

JOINT

**REPORT OF THE
WORKSHOP ON
THE GLOBAL OCEAN OBSERVING SYSTEM – GOOS**

**Bergen, Norway
22–24 March 1999**

**AND
STEERING GROUP
ON THE GLOBAL OCEAN OBSERVING SYSTEM**

By correspondence

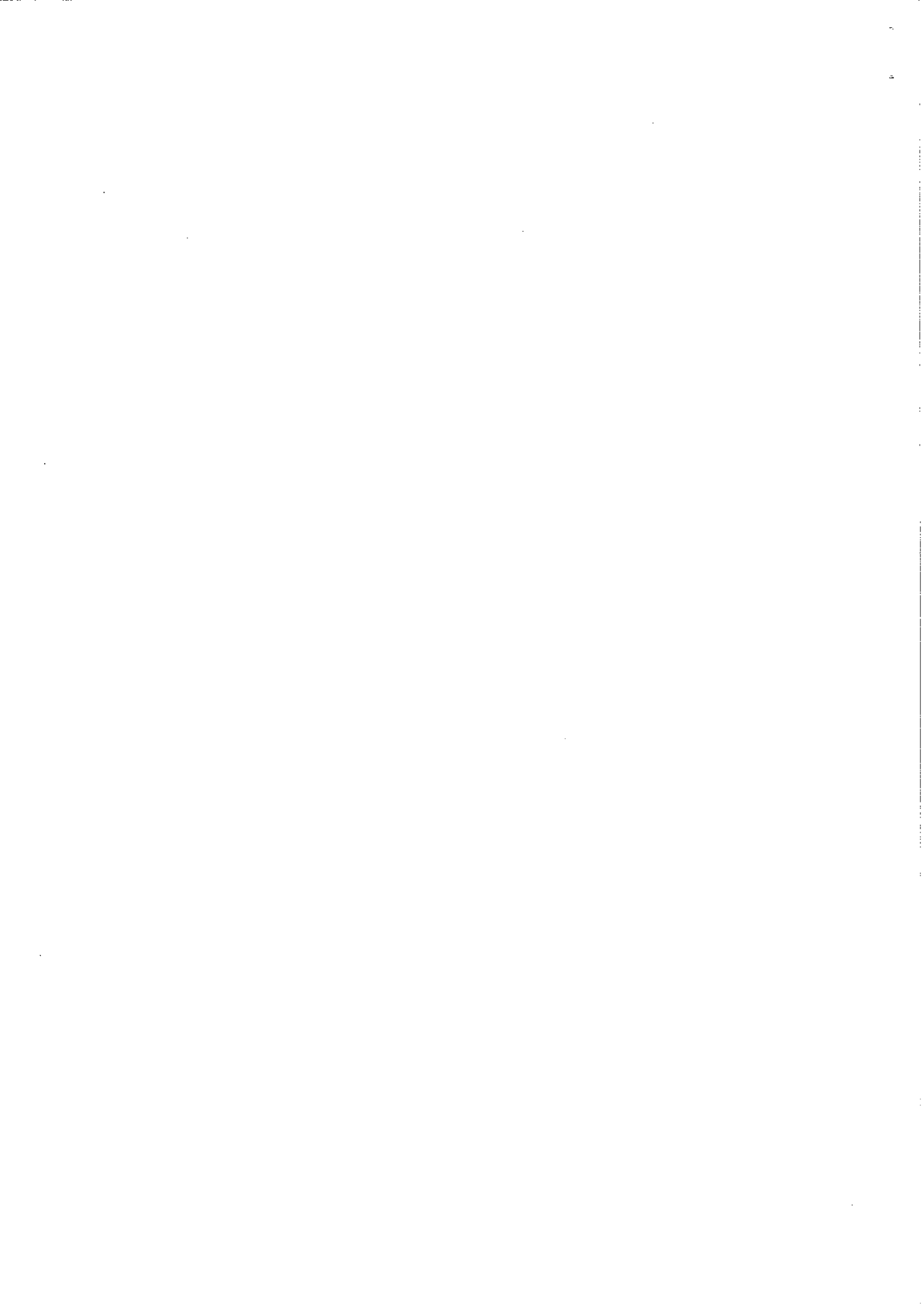
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1 BACKGROUND

The Global Ocean Observing System(GOOS) is an international programme preparing a permanent global framework of observations, modelling and analyses of ocean variables needed to support operational ocean services. GOOS is sponsored by several United Nation agencies, such as Intergovernmental Oceanographic Commission(IOC), the World Meteorological Organisation(WMO) , and United Nations Environmental Programme(UNEP),plus and the International Council of Scientific Unions(ICSU)

In 1997 ICES established a Steering Group on the Global Ocean Observing System(SGGOOS). Its term of reference was to:

«prepare an action plan for how ICES should take an active and leading role in the further development and implementation of GOOS at a North-Atlantic regional level

with special emphasis on operational fisheries oceanography»

The Steering Group consisted of the chairmen of the Working Groups under the Oceanography, Marine Habitat, and Living Resources Committees, who have worked by correspondence.

The Steering Group reported to the Oceanography Committee at the Annual Science Meeting 1998. In this report the result from a poll of various Working Groups gave the clear conclusion that ICES must be active in the implementation and execution of GOOS. This result is consistent with the view of the Advisory Committee on Marine Environment(ACME) on the matter. Thus ICES should take an active and leading role in the development and implementation of a regional component of GOOS by taking the responsibility to establish and run a centre or centres for operational fisheries oceanography for the ICES area or parts thereof. One of the accepted recommendations was to organise an ICES-GOOS workshop (C.Res.1998/2.23). Such a workshop was considered to be an important step towards meeting ICES's ambitions in relation to GOOS.

According to C.Res.1998/2.22 the SGGOOS should continue to work by correspondence in 1999 to

- carry out the tasks of the action plan developed by the Steering Group in 1998.
- advise and support the Secretariat on GOOS-related matters
- act on any advice from ACME and Advisory Committee on Fisheries Management (ACFM) concerning the ICES role in GOOS
- prepare and distribute information on GOOS to encourage the broader participation of the Working Groups of the Living Resources and Marine Habitat Committees.

In the international discussion on GOOS a central term is «operational oceanography». In the present report we will use the EuroGOOS definition:

« Operational oceanography is the activity of routinely making, disseminating, and interpreting measurements of the seas and oceans and atmosphere so as to

Provide continuous forecasts of the future condition of the sea for as far ahead as possible(*Forecast*)

Provide the most usefully accurate description of the present state of the sea including living resources(*Nowcast*)

Assemble climatic long term data sets which will provide data for description of past states, and time series showing trends and changes(*Hindcast*)»

Operational oceanography, however, has been on the ICES agenda for many years, especially pioneered by Dr. Jens Eggvin from Norway, but during those days different terms were used. Forty years ago, at the ICES meeting in 1959 Eggvin spoke about synoptic oceanography. He said: «We know that certain hydrographic situations influence the fisheries in various ways. If we can predict such special hydrographic situations, we can expect to be able to assist the fisheries with valuable information, knowing in advance that certain oceanographic conditions affect the fish in such and such a manner that we shall know how the fishery will turn out».

Initiated by ICES a Pilot project on Synoptic Oceanography was carried out in January-March 1966 with Institute of Marine Research in Bergen as «Lead institution». Material was received from eighth European countries. Oceanographic charts were transmitted by facsimile 1 to 4 days after the termination of each 10-day period (J. Eggvin: Pilot project on rapid utilisation of synoptic oceanographic observations. ICES CM 1966, Hydrography Committee No 17).

2 TERMS OF REFERENCE

According to C.Res.1998/2.23 a **Workshop on GOOS [WKGOOS]** under the Co-Chairship of Mr Roald Sætre (Norway), Prof. Christopher N.K. Mooers (USA) and Dr Hans Dahlin (Sweden) will be held in Bergen, Norway from 22–24 March 1999 to:

- identify existing ocean observing activities within the ICES area that are relevant to GOOS;
- investigate how observations already being made routinely, could be combined, and enhanced, and incorporated within a common plan;
- propose a possible design for an ICES regional GOOS component;
- develop a draft implementation plan for ICES-GOOS;
- advise the Bureau on the policy role of ICES.

The Workshop will report to the 1999 mid-term meeting of the Bureau and to ACFM and ACME, and will also report to the Oceanography Committee at the 1999 Annual Science Conference. The General Secretary will invite IOC to co-sponsor the Workshop.

3 PARTICIPANTS

F. Colijn and W. Lenz (Germany), H. Dahlin (Sweden), J. Hare and C. Mooers (USA), S. Narayanan (Canada), H. Dooley (ICES), J. Fischer (EuroGOOS), C. Summerhayes (IOC), W.R. Turrell (UK), M. Svelle (The North Sea Secretariat), L. Føyn, R. Sætre, H.R. Skjoldal, E. Svendsen, T. Gytre, O. Nakken and G. Evensen (Norway). Full names and addresses are given in Annex 1.

4 WORKING PROCEDURE AND WORKING DOCUMENTS

Annex 2 presents the agenda of the workshop. The first day was used for several presentations setting the frame for the further work by reviewing the status of GOOS in relation to ICES as well as to relevant international organisations and programmes, such as IOC-GOOS, EuroGOOS, The North Sea Conferences, The SeaNet co-operation. Additionally, there were short reports from the participants, national or institutional, on observation systems relevant to ICES-GOOS and regular product based on these systems. Written reports from non-participants were received from Iceland and Spain and from James Aiken, NERC, UK on the Atlantic Meridional Transect (AMT). Abstracts of all these contributions are included in the Annex.

5 OBSERVING SYSTEMS WITHIN THE ICES AREA-STATUS AND POTENTIAL

GOOS has been on the agenda of several of the ICES working groups under the former Hydrography Committee. As a follow-up of proposal to prepare an annual ICES Environmental Report, some of the working groups have already started up the work to report annually on items such as Ocean climate status, Harmful algal blooms, and Zooplankton monitoring. These activities could actually form the core of ICES-GOOS. The Working Group on Oceanic Hydrography has been reviewing the ocean conditions of the North Atlantic and the adjacent seas on an annual basis for many decades, and for the first time in 1998 produced The Annual ICES Ocean Climate Status Summary. The climate summary is based on a series of 50 standard hydrographic sections and stations from the whole North Atlantic maintained by ICES member states. The workshop identified the ICES network of fixed hydrographic section in the North Atlantic as the most important climate component for an ICES-GOOS. These observations set the regional (North Atlantic ocean) fluctuations into a decadal context for locally observed climate changes in national EEZs. The ICES Ocean Climate Status Summary is an excellent starting point for providing information to clients and this could be further developed and improved. The workshop discussed concrete proposals on how to enhance and improve this and how this climatic umbrella could be a part of the ICES-GOOS.

The ICES Workshop on GOOS was informed about the ICES Annual International Bottom Trawl Surveys (IBTS). These surveys, which are conducted quarterly in a co-ordinated way by various North Sea countries under the auspices of ICES, produce data on a range of commercial fish species (herring, sprat, mackerel, cod, haddock, whiting, saithe, Norway pout) along with physical and chemical oceanographic data (temperature, salinity, nutrients). The surveys have been carried out since 1970, providing the basis for long time series and climatologies. The data are used primarily to support operations by providing abundance indices for use in ICES fish stock assessments, but also support research through provision of regional maps of water properties (such as salinity and temperature). Research based on IBTS data confirms that the proportion of mature cod in relation to their age is different depending on their location in relation to their spawning grounds, for instance (source: ICES GLOBEC, Coordinator, Dr K Brander)

Given the systematic, long term, operational nature of these surveys and the collection of the resulting data into a common and readily accessible database maintained in the ICES Secretariat, the ICES Workshop on GOOS concluded that the IBTS was fully consistent with the Principles of GOOS and could therefore qualify as a component of the GOOS Initial Observing System, albeit as a regional rather than a global entity. In accordance with this observation, the ICES Workshop on GOOS made a direct request to the Living Marine Resources (LMR) Panel of GOOS which was meeting concurrently in Montpellier, France to consider this matter. If the idea is accepted, then the LMR Panel should formally request ICES to invite the IBTS to become a component of GOOS.*

The ICES International Bottom Trawl Surveys were emphasised as a possible core observation system for an ICES-GOOS for the North Sea. Identification of other GOOS-relevant observing systems need to be done in collaboration with the proposed partners, such as EuroGOOS.

Most of the ICES countries operate national monitoring and reporting systems for the marine environment where the end products could contain elements of hindcasting, nowcasting or forecasting. Information on several of these were reported to the workshop (Annex 12-17) In selected areas, such as the North Sea, there is some co-ordination of the data collection and assessment reports that have been worked out within the framework of the North Sea Conferences. However, there is no permanent integrated information system to obtain the synergetic effect of all the national activities. Most likely, the ecosystem approach to management will be a central theme at the next North Sea Conference in 2002. Such management needs to be based on an integrated monitoring and information system.

6 POSSIBLE DESIGN FOR AN ICES REGIONAL GOOS

The ICES member countries have all signed the Rio declaration and Agenda 21, the Climate Convention and the Convention of Sustainable Development. GOOS is the system for ocean information which is being implemented to support Agenda 21 and the conventions. All work co-ordinated by ICES and carried out by its member states are of relevance and value for GOOS. For both the member states and for GOOS it is important that the ICES co-ordinated efforts also will be available for GOOS.

ICES encompass activities of relevance to all GOOS modules; for example

- Living Marine Resources (LMR)
 - repeated surveys of physical, chemical, ecological, and fisheries variables
- Climate
 - North Atlantic standard sections and stations repeated at least annually over several decades
- Coastal
 - seasonal sampling of physical and ecological variables in the Baltic, the North Sea, and the Nordic Seas
- Health of the Ocean (HOTO)
 - sampling of contaminants in the Baltic and the North Sea
 - development of monitoring techniques and quality standards

Hence, ICES has much to offer GOOS in terms of historical databases, observing system expertise, and interpretative expertise, including fish stock assessment. With the latter capabilities, ICES offers GOOS a relatively unique opportunity for enhancing the LMR module and should become involved in the planning process. With its long-term activities in monitoring and detecting climate variability, assessing the impact of climate change on marine resources, participating in international research programmes, and generating and providing information for public consumption, such as the North Atlantic Ocean Climate Summary, ICES offers historical context and expertise for the climate module. With its comprehensive databases, ongoing sampling programs, and circulation and ecosystem modelling for the North West European Shelf, ICES and its members offers the Coastal and HOTO modules advanced case studies in programmatic design.

One area of international debate is the role GOOS should play in contributing to the scientific management of fisheries, and ICES could be a significant participant in this discussion. In the ICES area, the most important data originators are still predominantly fisheries research institutes. Additionally, fisheries management probably represents one of the most important customers for GOOS. Active ICES participation in GOOS may result in putting more emphasis on fisheries and fisheries management into the GOOS concept. Up to now, the activities seem to be dominated by a free market approach to ocean observing systems rather than management of a common resource in a sustainable way.

The workshop proposed that ICES take action to improve the mutual co-operation between ICES and IOC-GOOS by

* Communication received later from IOC that the LMR Panel had supported this proposal.

