JOINT WMO-IOC TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY (JCOMM)

# OBSERVATIONS COORDINATION GROUP

## FIFTH SESSION

Silver Spring, USA

5 to 7 September 2013

## *FINAL REPORT*

2015

**JCOMM Meeting Report No. 107**

World Meteorological Organization
Weather • Climate • Water

United Nations Educational, Scientific and Cultural Organization

Intergovernmental Oceanographic Commission

*Group Photo*

**WORLD METEOROLOGICAL ORGANIZATION** **INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)**

# JCOMM OBSERVATIONS COORDINATION GROUP
# FIFTH SESSION

Silver Spring, USA
5-7 September 2013

## *FINAL REPORT*

**JCOMM Meeting Report No. 107**

# NOTES

## WMO AND IOC DISCLAIMERS

### WMO Regulation 42

Recommendations of working groups shall have no status within the Organization until they have been approved by the responsible constituent body. In the case of joint working groups the recommendations must be concurred with by the presidents of the constituent bodies concerned before being submitted to the designated constituent body.

### WMO Regulation 43

In the case of a recommendation made by a working group between sessions of the responsible constituent body, either in a session of a working group or by correspondence, the president of the body may, as an exceptional measure, approve the recommendation on behalf of the constituent body when the matter is, in his opinion, urgent, and does not appear to imply new obligations for Members. He may then submit this recommendation for adoption by the Executive Council or to the President of the Organization for action in accordance with Regulation 9(5).



Chair, Publications Board
World Meteorological Organization (WMO)
7 bis, avenue de la Paix
P.O. Box No. 2300
CH-1211 Geneva 2, Switzerland

Tel.: +(41 22) 730 84 03
Fax: +(41 22) 730 80 40
E-mail: Publications@wmo.int

### IOC (OF UNESCO) DISCLAIMER

**C O N T E N T S**

## GENERAL SUMMARY OF THE WORK OF THE SESSION

**Note**: Information updated after the meeting at the time of finalizing this report is indicated in brackets.

0.1 The Fifth Session of the JCOMM Observations Coordination Group was organized in Silver Spring, Maryland, from 5 to 7 September 2013 at the kind invitation of the NOAA Office for Climate Observations (OCO). The meeting was chaired by the JCOMM Observations Programme Area (OPA) Coordinator, Ms Candyce Clark (USA).

0.2 The OCG and OOPC Chairs, Ms Candyce Clark (USA), and Dr Mark Bourassa (USA) respectively opened the meeting, welcomed the participants, and briefed them about the meeting's objectives.

0.3 During the first day of the meeting, a joint Session with the sixteenth Session of the GCOS Ocean Observations Panel for Climate (OOPC) was Organized. This refers to agenda items J0 to J3. See the GCOS report No. 173 (see link below) and its Annex IV for this part of the agenda of the meeting. This annex is also provided in ***Annex III*** for convenience.

http://www.wmo.int/pages/prog/gcos/Publications/gcos-173.pdf

### 1 Introduction/Recap.

1.1 The meeting recalled the discussions and outcome of the joint day with the 16th Session of the OOPC. It agreed on the following:

- The link of the OOPC with the JCOMM Services and Forecasting Systems Programme Area (SFSPA) has to be realized;
- The OCG has role to play in contributing ocean observations to the WMO Integrated Global Observing System (WIGOS) (this is one way to assure sustainability).

1.2 The meeting also agreed on the following actions and recommendations:

1. The meeting **requested** the OOPC to work with OCG to develop a template for capturing characteristics of observations for O.S. Assessment, capturing nuances of obs methods, e.g. line obs.(action; OOPC, OCG Members supported by Katy Hill; OCG-6).
2. The meeting noted that the current 62% of the observing system completion did not necessarily reflect the drops noted in the last two years with regard to the drifter array, and the TAO array data availability. The OCG **requested the OSMC** to refine the metrics so that they are able to show the actual evolution of the observing systems (action; OSMC; OCG-6).
3. The meeting **requested the OOPC** to develop Whitepaper on a Quantitative. O.S. Assessment Process (action; Mark/OOPC; OCG-6).
4. The meeting **recommended** to organize teleconferences on a quarterly basis between secretariats of the GOV, GSOP, OCG, and OOPC to discuss cross panel activities and links. Katy Hill to organize. Participants: Katy Hill (OOPC), Albert Fischer (OCG), Kirsten Wilmer-Becker (GODAE), Nico Caltabiano (GSOP), Long Jiang (ETOOFS).
5. The meeting **requested the OOPC** to review the report on data flow of Bob Keeley (Katy to define process with Candyce, and divide up review between OOPC Members. Katy to collate. Review to Bob by Mid November). DMPA to be involved. (action; K. Hill, R. Kelley, S. Iona; Nov. 2013).
6. The meeting agreed that better links must be established between the OOPC and the SFSPA in order to better take into account the requirements for ocean application (marine services, ocean forecasting, etc.) to feed eventually into the OPA Implementation Goals. It

**requested the OOPC Secretariat** to initiate discussions in this regard (action; OOPC; asap).

7. The meeting recommended to develop an inventory and summary of usage of TIP and Argo data. It **requested TIP and Argo** to provide information in this regard. (action; TIP & Argo; OCG-6).
8. The meeting agreed that the OPA Implementation Goals continue to strengthen the GFCS, and **requested the OCG Chair** to address this issue, and promote the OPA related projects of the GFCS compendium (action; OCG Chair; OCG-6).

# 2 FRAMEWORK FOR OCEAN OBSERVING: SYSTEMS APPROACH (CONTINUED FROM J2)

## *2.1 Data flow and interoperability*

2.1.1 The Bob Keeley-led report on data flow will be available by end September 2013. OCG members were asked to review the report (**Action;** OCG members, November 2013), engaging their data teams and JCOMMOPS technical coordinators. [This action was taken, and the final report on *Data systems relevant to JCOMM activities* is available on the JCOMM website.]

2.1.2 The OCG **decided** to hold a teleconference on this topic (**Action;** secretariat to facilitate; asap) in order to:

1. *Review* the terms of reference of the [now accepted] JCOMM Cross-cutting Task Team 'Integrated Marine Meteorological and Oceanographic Services for WIS' (TT-MOWIS) and propose members from the OCG community, noting that its scope also includes integration of products data flow.
2. *Decide* if OCG should have a separate task team or activity to address some of the issues raised in the Keeley report that cannot be taken up by the larger JCOMM TT due to its scope.
3. *Ensure* European initiatives (for example MyOcean, SeaDataNet, Eurofleets, Jerico, EMODnet, ODIP) are engaged in the ongoing work.

2.1.3 As an example of an area that TT-MOWIS might not be able to take on that should perhaps be addressed by OCG along with other appropriate bodies would be the issue of common naming of parameters and metadata for the new variables that the OCG network platforms were beginning to measure, promoting convergence towards agreed metadata, standards and best practices for these new variables in terms of both observing techniques and data management and quality control. Keeley noted that this was an area that DMPA could not take on by itself, but needed the strong engagement and cooperation of the observing programmes.

## *2.2 Promoting standards and best practice*

2.2.1 David Meldrum gave a presentation[1] on JCOMM best practice activities, covering the JCOMM catalogue of best practices, the JCOMM pilot project for WIGOS, and a proposal for the revision of WMO and IOC manuals and guides.

2.2.2 The Group concurred with the following recommendations of Mr Meldrum:

- Propose to separate all regulatory material from guidance material in recognition that guidance material needs to be updated more easily and possibly more frequently than regulatory material [specific details in attached annex];
- Delegate all marine observation guidance documentation to the JCOMM OPA, with the expectation that all essential and current material will be identified and catalogued by

[1] http://jcomm.info/index.php?option=com_oe&task=viewDocumentRecord&docID=11650

means of two JCOMM Technical Documents explicitly created for the purpose, one to cover oceanographic observations, the other to cover marine meteorological observations;

- Within the JCOMM OPA, currently existing platform groups be tasked with submitting and linking their currently existing best-practice documentation to the proposed new JCOMM Technical Documents;

- The JCOMM OCG move as rapidly as possible to evaluating network performance by ECV, in order that network gaps might be more easily identified and appropriate guidance developed.

2.2.3 **The OCG agreed** with the proposal to produce two overarching JCOMM Guides for Marine Meteorological and Oceanographic Observations for non-regulatory material (published as Technical Reports). The Guides would be introductory 'wrappers' for annexes, and each appendix would be owned and updated by the relevant observing network team. Eventually, best practice guides by ECV should be encouraged.

2.2.4 **The OCG noted** that JCOMM will have to appoint an editor of these two guides to set the framework and develop a work plan for encouraging observing network teams to review and update their appendices (**Action;** Co-Presidents & secretariat; OCG-6).

## 3 ISSUES AND CHALLENGES FACED BY THE OBSERVING NETWORKS OF OCG

### *3.1 Quick review from each observing network of issues and challenges faced*

3.1.1 The meeting reviewed the status of the global ocean observing system. It was noted that the percentage of completion of the global ocean observing system was actually decreasing as it was now lower than the 62% level.

3.1.2 The meeting recognized that maintaining the networks is resource demanding, and that efforts should be made to make the observing systems more cost-effective, and consideration should be given to reach the 100% level of completion. However, the impact of the global economy is mitigating such efforts.

***DATA BUOY COOPERATION PANEL (DBCP)***

3.1.3 Al Wallace (Canada) reported to the OCG on behalf of the Data Buoy Cooperation Panel (DBCP).

3.1.4 The following issues and challenges were also reported: (i) relocation to Brest of the JCOMMOPS centre, and the recruitment of a new DBCP Technical Coordinator to replace Ms Stroker; (ii) financial support to the DBCP activities, and seeking increased participation while the demands are increasing or steady and the funding decreasing; and (iii) addressing the gaps and maintaining the global drifter array with routine deployments, and meeting the community requests (e.g. for High Resolution SST).

3.1.5 The DBCP recognized the difficulties faces by the Panel, as the drifter network has evolved from 102% of completion to 86% in the last two years. The meeting agreed that the trends of gaps of the array, and difficulties to maintain the array should be documented.

3.1.6 Technical challenges include drogue loss, buoy life-time, data timeliness, and data telecommunication issues.

3.1.7 It was also noted that the DBCP is undertaking a number of Capacity Building activities, which are in line with the Partnership for New GEOSS Applications (PANGEA). For example a Capacity Building workshop for Countries of the Western Indian Ocean Region (WIO-4) was organized in Tanzania from 29 april to 3 May 2013.

3.1.8 With regard to the DBCP strategy for the evolution of the observing system and sensors, the Panel has initiated a pilot project on the impact of sea level pressure data from drifters on NWP. A wave measurement evaluation and test pilot project is also underway. Two satellite data telecommunication pilot projects (on Iridium, and Argos-3) have also been completed. Another pilot project on the development and test of high resolution SST sensors on drifters is also about to be completed.

3.1.9 Regarding integration across networks, the Group noted DBCP efforts to sustain the JCOMMOPS function, to seek collaborate opportunities, to address client requirements.

3.1.10 The Panel is expecting the following from its participation in the OCG:

- Sustainable, viable ocean observing networks that measure essential variables that mean the needs of oceanographic and meteorological clients;
- Integration/convergence of observing networks and sensors; and
- Alignment on future considerations for telecommunications.

3.1.11 The DBCP report is provided in ***Annex V***.

### *GLOBAL SEA LEVEL OBSERVING SYSTEM (GLOSS)*

3.1.12 Gary Mitchum (USA) reported to the OCG on behalf of the Global Sea Level Observing System (GLOSS).

3.1.13 He reported on the GLOSS requirements-setting process(es), which are detailed in the GLOSS Implementation Plan (GIP). However, he explained that additional guidance from GCOS would be useful. Tsunami monitoring, and sea-level rise requirements are being considered. Amongst issues and challenges, the following were mentioned:

- Operational funding. We need to move beyond the model of all resources provided at the national level and seek out new resources. These resources are badly needed in some regions (e.g., Africa).
- If a small fraction (<1%?) of what is spent globally on sea level observations was available to GLOSS to make sure that we had a climate-capable system, we would have one.

