

## The Argo management structure

A structural diagram showing relationship of Argo to other International Programmes or Organisations is shown in annex A.

### 1. The Argo programme

The management structure of Argo reflects its dual nature serving both basic oceanographic research and operational oceanography. The World Climate Research Programme's (WCRP, <http://www.wmo.ch/web/wcrp/>) Climate Variability and Predictability Experiment (CLIVAR, <http://www.clivar.org/>), through the CLIVAR Upper Ocean Panel, considered Argo at its April 1998 meeting and endorsed it as an important element of CLIVAR observations. CLIVAR aims to observe the climate system, including the ocean, well enough during a sustained period to understand and model climate-relevant ocean processes. Argo is the only global subsurface element of the observing system. As such it ties together many regional measurements and it enables interpretation of satellite remotely sensed surface fields such as sea level and wind stress. In January of 1998, the Global Ocean Data Assimilation Experiment (GODAE, <http://WWW.BoM.GOV.AU/bmrc/mrlr/nrs/oopc/godae/homepage.html>) recognised Argo as fundamental to its requirement for global ocean observations in support of global data assimilating models. The Argo Network will provide data for GODAE's models as well as for assessment of model performance. It is a transition from research to operational oceanography. With this background, in July 1998 GODAE and the CLIVAR UOP (now COOP) agreed to form an Argo Science Team (see terms of references in annex B).

Argo consists of a broad-scale global array of temperature/salinity profiling floats. It plans to deploy a global array of about 3000 sub-surface profiling floats in the period 2000-2005 at a horizontal resolution of about 3°x3°. Floats measure water temperature and salinity profiles in the upper 2000 meters of the water column. They drift at constant pressure level (some are designed to drift as deep as 2000 metres), and pop up to the surface every 10 day for a short period to transmit the data in real time via satellite.

### 2. The Argo Science Team (AST)

Argo is an internationally coordinated project **managed by the Argo Science Team** (AST, <http://www.argo.ucsd.edu>, see terms of reference and members in annex B). International planning for Argo, including sampling and technical issues, is coordinated by the Argo Science Team. Nations presently having Argo plans that include float procurement or production include Australia, Canada, China, France, Germany, India, Japan, the Republic of Korea, the U.K., and the U.S.A., plus a European Union project. Combined deployments from these nations are planned to exceed 700 floats per year by 2002. Broad participation in Argo by many nations is anticipated and encouraged either through float procurement, logistical support for float deployment, or through analysis and assimilation of Argo data.

Conceptually, Argo builds on the existing upper-ocean thermal networks, extending their spatial and temporal coverage, depth range and accuracy, and enhancing them through addition of salinity and velocity measurements. The name Argo is chosen to emphasise the strong complementary relationship of the global float array with the Jason altimeter mission. For the first time, the physical state of the upper ocean will be systematically measured and assimilated in near real-time. Argo will be, in effect, a real-time, upper-ocean WOCE.

Argo Science Team decided that the data and data products derived from those floats will be **freely available in real-time and delayed mode through IOC and WMO data exchange systems**, as well as other appropriate international mechanisms, and will support operational oceanography and marine meteorology.

International participation in Argo can take on a number of forms. Float production is technically difficult and expensive, so the burden of production or procurement of floats will fall on nations having strong interest and necessary resources. Presently, float-producing nations are the U.S.A. and France, with production facilities also being built in Japan and Canada. The open availability of the design of the Scripps SOLO float enables interested countries, institutions or companies to obtain state-of-the-art profiling float technology. Participation in Argo by

many nations is strongly encouraged, if not via float production or procurement, then through logistical support for float deployments and in establishment of regional analysis, assimilation and prediction centres. Expressions of interest are welcomed by the Argo Science Team (<http://www.argo.ucsd.edu>).

The existence of a comprehensive data system including float tracking and inventories makes it feasible to monitor the Argo array in real time. One aspect of array monitoring will be to identify and correct gaps in global sampling. This will be a responsibility of the Argo Science Team, drawing on the priorities and commitments of participating nations to fill gaps in a timely manner.

The Argo Science Team met in March 1999 and March 2000, and the reports of these meetings (available at <http://www.argo.ucsd.edu>) form the draft Implementation Plan for Argo. The reports discuss the requirements of the global float array, the commitments by float-providing nations, and the technical issues relevant to the profiling float and to its global deployment. The Science Team agreed that float deployments should be planned and coordinated on a regional basis and that the first step in this process should be implementation planning meetings for the Pacific, Atlantic and Indian Oceans. The Pacific meeting was held in Tokyo in April, 2000 and the Atlantic meeting in Paris in July, 2000.

