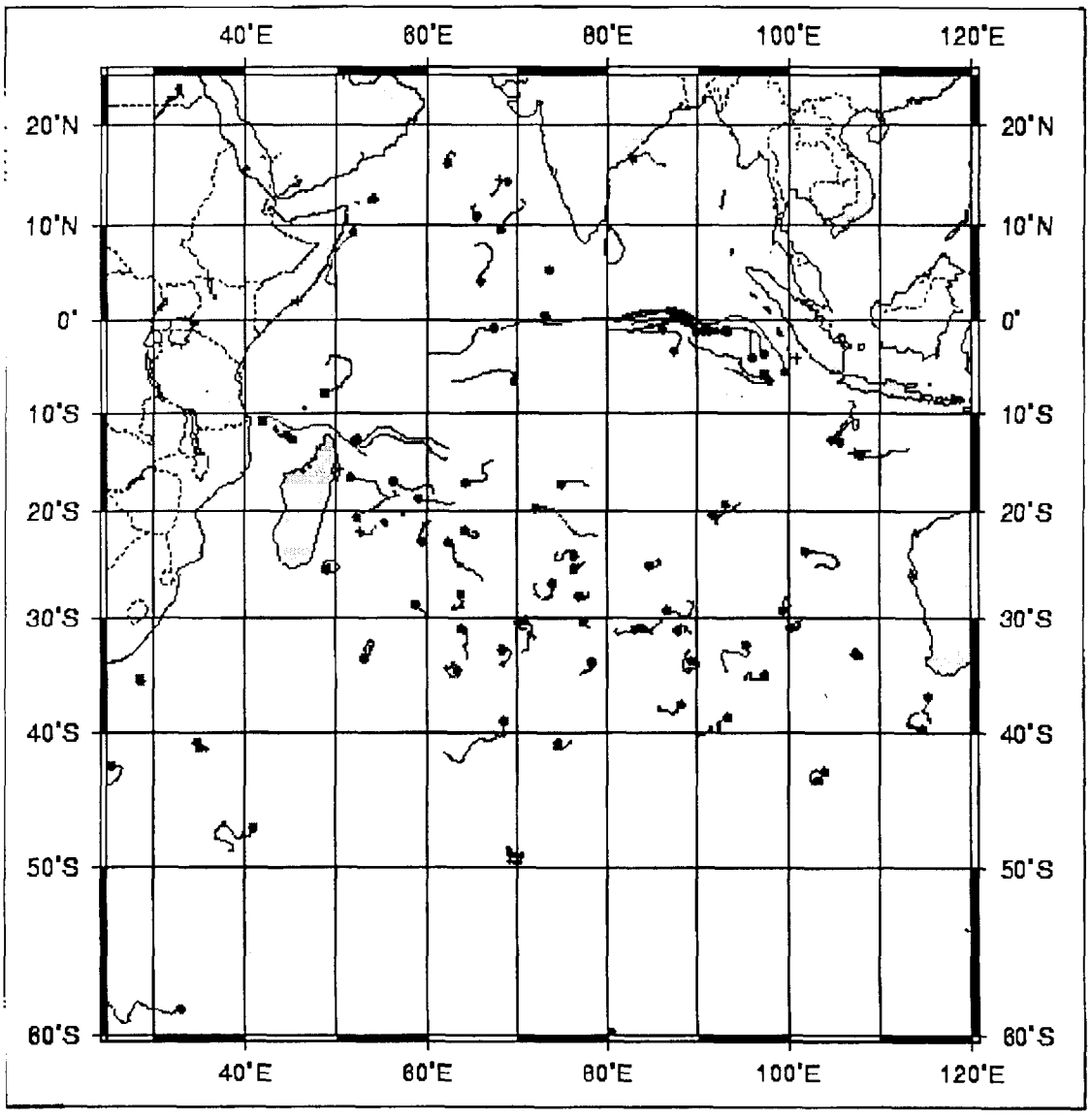


Figure 6: Plots of the IBPIO buoys, for April 1999

A contribution to the development of new measuring techniques from SVP-type drifters has also to be noted. This is especially the case for the "wotan" technique of wind measurement though ambient noise, which appears as a promising one with respect to observation of the surface wind field.

6.2 TAO

The TAO array is fundamental for the long-term monitoring, understanding and prediction of phenomena like El Niño and La Niña. The French contribution to the TAO array has therefore been active from the beginning of the project in 1985-1988, mainly through close cooperation between the IRD centre in New Caledonia and NOAA/PMEL. Unfortunately, the present contribution, due to unavailability of an adequate ship, is limited to the provision of thermosalinographs and to the maintenance of a few moorings. This has to be put in perspective with the intrinsic difficulties of the maintenance of an array of 70 moorings.

6.3 PIRATA

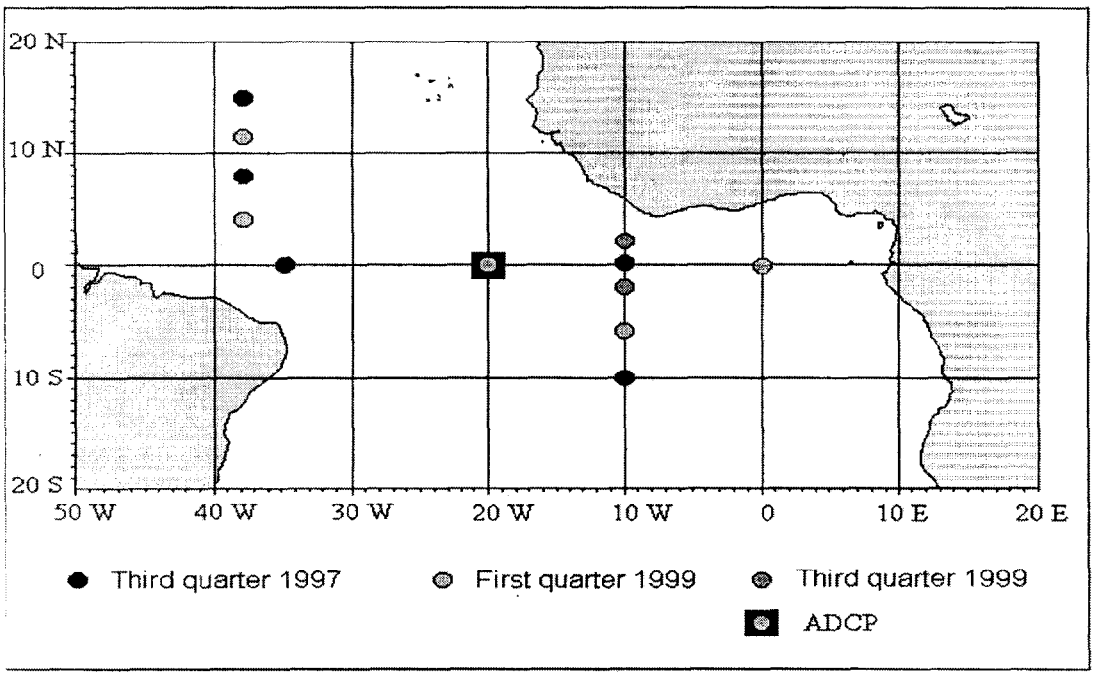


Figure 7: the PIRATA mooring array

The ambition of PIRATA (Pilot Research Project in the Tropical Atlantic) is to become in the long term the equivalent for the Atlantic of what TAO is for the Pacific: an operational system for the long-term observation of the tropical ocean based on an array of the same type of moored buoys (Fig. 7). The objective is to establish 12 moorings of the Atlas before mid 1999 and to operate them at least up to 2001.

France is one of the three contributors to PIRATA with Brazil and the USA. France finances 5 of the 20 Atlas buoys necessary to maintain the 12 moorings, and contributes to the maintenance of those moorings located in the western part of the Ocean. Jacques Servain (IRD) acts as Chairman of the PIRATA implementation panel. The French agencies involved in the project are IRD, CNRS and Météo-France.

7. WOCE

France has contributed to the experimental phase of WOCE, from 1990 to 1997, through its contribution to the TOPEX/POSEIDON satellite programme, in operating XBT lines in the Atlantic and Indian Oceans, and contributing to *in situ* campaigns in the South Atlantic, Indian and Antarctic Oceans. Now, we are in the phase of data interpretation and valorisation, from 1998 to 2002.

In this context, nearly 25 researchers in 8 laboratories are working on the following topics:

- Quantitative description of the variability and equilibrium of ocean circulation at regional scale (South Atlantic, Indian and Antarctic Oceans);

- Synthetic studies based on inverse modelling and on data assimilation. These studies, estimating the status

of ocean circulation in the Atlantic and Indian Oceans, will provide the reference state necessary for the study of climate variability foreseen under CLIVAR;

- Analysis of the results of the MOCA model of the south Atlantic, developed under the WOCE framework, and inter comparison with new high resolution models known as CLIPPER.

This has to be considered as having a clear relationship with the future developments and use of MERCATOR.

8. OTHER GOOS MODULES

IFREMER leads an important national effort aimed at operational monitoring of the quality of coastal waters. This effort, relevant to both Coastal and Health of the Ocean (HOTO) modules covers two main streams of activities:

- A national network for the surveillance of the quality of French coastal waters is operated. It addresses mainly the general quality of waters, chemical contamination, microbiology, toxic algae, etc. It includes three main systems, the RNO (Réseau National d'Observation) dedicated to general water quality, the REPHY (Réseau national de surveillance du Phytoplancton) for the toxic algae, and the REMI (Réseau de surveillance de Microbiologie) for microbiology. All data are now available in the QUADRIGE central archive including information backing to 1974 for some parameters.

- An action for automating the acquisition of data related to chemical composition and contamination of waters, either near the coast line or offshore. The core of this action is the development of the data acquisition platform MAREL which is now validated and available for an operational monitoring system, like the one established in the Seine estuary.

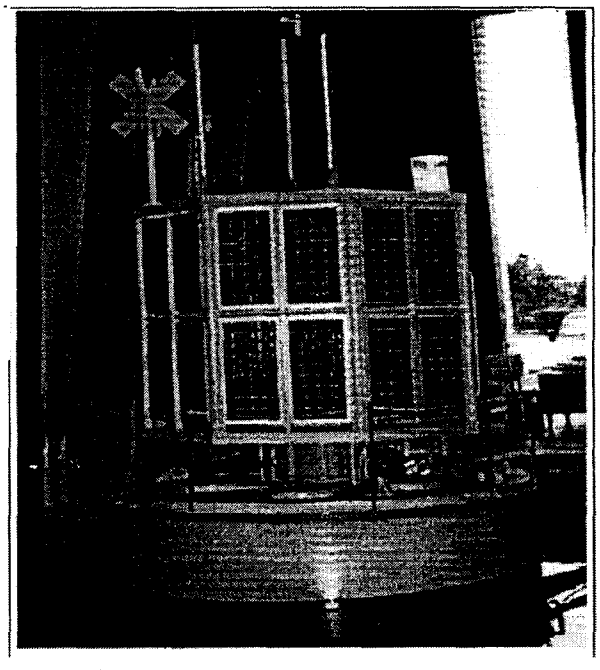


Figure 8: MAREL data acquisition platform on the test bed

The MAREL experimental network includes three offshore platforms and one coastal platform transmitting data in real time to a central data management station for validation, archive and dissemination -both electronic and paper information- to the users of the project. The core of the data stream addresses temperature, salinity, oxygen, pH, turbidity, nitrates and chlorophyll. It is completed by meteorological and ocean dynamic information (wind, temperature, current, sea and swell, etc.).

Other monitoring systems might be implemented in the near future in other sea areas like the Gulf of

Lion, in the Mediterranean. More information on these coastal activities may be found on the Web site of IFREMER (www.ifremer.fr).

9. REGIONAL ACTIVITIES

During the last two years, specific attention has been given to regional activities in relation to GOOS, namely EuroGOOS, MedGOOS and the PacificGOOS.

Three French agencies are now Member of EuroGOOS, IFREMER, Météo-France and CERFACS. IFREMER acts as the national representative and CERFACS is the host agency for the MERCATOR Programme.

10. CONTACT POINTS

The French contact points for the various items described above are listed below:

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D. GERMANY

(Bundersamt für Seeschiffahrt und Hydrographie)

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E. INDIA

(Department of Ocean Development, Government of India)

1. INTRODUCTION

India has presented national reports on GOOS related activities during the I, II and III Session of I-GOOS. Those reports described in detail the operational and research programmemes in oceanography with a key role played by the Department of Ocean Development and implemented collectively by various national laboratories, like National Institute of Oceanography, National Institute of Ocean Technology and other institutes/organisations under CSIR, Dept. of Space, Indian Council for Agricultural Research, Department of Science & Technology, etc. and with two ships, Oceanographic Research Vessel Sagar Kanya and Fisheries Ocean Research Vessel Sagar Sampada.

The Department of Ocean Development has established Indian National Centre for Ocean Information Services (INCOIS) at Hyderabad to provide Coastal and Ocean Information. Remotely sensed data from satellites, conventional data from ships buoys and surveys would be utilized to generate ocean parameters and coastal zone data products to disseminate to operational users like fisheries ports, shipping, weather and climate research. In addition fifteen National Marine Data Centres have been Identified by the Department, who are the sources for collecting Ocean Information, archiving, and dissemination, and this data would be utilized by INCOIS to generate data products as required by the user community.

The programmes initiated and carried out by various National organizations are recapitulated below. The activities and progress made have been reported in brief.

(i) **Marine Satellite Information Service (MARSIS)** implemented since 1991; data products such as sea-surface temperature, potential fishing zone forecast, mapping of coral reefs and mangroves, shore-line changes, etc. have been generated and disseminated to end users and the programme has concluded successfully. The objectives and scope of MARSIS have been enlarged and are undertaken as separate programmes in the scope of Ocean Observation and Information Services.

(ii) **Sea-Level Monitoring and Modelling (SELMAM)** is under implementation since 1992. The Sea Level Monitoring project envisages assessment of variations in the sea level due to climatic and other factors and impact of such variations on the Indian coastal belt. Under this project, 8 modern tide gauge stations have been established at Mumbai, Porbander, Goa, Kochi, Chennai, Visakhapatnam, Paradip and Kavaratti and two more tide gauges will be deployed at Machilipatnam and Tuticorin. The National Tide Data Centre at Survey of India, Dehradun, has analysed the data generated and developed a numerical model to simulate ocean circulation in the North Indian Ocean. Fine scale mapping of a segment of the Indian coast has been carried out.

(iii) **Coastal Ocean Monitoring and Prediction System (COMAPS)** is going on since 1990 and the health of coastal waters is monitored. Investigations relating to assessment of pollution through collection of data are undertaken. About 25 parameters at selected locations along the Indian coast are being monitored and analysed. About 13 National Research Institutions are involved in the monitoring programme.

(iv) **Joint Global Ocean Flux Studies (JGOFS India)** is going on since 1993 and the studies in the Arabian Sea are completed. The data collected were analysed to estimate the Carbon flux in the Arabian Sea and the findings were discussed in the International Seminar. The Arabian Sea has been identified as a source for atmospheric carbon dioxide. Similar studies are planned for the Bay of Bengal.

(v) **National Ocean Information System (NOIS)** for collection, archival, processing and dissemination of ocean parameters to end-users was initiated in 1993. The NOIS programme has been strengthened by identifying 15 National Marine Data Centres (NMDCs). Indian National Center for Ocean Information

Services has been setup and the 15 NMDCs provide Ocean parameters information for utilization in project studies.

(vi) **Drifting Buoy Programme** for collection of *in situ*, real-time data on sea-surface temperature and wind pressure for validating data derived from satellite is continuing. About 48 drifting buoys are planned to be deployed. The data are being used for forecast studies.

(vii) **Survey of Living Resources** to collect oceanographic data and relate it to the abundance and dynamics of living resources is continuing. The multi Institutional programme aims at assessing resources beyond 70-meter water depth in the EEZ and estimating potential of resources for sustainable development. Ten cruises have been undertaken by FORV Sagara Sampada for the projects on marine living resources during last year.

(viii) **Under the TOGA Programme, XBT** observations in the seas around India were carried out using ships of opportunity on the Madras-Andaman and Calcutta-Andaman routes to study the thermal structure of the equatorial Indian Ocean. During 1997-99 a total of 25 cruises were undertaken in the North Indian Ocean, of which 6 were in the Arabian Sea and 19 were in the Bay of Bengal, to collect XBT data. The inter-annual variability has been confirmed and compared with two other data sets. XBT data of all cruises including TOGA data collected during April have been processed, quality controlled and formatted into TOGA format.

(ix) **RNODC** at NIO Goa is in operation.

2. NEW PROGRAMMES PROPOSED FOR IMPLEMENTATION

During the next three years the following projects relating to GOOS would be implemented which have been initiated under the Five-Year Plan of India.

2.1 OCEAN OBSERVATION AND INFORMATION SERVICE (OOIS)

In addition to implementation of the basic research programmes, India launched several national programmes as described in the introductory part of this report. The objectives of the programmes were primarily to identify and provide information to coastal fishermen, ports and coastal industries, coastal zone management authorities, etc. These programmes have received positive responses from the user community. In order to boost the ocean services further, the Department of Ocean Development has formulated an integrated Programme "Ocean Observation and Information Service (OOIS)" for implementation through 1997-2002 coinciding with India's IX Five-Year Plan. The OOIS consists of four major components viz.

(i) Ocean Information Services (OIS);
(ii) Ocean Observation System;
(iii) Satellite Oceanography; and
(iv) Ocean Dynamics and Modelling.

All these would be implemented utilizing the expertise at national institutes, the leading among them being National Institute of Oceanography, Goa; Space Application Centre, Dept. of Space, Ahmedabad; Centre for Mathematical Modelling and Computer simulation (CSIR), Bangalore; National Institute of Ocean technology, Chennai; and Indian National Centre for Ocean Information Services (Dept. of Ocean Development), Hyderabad.

2.1.1 Ocean Observation System (OOS)

This programme is primarily designed for generation of Oceanographic and Meteorological data from the seas around India. The OOS envisages deployment of moored data buoys, drifting buoy, current meter array-moorings, XBT/SCTD at selected tracks with a view to generate in-situ data with reasonably good spatial and temporal coverage. One of the major components already launched under the scheme is National Met-

Ocean Data buoy operations. The National Met-Ocean Data Buoy system envisages to acquire long-term data on surface Meteorological and Oceanographic parameters from the coastal and deep waters of the Arabian Sea, Bay of Bengal and Indian Ocean with a view to improve short and long term weather forecasts and for application in the developmental activities in coastal and ocean sectors.

A set of twelve (12) moored met-ocean data buoys has been deployed in the seas around India. Eight will be moored in the coastal waters and 4 in the offshore waters. All the buoys are equipped with the state-of-the-art sensors for the measurement of various meteorological and oceanographic parameters *viz.* Wind, atmospheric temperature, atmospheric pressure, waves, sea surface temperature, salinity and currents. In addition, 4 buoys deployed near four major ports of India are equipped with water quality sensors to measure chlorophyll, radioactivity, turbidity, hydrocarbons, nutrient and dissolved oxygen. The project is proposed to be implemented over a period of 3 years, by 1999, and would continue to be in operation further. The data were provided to Indian Meteorological Department (IMD) and Institutions involved in ocean modelling. It is envisaged to deploy 10 more buoys to cater to the needs of IMD and Indian Climate Research Programme.

2.1.2 Ocean Modelling and Dynamics (OMD)

In order to exploit the ocean resources in a sustainable way and make use of the benefits cost effectively, it is important to understand the dynamics of the Oceanographic and Meteorological processes of the Northern Indian Ocean. Although, the general large scale oceanographic processes in the north Indian Ocean are well known, the seasonal and inter-annual variations in relation to climate change are relatively less understood partly due to lack of basin scale ocean-atmosphere coupled models and partly due to paucity of data. Knowledge on ocean dynamic processes is an essential prerequisite for prediction of Ocean State which can be accomplished through generation of a wide range of ocean models. Further, the fundamental requirements for ocean state forecasts are time-series oceanographic observations and numerical large-scale ocean models. The data generated under OOS would be utilised for the ocean modelling as complementary to the Data Buoy programme and used for developing ocean state forecasts and other models. The programme is also to develop a Basin Scale dynamical and biological coupled model (OGCM), Air-Sea-Land interaction and coupled models, intermediate coupled models, and a coastal circulation model. These models are expected to forecast currents, monthly and mean temperature, salinity and tidal circulation in the short term, and inter-annual and decadal variability in the long run. The programmes on climate variabilities in the tropics was one of the significant experiments conducted wherein the inter-annual variabilities of:

(i) SST and winds;
(ii) Mean surface winds with climatological annual cycles of SST;
(iii) Mean surface winds with SST variability, in summer months and winter months, were conducted.

Large scale Indian Ocean modelling has been carried-out for sea surface heights. The largest amplitudes associated with the monsoons were well recognized. Strong signals, which are annual cycles, were found as expected in the Somali region. A larger period signal of 1095 days in the South Indian Ocean, and also a semi-annual signal over most of the Indian Ocean with predominance in Southern Arabian Sea, were recognised. Particle transport in the North Indian Ocean was studied. The particles introduced in the Southern Arabian Sea are transported to the Northern Arabian Sea and Bay of Bengal. But significantly many particles do not get transported even after a 3-year period. A downward motion is noticed up to depths, of 300m, signifying no lateral mixing.

Ecosystem modelling was attempted and tested with CZCS data and JGOFS cruise data. Simulations were carried-out by varying grazing rate, mixing coefficient, detritus sinking velocity, up welling velocity, photosynthetically active radiation and sub surface nitrate concentration. Models describing the complete food Webfor primary production to Fishery potential are being studied. Simple models of the marine ecosystem are under progress to understand non-linear dynamic behaviour and also to study the vertical structure of the marine ecosystem and coupling of biological models with physical oceanographic models.

2.1.3 R&D in Satellite Oceanography

The programme is designed to develop regional algorithms for retrieval of oceanic data from satellite sensors, and simulation models to undertake data assimilation studies. It is also includes campaigns to validate the satellite sensors and also to define further satellite sensor requirements. The programme envisaged development for the Oceansat-1 of India, wherein the Ocean colour monitor (OCM) and multi-frequency scanning microwave radiometer (MSMR) are being flown.

The principal tasks	
for **OCM**	For **MSMR**
(i) Development of atmospheric corrections and retrieval of oceanic parameters and validation;	(i) Sea State;
(ii) Ocean colour application;	(ii) Atmospheric numerical prediction;
(iii) Coastal processes.	(iii) Sea ice mapping;
	(iv) Validation and inter comparison.

In addition fifteen national Marine Data Centres work in close liaison with the Indian National Centre for Ocean Information Services. These are institutions which are engaged in data collection and associated R&D in the fields of bathymetry, topographic surveys, fisheries, ocean & meteorology sciences, drugs from the sea and coastal processes. The concept is to update the existing databases, computerize systematically, adopting internationally accepted formats, and utilize the date for project execution and product development. Provision of information to users effecting transfer of data through dedicated networks is planned.

In addition to this, there is implementation of the programmes relating to the International Biosphere-Geosphere Programme (IGBP), Joint Global Ocean Flux Study (JGOFS-India), and Land Ocean Interaction in the Coastal Zone Study. The Indian component of JGOFS was launched in 1993, to assess the carbon flux in the Arabian Sea and to determine whether the Arabian Sea acts as a source of sink for atmospheric Carbon dioxide through bio-geo-chemical studies.

2.1.4 Ocean Information Services

OIS is a service-oriented programme aimed at generation and dissemination of ocean data products on an operational basis. A separate and dedicated Centre called the Indian National Centre for Ocean Information Service (INCOIS) has been established in February 1999 at Hyderabad in Central India. It will be an operational Centre equipped with computing facilities and supporting infrastructure and human resources for generating and marketing user oriented coastal and ocean data products like Sea Surface Temperature (SST), Potential Fishing Zone (PFZ) information, coastal maps on coral reef, mangroves, wetlands, shallow bathymetry maps, oceanic eddies and upwellings, wave heights and wave directional spectrum, surface winds, ship routings, etc. The Centre will work on close lines with the National Institute of Oceanography, National Institute of Ocean Technology, National Data Buoy Programme, Department of Space and other leading institutions in India. INCOIS will continuously interact with user organisations like fisheries, ports, meteorology, coastal industries, coastal zone authorities etc., for improving the format and specifications of data products. INCOIS would also issue experimental Ocean State Forecast on the lines of atmospheric weather bulletins for the benefit of agencies involved in fishing, navigation, offshore works, ports, advance warning, and search and rescue operations. The forecast is to aim at predictions 3 to 5 days in advance covering ocean state like waves, winds, surface currents, eddies, SST, etc.

The following Data products are envisaged:

2.1.4.1 Sea surface Temperatures derived from NOAA-AVHRR.

The North Indian Ocean is covered by the NOAA meteorological satellite everyday. The spatial resolution is 1.1. Km. Daily data is processed and weekly averaged SST data would be made available to users.

Data products: Daily – image data, in colour coded print and digital data form.
Weekly averaged SST:

(i) Colour coded image, digital data, contour map at full resolution of 1.1 Km pixel information;
(ii) 15' X 15' Grid averages of a week;
(iii) 0.5° X 0.5° or 1° X 1° and any other grid size as specified by user, for weekly averaged data-digital/maps;
(iv) Monthly means at 1° X 1° or as specified by the user digital/maps;
(v) Special products: Enhanced images of weekly averaged SSTs for studying the surface oceanic circulation.

The SST derived from NOAA-AVHRR are validated using ship & data buoy observations and the RMS deviation is found to be 0.8°C.

To users engaged in the following studies:
(i) Input to weather forecasting models;
(ii) Monitoring of eddies, gyres, oceanic fronts and upwelling zones;
(iii) Studies related to ocean circulation;
(iv) Air-Sea interaction, climate and heat budget studies.

Data Medium:
(i) On line access to data base;
(ii) Paper prints (Image & Data);
(iii) Digital products on Floppies, CCTs and CDs.

