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TABLE OF CONTENTS

ANNEXES

PREAMBLE

Part I of this Document describes in brief what the Global Ocean Observing System (GOOS) is and how it works. It is a 1999 update of the Executive Summary to *The GOOS 1998*, which is available on the GOOS web site at http://ioc.unesco.org/goos/Prospe98/Contents.html, and was published by the Intergovernmental Oceanographic Commission (IOC) of the United Nations Educational, Scientific and Cultural Organisation (UNESCO) as GOOS Publication 42.

Parts II and III provide a detailed report on GOOS activities for 1999. For more information on GOOS consult the GOOS Homepage at: **[http://ioc.unesco.org/goos]**

PART I INTRODUCTION TO GOOS

The Global Ocean Observing System (GOOS) is sponsored by UN Agencies (the IOC of UNESCO, the World Meteorological Organisation (WMO), and the United Nations Environment Programme (UNEP), with help from the Food and Agriculture Organisation (FAO)) together with the International Council for Science (ICSU). The GOOS is designed to provide descriptions of the present state of the sea and its contents, and forecasts of these for as far ahead as possible, and to underpin forecasts of changes in climate. It is not solely operational, but includes work to convert research understanding into operational tools. It is designed to produce products useful to a wide range of users.

The overall Principles upon which the GOOS is designed, and the Strategic Plan for achieving its long term goals have been published as IOC/INF-1091 (IOC,1998), and are summarised in *The GOOS 1998*.

The Primary objectives of the GOOS are:

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.

The planning of GOOS is well-founded. The GOOS is based on the past investment in marine scientific research, marine technological systems including earth observing satellites, and the existing operational observing and forecasting services. The GOOS has already begun by incorporating existing systems. Its full implementation is achievable on a reasonable time-scale, and it has started to produce useful products. Its products will continue to improve in scope, geographical coverage, and value, by logical and progressive development from the present state of science and operational services.

Scientific investment at the national, regional, and global level has been essential to make GOOS possible. In particular, global co-operative experiments such as the Tropical Ocean Global Atmosphere (TOGA) experiment, the World Ocean Circulation Experiment (WOCE), and the ongoing Global Ocean Ecosystem Dynamics (GLOBEC) and Climate Variability and Predictability (CLIVAR) programmes provide the basis of global data sets, and rapid processing of global data which are essential. These and other large scale scientific projects will be required to improve the performance of GOOS, and to extend the range of its predictive ability, particularly in the field of chemical and biological factors.

The technological basis of GOOS consists of a variety of proven and novel *in situ* instruments and communication systems, a large number of coastal and shallow water observing stations, and a number of measuring techniques based on research ships or voluntary observing ships and ships of opportunity. Satellite observations of sea ice, sea surface temperature, ocean colour, variations in sea level and sea surface topography, wind, waves, and currents are essential for the success of the GOOS. It is important that these types of data should be available in future from standardised satellite missions which are planned at optimum cost for operational purposes. The ability of the GOOS to convert observations rapidly into useful information depends critically upon the use of powerful computers and very sophisticated modelling software.

Many services already exist which provide local data and forecasts for marine operations. These services are provided by both governmental and commercial organisations. UN Agencies co-ordinate global collaboration in observations of sea level, upper ocean temperature, marine meteorology, and aspects of biology, fisheries, and pollution data. Some of these data are processed in real time to support forecasts. A supreme example of this has been the transition of the TOGA experiment in the tropical Pacific into an operational observing system to predict El Niño events. There is a great deal to be learned from the experience of existing marine measuring and forecasting services, and GOOS will collaborate with them, and add the elements of complete global coverage, temporal continuity, and access to the most advanced global computer models.

The legal basis for proceeding is defined by various international Conventions and Action Plans, including: the Convention on the Law of the Sea; the Framework Convention on Climate Change; the Biodiversity Convention; Agenda 21 (agreed at the United Nations Conference on Environment and Development in Rio in 1992); the Global Plan of Action for the Protection of the Marine Environment from Land-Based Activities; the London Dumping Convention; the Agreement on Highly Migratory and Straddling Stocks; the various UNEP Regional Seas Conventions and Action Plans, and so on. The information provided by the GOOS will be needed by governments to meet their obligations under these Conventions.

The GOOS includes the ocean component of the Global Climate Observing System (GCOS), and the marine coastal component of the Global Terrestrial Observing System (GTOS). All three observing systems are part of an Integrated Global Observing Strategy (IGOS), in which the partners include the sponsors of GOOS, the space agencies (through CEOS, the Committee on Earth Observation Satellites), and major research organisations including the World Climate Research Programme (WCRP) and the International Geosphere-Biosphere Programme (IGBP). Recently a number of major academic institutions have formed POGO, the Partnership for Observation of the Global Ocean, to promote the further development of GOOS within the context of the Integrated Global Observing Strategy.

The GOOS is being implemented through 5 overlapping phases:

1. planning, including design and technical definition;
2. operational demonstrations and pilot experiments;
3. incorporation of suitable existing observing and related activities and new activities that can be implemented now to constitute the GOOS Initial Observing System;
4. gradual operational implementation of the ‘permanent’ or ongoing Global Ocean Observing System;
5. continued assessment and improvement in individual aspects and in the entire system.

Phase 1. The first phase is well advanced. The initial shape of the GOOS is being developed by advisory panels dealing with: (i) climate and marine services; (ii) coastal seas; (iii) living marine resources (LMR); and (iv) the health of the ocean (HOTO). In addition, GOOS shares panels of (v) space-based observations; and (vi) data and information management; with GCOS and GTOS. These panels report to the GOOS Steering Committee (GSC), which is responsible for the design and implementation of the observing system. An Intergovernmental Committee (I-GOOS) assists in gaining intergovernmental approval and support for the design and implementation. Building the capacity of developing nations to contribute to and benefit from the GOOS is guided by a Capacity Building Panel.

During Phase 1 there have been studies of the economic, social, and scientific requirements of different countries and regions, and an assessment of these priorities against those observations, both those that are now technically feasible, and those that require further research or technical development.

At its 20th session (June-July, 1999) the IOC Assembly adopted a resolution (Resolution XX-7) to formally endorse the Principles of GOOS. At an Initial GOOS Commitments Meeting (July, 1999) 17 countries made commitments of substantial parts of their national operational programmes to GOOS to enhance its implementation. All nations are encouraged to co-ordinate their ocean observing activities through National GOOS Coordinating Committees, and to consider committing appropriate parts of their national observing systems to GOOS.

Phase 2 has begun with pilot projects to test the operation of the GOOS in specific regions, and to refine the GOOS subsystems. The NEAR-GOOS Pilot Project covers North East Asian seas. It focuses initially on developing data exchange between its partners, and on building the user community. In the future it will develop numerical modelling and forecasting capabilities. The initial focus is primarily on physical data, but discussions are underway on how to include more chemical and biological parameters. In Europe, the EuroGOOS Association of 31 operational agencies from 16 countries is bringing researchers and operators together to create more efficient and effective observing systems for the Arctic, Baltic, Mediterranean, and North West Shelf of the continent - in the process identifying the needs for research and technology to make GOOS more effective. Ocean modelling and forecasting, along with improved data exchange, are high on their agenda. An Atlantic-scale project is proposed to provide improved boundary conditions for the forcing of models for European coastal seas. While the initial focus of EuroGOOS is on physical parameters, chemical (nutrient) and biological (plankton) parameters also feature prominently in the EuroGOOS programme.

Active interest in building other regional projects has been expressed by the nations of: (i) the western Indian Ocean (WIOMAP); (ii) south-east Asia (SEAGOOS); (iii) Mediterranean (MedGOOS); (iv) south-west Pacific (Pacific GOOS); (v) Africa (GOOS-AFRICA); and (vi) Caribbean (IOCARIBE-GOOS).

Pilot demonstration projects include PIRATA (Pilot Research Array (of buoys) in the Tropical Atlantic), and GODAE (Global Ocean Data Assimilation Experiment). PIRATA is demonstrating the value to climate forecasting of measurements from the equatorial Atlantic. GODAE, fed with data from its pilot project *Argo,* will integrate and assimilate *in situ* and satellite data in real time into global ocean models in order to depict ocean circulation on time scales of weeks and on space scales of a few tens of kilometres. The prime objective is to demonstrate the potential of the GOOS.

A demonstration of the operation of GOOS in coastal seas is offered by Baltic GOOS (BOOS). A demonstration of technologies for use in detecting pollution in coastal seas is offered by the RAMP (Rapid Assessment of Marine Pollution Project) of the Health of the Oceans (HOTO) Module Panel of GOOS. There is as yet no specific GOOS demonstration project on living marine resources, but projects like the Benguela Current Large Marine Ecosystem study are targeted on this issue. Other demonstration projects for coastal seas and living resources are in the process of gestation. In developing them attention is being given to the links between coastal seas and the open ocean. Coastal seas are strongly influenced by variability of the open ocean, including transports of heat, salt, and nutrients, and vertical upwelling. The living marine resources of coastal seas are affected by large-scale, open ocean phenomena. Examples include the El Niño and its massive impact on the fisheries of many countries, and the huge regime shifts in sardines and anchovies in many coastal fisheries in recent decades, which reflects some very large scale forcing.

Phase 3 has begun with the creation of a GOOS Initial Observing System (GOOS-IOS), from a number of pre-existing international observing systems. Each will continue to serve its previous group of clients. Most of these pre-existing systems deal with the open ocean. The challenge for the immediate future, which we have begun to meet through the Initial GOOS Commitments, is to expand this Initial Observing System by incorporating many of the well-developed national observing and forecasting systems in coastal seas.

Phase 4 will involve continued integration of other components, including new systems, with every attempt to enlarge the range of variables to include chemical and biological ones pertaining to the management of sustainable healthy coasts, including living marine resources and ecosystems. The new systems should follow GOOS designs and principles from the start; the older systems may adapt to meet GOOS requirements. The maximum benefit from measuring and modelling the coastal zone will come from coupling ocean models of large time and space scales to finer scale models on the continental shelf and in estuaries. The ultimate goal is to develop a systematic and integrated approach to coastal monitoring and forecasting based on the needs of coastal states and the goals of sustainable development.

It is likely that implementation will proceed following two parallel tracks:

1. coastal and shelf monitoring and prediction;
2. open ocean monitoring and prediction.

Within both themes it is suggested that investment should be focused on actions that:

1. have a high impact in terms of the delivery of the data and information that are needed;
2. are known to be feasible and thus likely to be successful;
3. continue and enhance activities that are already proving their worth, and encourage replication or expansion at a low level of risk;
4. comprise more substantial demonstration projects having community support;
5. give effect to intergovernmental conventions and agreements.

Within theme 1 (Coastal) the following actions, amongst others, are called for:

1. maintenance of the existing programmes of the GOOS-IOS;
2. development and application of automated biological and chemical sensors and methods needed to implement integrated observing systems, including physical-chemical-biological data, *in situ* and remote sensing, data telemetry, data assimilation and modelling;
3. development of observational programmes of sufficient duration, spatial extent, resolution and synopticity, to permit nowcasting, forecasting, and prediction;
4. expansion of geographic coverage of observing systems to include data sparse areas, and allow for comparative analysis of coastal systems;
5. building upon and expanding operational modelling services to include a wider range of marine modelling and forecasts;
6. creation of improved environmental data bases, including precision bathymetry, to underpin numerical modelling of shelf areas;
7. implementation of key priorities and achievement of key milestones in regional and national GOOS programmes;
8. transfer of experience where appropriate between regions, and between regional GOOS programmes.

Within theme 2 (Open Ocean) the following actions, amongst others, are called for:

1. the conduct of Observing System Simulation Experiments (OSSEs) to assist in prioritising the design of the GOOS for seasonal to inter-annual forecasting;
2. the prioritisation and implementation of *in situ* monitoring networks that complement the space component;
3. the definition of contributions needed to maintain and adapt existing systems;
4. consolidation of GODAE as a unifying framework for a concerted effort involving both researchers and operational agencies;
5. incremental enhancement of the capabilities of observing systems by (i) addition of new or improved sensors (e.g. optical, acoustic, salinity) to existing platforms; (ii) operational support for PIRATA beyond 2000 AD; (iii) other extensions of the TAO network (e.g. to include the Indian Ocean).
6. maintenance of important time series;
7. support for projects within WOCE, JGOFS, CLIVAR, and GLOBEC that contribute to the development of the GOOS;
8. support for regional monitoring and modelling of the Arctic, Atlantic and North Pacific;
9. prioritisation of technology development in the fields of:
    - acoustic thermometry and tomography;
    - salinity measurements;
    - profiling floats;
    - autonomous underwater vehicles;
    - acoustic Doppler current profilers for deployment on Voluntary Observing Ships (VOS);
    - better definition of ice cover at the ice edge;
    - anti-fouling (for improved instrument performance);
    - optics and acoustics for biological measurements.

In due course, when the module panels have developed their initial plans, the present modular panel structure of the GOOS will be changed to reflect the thematic structure of this implementation framework. Coastal, LMR, and HOTO panels are planned to merge in late 2000 after each panel completes an initial strategic implementation design.

Achievement of this implementation framework, and the necessary review of performance of the system required for **Phase 5**, demand the provision of appropriate structural support and expertise to: (i) conduct appropriate planning and co-ordination; (ii) ensure creation, maintenance and promotion of internationally accepted operational procedures and practices; (iii) facilitate training and awareness and capacity building.

Key items envisioned in the resulting infrastructure include:

1. an Information Centre to assist in the location of data and products;
2. improved networks for the real time and near real time telecommunication of data, assimilation into models, and dissemination of products and forecasts;
3. a data policy according to the GOOS Principles;
4. technology transfer and training for the purposes of capacity building, and sustained investment in capacity building.

Infrastructure development was facilitated in 1999 by the formation by the WMO and the IOC of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), which will streamline the processes of data capture by hitherto separate oceanographic and marine meteorological operations both internationally and at the national level.

Benefits and Costs: A significant part of world economic activity and a wide range of services, amenities and social benefits depend upon efficient management of the sea. For many countries marine resources and services provide 3-5% of their Gross National Product. For a few it is much higher. Some countries depend almost entirely upon marine fisheries and aquaculture for food protein.

The GOOS was created in 1991 in response to the desire of many nations to improve understanding and management of the marine environment and to improve forecasts of climate change, thereby enabling more sustainable exploitation of marine resources, maintaining healthy ecosystems, improving safety of life and property at sea and along the coast, and providing more advanced warning of natural hazards like storms, storm surges, high waves, excessive rains associated with flooding, and excessive dryness leading to droughts and forest fires.

Direct beneficiaries of the services produced by GOOS are the managers of coastal defences, ports and harbours, coastal civil engineering, fishing and fish farming, shellfish farming, shipping and ship routeing, the offshore oil and gas industry, cable- and pipe-laying, recreation and tourism. Indirect beneficiaries, through improved forecasting of seasonal and multi-year climate variability based on ocean observations, include agriculture and food production, and the management of energy, fresh water, and public health (e.g. for epidemics of malaria such as those associated with El Niño events).