- Taking an initiative to have ICES formally represented in I-GOOS and the GOOS Steering Committee (GSC) and invite IOC-GOOS representatives to participate in relevant ICES meetings and activities
- Taking steps to be represented especially in the Living Marine Resource Panel and thereby influence planning and ensure that fishery concerns are properly incorporated in the panel's activities

In summary, it was recommended that ICES offers its expertise to GOOS and be willing to become involved in the planning of GOOS, especially in bringing its fisheries and oceanography expertise into the LMR module

The workshop proposed an ICES-GOOS system consisting of two initial elements:

- An Atlantic component focusing on ocean climate consisting of an enhanced ICES standard sections and stations, climate databases, and climate summary publications such as the Ocean Climate Status Report as a co-operation between the ICES member states, including USA and Canada, and EuroGOOS.
- An ICES regional GOOS system on appropriate time scale for the North Sea focusing on ecosystem dynamics with special emphasis on the needs for improving the management of fish stocks.

The design of an ICES-GOOS needs to be discussed with the potential partners in the development of the system and ICES should especially liaise with EuroGOOS to seek common grounds and exploit developments.

The workshop proposed to develop concrete plans for establishing networks of operational fisheries oceanography for the North Sea. Based on the routine observation systems carried out in the region, the participating network institutions could share the responsibility to produce regular environmental reports or nowcasts, for instance twice a year. These reports could be adapted for use in the fish stock assessment Working Groups and the preparation of them should be co-ordinated within the time schedule of these groups. At the start, the main emphasis of the regular environmental reports will probably be on the physical environment but both nutrients and plankton should be included to a degree which is feasible.

New working procedures, such as applying the OSPAR's principles of «Lead country» and «Regional Task Team» should also be considered. The development of a regional GOOS system should be a stepwise expansion from a core area, both geographically and in the amount and quality of services.

7 THE IMPLEMENTATION PLAN FOR ICES-GOOS

The challenge for the fisheries research and management community is to assemble, assess, and use environmental data within the annual fish stock assessment cycle. ICES has already started this work and in the future there will be a need for integrated environmental-fish stock assessment working groups with a regional or ecosystem focus

In the Statement of Conclusion from the Intermediate Ministerial Meeting for the North Sea on the Integration of Fisheries and Environmental Issues in Bergen, March 1997, the ministers adopted several guiding principles. One of these was that «further integration of fisheries and environmental protection, conservation and management measures, shall draw upon the development and application of an ecosystem approach». The next North Sea Conference will be held in 2002 and most likely the ecosystem approach to management will be a central theme at the conference. Different human uses impact directly or indirectly the same components of marine ecosystems. In management of these systems there is a need for continuous updated information. Instead of the present periodic assessment, typical decadal, a more continuous (possible monthly) assessment is needed. Consequently, the concept of an ecosystem approach to the management of the North Sea calls for an integrated monitoring and information system.

For marine ecosystems, climatic variability is a primary driving force for ecosystem variability. Improved knowledge of the relationship between climate and ecosystem variability would greatly benefit the difficult task of distinguishing human impact from natural variability. Consequently, there is a need to develop a harmonised system for monitoring, assessing, and forecasting the ocean climate for the European seas. This will be of relevance not only for environmental assessment but also for the assessment and management of living resources, coastal zone management, and marine operations. This activity should be seen as a European level component of GOOS which would provide a framework for co-operation to fulfil the needs of the regional conventions (OSPAR), the European Environment Agency (EEA), and other international organisations such as ICES and EuroGOOS.

Given the above the Workshop identified three main elements of an implementation plan for ICES-GOOS which should become the responsibility of the SGGOOS to develop. These elements are:

- 1) the Global and Regional Linkage,

- 2) the ICES Ocean Observing System and
- 3) a regional ICES-GOOS component for the North Sea.

Details of the three elements of the Draft ICES Implementation Plan for GOOS are as follows:

1) The global and regional linkage

- a) IOC should be invited to co-sponsor the ICES Steering Group on GOOS, including co-chairing it, and to nominate GOOS representatives to join that Group as appropriate. ICES Delegates are encouraged to co-ordinate ICES and IOC-GOOS contribution activities on the national levels via participation of national representatives to GOOS on the Steering Group.
- b) IOC should be encouraged to work with ICES to determine which of the ICES activities meet the GOOS Principles and would be best suited for adoption as elements of GOOS, either in an operational or a research sense including technology demonstrators or other forms of pilot projects, and, in addition, to consider how ICES might assist in «capacity building» to enable developing countries to participate in and benefit from GOOS.
- c) Co-operative arrangements should be developed between IOC and ICES to enhance mutual awareness through the
 - attendance of ICES Representatives at meetings of the intergovernmental Panel for GOOS (I-GOOS) (next meeting June 23-25, 1999, Paris) and the GOOS Steering Committee
 - the attendance of GOOS Senior officer(s) or their representatives at the appropriate ICES meeting(s) and a continuing involvement of an ICES fisheries expert on the meeting of the GOOS LMR Panel.
- d) Invite EuroGOOS and any other relevant regional GOOS Programme to participate in the ICES SGGOOS with a view to seeking common grounds and exploiting complementarity
- e) An additional task for the Steering Group would be to nominate ICES representatives, with the approval of the ICES Council, to serve as advisors to selected IOC-GOOS design panels and committees as appropriate.

2) The ICES Ocean Observing System

- a) ICES should identify and propose existing operational (regular - at least once per year, routine - existing or planned for more than 10 years duration) ocean climate monitoring activities as ICES-GOOS components. These may be standard sections or stations, spatial surveys or numerical model outputs.
- b) Each member state should submit agreed results from each designated ICES-GOOS activity within an appropriate time (e.g., one month from the end of a survey) through nominated national contact points and under the auspices of SGGOOS
- c) The ICES Secretariat should maintain a list of all such ICES-GOOS activities, monitor submission performance and produce summary data products (e.g. sub-sets of vertical profiles, averaged data) which will be rapidly communicated, using the Internet and the GTS network.
- d) The Oceanography Committee and its working groups should work together to produce and tailor summary products on a periodic basis, at least annually, exploiting the results of the ICES Ocean Observing System. These will take into account the needs and timing of the Fish Stock Assessment Working Groups.
- e) Develop further the pilot ICES Ocean Climate Status Summary produced by the Oceanic Hydrography Working Group, and other status reports as appropriate (e.g., that produced by ACME and also on behalf of the Nordic Council). The Working Groups, at the invitation of SGGOOS, will consider on a regional basis which key environmental indices are most relevant, and present these in a brief, informative manner with the addition of expert interpretation. Once developed, member countries will undertake to supply the necessary input to each WG needed to produce the summary products on an annual or biannual basis.
- f) The above activities should be identified as the ICES Ocean Observing System (I-OOS) which will complement ICES activities in fish stock assessment, which already has agreed data and model output collection, submission, and dissemination systems. The two components, the ICES Fish Stock Assessment products and the ICES Ocean Observing System, will form a substantial contribution to GOOS, while at the same time involving little additional effort than is already underway within individual ICES member states.

3) A regional ICES-GOOS component for the North Sea

- a) ICES, in cooperation with EuroGOOS and other relevant partners, and under the auspices of SGGOOS establish a co-ordinated and harmonised observation network and design a system for operational oceanography on appropriate

time scale for the North Sea. Such system may consist of a network of participating institutions with one institution acting as co-ordinator or «Lead institution».

- b) ICES should explore the feasibility to establish similar systems for other ICES regional seas, such as the Barents Sea, the Nordic Seas and the Labrador Sea.
- c) Assuming the endorsement by ICES of the quarterly IBTS North Sea Surveys as an element of the Initial Observing System of GOOS, a formal liaison between relevant IOC-GOOS bodies and the SGGOOS should be developed to ensure the continued application of GOOS Principles
- d) The North Sea GOOS has the potential of offering the most comprehensive prototype integrated Coastal, LMR and HOTO system for the world community to consider.

8 RECOMMENDATIONS

The ICES Workshop on GOOS recommends that:

The Steering Group on the Global Ocean Observing System [SGGOOS] be re-established as the ICES-IOC Steering Group on GOOS (Co-Chairs ICES rep/IOC rep) and will meet at

(place to be decided) from (date to be decided) 2000 to:

- a) develop the ICES-GOOS Implementation Plan described in the WKGOOS including
 - (i) development of co-operative arrangements to enhance mutual awareness with IOC and EuroGOOS;
 - (ii) develop an ICES-Ocean Observing System (I-OOS) based on the ICES Ocean Climate Summary and other relevant products and to find ways to produce and tailor products exploiting the results of the ICES Ocean Observing System;
 - (iii) establish a co-ordinated and harmonised observation network and design a system for operational oceanography on appropriate time scale for the North Sea;
 - (iv) develop and oversee the role of the North Sea IBTS quarterly surveys in the Initial Observing System of GOOS, and liaise with and report to GOOS bodies as appropriate;
- b) advise and support the Secretariat on GOOS-related matters;
- c) promote the role of ICES in GOOS taking into account input from ICES Advisory and
- d) Scientific Committees
- e) identify a programme of workshops to facilitate the implementation of ICES-GOOS and to improve awareness of GOOS in ICES, including special sessions at the ICES Annual Science Meeting
- f) identify those IOC-GOOS design panels and committees of relevance to ICES-GOOS with a view to proposing the appropriate ICES representatives at these meetings, with the approval of the ICES Council, and to prepare the briefs for these representatives.

Justification

SGGOOS has up to now been working by correspondence. The members have included the chairs of the working groups under the Oceanography, Living Resources and Marine Habitat Committees. A significant number of the appointed members have shown little or no interest in the work of the group. If the Steering Group should really be able to steer the GOOS process within ICES the group needs members more dedicated to the task, and they should have the possibility to meet.

The membership of the Steering Group should include IOC representatives, national GOOS contacts of ICES Member Countries, and chairs of the Oceanic Hydrography Working Group and the International Young Fish Survey (IYFS) Working Group

ICES should also invite representatives of appropriate regional GOOS bodies such as EuroGOOS to join the reconstituted Steering Group. Such ICES - EuroGOOS co-operation is expected to design common plans for development of a operational oceanography to support the management of living resources, coastal areas, and health of the ocean and to increase the understanding of climate change.

9 LIST OF ANNEXES

1. List of participants
2. Workshop agenda
3. C. Summerhayes, IOC-GOOS: The Global Ocean Observing System in 1998
4. J. Fischer, EuroGOOS: Plans and status for EuroGOOS
5. M. Svelle, The North Sea Secretariat: The North Sea Conferences
6. J. Hare, USA: Links between environment and fish populations
7. G. Evensen, Norway: Data-assimilation in relation to GOOS
8. C. Mooers, USA: Conceptual background for IAS-GOOS
9. H. Dooley, ICES: The role of ICES in relation to GOOS
10. W.R. Turrell, UK: The ICES Ocean Climate Status Summary
11. J. Aiken, UK: The Atlantic Meridional Section (AMT)
12. National report: Norway
13. National report: Germany
14. National report: Iceland
15. National Report: Spain
16. National report: Canada
17. National report: UK

ANNEX 1 – LIST OF PARTICIPANTS - ICES - GOOS WORKSHOP, BERGEN 22 - 24 MARCH

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ANNEX 2 – WORKSHOP AGENDA

Monday, 22 March, 10 00 hours

- 1000 - 1015 Roald Saetre, IMR: Welcome and opening of the meeting
- 1015 - 1030 The chairmen: Background, objectives and expected results from the workshop
- 1030 - 1100 Colin Summerhayes, IOC-GOOS: Progress in GOOS at the international level
- 1100 - 1130 Johanne Fischer, EuroGOOS: Status and plans of EuroGOOS
- 1130 - 1200 Morten Svelle, North Sea Secretariat: The North Sea Conferences- status and plans
- 1200 - 1230 Hans Dahlin, SMHI: The SeaNet co-operation
- 1230 - 1330 LUNCH
- 1330 - 1400 Geir Evensen, NERSC: Development of an operational data assimilation system for the North Atlantic and the Nordic Seas
- 1400 - 1430 Chris Mooers, USA: The situation in the Intra-Americas Seas (IAS-GOOS)
- 1430 - 1500 Harry Dooley, ICES: The role of ICES secretariat and the work with ICES Strategic Plan
- 1500 - 1530 Coffee Break
- 1530 - 1600 Bill Turrell, Marlab-UK: The ICES Ocean Climate Status Summary
- 1600 - 1630 Hans Dahlin, SMHI: The Baltic Monitoring System(BOOS)
- 1630 - 1700 Odd Nakken, IMR: Customers demands; How can environmental information be incorporated into the fish stock assessment work in a best possible way?
- 1800 - 2000 Reception at IMR-Main building

Tuesday, 23 March, 09 00 AM

- 0900 - 1030 Short reports, national or institutional, from the participants:
- Observation systems relevant to ICES-GOOS
 - Regular products based on these systems, such as
 - Data reports, Environmental Status Reports, Forecasts

1030 - 1045 Coffee Break

1045 - 1200 General discussion:

Which of the regions in the ICES area are suitable for an ICES-GOOS network?

How could such network be organised? Do we need a lead country/institution for each region?

What kind of products should be emphasised?

How should the products be distributed and how frequent?

What will be the relation of a regional ICES-GOOS to the international activities, such as IOC, EuroGOOS, SeaNet, OSPAR/HELCOM?

How could the further work be funded? Relations to EU's Fifth Framework Programme

What is the role of the ICES secretariat?

1200 - 1300 LUNCH

1300 - 1500 Discussion continue

1500 - 1530 Coffee Break

1530 - 1700 Discussion continue

Wednesday, 24 March, 09 00 hours

The discussion will be continued and the report finalised. The workshop meeting will be closed at 13 00 hours.

ANNEX 3 – THE GLOBAL OCEAN OBSERVING SYSTEM (GOOS) IN 1998

by

Colin Summerhayes, Director GOOS Project Office, IOC, UNESCO

Routine, systematic, long-term measurements of relevant ocean properties are essential to underpin accurate forecasts of the changes in ocean conditions that in turn provide essential input to the numerical models used to forecast storms and climatic events like El Niño, thereby helping countries to plan ahead to reduce impacts. Improving the system requires funding to maintain and extend the observational network, to improve the numerical models used to process data, and to improve the methods by which the data are assimilated into models. In due course operational oceanographic observations will be obtained and used for living resources, pollution, and coastal issues, as well as for weather and climate forecasting. Much of what we can do at present is limited by the state of the various sciences, the cost of global scale observation and the power of computing.

During the year a major achievement was the creation of the GOOS Initial Observing System, which unites the main global observing sub-systems supported by the IOC, WMO and (in the case of coral reefs) the IUCN, and includes measurements from ships, buoys, coastal stations and satellites. The GOOS-IOS is the first major physical manifestation of the GOOS concept, and is entirely consistent with the notion that GOOS must be built at least in the first instance from existing systems.

The Tropical Atmosphere-Ocean (TAO) array of buoys in the tropical Pacific, which underpins El Niño forecasts and is part of the GOOS Initial Observing System, proved its worth by providing even more accurate forecasts than before of the 1997-98 El Niño. Retrospective analyses of the data show that the first indications of the event appeared in subsurface data from the buoys. A conference sponsored by IOC and WMO in Guayaquil in November called for more investment in Pacific observing systems to improve El Niño forecasts.