2.1.4.2 Potential Fishing Zones maps (PFZ):

The SST information generated is utilised for identifying the potential fishing zone information. Eleven sectors information is generated covering all the maritime states including island regions.

The temperature gradient information signifying zones of upwelling, eddies and cold/warm water fronts is transferred on to hydrographic maps for the use by Fishermen. SST annual range is from 21° - 32° C in coastal waters.

Data products of PFZ are:
(i) Maps;
(ii) Description of PFZ occurrence in terms of distance and direction from a Fishing Harbour and water depth prevailing at that place.

The above are routinely made available to about 170 locations. The PFZ width at Sea is about 5 Km. and the positional accuracy of delineation is about 3 Km.

Data products medium and mode of transmission:
(i) Maps - FAX;
(ii) Information – telegraphic/telephone.

Time: near real-time: Twice a week with a validity period of 4 to 5 days.

2.1.4.3 OCEANSAT: 350m resolution : two day repetivity.

Ocean Sat products (envisaged).

Parameters derived from Ocean Colour Monitor:
(i) Chlorophyll & gelbstoff;
(ii) Suspended sediment;
(iii) Coastal surface circulation;
(iv) Aerosols;
(v) Coastal zone maps/information.

Ocean colour monitor data could be utilized for the following studies:

(i) Ocean colour application;
(ii) Potential Fishing Zone;
(iii) Primary production estimates and fishery stocks,
(iv) Algal blooms;
(v) Coastal sediment dynamics;
(vi) Estuary studies;
(vii) Circulation patterns;
(viii) Oil slick identification.

2.1.4.4 From multi frequency scanning microwave radiometer: The following parameters are derived to be used as inputs to various studies related to Oceanography and Meteorology.

SST	**Water vapour**	**Sea Surface wind**	**Cloud liquid water**
150 X 146 Km	50 X 36 Km	75 X 75 Km	50 X 36 Km
Resolution	0.3 gm/cm2	1.7 m/s accuracy	3.5 mg/cm2
1.6 K	0.9 to 7.6 gm/cm2	0-20 m/s range	0 - 10 mg/cm2

2.2. INTEGRATED COASTAL AND MARINE AREA MANAGEMENT (ICMAM)

The Agenda 21 adopted in UNCED (1992) emphasises the need to adopt the concept of Integrated Coastal Marine Area Management (ICMAM) for sustainable utilisation of coastal and marine resources and prevention of degradation of the marine environment. This is best achieved through integration of activities prevalent in the land, coastal and marine areas. The Department of Ocean Development is the Nodal Department in the Government of India, to oversee the implementation of Chapter 17 of Agenda 21 dealing with Oceans, Seas, semi-enclosed Water bodies and Estuaries.

The DOD has set up a project Directorate office and infrastructure for development and capacity building activities at Chennai, on the East coast of India.

A number of coastal establishments like ports, harbours and activities like waste disposal prevalent in the coastal areas have impact in local and neighbouring areas. The data collected under the COMAPS Programme and information from other sources indicate degradation of coastal and marine environments in a few areas and beginning of the same at a number of other locations. These locations include certain critical habitats. In order to prevent further degradation of coastal and marine environments and habitats, India has proposed to introduce the concept of ICMAM. The Department of Ocean Development and Ministry of Environment & Forests (MEF) have been considering the development of a suitable notification like Ocean Regulation Zone (ORZ) wherein a provision to give a legal framework to adopt the concept ICMAM is proposed to be incorporated.

The department has taken up an infrastructure development and capacity building programme to facilitate adoption of the concept of ICMAM in the coming years. The programme focuses on development of expertise in ICMAM oriented activities and dissemination of knowledge gained to the users like coastal States through organised training programmes. Towards accomplishing these objectives, the following priority activities are being undertaken:

2.2.1 Capacity building

This component is funded by the World Bank in the form of a International Development Association (IDA) credit under the project "Environment Management Capacity Building" which is coordinated by the Ministry of Environment and Forests. The capacity building activities are being carried out in the following areas:

- Development of GIS based information system for critical habitats containing all information necessary to prepare management plans;

- Determination of waste load allocation based on waste assimilation characteristics of selected locations (Tapi estuary, Ennore creek and coastal waters);
- Development of EIA guidelines for major coastal developmental activities and processes;
- Development of model ICMAM plans for Chennai, Goa and Gulf of Kutch.

2.2.2 The details of activities carried out during the year 1998-99 under the above projects are given below:

2.2.1.1 Development of GIS based information system for critical habitats:

A major activity envisaged under the project includes demonstration of use of GIS as a Decision Support System (DSS) in the management of critical habitats like mangroves, coral reels, areas rich in bio-diversity, etc. The tasks involved are collection of data and information on the 11 critical habitats.

2.2.1.2 Determination of Water Assimilation capacity in Ennore Creek and Coastal waters and Tapi estuary:

In order to take measures for control of marine pollution from land based activities, it is necessary to know the information relating to the assimilation capacity of coastal waters. This will help in deciding the amount of pollutants that could be permitted to be discharged in the coastal waters. In order to apply this concept in pollution control measures in India, a capacity building exercise on Determination of Waste Assimilation Capacity (WAC) is proposed to be undertaken. The task of Determination of WAC will be carried out for Tapi estuary and Ennore creek and coastal waters as model areas. Such a task is being attempted for the first time.

2.2.1.3 Development of guidelines for Environmental Impact Assessment for coastal projects:

Under this project, it is proposed to develop guidelines for conducting EIA studies for coastal related activities like construction of ports, harbours and breakwaters, waste disposal from domestic and industrial wastes, marine transportation and coastal tourism. The guidelines will bring out in detail the various tasks which will have to be performed by the project proponents. NIOT which has expertize in the areas of construction of ports and harbours has already initiated the task relating to development of Environmental Impact Assessment guidelines for this sector. Based on the outcome, guidelines for other sectors will be developed.

2.2.1.4 Preparation of Model Integrated Coastal and Marine Area Management Plans for Chennai, Goa and gulf of Kutch :

In order to introduce the concept of ICMAM plan in India, it is necessary to have expertise in various aspects relating to development of ICMAM Plans. These aspects include application of modern tools and techniques like computer based modelling that predict the impact of various inter-related activities occurring in the coastal areas.

2.2.1.5 Infrastructure, Training, R&D and Survey:

Under this component, infrastructure facilities are created to house a long term training programme for utilising the capacity built under the Capacity building programme. The training will be provided to the coastal States in the development of ICMAM Plans and use of GIS in the management of critical habitats. R&D activities like determination of Use Classification for coastal waters and limits of acceptable changes in critical habitats like mangroves, lagoons, etc., are a part of the prerequisite needed for adoption of ICMAM, and are also being carried out.

2.3 OCEANSAT

The Oceansat-1 spacecraft was launched successfully on 26 May 1999 by the Polar orbiting Satellite Launch Vehicle (PSLV)-C2, carrying payloads primarily for oceanographic applications. The satellite was launched into a polar, sun-synchronous orbit at an altitude of 727 km. The satellite has a repetivity of 2 days.

The Oceansat-1 consists of Ocean Colour Monitor (OCM) and Multi-frequency Scanner Microwave Radiometer (MSMR) payloads and also has a solid state memory for recording data outside the visibility region of the ground station. These payloads are useful for studies of ocean colour/chlorophyll and sea-surface temperature, atmospheric water vapour and surface temperature even during cloudy conditions. All the sensors are working and the data is being received regularly. Following Oceansat-1, India is also planning to launch Occansat-II with major ocean payloads: *viz*, OCM, Scatterometer, altimeter and Thermal Infrared Radiometer.

2.3.1 Ocean Colour Monitor

The OCM will have eight spectral bands in the visible and near infra-red (VNIR) region. The data collected by this sensor will be optimum for quantitative estimation of the chlorophyll concentration.

The resolution of the OCM in VNIR bands will be 360m x 236m. With this resolution, it is expected to get better information on chlorophyll distribution in the coastal water.

High radiometric sensitivity and dynamic range are required to measure the reflectance, varying from 0.7 to 7% from the ocean surface. The bands 0.545-0.565, 0.660-0.680, 0.745-0.785 and 0.845-0.885 microns will have a dynamic range covering 100% solar reflectance, thus making it suitable for land, including snow and cloud studies. Table-1 gives the other specifications of OCM.

TABLE 1

OCM		MSMR	
Spectral bands (in nanometres)	1. 402-422 2. 433-453 3. 480-500 4. 500-520 5. 545-565 6. 660-680 7. 745-785 8. 845-885	Frequencies	6.6 GHz 10.65 GHz, 18.7 GHz and 21.3 GHz
Spatial resolution	360m X 236m	Polarisation	V&H for all frequencies
Field of view	+/- 43°	Spatial resolution	120, 75, 45 &40 km respectively
Swath	1420 km	Swath	1420 km
Digitisation	12 bits	Digitisation	12 bits
Along track steering to avoid sun glint	+/- 20° in steps of 5°		

Multi-Frequency Scanning Microwave Radiometer:

Many geophysical parameters such as sea surface temperature (SST) wind speed over oceans, total precipitable water in the atmosphere etc., strongly influence the black body radiation from the earth's surface. It is therefore possible to estimate a number of such parameters by passive microwave radiometers. Microwave measurements have the additional advantage of all weather capacity.

Since the microwave emission characteristics are different at different frequencies and polarisation, multi-frequency, dual polarised radiometer system has been conceived to retrieve the required geophysical parameters. The radiometer will be operated in four frequencies namely 6.6 GHz, 10.65 GHz, 18.7 GHz and 21.3 GHz. The system has been configured with conical scanning mechanism in order to collect data at a constant incident angle of 50°, over the total swath.

The parameters derived would be used for studies related to forecasting of weather and modelling of atmosphere and oceans.

2.4. INDIA'S COMMITTMENT TO AND INVESTMENT IN GOOS

India is implementing and has proposals to implement several programmes relating to GOOS. By virtue of these, GOOS stands already established in India. The Government has already spent large amount of funds and has committed to spend more on these programmes. One of the most useful Ocean Observing Programmes is the National Met-Ocean Data buoy programme for which alone the committed funds are Rs.370 million. India has budgeted to spend about Rs.1000 million on Ocean Observation and Information Services (OOIS) for the next 5 years.

F. JAPAN

1. INTRODUCTION

Japan has established repeated hydrographic sections in the adjacent seas and in the western North Pacific Ocean since 1960's and will utilize the recent world impetus to maintain and enhance the existing ocean observing system. For the development of the GOOS, Japan recognizes the importance of establishing an interactive scheme among basic research, technology development and operational programmes.

In Japan, several ministries and governmental agencies are taking part in GOOS and conducting related activities. The Ministry of Education, Science and Culture, and the Science and Technology Agency have been supporting basic studies and technology development to establish GOOS. Various operational activities have been carried out by Governmental Agencies, Prefectural Governments, and universities. The Japan Meteorological Agency has been in charge of oceanographic observations with initiatives in IGOSS and GLOSS, and recently established its El Niño Monitoring and Prediction Center. The Hydrographic Department, Japan Maritime Safety Agency, is operating the Japan Oceanographic Data Center of IODE, and conducting oceanographic observations and marine pollution monitoring. The Japan Fisheries Agency is responsible for living resources and for related marine environmental issues, while making remarkable contributions to monitoring of the coastal zone and the ocean.

The Environment Agency has been carrying out pollution monitoring in the coastal zone and adjacent seas of Japan. The Ministry of Posts and Telecommunications has been observing rainfall, oil pollution, and offshore currents by using satellites, and airborne and coastal radars. The Ministry of Construction has been conducting various researches on sea level rise and its socio-economic impact from the view point of coastal zone conservation.

It should be stressed that Japan has been actively participating in training, education and mutual assistance (TEMA), and technology transfer in marine sciences and services within the framework of IOC/WESTPAC, and *via* various international and bilateral cooperation programmes. Japan provides the opportunities for scientists and technicians in the WESTPAC region to participate in the training course on NEAR-GOOS data management.

This report, prepared by the Liaison Conference on GOOS of the Inter-Ministries and Agencies, describes the Japanese GOOS activities in 1999.

2. THE NATIONAL MECHANISM FOR DEVELOPMENT OF GOOS

The National Committee for IOC, the National Commission for UNESCO of Japan, is the focal point of the IOC activities as a whole for national and international co-ordination. The official correspondence and international co-ordination with the IOC Secretariat regarding GOOS have been done under the responsibility of the Committee. The Committee has established the NEAR-GOOS Working Group of the Inter-Ministries and Agencies for development of the implementation plan of the North-East Asian Regional GOOS, in the Japan Sea, East China Sea and Yellow Sea.

The Liaison Conference on GOOS of the Inter-Ministries and Agencies provides a forum among the governmental GOOS members for the further co-ordination of GOOS-related activities. The Sub-committee for GOOS, the National Committee for SCOR of the Japan Science Congress, is co-ordinating the scientific aspects of GOOS.

NEAR-GOOS came into its operational phase on 1 October 1996, as a result of Resolution of WESTPAC-III in February/March 1996 according to the Operational Manual adopted by the First NEAR-GOOS Co-ordinating Committee in September 1996. The manual is published by IOC and the Japan Oceanographic Data Center in English and by the Japan Meteorological Agency in Japanese.

The Japan Science Congress established the GOOS Sub-committee within the National Committee for SCOR, to investigate a long-term observational system for the ocean. In March 1997, the Sub-Committee published a report, 93 pages in Japanese, to propose a system based on the Report of OOSDP.

3. PARTICIPATION OF THE GOVERNMENTAL ORGANIZATIONS IN PLANNING, DEVELOPMENT AND IMPLEMENTATION OF GOOS

3.1 SCIENCE AND TECHNOLOGY AGENCY (STA)

STA is the co-ordinating agency for ocean research and development, and has participated in the existing international ocean research programmes by funding the institutions. Furthermore, STA has directly supervised, and funded the Japan Marine Science and Technology Center (JAMSTEC) and the National Space Development Agency of Japan (NASDA).

3.2 ENVIRONMENT AGENCY

The major mission of the Environment Agency is to promote environmental administration in comprehensive manner. The Water Quality Bureau is responsible for water quality management including the coastal seas and EEZ of Japan. The Nature Conservation Bureau is concerned with the marine environment with particular attention to the marine ecosystem, such as coral reefs. The Environment Agency coordinates environmental research activities undertaken by the governmental research institutions which are studying marine pollution or environmental conservation issues. The National Institute for Environmental Studies attached to the Environment Agency has conducted research on the marine environment of both global and regional scale.

3.3 MINISTRY OF EDUCATION, SCIENCE AND CULTURE (MONBUSHO)

Monbusho, which supports research at the universities, has promoted many international programmes such as WCRP, IGBP, and GOOS. The basic studies towards establishment of GOOS were made for five years from 1993 to 1997. The scientific results were reviewed during the WESTPAC Science Symposium in February 1998. The efforts in 1998-2003 are focused on ocean forecasting for the marginal seas in NEAR-GOOS. Monbusho will keep supporting research which leads to development of GOOS through Scientific Grants in-aid and the budgets of universities.

The GOOS activities at universities are coordinated by the Center for International Cooperation of the Ocean Research Institute of the University of Tokyo.

3.4 JAPAN FISHERIES AGENCY (JFA)

The Fisheries Agency is the authority responsible for living resources and related environmental issues of the marine and fresh water realms. National Fisheries Research Institutes are engaged in research on the physical and chemical environment and its relation to primary and secondary biological productivity as well as of various aspects of fishery resources participating in the international research activities. Monitoring of the change in biological activity of aquatic creatures, and their environment is also made in relation to global environment change.

3.5 MINISTRY OF TRANSPORT (MOT)

The Ports and Harbours Bureau is observing natural condition in the coastal areas of Japan to construct ports and coastal facilities. Wave observation has been operated on offshore network stations.

3.6 JAPAN MARITIME SAFETY AGENCY (JMSA)

The Hydrographic Department of JMSA is a representative authority in Japan for marine surveys and observations, and also operates the Japan Oceanographic Data Center (JODC). The department produces and

provides products necessary for navigation, such as nautical charts, tidal tables, biweekly oceanographic bulletins, etc. from data obtained by its extensive hydrographic and oceanographic surveys and observation operations. It is also one of the responsible organizations for marine pollution monitoring. Utilizing its superb research capacity, the Department has actively participated in various operational and scientific programmes. It is planned that the Department will positively contribute to the development and implementation of GOOS, based upon its extensive experience and contributions of operational ocean monitoring around Japan.

The Japan Oceanographic Data Center, which is one of the most active national oceanographic data centers in the International Oceanographic Data and Information Exchange of UNESCO/IOC, has been serving the community as the sole comprehensive oceanographic data center in Japan. The JODC is the RNODC of WESTPAC, and has operated the DMDB (delayed mode data-base) in NEAR-GOOS.

3.7 JAPAN METEOROLOGICAL AGENCY (JMA)

The Japan Meteorological Agency (JMA), one of the national organizations responsible for oceanographic observations and services as well as the authorized National Meteorological Service, has been actively contributing to each module of GOOS, in particular to the climate module and ocean service module. JMA will further improve existing activities and develop coupled ocean-atmosphere models to predict El Ñiño events and climate change.

JMA is also actively participating in the NEAR-GOOS project, one of the successful regional pilot projects of GOOS. Within this framework, JMA has been providing users with oceanographic and meteorological data through the NEAR-GOOS Regional Real Time Data Base operated by JMA.

Further, JMA has been making efforts to digitize historical marine meteorological observations (the Kobe Collection), and the digitized data were made available on a CD-ROM in 1999.

3.8 MINISTRY OF POSTS AND TELECOMMUNICATIONS (MPT)

The Communications Research Laboratory (CRL) is a VLBI (Very Long Baseline Interferometry) technology development center of the International VLBI Service. The CRL developed an ultra small VLBI station with the Geographical Survey Institute (GSI) through the support of the Environment Agency. The idea is to connect tide gauges by VLBI technique to remove the crucial movements from the record of tide in each station, when monitoring the mean sea level change. Since international cooperation is essential for this observation, this activity is extended under the U.S./Japan Conference on Natural Resources Panel (UJNR) to have cooperative work in the Pacific Ocean area. The VLBI and GPS experiments are planned with GSI to connect each position to the global reference coordinate.

3.9 MINISTRY OF CONSTRUCTION (MOC)

The Ministry of Construction (MOC) has conducted various researches through the Geographical Survey Institute, to assess the effects of rapid sea level rise, and collected basic information on the coastal sea area.

4. ACTIVITIES RELATED TO GOOS TO BE SUPPORTED OR IMPLEMENTED BY THE GOVERNMENTAL ORGANIZATIONS

4.1. SCIENCE AND TECHNOLOGY AGENCY (STA)

4.1.1 Introduction

STA has been co-ordinating "the Pacific Ocean Observation and Research Initiative (TYKKI)" in cooperation with the United States since 1993, in order to enhance the activities on observation and research in the Pacific Ocean. This cooperative work will contribute to develop GOOS in this region (The details are shown in Appendix).

By using the Special Co-ordination Funds for Promoting Science and Technology, STA has supported the development of a multi-purpose, automated moored buoy system with capability of easy deployment and multi-parametric observation, and the development of real time transmission of the observed data *via* satellites on a routine basis for weather forecasting.

4.1.2 The Japan Marine Science and Technology Center (JAMSTEC)

(i) TRITON project: JAMSTEC is developing a surface moored-buoy network named TRITON (TRIangle Trans-Ocean buoy Network) for observing oceanic and atmospheric variability in the Pacific Ocean and its adjacent seas in cooperation with interested Japanese and foreign agencies and institutions. The principal scientific objective is to understand variations of ocean circulation and heat/salt transports with emphasis on ENSO, the Asian monsoon, and decadal scale variability that influences climate change in the Pacific and its adjacent seas. In its first phase, the buoy network will be established mainly in the western tropical Pacific Ocean, and harmonized with TAO-ATLAS buoys which are presently maintained by NOAA's Pacific Marine Environmental Laboratory

JAMSTEC has already deployed nine (9) TRITON buoys in the western tropical Pacific Ocean, and the data obtained by using this system have been distributed on the TRITON homepage (http://jamstec.go.jp/jamstec/TRITON) and through the GTS since April 1999. In the future, we are planning to set a similar network in the Indian Ocean in October 2000, upon successful deployment in the western tropical Pacific Ocean. Deployment will be started as a pilot study for three years and be coordinated with other programme like JASMINE, the Indian National Date Buoy programme, Indonesian climate studies, etc.

However, there are some difficulties in operation: one of the TRITON buoys had stopped satellite data transmission on April 22, 1999. The tower of the buoy had been lost where only a part of a tower-leg remained. A vessel may have pulled down the tower intentionally. Aside from this buoy, one (1) buoy had started drifting on March 13 and was recovered on 16 March. The TRITON buoy wire may have been broken at 500m depth by some boat; two (2) TRITON buoys have started drifting. If this kind of damage is continuous, the deployment of TRITON buoys in the Pacific and in the Indian Ocean might be delayed.

(iii) Tropical Ocean Climate Study: The objective of the Tropical Ocean Climate Study (TOCS) is to achieve a better understanding of ocean circulation in the warm pool affecting the ENSO phenomena and global climate change. As part of TOCS, JAMSTEC has deployed subsurface ADCP moorings to detect daily, seasonal and year-to-year changes of the equatorial and low latitude western boundary currents.

JAMSTEC has conducted two cruises per year since Japanese Fiscal Year 1993 (April 1993-March 1994) using R/V *Kaiyo*, and increased to three cruises per year since FY 97 using the R/V *Kaiyo* and R/V *Mirai*. Hydrographic and atmospheric measurements have been carried out using CTD, shipboard-ADCP, and radiosonde. These cruises also maintain the JAMSTEC subsurface ADCP array and TAO array in the western Pacific. The TRITON buoy operations are carried out in conjunction with TOCS.

(iii) Kuroshio Extension Study: JAMSTEC has been conducting oceanographic observations in the Kuroshio extension and adjacent regions in order to understand physical processes associated with the inter-gyre exchange of heat and potential vorticity and to understand ocean-atmosphere mixed-layer processes.

(iv) Arctic Ocean Research: JAMSTEC has been conducting meteorological, glaciological, and oceanographic observations in the mid-Arctic Ocean in cooperation with Canada and the U.S.

(v) Ridge Flux Study: JAMSTEC is now involved in the Ridge Flux Project, aiming at quantitative estimation of the total energy and mass flux from the interior of the earth to the hydrosphere and atmosphere, through geophysical and geochemical observation on the seabed of mid-oceanic ridges and active back-arc basins. A diving cruise using the manned submersible SHINKAI 6500 was carried out of the southern East Pacific Rise in collaboration with the U.S.A. in 1997. During the cruise, JAMSTEC and other institutions deployed long-term seafloor monitoring stations at two (2) different hydrothermal active areas located at 17°S and 18°S. In 1998, about one (1) year after the diving cruise, the monitoring stations were recovered in the cruise of ALVIN/ATLANTIS, and we obtained the data of one (1) year-long variability of hydrothermalism.

(vi) Primary Production Research: JAMSTEC has started a programme to observe phytoplankton and its primary production in equatorial upwelling regions and in the equatorial western Pacific using ocean LIDAR (laser radar), in addition to traditional measurement methods. This research programme helps to build a data set of phytoplankton distribution originating from the data of satellite-borne ocean colour sensors which are received at a ship-board satellite receiving station.

(vii) Zooplankton Research: JAMSTEC has been studying a measurement technique to obtain vertical profiles of size and density distribution of zooplankton. JAMSTEC is planning to use and improve the technique of *in situ* measurement to study the processes in the lower tropic region and in Japanese coastal waters.

(viii) Research and Development on Ocean Observation System: JAMSTEC has been researching and developing the following new ocean observation systems:
- a) Ocean Acoustic Tomography System;
- b) Ocean LIDAR System;
- c) Surface Moored Buoy Network;
- d) Ice Ocean Environment Buoys;
- e) Large Size Research Vessel.

4.1.3 The National Space Development Agency of Japan (NASDA)

Research and Development of Satellite Remote Sensing

The National Space Development Agency of Japan (NASDA) has developed and launched the R/S satellites to observe the sea surface temperature, ocean colour (ADEOS/OCTS, etc.), sea surface wind (ADEOS/NSCAT), and so on, and conducted analysis of satellite oceanography using both foreign and Japanese earth observing satellites. Also, NASDA has developed the Earth Observation Information System (EOIS) for easier public access to the earth observation data.

4.2.1 ENVIRONMENT AGENCY

4.2.1 Marine Pollution Survey and Monitoring

The Environment Agency has conducted various surveys which are required in promoting environmental administration for protection and preservation of the marine environment. The Environmental Agency has carried out marine pollution monitoring of waters around Japan since 1975. Water temperature, salinity, concentration of nutrient salts, heavy metals, etc., in the sea water are monitored at the stations on the lines which cross the ocean currents around Japan and extend from the coast to the designated waste dumping areas in the open sea. Concentrations of heavy metals in the bottom sediment, and zooplankton, are also monitored. In order to grasp the environmental pollution situation caused by chemical substances, the Environment Agency conducts every year environmental monitoring of the water, bottom sediment, fish and shellfish in the coastal zones.

At local level, the prefectural governments monitor annually the water quality of public water areas, i.e., rivers, lakes, coastal waters, ports and harbours, etc., and the results of the monitoring are compiled by the Environment Agency.

4.2.2 The Survey of Biological Environment on Coastal Area

The locations, areas and types of tidal-flats, seaweed beds and coral reefs were investigated in 1978 and 1989-1992, by field survey or using aerial photographs and/or other materials. The existing and vanished areas of tidal-flats, seaweed beds and coral reefs in 1989-1992 have been plotted on 1:200,000 scale maps.

4.2.3 Research Projects for Marine Environmental Protection

The Global Environment Research Programme of the Environment Agency has supported research projects on ocean environment and marine pollution since 1990. In FY 1996, 14 national institutes and 24 universities have conducted 4 research projects; (i) Impact of environmental load through large river on marine ecosystem in Bohai and East China Seas; (ii) Studies on movement of hazardous chemicals in east-Asian seas; (iii) Study on the detection of ecological changes and land-based loading effects in the Asian marginal seas; and (iv) Studies on preservation of coral reef ecosystem.

