JCOMM OPERATING PLAN

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JCOMM Operating Plan
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Executive Summary

The Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) was established in 1999 in order to ensure that all the elements necessary for an internationally coordinated, operational, comprehensive Global Ocean Observing System (GOOS) are put in place and adequately funded. The system will be end-to-end, from maintaining observing systems of in situ and air- and space-based instrumentation to data collection and archiving, standards and quality control and finally to the real-time delivery of data and services to all users. Together with the marine meteorology part of the World Weather Watch, the system will meet critical societal goals as identified by the Global Climate Observing System (GCOS) and the Group on Earth Observations (GEO).

Parts of such a global system are in place today, some coordinated by international bodies such as WMO and IOC, some coordinated by regions or groups of nations, and some coordinated by nations and sub-national regions. But although the coverage of observations reaches close to half of what is needed, the full delivery of data and services and the global coordination and sustainability of funding still fall far short of that required by a global society vulnerable to ocean and weather-related disasters and human-induced climate change.

The goal of JCOMM is to identify and coordinate all of the necessary sub-systems as a coherent whole and to ensure that nations are aware of and commit to the necessary funding for the full system. For this reason, JCOMM has prepared a Strategic Plan (2007) which organizes the work into three Programme Areas: Observations, Services, and Data Management, together with a Communications Plan to build awareness of needs both inside the management and coordination institutions and outside with the users and general public. The Programme Areas are formally organized with expert teams and have been active with meetings, workshops, and pilot projects in setting standards, identifying needs for quality control, and outlining funding and other resource requirements. Each of the Programme Areas is developing a plan that documents the progress that has been made in implementing the needs that have been identified by JCOMM as well as the parent organizations and member states.

The goal of this document, the JCOMM Operating Plan (JCOMM OP V1.0), is to bring together, in the context of the Strategic Plan, the current Programme Area and Communication Plan goals and action items into a single overall document that shows how JCOMM operates and actions and progress to date.

This Operating Plan has thus been compiled from the existing material on priority items that has been prepared for the Programme Areas (PAs), the communications plan, and from other descriptive material available from the JCOMM and associated web sites. The Operating Plan is organized to start with introductory chapters on objectives, drivers, and benefits, followed by a chapter on programme management that outlines how JCOMM operates. This chapter is followed by chapters on the specific priorities and action items from each of the Programme Areas and the Communications Plan, and then chapters on external interactions and on how JCOMM will evolve into the future. A brief history, the terms of reference for JCOMM, and acronym definitions are provided in the Annexes.

The Operating Plan also addresses, in each programme area, the necessary supporting activities necessary to make the system responsive so that adequate data and services can be delivered. Roughly 50% of the necessary observing system is now in place; it is supported mostly with short-term funding. An important goal of JCOMM is to make sure that the remaining 50% is put in place, that the associated services are delivered, and that adequate long-term funding is found for the entire system. It is also important to note that JCOMM has expressed a willingness to consider the conditions under which it could take on the oversight and coordination of non-physical observations, data management, and services.

Funding is an important aspect of operations, and generally must come from member states. This Operating Plan addresses some of the funding issues. It is abundantly clear that without adequate
funding, the system will not be able to deliver, with the needed spatial and temporal coverage, the data and services desired and required. Moreover, if member states do not commit to continual and long-term funding, then WMO and IOC cannot guarantee that data will be available. Without such a guarantee, it is unlikely that the private sector will plan for any activities that require such a data stream.

Identification of risks also is a key to implementation. This includes the risks of not being able to deliver the promised information as well as funding to establish systems. In some cases, the risk depends on existing instrument reliability and in some cases new instrumentation is required to deliver the service proposed. There are engineering design risks as well as funding risks. Since instruments in the ocean most often face a hostile environment, the failure rate of instruments, their longevity, and the communications systems are all part of the risks of implementation. Some risk issues are discussed in this operating plan.

Finally, essential and key roles of JCOMM are coordination and communication. In the end, member states are responsible for establishing, maintaining, and upgrading systems for observations, service provision and data archiving. This operating plan shows how JCOMM coordinates these systems, how international data centres are maintained, and how data links are kept operating. JCOMM maintains strong external interactions as noted in the Programme Area chapters, and also provides a venue for users to discuss on-going and new services needed and for researchers to offer new ways to meet the needs of users. The JCOMM Communications Plan, summarized here, is an essential element of JCOMM’s connections to the broad set of users both inside and outside JCOMM.

The final chapter on evolution emphasizes that the JCOMM Operating Plan is a living document, in the sense that it will change as programmes plans evolve and commitments are developed. This Version 1.0 was approved at the sixth JCOMM Management Committee in December 2007 pending some editorial revisions. Version numbers will increase by one whole number as major revisions are made, by tenths as minor revisions are incorporated. Each version number will be associated with a unique date.

1. Introduction: JCOMM and its Operating Plan

1.1 WMO, IOC, and JCOMM

The Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology, known by the acronym JCOMM, is an intergovernmental body of experts that provides the mechanism for international coordination, regulation and management of oceanographic and marine meteorological observing, data management and services systems. The creation of this Joint Technical Commission results from a general recognition of the growing dependence of global society on the ocean, the atmosphere above it, and the resources it contains. Long-term sustained observations in the open ocean, at the coast, and in the marine atmosphere are needed in order for society to deal with this part of the environment which covers 70 percent of Earth and can influence all of Earth. The history of the establishment of JCOMM is summarized in Annex A1.

To coordinate and carry out the necessary observations, a combination of national support and international coordination is required. JCOMM has been established to meet those goals of support and coordination. Clearly, a successful JCOMM is an ambitious and complex endeavour. It holds the prospect of considerable potential benefits to all countries in the long-term operation of a coordinated, integrated, global oceanographic and marine meteorological observing, data management and services system.

JCOMM coordinates, regulates and manages a fully integrated marine observing, data management and services system that uses state-of-the-art and next-generation technologies and capabilities, is responsive to the evolving needs of all users of marine data and products, and
includes an outreach programme to enhance the national capacity of all maritime countries. It works closely with partners including the International Oceanographic Data and Information Exchange (IODE), the Global Ocean Observing System (GOOS), and the Global Climate Observing System (GCOS), and coordinates the implementation of the WMO's Marine Meteorology and Oceanography Programme. JCOMM aims to maximize the benefits for its Members/Member States in the projects, programmes and activities that it undertakes in their interest and that of the global community in general.

1.2 The Long-Term Objectives of JCOMM

The overall goal of JCOMM is to ensure a well functioning and fully implemented Global Ocean Observing System and associated parts of the World Weather Watch. Successful implementation will ensure that high quality and widely used marine meteorology and ocean services will address the societal needs that have been identified by the Global Climate Observing System (GCOS) and the Group on Earth Observations (GEO).

The specific long-term objectives of JCOMM are:
(i) To enhance the provision of marine meteorological and oceanographic services in support of the safety of navigation and safe operations at sea; contribute to risk management for ocean-based economic, commercial and industrial activities; contribute to the prevention and control of marine pollution, sustainable development of the marine environment, coastal area management and recreational activities, and support of the safety of coastal habitation and activities; and to coordinate and enhance the provision of the data, information, products and services required to support climate research and the detection and prediction of climate variability;

(ii) To coordinate the enhancement and long-term maintenance of an integrated global marine meteorological and oceanographic observing and data management system, containing both in situ and remote sensing components and including data communication facilities, as part of the Global Ocean Observing System (GOOS) and the World Weather Watch (WWW), and in support of the World Climate Programme (WCP), the World Climate Research Programme (WCRP), the Global Climate Observing System (GCOS), and other major WMO and IOC Programmes;

(iii) To coordinate and regulate the maintenance and expansion of a comprehensive database of marine meteorological, oceanographic and sea ice data, in support of marine services, operational meteorology and oceanography and the WCP;

(iv) To manage the evolution of an effective and efficient programme through the selective incorporation of advances in meteorological and oceanographic science and technology; and to work to ensure that all countries have the capacity to benefit from and contribute to these advances.

1.3 The JCOMM Operating Plan and Programme Areas

The implementation of JCOMM's programme will be a long-term, complex process, necessitating a phased, iterative and cost-effective approach over the decades to come.

This operating plan shows how a worldwide improvement in coordination and efficiency may be achieved by combining the expertise and technological capabilities of the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC). JCOMM is divided into three Programme Areas (PAs): Observations (OPA), Services (SPA), and Data Management (DMPA). Each of these has a number of expert teams or coordination groups to oversee particular activities. Satellite requirements and capacity-building are cross-cutting themes across the PAs. This Operating Plan has been compiled in large part from the operating and implementation plans for the component JCOMM Programme Areas.

The Operating Plan illustrates how, through the Programme Areas, JCOMM is already coordinating the development and implementation of operational oceanography on the basis of
designs and requirements expressed by the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS), the International Convention for the Safety of Life at Sea (SOLAS) and other international treaties and conventions that rely on oceanic and marine meteorological data.

The Operating Plan builds on the Strategic Plan – which outlines goals and directions – showing how JCOMM is currently operating. The Operating Plan lays out the overall goals, the specific objectives, goals and targets, with milestones to be met along the way, together with responsible parties and institutions. To the extent that information is available, the plan indicates that funding is required for work necessary to meet the goals and what specific products will be made available. The plan discusses in broad terms some of the risks faced in meeting the goals. The plan includes the themes covered in the JCOMM Strategy Document, including in particular issues relating to specific implementation targets and performance evaluation.

The overall JCOMM management strategy that has been developed takes a pragmatic approach, designed to encourage creative synergies and knowledge amongst governments, the international community, donors and the private sector, and to foster increased national support in terms of experts, in-kind resources, and funding. Implementation of the JCOMM work programme is the responsibility of the subsidiary expert teams and pilot projects in collaboration with national and international institutions. All of this is done in collaboration with other programmes. Due to the complex nature of the systems operated across the world, the management and coordination process requires a phased, iterative and cost-effective approach. Through the work programme of JCOMM, the long-term operation of a coordinated, integrated, global oceanographic and marine meteorological observing, data management and services system will become a reality providing many potential benefits to all countries.

Updates in the overall JCOMM work programme will be based on changes in requirements, emphasis, priorities and resources within JCOMM. JCOMM receives scientific advice from WMO programmes, GCOS, and from the GOOS Science Steering Committee (GSSC) and its subsidiary bodies the Ocean Observations Panel for Climate (OOPC) and the Panel for Integrated Coastal Observations. The procedures by which the work programme for JCOMM is developed, modified and implemented are detailed in Section 3 of this plan.

2. Driving Forces and Benefits of JCOMM

2.1 Driving Forces

Driving forces for a successful JCOMM come from its sponsoring bodies, the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC). JCOMM is the central critical element in the implementation of the Global Ocean Observing System and the oceanic part of the Global Climate Observing System and the Global Earth Observing System of Systems. In addition, the work of JCOMM will contribute substantially to the success of WMO’s World Weather Watch (WWW), WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS); the International Convention for the Safety of Life at Sea (SOLAS); and all of the other international treaties and conventions that rely on accurate, near-term and long-term oceanic and marine meteorological data. To show the range of driving forces for JCOMM, the objectives and benefits of these organizations are summarized below.

2.11 WMO and its Subsidiary Programmes

The goals of WMO are to produce more accurate, timely and reliable forecasts and warnings of weather, climate, water, and related environmental elements, to improve the delivery of environmental information and services to the public, governments and other users, and to provide scientific and technical expertise and advice in support of policy and decision-making and implementation of the agreed international development goals and multilateral agreements.

WMO meets these goals with several strategic thrusts: Science and Technology Development and Implementation, which enhances the capabilities of members to produce better weather, climate,
and hydrological forecasts and assessments. *Service Delivery* enables Members to improve multi-hazard early warning and disaster prevention and preparedness. *Partnership* enables broader use of weather, climate and water outputs for decision-making and implementation, and *Capacity Building* improves the capability of Members in developing countries to fulfill their mandates. The WMO Strategic Plan includes maintaining the World Weather Watch (WWW) as well as the need for the establishment of the WMO Integrated Global Observing System (WIGOS) and the WMO Information System (WIS). Later chapters in this operating plan will show how JCOMM helps WMO meet these needs.

**World Weather Watch**
Established in 1963, the World Weather Watch—the core of the WMO Programmes—combines observing systems, telecommunication facilities, and data-processing and forecasting centres (operated by Members) to make available meteorological and related environmental information needed to provide efficient services in all countries. Through the WWW, WMO Members coordinate and implement standardization of measuring methods and techniques, common telecommunication procedures, and the presentation of observed data and processed information in a manner which is understood by all, regardless of language. These arrangements, as well as the operation of the WWW facilities, are coordinated and monitored by WMO with a view to ensuring that every country has available all of the information it needs to provide weather services on a day-to-day basis as well as for long-term planning and research.

**WMO Integrated Global Observing System (WIGOS) and WMO Information System (WIS)**
The Fifteenth WMO Congress, held in May 2007, agreed that better coordinated and more streamlined international management mechanisms should be achievable through enhanced integration and should result in important enhanced benefits for Members and their national services and for the Organization as a whole. WIGOS combined with WIS should result in a comprehensive, coordinated and sustainable system of observing systems through ensured interoperability between component systems. The benefits from integration include: reduced financial demands on Members; increased availability of required information; improved access; higher data quality standards; and archiving and technological innovations. Congress envisaged that the integration process would encompass four broad objectives: improve management and governance; increase interoperability between the various systems; address atmospheric, oceanic and terrestrial including hydrological domains as a comprehensive total system; and ensure that broader governance frameworks and relationships with other international initiatives are respected, sustained and strengthened.

2.12 IOC and GOOS
The purpose of IOC is to promote international cooperation and to coordinate programmes in marine research, services and capacity building. The goals are to learn more about the nature and resources of the ocean and coastal areas and to apply that knowledge for the improvement of management, sustainable development, the protection of the marine environment, and the decision-making processes of its Member States. IOC seeks to prevent and reduce the impacts of natural hazards, to help society mitigate and adapt to climate change and variability, to safeguard the health of oceans ecosystems, and to establish the management procedures and policies leading to the sustainability of coastal and ocean environment and resources.

IOC advocates, promotes and coordinates international research in ocean sciences, and maintains and nurtures a strong link with the scientific community and supports its work at the intergovernmental level. It is the leading international organization in facilitating worldwide cooperation in ocean observing networks, in promoting the establishment and maintenance of communication systems for the rapid exchange and distribution of ocean data and information. IOC has been a leader in measurements of sea level through the GLOSS programme and in monitoring warning and mitigation for Tsunamis through its Tsunami Programme.

Since 1991, IOC has integrated a wide range of global and coastal measurements into the Global Ocean Observing System (GOOS). GOOS is a global system for sustained observations of the ocean, including the oceanographic component of the Global Climate Observing System (GCOS)
and the Global Earth Observing System of Systems (GEOSS). GOOS is sponsored by IOC, UNEP, WMO and ICSU, and is implemented by member states via their government agencies, navies and oceanographic research institutions working together in a wide range of thematic panels and regional alliances. GOOS receives scientific and technical advice through the GOOS Science Steering Committee (GSSC) which also advises JCOMM. One of the sub-committees of the GSSC, the Ocean Observations Panel for Climate, also advises GCOS (see Section 2.14).

IOC supports ocean services, i.e., the continuous, routine delivery of information products containing current or forecasted conditions for a given set of ocean properties, which are produced and distributed free as public services for the use of a wide range of users. See Chapter 5 of this document for examples of current public service operations supported by IOC and WMO through JCOMM. For ocean data management and exchange, and consistent with its international public service mission, all data collected by Member States as part of IOC Programmes and activities are subject to free and open exchange under the current IOC Data Policy. New automated systems deployed over the whole world ocean are providing a data stream never attained before in history. Organizing the necessary technological networks, collaborating with WMO and using its Global Telecommunications System (GTS) system, IOC has significantly closed the gap between the traditional delayed mode exchange of data (weeks to months) and real-time exchange of data.