Also in November, the 4th Conference of the Parties (COP) to the Framework Convention on Climate Change, which took place in Buenos Aires, agreed on the URGENT need to improve the quality, coverage and management of GOOS, especially to increase in the number of ocean observations, particularly in remote locations, reinforcing the need for GOOS pilot projects like the Global Ocean Data Assimilation Experiment (GODAE) and the Array for Real-time Geostrophic Oceanography (ARGO), which will seed the ocean with 3000 profiling floats. Space agencies are financing the initial stages of GODAE.

Plans began for the creation of the Joint WMO-IOC Technical Commission on Oceanography and Marine Meteorology (JCOMM), which will change the face of oceanography by providing a unified and integrated infrastructure for cost effective operations in support of GOOS, by combining the WMO's Commission on Marine Meteorology (CMM) with the IOC-WMO Integrated Global Ocean services System (IGOSS).

GOOS is now part of an Integrated Global Observing Strategy (IGOS) (only one S) involving the major space-based and *in situ* systems for global observations of the Earth in an integrated framework aimed at enabling better observations to be derived in a more cost-effective and more timely fashion by building on the strategies of existing international global observing programmes. IGOS brings together the global observing systems like GOOS, the space agencies, the UN agencies with environmental concerns, and research organisations including ICSU, the World Climate Research Programme and the International Geosphere Biosphere Programme.

The major academic institutions (Scripps, Woods Hole, Southampton, JAMSTEC, IFREMER etc) have now formed a Partnership for Observations of the Global Ocean (POGO), to enable them to make a more effective contribution to the development of GOOS.

At the regional level, NEAR-GOOS continues to successfully develop a data exchange programme between Japan, Korea, China and Russia. EuroGOOS has grown in size and output, and succeeded in attracting 15 million ecus from the European Commission into pre-operational research projects to develop the skills and capabilities to implement. EuroGOOS has also succeeded in persuading the European Commission to give ocean observation and operational oceanography high priority in the Fifth Framework Programme. New regional projects include BOOS, MedGOOS and PacificGOOS. PIRATA is a regional pilot project led by Brazil, which involves the emplacement of 12 buoys in a TAO-type array in the equatorial Atlantic, for climate forecasting.

At the national level, many IOC Member States are now planning or collecting their own coastal observations following GOOS Principles. This is exciting news, as implementation of GOOS at the national level will facilitate the essential

integration of data from neighbouring states as GOOS develops. At a Commitments Meeting at the IOC in July, nations will declare parts of their national observing systems as contributions to GOOS, which will further expand the system.

Design advice for the implementation of GOOS was published in the "Strategic Plan and Principles", and "The GOOS 1998, a Prospectus for GOOS". These documents help IOC Member States to appreciate the costs and benefits of GOOS, and to see how they may participate in it. Design advice on implementing the climate system is available on the GOOS web site (report of Sydney meeting).

The launch of the GOOS Coastal and Living Marine Resources Panels enabled the IOC to begin the balanced development of GOOS in accordance with the wishes of the sponsors and governing bodies. Ecosystem observations are a key part of both of these modules. More information about their planning is available in their reports on the GOOS web site (below).

Next steps involve developing a data management service and related centres; entraining more national observing systems; implementing a plan for coastal seas; establishing new pilot projects; developing new technologies (e.g. sensors); ensuring follow-on space programmes for continuity of key measurements; refining the designs; and building the capacity of developing nations.

Despite the profusion of GOOS entities, there is only one GOOS. GOOS is THE Global Ocean Observing System. It is part of the Integrated Global Observing Strategy (IGOS). It is being designed by 4 generic design panels (OOPC for climate, LMR for living resources; Coastal; and HOTO for health of the ocean) each representing a different customer group. It is managed by a GOOS Steering Committee (responsible for the technical elements), an Intergovernmental Panel (I-GOOS) responsible for policy and interaction with governments, and a GOOS Project Office acting as the Secretariat. There are also generic panels for data and information management and for advising space agencies about GOOS requirements. In due course the plans of the 4 design panels will be integrated into an overall GOOS implementation plan, probably with two elements, a low density open ocean one, and a high density coastal one. Global scale implementation has begun with the GOOS Initial Observing System (operational), and with GOOS demonstrator projects GODAE and ARGO (research and development). Regional planning for the implementation of the GOOS design takes place through regional GOOS bodies (EuroGOOS, BOOS, NEAR-GOOS, MedGOOS, PacificGOOS, GOOS-AFRICA and others on the drawing board). Each of these has, or will have, operational elements, as well as R & D projects designed to enable GOOS development. Finally, at the national level, GOOS implementation and R & D is being planned by national agencies working together through national GOOS committees. Many national operations could, and eventually will, form contributions to GOOS. In many instances ocean monitoring is carried out by national research agencies and is therefore quasi-operational. The research community is involved with GOOS in that way, and also in developing proposals for GOOS projects, like GODAE and ARGO, or EuroGOOS R & D projects for EC funding. All the different elements of GOOS described above are working in concert with one another towards a common goal but at different levels or in different sectors.

GOOS has a web page and a newsletter (available in hard copy or on the web page). For more information about GOOS see the following web sites:

GOOS: (<http://ioc.unesco.org/goos>)
EuroGOOS: (<http://www.soc.soton.ac.uk/OTHERS/EUROGOOS/>)
GODAE: (<http://WWW.BoM.GOV.AU/bmrc/mrlr/nrs/oopc/godae/homepage.html>)
ARGO: (http://WWW.BoM.GOV.AU/bmrc/mrlr/nrs/oopc/godae/Argo_Design.html)
PIRATA: <http://www.ifremer.fr/orstom/pirata>
NEARGOOS: <http://ioc.unesco.org/goos/neargoos.htm>
US-GOOS: <http://core.cast.msstate.edu/NOPPobsplan.html>

ANNEX 4 – PLAN AND STATUS FOR EUROGOOS

Johanne Fischer, EuroGOOS

EuroGOOS is the Association of European national agencies for developing operational oceanographic systems and services in European seas, and for promoting European participation in the Global Ocean Observing System (GOOS).

EuroGOOS was set up in December 1994. In 1999 it has 31 Members from 16 countries, and Associate Membership from several key European multi-national bodies (e.g. ICES, ESA, and the NATO SACLANTCEN Lab in La Spezia). The primary purpose of EuroGOOS consists in promoting and supporting the continuing development of operational oceanography in Europe, providing regional benefits for Europe, and helping to implement GOOS objectives and activities, and contributing to them. These goals will be reached through the following activities:

- Specification of the marine observational data needed on a continuous operational basis to meet the needs of the world community of users of the oceanic environment
- Development and implementation of an internationally co-ordinated strategy for the gathering, acquisition and exchange of these data in real time and near-real time
- Facilitation of the development of use and products of these data and widen their application in use and protection of the marine environment, particularly through numerical modelling and forecasting
- Facilitation of means by which less-developed nations can increase their capacity to acquire and use marine data according to the GOOS framework
- Contribution to the co-ordination of the ongoing operations of GOOS and ensure its integration within the wider global observational and environmental strategies

According to the present MoU, all decisions concerning the activities and the organisation of EuroGOOS are taken by the members during the Annual Meeting who also elect the EuroGOOS chairperson (at present: Dik Trump), the EuroGOOS director (at present: Nic Flemming) and 4 EuroGOOS officers. In addition, a number of committees and working groups carry out decisions taken by the Annual Meeting, give advice to the Annual Meeting, prepare EuroGOOS publications, and assist EuroGOOS projects. These are the Project Leaders Committee, the Scientific Advisory Working Group (SAWG), the Technology Plan Working Group (TPWG), the Economics Working Group, the Data Product Working Group, and the Regional Task Teams (Arctic, Baltic, North-West Shelf, Mediterranean, Atlantic).

In addition to the numerous existing national operational oceanographic programmes (the so-called Initial Observing System that has yet to be compiled), the European contribution to GOOS is being prepared by a number of projects. Examples are:

Atlantic Pilot Project = European contribution to GODAE. Objectives: (a) design an operational system monitoring the North Atlantic on the basis of real-time observations, modelling and assimilation; (b) demonstrate the feasibility of such a system. Status: Proposal to be submitted in 1999. Led by C. LeProvost (France).

ESODAE = European Shelf seas Data Assimilation and forecast Experiment. Objectives: design an experiment to provide a practical demonstration of the overall capabilities of ocean analysis/assimilation and forecasting models for the region in relation to applications. Status: EC Concerted Action funded in 1998. Led by UK Met Office (United Kingdom).

EuroROSE = European Radar Ocean Sensing. Objectives: develop a transportable tool to monitor and predict the significant met-oceans conditions (winds, waves, water levels and currents) with high time/spatial resolution in limited sea areas surrounding locations of dense and sensitive marine locations (typically 40 by 40 km) = coastal and port approach areas. Users: Vessel Traffic Services operators, harbour and coastal managers. Status: MAST-III 1998 -2001. Led by GKSS (Germany). Partners from Norway, United Kingdom, Spain. Remarks: In addition to EuroROSE, a larger scale RADAR proposal is planned (for ranges of 200-1000 km).

Gridded Bathymetry: Objectives: to develop a state of the art bathymetry grid on the NW European shelf over depths shallower than 200 m (horizontal resolution < 500 m, vertical resolution < 2 m). Users: Existing and future modelling projects, offshore oil and gas industry, coastal defences, flood prevention, safety and navigation management. Status: Proposal to be submitted in 1999. Co-ordinated by SOC (United Kingdom).

PROMISE: Pre-Operational Modelling In the Seas of Europe. Objectives: (a) optimise the application of existing pre-operational dynamical models of the North Sea, (b) focus of quantifying the rates and scales of exchange of sediment between the coast and the near-shore zone, and (c) specific orientation on the COUPLING of physical processes on different space-time scales (tidal and storm waves, surface gravity waves, turbulence, currents, erosion and settling of

bottom material). Status: MAST-III 1996-1999, completed. Led by POL (United Kingdom). Partners from Germany, Norway, France, Netherlands, Belgium, Spain

MFSPP = Mediterranean Forecasting System Pilot Project. Objectives: (a) develop a strategy for the implementation of a Mediterranean forecasting system (observation and modelling/data assimilation), (b) predict marine ecosystem variability at coastal areas (including primary production), and (c) show that Near Real Time forecasts of the large scale basin currents are possible. Time scales of days to months. Includes a trial operational period of 2-3 months in 1999. Status: MAST-III 1998 -2001. Led by IMGA-CNR (Italy). Partners from France, United Kingdom, Malta, Cyprus, Egypt, Greece, Norway, Denmark, Spain, Israel.

Remarks:

Ferrybox. Objectives: develop a ship-borne instrument package for routine operational monitoring of surface water parameters from ships of opportunity in general or ferry boats in particular. Variables monitored: Temperature, salinity, nutrients, optic water properties, chlorophyll, phytoplankton. Status: F5 R&D Proposal to be submitted 1999. Partners (so far) from United Kingdom, Germany, Finland, Norway, France, Netherlands.

Examples for other relevant activities are:

Sensors and Biofouling Panel (chair: John Wheaton). Objectives: recommend procedures or lines of development which are most likely to extend the maintenance-free life of instruments, especially in coastal seas; focus on engineering solutions which show a possible success in the short term; initiate F5 project proposal. Status: Workshop February 1999 in Southampton.

Data Policy Panel (chair: Hans Dahlin). Objectives: produce detailed recommendation for a EuroGOOS data and products exchange policy considering national and international laws and agreements. Status: Meeting November 1998 in Norrköping; report by end 1999.

SAWG Workshop Series "Extending the Limits of Predictability". Objectives: bring together international scientific expertise to discuss GOOS-relevant issues, identify state of the art as well as present gaps, and suggest future developments (8-9 March 1999 in Rome: Predicting the Ocean for the 21st Century. Optimising the Observations Network for the Atlantic and Adjacent Seas. (14-15 September 1999 in Norrköping, Sweden untitled yet but dealing with atmosphere-ocean coupling. (March or April 2000 in Den Haag, tentative title: Bio-ecological Observations in Operational Oceanography.

An important aspect of operational oceanography is its close connection to customers. The recently published EuroGOOS Data Requirements Survey represents a first step to assess the demands regarding marine data forecasts and models of a wide range of potential users of oceanographic data and products in Europe. Such users include marine research, governmental resource management and environmental protection as well as commercial businesses, which work on the sea and the coast. Results reveal that although physical (especially sea surface) variables are in high demand by a majority of respondents, some biogeochemical variables (e.g. phytoplankton, chlorophyll, nutrients, oxygen, and suspended sediments) occur in the top 40 variable list. They dominate the variables in the environment sector and feature strongly in the food sector. Furthermore, the top variables do not necessarily include some of the deep ocean variables needed for climate research or other environmental or global activities that are of great political and social importance. It was concluded that because there is no single dominant customer for marine environmental data, the survey data set is multidimensional, with dozens of customers requiring dozens of different variables in dozens of different combinations and characteristics. There can be no attempt to discover or define the ideal or "average" product and thus products from operational oceanography must be targeted to applications. They could be supported by European standard variables requested by a majority of users.

Until now, 12 EuroGOOS publications are available through the member agencies. They describe the strategy of EuroGOOS, the science and technology of operational oceanography, conference proceedings, as well as specific programmes, e.g. the Mediterranean Forecasting System or the EuroGOOS Data Requirement Survey. In 1994, a set of specific tasks for EuroGOOS has been defined. Today, we can report progress on all of them:

The next Annual Meeting in December 1999 plans to authorise the publication of the so-called "Forward Look" that describes the EuroGOOS plans for the future. The draft version of this document contains a list of services and products that EuroGOOS members plan to offer from 2003 to 2008 onwards (summary):

- improved real-time services, products and forecasts
- Spatial resolution < 1 km in the coastal and shelf seas (possibly 1-5 km in the Mediterranean)
- all standard physical parameters and states
- water quality parameters, suspended sediments, and optical properties
- nutrients, primary productivity, and other basic biological conditions modelling of shelf edge and slope processes

- forecasts of probable states (current, salinity, temperature) for seasonal and inter-seasonal time-scales
- approaching multi-year forecasts for the Atlantic (post-GODAE operational services)
- data contribution to global GOOS and GCOS
- for short period and seasonal forecasting
- for global climate studies contribution to predicting NAO
(collaboration with USA on Gulf Stream forecasting (fluctuations, convection, deep water formation)
working links to some South Atlantic states
- participation in modelling and predicting on the Atlantic scale
- EuroGOOS members promote capacity building in developing countries

Further information on EuroGOOS and it's members, structure, activities, etc. can be obtained at the EuroGOOS homepage:

<http://www.soc.soton.ac.uk/OTHERS/EUROGOOS/eurogoosindex.html>

ANNEX 5 – THE NORTH SEA CONFERENCES-BACKGROUND, ACHIEVEMENTS, AND PLANS

Morten Svelle, North Sea Secretariat

Background - first NSC 1984

- Growing environmental awareness
- Increasing inputs of heavy metals and chlorinated hydrocarbons (e.g. PCB)
- Increasing fear for long term effects
- Active NGOs and "Green" parties
- Lack of progress in international organisations
- Political impetus for intensification of work

North Sea related legal authorities Participants

- Belgium
- Denmark
- France
- Germany
- Netherlands

Observers:

International North Sea Conferences

- Bremen, Germany, 1984
- London, UK, 1987
- Hague, the Netherlands, 1990
- Copenhagen, Denmark, 1993 Intermediate Ministerial Meeting (nutrients, agriculture)
- Esbjerg, Denmark, 1995
- Bergen, Norway, 1997 Integration of Fisheries and Environmental Issues
- Norway, 2002

NSC - Main Issues

- Dumping of waste at sea
- Incineration of industrial waste at sea
- Hazardous substances
- Nutrients
- Pollution from ships
- Pollution from offshore installations
- Radioactive substances
- Protection of species and habitats
- Fisheries

London 1987

- 50% reduction of hazardous substances
- 50% reduction of nutrients
- Phasing out of marine incineration
- Phasing out of the dumping of industrial waste
- Enhanced scientific knowledge and understanding

The Hague 1990

- 36 hazardous substances for the 50% reduction target
- 70% reduction of dioxins, cadmium, mercury, lead
- Phasing out of PCBs
- Phasing out of 18 pesticides
- Protection of species and habitats
- Impact of fishing activities

Esbjerg, 1995

- Cessation of discharges of hazardous substances in one generation
- More attention to fisheries management issues
- Application of the precautionary principle in fisheries management
- Phasing out of TBTs
- Disposal on land of decommissioned offshore installations

IMM 97, Bergen

Main objectives:

- to ensure sustainable, sound and healthy ecosystems
- to maintain the biological diversity
- to achieve sustainable exploitation of the living marine resources
- to ensure economically viable fisheries

IMM 97, Bergen

Guiding principles:

- sustainable utilisation of the ecosystem
- conservation of biological diversity
- application of the precautionary approach
- further integration of fisheries and environmental management
- development of an ecosystem approach
- integration of environmental objectives into fisheries policy

Ecosystem Approach

- Integrated management
- Clear objectives, EcoQOs
- Better use of scientific knowledge
- Focused ecosystem oriented research
- Improved, integrated monitoring
- Integrated assessments of Eco Q (fish stocks, environment, socio-economics)

Fifth North Sea Conference 2002

- Further integration of fisheries and environmental management
- Application of ecosystem approach
- Setting of ecological quality objectives
- Integrated coastal zone management
- Existing and new commitments on hazardous substances, nutrients, ships, radioactive waste

Future need for information

- Status of North Sea ecosystem
 - Living resources incl. fish stocks
 - Physical/chemical environment
 - Eutrophication
 - Hazardous substances
- Assessment of compliance with EcoQOs

Organisational aspects

- NSC rely on data and assessment in international organisations
- Comprehensive, integrated monitoring programmes
- Eco Q -assessments based on all available data
- Coordination, cooperation, transparency

ANNEX 6 – LINKS BETWEEN ENVIRONMENT AND FISH POPULATION

John Hare, USA

My presentation is based strictly on personal experience, not as a representative of the US government. My research examines the links between the ocean environment and fish population biology and community ecology. Most of my work focuses on the larval stages of fish, which are planktonic; their distribution, abundance and survival is influenced by a wide range of oceanographic processes. I am also the manager for NOAA's Southeast Regional CoastWatch Node, which is responsible for distribution oceanographic data, primarily satellite-derived sea surface temperature (SST) data in near-real time (NRT) to any user, regardless of purpose. My knowledge of oceanographic observing systems in the US is biased owing to these experiences.

There are a variety of Executive Branch Departments (underneath the President) in the US government that have varying missions in the marine environment. These different departments and agencies collect a wide variety of information regarding the ocean environment and biology. Academic institutions, non-profit groups and state governments also collect various types of data. I will discuss only some of the oceanographic data collected by the National Oceanic and Atmospheric Administration (within the Department of Commerce) and thus, am covering only a small part of potential data sources for a Global Ocean Observing System.

NOAA's National Data Buoy Center operates a series of open-ocean and coastal buoys that collect oceanographic and meteorological data. Data collected differ for each buoy, but common measurements are air temperature, sea temperature, wave height, wind speed, wind direction, and barometric pressure. The starting date for each buoy also differs, but most records extend back into the mid-1980's.

NOAA's Center for Operational Oceanographic Products and Services distributes a variety of oceanographic products. They provide a national network of real-time physical oceanographic predictions for major harbours in the US. They also provide tidal predictions for a variety of areas in the US. Finally, they have water-level data from a variety of stations along the coast. The starting time for these stations varies widely, with some established recently, and others established in early 1900's. Some of these stations also record wind and water temperature.

NOAA also operates a variety of satellites that collect sea surface information. The Polar Orbiting Environmental Satellites collect sea surface temperature (SST) and reflectance data, from which turbidity can be estimated. This series of satellites began in the late-1970's and continues today. Other satellites also operate, some under NOAA, others not. These include the Geostationary Operational Environmental Satellite and the SeaWiFS satellite.

The Southeast Regional CoastWatch Node, of which I am manager, provides several operational oceanographic data products. Other regional CoastWatch Nodes also provide analogous products. As examples: 1) From our website (<http://www.bea.nmfs.gov>), we provide the seven most recent days of SST imagery for the southeastern US. This imagery is used primarily by recreational fisherman looking for the location of the western-wall of the Gulf Stream. 2) We have the capability to provide NRT-SST data (within 12 hours) to fisheries oceanographic cruises. These data are sent via email on an as-needed basis. We have supported cruises in the eastern Gulf of Mexico and along the southeastern coast of the US. These data are used primarily to adjust sampling locations to account for the dynamic nature of oceanographic features. 3) We have the capability to provide NRT-Ocean Colour data to support biological oceanography programs. We have performed this operation once, but were able to direct a ship to sample a 5 by 15 km ocean colour feature during an EcoHAB (Ecology of Harmful Algal Blooms) project. 4) We provide NRT-SST data to scientists involved in the management of sea-turtles. SST data are used in making decisions regarding the implementation of turtle excluder devices on trawls. We also make a product for a group which releases stranded sea turtles. This product involves an assessment of oceanographic conditions in the area of release and a suggestion of a release location. Some of these special projects can be found at http://www.bea.nmfs.gov/special_projects.html. These operational oceanographic activities are supported by the NOAA CoastWatch Program and by the NOAA NOS Center for Coastal Fisheries and Habitat Research.

ANNEX 7 – DATA ASSIMILATION IN RELATION TO GOOS

G. Evensen, Norway

An operational ocean forecasting system will have to rely on integrated use of observations of physical, biological, and chemical variables and coupled physical and marine ecosystem models. This can best be done using data assimilation techniques. Thus, one will have to further develop and implement consistent data assimilation techniques for primitive equation models and also new suitable methods for assimilation of data into the models of the marine ecosystem.

DIADEM is a project focusing on the implementation and validation of novel advanced data assimilation methods with an Ocean General Circulation Model and a model for the marine ecosystem, to build a pre-operational marine monitoring and forecasting system. The data assimilation methods are all based on dynamically consistent estimates of error statistics. The data assimilation system will first be validated in a hind-cast experiment and thereafter examined in a real time operation experiment.

The project focuses on the use of satellite observations. Sea- surface heights (SSH) from radar altimeter data and sea-surface temperature (SST) from AVHRR data will be assimilated in the physical model, while ocean colour data from CZCS, SeaWiFS and MOS will be assimilated in the ecosystem model.

The capabilities of the assimilation system to track the true evolution of the ocean and ecosystem will be assessed. Further, the real time data flow from existing satellite observing systems and their capabilities in providing observations that can be used with the data assimilation system in an operational mode will be evaluated.

The major outcome of the project is first of all expected to be a general and portable "pre"-operational ocean monitoring and forecasting system. Further, the project will provide properly evaluated data assimilation techniques which can be applied with other OGCMs and marine ecosystem models; estimates of error statistics such as correlation scales and cross correlation between different variables which are crucial information in all data assimilation systems; and finally an evaluation of the capability of currently available earth observations to control the evolution of the model system when used in an operational context.

ANNEX 8 – CONCEPTUAL BACKGROUND FOR IAS-GOOS

Christopher N. K. Mooers

The Intra-Americas Sea (IAS) covers the Caribbean Sea, Gulf of Mexico, and Straits of Florida, from 55W to the continents and ca. 6N to ca. 30N, which is basically the domain of IOCARIBE. The physical, chemical, and ecological systems of the IAS are dominated by the physical transports provided by the throughflow of the Gulf Stream System and its associated mesoscale variability. Forcing from runoff from several major rivers, heavy precipitation, and tropical and subtropical cyclones and fronts are important, too, but secondary for the physical system but probably vital for the ecological system. Because the oceanic regime is highly advective, a Lagrangian perspective is important for both modelling and observing systems.

In recent years, IOCARIBE has recognised the need to develop a regional approach to GOOS, especially for its less-developed members to build capacity for their national coastal GOOS activities. Simultaneously but largely independently, the regional scientific research community has been building cohesion and has recognised the scientific opportunity to investigate regional system-science questions that include the functionality of coastal ecosystems in a region dominated by coral reef, seagrass beds, and mangrove forests and where offshore waters are largely oligotrophic but significant upwelling zones exist. One of the interesting scientific issues concerns the efficient design of an array of regional marine reserves to sustain coastal ecosystems and certain fisheries. To address these questions, a regional GOOS (IAS-GOOS) is essential not only in the design phase but also for the long term-term system management of the reserves..

Some of the initial ingredients for IAS-GOOS already exist. For example, there are networks of tide gauges, meteorological coastal and buoy stations, drifting buoys, telephone cables, and VOS ships and long time series at research sites and coastal radars operated in a research mode. One need is to integrate these disparate data sources into a single information system. Another is to form a group that will provide stewardship for the evolving observing system. As another example, numerous circulation models exist, including one that is assimilating satellite radar altimetric sea surface heights and is being forced by synoptic operational winds on a continuing basis, but they are of uncertain validity. Thus, another need is to establish an evaluation effort focused on this zero-order prediction system that can be used to develop and assess both scientific and societal products, which will refine the system design. To examine the research issues for a solid scientific design of IAS-GOOS, it is proposed to initiate a regional version of GODAE, called IAS-RODAE, and conduct it during GODAE to use the latter's field estimates as open boundary conditions.

Initiation of IAS-GOOS activities is being proposed to IOCARIBE in late April at an IOC-organised GOOS Capacity Building Workshop in Costa Rica. There are opportunities for ICES to participate, especially since UK, NE, and FR are members of IOCARIBE, Sweden is a major supporter of ICARIBE, and other ICES members provide aid to IAS nations. The IAS, with its large portion of the Western Atlantic Warm Pool, is also an important component of the climate system of concern to ICES, and there are fisheries issues worthy of integration into a total Atlantic fisheries management scheme of the future.

ANNEX 9 – THE ROLE OF ICES IN RELATION TO GOOS

Harry Dooley, ICES

The ICES Oceanographer briefly reviewed the Secretariat's databases, and explained their relevance in the context of GOOS. The Secretariat has supported databases in fisheries, environment and oceanography for many years, in some cases for as long as ICES itself. These databases now support ICES aims in producing advice, and also in supporting the research infrastructure of ICES. As a result the Secretariat sets standards in data quality and data validation. The presentation also demonstrated how ICES archives have, in the past, supported systematic observations which are the objective now being promoted in the framework of GOOS.

A number of advantages of using the Secretariat in support of GOOS activities were noted. These included:

- if within the frame of existing activities, then resources are freely available to ICES Member Countries;
- the Secretariat is a use of data via working group's etc., enhancing quality;
- it takes an international view, avoiding national prejudices;
- it has long-standing experience, broad contacts, expertise and a reputation for quality;
- it has the ability to organise assessments based on its data holdings, and the peer review of products;
- it has a multidisciplinary environment;
- allows ICES to be more closely involved and aware of GOOS initiatives which directly evolve from ICES activities (e.g. RAMP and SCICOM).

The meeting noted however that the Secretariat was a less than optimal environment for maintaining databases in support of GOOS-related activities and it was important that some of these would need to be addressed. These include:

- The Secretariat is under-resourced in hard ware, software and human skills;
- the Secretariat is several steps removed from data originators (as with many national data centres)
- Use of the ICES Secretariat must match ICES needs and hence the ICES Strategy.

In concluding this presentation, the Oceanographer outlined the current efforts in developing an ICES strategy, especially with regard to those elements that impacted on the objectives of GOOS. ICES in particular recognised that objectives were parallel to these of GOOS and that ICES has the structure which enables it to respond to those challenges being identified by GOOS within the context of the Global Science Agenda. These include the growth of integrated ecosystem modelling and a development towards operational forecasting that will be stimulated by the developments in GOOS. Currently the Oceanography Committee was taking the lead in adapting and identifying ICES goals in the context of GOOS. In particular it sees a role in participating in the development, implementation and incorporation of monitoring activities as part of GOOS. It also saw itself as an important forum to promote the development of tools for the incorporation of environmental information into fisheries and ecosystem management. Thus, it would be an important source of expertise in the development of forecasting systems as required by GOOS.

ANNEX 10 – THE ICES OCEAN CLIMATE STATUS SUMMARY

W.R.Turrell, UK:

1. I-OOS - Advantages: The ICES Ocean Climate Summary is based upon results from the ICES Standard Sections and Stations (renamed the ICES - Ocean Observing System I-OOS) which are presented each year at the ICES Oceanic Hydrography Working Group. There are approximately 30-40 Standard Sections and Stations distributed throughout the oceanic area of the North Atlantic / Nordic Seas. Observations for I-OOS have several advantages compared to other sources of marine ocean climate data. The observations are generally full depth, multi-parameter rather than single depth, single parameter as obtained from ships of opportunity. Data from the I-OOS is in many cases already multi-decadal, and generally the I-OOS is maintained by Fishery Institutes, and therefore their products are already known to and integrated with the needs of a main GOOS customer - fisheries. In addition Fishery Institutes often have the resources in terms of ships and staff which are needed in order to maintain decadal scale observations, as compared with research institutes which often are restricted by shorter funding cycles.

2. I-OOS - Drawbacks: However, the I-OOS also has some disadvantages associated with its make up. For example sampling is often infrequent, typically on a seasonal basis. Presently efforts within I-OOS are not well organised, for example two ICES institutes sample along the same line in the North Sea, and data is not shared or compared (e.g. MLA-JONSIS / IMR-Utsira). Suppliers of I-OOS data often have disparate methods, products and formats for data reporting. For example, some report raw data while others report filtered data. Some supply meteorological data along with ocean data, while others do not. Nutrient data is reported by some and not others.

3. 1998 Pilot Climate Summary: Up until 1998 results from the I-OOS were reported in the main text the ICES OHWG annual report with detailed national reports added as Appendices. This resulted in the results being in a form not easily accessible by potential users of the data. In 1998 a simple, short summary was produced, aimed at potential 'customers' of the products from I-OOS. The aim was to produce a readable (e.g. no technical terms were included such as water mass names) product. Text boxes were included to add points of general interest and explanations of technical terms where these were unavoidable. Data presentations were kept to one format to enable a reader to navigate through the report using standardised presentations.

4. Areas for Improvement: However, following the first pilot edition in 1998, there are several areas where improvements can be made. A structured submission format will be attempted. For the 1999 summary, data providers have been asked to structure their submission using common chapter headings (1. Area description, 2. 1998 Synopsis, 3a. Parameter - 1998, 3b. Parameter - Trend, 4. 1998 Extreme Events).