### 3. Argo is a CLIVAR and GODAE project

Argo is a project of (i) the Global Ocean Data Assimilation Experiment (GODAE, see scope of GODAE in annex E) of the Ocean Observations Panel for Climate (OOPC, <http://www.wmo.ch/web/gcos/oopc.htm>, see terms of reference and members in annex D), and (ii) the Ocean Observations Panel (COOP, <http://www.clivar.org/organization/oop/index.htm>, see terms of reference and members in annex C) of the Climate Variability and Predictability programme (CLIVAR):

- **CLIVAR:** Argo is formally endorsed by CLIVAR and falls within the scope of the CLIVAR Ocean Observations Panel (COOP). Within the climate research context set by CLIVAR and the operational estimation objectives of GODAE, the primary practical goal of Argo is to provide an enhanced real-time capability for measurement of temperature and salinity through the upper 2000 m of the ocean and contribute to a global description of the seasonal cycle and interannual variability of the upper ocean thermohaline circulation.
- **GODAE:** Argo is the primary *in situ* data-gathering component of GODAE to contribute to short-term ocean forecasting, to provide boundary conditions for forecasting in coastal areas, and to contribute to seasonal in inter-annual atmospheric forecasts. GODAE will meet the pressing need for: (a) a vastly improved co-operation and integration of remote and *in situ* data streams, and (b) improved ocean models and data assimilation techniques to exploit this information, to meet various kinds of user's requirements, such as the stated requirements of the Conference of Parties to the Framework Convention on Climate Change for observational data to support its needs for monitoring and assessing climate change and its impacts,

Argo will therefore provide a quantitative description of the evolving state of the upper ocean and the patterns of ocean climate variability, including heat and freshwater storage and transport. The data will enhance the value of the Jason altimeter through measurement of subsurface vertical structure ( $T(z)$ ,  $S(z)$ ) and reference velocity, with sufficient coverage and resolution for interpretation of altimetric sea surface height variability. Argo data will be used for initialisation of ocean and coupled forecast models, data assimilation and dynamical model testing. A primary focus of Argo is seasonal to decadal climate variability and predictability, but a wide range of applications for high-quality global ocean analyses is anticipated.

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

### 4. Relationship to GOOS and GCOS

CLIVAR is a major project of the World Climate Research Programme (WCRP). WCRP is sponsored by the World Meteorological Organization (WMO), the Intergovernmental Oceanographic Commission (IOC), and the International Council for Science (ICSU).

GODAE is a project of OOPC. OOPC is a scientific and technical advisory panel of both the Global Ocean Observing System (GOOS, <http://ioc.unesco.org/goos/>), and the Global Climate Observing System (GCOS, <http://www.wmo.ch/web/gcos/>). OOPC reports to the GOOS Steering Committee (GSC, see terms of reference and members in annex F) and to the GCOS Steering Committee (GCOS SC).

GSC, among other things is responsible for all the scientific and technical aspects of GOOS design, undertakes appropriate activities to support the design process, and provides oversight of the implementation process, on the basis of the scientific and technical design, and of intergovernmental requirements and resources as expressed through the Intergovernmental Committee for GOOS (I-GOOS).

GCOS is directed by a Steering Committee which provides guidance, coordination and oversight to the programme. Five panels, reporting to the Steering Committee, have been established to prepare specific programme elements (atmosphere, ocean, land, space-based observations, data and information management) and to make recommendations for implementation. OOPC is one of those Panels.

As a OOPC project, and considering its scale, **Argo is a major pilot project of GOOS and GCOS**. Both GOOS and GCOS are supported by WMO, IOC, ICSU, and the United Nations Environment Programme (UNEP).

## 5. IOC and Argo

At its 20<sup>th</sup> Executive Council, IOC accepted Argo as an important contribution to the operational ocean observing system of GOOS and GCOS, as well as a major contribution to CLIVAR and other scientific research programmes. The Executive Council adopted resolution XX-6 which requires that *“the concerned coastal states must be informed in advance, through appropriate channels, of all deployments of profiling floats which might drift into waters under their jurisdiction, indicating the exact location of such deployments.”*

To meet this requirement, the IOC, with the support from interested Member States, is establishing an international Argo Information Center (AIC) staffed by a Coordinator. The Center which will be located in Toulouse, France, will inform designated contact points in Member States about float deployments, how to track float positions, and how to access float data, in compliance with the IOC Resolution. Before the Argo Coordinator's position is formally established, an interim mechanism was put in place to regularly inform member states about float deployments (<http://argo-forum.jcommops.org>).

