JCOMM OBSERVATIONS COORDINATION GROUP

SECOND SESSION

Geneva, Switzerland, 23-25 April 2007

FINAL REPORT

JCOMM Meeting Report No. 53

WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)

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NOTE

C O N T E N T S

EXECUTIVE SUMMARY

The Second Session of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) Observations Coordination Group (DMCG) met in Geneva, Switzerland, at the WMO Secretariat Headquarters from 23 to 25 April 2007.

The Group reviewed the status of the different observing system components in light of GOOS and GCOS implementation requirements. The meeting agreed that much work remained for reaching the desired global network coverage and optimize geographical distribution of the instruments deployed.

While JCOMM OPA requirements primarily address climate requirements, the Group also addressed requirements arising from global operational oceanography, marine services, and Numerical Weather Prediction. It made recommendations to the JCOMM Services Coordination Group for better documenting the requirements, and for updating the JCOMM Statement of Guidance for Ocean Applications in order for such requirements to be properly included in the OPA strategic workplan. The OGC requested that the SPA recommend the priority for wave measurements.

The Group addressed requirements for satellite data and agreed that one could build on GHRSST success to address other variables such as altimetry, and surface vector wind. However, proper governance for related Pilot Projects would have to be proposed by JCOMM in order to move forward. The meeting also welcomed the offer from Eric Lindstron to work at a JCOMM Satellite Requirements Reference Document.

Major topic of discussion at the meeting was the development of an international Observing Programme Support Centre (OPSC). The Group discussed and agreed on a proposed announcement and call for Letters of Intent (LOI) to host an OPSC.

The Group reviewed the action items resulting from the Second session of JCOMM as well as from the fifth Session of the JCOMM Management Committee.

The Group updated the OPA Strategic workplan taking into account user requirements and priorities. Yet, work remained to be made in order to address the realistic targets for 2012 (instead of 2010) and consider requirements for ocean applications and numerical weather prediction.

GENERAL SUMMARY OF THE WORK OF THE SESSION

1. Opening of the session

1.1 The second session of the Observations Coordination Group (OCG) of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) was opened at 09.00 hours on Monday, 23 April 2007, WMO Headquarters Conference Room 7L, Geneva, by Mr Mike Johnson, meeting chair and coordinator of the OCG.

1.2 On behalf of the Secretary-General of WMO, Mr Michel Jarraud, and the Executive Secretary IOC, Dr Patricio Bernal, Dr Georgi Kortchev welcomed the participants to the meeting.

1.3 The meeting reviewed the agenda for the meeting and adopted it (***Annex I***). The list of participants is given in ***Annex II***.

2. Reports on cross-cutting issues (reports 20 minutes each)

2.1 Goals of the meeting

2.1.1The Observations Programme Area Coordinator, Mr Mike Johnson, recalled that the JCOMM Observations Programme Area strategic workplan (***Annex III***
) was in place and layed out an initial strategy for phased implementation of JCOMM/OPA contributions to the composite global ocean observing system as defined in the GCOS *Implementation Plan for the Global Observing System for Climate in support of the UNFCCC* (GCOS-92). GCOS-92 has been endorsed by the UNFCCC, and the ocean chapter has been endorsed as the ocean backbone of the Global Earth Observation System of Systems (GEOSS). Implementation Targets are designed for climate but also serve global weather prediction, global and coastal ocean prediction, marine transportation, marine hazards warning, marine environmental monitoring, naval applications, and many other non-climate users.

2.1.2 Mr Johnson reported that 57% of the global observing system was completed, a figure slighlty behind the initial objective of 60% for 2006. The drifter network was completed and the Argo network was going towards completion by end of 2007.

2.1.3 He then outlined the goals of the meeting, focusing on system-wide requirements and coordinated, system-wide solutions. Resources to meet implementation targets will be an issue to discuss during the meeting. He explained that the review of JCOMMOPS requested by JCOMM-III was effectively being considered though the proposal to move towards an Observing Programme Support Centre (OPSC). A number of cross cutting issues will have to be addressed, including (i) data dissemination, management and QC; (ii) standards and best practices references; (iii) capacity building; (iv) the WMO Information System (WIS); (v) the WMO Integrated Global Observing System (WIGOS); (vi) satellite data requirements and satellite systems;,(vii) satellite telecommunications; and (viii) relationship of JCOMM to GOOS Regional Alliances.

2.1.4 Mr Johnson presented a brief status of JCOMM component programmes: DBCP (inc TIP), SOT, GLOSS, and the JCOMM affiliated programmes Argo, OceanSITES, IOOCP. The chairs of the component and associated teams highlighted topics and cross-cutting issues within their respective groups that require action or discussion by the OCG.

2.1.5 The meeting invited OCG members to comment within two weeks on consideration of the OPA strategic implementation plan into the JCOMM strategic plan **(*action, Members, 15 May 2007*)**.

2.2 Component teams

2.2.1 Data Buoy Cooperation Panel (DBCP)

2.2.1.1 Mr David Meldrum reported on the activities of the DBCP and recalled that the DBCP has engaged in new activities, especially (i) Capacity Building and organization of training courses, and (iii) technology developments (e.g. Iridium Pilot Project, wave observations, drogue sensor).

2.2.1.2 The DBCP has initiated a drifter Iridium Pilot Project for a two year period. The Pilot Project seeks to evaluate the feasibility of Iridium technology for real-time telecommunication of drifter data globally (at least 50 units worldwide) and under various conditions, particularly in rough seas, to demonstrate performance with submergence, in various temperatures and levels of wind. Thanks to US contribution, an Iridium upgrade scheme was proposed where the additional $500 cost per unit to equip the drifters with Iridium transmitters are paid through the DBCP Trust Fund.

2.2.1.3 The DBCP is now exploiting the Panel's experience and resources in the development of training materials and the active participation in Capacity Building in developing nations. DBCP is planning to organize a training course on data management and buoy programme implementation in Ostend, 11-15 June 2007 (support from Flandres gov., IODE PO, ODINAFRICA, and DBCP TF).

2.2.1.4 The number of barometer drifters operationally reporting on GTS has reached a record level of about 450 units. Plans are to eventually equip all buoys with barometers as recommended by the DBCP workshop in Reading, UK, March 2006.

2.2.2 Global Sea-Level Observing System Group of Experts (GLOSS)

2.2.2.1 Thorkild Aarup reported on the activities of GLOSS and its Group of Experts. Of the 290 stations in the GLOSS Core Network (GCN), 217 (75%) have provided data recently to one of the GLOSS Data Centres, which represents the participation of 69 nations. It was decided that the GE will expand its activities to include technical advice and strategic planning for water level stations intended for hazards monitoring. GLOSS GE will also explore funding opportunities to upgrade 50 GCN stations to include continuous GPS for land motion corrections. An update of the GLOSS Implementation Plan is under development and the first draft is expected to be completed by the end of 2007.

2.2.2.2 The meeting agreed that there was a need for ongoing and timely monitoring of the extended sea level network (incl. GCN). Support was required for technician to travel in regions and provide support. The meeting agreed that the partnership with regional Tsunameter initiatives as well as with operational initiatives should be enhanced to improve the networks. The Group was pleased to note much progress on the development of the real-time network. It asked JCOMMOPS to develop web pages to show the progress of the real-time network (e.g. make the color dots bigger) (***action, JCOMMOPS, ASAP***) so that users can see where progress has been made.

2.2.3 Ship Observations Team (SOT)

2.2.3.1 Mr Graeme Ball reported on the activities of the JCOMM Ship Observations Team and on the outcome of the fourth Session of the SOT, Geneva, Switzerland, 16-21 April 2007. SOT-IV agreed with the modernization process of the Marine Climatology Summaries Scheme (MCSS) and with the proposed Terms of Reference for the new Task Team on Delayed Mode VOS data (TT-DMVOS). This modernization was proposed by the second meeting of the JCOMM DMCG, Geneva, Switzerland, 10-11 October 2006, and later also endorsed by the second meeting of the Expert Team on Marine Climatology (ETMC), Geneva, 26-27 March 2007. More details are provided in document 3.1(3).

2.2.3.2 SOT-IV recognized that regarding the issue of ship owners and masters concerns with regard to the availability of VOS observations through public web sites, there were not only ship security aspects but also commercial matters to be considered as well as protecting the partnership of WMO Members with the private sector. Per ETMC-II recommendations, the Team stressed that the delayed mode data should not be masked as access to the ship's identification and related metadata is crucial for climate studies. For real-time data, the SOT recommended encrypting the ship's call sign as a long term solution to address such concerns. Specific recommendations were agreed upon for those countries who wish to implement ship masking of the real-time data as a medium term solution. A Task Team on Call Sign masking and encoding was established to make further recommendations in this regard. SOT recommendations were reviewed agreed upon by the 59th WMO Executive Council which adopted Resolution 7.7/1 (EC-LIX) (see document 2(2) for details).

2.2.3.3 VOSClim exceeded its initial target of 200 ships for the VOSClim fleet. However, SOT-IV agreed that the new target should be 250 ships by the fifth SOT Session (SOT-V) and that efforts should also be made to increase the number of observations and the number of VOS ships recording the additional parameters. The Panel asked the Task Team on VOSClim to consider how many observations are needed from the VOSClim yearly. Regarding the status of the VOSClim Project (i.e. project or programme)the VOS Panel agreed that it should remain a project until all the data stream issues are fixed and decided that the SOT-V should again consider this issue with perhaps the goal of making the VOSClim Project evolve as a special project under the VOS.

2.2.3.4 SOT-IV approved the definition of global VOS routes for WMO Pub. No. 47. These will also be useful to identify deployment opportunities for drifters and floats.

2.2.3.5 At SOT-IV, the VOS Panel expressed concerns regarding the possible reduction of the Voluntary Observing Fleet at the National Level and noted that the justification for such reduction was not always obvious. At the same time, the Panel noted that while the NWP and marine forecasters were still relying on VOS observations especially in data sparse regions there has in fact been an increasing demand for VOS observations by users for a number of applications, and especially for climate studies where the consistency of historical time series is paramount, for the GHRSST-PP which is assimilating both satellite and in situ products, for independent intercomparisons between the different observing systems including buoys and OceanSITES. VOS ships are a primary source of air temperature and humidity data in the open ocean and these variables cannot be derived from remote sensing but can help in validating future satellite products. SOT-IV asked its Task Team on VOS Recruitment and Programme Promotion to investigate the conduction of an impact assessment study in liaison with other appropriate bodies and to report at the next SOT Session. Following ETMC proposal, the Task Team was also asked to conduct an intercomparison study of electronic logbooks, and to review best practices documentation of interest to the SOT.

2.2.3.6 The meeting noted that SOT-IV decided to evaluate the Iridium technology for collecting VOS data in real time and had therefore established a VOS Iridium Task Team. The Task Team will operate closely with the DBCP Iridium Pilot Project.

2.2.3.7 The meeting noted that SOT-IV agreed that it should form a "XBT Hardware Evaluation and Design" subgroup of the Task Team on Instrument Standards to address two tasks, (i) to propose and conduct additional experiments to review the fall rate equation of various XBT types, targeting publication of the results in time to be included in a new Upper Ocean Review, and (ii) to explore the possibilities of designing a standard XBT auto-launcher. A meeting was planned in Miami, 10-12 March 2008. The OOPC will invite SOOP members to provide input for an Upper Ocean Review, which may take place either as a preparatory event or as part of the proposed 2009 ocean observations conference, and would welcome any input from the Panel on its proposed focus and during planning stages.

2.2.3.8 The meeting noted with appreciation that the study by the SOT Task Team on standards should eventually be published as a JCOMM Publication.

2.2.4 Tropical Moored Buoys Implementation Panel (TIP)

2.2.4.1 Dr Mike McPhaden reported on the Tropical Moored Buoys Implementation Panel, and the development of the Arrays in the Pacific Ocean, Atlantic Ocean, and Indian Ocean.

Capacity Building

2.2.4.2 PMEL has trained technicians from other countries in ATLAS field operations, instrument evaluation and data download techniques. As a result of this training, both during mooring cruises and at workshops conducted at PMEL, French and Brazilian PIRATA cruises are now staffed solely by technicians from France and Brazil. While Indian and Indonesian technicians have become acquainted with ATLAS field operations during recent cruises, more in-depth training of technicians from Indian Ocean partners would be a desirable endeavor as new partnerships develop.

Ship time

2.2.4.3 The ability for nations to maintain moored buoy arrays is critically dependent on adequate ship time. The OCG can help promote awareness of the importance of ship time for regular mooring maintenance and advocate when necessary for adequate levels of support.

Vandalism

2.2.4.4 Damage to moorings and sensors due to fishing activity continues to be a concern. This damage accounts for a significant amount of data loss, especially in the far eastern and far western portions of the Pacific basin, the Gulf of Guinea in the Atlantic, and at many sites in the Indian Ocean.

2.2.4.5 PMEL is developing several approaches to the problem of mooring vandalism. The first test deployments of possible alternative designs will be in late 2007 or early 2008 in the Indian Ocean. A second approach will be to remove all meteorological sensors from ATLAS surface moorings at some sites. The buoy tower structure will also be removed, with remaining instrumentation installed beneath a protective cover. The shape of the cover will be designed to discourage vandals from boarding the buoy. Water column measurements from depths of 1 m to 500 m will continue to be transmitted in real time. If this design proves successful in reducing vandalism and increasing ocean data return, future deployments could include meteorological sensors that would be mounted such that the buoy cover protects them from vandalism. A third approach will be to modify buoys to inhibit the removal of present generation sensors and the tower structure from the mooring. This approach would employ the use of tamper resistant hardware, which requires tools not commonly available for removal. Appropriate signage will be placed on the buoys (both those with and without towers) to inform fishermen of the purpose of the moorings and that they provide data useful to the fishing community.

International Coordination

2.2.4.6 The Group agreed to enhance cooperation at the international level where feasible with other observing system elements in efforts to develop the ocean observing system for climate in all three tropical ocean basins. This will help streamline the process of identifying and scheduling national resources, capacity building, and multi-year planning.

2.2.4.7 The report from TIP is reproduced in ***Annex V***

2.3 Associated teams

2.3.1 Argo Steering Team

2.3.1.1 John Gould reported on the development of the Argo Pilot Project on behalf of the Co-Chairpersons of the Argo Steering Team, Prof Dean Roemmich, and Dr Howard Freeland. Argo was planning to achieve completion of the network by the end of 2007 with a network of 3000 operational floats.

2.3.1.2 The Eighth Argo Steering Team meeting was held in Paris, France, 6-9 March 2007. Argo is now in transition from its implementation phase to its sustained maintenance phase. The implementation phase basically consisted of:

- Extending float lifetimes;
- Implementing an effective data system capable of delivering real-time and delayed mode data;
- Diagnosing and rectifying problems with floats and their sensors in collaboration with manufacturers;
- Implementing an efficient oversight structure (AST and ADMT);
- Employing an Argo Technical Co-coordinator within JCOMMOPS to ensure compliance with IOC Res XX-6;
- Developing a widespread user community of both academic researchers and operational;
- Agencies broadening the number of participating countries

2.3.1.3 Sustainability over decadal timescale remains an issue since most of the national Argo programmes are still supported through research funding. Operational applications will also permit to justify sustainability of Argo. Sustained maintenance phase that has now started will address new challenges:

- Further extending the float lifetime
- Eliminating the continuing Northern Hemisphere bias in float distribution
- Further improving the effectiveness and throughput of delayed-mode quality control
- Learning through scientific analysis how to improve data quality
- Improving the delivery of high quality real-time data to meet the evolving needs of the
- user community
- Continuing and completing initial steps taken to produce high quality subsurface velocity
- data
- Developing effective means for maintaining the integrity of the array when floats reach the end of their operating life

2.3.1.4 Sustain maintenance phase will require (i) to continue to monitor array performance and improve it through careful adjustments to the network design and through the deployment and evaluation of appropriate new sensors and communication systems, (ii) to maintain the two global data assembly centers and an appropriate network of national and regional centers, and (iii) to evolve and sustain an effective project oversight structure within the existing intergovernmental and international framework (see agenda item 4.4).

2.3.1.5 The sustained maintenance phase will be considered complete when Argo has (i) maintained the array at a level of 3000 ± 250 floats for 5 years, (ii) global coverage with no significant northern hemisphere bias, (iii) reached a point where float technical capabilities and survival rates have stabilized at an adequate level, and (iv) carried out an evaluation of the array's design and its benefits to users.

2.3.1.6 Recent problems with incorrect pressure binning in some of the floats has highlighted the need for Argo to become more proactive in rapidly identifying and correcting data quality problems. Cause of the problem was understood and corrective action proposed as well as guidance for research and operational users.

2.3.1.7 For the long-term maintenance of the Argo project, and recognizing the difficulty in deployment of floats in remote ocean regions, it is desirable to extend the lifetime of profiling floats beyond the present capability of approximately 4 years. AST considers that extended lifetimes of six or more years can be attained with technical improvements.

2.3.1.8 Argo floats provide potential platforms for accommodating additional sensors that may increase the scientific value of the Argo array. Any additions must be carefully considered and cannot impact the core capabilities of Argo, including float lifetime.