2.13 SOLAS
The International Convention for the Safety of Life at Sea (SOLAS) in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant ships. The main objective of the SOLAS Convention is to specify minimum standards for the construction, equipping and operation of ships compatible with their safety. The convention identifies navigation safety services which should be provided by Contracting Governments and sets forth provisions of an operational nature applicable in general to all ships on all voyages. The subjects covered include the maintenance of meteorological services for ships, the ice patrol service; routing of ships, and the maintenance of search and rescue services. JCOMM observations and services apply to all of these areas.

2.14 GCOS
GCOS is a long-term, user-driven operational system capable of providing the comprehensive observations required for monitoring the climate system, for detecting and attributing climate change, for assessing the impacts of climate variability and change, and for supporting research toward improved understanding, modeling and prediction of the climate system. It addresses the total climate system including physical, chemical and biological properties within atmospheric, oceanic, terrestrial, hydrologic, and cryospheric components.

GCOS builds upon, and works in partnership with, other existing and developing observing systems such as the WMO Global Observing System and Global Atmosphere Watch, the Global Ocean Observing System and the Global Terrestrial Observing System. It includes in situ, airborne and space-based observational components. GOOS is expected to include the oceanic component of GCOS. The GCOS Secretariat is located at the WMO headquarters in Geneva, Switzerland, and supports the activities of the Steering Committee, the panels and the GCOS programme as a whole.

2.2 Benefits of Successful Implementation

2.21 General Benefits: Global Earth Observation System of Systems (GEOSS)
The best description of general benefits from an observing system for an implementing body like JCOMM comes from the Global Earth Observation System of Systems (GEOSS). The goal of GEOSS is to realize a future wherein decisions and actions for the benefit of humankind are informed via coordinated, comprehensive and sustained Earth observations and information. GEOSS builds on and adds value to existing Earth-observation systems by coordinating their efforts, addressing critical gaps, supporting their interoperability, sharing information, reaching a common understanding of user requirements, and improving delivery of information to users. It
works with and builds upon existing national, regional and international systems, such as GOOS and GCOS. GEOSS is coordinated by the intergovernmental Group on Earth Observations (GEO).

GEOSS, and by inference JCOMM in its more limited sphere, will yield a broad range of societal benefits, including:

- Reducing loss of life and property from natural and human-induced disasters.
- Understanding environmental factors affecting human health and well-being.
- Improving management of energy resources.
- Understanding, assessing, predicting, mitigating, and adapting to climate variability and change.
- Improving water resource management through better understanding of the water cycle.
- Improving weather information, forecasting and warning.
- Improving the management and protection of terrestrial, coastal and marine ecosystems.
- Supporting sustainable agriculture and combating desertification.
- Understanding, monitoring and conserving biodiversity.

2.22 Specific Benefits

JCOMM offers benefits to Members/Member States of the Commission, or potential Members, that are tangible and of direct use. In this operating plan, the chapters on observations, services and data management go into greater detail, but examples of benefits include the timely delivery to national agencies (and sometimes directly to middle or end users) of integrated streams of high quality ocean data and metadata, support of the provision of operational oceanographic products and services, a range of operational oceanographic products prepared and made freely available by designated specialized centres, and direct and indirect support for developing countries to enhance their capacity to benefit from available operational ocean data and products.

Members/Member States of JCOMM, and indeed the global community in general, are recipients of the benefits. Even if a country is unable to participate as a Member State of WMO or IOC, benefits nevertheless accrue. One of the purposes of this document is to demonstrate how such countries, by participating in the program areas of JCOMM, can influence JCOMM evolution and the services/deliverables on which it focuses. In operational meteorology, the potential contributions to and benefits for all countries from a global system such as the WWW are evident (e.g., through accurate and timely meteorological warnings and forecasts) and directly related to national concerns and responsibilities.

But due to lack of knowledge and participation in JCOMM programmes, many countries are not aware of the importance of operational oceanography and marine meteorology and the work of JCOMM. In order to facilitate non-Member states’ involvement, JCOMM uses a more regional approach when interacting with Members/Member States, via the WMO Regional Associations, IOC Sub-Commissions and GOOS Regional Alliances. In this way, JCOMM will have a better chance of developing relationships with non-Member countries and communicating the potential benefits to them. Such an approach is reflected in both the JCOMM Strategy and the Operating Plan.

3. General Programme Management

3.1 JCOMM Structure and Governance

3.11 General Governance

As formally constituted, JCOMM is an intergovernmental body of experts, and is the major advisory body to its two parent Organizations WMO and IOC (consisting of their Members/Member States, Governing Bodies and other subsidiary bodies and programmes) on all technical aspects of operational marine meteorology and oceanography. In fulfilling this role, it is expected to prepare plans, proposals, regulations, guidance etc, within its field of competence, for consideration and
approval by the Governing Bodies. Following such approval, there is an obligation on Members/Member States to apply and implement these plans and proposals. However, it is also important to understand that JCOMM is a technical body and not a commitments mechanism.

The Commission itself and its subsidiary bodies normally meet at regular intervals (currently set at four-year intervals) as dictated by the requirements of the work programme. The work programme is recommended by the co-presidents and other members of the Management Committee and by JCOMM in session and approved by the Governing Bodies of WMO and IOC. Meetings of the Commission are normally financed through the regular budgets of WMO and IOC, supplemented where possible and necessary by extra-budgetary funds and various "self-financing" mechanisms.

The JCOMM structure, shown diagrammatically in Figure 3.1, is approved by the Commission. The Terms of Reference are given in Annex 2. JCOMM has a current membership of approximately 250 experts, with most national delegations comprising roughly equal numbers of oceanographers and marine meteorologists. JCOMM is co-chaired by a meteorologist and an oceanographer, reflecting JCOMM’s integrated responsibilities for meteorological and oceanographic programmes. Between sessions of the Commission, the responsibility for the management of JCOMM is vested with the co-presidents with advice from the Management Committee and support from the JCOMM Secretariat.

![Figure 3.1. The structure of the WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM)](image)

The structure of JCOMM Programme Areas is intended to facilitate the delivery of JCOMM's mandated responsibilities by subdividing them into logical and coherent groupings. The work of the Commission is split into three programme areas (PA's): Observations programme area (OPA), Data Management programme area (DMPA) and Services programme area (SPA), as well as two Cross-cutting Teams on Capacity Building and on Satellite Data Requirements.

### 3.12 The Management Committee

The Management Committee presently consists of the 2 co-presidents, the coordinators of the 3 Programme Areas, representatives of the 2 major cross-cutting activities and several additional experts, as well as the chairs (or their representatives) of the GOOS Scientific Steering Committee.
(GSSC), the GCOS Steering Committee and the IOC Committee for IODE. Other experts are invited to the Management Committee meetings as needed.

The Management Committee advises the co-presidents. It is both tactical and strategic. It is charged with overseeing the operations of JCOMM as well as the implementation of the JCOMM work programme agreed by the Commission in session, as well as any adjustments to this programme and associated subsidiary body structure as the work progresses. It develops a conceptual and strategic approach to fulfilling the JCOMM mandate, and it drafts future plans and programmes for the Commission to consider. It organizes liaison with and reporting to the IOC and WMO Governing Bodies, as well as with external bodies and programmes, and it deals with a number of additional cross-cutting issues such as communication and outreach.

3.13 Programme Areas

Under the overall direction of the Management Committee chaired by the co-presidents, the Commission is organized into three Programme Areas: Observations (OPA), Data Management (DMPA) and Services (SPA), together with two cross-cutting activities: capacity building and satellite data requirements. Each Programme Area is, in turn, managed by a Coordinator with support from a small coordination group and with specific activities being undertaken by designated teams or panels of experts. The establishment of these three Programme Areas is intended to facilitate the delivery of JCOMM's mandated responsibilities by subdividing them into logical and coherent groupings. The Terms of Reference for JCOMM and its Programme Areas are given in Annex 2.

Each PA has a set of subsidiary expert teams (ETs) and task teams (TTs). The Observations Programme Area (OPA) and associated teams focus on the sustained development and collection of meteorological and oceanic observations to support Member/Member State activities. The Services Programme Area (SPA) and associated systems focus on the application of these observations within operational systems that generate products (climatologies, analyses, hindcasts and forecasts) using advanced ocean model and synthesis systems. The Data Management Programme Area (DMPA) is concerned with developing and monitoring new standards for data product formats, distributed data management systems, communication protocols, data base formats, quality control and marine climatology (among others). The DMPA ‘bridges the gap’ between the SPA and the OPA and has a central role to play in terms of providing interfaces to data (in situ observations, satellite observations), ocean model outputs (analyses, hindcasts and forecasts, including observation input to assimilation systems etc.), data providers and the user community. Data management standards and protocols for ocean model outputs are rapidly evolving and the DMPA has a key role in terms of ensuring that interoperability and data management standards are adhered to at an international level (especially important when integrating the outputs of several national systems in critical applications and inter-comparison projects).

JCOMM does not itself conduct research, develop models or serve products and provide services. Instead, it coordinates and facilitates the operational implementation and dissemination of data, proven models, products and services. Through its work, JCOMM aims to reduce duplication of effort and instead develop operational robustness within systems that serve a variety of national, regional and international users. Part of this process is the implementation and maintenance of a JCOMM Products Web Portal that can showcase exemplary products and services and provide links to operational systems.

JCOMM activities also include user interactions, guidance and standards for quality assurance, and standards issues related to the definition and delivery of products and services. The applications that JCOMM must consider have a large range, from ocean state variables forecasts to complex decision making tools and systems requiring state of the art inputs (e.g., current, wind, sea ice, waves, storm surges etc) such as ship routing, engineering design, search and rescue or oil spill management tools. Crosscutting activities were developed at JCOMM-II: one for capacity
building and one for satellite data requirements. This structure fosters a comprehensive view of JCOMM satellite data requirements and capacity building requirements.

3.2. Management and Implementation

3.21 The JCOMM Secretariat
The Secretariat responsibilities of JCOMM are undertaken jointly by its parent bodies. This falls under the Marine Meteorology and Oceanography Programme at WMO and under the GOOS Project Office and the IODE and TEMA Secretariats at IOC. The composition of the Secretariat and the division of responsibilities is specified in detail in a formal Memorandum of Understanding between WMO and IOC.

3.22 JCOMM in Session
WMO and IOC have approved a meeting frequency of 4 years for the formal JCOMM Sessions, alternately funded by the two organizations. These Sessions provide a forum for JCOMM officers to present to the Members/Member States the status of JCOMM development, its successes and failures, challenges and work plan for the next inter-sessional period. It also provides an opportunity to adjust the JCOMM structure to meet the evolving requirements and to align the skill set in the JCOMM groups to such requirements. Intersessional activities are overseen by the JCOMM Management Committee.

3.23 Implementation of JCOMM Activities through Pilot Projects and Science and Technology Workshops and Conferences
An important aspect of JCOMM's work is the use of pilot projects and workshops to test feasibility of concepts and new ideas. The use of these is discussed in more detail in the programme area chapters, but for completeness, a definition of each is provided here:

A “pilot project” (using the definition in widespread use in GOOS; the term “demonstration project” is also used for this) is defined as an organized, planned set of activities, with focused objectives, designed to provide an evaluation of technology, methods or concepts, within a defined schedule and having an overall goal of advancing the development of the sustained, integrated ocean observing system. Once a project has been identified as a potential JCOMM pilot project, a process will be established for the relevant Programme Area to liaise with the project leader to ensure that JCOMM will benefit from and contribute to that project.

Science and technology workshops and conferences allow developers and stakeholders to participate in the development of new technologies, modeling systems, methodologies and procedures relevant to JCOMM and in the performance evaluation of current ones. Specialized workshops may be organized in coordination with the meetings of the expert teams or by co-sponsoring workshops organized by other scientific and technical groups. Stand-alone workshops and conferences may also be organized to address specific topics.

3.24 Reporting to the Parent Bodies
JCOMM is a major subsidiary body of IOC and WMO and as such must report to the Executive Council and Congress/Assembly of each of these Organizations, which implies annual reporting. These reports should include the progress made during the reporting period, the work plan for the following year and the current and expected challenges. It is just as important to showcase the successes as to inform on the obstacles for JCOMM implementation. The JCOMM Secretariat supports the implementation of the work plans and develops an appropriate budget for this purpose, to be included in the IOC and WMO budget process. This budget should, inter alia, fund meetings of the Commission and its subsidiary bodies, as proposed by JCOMM and the Management Committee and approved by the Governing Bodies of WMO and IOC.

3.3 Monitoring and Evaluation
The WMO strategy has provided general guidance for monitoring and evaluation which are important tools in results-based management to help improve performance and achieve results.
JCOMM will use this guidance for both overall and for specific Programme Area monitoring and evaluation. Continuous monitoring of WMO strategic thrusts and initiatives are carried out through the WMO Operating Plan, which assesses the effectiveness of the implementation strategies in tackling the constraints to achieve the Expected Results. Monitoring outcomes in addition to programme outputs is particularly important for assessing the effectiveness of WMO scientific and technical programmes. This requires ability to track the outputs of activities and measure their contributions to outcomes by assessing periodic change. Monitoring is thus a critical input to the overall performance of the Plan.

By monitoring programme activities as well as changes in the external situation that may affect programme performance, it will be possible to conduct routine evaluations of the effectiveness of JCOMM strategy and implementation. The evaluations will take place at regularly scheduled times.

3.31 Reviews
Reviews and performance evaluation will be done in a top-down and bottom-up process. The Management Committee will review the progress of JCOMM annually and will adjust its work plans in response to input from its advisory or associated groups such as the GSSC, the GCOS Steering Committee and IODE, as well as from its parent bodies IOC and WMO. The changes in the work plan of the Management Committee will be reflected in the work plans of each programme area coordination group, which are expected to meet at a frequency of about two years. In turn, each of the expert teams and task teams will meet at appropriate intervals, but typically at least every two years, to review the progress of its activities and align its work plans. Similarly, any new requirements identified by the expert and task teams will be reviewed and approved as appropriate by the coordination groups and the Management Committee and will be integrated into the work plans of the relevant groups. The Management Committee will adjust the meeting schedules of JCOMM subsidiary groups to be responsive to the requirements, subject to funding levels.

3.32 External Review
The reviews mentioned above are either carried out internally by the JCOMM groups or by the Commission in session based on the information presented to it by its officers and subsidiary bodies. The parent bodies must ensure that JCOMM is periodically reviewed by an external group of experts approximately every eight years and the findings reported to every alternate session, to ensure that JCOMM is best aligned to the requirements identified by its parent bodies and its clients.

In addition, JCOMM must develop and maintain close links to and feedback mechanisms with major external bodies representing the users of JCOMM data, information, products and services, including, inter alia, other programmes and subsidiary bodies of WMO and IOC, research programmes and the representatives of different user communities. Such mechanisms and feedback, at regular and frequent intervals, are essential to ensure that JCOMM supports and is responsive to all such user requirements.

3.33 Performance Evaluation
An integral part of any programme has to be the performance evaluation of its components. For an organization or body such as JCOMM, with its many programme activities and links with many organizations, such evaluation has to occur at many levels. In addition, JCOMM has to be able to evaluate and take account of user response to and satisfaction with its data, products and services. This can be done primarily through the maintenance of close relations with organizations representing major user groups, such as the International Maritime Organization or the energy producer groups.