The AIC will support the international program in a number of ways, including providing liaison between float-providers and float-deployment opportunities. Argo Coordinator will act as a clearing house for information on all aspects of float use, and promote an improved international dialogue between oceanographers and meteorologists, and between research and operational communities.

## 6. WMO and Argo

At its 13<sup>th</sup> Congress, WMO endorsed Argo as an important component of the operational ocean observing system of GOOS and GCOS, and also as a major contributor to CLIVAR. It requested the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) to address the issue of coordinating Argo with other components of the system, such as the Ship Of Opportunity Programme (SOOP) and the Tropical Atmosphere Ocean array (TAO), and urged Members to participate in, and contribute to, the implementation of Argo wherever possible, in view of its importance to global climate studies.

## 7. JCOMM and Argo

The second transition planning meeting for JCOMM (meeting's final report available at <http://www.jcommops.org/jcomm/jcommtran2/JCOMMTRAN-2-rpt.doc>) agreed that JCOMM would review

progress with the Argo project through its Observations Coordination Group, which would also be charged with developing and overseeing the implementation of procedures for the full integration of Argo into the overall observing system at the appropriate time.

## **8. Data system**

It is envisioned that the resulting temperature and salinity profiles obtained by Argo will be used to (1) initialize climate forecast models, (2) detect and attribute climate change effects on the ocean, (3) calibrate/validate satellite altimetric data, and (4) increase understanding of the ocean and its role in global climate. These objectives demonstrate that ARGO data are to be utilized by both operational and research communities.

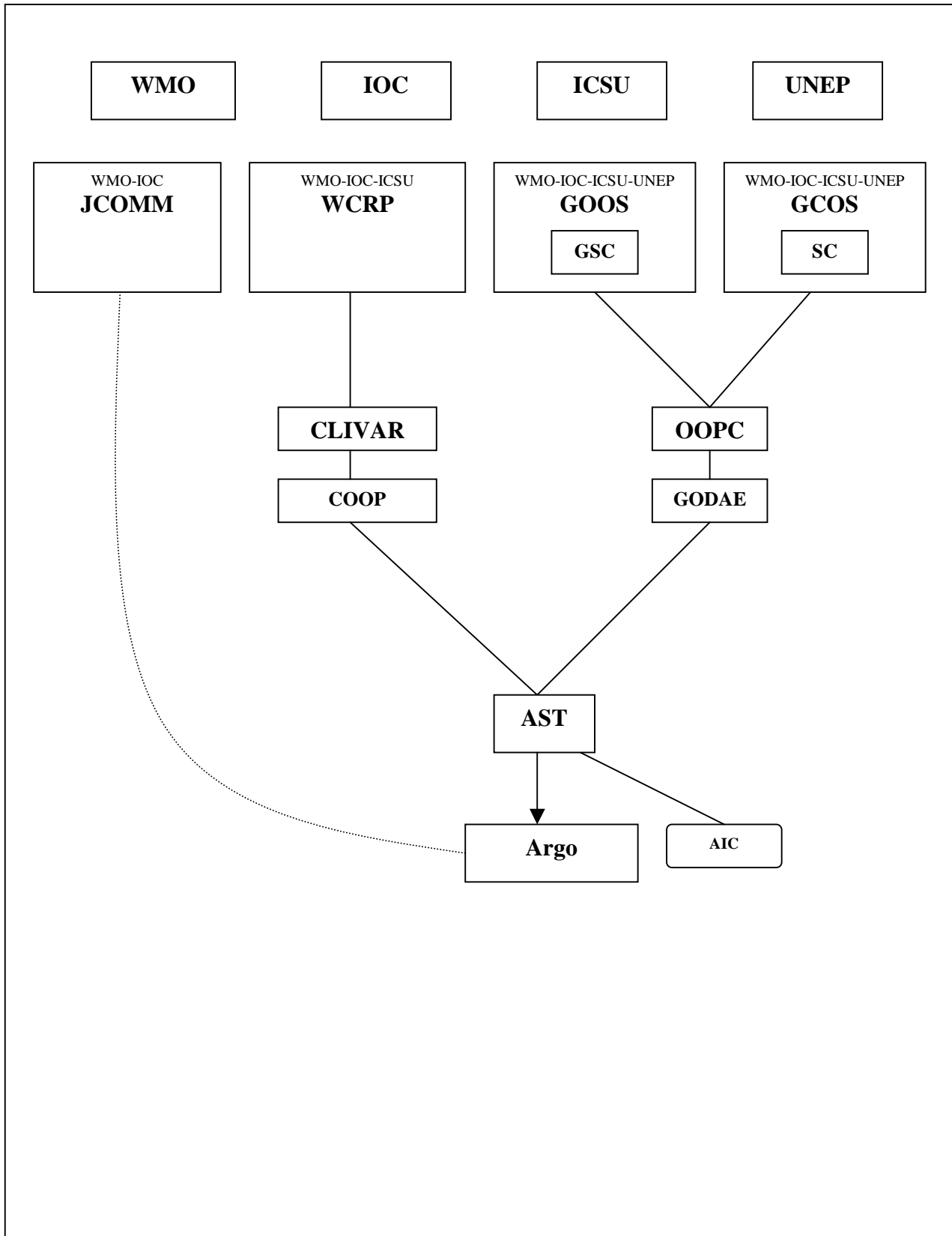
The international and global nature of ARGO dictates that there will be diverse float manufacturers, deployers of floats and centers for data management. Specifically, at least Asian, European, and American Data Centers are planned to manage the data from ARGO (Argo data centres). The ARGO Science Team has stated that, as practical, data processing procedures should be standardized to simplify the tasks of the data users. Regular data exchange among the different centres will take place to keep consistency among data-bases.