2.3.2 OceanSITES Project

2.3.2.1 Bob Weller presented a report on behalf of the OceanSITES and reported on its current status. The development of OceanSITES has been relatively slow in the last 12 months, due to the lack of manpower. However, plans for new sites and further integration are under way, including 1) 4 sites planned under the US/NSF ORION programme, with ambitious infrastructure (e.g. 55S power discus buoy) - Funding and final decision on each site's development were yet to be decided, 2) integration of 11 existing timeseries stations under EuroSITES framework, in terms of technology, operation, and data management. Enhanced interaction with the International Ocean Carbon Coordination Project (IOCCP) is being pursued regarding ocean carbon measurements.

2.3.2.2 OceanSITES data management is still under development. Specific data format was established but still being tested with some sites. Some of the sites are reporting in real-time (e.g. TAO/PIRATA, ANIMATE) and others in delayed mode (e.g. MOVE, hydrography BATS and HOT).

2.3.2.3 Project office and management support is critically needed for the OceanSITES not only for monitoring purposes but also for chasing after the data suppliers. Discussions have been underway in the context of the future Observing Programme Support Centre (OPSC).

2.3.2.4 There was considerable discussion regarding making OceanSITES data available in real time on the GTS. There is concern that OceanSITES data might be assimilated in forecast models; this would reduce its value as "validation" for model outputs, which is a primary goal of the OceanSITES reference stations. It was agreed that making data available in real time will be done via the web, and in the mean time pilot projects can test the effectiveness of GTS schemes for withholding the validation data from model assimilation. The Group noted that the advance of the OceanSITES programme in general has been hampered by of lack of a project office. There is need to develop a plan for OceanSITES technical support, possibly at JCOMMOPS (see paragraph 8.3 below for action by OceanSITES).

2.3.3 International Ocean Carbon Coordination Project (IOOCP)

2.3.3.1 Maria Hood reported on the IOCCP. The OCG was particularly interested in the development of a coordinated support service for ship-based repeat hydrography. Hydrography is still the only method to obtain high-quality global data from the ocean interior for carbon, biogeochemistry, and many physical oceanographic processes. It is also essential for providing high-quality data for validation and calibration of other systems such as Argo, has the possibility to provide unique deployment opportunities for Argo floats, and needs to be coordinated with mooring deployments and maintenance requirements. It may be possible in the near future to automate real-time data transmission of CTD data, creating a hybrid observing network that has both operational and research components.

2.3.3.2 Because it is so critical to so many programs, developing a sustained network requires guidance from many different groups. The IOCCP, CLIVAR-GSOP , and the SOLAR-IMBER carbon coordination group have agreed to develop an Advisory Panel on international repeat hydrography whose draft terms of reference include: Defining a ship-based repeat hydrography network for coordination / tracking, incorporating needs and contribution from other programs such as Argo, OceanSITES, Geotraces, etc.; developing guidelines for a single international information center and data directory for hydrography that has support and buy-in from the community; and reviewing and providing guidance on t he need to update the WOCE hydrographic manual. The OCG supported the development of this group and suggested that Maria Hood represents the interests of the OCG in this activity to ensure that the developments are well-coordinated with other observing system elements. They also suggested that Maria work closely with John Gould (Argo) and Bob Weller (OceanSITES) to ensure that the needs of these programs are integrated. The OCG also suggested that POGO be invited to participate in this activity, since they are planning to develop a web-based cruise database that would contribute to and benefit from information about repeat hydrography. They also suggested that Gustavo Goni (SOOPIP chair) also be included in this group because of the interests in coordinating repeat hydrography with the XBT network. (***action, IOCCP/Secretariat, ongoing***).

2.3.3.4 The report from IOCCP is reproduced in ***Annex VI***

3. Requirements and interactions

3.1 GCOS/GOOS Implementation

3.1.1 The meeting addressed the requirements for GOOS and GCOS implementation and agreed that the decadal variability of the ocean was an issue to consider as well as long term trends and variability. Establishing a web site on indices could be a way to proceed.

3.1.2 The question of surface salinity measurements from the *in situ* and space-based platforms was identified as needing scientific guidance. The OCG will work with the OOPC to consider a pilot project or other strategy for better definition of surface salinity measurement requirements (***action, OCG, ongoing***).

3.1.3 The meeting agreed that much work remained for reaching the desired global network coverage. Also, despite the 1250 number achievement for the drifter network, more efforts are needed to achieve a proper data distribution as big ocean areas are still requiring appropriate spatial distribution. Strategies must be defined for anticipating component networks spatial distribution (e.g. Argo) in order to maintain optimal coverage.

3.1.4 The Group reviewed the forthcoming meetings (e.g. Post-AR4 WCRP/GCOS - Oct 07 - Obs System Experiments workshop - Nov. 07 – the final GODAE symposium - late 08 - the 10 year successor of the OceanObs99 conference in 2009) that should be addressing implementation issues and help to raise awareness about observing systems issues. The meeting also identified the need to organize a Sensor workshop. The meeting invited its members to liaise with the organizers of such meetings and workshops in order to have OCG perspective taken into account (***action, OCG Members, ongoing***).

3.1.5 The Group agreed that it would be useful to document how to distribute ocean observations in real-time, including through the GTS but also through other existing data systems (***action, OCG Chair, ASAP***). The issue of real time distribution of instrument/platform metadata should also be given priority. This was being addressed by the Water Temperature metadata Pilot Project and by the ODAS Metadata Service (ODASMS) operated by NMDIS, China.

3.1.6 Regarding the VOS Scheme, the Group agreed that it had a role to play on instrument best practices issue and satellite data transmissions. For example, Inmarsat costs could be reduced by changing the data transmission practices. It invited the SOT to address those issues in liaison with the OCG Chair.

3.1.7Regarding the SOOP, the issue of complementarity with Argo required to be revisited in light of effective SOOP implementation, and Argo near completion. Feedback was required on SOOP line feasibility. For example, the lines that we cannot reasonably sample should perhaps be taken

off the OPA strategic workplan (***Annex III***
); some lines have in fact already been removed.

3.2 Global operational oceanography requirements

3.2.1 The meeting discussed global operational oceanography requirements, including ocean mesoscale forecast. The meeting noted that such requirements were documented in the Statement of guidance for Ocean Applications developed by JCOMM for the WMO Rolling Review of Requirements. While noting that the Statement of Guidance was still being reviewed and required updating, the meeting agreed that such requirements should better be documented in a future version of the JCOMM OPA Strategic workplan (***action, OPA, next OCG meeting***).

3.3 SCG requirements for observations

3.3.1 The Services Program Area Coordinator, Mr Craig Donlon, presented a draft (version 1) Observation User Requirements Document (ORD) for comment by the OCG. The Group recognized that the document was an ongoing and challenging necessary exercise. It was pleased to see that good progress had been made in this regard. Version 2 of the document should eventually become a key deliverable to JCOMM-III. The Group thanked Craig Donlon, the Services Coordination Group and the SPA Expert Teams for producing the document.

3.3.2 The Group agreed that more work was needed before the document could be presented to the CBS ET-EGOS. In particular, the Group agreed that funding issues should be addressed, and priorities stated. The meeting considered establishing a small cross cutting SPA-OPA Task Team to look at requirements for observations to review the ORD and provide feedback on feasibility and options for implementing the observing system, identify gaps, potential improvements, etc. The Group agreed that OCG should look further at the document and then suggest ways and comment on the need or not to establish a Task Team. Each of the OCG Member were invited to make recommendations (***action, OCG Members, deadline Jan 2009***).

3.3.3 The Group agreed that both in situ and satellite observations had to be considered by the JCOMM OPA in its strategic workplan (e.g. AATSR is more accurate than buoys).

3.3.4 The Group agreed that the following OPA activities needed to be coordinated with the SPA as SPA was a key end user of the observations and data products coordinated and/or regulated under the OPA and DMPA:

- Web services
- Quality Control services
- Data aggregation services
- Format verification service

3.3.5 The Group considered that conducting specific experiments or special project in a particular area during a particular period to investigate impact of specific observational components (e.g. wave observations) could be a way to go although no specific funding for such activities are identified.

3.4 Numerical Weather Prediction (NWP) [CBS ET-EGOS]

3.4.1 The WMO Secretariat representative reported on the outcome of the second session of the CBS Expert Team on the Evolution of the Global Observing System (ET-EGOS), Geneva, Switzerland, 10-14 July 2006. Prior to the meeting, the JCOMM Statement of Guidance for JCOMM Program Areas was reviewed and updated by the WMO Secretariat, Eric Lindstrom and

Jean-Louis Fellous. The revised version dated June 2006 was presented to the meeting but still needs to be refined. The Group noted the following recommendations from ET-EGOS:

- ET-EGOS is concerned with observing programmes sustainability, including Argo, and extension of tropical mooring arrays in the Atlantic and Indian Oceans. JCOMM was invited to communicate Argo demonstrated benefits to its Member Countries/States. OOPC is invited to to provide up to date information regarding complementarity of in situ upper ocean thermal networks.
- ET-EGOS recommended to pursue real-time distribution of Essential Climate Variables (ECV) as defined in the GCOS implementation plan.
- Statements of Guidance for NWP and Seasonal to Inter-Annual Forecasts should now reflect dramatic improvements with regard to *in situ* SST data thanks mainly to the completion of the surface drifting buoy networks.
- Impact studies of surface pressure drifter networks was proposed, e.g. impact of Northern Hemisphere data density versus Southern Hemisphere. The goal is to investigate whether it will be required to equip all SH drifters with barometers.
- For sea surface winds, guidance is required regarding the impact on applications of having 1 scatterometer plus one or two microwave imagers rather than two scatterometers on LEO.
- SHIP security issue following WMO EC-58 resolution: JCOMM was asked to work with members to overcome the generic SHIP call sign issued to ensure that quality monitoring and feedback activities can continue to be undertaken.
- DBCP asked to pursue improvement of data timeliness of drifter data especially in the South Atlantic and SouthEast Pacific Oceans.
- Higher satellite data rate transmissions remains a topic of interest and JCOMM is asked to pursue pro-active action in this regard.
- IABP, IPAB, IPY: Impact of expected increased ice buoy deployment should be reviewed at the next OSE/OSSE workshop.

3.4.2 At its fifth Session, the JCOMM Management Committee, Geneva, October 2006, noted the outcome from the Second Session of the CBS Expert Team on the Evolution of the Global Observing System. The Committee agreed that the SoG should be regularly reviewed by the JCOMM, thanks primarily to the designation of: (i.) a focal point for user requirements (i.e., ocean mesoscale forecasts and coastal marine services, including tsunami monitoring), and (ii.) a focal point for estimating *in situ* observing system capabilities. The Committee designated Dr Craig Donlon and Ms Hester Viola as the respective focal points. The Committee agreed that a specific section for marine services should be developed in the WMO CEOS database.

3.4.3 MAN-V agreed that the JCOMM must participate more actively in the ET-EGOS Rolling Review of Requirements (RRR) process, and to make use of its Critical Review Charts while taking existing JCOMM metrics and other tools into account, and stressing observing system deficiencies. The Committee tasked the SPA to designate a focal point to liaise with the WMO Secretariat and provide input on the issue (***action, SCG, ASAP***). The new SoG should be submitted by mid-2007 prior to the next ET-EGOS meeting (***action, SCG, mid-2007***). MAN-V agreed that the ASAP Programme should be regarded as complementary to the AMDAR Programme, as a source of *in situ* aerological profiles (AMDAR provides for few ascents and descents over the oceans). MAN-V noted the request by the ET-EGOS to provide the JCOMM with input on requirements for satellite sea surface winds, as well as guidance regarding the impact on applications of scatterometers and microwave imagers. It asked the Cross-cutting Team on Satellite Data Requirements to provide input (***action, Sat Team, ASAP***).

3.4.4 The OCG agreed to include the actions proposed by the ET-EGOS and MAN-V in its action plan (***action, Secretariat, ASAP***).

3.5 WMO Information System (WIS)

3.5.1 The WMO Secretariat representative presented an overview of the WMO Information System. He explained that the present GTS was efficient in interconnecting National Meteorological Hubs but that international programmes did not necessarily have easy access to the GTS for data submission or data access. The WIS concept, which had been endorsed by the WMO Congress, was to build an overarching system based not only on the GTS but also on new facilities that would permit other international programmes such as GOOS or GCOS to access the system. WIS was designed as an inter-disciplinary system that would provide common information exchange standards, metadata catalogues based on ISO standards (e.g. ISO 19100 series, geographical information standard), and other industry standards. Its functional structure was based on (i) National Centres (data generation and collection in the particular country; national portal to the WIS), (ii) Data Collection and Production Centres (DCPC, collecting and distributing data of interest for a larger community and data meant for international exchange; can be programme related, and provide for push and pull data access mechanisms and maintain metadata catalogues), (iii) Global Information System Centres (GISC, key global centres synchronising the data with each other; receive information from the NCs, and the DCPCs, and provide for global pull mechanism for data access; generate and maintain catalogues of data and metadata, that are fully operational), and (iv) data telecommunication networks.

3.5.2 It was noted that WIS concerned only information exchange and data information. Interoperability was a key to WIS and active involvement from all of the Technical Commissions, including JCOMM was required. The WMO Core Metadata profile had been developed for data discovery, but needed further refinement. The WIS was intended to provide various types of services to meet different requirements, and the following fundamental types of service had been identified:

(i) Routine collection and dissemination service for time-critical and operation-critical data and products (push, multicast and broadcast, smooth evolution from the GTS, IGDDS);

(ii) Data Discovery, Access and Retrieval (DAR) service (pull), and (iii) Timely delivery service for data and products (push).

3.5.3 Two implementation phases were planned. Phase A would improve the GTS and provide support to other programmes than the WWW. Phase B would be an extension of the Information System through flexible data discovery, access, and retrieval. IGDDS, which was providing for space based observational data and products, would be further developed under both phases A and B.

3.5.4 A number of Pilot Projects had already started, including in particular the JCOMM E2EDM Pilot Project, which would provide a DCPC function. Dr Nick Miklhailov, Chairperson of the ETDMP, made a life demonstration of the prototype at the TECO-WIS meeting in Seoul, Republic of Korea, 6-8 November 2006.

3.5.5 The Group agreed that platform/instrumental metadata must eventually be provided into the WIS but that more coordination was required with WIS related Expert Teams. It invited META-T to address this issue (***action, META-T, ASAP***)

4. Cross-cutting issues

4.1 Integrated performance metrics

4.1.1 The meeting noted with appreciation the progress made since JCOMM-II regarding the development of integrated performance metrics to routinely report observing system monitoring and performance for certain key ocean variables (e.g. SST, currents, heat content). This was made possible thanks to cooperation with the GOOS Project Office, MEDS, Canada, various US agencies through the new Observing System Monitoring Center (OSMC), and JCOMMOPS. The meeting thanked USA for its commitments in this regard and invited it to continue its efforts to develop the metrics further in cooperation with the OSMC and JCOMMOPS (***action, USA, ongoing***).

4.2 Data dissemination, management and QC, standards

4.2.1 Bob Keeley reported on the data management, distribution, quality management, and standards aspects discussed under the JCOMM Data Management Programme Area. The OGC agreed on the need to work with the DMPA to implement real-time reporting from tide gauge stations with standard CREX messaging. For global observing system monitoring, there is need to develop a plan for providing GLOSS system access to JCOMMOPS. GPS monitoring of land levels at a subset of GLOSS core network gauge sites was also considered to be a high priority.

4.2.2 The OCG requested assistance from JCOMMOPS and the Secretariat in collating a catalogue of all existing technical standards and best practices. This catalogue, as well as the documents themselves, should be posted on the JCOMMOPS web site (***action, JCOMMOPS, ASAP***).

4.3 Capacity building

4.3.1 The Group reviewed the Capacity Building initiatives that should be promoted. It agreed with the strategy defined in the PANGEA prospectus. It also agreed that the donation of Argo floats to developing countries, and the transfer of technology will help to achieve global coverage thanks also to logistical means (e.g. ship time) provided regionally.

4.3.2 The Group noted the problems to maintain appropriate geographical coverage in the Gulf of Guinea (e.g. drifters). It noted with appreciation that Nigeria and Gabon were interested to participate in Argo and that deployment opportunities could be used to support both the DBCP and Argo.

4.3.3 However, the meeting noted that Capacity Building initiatives were time consuming and that it was sometimes difficult to find partners for making donations. The meeting invited JCOMM Members to help to find new partners with the assistance form the Argo Information Centre acting as a coordinator in this exercise (***action, AIC, ongoing***).

4.4 Satellite data requirements

4.4.1 Eric Lindstrom reported on behalf of the JCOMM cross cutting team on Satellite Data Requirements. The Group reviewed the requirements for satellite observations in support of JCOMM applications. The following satellite related activities are being addressed by OCG:

- Making satellite observations more accessible through expansion of a data assembly and data delivery model pioneered as the GHRSST Pilot Project. Priority will be given to sea surface temperature, ocean surface topography, and ocean vector winds.
- GPS monitoring of land levels at GLOSS core network tide gauge sites;
- Development of a surface salinity pilot project in cooperation with the OOPC;
- Development of a work plan for monitoring and documenting satellite system status as a JCOMMOPS task;
- Reviewing the JCOMM Service Programme Area draft User Requirements Document.