The JCOMM Programme Areas have (or will have) mechanisms to evaluate performance, “compliance” and satisfaction with information or data from its stakeholder or client groups. Existing examples include the regular marine meteorological services user surveys within the SPA, and the observing system performance metrics already implemented by components of the OPA. Further, there must be enough expertise in the technical groups to give the PA Coordinators at least first order advice about whether targets are within reach or not. Other WMO Technical
Commissions undertake extensive surveys to determine more quantitatively what the requirements of Members and client groups are, and their perceptions on how well they are being met. JCOMM must adopt a more structured and holistic approach to this type of process, under the auspices of the Management Committee, to provide regular feedback to the extent possible. The surveys should take into account the work plan and dimensions established by the stakeholders.

3.4 Capacity Building

JCOMM will assist countries to enhance their capacities in marine data collection, data management and provision of marine meteorological and oceanographic services. Building capacity is a high priority activity directed at ensuring that maritime nations can not only contribute meaningfully to JCOMM's various programmes but also gain optimum benefits from the global system. The Capacity Building activity, in direct consultation and cooperation with the three Programme Areas, has the mandate to coordinate the delivery of training, facilitate the transfer of technology, assist in providing equipment, and work closely with the capacity building programmes of donor countries and other UN Agencies. In structural terms, the JCOMM Capacity Building activity is supported by and delivered through three Capacity Building Rapporteurs, attached to each of the three Programme Areas, and reporting to the Management Committee through a single designated representative.

The JCOMM capacity building strategy is straightforward: to first determine national and regional needs, and then address identified deficiencies in knowledge, skills, observing and telecommunications systems, data management and services. The implementation of this strategy will, however, necessitate carefully targeted initiatives, the pursuit of mutual cooperation and the aggressive development of partnerships with national governments, donors and international organizations. Capacity Building within IOC is coordinated through the Training, Education and Mutual Assistance (TEMA) programme. Similarly, within WMO, capacity building generally is coordinated and implemented through the Education and Training and Technical Cooperation Programmes. JCOMM will continue to work closely with these broader CB programmes, and adapt as required to their evolving mandates.

4. Observations Programme Area (OPA): Observing System Implementation Goals

4.1 Scope and Organization

The Observations Programme Area (OPA) is primarily responsible for coordinating and facilitating the development and maintenance of in situ and ground-based remote sensing observation networks (moored and drifting buoys, all ship-based systems, tide gauge networks, and others as appropriate), as well as their related telecommunication facilities, and their coordination with space-based observational networks. The ocean chapter of the Global Climate Observing System Implementation Plan (GCOS-92) provides specific implementation targets for building and sustaining an initial global ocean system, and the work of the OPA is to help implement this system in support of GCOS, GOOS, WWW and major research programmes of WMO and IOC. OPA monitors the efficiency of the overall observing system and, as necessary, recommends and coordinates changes designed to improve it. It also coordinates the setting and maintenance of instrument and network standards and intercalibration.

OPA has inherited lead responsibility for a number of important and well-established observational programmes which are managed by bodies that now report through JCOMM. The operational in situ observing system is only some 60% implemented, and significant new resources will be required to achieve full implementation. These resources must be in addition to existing resources, not simply a re-allocation of resources as has occurred in the past. OPA is organized into sub-teams as follows:
• **The Ship Observations Team (SOT)** coordinates the Voluntary Observing Ship (VOS) programme, the Automated Shipboard Aerological Programme (ASAP) and the Ship-of-opportunity Programme (SOOP). VOS ships volunteer to take surface meteorological and surface oceanographic observations while ASAP vessels acquire upper air observations over data-sparse ocean areas by means of automated radiosonde systems. Similarly, the SOOP involves volunteer merchant and scientific ships that acquire oceanographic measurements using one or more scientific instruments such as Expendable Bathythermographs (XBTs) and thermo-salinographs.

• **The Data Buoy Co-operation Panel (DBCP)** addresses the requirements for real-time and archived data from drifting and moored data buoys on the high seas by coordinating buoy deployments in the world’s oceans. It also provides a forum for the exchange of information on buoy technology, communications systems and applications of buoy data. The DBCP undertakes a large part of its implementation work through regional or programmatic Action Groups, including the Tropical Moored Buoy Implementation Panel (TIP), and the Global Drifter Programme (GDP).

• **The Global Sea Level Observing System (GLOSS)** oversees the operation of a worldwide network of tide gauge stations in support of both operational activities and studies of sea level variations and global climate.

Three other sub-teams participate in the Observations Coordination Group (OCG):

- **The Argo Programme** provides the subsurface measurements of ocean temperature and salinity that are necessary, along with the satellite altimeter measurements, to monitor global sea level change and changes in the ocean’s heat storage. This is an international effort with 18 nations plus the European Union currently providing floats.

- **OceanSITES** is the research-driven international project working towards the coordination and implementation of a global system of sustained multi-disciplinary timeseries observatories, particularly in data-sparse regions of the oceans.

- **The International Ocean Carbon Coordination Project**, co-sponsored by UNESCO/IOC and the Scientific Committee on Oceanic Research (SCOR), promotes the development of a global network of ocean carbon observations for research through technical coordination and communications services, international agreements on standards and methods, and advocacy and links to the global observing system.

As new global observational programmes become operationally-sustained, JCOMM will liaise with their science teams and managers with a view to their future association with the overall global programme, either within the context of one of the existing teams, or through the establishment of new expert or task teams as appropriate. Potential candidates may include communities that use sensors on marine mammals (“animal oceanographers”), gliders and the Coastal Ocean Observing System.

The JCOMM *in situ* Observing Platform Support Centre (JCOMMOPS) was formally established by JCOMM-I to assist internationally those in charge of the national components of the DBCP, SOT, Argo and now OceanSITES. JCOMMOPS helps these programmes through planning, implementation and operations and by providing technical assistance. It encourages platform operators to share and distribute data in real-time. The JCOMMOPS Terms of Reference were modified by JCOMM-II to enable it to also provide integrated technical support to all the other components of the JCOMM *in situ* ocean observing system.

The assignment to JCOMM of overall responsibility for coordinating and facilitating the implementation and maintenance, on a continuing basis, of the observational networks clearly brings a new level of integration to these ongoing programmes and paves the way for continued integration of other appropriate elements as required. Consequently, it significantly advances the long-term goal of a fully integrated ocean observing system – one that provides easy access to detailed observations of the temporal and spatial structure of the oceans and overlying atmosphere.
and thus support responsible management of the marine environment, its resources and the ecosystem.

4.2 System Design and Milestones

The ocean observing system documented in GCOS-92 is a composite system of systems, made up of sustained high-quality satellite measurements of the atmosphere and ocean surface, in situ measurements of the surface and sub-surface ocean, and in situ measurements of the atmosphere over the ocean. There are fifteen ocean-related Essential Climate Variables (ECVs) called for in GCOS-92, and OPA strives to develop and strengthen an integrated and rationalized observing system that best meets these requirements. Each component subsystem brings its unique strengths and limitations; together they build the composite system of systems. Figure 4.1 illustrates this initial global ocean observation system of systems. In addition to the platforms illustrated in Figure 4.1, two more components are essential: data and assimilation subsystems, and product delivery.

This baseline of systematic observations called for by the GCOS-92 Plan is designed to meet climate requirements. However, in addition to meeting climate requirements for the ocean, marine services in general will be improved by its implementation. The system will support other applications including global and regional numerical weather prediction, global and coastal ocean prediction, marine hazards warning, marine environmental monitoring, naval applications and many other non-climate uses.

![Figure 4.1: A schematic of the initial composite ocean observing system design, including the current status against the goals of the GCOS Implementation Plan (GCOS-92).](image)

An urgent and fundamental need identified by GCOS-92—and endorsed by the United Nations Framework Convention on Climate Change (UNFCCC) and the GEOSS 10-Year Implementation Plan Reference Document—is the need for achieving global coverage by the in situ networks. Coordination of national contributions for the implementation of these networks is the job of JCOMM, in cooperation with other global programmes. Within the ocean chapter of GCOS-92,
JCOMM is identified as the implementing agent, or a contributing implementing agent, for 21 of the specific actions. These specific actions for implementation of the *in situ* elements have been adopted by JCOMM as an implementation roadmap. The initial work plan described below outlines the ongoing work and the challenges ahead for JCOMM in building the global ocean component for GCOS, GOOS and the Global Earth Observation System of Systems (GEOSS).

In order to achieve global coverage as soon as possible, the following schedule has been established. It is an ambitious schedule based on the initial system design and projections of adequate funding, and in fact actual implementation has fallen far behind what was originally planned. Global coverage cannot be achieved with existing resources. Accomplishment of this plan will require substantial additional investment by the Members/Member States. The milestones will be updated to reflect evolution of the design as knowledge and technology advance; to reflect the community advancement in the OceanObs’09 Conference planning process; the anticipated update of the GCOS Implementation Plan; and to reflect the realities of funding availability.

<table>
<thead>
<tr>
<th>System Complete</th>
<th>Percent Complete</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
<th>2010</th>
</tr>
</thead>
<tbody>
<tr>
<td>initial design</td>
<td>goals</td>
<td>40</td>
<td>45</td>
<td>48</td>
<td>53</td>
<td>57</td>
<td>66</td>
<td>77</td>
<td>88</td>
<td>99</td>
</tr>
<tr>
<td>Actual</td>
<td>implementation</td>
<td>40</td>
<td>45</td>
<td>48</td>
<td>55</td>
<td>56</td>
<td>59</td>
<td>60</td>
<td>61</td>
<td></td>
</tr>
</tbody>
</table>

The remainder of Section 4.2 describes the contribution each observing network makes to studying the ECVs called for in GCOS-92, gives individual network status from 2005 – 2009, and gives improvements needed to build the observing system as an integrated whole. The ocean observing system is a composite of complementary networks; most serve multiple purposes. One of the primary goals of JCOMM is to look for efficiencies to be gained by utilizing common data, platforms, sites or other infrastructure in parallel to meet several different objectives. Although individual network priorities are described below, they must all go forward together as a system. For example, the global Argo array of profiling floats is a primary tool for documenting ocean heat content; yet deployment of the floats in the far corners of the ocean cannot be achieved without the ships-of-opportunity and dedicated ship elements; and the Argo array cannot do its work without global over-flight by continued precision altimeter space missions. The measurements taken by all networks will be rendered effective only through the data and assimilation subsystems and effective product delivery.

### 4.2.1 Tide Gauge Network

Tide gauges are necessary for accurately measuring long-term trends in sea level change and for calibration and validation of sea level measurements from satellite altimeters. These data are assimilated into global climate models for predicting climate variability. Many tide stations need to be upgraded with modern technology. Permanent GPS/DORIS receivers will be installed at a selected subset of stations, leading to an expansion of the geocentrically-located subset to 170 sites globally. These 170 GCOS Climate Reference Stations also will be upgraded for real-time reporting, not only for climate monitoring, but also to support marine hazard warning (e.g., for tsunami warning in some cases). Cooperating Member/Member States will maintain a global network of 290 tide gauge stations, including the GCOS subset noted above, for measuring tides and storm surges, tsunami warning, validation of satellite retrievals, validation of climate model results, documentation of seasonal to centennial variability in the El Nino Southern Oscillation, Indian Ocean and Asian-Australian monsoons, tropical Atlantic variability, North Atlantic Oscillation, North Pacific variability, high latitude circulation, western boundary currents, and circulation through narrow straits and chokepoints.
4.2.2 Drifting Buoy Array
Sea surface temperature is used to drive all forecast models. Data sparse regions of the global ocean are a major source of uncertainty in the seasonal forecasts and are also a major uncertainty in the detection of long-term trends in global sea surface temperature, which in turn is an indicator of global change. Data gaps must be filled by surface drifting buoys to reduce these sources of error to acceptable limits. JCOMM will extend the global SST/velocity drifting buoy array to data sparse regions, maintaining 1250 buoys while adding wind and pressure measurement capabilities to serve short term forecasting as well as climate research, seasonal forecasting, and assessment of long-term trends. JCOMM achieved the design target of 1250 buoys in sustained service in 2005. The global drifting buoy array thus became the first component of GOOS to be completed in terms of numbers, though measurement upgrades remain to be completed.

<table>
<thead>
<tr>
<th>Year</th>
<th>Operational buoys</th>
<th>Barometer upgrades</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>964</td>
<td>84</td>
</tr>
<tr>
<td>2005</td>
<td>1187</td>
<td>279</td>
</tr>
<tr>
<td>2006</td>
<td>1256</td>
<td>317</td>
</tr>
<tr>
<td>2007</td>
<td>1255</td>
<td>465</td>
</tr>
<tr>
<td>2008</td>
<td>1255</td>
<td>565</td>
</tr>
<tr>
<td>2009</td>
<td>1257</td>
<td>575</td>
</tr>
</tbody>
</table>

4.2.3 Tropical Moored Buoy Network
Most of the heat from the sun received by Earth enters the ocean in the tropical/sub-tropical belt. Advanced understanding of the role of the tropics in forcing mid-latitude weather and climate was learned primarily through the observations of the tropical moored buoy array (TAO/TRITON) in the Pacific. A similar array in the Atlantic basin (PIRATA) now offers the potential of even better understanding, improved forecasts, and improved ability to discern the causes of longer-term changes in the oceans. In addition to monitoring the air-sea exchange of heat, the moored buoys provide platforms for supporting instrumentation to measure carbon dioxide and rainfall in the tropics. The plan is for the global tropical moored buoy network to be expanded to 132 stations to ultimately span all three oceans: Pacific, Atlantic and Indian.

<table>
<thead>
<tr>
<th>Year</th>
<th>Sustained buoys</th>
<th>RAMA</th>
<th>PIRATA</th>
<th>TAO/TRITON</th>
<th>Upgraded with surface salinity sensors</th>
<th>Upgraded with net heat flux capability</th>
</tr>
</thead>
<tbody>
<tr>
<td>2004</td>
<td>73</td>
<td>3</td>
<td>7</td>
<td>63</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>2005</td>
<td>75</td>
<td>3</td>
<td>12</td>
<td>60</td>
<td>23</td>
<td>0</td>
</tr>
<tr>
<td>2006</td>
<td>82</td>
<td>6</td>
<td>16</td>
<td>60</td>
<td>46</td>
<td>7</td>
</tr>
<tr>
<td>2007</td>
<td>94</td>
<td>8</td>
<td>18</td>
<td>68</td>
<td>68</td>
<td>9</td>
</tr>
<tr>
<td>2008</td>
<td>96</td>
<td>11</td>
<td>17</td>
<td>68</td>
<td>68</td>
<td>10</td>
</tr>
<tr>
<td>2009</td>
<td>104</td>
<td>20</td>
<td>17</td>
<td>67</td>
<td>67</td>
<td>13</td>
</tr>
</tbody>
</table>

4.2.4 Volunteer Observing Ships and Ships of Opportunity
The global atmospheric and oceanic data from the Ship of Opportunity Programme (SOOP) have been the foundation for understanding long-term changes in marine climate. These data, together with the marine meteorology observations from Volunteer Observing Ships (VOS), are essential input to climate and weather forecast models. Improved instrument accuracy, automated reporting and improved information about how the observations were taken (the VOSClim project) will greatly enhance the quality of these data, reducing both systematic and random errors. JCOMM will improve meteorological measurement capabilities on the global volunteer fleet for improved
marine weather and climate forecasting in general, and will concentrate on a specific subset of high accuracy SOOP lines to be repeated frequently and sampled at high resolution for systematic upper ocean and atmospheric measurement. This climate-specific subset will build to a designed global network of 51 lines and will provide high-accuracy measurements of the upper ocean thermal structure, sea surface temperature and chemistry, and surface meteorology. Additionally, the volunteer fleet is the primary vehicle for deployment of the drifting buoys.