The Center for Global Environment Research (CGER) of the National Institute for Environmental Studies is conducting marine environmental monitoring programmes including studying green house gas exchange between the atmosphere and ocean, using ships-of-opportunity and analysis of pollutants concentrated in marine organisms.

4.3 MINISTRY OF EDUCATION, SCIENCE, SPORTS AND CULTURE (MONBUSHO)

4.3.1 Physical, chemical and biological studies on monitoring of marginal seas for ocean forecasting (NEAR-GOOS)

An International Cooperative Research Programme on NEAR-GOOS was carried out in 1998 at Japanese universities, and it will be continued for fiscal years of 1999-2003 by the Grant-in-Aid for Scientific Research on Priority Areas (B). GOOS will provide accurate description of the present state of the oceans, including living marine resources, and will provide forecasts of the sea conditions. GOOS is intended to be an operational system for observations, modelling and analysis of ocean variables needed to support marine activities. The North East Asian Regional Project of Global Ocean Observing System, NEAR-GOOS, was started in 1997 according to Recommendation of the IOC Sub-Commission for the Western Pacific, WESTPAC, held in 1996 in Tokyo. Oceanographic data collected in the Japan Sea, Yellow Sea and East China Sea are to be exchanged at quasi-real time mode to facilitate daily mapping of temperature, salinity and ocean currents. Four countries facing the marginal seas, China, Japan, Republic of Korea, and the Russian Federation, have set up a NEAR-GOOS Co-ordinating Committee. The oceanographic data reported through GTS or Internet to the NEAR-GOOS real-time Database on the Internet are open to everybody, and the data are sent to the NEAR-GOOS Delayed Mode Database, which is open to everybody. Anybody who makes observation in the marginal seas is encouraged to report the data to the NEAR-GOOS Database to share the data. The daily mapping of the sea conditions is the basis for ocean forecasting. Although NEAR-GOOS is carried out in the seas having dense observations, the present data are not sufficient for accurate ocean forecasting, and the research groups of Japanese universities utilize several new methods, such as ADCP equipped to ferry boats, drifters, pop-up floats, satellite data, and so on. Among them, submarine cables between islands and peninsular are used to detect electric potential difference caused by ocean currents. The measurements are made at Pusan, Korea, at Aomori, Miyake-jima, Fukuoka and Okinawa, Japan. Research vessels of the Ocean Research Institute are used to calibrate the measurements. The research group is developing a numerical model for forecasting based on the daily mapping of NEAR-GOOS. Biological and chemical studies are also included. Transportation and dispersion of chemical substances and plankton are to be estimated by the forecasted field of ocean currents. Weather forecasting is based on the meteorological data transmitted in real time mode. The expansion of human activities on the sea and in the ocean needs ocean

forecasting, and the data sharing through electric communication is a pre-requisite. International cooperation becomes important as demonstrated by NEAR-GOOS.

4.3.2 International Cooperative Research

The development of GOOS has been supported by Monbusho through Scientific Grants-in-aid for International Research Programmes, and the subjects on going are as follows.

(i) Mussel Watch: Marine Pollution Monitoring in Asian Waters: 1997-1999:

As the Asia-Pacific project of the International Mussel Watch, monitoring, collection and analysis of hazardous chemicals and substances in the coastal marine areas of India, Viet Nam, Indonesia, Malaysia, Philippine, Taiwan, Republic of Korea, Thailand, and others will be made by Japanese research groups and the invited researchers from these countries. Activity for capacity building is also included in the project. (S. Tanabe, Faculty of Agriculture, Ehime University, shinsuke@agr.ehime-u.ac.jp).

(ii) Observations and models for ocean forecasting of marginal seas: 1998-2000:

Overseas travels of Japanese university scientists engaged with NEAR-GOOS projects, and invited foreign scientists are supported by this fund, including, in 1998, instructors for training workshop in Bali for an IYO Cruise of T/S *Kagoshima Maru*, mission to and from Vladivostock for NEAR-GOOS data handling, Korean scientists for voltage measurements by submarine cable, and others (Keisuke Taira, Ocean Research Institute, the University of Tokyo).

4.4 JAPAN FISHERIES AGENCY (JFA)

4.4.1 Oceanic Research

(i) Annual variation of surface layer temperature in the tropical seas (1987-): The hydrographic observations have been made by the fisheries experiments and the fisheries training vessels of the local governments in the tropical area of the Pacific and Indian Ocean to establish the temperature observation network by means of fishing boats operating in these areas.

(ii) Oceanographic structure and biological productivity in the North Pacific Ocean and the Kuroshio/Oyashio area (1997-2001). Physical, chemical and biological observations were made under the WOCE programme to elucidate the relationship between the ocean and the lower tropic level biological productivity.

(iii) Exploration of Kuroshio and adjacent areas (1986-1999): A cooperative study with China has been made since 1986. Relationships between the plankton production and spatial accumulation of pelagic fish eggs and larvae, and the physical structure of ocean are studied.

4.4.2 Researches on Environmental Issues

(i) Ultraviolet effect on interrelationship between phytoplankton and zooplankton: The influence of enhanced UV-B radiation on the interrelationship between marine phytoplankton and zooplankton was investigated.

(ii) Monitoring methodology for marine pollution by hazardous chemicals accumulated in organisms (1997-2001): This project intends to establish the methods to evaluate marine pollution by hazardous chemicals by determining the chemicals accumulated in marine organisms such as mussels, fish, and squid.

(iii) Preservation of coral reef ecosystems (1997-1999): On the biodiversity in coral reefs around the Ryukyu Islands, its structure and function are investigated, and methods of its evaluation and monitoring technique are developed.

4.4.3 Living Resources Research

Numerous research projects on marine and fresh water living resources have been operated under the direction of the Fisheries Agency. Representative ones are as follows:

(i) Fish resources investigations in the northern North Pacific (partly 1955-): Ecological and biological investigations for salmonids, Alaskan pollack, squids, etc. are carried out.

(ii) Fish resources investigations in the far seas (partly 1953-): Ecological and biological investigations for the resources of demersal and pelagic fishes are made in the North Atlantic, tropical Pacific.

(iii) Comprehensive study of the variation of the oceanic environment and fish populations in the North-western Pacific (1997-2002): This project intends to clarify the influence of the oceanic environment, phytoplankton and zooplankton on the resource variation of walleye pollock and saury, and to develop ecosystem forecasting models through out the food chain.

4.5 MINISTRY OF TRANSPORT (MOT)

4.5.1 NOWPHAS

NOWPHAS (Nation wide Ocean Wave information network for Port and Harbours), the Japanese coastal wave observation and analysing system, has been operated since 1970 by the Ports and Harbours Bureau of the Ministry of Transport and its associated agencies including the Port and Harbour Research Institute (PHRI). As of the end of March 1999, observed wave records of 49 NOWPHAS offshore stations are being collected and analysed at PHRI (49 stations for wave height and period, 30 stations for wave direction: the number of observation points will grow up to 53 in 2000).

4.5.2 Doppler Type Wave Directional Meter (DWDM)

Doppler Type Wave Directional Meter (DWDM) was developed by PHRI in 1995. DWDM integrates the Ultrasonic Wave Gauge (USW) and the Current Meter Type Wave Direction Gauge (CWD), and is able to measure directional wave spectra in deep seas by applying the Doppler principle. DWDMs will be principal wave gauges of NOWPHAS and have already been installed at 9 stations in March 1999 (13 stations by 2000).

4.5.3 Tsunami and Infra-gravity Wave Observation

NOWPHAS contributes to the exact offshore tsunami profiles for the 1993 Hokkaido-Southwest-Earthquake, 1994 Hokkaido-East-off-Earthquake, and 1996 Irianjaya-Earthquake. The newly developed continuous data acquisition system plays an important role in Tsunami disaster prevention and the coastal infra-gravity wave study. In March 1999, the continuous data system was applied at 13 NOWPHAS stations.

4.6 JAPAN MARITIME SAFETY AGENCY (JMSA)

4.6.1 Ocean Survey

The Hydrographic Department, JMSA, is regularly conducting oceanographic observation of ocean current, water temperature, salinity, etc., in and around Japanese waters and publishes various products including a bi-weekly oceanographic bulletin. As a part of the implementation of WESTPAC Programmes, the Japan Antarctic Research Expedition (JARE), etc., the Department is also carrying out observation of ocean currents, water temperature, etc., and precise observation of deep sea currents by using oceanographic mooring

systems and drifting buoys in the North Pacific Ocean and the Southern Ocean. It also participates in the WOCE programme and has completed the one-time and P8 lines. It initiates oceanographic observations including CTD, XBT, and Drifters in the sub-arctic gyre in the North Pacific, in a 5-year programme starting from 1997.

4.6.2 Marine Pollution Survey and Monitoring

In and around Japanese waters, major bays and harbours, as well as in the western Pacific area, mid latitude areas in the North Pacific Ocean, and the Southern Ocean, the Hydrographic Department, JMSA, is carrying out marine pollution surveys and monitoring sea water, bottom sediment, oil, PCB, heavy metals and radioactive materials for their concentrations and inter-annual changes. In order to find diffusing conditions of pollutants, observation of deep sea currents is also being conducted.

4.6.3 Tidal Observation

In order to monitor the sea level, the Hydrographic Department, JMSA, has been carrying out tidal observations at 29 tide stations around Japan. The data are telemetered to the head office and the station at the Showa Base in the Antarctica, which contributes to GLOSS and WOCE.

4.6.4 Oceanographic Data and Informational Services

The Japan Oceanographic Data Center (JODC) has been serving as the sole comprehensive oceanographic data bank in Japan, collecting, processing, managing and supplying various marine data and information. The JODC also acts internationally as an organization representing Japan in the International Oceanographic Data and Information Exchange (IODE) system and as the Responsible National Oceanographic Data Center (RNODC) for the IOC/WESTPAC Programme, IGOSS, MARPOLMON, and ADCP. In recent years, JODC has also contributed to the global climate programmes such as WOCE and JGOFS. The JODC has been organizing the WESTPAC training course on oceanographic data management every year since 1982, in support of IOC and the Japanese Fund-in-Trust. This training course will be shifted to the NEAR-GOOS training course from 1997.

4.7 JAPAN METEOROLOGICAL AGENCY (JMA)

JMA operates six research vessels in the seas adjacent to Japan and the western Pacific Ocean for oceanographic and marine meteorological surveys. JMA has been conducting oceanographic observations along the fixed lines in the waters around Japan every season for more than 50 years, and from the south coast of Japan to the equatorial region in the western North Pacific over 30 years on a semi-annual basis. Since 1992, oceanographic surveys in the western North Pacific have been expanded from twice to four times per year. These observations cover the fields of physical, chemical and biological oceanography as well as marine meteorology, aerology and radar meteorology. The observations of greenhouse gases and ozone depleting substances are implemented within the framework of the Global Atmosphere Watch (GAW) of WMO, and the observed data are distributed through the World Data Center for Greenhouse Gases (WDCGG) operated by JMA to users all over the world. The marine pollution monitoring is being made under the MARPOLMON of IOC.

JMA plans to launch a new research vessel *Keifu Maru* in late 2000 to enhance the monitoring of the oceanic conditions in the western Pacific and understand the mechanism responsible for oceanic variability on various temporal and spatial scales, especially the role of the ocean in climate change.

JMA deploys three moored ocean data buoys in the seas adjacent to Japan to obtain three-hourly meteorological and oceanographic data *via* the Geostationary Meteorological Satellite (GMS) operated by JMA, and puts them onto the Global Telecommunication System (GTS) of WMO on a real-time basis. Furthermore, JMA has deployed PALACE floats in the western North Pacific and has been providing their temperature profile data *via* GTS.

For monitoring of tsunami, storm surge and unusual tide, JMA operates 84 tidal stations and the extensive tsunami observing apparatus at 76 sites in coastal areas and islands. In this connection, it is particularly worthy to note that JMA initiated sea level observation by a pressure-type gauge at Minamitorishima in March 1996. Monthly mean sea level data from the 10 tidal stations are provided to GLOSS of IOC and to the IGOSS Sea-Level Programme in the Pacific (ISLP-Pac).

JMA has recruited two merchant ships equipped with XBT observation facilities cruising in the Pacific Ocean and the Indian Ocean to collect subsurface temperature data. Since 1998, two additional ships-of-opportunity have been sampling in the North Pacific under a cooperative project between JMA and the National Oceanic and Atmospheric Administration (NOAA). Further, JMA is making an effort to have more merchant ships and fishing boats as well as research vessels report more data on marine meteorology, sea surface and subsurface temperatures and ocean surface current. As one of the responsible members of the WMO Marine Climatological Summaries Scheme (MCSS), JMA is publishing the statistics of marine meteorological elements for the North Pacific.

The GMS, stationed at 140° E above the equator, provides the information about cloud distribution and height, upper and lower wind inferred from cloud motion and water vapour motion and sea surface temperature. As the successor to GMS, the first Multi-Functional Transport Satellite (MTSAT), a three-axis stabilized satellite, will be launched in August 1999 to enhance the capability of observations by adding more signal quantization and a new infrared channel.

JMA collects marine meteorological and oceanographic data through GTS, and the observed data are also reported to JMA by Japanese domestic organizations and universities. JMA issues the *Monthly Ocean Report* containing latest data/information on oceanic conditions for the domestic and foreign users and the "El Niño Monitoring Report" (in Japanese) containing a summary of oceanic and atmospheric conditions in the equatorial Pacific for domestic users on a monthly basis. JMA has been operating the Ocean Data Assimilation System (ODAS) since the beginning of 1995 and some products of ODAS appear in the *Monthly Ocean Report*.

JMA issues the *Monthly Report on Climate System* which contains the oceanographic information including ODAS output together with atmospheric products for climate monitoring. Most of the contents of this publication are exchanged with other national Meteorological Services through the WMO Distributed Database (http://ddb.kishou.go.jp).

In 1995, because of a great interest in the scientific community in the historical observations, JMA started to conduct a project to construct a digital data base of the pre-1933 merchant ship data archived in the Kobe Collection by the Nippon Foundation. The Kobe Collection is historical surface marine meteorological data observed by Japanese Voluntary Observing Ships for the period from 1890 to 1960. In the collection, reports by merchant ships and research vessels number about 6.8 million and those by the Japanese Imperial Navy number about 5 million. All the data by merchant ships after 1933 were digitized in 1960/61 and have already been included in Comprehensive Ocean-Atmosphere Data Set (COADS). About 1.6 million of the data have already been keyed since the start of the project. Among them, about 1 million quality-checked data were made available on a CD-ROM and distributed to the interested organizations and researchers in March 1999. JMA is making efforts to digitize as many data as possible.

JMA is also in charge of the IGOSS Specialized Oceanographic Center (SOC) for the Pacific Ocean to collect and to process wide-ranging oceanographic data, and to disseminate products through the Meteorological Radio Facsimile Broadcasting and the *Monthly Ocean Report* on an operational basis.

The NEAR-GOOS Regional Real Time Data Base (RRTDB), collecting the real time *in situ* observational data in the east Asian seas, has been operated by JMA since 1997. The number of registered organizations of the RRTDB has steadily increased to 33 as of June 1999. With regard to the access to the RRTDB, the access to the RRTDB homepage has increased from around 500 hits per month in 1997 to over 2000 hits per month in 1999. The ftp access number also increased and has been around 1000 hits per month. JMA published the Japanese version of the *Operational Manual for the NEAR-GOOS Data Exchange* revised at the third session of the NEAR-GOOS Co-ordinating Committee, and distributed them in the Japanese

oceanographic community to encourage the participation to the NEAR-GOOS data exchange.

For the safety of ships' navigation, JMA issues forecasts and warnings on marine weather as well as forecasts on ocean waves in the vicinity of Japan and the western North Pacific. In addition, JMA issues forecasts and information on sea ice in winter. Another responsibility of JMA is to disseminate meteorological forecasts and warnings for the western North Pacific and the South China Sea to ships *via* the INMARSAT under the Global Maritime Distress and Safety System (GMDSS). Furthermore, JMA issues information to support the activity for combating marine pollution (oil spill) in case of emergency under the framework of Marine Pollution Emergency Response Support System (MPERSS) conducted by WMO.

JMA plans to start El Niño forecasting on an operational basis by using the coupled ocean-atmosphere model, and development of an ocean data assimilation system for the mid-latitude region of the North Pacific, which introduces ocean surface topography data obtained by TOPEX/Poseidon satellite.

4.8 MINISTRY OF POSTS AND TELECOMMUNICATIONS (MPT)

4.8.1 Ocean oil pollution detection by Airborne Imaging Radar

The Communications Research Laboratory (CRL) developed an 9.5 GHz Side-Looking Airborne Radar (SLAR) system for the surveillance of oil pollution over the ocean in 1986. SLAR has a very high sensitivity in oil slick detection over the ocean. CRL also has been developing the 9.5GHz airborne high resolution Synthetic Aperture Radar (SAR) since 1993. This imaging radar will be useful to monitor marine oil pollution, and to observe currents and so on.

4.8.2 The HF Doppler radar system for measurement of ocean currents

CRL developed an High Frequency (25MHz) Doppler radar system for continuous measurement of ocean current distributions and sea status over a wide range. In the actual observation, dual-ocean-radars are located at the seashore for monitoring ocean current vectors.

4.8.3 Airborne laser altimeter for sea ice measurement

CRL developed an airborne laser altimeter to measure the distribution and height of sea ice to an accuracy of an order of cm. The experiments were made in February 1992 and 1993 for the sea ice of the Sea of Okhotsk.

4.9 MINISTRY OF CONSTRUCTION (MOC)

The MOC is conducting research through its Geographical Survey Institute (GSI). The GSI developed a method for assessing socio-economic loss in an inundated area. A Pilot study has been performed in the areas of Nagoya, Japan, and Bangkok, Thailand. To discriminate net sea level rise from crucial deformation, GSI connected some tide gauge stations to global datum using VLBI and GPS. The GSI has conducted "Fundamental Survey of the Coastal Area" since 1972. On the basis of the research, GSI compiled maps useful for counter plans against flood, conservation of coastal environment, coastal fishery etc. Using aerial-photographs, multi MSS, and LANDSAT TM images, GSI studied changes in the natural environment especially the damage of coral reefs by red soil.

The Coastal Movements Data Center (CMDC) was established in 1966 as an organization that uniformly compiles tidal data from tide gauge stations of the Japan Meteorological Agency, Hydrographic Department, Geographical Survey Institute and others.

APPENDIX

PROJECTS OF PACIFIC OCEAN OBSERVATION AND RESEARCH INITIATIVE (TYKKI)

1. Projects on ocean observation and research

(i) Arctic-Sub-Arctic Pacific:
- Deformation of Arctic Pack Ice Field;
- Air-sea/Ice-sea Interactions in the Chukchi Sea;
- Water Circulation and Flux Study in the Okhotsk Sea;
- Bering Air-Sea Interaction Study.

(ii) Sub-Arctic-Sub-tropical Pacific:
- Sub-Arctic Gyre Experiment in the North Pacific Ocean.

(iii) North-West Pacific:
- Heat and Materials Transport from the Kuroshio Extension by Meso-scale Eddies East of Japan.

(iv) Sub-tropical-Tropical Pacific:
- Tropical Ocean Climate Study;
- Ocean Modelling Utilizing Three Dimensional Ocean Observation System;
- Space-based and Acoustic Tomography Technology;
- Observation Research for Primary Production and Carbon Flux over Equatorial Upwelling;
- Long-term Thermal Field Monitoring in the Tropical Area and Subtropical Gyre.

(v) Uncertain:
- The Study on Ocean Conditions and Current Variability;
- Prediction of Variability of Oceanographic Condition;
- In Situ Sea Level Monitoring;
- Cost-benefit Analysis of Large Mooring Buoy Arrays;
- Coral Reef Research, Monitoring and Information Management;
- Chemical Tracers in the Pacific Ocean.

2. Projects on Development of Observation Techniques and Information Exchange System

(i) Observation Techniques:
- Evaluation of Giant Magnetostrictive Source;
- Development of the Measurements for Greenhouse Gases and the Analytical procedures for the behaviour of the gases;
- Improvement, Development and Deployment of Surface Drifter;
- Establishment of Vertical Reference Frame for Mean Sea Level Change in the Pacific Ocean;
- Inter-comparison of Absolute Gravity Meters;
- Development of Deep Ocean Tsunami Gauges.

(ii) Information Exchange System:
- On-line Oceanographic Data System for Mooring Buoy
- Intensification of Global Ocean Data Collection System
- Development of On-line Data Base for Oceanographic Data

G. NETHERLANDS

IMPROVED MONITORING OF SYSTEM EARTH
Dutch contributions to International Monitoring Systems

Report by the Task Team Monitoring Systems
led by Harry van der Laan, in collaboration with Niek de Kort (June 1998)
Provided by Dr. J. Stel, Netherlands Geosciences Foundation

This report is an abridged version in English of the original report, written in Dutch, entitled *Een betere bewaking van systeem Aarde*. In the English version of the report, in both the main text and in the KPMG Annex, some parts of specific interest to the Dutch situation have been omitted. The same is true for parts in which the concept "monitoring" is explained. The Table of Contents is complete. Sections omitted are indicated.

I. EXECUTIVE SUMMARY

1. THE ASSIGNMENT, THE TEAM AND THE WORKING PROCEDURE (translated in part)

The work for this report was done by a Task Team Monitoring Systems (TTMS) consisting of some seven experts, coordinated by a team leader at some distance from the field, who was in turn assisted by a professional writer and a secretary.

2. MONITORING SYSTEM EARTH

2.1. ENVIRONMENTAL CHANGES AND SUSTAINABLE DEVELOPMENT

International monitoring systems for environmental change consist of systems *in space* and systems on earth. Those in space are operated largely by the major space agencies, they are diverse, numerous and costly. The data gathered with these systems co-depend for their value on measurements *in situ*. The monitoring systems *in situ* consist primarily of a patchwork of local, national and regional, grown historically. In this study the Netherlands contribution to the *in situ* systems is especially analyzed.

The motive for initiatives to improve monitoring systems is a watch over system Earth such that humanity can achieve sustainability with quality of its existence. With the combined growth of the number of humans and the consumption per capita, sustainability, let alone sustainability with quality of life, is no foregone conclusion. Environmental measures require, in both design and implementation phase, adequate, reliable information about environmental changes. Integral end-to-end monitoring systems deliver that information.

2.2. HOW DOES A MONITORING SYSTEM FUNCTION?

Monitoring systems consist of instruments on earth and in satellites, of databases and data assimilation plus modelling techniques. They require good organizations to keep them "in the air" and become much more effective when attuned to each other in multiple ways. Monitoring techniques are continually renewed under the influence of international agreements, of new techniques and methods and by the evolving demands of users. They cost a few percent of the processes they trace and which they aim to be optimally steered and managed.

2.3. FIVE INTERWOVEN FIELDS FOR MONITORING

This report deals with five interwoven terrains for monitoring activities. They are: Oceans, Coast & Delta, The Land, Weather & Climate and the Atmospheric Composition. For each the working area is sketched, the requisite data are indicated, and programmes are described, international, regional (European) and national. In this manner a fairly complete overview emerges of the whole activities domain, a 'primer' for the (as yet) uninitiated. Finally the coherence of the five terrains, natural and organizational, is dealt with.

2.4. SPACE SYSTEM

Space systems are discussed separately but very briefly. The recent foresight study Space Technology, under the same leadership as this study, justifies this shortcut. It is concluded that *space based* systems have a wholly different history than the *in situ* systems and hence are embedded organizationally quite differently also. The data are complementary, satellite data have a spatially superior coverage but for their information harvest are very dependent on *'ground truth'*. In Europe the strategy -and decision-making- has stagnated. For *earth watch* monitoring the users' influence leaves much to be desired.

3. THE NETHERLANDS' INVOLVEMENT IN MONITORING SYSTEMS

3.1. STRATEGIC OVERVIEW

Global environmental change has the attention both scientifically and operationally of a number of organizations dedicated to the subject. IGBP, WCRP and IHDP are the world science frameworks, GOOS, GTOS and GCOS the operational ones. The latter three, together denoted as G30S, have in dialogue with CEOS, the space agencies' joint committee, in 1997 initiated the move towards an Integrated Global Observing Strategy. This striving for IGOS promises an essential further rationalization of regional and national efforts and provides a reference frame for new plans.

3.2. THE NETHERLANDS AND THE FIVE AREAS INVOLVED

The five terrains mentioned in 2.3 are treated from the Dutch perspective. Each time the global, the European and the Dutch strategy are at issue, followed by a series of advice for improvement of the Dutch role. From these sections it becomes clear that the Netherlands have a lot to offer. Our experience of coast, delta, seas and oceans, our knowledge of agriculture and forestry, our meteorological contribution are world class. And so are our contributions to the science and operational tasks in atmospheric composition.

The coherence of Dutch industriousness in this field can become closer and more effective still. Now that the world with the IGOS concept prepares to make a quality jump towards effective monitoring systems, it is a matter of good management and of economic behaviour to much better organize both the interaction of the five terrains in the Netherlands mutually and the interactions with the rest of the world. Distributing tasks in an obligatory manner and supervising the coherence is an urgent, concrete advice.

4. SOCIO-ECONOMIC AND FINANCIAL ASPECTS

4.1. APPROACHES

There are many ways to appreciate the costs of monitoring. For economists these costs belong to a greater whole, the field of a subdiscipline in economics *-environmental economics-* an area under development since more than thirty years. Environmental questions deal with security, sustainability, quality of life, categories of which the social value is unassailed but for which the determination of monetary value is problematic. This therefore obtains *a fortiori* for the monetary value of environment monitoring.