Economic analyses show that investment in GOOS by national and international agencies, by research organisations, commercial companies and by aid agencies, will produce economic and social benefits that are valuable on a global scale, and at a cost and risk that are acceptable.

PART II GOOS HIGHLIGHTS FOR 1999

WMO and the IOC formed JCOMM (the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology), to help to implement GOOS and other marine operations carried out for the benefit of the user community.

The GOOS Initial Observing System (GOOS-IOS) was expanded by the inclusion of the Continuous Plankton Recorder Survey, the ICES International Bottom Trawl Survey, and selected time series stations ('S' and BRAVO).

Retrospective analyses published in 1999 show that the first indications of the 1997-98 El Niño event appeared in subsurface data from the Tropical Atmosphere-Ocean (TAO) array of buoys in the tropical Pacific, which is part of the GOOS-IOS (Leetma *et al.*, 1999; McPhaden *et al.*, 1999). Reports published by Weiher (1999) indicate the benefits arising from investment in the ENSO forecasting system including the TAO buoys.

Further general advice on the GOOS design was published by Nowlin (1999), Nowlin *et al.*, (1999), Woods (1997) and Woods (in press).

The spectacular performance of the TOPEX/POSEIDON altimeter, the vastly improved global wind fields provided by the NSCATT scatterometer, and the increased lifetimes and reliability of profiling floats forced a revisit of the original design for an observing system for ocean climate. The design was considered at an ocean observations conference at St Raphaël, France, in October 1999. The key message for the space agencies from the Conference was the need for continuity of key observations (e.g. sea-surface height; surface winds; ocean colour; sea-ice). A gravity mission is essential to improve estimates of the geoid, so as to improve the accuracy of altimetric measurements of sea surface height.

The Conference gave high priority to deployment of profiling floats in the *Argo* Project. Over a 4-year period, *Argo* will provide some 300,000 profiles that together give full global coverage of the ocean interior for the first time. Added to satellite data from the ocean surface these profiles will underpin models of ocean behaviour and of climate.

The needs of Small Island Developing States (SIDS) and developing countries are addressed by the initiation of three new GOOS regional programmes: IOCARIBE-GOOS for Caribbean states; MedGOOS for Mediterranean states; and an Indian Ocean programme which is being developed through the new IOC (GOOS) Office in Perth, Western Australia.

Several major oceanographic institutions formed a Partnership for Observation of the Global Oceans (POGO), designed to aid in the development and implementation of GOOS.

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PART III. GOOS DEVELOPMENTS

Figure 1 and **2** display the structure of GOOS. In many respects, GOOS is like a spatially distributed large facility, and needs commensurate international management. If it is designed and managed well, GOOS should provide nations with the ability to convert research results into useful products to meet societal needs. It will benefit from a unified and integrated infrastructure for cost effective operations. That infrastructure is likely to be enhanced by the newly formed Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), the operation of which is likely to change the face of oceanography over the next 10 years. JCOMM, formed by the recent merger of the WMO's Commission on Marine Meteorology (CMM) and the IOC/WMO Integrated Global Ocean Services System (IGOSS), will facilitate the collection of both marine meteorological and subsurface data through increasingly automatic measurement systems, and will improve data gathering and data flow, leading to more efficient services.

Figure 1: GOOS Organization Diagram

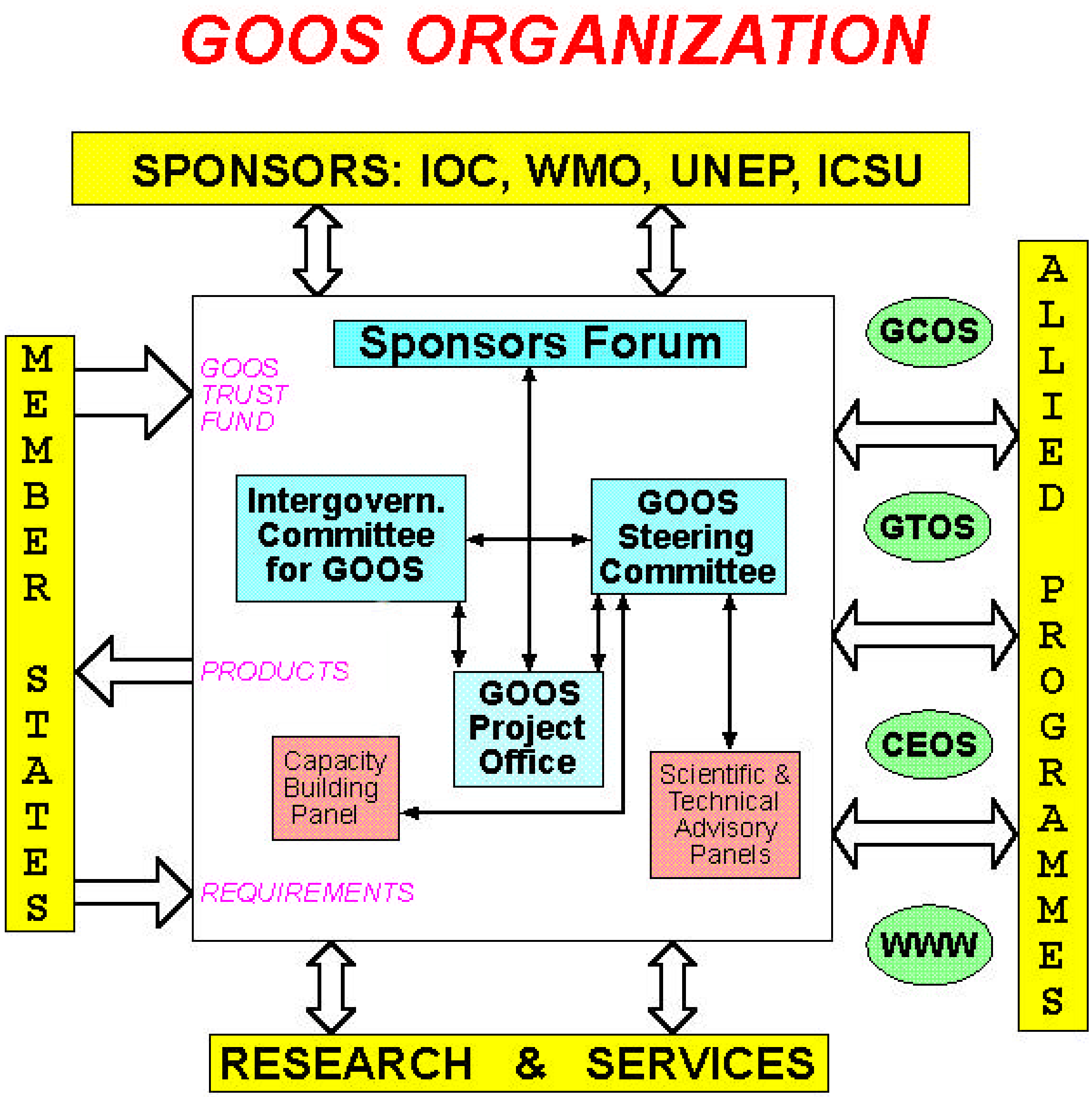

Figure 2: GOOS Activity Structure

MAJOR FUNCTION	SUB-FUNCTION	BODY, PANEL or COMMITTEE	SUB-GROUP or ACTIVITY	
Scientific Design & Guidance	System Design	OOPC C-GOOS LMR HOTO	SSTWG COP/UNFCCC GODAE/*Argo* UOT & S Study OceanObs 99 etc.	
	Cross-Cutting Between Observing Systems	GOSSP JDIMP	IOCCG GOSIC	
Implementation Oversight	Regional	EuroGOOS GOOS-AFRICA NEAR-GOOS PacificGOOS IOCARIBE-GOOS PIRATA WIOMAP	BOOS eg MedGOOS	
	Global	JCOMM	Surface/Marine	DBCP CPR
			UOT & S	SOOP TAOIP Argo etc.
			GLOSS	
Liaison/Integration	With Observing Systems	IGOS GCOS GTOS WWW		
	With Research Programmes	IGBP WCRP	LOICZ GLOBEC CLIVAR etc.	
	With Conventions	UNFCCC Straddling Stocks GPA etc.		
	With Partnerships	CEOS POGO ICES/PICES		
Outreach/ Infrastructure	Publications		Brochures Web Material Publications	
	Posts	eg Perth Office	Regional Programme Development	
	Capacity Building	Capacity Building Panel	Regional Meetings Training Sessions Fellowships Build Infrastructure Distance Learning etc.	

1. NEEDS, BENEFITS AND COSTS

Most operational oceanography is carried out locally to solve local problems – for instance to provide information for oil platform operators in a specific area, or to model water levels in a particular port and its approaches, or to model an oil slick. However, in all of those cases local conditions are subject to regional controls set in a global ocean-atmosphere-ice system within which there are teleconnections between areas thousands of miles apart. As John Woods pointed out in the 1999 Bruun Memorial Lecture, there is a flow of information from one part of the ocean to another. For example, the oceanography, water quality and biology of the North Sea are affected by processes far out in the Atlantic and in the Gulf Stream; the depth of the thermocline off Peru is affected by events far away in the eastern Indian Ocean and western Pacific; and swell heights off South Africa depend on weather in the Southern Ocean.

GOOS is designed to assess and analyse that information flow, so as to provide the boundary conditions required to improve the accuracy of local forecasts and other services. By providing the local user with an accurate regional framework, GOOS will help to improve predictability. It will complement, but not replace, the collection of data and application of models for specific local applications.

Improving predictability demands routine, systematic, long-term measurements of relevant ocean properties on a global basis, or at the very least on a basin-wide scale. The ENSO forecasting system is a good example of GOOS operating at the basin-scale. Analyses published in 1999 show that it was successful in helping countries to plan ahead to reduce impacts.

Worth Nowlin, Chairman of the GOOS Steering Committee listed in 1999 the following uses for GOOS data (**BOX 1**):

BOX 1: THE USES OF GOOS DATA
• **provide data for numerical weather prediction;** • **describe and predict marine meteorological and ocean surface conditions to facilitate safe and efficient marine operations;** • **ensure national security;** • **describe and understand the energetic variability and predictability of the physical climate system on time-scales of seasons to centuries through analyses of observations and modelling;** • **monitor and predict, as feasible, climatic variability;** • **detect and assess importance of the effects of climate change on ocean conditions;** • **preserve and restore healthy marine ecosystems;** • **manage living marine resources for sustainable use;** • **assist in the mitigation of natural coastal hazards;** • **ensure public health.**

Improving the system will require 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.

Numbers of studies have been published on the benefits of making global ocean observations. Where calculations have been made, a return on investment of significantly greater than 10% seems commonplace, the costs of implementing and maintaining an observing system and its associated forecasting service being substantially less than the huge losses incurred from single events like major hurricanes, or multiple events like those caused by the El Niño and the La Niña (Weiher, 1999). Much of the benefit from such forecasts comes not from the marine sector but from improving prediction of the water cycle, and precipitation on adjacent land masses to help manage supplies of water and food and to anticipate and mitigate floods and droughts, or from improving prediction of thermal conditions on land, so contributing to the management of energy supplies.

While the benefits of developing GOOS are becoming more apparent, the costs of making observations are dropping. As Woods pointed out in his Bruun Memorial Lecture in 1999: satellites are becoming cheaper, and measurements of upper ocean properties are beginning to be made by profiling floats and autonomous underwater vehicles more cheaply than can be achieved from expensive research vessels.

2. THE GOOS DESIGN

GOOS will differ from most present observing systems (i) in having modelling and forecasting as part of its mandate, as well as the collection of data; (ii) in being holistic, integrated and interdisciplinary, rather than narrow and sectoral; and (iii) in being designed to deliver useful products for both decision makers and the scientific community.

Several strategic elements have to be considered in any design for sustained ocean observations of the kind required for GOOS, among them those listed in **BOX 2** by Worth Nowlin.

Advice on the GOOS design is published on the GOOS Web site. Detailed strategies for implementation are being devised by scientific advisory panels on Climate, Living Marine Resources, Health of the Ocean (dealing with pollution and its consequences), and Coastal Seas. At the time of writing, the work of these advisory panels on the GOOS design was rapidly drawing to a conclusion (their progress is visible on the GOOS Web site). Finalised strategies for implementation are expected to emerge during 2000-2001.

Implementation will be incremental, and full implementation, following tests of the system through pilot projects, is expected to be achieved in the period 2010-2020. As part of the design and implementation exercise, Observing System Simulation Experiments (OSSEs) will be needed to discover what appears to be the most economical mix of observations capable of constraining models so that they yield desired products with appropriate accuracies.

At the detailed design level, it is anticipated that we will see an open ocean GOOS devoted mainly to weather and climate forecasting and related issues, and a Coastal GOOS with a much higher density of observations that addresses a wider variety of issues including pollution and living marine resources. The details of the design will vary from one area to another, depending on local concerns. For example, observational networks should be designed to take into account the variability of risk from one region to another for different kinds of natural hazards, such as hurricanes, tropical cyclones, and storm surges.

BOX 2: STRATEGIES FOR GOOS DESIGN

- **implement operational observing systems for different environments;**
- **determine user needs and design sustained observing systems to meet requirements;**
- **coordinate observing systems via an integrated global observing strategy;**
- **develop mechanisms to involve researchers in the planning and oversight of observing system components;**
- **establish formal relationships between ocean and atmosphere communities for purposes of data collection, communication and analyses;**
- **ensure timely release of data for intended uses;**
- **implement data and information management systems, supplementary to existing systems, that are attuned to the multiple sources of data and their multiple uses;**
- **develop and implement enhanced capabilities for the production of products;**
- **establish the coordination and agreements between agencies within nations necessary to integrate observing system activities;**
- **devise arrangements to provide stable, long-term support for required observing systems elements;**
- **develop and use new technologies.**

For the open ocean, the spectacular performance of the TOPEX/POSEIDON altimeter, the vastly improved global wind fields provided by the NSCATT scatterometer, and the increased lifetimes and reliability of profiling floats has forced a revisit of the original observing system design for ocean climate, as described in section 7, below.

3. THE GOOS INITIAL OBSERVING SYSTEM (GOOS-IOS)

There is now a GOOS Initial Observing System (GOOS-IOS) uniting the main global observing sub-systems supported by the IOC, WMO and (in the case of coral reefs) the IUCN, and including measurements from ships, buoys, coastal stations and satellites (see **BOX 3**). In addition to these international elements, as of July 1999 many nations are now contributing substantial parts of their national observing systems to GOOS. The GOOS-IOS is the nucleus on which GOOS will grow. During 1999 three new elements were added to the GOOS-IOS: (i) plankton data from the Continuous Plankton Recorder (CPR) Survey, managed by the Sir Alister Hardy Foundation for Ocean Science; (ii) time series data from time series stations ‘S’ (Bermuda) and BRAVO (Labrador Sea); and (iii) physical, chemical and biological data from the International Bottom Trawl Survey (ITBS) of the North Sea, managed by ICES (International Council for the Exploration of the Sea).