The WG would also like to see rapid publication of the summary on web, and in this area the ICES Secretariat can help. In addition better interaction with Stock Assessment WGs could be undertaken by consulting with them on their specific needs, and the best timing for them to receive ocean climate products in relation to their own stock assessment cycles. Another area where improvements will be possible is the addition of more interpretation into the climate status summary, and to combine the expert regional knowledge of the OHWG / SSOWG. An attempt at some form of prognosis might also be attempted.

One way forward might be for the WG to carry out a few specific scoping studies, examining predictability using oceanographic time-series (e.g. NAO preceding ocean events, advective events monitored 'down stream') or examining past ocean climate events and how existing time-series might have been best used during the events themselves.

5. Other Potential Developments: Attempts should be made to promote I-OOS activities to the research community presently involved in initiatives such as CLIVAR, GCOS and EuroGOOS. Initiatives developing and deploying new technologies such as long-term moorings and autonomous vehicles should be used to augment the I-OOS. An example is the deployment of bottom mounted ADCPs across the standard sections around Faroe. The extensive ICES fish stock assessment surveys should be better employed to provide environmental data sets from the ICES area by adding a requirement to undertake environmental measurements during the surveys.

The I-OOS and the ICES Ocean Climate Summary could begin to include other data sources, such as the extensive SST data sets (e.g. COADS, BSH), data from remote sensing sources, data from research institutes, products derived from the ICES databank and perhaps most importantly numerical model outputs.

ANNEX 11 – THE ATLANTIC MERIDIONAL TRANSECT (AMT).

James Aiken, UK

The AMT Project exploits the passage of the Royal Research Ship *James Clark Ross* (JCR) through the Atlantic Ocean (latitudinally from 52 N to 52 S) between the U.K. and the Falkland Islands. In September the JCR sails southward, sampling the boreal fall and the austral spring (BFAS cruises); the following April it returns to the UK, sampling the austral fall and the spring conditions in the northern hemisphere (AFBS cruises). The ship's track crosses a range of ecosystems and physio-chemical regimes, within which conditions vary from sub-polar to tropical and from eutrophic shelf seas and upwelling systems to oligotrophic mid-ocean gyres. The JCR provides the ideal platform to measure physical, biological and bio-optical properties and processes through these diverse ecosystems of the Atlantic Ocean.

The project goals are:

To test and refine hypotheses on the responses of oceanic ecosystems and the coupled marine atmosphere to anthropogenically forced environmental change.

To develop a holistic strategy, integrating shipboard measurements using autonomous and novel technologies, remote sensing and modelling.

To provide calibration and validation of new satellite sensors of ocean colour, sea surface temperature, sea surface height and solar radiation.

To improve our knowledge of marine biogeochemical processes, ecosystem dynamics, food webs and fisheries and characterise biogeochemical provinces.

To develop coupled physical-biological models of production and ecosystem dynamics.

To quantify oceanic responses to changes in abundance of radioactively & chemically active gases.

It has been an inherent goal of the AMT project to examine the hypothesis of biogeochemical provinces and determine their characteristic properties. Traditionally oceanographers have partitioned the oceans on the basis of physical and biological characteristics: for the former, topography, geostrophic flows, wind driven circulation, gyres, fronts, upwelling zones and patterns of seasonal stratification; for the latter, biological productivity, as well as phytoplankton and zooplankton assemblages and community structure. Taken together, this bio-physical partitioning provides the descriptors of regional ecosystems or biogeochemical provinces, each with discrete boundaries and each having distinct flora and fauna. The concept of biogeochemical provinces has been promoted by Longhurst *et al* (1995) particularly as a means of evaluating patterns of basin-scale productivity from remotely sensed measurements of ocean colour, making use of province-specific physical and biological parameterisations (climatological values of the key variables). Substantial progress has been made towards validating this hypothesis and on objective methods for province identification.

There have been 8 AMT cruises to date: AMT-1, Sept./Oct. 1995; AMT-2, April/May 1996; AMT-3, Sept./Oct. 1996; AMT-4 April/May 1997; AMT-5, Sept/Oct 1997; AMT-6a April/May 1998 (FI to UK on RRS Bransfield); AMT-6 May/June 1998 (Cape Town to UK on JCR); AMT-7 Sept/Oct 1998. AMT-5, 14 Sept. 1997 to 17 Oct. 1997 coinciding with the start of the operational phase of SeaWiFS (18 Sept. 1997), was designated the **SeaWiFS Atlantic Experiment** as the only major research cruise involved in calibration and validation of SeaWiFS data during the first 100 d of operations.

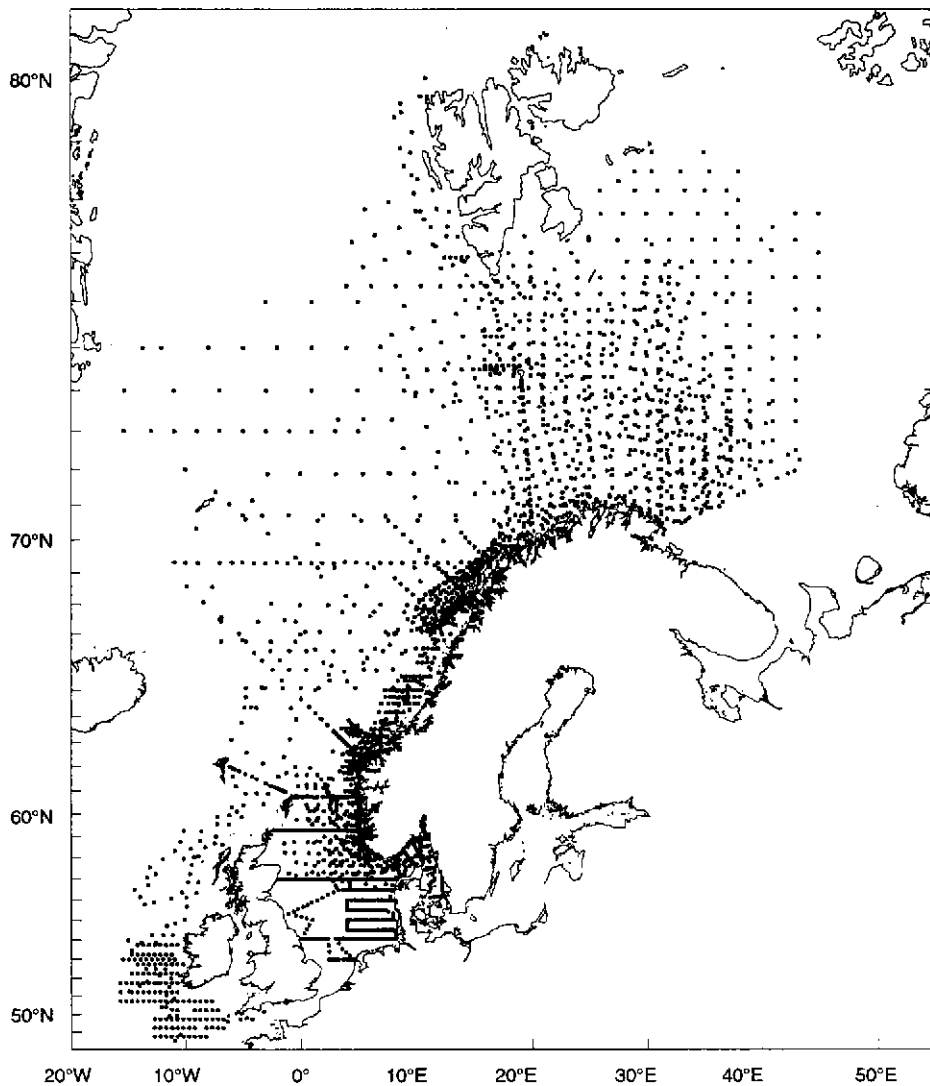
AMT-6 from Cape Town to the UK, focused on the Benguela and N W Africa upwelling systems providing substantial new insights into bio-optical properties and productivity of these systems.

Considerable progress has been made towards the principal objective of deriving the functional interpretation of optical signatures. This has come about through the high quality optical and bio-optical measurements, the new measurements of photosynthetic parameter values with the FRRF and the new bio-optical models on photon absorption which have been developed from these data. The main conclusions are:

1. **The AMT has provided a new insight into the structure, functioning and variability of ocean basin physical provinces and ecosystems.**

- 2. Physical and biological provinces can be detected by objective (derivative) analysis of surface density and or surface chlorophyll (or phytoplankton pigments), showing the co-existence of physical and biogeochemical provinces.**
- 3. Provinces can be derived from remotely sensed data of SST or SSH by objective analysis; bio-optical provinces can be determined objectively from remotely sensed data.**
- 4. The FRRF has revolutionised the acquisition of photosynthetic rates at ocean basin scales. Functional relationships have been derived between photosynthetic parameters and incident light (PAR).**
- 5. SeaWiFS algorithms have been validated to high precision using AMT data of optical properties and chlorophyll concentration.**
- 6. SeaWiFS derived water leaving radiances (L_{wn}) have been validated with AMT measurements of L_{wn} and shown to have high precision.**
- 7. SeaWiFS derived products Chlorophyll a and the diffuse attenuation coefficient K_d490 have been validated and shown to have high precision.**
- 8. New photon absorption models have been developed which provide algorithms to derive productivity from remotely sensed data with higher precision than possible hitherto. The new bio-optical models link the functioning of phytoplankton production to their bio-optical signatures that can be derived from remotely sensed observations of ocean colour.**

IMR's Environmental Observing System



10

Fig 1. Distribution of oceanographic stations in 1998 (4050 stations)

IMR is a national centre placed under the Ministry of Fisheries for research on the marine living resources and the marine environment.

The institute has about 500 employees of which 150 are scientists. In addition to the main facilities in Bergen, IMR has three research stations and five research vessels. The overall objectives of the institute are to provide the scientific basis for;

- A future-oriented and sustainable management of the marine environment.
- A diverse and economic viable fisheries by ecologically responsible utilisation of the marine living resources.
- A diverse and viable aquaculture on a genetic and environmental safe base.



The IMR's Environmental Observing System

Activity	Observations/year	Parameters	Start year
Fixed Stations			
Hydrographic stations, coastal	26 – 40	T, S	1935
Thermographic service	100 coast, 50 North Sea	T, S	1936
Flødevigen Research Station	350, *50	T, S, *Ppl (harmful algae)	1924
Fjords: Rogaland - Finnmark	1 (Nov-Des)	T, S, N, O ₂	1975
Fjords: Skagerrak	1 (Oct), 12*	T, S, O ₂ * Oslofjord T,S,N,O ₂	1920
Coastal monitoring, southern coast	12-24	T, S, N, O ₂ , Pm, Kl, Ppl, Zpl	1990
Station Mike - Norwegian Sea	60 (T/S)	T, S, N, Kl, Ppl, Zpl	1948
Fixed Sections			
Torungen – Hirtshals	11	T, S, O ₂ , N, Kl	1951
Hanstholm – Aberdeen	4 (Feb, April, June-July, *Nov)	T, S, *N, *Kl	1970
Oksø – Hanstholmen	4 (Feb, *April, June-July, *Nov)	T, S, *N, *Kl	1970
Utsira - Start Point	4 (Feb, April, June-July, *Nov)	T, S, *N, *Kl	1970
Feie – Shetland	4 (Feb, Apr, June-July, *Nov)	T, S, *N, *Kl	1970
Svingøy – NW	2 (Mar-Apr, July-Aug) *5-10 after 1995	T, S, *N, *Kl, *Ppl, *Zpl	1978
Gimsøy –NW	2 (Mar-Apr, July-Aug) *5-10 after 1995	T, S, *N, *Kl, *Ppl, *Zpl	1978
Fugløya – Bjørnøya	6 (Jan, Mar, Apr-May, June, Aug-Sept, Oct)	T, S, N, Kl, Zpl	1968
Bjørnøya –W	2 (March, Oct)	T, S	1958
Sørkapp –W	1 (Aug/Sept)	T, S	1978
Vardø –N	4 (Jan, Mar, June, Aug-Sept, Oct)	T, S, N, Kl, Zpl	1953
Sermøyene – N	2 (Jan-Feb, Aug-Sept)	T, S	1977
Regional coverage			
Barents Sea	4 (Jan-Feb, **June, *Aug - Sept)	T, S, *N, *Kl, *Zpl, **Flrv	1966
Barents Sea	Periodic observations	Contaminants, radioactivity,	1991
Norwegian Sea	3 (May, July-Aug, Oct-Nov)	T, S, O ₂ , N, Kl, Zpl	1951
Norwegian Sea	Periodic observations	Contaminants and org. mat.	1994
Norwegian coast, North of 62 degr.	2 (*Apr, Oct)	T, S, *Flrv,Zpl,*N	1981
North Sea/Skagerrak	4 (Jan, July, Oct, *Nov-Des)	T, S, *N, *Kl	1967
North Sea/Skagerrak	Periodic observations	Contaminants, radioactivity,	1991
Skagerrak – Jylland W	1 (April)	T, S, N,O ₂ , Kl, Ppl	1988
Lofoten	1 (March – April)	T, S	1951
Ireland – Shetland - Faroe Is.	2 (March-April, May-June)	T, S	1971
Svalbard – W	1 (Aug-Sept)	T, S	1981

T=temperature, S=salinity, O₂=oxygen, N=nutrients, Pm=particulate matter, Kl=chlorophyll a, Ph=phytoplankton, Zpl=zooplankton, Flrv=fish larvae

FIXED OCEANOGRAPHIC STATIONS AND SECTIONS

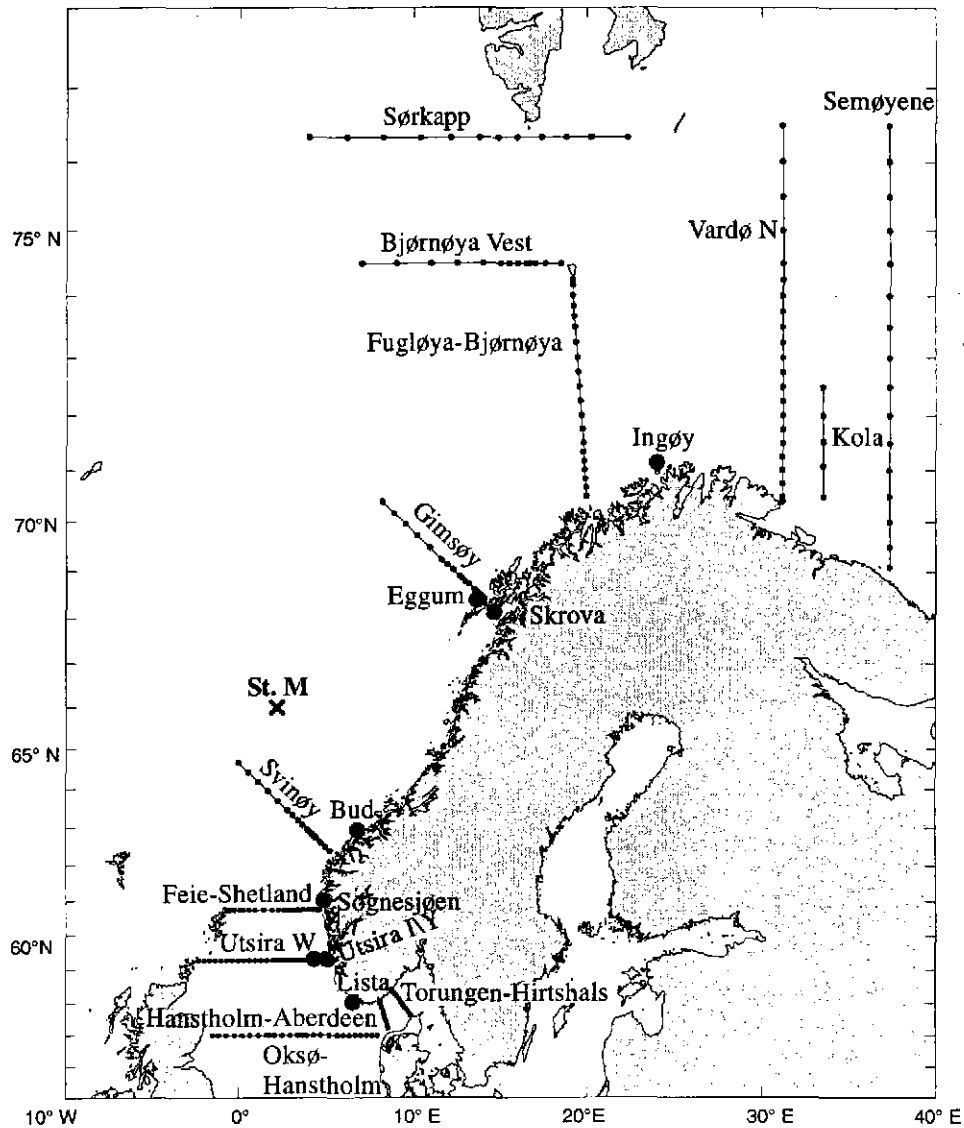


Fig. 2. Fixed oceanographic stations and sections

During the period 1935-1947 the Institute of Marine Research established a number of fixed oceanographic stations along the Norwegian coast between the Skagerrak and the Barents Sea (Table and Fig. 2).