4.4.1 The Group noted the success of the GODAE High Resolution SST Pilot Project (GHRSST) which developed products build from data sets from many satellite systems using different technologies and sensors. Also, the way GHRSST addressed the SST diurnal cycle issue helped making progress with regard to refining user requirements (e.g. for metadata for in situ observing systems), and terminology. The meeting agreed that one could build on GHRSST success to address other variables such as altimetry, and surface vector wind.

4.4.2 For example, as far as altimetry is concerned, while work has already been made for bringing many satellite systems together (e.g. Topeix, Jason) just like what has been done with SST for GHRSST, more satellite systems need to be added (e.g. polar orbiting satellites, Envisat). However, continuity of the data sets is still an issue. An Altimetry Pilot Project could help in addressing possible gaps in some satellite missions.

4.4.3 As far a surface vector wind is concerned, similar approach can be promoted. End products can help for example to predict early evolution of hurricanes. Multiple data sources can be used (e.g. QuikSCAT) but a complex data processing system would have to be built for near-real-time utilization but also for developing the climate data record. Challenges will have to be addressed to define standard formats, document ancillary data, and facilitate their accessibility.

4.4.4 The meeting agreed that Pilot Projects in the area satellite data products and services could be promoted for addressing variables such as altimetry and surface vector wind but that proper governance model had yet to be proposed possibly by JCOMM (***action, MAN, MAN-VII***). Converging operational and "climate" requirements is a challenging, but productive approach. Both in situ and space based systems are needed and the in situ components will have to be properly addressed (e.g. how to use tide gauges in altimetry products). The Group agreed that real-time operations can serve and enhance climate records and "delayed-mode" research. JCOMM can assist in building a model for such Pilot Projects that would also help assess the benefits to JCOMM from data utilization. Pilot Projects could also determine the sensitivity of JCOMM community to the losses that may occur if current data resources are not maintained.

4.4.5 The meeting also welcomed the offer from Eric Lindstron to work at a JCOMM Satellite Requirements Reference Document that will be describing the following:

1) the degree of current use of space-based observations in the JCOMM community in existing products and services
2) the benefits that could be gained from additional space-based measurements
3) the losses that would be experienced should there be a discontinuity in the availability of current data resources
4) And highlight the strengths and weaknesses in the current use of space-based data in the field of oceanography and marine meteorology include an enumeration of the obstacles to increased use of satellite data

4.4.6 The Group thanked Eric Lindstrom for his offer (***action, E. Lindstrom, OCG-III***)

4.5 Satellite data telecommunication

4.5.1 David Meldrum reported on recent developments with regard to satellite data telecommunication. The Group was pleased to note the establishment of Iridium Pilot Projects by both the DBCP and the SOT.

4.6 IPY

4.6.1 Mr Eduard Sarukhanian presented a progress report on the preparation of the International Polar Year 2007-2008. The full report is given in ***Annex VII***

4.6.2 The Group noted the information and agreed to develop a plan of actions during the IPY implementation stage, as well as in the post-IPY era in provision of the efficient operations of the observational networks, of the sustainable exchange of the IPY data in real- and non-real time modes, and in security of a legacy of the IPY to include sea-ice observing systems and observational data sets.

4.7 Wave observations

4.7.1 The Group noted that the requirement of the SPA for enhanced high-quality, long-term wave measurements in the global oceans in support of Maritime Safety Services were discussed at the twenty-second session of the DBCP, La Jolla, October 2006, as well as at the Second Session of the JCOMM Expert Team on wind Waves and Storm Surges, Geneva, Swizerland, 20-24 March 2007.

4.7.2 The group agreed that working with JCOMMOPS, it should develop an observing system monitoring capability to assess wave observations across the observing system (***action, SCG, ASAP***). The Group agreed in general that adding wave observations to data buoys whenever possible would be a positive step forward for the observing system. An experiment or a demonstration project (in a particular area during a particular period) was suggested to investigate impacts of wave observations (***action, DBCP & ETWS, end 2008***). However, no specific funding has been identified by the group to support such activities. The OGC requested that the SPA recommend the priority for wave measurements (***action, SCG, ASAP***). It was recommended that the OceanSITES increase wave measurements globally and consider best practices.

4.7.3 Provisional surface wave observational requirements are detailed in ***ANNEX VIII***
.

4.8 Support to Tsunami warning systems

4.8.1 The importance of coordination with the international marine hazards (tsunami) warning programme was discussed. It was agreed that the international hazards programme was still being formulated and that as soon as it is well established, the International Tsunameter Coordination Group will be invited to become an Action Group of the DBCP (***action, DBCP, DBCP-XXIII***).

4.9 Response to other cross-cutting issues from teams (from agenda item 2)

There was no additional issue to discuss in this regard.

5. JCOMMOPS and an expanded observing programme support centre

5.1 The meeting reviewed the outcome from the informal roundtable discussion (May 2006) on strategic long-range brainstorming on JCOMMOPS, and a draft specification of requirements for the evolution of JCOMMOPS over the next few years into an expanded Observing Programme Support Centre (OPSC) for the integrated support of all the global observing implementation programmes. The OCG developed a draft specification and solicitation for proposals from institutions interested in hosting this Centre, for submission to the JCOMM co-presidents for their action.

5.2 It was also agreed that the approach to potential hosts should be in the form of Joint Circular Letter to the member states of IOC and the permanent representatives of members of WMO. The letter would explain the background and justification for an OPSC specify the requirements that the host should meet, and solicit a letter of intent from prospective hosts. The Group finally agreed on a proposed announcement and call for Letters of Intent (LOI) to host an OPSC (***Annex IV***
) (***action, Secretariat, end 2007***).

5.3 There is still need to conduct an external review of JCOMMOPS by 2009 for JCOMM-III, as requested by JCOMM-II. The actual mechanism for this review has not yet been determined. However, the ongoing evaluation of JCOMMOPS in the context of evolving into an OPSC, beginning with the Roundtable meeting in 2006 and continuing with OCG-II, has provided a thorough review and endorsement of the importance of JCOMMOPS for implementation of the global ocean observing system. The Group agreed that this process de facto constituted the external review that was requested by JCOMM-II.

6. OCG workplan for intersessional period

6.1 Review of JCOMM-II and MAN-V decisions and instructions

6.1.1 The Group reviewed the work assigned by the Second Session of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), Halifax, Canada, 19-27 September 2005 and the fifth session of the JCOMM Management Committee (October 2006). The Group updated its action plan accordingly.

6.2 Strategic workplan, implementation strategy/Targets and priorities for intersessional period; Review of OCG-II workplan

6.2.1The draft Strategic Work Plan for the OPA was reviewed and endorsed by the OCG. The OCG noted that the plan was initially written for phased implementation between 2000 and 2010. Because of fiscal realities, however, it now appears that the initial global ocean observing system, as defined by GCOS-92 and as reflected in the draft Strategic Work Plan, will not be completed by 2010. The draft plan has been submitted to Jim Baker as input to the JCOMM Implementation Plan, but the OCG requested that the OPA Work Plan be updated to represent fiscal realities and extend the plan to at least 2012 for completion of the initial system (***action, OCG Chair, OCG-III***). The version discussed at the meeting is provided as ***Annex III***
.

6.3 Resources to meet implementation goals

6.3.1 The OCG stressed the importance of continued outreach to remind Members/Member States that a global system cannot be achieved with existing resources. The system is now only about 59% complete, which is considerably less that the intitia; 2007 target of 66% complete. National commitments to ocean observation must be increased to ensure a sustained global system.

7. Closing

7.1 Calendar (including date and place of next meeting)

7.1.1 The Group reviewed the calendar ad activities until 2009. No decision was made at this point regarding the next session of the OCG but the Group agreed to meet before JCOMM-III in order to prepare the work for the JCOMM Session.

7.2 Other

There was no other item to discuss at this point.

7.3 Closure of session

7.3.1 The Second Session of the JCOMM Observations Coordination Group closed at 5pm, 25 April 2007. Action items arising from this OCG Session are listed in ***ANNEX VIII***

ANNEX I

AGENDA

1. Opening of the session

1.1 Opening and welcome
1.2 Adoption of the agenda
1.3 Working arrangements

2. Reports on cross-cutting issues (reports 20 minutes each)

2.1 Goals of the meeting

2.2 Component teams
2.2.1 Data Buoy Cooperation Panel (DBCP)
2.2.2 Global Sea-Level Observing System Group of Experts (GLOSS)
2.2.3 Ship Observations Team (SOT)
2.2.4 Tropical Moored Buoys Implementation Panel (TIP)

2.3 Associated teams
2.3.1 Argo Steering Team
2.3.2 OceanSITES Project
2.3.3 International Ocean Carbon Coordination Project (IOOCP)

3. Requirements and interactions (reports 20 minutes each)

3.1 GCOS/GOOS Implementation
3.2 Global operational oceanography requirements
3.3 SCG requirements for observations
3.4 Numerical Weather Prediction (NWP) [CBS ET-EGOS]
3.5 WMO Information System (WIS)

4. Cross-cutting issues (20 minutes each report)

4.1 Integrated performance metrics
4.2 Data dissemination, management and QC, standards
4.3 Capacity building
4.4 Satellite data requirements
4.5 Satellite data telecommunication
4.6 IPY
4.7 Wave observations
4.8 Support to Tsunami warning systems
4.9 Response to other cross-cutting issues from teams (from agenda item 2)

5. JCOMMOPS and an expanded observing programme support centre

6. OCG workplan for intersessional period

6.1 Review of JCOMM-II and MAN-V decisions and instructions
6.2 Strategic workplan, implementation strategy/Targets and priorities for intersessional period; Review of OCG-II workplan
6.3 Resources to meet implementation goals

7. Closing

7.1 Calendar (including date and place of next meeting)

7.2 Other

7.3 Closure of session

ANNEX II

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ANNEX III

Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM)
Observations Program Area (OPA)
Strategic Work Plan

for Building a Sustained Global Ocean Observing System
in Support of the Global Earth Observation System of Systems
(April 2007)

1.0 Scope

There is presently significant international momentum for implementation of a global ocean observing system. The GCOS *Implementation Plan for the Global Observing System for Climate in support of the UNFCCC* (GCOS-92) has now been endorsed by the United Nations Framework Convention on Climate Change (UNFCCC) and by the Global Earth Observation System of Systems (GEOSS) 10-Year Implementation Plan Reference Document. The ocean chapter of GCOS-92 provides specific implementation targets for building and sustaining an initial global ocean observing system.

This initial ocean observing system represents the climate component of the Global Ocean Observing System (GOOS), and the ocean component of the Global Climate Observing System (GCOS). The Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) is the intergovernmental body that has primary responsibility for implementation of the *in situ* elements. The work plan that follows details how the JCOMM Observations Programme Area plans to do its part to help implement the initial ocean observing system in support of GOOS and GCOS, and consequently contribute to the Global Earth Observation System of Systems.

2.0 System Design

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 ocean surface and the sub-surface ocean, and *in situ* measurements of the atmosphere over the ocean. Each component subsystem brings its unique strengths and limitations; together they build the composite system of systems. Figure 1 illustrates this initial global ocean observation system of systems. In addition to the platforms illustrated in Figure 1, two more components are essential: data and assimilation subsystems, and product delivery.

Although this baseline system is designed to meet climate requirements, marine services in general will be improved by implementation of the systematic global observations called for by the GCOS-92 plan. The system will support global weather prediction, global and coastal ocean prediction, marine hazard warning, marine environmental monitoring, naval applications, and many other non-climate uses.

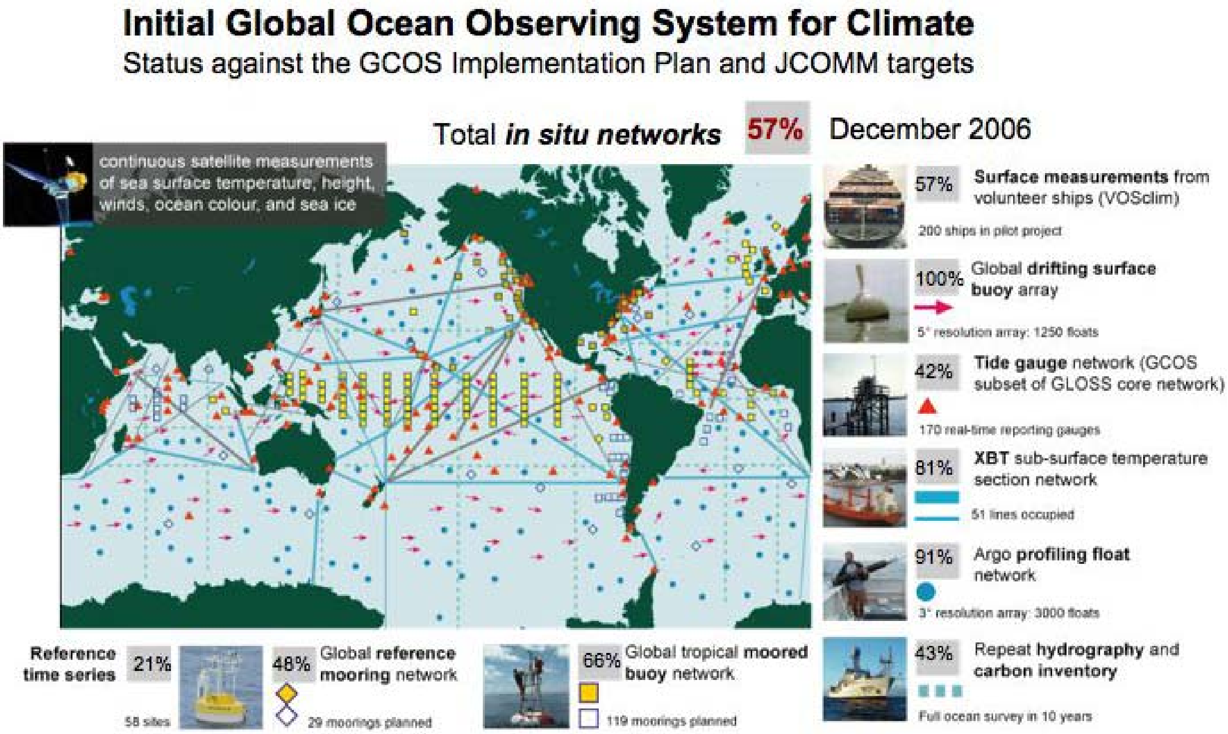


Figure 1: A schematic of the initial composite ocean observing system design, including the current status against the goals of the GCOS Implementation Plan (GCOS-92).

An urgent and fundamental need identified by GCOS-92 – endorsed by the UNFCCC and the GOESS 10-Year Implementation Plan Reference Document – is the need for achieving global coverage by the *in situ* networks. The *in situ* networks include moored and drifting buoys, tide gauge stations, profiling floats, and ship-based systems. Coordination of national contributions to 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 a Global Earth Observation System of Systems.

1.1.1.1.1 3.0 Milestones

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. 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 annually to reflect evolution of the design as knowledge and technology advance, and to reflect the realities of funding availability.

	2002	2003	2004	2005	2006	2007	2008	2009	2010
System Percent Complete:	40	45	48	53	57	66	77	88	99

The following sections indicate individual network improvements that work toward building the observing system as a 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 platforms/sites/data infrastructure for several objectives in parallel. 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; while the measurements taken by all networks will be rendered effective only through the data and assimilation subsystems, and effective product delivery.