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>VOS reporting regularly</td>
<td>910</td>
<td>910</td>
<td>765</td>
<td>762</td>
<td></td>
<td></td>
</tr>
<tr>
<td>High resolution XBT lines</td>
<td>16</td>
<td>22</td>
<td>22</td>
<td>24</td>
<td>24</td>
<td>24</td>
</tr>
<tr>
<td>Frequently repeated XBT lines</td>
<td>11</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>17</td>
<td>22</td>
</tr>
<tr>
<td>AWS Ship</td>
<td>80</td>
<td>140</td>
<td>140</td>
<td>201</td>
<td>204</td>
<td>204</td>
</tr>
<tr>
<td>VOSClim ships</td>
<td>108</td>
<td>113</td>
<td>113</td>
<td>217</td>
<td>217</td>
<td>266</td>
</tr>
</tbody>
</table>

4.2.5 Argo array of profiling floats
The heat content of the upper 2000 meters of the world’s oceans, and the transfer of that heat to and from the atmosphere, are variables central to the climate system. The Argo array of profiling floats is designed to provide essential broad-scale, basin-wide monitoring of the upper ocean heat content. As of late 2007, three thousand floats had been deployed, meeting the initial target. Glider technology will replace standard drifting Argo floats in the boundary currents and targeted deep circulation regions.

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Argo floats in operation</td>
<td>1469</td>
<td>1918</td>
<td>3512</td>
<td>2857</td>
<td>3055</td>
<td>3388</td>
</tr>
</tbody>
</table>

4.2.6 Ocean Reference Stations

**Subtask 1:** JCOMM, together with international OceanSITES, will implement a global network of ocean reference station moorings, expanding from pilot stations to a permanent network of 28 (including 7 within the tropical moored buoy network). OceanSITES will provide the major piece of the infrastructure needed for this network, establishing high-capability moored buoys in remote ocean locations. JCOMM will maintain long-term weather and climate instrumentation aboard the OceanSITES platforms.

**Subtask 2:** Monitoring the transport within the ocean is a central element of documenting the overturning circulation of fresh water and heat and carbon uptake and release. Heat and carbon generally are released to the atmosphere in regions of the ocean far distant from where they enter. Long-term monitoring of key choke points, such as the Indonesian through-flow, and of boundary currents along the continents (e.g., the Gulf Stream) must be established to measure the primary routes of ocean heat, carbon and fresh water transports.

**Subtask 3:** Monitoring thermohaline circulation is a central element of documenting the ocean’s overturning circulation and a critical need for helping scientists understand the role of the ocean in abrupt climate change. It is essential that the ocean observing system maintain watch at a few control points at critical locations. Key monitoring sites have been identified by the OceanSITES team of scientists for deployment of long-term subsurface moored arrays and repeated temperature, salinity, and chemical tracer surveys from research vessels.
4.2.7 Coastal Moorings
Improved near-shore measurements from moored buoys are critical to coastal forecasting as well as to linking the deep ocean to regional impacts of climate variability. The boundary currents along continental coasts are major movers of the ocean’s heat and fresh water. Furthermore, the coastal regions are critical to the study of the role of the ocean in the intensification of storms, which are key to the global atmospheric transport of heat, momentum and water, and are regions with significant impacts of climate on society. Coastal arrays are maintained by many nations making this a “global network of coastal” stations. A climate subset of this network will be improved by augmenting and upgrading the instrument suites to provide measurements of the upper ocean as well as the sea surface and surface meteorology. Many of these moorings will serve as platforms-of-opportunity for the addition of carbon sampling instrumentation and other biochemical measurements.

4.2.8 Ocean Carbon
Understanding the global carbon cycle and the accurate measurement of the regional sources and sinks of carbon are of critical importance to international policy decision making as well as to forecasting long term trends in climate. Projections of long-term global climate change are closely linked to assumptions about feedback effects between the atmosphere, the land and the ocean. To understand how carbon is cycled through the global climate system, ocean measurements are critical. JCOMM will coordinate with the International Ocean Carbon Coordination Project and OceanSITES for addition of autonomous carbon dioxide sampling to the moored arrays and the VOS fleet to analyze the seasonal variability in carbon exchange between the ocean and atmosphere. In addition JCOMM, in cooperation with the above programmes, will help implement a programme of systematic global ocean surveys that will provide a complete carbon inventory once every ten years.

4.2.9 Arctic and Antarctic Observing Systems
Given the sensitivity of the Arctic and Antarctic environment to climate variability and change, it is in these regions that early indications of the future progression of climate change are likely to be first detected. A programme of observations in these areas was developed for the International Polar Year through dedicated and shared ship-based cruises, oceanographic moorings and ice buoys, and supplemented by acquisition and analysis of historical data sets. The long-term goal is to detect climate-driven physical and ecological change, especially due to changes in sea ice extent and duration, and in ocean density and circulation that together may lead to changes in ocean heat transport, productivity, and food web structure. Ice-tethered buoys and bottom-mounted moorings are deployed to monitor the drift of sea ice and to determine its thickness. The long-term goal is to provide an accurate record of changes in sea ice thickness that, together with satellite observations of sea ice extent, can provide an estimate of changes in sea ice volume.
4.2.10 Dedicated Ships
Ship support within the international research fleets for deployment of the moored and drifting arrays and for deep ocean surveys is an essential component of the global ocean observing system. The deep ocean cannot be reached by SOOP and Argo; yet quantification of the carbon and heat content of the entire ocean column is needed to solve the climate equations. In addition to providing the survey and deployment platforms for the autonomous arrays, the research fleet will maintain sensor suites on a small core of vessels in coordination with the VOSClim project as the highest quality calibration points for validation of the other system measurements.

### Operating days at sea

<table>
<thead>
<tr>
<th></th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tropical Moored Buoys</td>
<td>414</td>
<td>428</td>
<td>463</td>
<td>477</td>
<td>484</td>
<td>498</td>
</tr>
<tr>
<td>Carbon survey</td>
<td>148</td>
<td>148</td>
<td>220</td>
<td>228</td>
<td>228</td>
<td>228</td>
</tr>
<tr>
<td>Reference Stations</td>
<td>94</td>
<td>94</td>
<td>120</td>
<td>204</td>
<td>240</td>
<td>360</td>
</tr>
<tr>
<td>Deployment of drifting arrays</td>
<td>60</td>
<td>60</td>
<td>60</td>
<td>80</td>
<td>80</td>
<td>120</td>
</tr>
</tbody>
</table>

### International Goal

<table>
<thead>
<tr>
<th></th>
<th>54</th>
</tr>
</thead>
</table>

4.2.11 Satellites
The initial ocean observing system for climate depends on space-based global measurements of 1) sea surface temperature, 2) sea surface height, 3) surface vector winds, 4) ocean color, and 5) sea ice. These satellite contributions are detailed in other international plans, but continued close coordination with the in situ systems is essential for comprehensive ocean observation.

**Sea surface temperature:** Satellite measurements from both infrared and microwave instruments provide high-resolution sea surface temperature data. Microwave sea surface temperature data have a significant coverage advantage over infrared sea surface temperature data, because microwave data can be retrieved in cloud-covered regions while infrared cannot. However, microwave sea surface temperatures are at a much lower spatial resolution than infrared. In addition microwave sea surface temperatures cannot be obtained within roughly 50 km of land. Thus, a combination of both infrared and microwave data are needed because they have different coverage and error properties. Drifting buoy and other in situ data are critically important in providing calibration and validation to satellite data as well as providing bias corrections to these data. Satellite biases can occur from orbit changes, satellite instrument changes and changes in the physics of the atmosphere (e.g., through the addition of volcanic aerosols). Thus, drifting buoy and other in situ data are needed to correct for these changes.

**Sea surface height:** The value of spaced-based altimeter measurements of sea surface height has been clearly demonstrated by the TOPEX/Poseidon and Jason missions. Changes in sea level during major El Nino events can now be discerned at high resolution and provide realistic model initializations for seasonal climate forecasting. The same data, when calibrated with island tide gauge observations, are also able to monitor the rate of global sea level change with an accuracy of 1 mm per year. The planned NPOESS altimeter will be adequate for shorter term forecasting, but the NPOESS altimeter will not fly in the same orbit as TOPEX/Poseidon and Jason; and for monitoring long-term sea level change, continuation of precision altimeter missions in the TOPEX/Poseidon/Jason orbit is necessary. Jason follow-on altimeter missions (Ocean Surface...
Topography Mission) are necessary to continue the long-term sea level record, but the necessary long-term commitments for these missions is not yet in place.

**Surface vector winds, ocean colour and sea ice:** The best methods for sustained satellite measurements of surface vector winds, ocean colour and sea ice are still in research and development phases. Over the next five years the satellite agencies will weigh the alternatives and determine the long term strategy for maintenance of these elements. Operational measurements of these variables are not yet established.

4.3. Performance Reporting and System-wide Monitoring and Evaluation

4.3.1 Performance Reports

A major challenge for the OPA is to develop easy-to-understand performance reports that can help in evaluating the effectiveness of the observing system and help in efforts to convince governments to provide the funding needed to meet global implementation targets. It will not be possible to achieve global coverage of Earth’s oceans with existing resources. Governments need to commit additional resources if the JCOMM Members/Member States are to collectively achieve global coverage. The JCOMM in situ Observing Platform Support Centre (JCOMMOPS) was established to facilitate the Implementation of operationally-sustained in situ ocean and marine meteorology observing systems associated with the Data Buoy Cooperation Panel (DBCP), the Ship Observations Team (SOT), the Argo Science Team and now the OceanSITES Science Team. JCOMMOPS and the Observations Coordination Group have developed standard base maps showing required global coverage against what is presently in place, to evaluate observing system status and effectiveness, and to develop summary reports illustrating how advancements toward global coverage improve the adequacy of the observational information.

In addition to platform statistics calculated by JCOMMOPS, quarterly performance reports are now produced for four ECVs (sea surface temperature (see Figure 4.2), sea surface salinity, temperature profiles, salinity profiles) and on an experimental basis for several more (e.g., near-surface currents). The OPA is working on metrics for other ocean ECVs that integrate in situ and satellite observations, as specified by GOOS and GCOS. Access to these reports is via JCOMMOPS at [www.jcommops.org/network_status](http://www.jcommops.org/network_status).

![Figure 4.2](image-url)  
**Figure 4.2:** this example for the second quarter of 2009 shows that 41% of the ocean is presently being observed adequately for measurement of sea surface temperature to the required accuracy.
4.3.2 System Monitoring: Stakeholder Engagement and Performance Metrics
The OPA is now routinely reporting observing system monitoring and performance metrics in cooperation with the GOOS Project Office of the IOC. A consolidated Progress Report with Contributions by Countries is available at www.jcommops.org/network_status which lists the 68 countries and the European Union that maintain elements of the composite global ocean observing system, and the number of in situ platforms and expendables contributed by each country. All JCOMM Members/Member States are invited to routinely review this report and provide corrections as needed to opa@jcommops.org. Note: national contributions are included in this report only if they provide data to the international community in accordance with WMO and IOC data policies. This report was used to estimate the summary of total system percent complete as noted in Figure 4.1.

A new near-real-time system monitoring tool (http://osmc.info) has been developed for use by observing system managers. The Observing System Monitoring Centre (OSMC) database gathers its primary information from the GTS via the U.S. GODAE server system at Monterey – this allows comparison with the GTS access via MeteoFrance which is the primary data source for the JCOMMOPS data base. Additional non-GTS data sources also are added to the OSMC. The OSMC allows users to monitor observing system status in near-real-time (the database is updated daily) and sort platform reports by country, variable, time frame, and platform type. Ship reports are suppressed for the most recent 48 hours to provide location security.

4.4 Funding and Other Resources Required
JCOMM must help in efforts to convince governments to provide the funding needed to meet global implementation targets. Global coverage cannot be achieved with the resources that are presently being applied. The baseline GCOS-92 system is only slightly more than 60% complete. Much work remains to be done and additional resources are needed. One way the OPA can help is to further develop easy-to-understand statistics and reports that decision makers will be able to use to justify new funding.

JCOMM-II authorized the establishment of a common fund for consumables, initially focused on XBTs but other expendables could be added in time. The Commission noted that the provision of ship time as well as expendables could be contributed to the global observing system by developing countries. Recommendation 2 from JCOMM-I strongly encouraged Members/Member States to “increase the resources committed to supplying expendables for ship observations in support of international implementation plans.”

Accordingly, JCOMM-II passed Recommendation 3 (JCOMM-II)—Consumables for Ship-Based Observations—for the establishment and management of a JCOMM Trust Fund to provide a simple mechanism to help more counties contribute to the international observing system and complete the global XBT network. Based on similar previous experience with purchasing radio-sounding equipment on behalf of Member Countries, WMO has agreed to manage the trust fund on behalf of the SOT as soon as Member Countries are willing to make commitments to it. It is proposed that any expenditure should be authorized by the way of a letter from the Chair of the SOT to WMO. Expenditures would then be made by WMO provided that sufficient funds exist in the trust fund. WMO would report on the use of the trust fund to the SOT at its regular meetings.

5. Services Programme Area (SPA)

5.1 Scope and Organization
The continuing provision of safety-related weather and oceanographic services is a fundamental aspect of JCOMM and the JCOMM Services Programme Area (SPA). The aim of the SPA is to coordinate and facilitate the sustained provision of global and regional coverage data products
and services to address the continued and expanding requirements of the maritime user community for marine meteorological and oceanographic services and information. The SPA has been created to facilitate the development and application of these globally distributed services in partnership with the user communities, supporting the JCOMM observational, data management and, capacity building areas. The SPA also covers Quality Assurance, Standards and User Interactions related to products and services. This chapter is based on the work plan of the JCOMM SPA for the 2006-2009 period.

The SPA is overseen by a Services Coordination Group (SCG) that provides overall management and co-ordination of SPA activities and tasks. The SCG is responsible for developing and managing a JCOMM SPA work plan and delivering outcomes against the work-plan. The SPA and SCG link various SPA expert teams (across all of JCOMM) together through cross cutting activities. The SCG includes a Capacity Building Rapporteur who will help develop appropriate capacity within JCOMM (including a strategy, review and update of training and guidance material and secure appropriate resources). The SCG also includes a Satellite Expert who will identify and coordinate the end-to-end user requirements for satellite data within JCOMM and communicate these to relevant external bodies.

Currently JCOMM supports the coordination and facilitation of marine and meteorological services and products through the following SPA Expert Teams:

- **Expert Team on Maritime Safety Services (ETMSS)**, which coordinates, monitors and reviews arrangements for GMDSS and related services provided in support of safety at sea. ETMSS also coordinates Marine Accident Emergency Response activities, including promotion and development of pollution response support capabilities on a worldwide basis. ETMSS advises on techniques and systems available to agencies charged with combating marine pollution emergencies. Finally, ETMSS also facilitates coordination and cooperation in the provision of meteorological and oceanographic information and support to maritime search and rescue operations.

- **Expert Team on Wind Waves and Storm Surges (ETWS)**, which advises on scientific and operational aspects of wind-wave and storm surge forecasting, and coordinates with other JCOMM groups, scientific and technical bodies to ensure that the latest advances are incorporated into operational practice.

- **Expert Team on Sea Ice (ETSI)**, which coordinates the delivery of sea ice products and services to facilitate maritime operations in high latitudes, advises on scientific and operational aspects of sea ice, and oversees the operations of the Global Digital Sea Ice Data Bank.

- **Expert Team on Operational Ocean Forecasting Systems (ETOOFS)**, that supports operational agencies through inter-agency and intergovernmental coordination to deliver consistent ocean forecasting and related services that positively impact their users. ETOOFS’s role is to foster international activities that will lead to improved services from existing operational systems.