Although the implementation of GOOS through the GOOS-IOS has begun by exploiting existing systems, it is expected that the existing systems will be adapted to meet the design requirements. New components will be added as appropriate and in accordance with GOOS designs.

BOX 3: THE GOOS INITIAL OBSERVING SYSTEM

LEVEL 1 CONTRIBUTIONS : Those for which statements from operators exist to the effect that, whatever else they may contribute to, they are expressly contributions to GOOS

- **The operational ENSO Observing System in the tropical Pacific, including the TAO/TRITON array of buoys [http://www.ogp.noaa.gov/enso/] [http://www.pmel.noaa.gov/toga-tao/]**
- **Meteorological measurements from the Voluntary Observing Ship (VOS) network of the WMO**
- **Upper ocean measurements of the Ship-of-Opportunity Programme (SOOP) [http://www.ifremer.fr/ird/soopip/]**
- **Fixed and drifting buoys co-ordinated by the Data Buoy Co-operation Panel (DBCP) [http://dbcp.nos.noaa.gov/dbcp/]**
- **The Global Sea Level Observing System (GLOSS) network of tide gauges [http://www.pol.ac.uk/psmsl/gloss.info.html]**
- **The Global Temperature and Salinity Profile Programme (GTSPP) [http://www.nodc.noaa.gov/GTSPP/gtspp-home.html]**
- **The Global Coral Reef Monitoring Network (GCRMN) [http://coral.aoml.noaa.gov/gcrmn/index.html]**
- **The Global Telecommunications System (GTS) of the WMO**
- **The Global Data Centre of the Atlantic Oceanographic and Meteorological Laboratory (AOML) of the US National Oceanic and Atmospheric Administration (NOAA) [http://www.aoml.noaa.gov/]**
- **Ocean observations from the operational satellites of NOAA and other entities [http://www.oso.noaa.gov/]**
- **The Continuous Plankton Recorder (CPR) programme of the Sir Alister Hardy Foundation for Ocean Science (SAHFOS) [http://www.npm.ac.uk/sahfos/introduction.html]**
- **The ICES International Bottom Trawl Survey (IBTS) of the North Sea**
- **Time Series Station 'S' off Bermuda**
- **Time Series Station BRAVO in the Labrador Sea**

BOX 3 CONTINUED:

LEVEL 2 CONTRIBUTIONS : Those for which specific commitments remain to be negotiated

- **Selected ocean observing satellite missions**
- **The US PORTS programme**
- **Appropriate parts of JCOMM (Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology)**
- **Appropriate parts of IODE (International Ocean Data and Information Exchange programme of IOC)**
- **Appropriate components of national observing systems (like the US Sea Ice Centre)**
- **Appropriate commercial observing systems (like long-lived oil platforms)**
- **The international Mussel Watch programme (recognising that it measures contaminants but does not provide direct information on the health of the organism or the environment)**
- **Appropriate parts of the IOC's Harmful Algal Bloom (HAB) programme**
- **Various operational centres**

MAJOR PILOT PROJECTS : These are specifically acknowledged as parts of GOOS and are described in section 4, below.

- **The NEAR-GOOS Pilot Project shared by Japan, China, the Republic of Korea and the Russian Federation [http://ioc.unesco.org/goos/neargoos.htm]**
- **Five EuroGOOS regional projects (Arctic, Baltic, Mediterranean, NW Shelf, Atlantic) [http://www.soc.soton.ac.uk/OTHERS/EUROGOOS/]**
- **The Western Indian Ocean Marine Applications Project (WIOMAP) (which is at present unfunded)**
- **The Pilot Research Array in the Tropical Atlantic (PIRATA) [http://www.ifremer.fr/orstom/pirata/pirataus.html]**
- **The Global Ocean Data Assimilation Experiment (GODAE), including the Argo float programme [http://www.bom.gov.au/bmrc/mrlr/nrs/oopc/godae/homepage.html/]**
- **The RAMP (Rapid Assessment of Marine Pollution) pilot project of the HOTO Panel**

4. GOOS PILOT PROJECTS

Pilot projects are being developed and initiated as steps towards GOOS implementation.

4.1 GODAE AND *Argo*

The main GOOS pilot project is GODAE, the Global Ocean Data Assimilation Experiment. Its key objectives, as re-designed this year are:

(i) To apply state-of-the-art ocean models and assimilation methods for short-range open-ocean forecasts, for boundary conditions to extend predictability of coastal and regional subsystems, and for initial conditions of climate forecast models.
(ii) To provide global ocean analyses and re-analyses for developing improved understanding of the oceans, improved assessments of the predictability of ocean systems, and as a basis for improving the design and effectiveness of the global ocean observing system.

GODAE will demonstrate the power of integrating satellite and *in situ* data, the power of assimilating data into numerical models, and the value of a global system capable of working in real-time. GODAE is needed not only for open ocean analyses and forecasts, but also to establish boundary forcing for regional models to improve forecasting in coastal systems at the local level.

There has been good progress with national initiatives. The US will establish a server dedicated to GODAE data at the Fleet Numerical Meteorological and Oceanographic Center (FNMOC) in Monterey, California. It will include high real-time capacity, distributed data handling capability, holdings of GTS and other data with a residency time of at least 30 days. This is a significant and important commitment.

A global net of upper ocean temperature and salinity data is needed by GODAE for integration with the global net of surface ocean data provided by remote sensing from satellites. To provide this coverage, the GOOS/GODAE community is planning the *Argo* Pilot Project, which will seed the ocean with 3,000 profiling floats that will rise from approximately 2,000m to the surface every 14 days, each one collecting 100 CTD profiles over a 4-year period. At maximum capacity *Argo* should provide 300,000 profiles that together give full global coverage of the ocean interior for the first time. Added to satellite data from the ocean surface these profiles will underpin models of ocean behaviour and of climate.

The GODAE Science Team (GST) is developing a strategic plan. Implementation plans conforming to the GODAE strategy document will be prepared for separate projects (e.g. *Argo*) by their steering panels. Consideration will be given in the plan to enabling developing countries to contribute to GODAE. For example, while developed countries may provide the floats for *Argo*, developing countries may best be in a position to deploy them in their regions. They may also be best able to provide logistics and maintenance for components of the GODAE observing network.

The homepage addresses for *Argo* and GODAE are:
[http://www.argo.ucsd.edu/]
[http://WWW.BoM.GOV.AU/bmrc/mrlr/nrs/oopc/ godae/homepage.html].

4.2 PIRATA

Another major GOOS pilot project is PIRATA (Pilot Research Moored Array in the Tropical Atlantic), which extends the TAO array to monitor ocean and atmospheric variables and upper ocean thermal structure at key locations in the tropical Atlantic region. The real-time transmission of PIRATA data will improve understanding of ocean-atmosphere processes, and so lead to improved prediction of short term climate change for Africa and South America. It is intended that once past the research phase, PIRATA should become a permanent operational programme (end 2000 - beginning 2001).

For both TAO and PIRATA vandalising buoys by fishermen is a threat to moored devices for climate observation, and needs to be addressed by the UN.

For more information of PIRATA, see the Website at [http://www.ifremer.fr/orstom/pirata/pirataus.html].

4.3 RAMP

One of the key aims of the HOTO Panel has been to provide sensitive rapid assessments of contamination from discharges of sewage and chemical pollutants, as well as of physical stresses associated with land reclamation and development of coastal areas for tourism and industrial activities. HOTO's main pilot project is Rapid Assessment of Marine Pollution (RAMP), designed to test and provide easy-to-use, inexpensive chemical and biological markers that can be used to assess pollution and improve environmental management. A RAMP pilot project was initiated in Brazil in 1997. RAMP's immunoassay-based tests provide an inexpensive, rapid and highly selective means of measuring specific chemical compounds and have been used to diagnose medical conditions for many years. Recently the technology has been directed towards environmental contaminants in water, food and soil samples. The analyses can be run by relatively unskilled personnel in the field and provide obvious advantages for developing countries. Limited trials have proved of great interest and some environmental agencies are discussing incorporation of such techniques for screening. The choice of determinants amenable to detection by the rapid chemical analyses procedures is broad and thus the most relevant contaminants were selected following surveys and discussions with the Brazilian partners. PAH, PCB's, organochlorine and organophosphorous pesticides, selected herbicides and fungicides have all been identified as relevant environmental contaminants/pollutants. Biomarkers used in the RAMP programme are simple to use, inexpensive and reliable. They provide a means of detecting deterioration in the condition of biota from contaminated sites. Progress to date in Brazil has been excellent. Based on the early success of the work, plans were developed to perform RAMP programmes in the Caribbean region in mid-1999 and in Vietnam in the near future.

5. GOOS REGIONAL AND NATIONAL PROGRAMMES

GOOS is also being planned and implemented at the regional level. Several newly created GOOS regional bodies are expected to increase their capabilities and implement operational activities during the next 5-10 years, thus helping the further development of GOOS. In many respects these regional programmes, with their focus largely on coastal seas, are already implementing aspects of Coastal GOOS, as well as elements of the GOOS-IOS, like GLOSS and the GCRMN.

5.1 SMALL ISLAND DEVELOPING STATES (SIDS)

The interests of SIDS are being taken care of in four main GOOS regional projects. They include: PacificGOOS, covering S.W. Pacific island states; MedGOOS for Mediterranean island states; IOCARIBE-GOOS for Caribbean island states; and WIOMAP (Western Indian Ocean Marine Applications Project). In addition through a newly created IOC (GOOS) Office in Perth, Western Australia, we are beginning to spin up an Indian Ocean programme which will help Indian Ocean island states. A PacificGOOS meeting was initially proposed for 1999, but will now take place in Tonga in August 2000. A MedGOOS meeting took place in Rabat, Morocco, in November 1999 (see 5.2, below). Although we have not yet found funds to start WIOMAP, an Indian Ocean GOOS planning meeting involving many regional representatives took place in Perth in September 1999. A Caribbean meeting, at which IOCARIBE-GOOS was formed, took place in Costa Rica in April 1999 with a follow-up in November.

5.2 AFRICA AND THE MEDITERRANEAN

Top priorities for the GOOS-AFRICA Coordinating Committee continue to be:

(i) encourage the formation of an Africa-wide network of national ocean data centres that are properly equipped and staffed by trained personnel;
(ii) upgrade and expand the present African network of stations for the measurement of tides and sea levels so as to provide warnings on potentially hazardous and costly changes in the local marine environment - such as sea level rise;
(iii) create a network of specialists trained in the use of data acquired by remote sensing from space satellites so that coastal managers have ready access to the rapidly increasing wealth of spatial data on the coastal environment;
(iv) facilitate the further implementation of modern electronic communication systems such as Internet connections and data transfer mechanisms so as to promote effective communication and availability of information for coastal planning.

As a follow-up to the PACSICOM (Pan-African Conference on Sustainable Integrated Coastal Management) meeting in Maputo in July 1998, we have now begun planning proposals to implement priorities (ii), (iii), and (iv). The first is already being effected by IODE through the work of ODINAFRICA. The GOOS-AFRICA report of the PACSICOM meeting is now available on the GOOS Web site at [http://ioc.unesco.org/goos/GOOSAFRICA.pdf], or in hard copy from the IOC (IOC Workshop Report 152).

MedGOOS provides a link between EuroGOOS and GOOS-AFRICA, some Mediterranean countries belonging to both EuroGOOS and MedGOOS, and some African countries belonging to both MedGOOS and GOOS-AFRICA. During November 1999, the GOOS-AFRICA Committee co-sponsored a MedGOOS workshop in Rabat, Morocco, essentially on behalf of all the North African countries. The workshop, on *"The Benefits of Implementation of the Global Ocean Observing System in the Mediterranean, MedGOOS"*, was attended by members of all Mediterranean countries but one. The outcome of the workshop will be a set of proposals for different donor agencies, including the European Commission and the funders of the post-PACSICOM process. At the meeting several countries signed the MedGOOS Memorandum of Understanding and worked on the development of the MedGOOS Strategy.

Other GOOS-related meetings in Africa included a PIRATA meeting, held in Cape Town in December, to plan African involvement in that project, and the third session of Coastal GOOS, held in Accra, Ghana in April 1999.

5.3 EUROPE (http://www.soc.soton.ac.uk/OTHERS/EUROGOOS/)

The second EuroGOOS Conference, attended by over 300 people, was held in Rome, Italy, in March 1999; the proceedings will be published by Elsevier. Key reports were published on Operational Data Requirements and on Technology, the latter outlining the areas of instrumentation and the development of instrument platforms deemed most valuable in the near future. Most EuroGOOS documents are now available on their Web site. The EuroGOOS Web site (details above) has been adapted to provide a route enabling users to access many of the real-time data displays of EuroGOOS Members. These individual sites are averaging hits of tens of thousands per month, indicating that there is widespread user interest in operational oceanography. EuroGOOS's work behind the scenes has led to operational oceanography and global ocean observations having a high profile in the new budget lines of the European Union's Framework V Research Programme. Planning continues for the development of pre-operational research projects to develop the skills and capabilities to implement GOOS. And significant operational developments are taking place in the six EuroGOOS sub-regions: the Mediterranean, the Arctic, the Baltic, the northwest shelf, the Black Sea and the wider Atlantic.

5.4 NORTH-EAST ASIA [http://ioc.unesco.org/goos/neargoos.htm]

NEAR-GOOS has been operating the data exchange system using Internet very successfully. In order to make the system more attractive to users, discussions are currently focused on how it can provide more user-friendly information to a wider range of users. In this respect, the coverage of the information available in the system should expand, from the current physical parameters to chemical and biological parameters; expansion is also contemplated from the current primary data to more data products such as forecasts. For this purpose, cooperation and coordination with other projects dealing with ocean environment and forecasting is needed. Representatives of five other projects were invited to the Fourth Session of the NEAR-GOOS Co-ordinating Committee (Tokyo, Sep./Oct. 1999), and papers were submitted from two projects whose representatives could not attend. Preparation is being made for a workshop on Ocean Environment Forecasting in the NEAR-GOOS Region, jointly with the WESTPAC Continental Shelf Circulation Programme. NEAR-GOOS provides capacity building to not only NEAR-GOOS countries but the entire WESTPAC region. More information on NEAR-GOOS is available on the Web site listed above.

5.5 NORTH ATLANTIC REGION

A new GOOS Coordinating Committee has been established jointly between the IOC and ICES (International Council for the Exploration of the Sea) to build on ICES activities and databases in the region.