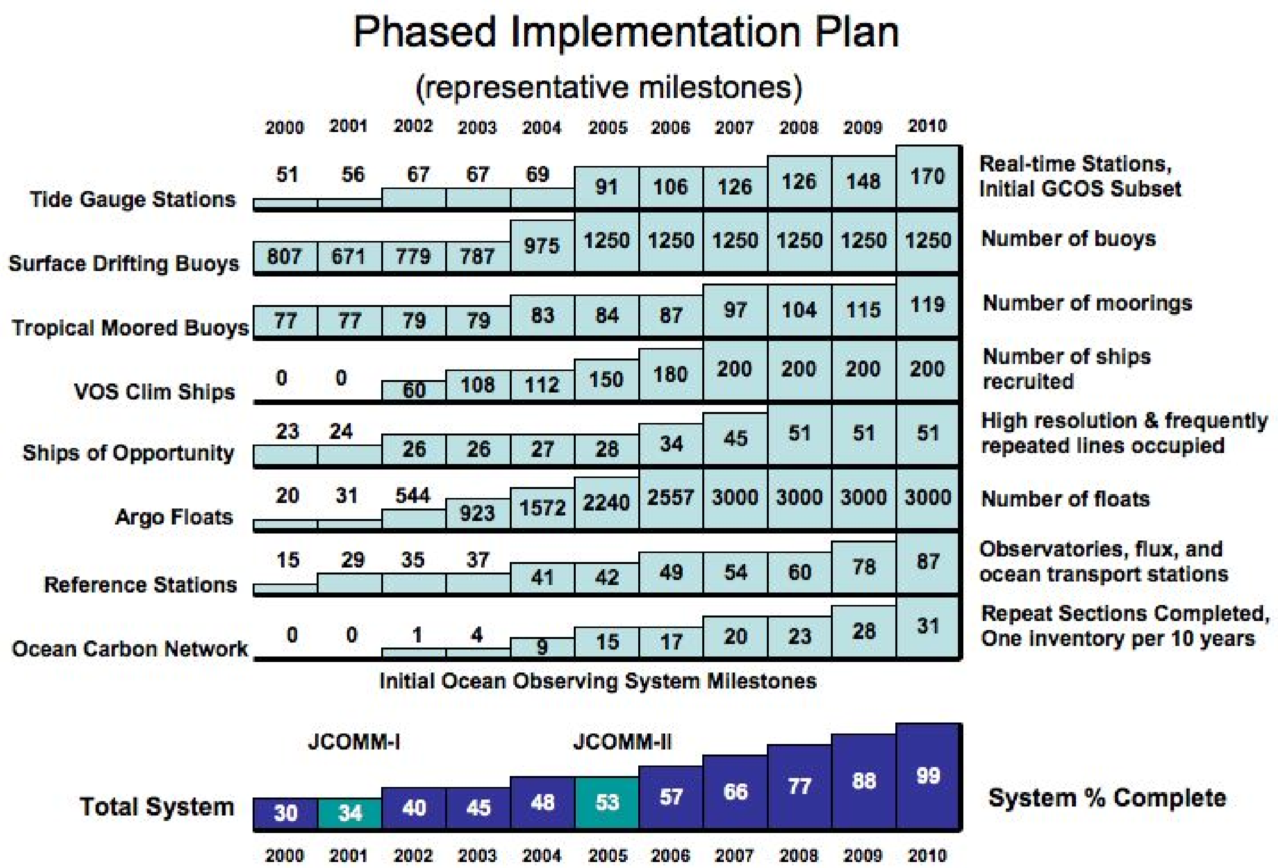


Figure 2: Phased Multi-year Implementation Plan: The history and future plan showing representative milestones for the implementation of the *in situ* elements of the ocean observing system. The plan envisions completion of the initial ocean climate observing system by 2010, which will require substantial additional investment by the Members/Member States.

3.1 Tide Gauge Network: Tide gauges are necessary for accurately measuring long-term trends in sea level change and for calibration and validation of the measurements from satellite altimeters, which 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 a geocentrically located subset expansion from the present 69 GPS/DORIS sites to 170 sites globally. These 170 GCOS Climate Reference Stations will also be upgraded for real-time reporting, not only for climate monitoring, but also to support marine hazard warning (e.g., tsunami warning). 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.

International
Goal

	2003	2004	2005	2006	2007	2008	2009	2010	
Operational GLOSS stations	168	185	204	216	231	251	273	290	290
GPS/DORIS installation	37	53	55	69	75	90	130	170	170
Real-time reporting	67	69	79	91	106	126	148	170	170

3.2 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, pressure, and salinity 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.

	2003	2004	2005	2006	2007	2008	2009	2010	International Goal
Operational buoys	620	870	1250	1250	1250	1250	1250	1250	1250
Barometer upgrades	82	184	279	350	450	500	800	1250	1250
Wind sensors	42	42	50	50	50	60	70	80	
Salinity sensors			9	150	200	300	300	300	300

3.3 Tropical Moored Buoy Network: Most of the heat from the sun enters the ocean in the tropical/sub-tropical belt. The 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 global tropical moored buoy network will be expanded from 83 to 119 stations and will ultimately span all three oceans - Pacific, Atlantic, and Indian Ocean.

	2003	2004	2005	2006	2007	2008	2009	2010	International Goal
Operational buoys	79	83	86	91	97	104	115	119	119
Indian Ocean expansion	2	6	7	10	13	18	29	33	33
Atlantic Ocean expansior	0	0	3	6	8	8	8	8	8
Add salinity sensors	10	10	10	65	80	100	115	119	119
Add flux capability	0	0	0	5	7	7	7	7	7

3.4 Volunteer Observing Ships and Ships of Opportunity: The global atmospheric and oceanic data from Ships of Opportunity (SOOP) have been the foundation for understanding long-term changes in marine climate and, 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 frequently repeated and sampled at high resolution for systematic upper ocean and atmospheric measurement. This climate-specific subset will build from 34 lines presently occupied to a designed global network of 51 lines and will provide measurements of the upper ocean thermal structure, sea surface temperature and chemistry, and surface meteorology of high accuracy. Additionally, the volunteer fleet is the primary vehicle for deployment of the drifting arrays.

	2003	2004	2005	2006	2007	2008	2009	2010	International Goal
VOS reporting regularly	900	900	900	950	1000	1500	2000	3000	
High resolution XBT lines	16	17	17	23	25	26	26	26	26
Frequently repeated lines	11	11	11	11	20	25	25	25	25
Salinity systems	2	2	7	12	15	20	26	26	
Auto-met systems	0	0	40	100	200	250	300	500	
VOSClim ships	108	112	150	180	200	200	200	200	200

3.5 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. Three thousand floats will be deployed worldwide by 2007. Glider technology will replace standard drifting Argo floats in the boundary currents and targeted deep circulation regions.

	2003	2004	2005	2006	2007	2008	2009	2010	International Goal
Argo floats in operation	923	1500	2240	2557	3000	3000	3000	3000	3000
Gliders	3	3	3	3	10	40	80	100	

3.6 Ocean Reference Stations:

3.6.1 Subtask 1: JCOMM, together with international OceanSITES, will implement a global network of ocean reference station moorings, expanding from the present six pilot stations to a permanent network of 29 (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.

3.6.2 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, such as the Gulf Stream, must be established to measure the primary routes of ocean heat, carbon, and fresh water transport.

3.6.3 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.

	2003	2004	2005	2006	2007	2008	2009	2010	International Goal
Flux moorings	2	2	6	7	9	15	22	29	29
Time series stations	26	26	28	30	35	45	50	58	58
Transport sections	9	9	9	9	10	12	14	15	15

3.7 Coastal Moorings: Improved off 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 coastlines are major movers of the ocean's heat and fresh water (e.g., the Gulf Stream). 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 a significant impact 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 suite to provide measurements of the upper ocean as well as the sea surface and surface meteorology. Of these moorings many will serve as platforms-of-opportunity for the addition of carbon sampling instrumentation and other biochemical measurements.

	2003	2004	2005	2006	2007	2008	2009	2010	International Goal
Upgrade w/climate sensors	0	0	0	20	40	60	80	105	

3.8 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 IOCCP 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, and in cooperation will help implement a program of systematic global ocean surveys that will provide a complete carbon inventory once every ten years.

	2003	2004	2005	2006	2007	2008	2009	2010	International Goal
Inventory lines per decade	4	9	15	17	20	23	28	31	37
Time series moorings	2	4	8	10	15	22	32	45	
Flux on ships of opportunity	4	12	28	29	29	33	33	33	

3.9 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 program of observations of this area is being developed for the International Polar Year through dedicated and shared ship-based cruises and oceanographic moorings, 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.

	2003	2004	2005	2006	2007	2008	2009	2010	International Goal
Ice buoys and Ice Stations	24	24	24	24	34	40	45	54	
Subsurface moorings	4	4	4	4	8	12	14	16	
Ship transects maintained	1	1	1	1	2	6	7	10	

3.10 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	2003	2004	2005	2006	2007	2008	2009	2010	International Goal
Tropical Moored Buoys	414	414	428	463	477	484	498	498	
Carbon survey	148	148	148	220	228	228	228	228	
Reference Stations	94	94	94	120	204	240	360	480	

Deployment of drifting arrays	0	60	60	60	80	80	120	120
Thermohaline circulation	340	340	340	340	340	340	340	340

3.11 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 colour, 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.

3.11.1 Sea surface temperature: Satellite measurements provide high-resolution sea surface temperature data. Both infrared and microwave satellite data are important. 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. 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 in satellite data as well as providing bias correction of these data. Satellite biases can occur from orbit changes, satellite instrument changes and changes in physical assumptions on 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 any of these changes.

3.11.2 Sea surface height: The value of spaced-based altimeter measurements of sea surface height has now 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, OSTM) are necessary to continue the long-term sea level record.

3.11.3 Surface vector winds, ocean colour, and sea ice: The best methods of sustaining satellite measurement of surface vector winds, ocean colour, and sea ice are still research and development questions. Over the next five years the satellite agencies will weigh the alternatives and determine the long term strategy for maintenance of these elements.

Appendix

1.1.2 Current status of in situ *ocean observing networks*

Figure 1: Drifting and moored buoys, January 2007

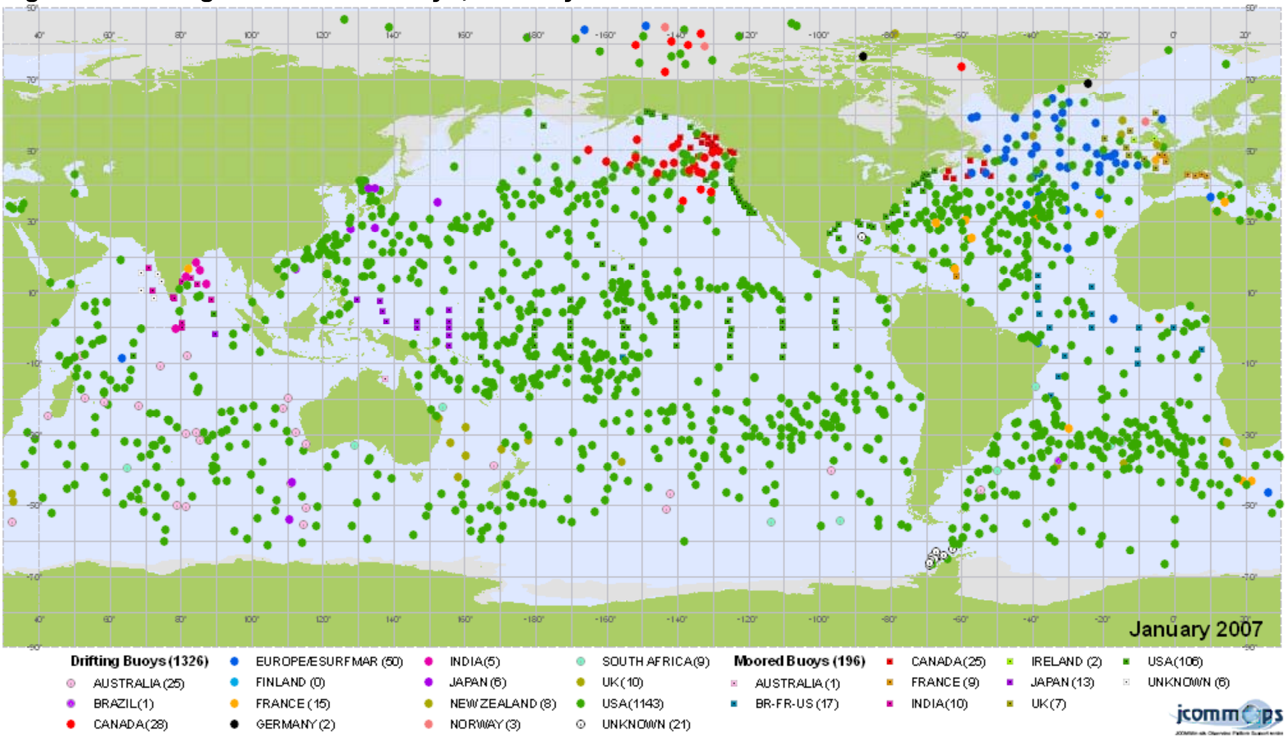


Figure 2: Upper Ocean Thermal Review lines (XBT survey from Ships of Opportunity), 2005