The main objective was to monitor the ocean climate variability in relation to fisheries. Temperature and salinity measurements were regularly taken on these fixed stations since the start with yearly observation frequency of 26 - 40. The work is carried out by local observers who today are equipped with modern instrumentation.

Ocean Weather Station Mike in the Norwegian Sea (Fig.2) has been operated by the University of Bergen since 1948. Since 1990 the IMR has carried out weekly measurements of nutrients, chlorophyll and phytoplankton.

The system of fixed oceanographic sections have been operated for about 20 years in the Norwegian and the Barents Seas and for about 30 years in the North Sea. Some of the sections have sporadically been observed since the turn of this century. Chemical parameters, such as nutrients and oxygen, as well as plankton have been observed on selected stations and sections during the last 10-20 years.

REGIONAL COVERAGE

In addition to the system of fixed oceanographic stations and sections IMR has regular regional monitoring of the conditions in the North Sea/Skagerrak, the Norwegian Sea, the Barents Sea and in the Norwegian coastal area. This activity is related to variability in ocean climate, plankton production, recruitment to fish stocks and anthropogenic impacts, such as input of nutrients and harmful algae blooms, organic contaminants and radioactivity.

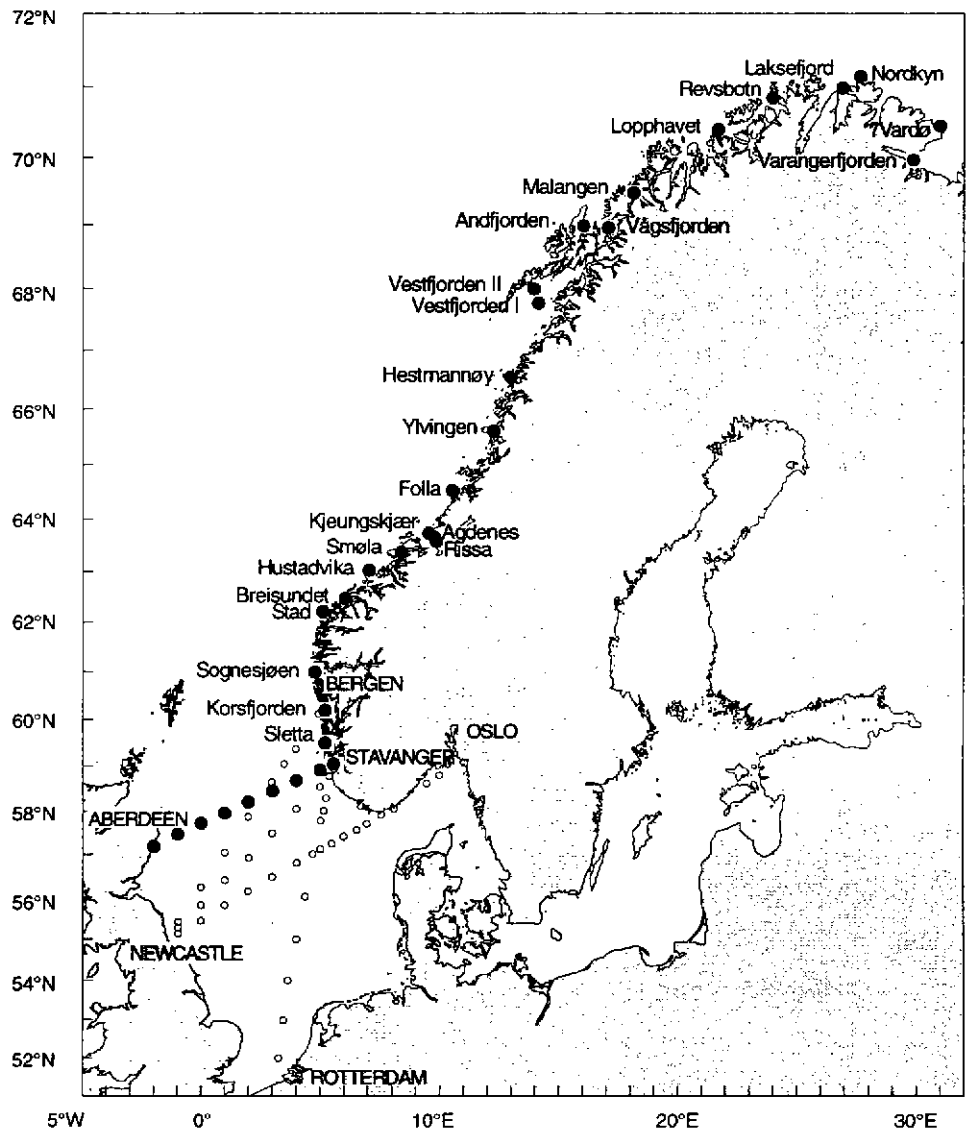
THERMOGRAPH SERVICE

In 1936 the IMR established a system for recording temperature and salinity in the surface layer along the Norwegian coast by using commercial vessels.

The route between Stavanger and the northernmost coast of Norway is surveyed twice a week. In the mid-fifties the program was extended to some shipping routes across the North Sea (Fig 3).

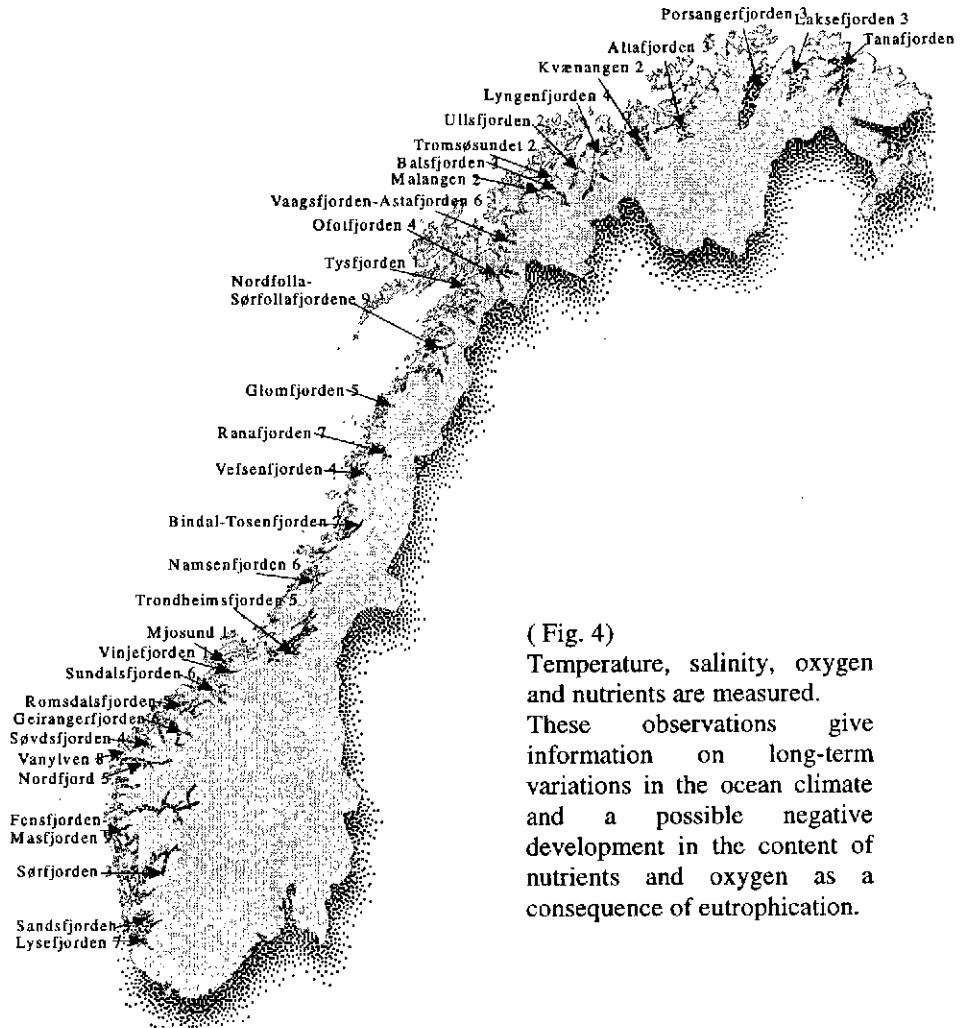
These routes were stopped in the early 1980s and today only the North Sea route between Stavanger and Aberdeen is covered once a week.

*Fig.3
The thermograph service.
Filled dots indicate ongoing activities.
Open dots indicate historical time series*



MONITORING THE FJORDS

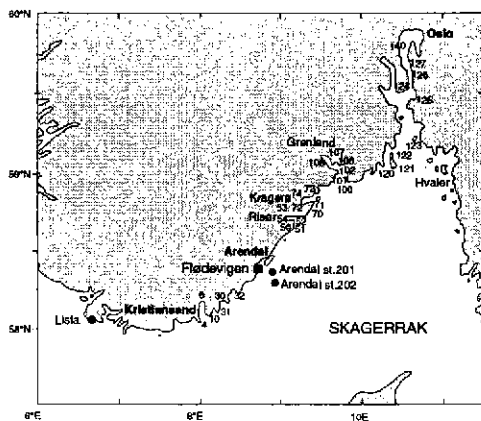
In November - December each year the environmental conditions in the fjords along the western and northern coast of Norway are observed.



(Fig. 4)
Temperature, salinity, oxygen and nutrients are measured. These observations give information on long-term variations in the ocean climate and a possible negative development in the content of nutrients and oxygen as a consequence of eutrophication.

THE SKAGERRAK COASTAL CONDITIONS

Fig. 5.
The IMRs Research Station
Flødevigen
and the coastal and fjord stations of
the Skagerrak coast



At Flødevigen Research Station temperature and salinity are observed daily at several depths. These time series dates back to 1924. Since 1985 there has been a regular monitoring for harmful algae and the results are reported weekly during the algae season.

Since 1990 hydrographic, hydrochemical and biological parameters have been observed monthly at two locations off Arendal (Fig. 5).

In October each year the fjords of the Norwegian Skagerrak coast are monitored with respect to hydrographic and hydrochemical parameters as well as beach seine sampling for juvenile fish. These investigations started in 1920.

The IMR publish annually an Environmental Assessment Report for the seas around Norway based on its Environmental Observing System. For each of the ecosystems the Barents Sea, the Norwegian Sea and the North Sea including Skagerrak this report assess the current environmental status in relation to ocean climate, biological productivity, pollution and special events, such as harmful algae blooms. It also contain a collection of popular articles on themes which we think should be of public interest. The Environmental Report includes prognosis for the development in ocean climate and the possible biological consequences of this development.

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ANNEX 13 – NATIONAL REPORT: GERMANY

F. Colijn: The German contribution to GOOS

In 1995 a report (BSH, 1995)* was published on current and planned operational Programs in relation to GOOS. The most important contributions are conducted by the following two governmental agencies:

Bundesamt für Seeschifffahrt und Hydrographie (BSH), Hamburg

- water level/storm surge prediction;
ice observation and prediction;
wave observation and prediction
- long-term variability of hydrographic parameters in North Sea and Baltic;
- remote sensing of sea surface temperature (weekly SST-maps of the North Sea);
- ship of opportunity observations (XBT and XCTD) on a route between Europe and South - respectively North-America.
- Monitoring programme in North Sea and the Baltic (Nutrients, heavy metals, oxygen, organic substances, radioactivity North Sea only).
- automatic network in North Sea and the Baltic (temp., salinity, current, O₂, sea level, irradiation meteorological parameters)

Bundesanstalt für Fischerei (BFaFi), Hamburg

- fish stock assessments
- contaminants in living organisms

During the last few years a broad discussion took place in Germany between institutions and scientists on how GOOS modules should be handled with (see. Annex: Lenz, W.(1998). The German approach to GOOS and EuroGOOS. In: Operational Oceanography - The challenge for European Co-operation, 528-532).

BSH [Hrsg.] (1995). Global Ocean Observing System - Statusbericht über Programme, die als deutscher Beitrag zu GOOS eingebracht werden können. Berichte ds BSM, no. 7, 100pp.

W. Lenz: On the German approach to GOOS and EuroGOOS

1. INTRODUCTION

The idea of GOOS, the Global Ocean Observing System, was first launched by IOC in 1989[1]. The second World Climate Conference in 1990 took up this idea and urged for its establishment to provide the oceanographic data needed by the Global Climate Observing System (GCOS) initiated in 1992. In the same year, the United Nations Conference on Environment and Development (UNCED) in Rio de Janeiro called for the development of a global system of ocean observation to help understand and monitor changes. In all these international bodies German representatives were present and they started a process to support the idea of GOOS in Germany. The following report is a compilation of activities on the governmental, academic and industrial side. It is by far not complete and represents the personal view of the author only.

2. ON THE BEGINNING OF GERMAN INVOLVEMENT IN GOOS

The German IOC-Section, which is associated to the Ministry of Foreign Affairs became active in 1992 by forming an *ad hoc* working-group on GOOS. 6 persons from scientific institutions and governmental agencies were nominated. They drafted a manuscript "Der deutsche Beitrag zu GOOS" (the German contribution to GOOS) dealing with the five modules, which had been defined by the Blue Ribbon Panel for GOOS of the IOC, an *ad hoc* panel of internationally-recognised experts. The manuscript was published as colour printed brochure under the tide "GOOS - Ziel und Bedeutung" (GOOS - aim and meaning) [2]. The difference between the published tide and the proposed one obviously shows, that the official position was first just to inform on GOOS and wait for response within the German community of marine scientists, governmental agencies as well as private industry.