5.6 NATIONAL GOOS PROGRAMMES

At the national level, many coastal countries are planning or collecting their own coastal seas observations following GOOS Principles. We encourage all IOC Member States to form National GOOS Coordinating Committees involving all stakeholders (advice on such a committee is given on the GOOS Web site at [http://ioc.unesco.org/goos/nat_com.htm]). In July 1999, 22 countries attended the Initial GOOS Commitments Meeting in Paris, and most committed substantial parts of their present observing systems to GOOS. As the latest details of the GOOS designs emerge over the next 18 months, we anticipate that national agencies will adapt their observing systems and data exchange practices to meet the emerging GOOS requirements, so as to make GOOS work as intended. Continued implementation of GOOS at the national level is essential to facilitate GOOS development.

6. OBSERVATIONS FOR CLIMATE

An ocean observing system for climate is being developed by the Ocean Observations Panel for Climate (OOPC), which is jointly sponsored by GOOS, the WCRP and GCOS. The latest advice on what is required for implementing a physical observing system in support of climate monitoring and forecasting for GOOS and GCOS was published on the GOOS Web Site as *Global Physical Ocean Observations for GOOS/GCOS: an Action Plan* *for Existing Bodies and Mechanisms* (http://ioc.unesco.org/goos/act_pl.htm).

During 1999 the OOPC focused on preparing for the first international Conference on the Ocean Observing System for Climate (OCEANOBS99), which was convened jointly with the CLIVAR Upper Ocean Panel (UOP) in St Raphaël, France from October 18-22, 1999 (see **BOX 4**). Given that ocean observing systems can be quite costly, it is useful to seek consensus between the research and operational communities regarding the most appropriate blend of observations required to satisfy the collective needs of research and operational applications. The vision of the consensus-seeking Conference at St Raphaël was that we are seeing the dawn of a new era for oceanography and ocean observations, where the core needs of research and the long-term needs of operational applications are addressed by a viable and sustained effort that meets the collective need rather than the individual want. At the heart of this vision is the belief that the strategy must be based on global integrated networks of high quality, cost-effective, space-based and *in situ* measuring systems, with timely and efficient distribution of data and products to all participants. The Conference welcomed the introduction of a new paradigm for oceanographic data systems, where rapid dissemination and wide sharing of data is the norm. The conference statement is available on the Web at (http://WWW.BoM.GOV.AU/OceanObs99/Papers/Statement.pdf).

The Conference was a success; it enjoyed 21 sponsors and was well attended by key officials and senior scientists in positions to promote the implementation of the ocean observing system for climate. Some 340 individuals representing 20 countries participated. The Conference outcome generated the encouragement looked for by those who have worked long hours over many years to move the concept of a global climate ocean observing system closer to reality. The results also demonstrated that the close interaction and cooperation between the OOPC and the UOP was critically important in leading to an observing system design for the upper ocean that satisfies the needs of both the operational and the research communities. The Conference papers will be published as a book.

BOX 4: NEW DESIGN FOR OCEAN OBSERVING SYSTEM FOR CLIMATE

In terms of remote sensing, the Conference endorsed continuation of sustained low resolution (100km) sampling for sea surface temperature (SST). It recognized the significant impact of remote and direct measurements of sea surface height for understanding ocean dynamics, and supported the establishment of a sustained measurement programme consisting of one precision altimeter, and one high resolution altimeter. It strongly endorsed the need for global daily observations of surface winds, with at least 25km resolution, which can be accomplished by one swath scatterometer of Seawinds quality. And it endorsed the need for continued measurements of ocean colour as a proxy for ocean productivity. Sustained passive microwave systems are needed for observing the concentration and extent of sea-ice. Synthetic Aperture Radar (SAR) data were recognized as useful for surface wave applications and ice studies, although it was accepted that such observations were rather costly. A gravity mission was regarded as essential to improve estimates of the geoid, and hence to underpin further improvements in the accuracy of altimetric measurements of sea surface height. Finally the Conference strongly supported the development of global remote sensing of salinity. These recommendations are further endorsed by the Partners in the Integrated Global Observing Strategy (IGOS). The key message for the space agencies is the need for continuity of certain kinds of observations from one mission to the next.

In terms of *in-situ* observations, the Conference gave high priority to maintenance of the ENSO observing network. It noted that coverage of sea surface temperature by ships of opportunity and drifting buoys is poor in some locations and must be rectified. Higher quality is needed, as well as a broader suite of measurements, to better determine surface fluxes. The emphasis should shift from broad-scale areal sampling to collecting higher resolution surface and upper ocean data with higher frequency along selected SOOP lines. The Argo Project was endorsed as an effective strategy for global sampling of temperature and salinity in the upper ocean. Repeat sampling along selected hydrographic lines was endorsed to complement the more

frequent sampling of systems like Argo and SOOP. Fixed location time series measurements at a selected number of stations would help to provide long time-series and resolve complex interactions. Surface wind data should be collected by dedicated surface moorings. Special attention should be given to observations in ice-covered areas, boundary currents, regions of intense episodic convection, straits and other constricted pathways.

The "drivers" for OOPC activities for the future now fit into 4 themes:

(i) ENSO and related seasonal-to-interannual prediction;
(ii) climate change, including elements of the carbon cycle and sea-ice;
(iii) short-range ocean (and marine) prediction and fields for meteorology; and
(iv) general requirements for the climate database and climatologies.

The elements of a strategy that has developed for responding to these plans/design are:

(i) seek effective implementation mechanisms (e.g. through JCOMM);
(ii) establish integrating "frontier" pilot projects (e.g. GODAE and *Argo* described in section 4.1, above);
(iii) gain wider interest and involvement (e.g. through continuing interaction with the UNFCCC);
(iv) encourage partnerships, and build consensus (e.g. cooperation with CLIVAR UOP, and the Partnership for Observation of the Global Ocean (POGO)).

Prospects for implementing many of the recommended enhancements to the climate observing system now seem good. Many different strands have come together to make this possible (e.g. the decisions of COP V of the UNFCCC, the momentum of the OceanObs99 Conference, the establishment of JCOMM). The OOPC is determined to do its utmost to exploit this unprecedented opportunity to put in place an observing system that will stand the test of time.

7. COASTAL GOOS (C-GOOS)

To assess what users wish Coastal GOOS to produce, C-GOOS meetings are being held in different regions. In 1999 the panel held meetings in Accra, Ghana (April) and Tianjin, China (November). Each included a one-day Stakeholders' Workshop to promote user input to the planning process and to determine capacity building needs.

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

The design strategy being developed by the C-GOOS panel is converging on two components:

(i) a global network to document the global dimensions of local to regional patterns of change in coastal waters and to provide the large scale perspective required to distinguish between locally generated patterns and those generated by regional-global scale forcings; and

(ii) area networks (pilot projects) that incorporate selected index sites where high intensity observations provide the basis for understanding the causes & effects of environmental variability and for the development of models required to translate data into useful visualisations & predictions.

The core elements of the global network will include: (i) remote sensing (winds from scatterometers, sea surface height from altimeters, surface temperature from AVHRR sensors and ocean colour); (ii) *in situ* measurements (an enhanced sea-level measuring network, enhanced arrays of instrumented moorings and fixed platforms, drifters, voluntary observing ships/ferries for monitoring critical sections, and observations from autonomous or remotely operated vehicles; (iii) Coastal Ocean Watch - a flexible observing network for making basic *in situ* measurements in the near-shore zone (coastal laboratories, schools, NGOs can be networked into the coastal ocean watch modules to monitor environmental conditions in the coastal zone); and (iv) a data management system.

The pilot projects are being developed to test C-GOOS concepts or demonstrate how the C-GOOS design works. These include for instance: (i) south-east Pacific coastal oceanography in relation to far-field forcing; (ii) a hazard warning system for the south-west Atlantic coast; (iii) an environmental pollution and forecasting project in the Adriatic; (iv) a harmful algae bloom monitoring network; and (v) a storm surge modelling project in NE Asia.

An initial task is to determine what monitoring activities and capabilities already exist that may constitute an initial coastal observing system. As an initial step an inventory of the existing monitoring systems of the IOC Member States has been compiled.

8. HEALTH OF THE OCEANS (HOTO)

This module is concerned with pollution of seas and oceans and the degradation of ecosystems and their components by contaminants and pollution. A strategic plan has been published (IOC/INF-1044, May 1996), and the latest thinking of this advisory panel is published as GOOS report 40 (report of the 4th session of the HOTO Panel, Singapore, October 1997). In effect HOTO is an operational extension of the IOC's GIPME programme. The main HOTO Pilot Project is RAMP, described in 4.3, above.

9. LIVING MARINE RESOURCES (LMR)

LMR GOOS intends to provide information that: (i) describes changes in ecosystems over time, including fluctuations in abundance and spatial distribution of species; (ii) helps interpret observed changes in relation to such factors as natural environmental variability, anthropogenic climate change (including increased UV radiation), predation/disease, and fishing activities; and (iii) contributes to forecasting future states of marine ecosystems.

The LMR GOOS panel met twice in 1999 (in Montpellier, France, and Talcahuano, Chile), to make progress in developing a strategic design plan to achieve these ends. One step in developing the design was to use retrospective experiments to test whether existing monitoring systems have been effective at forecasting and detecting major ecosystem changes. In 1999 panelists conducted retrospective studies for the Black Sea, the Baltic Sea, the northwest Pacific, and the coastal upwelling system off California and Mexico. Particular attention was given to such an experiment on the eastern Scotian Shelf where major changes in cod stocks occurred. In addition, as a contribution to the retrospective experiments, the 1999 PICES Annual Meeting in Vladivostok convened a symposium on the nature and impacts of North Pacific Climate Regime shifts in which the 1976-77 regime shift was analysed.

The retrospective experiments have guided the panel toward the development of generic operational observing system which operates on three scales: open-ocean, coastal ocean and coastal/inshore. The three-system approach is necessary because of differences in observing system cost and feasibility between coastal and more offshore areas. Observations will be made at higher resolution in areas of particular ecological significance or importance for human activities. A proposal has been developed for an open-ocean observing scheme, and several examples of regional observing systems are being considered.

Recognising that LMR GOOS development should exploit existing monitoring systems, the panel has nominated several ongoing monitoring systems as components of the GOOS-IOS, and has designated others as LMR GOOS Pilot Projects. Five programmes were recommended for inclusion in the IOS - the SAHFOS Continuous Plankton Recorder (CPR) survey; the ICES International Bottom Trawl Survey; the California Cooperative Oceanic Fisheries Investigations (CalCOFI); Southern Ocean monitoring in connection with the Convention for the Conservation of Antarctic Marine Living Resources (CCAMLR); and Finland's Alg@line programme. Other programmes for possible inclusion in IOS are (1) Line P - Station P, (2) EcoFISH, and the Japan and Korea observing systems. Pilot projects include a North Pacific CPR Network, and a project on Biological Action Centres (BACs) in the eastern North Pacific.

10. GOOS SERVICES AND PRODUCTS BULLETIN AND GOOS NEWSLETTER

At the Second Session of the GOOS Steering Committee in Beijing (April 26-29, 1999) it was decided to establish a GOOS Service and Products Bulletin to provide regular and continuous information on the range of products and services associated with GOOS, and to illustrate the point that GOOS is meant to be an operational end-to-end data and information system, developed to provide data products and services to a wide range of users, including policy makers, industry, research, and the general public. The bulletin will provide these groups with an overview of the kinds of services and products available from GOOS.

The bulletin will be updated monthly on the Internet, with print issues every 6 months. It will contain highlights of products from existing GOOS programmes (SOOP, GLOSS, TAO, DBCP), GOOS pilot programmes (PIRATA, *Argo*, GODAE), regional GOOS programmes, and international monitoring programmes relevant to GOOS. The bulletin will be managed by an Advisory Board which will set standards for all products. Features of the bulletin will include a set of user-scenarios, designed to help users determine what products or set of products would be suit their needs, and a searchable directory with hyperlinks to available products.

One set of GOOS products is already available through the IGOSS (now JCOMM) Electronic Products Bulletin managed by Yves Tourre at Columbia University (see IGOSS/JCOMM EPB Web site at [http://iri.ldeo. columbia.edu/climate/monitoring/ipb/]).

A GOOS Newsletter providing information on GOOS and related activities is published in hard copy and on the GOOS Web site (http://ioc.unesco.org/goos/GOOSnews.htm). One issue appeared in April 1999, and a December 1999 issue was issued in January 2000.

11. GLOBAL SEA LEVEL OBSERVING SYSTEM (GLOSS)

The Global Sea Level Observing System (GLOSS), is an international programme co-ordinated by the IOC for the establishment of high quality global and regional sea-level networks for application to climate, oceanographic and coastal sea level research. GLOSS is an integral component of GOOS.

Since 1933, the Permanent Service for Mean Sea Level (PSMSL) has been responsible for the collection, publication analysis and interpretation of sea level data from the global network of tide gauges. A contract between IOC and PSMSL was signed in 1999, as in previous years, to keep continuity of sea level data availability to all Member States participating in GLOSS. All PSMSL data, including those from GLOSS stations, are on the PSMSL Web site (http://www.pol.ac.uk/psmsl/ psmsl.info.html).

The IOC Group of Experts on GLOSS, chaired by Philip Woodworth of the Proudman Oceanographic Laboratory, UK, held its sixth meeting from May 10-14, 1999 in Toulouse, France. Two workshops were held in connection with the meeting: (i) Ocean Circulation Science derived from the Atlantic, Indian and Arctic Sea Level Networks (which will result in an IOC Workshop Report); and (ii) GPS at tide gauge benchmarks for long-term sea-level change studies for altimeter calibration (which will result in an 'IOC Manual 3' on how to operate GPS near to tide gauges). The meeting report and related documents are available on the PSMSL Web site.

Two thirds of the 287 GLOSS Core Network stations appear to be operational. Eighty-five GLOSS stations report to the WOCE ‘Fast Delivery’/’Real-time’ Data Acquisition Center in Hawaii, with data usually available within one to two months of data collection. There is a growing need for real-time data, for model data assimilation or altimeter calibration, but also for more efficient data gathering and quality control. Special efforts will be made to get all authorities to go ‘real-time’ in the near future.

The meeting endorsed the *ex officio* right to membership of the Group of Experts by the Directors PSMSL, UHSLC, NTF, WOCE Centres, IAPSO/CMSLT, IGS and other future appropriate bodies, although this list was not exclusive or exhaustive. This extension of the Group should increase the number of people well-briefed about GLOSS who will be able to represent the programme at international meetings.

The meeting endorsed the concept that a sub-group of the Group of Experts be formed to provide scientific advice, especially for climate. This sub-group could become a joint committee with OOPC, CLIVAR/UOP and IAPSO/CMSLT. This proposal was approved by the 20th IOC Assembly.

GLOSS is now collaborating with the Coastal Panel of GOOS, especially in relation to the GGOOS plans for sea level measurements.

Several sets of tidal analysis software continue to be widely distributed and play a major role in improving data quality and timely delivery. The IOC Manuals and Guides on methods for operating gauges will be re-written and updated during 1999/2000.