The SPA has also established a number of ad hoc task teams, in association with intermediate and end users and jointly with other external bodies and groups to identify, standardize and implement operationally, new ocean products and public good services. Figure 5.1 summarizes the various teams and services.
5.2 Top Level Objectives: Summary and Priority Actions

In order to develop activities and actions across the SPA Expert Teams, the Rapporteurs and the Services Coordination Group, the JCOMM SPA work plan defines seven Top Level Objectives (TLOs). All work conducted by SPA Expert Teams will support one or more of the Top Level Objectives through dedicated actions and team work-plans. The actions and expert team work-plans are derived from workshops, expert team meetings, and from formal recommendations arising from WMO, IOC and JCOMM meetings. The JCOMM SPA TLOs are:

TLO – 1: To provide support to maritime safety, hazard warning and disaster mitigation systems

The objective here is to monitor and develop modifications to maritime safety, hazard warning and disaster mitigation systems and to provide assistance to Members/Member States as required. Systems include: the WMO marine broadcast system for the GMDSS, as well as MPERS; storm surges; tropical cyclones; Tsunami; search and rescue; marine pollution; ice and iceberg warnings; rogue waves and dangerous sea state. Standing actions include:

- Review, revise and maintain the guidelines for the provision of meteorological forecast and warning broadcasts through the international NAVTEX Service;
- Review, revise and maintain Guide to Marine Meteorological Services (WMO-No. 471);
- Keep under review the implementation and user response to MPERS.

TLO – 2: To develop, maintain and monitor international MetOcean product and service standards

The objective here is to ensure that the JCOMM SPA acts as a flexible and streamlined organization that is capable of coordinating international maritime services. Standing actions include:

- Ensure that expert teams to work effectively according to the SPA and expert team work plans.
Work effectively with the JCOMM Management Committee (MAN)
Work effectively with the Services Coordination Group (SCG)
Work effectively with the Capacity Building Rapporteur
Work effectively with the SPA satellite expert

TLO – 3: To implement a user focused programme
The objective is to understand and respond to present and future needs of the maritime service industry and ensure that the services provided to users meet these requirements, including content, delivery timeliness and quality. A key priority for the JCOMM SPA is to provide mechanisms and services that engage the user community in JCOMM discussions, plans and activities and to manage user feedback on all aspects of JCOMM. Standing actions include:

Maintain a JCOMM Electronics Product Bulletin as a web portal to sample MetOcean products and services;
Review, revise and maintain a user requirement document of the needs, applications and scenarios for operational MetOcean products;
Review, revise and maintain guidelines on ocean product presentation, symbology and nomenclature;
Review, revise and maintain standard data and metadata formats for ocean products in collaboration with CBS, IODE, DMPA and GODAE;
Solicit, evaluate and recommend follow up action on user feedback to delivered products and services.

TLO- 4: To work effectively with JCOMM Members/Member States
The objective is to keep under review and respond to the requirements of Members/Member States for guidance in the implementation of their duties and obligations with regard to marine services—in particular, those specified in the WMO Manual on Marine Meteorological Services (WMO-No. 558). Standing actions include:

Review, revise and maintain the guidelines for the provision of meteorological forecast and warning broadcasts through international NAVTEX Service;
Review, revise and maintain the implementation and user response to changes (abbreviations and guidelines) to the NAVTEX service.
Ensure the effective coordination of JCOMM activities within a global framework of cooperation for tsunami and marine-related natural disaster reduction as appropriate.

TLO-5: To co-ordinate the pull-through of scientific and technical expertise to operational systems
The objective is to build on international scientific and technical excellence to better meet the needs of the international maritime service industry through development, preparation and dissemination of ocean products and services.

TLO-6: To develop and maintain communications across JCOMM and “join up” the SPA
The objective here is to integrate the internal cross-programme area activities of JCOMM, with international regional/global efforts and with those of others to increase efficiency and capability in the provision of marine services and information. Activities outside JCOMM include relevant programmes of WMO and IOC (e.g., WWW, WCP, GOOS, GCOS, and Disaster Risk Reduction) as well as those of other organizations such as IMO, IHO, IMSO and ICS.

TLO-7: To build appropriate capacity within JCOMM
The objective here is to build appropriate capacity within JCOMM to make the most of international collaboration to share marine meteorological and oceanographic knowledge, infrastructure and services for the benefit of the Maritime community.
5.3 Expert Teams

A summary of the objectives of the expert teams is given below. Further details can be found in the JCOMM Services Programme Area Work Plan for 2006-2009.

**Expert Team on Marine Safety Systems (ETMSS)**
ETMSS coordinates, monitors and reviews arrangements for GMDSS (see http://weather.gmdss.org) and related services provided in support of safety at sea. ETMSS is the key actor regarding the coordination of the provision of meteorological and oceanographic multi-hazards safety information and warnings for mariners. In addition to coordination aspects, the Terms of Reference for this Expert Team include the monitoring and review of the operations of marine broadcast systems, not only for the GMDSS but also for others related to vessels not covered by the SOLAS convention, the monitoring and review of the technical and service quality standards for meteorological and oceanographic maritime safety information (particularly for the GMDSS) and the implementation of appropriate actions to ensure that feedback from the user communities is obtained through appropriate and organized channels and applied to improve the relevance, effectiveness and quality of services.

ETMSS also coordinates and monitors **Marine Accident and Emergency systems (MAES)**. In this role it promotes the development of pollution response support capabilities on a world-wide basis (see http://www.maesmperss.org) and advises on techniques and systems available to agencies charged with combating marine pollution emergencies. It also facilitates coordination and cooperation in the provision of meteorological and oceanographic information and support to maritime search and rescue operations.

**Expert Team on Wind Waves and Storm Surges (ETWS)**
ETWS advises on the scientific and operational aspects of wind-wave and storm surge forecasting, and coordinates with other JCOMM groups, scientific and technical bodies to ensure that the latest advances are incorporated into operational practice.

**Expert Team on Sea Ice (ETSI)**
ETSI coordinates the delivery of sea ice products and services to facilitate maritime operations in high latitudes, advises on scientific and operational aspects of sea ice, and oversees the operations of the Global Digital Sea Ice Data Bank. (see http://www.wmo.ch/web/aom/marprog/Publications/publications.htm)

**Expert Team on Operational Ocean Forecast Systems (ETOOFS)**
ETOOFS supports operational agencies through inter-agency and intergovernmental coordination to deliver consistent ocean forecasting and related services that positively impact their users. ETOOFS’s role is to foster international activities that will lead to improved services from existing operational systems.

5.4 Developing and Maintaining Standards within the JCOMM Services Program Area

Figure 5.2 shows the essential elements of a cross-cutting strategy required to generate and manage marine oceanographic and meteorological products and services. Three main data streams are identified: traditional *in situ* and satellite observations; ocean model system outputs; and marine climatology. Each of these areas requires specific activities, including quality control, agreements on data formats, data management and stewardship, communications, bringing scientific advances into operating systems, documentation, and user interfaces. Most are coordinated by JCOMM. However, in order for JCOMM to gain the trust of the diverse communities working in these areas, useful and appropriate standards need to be set and monitored for conformance.
The development/endorsement of standards for oceanographic data products and services in a Guide to Ocean Product Presentation, Symbology and Nomenclature and its review and acceptance by authoritative Member States is particularly important to the success of the JCOMM SPA. Where products and services fail to meet agreed standards, JCOMM and partner organizations must promptly advise the user community of deficiencies and shortcomings and apply influence to resolve these in a cost effective and timely manner. This is a complex task requiring expert scientific and technical expertise. The JCOMM SCG, supported by all expert teams, should develop a draft Guide to Ocean Product Presentation, Symbology and Nomenclature, for review through a wider JCOMM process (e.g., SCG, MAN, JCOMM members). The guide should address:

- Standards for product/service timeliness, accuracy, robustness;
- Standards for the provision of appropriate uncertainty estimation;
- Standardization of presentation and delivery formats, nomenclature, etc;
- Standards for inter-comparison of data products;
- Standards for assessment of products (metrics);
- Classification of needs according to users;
- Detailed specifications for such user requirements;
- Criteria for selection as “branded JCOMM products”; and
- Data and metadata (file and discovery) related to products;

5.5 Stakeholder Engagement and User Feedback

The framework outlined in Figure 5.3 describes a mechanism to define current capability, obtain and analyze user requirements, and prioritize the activities of the SPA in an ongoing manner placing the aim of the SPA within a user community framework. A key activity for the JCOMM SPA is to draft and publish a proper user community specification of needs within a well-articulated JCOMM Services User Requirement Document. This must capture present and future needs, applications and scenarios for operational met ocean products from individual user communities. A template to systematically capture descriptions of current user system requirements in a scenario-based approach is one (previously used) approach that works well. A high level of detail on the application, products, and support requested by each user must be documented to gain a
clear understanding of what is required. Often detailed discussions are required to clarify aspects of a user requirement. Typically, the scope is large: encompassing data products (including):

- observations, analyses & bulletins (graphical and text based) timeliness, reliability, accuracy/uncertainty estimates, formats and services e.g., guidance, technical reference,
- international standards,
- training,
- delivery mechanisms,
- intellectual property rights and licensing issues,
- verification and validation,
- system sharing and coordination etc.

![Diagram](image)

**Figure 5.3.** This figure shows a framework in which user interaction/feedback is used to guide the development and implementation of the JCOMM SPA. A user requirement document specifies what services users actually require, a reference baseline document (containing a capability audit) and a number of pre-defined performance metrics (which measure the progress of the SPA using the reference baseline) towards satisfying the need defined in the user requirement) are highlighted. The use of these tools as a means to manage user community interactions and the development of the SPA in a prioritized manner is through user feedback and information/data flows (arrows).

Once user requirements are captured and formalized within a User Requirement Document, a set of common user requirements (e.g., the need for more surface wave observations for use in wave prediction systems) or specific high priority requirements (e.g., access to basic met ocean system outputs) can be extracted.

The User Requirement Document can then be used to prioritize specific developments and actions within the JCOMM SPA by identification of gaps in current service provision. A review of current capabilities (services, products, user community etc.) is conducted and a capability audit performed to generate a reference baseline document. The JCOMM SPA will produce the JCOMM Catalogue of Operational Ocean Products and Services as a reference baseline. The mismatch between the reference baseline and the User Requirement Document is used to prioritize activities within the SPA that address user requirements in the most efficient manner. Gaps and differences between the reference baseline and User Requirement Document can also be used to define appropriate performance metrics that measure the progress of the SPA towards satisfying user requirements. This is requested by Rec. 1 (CMM-XI) Marine Meteorological services monitoring program which calls for ‘…a systematic long-term marine meteorological services monitoring program be implemented’.
5.6 Performance Metrics

For the purpose of the JCOMM SPA, a performance metric defines common quantities and diagnostics with given mathematical definitions. Thus, given a specific metric, there is a need to absolutely classify numerical threshold that defines acceptable and unacceptable performance. Such a threshold may be called a target. A range of “acceptability” should be avoided so that metrics are specific; e.g., ‘Surface current fields should be available within 30 minutes of production’. Perceptions are such that extreme (high or low) numbers carry implied performance and care is required to develop consistency in terms of scaling (i.e., low is bad and high is good or vice versa). Metrics must provide a number that shows how the JCOMM SPA is performing in well-defined user interactions and operations or against the stated actions within the work plan. This approach has been used successfully in other large international projects (e.g., the WMO Rolling Requirements Review process) and the SPA can take benefit from the experience and lessons learned from these initiatives.

6. Data Management Programme Area (DMPA)

6.1 Introduction

Data management has in its own Programme Area to recognize that managing the data and information of JCOMM is on a par with acquiring and delivering data and services. It is the challenge to the DMPA to work within the requirements of the OPA and SPA and still achieve the broad goals of JCOMM. The data management implementation plan adopts an approach that looks for commonalities across these systems and exploits those to improve interoperability. In addition, JCOMM must position itself to be able in the future to handle data and information from the broader range of coastal and biological observations.

In this section we will cover data and information exchange, data processing, access, coordination and linkages, communications, risk management, stakeholder engagement, and funding and other resources required. It is important to note that in addition to the large amounts of data from instruments both in-situ and satellite-borne, JCOMM must handle model results and the metadata that provide information needed to use the data.

6.2 Data and Information Exchange

1. From Collectors to the Shore: The data streams that come ashore are strongly linked to the types of instruments used and so manifest a wide variety of data formats. Without the adoption of standards for reporting from platforms at sea, there will continue to be a variety of data formats. Standards also are needed when transporting data to and between archives or processing centres. Instrument manufacturers should be encouraged to standardize the formats of the data and information coming from instruments used at sea.

2. Using the GTS: The Global Telecommunications System (GTS, see http://www.wmo.ch/web/www/TEM/gts.html), is one means of data exchange used by JCOMM. For WMO it is the transmission mechanism of choice for operational, time critical data exchange. This is still true in the development of the WMO Information System, WIS. Being co-sponsored by WMO, JCOMM will need to adopt this same view.

On the GTS, the Traditional Alphanumeric Code forms (TACs) have strongly regulated formats and contents (for example FM-13 SHIP), but are now being phased out. Replacing the TACs are Table-Driven Codes (TDCs) such as the Binary Universal Form for the Representation of meteorological data (BUFR, see http://www.wmo.ch/web/www/WMOCodes.htm). TDCs offer a flexible form that allows data to be structured within the exchange format in ways that are linked to the kind of data observed. The work will entail such tasks as devising and validating appropriate
BUFR templates that include and extend the information now sent in TACs, encouraging ocean and meteorological centres to develop capacity to both read and write TDCs, and consideration of how TDCs may be used to acquire data from instruments and platforms at sea.

It is planned that DMPA lead the development of the detailed plan to change GTS data reporting from TACs to TDCs, and, in association with the appropriate WMO committee, evaluate the new set of BUFR tables (MT10) for its relevance to present needs. In addition, it is noted that enhanced interaction between JCOMM and CBS or other appropriate WMO committees is needed to expand the scope of TDCs to more fully incorporate JCOMM considerations, including software reliability, human readability, and the archival and exchange of historical and delayed-mode data in its originally reported form.

3. Using the Internet: Data are also exchanged using other telecommunication systems, notably the Internet. For these exchanges there is no standard for naming variables and attributes, no universally agreed structures or formats—in fact, there are no standards beyond the broad constraints of standards such as the Hypertext Transfer Protocol (HTTP) and the File Transfer Protocol (FTP). Use of the Internet is very widespread and this lack of order makes the exchange of data a process that requires "handshakes" between every partner in the exchange. There are preferred practices that are starting to emerge for data exchange using the Internet. The use of netCDF for the exchange of in situ ocean data is increasingly prevalent. It is planned that JCOMM encourage and support the widespread use of netCDF as a data exchange format, encourage usage of CF convention for variable naming in netCDF, and stay informed of CF updates to meet JCOMM contributors' needs as well as netCDF maintenance and developments.

Xml is yet another way to structure data and information for exchange. It is a very popular structure because of its flexibility, its readability and the wide availability of software to parse messages and extract content. The DMPA will monitor the development of xml and encourage appropriate use for the exchange of data and metadata, and encourage the development of vocabularies used in xml that are as close as possible to those used in other formats.

4. Other Formats and Data Structures: JCOMM recognizes that other formats and data structures besides netCDF will have appeal and it must encourage activities that broaden their use and standardize their content. There is a distinction made at present between data that are exchanged in real-time and those exchanged in delayed mode. There are a wide variety of exchange formats for delayed mode data using whatever communications channels are available. JCOMM and its other data management partners will encourage the evolution to more capable exchange formats that are flexible and yet relatively simple to alter.