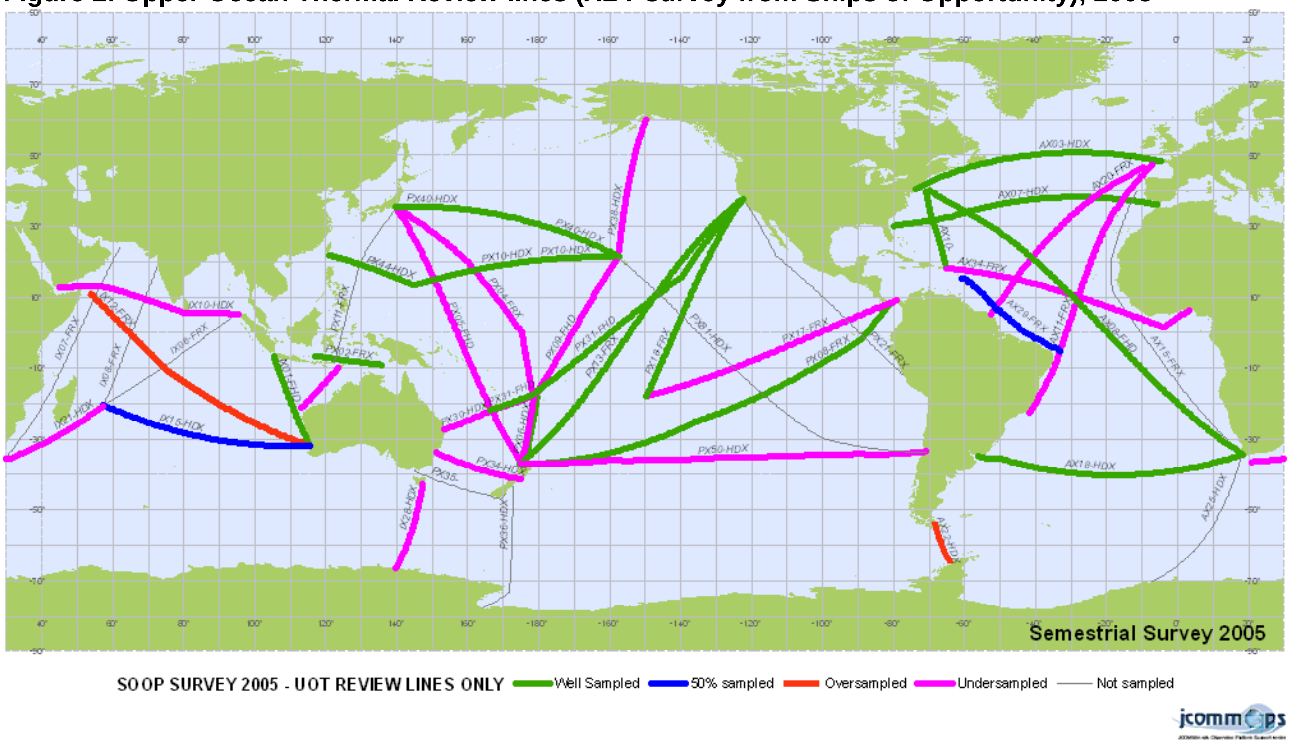


Figure 3: Global Sea Level network (tide gauges), October 2006

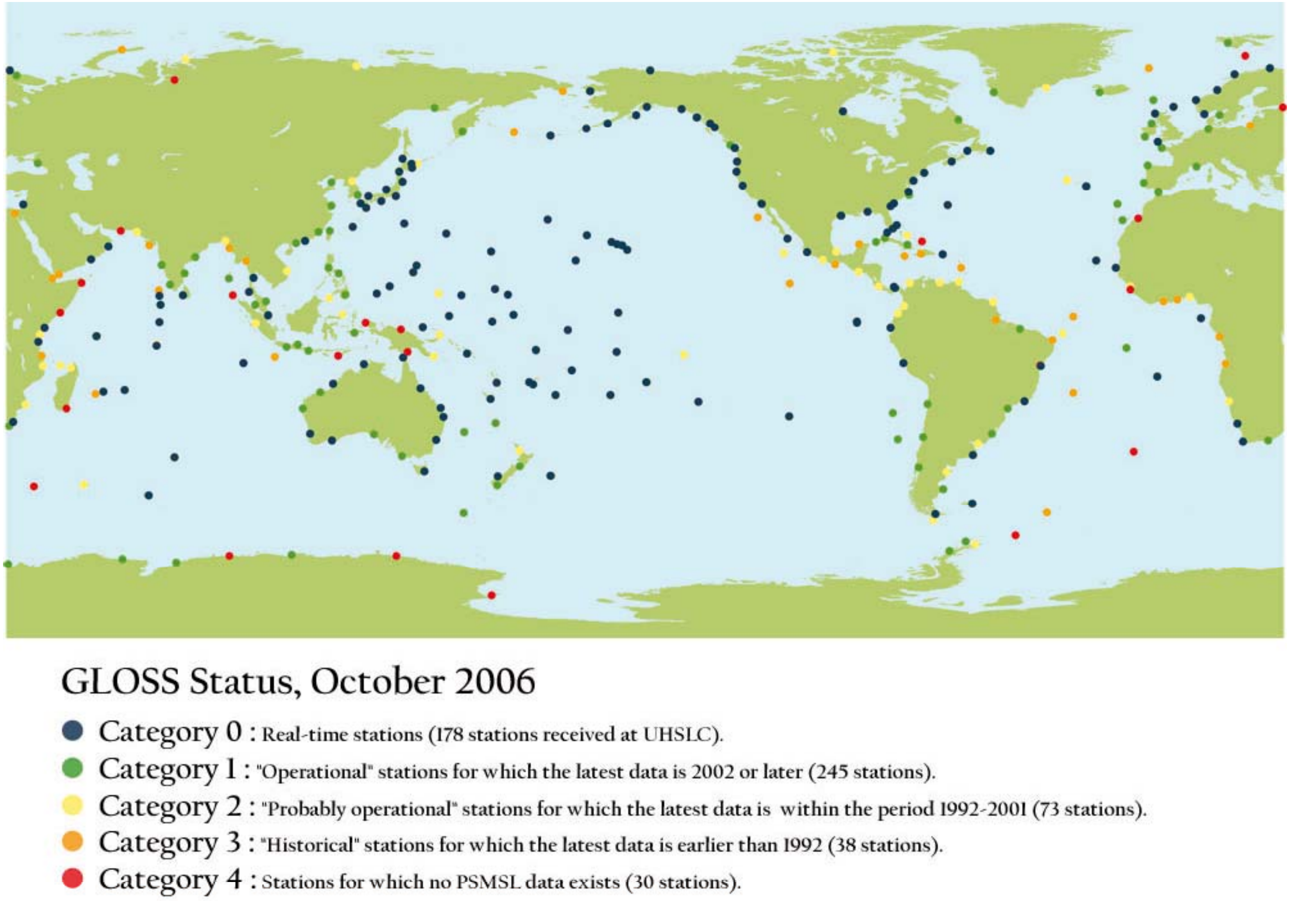


Figure 4: Argo Temperature/Salinity profiling floats, January 2007

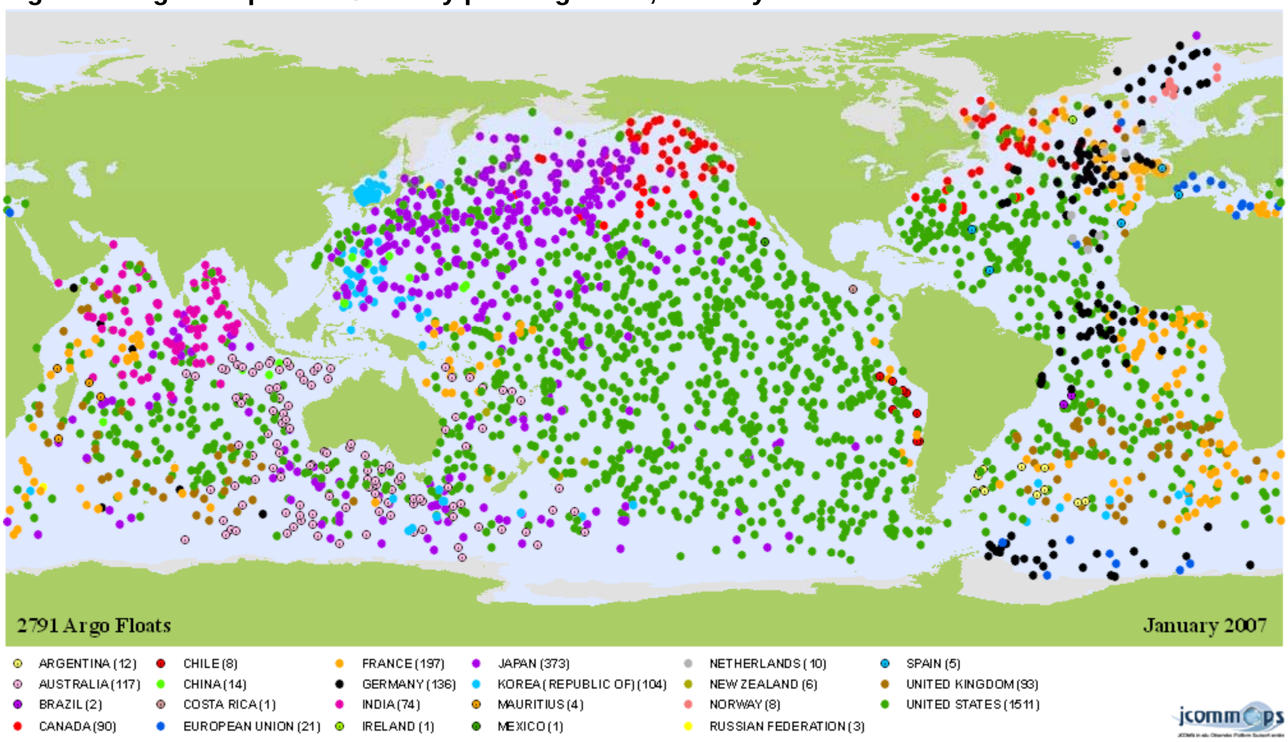


Figure 5: Repeat hydrographic sections

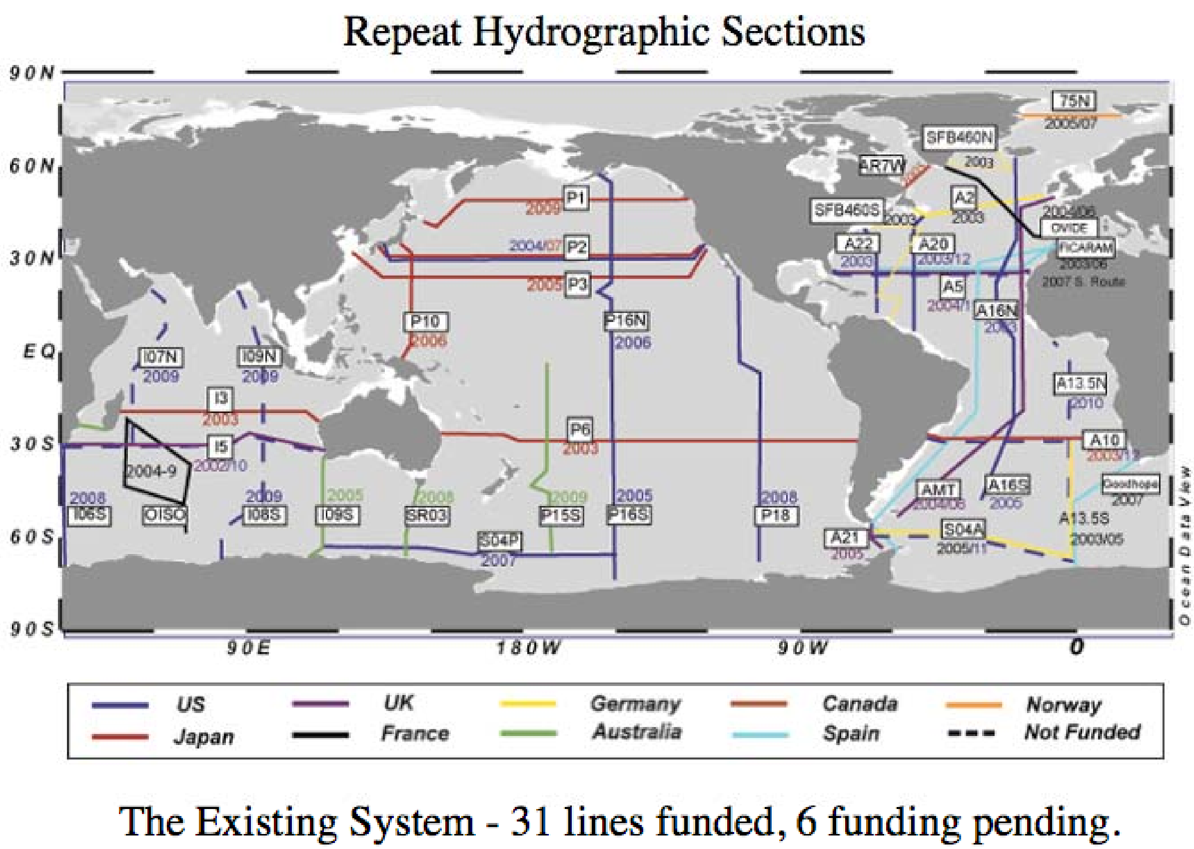


Figure 5: Deep ocean multi-disciplinary time-series reference stations (OceanSITES)

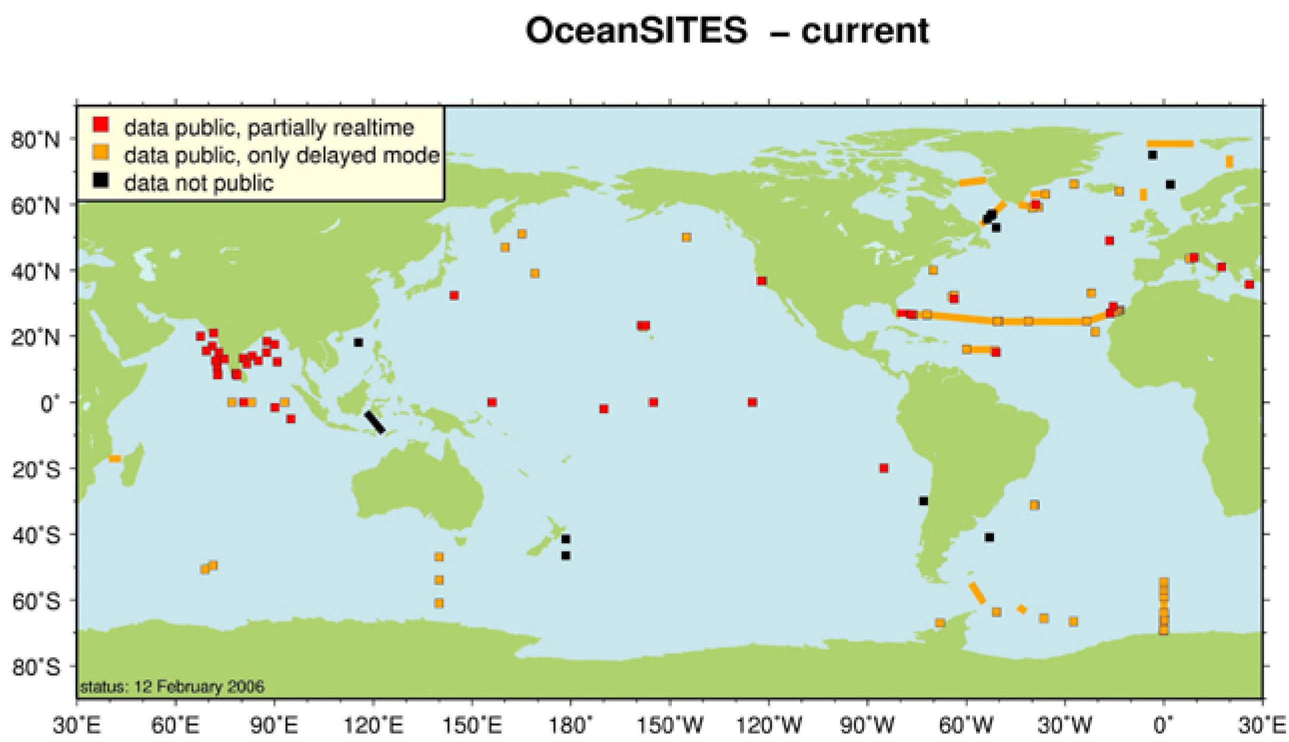
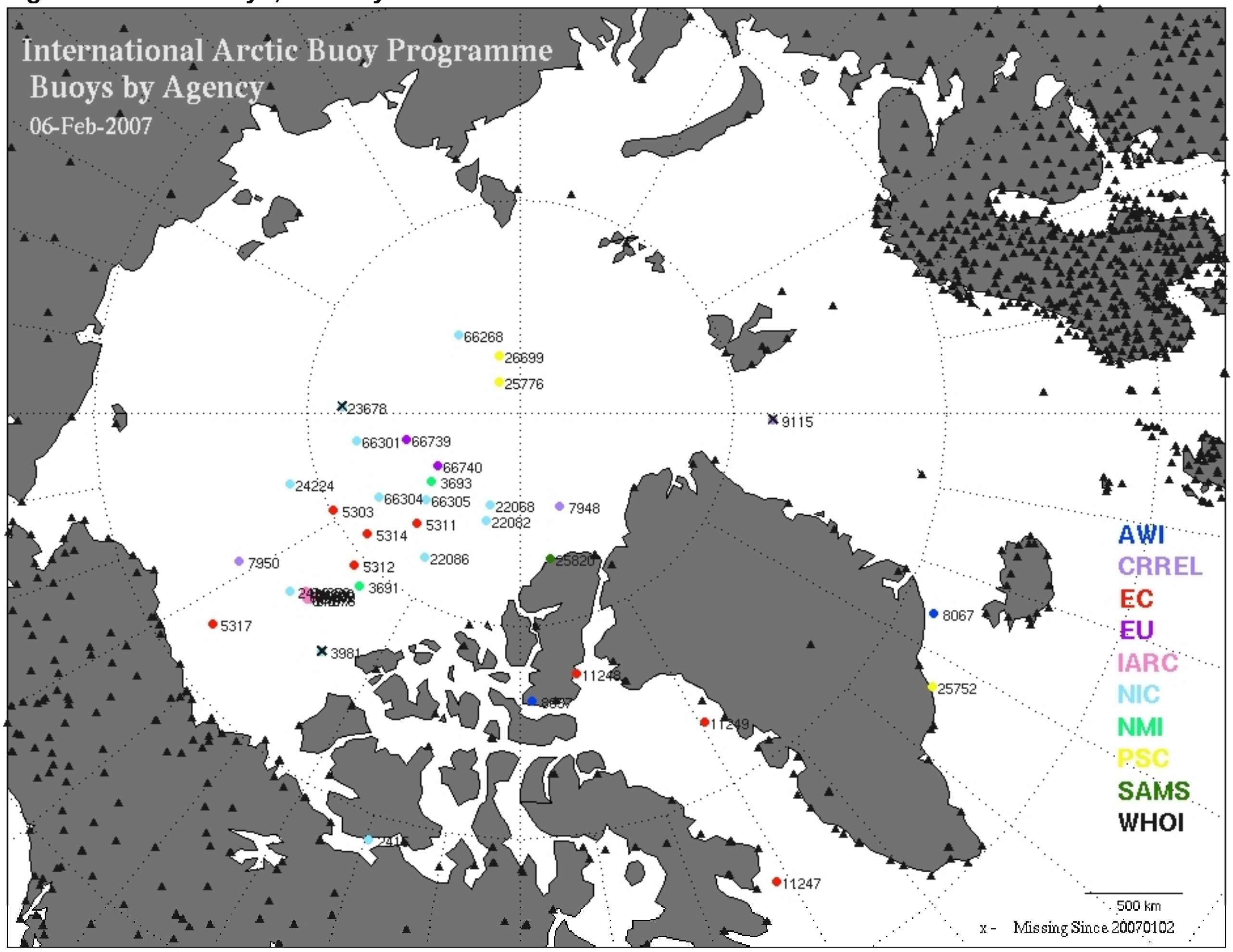


Figure 6: Arctic buoys, January 2007



ANNEX IV

Proposed Announcement and Call for LETTERS OF INTENT

to host an international

Observing Programme Support Centre (OPSC)

Letters of Intent are solicited from institutions interested in hosting an international Observing Programme Support Centre (OPSC). The OPSC will include the existing JCOMM *in situ* Observing Platform Support Center (JCOMMOPS) and in addition will serve the growing requirements of the several international programmes that are working to coordinate implementation of the sustained Global Ocean Observing System.

Framework for an OPSC

The Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) serves as the intergovernmental coordinating mechanism for implementation of the initial Global Ocean Observing System (GOOS) defined in the ocean chapter of the Global Climate Observing System (GCOS) *Implementation Plan for the Global Observing System for Climate in support of the UNFCCC* (GCOS-92). The ocean domain of GCOS-92 has been endorsed as the ocean backbone of the Global Earth Observation System of Systems (GEOSS) and provides the foundation for ocean climate research and operational oceanography. Although designed to meet climate requirements, the initial system defined by GCOS-92 also supports global weather prediction, global and coastal ocean prediction, marine related multi-hazard warning systems, marine environmental monitoring, naval applications, and many other non-climate users.

Description of an Expanded OPSC

The JCOMM *in situ* Observing Platform Support Centre (JCOMMOPS) is currently hosted very ably by CLS (Collecte Localisation Satellites) in Toulouse, and serves three programmes cooperating to help implement elements of the initial global ocean observing system -- the Data Buoy Cooperation Panel (DBCP), the Ship Observations Team (SOT), and the Argo Steering Team (AST). It is recognized that in order to fully implement a sustained global ocean observing system, an expanded technical support centre will be needed to serve the growing requirements of the DBCP, SOT, and AST, and in addition begin to serve the developing requirements of other international programmes, which are also working to coordinate elements of the global ocean observing system. This expansion will greatly enhance the implementation of GOOS by servicing all global observing components/elements with a system-wide approach. System-wide coordination, cooperation, and efficiencies will be improved by all programmes working together to manage global implementation issues. This cooperative support will include system performance monitoring, system evaluation, coordination of deployment opportunities, consolidated reporting, technical advice, and coordination to improve system efficiency and effectiveness.