3.1.14 GLOSS has also a strategy for the evolution of its observing systems and sensors, which takes into account (i) the fact that the GLOSS is largely a mature network in terms of sensors; (ii) the major challenge of finding resources to keep the observing system operating; and (iii) required continued development of infrastructure in many regions. He stressed on the required integration across networks, and the fact that continuous GPS networks are essential. However, these networks are typically disparate from what we are doing. We need better connections with the geodetic community and networks.

3.1.15 To conclude, the desired outcomes of GLOSS include (i) guidance on contribution to GCOS; (ii) addressing whether storm surge modeling on a local or regional basis should be a priority; (iii) for sea level rise, adding co-located continuous GPS to the GLOSS network; and (iv) finding new resources, which is essential.

3.1.16 The full report of GLOSS is provided in ***Annex VI***.

### *SHIP OBSERVATIONS TEAM (SOT)*

3.1.17 Graeme Ball (Australia), reported to the OCG on behalf of the Ship Observations Team (SOT). The SOT report included information on the three programmes under the SOT:

- The Voluntary Observing Ship (VOS) Scheme
- The Automated Shipboard Aerological Programme (ASAP)
- The Ship of Opportunity Programme (SOOP)

3.1.18 Details were provided on network status, network performance metrics, standards and best practices, evolution of network and new technologies or sensors, logistics and resource issues, capacity building opportunities/requirements, and issues and challenges, including ideas for integration, and the way forward.

3.1.19 Further information was provided by Sarah North (UK) and Gustavo Goni (USA) on the VOS and SOOP Programmes respectively.

3.1.20 The Group noted that three KPI s were introduced at SOT-6:

- The KPI for 25% of the global active VOS to be upgraded to VOSClim Class by SOT-7 was just met (global active VOS being defined as the number or Pub47 VOS reporting at least once/moth). Each month approximately 1500 ships submit at least one obs.
- The KPI for less than 3% of VOSClim ships being flagged as suspect for air pressure is being met
- The KPI for 95% of VOSClim observations being received within 120 minutes is also being met

3.1.21 These KPIs will continue to be measured. Decisions taken at SOT-7 to tighten the VOSClim monitoring criteria are likely to impact on compliance with the quality KPI which is already close. A new KPI was introduced at SOT-8 for at least 25% of the active VOS fleet (registered on the E-SURFMAR database) to be VOSClim class by SOT-8.

3.1.22 The OCG **recommended** enhanced JCOMM links with the International Maritime Organization (IMO), classification societies, and the International Chamber of Shipping in order to strengthen the cooperation with the shipping industry, and their “buy-in” for the making of marine meteorological & oceanographic observations. The OCG particularly **requested the SOT** to develop best practices for new ship design, taking into account relevant developments at IMO (eNav etc.), in collaboration with the ICS and IACS, in the view to eventually submit related recommendation to the IMO (action; SOT; OCG-6). [see also the action under item 4.3].

3.1.23 The OCG **requested** the VOS Panel to provide information that would help OCG, AOPC, and OOPC make the case (balancing feasibility including cost and impact) to Members/Member States for a sustained and/or evolved VOS network (e.g., balance between automated and manual observations), using the observing network template that identifies the unique characteristics of the observing network (action; VOSP; OCG-6) [see also actions on the observing network template from the joint day; linked to OOPC/AOPC actions on requirements for surface fluxes].

3.1.24 The full SOT report is provided in ***Annex VII***.

### *ARGO PROFILING FLOAT PROGRAMME*

3.1.25 Dead Roemmich (USA) reported to the OCG on behalf of the Argo profiling float programme. He provided details on the status of the programme as well as of Argo Data Management. The Status of Argo international coordination was discussed. The meeting also discussed the status of Argo data utilization, network implementation metrics, standards and Best Practices, evolution of the Network, the use of new technologies and sensors, logistics and resource Issues, and capacity building, including education.

3.1.26 The Group noted the following issues and challenges, ideas for Integration, and the way forward:

- The need for Argo, or for equivalent ocean observations, extends beyond the timescales of individual careers, and constitutes a multi-generational undertaking (e.g. Wunsch et al, 2013, PNAS). Mechanisms must be found to ensure continuity, consistency, and further improvement in Argo and other elements of the integrated ocean observing system.

- Argo has major intersections with nearly all elements of the ocean observing system. oordination by JCOMM OPS and the JCOMM OCG are recognized and valuable. Much of the coordination at key interfaces such as Argo/GO-SHIP, Argo/DBCP, Argo/Altimetry, and others, remains informal. These activities should be encouraged and rewarded.

- About 1/3 of all Argo floats are presently inside EEZs, and sampling in EEZs is critical for the global objectives of the Argo Program. Nevertheless, not all nations have concurred with the deployment of Argo floats in EEZs. Moreover, IOC guidelines on the drift of floats into EEZs are sufficiently burdensome as to have discouraged float deployments by smaller national programs in specific regions. It is difficult to envision how Argo can be sustained without an international consensus on these issues.

3.1.27 The OCG **congratulated** Argo on being able to maintain a network Science Director position, and **invited the Management Committee** to investigate ways to assure proper funding of that position, in conjunction with overall scientific direction for all the OCG observing networks (action; MAN; MAN-11). The OCG noted the importance of such a role [which can be a separate position or associated with the chair of the network steering team/panel] for the sustainability of the networks, integration with other observing networks, and where relevant in providing input to the work plan of JCOMMOPS.

3.1.28 The full Argo report is provided in ***Annex IX***.

### *OCEANSITES*

3.1.29 Bob Weller (USA) reported to the OCG on behalf of the OceanSITEs. He recalled that OceanSITES is a volunteer aggregation of existing time series observing efforts. As such it includes considerable diversity. Diversity of purpose as well as diversity of instrumentation. Thus, it is quite difficult for such a heterogeneous network to apply, in the same fashion as other elements of the observing system, the same tools for assessment.

3.1.30 He provided information on the network status (measured against requirements with details of variables - scales, accuracies, application), network implementation metrics, and standards and best practices (draft and documented), for the following components of OceanSITEs: flux reference sites, and biogeochemical sites.

3.1.31 The OCG **requested** OceanSITES, DBCP, and the OOPC to clarify the definitions of the OceanSITES network and DBCP-OceanSITES intersections, particularly focused on the overlap in the networks (action; OceanSITEs, DBCP, OOPC; OCG-6). These could clarify responsibility in defining global requirements and network plans, observations coordination, and data management system coordination.

3.1.32 The full OceanSITEs report is provided in ***Annex X***.

### *THE GLOBAL OCEAN SHIP-BASED HYDROGRAPHIC INVESTIGATIONS PROGRAMME (GO-SHIP)*

3.1.33 Lynne Talley (USA) reported to the OCG on behalf of the GO-SHIP programme.

3.1.34 She recalled that the GO-SHIP principal scientific objectives are: (1) understanding and documenting the large-scale ocean water property distributions, their changes, and drivers of those changes, and (2) addressing questions of how a future ocean that will increase in dissolved inorganic carbon, become more acidic and more stratified, and experience changes in circulation and ventilation processes due to global warming, altered water cycle and sea-ice will interact with natural ocean variability.

3.1.35 She provided information on the network status, implementation metrics, standards and best practices, evolution of the network and new technologies and sensors, logistics and resource issues, and capacity building opportunities/requirements.

3.1.36 The Group noted the following issues and challenges, ideas for Integration:

(1) Funding of GO-SHIP sections are within each national research budgets. Therefore the ability of nations to support sections will require continued financial support within national research budgets.

(2) GO-SHIP needs to review the list of standard parameter collected and accuracy of these observations.

(3) Ensure that all data are submitted and accessible within the GO-SHIP specified time limits.

(4) Provide leadership for the development of an International data centre for LADCP and SADCP data

3.1.37 Regarding the way forward: (i) GO-SHIP, in conjunction IOCCP, will hold a committee meeting on 21 February 2014; and (ii) GO-SHIP and IOCCP will host a Town Hall meeting at Ocean Sciences 2014; (3) We will establish regular committee meetings (teleconference).

3.1.38 The full GO-SHIP report is provided in ***Annex XI***.

Discussion, decisions and actions

*Overall*

3.1.39 The OCG **requested** JCOMMOPS to compile information about the evolution of the observing networks in order to visualize with new graphical products the *trends of gaps of the arrays*. Such tools will in particular be useful to the OOPC for making its recommendations to JCOMM (**Action;** JCOMMOPS; OCG-6).

3.1.40 The OCG held a discussion on capacity development, and **agreed** on the importance of connecting observing activities with the delivery of services. For GLOSS, the OCG **asked** Gary Mitchum, Mark Merrifield, David Legler, [Candyce Clark], and Albert Fischer to develop concepts for pilot projects linking observing with a services component (**Action**; G. Mitchum, D. Legler, A. Fischer; OCG-6), [in conjunction with the relevant JCOMM teams in the SFSPA], and welcomed Nadia Pinardi's offer to bring these project concepts to development agencies.

*Other*

3.1.50 The OCG **noted** some lack of coordination around data repositories for lowered ADCP data and CTD data taken at point sites during OceanSITES and other mooring cruises, which do not fit clearly into present network data management systems but have operators who are willing to share and clear utility for science and intercomparison.

## *3.2 Quick review from groups new to OCG of issues and challenges faced, with particular eye to developing common actions*

### *GLIDERS*

3.2.1 The OCG **noted** the rapid and positive developments with regard to sub-surface glider networks (e.g. www.ego-network.org), and recognized the benefits to JCOMM and to the glider community of building closer links. In particular, JCOMM may eventually help to address the maritime legal aspects of glider deployments and operations in coastal regions. The OCG **invited** the glider community to (action; glider community; asap):

- consult with the OOPC and the other ocean observing networks in the view to seek consensus on the *main scientific objectives, and elaborate a global implementation strategy for gliders* to complement other ocean observing systems and address the requirements of GCOS, GOOS, and WIGOS, noting that many glider missions may respond to local observing requirements.
- Continue to work with glider operators worldwide on best practices and eventually standards for observing techniques and data management systems and quality control.
- Continue to work on real-time and delayed-mode data management arrangements in cooperation with other relevant networks.

3.2.2 The OCG **welcomed** the desire for the glider community to have a formal place as a part of the OCG, and decided to work with the glider community to formulate a plan for this to happen through the decision on the OCG at JCOMM-5. This plan should include proposals for coordination mechanisms for the *global network* [responding to global-level requirements, demonstrating and evaluating the capabilities of gliders] and the *community of practice* [common best practices and data systems, engagement with GOOS Regional Alliances and national observing activities] aspects of work with gliders, and should be presented to the Management Committee for advice (action; OCG; JCOMM-5).

3.2.3 The OCG **noted** that gliders could contribute to the OOPC mandate to engage coastal observations and the links between basin-scale and coastal observing networks.

### *SUBMARINE CABLES*

3.2.4 The OCG **agreed** that a science case needed to be developed for the submarine cables to be used for making multi-disciplinary ocean observations. It **requested** David Meldrum to initiate a pilot project for Tsunami Monitoring using submarine cables, and to propose terms of reference and membership of a steering group for the pilot project to the OCG (action; D. Meldrum; asap). [Action on review of SCOR proposal for working group taken, unfortunately not funded by SCOR]

### *GLOBAL ALLIANCE FOR CONTINUOUS PLANKTON RECORDER (CPR) SURVEYS (GACS)*

3.2.5 The OCG noted de developments of the Global Alliance for Continuous Plankton Recorder (CPR) Surveys (GACS[2]). GACS was established in September 2011 with the overall goal of understanding changes in plankton biodiversity at ocean basin scales through a global network of Continuous Plankton Recorder (CPR) surveys. GACS has been invited to the JCOMM OCG to discuss common challenges in working with commercial and research fleets, developing standards and best practice, coordination of data systems, and to explore the possibility of mutually beneficial common actions.