Governments can neither steer responsibly nor manage effectively, without reliable information covering the processes at stake. Citizens, electorate must be convinced of the necessity and effectiveness of expensive environmental measures. Government can only prevail if in court and in negotiations with for example economic sectors about environmental covenants, if the data confirm that norms inherent in proposed regulations correspond with reality. There are numerous arguments that plausibly show that the adequate provision for and operation of monitoring systems is amply rewarding. The return on investment must be particularly expected from a better informed and hence more effective policy design and implementation. For the incremental investment of about 100 million guilders per year argued for in this report, an ROI of 200 %, that is about one percent of the extent of the national environmental measures, seems achievable. The costs of monitoring can also be regarded as a premium, much less than 0,1 percent of GDP, which must be paid to drastically reduce the risk of unacceptable or catastrophic damage.

Two thirds of all costs for environment monitoring are costs for knowledge-intensive employment. The rest are contributions to international organizations and investments for hardware (which of course are in turn spent on sophisticated work). The work is done largely at scientific institutes, at public institutions and in many, mostly small, enterprises. The results are used by governments, by knowledge and utility institutions and by many branches of industry. In the annex of this report a detailed economic analysis is provided.

4.2. DESIRABLE INVESTMENTS, EXPLOITATION AND FLANKING EFFORTS

The TTMS anticipates phase 11 of this study with a start for proposals to strengthen the quantity and quality of the Dutch contributions to international monitoring systems. This is done in the form of specific proposals per G30S area. Each time it is indicated, per subject, how these innovations improve the systems and what advantages that offers. The proposals concern primarily in situ systems; for space systems the TTMS defers to the Foresight Committee on Space Technology. This strengthening comes down to Mfl 56 per annum for the period 2000-2004, with the assumption that a comparable amount will be additionally invested (as compared to the last several years) in the earth observation programme of ESA. With these means thus spent and with the proposed rationalization and attuning activities, the Netherlands becomes a full fledged member of the international community in this area, so crucial for the 21st century.

5. CONCLUSIONS AND RECOMMENDATIONS

5.1. GENERAL CONCLUSIONS

The qualitative insight this study has brought is summarized in seven general conclusions. The third conclusion is here repeated for emphasis:

"System Earth is a coherent whole that knows no national boundaries or differences of culture. Effective monitoring systems will have to uniformly cover planet Earth, a desideratum well met by space based systems, but not by a long way by essential, complementary in situ systems. It is necessary, and not for this reason only, to support developing countries in their indispensable participation in global, regional and national monitoring activities. Programmes for capacity building, partners in science and the construction of infrastructure need support from development aid in order to enable sustainability for all humanity."

5.2 RECOMMENDATIONS

§ 59 of the document "Developing partnership on an IGOS" states the following:

"There is also a need for integrated approaches at the national level, where fragmented agencies and programmes make it difficult to articulate national activities with integrated multidisciplinary global programmes".

For the Netherlands the TTMS regards it as particularly desirable to designate an agency for each of the G30S fields, which in dialogue with an advisory committee from the field:

(i) maintains the contacts with the secretariat for GXOS and with the relevant European organs;
(ii) promotes and cares for the relations between the operational and scientific activities;
(iii) regularly tests the effectiveness, the quality and the coherence of the Dutch contribution to international monitoring;
(iv) supervises the Dutch contribution to the international training efforts (capacity building) for developing countries on the GxOS terrain.

The TTMS proposes:

(i) to designate the RIKZ as the agency for Dutch activities on the terrain of GOOS in general and EuroGOOS in particular;
(ii) to designate the RIVM, together with an institute to be selected from the Knowledge Centre Wageningen (KCW) for these tasks on the terrain of GTOS;
(iii) to designate the KNMI as the agency for Netherlands activities on GCOS (and WMO/ECFMW) terrain.

For contacts with CEOS about space based systems we propose to designate the NIVR in dialogue with SRON and the BCRS (and in due course its successor), for an analogous role.

Also to nationally deal properly with the evolution which IGOS will bring about on a global scale, we note § 60 of the document cited above:

"*A few governments have expressed a preference for a single national body to deal with all three observing systems. For this, they will have to develop some integrating mechanism at the national level. Otherwise, it is not evident to identify who in a government would be the appropriate national counterparts for all three systems, and who to invite to intergovernmental meetings*".

The TTMS proposes to appoint a Steering Group, consisting of eight members, to be nominated one each by the four above-mentioned agencies/institutes (RIVM/KCW in turn) and their advisory committees, to be led by an independent chairperson who is appointed by the government. The Steering Group disposes of its own means and a small staff. This Netherlands Steering Group Monitoring Systems for Global Environmental Change then becomes responsible for:

(i) the continuous tuning of the national fourfold efforts to the unfolding Integrated Global Observing Strategy-IGOS;
(ii) advising the government, upon request or otherwise, about the quantity, quality, structure and co-ordination of the national programmes at issue;
(iii) advise about budget allocations for both the international and the national operational projects and programmes;
(iv) the co-ordination of the national efforts concerning global environmental change which surpass the boundaries of the four agencies mentioned, including the collaboration of these agencies themselves;
(v) the public information task, for politics, for all levels of policy-making, management, the NGOs, the media, the schools and for citizens at large.

The Steering Group collaborates with the Royal Netherlands Academy for Arts and Sciences (KNAW) and the Netherlands Organization for Scientific Research (NOW) where (parts of) IGBP, WCRP, and IHDP related research are coordinated and financed respectively.

II. MONITORING SYSTEM EARTH

1. ENVIRONMENTAL CHANGES AND SUSTAINABLE DEVELOPMENT

The National Environmental Policy Plan 3 (NMP 3) demonstrates in 220 pages of text and more than a hundred pages of illustrations, charts and frames with facts, definitions, descriptions of trends and conclusions, how much the care for the natural environment co-determines government policy. It can also be deduced from

NMP 3 that structuring as well as execution and assessment of a policy depend entirely on measuring in a systematic and continuous way, thus on monitoring as described below in part 2.2. Critical tracing of the information sources which enable policy-making also shows that a broad diversity is involved here, evoking an impression of arbitrariness. This impression would be justified if it were about a system designed and developed in context. But this is exactly what is not the case: in the course of time cities and provinces, district water boards and forest management, ministries and agencies have taken those measures, have devised and acquired those measuring- and watch systems necessary to enable them to discharge themselves of their respective tasks. It is typical of history that in this way a patchwork develops of which nobody may expect that its parts, layers and partial systems are attuned to each other, use mutually consistent measuring methods, yield exchangeable data and result in homogeneous, let alone congruent knowledge patterns. This coherence, however, is now necessary, nationally, continentally and even globally.

On the verge of a new century it is precisely the consciousness of this necessity which is the driver for many developments: sustainability is not self-evident any more but requires great efforts. These efforts become much more effective when national activities are organized rationally, are embedded in the corresponding regional (for us, European) contexts which are in turn part of global organizations. In part 2.3 which follows, five segments of integral monitoring are successively described with respect to content. Thereafter, the work done at present in each sector is sketched in a three step form going from the global *via* the regional to the national scale. The largest part of all programmes consists of national work, done by people who are employed by the above mentioned 'patchwork' of organizations and institutions, financed through national budgets. The embedding in regional contexts and the focus obtained through global organizations provide the national efforts with a large added value, one reason being that environmental changes do not respect state borders and the other that the embedding and focus yield coherence and rationalization, even force them sometimes. In chapter 3 the Dutch strategy with respect to the five distinct fields is also apprehended from this global perspective and the advice is formulated along these lines.

On the first page of the First edition of the 1997 UNEP report 'Global Environmental Outlook' one reads as follows: "*Significant progress has been made in confronting environmental challenges. Nevertheless, the environment has continued to degrade in nations of all regions. Progress towards a sustainable future has simply been too slow.*"

The reason for this worrysome statement motivates the developers of integral monitoring systems as well as the initiators of this study. And indeed, the UNEP report contains about two hundred acronyms, especially of the names of commissions and organizations; each of these letter combinations hides people, activities, plans and budgets. On the *World Wide Web* some millions of documents with the subject *environment and sustainable development* can be found. Each public servant, researcher, technical employee, working in fields which deal with *environment and sustainable development* has piles of books, magazines, reports and brochures, for the better part unread, in his office. The bulk of this broad literature describes the problem area and indicates possible solutions. For these solutions data sets are collected, analyzed and tested for compatibility with diverse conceptions and world views. However, the underlying data are insufficient, of poor quality and/or not adequate for the chosen analysis. That is the reason why we barely know how and where the climate changes and are not able to unambiguously define the causes of possible changes. Comparable problems appear with shifts in biodiversity, with respect to the issue of fishery, to acidification and drought.

This report does therefore not aim to work out a new analysis of the many environmental problems, but presents a structure for a better integrated information supply to enable the tackling of these problems. It deals with the questions: 'What can and must the Netherlands do in order to objectively map environmental changes? How can the existing observation infrastructure be used for this purpose? Which supplements are necessary?' and substantiates the recommendation to structurally invest in end-to-end systems, which reliably reflect the state of system Earth and the trends of changes in this condition. At issue are specific investments in the extension of monitoring and strengthening of the cooperation, national and international, by which the impact of the Dutch contribution is enlarged and a better cost efficiency is realized.

During the coming fifty years the number of people will grow from almost six thousand to at least ten thousand million people. The average prosperity per capita will also more than triple in this period of time and

reach a level comparable to the one of the OECD countries in the eighties of this century. If production and consumption patterns remain unchanged, the pressure on the natural environment will therefore rise by more than a factor five. Such a load is unbearable for system Earth as the humans' habitat.

As the above mentioned growth curve of the Earth's population will flatten only after the middle of the next century -the growth till then is inherent in the age composition of the people alive now- and as the aspirations for a decent existence of the great majority of the world population, which is poor at present, cannot be stalled, major measures in all sectors of the world economy are necessary to keep our planet liveable in a sustainable way.

Specific measures in the public sector as well as reglementation and changing distribution of loads across the private sector require support in politics and society. The availability of consistent, reliable information attuned to each specific problem category is a necessary condition for designing effective measures as well as for mustering support. Monitoring systems are the indispensable links in this information supply.

During the last twenty years a great deal of work has been done with respect to maintaining a wholesome environment and much progress has been made in mapping the developments and problems and the measures to tackle problems. This goes for many scales and all parts of the world. The above cited UNEP report testifies to this worldwide effort, the National Environmental Policy Plan 3 illustrates the degree of intricate detail on the national level by which the care for the environment is characterized here. On the scientific scene innumerable projects and programmes are coordinated in three big frameworks, the one of the WCRP for physical and chemical aspects of climate and global change, the one of the IGBP for all aspects of the geo- and bio-sciences, the one of the IHDP for the socio-cultural and economic dimensions of the care for the environment.

The nineties did not only bring about a strong development of research in these frameworks but also more and more attention for the interaction and the definition of problems beyond the boundaries of these frameworks. There are even organizations and institutes where all these perspectives are covered under one roof. A striking, ambitious example is the initiative by Columbia University (New York) for the forming of an institute which will dispose of almost all requisite disciplines in the humanities, natural- and social sciences. Part of the mission is formulated as follows: "*The mission of the Columbia Earth Institute is to create the knowledge base, educate the leadership and citizenry, and help develop the innovations that will enable us to become wise stewards of our planet.*"

In our country the research school SENSE (socio-economic and natural sciences of the environment) is an example for a multidisciplinary initiative, albeit more narrow and smaller. This integral approach also takes a central position in the foresight studies of the RIVM. The report *Zorgen voor Morgen* (Care for tomorrow) (1989) was one of the first national broad environmental foresight studies worldwide. The institute is still world-famous with its integral models and has contributed through this activity to the above cited UNEP report.

Constant scientific research is necessary for obtaining a good insight into environmental trends. On the basis of insight into processes, measures are designed which alter dead-end trends and render sustainable development possible. Neither research nor administrating and legislative authorities can do without reliable, manageable, accessible information. This report deals with the process yielding information that is gathered *via* end-to-end systems which are called monitoring systems.

In this chapter terms and concepts are described and it is illustrated which layers and links an end-to-end monitoring system consists of. Thereafter, a brief description follows of five fields which have to be distinguished but overlap and are interwoven; fields which form the focus for monitoring systems and which organizations on a worldwide scale have chosen for their task of co-ordinating monitoring activities. As space technology knows tight organizational bonds in the form of agencies, and as satellites are expensive, but also dispose of a unique range, a special section of this report is devoted to this subject.

How a country uses the possibilities to shape its future depends on the one hand on the values and norms in this society, on the other hand on knowledge, insight and capacities in this society. From this, priorities are developed that can be converted into generic policy and concrete measures resulting from this.

The ages, during which the human species only had a marginal influence on planet Earth lay far behind us by now. To act as if nature supplies inexhaustible sources for human well-being is an anachronism. Humanity will have to pay if this attitude persists. For the highly developed countries it is a privilege as well as a challenge to bring in their knowledge, skills and means to deal in the coming century with planet Earth in such a respectful manner that it will remain habitable for ten billion prosperous people. Constant monitoring is an absolute requisite for this.

2. FIVE INTERWOVEN FIELDS FOR MONITORING

In practice many organizations, institutes and systems have been developed to cover the need for information. At the highest, global, aggregation level a tripartite task distribution materialized by now, with ever more intensive border traffic between the three fields for monitoring. This situation will be explained in parts 2.3.6 and 3.1. The acronyms which belong to these three sections are: GOOS (Global Ocean Observing System), GTOS (Global Terrestrial Observing System) and GCOS (Global Climate Observing System). In this report we decided to have five sections, i.e. Oceans, Coast and Delta, the Land, Weather and Climate, and the Atmospheric Composition. The first two belong to the GOOS regime, but, conforming to the many activities taking place in these fields, we distinguish these explicitly, as coast and delta play a special role for the Netherlands. The two latter ones belong to GCOS but also here the atmospheric chemistry is a field, given much attention by our country, which is to be distinguished separately.

2.1. THE OCEANS

2.1.1 Field of activity

More than 70 % of the surface of our planet is covered with water. The water in the oceans and in the atmosphere plays a crucial role in the distribution of solar energy over the Earth. Even though water seems to be a normal liquid, it has -seen physically- a number of extraordinary characteristics. It is known to be an excellent medium to store large quantities of energy in the form of heat. In areas around the equator the oceans take in much incident solar energy which results in an increase in the water temperature. *Via* currents in the deep sea and surface currents this heat is transported to areas with a higher degree of latitude. The heat which is thus released *via* condensation of water vapour and *via* interaction with the lowest layer in the atmosphere determines the kind of climate in these areas to a large extent. The oceans form in essence the most important temperature regulator on Earth. They act as a "cooling agent" around the equator and prevent the temperature to rise strongly whereas in other areas the oceans can be seen as a warming agent.

In addition to the characteristic that large quantities of heat can be taken up and emitted, another feature of water is that it becomes lighter the warmer it gets. This is of course also true the other way round: cooler water becomes heavier and sinks. These differences in the specific density of quantities of water drive among others the currents in. the deep sea. This current can be pictured as an enormous conveyor belt along which solar energy is transported across the Earth. In addition, the rotation of the Earth and the location of the continents determine the course of these currents. Regional surface currents are co-determined by the interaction with the predominant wind direction in the atmosphere. A well-known part of the large conveyor is the Gulf Stream to which Western Europe owes its moderate climate.

2.1.2 Issues

Knowledge about the dynamics of the oceans is of vital interest for the creation of usable models with which the nature of and the changes in the world climate can be studied. During the second World Climate Conference, held in 1990, it was stated that the data available on the oceans are absolutely insufficient to construct somewhat reliable models. Thereupon the Intergovernmental Oceanographic Commission of the UNESCO took the initiative to develop the Global Ocean Observing System (GOOS) concept. For its execution

a close collaboration between the industrialized and developing countries is a requisite. Indeed, it is about a global observing system where nature of course does not care about borders between rich and poor countries, established by mankind.

Via a programme such as GOOS it is possible to gain better insight into the manner in which the oceans transport solar energy and, this is very important, to know the natural variations which occur in this process. A well-known example of disturbances in the "normal" current pattern is El Niño. The phenomenon is related to the warming up of the ocean surface around the equator, which causes the influx of cold nutritious water along the coast of South America to be suppressed temporarily. The consequence is an abnormal distribution of areas with warm and cold water. This anomaly is transferred to the atmosphere, the effect being that the prevailing climate in a large number of areas (Australia, Indonesia, Mexico, the United States of America, South East Africa) becomes disordered. We do not understand by any means everything about the causes of this phenomenon because hardly any relevant data are at hand. GOOS attempts to improve this situation. In addition to El Niño, also other temporary disturbances in the mechanism of transport of solar energy across the oceans are known.

2.1.3 Data

To gain better insight into the processes that take place in the oceans an extensive data base is necessary. Extensive in the sense of a broad scale of data, but also in the sense of recording the data during a long period of time. El Niño is a characteristic example for a disturbance, relatively short in time. The entire phenomenon takes place on a time scale of one or two years. However there is hardly any insight into changing processes which take place on a time scale of decades or longer. Therefore it is necessary to record various data over a long period of time at a large number of places in the oceans. Examples for these data are the temperature at the surface and at various depths, the salinity (co-determines the mass of a quantity of water), ice coverage, wave movements varying on scales from meters to hundreds of kilometres, location, direction and speed of currents at various depths, the water chemistry (among others oxygen, carbon dioxide and nutrients), biomass, acidity and the like.

2.1.4 International programmes

GOOS is a global observation programme which is at present in a development phase. It is an ambitious as well as necessary programme, comparable to the World Weather Watch system in meteorology. In a concept for a strategic plan of January 1998 the mission, objectives and points of departure were laid down. The programme is divided in five different modules which serve as a prelude to a more thematic approach to be used at a later stage.

Climate module	Monitoring of the climate, data analysis and forecasts.
Living marine resources module	Monitoring of biological activity and biomass, data analysis.
Coastal module	Monitoring and forecast with respect to processes which take place in coastal areas.
Health of the Ocean	Analysis and forecast regarding the general "health condition" of the oceans.
Ocean services	Operational services in the field of marine meteorological measurements and oceanographic measurements.

An essential part of the GOOS concept is to develop and to make available qualitatively high-level knowledge. With the exchange of information also the exchange of this knowledge is brought about.

The annual cost of a completely developed GOOS system is estimated to be around 3 to 4 billion Dutch guilders. This amount has to be compared to, e.g. the economic damage which occurs as a consequence of temporary disturbances in the current pattern in the oceans. The total damage as a consequence of El Niño in 1982/1983 was estimated at 26 billion Dutch guilders; this amount is probably surpassed by El Niño of 1997/1998. If, with GOOS, warnings can be given much ahead with respect to the occurrence of El Niño, this damage can be limited considerably.

2.1.5 Regional programmes

Within GOOS an explicit difference is made between the global, regional and national level. Especially the regional layer is important for the link between the world of far away problems on a global level and the results with usable forecasting values on a national level. On a European scale EuroGOOS was founded. The members of this association are all involved in real oceanographic measuring programmes and in the distribution of analyses products to clients. The Netherlands are a founding member of this dynamic Organization. A large number of projects are operational or are in the development phase. Many of these projects tackle sub-regions as the North Atlantic Ocean, the Polar Sea, the Mediterranean Sea, the continental shelf and the Baltic Region. Other projects focus on measuring strategy *(in situ,* remote sensing, space-based systems), instrument development and data analysis and data management. Recently, with the involvement of Brussels, also the socio-economic side came more to the fore in the formation of ideas.

Since the middle of 1980 there has always been within the European framework programme a part called "Marine Science and Technology" (MAST). Many Dutch institutions, companies and also government offices have been participating successfully. The network of Organization and people, thus developed, also forms the basis for further international cooperation in the field of marine science and also monitoring systems. The expectation is that within the new framework programme there will also be enough attention and space for operational oceanography. This can mean at the same time a solid financial impulse for the realization of EuroGOOS within the various European regions and the common programme.

2.1.6 National programmes

In the last decades the pioneering work concerning Dutch involvement in oceanographic research was especially carried out in scientific disciplines, *in casu* at the NWO Stichting Onderzoek der Zee (SOZ) (NWO Foundation Research of the Seas). The involvement of Rijkswaterstaat (Department of Public Works) (RIKZ and Directie Noordzee) (Direction North Sea) grew continually because of concrete policy developments with respect to the North Sea and the coast. The secretariat of LOICZ is established on the island of Texel. The RIKZ also provides the chairperson for the national EuroGOOS commission. NWO is active in the intergovernmental field (IOC, GOOS). *Via* partner projects, with among others Indonesia in the Snellius II project, the Netherlands have gained comprehensive experience. In both countries research gained momentum, while through education and training knowledge was transferred to the partner countries. Through this, Indonesia for example developed a marine research capacity of its own, an essential development in the framework of GOOS. The concept of "Partners in Science" which arose from the Snellius II research, is based on long-term cooperation and mutual, active input.

2.2 COAST AND DELTA

2.2.1 Field of activity

The borderlands between oceans and continents are of huge importance to mankind because circa 60 % of the world population lives and works in coastal areas. For the human inhabitants the proximity of the sea implies advantages as well as disadvantages. The disadvantages concern primarily the issue of safety (storms, floods and break-up of ice) and of the quality of the environment (silt, supply and accumulation of contamination, risks for human health, flora and fauna). Advantages are to be found especially in economic respect. A very large part of the world's industrial production is transported by ship. Harbours stand for economic activity. Especially for a country like the Netherland, all facets of coast and delta come together: Rotterdam is the biggest harbour worldwide, the safety measures against the sea require continuous attention and cost considerable amounts of money per year and good management of the environment is a requisite for the continuation of the liveability of the region. In addition, coastal areas and deltas represent a priceless value for the maintenance of biodiversity on our planet. Shallow sea regions offer a place for the richest variety of micro- and macro- organisms. Well-known examples are the coral reefs, the Galapagos archipelago and the Wadden Sea.

2.2.2 Issues

Monitoring of coastal areas and deltas is important for many different areas of interest. First of all it is the form and location of the border between water and land. Sea currents, wind and human activities determine on a short time scale where this border is located. With respect to a longer time scale climatological developments are important, such as a possible rise or lowering of the sea surface level as a consequence of a change in the average temperature on Earth. A second area of interest includes a number of safety aspects. By means of models, forecasts can be made about, e.g. the water distribution along the coast under certain wind- and tide circumstances. This is linked to a third area of issues which covers the field of support of activities and work in coastal areas, such as offshore, fisheries, shipping and the like. In this context the recreation interests and the quality of the living environment (biodiversity) play a role. The planning and structuring of coastal expansions and islands, or the conscious "giving back" of certain land areas to the free interaction between land and sea can be seen as a fourth cluster of issues which can be tackled with the help of monitoring systems for coast and delta. This concept is also known as 'Building with Nature'. This cluster automatically leads to issues in the area of coast and delta policy and management as well as to the working out of scenarios for fighting disasters and extreme circumstances. With this, the circle to the first area of interest has been closed.

In general, the following customers for data from coast and delta monitoring systems can be distinguished from the various clusters of issues:

Management and policy	Coastguard, water works, provinces, national public bodies in the field of transport and public works, agriculture, nature management and fisheries, regional development and environment, (including the international treaties with neighbouring countries).
Use of coastal areas	Shipping, harbours, dredging companies, offshore, fisheries, recreation, sand/gravel winning, drinking water provisions, agriculture, waste water management.
Scientific research	Meteorology, climate, coast dynamics, oceanography, fisheries, and the like.
Service	Meteo-services, consultants, institutions for applied research.

2.2.3 Data

The need for information of the users determines which sort of data has to be included in the monitoring systems for coast and delta. Many of these data will have to be collected on a routine basis for a long period of time (the monitoring function) in order to be able to discover and to learn to understand changes within a short period of time and to test measures taken (inter) nationally. In addition, data will also be assembled on a project basis, e.g. for the execution of special projects or during extreme circumstances and disasters. Examples are: storm floods, ship disasters and environmental disasters. The routinely obtained data form the basis for the improvement c.q. optimization of processes which take place in the coastal areas (shipping routes, coast defence, evacuation plans) and for models with which developments can be forecast. Furthermore, they form the basis for Quality Status Reports (nationally, regionally and globally) which support the policy development and the management on a long-time scale.

A monitoring system for coast and delta is characterized by a rich diversity of gathered data. Geometric and morphologic data serve to record the form and location of coast and soil formations and to document their changes. Other data, derived from chemical analyses and biologic observations serve to typify the quality of water and the condition of ecosystems. With the aid of accurate data on the soil structure and the form of the water surface (tide waves) insight into the dynamics of the coast and delta area is gained. This insight is further enlarged by information on sand transports, water movements and water levels. The gathering of all these data, supplemented by meteorological data such as wind, air temperature and air humidity, takes place *via* a mixture of observation strategies, such as measurements *via* ships, buoys, poles and pontoons and *via* optical/remote sensing data derived from air planes and satellites; they are also more and more supplemented by operational numerical models and data assimilation.

2.2.4 International and regional programmes

Primarily observations in coastal areas and big rivers are important within the framework of attunement to international monitoring programmes. For the Netherlands this implies: Rhine, Schelde, Maas, Delta-area, IJsselmeer, Wadden Sea and North Sea. The attunement takes place *via* international commissions for the big rivers, e.g. the International Rhine-Commission and the Oslo Paris Commission (OSPARCOM) for the North Sea. At the same time attunement and bundling of national programmes and activities are achieved within the association of EuroGOOS (see 2.3.1).

The following (incomplete) overview of recent initiatives around monitoring of the North Sea is an example of international attunement and bundling.

2.2.4.1 SEANET

Cooperation among all countries around the North Sea and the Irish Sea (the entire continental shelf) on government level, in order to come to a common network of "fixed monitoring platforms". This initiative was taken by Rijkswaterstaat in around 1993. In the first place directed at physical and meteorological observations and data exchange but developing into other observations as well. The joining with EuroGOOS (North West Shelf Task Team) is taking place.