6.3 Data Processing

1. Data Versions: In the simplest terms, the raw observations coming from an instrument may be considered to be one version of the data, and the highly processed data that are exchanged to be another version. There may be many versions representing the processing steps between these two and there may be other versions after data are available for exchange. Versions are generated by the verification of the data collected, by value adding processes such as quality control, by smoothing and filtering, etc. It is important to be able to distinguish between these versions especially after the versions have reached archives or are exchanged. The DMPA will consult with the other JCOMM Programme Areas to get a full description of the versioning issue, to develop a strategy to manage versions, and to implement that strategy.

2. Data Quality: Assessing the quality of data is a complicated process that uses knowledge of oceanography and meteorology and knowledge of the area and time in which the data are collected. There are a number of places where standardization of practice would benefit users. A standard set of tests to be applied as a minimum set would greatly improve the process. There are substantial resources expended in assessing the quality of data, and these are consumed over and over again by each group receiving data. Until there is consistency in what procedures are applied, acceptance on a broad scale of the correctness of the procedures, and a standardization
of how results are reported, there will be no resource savings. DMPA will encourage the development and wide-spread implementation of a standard suite of data quality testing procedures.

In situations where there is an abundance of data, algorithms can be used to decide on the inclusion or exclusion of data to be used. Where data are scarce, each observation is precious and work is undertaken to use everything that can be used. It is time to reconcile these different approaches to ensure that users are best served. DMPA must resolve the differences in how the quality of data is indicated to best serve user needs, and work with all appropriate bodies to come to agreement on a single scheme to indicate quality of data.

3. Duplicates: JCOMM is interested in data that arrive both in real-time and in delayed mode. In a broader context, the data collected by JCOMM are transferred to various archive centres and projects around the world. In this way many copies of the same original data exist in many different centres. But because of processing that takes place at each of these centres, the data and information may not be identical to the original. This can be the result of format conversions, trimming away of some of the information when data are sent from one place to another, errors in transcription, etc. The result is that a user will get different copies of the data depending on who has provided the copy, or perhaps duplicate or near duplicate copies of the original. DMPA will develop a methodology to address how to identify exact and inexact duplicates in contemporary JCOMM data, and will investigate developing a comprehensive system to uniquely tag data from all JCOMM programmes, and employ this to detect data duplications. Noting that each action taken on a data set creates a different version, tracking those versions will go far to help remedy the problem of undetected duplicates.

4. Contents: Each data system, whether dealing in real-time or delayed mode data, has its own scheme for storing the data and the information about the data. The methods that are used are strongly influenced by the available computer infrastructure. The result of these varying approaches is that it is difficult to compare data and information from different sources. It should be possible to develop a set of standard attributes regarding the sources to be recorded. Then, when data are requested, this information can be reported in a standard way. A few years ago, this idea was presented in the context of a discussion of Marine XML. The idea was that information could be assembled into packages of standard content that were called "bricks" (see http://ioc.unesco.org/iocweb/iocpub/iocpdf/IODE17_19_sgxml.pdf ). JCOMM should explore the ideas embedded in xml "bricks" as a standard way to organize and preserve information and data.

5. Processing history: Since errors can frequently occur in translations of data between different formats, keeping a copy of the data as originally received is a safe way to guard against transcription errors. There are a few programmes within JCOMM now where retaining a processing history has become standard practice. These programmes will be examined to determine the value of creating and preserving a processing history. JCOMM can then use this advice as a basis for a recommending appropriate usage on a broad scale. DMPA will explore the value of preserving a processing history and recommend broad adoption if appropriate.

6.4 Metadata and Model Data

1. Metadata: At present, the term metadata is used in many ways, with the interpretation being provided by the context of the use. It would be far better to take the approach of developing categories of metadata, and defining the content to suit the purpose. We would then speak of discovery metadata, or transport metadata and both the purpose and content would be clear. DMPA will examine existing metadata initiatives to develop a categorization that aligns with the purpose of the metadata, and use the metadata categorization to develop a plan on which metadata initiatives align with its work and become engaged in these activities.

There is a fairly well described class of metadata that is used for discovery. The information in this class is sufficient for a potential user of data to identify the data collections that exist in their area of interest, in a time frame of interest, in a scientific domain of interest, and perhaps even with
variables of interest. JCOMM should define its requirements for discovery metadata and embody these in a formal metadata structure.

Gathering information on platforms and instruments and keeping the information up to date is not simple. It now relies on the individuals in member states whose job it is to service the platforms or instruments to ensure that changes are recorded quickly. However, it is the role of an international body to be sure that the information is readily available and reflects the most recent information. JCOMM should encourage all agencies keeping information about instruments, platforms, etc., to place this information on-line and keep it up-to-date, and to develop a strategy for managing the international suite of these metadata sources so that they are easily found and used.

2. Model Data: Computer model outputs are closely linked to how the observational data are assimilated into the model and how the computations are carried out by the software. Numerical models can produce large volumes of data since they can provide a continuous, quantitative representation of atmosphere or ocean variability in the four dimensions of space and time. Although research model data are of immediate use to only a small audience, operational models are run on a routine schedule, have characteristics that are fixed for considerable periods of time and hence can be readily documented, have undergone some degree of observational validation, and provide products that are of wider use and distributed to clients on a routine basis. JCOMM must consider the outputs of such operational models as data assets and manage them appropriately. JCOMM must work with the modeling community to define the characteristics that determine which outputs should be archived and to develop cost-effective strategies for the storage and archival of operational model outputs and products. It will be important that appropriate model characteristics such as data assimilation schemes and computational algorithms are archived with model results. JCOMM will collaborate with model developers to decide the long-term value of preserving outputs of retired versions of models.

6.5 Access

1. Discovery: Currently, there is a high level of importance assigned in the international data management community to the construction of catalogues that describe the data held in the large archive centres. Constructing catalogues with the same (or fields that have a 1-1 mapping) contents and linking catalogues by using standards such as ISO-23950 allows queries to cross from one catalogue to another. This achieves interoperability, without the requirement of centralizing the catalogue. These help to address the "data discovery" problem. Another strategy is to exploit existing commercial search engines, such as Google, as the way to locate data. To be effective, there needs to be an agreed standard for how data will be described, perhaps similar to what appears in ISO profiles. JCOMM must pursue the creation of standards for data discovery metadata and encourage these to be used to support interoperable catalogue services and registries, and explore how commercial search engines can be used as another way to search catalogues so that users can use internet tools to locate data.

2. Browse: After potentially useful data collections have been identified, some further exploration usually is required to determine if the archive has the specific data of interest. Generally, the tools needed to support this browse capability are closely tied to the archive in which the data reside. JCOMM must explore the implementation issues of existing or proposed methods for supporting browse functions.

3. Data Delivery: Once the source of data has been identified and the data of interest have been verified to be in the archives, the next step is to provide access to the data. Ideally, this would take place through an interactive query that selects only the data of interest and passes the results directly to the person making the query. Each data archive providing data should examine its ability to provide all of its data holdings on-line and determine what level of support it can bring to bear.

Not all data users will be satisfied by the functionality provided by WIS. There must be agreements on a small but common set of data exchange formats that all sites will offer. DMPA
must keep aware of other, continuing projects to improve the access to data and where possible both participate in the projects and adopt procedures that improve access to JCOMM data.

Because many real-time data are collected through JCOMM programmes, and because JCOMM through cooperation with IODE and WMO has access to the historical record, an argument can be made for developing at least two types of products from the archives. The first is to build climatologies that can be used by all members. A second product is a specialized archive. A good example would be an archive of all of the instrumented wave elevation and wind data where the waves are extreme. The building of such archives needs to be done in close cooperation with appropriate scientific groups. DMPA will consider ways to collaborate or build products that have wide applicability to members.

Not to be forgotten is the importance of the information that describes the instruments used to make the observations, the ways the observations were collected, whatever processing they may have passed through and so on. JCOMM should ensure that all information required for the correct interpretation of data is included when data are delivered to clients.

6.6 Coordination and Linkages

The DMPA is not alone in addressing issues of managing oceanographic and meteorological data in the international arena. On the oceanographic side, the Intergovernmental Oceanographic Data and Information Exchange (IODE, http://www.iode.org/) committee of IOC has operated since 1961 managing many different kinds of data including types common with JCOMM. The difference has been that IODE has concentrated mainly on data that arrive in the data system with significant time delays—up to years in some cases—while the management of the real-time data was left principally to IGOSS. Now, the IODE is a close partner in managing oceanographic data and is a co-sponsor of some of the data management activities of relevance to JCOMM.

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). It is expected that the IODE system will ultimately archive most of the data collected by JCOMM. The JCOMM data management activities, therefore, need to provide data and information to those data centers and work with them to build a complete, global data system.

A more recent initiative of WMO, thus far advanced largely through its Commission for Basic Systems (CBS), is its WMO Information System, WIS (see http://www.wmo.ch/web/www/WISWeb/home.html). This is an overarching approach and a single coordinated global infrastructure for the collection, distribution, retrieval of, and access to data and information of all WMO and related programmes. JCOMM, being co-sponsored by WMO, is a contributor to WIS.

Finally, the creation of the Global Climate Observing System and all of its components places expectations on what JCOMM will provide in support. JCOMM programmes are mentioned in more than 20 of the actions in the GCOS plan (see http://www.wmo.ch/web/gcos/Implementation_Plan_(GCOS).pdf). Of these, some relate directly to the data systems. JCOMM must provide the direction that will ensure these expectations are met.

1. Within JCOMM Activities: The OPA encompasses many at-sea observation programmes. The SPA includes groups with a strong focus on products to support such activities as safe operations at sea or responding to accidents, and they rely on observing programmes. The DMPA has activities that connect directly to these observation programmes. The interaction between the data managers of the different groups has been only through informal discussions with the result that there is only a small degree of commonality. JCOMM should develop a formal mechanism to ensure regular exchanges of information and ideas on how data are managed between the groups in OPA, SPA, and DMPA.
It was recognized early that in creating JCOMM there needed to be links to the satellite community because data so acquired are needed. However, data management in the DMPA is focused on *in situ* observations. There is no intention to duplicate the data management activities that are employed in the satellite community. However, it is important to build bridges to that community so that data handled by JCOMM and data acquired by satellite operators can easily be combined and compared. JCOMM must address interoperability issues with satellite data providers so that satellite and *in situ* data are easily compared.

There is much work to be done in the domain of standards. However, there have already been significant activities by other groups so that all of what is needed may not have to be developed by JCOMM. JCOMM should first adopt an existing standard or best practice, as a second option adapt an existing one, or failing that create its own. To this end, JCOMM must develop a process to adopt, adapt, or create its standard practices. The accreditation process for standards will require both a group to coordinate this activity and assistance by JCOMM members to take part in the evaluation process. JCOMM should develop a process to accredit standards to be recommended for use across all activities. DMPA will develop a plan for coordination of the accreditation process and carrying out of evaluations.

When a standard is adopted, this information must get out to JCOMM members, and they should take steps to implement it. There will, therefore, be a role for communications and a repository for the documentation of the standards used by JCOMM. This could well be served by JCOMMOPS, or some other suitable and widely visible agency. JCOMM must establish a highly visible and accessible repository where information about JCOMM standards can be found. Members will have varied abilities to respond by adopting recommended standards. It is unlikely that a standard will be implemented across all JCOMM members simultaneously. As part of the accreditation process, consideration must be given to how to implement the standard across JCOMM members as rapidly as possible. Due consideration must be given to how capacity building resources may be used to this end. Coordination also must take place with the other programmes in IOC, WMO, regional and national activities.

DMPA will set priority activities each intersessional period and use these as guidance when selecting activities for its members. In collaboration with OPA and SPA, DMPA will implement quarterly reporting of other important variables following the model used by OPA. DMPA will also collaborate with appropriate members of OPA and SPA to develop a set of data system performance metrics and implement standard reporting of these results. These could include measures such as: the percentage of data reporting in real-time with detected problems, the percentage of total data received that report in real-time, the time delays between receiving real-time and delayed mode versions of the same measurements, and the mean time to report a real-time observation (report time – observation time).

2. *With IODE Activities:* There is overlap in both the kinds of data managed by JCOMM and IODE and the time scales on which those data are handled. The full suite of oceanographic and meteorological measurements is large and the work needed to manage the data is diverse. IODE and JCOMM have agreed on relationships between the organizations and members of both groups serve on joint panels. Data management programmes of joint interest to both JCOMM and IODE need to be formally recognized and supported by both organizations to ensure easy access and clearly described content of respective data streams and archives.

3. *With Other IOC Programmes:* There are a number of other programmes and projects within IOC including GOOS and its role as the ocean component in GCOS, GODAE, OOPC, GHRSSST, Argo, etc. JCOMM is involved in many of these. JCOMM and DMPA will move quickly to adopt a data management strategy and to further develop an implementation plan based on the strategy. JCOMM must work closely with other IOC programmes in developing its operating and implementation plans.
Capacity building covers all aspects from assembly of collected data, to processing and quality control, to archiving and providing access to the data. JCOMM must collaborate with existing WMO and IOC capacity building activities to ensure that the marine component is adequately included.

4. With WMO: The WMO Information System (WIS) has an important role to play in providing data (see http://www.wmo.ch/web/www/WISweb/home.html). DMPA and WIS will cooperate to ensure that all components of JCOMM data systems are available to WIS. Also, DMPA will ensure that appropriate experts are fully engaged in appropriate WMO activities.

5. With ICSU World Data Centres (WDCs) and other programmes: On the broadest international level of archives there are the World Data Centres (WDCs, http://www.ngdc.noaa.gov/wdc/wdcmain.html). Just as JCOMM must have close ties to IODE for oceanographic data, it must also have similar ties to the various WDCs managing data of interest. Indeed, the issues of standards, archives, and access all apply to consideration of interactions with WDCs as well. JCOMM should take the opportunity to build stronger ties. DMPA will initiate discussions with WDCs to build stronger links between the observing and archive systems. JCOMM members should support the timely assembly of data in WDCs and encourage timely updates and distribution of the global data sets and climatologies. JCOMM must also develop a level of interoperability in data management with other major international and significant national programmes.

6.7 Communications

One way to provide information is to use the Internet and WWW technology. JCOMM already has a web site. There are also sites, e.g. http://wmo.jcommops.org/cgi-bin/WebObjects/JCOMMOPS and http://icoads.noaa.gov/etmc/, associated with specific programmes or Expert Teams. Within these sites, it will be necessary to have additional pages that provide information about standards adopted by JCOMM, about how to connect to data and information, to the work programme and to results from the DMPA. DMPA will design and populate web pages that explain its activities, and provide members to attend meetings of other organizations and committees whose interests intersect.

7. An Integrated Approach: Integration and Interoperability

7.1 Integration and Interoperability

As noted in foregoing sections, the assignment to JCOMM of overall responsibility for coordinating and facilitating the implementation and maintenance, on an operational basis, of the observational elements described clearly brings a new level of integration to these ongoing programmes and paves the way for continued integration of other appropriate elements as required. Consequently, JCOMM significantly advances the long-term goal of a fully integrated ocean observing system—one that provides easy access to detailed observations of the temporal and spatial structure of the oceans and overlying atmosphere and thus supports responsible management of the marine environment, its resources and the ecosystem. Four examples of integration and interoperability are provided in the following sub-sections.

7.2 Example: Satellite Data Requirements

Remote sensing, and in particular satellite space-based sensing, is important across all the Programme Areas. The data play an increasingly important role in the realization of the goals and work programme of JCOMM. Therefore, JCOMM has designated for each of the Programme Area Coordination Groups, an expert on satellite data, with two such experts in the Observations Programme Area, bringing both a meteorological and oceanographic perspective. These four experts form a crosscutting and integrative Team on Satellite Data Requirements; the team’s chair is designated to represent the team on and provide appropriate advice to the Management Committee. The chair also is responsible for organizing satellite/remote sensing data
requirements within the Commission, through coordination of the work and inputs of the other experts, as well as through liaison with other external bodies.