3.2.6 The Group agreed that they would be value of establishing links between GACS and the GFCS on food security issues. It invited the Management Committee to address this issue, and provide further guidance to OCG and GACS in this regard.

3.2.7 The GACS report is provided in ***Annex XII***.

## 4 TECHNOLOGY AND OBSERVING FRONTIERS

### *4.1 Contributing to JCOMM work around improving surface vector wind products*

4.1.1 A report was presented by the OOPC co-Chairs, Mark Bourassa (USA) on the evaluation of satellite systems, in particular with regard to the observation of surface vector winds. The meeting noted that satellite systems rarely have absolute calibration (if they do have it, it applies to backscatter or radiance), and that satellites usually have relatively stable calibration. For climate applications, such as decadal changes, the calibration must be quite accurate (careful definition of variable e.g. equivalent neutral winds; careful adjustment of in situ data to same definition; removal of relative biases in each source (platform) for situ data; and if the apparent bias is outside expected bounds, it indicates a problem with the data or physical assumptions).

4.1.2 Regarding stability of calibration, the meeting noted that a relatively small number of very high quality observations can be used to test calibrations, and they must be sustained to test and/or maintain the calibration. Also, there have been several examples where drifts in calibration appear to be trends in time series. Other sensors are needed to provide better space/time coverage.

4.1.3 It was noted that oversmoothing is much less of an issue in the modern period with more Ocean Vector Wind (and wind speed) satellites. However, for climate we want the longer time series with realistic spatial derivatives. Making a gridded wind product with these characteristics, and realist variance in curl at scales <500km seems to require using physical constraints related to ocean vector winds and SST.

4.1.4 The meeting agreed that the combined in situ and satellite system is needed to maintain a global network for surface observations. OOPC (or the researchers who's assessments we report) need the data we asked for to assess the fitness of the observing system for climate and operations.

### *4.2 Sensors: emerging technology and potential for pilot projects*

[2] http://www.globalcpr.org/

4.2.1 David Meldrum (UK) reported on emerging technology to the observation of ocean variables. It was noted that such technologies are very often not driven by earth observation needs but rather by mass-market commercial forces such as for example medical (biochemical, tracers), military (GPS/Satcom, optical sensors), and consumer (mobile phones, games consoles, digital cameras). The should be low cost for the latter. The question was whether we can adapt any of these technologies. A good example was the Microelectromechanical systems (MEMS) currently used with the smartphones and other similar electronic devices. MEMS like 9 Degree of Freedom (9DOF) could for example potentially be used for example for the measurement of waves and sea state.

### *4.3 Industry cooperation on Ships and Platforms*

4.3.1 Candyce Clark and Eric Lindstrom recalled the outcomes of the World Ocean Council (WOC) "Smart Ocean / Smart Industries" workshop (12-13 December 2011, IOC/UNESCO, Paris, France), which called for the establishment of a joint science and industry working group to explore engagement of industry platforms in ocean observations. Peter Ortner recalled the SCOR OceanScope Working Group outcomes, which developed a vision for the use of ships as highly-instrumented 'ocean satellites'. All stressed the importance of not interfering with ship operations, and the need to develop the value proposition for industry.

4.3.2 The OCG agreed that it was strategic to coordinate the efforts of a number of groups to speak to industry with a single voice from the scientific / observing side.

4.3.3 The OCG **decided** to facilitate the formation of a Task Team (TT) to focus on the scientific and strategic aspects of engaging the shipping industry on marine observing. This TT would include representatives of SOT/VOS, SOT/SOOP, OceanScope, IOCCP (Carbon VOS), and GACS. Initial membership includes Peter Ortner, Graeme Ball, Gustavo Goni, and Sarah North, Ute Schuster, Martin Kramp (JCOMMOPS ship coordinator).

4.3.4 This Task Team would consider the terms of reference decided at the Smart Industries/Smart Oceans workshop (November 2011): preparing a menu of options for the shipping industry and defining a strategy to engage them through the IMO, International Chamber of Shipping, and other organizations. The team would be charged to identify its leader, seek funding for its activities, and report back to OCG-6. The secretariat is unfortunately limited to providing a coordination platform. The meeting requested Martin Kramp, to organize a first teleconference and facilitate future calls (action; M. Kramp; asap).

## 5 TECHNICAL COORDINATION / JCOMMOPS

### *5.1 Activities report from JCOMMOPS*

5.1.1 OCG **urged JCOMMOPS and OSMC** to work on a common plan to summarize the roles and responsibilities of each centre, clarify overlap (and rationale for such overlap), and description of how they complement each other (e.g. JCOMMOPS is in direct contact with the platform operators, and is providing direct support to them, including with network monitoring tools and metrics on data flow; OSMC focused on system-wide metrics, EOV metrics, metrics on flow into EOV data assembly) (action; JCOMMOPS & OSPC; OCg-6).

5.1.2 OCG **requested the OCG Chair** to propose Terms of Reference of the OSMC for discussion at the next OCG meeting, for interim use and formal submission to JCOMM-5. (action; OCG Chair; OCG-6)

5.1.3 The OCG **requested** JCOMMOPS to compile information about the evolution of the observing networks in order to visualize with new graphical products trends of gaps of the arrays. Such tools will in particular be useful to the OOPC for making its recommendations to JCOMM (action; JCOMMOPS; OCG-6).

### *5.2 Overview of Budget/Management*

5.2.1 OCG **requested JCOMMOPS** to develop its workplan, including (i) the general (synergetic) part, and (ii) the workplans developed by each Panel (DBCP, Argo, SOT, OceanSITEs, GO-SHIP), for regular review by the JCOMMOPS Roundtable (action; JCOMMOPS; OCG-6).

5.2.2 The OCG **requested** the further development of a long-range JCOMMOPS Strategy to provide services in support of JCOMM ocean observing networks (action; OCG Chair & Secr.; OCG-6). It noted that OCG-5/Doc 5.2 had some core ideas for management through the Roundtable, as a contribution to this strategy.

5.2.3 The OCG **requested its members** to review the OCG-5 JCOMMOPS budget document, and to provide comments to the Secretariat (action; OCG members; asap). [An action has been taken forward by the IOC and WMO secretariats: the preparation of a joint JCOMMOPS budget for reporting purposes (now complete for 2013, in progress for 2014), which is also a good basis for giving guidance on forward planning. This budget should be presented at OCG-6]

5.2.4 The OCG agreed that some principles should be proposed and agreed upon on the type and level of services to be provided by JCOMMOPS to the Panels and the associated groups taking into account the different levels of commitments of each Panels. It **requested JCOMMOPS** to make a proposal in this regard to the OCG chair (action; JCOMMOPS; OCG-6).

5.2.5 OCG **agreed** that the JCOMMOPS Roundtable should meet every 6 months. The roundtable includes the OCG Coordinator (Chair), the Panels representatives (DBCP, Argo, SOT, OceanSITEs, GO-SHIP), the IOC & WMO Secretariats, and a representative of the host organizations (IFREMER, CORIOLIS, CLS)).

### *5.3 Move to Brest*

5.3.1 The OCG **agreed** in principle on the move to Brest.

5.3.2 The OCG **requested JCOMMOPS** to provide a quantitative (vs. qualitative) analysis of pros and cons of moving JCOMMOPS to Brest vs. keeping it in Toulouse: e.g. to include information on the cost of moving the staff; on the impact on productivity; on what the IFREMER rent is going to be (commitment of IFREMER to be documented). (action; JCOMMOPS; OCG-6) [done]

5.3.3 The OCG **requested JCOMMOPS** to seek commitment letters from IFREMER and CLS if JCOMMOPS has to be based in Brest (action; JCOMMOPS; asap) [done]. This should include details about the impact of reduced CLS in kind support to JCOMMOPS in case substantial number of platforms will be using other Satcom systems than Argos. It should seek a 3-5 year commitment [**Action** that has been taken forward is for IOC, WMO secretariats in conjunction with Ifremer and CLS to draft a 3-5 year Memorandum of Understanding for the hosting of JCOMMOPS that identifies the responsibilities and contributions of each organization].

5.3.4 The OCG **agreed** that the JCOMMOPS Rountable should give formal approval for the move to Brest when the information above was available [done].

5.3.5 Once a decision is made on the move to Brest, the OCG **requested the Secretariat** to finalize the TC DBCP position description and to submit it to the DBCP/OceanSITES Chairs for approval (action; Secr.; asap) [done and recruited].

## 6 REGIONAL AND COASTAL ACTIVITIES

### *6.1 Regional Marine Information Centres (RMICs)*

6.1.1 The meeting reviewed a proposal from the Activity Leader on Intercomparisons, Dr Jingli Sun (China) for establishing Procedures and Guidelines for JCOMM Global and Regional Intercomparisons of Marine Meteorological and Oceanographic Instruments.

6.1.2 Dr Sun explained that intercomparisons of marine meteorological and oceanographic instruments and observing systems, as well as marine metrological laboratories, together with agreed quality-control procedures, are essential for the establishment of compatible data sets. All intercomparisons should be planned and carried out carefully in order to maintain an adequate and uniform quality level of measurements of each meteorological and oceanographic variable. Many marine meteorological and oceanographic variables cannot be directly compared with standards and hence to absolute references — for example, cloud‑base height and precipitation. For such quantities, intercomparisons are of primary value.

6.1.3 He proposed that International comparisons or evaluations could be organized and carried out at the following levels:

(a) International comparisons, in which participants from all interested countries may attend in response to a general invitation;

(b) Regional intercomparisons, in which participants from countries of a certain region (for example, WMO Regions or GOOS Regional Alliances) may attend in response to a general invitation;

(c) Multilateral and bilateral intercomparisons, in which participants from two or more countries may agree to attend without a general invitation;

6.1.4 Because of the importance of international comparability of measurements, the meeting agreed that the WMO (for marine meteorological measurements) and/or the IOC (for oceanographic measurements) could organize through JCOMM international and regional comparisons. Such intercomparisons or evaluations of marine instruments and observing systems may be very lengthy and expensive. Rules have therefore been proposed so that coordination will be effective and assured (see OCG-6 document 6.1(1)). They contain general guidelines and should, when necessary, be supplemented by specific working rules for each intercomparison (see for example the relevant chapters of the CIMO Guide, WMO No. 8).

6.1.5 Reports of the comparisons at any level should be made known and available to the meteorological and oceanographic communities at large.

6.1.6 As a way to promote and test such rules and procedures, and following a proposal from China, the meeting decided to organize a pilot project for Laboratory intercomparison of Seawater measurements. Seawater salinity is one of the most basic parameters generally acknowledged in the oceanography community, and the accuracy and compatibility of seawater salinity measurements will directly affect the quality of many oceanographic research programmes, especially those marine meteorological and oceanographic observation programmes under JCOMM. The main objectives of this intercomparison project are of understanding the overall level of salinity measurements of JCOMM Members/Member States, identifying the differences, promoting the levels of JCOMM salinity measurement, and accumulating experience of organizing JCOMM international comparisons.

6.1.7 China volunteered to act as the host country for the Seawater Salinity Measurement Intercomparison Pilot Project, as well as to provide financial support for this activity.

6.1.8 The plan is essentially for China to distribute two types of seawater samples with different salinity values to each participant, be responsible for the activity conduct, the data analysis, and the preparation of a final report. Also, China has been ready to nominate the project leader, planned the operation place, starting date, duration, time schedule, and data acquisition, processing and analysis methodology in this project. Details concerning the project are provided in OCG-6 document 6.1(2).

6.1.9 Before the intercomparison activity begins, an organizing committee should be established by the JCOMM co-Presidents, and the details of the Pilot Project organization agree on by the organizing committee.