There have been seven issues of the GLOSS Bulletin on the PSMSL Web site, and an eighth is in preparation. The Afro-American GLOSS News (AAGN) continues to be produced by the University of São Paulo; it has articles mostly in Spanish and Portuguese, and is available in hard copy and on the Web (http://www/mares.io.usp.br/). The meeting recommended that the AAGN be co-produced with the University of Cape Town so as to widen African interests. An updated two-page brochure advertising GLOSS has been produced by the PSMSL with 2,000 copies printed for circulation in the UK. A Portuguese version is available on the PSMSL Web site, thanks to Dr. Eduardo Marone.

A training course on sea-level measurements and analysis was organised by Professor Affranio de Mesquitta and his staff, and held at the Instuto Oceanografico da University of São Paulo, Brazil from August 30 – September 25, 1999. Participants from 8 countries in Africa and South America were represented.

12. SHIP-OF-OPPORTUNITY PROGRAMME (SOOP)

The SOOP, originally a product of IGOSS, and now to be managed by the new body, JCOMM, is now an integral part of the GOOS Initial Observing System (IOS). Information about SOOP is available on the new SOOP Web site (http://www.brest.ird.fr/soopip). Some 14,000 XBT profiles were made during the first six months of 1999 by SOOP operators from Australia, France, Germany, India, Japan, and USA, including about 8,500 profiles in the Pacific Ocean, 3,200 in the Indian Ocean, and 2,300 in the Atlantic Ocean. The Equatorial and North Atlantic Ocean is well covered while the South Atlantic is under-sampled. The Indian Ocean is adequately sampled except in the south. The Pacific Ocean is relatively well sampled, except in the south. And the Southern Ocean is under-sampled. To optimise XBT deployments, SOOP operators are considering upper ocean thermal data requirements, available resources, and other sources of data, and co-ordinating their efforts.

Since June 1999, SOOP has been served by a Co-ordinator, Mr. Etienne Charpentier, who also serves as technical co-ordinator of the Data Buoy Co-operation Panel (DBCP). Based on input from SOOP operators and data users, the Co-ordinator evaluates available global programme resources and real-time data flow, and, to some extent, data quality, and provides SOOP operators with information enabling them to improve co-ordination and overall network efficiency.

The SOOP Implementation Panel (SOOP-IP), chaired by Mr. Rick Bailey of the Joint Australian Facility for Ocean Observing Systems (JAFOOS), has recently defined its implementation plan. Ways to enhance co-ordination between VOS and SOOP programmes are being considered, and to this end SOOP was formally represented at the CMM VOS meeting in Athens, Greece, in March 1999, and at the JCOMM First Transition Planning Meeting, in July 1999, in Saint Petersburg, Russia.

To assist the development of the implementation plan, an Upper Ocean Thermal Review was conducted and a dedicated workshop held in Melbourne in August 1999, under the sponsorship of the NOAA Office of Global Programmes and the Australian Bureau of Meteorology. A paper summarising the contributions and results from the workshop and entitled "*The role of XBT sampling in the ocean thermal network*", was presented at the OceanObs99 conference in Saint Raphaël, October 1999. The paper is available *via* the SOOP Web site.

The workshop reviewed the past experience with XBT sampling from the ship-of-opportunity programme. Until now, sampling has been in three modes: low density, frequently repeated and high density. SOOP has been extremely cost-effective for science and for operational applications. However as GOOS and JCOMM develop it is timely to consider a change of direction and a new focus. The workshop proposed a major revision of the SOOP. The programme would gradually withdraw from broadcast (areal) sampling while the *Argo* float programme is implemented, and would at the same time ramp up its effort in repeat (transect) sampling. This transit sampling would include both intermediate resolution, frequently repeated lines, and high-density, quarterly repeat lines. This change in approach enhances complementarity with existing elements, particularly the TAO buoy array and altimetry data, and seeks optimum complementarity for the system envisaged for the future. The new design will address several important scientific goals, both for GOOS and CLIVAR, including estimates of cross-transect transports and variability/representativeness. It will make unique contributions in terms of *in situ* eddy-resolving data sets and in terms of the repeated lines. It is estimated that this new design will not have significant resource implications. This new mode of operation opens up opportunities for new and different kinds of observations from SOOP, though this has to be balanced against the good-will being offered by the shipping companies. The workshop also made some recommendations on data management to improve efficient and effective use of the data.

During the year, a comprehensive users guide for thermosalinograph installation and maintenance aboard ship was prepared and published by IRD in Nouméa, New Caledonia. Copies of the guide can be obtained from IRD in Nouméa or can be downloaded from the SOOP Web site.

13. DATA BUOY COOPERATION PANEL (DBCP)

The Data Buoy Co-operation Panel was jointly established in 1985 by WMO and IOC to: *(i) achieve the optimum use of any data buoy deployments being undertaken worldwide and an increase in the amount and quality of buoy data available to meet the objectives of major IOC and WMO programmes; and (ii) encourage and support the establishment of "action groups" in particular programmes or regional applications to effect the desired co-operation in data buoy activities.* It is served by a full-time Technical Co-ordinator funded through voluntary contributions by some Member States of IOC and Members of WMO. In future, DBCP will report to JCOMM. The new reporting procedures necessitate some minor changes to the DBCP's Terms of Reference, which will be submitted to the forthcoming sessions of the Executive Councils of IOC and WMO for formal approval.

The panel's fifteenth session (Wellington, 26-29 October 1999), highlighted several items for 1999. They noted that acts of vandalism have seriously damaged several deep water buoys, and asked WMO to write to the International Hydrographic Organization (IHO) requesting the promulgation of navigational warnings regarding the presence of data buoys and value of the buoy data to the safety of mariners.

In May 1999, with assistance from the Technical Co-ordinator, Collecte-Localisation-Satellite (CLS)/Service Argos opened a DBCP Internet forum (http://www-dbcp.cls.fr) to facilitate debate on technical issues and to exchange information among buoy operators or actors. The forum presently includes themes such as Argos (technical questions, Joint Tariff Agreement (JTA) information, etc.), DBCP (QC, buoy technology, etc.), Global Telecommunication System (GTS) of WMO (formats, QC, technical questions, problems, etc.). It also includes "sub-forums" or "teams" reserved for a smaller community: evaluation of Surface Velocity Programme buoy equipped with a barometer and a wind sensor (SVPBW)/Minimet (reserved to SVPBW evaluation group), DBCP (reserved to DBCP members), and European Group on Ocean Stations (EGOS) (reserved to EGOS members). If desired, new "teams" dedicated to other DBCP Action Groups (AG) could be created on the forum with privileged access for AG Participants. For example, the AG "team" can be administered by the AG Co-ordinator, as is the case for EGOS.

A DBCP brochure was printed and distributed in early 1999. The French, Portuguese and Spanish versions have also been printed and were distributed by the end of 1999.

The panel discussed the issue of metadata communication and archiving. It recognized that it is crucial for both scientific and operational purposes to have easy access to metadata concerning buoys that are reporting *via* the GTS and also for archived data. When using the data, users must have certain information in hand in order to conduct their work as efficiently as possible (e.g. buoy type, drogue type, drogue depth, instruments and calibration procedures, anemometer height, etc.). The panel therefore requested the Technical Co-ordinator to prepare a set of DBCP recommendations about a buoy metadata database, based on inputs from DBCP members and to submit it to the Sub-group on Marine Climatology of JCOMM. The sub-group will meet in early 2000 and take the DBCP recommendations into account. In addition, the panel recognised that there was also a need to include certain types of metadata in the telecommunicated reports from data buoys (including buoy type, drogue type, and drogue depth, if any; anemometer height or indication that the Wind Observation Through Ambient Noise (WOTAN) device is being used). Inclusion of such information requires small changes in the code form used to transmit the data. The panel agreed in principle with this proposed code change. It requested members to pass comments and suggested modifications regarding the proposal to the technical co-ordinator by the end of

November 1999. The technical co-ordinator would then finalize the proposal and pass it to the WMO Secretariat for consideration and approval by the Commission for Basic Systems (CBS) in late 2000.

The Technical Co-ordinator, working with CLS, had evaluated developments required for GTS distribution of sub-surface float data. Technical specifications for inclusion of sub-surface float data processing within the Argos GTS sub-system were written and sent by CLS to a French company for evaluation. Based upon requirements and request for GTS distribution of sub-surface float, CLS decided to go ahead with the developments. Work should be finalised in January 2000. Specifications have been written based upon existing formats of floats deployed by JMA (PALACE), Woods Hole (PALACE), and IFREMER (PROVOR). With this type of instrumentation, it would be unrealistic to aim for a universal data processing system, so standards based upon existing formats have been proposed. There is, however, room for flexibility within proposed specifications.

The Atlantic Oceanographic and Meteorological Laboratory (AOML) of NOAA informed the panel that, because of priorities within the USA buoy community (NOAA and Scripps principally), it was no longer in a position to purchase and deploy SVP Barometer drifters, in particular in the Southern Ocean. Under certain conditions, interested meteorological agencies could use the Global Drifter Programme (GDP) potential of deploying standard SVP drifters to upgrade such buoys with a barometer by paying for the equivalent cost of the barometer. Costs of deployment, as well as the Argos communications costs would continue to be met by AOML. The panel noted with considerable concern the likely loss of important atmospheric pressure data from the Southern Oceans that would result from this decision. It recommended that the meteorological services concerned should consult together and with other interested agencies, perhaps by way of the DBCP Forum, with a view to developing a common position regarding the offer from AOML. They should then undertake direct discussions with NOAA on a resolution of the problems and the possible eventual implementation of the offer.

The Argos Joint Tariff Agreement (JTA) meeting promotes the use of the Argos system for the location of and data collection from buoys and other platforms, both ocean- and land-based, by securing a preferential tariff for governmental users. The negotiations that take place at the annual meeting have to take into account the expenses incurred by CLS/Service Argos (the "operating costs") as well as the national budgets for platform location and/or data collection. At the XIXth meeting (Wellington, 1-3 November 1999), the main topics for discussion were to: (i) assess and review the operation of the new basic principles adopted by JTA-XVII for the 1998 and 1999 JTAs at least; and (ii) devise a mechanism to overcome the financial constraints faced by the participants on the one hand and CLS/Service Argos on the other.

The principles adopted at JTA-XVII were based on the recognition that the number of platforms processed in the system did not impinge significantly upon CLS/Service Argos operating costs. The JTA users would therefore have to pay annually a certain amount of money to CLS (initially, 60% of the operating costs) and be allowed a 35% increase ("bonus") in Argos system usage without further charge. That "bonus" could be compounded over two years (i.e. 1998 and 1999) provided that the sum guaranteed to be paid to Argos by the user did not decrease in 1999 from that guaranteed at JTA-XVII. At JTA-XIX it was evident that the operating deficit of Argos had continued. The meeting considered that efforts should begin immediately to address this deficit problem, and eventually to eliminate entirely the accumulated Argos operating losses. A five-year plan (2000-2004) was developed to eliminate the annual operating deficit, and to remove the accumulated losses. Reduction in the accumulated losses should occur towards the end of the plan, but the annual operating deficit would be partially reduced from the first year.

14. TROPICAL ATMOSPHERE OCEAN (TAO) IMPLEMENTATION PANEL (TIP)

The Tropical Atmosphere Ocean (TAO) Implementation Panel (TIP) was formed to define strategies that will ensure uninterrupted implementation and long-term maintenance of the TAO array. The TAO Panel was established in 1992 under auspices of the international Tropical Ocean Global Atmosphere (TOGA) programme. At the end of TOGA in 1994, sponsorship of the panel shifted jointly to the World Climate Research Program's international Climate Variability and Predictability programme (CLIVAR), the IOC/WMO/UNEP/ICSU Global Ocean Observing System (GOOS) and Global Climate Observing System (GCOS) programmes. The TAO project is managed by NOAA's Pacific Marine Environmental Laboratory (PMEL) in Seattle, Washington, USA.

In January 2000, responsibility for moorings west of 165°E longitude transitioned from PMEL to the Japan Marine Science and Technology Centre (JAMSTEC), hence the moored array is now named the

TAO/TRITON (Triangle Trans-Ocean buoy Network) array. TAO/TRITON data are maintained as a unified data set and are available from either PMEL or JAMSTEC.

The most recent meeting of the TIP took place in St. Raphaël, France, on 15 October 1999. Most TIP members are representatives of Member States of IOC and WMO which are actively involved in TAO activities. Presently, institutes and agencies from the United States, Japan, France and Taiwan participate in TAO/TRITON by contributing critical resources (including ship time, specialized mooring hardware or instrumentation, or funding for operation), to the maintenance and/or expansion of the moored array.

TIP coordinates technical and logistical support from institutions participating in the maintenance of the array. It also cooperates with organizations such as the WOCE/CLIVAR planning committees to ensure an integrated approach to tropical observational programmes. Reports are made regularly to the GCOS/GOOS Project Offices and the CLIVAR Scientific Steering Group on the status of the TAO/TRITON array.

TIP ensures the rapid dissemination of TAO/TRITON data to serve both operational and research applications. Near real-time surface meteorological and oceanographic data from the tropical Pacific and Atlantic Oceans are provided *via* Argos on the GTS network in BUOY format to operational weather centres (WWW). TAO/TRITON works with Argos and the Data Buoy Cooperation Panel (DBCP) to quality control and monitor GTS transmissions. Data are also provided in near real-time to the research community (GOOS/GCOS/CLIVAR) *via* anonymous ftp and on a Web server. High-resolution data are distributed in delayed mode for research purposes.

TIP promotes new technology and instrumentation for moored buoy applications, impact studies based on buoy data, exchanges of technical information and training between participating countries, and participates in data quality control procedures.

TIP produces various publications:

- TAO Implementation Panel Reports once per year
- Technical reports on instrumentation and calibrations (NOAA Technical Reports)
- Scientific publications (see http://www.pmel.noaa.gov/pubs.html)
- TAO Web pages with detailed information on the project at (http://www.pmel.noaa.gov/toga-tao/).
- TRITON Web pages at (http://www.jamstec.go.jp/jamstec/TRITON/)

The TAO Implementation Panel meets yearly (September-November). The working language is English. Membership of the TIP is by invitation of the Global Ocean Observing System Project Office, based on recommendations made by the Panel or its sponsors (GOOS/GCOS/CLIVAR). Categories of membership are:

- Executive Committee - One representative from each country actively supporting the TAO/TRITON Array. The TAO Panel chairman and vice-chairman will serve as national representatives on the executive committee. Responsibilities of the executive committee include: coordinating intersessional activities, recommending membership changes, organizing panel meetings, reporting to parent bodies, etc.

- Members - Individuals representing institutions (or agencies) that provide resources such as ships, mooring hardware and/or technician time to maintain the TAO/TRITON array; or individuals having special expertise in analysis and/or interpretation of TAO/TRITON and other ocean-climate data sets.