An expanded OPSC will provide synergies for functions that are now distributed (for example: (i) provide a central portal for documents on instrument evaluation and observational best practices; (ii) assistance with satellite data telecommunication; (iii) support data providers and data users across the whole ocean observing system; and (iv) maximize deployment opportunities and sharing of observing platform); and also provide a more integrated framework for deployment and further development of ocean observing networks. The long-term maintenance and sustainability of the global ocean observing system depends on the efficient use of existing resources, and an expanded OPSC will do much to rationalize and optimize the national contributions of the several

Members/Member States that are working to cooperatively implement the global ocean observing system.

The envisioned OPSC will promote integration across elements of the *in situ* observing system, as well as provide sustained support to the individual components. A dynamic centre with high profile (both on the web and in person) is a key element in highlighting to the contributing Members/Members States, present and prospective, the benefits and value of sustained ocean observations. It will also assist in the cross-JCOMM coordination of the observation requirements from the Data Management and Services Program Areas, as well as coordination across the international science programmes working to help implement a global ocean observing system.

In particular the following programmes have expressed interest in possibly joining together with the DBCP, SOT, and Argo in establishing a cooperative international system-wide technical support capability: the Global Sea Level Observing System (GLOSS), the OceanSITES network of deepwater reference stations, the International Ocean Carbon Coordination Project (IOCCP), and the Partnership for Observation of the Global Oceans (POGO). In addition there is a need to improve coordination between satellite and *in situ* data systems, and there may be a role for maintaining information about the satellite constellation as well. There are currently two full-time technical coordinators at JCOMMOPS, and it is envisioned that an expanded OPSC would begin with at least 4 personnel, with a potential expansion to 8 full-time staff. Information about the work of the existing JCOMMOPS and the above-noted programmes can be found at their respective web sites:

www.jcommops.org
www.jcommops.org/dbcp
www.jcommops.org/sot
argo.jcommops.org
www.gloss-sealevel.org
www.oceansites.org
www.ioccp.org/
www.ocean-partners.org

Specification of Potential Host Institution Capabilities and Infrastructure

Following is a description of the capabilities and infrastructure desired at institutions interested in proposing to host the OPSC. Institutions may propose to satisfy some or all of these requirements.

Programme

- Ongoing involvement in global oceanographic and marine meteorology activities; e.g., observing platform management, data collection and management, delivery of operational met-ocean services, and/or scientific research.

Location

- Location near an international airline hub, with direct and easily accessible ground transportation.
- Easy access from OPSC to national observing system managers, met-ocean services, and other users of ocean observations within the host country.
- Easy access for nationals of all contributing Members/Member States when making visits to OPSC (i.e., no significant delays due to visa applications or local security regulations).
- Nearby suitable hotels to service visitors and for hosting international conferences.

Infrastructure

- An operationally supported computer centre, including power, high internet band width, backup system, and remote access to servers.
- Initial space for four OPSC personnel; potential growth to include space for eight full-time employees; work space accessible to OPSC staff 24/7.
- Access to appropriate conference room facilities (including IT and administrative support) to hold technical workshops and meetings, ideally for 40 people.
- Access to data storage and server equipment, and be a holder of Oracle, ArcGIS licenses that would allow the Centre's use.
- Access to high-speed internet, local area network service and management, and firewall protection.
- Ability to provide updates/patches to the JCOMMOPS system as part of the host's routine system management, and provide IT support for system administration and management. The IT support and system administration and management should be responsive to the particular requirements of the Centre.
- Ability to assist with the possible relocation of the existing JCOMMOPS Information System
- Access to real-time data streams including WMO Information System (WIS)-GTS.

Financial and Administrative

- Ability to accept financial reimbursement from the WMO, IOC, and donor countries at a variety of times of year (due to the differing financial years of donor institutions) for OPSC operating costs.
- Mechanism to execute procurements on behalf of OPSC.
- Ability to assist with relocation of existing JCOMMOPS personnel (e.g., work permits, relocation advice).
- Ability to employ and support (e.g., travel) international staff working at the OPSC.

Review of Letters of Intent

The Letters of Intent will be reviewed by a Committee established by the JCOMM co-presidents, which will include participation from the IOC and WMO Secretariats, and the programme implementation panels planning to contribute resources to the support of the OPSC. The review will take into account the degree to which the desired OPSC specifications (above) are met, as well as the institution's ability/willingness to provide in-kind contributions to help support the operations of the Centre. Based on the successful outcome of this review, the JCOMM co-presidents will encourage a full proposal from the institution(s) considered most responsive.

Eligibility and Submission of Letters of Intent

All interested National meteorological and hydrological services, National oceanographic centres, and other met-ocean institutions in Members/Member States are eligible to submit Letters of Intent. Preference will be given to institutions that are already involved with JCOMM-related operations and are active participants in the JCOMM affiliated programme implementation panels noted above. The following information should be included in each Letter of Intent:

- Evidence of capability – please specify, for each of the specifications listed above, what kind of infrastructure and facilities will be made available to the Centre. Some of the specifications are no-cost attributes, and some are infrastructure requirements that will have cost. It is expected that most proposing institutions will be able/willing to offer some in-kind contributions to the operations and maintenance of the OPSC. This could also include support services such as Information Technology and administrative assistance. Letters of Intent should indicate where reimbursement will be requested from JCOMM versus where in-kind support (no cost to JCOMM) will be offered by the host.

- Rationale and vision for OPSC – please include an explanation of how an OPSC would contribute to the operations of the host institution and how the host institution's operations would contribute to the work of the OPSC.
- Other advantages, capabilities, and rationale for locating the OPSC at the proposed institution – please include other information about the host institution that may be relevant to this solicitation.

Deadline and Submission

Institutions interested in hosting an international Observing Programme Support Centre (OPSC) should submit a Letter of Intent to the JCOMM Secretariat at either the IOC or WMO on or before 15 November 2007.

ANNEX V

Tropical Moored Buoy Implementation Panel (TIP)

(Mike McPhaden, TIP Chairman, and Paul Freitag)

Moored buoy arrays are an integral component of most ocean observing systems. Tropical moored buoy arrays have been established in the Pacific Ocean basin since the early 1980s, in the Atlantic Ocean basin since 1997 and an array in the Indian Ocean basin has been under development since 2000. This report provides the present status and near-term plans for each array. Cross-cutting issues to be brought to the attention of the Observations Coordination Group (OCG) include capacity building, ship time, international coordination, and vandalism.

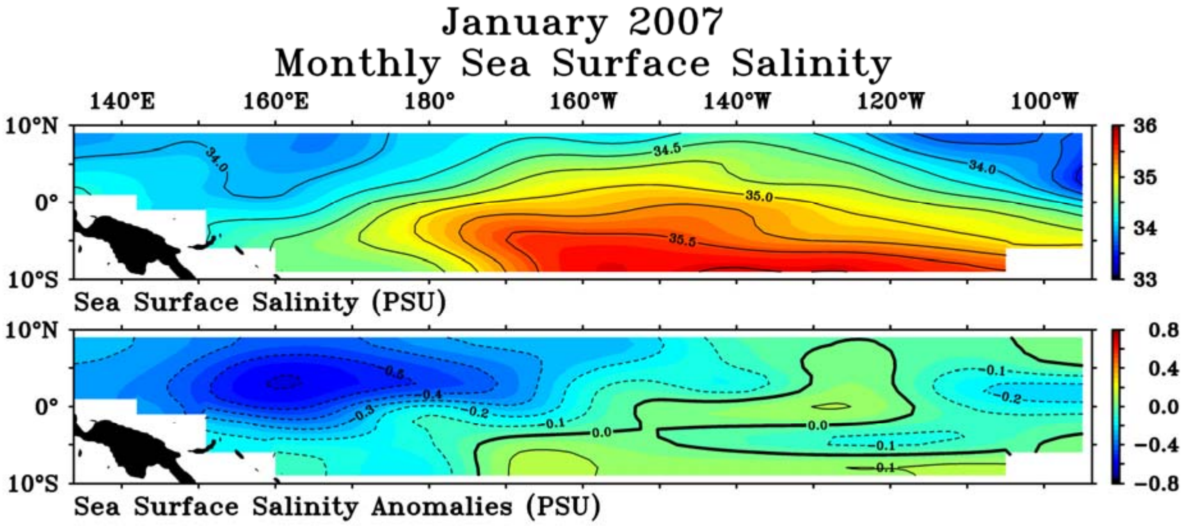
Pacific Ocean Status

The TAO/TRITON (Tropical Atmosphere Ocean/Triangle Trans-Ocean Buoy Network) moored buoy array is a central component of the ENSO Observing System, deployed specifically for research and forecasting of El Niño and La Niña. The Array consists of 55 ATLAS moorings originally maintained by PMEL (Pacific Marine Environmental Laboratory), but now maintained by NOAA's National Data Buoy Center (NDBC), 12 TRITON moorings maintained by JAMSTEC (Japan Agency for Marine-Earth Science and Technology), and 5 subsurface ADCP (Acoustic Doppler Current Profiler) moorings (4 maintained by NDBC and 1 by JAMSTEC). In addition to these core moorings, additional moorings deployed as enhancements include 4 TRITON moorings in the far western tropical Pacific along 130 E and 137 E.

PMEL's ATLAS mooring data processing, monitoring and quality control systems were cloned and established at NDBC in October 2005. After a year of parallel testing, sole operational responsibility for TAO data processing was assumed by NDBC in October 2006. In January 2007, NDBC assumed responsibility for TAO field operations. PMEL continues to provide all ATLAS instrumentation while NDBC develops an upgrade to the mooring electronics with more commercially available components. Side-by-side testing of legacy and developing mooring electronics is scheduled to begin in 2007.

PMEL has undertaken two enhancements to the TAO Array: 1) to measure surface fluxes of heat, momentum and fresh water at 4 sites (on the equator at 110ºW, 140ºW, 170ºW and 165ºE) as a contribution to the OceanSITES network of global time series reference stations, and 2) to measure surface salinity (SSS) at all TAO sites. The four surface flux enhancements were completed in 2006, complementing one TRITON site (2ºN, 156ºE) identified as a surface flux reference station. Presently real-time reporting of SSS has been established at 48 of 55 TAO mooring sites. The enhancement of TAO sites to measure SSS makes possible new, real-time SSS analysis across the Pacific since SSS is a standard measurement at all TRITON mooring sites (Fig 1.)

Multidisciplinary measurements are also supported at some TAO sites. For example, pCO_2 is presently measured at 5 TAO sites, 3 of which are instrumented with PMEL pCO_2 systems (0º, 125ºW, 0º, 140ºW and 0º, 170ºW), and 2 with Monterey Bay Aquarium Research Institute (MBARI) pCO_2 systems (0º, 155ºW and 2ºS, 170ºW).



<u>Figure 1</u>. A preliminary monthly analysis of January 2007 mean (upper panel) and anomaly (lower panel) Sea Surface Salinity from the TAO/TRITON Array.

Atlantic Ocean Status

PIRATA (Pilot Research Moored Array in the Tropical Atlantic) has completed a 5-year (2001-2006) consolidation phase during which the array's 10-mooring configuration has been evaluated for its utility in support of research and operational forecasting. Ship time and cruise technical staffing for mooring maintenance is provided by Brazil, France and the United States. Mooring preparation, data processing, evaluation and dissemination are provided by PMEL in the US. One subsurface ADCP mooring is maintained by France.

Beyond the 10-mooring backbone, the array has expanded substantially in the past 2 years. Three additional moorings to the southwest of the array were deployed in August 2005 (Fig. 2). Two additional moorings to the northeast were deployed in June 2006 and two additional moorings will be deployed in the northeast in May 2007. These southwest and northeast extensions have been established as ongoing components of the array. A mooring to the southeast of the array supported by South Africa was deployed in June 2006 and is to be recovered in June 2007. Continual occupation of this site may be established in the future if sufficient resources are identified. Three of the original sites (15ºN, 38ºW, 0º, 35ºW and 10ºS, 10ºW) have been enhanced for surface flux measurements.

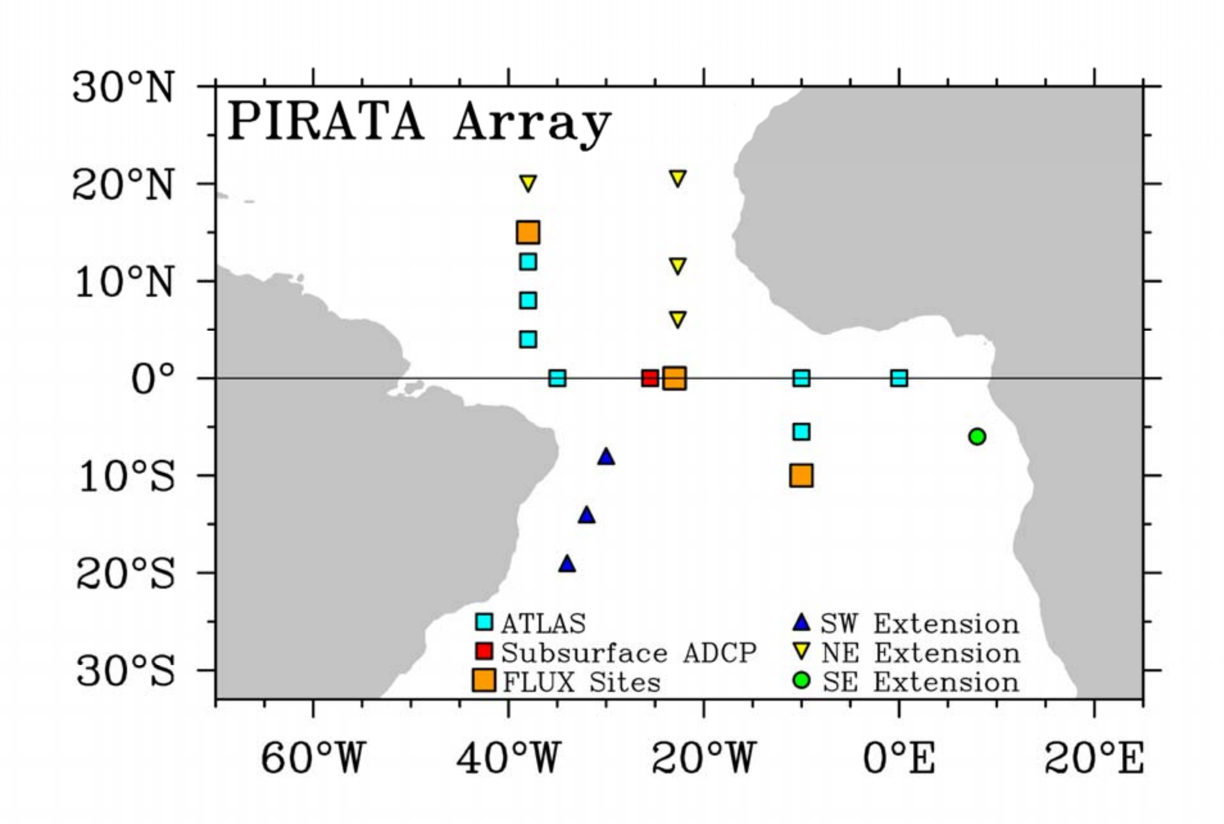


Figure 2. Map of PIRATA Array mooring sites, including the original 10-site array (blue and orange squares) and recent extensions and enhancements.

Indian Ocean Status

Progress towards the establishment of an Indian Ocean moored buoy array was made with the deployment of 4 surface ATLAS moorings (along 80.5ºE at 1.5ºS, 0º and 1.5ºN and at 0º, 90ºE) and one subsurface ADCP mooring (near 0º, 80.5ºE) in October/November 2004 (Fig. 3). The moorings were deployed from the Ocean Research Vessel Sagar Kanya in collaboration with India's National Institute of Oceanography (NIO) and National Center for Antarctic and Ocean Research (NCAOR). These moorings complement two previously established JAMSTEC TRITON moorings (at 1.5ºS, 90ºE and at 5ºS, 95ºE), one JAMSTEC subsurface ADCP mooring (at 0º, 90ºE), and 3 subsurface Deep Ocean moorings maintained by NIO (along the equator at 77ºE, 83ºE, and 93ºE). One ATLAS (at 0º, 80.5ºE) and one TRITON site (at 1.5ºS, 90ºE) have OceanSITES flux enhancements.

At present Japan has no plan to expand the number of TRITON sites in the Indian Ocean. Development of a smaller "Mini-TRITON" mooring is progressing with the first test deployments in the Indian Ocean in October 2006 as a component of JAMSTEC's MISMO Experiment. One of the drivers of this development is that the smaller buoy will not require Japan's R/V Mirai for deployment and recovery. The ability to use smaller ships will allow greater flexibility in servicing JAMSTEC moorings in the Indian Ocean and elsewhere in the future.