6.1.10 The Group thanked China for its commitment in this regard.

## 7 REVIEW OF DECISION, RECOMMENDATIONS AND ACTIONS

7.1 The participants reviewed decisions, recommendations and actions arising form the meeting. These are provided in ***Annex IV***.

# ANNEX I

# AGENDA

**Part 1 - Joint OOPC/JCOMM OCG Day**

| **Thursday 5th September: Joint OOPC/JCOMM OCG Day** | | | | |
|---|---|---|---|---|
| 8.30 am<br>(10 mins) | | Open, introductions and welcome | Chairs OOPC and OCG | |
| **J1. Framework for Ocean Observing/Requirements (chair: Clark)**<br>Purpose: identify activities for reviewing requirements (led by OOPC and others) where OCG role as observing community/network voice is required in negotiations of feasibility vs. impact. | | | | |
| 8.40<br>40 mins<br>(20+20) | J1.1 | Update on GOOS including idea of GOOS Projects | Albert Fischer | Document |
| 9.20<br>1 hr 20<br>(40+40) | J1.2. | Report on OOPC Plans and approaches<br>- Including information on GCOS Review, IP review and adequacy reporting, and updating of implementation plans<br>- Quantitative approaches to setting observing system requirements, design and assessment: EOVs, ECVs, scales and accuracies, linking to platform based requirements. | Toshio Suga, Mark Bourassa, Katy Hill | OOPC Draft Work Plan + update<br><br>Paper on Observing System Design and Assessment |
| 10.40<br>30 mins | | Coffee | | |
| 11.10<br>1 hr | J2.3. | Connections to synthesis and product development<br>(GODAE Oceanview, CLIVAR GSOP, JCOMM ETOOFS, JCOMM SFSPA, JCOMM TT SAT, GHRSST) | Eric Lindstrom, Eric Dombrowsky | |
| 12.10 | J1.3 | Reminder JCOMM-4 charge to OCG; Observing system missions: GCOS, GOOS, WMO/RRR | Candyce Clark | |

| | | | | |
|---|---|---|---|---|
| 20 mins | | | | |
| 12.30<br>30 mins<br>(15+15) | J1.4 | WMO RRR/GFCS | Etienne Charpentier | Document |
| 13.00<br>1hr | | Lunch onsite | | |
| 14.00<br>1 hour<br>(15+15+30) | J1.5 | Review workshops and activities:<br>- Tropical Pacific Observing System Review and Assessment<br>- Deep Ocean Observing System<br>- Discussion on OOPC/OCG Roles and Contributions | Toshio Suga<br>Eric Lindstrom | Document |
| **J2. Framework for Ocean Observing/Evaluation of the observing System (Chair: Bourassa/Suga)**<br>Purpose: improve JCOMM metrics and for involving synthesis/product community in OBS system evaluation. | | | | |
| 15.00<br>1 hour<br>(30+30) | J2.1 | Platform based metrics/implementation progress<br>- Overview of successes and major blockages<br>- Discussion | Candyce Clark | Report from OSMC<br>Reports from Networks. |
| 30 mins | | Coffee | | |
| 16.30<br>1 hour<br>(30+30) | J2.2 | Towards an EOVs/ECVs based evaluation of the overall system, satellite and in situ | Bob Keeley (presentation), Mark Bourassa/Toshio Suga (Discussion) | Document |
| 17.30<br>30 mins | | Joint Day wrap up | Mark Bourassa/Toshio Suga/Candyce Clark | |
| 18.00 | | Meeting close. | | |

**Part 2 – OCG-5 meeting**

**1 Introduction/Recap.**

**2 Framework for Ocean Observing: systems approach (continued from J2)**

2.1 Data flow and interoperability

2.2 Promoting standards and best practice

**3 Issues and challenges faced by the observing networks of OCG**

3.1 Quick review from each observing network of issues and challenges faced

3.2 and same from groups new to OCG, with particular eye to developing common actions

**4 Technology and Observing Frontiers**

4.1 Contributing to JCOMM work around improving surface vector wind products

4.2 Sensors: emerging technology and potential for pilot projects

4.3 Industry cooperation on Ships and Platforms

**5 Technical Coordination / JCOMMOPS**

5.1 Activities report from JCOMMOPS

5.2 Overview of Budget/Management

5.3 Move to Brest

5.4 Discussion on broadening support from networks and from countries

**6 Regional and coastal activities**

6.1 Regional Marine Information Centres (RMICs)

6.2 Coastal Observations and extending towards the coast

**7 Review of decision, recommendations and actions**

# ANNEX II

# LIST OF PARTICIPANTS

## Fifth Session of the JCOMM Observations Coordination Group (OCG)
*(Silver spring, Maryland, USA, 5-7 September 2013)*

**OCG members**

Graeme BALL
Manager, Marine Operations Group
Bureau of Meteorology, Melbourne
700 Collins Street
Docklands
GPO Box 1289
Melbourne VIC 3001
Australia
Tel: +61 3 9669 4203
Fax: +61 3 9669 4168
Email: g.ball@bom.gov.au

Ms Candyce CLARK
WMO-IOC JCOMM Observations Coordinator
National Oceanic and Atmospheric Administration
NOAA/Climate Program Office
Climate Observation Division
1100 Wayne Avenue, suite 1202
Silver Spring MD 20910
United States
Tel: +1 301 427 2463
Fax: +1 301 427 0033
Email: candyce.clark@noaa.gov

Dr Gustavo J. GONI
Oceanographer
National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorological Laboratories; OAR
Physical Oceanography Division
USDC/NOAA/AOML/PHOD 4301 Rickenbacker Causeway
Miami FL 33149
United States
Tel: +1 305-361-4339
Fax: +1 305-361-4412
Email: gustavo.goni@noaa.gov

Mr David MELDRUM
Research Fellow, Technology Development
Scottish Association for Marine Science
Scottish Marine Institute
Oban, Scotland
PA37 1QA
United Kingdom
Tel: +44 1631 559 273
Fax: +44 1631 559 001
Email: dtm@sams.ac.uk

Prof. Gary MITCHUM
College of Marine Science
University of South Florida
140 Seventh Avenue South
St. Petersburg FL 33701
United States
Tel: +1 727 5533941
Fax: +1 729 5531189
Email: mitchum@usf.edu

Dr Dean ROEMMICH
Professor (MLRG/PORD)
University of San Diego, Scripps Institution of Oceanography
Scripps Institution of Oceanography University of California, San Diego 9500 Gilman Drive, Mail Code 0230
La Jolla CA 92093-0230
United States
Tel: +1 (858) 534-2307
Fax: +1 (858) 534-0704
Email: droemmich@ucsd.edu

Mr Jingli SUN
Assistant Director
National Center for Ocean Standards and Metrology
219 W. Jieyuan Rd
300112 Nankai District
Tianjin
China
Tel: +86 (22) 27539525
Fax: +86 (22) 27532971
Email: jinglisun@gmail.com

Prof Lynne TALLEY
Professor/ Research Oceanographer (PORD)
University of San Diego, Scripps Institution of Oceanography
United States
Tel: [8] (858) 534-2230
Fax: [8] (858) 534-2230
Email: ltalley@ucsd.edu

Dr Maciej TELSZEWSKI
IOCCP Project Director
Institute of Oceanology Polish Academy of Sciences
ul. Powstancow Warszawy 55
81-712 Sopot
Poland

Tel: +48 587 311 610
Fax: +48 58 551 21 30
Email: m.telszewski@ioccp.org

Mr Al WALLACE
DBCP Chairperson
Environment Canada, Meteorological Service of Canada, Pacific and Yukon Region
201-401 Burrard Street
VANCOUVER V6C 3S5
BC
Canada
Tel: +1 604 664 9090
Fax: +1 604 664 9004
Email: alton.wallace@shaw.ca

Dr. Robert WELLER
Senior Scientist
Woods Hole Oceanographic Institution
WHOI
Clark 204a MS 29
Woods Hole MA 02543
United States
Tel: +1 508 289-2508
Fax: +1 508 457-2163
Email: rweller@whoi.edu

Dr Susan WIJFFELS
CSIRO Marine and Atmospheric Research, Tasmania
Marine Laboratories
Castray Esplanade
GPO BOx 1538
Hobart Tasmania 7001
Australia
Email: Susan.Wijffels@csiro.au

**OOPC Members**

Dr Mark BOURASSA
OOPC co-Chair
Florida State University, Center for Ocean-Atmospheric Prediction Studies
Tallahassee FL 32306-2840
United States
Tel.: +1 850 644 6923
Fax: +1 850644 4841
Email: Bourassa@coaps.fsu.edu

Dr Johnny JOHANNESSEN
Nansen Environmental and Remote Sensing Center
Thormøhlensgt. 47
N-5006 Bergen
Norway
Tel.: +47 5520 5836
Fax: +47 55205801
Email: johnny.johannessen@nersc.no

J. Robert KEELEY
2243 Rembrandt Road
Ottawa K2B 7P8
Ontario
Canada
Tel.: +1 613 829 7919
Email: robertkeeley@rogers.com

Dr Eric LINDSTROM
NASA Headquarters, Earth Science Division, Room 3D74
Science Mission Directorate, Mail Suite 3B74
300 E Street SW, Washington DC 20546
United States
Tel.: +1 202 358 4540
Fax: +1 202 358 2770
Email: eric.j.lindstrom@nasa.gov

Dr Toshio SUGA
OOPC co-Chair
Tohoku University, Graduate School of Science and Faculty of Science, Aobayama Campus
6-3, Aramaki Aza-Aoba,
Aoba-Ku 980-8578, Sendai
Japan
Tel.: +81 22 795 6527
Fax: +81 795 6530
Email: Suga@pol.gp.tohoku.jp

Dr Robert WELLER
(also OCG Member)
Woods Hole Oceanographic Institution (WHOI)
Clark 204a MS 29
Woods Hole MA 02543
United States
Tel.: +1 508 289 2508
Fax: +1 508 457 2163
Email: rweller@whoi.edu

**CLIVAR Panel Representatives**

Dr Molly BARINGER
NOAA, Atlantic Oceanographic and Meteorological Laboratories
Miami FL 33149
United States
Tel.: +1 305 361 4345
Email: molly.baringer@noaa.gov

Dr Alexandre GANACHAUD
Institute de Recherche pour le Developpement, LEGOS
14 Avenue E. Berlin
31400 Toulouse

France
Tel.: +33 61 33 2966
Email: alexandre.ganachaud@ird.fr

Dr Tony LEE
Jet Propulsion Laboratory
M/S 300-323
4800 Oak Grove Drive
Pasadena, CA 91109
United States
Tel.: +1 818 354 1401
Email: tlee@jpl.nasa.gov

Dr Michael MCPHADEN
Tropical Moored Buoy Implementation Panel (TIP)
NOAA/PMEL
Building 3, Bin C15700
7600 Sandpoint Way N.E.
Seattle WA 98115
United States
Tel.: +1 206 526 6783
Fax: +1 206 526 6744
Email: Michael.j.mcphaden@noaa.gov

Dr Eric LINDSTROM
Physical Oceanography Program Scientist
NASA Headquarters
Earth Science Division, Room 3D74
Science Mission Directorate
NASA Headquarters
Mail Suite 3B74
300 E Street SW
Washington DC 20546
United States
Tel: +1 202 358-4540
Fax: +1 202 358-2770
Email: eric.j.lindstrom@nasa.gov

Dr Michael MCPHADEN
Chair, Tropical Moored Buoy Implementation Panel (TIP)
NOAA/PMEL
Bldg. 3, Bin C15700
7600 Sandpoint Way N.E.
Seattle WA 98115
United States
Tel: +1 206 526 6783
Fax: +1 206 526 6744
Email: michael.j.mcphaden@noaa.gov