The TAO/TRITON array in the tropical Pacific consists of nearly 70 ATLAS, TRITON and current meter buoys, which transmit basic marine meteorological, surface, and subsurface data in near-real time *via* satellite. Moorings are typically deployed for a one-year period after which the instrumentation is recovered for calibration and refurbishment. The moorings are located between 8°N and 8°S from 95°W to 137°E and are maintained primarily through the efforts of the United States and Japan. Approximately 350 days at sea are required to maintain the array.

The TAO Implementation Panel is also involved with the PIRATA array in the tropical Atlantic (see section 4.2), which consists of ATLAS moorings at 12 sites. These moorings are supported by the United States, France, and Brazil.

Standard sensors consist of surface winds, air temperature, relative humidity, sea surface temperature and ten subsurface temperatures in the upper 500 meters. Ocean currents are measured at five sites along the equator and at all TRITON sites. Additional sensors, including rainfall, shortwave radiation, and surface salinity, can be added as required by collaborative programmes.

Engineering developments continue to incorporate new technology in order to improve data quality and data return from the array.

TAO is officially supported in the United States by operational rather than research funds. This funding is expected to continue for the foreseeable future.

Observations from the TAO/TRITON moorings are transmitted to shore in real time *via* NOAA's polar orbiting satellites. Data are processed and encoded into BUOY code by Service Argos, using calibrations and algorithms supplied by PMEL and JAMSTEC. Daily averaged subsurface data and several hourly values of surface data are available in real time each day from the moorings. The TAO and TRITON Project Offices work with the DBCP and Service Argos in quality controlling real-time TAO/TRITON data. In addition to the GTS submission, TAO/TRITON data are also processed and quality controlled by the TAO and TRITON Project Offices and made available as a unified data set *via* the World Wide Web at http://www.pmel.noaa.gov/toga-tao/ and http://www.jamstec.go.jp/jamstec/TRITON/, and *via* anonymous ftp from either PMEL or JAMSTEC. PIRATA data are available at http://www.pmel.noaa.gov/pirata/. Quality control checks are performed daily to detect instrumentation failures or calibration problems.

On-line archives are maintained for all TAO/TRITON sites. High-resolution data (e.g., hourly or 10-min data files) are obtained after each buoy is recovered and the data read from onboard storage. Standard data are processed, quality controlled, and made available *via* the Web and anonymous ftp within months of recovery. Non-standard or experimental data (e.g. salinity) may be available on a case-by-case basis. Current data from subsurface Acoustic Doppler Current Profiler (ADCP) moorings and single-point current meters are also processed and made available upon completion. Yearly submittals have been made of all TAO data to the USA National Oceanographic Data Centre (NODC).

15. GLOBAL TEMPERATURE AND SALINITY PILOT PROGRAMME (GTSPP)

The GTSPP continues to be an important participant in the evolving ocean observing system. It has demonstrated how a close international collaboration between data centres and scientific or operational programmes can help the collection, processing, quality, distribution and utility of data.

The Canadian Marine Environmental Data Service (MEDS) and the US National Oceanographic Data Centre (NODC) continue to handle the real-time data flow and the continuously managed database, respectively. Data exchange occurs regularly three times a week. Once a year, all data collected two years previously are divided into three oceans and forwarded for scientific QC to the Atlantic Oceanographic and Meteorological Laboratory (AOML), the Scripps Institute of Oceanography (SIO) and the Joint Australian Facility for Ocean Observing Systems (JAFOOS). The results are returned to the US NODC to update the archives.

Technology and expertise are shared between participants. Both MEDS and the US NODC benefit from the close working relationships with science centres. At present, AOML and the Australian Commonwealth Scientific and Industrial Research Organization (CSIRO) are collaborating in the development of more sophisticated semi-automated QC procedures that are expected to be incorporated in data centre operations in due course. The participating data centres have also benefited from the scientific expertise provided by science centres, which in turn have benefited from exposure to the data management practices of the data centres.

The number of profiles in the continuously managed database is slightly less than 1 million for the period 1990-1999. The table on the next page shows the repartition of the figures by instrument type and ocean.

	Atlantic	Indian	Pacific	Total
BATHY*	132055	39211	400952	**572218**
TESAC	38315	679	19693	**58687**
CTD	11239	544	14346	**26129**
Profiling floats	1502	0	678	**2180**
Bottles	1344	7	4316	**5667**
XBTs	70345	42727	139714	**252246**
Total	**254800**	**83168**	**579159**	**917127**

(* The figures include the nearly 200,000 profiles from moored buoys)

There are several users of the data. MEDS has about six users that receive data three times a week. Each user can define an area of interest, and the data are either sent by FTP, email or placed on MEDS anonymous FTP server for pickup. The US NODC has more than a dozen users receiving data weekly or monthly. These include NASA (for comparison with remote sensing), ECMWF (for seasonal forecasting), Tokyo University (studying the Eckman heat transport), NOAA offices, universities and meteorological services.

A very important development has been the active participation of GTSPP in scientific programmes. GTSPP plays a key role in the WOCE Upper Ocean Thermal (UOT) programme. In 1998, the first WOCE CDs of data collected were issued. GTSPP was responsible for the production of the master CD for UOT, with all data from 1990-1996 having passed through scientific QC. GTSPP is also directly linked to the Ship-of-Opportunity Programme (SOOP), in making available data sampling information as well as data quality statistics (to be found at www.meds-sdmm.dfo-mpo.gc.ca). By participation in WOCE and SOOP, GTSPP has developed a number of tools for monitoring the volume, distribution and quality of the data reported. In late 1993, GTSPP started monitoring the quality of the real-time data. GTSPP notifies ships' operators on a monthly basis of problems noted in SOOP. This service has benefited greatly from the close co-operation with SOOP and the OAR Office.

As GOOS develops, it is clear that GTSPP will play an important role. Already GTSPP is co-operating with NEAR-GOOS in the exchange of data from this programme. Representatives of GTSPP took part in discussions in Sydney in early 1998 to try and define the major players and their contributions to GOOS. In August 1999, GTSPP participated in discussions on a redefinition of the upper ocean monitoring network, held in Melbourne. Results of this were presented at the OceanObs-99 conference held in St. Raphaël in October 1999. At the same time, because of participation in WOCE, experience gained from GTSPP contributed to a paper for the same conference, discussing ocean data systems and data management.

GTSPP also assists in special monitoring activities. It participated twice in special monitoring of BATHYs and TESACs by WMO. It also provides a monthly report to the Argentinean Data Centre about data they should be receiving from the GTS from their area of interest. As moored buoys report profiles (such as from the TAO, PIRATA and TRITON arrays), GTSPP has been reporting on a weekly basis to OAR what it receives from these platforms, to help ensure an uninterrupted service.

A second version of the GTSPP Project Plan has been published. It updates the original version, indicating goals achieved and work still to be done, which includes:

1. The development of CLIVAR, GOOS and GODAE will require data management services like those provided by GTSPP. GTSPP needs to be well connected to these programmes to avoid duplication of effort, and to facilitate programme support. The growing need for more data and more diverse data in real-time will require adjustments by GTSPP, IODE and JCOMM. This constitutes a major challenge to IODE.

2. Increased co-operation is required between both international and national science programmes. The Global Oceanographic Data Archaeology and Rescue (GODAR) project identified substantial volumes of data collected but never exchanged within the IODE system. These data were collected primarily by national programmes. Each country participating in IODE can make a strong and positive contribution by developing the data exchange mechanisms with research and monitoring groups in their own countries, to increase the volume, type and timeliness of this exchange.

3. A number of products are based on data flowing through GTSPP. In addition there is a need for continual improvement in the distribution of data. Operational programmes require immediate and easy access to data. GTSPP needs to adjust to these needs and to document the uses of the data it handles.

4. Increased data volumes and more immediate needs for the data will require adjustments to how data are handled within GTSPP. Improvements include more standardization of data formats, more automated quality assessment procedures, more efficient and reliable real-time data transmission systems and better data monitoring (volumes, quality, types), reflecting the shift in oceanography from research requirements to operational programmes. GTSPP is in the vanguard of this process, but IODE must also make adjustments in data management practices.

16. CONTINUOUS PLANKTON RECORDER SURVEY (CPR)

Since the LMR GOOS II meeting in March 1999 the CPR survey has become part of the GOOS-IOS. The SAHFOS Council has also approved a draft data policy for CPR data which fully complies with the developing data policy of GOOS. Although details of the data licence agreement are still being finalised, CPR data are free of charge to the user with only a nominal computing charge levied for the cost of processing and delivering the data product.

In July of 1999 a new project began with SAHFOS as the main partner, supported by the UK Department of the Environment, Transport and the Regions, to further develop the U-Tow into an operational instrument for Ship of Opportunity (SOOP) use. This project involves polling the ships that currently deploy the CPR to obtain comments and identification of problems from their perspective with deploying the U-Tow. Further trials on SOOPs will also be undertaken and comparisons made between the sampling characteristics of the U-Tow and the CPR. At present the U-Tow has proved reliable and capable of undulating to depths of approximately 60m at speeds of up to 16 knots but it has not yet been towed unaccompanied. This project will move towards that goal.

SAHFOS also proposes that data for two plankton indices will be posted on its Web site, and updated monthly as part of its commitment to GOOS. Phytoplankton colour and the abundance of the copepod *Calanus finmarchicus* have both shown strong links with northern hemisphere climate variables and clear long-term trends. Colour has proven to be a reasonable proxy for phytoplankton abundance and *C. finmarchicus* is probably the most abundant copepod in the north eastern Atlantic. The Colour index is assessed almost as soon as the samples are returned to the laboratory and so data could be posted within a few weeks of sampling. The copepod abundance will take longer to determine for the entire sampled area, however, it is hoped that data would be made available within a year of collection, as a maximum, and probably often on a shorter time scale. It is expected that data will be available beginning in 2000.

The MONITOR Task Team of the PICES CCCC programme recommended that large scale measurements of zooplankton species composition and abundance be initiated in the NE Pacific. The CPR represented the best choice of instrument to sample now, since it has a proven record in the Atlantic and its sampling characteristics, although with some problems, are well known. In March 2000 a two-year sampling programme will begin that will occupy two transects, as suggested by the Task Team. The first, from Prince William Sound, Alaska to Long Beach, California will be run five times a year, with approximately monthly spacing from March to August, and the second, a great circle route from Vancouver Island, Canada to the Bering Sea will be run once per year. The first line will sample Prince William Sound, the offshore region feeding the downwelling zone on the shelf, close to the centre of the Alaska Gyre (crossing Line P) and will intersect the CalCOFI grid off California. The second line will cross the first and also run parallel to Line P. In the short term this research will provide data on the structure of plankton variability along these lines and will be used to design a long-term zooplankton sampling programme for the NE Pacific. This future programme would reflect improvements in the technology available to estimate plankton abundance and will enable the monitoring of climate change variability. PICES would like to see the CPR programme as a Pilot Project within GOOS and would hope to work with GOOS to develop a long-term strategy.

17. GLOBAL CORAL REEF MONITORING NETWORK (GCRMN)

Co-Sponsored by the IOC, UNEP, IUCN and The World Bank, the Global Coral Reef Monitoring Network continued to expand during 1999 and is now active in all oceans. Funding is provided by the U.S.

Department of State and NOAA, and the governments of Australia, France and the UK, and coordination is provided by IOC/UNESCO in collaboration with UNEP, IUCN, ICLARM and the World Bank.

The focus of reef monitoring activities continues to be the Indian Ocean and Southeast Asia, where coincidentally there was massive coral bleaching and mortality in 1998 (reported in *Status of the Coral Reefs of the World: 1998* and on the AIMS Home Page www.aims.gov.au/scr1998). The UK Department for International Development (DFID) has extended funding for the GCRMN South Asia Node (India, Sri Lanka, the Maldives) for a second 30-month phase, with coordination provided by IOC/UNESCO. A new regional coordinator for the project, Emma Whittingham, has been appointed and is located at the project headquarters at IUCN in Colombo, Sri Lanka. India, the Maldives and Sri Lanka have prepared Coral Reef Monitoring Action Plans which will be available in early 2000. Coral monitoring is also now in planning or underway in the Western Indian Ocean, East African States, Micronesia and the Caribbean Sea.

The major activity now underway is the preparation of a report for GOOS, *Status of the Coral Reefs of the World: 2000* which will provide a global perspective on coral reef status and monitoring. All coral reef nations are being asked to provide country reports by May 2000. These will be combined into regional reports, which will constitute the chapters for the global report. This report will constitute the first GOOS global ecosystem report and will assist all coral reef managers, agencies and donors to assess the status of reefs in order to plan for more effective conservation.

18. INTERNATIONAL OCEANOGRAPHIC DATA AND INFORMATION EXCHANGE (IODE)

The IODE System is an important element of the infrastructure required to implement GOOS. IODE was established in 1961 to enhance marine research, exploitation and development by facilitating the exchange of oceanographic data and information between participating Member States and by meeting the needs of users for data and information products. The IODE system forms a worldwide service-oriented network consisting of DNAs (Designated National Agencies), NODCs (National Oceanographic Data Centres), RNODCs (Responsible National Oceanographic Data Centres) and WDCs (World Data Centres – Oceanography).

In 1999, Mauritius joined the System, bringing the total number of DNAs and NODCs to 57 (Fig.1).

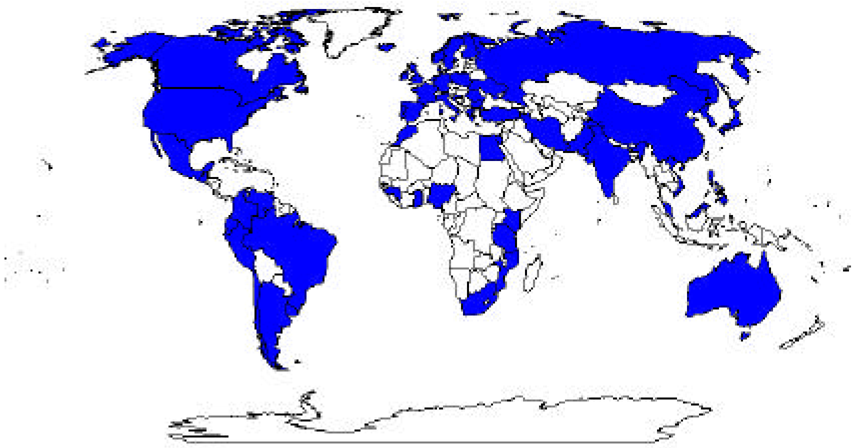

Fig. 1: IODE Data Centres around the World. Countries marked in dark have established a DNA or NODC.

The IODE System gives worldwide access to literally millions of measurements and observations. Many more are added each year. The largest data banks are available in the World Data Centres: A (Silver Spring, USA); B (Obninsk, Russia); and C (Tianjin, China). Users can approach the data centres of the IODE System with requests for data and/or information or advice regarding data or information management. The data and services are provided either in exchange or at a cost not to exceed that of processing and shipping. Increasingly the data centres provide their data and information services on-line over the World Wide Web (find out more from the IODE Web site on http://ioc.unesco.org/iode).