Specifically, working through the Team on Satellite Data Requirements, JCOMM is responsible for collecting and integrating the space-based remote sensing requirements that are essential for JCOMM services and products. It advises JCOMM subsidiary bodies on satellite/remote-sensing matters, within each PA, such as the distribution and dissemination of satellite data and relevant data products. It also maintains JCOMM satellite remote sensing data requirements based on regular contact with CGMS, the WMO Space Programme, the IOC Remote Sensing Plan, CEOS, the relevant IGOS Themes, the WMO high level policy meetings, the COOP and OOPC, and other appropriate groups.

7.3 Example: Capacity Building

The JCOMM capacity building strategy integrates by first determining national and regional needs and then addressing identified deficiencies in knowledge, skills, observing and telecommunications systems, data management and services. The implementation of this strategy will, however, necessitate carefully targeted initiatives, the pursuit of mutual cooperation, and the aggressive development of partnerships with national governments, donors and international organizations. To achieve these objectives, JCOMM Capacity Building will work closely with the capacity building programmes of the WMO and IOC as well as identify other potential sources of funding as feasible. Capacity Building within IOC is coordinated through the Training, Education and Mutual Assistance (TEMA) programme. Similarly, within WMO, capacity building generally is coordinated and implemented through the Education and Training and Technical Cooperation Programmes. JCOMM will continue to work closely with these broader CB programmes, and adapt as required to their evolving mandates.

JCOMM will assist countries to enhance their capacities in marine data collection, data management and provision of marine meteorological and oceanographic services. Building capacity is a high priority activity directed at ensuring that maritime nations can not only contribute meaningfully to JCOMM’s various programmes but also gain optimum benefits from the global observing system. In structural terms, the JCOMM Capacity Building activity is supported by and delivered through three Capacity Building Rapporteurs, attached to each of the three Programme Areas, and reporting to the Management Committee through a single designated representative. In direct consultation and cooperation with the three Programme Areas, the JCOMM capacity building activity has the mandate to coordinate the delivery of training, facilitate the transfer of technology, assist in providing equipment and work closely with the capacity building programmes of donor countries and other UN Agencies.

7.4 Example: GODAE

An example of the integration and incorporation of new elements comes from the interaction of JCOMM and the Global Ocean Data Assimilation Experiment (GODAE). GODAE conducted its main demonstration phase from 2003 to 2006. Operational and research institutions from Australia, Japan, United States, United Kingdom, France and Norway performed global oceanic data assimilation and ocean forecasts to provide regular and comprehensive descriptions of ocean fields such as temperature, salinity and currents at high temporal and spatial resolution. This demonstration phase was followed by a consolidation and transition phase from 2005 to 2008 focused on synthesis and transition to operational systems.

Climate and seasonal forecasting, navy applications, marine safety, fisheries, the offshore industry and management of shelf/coastal areas are among the expected beneficiaries of GODAE. The integrated description of the ocean that GODAE models provide also will be highly beneficial to the research community. Of importance is the need for JCOMM to help transition appropriate GODAE capability into an operational system environment.

7.5 Example: Argo
The Argo programme is a good example of integration and interoperability. Argo uses autonomous profiling floats to collect temperature and salinity data from the upper 2000 m of the world’s ice-free oceans and velocity data primarily from the ocean interior, usually at 1000 m, and from the sea surface. Argo was co-sponsored by the WCRP’s Climate Variability and Predictability project (CLIVAR) and by the Global Ocean Data Assimilation Experiment (GODAE). Argo is an integral part of the Global Ocean Observing System (GOOS) and is specifically designed to complement the satellite radar altimetry data from JASON. Float deployment demonstrates the international cooperative spirit of Argo—twenty-seven countries are participating at this time.

The project is overseen by the Argo Steering Team and the Argo Data Management Team. Argo currently has over 3000 floats deployed in the world ocean, meeting the initial goal, which is needed to maintain a 3° x 3° array. The array has grown steadily since the first floats were deployed in 1999, and achieved global coverage in late 2004.

8. Communications Strategy

8.1 Introduction

The preceding chapters have shown that JCOMM promotes a state-of-the-art globally distributed and inter-connected system based on present and next-generation technologies and capabilities. The system must be responsive to the evolving needs of all users of marine data and products and a close dialog with the user community is fundamental to the system design. In addition, JCOMM promotes the implementation of an outreach programme to enhance the national capacity of all maritime countries to work effectively for the maritime community and the management of the marine environment.

Thus effectiveness in communicating the availability of data and services to, and in receiving feedback from, potential clients is as fundamental to the success of JCOMM and its members as the actual delivery of the products themselves. In consequence, JCOMM will devote continuing efforts to the dissemination of information on its various programmes, activities and initiatives to the broader client community around the world in both a “push” mode, where information is directed to specific audiences, and in a “pull” mode, relying on the user to obtain information.

8.2 Current Communications Activity

To sensitize the marine community to the vital role that JCOMM now plays in operational oceanography and marine meteorology, and to provide easy access to updated information on its programmes, meetings and reports, a JCOMM web site and internet portal is under development at the address: http://www.jcomm.info.

JCOMMOPS, an operationally oriented centre, has also been established to provide direct technical support to observational system components such as Argo, SOOP, the VOS and ocean data buoys, as well as associated satellite data collection systems. The JCOMMOPS web site address is: http://www.jcommops.org/. As more and more products become available and are required to be distributed, these will be disseminated through a distributed network of operational centres, accessed through a dedicated JCOMM Products Web Portal.

8.3 Communications Strategy to be Implemented

The communications plan for JCOMM will rely primarily on the worldwide web as the medium, using other media such as the JCOMM newsletter and an updated brochure as needs are defined and resources made available. The JCOMM newsletter, which is distributed via email to a broad community, will be sent out on a quarterly basis and will include summary information of new web content. The initial JCOMM Communications Strategy (approved at MAN-V) will be placed on the JCOMM website. A summary of the elements of the plan, covering inreach, outreach, capacity
building, web sites, and other means of communication is provided below, followed by a list of action items.

**Inreach** refers to the communication of information regarding JCOMM among the planners, developers, and operators of the system, i.e., what we might call “the JCOMM family.” Inreach information certainly should be of interest and assistance to: the Management Committee; the Joint Secretariat; members of the Programme Area Coordination Groups and their sub-bodies; JCOMM Task Teams, cross-cutting teams, and ad hoc groups; the many individuals working to produce measurements, products, or data management techniques that contribute to JCOMM; and representatives of nations participating in the Commission itself.

**Outreach** refers to the need for JCOMM to communicate with a wider audience, including notably those entities that might become general users of, contributors to, or advocates for JCOMM and the entire ocean observing system, but that are not now participating in the system. Members of that audience include: decision makers in the private sector and at all levels of government; users or potential users of JCOMM information (government, public, NGOs, private sector, academic/research); potential participants in the system; possible advocates for the system, and other interested parties.

**Capacity Building** information refers to information that JCOMM wishes to share with all entities involved or potentially involved with JCOMM capacity building. The audience for such information includes: representatives in developing and developed countries; potential donors; developers of and participants in capacity building projects; risk management agencies; individual capacity building experts; academic/research institutions and members; private firms; and NGOs.

**JCOMM Web Sites: the “pull” mode**

One main web site is envisioned that is clearly partitioned so that users may easily select the type of information they are seeking: inreach, outreach, capacity building, or work-in-progress (shared files and work space). This web site will have the URL http://www.jcomm.info. The homepage will have a clear, concise guide to the site with four links. Each of the four divisional home pages should contain common JCOMM information and a clear statement of the intended uses, including examples, of that division. There are/will be many secondary or related (ancillary) JCOMM websites, focused on more specialized types of information (e.g., the three Programme Areas, the subsidiary bodies of the Programme Areas, projects in which JCOMM is involved, etc), that will be of interest to JCOMM audiences.

The site www.jcomm.info will be maintained by the Joint Secretariat and hosted by the IOC Project Office for IODE in Ostend, Belgium using the same dynamic content management system technology as the GOOS and IODE web sites. The shared responsibility of the Joint Secretariat will include maintaining the technology (hardware and software); preparing and/or placing materials on the site; selecting links to ancillary sites; contacting web managers of ancillary sites as necessary; and controlling access to all sectors of the site (by external content providers/content editors).

**Other Communication Media: the “push” mode**

All the following "push" mode of information dissemination should appear on the main JCOMM website:

- **JCOMM Newsletter.** The JCOMM Newsletter is distributed through email and available on the web. A user survey might be employed to determine ways in which it could be improved for users.
- **Brochures.** A general JCOMM brochure should be prepared and up-to-date copies maintained for distribution at meetings, trade shows, and smaller, focused conferences.
- **Written Presentations.** Op-ed pieces and other popular media articles as well as conference proceedings, trade journal articles, and refereed papers are financially relatively inexpensive, but need to be carefully targeted.
- **Oral Presentations.** Presentations at professional and trade association meetings with emphasis on the more general plenary talks.
8.4 Implementation Action Items

- The site www.jcomm.info will be hosted by the IOC Project Office for IODE in Ostend, Belgium.
- Materials for the inreach and capacity building divisions will be prepared by the Joint Secretariat.
- The technical requirements for the “work in progress” division will require further investigation by the Joint Secretariat and IOC Project Office for IODE information technology team.

A www.jcomm-services.org web site has been developed by the Coordinator of the SPA using an “events”, “people” and “documents” content type management function. Consideration should be given to whether ancillary sites may be needed for the Operations and Data Management Programme Areas. The Joint Secretariat, DMPA and OPA Coordinators and the IOC Project Office for IODE information technology team will need to discuss whether these sites will utilize the same technology framework as the www.jcomm.info site and be hosted at the IOC Project Office for IODE in Ostend. Note also that a considerable number of contacts will have to be made, both initially and on a continuing basis, to reach all appropriate managers of ancillary links to promote JCOMM identification and remove redundancy. Note also that implementation of the outreach division of www.jcomm.info site requires information and expertise currently not available at the Joint Secretariat.

In addition, JCOMM should carry out a comprehensive needs analysis for outreach audiences (as decided at MAN-V) and hire a consultant to conduct the analysis with the following terms of reference: to contact the audiences who would use the outreach web (decision makers, private sector, government agencies, NGOs, and news media;) to contact the audiences who would use the capacity building web (e.g., donor agencies, individual experts, training groups); to suggest types of information that these audiences need; and to prepare an initial description of the outreach web division. Internationalization of the outreach division also may require preparation of multi-language versions of general background materials and selection of links, based in part on the results of the needs analysis of the outreach audience sectors.

9. External Interactions

9.1 Complementarity with IOC and WMO Bodies

JCOMM is, by definition, a body dealing with concerns covering the global ocean, and thus relevant to all Member States of IOC and WMO maritime Members. On the other hand, the WMO Regional Associations and IOC Sub-Commissions are concerned primarily with issues relating to their specific regions or national groupings. Therefore, in many cases JCOMM implementation (e.g., in the case of implementing observing system elements) is best coordinated at the regional level, while many of the benefits of JCOMM, such as specific regional products and services, are delivered at the regional or even national level. It is therefore important for JCOMM to engage with these regional subsidiary bodies at various levels to ensure that the interactions are both two-way and mutually beneficial.

The WMO Regional Associations (RAs) all have established Regional Rapporteurs on Marine Meteorological and Oceanographic Services. These rapporteurs provide a basic network for JCOMM to interact with the RAs; they should be closely involved with the work of all Programme Areas. Similarly, the DBCP, within the Observations Programme Area, has established a number of regionally-based Action Groups, which are proving very effective in entraining smaller countries into buoy programmes and in implementing such programmes through regionally coordinated deployments. Mechanisms such as these must also be found to enhance JCOMM interaction with the IOC Sub-Commissions.
As one of the Technical Commissions of WMO, JCOMM must ensure complementarity with and synergy from the activities of other WMO Technical Commissions, as well as those of other WMO Programmes such as the World Weather Watch, Space and Natural Disaster Prevention, and Mitigation Programmes. The JCOMM Satellite Data Requirements Team will interact with WMO’s Space Programme to promote the marine applications of satellite observations and to influence the space agencies in decisions on technologies, on the type of satellites and deployment schedules, and on their data policies. A common challenge for all WMO activities is the development and implementation of the WMO Information System (WIS) as an effective and efficient data and information system. JCOMM must contribute to this activity.

There will be a number of overlapping elements between JCOMM and other programmes and Committees of IOC. These include the International Ocean Carbon Coordination Project on ocean carbon monitoring, oceanographic instrument and measurement standards with the IOC Ocean Science programme, ocean data management with IODE, and capacity building with the TEMA programme. JCOMM must strive to ensure economies of scale and work closely with these programmes.

With regard specifically to the implementation of GOOS, while JCOMM is responsible for coordinating such implementation for global elements, in particular relating to climate and similar issues, the GOOS Regional Alliances (GRAs) have a major role to play in implementation at the regional level, in particular with elements of the design for coastal work. It is thus important that interactions between JCOMM and the GRAs are enhanced, and perhaps formalized, to ensure maximum synergy and minimum overlap of effort.

JCOMM should enhance its participation in the IODE’s regional networks for data management, namely the Oceanographic Data and Information Network (ODIN) initiative. JCOMM’s data management strategy will include strong collaboration among the meteorological service delivery within WMO Regional Associations, the modified specialized oceanographic centres providing marine data and products, the IODE centres (ODIN centres) and the World Data Centres of ICSU.

9.2 External Interactions, Governmental, and Non-Governmental Global Organizations
JCOMM is closely linked to many international, intergovernmental, and non-governmental science bodies and organizations. It is through these close-working relationships that JCOMM can continue to gain maximum leverage for the entire range of activities it undertakes. In addition, the private sector is already, or has the potential to be, a major user of, advocate for, and partner in the data products and services flowing from the work of JCOMM. The Commission must therefore strengthen and further develop its links with the private sector in marine observing systems, data management, products and services.

JCOMM must also strive to contribute to and benefit from the contributions of WMO and IOC to external programmes that are relevant to JCOMM, such as the Global Earth Observing System of Systems (GEOSS), the International Polar Year, and others.

JCOMM has much in common with other international and intergovernmental organizations such as the International Maritime Organization (IMO), the International Hydrographic Organization (IHO), the United Nations Environment Programme (UNEP), United Nations Food and Agriculture Organization, the International Council for the Exploration of the Sea, the North Pacific Marine Science Organization, the North Atlantic Fisheries Organization, as well as non-governmental ones such as the Partnership for Observations of the Global Ocean. Through cross membership in working groups and implementation teams, and through co-sponsorship of activities, JCOMM will ensure that it provides support to and benefits from the work of these organizations.

9.3 Links to Science Programmes
Because JCOMM is a technical implementation body, it must rely on science programmes for scientific and technical directions. Such input will be necessary on many fronts, including: setting standards for instrumentation and data collection, data transmission, products, quality control and
others. Science programmes also provide opportunities to develop pilot studies, instruments and infrastructure. Consequently, JCOMM must interact with global and regional science programmes beginning at their conceptual stage. In general, this can be achieved by direct cross-involvement of key representatives from these programmes in the relevant organs of JCOMM, or cross-membership of bodies, panels, teams, etc. where mutual interest is strong and potential benefit is high.

At the same time, and as is already the case for the WWW and atmospheric research, JCOMM facilitates the provision, through the operational ocean observing system and related infrastructure, of a basic structure to support ocean science and to which science programmes can add specific elements as required. Ultimately, if this proves cost-effective, such elements may in turn be absorbed into the operational structure.