**INVITED GUESTS**

Dr Eric DOMBROWSKY
Mercator Océan
Parc Technologique du Canal
8-10 Rue Hermès
31520 Ramonville St Agne
France
Tel.: +33 561 39 3833
Fax : +33 561 39 3899
Email: eric.dombrowsky@mercator-ocean.fr

Dr D. E. HARRISON
NOAA Pacific Marine Environmental Laboratory
NOAA Pacific Marine Environmental Laboratory
7600 Sand Point Way NE
Seattle WA 98115
United States
Tel: +1 206 526 6225
Fax: +1 206 526 6744
Email: d.e.harrison@noaa.gov

Dr David LEGLER
Chief, Climate Observations
National Oceanic and Atmospheric Administration
Office of Oceanic and Atmospheric Research
1100 Wayne Ave
Suite 1202
Washington DC 20910
United States
Tel: +1 301 427-2460
Fax: +1 301 427-0033
Email: david.legler@noaa.gov

Dr Chris MELROSE
Research Oceanographer
NOAA/NMFS/NEFSC
Oceanography Branch
28 Tarzwell Drive
Narragansett RI 02882
United States
Tel: +1 401 782 3350
Email: Chris.Melrose@NOAA.gov

Dr Mark MERRIFIELD
Professor
1000 Pope Road, MSB 317
Honolulu HI 96822
United States
Tel: +1 808 9566161
Fax: +1 808 9562352
Email: markm@soest.hawaii.edu

Ms Sarah NORTH
Marine Networks Manager
Met Office
FitzRoy Road
Exeter
Devon
EX1 3PB
United Kingdom
Tel: +44 (0) 1392 885 617
Fax: +44 (0) 1392 885 681
Email: sarah.north@metoffice.gov.uk

Peter ORTNER
Research Professor and Director
National Oceanic and Atmospheric Administration, Atlantic Oceanographic and Meteorological Laboratories, CIMAS
Physical Oceanography Division
4301 Rickenbacker Causeway
Miami Florida 33149
United States
Tel: +1 305 421-4619
Email: portner@rsmas.miami.edu

Dr Pierre TESTOR
Laboratoire d'Oceanographie et du Climat: Experimentation et Approches Numeriques, Institute Pierre Simon Laplace, University Pierre and Marie Curie
4 place Jussieu
75005 Paris
France
Email: testor@locean-ipsl.upmc.fr

Dr John WILKIN
Rutgers University, Institute of Marine and Coastal Sciences
United States
Tel.: +1 848 932 3366
Email: wilkin@marine.rutgers.edu

Dr Douglas WILSON
IOCARIBE-GOOS
Caribbean Wind LLC
222 Severn Ave Suite 15
Building 7-10
Annapolis MD 21403
United States
Tel.: +1 410 507 8587
Email: doug@coastaloceanobs.com

Prof. Aina WU
Director, RMIC/AP
National Centre of Ocean Standard and Metrology
300112 Tianjin
China
Tel: +86-22-27539501
Fax: +86-22-27532971
Email: wuainatj@126.com

**JCOMMOPS**

Mathieu BELBEOCH
Argo Technical Coordinator, JCOMMOPS lead
JCOMM *in situ* Observation Programmes Support Centre (JCOMMOPS)
8-10, rue Hermès
Parc Technologique du Canal
31526 Ramonville
France
Tel: +33 5 61 39 47 30
Fax: +33 5 61 75 10 14
Email: belbeoch@jcommops.org

Kelly STROKER
Technical Coordinator, DBCP & OceanSITEs
JCOMM *in situ* Observation Programmes Support Centre (JCOMMOPS)
8-10 rue Hermès
Parc Technologique du Canal
31520 Ramonville Saint-Agne
France
Tel: +33 5 61 39 47 82
Fax: +33 5 61 75 10 14
Email: kstroker@jcommops.org

**JCOMM CO-PRESIDENTS AND COORDINATORS**

Sissy IONA
JCOMM DMPA Coordinator
Head HNODC
Hellenic Centre for Marine Research (HCMR), Hellenic National Oceanographic Data Centre (HNODC)
46.7 Km, Athens-Sounio Ave.
PO BOX 712 Anavyssos
190 13 Anavyssos, Attica
Greece
Tel: +30-22910-76367
Fax: +30-22910-76347
Email: sissy@hnodc.hcmr.gr

Dr Ming JI
JCOMM SFSPA Coordinator
Director
Ocean Prediction Center, NOAA/NCEP
5830 University Research Court, Rm 4642
College Park MD 20740
United States
Tel: +1 301 683 1332
Fax: +1 301 683 1332
Email: Ming.Ji@noaa.gov

Prof. Nadia PINARDI
JCOMM Co-President
Via S.Alberto 163
48100 Ravenna
Italy
Tel: +39 0544 937332
Fax: +39 0544 937323
Email: n.pinardi@sincem.unibo.it

Mr Johan STANDER
JCOMM Co-President

South African Weather Service
Weather Office,
P O Box 21,
International Airport
Cape Town
7525
South Africa
Tel: +27 (0) 21 934 0450
Fax: +27 (0) 21 934 3296
Email: Johan.Stander@weathersa.co.za

**SECRETARIAT**

Mr Etienne CHARPENTIER
Scientific Officer
World Meteorological Organization
Observing and Information Systems Department
Observing Systems Division
World Meteorological Organization
7bis, av. de la Paix
Case Postale 2300
1211 Genève 2
Switzerland
Tel: +41 22 730 82 23
Fax: +41 22 730 81 28
Email: ECharpentier@wmo.int

Albert FISCHER
Head, Ocean Observations and Services section
Intergovernmental Oceanographic Commission of UNESCO
7, place de Fontenoy
75732 Paris cedex 07
France
Tel: +33 1 45 68 40 40
Fax: +33 1 45 68 58 13
Email: a.fischer@unesco.org

Dr Katherine (Katy) HILL
GOOS/GCOS Programme Specialist
World Meteorological Organization
7bis, avenue de la Paix
Case Postale 2300
1211 Geneva
Switzerland
Tel: +41 (0)22 730 80 83
Fax: +41 (0)22 730 8052
Email: khill@wmo.int

Ms Jessica HOLTERHOF
GCOS Secretariat
World Meteorological Organization
7 bis, Avenue de la Paix
Case Postale 2300
1211 Geneva
Switzerland
Tel.: +41 22 730 8128
Fax: +41 22 730 8052
Email: JHolterhof@wmo.int

Dr Carolin RICHTER
GCOS Secretariat
World Meteorological Organization
7 bis, Avenue de la Paix
Caste Postale 2300
Geneva 1211
Switzerland
Tel.: +41 22 730 8275
Fax: +41 22 730 8052
Email: CRichter@wmo.int

---

## ANNEX III

## Report of the OOPC/OCG joint day meeting, Silver Spring, 5 September 2013

Note: The information below is an excerpt from Annex IV of GCOS Report No. 171. For the full GCOS report, see the link below

http://www.wmo.int/pages/prog/gcos/Publications/gcos-173.pdf

**Members of the Ocean Observation Panel for Climate (OOPC) and Observations Coordination Group (OCG) of the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), as well as invited experts representing major ocean observing networks, met for a joint day session on the 5 September 2013 in Washington DC, United States. As OOPC-16 was held back-to-back with OCG-5, this was the perfect opportunity to talk about requirements for the Framework for Ocean Observing (FOO), and to further discuss about an evaluation of the observing system. All presentations and background documents from the joint day meeting can be found on both the OOPC meeting website at** www.ioc-goos.org/oopc-16 **and OCG meeting website at** www.ioc-goos.org/ocg-5**.**

**Dr Wayne Higgins, director of the NOAA Climate Programme Office, welcomed participants to the session and shared his future vision for ocean observations. He stressed that NOAA's efforts are strongly dependent on international coordination, and therefore strongly appreciated the efforts made by OOPC and OCG to further discussions on ocean observations together.**

### J1. Framework for Ocean Observing/Requirements.

**The purpose of the first session was to identify activities for reviewing ocean observation requirements, led by OOPC and others, where the role of OCG as an observing network is required in negotiations of feasibility, impact, etc. Therefore, GOOS and OOPC updated participants on recent activities and newly agreed plans following OOPC-16, and OCG provided updates on observing system missions including those of GCOS, GOOS, and WMO (Rolling Review of Requirements).**

### J1.1 The Global Ocean Observing System (GOOS)

**Dr Albert Fischer, director of GOOS, and Dr Eric Lindstrom, co-chair of GOOS, updated OCG Members and invited experts that had not attended OOPC-16 on the role of GOOS in a global context, the restructuring of GOOS, and outlined the observing systems expectations for OOPC in the future. A detailed description of the main aspects of their talk can be found in Paragraph 1.1 of the OOPC-16 report.**

**Additionally to the presentation of the Framework for Ocean Observing (FOO) and an update on the current restructuring of the GOOS structure, Dr Fischer introduced OCG participants to the GOOS Regional Alliances (GRAs) that have updated their GOOS Regional Policy[3] in line with the restructuring of the GOOS**

[3] **The GOOS Regional Framework 2013 (in EN, ES, FR, RU):**

http://www.ioc-unesco.org/index.php?option=com_oe&task=viewDocumentRecord&docID=11235

**governance and the updated Framework guidance for GRAs. Historically, GRAs were introduced as a way to integrate national needs into a regional system, and to deliver the benefits of the GOOS strategy, structure, and programmes at a regional and national level. Since then, the GRAs have evolved to meet a wide range of societal challenges related to both coastal and open ocean observations, and the updated Regional Policy that not only recognizes the importance of GRAs to the GOOS goals, but also sets guidelines for recognition by the IOC governing bodies and Terms of Reference for the self-governed GOOS Regional Council, to be comprised of all GRA chairs. A close collaboration between GOOS/OOPC and OCG will further support for implementation on a regional scale.**

**The most successful component of GOOS over the past decade has been its climate component, which is the global observing system that is required for climate research, monitoring, forecasting and long-term projections of climate variability and change. Since 2009, its overall system has currently stabilized at about 62% of full implementation. Both presenters stressed that the progress has not been going forward the way originally envisaged, and therefore there is a need for the community to strengthen engagement in observing system implementation and ensure delivery of products and information to meet user needs. This also includes the cost effectiveness element, as maintaining such a global observing network is strongly resource demanding. Participants of the meeting expressed their concerns that the impact of the global economy is mitigating this statement of feasibility, and GOOS needs to define a strategy of how to communicate the status of ocean observations to potential funders. This will include OOPC/OCG efforts to develop new and expanded observing system metrics to communicate the need for ongoing effort to sustain the observing system, and also report implementation against requirements for variables in addition to the existing platform reporting.**

**Additionally, experts mentioned that the development of ocean forecasting systems on a global and regional level, as well as in coastal regions presents an opportunity to strengthen the relationship between observations and modeling to deliver to societal applications and also inform observing system design; and that the observing system 'fitness-for-purpose' status should be assessed in regard to this key data application area. Dr Fischer then informed participants that OOPC is currently trying to increase its connection with GODAE OceanView, which is an international coordination activity that provides coordination and leadership in consolidating and improving global and regional ocean analysis and forecasting systems on an international level.**

**J1.2 The Ocean Observations Panel for Climate (OOPC)**

**Dr Toshio Suga and Dr Mark Bourassa, the two new co-chairs of the Ocean Observations Panel for Climate (OOPC), filled OCG Members in on the decisions that had been made at the OOPC-16 meeting. Dr Suga introduced the new OOPC work plan and updated participants on OOPC's future plans and priorities. A detailed description of the discussion concerning the new OOPC work plan can be found in the OOPC-16 report, which includes a section on how to (1) develop and (2) implement the work plan. Future activities and priorities are further explained in item 1.5 of the joint day report.**