18.1 IODE Programmes and Activities

Global Oceanographic Data Archaeology and Rescue Project (GODAR)

The success of GODAR is manifest in the publication by Sydney Levitus of NOAA in the March 24 (2000) issue of *Science Magazine* of an article titled "Warming of the World Ocean." Use of 5.1 million temperature profiles from sources around the world, largely facilitated through GODAR, to quantify the variability of the heat content (mean temperature) of the world ocean from the surface through 3,000 meter depth for the period 1948 to 1996, showed that the world ocean has warmed significantly during the past 40 years. The largest warming has occurred in the upper 300 meters of the world ocean on average by 0.31°C. The water in the upper 3,000 meters of the world ocean warmed on average by 0.06°C. These findings represent the first time scientists have quantified temperature changes in all of the world's oceans from the surface to 3000 meters depth. The changes are occurring at much deeper depths than was previously thought. The warming is likely due to a combination of natural variability, such as the Pacific Decadal Oscillation, and human-induced effects. Interestingly, the increase in subsurface ocean temperatures preceded the observed warming of surface air and sea surface temperatures, which began in the 1970's, suggesting that ocean heat content may be an early indicator of the warming of surface, air and sea surface temperatures more than a decade in advance. The results support climate modelling predictions that show increasing atmospheric greenhouse gases will have a relatively large warming influence on the earth's atmosphere. One criticism of the models is that they predict more warming of the atmosphere than has been actually observed. Climate modelers have suggested that this "missing warming" was probably to be found in the world ocean. The results of this study lend credence to this scenario. International cooperation through GODAR in building the global ocean databases required for understanding the role of the ocean as part of the earth's climate system has been excellent. Understanding the role of the ocean in climate change and making decadal climate forecasts will be greatly enhanced by observations planned as part of GOOS.

OceanPC/IODE Resource Kit

Further building on the first draft of the ‘IODE Resource Kit’, prepared in 1998, a second, even more comprehensive version has been prepared in 1999. The kit is now composed of 2 CD-ROMs: Part I: training module; Part II: data module. Whereas Part I will be a standard module, Part II will be customized by region. The Kit has been demonstrated during the ODINEA 99 Workshop and participants were given the opportunity to test-run the product. During the year 2000 the Kit will be finalized and distributed to the IODE National Coordinators for comments and suggestion, prior to submission to IODE-XVI.

Marine Information Management (MIM)

The 6th Session of the IODE Group of Experts on Marine Information Management was held from 31 May to 3 June 1999 in Silver Spring, Maryland, USA. The Group noted the progress in the past years related to (i) regional information networks such as RECOSCIX (see also under ‘The Regional Approach’); (ii) the development of the IOC Web site and its Web based infobases; (iii) the successful development of the Global Directory of Marine (and freshwater) Professionals (see also below under ‘GLODIR’); (iv) close cooperation between IODE/MIM and IAMSLIC/EURASLIC; and (v) the successful collaboration with the data management community in relation to meta data management. The Group identified 4 major lines of action for the period 1999-2002:

1. Capacity building: development of information centres and/or regional information networks building on the RECOSCIX model
2. Capacity building: development of training tools and products
3. Capacity building: support for skills training and education
4. Products and services: GLODIR, IDALIC and other directories; IOC Publications catalogue; infobases; development of integrated data and information products; identification of Integrated Library Management system (ILMS), with special attention to developing countries.

The report of the Session is available from the IOC e-Library’s ‘Report of Meetings of Experts and Equivalent Bodies’ section (http://ioc.unesco.org/iocweb/IOCpub/elibexp.htm).

MEDI Pilot Project

The MEDI Pilot Project (meta database development tool), developed in 1998, was modified. The tool was provided to data centres in the IOCINCWIO region within the framework of the ODINEA project.

Global Directory of Marine (and Freshwater) Professionals (GLODIR)

1999 was a most successful year for GLODIR. Entries in the database more than doubled from 4593 in December 1998 to 10426 in December 1999. This was mainly due to the cooperation of dedicated GLODIR input centres. The GLODIR database can be accessed through URL [http://ioc.unesco.org/glodir].

Partnerships

Additional to its own programmes and projects, IODE has also forged partnerships with other organisations, programmes or projects.

MEDAR/MEDATLAS-2

The Mediterranean Data Archaeology and Rescue / Mediterranean Atlas (MEDAR / MEDATLAS) programme is the regional component of the GODAR programme in the Mediterranean and Black Sea Regions and is implemented by a group of 20 partner countries co-ordinated by IFREMER/SISMER, France. The programme objectives are to compile and safeguard historical oceanographic data, to make available comparable and compatible data sets of temperature, salinity, and biological and chemical profiles, to prepare and disseminate value added products, and to enhance communication between data managers and scientists. The first meeting of the MEDAR / MEDATLAS programme partners was held at the 'Institut Oceanographique' in Paris on March 22-24, 1999. Following this first organisational meeting, two workshops on data quality control, assessment, and formatting procedures were held; one in Brest, France, 22 November – 3 December, for the Western and Central Mediterranean region, and one in Athens, Greece, 29 November – 10 December, for the Black Sea and Eastern Mediterranean region. The results of the data rescue programmes and cruise inventories have been quality controlled and compiled in a standard format, producing a data base of over 21,000 cruises. A number of value-added data products are already available on the MEDAR / MEDATLAS Web site (http://ioc.unesco.org/medar).

UN Ocean Atlas

The UN Atlas of the Oceans is a digital, CD-ROM and Web based interactive information tool focusing on policy-oriented issues and the sustainable use of the ocean resources. The project is being implemented by a core group of UN Agencies (FAO, UNESCO-IOC, IMO, UNEP, UNDP, IAEA, and WMO) under the co-ordination of FAO, and in collaboration with prominent academic organisations and research institutions. The Atlas is to be built from existing documents available from programmes of the UN agencies and participating organisations, and will be regularly updated in co-operation with a private publisher. A meeting of the partner organisations was held in London in August 1999 to discuss policy issues to be included in the Atlas. The first meeting of the technical staff from the six UN core agencies was held in Rome in December 1999 to discuss the information and policy contributions of each agency.

18.2 The Regional Approach

<u>IOCINCWIO region:</u>

ODINEA/ ODINAFRICA

- Continuation of support to data centres through the ODINEA & RECOSCIX-WIO projects within the framework of the ‘Ocean Data and Information Network for Africa’ (ODINAFRICA) project, with support from the Government of Flanders, SAREC of Sida, and IOC/UNESCO.

- In 1999 Mauritius joined the IODE system as its 57th National Oceanographic Data Centre. The Mauritius NODC was established as part of the University of Mauritius.

- The main thrust of ODINAFRICA-I in the Western Indian Ocean region in 1999 was aimed at the further strengthening of the National Oceanographic Data Centres (or Designated National Agencies). We are pleased to report that, out of the seven cooperating countries, six have now established a data centre: (1) Kenya; (2) Mauritius; (3) Mozambique; (4) Seychelles; (5) South Africa; and (6) Tanzania. Madagascar is expected to establish its Centre in the year 2000.

- In 1999, the ODINEA cooperating data centres concentrated their efforts on the development of national meta data bases as well as ocean data bases.

- At the end of the year the project has also made a clear move towards a better integration of the national oceanographic data management capabilities into national priority areas through the participation of the ODINEA group in the 'WORKSHOP ON OCEAN DATA AND INFORMATION FOR INTEGRATED COASTAL AREA MANAGEMENT', Capetown, South Africa (13 - 15 December 1999).

- The RECOSCIX-WIO project took 1999 as an occasion to plan for the future during the 'IOC-LUC-KMFRI Workshop on RECOSCIX-WIO in the year 2000 and beyond' (Mombasa, Kenya, 12-17 April 1999). Participants reviewed the objectives of the project and prepared a comprehensive work plan for the period 2000-2004.

IOCEA region:

- Support to information centres through the RECOSCIX-CEA project within the framework of the 'Ocean Data and Information Network for Africa' (ODINAFRICA) project, with support from the Government of Flanders and IOC/UNESCO.

- Support to the RECOSCIX-CEA project of which the Regional Dispatch Centre is based at the 'Centre de Recherches Océanologiques', Abidjan, Côte d'Ivoire, has continued in 1999. Computer equipment, as well as support for document delivery was provided. Additional support was also provided for the development of the CEADIR (Central Eastern Atlantic Directory of Marine Professionals), which was merged with the GLODIR.

Central and South America

Responding to the need for training courses and workshops focusing on the management and exchange of oceanographic data and information, an IODE training course on oceanographic data and information management for the spanish-speaking countries of Central and South America (Taller Regional de la COI para la Gestion de Datos Marinos y Costeros en Latinoamerica y el Caribe) was held on 20 – 29 September, 1999, at the Fundacion Universidad de Rio Grande, Rio Grande do Sul, Brasil. This programme focused on promoting methods and techniques for the management of marine data and information at the national and international level, and on the promotion of regional co-operation among data centres.

19. INTEGRATED GLOBAL OCEAN OBSERVING STRATEGY (IGOS)

It is easy to see that the range of observations needed to understand and monitor Earth processes, and to assess human impacts, cannot be satisfied by any single programme, agency or country, and hence that international cooperation is essential to provide these observations. Effective monitoring of our planet on the global scale requires cooperation on that scale. Recognising this requirement, in 1998 GOOS became part of an Integrated Global Observing Strategy (IGOS) involving the major space-based and *in situ* systems for global observations of the Earth. IGOS provides an integrated framework 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.

The IGOS Partners comprise the offices of the three global observing systems – the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS), and the Global Terrestrial Observing System (GTOS), along with their sponsoring agencies (WMO, UNEP, UNESCO, FAO, ICSU and the IOC), plus the space agencies represented by the Committee on Earth Observation Satellites, along with the World Climate Research Programme (WCRP), the International Geosphere-Biosphere Programme (IGBP), and the International Group of Funding Agencies for Global Change Research (IGFA). Other organisations are expected to join in due course.

IGOS is developing through the promotion of a set of themes, the first of which is the *Oceans Theme*, which will emphasise to governments the requirements for a comprehensive GOOS.

Information on IGOS is available at [http://www.unep.ch/earthw/igos.htm].

ANNEX I

LIST OF GOOS WEBSITES

GOOS: http://ioc.unesco.org/goos

GLOSS: http://www.pol.ac.uk/psmsl/gloss.info.html

PSMSL: http://www.pol.ac.uk/psmsl/psmsl.info.html

SOOP: http://www.ifremer.fr/ird/soopip/

DBCP: http://dbcp.nos.noaa.gov/dbcp/

IGOSS/JCOMM Electronic Products Bulletin : http://iri.ldeo.columbia.edu/climate/monitoring/ipb/

JCOMM: http://ioc.unesco.org/goos/jcomm.htm

OOPC: http://www.bom.gov.au/bmrc/mrlr/nrs/oopc/oopc.htm

GODAE: http://www.bom.gov.au/bmrc/mrlr/nrs/oopc/godae/homepage.html

Argo: http://www.argo.ucsd.edu/

TAO: http://www.pmel.noaa.gov/toga-tao/

TRITON: http://www.jamstec.go.jp/jamstec/TRITON/

PIRATA: http://www.ifremer.fr/orstom/pirata/piurataus.html

GTSPP: http://www.nodc.noaa.gov/GTSPP/gtspp-home.html

CPR: http://www.npm.ac.uk/sahfos/introduction.html

GCRMN: http://coral.aoml.noaa.gov/gcrmn/index.html

EuroGOOS: http://www.soc.soton.ac.uk/OTHERS/EUROGOOS/

NEAR-GOOS: http://ioc.unesco.org/goos/neargoos.htm

GCOS: http://www.wmo.ch/web/gcos/gcoshome.html

GTOS: http://www.fao.org/GTOS/Home.htm

IGOS: http://www.unep.ch/earthw/igos.htm

ANNEX II

GOOS SUMMARY OF MEETINGS IN 1999
(RP= UNESCO Regular programme funds; TF = IOC General trust Fund; EX = extra-budgetary resources from agencies, earmarked for GOOS)

Title	Place	Date	Attendees	Countries	Budget ($)
JGOFS CO_2 Panel and Symposium	Tsukuba	Jan 16-22	16 panel 200 sympo	6 18	RP 8,500
GCOS JSTC	Geneva	Feb 9-12	25	12	TF 1,300
INFO Coast 99	Nordwigkerhout	Feb 10-14	150	10	RP 1,410
Explanatory Meeting for a Partnership for Observation of the Global Oceans (POGO)	Paris	Mar 8-10	24	6	none
VOS (WMO) Meeting	Athens	Mar 8-12	29	18	RP 1,500
Organizational meeting for the OceanObs99 Conference	St-Raphael	Mar 11-12	9	3	RP 910
2nd EuroGOOS Conference	Rome	Mar 11-13	287	26	RP 2,650
MedGOOS Planning Meeting	Rome	Mar 11-13	30	11	RP 2,240
WCRP JSC Meeting	Kiel	Mar 15-20	43	14	RP 1,600
Scoping meeting on high-seas marine protected areas	Montpellier	Mar 20	8	4	none
LMR Panel-II	Montpellier	Mar 22-26	16	11	RP 13,000 EX 12,000
ICES-GOOS	Bergen	Mar 22-24	20	7	RP 1,930
GODAE-III, ARGO	Easton , USA	Mar 22-26	42	7	RP 2,700
Coastal GOOS-III	Accra	Apr 12-15	35	15	RP 2,500 TF 16,700 EX 20,000
Meeting on Marine Models	London	Apr 21	45	1	none
IOCARIBE Users and GOOS Workshop	San José	Apr 22-24	43	16	TF 2,500 EX 27,000
2nd session of the GOOS Steering Committee	Beijing	Apr 26-29	33	10	RP 1,700 TF 16,000 EX 15,000
Earthwatch	Geneva	May 3-4	15	6	RP 1,250
PIRATA-VI	Miami	May 3-7	63	6	TF 2,000 EX 3,000
GLOBEC SSC	Yokohama	May 6-14	15	11	RP 2,300