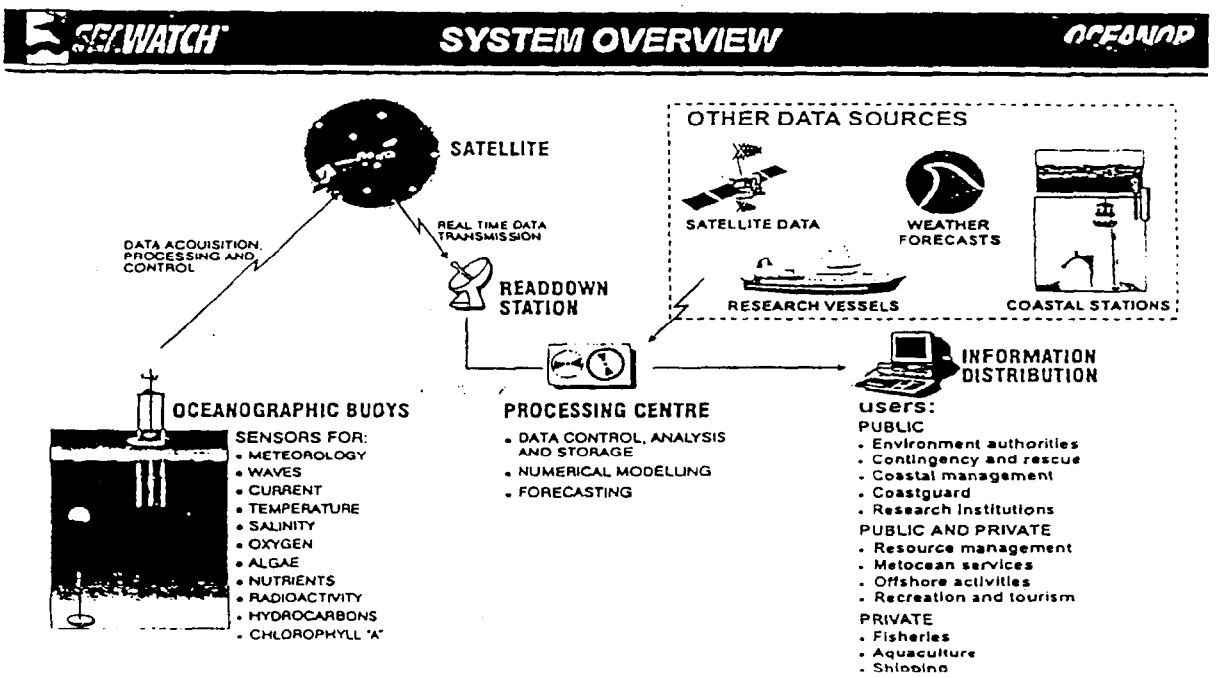
2.2.4.2 EuroGOOS

European cooperation to develop the GOOS objectives from Europe, indeed including also the protection of regional and national interests. For the Netherlands primarily the participation in the North West Shelf Task Team is of main importance to thus give also an interpretation to the national aspects looking at climate, storms, fisheries and biodiversity, development and safety of coastal areas, etc. An international data assimilation experiment is in preparation on the scale of the continental shelf (start of the experiment as of 2000/2001).

2.2.4.3 EuroMAR

A EUREKA-programme part in the field of marine technology. In the past ca. 10 years this led to a number of innovative products which are usable for operational oceanography. SEAWATCH is an example for this. The execution is based on national projects, partly subsidized, undertaken by companies from various countries in Europe:

- **SEAWATCH-North Sea**: Uses a network of strategically placed buoys for meteorological and environmental data. They are read out periodically *via* satellites and are available to users on-line after a short time. The programme focuses primarily on offshore and fisheries and is financed through EUREKA and oil companies. In South East Asia regional monitoring systems are active which function according to the SEAWATCH project. The following figure illustrates the system.



- **Ferry box:** Use of standard measuring systems on ferries on important North Sea routes for the gathering of data. (Initiative taken through EuroGOOS).

- **Maestro:** Flexible use of measuring buoys for meteorological data and wave movements for the improvement of wave forecast models for a certain location. (Primarily applicable for offshore work).

- **HF-Radar:** Spatial distribution of surface currents around river and harbour estuaries. Leads to a better overview of the actual current for the shipping industry.

- **RWS-BAS:** Deriving of information about soil location from radar reflections of the water surface, taken by aircraft and satellites.

- **RESTWAQ/REST3D:** Better information on the temperature stratification and mixture between various layers of the North Sea by focused combination (harmonization) of *in situ* data, satellite data and modelling.

2.2.5 National Programmes

For more than one hundred years, Rijkswaterstaat has gathered and archived information in a systematic way about water levels, discharge, soil topography and water quality as well as biological data. In many cases no strict separation can be established between international/regional programmes and national programmes. After all, many measurements, obtained on a national level, are directly made available on the international scale. In the framework of this chapter a complete overview of all national programmes concerning coast and delta monitoring would be too much. The overview below gives an impression of the national programmes' range.

Aspect	Issue	Organization
Dikes, high water coast (safety)	water levels, waves	RWS
	water temperature	RWS
	climatic influence on river	KNMI/
	discharge and sea level	RWS
	coastline maintenance	RWS
Warning services	drinking water	RWS
	high water	KNMI/RWS
	calamitous dumpings	RWS/PROV
Ecology	main structure	RWS
	balanced development biota	RIVO/RWS/LNV
	drought	PROV/RWS
Measuring strategy 2000+	attuning demand/supply of basic information	RWS
	technological modernization	RWS
Utility functions	cooling water	RWS/VROM
	quality of drinking water	RWS and others
	fishery	RWS
	shipping	RWS
	dumping	RWS
Environment	emission/pollution norms	various

Scientifically it is important to state that the capacities for coast research within the Netherlands are bundled in the CKO (Utrecht), the RIKZ, the direction North Sea, the WL and IMAU.

3. THE NETHERLANDS' INVOLVEMENT IN MONITORING SYSTEMS

3.1 STRATEGIC OVERVIEW

The global and regional (for the Netherlands read European) context of a national monitoring programme determines, in addition to specific national needs, the optimum effort and concept. Although already for decades work has been done on a global scale, 1997 stood out as the year in which the awareness of system Earth as a whole and of the coherence-in-diversity of global environmental problems found expression. Hitherto the diversity of numerous national programmes and the complexity of mankind's interaction with nature are the unavoidable causes for a fragmentation of efforts, discouraging at first sight. It is because nature does not know the borders of states and because our planet Earth is a system with interdependent cycles and feedbacks, that first scientists and somewhat later policy makers recognized their common interests. At present a major movement is on its way to join forces, share data, attune observation instruments and design them in complementary ways - in brief, to dispose of the highly needed usable information worldwide.

The global structures of science: IGBP, WCRP and IHDP were already mentioned. Operational systems for monitoring, of which scientists are merely one category of users, have, during recent years, also created their co-ordinating organizations. These are pragmatically categorized, into seas and oceans Global Ocean Observing System, GOOS, into climate issues Global Climate Observing System, GCOS, and into themes of land coverage and land use Global Terrestrial Observing System, GTOS. These three systems together are also designated by the acronym G3OS. None of these three systems is yet fully developed, but all

three of them are fully into development, dispose of international sponsors[1], active secretariats (see Internet sites) and a network of relations with the workers in the field, or better, in their manifold fields.

Space-based systems take a special, in the literal and figurative sense, overarching place. Therefore it was not surprising that in September 1997 the Committee on Earth Observation Satellites CEOS, together with the International Group of Funding Agencies (for global change research) -IGFA- took the initiative for a discussion about the development of an Integrated Global Observing Strategy -IGOS-. In an exceptionally fascinating response (Developing partnership on an IGOS, 10.11.1997) to a letter by CEOS about this issue the sponsors of G3OS take over this initiative and work out this idea in 85 paragraphs. This document demonstrates convincingly that time is ripe for a global strategy of data gathering and information forming, archiving and distribution.

The importance of the IGOS initiative can hardly be overestimated: completeness, exchangeability and the combination of information are indispensable for the tackling of innumerable problems, on all space-time scales from meters to earth diameter, from minutes to decades. This presents us with major challenges which can be realistically met only if knowledge, skills, facilities and funds are applied with care and with economic effectiveness. To realize this, it is not only necessary to look over the frontiers of disciplines and observing systems but also over the walls of organizations and agencies. The discussion on a worldwide level, as this has begun now, also needs attuning and a degree of corresponding integration within the regions and on the national level.

Within the European Union the European Environment Agency -EEA, with its headquarters in Copenhagen, forms an important focus for regional tasks which the IGOS initiative has in mind. The EEA cooperates with the Joint Research Centre -JRC of the EU and with the Office for Statistics - Eurostat. In the founding advice[2] ten years ago one reads as follows: *The Agency's task is to analyze and to solve problems, and has to be the driving force behind a measurement and information network.* Since then the Agency plays a central role in the watch over the environment in Western Europe. It also serves as an exchange center for national activities in the member states of the EU and of Norway and Iceland. The decision-making about the Fifth Framework Programme, in which within four thematic programmes for subject 4a: Environment and Sustainable Development well over a billion ECU has been earmarked, may prove that the ECU will continue to play a driving role also in scientific research in this field.

As far as monitoring systems are concerned, EuroGOOS is the most developed programme of all GOOS regions, while Europe plays a leading role worldwide as far as weather and climate are concerned. The Netherlands are fully involved in the tasks of GCOS in our region. The fact that our country, despite its major interests in delta and coast, in the North Sea and the Wadden Sea and in the North Atlantic Ocean on a regional scale, participates so little in EuroGOOS, urgently needs corrections. This point will be taken up later in this chapter. The development of GTOS is still too recent to sketch the European formation. It is beyond questioning that the Netherlands as an agricultural nation par excellence can play and will have to play a significant role in this programme. It may be expected that in parallel to the strategy formation on a worldwide scale, the European coherence of the G3OS will at least improve proportionally. The immense population density of Western Europe and the enormous environmental pressure, which our economically so prosperous part of the world generates, mean that systematic monitoring of all, relevant environmental indicators and their changes is an absolute requisite for sustainable cohabitation. This sustainability is such a precious good that monitoring, competently executed, in a strategic embedding of global *via* regional to national patterns guarantees an according return.

On the national scale there is much more going on than is possible to summarize at this point. In chapter 2 the goal was to sketch the contours of the five fields and in this chapter this aim is repeated with specific attention for our national effort.

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[1] Sponsors Group for the Global Observing Systems (GCOS, GOOS, GTOS), Geneva, November 1997

[2] From the advice by the Economic and Social Committee with respect to the application for an order by the Council for the establishment of the EEA, November 1989.

3.2 THE NETHERLANDS AND THE FIVE AREAS INVOLVED

As in part 2.3 the five fields which are distinguished in this report are dealt with in this chapter. Always a strategy is sketched, followed by a series of advice. These pieces of advice have a provisional, indicative character. They have to be read in context with the likewise provisional list of investments and supporting activities which is given in part 4.2. In a subsequent phase of this study advice and investment indications can be worked out into concrete proposals.

3.2.1 The Netherlands and the oceans

3.2.1.1 Strategy

There are two developments which are important for the monitoring strategy. The first one is the extension and regional attuning of existing networks such as those of Rijkswaterstaat. Measurement strategy 2000+ and SEANET play an important role here (see also 2.3.1 and 3.2.2). The second development is of a regional nature. The processes which take place in and above the North Atlantic Ocean are very important for the climate in the Netherlands. Paleo-oceanographic data and ice core data derived from Greenland made clear that rapid changes in the climate can happen on a time scale of a few decades. For the study of this topic the observation areas North Sea and Nordic Sea are of vital importance. For a better understanding of the North Atlantic Oscillation and of the position and the behaviour of the Gulfstream, phenomena that have a major influence on the climate in Western Europe, this network can be coupled to a network for observations in the entire North Atlantic Ocean. This network connects well with the international CLIVAR programme of the World Climate Research Programme. CLIVAR continues the work of the successful World Ocean Circulation Experiment which is at present in the phase of execution, and in which also the Netherlands participate. The Dutch Organization for Scientific Research (Nederiandse Organisatie voor Wetenschappefijk Onderzoek - NWO) took the initiative for CLIVARNET which focuses especially on the study of processes on a time scale from years to centuries. The research is of major importance for obtaining insights in climate variability and for the possibilities of producing forecasts in Europe.

The measuring network for the North Sea/Nordic Sea, coupled to a network for the North Atlantic Ocean, offers the possibility to link scientific research to operational oceanography, precisely as foreseen within GOOS. An investment in this network therefore has to be seen as the Dutch contribution to the implementation of UNCED/GOOS. In addition, there are indeed also cooperations within existing conventions, such as OSPARCOM (see 2.3.1). Participation in GOOS offers the possibility to internationally market the Dutch expertise, particularly in the field of coastal research and coastal management.

Within EuroGOOS an end-user survey is being carried out. Preliminary data from England, the Netherlands, Italy, Spain and Greece make it evident that there is a demand especially for physical data and information. This concerns among others: surface temperature and current patterns, wave level and wave direction, form and structure of the seabed, sedimentation, eddying, and other current phenomena. Organizations and companies need this information for internal use or for processing it into new products. There is as yet less interest in the so-called green parameters as chlorophyll, the amount of suspended matter, colour, nutritive substances, zooplankton, phosphates and the like. Much of this information is still in a research mode but can be made operational in a short time frame. Finally, it turns out that the interest in the data mentioned is especially present with high tech companies, which expect a new market for this.

Within the EuroGOOS framework the company OCN carried out a study with respect to the requirements an oceanographic information system for the North Sea has to meet according to Dutch users. The reactions convey a representative picture of the requirements which 'live' in the field. It comes to the fore that:

(i) it is difficult to translate the EuroGOOS goals into advantages for the individual organizations/companies. Thus, there is still 'missionary work' necessary to transparently communicate these goals towards the user communities;

(ii) there is much interest in data about wind, waves, water level, current and content of suspended matter. A time resolution of one hour is minimally required; often information is necessary which was obtained every ten minutes. The spatial resolution amounts to at least ten kilometers; in coastal areas and deltas this is higher. The measurements must generally show an accuracy of 10%;

(iii) there is a preference to dispose of 'processed' data, forecasts and statistics. A 'delay' of ten to twenty minutes, as a consequence of this preparatory work, is accepted. In the research world one is also interested in 'raw' data;

(iv) there is a need for forecasts in the short term, ranging from a few days to a week maximally;

(v) the interest in 'green (biotic) parameters' is small. At present these data are available only sporadically and this market still has to be developed.

3.2.1.2 Advice

It is of major importance that the Netherlands invest in a monitoring system for the North Sea and the North Atlantic Ocean. The Netherlands can do this from its strong position in the field of coastal research, models, integral water management, paleo-research and research about ecosystems and icecaps. The Organization of the coastal research and sea research has to be strengthened. This can be realized by preventing fragmentation and by assigning the RIKZ a co-ordinating role.

A second advice focuses on the international education in the Netherlands. Our country disposes of a first-rate infrastructure as well as of networks and has an excellent reputation in this field (IHE in Delft and other organizations). However, education with respect to knowledge about coastal areas is still underdeveloped. Programmes as the Partners in Science concept offer possibilities for 'Capacity building' in other parts of the world. In this context one could think of the Caribbean, Surinam, East Africa and Southern Africa.

The third advice is about the intensification of the relation the Netherlands maintain with EuroGOOS and GOOS, within the framework of G3OS. It is of vital importance, if only because of our international societal responsibility and our obligations which have been accepted *via* various international conventions, that the Netherlands maintain the connection with the structuring and developing of knowledge around all facets of system Earth.

The fourth advice concerns the execution of a Partners in marine Science programme in East Africa and Southern Africa (Kenya, Tanzania, Mozambique and South Africa) which is related to the Land Ocean Interactions in the Coastal Zone programme of the IGBP and to the Coastal Module of GOOS. Along the main lines the programme is completed and concerns in addition to the execution of research along the coast and in the EEZ the setting up of marine capabilities in the countries mentioned above. As a contribution to GOOS it is suggested to install a SEAWATCH system in this area.

A fifth but not less important advice is directed at the investment in a so-called NAO-array: a measurement network for the monitoring of the North Atlantic Oscillation. This network contains a series of buoys and measuring instruments tied to the seabed for monitoring the ocean circulation and ocean surface temperatures. This part of GCOS/GOOS will be implemented within the CLIVAR programme if sufficient funds can be found.

Till recently the archiving and accessibility of oceanographic data was not well organized in the Netherlands. In 1997 however, all organizations with oceanographic and coast-related data signed an agreement which made the NODC (National Oceanographic Data Commission) a fact. It is chaired by the RIKZ and the secretariat is in the hands of NIOZ. Experiences in the UK showed already that government can successfully play an initiating/stimulating role in order to tackle this problem effectively (British Oceanographic Data Centre of NERC). The commercialization of the often scientific data turns out to be hardly possible or impossible in practice.

3.2.2 The Netherlands and coast & delta

3.2.2.1 Strategy

The need for information by end users is central to the strategy and the design of monitoring systems for coast & deltas. Methods and instruments for the gathering and processing of data represent the basis for the monitoring system. However, the transformation into user information is an indispensable link, in order to be able to the needs of the users. With respect to coast & delta the following developments in the users'needs occur at present:

(i) Demand for higher information density, in space (density of the measurement network) as well as in time (frequency with which parameters are measured);

(ii) Faster delivery of information, *via* a well-structured central database, adequate data assimilation technique and a good telecommunication infrastructure. The users do not show a high need for raw data but rather for coherent harmonized information:

(iii) Availability of long-term measurement series for the analysis of trends, especially in the field of transport of sand, sediment, nutrients, plankton and the like;

(iv) More insight into causal relations and forecasts of the effect of certain interferences in the coast area & delta area. This information is of vital importance for the managing of sustainable developments;

(v) Better insight into influences of global processes on regional and local circumstances;

(vi) Good data with respect to extreme conditions, as with floods, storms, droughts and accidents with, e.g. ships.

Within the monitoring field of coast & delta a number of user groups has to be distinguished, each with its own specific wishes and objectives. From the aspect 'safety' there is a need for insight into the effect of climate changes on large-scale currents and the tides in the Atlantic ocean and on the behaviour of the atmospheric circulations, e.g. the characteristics of depression paths and depression intensity. Changes in this behaviour can entail major consequences for (extremes in) tides, waves and storm floods in the North Sea and thus influence the efforts necessary in order to continually guarantee the safety of coast and shipping, also in future. In the framework of Policy and Management there is a need for knowledge of change processes in the coastal areas, especially in relation with projects as Maasvlakte-2, the deepening of the Westerschelde and a possible airport in the North Sea. In addition, a good evaluation of the consequences of alternative forms of management is necessary, to be applied at the Haringvliet locks and in the Oosterschelde bassin. Furthermore, in the framework of Policy and Management, a better insight into the necessity of emission limiting measures and the tracing of illegal dumping is desired.

The interest by the user group Shipping is evident. The support of the shipping trade can be further improved through good, up-to-date information about currents, waves, water depths and water levels. Beyond this, knowledge of sand transport, silt formation and the location of channels prepares the ground for a more efficient dredging policy so that adverse effects can be pushed back further. Also other industrial activities, such as the off-shore industry and fisheries, have an interest in a monitoring system for coast & delta. Especially the fisheries can get a better insight into the development of the numbers of annual classes of commercially exploitable fish species. At the same time it can be checked by which factors this development is influenced and how this happens. In this context the current pattern in the North Sea, the relation with the Atlantic Ocean, the transport of nutrients and plankton and the like play a role.

Other user groups of a monitoring system for coast & delta belong to the recreational sphere (information about the quality of swimming water, temperature, currents and water levels) and to scientific research. Knowledge about multiyear changes, such as the level of the sea, is furthermore of interest to the national 'utility task' with respect to securing low-lying areas against floods.

3.2.2.2 Advice

Within a very diverse user community there is a major need for data, c.q. information which can be obtained with a monitoring system for coast & deltas. The monitoring system furthermore renders essential services for the evaluation of agreements made in an international context (North Sea, Rhine, Maas, Schelde) about the reduction of pollutants and nutrients, and about fisheries' agreements. Beyond this, the Dutch obligation with respect to the input in, e.g. OSPARCOM, EuroGOOS and SEANET must be borne in mind. (SEANET is a cooperation agreement between the eight national monitoring organizations around the North Sea, including France and Sweden, the goal being the promotion of on-line mutual data exchange, standardization of the monitoring process and the data processing, attuning of development of new measuring techniques and optimalization of the entire measurement network).

The need and the obligations lead to the following advice:

The first advice is to take the development and initiation of new measuring techniques vigorously in hand and to integrate them into the existing arsenal of measuring methods. Among these potential techniques are the following:

(i) Measurements of the surface currents with HF-radar;
(ii) Determination of bottom-location with the RWS-BAS technique;
(iii) Observation of the coast development *via* Argus video technique;
(iv) Evaluating and rendering applicable of remote sensing techniques from aircraft and satellites; for this, among others it is necessary to couple local observations to RS observations (calibration);
(v) Integration of measuring platforms with techniques for the determination of locations (among others GPS);
(vi) Sensors for environment parameters on flexible buoys, to be installed jointly and to be exploited at strategically located positions in the North Sea;
(vii) Acoustic tomography for the determination of changing mass fluxes in certain areas of the North Sea;
(viii) Execution of international experiments with drifters coupled to GPS for the determination of large-scale transport paths, time of stay and migration patterns;
(ix) North Sea-wide implementation of the measurements on ferries ("moving platforms") and integration with *in situ* monitoring and RS monitoring.

A second advice concerns the field of processing and of interpreting measuring data. Just because users need coherent, processed information, it is necessary to carry out data assimilation. A requisite are three-dimensional models for the water movement, the transport of matter, the water quality and the ecology. Furthermore, there is an interest in simulation models from which forecasts with respect to the development in (the near) future can be derived. Just as in other fields of monitoring systems it is also true here that the existence of a good data archive structure with appropriate "opening techniques" is very important for being able to serve the users in the right way.

4. SOCIO-ECONOMIC AND FINANCIAL ASPECTS

4.1 DESIRABLE INVESTMENTS, EXPLOITATION AND FLANKING EFFORTS

This study does not aim at working out, already at this stage, concrete investment proposals and to judge these on their own and their relative merits. In a later phase this will certainly be the case. The Team is nevertheless of the opinion that also this report has to be as specific as possible and has to provide some insight already now into the nature and the size of desired investments in the short to medium term. With this in mind it was therefore decided to produce for each of the G30S fields a **preliminary** listing.

The following three parts are such listings. These are the answer to the question: "Which additional investments in this field will make the Netherlands a full member of the community of countries which support the international monitoring systems in this field?" The response bears in mind the present Dutch effort with respect to quantity and quality, national interests, priorities, preferences and contractual obligations as well the

knowledge and skills necessary to realize the investments. The exploitation cost of these investments over a period of five years as well as flanking activities, without which these investments cannot come to fruition are considered an integral part.

These investments concern primarily the so-called *in situ* systems which are essential for the measuring work and also for the validation of the measurements *via* space-based systems. About the latter an important remark fits at this place. In this phase the TTMS did not go deeply again into space-based systems of today and of the coming ten years. The recent foresight study by the Foresight Committee Space Technology (Verkenningscommissie Ruimtetechnologie (VCRT)) wrote things worthy of consideration also about earth observations. The TTMS agrees to the tests and the interpretation of possible future routes mentioned in the VCRT report as well as to the point of departure "*...that the Netherlands are a loyal and stimulating member of ESA and that the country participate more or less proportionally to the main line programmes of the agency in the obligatory as well as in the optional programmes.*" **This implies certainly for the ESA earth observation programme a considerable strengthening of the Dutch role compared to a few years ago, a financial impulse of some tens of million guilders per year for the period 2000-2004. Interdepartmental consultation going into this direction is well advanced.**

The experts provided the material, from their own responsibility, in interaction with their professional environment. In phase 2 these possibilities will have to be thoroughly analyzed, compared and tested. The concrete options demonstrate in any case the character and size of the improvements the Team has in mind.

4.1.1 Coast, delta, seas and oceans: GOOS

4.1.1.1 Observation system for the determination of the influence of the Atlantic Ocean on the North Sea and the significance for the Dutch Coastal Waters.

For the Netherlands it is of direct interest to be involved in the international monitoring of the North Atlantic Ocean. To an important extent this oceanic system determines the meteorological and climatological development of Western Europe and of the neighbouring epicontinental seas. The North Atlantic Ocean is at the same time an important determinant for the circulation and the chemical and biological composition of the North Sea.

The circulation of the North Sea is a combination of Gulf Stream, meteorology (air pressure and wind) and density differences of water masses, caused by temperature -and salinity- gradients. In order to get more insight into the processes of change which operate in the North Sea system and in order to get more insight whether changes are the consequence of large-scale changing processes or whether those are more the consequence of local influences, solid knowledge of the oceanic boundary conditions is a requisite. This concerns especially the knowledge about large-scale currents and the coupled matter transport and the knowledge about the chemical and biological composition of the ocean water influx.

Methods to dispose of this knowledge are among others:

- the gathering and interpretation of remote sensing images for temperature, ocean colour and the like;
- the placing of buoy systems and measuring platforms for the observation of currents, temperature and salinity;
- the use of ferries for transact monitoring of salinity, temperature and the like;
- the maintenance and (financial) support of the "Continuous Plankton Recorder" by SAHFOS, through which insight into the plankton composition of the oceanwater influx is obtained;
- the development and application of operational 3D-modelling systems which can provide insight into the transport routes of matter and change processes which are the consequence of variations in the circulation of the North Sea.

The investment and exploitation of this observing system can be seen as a concretization of the Dutch share in EuroGOOS and at the same time is directly related to a better understanding of the variability of the North Sea system and of the Dutch coastal waters in particular. The necessary investments are estimated at ca.

5 Mfl. The cost for the annual exploitation (= collecting and primary processing of measuring data) are estimated at ca. 4 Mfl/p.a., whereas the cost for the definitive processing and interpretation of the measuring data, assimilation in causal operational (30)-models included-, is estimated at ca. 2 Mfl/p.a.