**Main focus of OOPC efforts will be set on a regular reporting to its main sponsors GCOS, GOOS, and WCRP, as well as to deliver advice on scientific requirements to JCOMM, and to strengthen its link to the GODAE OceanView project. This will include the evaluation of existing components of the ocean observation system, and the delivering of recommendations on requirements, and systems analyses. OCG Members stressed that OOPC needs to expand its mandate into the forecasting and services area, and should further ensure a stronger contribution of the ocean observing network to surface atmospheric variables.**

**Dr Suga also presented decisions made at OOPC-16, which include recommendations and actions for OOPC regarding its new Terms of Reference, the new work plan, new and current memberships, fostering links with other observation networks and communities (e.g. satellite community, GODAE OceanView, CLIVAR Working Groups, etc.), OOPC representation at meetings, and potential contributions to GOOS projects. The full list of actions from the OOPC-16 meeting is provided in Chapter 4 of the OOPC-16 report. Regarding the latest draft of the OOPC Terms of Reference, representatives of JCOMM requested that**

**OOPC should include the connection to the JCOMM Management Committee and JCOMM's Data Management programme area. Additionally, JCOMM stressed that OOPC needs to stronger focus on atmospheric observations, and should pay attention to both observations of sea state and waves. An up to date draft of the Terms of Reference which is currently being considered by the OOPC sponsors can be found in Appendix III**

**Dr Mark Bourassa presented OOPC's future plans for the quantitative assessment of observing system design based on spatial, temporal and accuracy requirements for variables using statistical and modeling techniques, and assessments of the contribution of various observing platforms. Both observing system requirements and contributing observing networks will be assessed on their 'readiness', in line with the FOO. The requirements are based on scientific and operational objectives, and will be evaluated on their feasibility. OOPC and OCG need to work together to develop clear guidelines for contributing networks to articulate their role in the observing sytem. OOPC will develop a set of templates to evaluate the requirements for and implementation of the observing system by variable, and the contribution/readiness of component observing elements/networks. Additionally, OOPC is currently in the process of writing a whitepaper on 'Quantitative approaches to observing system design and assessment', which provides a rationale for the need of a quantitative systems based assessment with a focus on variables and scales.**

**1. OOPC is developing a whitepaper on quantitative observing system design and assessment, and is seeking engagement from OCG:**

**1.1 Action:** OOPC to work with OCG to develop a template for capturing characteristics of observations for Observing System Assessment by variable, including capturing nuances of observation methods, e.g. line observations (OOPC Members, OCG Members).

**1.2 Recommendation:** OOPC to include GSOP in the development of an Evaluation of Observing System template, and initialize projects (e.g. engaging GSOP experts) (OOPC Members, OOPC Secretariat, OCG Members).

**1.3 Recommendation:** Gliders to work with both OOPC and GRAs, and continue to demonstrate and evaluate the capabilities of gliders for the evaluations (GROOM, OOPC Members).

*J1.3 OCG-4 summary to JCOMM*

Ms Candyce Clark, chair of the OCG, updated participants on the current OCG priorities, underlined the important value that the coordination group is adding to JCOMM, and highlighted collective charges for OCG and OOPC. OCG is part of JCOMM's Observations Programme Area (OPA), which aims at implementing and maintaining a fully integrated ocean observing system across the entire marine meteorology and oceanographic community, and works to develop, plan and coordinate the acquisition, exchange and management of observations. The OCG seeks scientific advice on requirements from the OOPC, and also responds to the observational requirements of the other JCOMM Programme areas, such as Services and Forecasting Systems, as well as the broader Global Framework for Climate Services (GFCS).

OCG links global in-situ implementation programmes. Formal members are the Data Buoy Cooperation Panel – DBCP, the Global Sea Level Observing System – GLOSS and the Ship Observations Team – SOT; while ad hoc members include the Interational Argo Programme, the OceanSITES Reference Stations, the Global Ocean Shipboard Hydrographic Investigations Programme - GO-SHIP and the International Ocean Carbon Coordination Project – IOCCP through JCOMM coordination. A technical coordination of the formal OGC networks is provided by JCOMMOPS. The OCG's current priorities are to identify key drivers for existing observing system requirements, work with OOPC on system based design and observing system metrics by network and variable, and to identify new potential new elements of the sustained observing system in response to requirements and technology readiness, such as ocean gliders. The ocean glider community was represented at the meeting by Pierre Testore from the European GROOM project, to discuss future engagement in the OCG and the development of a global sustained ocean glider observation network.

*J1.4 The World Meteorological Organization*

Mr Etienne Charpentier, representative of the WMO Marine Meteorology and Oceanography Programme (MMOP), updated OCG Members and invited experts on the current status of the Global Framework for Climate Services (GFCS), and the WMO Rolling Review of Requirements (RRR) database.

*Global Framework for Climate Services (GFCS)*

Mr Charpentier gave a short update on WMO key priority areas, which include the GFCS, aviation meteorological services, capacity building for the developing and least developed countries, the implementation of the WMO Integrated Global Observing System (WIGOS) and the WMO Information System (WIS), and disaster risk reduction.

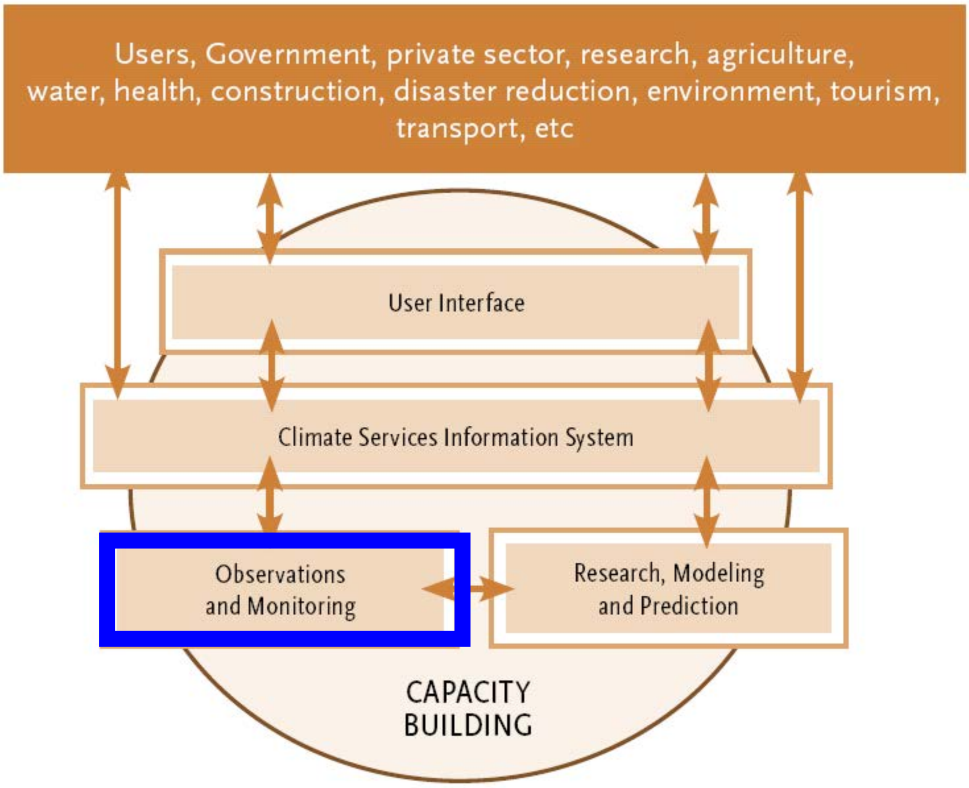



***Figure 1: The main pillars of the Global Framework for Climate Services.***

GFCS was developed to enable a better management of the risks of climate variability and change, and adaptation to climate change at all levels – through development and incorporation of science-based climate information and prediction into planning, policy and practice. The need for such a framework arose as the present capabilities for providing climate services do not exploit all that we know about the climate, and fall short of meeting the current and future needs and do not deliver their full benefits, especially in developing countries, as many countries currently lack the infrastructural, technical, human and institutional capacities to provide high-quality climate services. GFCS will build on existing capacities and leverage these through coordination to address these shortcomings. Mr Charpentier also explained the vision of the GFCS, which is expected to provide ways for climate services users and providers to interact and improve the effectiveness of the framework and its climate services; to generate, protect and distribute climate data and information according to the needs of users and to agree on standards; and to collect data to meet service provision needs, and develop agreements and standards for generating the necessary climate data. The ocean observation community will mainly provide expertise to the latter aspect of GFCS (see Figure 1).

Current JCOMM activities that directly contribute to the development and enhancement of climate services for the marine and coastal community include ocean climate observations and the support for research, long-term maintenance of an integrated global metocean data management (both for in-situ and remote sensing components), and polar metocean information services. JCOMM's core mandate in GFCS should focus on services in support of the safety of life and property at sea and in coastal areas, the management for ocean-based economic, commercial and industrial activities, prevention and control of marine pollution, sustainable development of the marine environment, provision of data information, products and services required to support climate research and the prediction of climate variability.

Future GFCS-projects proposed by JCOMM include:

- Ocean Extremes Monitoring System, Marine Climate Data System – MCDS,
- Integration of in-situ and satellite-based data for ocean observations,
- Integrated marine meteorological and oceanographic data and services in the framework of WIGOS and WIS, Global ocean observations in support of climate services),
- Marine and ocean climate information and assessment tools focusing on the impacts of weather and climate change on fisheries resources - in collaboration with the Commission for Agricultural Meteorology, Seasonal Ocean Climate Forecast System,
- Wave and Surge Climate Services,
- Coastal Inundation Forecasting Demonstration Project – CIFDP, in collaboration with the Commission for Hydrology,
- Enhanced Arctic Ocean Maritime Safety Information for Global Maritime Distress and Safety System – GMDSS, Adoption of an ISO 9001 Framework for the Delivery of Marine Weather and Ocean Services,
- Development and Adoption of a Generic Set of Competencies for Marine Weather Forecasters).

During the follow-up discussion, OCG Members and invited experts stressed about the fact that most of those proposed projects were decided on a tight timeframe, and without opportunity for consultation with the OOPC or OCG. Therefore, JCOMM and OCG experts need to further discuss on how to provide coordinated input to the GFCS projects in the future.

**2. Recommendation: Strengthen the connection to the Global Framework for Climate Services (GFCS).**

**4.1 Recommendation: JCOMM OPA Implementation Goals should be better reflected in the GFCS compendium of related projects (OCG Chair, JCOMM Co-Presidents).**

**4.2 Recommendation: Global Alliance for CPR Surveys (GACS) should be connected to GFCS on food security issues (OCG Secretariat, GACS Representatives, JCOMM Management Committee).**

*Rolling Review of Requirements (RRR)*

Mr Charpentier also presented an update on the process of the Rolling Review of Requirements (RRR), which defines user requirements for observations that are compared with the capabilities of present and planned observing systems. Currently, the RRR has 12 application areas: Global Numerical Weather Prediction, High Resolution Numerical Weather Prediction, Synoptic Meteorology, Nowcasting and Very Short Range Forecasting, Seasonal to Inter-annual Forecasts, Aeronautical Meteorology, Atmospheric Chemistry, Ocean Applications, Agricultural Meteorology, Hydrology, Climate Monitoring (GCOS), and Climate Applications (Other aspects, addressed by the Commission for Climatology). For each of the application areas considered, the Statement of Guidance (SOG) provides an assessment of the adequacy of observations to fulfill requirements and suggests areas of progress towards improved use of space-based and surface-based observing systems. Only the most significant variables in the given application areas have been analyzed in the SOGs, which can be found on the WMO website: http://www.wmo.int/pages/prog/www/OSY/GOS-RRR.html).