To maximize the effectiveness of the ARGO data-set, a Data Management (DM) methodology is required to ensure that high quality information is readily accessible to a wide variety of users in a timely manner. The DM Handbook (DMH) which is now being prepared is one step in achieving this objective. Specifically, the objectives of the DMH are (1) to standardize, as practical, DM procedures among ARGO Data Centers through distribution of accepted procedures and protocols, (2) to provide start-up information for new Data Centers, and (3) to familiarize ARGO data users with DM procedures and standards.

An Argo data management meeting will discuss the details in Brest, 2-6 October 2000, i.e. communication between the various data centres and with the Argo Information Centre, common data exchange format, standardized flag convention, standardized quality control tests, meta-data format, header format, etc.

## Annex A

## Structural diagram showing relationship of Argo to other International Programmes or Organizations



**Annex B**  
**The Argo Science Team**  
(<http://www.argo.ucsd.edu> )

**Terms of Reference**

GODAE and CLIVAR UOP (now COOP) have agreed to form an Argo Science Team with the following Terms of Reference:

- (i) Develop an Implementation Plan for a global network of profiling (temperature and salinity) floats, using the GODAE/UOP Prospectus and Workshop Report as representative of the CLIVAR and GODAE requirements.
- (ii) Provide scientific guidance to, and receive advice from, the Upper Ocean Panel of CLIVAR and the International GODAE Steering Team on the scientific and technical issues associated with the implementation of the profiling float contribution to the sustained (ocean) observing system of CLIVAR and the global ocean climate observing system of GODAE and GOOS/GCOS.
- (iii) Develop an international consortium, to undertake the implementation and maintenance of the global network, and provide advice to the consortium as necessary.
- (iv) Promote and evaluate observing system studies to guide the initial Argo sampling design and to guide the long-term development and evolution.
- (v) Provide advice and guidance technical innovations relevant to the float array.
- (vi) Liaise as appropriate with other groups associated with the (sustained) global ocean observing system, including the ship-of-opportunity program, the tropical atmosphere-ocean array, and remote sensing program such as Topex/Poseidon and Jason.
- (vii) Provide regular reports on progress to the GODAE and CLIVAR International Project Offices.