Investments		5 Mfl
Exploitation	4 Mfl/p.a.	20 Mfl
Processing and dissemination	2 Mfl/p.a.	10 Mfl
Sub-total		**35 Mfl**

4.1.1.2. Integral monitoring of the change processes in the Dutch Coastal Waters, (Pre) Delta and the Wadden Sea

In support of the possibilities for coastal extension plans (think of, e.g. Maasvlakte-2 and an airport at sea) as well as of the study of the consequences of, e.g. an alternative management of the Haringvliet locks, the deepening of the Westerschelde and the construction of a permanent cross-channel connection with Zeeland Flanders, integral monitoring of change processes in the coastal (water) system is an essential part of the detection of changes on a regional and possibly even local scale.

By using causal models at the same time and thereby considering the large-scale variability of the sea-system North Sea, it is possible to analyze which changes are the consequence of more large-scale influences and which are caused by local interference.

Investments concern the introduction of new observing methods in the coastal zone such as the Argus system and RWS-BAS for the determination of changes in the coast morphology. New remote sensing methods on the basis of airborne observations and satellites can make a valuable contribution to the knowledge of water quality and ecology in the Dutch coastal waters, delta waters and the Wadden Sea.

Also methods such as HF radar and integration of *in situ* observations with remote sensing and model results can make an important contribution to the quantification of the consequences of possible interferences with the coastal system. Hereby effects are not quantified only after realization but also *a priori* on the basis of prognostic models.

The cost for investments related to a better observation of change processes in the Dutch coast, the delta waters and the Wadden Sea are estimated at ca. 5 Mfl/p.a. The annual exploitation cost is estimated at 3 Mfl/p.a., whereas for further processing and dissemination of the information for various purposes ca. 1 Mfl/p.a. is budgeted.

Investments		5 Mfl
Exploitation	3 Mfl/p.a.	15 Mfl
Processing and dissemination	1 Mfl/p.a.	5 Mfl
Sub-total		**25 Mfl**

4.1.1.3 Operationally induced monitoring of extreme conditions (extreme events)

An important problem with routine monitoring is that the measuring density during extreme conditions is often insufficient to obtain enough insight into the precise development of such events. By setting up an operational monitoring which at the same time gives input to the operational forecast of extreme conditions a timely anticipation of the intense monitoring of, e.g. conditions which can lead to the blooming of pestering algae and their risks for fishery and recreation should be possible. The use of altimeter methods, remote sensing of temperature and ocean colour and radar images for waves, oil and the like as well can provide important insights into the appearance of extreme conditions which enable measures to be taken in time.

An aspect of such operational monitoring is also the timely signalling of calamitous discharges (e.g. oil), which makes it easier to trace possible offenders but also speeds up the neutralization of the discharge.

Another aspect concerns the gaining of insight into, e.g. the silt transport along the Dutch coast under storm circumstances. It is well known that during stormy periods much silt comes in suspension and is subsequently deposited in the harbours of the Rijnmond area and along the Dutch coast. Due to the high cost caused by maintaining adequate harbour depth it is very important to dispose of more knowledge about the silt- and sand transports under such circumstances. Specific measuring campaigns together with the use of causal model applications are therefore of considerable importance.

Investments related to the monitoring of extreme conditions are estimated at 2 Mfl. For specific measuring campaigns and exploitation of a system for early signalling of extreme conditions the cost is estimated at ca. 2 Mfl/p.a. The cost caused by a further processing and dissemination of the results obtained are estimated at I Mfl/p. a.

Investments		2 Mfl
Exploitation	2 Mfl/p.a.	10 Mfl
Processing and dissemination	1 Mfl/p.a.	5 Mfl
Sub-total		**17 Mfl**

4.1.1.4 Development and application of operational end-to-end monitoring system the management and the use of coasts, seas and estuaries

For applications in the Dutch coastal waters as well as for possible applications at other places in the world where consultants, contractors and researchers work, it is highly important to be able to dispose of generally usable monitoring systems and monitoring methods. During the development of such end-to-end monitoring systems attention has to be paid especially to the type of information important for the users. Examples for end-to-end systems which dispose of a high potential but still need further development are among others:

- HF radar system for the quantification of current patterns among others for the guiding of shipping;
- DMI systems for water level, current and transport;
- Argus system for the monitoring of the coast dynamics;
- integration methods for processing and harmonization of data derived from remote sensing, *in situ* observations and model applications;
- airborne remote sensing voor tracing and fighting of a.o. calamitous discharges and support of integral sea- and coast research.

The investment cost is estimated at ca. 5 Mfl, whereas ca. 2 Mfl per year are budgeted for testing and improving the processing methods.

Investments		5 Mfl
Testing and improving	2Mfl/p.a.	1 Mfl
Sub-Total		**15Mfl**
Total (1+2+3+4)		**92 Mfl**

4.1.1.5 Routine gathering and processing of data of the North Atlantic Ocean

The point of departure is the participation in the routine gathering and processing of data of the ocean in one area of direct interest for our country and one for which this is indirectly the case. The first area concerns the North Atlantic Ocean and thus relates to the North Sea and to the Nordic Sea. These initiatives relate well to existing plans within EuroGOOS, SEANET and CLIVAR. In this part of the proposal it is also supposed that the Netherlands will play a more pro-active role within GOOS and EuroGOOS. The reason for this is the knowledge and skill available in our country in the field of coast research and sea research. This goes especially for the management. The participation in GOOS offers a possibility to promote this knowledge and skill within a constellation in demand.

a) 5 buoys at Mfl 1.1		
Investment cost		5.50 Mfl
Exploitation cost	0.50 Mfl/p.a.	2.50 Mfl
b) EuroGOOS		
Personnel cost	0.40 Mfl/p.a.	2.00 Mfl
Exploitation cost	0.15 Mfl/p.a.	0.75 Mfl
c) GOOS		
Trust Fund	0.20 Mfl/p.a.	1.00 Mfl
Exploitation cost	0.10 Mfl/p.a.	0.50 Mfl
d) Capacity building in Caribbean area		
Investment cost/ Exploitation cost	1.00 Mfl/p.a.	5.00 Mfl
Sub-total		**17.25 Mfl**

4.1.1.6 The Extended Economic Zone (EEZ) of four coast states in Eastern and Southern Africa

The plans for a regional Partner in Marine Science Programme with these countries are in a far advanced phase. The programme is a good match with LOICZ (especially the coastal module and climate module of) GOOS. The countries in question are: Kenya, Tanzania, Mozambique and South Africa. The rough estimate given below concerns a period of 5 years:

Investment cost		
Seawatch Unit		20.00 Mfl
Programme research	1.00 Mfl/p.a.	5.00 Mfl
Programme capacity building	2.00 Mfl/p.a.	10.00 Mfl
Programme training	0.50 Mfl/p.a.	2.50 Mfl
Sub-total		**37.50 Mfl**
Total GOOS (1+2+3+4+5+6)		**147.00 Mfl**

4.2.2 Overview Investments with corresponding costs (from 4.2.1 Coast, delta, seas and oceans: GOOS)

(i) Observation system for the determination of the influence of the Atlantic Ocean on the North Sea and the significance for the Dutch Coastal Waters		
Investments		5 Mfl
Exploitation	4 Mfl/p.a.	20 Mfl
Processing and dissemination	2 Mfl/p.a.	10 Mfl
Sub-total		**35 Mfl**
(ii) Integral monitoring of the change processes in the Dutch Coastal Waters, (Pre) Delta and the Wadden Sea		
Investments		5 Mfl
Exploitation	3 Mfl/p.a.	15 Mfl
Processing and dissemination	1 Mfl/p.a.	5 Mfl
Sub-total		**25 Mfl**
(iii) Operationally induced monitoring of extreme conditions (extreme events)		
Investments		2 Mfl
Exploitation	2 Mfl/p.a.	10 Mfl
Processing and dissemination	1 Mfl/p.a.	5 Mfl
Sub-total		**17 Mfl**
(iv) Development and application of operational end-to-end monitoring systems for the management and the use of coasts, seas and estuaries		
Investments		5 Mfl
Testing and improving	2 Mf/p.a.	10 Mfl
Sub-total		
Total (1+2+3+4)		**92 Mfl**

(v) Routine gathering and processing of data of the North Atlantic Ocean		
a) 5 buoys at Mfl 1,1		
Investment cost		5.50 Mfl
Exploitation cost	0.50 Mfl/p.a.	2.50 Mfl
b) EuroGOOS		
Personnel cost	0.40 Mfl/p.a.	2.00 Mfl
Exploitation cost	0.15 Mfl/p.a.	0.75 Mfl
c) GOOS		
Trust Fund	0.20 Mfl/p.a.	1.00 Mfl
Exploitation cost	0.10 Mfl/p.a.	0.50 Mfl
d) Capacity building in Caribbean area		
Investment cost/ Exploitation cost	1.00 Mfl/p.a.	5.00 Mfl
Sub-total		**17.25 Mfl**
(vi) The second area concerns the Extended Economic Zone (EEZ) of four coast states in Eastern and Southern Africa		
Investment cost (Seawatch Unit)		20.00 Mfl
Programme research	1.00 Mfl/p.a.	5.00 Mfl
Programme capacity building	2.00 Mfl/p.a.	10.00 Mfl
Programme training	0.50 Mfl/p.a.	2.50 Mfl
Sub-total		**37.15 Mfl**
Total GOOS (92 Mfl+55 Mfl)		**147.00 Mfl**

5. CONCLUSIONS AND RECOMMENDATIONS

This short study led the Team to a number of general conclusions and prompts a series of managerial recommendations.

5.1 GENERAL CONCLUSIONS

(i) Internationally, a great deal was initiated in the field of "monitoring global environmental change", especially in the 1990s. Scientific research as well as operational monitoring systems are more and more globally coordinated on a qualitatively high level. National work needs to be dovetailed with the global strategies and the attuned regional/continental effort.

(ii) The co-ordination of end-to-end monitoring systems for global environmental changes is in adequate hands at G3OS and CEOS; they deserve Dutch involvement and support. Their initiative for the development of an Integrated Global Observing Strategy-IGOS is extremely important and has to be promoted with vigour. This is the only way to transform fragmentation, ineffective work and efforts far from optimum by people and means into an effective system which can provide the multifaceted need for information for the description of the problem and the development and evaluation of effective measures for basic scientific research.

(iii) System Earth is a coherent entity that does not care about national borders and cultural differences. Effective monitoring systems will have to evenly cover planet Earth, a desideratum well accomplished by *space-based* systems, but this will not be the case for a long-time by the essential, complementary *in situ* systems. It is necessary, not only because of this, to support the developing countries in their indispensable participation in global, regional and national monitoring activities. Programmes for capacity building, partners in science and construction of infrastructure need support coming from development aid in order to ascertain sustainability for all of humanity.

(iv) Environment measures in the highly developed countries (OECD Member States), in public and private institutions jointly, concern economic activities which amount typically to a few percent (in the Netherlands ca. 4%) of the GNP. It is an elementary requirement of good and effective management to use an adequate fraction of this "turnover" for monitoring so that these activities can be mapped and,

followed and that these measures can be tested for their effectiveness. Only integral monitoring makes it possible to better understand natural systems, to reduce uncertainties to state sensitivities and to follow the effects of measures. This fraction will have to amount to a few percent of the turnover for maintaining global overview and detailed insight and will, macro-economically, more than pay for itself by efficiency-increase which is rendered possible by this information and by the information-based insight.

(v) Almost everywhere, but certainly also in our country, the financing and the Organization of environment monitoring are lagging behind in the macro-economic interest which is at stake, *a fortiori* with the societal interest of sustainable development which is endangered in numerous fields without reliable monitoring.

(vi) A concerted action is needed at all scales of activity in order to treat, to calibrate and to combine data with models *via* data assimilation in such a way that usable, exchangeable information is created. The network of electronic highways forms an indispensable infrastructure for these activities.

(vii) The Netherlands internationally play an active role in formulating Environment Agreements such as Climate and Biodiversity. The deriving obligations induce corresponding contributions to the development of G3OS/IGOS, including monitoring systems. This is achieved through the input of national efforts and the investment in national systems in proportion with international partners. This cooperation also results in continuous rationalization and in an accentuation of the national effort.

5.2 RECOMMENDATIONS

§ 59 of the document *Developing partnership on an IGOS*, mentioned at an earlier place, states the following:

"There is also a need for integrated approaches at the national level, where fragmented agencies and programmes make it difficult to articulate national activities with integrated multidisciplinary global programmes"

For the Netherlands the TTMS regards it as particularly desirable to designate an agency for each of the G3OS fields, which in dialogue with an advisory committee from the field:

(i) maintains the contacts with the secretariat for GxOS and with the relevant European organs;
(ii) promotes and cares for the relations between the operational and scientific activities;
(iii) regularly tests the effectiveness, the quality and the coherence of the Dutch contribution to international monitoring;
(iv) supervises the Dutch contribution to the international training efforts (capacity building) for developing countries on the GxOS terrain.

The TTMS proposes:

(i) to designate the RIKZ as the agency for Dutch activities on the terrain of GOOS in general and EuroGOOS in particular;
(ii) to designate the RIVM, together with an institute to be selected from the Knowledge Centre Wageningen (KCW) for these tasks on the terrain of GTOS;
(iii) to designate the KNMI as the agency for Netherlands activities on GCOS (and WMO/ECFMW) terrain;
(iv) for contacts with CEOS about space based systems we propose to designate the NIVR in dialogue with SRON and the BCRS (and in due course its successor), for an analogous role.

Also to nationally deal properly with the evolution which IGOS will bring about on a global scale, we note § 60 of the document cited above:

"A few governments have expressed a preference for a single national body to deal with all three observing systems. For this, they will have to develop some integrating mechanism at the national level. Otherwise, 4 is not evident to identify who in a government would be the appropriate national counterparts for all three systems, and who to invite to intergovernmental meetings."

The TTMS proposes to appoint a Steering Group, consisting of eight members, to be nominated one each by the four above-mentioned agencies/institutes (RIVM/KCW in turn) and by their advisory committees, to be led by an independent chairperson who is appointed by the government. The Steering Group disposes of its own means and a small staff. This Netherlands Steering Group Monitoring Systems for Global Environmental Change then becomes responsible for:

(i) the continuous tuning of the national fourfold efforts to the unfolding Integrated Global Observing Strategy-IGOS;
(ii) advising the government, upon request or otherwise, about the quantity, quality, structure and co-ordination of the national programmes at issue;
(iii) advice about budget allocations for both the international and the national operational projects and programmes;
(iv) the co-ordination of the national efforts concerning global environmental change which surpass the boundaries of the four agencies mentioned, including the collaboration of these agencies themselves;
(v) the public information task, for politics, for all levels of policy-making, management, the NGOs, the media, the schools and for citizens at large.

The Steering Group collaborates with the Royal Netherlands Academy for Arts and Sciences (KNAW) and the Netherlands Organization for Scientific Research (NWO) where (parts of) IGBP, WCRP and IHDP related research are coordinated and financed respectively.

I. NIGERIA

Nigeria has been participating in different modules of GOOS. These include:

1. GLOBAL CLIMATE OBSERVING SYSTEM

The Nigerian Institute for Oceanography and Marine Research (NIOMR) operates two tide gauges - an analogue tide gauge and an acoustic tide gauge - under the GLOSS network. The analogue tide gauge was donated by the Government of Sweden through the IOC of UNESCO. Sea level data and tidal data are collected regularly and analyzed.

The second tide gauge is an acoustic type - Next Generation Water Level Measuring System (NGWLMS). This tide gauge was provided by NIOMR. It is equipped with ancillary sensors for monitoring climate related parameters such as wind speed, wind direction, wind gust, barometric pressure, primary water level, air temperature and water temperature.

This equipment has generated large volumes of marine meteorological data since 1992. These data are processed and analysed in NIOMR and also in the WDCA database.

2. OCEAN OBSERVING PANEL FOR CLIMATE

The Nigerian Institute for Oceanography and Marine Research with assistance of the National Oceanic and Atmospheric Administration (NOAA) of the USA are collaborating in a climate related research: the Shipboard Environmental Acquisition System III (SEAS III) Programme. The project is designed to collect oceanographic and marine meteorological data with prompted data entry and transmission.

This collaborative effort involves the use of a Voluntary Observing Ship (VOS) - *Clipper-Sao-Louis*. The VOS regularly transacts the WOCE/TOGA route AX-14 - Lagos-Rio-Lagos. Data regularly collected along this route include: depth, temperature profiles, wind speed, wind direction, atmospheric pressure, cloud type, cloud height, surface visibility, swells and ice.

All data collected during navigation are automatically sent to NOAA while the downloaded data is processed and analysed in NIOMR.

3. COASTAL INFORMATION

NIOMR-NOAA-NODC exchanged a memorandum of understanding on the establishment of oceanographic data exchange programme. The types of data to be exchanged are as follows:

- Physical and chemical data;
- Sea surface temperature;
- Vertical profile of temperature (XBT data);
- Vertical profile of salinity;
- Biological data;
- Marine geological data.

4. LIVING MARINE RESOURCES

The Nigerian Institute for Oceanography and Marine Research is involved with various research activities with focus on the living marine resources in the marine environment. These include:

- Stock assessment of marine fisheries resources;
- Catch statistics and fisheries management;
- Assessment of shell-fish fisheries in Nigeria marine environment;
- Fisheries resources survey;

- Monitoring of sea turtles in the Nigeria marine environment.

5. HEALTH OF THE OCEAN

The Nigerian Institute for Oceanography and Marine Research is actively involved in the Gulf of Guinea Large Marine Ecosystem (GOG-LME) project. The focus of this project is the assessment of the health of the marine environment of the Gulf of Guinea.

J. POLAND

The Poland supports GOOS and is active in its development, concentrating mainly on the regional components like EuroGOOS and the Baltic Operational Oceanographic System (BOOS). Two Polish institutions are members of EuroGOOS and three are active in BOOS.

The main activities in operational oceanography in Poland are devoted to the Baltic Sea area. The following large international projects, which Poland is engaged in, can be mentioned here:

(i) The Baltic Monitoring Programme under the Helsinki Convention: the five years periodical assessments of the state of the sea are published regularly. Project for the Polish Coastal Zone Monitoring (1995 - 2010) has been worked out and approved;

(ii) The BALTEX, which is the GEWEX regional project. A plan for the Main BALTEX Experiment (BRIDGE) has been worked out. The DIAMIX (Diapicnal Mixing) field experiment has been elaborated and the pilot experiment is under way;

(iii) BASYS (Baltic Sea System Studies), with the goal to better understand the functioning of the Baltic Sea as a whole, including its ecosystem.

Besides this, the national activity includes:

(i) Regular cruises recording physical, chemical and biological variables for the long-term monitoring of changes;

(ii) Monitoring of pollution in the coastal waters and modelling of the transport of pollutants;

(iii) Sea-level observations along the Polish Coast, and modelling of probable sea-level changes connected to climate warming;

(iv) Monitoring of sea-shore changes and protection of the coast.

Outside the Baltic Sea, it is worth mentioning the Polish engagement in research and monitoring of changes in the Arctic Seas oceanography and climate. Poland participates in the VEINS and ACSYS programmes.

The "Polish National Programme of Marine Research up to 2010" has been worked out and adopted. Summary of this programme is included.

The organizational matters are still at the development stage. We are re-organizing our GOOS Committee, trying to involve a broader representation of marine industries and shipping.

Excellent cooperation of the Baltic oceanographers and the Baltic States in general provides a good basis for the unified system of operational oceanography in the region.

R. RUSSIAN FEDERATION

REPORT ON THE ACTIVITIES OF THE MARITIME INSTITUTIONS OF THE RUSSIAN FEDERATION RELATED TO THE GLOBAL OCEAN OBSERVING SYSTEM (GOOS)

In 1998 the National Oceanographic Committee of the Russian Federation (NOC RF) established a national Working Group on GOOS. Its goal is to prepare the national GOOS programme and proposals on the participation of Russian institutions in various projects related to GOOS activities.

The composition and Terms of Reference of the Working Group are given in the Appendix to this report.

The following national agencies and institutions participate in various areas of GOOS activities:

(i) The Russian Academy of Sciences (RAS):
- P.P. Shirshov Institute of Oceanology;
- Southern Branch of P.P. Shirshov Institute of Oceanology;
- Pacific Oceanological Institute, Far-Eastern Branch of RAS;
- Institute of Global Climate and Ecology (RAS and Roshydromet).

(ii) Federal Service of Russia for Hydrometeorology and Environmental Monitoring (Roshydromet):
- Hydrometeorological Centre of Russia (a State Scientific Centre of Russia);
- All-Russian Research Institute of Hydrometeorological Information -World Data Centre (RIHMI-WDC);
- The State Oceanographic Institute;
- St.-Petersburg Branch of the State Oceanographic Institute;
- Far-Eastern Regional Hydrometeorological Institute;
- Arctic and Antarctic Research Institute (a State Scientific Centre of Russia).

(iii) Department of Navigation and Oceanography, Ministry of Defense:
- Oceanographic Research Centre of the State Navigation & Hydrography Research Institute;
- Hydrometeorological Service of the Navy;
- N.N. Andreyev Acoustics institute (a State Scientific Centre of Russia).

In 1998 NOC RF created a Web-site "Russian Marine Research" containing information on national marine research programmes and various aspects of participation of Russia in major international programmes such as GOOS. An English version of the Web-site is located at:

(http://www.extech.msk.su/english/ocean/index.htm).

In 1998 the Government of the Russian Federation adopted a new long-term federal programme "World Ocean". It will be the main programme co-ordinating all national marine activities up to the year 2012. The programme consists of ten sub-programmes. Two of them, namely "Study of the Nature of the World Ocean" supervised by the Ministry of Science and Technologies of the Russian Federation and "Creation of the unified information system on the state of the World Ocean" supervised by the Roshydromet, include tasks aimed at development of modern systems for ocean data acquisition and oceanographic data/information exchange. Both sub-programmes are of direct relevance to GOOS. The other eight sub-programmes also contain numerous elements, which are of importance for all five modules of GOOS.

Within the framework of the federal programme "World Ocean" and under the leadership of the Institute of Oceanology several research institutions have initiated a research programme called "Acoustic Thermometry of Ocean Climate". The programme is aimed at developing acoustic systems for monitoring the climate variability of the Arctic Ocean, acoustic monitoring of water and heat exchange through the Fram Strait and integrated monitoring of the Bering Strait. The research work under this programme will further promote the study of global climate change. It will contribute to the climatic module of GOOS as well as to such

research programmes as CLIVAR and ACSYS. Development of the autonomous system for acoustical monitoring of the Arctic Ocean and long-term monitoring of area along the Hawaii-Kamchatka traverse is the main objective of the ATOC project being implemented jointly by Russia and USA.

The Institute of Oceanology also conducts a research programme "Monitoring of the ocean-atmosphere interaction". It is focused on climate change forecasting and the programme objectives are of direct relevance to CLIVAR and GOOS. At present a Working Group on CLIVAR develops a coordinated national CLIVAR programme.

RAS, Roshydromet, and the Russian Space Agency (RSA) approved the concept of a national programme on development of space-based observations of the oceans. The programme will be implemented in 1996-2015. Its basic idea is to create a system of specialized satellites for oceanographic research. Several institutes of the RAS, Roshydromet, and RSA participate in this programme. The programme leader is the P.P. Shirshov Institute of Oceanology.

The Arctic and Antarctic Research Institute (AARI) continues to carry out the integrated environmental studies of the northern and southern polar areas and provides operational hydro-meteorological services to shipping and economic activities in the Arctic and Antarctic. Within the EuroGOOS activities the AARI plans to ensure operational exchange of hydro-meteorological and sea-ice information for the Arctic seas of Europe. Information to be provided by AARI will be available on the WWW server (at http://www.aari.nw.ru). On July 19-23, 1999, the AARI holds the First Transition Planning Meeting to the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology, which is expected to be the major vehicle supporting the development of operational oceanography.

The automated sea-ice information system for the Arctic (ALISA) developed at the AARI continues to be improved. The AARI is a leading institute of the research project "Development of the basis for the GOOS module on operational marine meteorological and oceanographic services", which is a part of the Roshydromet research programme.

The Hydrometeorological Centre of Russia fulfils duties of the World Meteorological Centre "MOSCOW" of the WMO. In addition to a wide range of weather forecasts the centre prepares and disseminates marine meteorological analyses and forecasts. Their list includes wind wave forecasts over the North Atlantic and non-Arctic seas of Russia, global data on SST distribution, ice conditions and storm surge predictions for the non-Arctic seas, long-term forecasts of the Caspian sea-level, ship routing services. The research at HMC Russia is aimed at further improvement of the operational hydro-meteorological monitoring and forecasting and is of particular relevance to the GOOS marine meteorological and oceanographic services module.

The State Oceanographic Institute and its St.-Petersburg Branch conduct monitoring of the Baltic Sea within the framework of the HELCOM. They participate in a regular assessment of the state of the Baltic Sea.

The St. Petersburg Branch of the SOI jointly with the North - Western Regional Branch of the Roshydromet prepared a proposal on the information exchange with the Swedish Meteorological and Hydrological Institute. Its purpose is to develop a regional operational forecasting system based on a high resolution oceanographic model.

Within the framework of the IOC Black Sea Regional Committee actions have been taken to plan and develop a Black Sea Regional GOOS project. The State Oceanographic Institute presented at the 2nd session of the IOC Regional Black Sea Committee (Istanbul, May 1999) its proposals on the development of GOOS regional activities related to the Health of the Ocean and Coastal modules of GOOS. In 1997-1998 the Hydrometeorological Centre of Russia in cooperation with the Institute of Meteorology and Hydrology of Bulgaria and Meteo-France formulated a proposal on the development of a modern regional operational marine services system in the Black Sea (BLACKMARS). At the 2nd session of the GOOS LMR Panel (Montpelier, France, March 1999) the Institute of Oceanology presented a report on the environmental changes of the Black Sea that occurred during the last 20 years under the influence of anthropogenic factors. The report also

described the status and results of monitoring of living marine resources conducted by the institute during the last decade.