Title	Place	Date	Attendees	Countries	Budget ($)
CLIVAR SSG-8	Southampton	May 10-14	78	11	RP 1,600
GLOSS Workshop GLOSS-VI Group of Experts	Toulouse Toulouse	May 10-11 May 12-14	25	20	RP 5,000 TF 9,800 EX 12,000
OOPC-IV / CLIVAR VOP-IV	Woods Hole	May 17-20	36	11	RP 12,500 EX 2,000
EGOS Management Committee & Sub-group meetings	Brest	May 26-28	12	9	TF 3,000
IABP Annual Meeting	Bremerhaven	Jun 2-4	19	8	
G3OS Sponsors Meeting	Rome	Jun 6-8	25	10	RP 1,500
UK Argos Users Conference	Oban	Jun 14-15	30	2	TF 1,800
I-GOOS-IV	Paris	Jun 23-25	61	23	RP 7,000
GOOS Commitments Meeting	Paris	Jul 5-6	40	22	TF 2,000
GODAR Meeting	Washington	Jul 11-15	40	35	none
JCOMM First Transition Meeting	St Petersburg	Jul 19-23	35	10	TF 1,700
IGOS Forum session at UNISPACE-III Conference	Vienna	Jul 21	90	35	RP 1,500
GOSSP Meeting	Pasadena	Aug 5-6	15	8	RP 1,900 EX 1,900
IOC-WMO-CPPS Joint Working Group on the Investigations on "El Niño"	Concepcion	Aug 9-13	32	7	RP 3,000
GLOSS Training Course	Sao Paulo	Aug 30 - Sep 20	9	6	RP 2,500 TF 17,500 EX 22,500
East Indian and West Pacific Observation Systems	Perth	Sep 16-17	24	8	EX 11,600
RAMP Training Workshop	San José	Sep 20-24	34	12	EX 46,000
Workshop on Operational Oceanographic Products & Services	Bergen	Se p 28-29	41	7	EX 1,500
4th Session of the Coordinating Committee for NEAR-GOOS	Tokyo	Sep 28 - Oct 1	26	4	EX 22,000

Title	Place	Date	Attendees	Countries	Budget ($)
First Integrated Transboundary Coastal Area and Management Meeting	Tehran	Oct 1-6	35	6	RP 2,500
8th Annual PICES Meeting	Vladivostok	Oct 6-14	300	8	EX 2,600
WOCE SSG-26	La Jolla	Oct 4-8	16	5	RP 2,500
TAO-VIII Meeting	St Raphael	Oct 15-16	9	3	RP 7,000
Ocean Climate Observations Conference	St Raphael	Oct 18-22	330	27	RP 10,000 EX 24,600
COP-5	Bonn	Oct 25 - Nov 5	1000	100	RP 3,000
DBCP-XV	Wellington	Oct 26-29	70	13	RP 3,600
ARGOS-JTA-XIX	Wellington	Nov 1-3	32	12	
MedGOOS Workshop	Rabat	Nov 1-3	53	15	RP 10,000 EX 60,000
Coastal GOOS -IV	Tianjin	Nov 2-5	35	13	RP 5,000 EX 30,000
GIPME/HOTO Indicators of Ocean and Human Health Workshop	Bermuda	Nov 16-19	34	6	RP 4,500 EX 8,300
IOCARIBE GOOS *ad hoc* Advisory Group	Caracas	Nov 3-5	8	5	RP 2,000 EX 5,500
POGO	La Jolla	Dec 1-3	30	12	EX 2,500
EuroGOOS	Madrid	Dec 3	20	10	RP 1,500
Arctic GOOS/JCOMM	Geneva	Dec 6-8	13	8	RP 3,000
EGOS Meetings	Paris	Dec 7-8	10	6	RP 500
LMR-III	Tacahualco	Dec 8-11	12	7	EX 35,000

ANNEX III

LIST OF GOOS OUTPUTS IN 1999

1 GOOS REPORTS

(1) The reports published in 1999

GOOS-60: IOC/WESTPAC Co-ordinating Committee for the North-East Asian Regional-Global Ocean Observing System (NEAR-GOOS) Third Session (Beijing, China, 3-6 August 1998)

GOOS-61: Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC) Third Session (Grasse, France, 6-8 April 1998)

GOOS-62: PACSICOM Workshop on GOOS-AFRICA: Global Ocean Observing System for SICOM (Maputo, Mozambique, 18-25 July 1998)

GOOS-63: IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS) Second Session (Curitiba, Brazil, 29 October - 1 November 1998)

GOOS-64: Implementation of Global Ocean Observation First Session (Sydney, Australia, 4-7 March 1998)

GOOS-65: Implementation of Global Ocean Observation Second Session (Paris, France, 30 November 1998)

GOOS-67: Global Observing System Space Panel Fourth Session (College Park, Maryland, USA, 22/23 October 1998)

GOOS-68: Tropical Atmosphere-Ocean Array (TAO) Implementation Panel Seventh Session (Adidjan, Côte d'Ivoire, 11-13 November 1998)

GOOS-79: OOPC/AOPC Workshop on Global Sea Surface Temperature Data Sets (Palisades, NY, Usa, November 2-4, 1998)

(2) The reports prepared but not issued in 1999

GOOS-66: Global Ocean Observations for GOOS/GCOS: An Action Plan for Existing Bodies and Mechanisms

GOOS-71: IOC Group of Experts on the Global Sea Level Climate Observing System (GLOOS) Sixth Session (Toulouse, France, 12-14 May 1999)

GOOS-73: IOC-WMO-UNEP-ICSU Steering Committee of the Global Ocean Observing System (GOOS) Second Session (Beijing, China, 26-29 April 1999)

GOOS-74: IOC-WMO-UNEP-ICSU-FAO Living Marine Resources Panel of the Global Ocean Observing System (GOOS) Second Session (Montpellier, France, 22-26 March 1999)

GOOS-75: Joint GCOS-GOOS-WCRP Ocean Observations Panel for Climate (OOPC) Fourth Session (Woods Hole, USA, 17-20 May 1999)

GOOS-76: IOC-WMO-UNEP-ICSU Coastal Panel of the Global Ocean Observing System (GOOS) Third Session (Accra, Ghana, 13-15 April 1999)

2 GOOS RELATED PUBLICATIONS

Summerhayes, C.P., 1999, The Global Ocean Observing System (GOOS) in 1998. Abstract, Proc. EuroGOOS Conference, Rome.

Summerhayes, C.P., and Rayner, R., 1999 (in press), Operational Oceanography. In Proc. IOC/SCOR/SCOPE Workshop Oceans 2020, Potsdam, October 2-8, 1999.

Wilkinson, C., Linden, O., Cesar, H., Hodgson, G., Rubens, J. and Strong, A.E. (1999). Ecological and socio-economic impacts of 1998 coral mortality in the Indian Ocean: An ENSO impact and a warning of future change? AMBIO, 28: 188-196.

Wilkinson, C., Hodgson, G. (1999). Coral reefs and the 1997-98 mass bleaching and mortality. Nature and Resources 35 (2): 16-25

Wilkinson, C.R. (1999). Global and local threats to coral reef functioning and existence: review and predictions. Marine Freshwater Research 50: 867-878

3 BROCHURES, etc.

The IGOS Brochure (July 1999)

GOOS News 7 and 8

ANNEX IV

LIST OF GOOS DONORS IN 1999

NOAA for Coastal GOOS

UK Met Office for GODAE

ICSU for GOOS in general

NERC for GLOSS

WMO for GOOS in general

FAO for LMR

NOAA for LMR (via Texas A & M)

NOW for Coastal GOOS and GOOS Capacity Building

NOAA for GLOSS (indirect)

NOAA for GODAE

NOAA for GOOS in general

France for GLOSS and Pirata

SIDA for IOCARIBE-GOOS

ONR for MedGOOS

IOI for MedGOOS

WMO for MedGOOS

IFREMER for MedGOOS

OGS for MedGOOS

UK Met Office for MedGOOS

Monbusho for NEAR-GOOS

ANNEX V

LIST OF ACRONYMS

AAGN	Afro-American GLOSS News
ADCP	Acoustic Doppler Current profiler
AOML	Atlantic Oceanographic and Meteorological Laboratory
AVHRR	Advanced Very High Resolution Radiometer
BAC	Biological Action Centre
BATHY	Bathythermograph Report
BOOS	Baltic GOOS
CalCOFI	California Cooperative Oceanic Fisheries Investigations
CBS	Commission for Basic Systems (of WMO)
CCAMLR	Convention for the Conservation of Antarctic Marine Living Resources
CCCC	Climate Change and Carrying Capacity (PICES)
CEADIR	Central Eastern Atlantic Directory of marine Professionals
CEOS	Committee for Earth Observation Satellites
CERN	European Organization for Nuclear Research
C-GOOS	Coastal Panel of GOOS
CLIVAR	Climate Variability Research Programme
CLS	Collecte-Localisation-Satellites
CMM	Commission for Marine Meteorology
CMSLT	Commission on Mean Sea Level and Tides
COP	Conference of the Parties
CPR	Continuous Plankton Recorder Programme
CSIRO	Commonwealth Scientific and Industrial Research Organization
CTD	Conductivity, Temperature, Depth Instrument
DBCP	Data Buoy Co-operation Panel
DFID	Department for International Development (UK)
DNA	Designated National Agency
EcoFISH	Programme for Ocean Ecosystems Observing and Fisheries Change
ECMWF	European Centre for Medium-Range Weather Forecasts
EGOS	European Group on Ocean Stations
ENSO	El Niño Southern Oscillation
EuroGOOS	European GOOS
EURASLIC	European Association of Aquatic Sciences Libraries and Information Centres
FAO	Food and Agricultural Organization
FCCC	Framework Convention on Climate Change
FNMOC	Fleet Numerical Meteorological and Oceanographic Center
GCOS	Global Climate Observing System
GCRMN	Global Coral Reef Monitoring Network
GDP	Global Drifter Programme
GLOBEC	Global Ocean Ecosystem Experiment
GLODIR	Global Directory of Marine (and Freshwater) Scientists
GLOSS	Global Sea-level Observing System
GODAE	Global Ocean Data Assimilation Experiment
GODAR	Global Oceanographic Data Archaeology and Rescue Project
GOOS	Global Ocean Observing System
GOOS-IOS	GOOS Initial Observing System
GOSIC	Global Observing Systems Information Centre
GOSSP	Global Observing Systems Space Panel
GPA	Global Plan of Action
GPS	Global Positioning System
GSC	GOOS Steering Committee
GST	GODAE Science Team
GTOS	Global Terrestrial Observing System
GTS	Global Telecommunication System (of WMO)

GTSPP	Global Temperature and Salinity Profile Programme
HAB	Harmful Algal Blooms
HOTO	Health of the Oceans
I-GOOS	Intergovernmental Committee for GOOS
IAEA	International Atomic Energy Agency
IAMSLIC	International Association of Aquatic and Marine Science Libraries and Information Centres
IAPSO	International Association for the Physical Sciences of the Ocean
IBTS	International Bottom Trawl Survey
ICES	International Council for the Exploration of the Sea
ICSU	International Council for Science
IDALIC	International Directory of Aquatic Libraries and Information Centres
IFREMER	Institut français de recherche pour l'exploitation de la mer
IGBP	International Geosphere-Biosphere Programme
IGFA	International Group of Funding Agencies for Global Change Research
IGOS	Integrated Global Observing Strategy
IGS	International Global Positioning Service
IHO	International Hydrographic Organization
ILMS	Integrated Library Management System
IMO	International Maritime Organization
IOC	Intergovernmental Oceanographic Commission
IOCARIBE	IOC Sub-commission for the Caribbean and Adjacent Regions
IOCCG	International Ocean Colour Coordination Group
IOCEA	IOC Regional Committee for the Central Eastern Atlantic
IOCINCWIO	IOC Regional Committee foe the Co-operative Investigation in the North and Central Western Indian Ocean
IODE	International Oceanographic Data and Information Exchange Programme
IRD	Institut français de recherche scientifique pour le développement en coopération
IUCN	World Conservation Union
JAFOOS	Joint Australian Facility for Ocean Observing Systems
JAMSTEC	Japan Marine Science and Technology Centre
JDIMP	Joint GOOS, GCOS, GTOS Data and Information Management Panel
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JGOFS	Joint Global Ocean Flux Study
JMA	Japan Meteorological Agency
JTA	Joint Tariff Agreement
KMFRI	Kenya Marine and Fisheries Research Institute
LMR	Living Marine Resources
LOICZ	Land-Ocean Interaction in the Coastal Zone
LUC	Limburg University Centre (Belgium)
MedGOOS	Mediterranean GOOS
MEDATLAS	Mediterranean Atlas
MEDAR	Mediterranean Data Archaeology and Rescue
MEDI	Marine Environmental Data Information Referral System
MEDS	Marine Environmental Data Service (Canada)
MIM	Marine Information Management
NEAR-GOOS	North-East Asian Regional GOOS
NOAA	National Oceanic and Atmospheric Administration (USA)
NODC	National Oceanographic Data Centre
NSCATT	NASA Scatterometer
NTF	National Tidal Facility (Australia)
OAR	Office of Atmospheric Research (USA)
ODINAFRICA	Oceanographic Data and Information Network for Africa
ODINEA	Ocean Data and Information Network for Eastern Africa
ODP	Ocean Drilling Programme
OOPC	Ocean Observations Panel for Climate
OSSE	Observing System Simulation Experiment
PACSICOM	Pan-African Conference on Sustainable Integrated Coastal Management
PAH	Polycyclic Aromatic Hydrocarbon

PALACE	Profiling ALACE (Autonomous Lagrangian Circulation Explorer)
PCB	polychlorinated biphenyl
PICES	North Pacific Marine Science Organization
PIRATA	Pilot Research Array in the Tropical Atlantic
PMEL	Pacific Marine Environmental Laboratory
PROVOR	Profiling MARVOR float
PSMSL	Permanent Service for Mean Sea-level (UK)
POGO	Partnership for Observation of the Global Ocean
QC	Quality Control
RAMP	Rapid Assessment of Marine Pollution
RECOSCIX-CEA	Regional Co-operation in Scientific Information Exchange in the Central Eastern Atlantic
RECOSCIX-WIO	Regional Co-operation in Scientific Information Exchange in the Western Indian Ocean
SAHFOS	Sir Alister Hardy Foundation for Ocean Science
SAR	Synthetic Aperture Radar
SAREC	Swedish Agency for Research Co-operation with Developing Countries
SEAGOOS	Southeast Asian GOOS
SIDS	Small Island Developing States
SIO	Scripps Institute of Oceanography
SISMER	Marine Scientific Information Systems
SOOP	Ship-of-Opportunity Programme
SST	Sea Surface Temperature
SVP	Surface Velocity Programme
SVPBW	SVP barometer and wind drifter
TAO	Tropical Atmosphere Ocean (buoy array)
TESAC	Temperature, Salinity and Currents Report from a Sea Station
TIP	TAO Implementation Panel
TOGA	Tropical Ocean and Global Atmosphere
TOPEX/POSEIDON	Join US/French Ocean Topography Experiment
TRITON	TRIangle Trans-Ocean buoy Network
UHSLC	University of Hawaii Sea-Level Centre
UN	United Nations
UNDP	United Nations Development Programme
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
UOP	Upper Ocean Panel
UOT	Upper Ocean Thermal
VOS	Voluntary Observing Ship
WCRP	World Climate Research Programme
WDC	World Data Centre
WESTPAC	IOC Sub-Commission for the Western Pacific
WIOMAP	Western Indian Ocean Marine Applications Project
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WOTAN	Wind Observations Through Ambient Noise
WWW	World Weather Watch
XBT	Expendable Bathythermograph