The Ministry for Research and Technology, too, responded to the IOC recommendation to support GOOS. In its latest programme for marine research, published in 1993 [3], GOOS was mentioned and it was stated that a more intensive participation in the planning of GOOS should be supported.

The Bundesamt für Seeschifffahrt und Hydrographie (BSH), a board of the Ministry of Transportation, was charged with functions of a national secretariat for GOOS to plan, co-ordinate and manage the German contributions to GOOS. It represents Germany in international planning activities and maintains a contact office.

3. THE INITIATIVE OF DEUTSCHES KOMITEE FÜR MEERESFORSCHUNG UND MEEREESTECHNIK

The Deutsches Komitee für Meeresforschung und Meerestechnik (DKMM; German Committee for Marine Research and Technology) was founded in 1970 to stimulate the communication between academic marine institutions and marine technology industry in Germany for establishing a marine technology market. This is done by the distribution of relevant information and by organising meetings. Members of the Committee are scientific societies with maritime ambition as well as commercial companies. As far as we know such a non-governmental committee is unique in European countries.

Of course, this Committee early became active starting an initiative to foster the GOOS idea in circles it has access to. The subject was introduced to a broader audience in 1993 at its annual meeting and it used the newsletters of its member societies to distribute information on GOOS stressing the importance of this up-coming challenge for marine science and industry.

When EuroGOOS was founded in December 1994 by the signing of the Memorandum of Understanding (MoU) in Rome, the BSH became national member, whereas the DKMM received the status of observer.

4. NATIONAL ACTIVITIES

After signing the MoU, German governmental circles enhanced fostering the EuroGOOS idea. It was hoped that future EU MAST programmes would at least concentrate on the development of EuroGOOS technology - delegating the decision of sponsoring to the European level.

In September 1995, a regional technology association of four medium-sized towns in northern Germany (K.E.RX, see below) awarded a prize for marine technology to a Norwegian company (Aanderaa) and a German one (ME-Meerestechnik/Elektronik), which have gained extraordinary reputation by producing reliable instruments for operational oceanography. The State Secretary of the Ministry of Education, Science, Research and Technology was invited to address the prize-winners and in his laudation he stressed the importance of German contributions to GOOS. The president of BSH declared at the same meeting that BSH is ready for leadership in German GOOS/EuroGOOS activities if provided with the necessary governmental support.

In 1995, the BSH published a survey on current and planned operational programmes, which could be considered as the German contribution to GOOS [4]. This survey is a very valuable compendium to demonstrate German activities which are related to GOOS:

To help to overcome the scientific institutions reservation towards operational oceanography the D- established a working sub-group on GOOS to bring scientists and technologists at one table together. The first meeting took place on 15 November 1995. Some recommendations of this meeting are listed below:

- companies need more reliability in the investment on GOOS technology
- the development of technology should be intentionally backed by standardisation of measuring methods as well as in instrumental components in order to reach high production- numbers
- GOOS technology should not be restricted to coastal and near surface applications, but should also be applicable to deep sea measurements
- GOOS measuring technology should seek permanent operation with as little maintenance as possible to make it also available for developing countries
- research on anti-fouling coating of sensors should be given a high priority
- the experiences of ESA in making high amounts of data useful for customers should be incorporated

- the conversion of military developments into civil applications should be aspired; their products are usually three times more costly, but they are more robust and have a far longer duration, which is particularly desirable for deep sea missions; such a conversion was very successful with the ADCP
- an exhaustive dialogue is substantial between governmental research and industry
- it is essential to create a market for GOOS/EuroGOOS products, otherwise the idea will fail.

Although most of the participants of the working group were not familiar with GOOS and EuroGOOS papers, it turned out that their recommendations are quite similar to the ones published in the GOOS papers. Special emphasis was laid on the problem of standardisation. This being one of the most important traditions in German industrial success, the suggestion did not come as a surprise. Regarding EUROMAR - its headquarters is run in Germany - the German government strongly supported the respective activities and initiatives to take up the technological challenges arising from EuroGOOS. In this context it was welcomed that EUROMAR received observer status in EuroGOOS framework.

5. ACTIVITIES IN 1996

The activity to discuss the German engagement in GOOS and EuroGOOS has increased during this year. Four quite different initiatives called for a meeting. In chronological order they are - with main discussion points:

- 24.01.96
(Hamburg) Deutsches Komitee für Meeresforschung und Meerestechnik (DKMM), second meeting of its working group on GOOS technology development; ten agencies and companies had sent delegates:
- discussion on the future of German marine technology
 - founding an institute for marine research technology - on governmental and/or on academic basis?
- 08.02.96
(Kiel) Technologie-Region Kiel, Eckernförde, Rendsburg, Neurmünster (K.E.R.N.), 13th Technology-Circle; about 25 persons mostly from companies and local administrations were present; the programme consisted of two speeches by the president of the BSH and the GOOS secretary:
- for small- and medium-sized companies the period between start of development and delivery should not exceed 1-1 1/2 years
 - the technical control of monitoring systems should be given to consulting companies.
- GOOS technology should not be restricted to coastal and near surface applications, but should also be applicable to deep sea measurements
 - GOOS measuring technology should seek permanent operation with as little maintenance as possible to make it also available for developing countries
 - research on anti-fouling coating of sensors should be given a high priority
 - the experiences of ESA in making high amounts of data useful for customers should be incorporated
 - the conversion of military developments into civil applications should be aspired; their products are usually three times more costly, but they are more robust and have a far longer duration, which is particularly desirable for deep sea missions; such a conversion was very successful with the ADCP
 - an exhaustive dialogue is substantial between governmental research and industry
 - it is essential to create a market for GOOS/EuroGOOS products, otherwise the idea will fail.
- 18.04.96
(Hamburg) Gesellschaft für Maritime Technik (GMT) in co-operation with Verband für Schiffbau. und Meerestechnik (VSM) and DKMM; 20 persons mostly from companies were present:
- projects to be financed by the government on the basis of 50% privately owned capital
 - how to represent industrial interest at the up-coming GOOS workshop of the BSH.
- 23.04.96
(Rostock) Bundesamt für Seeschifffahrt und Hydrographie (BSH) and University of Rostock; this national workshop on GOOS was titled "demands for a scientific concept for the German contribution" and was more like a symposium with 15 contributions and a final discussion; ca. 75 persons were present:
- Germany as an industrial nation with responsibilities should participate in GOOS and should do this in intercorrelation between users, operational services, research and technological development

- German monitoring programmes on hydrography along the coast as well as on stock recruitment should be considered as national contribution to GOOS
- the "Science Plan" of CLIVAR should be taken as scientific basis; Standardisation of methods and sensors.

GMT, DKMM, BSH and GKSS (hosting the newly established contact office for marine research technology) will have another GOOS related meeting in November 1996 in the building of Stock Exchange in Hamburg. The aim is to intensify information and discussion between the three parties science, industry and administration as well as to deliberate on the establishment of working groups for each module and to bring in line recommendations for the next concrete steps. It is expected that these working groups will define projects for the industry.

6. ON THE PROBLEM OF NATIONAL CO-OPERATION

The recent activity of several meetings demonstrates the increasing interest in GOOS/EuroGOOS particularly on the governmental as well as on the commercial side. It also demonstrates the endeavour to find a common- platform, which is difficult to get in Germany as stated in a study on high-tech-transfer into marine research and marine controlling technology, which had been produced on behalf of the Ministry of Education, Science, Research and Technology.

It was published in early 1996 and is available for everyone on the internet under "<ftp://ftp.gkss.de/pub/htt-studie>". GOOS related results are summarised to the effect that GOOS exists on paper only, up to now, and that not a few experts still see a big question-mark behind the implementation of the GOOS modules. It is further mentioned that Germany is extremely cautious in regard to GOOS and, if this is not changed, it will lead to negative consequences especially in the development of instruments.

German industry is ready and ambitious to start development and production of new GOOS technology. It is ready to take off waiting for distinct boundary conditions within funding and knowing that in some other European countries industry has already started.

7. PROPOSED THEMES FOR DISCUSSION AT THE HAGUE

The EuroGOOS Conference Organiser has asked the authors to present three propositions for discussion. To me the following seem to be the most important ones:

1. How to obtain international conventions on GOOS and EuroGOOS? 2. How to achieve standardisation of GOOS technology and of GOOS data exchange? 3. How to finally initialise co-operation with industry?

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ANNEX 14 – NATIONAL REPORT: ICELAND

S. Aa. Malmberg: Long-term monitoring on hydro-biological conditions in Icelandic waters

On behalf of the Marine Research Institute in Reykjavík (MRI) a long - term monitoring on hydro-biological conditions has been carried out in Icelandic waters since around 1950. During the period 1950-1970 the investigations were carried out annually in spring in connection with herring research in North and East Icelandic waters, but since 1970 seasonal investigations have been carried out in the waters all around Iceland. Hydrographic investigations (t,s at least) are carried out in all cruises, but biological ones on phyto- and zooplankton including chemical work (nutrients and oxygen) are mainly carried out in the spring cruises. The hydrographic investigations in summer and winter are also related to 0-group, capelin and herring surveys.

After each cruise the results are reported to the user community in Iceland through news-media, in the last years including the homepage of the MRI. Later on in the year, or within a year, the results are reported in written reports for fishery management and to the International Council for the Exploration of the Sea (ICES). At ICES the results are incorporated into the overall results across the northern North Atlantic. Results which again are forwarded to the Advisory Committee of Marine Environment (ACME) of ICES.

In due time the results are furthermore used in scientific papers of several categories (internal, national, international), papers not only dealing with marine life and resources, but climate as well including drift-ice conditions.

The above mentioned investigations and efforts can be looked at as, monitoring (repeat hydrography) going along with some of the following main primary and selected objectives of GOOS for the benefit of the user community of many different categories and goals (fisheries, climate, pollution, transporting, hazards, science etc.).

These primary objectives are (GOOS Publication 42, UNESCO, 1998):

1. to specify the marine observational data needed to meet the needs of the world community of users of the oceanic environment;
2. to develop and implement an international co-ordinated strategy for the gathering, acquisition, and exchange of these data;
3. to facilitate the development of products and services based on the data, and widen their application in the use and protection of the marine environment;
4. to facilitate the means by which less- developed nations can increase their capacity to acquire and use marine data according to the GOOS framework;
5. to co-ordinate the ongoing operations of the GOOS and ensure its integration within wider global observational and environmental management strategies.

Thus the GOOS is based on the past investment in marine scientific research, marine technological systems including earth observing satellites, and the existing observational observing and forecasting services.

These goals go well along with the long-term efforts of repeated hydrography of the MRI in Icelandic waters, just the manifold and formal procedure has still not been decided on behalf of the MRI in Reykjavik, Iceland.

ANNEX 15 – NATIONAL REPORT: SPAIN

SPANISH OCEAN OBSERVATION SYSTEM. IEO CORE PROJECT: STUDIES ON TIME SERIES OF OCEANOGRAPHIC DATA

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ABSTRACT

The Marine Environment Department of the Instituto Español de Oceanografía (IEO) is conducting several research projects based on the systematic and continuous study of the Ocean with observations made regularly over much long periods than a year-round and covering events in all seasons. The principal goal of the core project "Studies on time series of oceanographic data" is 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. The scientific objectives are integrated in the framework of GLOBEC and JGOFS. The research effort involves 1) time series measurements in several transects along the Spanish coast, on both the Atlantic and the Mediterranean sides, and 2) synoptic observations by satellite imagery.

The network of time series stations are being sampled according with JGOFS recommendations at monthly intervals in the following locations: Santander (started in 1991), Cudillero (1993), La Coruña (1988), Vigo (1987), Fuengirola (1992), Baleares (1993), and Cabo de Palos (1996). Each transect include the sampling in, at least, 3 stations of coastal, neritic and oceanic characteristics. Sampling include measurements on hydrographic parameters and diverse analysis on the community structure and properties of phytoplankton, zooplankton and ichthyoplankton. Sampling design also include specific works oriented to the study of processes and the study of hydrographic phenomena by means of AVHRR satellite images. A data management system was developed for both: to archive the data and as a tool for data analysis and elaboration of reports. This project also supply data to ICES data bank, and annual summaries on main results are reported to the ICES Working Groups WGOH, WGSSO, WPE and WGZE.

The project is supported by the IEO. Average annual cost, including amortisation of durable equipment, consumables, travels and overheads, is 175,000 Euro.

1. INTRODUCTION

The marine ecosystem's variability over time shows large fluctuations on a wide variety of scales (e.g. seasonal, interannual, decadal, etc.) which strongly limit the attempts to make predictions of how changes in the environment affect the physical and biological properties of water masses over a given time period. This high variability also limits our present ability to differentiate anthropogenic from naturally occurring effects. Thirdly, the wide range of variation also makes it difficult to compare data differing either in sampling location or year of sampling.

Because of these constraints, many authors have advocated the search for trends in time series as the best procedure to identify and compare common patterns of variation among different oceanographic data sets [1, 2, 3, 4]. It was also with the purpose of overcoming these bottlenecks that the establishment of long-term observation programmes has been encouraged by different panels and science plans developed in the frame of the IGBP and other initiatives (e.g. EuroGOOS, JGOFS, GLOBEC, etc) [5, 6, 7].

Coherent with the need to produce historical series of oceanographic data and within the framework of these international programmes, in 1991 the Instituto Español de Oceanografía (IEO) started the core project "Studies on time series of oceanographic data", a research project based on the systematic and continuous study of the ocean with interdisciplinary observations made regularly over much longer periods than a year and covering events in all seasons. This research project constitutes one of the most complex and complete contributions to ocean observation in Spain.

2. SCOPE AND OBJECTIVES

The Instituto Español de Oceanografía (IEO) is the main oceanographic agency in Spain, with a national network of research centres comprising 7 laboratories in the Spanish coast (4 in the Atlantic and 3 in the Mediterranean). As the IEO is a public research organism, and the results of its research provide support to the Spanish government and international organisations, a significant proportion of the effort of the marine ecology and fisheries departments has been allocated to the understanding of mechanisms influencing fish recruitment, and to factors which influence biological production and can alter ecosystems.

Thus, since the mid-80's the IEO has conducted several research projects on the temporal variability of physical and biological properties and processes in the pelagic ecosystem. This topic was considered a research priority in the 90's, and in 1991 the core project "Studies on time series of oceanographic data" was started.

The project addresses two major scientific questions:

1. The understanding of underlying causes of temporal variability, quantification of trends on oceanographic properties and biological communities, and predict future scenarios and effects of global change in marine resources.
2. To identify significant mesoscale processes, and understand the effects of physical forcing on pelagic marine ecosystems.

The research effort involves 1) time series measurements in several transects along the Spanish coast, on both the Atlantic and the Mediterranean sides, 2) synoptic observations by satellite imagery and 3) local process studies.