The Chief Department of Navigation and Oceanography of the Ministry of Defense prepares various manuals and guides needed for shipping including electronic marine charts, electronic sailing directions, notices to mariners as well as ocean atlases which are of particular importance for the GOOS operational services and climate modules.

The Pacific Oceanological Institute and the Far-Eastern Hydrometeorological Research Institute participate in the NEAR-GOOS project.

With regard to further development of GOOS the priorities of Russia are determined by the above mentioned national programmes and activities, which have received approval and support by the Government.

The following activities are considered the high priority:

(i) Development of ocean monitoring system required for climate change forecasting (as a part of the GOOS climate module) Development of methodology and technology for coastal area monitoring (as a part of the GOOS coastal module);
(ii) Development of the operational marine meteorological and oceanographic services module of GOOS;
(iii) Participation in GOOS regional pilot projects, particularly, NEAR-GOOS and the Black Sea GOOS;
(iv) Development of GOOS regional pilot project for the Baltic Sea and the Arctic Seas in cooperation with EuroGOOS;
(v) Further participation in operations of existing ocean observing systems such as IGOSS, GLOSS, and VOS of WMO;
(vi) Development of space-based ocean observing systems, acoustical and buoy technologies for ocean monitoring;
(vii) Preparation of oceanographic climatic atlases, charts and guides for shipping;
(viii) Improvement of the system for oceanographic data/information exchange.

APPENDIX

NATIONAL OCEANOGRAPHIC COMMITTEE OF THE RUSSIAN FEDERATION (NOC/RF) WORKING GROUP OF THE NOC/RF ON THE GLOBAL OCEAN OBSERVING SYSTEM (WG/GOOS)

The WG/GOOS was established by the National Oceanographic Committee on the 18th June 1998 to coordinate national GOOS activities, and, in particular:

(i) to review the development of GOOS;
(ii) to carry out analyses and make proposals on participation of national institutions in the regional and global GOOS projects;
(iii) to make proposals on the improvement of the existing ocean observing systems and related data management activities and their integration into GOOS;
(iv) to review the activities within other global observing systems, GCOS and GTOS in particular, in order to ensure their proper co-ordination with GOOS; and
(v) to prepare national GOOS programme and plan as a component of relevant sub-programmes of the federal programme "World Ocean".

Composition of the Group:

AKOULICHEV V.A	Pacific Oceanological Institute, Vladivostok
BOBKOV S.A.	Hydrometeorological Service, Dept. of Navigation & Oceanography of the Ministry of Defense, St-Petersburg
DANILOV A.I.	Arctic and Antarctic Research Institute, St-Petersburg
KONTAR E.A.	Institute of Oceanology, Moscow
KOSYAN R.D.	Institute of Oceanology, Southern Branch, Gelenzhik
KRIVOSHEYA V.G.	Institute of Oceanology, Southern Branch, Gelenzhik
LAPPO S.S	Institute of Oceanology, RAS - Co-Chairman, Moscow
LAPSHIN V.B.	State Oceanographic Institute, Moscow
LAVRENOV I.V.	Arctic and Antarctic Research Institute, St Petersburg
MARTISHTHENKO V.A.	Roshydromet, Moscow
MIKHAILOV N.N.	National Oceanographic Data Centre (RHHMI-WDC), Obninsk
NESTEROV N.A.	Dept. of Navigation & Oceanography, Ministry of Defense, St-Petersburg
ORADOVSKIY S.G.	State Oceanographic Institute, Moscow
PELEVIN V.N.	Institute of Oceanology, Moscow
PRIYMAK G.I.	Acoustic Institute, Moscow
RYABININ V.E	Hydrometeorological Centre - Co-chairman, Moscow
SHIGANOVA T.A.	Institute of Oceanology, Moscow
TKALIN A.V.	Far-Eastern Hydrometeorological Research Institute, Vladivostok
TOLKATCHEV A.	Ya. National Oceanographic Committee, Moscow
TSYBAN A.V.	Institute of Global Climate and Ecology, Moscow
TUROVTSEV O.N.	State Navigation & Hydrography Research Centre, Ministry of Defense, St-Petersburg
UTYAKOV L.P.	Institute of Oceanology, Moscow
VASILYEV A.S.	State Oceanographic Institute, Moscow
VIKTOROV S.V.	State Oceanographic Institute, St.-Petersburg Branch, St-Petersburg
ZILBERSTEIN O.I.	State Oceanographic Institute, Moscow

L. SOUTH AFRICA

IMPLEMENTATION AND PLANNING ACTIVITIES RELATED TO GOOS

Prepared by Professor G. Brundrit (Chair: GOOS Africa)
Dr. D. Pollock (S.A. Delegate, IOC)

1. PREAMBLE

This document serves to describe, in brief terms, the range of oceanographic and atmospheric operational activities currently in existence in South Africa which can be viewed within the context of GOOS. In addition, it highlights co-ordination efforts, nationally, regionally and internationally, and gives examples of capacity-building initiatives in marine science in South Africa.

2. GOOS MODULES

In South Africa, the following activities are GOOS-related:

ACTIVITY	RESPONSIBLE AGENCY
1. **Marine services:**	
• Sea level network	S.A. Navy Hydrographic Office
• Maritime weather forecasts	S.A. Weather Bureau (SAWB)
2. **Living Marine Resources:**	
• Biodiversity, Stock biomass,Population dynamics	Marine and Coastal Management
3. **Coastal Management:**	
• Integrated Marine and Coastal Management	Marine and Coastal Management
4. **Health of the Ocean:**	
• HABS research, monitoring and surveillance	Marine and Coastal Management
• Oil spill contingency plans	Dept. Environment: Poll. Control
• Effluent disposal	Local authorities
5. **Weather/climate:**	
• Seasonal rainfall forecasts	SAWB

In addition, South Africa has as its NODC the CSIR-managed SADCO oceanographic database while also contributing to the East African ODINEA network *via* the links between IOC and the Chief Directorate Marine and Coastal Management (formerly Sea Fisheries).

3. GOOS INITIAL OBSERVING SYSTEM

S. African contributions to the IOS include:

- GLOSS (SAN Hydrographic Office, SAWB and UCT)
- Data Buoy Cooperation Panel (SAWB and Marine and Coastal Management)
- VOS (Voluntary oceanographic/ met observations from vessels) (SAWB)

Note: S. Africa also contributes to African regional initiatives *via* GOOS-AFRICA; the African GLOSS network; ODINEA and SADCO; the BENEFIT and BCLME programmes (S. Africa/Namibia/Angola cooperative regional research). Although there is currently no National Committee for GOOS in S.Africa, co-ordination of marine science-related issues takes place *via* SANCOR (S.A. Network for Coastal and Oceanic Research).

4. CAPACITY BUILDING

Within S. Africa, capacity building is largely carried out by universities and technikons which provide specialist advanced courses in marine science and technology. Much in-house training is also provided by operational agencies such as Marine and Coastal Management, the Oceanographic Research Institute in Durban, etc. These operational agencies maintain close links with the universities specialising in marine science. Annual enrolment of senior and postgraduate students is currently over 100, and due to increase sharply under the sponsorship of the US/SA bi-national Commission.

As a relatively technically-advanced country in the continent, S. Africa offers capacity building facilities for the benefit of the region, vested primarily at tertiary training institutions such as UCT, UWC and at other universities and NGO's.

5. GOOS AGREEMENT

South Africa is keen to continue to participate in GOOS-related activities at both national and international levels. However, as a developing country, like all other African nations, we face the reality that national funding priorities lie in areas other than marine science in general, and other than in operational oceanography in particular. We will endeavour to continue our efforts in the face of increasing uncertainty about national research funding priorities in the future.

M. SPAIN

NATIONAL STATUS OF GOOS/EUROGOOS ACTIVITIES (June 1999)

Although in Spain there is no common national programme in operational oceanography, interest in the topic has grown steadily in recent years. Several Spanish agencies include among their activities systematic and routine observation programmes that can be considered under the heading of operational oceanography. Some of these institutions are working together with the goal of reaching an agreement to pool their resources and to combine interests in particular areas of observation, setting up the foundation of a future national oceanic service.

Spain is contributing to GOOS through her involvement in EuroGOOS and MedGOOS. A committee involving the main Spanish marine environment agencies coordinates the dissemination of the GOOS initiatives among the interested Spanish parties. At the moment, our infrastructure and resources do not allow us to get involved in tasks of larger scope, although we will cooperate willingly with the I-GOOS activities up to where our possibilities permit.

The activities of operational type that Spanish institutions are carrying out are as follows:

One of the priority lines of research of the Instituto Español de Oceanografía (IEO) is the study of temporal variability and trends in oceanographic conditions and biological communities. This implies long-term and systematic monitoring at specific sites to understand the underlying causes of temporal variability of the physical and biological properties and processes in the pelagic ecosystem in the neritic and oceanic waters surrounding the Spanish coast. Its scientific objectives are integrated in the framework of GLOBEC and JGOFS. The research effort involves (i) time series in several transects along the Spanish coast, on both the Atlantic and the Mediterranean sides, sampled according to JGOFS recommendations at monthly intervals, and (ii) synoptic observations by satellite imagery. Each transect includes sampling in, at least, 3 stations of coastal, neritic and oceanic characteristics. Sampling includes measurements of hydrographic parameters and diverse analyses of the community structure and properties of phytoplankton, zooplankton and ichthyoplankton.

The sampling design also includes specific work oriented to the study of processes and the study of hydrographic phenomena by means of AVHRR satellite images. A data management system has been developed both to archive the data and as a tool for data analysis and elaboration of reports. This project, supported only by the IEO, also supplies data to the ICES data bank, and annual summaries on main results are reported to different ICES Working Groups.

In the early 90s, IEO, Instituto Canario de Ciencias Marinas, the Marine Physics group from the Institut für Meereskunde in Kiel and the JGOFS group of the University of Bremen established jointly a time series station. The European Station for Time Series in the Ocean Canary Islands (ESTOC) is located 60 miles north of the island of Gran Canaria in the Canary Islands in water some 3000 m deep. The station is in an eastern boundary regime and is a very appropriate complement to the Bermuda station. The station is visited every month. Sampling covers a wide gamut of parameters complemented by moored observations.

Some three years ago IEO started a cooperative project (SIGMAZAL) with Secretaria General de Pesca Maritima, whose objective is to develop tools that permit and facilitate integral and effective management of marine resources. These tools integrate several databases and information levels: geographical, geological, oceanographic, living organisms, legislation, etc., and generate different products or new levels of information which can be supplied in different ways. For the moment the project is in the phase of data compilation and input; its ultimate goal is to make all the products and information accessible to the marine sector in the first place and, later, to the general public.

There are three tide gauge networks in Spain in the charge of IEO, Instituto Geografico Nacional and Puertos del Estado (PE); each organization is responsible for its own network. There are twenty-four stations, some with more than one gauge, distributed along the Spanish Mediterranean and Atlantic coast as well as in the archipelagos. Some of the stations started gathering data from the end of the 19th century although the main

bulk of information has been registered from the mid-1940s. Data can be obtained in real time from ten stations. Three of the stations belong to the GLOSS network. Information is also sent to international tidal centres. Spain is a member of COST Action 40 European Sea level Observing System (EOSS). The above mentioned three institutions plus Instituto Hidrografico de la Marina are collaborating in a project within CYTMAR, RIMA, to integrate the networks and to create a common Spanish sea level data bank. Presently, institutions are publishing an annual volume with astronomical prediction, mean and extreme sea level, tidal ranges, etc. Data is provided to users on personal request. It is expected to set up a Web system through which information can be requested and distributed.

A wave forecasting system developed to predict waves at the coast is run on a twice a day cycle by Clima Maritimo (CM), a group dependent on Puertos del Estado (PE). This system is based on two wave generation models: the WAM model and the WAVEWATCH model. The system is designed to provide a wave forecast with 72 hours of horizon to the Spanish harbours in the Atlantic and on the Mediterranean coast.

The continental shelf surrounding the Spanish coast is very narrow. A forecasting system designed to predict waves in the coast has to cope with the problem of solving in the same run the basin scale at which waves are generated, and the much smaller coastal scale where waves are modified. The approach to the problem at CM has been to couple a propagation model, the PROPS model to the wave generation models. The performance of the wave prediction system is verified in real time against measurements from the Spanish network of directional and scalar buoys, and is distributed to the users through Internet, fax and e-mail.

CM is running also a storm surge forecasting system developed to predict sea levels at the coast. It runs on a twice a day cycle. The system is based on runs from a 3-D hydrodynamical model (HAMSOM) and data assimilation of tidal levels recorded by the tidal gauge network from PE. The model runs are carried out on a computational mesh settled around Spanish waters and is forced by meteorological fields provided by the atmospheric forecasting model HIRLAM from the Spanish Instituto Nacional de Meteorologia. The system is designed to provide a sea-level forecast with 48 hours of horizon to the Spanish harbours in the Atlantic and on the Mediterranean coast.

PE and Centro de Estudios y Experimentacion de Obras Publicas (CEDEX) maintain, since the early eighties, a full operational wave buoy network. It consists of nineteen scalar buoys and three directional ones that transmit data in real time *via* radio to shore stations. This network was settled in order to provide decision-making tools for harbour management and to assess wave climatology around the coast required for the planning and design of civil works and shore protection studies.

PE begun ten years ago to work in the development of wave remote measuring techniques based in navigational radar that culminated by installing two experimental stations in the north Iberian coast and the Canary Islands.

In 1996 PE launched a marine monitoring project whose acronym is RAYO (Red de Alerta y Observacion) intended to set-up a permanent observing system of surface waters around the Spanish coast. The core of the system consists of nine ocean-meteorological buoys, moored in the vicinity of the shelf-break in depths ranging from to 250 m up to 900 m at the Atlantic waters of the Iberian Peninsula and the Canary Islands. These buoys transmit recorded data on an hourly basis *via* satellite to the Control Centre at Madrid. The multisensor buoys register meteorological parameters (wind, pressure, and temperature) and surface oceanographic parameters (wave, current, temperature and conductivity). Three of the buoys also carry a CTD chain. Also three independently moored current meter lines have been installed, with the cooperation of the IEO, in the vicinity of some buoys. The project has increased the existing coastal sampling coverage by installing three land-based wave radar stations and three wave directional buoys. An objective of the project has been to emphasise quasi real time transmission and final user's data delivery by installing a dedicated communication link between the Control Centre and the main users (Port Authorities) and developing a Web page where other institutional bodies and third parties can get these data. By-products derived from real time transmitting deep water buoys have been developed such as on-line verification of current wave model forecast and a coastal wave nowcast based on the propagation of the directional spectrum transmitted by the buoys.

N. UNITED KINGDOM GOOS ACTIVITIES

Much of the UK's participation in GOOS comes through its involvement in EuroGOOS, in which a number of UK agencies and institutes participate, including the Meteorological Office, the Environment Agency and the Natural Environment Research Council's (NERC's) Southampton Oceanography Centre (SOC) and Centre for Coastal and Marine Studies. In addition, the NERC has provided the funding to maintain the EuroGOOS Secretariat at SOC. Co-ordination of GOOS activities in the UK is carried out the UK's Inter-Agency Committee on Marine Science and Technology (IACMST) (http://www.marine.gov.uk) and its GOOS Action Group. The group is chaired by Dr Howard Cattle (UK Met Office) and its co-ordinator is Dr John Portmann. Meetings take place twice yearly. Particular tasks for 1998 included:

- Briefing UK Delegations to GOOS and EuroGOOS;
- Co-ordination of the UK input to the GOOS Commitments Meeting;
- Maintenance and development of a Web site of UK observing programmes; (http://www.pol.ac.uk/bodc/goosinv/ukmoninv.html)
- Initiating a review of all UK marine observing programmes;
- Stimulation of the co-ordination of numerical modelling of shelf seas in the UK.

Specific activities included:

- Preparation for the anticipated GOOS Commitments Meeting by contacting UK organisations known to have a major involvement in marine observations with a view to seeking an agreement in principle that the results of their observations might be considered as contributions to GOOS (the outcome has since been reported to the GOOS Commitments meeting held in Paris on 5-6 July 1999);
- Initial discussion and review of the role of the UK in Argo;
- Establishment of formal relations with the SeaNet organisation through the appointment of the Action Group's co-ordinator as the representative of UK interests;
- Initiation of a review of UK marine monitoring, initially through development of a questionnaire to organisation involved;
- Encouragement of wider UK involvement in planning for a North West European Shelf Seas Data Assimilation and Forecast Experiment (ESODAE) being carried out through a European Commission MAST III Concerted Action which is led by the Met Office. The proposed experiment shadows international plans to carry out a Global Ocean Data Assimilation Experiment (GODAE) in the 2003 timeframe and has grown out of the discussions of the EuroGOOS North West Shelf Task Team.

For 1999, the Group's activities include:

- Briefing of UK Delegations to GOOS and EuroGOOS;
- Continued co-ordination of the UK input on the commitments to GOOS;
- Continuing to maintain and develop the Web site of UK observing;
- Developing the UK case for contributions to Argo;
- Continued liaison with SeaNet;
- Finalising its review all UK marine observing programmes;
- Development of an 'Ocean climate status report' for UK waters;
- A Workshop on numerical modelling of shelf and coastal seas around the UK.

Interest in GOOS continues to develop within the UK, encouraged by the efforts within GOOS to move from its planning to an implementation phase. In addition to supporting the GOOS Project Office through UNESCO's core support for the IOC, the UK also supports GOOS though donations to its trust fund and for the GLOSS programme within GOOS.

O. UKRAINE

GLOBAL OBSERVING SYSTEM FOR THE BLACK SEA: RESEARCH IN 1997-1999

The Ukrainian National Programme "Global Observing System of the Black Sea" was established in 1997 as the result of understanding that the Black Sea ecosystem has manifested strong changes during the last two decades. Potential increase of human activity in the region will provide stronger pressure on the environment, and management efforts to prevent the environmental collapse should be based on systematic observations. The previous type of observing system of the Black Sea, which was supported mainly by Ukraine and Russia, is inefficient economically as it used ship surveys which are too expensive now for the Black Sea countries. However modern technologies of oceanographic observation are now available and the main goal of the programme is to design and to develop a new observing system for the Black Sea basin. The new observing system should be cost-effective, use a modern technology and have a match with previous observations. The duration of the programme is five years. The programme is funded by the Ministry of Science and Technology of Ukraine and is considered as an input of the Ukraine to the regional project of IOC.

The strategy of the programme follows from the demands to the observing system. The cost-effectiveness is supposed to be achieved by optimization of *in situ* observations, broad use of remote sensing from near-operational satellites (for example, AVHRR for observations of SST and mesoscale dynamics; OCTS, MOS, SeaWIFS for observations of the surface concentration of phytoplankton and primary production, NSCAT for the observation of a surface winds, TOPEX/Poseidon and ERS altimetry for the observation of sea surface elevation and the surface geostrophic currents) and assimilation of satellite observations at OGCM and BGCM for space-time interpolation and extrapolation to depth. *In situ* observations should be used for the controlling of the deep-sea processes, air-sea interaction in the basin, the development of regional algorithms of satellite data processing, and validation of remote sensing and the model extrapolation products.

Three types of *in situ* observations are considered: coastal observations, repeating observations of the coastal zone from small ships, and repeating observations of the open sea from ships of opportunity and episodic scientific cruises. Aside from traditional hydrometeorological observations a special set of chemical and biological observations is planned for the coastal zone together with pollution observations. The system of observations at coastal stations and in the coastal zone is carried out in few critical regions with the goal to define and to broaden remote observations. Experimental launch of surface free-floating buoys is considered as a basis for the subsequent development of the observing system. Analyses of trends based on archive data form an essential part of the programme which should permit matching the data collected in the past with new observations.

The Ukrainian National programme "Global Observing System of the Black Sea" consists of six projects:

(i) "**Prediction**" (System of observation of long-term variations of the marine environment induced by anthropogenic and natural causes. Leading oceanographic center: Marine Hydrophysical Institute of the National Academy of Sciences of Ukraine).

(ii) "**Coastal zone**" (System of observations of variability of the marine environment in the coastal zone. Leading oceanographic center: Marine Hydrophysical Institute of National Academy of Sciences of Ukraine).

(iii) "**Biota**" (System of observations and assessment of the Black Sea living resources. Leading oceanographic center: Institute of Biology of Southern Seas of the National Academy of Sciences of Ukraine).

(iv) "**Health of the sea**" (System of estimation, diagnosis and prognosis of the health of the sea. Leading oceanographic center: Ukrainian Science and Technology Center of Marine Ecology of the Ministry of Natural Environment and Nuclear Safety).

(v) "**Control**" (Integrated system of operational collection and distribution of the data about the state of marine environment and overlying atmosphere. Leading oceanographic center: Marine Hydrophysical Institute of the National Academy of Sciences of Ukraine).

(vi) "**Design**" (Design and support of oceanographic equipment for coastal and marine observations and metrological complexes. Leading oceanographic center: Marine Hydrophysical Institute of the National Academy of Sciences of Ukraine).

The first and the second projects are concerned with observations of the state of the deep-sea area and coastal zone respectively. The third and the fourth projects have a thematic direction dealing with living resources and pollution. The fifth and sixth represent informational problems, design, support and service of the oceanographic equipment.

The Marine Branch of Ukrainian Research Institute of State Committee of Hydrometeorology and the Southern Research Institute of Fisheries and Oceanography of the State Committee of Fisheries are also among the basic participants of the programme.

The following works were carried out within the programme during 1997-1999:

- Estimations of trends of different fields using the archive data;
- Collection and storing of the satellite remote sensing data for the region;
- Design of equipment for systematic measurements at coastal stations and on ships of opportunity;
- Field observations in the open sea using ships of opportunity and scientific cruises;
- Multi-disciplinary observations in the coastal zone of Ukraine;
- Improvement of OGCM and methods of assimilation of observations for the nowcast and hindcast of three-dimensional circulation in the basin;
- Improvement of BGCM for the North-Western shelf of the Black Sea.

The funding of the programme is carried out by the Ministry of Sciences and Technology of Ukraine but an essential part of the investigations also was supported by the National Academy of Sciences of Ukraine, State Committee of Hydrometeorology of Ukraine, State Committee of Fisheries of Ukraine and the Ministry of Natural Environment and Nuclear Safety. Total funding of the programme is estimated as $400K in 1997-1999.

P. UNITED STATES OF AMERICA

GLOBAL OCEAN OBSERVING SYSTEM
U.S. NATIONAL IMPLEMENTATIONAND PLANNING ACTIVITIES
HIGHLIGHTS
(June 1999)

Introduction

The U.S. Government, both the Executive Branch (the Administration) and the Legislative Branch (the Congress), are increasingly cognizant of the need for GOOS and are supportive of strong U.S. involvement in its implementation. The Administration held a National Ocean Conference in June 1998 to demonstrate the President's personal commitment to the oceans, launching major new initiatives totaling $224 million through 2002. The Legislative Branch held hearings on need for ocean observations and commissioned a report, further described below. And in May 1999 the President of the Consortium for Oceanographic Research and Observations presented to the Congress and the Administration a letter signed by almost 1800 members of the ocean community calling for:

"The U.S. government to commit to, plan, and implement a sustained national programme of ocean observations with funding and resources supplemental to those currently available."

Oceans: An Agenda for Action

A total of nine major initiatives were announced at the National Ocean Conference in June 1998. These include 1) the expansion of two shallow-water observatories and the establishment of two deep sea observatories, and 2) the deployment of autonomous profiling buoys, a contribution to the Argo network, further described below. The request for funds to implement these priorities is now pending with the U.S. Congress as part of the President's request for FY00, which begins October 1, 1999.

(Web Site: http://www.pub.whitehouse.gov/uri-res/I2R?urn:pdi://oma.eop.gov.us/1998/6/16/5.text.1)

Toward a U.S. Plan for an Integrated, Sustained Ocean Observing System

In July 1998 the U.S. House of Representatives Subcommittee on Fisheries Conservation, Wildlife and Oceans held a hearing on the state of U.S. ocean observations. Witnesses testified about the tremendous advances in technology that have become available to oceanographers in the past two decades, and about the spectacular success of using that technology in such new systems as the one in the Pacific which contributed to the accurate prediction of the 1998 ENSO event. The legislators learned how little is known about the ocean and its impact on the environment, however. Following that testimony, Congressmen Saxton and Weldon requested that the U.S. National Ocean Research Leadership Council (which is composed of high-level officials form 12 federal agencies) propose a plan to achieve a truly integrated ocean observing system. This request resulted in an initial action plan prepared under the leadership of Drs. Worth Nowlin and Tom Malone and transmitted in April 1999. This document represents the first significant step by the U.S. oceanographic community toward the development of a comprehensive plan. It is also notable that the request also established a process of open discussion among and within the involved agencies regarding sustained ocean observations. The report can be found at: http://ocean.tamu.edu/GOOS/sw.html

The report is, however, but a first step in an overall effort that will continue. The next version of the report, to be completed by the end of 1999, will include topics such a management, methods to achieve integration, and priorities.

Scientific Views

The National Research Council has recently issued a number of reports describing needs fundamentally served by GOOS and calling for better ocean observation programmes. These reports include:

- Decade-to-Century-Scale Climate Variability and Change (1998).
- Adequacy of Climate Observing Systems (1999).
- Global Environmental Change: Research Pathways for the Next Decade (in press).

Information on obtaining copies is available at: http://www.nap.edu

U.S. GOOS Structure and International Involvement

A U.S. GOOS Steering Committee is composed of representatives from academia, industry, government, and environmental organizations providing advice for the planning, implementing, and coordinating of U.S. GOOS. A U.S. GOOS Support Office has also been established, with one branch for global-scale (directed by Dr. Worth D. Nowlin, Jr. at Texas A&M University) and another branch for coastal-scale observations (directed by Dr. Thomas Malone at Horn Point Environmental Laboratory at the University of Maryland). This office promotes planning and coordination for collection and sharing of data and products across programmatic, institutional, and national boundaries and promotes the development of GOOS internationally. Linkages to international activities are facilitated by Dr. Nowlin as the chair of the GOOS Steering Committee and Dr. Malone as Chair of the Panel for Coastal GOOS. The U.S. continues to provide leadership in a number of other planning and implementation activities. In March 1998 the U.S. hosted the GODAE Science Steering Team meeting and plans to provide up to $35,000 to host the third GOOS Living Marine Resources Panel meeting. A recent commitment of $20,000 was made to support the GOOS Steering Committee and financial support is supplied to the Coastal GOOS Module Panel.