Mr Charpentier then presented JCOMM's main future contributions to the RRR, which includes an evaluation of the quality of wave observations, the development of cost-effective wave observations from drifters, a completion of the RAMA array, the promotion of an integrated approach between in-situ and remote-sensed measurements when considering requirements, and to further address ocean-related actions in the Implementation Plan for the Evolution of the Global Observing System (EGOS-IP), which are focusing on a transition to operational observations and include the following (C – cross-cutting, S – space-based, G – ground level, in-situ):

**C5** Sustained funding for the key marine/ocean observing systems (e.g. TIP, Argo, surface drifters with barometers, altimeter, scatterometer, SST from microwave radiometry, sea ice measurements from research satellite missions)

**C8** Continued adherence to WMO data sharing principles irrespective of origin of data, including data provided by commercial entities

**C13** Establish capacity building strategies for observing systems in developing countries

**G1** Traceability of meteorological observations and measurements to SI or WMO standards

**G2** Global exchange of hourly data which are used in global applications

**G3** Global exchange of sub-hourly data in support of relevant application areas

**G4** Exchange of observations according to the WIGOS standards

**G49** Maintain and optimize ASAP network over North Atlantic, & develop similar programmes for the N. Pacific & Indian Ocean

**G50** Use state-of-art technologies to improve accuracy for all measurements made at sea stations. Develop visibility measurement capabilities over the ocean.

**G51** Improve the quality of ship observations.

**G52** Support DBCP in its mission (1250 drifters, 400 MB) for SST, surface velocity, air T & wind

**G53** Install barometer on all newly deployed drifting buoys

**G54** Extend RAMA to similar coverage as TAO & PIRATA

**G55** Increase ice buoy data coverage on the northern polar cap

**G56** Global availability of in-situ sea level data (e.g. tide gauges, Tsunameters).

**G57** For ocean and weather forecasting purposes, transition the Argo profiling float network from research to operational status, & ensure timely delivery & distribution of high vertical resolution data for sub-surface temperature and salinity

**G58** For ocean and weather forecasting purposes, improve timely delivery & distribute high vertical resolution data for sub-surface temperature from Ships/XBT

Additionally, Mr Charpentier explained to participants that the RRR database will not include all of the requirements for the observing and monitoring mechanisms involved within the GFCS.

*J1.5 Observing System Evaluations and Workshops*

**Dr Toshio Suga gave meeting participants a more detailed look into the future review and evaluation plans for OOPC in the timeframe of 2013-2015. For a detailed description of the most pressing issues, please see item 2.2 of the OOPC-16 meeting report.**

Main focus in early 2014 is set on the evaluation of the Tropical Pacific Observing System (TPOS). Driven by the recent deterioration of the data return from the TAO/TRITON array, a NOAA/JAMSTEC co-sponsored Workshop on the 'Future sustained Tropical Pacific Ocean Observing System for Climate Research and Forecasting (TPOS-2020)' will be held at Scripps Institute for Oceanography in the United States from 27-30 January 2014. The workshop will evaluate the requirements for Tropical Pacific observations and will discuss the potential of existing (i.e. TAO/TRITON moorings, Argo profiling floats, satellite observation), and new technologies (i.e. profiling moorings, gliders) of ocean observations in the Tropical Pacific region. OOPC has already provided input on the scope of the meeting. OOPC co-chair Toshio Suga is also the co-chair of the TPOS Scientific Organizing Committee, and the OOPC Secretariat will be providing technical support to the workshop. The workshop will be based on a whitepaper process, and the recommendations will be published in the meeting report the first half of 2014. For more information, see www.ioc-goos.org/tpos2020.

Dr Eric Lindstrom introduced OCG participants to the concept of the Deep Ocean Observing Srategy (DOOS). The DOOS is a cross-GOOS activity, and therefore tries to integrate all three GOOS focus disciplines – physics, carbon/biogeochemistry, and biology/ecosystems. There is a need to communicate the relevance of the deep ocean to governments and science-funding agencies, and clarify the need for a global strategy for Deep Ocean observing (starting at approximately 2 km water depth) that will incorporate new observation technologies and networks in the existing observing system. The DOOS is a GOOS activity structured in line with the Framework for Ocean Observing, which includes the use of readiness levels to assess the fitness-for-purpose (related to EOVs and associated observations and data products), as well as communication with oversight panels, expert teams, and implementation communities to organize discussions related to system requirements and observations. Dr Lindstrom presented a timeline of planning and moving towards implementing such a deep ocean observing system up to OceanObs'19, which will include the establishment of a development programme, conducting design studies based on models, existing observation systems, evaluation framework, and the implementation of a pilot programme.

Furthermore, Dr Lindstrom informed participants paper on the Deep Ocean Observing Strategy will be available within a few months. He also welcomed participants to provide input for a future strategy, and to identify potential future needs and actions.

**3. Recommendation: OOPC and OCG to work together to strengthen the connection between observing system requirements and network data delivery.**

**3.1 Action:** OCG Members to work with the OOPC Secretariat to identify where existing drivers/requirements come from for each network. The OOPC Secretariat will draw on OCG talks for a first draft, and send out to OCG Members for comment (OOPC Secretariat, OCG Members).

**3.2 Recommendation:** Information on how individual EOVs are distributed amongst the observing networks to be collated in EOV document templates (OOPC Secretariat, OOPC Members).

**3.3 Action:** OOPC draft template for assessing status/proposing new observing networks/ elements to be circulated to OCG for discussion (OOPC Secretariat, OOPC Members).

**3.4 Recommendation:** Stronger connections to be developed between OOPC and the JCOMM Services and Forecasting Systems program area for developing requirements for ocean applications (marine services, ocean forecasting, etc.) to feed eventually into the OCG implementation goals (OOPC Secretariat).

**3.5 Action:** Organize teleconferences on a quarterly basis between Secretariats of the GOV, GSOP, OCG, and OOPC to discuss cross panel activities and links (Katy Hill – OOPC, Albert Fischer – OCG, Kirsten Wilmer-Becker – GODAE, Nico Caltabiano – GSOP, Long Jiang – ETOOFS).

**J2. Framework for Ocean Observing/Evaluation of the Observing System.**

**The second session of the day dealt with current observing system metrics and their potential improvement, as well as how OOPC and OCG can work together in the evaluation of the observation system. Discussions also included potential steps on how to successfully evaluate the overall observation system, both satellite-based and in-situ, in regard to the ECV/EOV concept.**

### *J2.1 Platform-based Metrics*

**Ms Candyce Clark summed up the sorts of information that needed to be captured by an expanded set of observing system metrics:**

- **Identification of the individual network implementation goals and automated programme metrics.**
- **The intensity of effort required to sustain the different networks;**
- **EOV/ECV based implementation, against requirements for those variables.**
- **Data flow – metrics of flow of real-time and delayed-mode data (including quality standards); and**
- **Products – delivery of value added products (derived or gridded).**
- **Uptake and Use - Is the data being used? By whom and what is the main reason? What kind (and level) of impact do they have?**

**Ms Clark asked for input and comments from OOPC and OCG Members and invited experts, and pressed that there needs to be further discussion among each – How do they define and implement metrics? Do they have real-time and/or delayed-mode data delivery? What is the networks' data uptake and use? What is the networks' performance? OCG will need to evaluate the performance of the existing networks in the observing system, and work with OOPC to evaluate the implementation by Variable.**

**4. Recommendation: The current metrics for the observing system implementation need to be revised to include an EOV/ECV focus, reflect ongoing effort required for deployment/ implementation, real time/delay mode data delivery and data uptake and use.**

**2.1 Action:** The current 62% of the observing system completion did not necessarily reflect the drops noted in the last two years with regard to the drifter array, and the TAO array data availability (OSMC/JCOMMOPS to update based on data availability).

**2.2 Action:** JCOMMOPS/OSMC to work with networks to refine the implementation metrics so that they are able to show the actual evolution of the observing systems, and ongoing effort required to sustain those (JCOMMOPS, OSMC).

**2.3 Action:** Roles of OSMC and JCOMMOPS need to be defined with regard to delivering Observing System information (Candyce Clark, JCOMMOPS, OSMC).

**2.4 Action:** JCOMMOPS to compile information about the evolution of the observing networks in order to visualize with new graphical products the trends of gaps of the array. Such tools will in particular be useful to the OOPC for making its recommendations to JCOMM in the future (JCOMMOPS, OOPC Members).

**2.5 Action:** OCG to develop an inventory and summary of usage of data. TIP and Argo already actively develop bibliographies, which can form a starting point (OCG Members, OCG Secretariat).

**2.5.1 Action:** Request TIP and Argo to provide information on status of bibliography, how data is collected and managed (e.g. database), and what resources are required for this activity.

*J2.2 Evaluation of the overall Ocean Observing System*

Mr Bob Keeley introduced meeting participants to a review report he is currently writing on an ECV-based evaluation of the whole in-situ ocean observing system, as the JCOMM Management Committee has voiced the need for an assessment on the state of in-situ data systems with respect to interoperability, consistency of treatment, metadata collection, etc. The report is composed as follows: (1) a description of the work, (2) evaluation of each of the following observing systems – SOOP, TSG, VOS, Drifters, TIP, OceanSITES, GLOSS, Argo, GO-SHIP, and IOCCP, (3) evaluation based on individual ocean ECVs, and (4) concluding remarks. Part (2) will focus on data providers, data assembly, processing and archiving processes, data dissemination, difference between data sets, user communities, monitoring and performance metrics, GCOS-IP performance indicators, and future recommendations for each evaluated network. Part (3), focusing on an ECV-based approach, provides information about the review of instruments, instrument characteristics, data providers, FOO system readiness descriptions, ECV requirements (from WMO OSCAR), composite view, and future recommendations. Mr Keeley reminded the attending experts that the approach had to be ECV-based, as there is no current existing list of Essential Ocean Variables available yet.

Mr Keeley also expressed his concerns, and furthermore explained some of the problems and difficulties he faced during his writing progress, especially in regard to the structure of the OSCAR database, differences in real-time and delayed-mode data reporting, and duplication across different data sets. He welcomed OCG and OOPC experts to think about the following aspects:

- How to provide sensible targets for marine observing systems that are not sampled in the x-y-z boxes of OSCAR? Is there a possibility to recast the OSCAR requirements?
- How to assess success for measuring an ECV across many different observing systems?
- What role do OOPC and/or OCG want to have in the review of the draft report?
- Are observing targets different for real-time and delayed-mode data? And if so, what are those differences?

- Is it possible for OOPC/OCG to provide a general future direction on how to avoid duplication of data sets in archives?
- What are OOPC's plans for regular reporting on the performance of observing data systems to deliver the data?
- In the process of defining EOVs, OOPC should indicate the type of metadata that will be crucial to capture. Should there be encouragement of data providers to indicate their uncertainty estimates?

After finalizing the draft version, the report will be circulated to individual experts from both the OOPC and OCG community for review. The report itself will then be published some time in early 2014.

In addition to the planned evaluation on in-situ observing systems, Dr Mark Bourassa presented a talk on the importance of an evaluation of satellite systems, and furthermore the combination of future recommendations for both the in-situ and satellite-based observing community. Combining satellite and in-situ systems would benefit the ocean community, as satellite systems rarely have an absolute calibration, but usually have stable calibrations, which is of huge importance for climate applications such as decadal changes. Examples for such a successful combination include ocean observations for sea level change, and change in Tropical Pacific winds. Dr Bourassa underlined the importance of a stable calibration, and stressed that currently only a relatively small number of high-quality observations can be used to test those calibrations. Therefore, other sensors are needed to provide a better space/time coverage.

A combined in-situ and satellite-based system is needed to maintain a global network for surface observations. OOPC will need the information to further assess the fitness-for-purpose of the observing system for climate and operations.