The PMEL/NIO moorings were replaced from the ORV Sagar Kanya in September 2006 and one additional ATLAS site established at 1.5ºN, 90ºE. Two additional ATLAS moorings were deployed in November 2006 from Indonesia's RV Baruna Jaya I (at 4ºN, 90ºE and 8ºN, 90ºE). An additional ATLAS mooring in the southwest Indian basin (at 8ºS, 67ºE) was deployed as part of the French VASCO-CIRENE Experiment in January 2007. The Peoples Republic of China's First Institute of Oceanography and Indonesia's Agency for Marine & Fisheries Research plan to deploy a subsurface ADCP mooring south of JAVA in 2007.

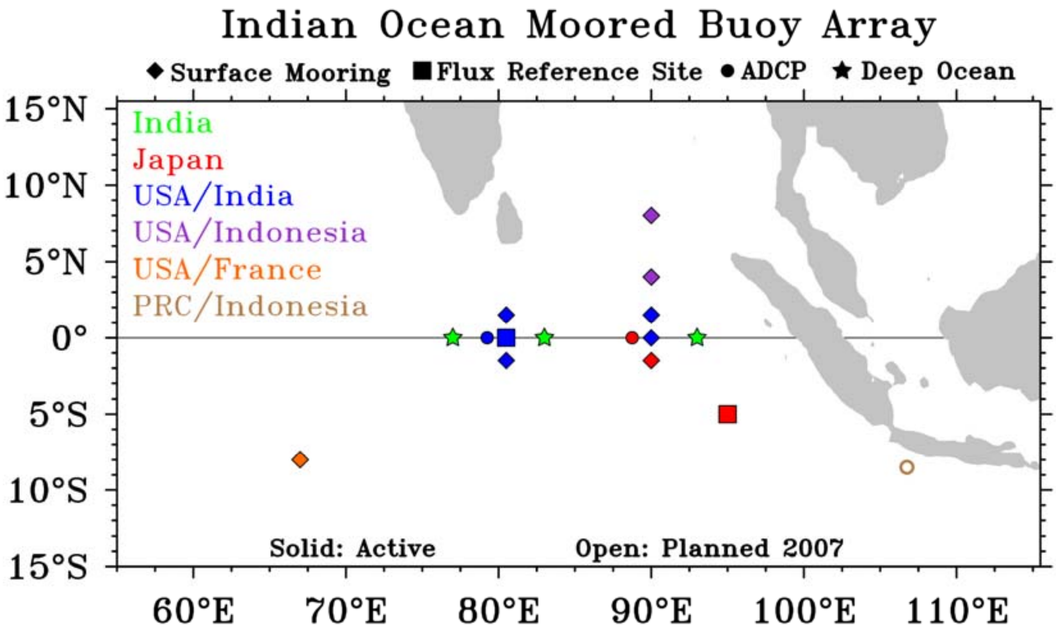


Figure 3. Locations of presently deployed and planned Indian Ocean mooring sites.

More information on TAO/TRITON, PIRATA, and the Indian Ocean Array along with data display and dissemination are available on the web at www.pmel.noaa.gov/tao.

ANNEX VI

International Ocean Carbon Coordination Project Status Report 2006

(Maria Hood, IOCCP Director)

The International Ocean Carbon Coordination Project promotes the development of a global network of ocean carbon observations for research through technical coordination and communication services, international agreements on standards and methods, advocacy, and links to the global observing systems. The IOCCP is co-sponsored by the Intergovernmental Oceanographic Commission of UNESCO and the Scientific Committee on Oceanic Research. The IOCCP project office is located at UNESCO's Intergovernmental Oceanographic Commission, where two project office positions are supported by grants from the US National Science Foundation. For more information about the IOCCP including detailed progress reports on items summarized here, please visit the IOCCP's Ocean Carbon Directory at: www.ioccp.org

Observations Network at a Glance *(for details, see the system maps at tables at www.ioccp.org)* :

- Hydrography – 22 planned or proposed cruises for carbon from 2006-2012. International synthesis work is underway in the Atlantic. Plans for a sustained and comprehensive information and data center are being discussed.
- VOS – 33 lines currently operating. April 2007 workshop will focus on observing strategies for surface CO_2 research.
- Time Series – 27 stations, both ship-based and from permanent moorings.
- Standards and Methods – Guide of Best Practice is in final review; should be published by 2007.

Hydrography and Carbon – As a follow-up action from the November 2005 IOCCP-JAMSTEC-CLIVAR International Repeat Hydrography and Carbon (IRHC) workshop, it was agreed to establish a small advisory group to develop a cohesive and comprehensive "observations support service" for international repeat hydrography and carbon. The advisory group would be co-sponsored by IOCCP, CLIVAR-GSOP and the SOLAS/IMBER Carbon Group. Some of the tasks identified for immediate attention included:

i. the development of a single-site, comprehensive information and data center for all ship-based hydrography (encompassing more than just the official CLIVAR cruises, and combining / coordinating the information, data services, and "community bulletin board" outreach and communication services currently provided by CCHDO, NODC-A, CDIAC, IOCCP, and CLIVAR IPO);
ii. providing input to the "Friends of Oxygen on Argo" activities;
iii. providing input to the North Atlantic synthesis, with its first meeting of carbon scientists scheduled for late June 2006, and making plans to update the hydrographic program manual as needed.

In 2006 and early 2007, the three sponsoring organizations endorsed the concept, but noted that detailed terms of reference were needed to better define the activity and its scope. Of the three actions listed, only the development of the single-site information and data center currently requires action, as the other two projects have progressed (see below).

Friends of Oxygen on Argo - Following the IRHC Workshop, a small group (the "Friends of Oxygen on Argo", FOA) was established to develop plans and proposals for a large-scale extension of the current small-scale deployments of Argo floats instrumented with O_2 sensors. It was agreed that the IOCCP should facilitate the work of this group. The IOCCP hosted a small meeting of the principle authors for the FOA group in June of 2006. A white paper to promote the addition of oxygen sensors to the Argo float program has been released, and the authors are currently seeking comments from the wider community (see www.ioccp.org). This paper is aimed to form the basis for the discussions in March at the Argo SC meeting in Paris. The paper has been written by the members of the Argo-Oxygen writing team with input from the community at large. It synthesizes the main scientific motivations, the objective, as well as the current status of the technology, including the identification of currently existing gaps. It also outlines a possible path forward with regard to the actual implementation.

North Atlantic Synthesis Workshop – In June, the IOCCP co-hosted an Initial North Atlantic Synthesis meeting, jointly with the EU CarboOcean program. The meeting brought together 23 participants from 9 countries with expertise ranging from hydrography, physical oceanography, surface pCO2, ocean tracers (CFCs, O2), numerical modelling and data management to discuss development of a synthesis of carbon and carbon-related data collected in the Atlantic Ocean. The goals of this meeting were to identify existing datasets, to document the plans and interests of individual research groups, to establish collaborations between groups based around key scientific questions, to discuss common methodologies, and to plan for a North Atlantic synthesis using multi-disciplinary approaches. Three working groups were established:

- Southern (South of 16°N, with emphasis on the Southern Ocean)
- Northern (North of 60°N)
- Middle (North Atlantic Sub-polar and sub-tropical gyres).

Each working group identified the datasets currently available, and those that would become available in the near future. Individuals were nominated within each group to be responsible for data quality assessment of each variable (discrete pCO_2, Talk, pH, Nutrients, DOC, O_2, T&S, Oxygen and Carbon isotopes, CFCs). The working groups have continued progress on assembling the data, and two of the three groups will be meeting later in March. The IOCCP has been asked to serve as a central coordinator for these activities, and a dedicated web-site will soon be developed to inform the wider community of the progress of these groups.

Surface CO_2 – the IOCCP, SOLAS/IMBER Carbon Group, and the Global Carbon Project are co-sponsoring a workshop on Ocean Surface CO_2 Variability and Vulnerability at UNESCO, April 11-14. The purpose of this workshop is to review the current knowledge base and enhance international cooperation to resolve the magnitude, variability and processes governing ocean sources and sinks of carbon: from observations, process-based models and atmospheric and oceanic inversions. Approximately 90 participants are registered to attend. Twenty national reports are being submitted to provide updates on observation and research programs. Three working groups will be developed to address the following issues:

Working Group 1: To identify from field observations and model outputs the most likely regions of the ocean where the large-scale air-sea CO_2 fluxes have changed in the recent past and are most susceptible to change in the future (i.e. most vulnerable), to understand the underlying processes, and to assess the content and quality of the models that are used to quantify the observed and projected changes.

Working Group 2: To develop observing strategies to address our largest unknowns, data and gas exchange uncertainties, and taking into account new techniques, measurement technology, and observing system experiments.

Working Group 3: To identify opportunities and needs for coordinated data synthesis activities based on existing projects, new results, and recent data releases. Should we begin developing a "GlobalView Ocean CO_2" database?

A special issue of a peer-reviewed journal will be produced from invited papers presented at the workshop.

Time Series – In 2006, the IOCCP maps were updated and redesigned to provide more detailed information. Discussions with CDIAC are underway to provide direct data links from the tables and maps. Discussions with OceanSITES on collaborations are ongoing.

Ocean Colour – The IOCCP is a partner in the European Space Agency GlobColour project, which aims to develop and demonstrate a service supporting global ocean carbon-cycle research. The project will provide scientists with a long time-series of consistently calibrated global ocean colour information, according to requirements specified by the global ocean colour user community, as represented by the user group. GLOBCOLOUR will also put in place the capacity to continue the ocean colour service in the future. The IOCCP, working with the International Ocean-Colour Coordinating Group, serves as a link between the ocean carbon community and this project, to provide input into the development of the data products to ensure they are useful for the ocean carbon community. In January of 2006, the IOCCP hosted the first meeting of the GlobColour science team to review System Requirements and Validation Protocols for the project, and in December 2006 the IOCCP also sent an ocean carbon representative to the first GlobColour user workshop to obtain feedback from the research community about needs for and uses of ocean colour data.

Standards and Methods – the IOCCP and PICES co-sponsored the development of "The Guide of Best Practices for Oceanic CO_2 Measurement and Data Reporting". The manuscript was completed in late 2006 and has been sent out to the community for review and comments. It is anticipated that the guide will be published by third-quarter 2007.

ANNEX VII

Progress Report on Preparation of the International Polar Year 2007-2008

1. The IPY (2007-2008) initiated by the WMO and ICSU will be an intensive and internationally coordinated campaign of high quality research activities and observations in Polar Regions during the periods of 1 March 2007 to 1 March 2009. In April 2006, the WMO/ICSU Joint Committee (JC) for IPY had completed an evaluation of 452 full project proposals (received from nations up to 31 January 2006) for scientific or educational significance, consistency with the IPY themes, evidence of international collaboration, and evidence that activities proposed would contribute to an IPY legacy. Of these 452 project proposals, the JC endorsed 228 (170 scientific project proposals, one for data and information services, and 56 proposals for education and outreach).

Information on the IPY projects can be located at the following web address: www.ipy.org. Of the 170 scientific project proposals, over 100 scientific projects of these are focused on comprehensive studies of the atmosphere, ocean, cryosphere and hydrological cycle, ecosystems in Polar Regions, as well as on the study of climate change impact on socio-economic and living conditions of local population.

2. The Intercommission Task Group (ITG) on the IPY (Chaired by Professor Qin Dahe (China)) had played an active role in the process of preparation of full project proposals for the IPY. The ITG activities during 2006 were found to be going in two directions. The first direction aimed to assist technical commissions in determining of their role at the IPY implementation stage within their areas of responsibility. The second was to contribute to the development and coordination of concrete IPY projects. With regards the first direction, the sessions of the CAS, CAeM, CBS, and CIMO, which took place in 2006, have endorsed concrete proposals for the activities during the IPY. Similar actions were taken by the sessions of the CCl and JCOMM in 2005.

3. With respect to the second approach, there are several examples of active involvement ITG Members in preparation and coordination of the IPY projects. The IPY projects dedicated to studies of atmosphere, ocean, hydrological cycle and cryosphere in polar regions such as the IPY-THORPEX, COMPASS, IASOA, IAOOS, CASO, ARCTIC-HYDRA, CRYOS and others have been, to large extent, developed thanks to leading role in their planning and coordination provided by the following ITG Members: Dr O. Hov (CAS), Dr S. Pendlebury and Dr I. Frolov (JCOMM), Dr A. Snorrason (CHy), and Dr B. Goodison (WCRP/CliC). The important contribution of the ITG Members, as well as the Presidents of some technical commissions to the overall coordination of IPY, through the participation in the established mechanisms such as IPY Joint Committee (Dr Beland, Professor Qin), Sub-Committee on Observations (Dr Snorrason and Dr Dexter), and Sub-Committee on Data Policy and Management (Dr Sterin), was well recognized by polar scientific community.

4. Proponents of all endorsed projects have applied for funding from national and international funding agencies. In July 2006, the letter signed by the WMO Secretary-General and Executive Director of the ICSU was sent to Ministers of Foreign Affairs and of Science and Technology of all WMO and ICSU Members. The two Organizations strongly urge governments of their Members to provide financial support for the IPY implementation, in the context of their respective national research budgets, in order to allow scientists to make a contribution to this extraordinary international scientific collaborative effort. The reaction received was positive. Many nations (such as Brazil, Canada, China, France, Italy, Norway, Russian Federation, Netherlands, UK and other respective nations) have developed new funding to support these innovative and coordinated studies. According to information collected by the IPY International Programme Office, as of 15 January 2007 (see: www.ipy.dk), 76 of 228 endorsed projects received substantial funding, 65 projects received partial funding, 5 projects are pending funding, and information has not been received from 81 projects. One project has been withdrawn.

5. The IPY Sub-Committee on Observations (SCOBS) with participation of ITG Members had prepared the assessments of the observing systems contained within the 156 IPY scientific projects. The assessment covered all projects within the domains of: Atmosphere, Ocean, Ice, Land, People, and Earth & Space (partially). The assessment results were very informative, in particular with respect to observational data requirements, data sources, technology/institutional gaps, data management requirements and potential legacy of observing systems planned to be established during the IPY. The assessments are used to large extend to assist project in filling the gaps.

6. One of the important tasks of the IPY SCOBS is to establish an open means of communication between IPY project coordinators and Space Agencies to assist the IPY projects to meet the requirements for satellite data, products and services. To carry out this dialog, the Space Task Group (STG) for the IPY, comprised of nominated representatives of Space Agencies, was recently established within the SCOBS. The STG was tasked with reviewing the IPY space data requirements and making data acquisition plans, processing, archiving, and the distribution of recommendations regarding contributions of the Space Agencies. Results from the first meeting (WMO Headquarters, Geneva, Switzerland, 17-19 January 2007), indicated that the STG is well on the way to developing the concept of an effective space component of the observing system for the polar regions during the IPY. This would deliver a series of “firsts”, to include:

- Pole to coast multi-frequency InSAR measurements of ice-sheet surface velocity;
- Repeat fine-resolution SAR mapping of the entire Southern Ocean sea-ice cover for sea ice motion;
- One complete high-resolution visible and thermal IR (Vis/IR) snapshot of circumpolar permafrost; and
- Pan-Arctic high and moderate-resolution Vis/IR snapshots of freshwater (lake and river) freeze-up and break-up.

In terms of how this will information will be delivered, the Agencies have introduced the concept of IPY data portfolios. Each Agency will determine what data will be made available to the IPY scientists as part of its portfolio. The intention of this project is to provide open and easy access to these portfolios for scientific use.

The content of the portfolios will evolve through the STG coordination of planning, acquisition, downlink and processing satellite data during the IPY and beyond, as a legacy. The STG noted with appreciation, the presentation of Representative of Canadian Space Agency (who), who had provided the meeting with information on IPY PolarView Services and described the planned Web Portal for one-stop shopping for operational sea-ice products derived from ice services.

7. Another important task of the SCOBS is to establish through JC, a dialog with the CBS, CAS, CHy, JCOMM, GEO, CGOS, GOOS, WCRP, as well with the Arctic Council and ATCM to secure provision for the legacy of observing systems established or rehabilitated during the IPY. The results of the SCOBS assessment, in particular related to a legacy of IPY observing systems, are of potential use by international programmes and organisations. There is an idea proposed by the GEO Secretariat to organize an IPY Legacy Workshop in 2008, when detailed information on the real implementation of the IPY projects in the field during the first year of IPY would be available. This should provide information on the status of the observing systems that have been actually established and operated during the first annual period of the IPY.

8. The IPY Sub-Committee on Data Policy and Management (SCDPM) has finalized a Policy on IPY data management (www.ipy.org), and is currently working on developing an IPY Data and Information Service (DIS), which will be based on existing systems, and will follow the successful example of the Data Information Units developed by the World Ocean Circulation Experiment (WOCE). The Joint Committee of the SCOBS and SCDPM (Beijing, China, October 2006), has started to develop a strategy for the overall data flow within the IPY. The important issue in this connection would be an establishment of an “infobase’’ that should contain the following information: data sources both the IPY and non-IPY; templates for data and metadata,

where data to submit to; outcomes of survey on data management requirements and plans carried out by the SCDPM and IPO among Project Coordinators.