**Members**

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**Annex C****CLIVAR Ocean Observing Panel**

(<http://www.clivar.org/organization/oop/index.htm>)

**Terms of Reference**

1. To evolve, evaluate, and report to the CLIVAR Science Steering Group (hereafter referred to as the SSG) the implementation strategy for sustained ocean observations to meet the CLIVAR requirements for variability and predictability studies, monitoring and basic research. This strategy should comprise the appropriate mix of measurement platforms and synthesis techniques to determine the full suite of ocean variables, including air-sea fluxes, required by CLIVAR taking into account existing and new technologies and the emerging operational observing systems of the Global Ocean Observing System (GOOS) and the Global Climate Observing System (GCOS) and the deliberations of the Joint Commission on Oceanography and Marine Meteorology and its panels.
2. To study and take action to improve the effectiveness of the ocean observing system to achieve the CLIVAR objectives from measurement to end-user by examining actual data flow and synthesis techniques to produce useful information for the CLIVAR research programmes. This study will include research and, as appropriate, operational data assimilation methodologies, techniques, and products.
3. To study and take action to improve the effectiveness and impact of the ocean observing system to achieve the CLIVAR objectives through liaison with the CLIVAR Working Group on Seasonal-to-Interannual Prediction (WGSIP), the Data Task Team (DTT), the CLIVAR Principle Research Area (PRA) science teams and the various Ocean Basin Implementation panels, as well as other WCRP panels, as appropriate.
4. To work jointly with the WGSIP to determine observational requirements for experimental and operational predictions of ENSO and other predictable components of the climate system and develop a strategy for implementing these requirements.
5. To liaise with GOOS/GCOS and, in particular the Ocean Observations Panel for Climate (OOPC) and the Global Ocean Data Assimilation Experiment (GODAE), in regard to the development of the implementation strategy and evaluation for common elements of the sustained observing system, as well as operational and quasi-operational systems and products.

**Members:**

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**Annex D****The Ocean Observations Panel for Climate**

<http://www.wmo.ch/web/gcos/oopc.htm>

**Terms of Reference**

Recognizing the need for scientific and technical advice and guidance for the common module of the Global Climate Observing System (GCOS) and the Global Ocean Observing System (GOOS), and the need for liaison and co-ordination between these operational observing systems (e.g., systematic, long-term, global climate observations) and those of climate research (e.g., limited-life, hypothesis-validating observations), J-GOOS, JSTC for GCOS and JSC for the WCRP hereby establish an Ocean Observations Panel for Climate with the following terms of reference.

1. To evaluate, modify and update, as necessary, the design of the observing system for the common module of GOOS and GCOS whose goals are:
  - to monitor, describe and understand the physical and biogeochemical processes that determine ocean circulation and its influence on the carbon cycle as well as the effects of the ocean on seasonal to multi-decadal climate change,
  - to provide the information needed for climate prediction.
2. To provide a procedural plan and prioritization for an integrated set of requirements consistent with the observing system design criteria and in a form that enables timely and effective implementation. This will entail drawing from findings of WOCE, TOGA, JGOFS, and CLIVAR, and particularly close interaction with the CLIVAR Upper Ocean Panel (UOP).
3. To liaise and provide advice, assessment and feedback to other panels in task groups of GCOS, GOOS and WCRP, as requested, concerning ocean observing for climate in order to ensure that the designs and implementation schedules are consistent and mutually supportive.
4. To establish the necessary links with scientific and technical groups to ensure that they are cognizant of, and can take advantage of the recommended system, and that, in turn, the Panel can benefit from research and technical advances.
5. To carry out agreed assignments from and to report regularly to the JSTC, J-GOOS and the JSC for the WCRP.

**Members:**

Neville R. SMITH (Chair), BOM/BMRC, Australia  
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## Annex E

### Scope of the Global Ocean Data Assimilation Experiment (GODAE)

(excerpt from the 2<sup>nd</sup> meeting of the International GODAE Steering Team (IGST))

GODAE is to provide a practical demonstration of real-time, global ocean data assimilation in order to provide increasingly precise descriptions of the ocean physical state at high temporal and spatial resolution consistent with a suite of space and direct measurements and appropriate dynamical and physical constraints. The utility of the resulting products to the user community will be a major focus.

The main scientific objectives are:

1. The application of 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.
2. 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 is founded on the belief that such a demonstration is vital to the realization of a permanent, global ocean observing network and prediction system, with all components functional and operating on a global domain and delivering useful products in a timely manner. GODAE is first and foremost dedicated to the development of global systems. It is not a research program, but a practical test of our ability to deliver useful products in a timely manner using state-of-the-art scientific methods. The focus is on the ocean and operational oceanography, not on the coupled ocean-atmosphere or land-ocean systems; but GODAE places great emphasis on links (coastal-open ocean, coupled ocean-atmosphere for climate; physical-biological) as applications for GODAE products. GODAE provides a basis for these extensions.