3. OPERATIONAL PROCEDURES

The research project includes 7 transect sites around the Spanish coast, 4 in the ICES* area and 3 in the Mediterranean (Figure 1). All transects run perpendicular to the coast, and include at least three sampling stations of coastal, neritic and oceanic characteristics. Each station is visited monthly, with periods of intensification mainly in spring and summer, to study local processes. At each site, sampling involves extensive physical, chemical and biological measurements, paying special attention to the sampling and analysis of temperature, salinity, nutrients, PAR, fluorescence, chlorophyll a, phytoplanktonic species, biomass and zooplanktonic species, and ichthyoplankton abundance. Depending on the transect, measurements on physiological rates are also included. These data are being obtained from 4 research vessels that serve the 7 transects. Parameters are sampled in accordance with JGOFS protocols, using standard oceanographic equipment (CTD, plankton nets, Niskin bottles, etc.)

* International Council for the Exploration of the Sea

STANDARD SECTIONS

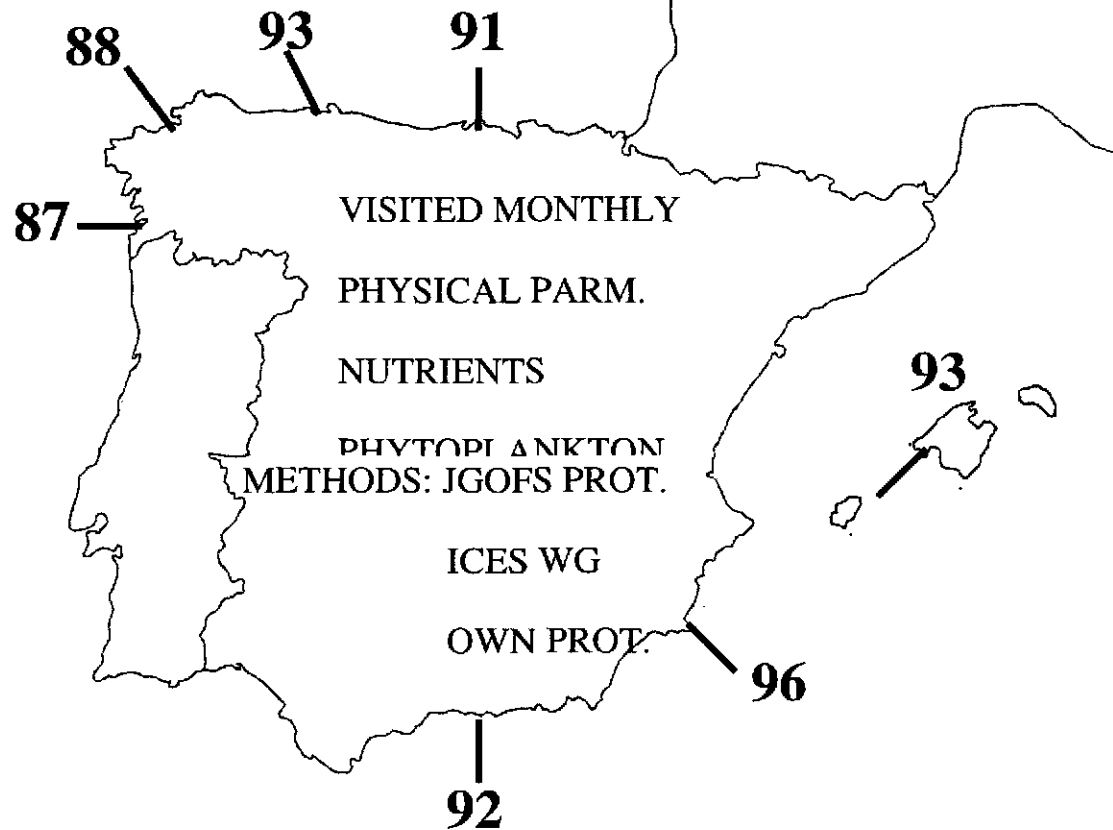


Figure 1. Map showing the location of the 7 transects sampled in the project with indications on sampling details and year of initiation.

Recently the project has implemented SST by satellite remote sensing as a routine tool for exploring large areas. Four daily passes of NOAA satellites 12 and 14 with Advanced Very High Resolution Radiometer (AVHRR) sensors are received in Santander. The infrared signal is processed to obtain SST images of the waters surrounding the Iberian Peninsula with a resolution of 1 x 1 km. By request or for specific research activities, the images are optimised to enhance mesoscale features.

The time series of sampling extends from 1987 (Vigo[♦]), 1988 (La Coruña[♦]), 1991 (Santander), 1992 (Fuengirola), 1993 (Balears), 1993 (Cudillero) and 1996 (Cabo de Palos). The collection of AVHRR SST satellite images has been available since July 1998.

A total of 24 scientists from 7 different IEO laboratories and from the University of Oviedo are directly involved in the project.

♦ Some gaps from 1988 to 1993

• Some gaps from 1989 to 1991

4. SUPPORTING ACTIVITIES

The complexity of the project requires supporting activities, which are programmed yearly by the IEO Coordination Group in its annual meeting. The first and second years were spent developing the internal organisation of the project, clarifying objectives, and establishing a working methodology.

In response to the need to deal effectively with the large and varied volumes of data that have been accumulated as result of sampling and from the compilation of existing data, the IEO has developed a database that acts as an archive of data and as a tool for analysis and elaboration of reports. A Data Reporting Format (log-book) was created, which is of general use and provides the database with the essential metadata of analysis and observations, and also plays a role as a control of data quality.

In order to ensure that the data are of high quality, and to make sure that all data are processed in a similar manner, sampling is being carried out in accordance with JGOFS protocols where possible, and/or following our guidelines. In the case of the analysis of nutrients, all the laboratories of the IEO where nutrients are being analysed have participated in the QUASIMEME exercise during recent years. A check list of phytoplankton and copepods (main zooplanktonic group) were also produced.

Project support costs for attendance of national and international meetings (Symposia, Working Groups, etc). Courses on statistical analysis of time series analysis, taxonomy (phytoplankton and zooplankton), and one workshop on analysis of zooplankton have been programmed and covered within the project.

Funding for coordinated projects based on this core project has been obtained from different national and local agencies (CICYT, CITMAR, Gobierno de Cantabria, Fundación Marcelino Botín, Fundación Pro-Vigo, and others). The number of proposals is expected to increase in coming years.

Investment in the acquisition of new durable equipment makes up a major part of the annual budget. The total cost of the project since 1991 (except salaries) is shown in Figure 2.

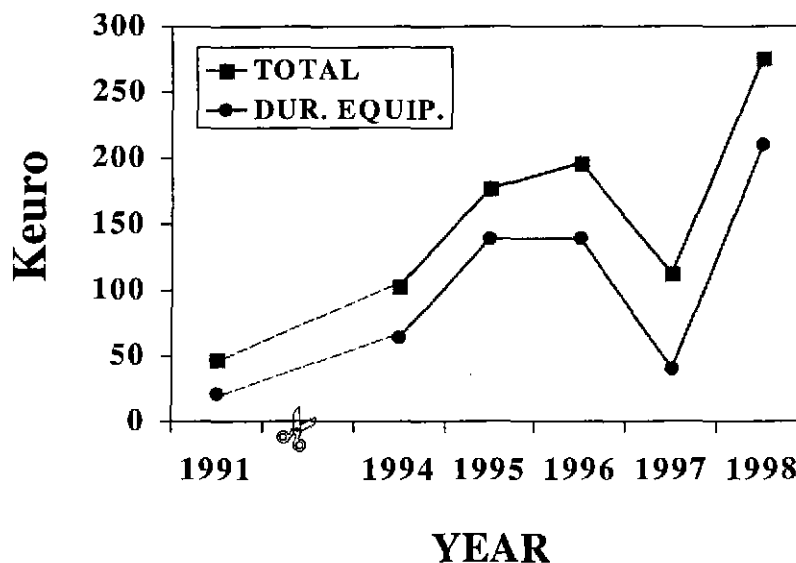


Figure 2. Annual investment in the project

5. RELEVANCE AND BENEFITS

The project addresses major scientific questions and the information obtained is important to science and society. The long time series measurements will provide better bases for rational management of marine resources and uses of coastal areas, which is a commitment of IEO as a consultative agency of the Spanish government and international organisations. As an example, the project supplies data to ICES data bank and annual summaries on main results are reported to ICES Working Groups OHWG, SSOWG, WPE and WGZE.

The benefits are evident at various levels. Within the IEO, collaboration among scientists from different laboratories and the shared use of durable equipment benefits the rational use of material and human resources (e.g., nutrients

analysis is centralised in the laboratory of A Coruña for the Atlantic transects, and in the laboratory of Baleares for the Mediterranean transects).

The time series obtained are also relevant to many other IEO projects, e.g.: pollution monitoring, harmful algal blooms, ichthyoplankton ecology, etc. The project has also established close liaisons with universities (Cantabria, Oviedo, A Coruña, Vigo) and research organisations (Instituto de Investigaciones Marinas, Instituto de Ecología Litoral, and Instituto Nacional de Meteorología).

Access to the project database has been requested from hospitals (e.g. Residencia Juan Canalejo, A Coruña), electric power companies (e.g. Electra del Viesgo, Cantabria), universities (including one from Denmark), etc. Data are also used for environmental assessment studies and the database was particularly useful in evaluating the ecological impact produced by the super tanker Aegean Sea, which wrecked in 1992 and produced an oil spill of 80 000 t in the coastal area off A Coruña.

6. CONSIDERATIONS AND RECOMMENDATIONS

Operational procedures and support activities are required to advance and reinforce the sampling network and to obtain a better yield in the exploitation of results. Satisfaction of both demands would result in a reinforcing of the structure of the project and would be the best guarantee of continuity in long-term programmes of the IEO.

Time series can resolve long-term scales of variability in a way that is impossible for normal process-oriented studies. However, practical limitations impose constraints on sampling strategy. The monthly sampling scale limits the observation of hydrographical features whose periodicity is of days or weeks (e.g. upwelling events). Because of this, the project has planned the implementation of two new sampling technologies. Firstly, one which is already operative consists of the satellite reception station. Satellite remote sensing offers the greatest potential for providing the truly synoptic data sets that are needed for global synthesis and integration. Secondly, to be achieved in the mid-term, a network of moorings will be deployed at each transect to integrate records of the vertical structure of the water column. Satellite remote sensing of oceanic biology and physical structures and conventional in situ methodologies can be made to operate synergetically. Together, they give an integrated and virtually complete suite of sampling strategies covering the full spectrum of time and space scales with quasi synoptic global coverage.

On the other hand, because continuation of long-term monitoring programmes is often heavily dependent on the personal effort and dedication of individual scientists, and because, by the very nature of long-term monitoring programmes, they are not competitive when evaluated by their short-term scientific yield, the challenge in the near future is to maintain operative the structure of collaborations among institutions, co-funding of coordinated projects, integration of network of sampling into a pan-European one, etc. An additional attraction for scientists to work in long term programmes appears if data sets are pooled together among institutions, as opposed to the isolation of present practices, thereby comparing observations from distant locations. On the other hand, detection of broad-scale changes, and distinguishing them from local imbalances, is possible only when data from distant locations are compared. Finally, this compatible approach will enhance the potential to detect risks and forecast them. Reluctance to share data is a serious threat to the continuity of long-term programmes [8].

The question of whether the marine environment should be monitored is no longer at stake, and there is an explicit demand from an increasingly concerned society for answers as to how and how much the marine environment is changing [8]. Human intervention and global warming are two sources of variability whose long-term impact on the ecosystem is not known, and add a high degree of uncertainty to the proper management of marine resources and uses of coastal areas. The development of a more coherent and comprehensive understanding of how these processes interact with physics and biology of marine ecosystems is a major challenge for coming years which can only be satisfactorily dealt with if collections of data with a suitable temporal perspective are obtained now.

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ANNEX 16 - NATIONAL REPORT: CANADA

Savi Narayanan: On The Development of a Canadian Climate Observing System

Introduction

Canada is in the process of developing an integrated climate research program as a result of the requirement to meet its commitments at the Third Conference of the Parties (COP3), an international climate change meeting, in Kyoto, Japan. This recognised that Canada is vulnerable to climate change. Even with the reductions in greenhouse gas emissions agreed to in Kyoto, there will continue to be changes in climate to which Canada and Canadians will have to adapt. Further research is required to advance our knowledge of the magnitude, rate, and regional distribution of these changes and their impacts on Canada in order to better estimate the risks of climate change.

It is also necessary to identify and implement the most appropriate portfolio of response strategies, including those required to adapt to the impacts of climate change. Furthermore, advances in our scientific understanding of climate change and its impacts must provide input to policy development and the international negotiations to address greenhouse gas reductions. The work of the Science, Impacts and Adaptation component of the Canadian program will focus on:

Systematic climate monitoring to detect climate change, as well as improve and validate our climate models.

- The study of key climate processes, particularly those related to greenhouse gas sources and sinks.
- Regional-scale climate modelling for impact and adaptation needs.
- The study of the impacts of climate change on Canada.
- Development, assessment and implementation of adaptation responses.

In the last few months, considerable effort has been made in Canada to develop a national plan for a climate observing system with terrestrial, atmospheric, oceanic and cryospheric components. The ocean's component will consist of two parts: one that will address our contribution to the Global Climate Observing System in response to the requirements laid out by international bodies and steering committees, and a second one that will address specific Canadian requirements for its waters. Both components have to satisfy four criteria, long-term, systematic, relevant to the global climate system and subject to continuing examination, as well as the GOOS principles. The Canadian observing system will have components in the Atlantic, Pacific and the Arctic and will utilise many of the state-of-the art technology. When funded and implemented, this observing system will not only provide a solid Initial Observing System to meet Canada's requirements but also will make a significant contribution to the international Global Climate Observing System (GCOS).

ANNEX 17 – NATIONAL REPORT: UNITED KINGDOM

W.R. Turrell: GOOS Activities within the UK

The Research Community: Research Institutes and individuals from them within the UK are heavily involved with the philosophy, politics, organisation and strategic planning of international GOOS and EuroGOOS. In addition there is much planned development of the new technologies required to underpin GOOS networks, such as moored instrumentation (e.g. SEANET) and autonomous underwater vehicles (e.g. AUTOSUB).

Inter-Agency GOOS Group: However, within the UK itself GOOS-developments are occurring slowly. An inter-Governmental coordinating group (the IACMST GOOS Action Group) has begun several initiatives to coordinate GOOS activities. The main initiative has been the commissioning of several inventories of GOOS-like activities in the UK. The most recent survey is about to be completed, and will hopefully lead on to proposed action in promoting operational oceanographic activity in the UK. The UK Meteorological Office is already involved in publicly funded operational oceanographic modelling, with projects such as FOAM, and a meeting sponsored by the IACMST GOOS Action Group will shortly be held in order to attempt to promote greater use and dissemination of the results of such operational models. The UK will also be participating in the ARGO project, and will be funding a component of this initiative.

Ocean Monitoring: In terms of operational monitoring systems in UK waters, there is rather a poor coverage available. The EA in England and Wales maintains a coastal survey, employing in-situ observations and airborne remote sensing. The CPR is run from SAHFOS based in Plymouth. In Scotland there are three oceanic standard sections used to monitor key water masses at the edge of the NW European shelf edge and within the North Sea. In addition a nation-wide coarse spatial scale survey of contaminants is performed once per year - the National Marine Monitoring Program (NMMP).

Web Site: An inventory of UK GOOS Activities may be found at <http://www.nbi.ac.uk/bodc/ukmeddir.html>