9. The Joint Committee produced a technical document entitled, "The scope of science for International Polar Year 2007-2008" (WMO/TD-No. 1364, February 2007), that provided scientific basis and organizational structure for the IPY. The IPY was officially launched on 1 March 2007, in Palais de la Decouverte, Paris, France, in the presence of the Executive Heads of WMO, ICSU and Members of the JC. At its Fifth Session, the JC (Paris, France, from 28 February to 2 March 2007) agreed to begin planning an IPY Science Conference to be tentatively scheduled for autumn 2010, and accepted the kind offer of Norway to host the Conference in Oslo. The Science Conference is considered as a complimentary conference to many polar science meetings already scheduled or planned, and in particular, as a way to accelerate our progress on the interdisciplinary and integrating themes of the IPY.

10. Following the WMO Resolution 34 (Cg-XIV) and the recommendations of JCOMM-II, the Expert Team on Sea Ice (ETSI) agreed to support the International Polar Year 2007-2008 by: (i.) providing tailored information, including web pages dedicated to GDSIDB normals, ice records and national ice data, available on a timely basis, (ii.) encouraging national ice services to supply updates and historical documents and ice data from coastal stations to the Global Digital Sea Ice Data Bank (GDSIDB) centres, and (iii.) encouraging the ETSI Members to enhance sea ice observations and data archiving at the designated centres. In this context, the ETSI has been developing an Ice Information Portal, hosted by the PolarView project (supported by the ESA and European Commission with participation by the CSA (see: http://www.polarview.org). This issue is further developed under document 2.10(2).

11. At present, regular meteorological forecasts and warning for shipping under the GMDSS do not extend to polar regions, because of lack of data from these areas would make such information very unreliable, and also because of the lack of broadcast coverage by Inmarsat. In response to this issue, a joint IMO/IHO/WMO Correspondence Group on Maritime Safety Information Services was established to address this problem and other associated issues. This Correspondence Group includes representatives of all affected countries (Canada, Denmark, Iceland, Norway, Russian Federation, United Kingdom and USA) and other interested organizations (including the IMSO, Inmarsat and any other respective approved safety-service providers). The JCOMM Expert Team on Maritime Safety Services (ETMSS) is represented on this Group, and the work of this Group was summarized and reported at the Eleventh Session of the IMO Sub-committee on Radio Communications and Search and Rescue (COMSAR-XI, London, United Kingdom, February 2007). This issue is further detailed under Agenda Item 2.6.2.

12. The coordination for the deployment of oceanographic and meteorological observing platforms in Polar Regions (e.g., ice buoys, ice tethered platforms and Ice Mass Balance buoys) was made possible through the IABP and WCRP-SCAR IPAB. The IPY development is also being followed through these two DBCP Action Groups. Both the IABP and IPAB participants have made submissions to the IPY accordingly.

13. The Meeting invited to note this information and develop a plan of actions during the IPY implementation stage, as well as in the post-IPY era in provision of the efficient operations of the observational networks, of the sustainable exchange of the IPY data in real- and non-real time modes, and in security of a legacy of the IPY to include sea-ice observing systems and observational data sets.

ANNEX VIII

Provisional Surface Wave Observation Requirement document

(new updated version to be provided to the SOT and the OCG by 12 April 2007)

1. Introduction

1.1 The purpose of this document is to specify the requirements for surface wave observations that arise from offshore wave forecast modelling and related activities. The purpose of this document is to include both the current requirement, and the foreseen requirement in the medium to long-term (next 5-10 years). The requirement has been prepared in consultation with the JCOMM Expert Team on Wind Waves and Storm Surges (ETWS).

1.2 It should be noted that this document presents the requirements for observations, without addressing the availability or otherwise of suitable technical solutions to deliver those observations. The technical solution best able to meet the requirements will depend upon the variety of observing platforms available with consideration of practicalities and costs.

1.3 The observation requirements are presented as follows: firstly, a brief description of the applications for which the data are required is given, including indications of any particular issues or priorities relating to the application. Secondly, the table of requirements is specified. Within the table, the requirements for temporal and spatial sampling, accuracy and timeliness are specified. In each case, two values are provided:

- Min: the value below which the observation does not yield any significant benefit for the application in question;

- Max: the value above which no further significant benefits would be obtained.

1.4 For applications with other quantitative requirements of particular importance, these additional requirements are noted in the table.

2. Applications

2.1 The applications included within the scope of this document, are those related to offshore wave forecast modelling. Particular applications are:

Assimilation into offshore wave forecast models

2.2 This application includes assimilation into both global and regional scale offshore wave models, and the requirements can be sub-divided accordingly. Assimilation is currently largely based around the use of satellite observations. Altimeter wave height observations provide the most straightforward data set to use, and would generally be used alongside associated wind speed observations. The SAR derived wave spectra can also be used, but present more technical challenges. *In situ* measurements are currently too sparse in the open ocean to be of particular value, but could potentially provide higher accuracy observations to complement (and correct for biases in) the satellite observations.

2.3 The requirements for observations for assimilation are dependent upon the resolution of the models employed, with a need to constrain model evolution across the model grid, and in particular, a need for sufficient resolution to capture the synoptic scales. Current global model resolutions are typically of the order of 30-100km, with regional model resolutions down to 3-4km (with a natural progression to higher resolution expected). The real-time nature of the assimilation application, together with the rapid response time of sea state parameters to changes in winds makes timeliness a priority.

Validation of wave forecast models

2.4 The requirements for validation are closely related to those for assimilation, though with greater emphasis on accuracy, and more relaxed timeliness requirements. *In situ* buoy data are currently the key data source for validation, due to their accuracy, and the availability of spectral data. However, spatial sampling of buoy data does not currently meet the requirement for validation of offshore wave models, and in consequence, altimeter data are also widely used for validation of point data.

2.5 Again, requirements are dependent upon model resolution, though the required sampling is less dense than is required for assimilation. The key requirement, however, is to ensure that the sampling is sufficient to include a representative sample of different physical regimes globally. There is a strong requirement for improved coverage of high quality spectral observations.

Calibration / validation of satellite wave sensors

2.6 Whilst the satellite instruments clearly have the potential to provide observations with synoptic global coverage, the quality and usability of these observations is dependent upon good calibration of the satellite sensors. This can only be achieved through use of a sufficiently dense network of accurate *in situ* measurements. Point data are required for the validation of altimeter wave measurements, whilst spectral data are required for use with the SAR derived wave spectra.

2.7 Sampling requirements are similar to those for validation of forecast models, with the additional consideration that buoy observations located along satellite ground tracks would be of particular value. Accuracy is of greater importance than timeliness for this application.

Ocean wave climate and variability

2.8 Determination of ocean wave climate requires a long time series of stable data, with sufficient sampling to capture the physical regimes of the global ocean. This application therefore involves additional requirements: stability and sustainability of the observing platform. *In situ* measurements provide the natural source for such a time series of data, though the open ocean *in situ* sampling is currently inadequate for this purpose. Satellite observations can provide complementary information, but cannot be used in isolation without the *in situ* observations. Timeliness is not a consideration for this application.

Role of waves in coupling

2.9 Investigation of the role of waves in coupling requires collocated observations of a wider range of parameters than is required for the other observations, most notably air-sea flux measurements. Spatial sampling could be restricted to a small number of open ocean locations to allow processes to be studied in detail. Again, timeliness is not a consideration for this application.

2.10 This application differs from the other applications in that the work in this area is generally focussed around dedicated process studies, rather than routine monitoring. Hence the requirements are more specific to particular studies, and in general are not likely to be addressed by the same platforms as the routine observation requirements.

Annex to Appendix A

TABLE OF REQUIREMENTS

Application	Parameter	Unit	Area	Horizontal Resolution (km)		Observing Cycle (hours)		Accuracy			Delay of Availability (hours)		Decadal Stability	Remarks
				Min	Max	Min	Max	Min	Max	Units	Min	Max		
Assimilation into global wave forecast models	Significant wave height	m	Global	60	5	24	1	10% 0.1m	2%	% / m	24	3		
	Dominant wave direction	degrees	Global	60	5	24	1	22.5	5	degrees	24	3		
	Peak period	s	Global	60	5	24	1	3	1	s	24	3		
	2D spectral wave energy density	m^2 / Hz	Global	500	50	24	1				24	3		Directional accuracy requirements as for wave direction data.
Assimilation into regional wave forecast models	Significant wave height	m	Regional	20	0.1	24	0.5	10% 0.1m	2%	% / m	24	3		
	Dominant wave direction	degrees	Regional	20	0.1	24	0.5	22.5	5	degrees	24	3		
	Peak period	s	Regional	20	0.1	24	0.5	3	1	s	24	3		
	2D spectral wave energy density	m^2 / Hz	Regional	200	10	24	0.5				24	3		
Validation of wave forecast models	Significant wave height	m	Global	1000	50	240	6	5% 0.05m	1%	% / m	720	24		Priority is increased coverage of high quality spectral observations
	Dominant wave direction	degrees	Global	1000	50	240	6	22.5	1	degrees	720	24		
	Peak period	s	Global	1000	50	240	6	1	0.5	s	720	24		
	2D spectral wave energy density	m^2 / Hz	Global	1000	50	240	6				720	24		
Calibration / validation of satellite wave sensors	Significant wave height	m	Global	1000	10	24	1	5% 0.05m	1%	% / m	720	24		Collocation with satellite ground tracks advantageous
	Dominant wave direction	degrees	Global	1000	10	24	1	5	1	degrees	720	24		
	Peak period	s	Global	1000	10	24	1	1	0.1	s	720	24		

	2D spectral wave energy density	m^2 / Hz	Global	1000	100	24	1				720	24		
Ocean wave climate and variability	Significant wave height	m	Global	1000	100	24	6	5% 0.05m	1%	% / m	720	24	0.01m	
	Dominant wave direction	degrees	Global	1000	100	24	6	22.5	1	degrees	720	24	1.0 degrees	
	Peak period	s	Global	1000	100	24	6	1	0.5	s	720	24	0.05s	
	2D spectral wave energy density	m^2 / Hz	Global	1000	100	24	6				720	24		
Role of waves in coupling	Significant wave height	m	Global	1000	10	6	0.5	5% 0.05m	1%	% / m	720	24		Additional collocated measurements required. Process studies likely to require dedicated dense sampling in small regions, and sampling to higher frequency than routine monitoring.
	Dominant wave direction	degrees	Global	1000	10	6	0.5	22.5	1	degrees	720	24		
	Peak period	s	Global	1000	10	6	0.5	1	0.5	s	720	24		
	2D spectral wave energy density	m^2 / Hz	Global	1000	10	6	0.5				720	24		

ANNEX IX

ACTION LIST / WORKPLAN

No.	Ref. (para)	Action item	By whom	Deadline
1	2.1.5	to comment within two weeks on consideration of the OPA strategic implementation plan into the JCOMM strategic plan	OCG members	15 May 2007
2	2.2.2.2	to develop web pages to show the progress of the real-time tide gauge network (e.g. make the color dots bigger) so that users can see where progress has been made	JCOMMOPS	ASAP
3	2.3.3.2	To coordinate integration of requirements between POGO, Argo (John Gould), OceanSITES (Bob Weller), SOOPIP (Gustavo Goni), and the Advisory Panel on international repeat hydrography which is being established by IOCCP, CLIVAR-GSOP, and SOLAR-IMBER	IOCCP/ Secretariat	ongoing
4	3.1.2	to work with the OOPC to consider a pilot project or other strategy for better definition of surface salinity measurement requirements	SCG	ongoing
5	3.1.4	to liaise with the organizers of meetings and workshops in order to have OCG perspective taken into account	OCG members	ongoing
6	3.1.5	to document how to distribute ocean observations in real-time, including through the GTS but also through other existing data systems	OCG Chair	ASAP
7	3.2.1	to better documented user requirements for ocean applications and NWP in a future version of the JCOMM OPA Strategic workplan	OCG	OCG-III
8	3.3.2	to make recommendations regarding SPA User Requirements Document, and comment on the need or not to establish a Task Team	OCG members	Jan 2009
9	3.4.3	SPA to designate a focal point to liaise with the WMO Secretariat and provide input on the RRR issue	SCG	ASAP
10	3.4.3	To submit the new SoG by mid-2007 prior to the next ET-EGOS meeting	SCG	mid-2007
11	3.4.3	to provide input on on requirements for satellite sea surface winds, as well as guidance regarding the impact on applications of scatterometers and microwave imagers	Sat Team	ASAP
12	3.4.4	to include the actions proposed by the ET-EGOS and MAN-V in its action plan	Secretariat	ASAP
13	3.5.5	to address the issue of platform/instrumental metadata to be provided into the WIS	META-T	ASAP
14	4.1.1	to continue efforts to develop the metrics further in cooperation with the OSMC and JCOMMOPS	USA	ongoing
15	4.2.2	to post a catalogue of all existing technical standards and best practices on the JCOMMOPS web site	JCOMMOPS	ASAP
16	4.3.3	JCOMM Members to find new partners with the assistance form the Argo Information Centre acting as a coordinator in Capacity Building	AIC	ongoing

17	4.4.4	to propose governance mode for Pilot Projects in the area satellite data products and services for addressing variables such as altimetry and surface vector wind	JCOMM	MAN-VII
18	4.4.6	to draft a JCOMM Satellite Requirements Reference Document	E. Lindstrom	OCG-III
19	4.7.2	to develop an observing system monitoring capability to assess wave observations across the observing system	SCG	ASAP
20	4.7.2	to consider establishing an experiment or a demonstration project (in a particular area during a particular period) for adding wave observations to data buoys whenever possible to investigate impacts of wave observations	DBCP & ETWS	end 2008
21	4.7.2	To recommend the priority for wave measurements	SCG	ASAP
22	4.8.1	to invite the International Tsunameter Coordination Group to become an Action Group of the DBCP	DBCP	DBCP-XXIII
23	5.2	to issue a Joint Circular Letter call for Letters of Intent (LOI) to host an OPSC	Secretariat	end 2007
24	6.2.1	to update the OPA strategic workplan to represent fiscal realities and extend the plan to at least 2012 for completion of the initial system	OCG Chair	OCG-III

ANNEX X

LIST OF ACRONYMS

CAS	WMO Commission for Atmospheric Sciences
CB	Capacity Building
CBS	WMO Commission for Basic Systems
CCl	WMO Commission for Climatology
CEOS	Committee on Earth Observation Satellites
CGMS	Coordination Group for Meteorological Satellites
CHy	WMO Commission for Hydrology
CLIVAR	WCRP Climate Variability and Predictability programme
DBCP	Data Buoy Cooperation Panel
DMCG	JCOMM Data Management Coordination Group
DMPA	JCOMM Data Management Programme Area
EC	Executive Council
GCOS	Global Climate Observing System
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GLOSS	JCOMM Global Sea-level Observing System
GLOSS-GE	GLOSS Group of Experts
GODAE	Global Ocean Data Assimilation Experiment
GOOS	Global Ocean Observing System
GOSUD	Global Ocean Surface Underway Data Pilot Project
GTS	Global Telecommunication System
GTSPP	Global Temperature and Salinity Profile Programme
ICSU	International Council for Science
IGOS	Integrated Global Observing Strategy
IOC	Intergovernmental Oceanographic Commission
IODE	International Oceanographic Data and Information Exchange
IOOS	Integrated Ocean Observing System (USA)
IPY	International Polar Year
ISO	International Organization for Standardization
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM *in situ* Observing Platform Support Centre
MAN	JCOMM Management Committee
META-T	Water Temperature metadata Pilot Project
NGO	Non Governmental Organization
NOAA	National Oceanic and Atmospheric Administration (USA)
NWP	Numerical Weather Prediction
OceanSITES	OCEAN Sustained Interdisciplinary Timeseries Environment observation System
OCG	JCOMM Observations Coordination Group
ODAS	Ocean Data Acquisition System
ODASMS	JCOMM ODAS Metadata Service
OGC	Open Geospatial Consortium
OOPC	Ocean Observing Panel for Climate
OPA	JCOMM Observations Programme Area
PA	Programme Area (of JCOMM)
PMO	Port Meteorological Officer
QA	Quality Assurance
QC	Quality Control
QMF	WMO Quality Management Framework
SOC	Specialized Oceanographic Data Centre (of former IGOSS, now JCOMM)
SOT	JCOMM Ship Observations Team
SSH	Sea surface Height

SST	Sea Surface Temperature
TESAC	Temperature, salinity and current report from a sea station (FM 64–XI Ext. TESAC)
TRACKOB	Report of marine surface observation along a ship's track (FM 62–VIII Ext. TRACKOB)
UN	United Nations
VOS	Voluntary Observing Ship
VOSClim	Voluntary Observing Ship Climate Project
WIS	WMO Information System
WMO	World Meteorological Organization
WWW	World Weather Watch
XBT	Expendable Bathythermograph
XCTD	Expandable Conductivity, Temperature and Depth profiling system
XML	Extensible Markup Language