JCOMM already has formal links to the GOOS scientific design bodies, GSSC, OOPC and COOP, through their representation on the Management Committee, which in turn provide links to the ocean science community and programmes such as WCRP/CLIVAR/CLiC, GODAE, LOICZ and SOLAS. At the same time, JCOMM, through its Management Committee, needs to consider how interactions with these communities and programmes can be enhanced, so ensuring that JCOMM can contribute to their implementation and also benefit from these programmes. An existing example of an effective interaction mechanism is the work of the DBCP (and JCOMMOPS), which supports both operational and research buoy deployments, and where the annual technical workshop provides a forum for the sharing of scientific and technical information on ocean data buoys and applications.

JCOMM already has an active involvement in global sea ice activities through the work of the SPA Expert Team on Sea Ice, as well as an involvement in polar region observing through the DBCP. And, it has expressed the wish to enhance its involvement in and support for other areas of polar science and operations, including polar oceanography and the International Polar Year.

9.4 Engagement of the Private Sector

JCOMM, through the former CMM, has inherited and maintains reasonably close interactions with some components of the private sector. These components include notably:

- Commercial shipping, through the International Chamber of Shipping, is both a service user (primarily maritime safety services) and also a data provider (the VOS);
- The offshore oil and gas industry, through the International Association of Oil and Gas Producers, is a major specialized service user (services normally provided through the private sector) and occasional data provider or collaborator;
- Some equipment manufacturers and vendors, through direct involvement with component panels of the Observations Programme Area (DBCP, SOT); and
- Providers of marine telecommunications systems, notably Inmarsat Ltd. and CLS/Service Argos.

Nevertheless, there remains considerable potential for benefits to both sides through enhancing the interactions between JCOMM and the private sector. Such involvement can take many forms of private sector action, including the design, manufacture and sale of observing system equipment; the possible operation of observing systems and the supply of data; and the use of data and products, derived from national agencies within the context of JCOMM programmes, to prepare improved or secondary products for sale to end users.

At the same time, it is likely that the private sector will wish to be actively involved in the planning, governance, and implementation of the overall system. Through such means, it is also likely that
the private sector could become a potentially powerful advocate for the full implementation of government funded, marine observing and data management systems.

JCOMM will therefore actively seek to enhance its involvement with the private sector, at the strategic level through the Management Committee, and at the working and implementation level through the Programme Area Coordination Groups and component expert teams and panels. An initial approach to this was through the establishment of a high-level industry panel under the Management Committee. This has evolved into a JCOMM/GOOS Advocacy Panel consisting of industry representatives meeting regularly by telephone to consider and carry our approaches to enhance private sector understanding of the goals of GOOS and JCOMM at high levels of management and to encourage advocacy by that level for the global observing system.

It is important to note that in addition to physical observations already included JCOMM has expressed willingness to take on the oversight and coordination of non-physical observations, data management and services.

10. Future Evolution of JCOMM

10.1 Evolving to Meet Future Needs

JCOMM, in both conceptual and management terms, is an ambitious and complex endeavour. At the same time, it holds the prospect of considerable potential benefits to all countries in the long-term operation of a coordinated, integrated, global oceanographic and marine meteorological observing, data management and services system. These benefits including supplying the basis for the provision of value-added data, products and services to virtually all sectors of society, both maritime and land-based. The full implementation of the Commission’s programme, the achievement of its objectives, and its future evolution, is therefore a long-term, complex process, necessitating a phased and iterative approach.

The first step in JCOMM implementation was to integrate and rationalize the relevant elements of CMM and IGOSS under the new Commission and thus create an organizational structure that resulted in efficiencies and economies of scale. This integrating process was further advanced at the first session of the Commission, through the introduction of measures, such as the formation of the Ship Observations Team (SOT) by merging the existing SOOP, VOS and ASAP Panels, all concerned in some way with the use of volunteer ships as marine observation platforms.

However, CMM and IGOSS, and thus the initial JCOMM, dealt with only standard physical variables. For JCOMM to be effective, it must consider an evolution to meet all the current and future needs of global operational oceanography and meteorology, including non-physical variables. Already, some of these needs have been identified, e.g., the design and implementation plans prepared by the Coastal Ocean Observations Panel (COOP) of GOOS. As stated in Section 9, JCOMM has expressed a willingness to consider the conditions under which it could take on the oversight and coordination of non-physical observations, data management, and services, as these need more operational support.

Such evolution will take many forms, including incorporation of new Expert/Task Teams, establishment of pilot projects, partnerships with other organizations within and outside the UN system, establishment of specialized centres and regional groupings to deliver the services, facilitating intergovernmental agreements to allow access to data, products, information and services, and capacity building and capacity enhancements. Periodic review of JCOMM is an essential step in its development.

10.2 Incorporation of New Elements
As noted in the previous Section 10.2, the current JCOMM structure is just the starting point. There are already many elements that are at varying stages of development and that will be required to be incorporated under JCOMM in coming years.

For the incorporation of new elements (essentially moving from pilot projects to operations), close coordination between those operating the pilot project and wishing to transition it to operational status and the appropriate PA(s) of JCOMM. JCOMM has made clear the conditions under which it would be willing to incorporate a particular observing system element (say a new programme of observations) into its program. The conditions for a new sampling programme would include a well-tested sampling approach, a team willing to take forward the activity on a continuing basis, financial support for such continuing operations, established methodology for data assurance and quality control, a tested approach.

Several key phases involved in implementing new elements of JCOMM are described in more detail in the following notes.

- All requirements and scientific, technical, organizational and procedural specifications associated with establishing the element within JCOMM should be determined.
- The feasibility of proceeding, and the appropriate pathway/model to migrate the concept from the pilot to the operational stage must be evaluated.
- The capacity/training needs and formulation of appropriate skill development or enhancement activities must be identified.
- The new element must be accommodated within JCOMM, either within an existing programme, team or activity, or within such after required changes are made.
- The progress of pre- and post-operational stages must be monitored and reviewed, including both quantitative and qualitative measures of the performance and success of the added element, by both internal and external stakeholders.

Again to summarize, JCOMM will need to be involved to some degree in all phases to effectively transition an element into operational status as a JCOMM Programme.

10.3 Evolution of the Overall JCOMM Structure

In view of the operational nature of the activities facilitated, coordinated and supported by JCOMM, which implies an ongoing, long-term, support infrastructure, it is to be expected that much of the basic JCOMM sub-structure will also be relatively long-term in nature. Nevertheless, there will always be developments and changes in requirements, emphasis and priorities for JCOMM, within the context of continuing limited resources. Therefore, the Commission should have in place, and be prepared to use, a mechanism to adapt to these developments and changes, and in particular to modify its structure as necessary to respond to new priorities and the maturing of ongoing work.

Formally, it is the Commission itself, in session, which decides on the format and membership of its structure, on advice from the Management Committee. In practice, the co-presidents of the Commission, advised by the Management Committee, will continuously review the operations of the structure, to ensure that it meets the needs and priorities of JCOMM, and make both tactical and strategic decisions for any modifications as required.

Annexes:

A.1 History and Background
The WMO partnership with the Intergovernmental Oceanographic Commission (IOC) of UNESCO officially started in 1999, when JCOMM was established. Prior to 1999, marine meteorological and oceanographic observations, data management and service provision programmes were internationally coordinated by two separate bodies: the World Meteorological Organization (WMO), through its Commission for Marine Meteorology (CMM), and UNESCO's Intergovernmental Oceanographic Commission (IOC) jointly with WMO through the Committee for the Integrated Global Ocean Services System (IGOSS). While enhancing safety at sea remained the primary objective of marine forecast and warning programmes, requirements for data and services steadily expanded in volume and breadth during the preceding decades. Other applications such as coastal area management, sustainable management of commercial fishing activities, ship routing, offshore resource exploration and development, pollution monitoring, prevention and clean-up and, most recently, climate modeling and prediction, became increasingly important. Moreover, many of these applications required observational data sets and prognostic products for both the oceans and the overlying atmosphere.

Responding to these interdisciplinary requirements necessitated the development of ever closer working relationships between oceanographers and marine meteorologists. This was reflected at the global level by growing collaboration between the IOC and the WMO in organizing and coordinating ocean data acquisition, data management, the provision of related services, and associated capacity building needs. The increasingly close relationship between the two agencies' operational activities in the oceans culminated when the Thirteenth WMO Congress (May 1999) and the 20th IOC Assembly (July 1999) formally agreed that a new WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) should be established, initially through the merger of CMM and IGOSS. This new body brought together the marine meteorological and oceanographic communities into a common global, intergovernmental forum, charged with overall responsibility for coordinating worldwide marine meteorological and oceanographic services and their supporting observational and data management programmes.

A.2 Terms of Reference for the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) (Annex to WMO Resolution XX-12)

The Technical Commission shall be responsible for matters relating to:

1. Further development of the observing networks
   Under the guidance of the relevant scientific and operational programmes of IOC and WMO, development, maintenance, co-ordination and guidance of the operation of the global marine meteorological and oceanographic observing systems and supporting communications facilities of these organizations to meet the needs of the IOC and WMO Programmes and in particular of the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS) and the World Weather Watch (WWW). Evaluation on a continuing basis of the efficiency of the overall observing system and suggesting and co-ordinating changes designed to improve it.

2. Implementation of data management systems
   Development and implementation, in co-operation with the Commission for Basic Systems (CBS), the Committee for International Oceanographic Data and Information Exchange (IODE), the International Council of Scientific Unions (ICSU), and other appropriate data management bodies, end to end data management systems to meet the real-time operational needs of the present operational systems and the global observing systems; co-operation with these bodies in seeking commitments for operation of the necessary national compilation, quality control, and analysis centres to implement data flows necessary for users at time scales appropriate to their needs.

3. Delivery of products and services
   Provision of guidance, assistance and encouragement for the national and international analysis centres, in co-operation with other appropriate bodies, to prepare and deliver the data products and services needed by the international science and operational programmes, Members of WMO, and Member States of IOC. Monitoring of the use of observations and derived products and

4. Provision of capacity building to Member States
Review and analysis of the needs of Member States of IOC and Members of WMO for education and training, and for technology transfer and implementation support in the areas of responsibility of the technical commission. Provision of the necessary technical publications, guidance material, and expert lecturers/trainers and operation of workshops as required to meet the needs. Development of projects to enhance Member States capacity to participate in and benefit from marine meteorological and oceanographic programmes of WMO and IOC.

5. Assistance in the documentation and management of the data in international systems
Development of co-operative arrangements with the data management bodies of IOC, ICSU, and WMO, such as IODE, the Commission for Climatology, and the ICSU World Data Centres to provide for comprehensive data sets (comprising both real-time and delayed mode data) with a high level of quality control, long term documentation and archival of the data, as required to meet the needs of secondary users of the data for future long term studies.

These responsibilities exclude those aspects specifically handled by other WMO constituent bodies or equivalent bodies of IOC.

JCOMM meets its mandate through:

Further development of the observing networks under the guidance of the WMO-IOC-UNEP-ICSU Global Ocean Observing System, the WMO-IOC-UNEP-ICSU Global Climate Observing System, the World Weather Watch and other operational programmes, and cooperation with these bodies in seeking commitments for all components of an operational programme in the global oceans.

Implementation of integrated end-to-end data management systems in collaboration with the WMO Commission for Basic Systems, the Committee for International Oceanographic Data and Information Exchange, the International Council of Scientific Unions, and other appropriate data management bodies, to meet the real-time operational needs of the present operational systems and the global observing systems.

Delivery of products and services needed by international science and operational programmes, Members of WMO, and Member States of IOC. An important component of this will be the coordination of the safety-related marine meteorological and associated oceanographic services as an integral part of the Global Maritime Distress and Safety System of the International Convention for the Safety of Life at Sea.

Provision of capacity building through education, training, technology transfer and implementation support to Member States.

Establishment and enhancement of partnerships, liaison and collaboration with other global programmes and international agencies both within and outside the UN system.

A.3 Acronyms

ASAP—Automated Shipboard Aerological Programme
BUFR—Binary Universal Form for the Representation of meteorological data
CB—Capacity Building
CBS—Commission for Basic Systems (WMO)
CliC—Climate and Cryosphere
CLIVAR—Climate Variability and Predictability
CMM—Commission for Marine Meteorology (WMO)
COOP—Coastal Ocean Observing Panel (GOOS)
DBCP—Data Buoy Co-operation Panel
DMPA—Data Management Programme Area
DORIS—Doppler Orbitography and Radio-positioning Integrated by Satellite, French precision navigation system
EC—Executive Council
ETMAES—Expert Team on Marine Accident Emergency Response
ETMSS—Expert Team on Maritime Safety Services
ETOOFS—Expert Team on Operational Ocean Forecast Systems
ETSI—Expert Team on Sea Ice
ETWS—Expert Team on Wind Waves and Storm Surges
ETMSS—Expert Team on Maritime Safety Services
GCOS—Global Climate Observing System (WMO, IOC, UNEP, ICSU)
GDP—Global Drifter Programme
GEO—Group on Earth Observations
GEOSS—Global Earth Observation System of Systems
GLOSS—Global Sea-Level Observing System
GMDSS—Global Maritime Distress and Safety System (IMO)
GODAE—Global Ocean Data Assimilation Experiment
GOOS—Global Ocean Observing System (WMO, IOC, UNEP, ICSU)
GPS—NAVSTAR global positioning system
GRA—GOOS Regional Alliance
GSSC—GOOS Scientific Steering Committee
GTS—Global Telecommunication System (WWW)
HF—High Frequency
ICSU—International Council for Science
IGOSS—Integrated Global Ocean Services System (of WMO and IOC)
IHO—International Hydrographic Organization
IMO—International Maritime Organization
IMSO—International Mobile Satellite Organization
IOC—Intergovernmental Oceanographic Commission of UNESCO
IODE—International Oceanographic Data and Information Exchange
JCOMM—WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS—JCOMM in situ Observing Platform Support Centre
LOICZ—Land-Ocean Interaction in the Coastal Zone
NAVTEx—International system for reception of marine safety information
NPOESS—National Polar-orbiting Operational Environmental Satellite System (USA)
OceanSITES—The name for a worldwide system of long-term, deepwater reference stations
ODIN—Oceanographic Data and Information Network (IODE)
OOPC—Ocean Observations Panel for Climate (GOOS, GCOS and WCRP)
OPA—Observations Programme Area
OSMC—Observation System Monitoring System (maintained for JCOMM by the National Oceanic and Atmospheric Administration)
PA—Programme Area
PIRATA—Prediction and Research Moored Array in the Atlantic (tropical)
RA—Regional Association (WMO)
RSMC—Regional Specialized Meteorological Centre
SCG—Services Coordination Group (JCOMM)
SOLAS—International Convention for the Safety of Life at Sea
SOOP—Ship-Of-Opportunity Programme
SOT—Ship Observations Team
SPA—Services Programme Area
TACs—Traditional Alphanumeric Code forms
TAO—Tropical Atmosphere Ocean project
TDCs—Table-Driven Codes
TEMA—IOC Programme for Training, Education and Mutual Assistance in the Marine Sciences
TIP—Tropical Moored Buoy Implementation Panel
TOPEX/Poseidon—High-precision satellite altimeter mission
TRITON—TRIangle Trans-Ocean buoy Network in western equatorial Atlantic and eastern equatorial Indian oceans
UN—United Nations
UNEP—United Nations Environment Programme
UNESCO—United Nations Educational, Scientific and Cultural Organization
VOS—Voluntary Observing Ship
VOSClim—Volunteer Observing Ship Climate Project
WCP—World Climate Programme
WCRP—World Climate Research Programme (WMO, IOC, ICSU)
WIGOS—WMO Integrated Global Observing Systems
WIS—WMO Information System
WMO—World Meteorological Organization
WWW—World Weather Watch (WMO)
XBT—Expendable Bathythermograph