(U.S. GOOS Home Page: http://ocean.tamu.edu/GOOS/sw.html)

U.S. Coastal GOOS Workshop

A workshop was held May 23-26, 1999, to begin the design of an integrated coastal ocean observing system. The event, titled "Challenges and Promise of Designing and Implementing an Ocean Observing System for U.S. Coastal Waters", brought together representatives from government (state and federal) and academia (U.S. and Canada) who are experienced in remote sensing, real time telemetry, assimilation modeling, and the needs of coastal managers. Participants were asked to address three related issues: (i) Detecting and predicting changes in coastal ecosystems; (ii) Monitoring capabilities and information needs; and (iii) the design and implementation of an integrated, multi-disciplinary coastal observing system. Papers were commissioned in advance and presented on:

- Lessons Learned from Previous Coastal Monitoring Efforts;
- Driving Science and Management Issues and Related Information Needs for Developing and Implementing Environmental Policies in the Coastal Zone;
- Long-Term, Real-Time Observation Networks for Ports, Estuaries, and the Open Shelf;
- Coastal GOOS: Processes, Models, and Real-Time Systems;
- Data Assimilation for Coastal Observing Systems.

These papers and a meeting report will be available later in 1999.

Global Coral Reef Monitoring Network

The IOC-UNEP-IUCN Global Coral Reef Monitoring Network (GCRMN) was established in April 1996 with U.S. policy and financial leadership provided through the International Coral Reef Initiative (ICRI), which began in 1994. U.S. support for ICRI and GCRMN has been strong. President Clinton has identified ICRI as a model of internationai environmental cooperation and encouraged further monitoring. A U.S. Coral Reef Task Force was established that has stressed the urgency of monitoring and research to improve our understanding of the relationship between climate and coral reef bleaching. In 1999 the U.S. contributed $500,000 to UNEP for ICR implementation including $150,000 for the GCRMN secretariat and additional funds to support regional implementation through the UNEP regional seas programmes. The U.S. has also

supported the development of a GCRMN Socio-economic Manual describing, for managers, socio-economic assessments.

Integrated Global Observing Strategy (IGOS)

The U.S. has actively supported the development of IGOS and its partnership approach. IGOS unites the major satellite and surface-based systems for global environmental observations of the atmosphere, ocean, and land and presents a coherent approach for establishing priorities. IGOS has highlighted the need for stronger agency interactions, both at national and international levels. The U.S. is particularly pleased that IGOS has identified GODAE as an IGOS prototype project and that oceans has been selected as the pilot for the new thematic approach being proposed for IGOS.

Continuity of Satellite Measurements

Two satellite measurements of particular importance to the oceans -sea surface topography and surface vector winds- are currently facing the prospect of a gap in continuity.

❖ **Sea Surface Topography**

NASA and CNES have committed to launch JASON-1 in 2000 to continue observations of the surface topography initiated by their cooperative TOPEX/POSEIDON (T/P) altimeter mission launched in 1992. These two missions (T/P and JASON-1), specifically designed for high accuracy/high precision, have the unique capability to address the circulation of the oceans, its relation to climate, and global sea level rise.

With the design life of JASON-1 ending in 2003, France has proposed to launch JASON-2 in 2003. U.S. participation is being actively considered in order to prevent a break in continuity of the altimetry record initiated by T/P.

❖ **Surface Vector Winds**

An advanced NASA scatterometer, Sea Winds, is included on both QUICKSCAT launched June 19, 1999, and the Japanese ADEOS-2 in 2000. Currently, ESA's ERS-2 satellite carries a single, 500-km swath scatterometer. It will be followed by the Advanced Scatterometer (ASCAT), to fly aboard the series of three operational METOP satellites. The first METOP is planned for launch in 2003, and each will have a five-year design life. The simultaneous flight of two scatterometers -whether Sea Winds or ASCAT- will provide a unique capability to resolve the significant scales of variability in the global marine wind field, characterize wind forcing of the upper ocean, and improve weather forecasts at sea. The earliest this capability can be realized is with Sea Winds on QUICKSCAT and ADEOS-2. Following these and depending on mission lifetimes, the potential capability for continuing two-scatterometer coverage will depend on METOP (with ASCAT) and the ADEOS-3 mission. The U.S. is now considering providing a Sea Winds-type sensor for the ADEOS-3 to prevent a break in continuity. U.S. participation will be based on a demonstration of the operational utility of surface vector winds from QUICKSCAT and ADEOS-2.

The U.S. is now giving attention to the orderly transition of these ocean remote sensing capabilities from research activities, sponsored by NASA, to operational efforts, sponsored by NOAA. Over the long term, consideration is being given to meeting these needs through the National Polar-orbiting Operational Environmental Satellite System.

Global Ocean Data Assimilation Experiment (GODAE) /Argo

Four agencies in the U.S. support GODAE--- NOAA, the National Science Foundation, NASA, and the U.S. Navy. A U.S. GODAE Steering Team has defined the scope and objectives of U.S. involvement. The goal, for the U.S., is a practical demonstration of near real-time, global ocean data assimilation that provides regular, complete depictions of the upper ocean structure, including temperature, salinity and currents, in support of operational oceanography and seasonal-to-decadal climate forecasts and analyses. The

products will be directed toward i) global seasonal-to-interannual variability, particularly ocean initialization for operational short-term climate forecasts, ii) near real-time operational oceanography at high temporal and spatial resolution, particularly ocean nowcasts, and iii) global seasonal-to-decadal climate research. Core near real-time activities take place at operational centers, with academic research groups making assessments, retrospective analyses, and model improvements.

Sampling of the ocean depth for GODAE must be done by *in situ* observations, which will also be used for calibration of the remote data from space-borne systems such as altimeters, scatterometers, operational meteorological satellites, and ocean color sensors. Argo, a programme proposed by an international team of scientists, consists of a global array of 3,000 autonomous profiling floats to observe the ocean's upper layer in real time. Argo will serve as a critical source of data for GODAE. It will be a consistent global system operating *within* the ocean to collect the subsurface observations to complement those observations from space. President Clinton has proposed a U.S. contribution of 1,000 floats over the period of 2000-2002, a total of $12 million.

The Global Ocean Observing System Center at NOAA's Atlantic Oceanographic and Meteorological Laboratory

NOAA now maintains a Global Ocean Observing System Center at NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML) in Miami, Florida. The initial objectives of the Center are (1) directed at coordinating NOAA's global and regional observing network efforts in order to maximize the quality and quantity of data available to users; (2) evaluating new observing methods for incorporation into existing networks; and (3) interacting with other national and international groups to coordinate GOOS activities.

NOAA's present global operations include the:

(i) Voluntary Observing Ship (VOS) network that provides surface marine meteorological observations;
(ii) VOS network that provides upper ocean temperature data; and
(iii) surface drifter array that provides surface current, temperature and meteorological data.

Regional networks include the TOGA TAO array, operated by NOAA's Pacific Marine Environmental Laboratory, that provides upper ocean and surface meteorological data in the tropical Pacific Ocean. The NOAA networks provide approximately 30000 of the 90000 total surface meteorological observations available per month from VOS; 40000 of the 80000 meteorological and SST observations available per month from surface drifters; and 1200 of the 4000 temperature profiles available per month from VOS.

The data provided by these networks are used by NOAA's weather and climate forecast groups. Thus, the GOOS Center will direct its efforts at the real-time, in situ, upper ocean and surface meteorological data needed by the NOAA forecasters. The Center activities will require that the operators of the individual networks (e.g., VOS, surface drifter, TAO) continue to collect, quality control and disseminate their data.

National Oceanographic Data Center

The National Oceanographic Data Center (NODC) maintains the world's largest unclassified oceanographic data base. Holdings include records from more than 2 million stations containing temperature, salinity, and in many cases nutrient chemistry data from the total water column (sea surface to ocean floor); 73 million surface and subsurface current measurements; 3.5 million bathythermograph records; and over 79 million records from automated ocean buoys. Data holdings also contain approximately 150 million records from special data sets such as ocean data from the U.S. Navy Geosat Altimetry Satellite. Access to these huge data bases is provided both by interactive use of the Internet and by personal inquiry to an information specialist. Data is distributed on a variety of media including on-line, CD-ROM, magnetic diskette, magnetic tape and/or paper as desired by the client. Plans include approximately 13 new CD-ROM products to be published each year for unlimited distribution. Over half of NODC's archived data are obtained through international exchange agreements. NODC operates World Data Center A for Oceanography under which data

exchange agreements are in place with over 40 countries engaged in marine research. The NODC also actively participates in the Global Temperature Salinity Profile Programme, one of seven countries maintaining a continuously managed data base. More information is available at:
http://www.nodc.noaa.gov/GTSPP/gtspp-home.html

International Seakeepers Society

The SeaKeepers Society was formed in response to the United Nation's designation of 1998 as the International Year of the Ocean and its call for public-private partnerships to help protect the oceans. The SeaKeepers Society's mission is to actively involve the international yachting community in monitoring the health of the world's ocean by equipping member yachts with a sophisticated ocean monitoring and testing module that will gather and transmit ocean data between member yachts as well as to research institutions around the world. The Society is funded through the donations of its members. The Society's Founding Members represent countries from around the world. NOAA and the University of Miami are developing a "SeaKeepers module" in conjunction with the Society to be installed on yachts. This module will collect data to be transmitted in real-time *via* satellite. The Society's five-year goal is to have over 1000 member yachts participating in its activities, covering all areas of the world's oceans. Procedures for quality control and data formatting are in process.

APPENDIX

A Selection of Web Sites for U.S. GOOS Activities

U.S. activities supporting the Global Ocean Observing System (GOOS) are rapidly moving from planning to implementation endeavors. Many, many activities are ongoing that contribute to GOOS. These Web Sites describe programmes that are some *examples* of these activities. There are many more.

U.S. GOOS - General Description
http://ocean.tamu.edu/GOOS
Tropical Atmosphere Ocean (TAO) Array of Buoys
http://www.pmel.noaa.gov/toga-tao/tao-tour.html
Voluntary Observing Ship (VOS) Network
http://www.pmo.noaa.gov
Data Buoy Cooperation Panel (DBCP)
http://dbcp.nos.noaa.gov/dbcp/
ARGO : A Global Array of Profiling Floats
www.argo.ucsd.edu
Global Sea Level Observing System (GLOSS) of Tide Gauges
http://www.grdl.noaa.gov/GRD/Projects/CB/SEALEVEL/sealevel.html
National Environmental Monitoring Initiative
http://www.epa.gov/cludygxb/
NODC Coastal Ocean Data Resources and Activities
http://www.nodc.noaa.gov/NODC-coastal/coindex.html
Global Coal Reef Monitoring Network
http://coral.aoml.noaa.gov/gcrmn.html
Ocean Space Missions During the 1990s and Beyond
http://airsea-www.jpl.nasa.gov/missions.html
NASA Satellite Ocean Remote Sensing
http://www.earth.nasa.gov/science/water.html/
NOAA Satellite Ocean Remote Sensing
sgoit2.wwb.noaa.gov/COASTWATCH
US PORTS
http://www.co-ops.nos.noaa.gov/d_ports.html
Mussel Watch
http://ccmaserver.nos.noaa.gov/CoastalMonitoring.html
National Estuarine Research Reserve Monitoring
http://www.nos.noaa.gov/ocrm/nerr/nerrs_education.html
Fisheries Assessments
http://www.noaa.gov/nmfs/vision/sustain_vision.html

ANNEX VIII

LIST OF ACRONYMS
(main text only)

AUV	Autonomous Underwater Vehicule
CARICOMP	Caribbean Coastal Marine Productivity
CEOS	Committee on Earth Observing Satellites
C-GOOS	Coastal GOOS
CLIVAR	Climate Variability and Predictability
CMM	Commission for Marine Meteorology (WMO)
COP-4	4th Conference of the Parties (to the UN FCCC)
CPPS	Permanent Commission for the South Pacific
CPR	Continuous Plankton Recorder
CSD	Commission on Sustainable Development (UN)
CSIRO	Commonwealth Scientific and Industrial Research Organization
DBCP	Drifting Buoy Cooperation Panel
DIMS	Data Information Management System
EC	European Commission
EEZ	Exclusive Economic Zone
ENSO	El Niño and the Southern Oscillation (USA)
ESODAE	European Shelf Seas Data Assimilation and Forecast Experiment
EU	European Union
EuroGOOS	European Programme for the Global Ocean Observing System
FAO	Food and Agricultural Organization of the United Nations
FCCC	Framework Convention on Climate Change
FGGE	First GARP (Global Atmospheric Research Programme) Global Experiment
FOAM	Forecast Ocean Atmosphere Model
G3OS	GCOS/GOOS/GTOS
GCOS	Global Climate Observing System (WMO-ICSU-IOC-UNEP)
GCRMN	Global Coral Reef Monitoring Network
GEF	Global Environment Facility
GESAMP	IMO-FAO-UNESCO-WMO-WHO-IAEA-UN-UNEP Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection
GIPME	Global Investigation of Pollution in the Marine Environment
GIWA	Global International Waters Assessment
GLOBEC	Global Ocean Ecosystems Dynamics (SCOR-IOC)
GLOSS	Global Sea-Level Observing System (IOC)
GODAE	Global Ocean Data Assimilation Experiment
GOOS	Global Ocean Observing System (IOC/WMO)
GOOS-IOS	GOOS Initial Observing System
GOSSP	Joint GOOS-GCOS-GTOS Space Panel
GPA	Global Plan of Action
GPO	GOOS Project Office
GSC	GOOS Steering Committee
GTOS	Global Terrestorial Observing System
GTS	Global Telecommunication System (WMO)
GTSPP	Global Temperature and Salinity Profile Programme
HOTO	Health of the Ocean
IAEA	International Atomic Energy Agency
IAPSO	International Association for the Physical Sciences of the Ocean
IBTS	ICES International Botton Trawl Survey
ICES	International Council for the Exploration of the Sea
ICMAM	Integrated Coastal and Marine Area Management
ICSU	International Council for Science
IFREMER	Institut Français de Recherche pour l'Exploitation de la Mer

IGBP	International Geosphere-Biosphere Programme
IGFA	International Group of Funding Agencies
I-GOOS	IOC-WMO-UNEP Committee for the Global Ocean Observing System
IGOS	Integrated Global Observing Strategy
IGOSS	Integrated Global Ocean Services System
IIAG	Interim Implementation Advisory Group
IOC	Intergovernmental Oceanographic Commission (UNESCO)
IOCCG	International Ocean Colour Co-ordinating Group
IOCARIBE	IOC Sub-Commission for the Caribbean and Adjacent Regions
IOCEA	IOC Regional Committee for Eastern Atlantic
IOCINCWIO	IOC Regional Committee for the Cooperative Investigation in the North and Central Western Indian Ocean
IODE	International Oceanographic Data and Information Exchange (IOC)
IPCC	Intergovernmental Panel on Climate Change
JCOMM	Joint IOC-WMO Technical Commission for Oceanography and Marine Meteorology
J-DIMP	Joint GOOS-GCOS-GTOS Data and Information Panel
JGOFS	Joint Global Ocean Flux Study (SCOR-IOC)
J-GOOS	Joint GOOS Scientific and Technical Committee (IOC-WMO-ICSU)
LME	Large Marine Ecosystem
LMR	Living Marine Resources
LOICZ	Land-Ocean Interactions in the Coastal Zone (IGBP)
MAST	Marine Science and Technology (Programme of the EC)
MAWS	Marine Automatic Weather Station
MEDAR	Mediterranean Data Archaeology and Rescue
MedGOOS	Mediterranean GOOS
MFSPP	Mediterranean Forecasting System Pilot Project
MOU	Memorandum of Understanding
NAO	North Atlantic Oscillation
NASA	National Aeronautics and Space Administration (USA)
NEAR-GOOS	North-East Asian Regional GOOS
NGCC	National GOOS Co-ordinating Committee
NOAA	National Oceanic and Atmospheric Administration (USA)
NODC	National Oceanographic Data Centre
NOWPAP	Northwest Pacific Action Plan
ODINAFRICA	Oceanographic Data and Information Network in Africa
OOPC	Ocean Observations Panel for Climate
OOSDP	Ocean Observing System Development Panel (JSC/WCRP)
OSLNR	Ocean Science and Non-Living Resources
OSLR	Ocean Science in Relation to Living Resources (IOC-FAO)
PACSICOM	Pan-African Conference on Sustainable Integrated Coastal Management
PIRATA	Pilot Research Moored Array in the Tropical Atlantic
PMEL	Pacific Marine Environmental Laboratory
POGO	Partnership for Observations of the Global Ocean
SAR	Synthetic Aperture Radar
SCAR	Scientific Committee on Antarctic Research
SCOR	Scientific Committee on Oceanic Research
SEACAMP	South East Asia Centre for Atmospheric and Marine Prediction
SEA-GOOS	South East Asia GOOS
SHOM	Service Hydrographique de la Marine (French Navy)
SOOP	Ship-of-Opportunity Programme
SOPAC	South Pacific Applied Geoscience Commission
SPREP	South Pacific Regional Environment Programme
TAO	Tropical Atmosphere Ocean Array
TEMA	Training, Education and Mutual Assistance in Marine Sciences (IOC)
ToRs	Terms of Reference
UKMO	UK Meteorological Office

UNCLOS	United Nations Convention on the Law of the Sea
UNEP	United Nations Environmental Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
VOS	Voluntary Observing Ship (WMO)
WCRP	World Climate Research Programme (WMO/ICSU/IOC)
WESTPAC	IOC Sub-Commission for the Western Pacific
WIOMAP	Western Indian Ocean Marine Applications Project
WIPO	World Intellectual Property Organization
WMO	World Meteorological Organization of the United Nations
WOCE	World Ocean Circulation Experiment (IOC/WMO/ICSU)
WWW	World Weather Watch
XBT	Expendable Bathythermograph

In this Series | *Languages*

Reports of Governing and Major Subsidiary Bodies, which was initiated at the beginning of 1984, the reports of the following meetings have already been issued:

1.	Eleventh Session of the Working Committee on international Oceanographic Data Exchange	E, F, S, R
2.	Seventeenth Session of the Executive Council	E, F, S, R, Ar
3.	Fourth Session of the Working Committee for Training, Education and Mutual Assistance	E, F, S, R
4.	Fifth Session of the Working Committee for the Global Investigation of Pollution in the Marine Environment	E, F, S, R
5.	First Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions	E, F, S
6.	Third Session of the *ad hoc* Task team to Study the Implications, for the Commission, of the UN Convention on the Law of the Sea and the New Ocean Regime	E, F, S, R
7.	First Session of the Programme Group on Ocean Processes and Climate	E, F, S, R
8.	Eighteenth Session of the Executive Council	E, F, S, R, Ar
9.	Thirteenth Session of the Assembly	E, F, S, R, Ar
10.	Tenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific	
11.	Nineteenth Session of the Executive Council, Paris, 1986	E, F, S, R, Ar
12.	Sixth Session of the IOC Scientific Committee for the Global Investigation of Pollution in the Marine Environment	E, F, S
13.	Twelfth Session of the IOC Working Committee on International Oceanographic Data Exchange	E, F, S, R
14.	Second Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, Havana, 1986	E, F, S
15.	First Session of the IOC Regional Committee for the Central Eastern Atlantic, Praia, 1987	E, F, S
16.	Second Session of the IOC Programme Group on Ocean Processes and Climate	E, F, S
17.	Twentieth Session of the Executive Council, Paris, 1987	E, F, S, R, Ar
18.	Fourteenth Session of the Assembly, Paris, 1987	E, F, S, R, Ar
19.	Fifth Session of the IOC Regional Committee for the Southern Ocean	E, F, S, R
20.	Eleventh Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Beijing, 1987	E, F, S, R
21.	Second Session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Arusha, 1987	E, F
22.	Fourth Session of the IOC Regional Committee for the Western Pacific, Bangkok, 1987	English only
23.	Twenty-first Session of the Executive Council, Paris, 1988	E, F, S, R
24.	Twenty-second Session of the Executive Council, Paris, 1989	E, F, S, R
25.	Fifteenth Session of the Assembly, Paris, 1989	E, F, S, R
26.	Third Session of the IOC Committee on Ocean Processes and Climate, Paris, 1989	E, F, S, R
27.	Twelfth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Novosibirski, 1989	E, F, S, R
28.	Third Session of the Sub-Commission for the Caribbean and Adjacent Regions, Caracas, 1989	E, S
29.	First Session of the IOC Sub-Commission for the Western Pacific, Hangzhou, 1990	English only
30.	Fifth Session of the IOC Regional Committee for the Western Pacific, Hangzhou, 1990	English only
31.	Twenty-third Session of the Executive Council, Paris, 1990	E, F, S, R
32.	Thirteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, New York, 1990	English only
33.	Seventh Session of the IOC Committee for the Global Investigation of Pollution in the Marine Environment, Paris, 1991	E, F, S, R
34.	Fifth Session of the IOC Committee for Training, Education and Mutual Assistance in Marine Sciences, Paris, 1991	E, F, S, R
35.	Fourth Session of the IOC Committee on Ocean Processes and Climate, Paris, 1991	E, F, S, R
36.	Twenty-fourth Session of the Executive Council, Paris, 1991	E, F, S, R
37.	Sixteenth Session of the Assembly, Paris, 1991	E, F, S, R, Ar
38.	Thirteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Baja California, 1991	E, F, S, R
39.	Second Session of the IOC-WMO Intergovernmental WOCE Panel, Paris, 1992	English only
40.	Twenty-fifth Session of the Executive Council, Paris, 1992	E, F, S, R
41.	Fifth Session of the IOC Committee on Ocean Processes and Climate, Paris, 1992	E, F, S, R
42.	Second Session of the IOC Regional Committee for the Central Eastern Atlantic, Lagos, 1990	E, F
43.	First Session of the Joint IOC-UNEP Intergovernmental Panel for the Global Investigation of Pollution in the Marine Environment, Paris, 1992	E, F, S, R
44.	First Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 1992	E, F, S
45.	Fourteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange, Paris, 1992	E, F, S, R
46.	Third Session of the IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Vascoas, 1992	E, F
47.	Second Session of the IOC Sub-Commission for the Western Pacific, Bangkok, 1993	English only
48.	Fourth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, Veracruz, 1992	E, S
49.	Third Session of the IOC Regional Committee for the Central Eastern Atlantic, Dakar, 1993	E, F
50.	First Session of the IOC Committee for the Global Ocean Observing System, Paris, 1993	E, F, S, R
51.	Twenty-sixth Session of the Executive Council, Paris, 1993	E, F, S, R
52.	Seventeenth Session of the Assembly, Paris, 1993	E, F, S, R
53.	Fourteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Tokyo, 1993	E, F, S, R
54.	Second Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 1993	E, F, S
55.	Twenty-seventh Session of the Executive Council, Paris, 1994	E, F, S, R
56.	First Planning Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Melbourne, 1994	E, F, S, R
57.	Eighth Session of the IOC-UNEP-IMO Committee for the Global Investigation of Pollution in the Marine Environment, San José, Costa Rica, 1994	E, F, S
58.	Twenty-eighth Session of the Executive Council, Paris, 1995	E, F, S, R
59.	Eighteenth Session of the Assembly, Paris, 1995	E, F, S, R
60.	Second Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1995	E, F, S, R

CONTINUED ON INSIDE OF BACK COVER

61.	Third Session of the IOC-WMO Intergovernmental WOCE Panel, Paris, 1995	E only
62.	Fifteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Papetee, 1995	E, F, S, R
63.	Third Session of the IOC-FAO Intergovernmental Panel on Harmful Algal Blooms, Paris, 1995	E, F, S
64.	Fifteenth Session of the IOC Committee on International Oceanographic Data and Information Exchange	E, F, S, R
65.	Second Planning Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1995	English only
66.	Third Session of the IOC Sub-Commission for the Western Pacific, Tokyo, 1996	English only
67.	Fifth Session of the IOC Sub-Commission for the Caribbean and Adjacent Regions, Christ Church, 1995	E, S
68.	Intergovernmental Meeting on the IOC Black Sea Regional Programme in Marine Sciences and Services	E, R
69.	Fourth Session of the IOC Regional Committee for the Central Eastern Atlantic, Las Palmas, 1995	E, F, S
70.	Twenty-ninth Session of the Executive Council, Paris, 1996	E, F, S, R
71.	Sixth Session for the IOC Regional Committee for the Southern Ocean and the First Southern Ocean Forum, Bremerhaven, 1996	E, F, S, R
72.	IOC Black Sea Regional Committee, First Session, Varna, 1996	E, R
73.	IOC Regional Committee for the Co-operative Investigation in the North and Central Western Indian Ocean, Fourth Session, Mombasa, 1997	E, F
74.	Nineteenth Session of the Assembly, Paris, 1997	E, F, S, R
75.	Third Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1997	E, F, S, R
76.	Thirtieth Session of the Executive Council, Paris, 1997	E, F, S, R
77.	Second Session of the IOC Regional Committee for the Central Indian Ocean, Goa, 1996	E only
78.	Sixteenth Session of the International Co-ordination Group for the Tsunami Warning System in the Pacific, Lima, 1997	E, F, S, R
79.	Thirty-first Session of the Executive Council, Paris, 1998	E, F, S, R
80.	Thirty-second Session of the Executive Council, Paris, 1999	E, F, S, R
81.	Second Session of the IOC Black Sea Regional Committee, Istanbul, 1999	English only
82.	Twentieth Session of the Assembly, Paris, 1999	E, F, S, R
83.	Fourth Session of the IOC-WMO-UNEP Committee for the Global Ocean Observing System, Paris, 1999	E, F, S, R