GODAE has defined a structure built around Patrons and Partners. Central to this structure is the concept of a GODAE "Common" which consists of data, products, processing systems, models and a project office, which is common to and shared by all GODAE Partners. The expectation is that activities undertaken within GODAE will contribute to the development and growth of the Common (for example, through enhanced observational capabilities and management of relevant data and product streams including assessment of the value of processing systems or through the development, testing, and application of assimilation methods for real-time applications). All the products of the Common are to be demonstrably practical, useful, valuable and part of the public domain.

The GODAE time frame is 2003-2005, however it is crucial to begin immediately to put the infrastructure in place and to develop the support necessary for a global experiment. A development phase (now-2000) will begin the process of identifying needed activities, building the GODAE constituency and developing the prototypes for the experiment. A pre-operational phase (2000-2003) will test the systems under operational-like conditions and begin the process of interaction with the user community. The years 2003-2005 constitute the operational phase.

The strategy to realize the global objectives of GODAE includes the development of infrastructure through Pilot Projects -- individuals and groups should be brought together to develop part of the GODAE Common. The Pilot Projects must have goals and outcomes that conform with GODAE objectives and integrally lead to the conduct of the primary global experiment. They should not be merely disjoint contributions to elements of the Common. In particular they need to develop and improve in-situ observing networks, ocean state estimation methodologies, and to be ultimately applied globally. They should provide a first demonstration of the feasibility and value of GODAE by providing both high-level output to the science community and products of societal benefit. It is essential that these Pilot Projects have a critical mass and resources to be effective.

It is anticipated that these Pilot Projects will develop through synergies with other groups/projects with shared or even complementary interests. However, there are certain criteria that GODAE-sanctioned synergistic projects should satisfy to further the GODAE objectives. Such projects should:

- develop techniques essential for the success of GODAE
- develop experience in generation of products that will potentially be useful on a global scale
- develop infrastructure essential for GODAE
- develop links to the wider community to demonstrate the usefulness and societal value of GODAE products
- entrain new people to meet the challenges facing GODAE
- train new students who will be essential for the success of GODAE and its successors garner more support for GODAE
- Some of the scientific and technical challenges facing GODAE are:
  - GODAE as a problem in estimation
  - understanding the impact of the chaotic nature of the ocean on initialization and forecasts
  - dealing with novel data streams and integration of data streams
  - developing appropriate instrumentation, telemetry, communications, and computing facilities
  - assessing accuracy and value of assimilation products

The global objective is a key aspect of GODAE. It should not be viewed as a piecemeal of regional projects. Regional projects should be viewed only as stepping stones to the global system.

The principles governing GODAE are:

- free, open and timely exchange of data and products
- work within existing structures when possible, implement new ones when required
- an R&D program, not a science program
- diversity in applications
- real-time, global objectives

## **Annex F**

### **The GOOS Steering Committee**

#### **Terms of Reference**

1. The GOOS Steering Committee shall:
  - a. be responsible for all the scientific and technical aspects of GOOS design, and undertake appropriate activities to support the design process;
  - b. coordinate and take responsibility for GOOS planning and provide oversight of the implementation process, on the basis of the scientific and technical design, and of intergovernmental requirements and resources as expressed through I-GOOS;
  - c. provide guidance to the Director of the GOOS Secretariat in the duties to be performed by the GOOS Secretariat staff;
  - d. submit reports to the sponsoring organisations and to I-GOOS at appropriate times.
  
2. Specifically, the GOOS Steering Committee will:
  - a. establish subordinate bodies, as appropriate, with as far as possible the chairs being selected from among the membership of the GOOS Steering Committee;
  - b. identify observational requirements ("user needs") and products in co-operation with I-GOOS; define design objectives; and recommend co-ordinated actions by the sponsoring organisations and other relevant organisations and agencies;
  - c. advise the Intergovernmental Committee for GOOS (I-GOOS) on all scientific and technical aspects of GOOS as well as on resource requirements, and take into account the proposals of I-GOOS in this regard;
  - d. collaborate with the steering committees of the other global observing systems (GCOS and GTOS) and with other appropriate bodies;
  - e. review and assess the progressive development and implementation of the components of GOOS;
  - f. identify and encourage research efforts, in close co-operation with the on-going research programmes (such as IGBP and WCRP) in order to promote studies of importance for the development of GOOS;
  - g. encourage the development of new technologies needed for GOOS.

#### **Members**

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