**5. JCOMM Report on data flow by Bob Keeley will be available in late 2013. OCG Members to review.**

**5.1 Action: OOPC to review sections by EOV, to be collated by OOPC Secretariat (OOPC Secretariat to define process with OCG Chair and coordination with OOPC Members).**

**5.2 Action: OCG networks to review sections by network, engaging data teams and JCOMMOPS technical coordinators, to be collated by OCG Secretariat (OCG Chair/Secretariat to coordinate with OCG Members).**

**5.3 Action: JCOMM Data Management Programme Area need to be engaged (OCG Secretariat, JCOMM Members).**

**5.4 Action: OCG will hold a teleconference on this topic in January 2014 (OCG Secretariat to facilitate) in order to:**

**5.4.1 Action: Review the Terms of Reference of the proposed JCOMM cross-cutting task team on Integrated Data Flows in Oceanographic Services for WIGOS and WIS and make adjustments, and propose new members, noting that its scope also includes integration of products data flow (OCG Secretariat, OCG Members).**

**5.4.2 Action: Decide if OCG should have a separate task team to address some of the issues raised in the report that cannot be taken up by the larger JCOMM task team due to its scope (OCG Members).**

**5.4.3 Action: Ensure European initiatives (e.g. MyOcean, SeaDataNet, Eurofleets, Jerico, EMODnet, ODIP) are engaged in the ongoing work (OCG Secretariat).**

### *J2.3 Connections to Synthesis and Product Development*

**Dr Eric Dombrowsky, co-chair of GODAE OceanView (GOV), gave a presentation on the connections to synthesis and product development, whereas Dr Tony Lee and Dr Eric Lindstrom underlined the**

**importance of a well-working collaboration between the modeling and the observation communities to not only improve the quality of future climate models, but also to identify the current observation gaps. It was suggested that OOPC should further its links to the Global Synthesis and Observations Panel (GSOP) of CLIVAR, as both have similar Terms of Reference and therefore need to avoid repetition. Areas such as working with the observations community to improve data quality (such as the recent Ocean temperature clean up work shop), is an area ripe for collaboration between these two groups. Rather than focusing on cross representation at meetings, it suggested that secretariats of the panels and projects connect up for a teleconference on a semi-regular basis to swap information, discuss activities and identify areas of mutual interest. Additional benefits for such collaboration will improve information provided for observational impact assessments (e.g. the deterioration of the TAO/TRITON network), and improve observation quality (control, error estimates, etc.). Furthermore, GSOP should be asked for input on the development of a template to evaluate observing systems that OOPC had already decided on during OOPC-16.**

**Dr Dombrowsky mentioned that the production of reanalysis implies the need for high-quality observation data sets (in delayed mode), and introduced the concepts of CORA (IFREMER), AVISO, and sea ice data products. All those products are available on GOV's MyOcean servers (http://www.myocean.eu). He also informed participants that different approaches are currently used for data forcing, whereas most European groups use ECMWF's ERA reanalysis products. Several of GOV's partners use their real-time systems to produce reanalysis, which is further explored on the website of the 4th WCRP international conference on reanalysis that took place in May 2012 (http://icr4.org). In Europe, there is a concerted effort to provide several global 1/4° reanalysis products that are served through the MyOcean portal.**

**J3. Next Steps.**

The actions identified at the meeting will further the links between OOPC, OCG, and JCOMM in the future. A summary of actions and recommendations can be found below.

**1. OOPC is developing a whitepaper on quantitative observing system design and assessment, and is seeking engagement from OCG:**

**1.1 Action:** OOPC to work with OCG to develop a template for capturing characteristics of observations for Observing System Assessment by variable, including capturing nuances of observation methods, e.g. line observations (OOPC Members, OCG Members).

**1.2 Recommendation:** OOPC to include GSOP in the development of an Evaluation of Observing System template, and initialize projects (e.g. engaging GSOP experts) (OOPC Members, OOPC Secretariat, OCG Members).

**1.3 Recommendation:** Gliders to work with both OOPC and GRAs, and continue to demonstrate and evaluate the capabilities of gliders for the evaluations (GROOM, OOPC Members).

**2. Recommendation: Strengthen the connection to the Global Framework for Climate Services (GFCS).**

**4.1 Recommendation: JCOMM OPA Implementation Goals should be better reflected in the GFCS compendium of related projects (OCG Chair, JCOMM Co-Presidents).**

**4.2 Recommendation:** Global Alliance for CPR Surveys (GACS) should be connected to GFCS on food security issues (OCG Secretariat, GACS Representatives, JCOMM Management Committee).

**3. Recommendation: OOPC and OCG to work together to strengthen the connection between observing system requirements and network data delivery.**

**3.1 Action:** OCG Members to work with the OOPC Secretariat to identify where existing drivers/requirements come from for each network. The OOPC Secretariat will draw on OCG talks for a first draft, and send out to OCG Members for comment (OOPC Secretariat, OCG Members).

**3.2 Recommendation:** Information on how individual EOVs are distributed amongst the observing networks to be collated in EOV document templates (OOPC Secretariat, OOPC Members).

**3.3 Action:** OOPC draft template for assessing status/proposing new observing networks/ elements to be circulated to OCG for discussion (OOPC Secretariat, OOPC Members).

**3.4 Recommendation:** Stronger connections to be developed between OOPC and the JCOMM Services and Forecasting Systems program area for developing requirements for ocean applications (marine services, ocean forecasting, etc.) to feed eventually into the OCG implementation goals (OOPC Secretariat).

**3.5 Action:** Organize teleconferences on a quarterly basis between Secretariats of the GOV, GSOP, OCG, and OOPC to discuss cross panel activities and links (Katy Hill – OOPC, Albert Fischer – OCG, Kirsten Wilmer-Becker – GODAE, Nico Caltabiano – GSOP, Long Jiang – ETOOFS).

**4. Recommendation: The current metrics for the observing system implementation need to be revised to include an EOV/ECV focus, reflect ongoing effort required for deployment/ implementation, real time/delay mode data delivery and data uptake and use.**

**2.1 Action:** The current 62% of the observing system completion did not necessarily reflect the drops noted in the last two years with regard to the drifter array, and the TAO array data availability (OSMC/JCOMMOPS to update based on data availability).

**2.2 Action:** JCOMMOPS/OSMC to work with networks to refine the implementation metrics so that they are able to show the actual evolution of the observing systems, and ongoing effort required to sustain those (JCOMMOPS, OSMC).

**2.3 Action:** Roles of OSMC and JCOMMOPS need to be defined with regard to delivering Observing System information (Candyce Clark, JCOMMOPS, OSMC).

**2.4 Action:** JCOMMOPS to compile information about the evolution of the observing networks in order to visualize with new graphical products the trends of gaps of the array. Such tools will in particular be useful to the OOPC for making its recommendations to JCOMM in the future (JCOMMOPS, OOPC Members).

**2.5 Action:** OCG to develop an inventory and summary of usage of data. TIP and Argo already actively develop bibliographies, which can form a starting point (OCG Members, OCG Secretariat).

**2.5.1 Action:** Request TIP and Argo to provide information on status of bibliography, how data is collected and managed (e.g. database), and what resources are required for this activity.

**5. JCOMM Report on data flow by Bob Keeley will be available in late 2013. OCG Members to review.**

**5.1 Action: OOPC to review sections by EOV, to be collated by OOPC Secretariat (OOPC Secretariat to define process with OCG Chair and coordination with OOPC Members).**

**5.2 Action: OCG networks to review sections by network, engaging data teams and JCOMMOPS technical coordinators, to be collated by OCG Secretariat (OCG Chair/Secretariat to coordinate with OCG Members).**

**5.3 Action: JCOMM Data Management Programme Area need to be engaged (OCG Secretariat, JCOMM Members).**

**5.4 Action: OCG will hold a teleconference on this topic in January 2014 (OCG Secretariat to facilitate) in order to:**

**5.4.1 Action: Review the Terms of Reference of the proposed JCOMM cross-cutting task team on Integrated Data Flows in Oceanographic Services for WIGOS and WIS and make adjustments, and propose new members, noting that its scope also includes integration of products data flow (OCG Secretariat, OCG Members).**

**5.4.2 Action: Decide if OCG should have a separate task team to address some of the issues raised in the report that cannot be taken up by the larger JCOMM task team due to its scope (OCG Members).**

**5.4.3 Action: Ensure European initiatives (e.g. MyOcean, SeaDataNet, Eurofleets, Jerico, EMODnet, ODIP) are engaged in the ongoing work (OCG Secretariat).**

The Secretariats of OOPC and OCG would like to thank all Members, invited experts, JCOMM and JCOMMOPS for the great discussions from which the good work relation between OOPC and OCG will benefit from in the future. The OOPC and OCG would also like to thank the NOAA Climate Program Office for generously organizing the meeting at the Hilton Doubletree Hotel.

**ANNEX IV**

**ACTION ITEMS ARISING FROM THE MEETING**

| ***No.*** | ***Ref.*** | ***Action item*** | ***By whom*** | ***Deadline*** |
|---|---|---|---|---|
| 1 | 1.2(1) | to work with OCG to develop a template for capturing characteristics of observations for O.S. Assessment, capturing nuances of obs methods, e.g. line obs. | OOPC, OCG Members supported by Katy Hill | OCG-6 |
| 2 | 1.2(2) | to refine the metrics so that they are able to show the actual evolution of the observing systems | OSMC | OCG-6 |
| 3 | 1.2(3) | to develop Whitepaper on a Quantitative. O.S. Assessment Process | Mark/OOPC | OCG-6 |
| 4 | 1.2(6) | to review the report on data flow of Bob Keeley (Katy to define process with Candyce, and divide up review between OOPC Members. Katy to collate. Review to Bob by Mid November). DMPA to be involved. | K. Hill, R. Kelley, S. Iona | Nov. 2013 |
| 5 | 1.2(7) | to initiate discussions regarding establishing better links between the OOPC and the SFSPA in order to better take into account the requirements for ocean application (marine services, ocean forecasting, etc.) to feed eventually into the OPA Implementation Goals. | OOPC | asap |
| 6 | 1.2(8) | to provide information on how to develop an inventory and summary of usage of TIP and Argo data | TIP & Argo | OCG-6 |
| 7 | 1.2(9) | to address the OPA Implementation Goals and promote the OPA related projects of the GFCS compendium | OCG Chair | OCG-6 |
| 8 | 2.1.1 | to review the Bob Keeley-led report on data flow | OCG members | November 2013 |
| 9 | 2.1.2 | to hold a teleconference on data flow (e.g. TT-MOWIS, activities needed to address issues outlines in the Keeley report, and intersections with emerging data services; see paragraph 2.1.2 for details) | secretariat to facilitate | asap |
| 10 | 2.2.4 | to appoint an editor of these two guides to set the framework and develop a work plan for encouraging observing network teams to review and update their | Co-Presidents & secretariat | OCG-6 |

| ***No.*** | ***Ref.*** | ***Action item*** | ***By whom*** | ***Deadline*** |
|---|---|---|---|---|
| | | appendices | | |
| 11 | 3.1.22 | to develop best practices for new ship design, taking into account relevant developments at IMO (eNav etc.), in collaboration with the ICS and IACS, in the view to eventually submit related recommendation to the IMO | SOT | OCG-6 |
| 12 | 3.1.23 | to provide information that would help OCG, AOPC, and OOPC make the case (balancing feasibility including cost and impact) to Members/Member States for a sustained and/or evolved VOS network (e.g., balance between automated and manual observations), using the observing network template that identifies the unique characteristics of the observing network | VOSP | OCG-6 |
| 13 | 3.1.27 | to investigate ways to assure proper funding of the Argo network Science Director position position, in conjunction with overall scientific direction for all the OCG observing networks | MAN | MAN-11 |
| 14 | 3.1.31 | to clarify the definitions of the OceanSITES network and DBCP-OceanSITES intersections, particularly focused on the overlap in the networks | OceanSITEs, DBCP, OOPC | OCG-6 |
| 15 | 3.1.39 | to compile information about the evolution of the observing networks in order to visualize with new graphical products the *trends of gaps of the arrays*. Such tools will in particular be useful to the OOPC for making its recommendations to JCOMM | JCOMMOPS | OCG-6 |
| 16 | 3.1.40 | to develop concepts for pilot projects linking observing with a services component | G. Mitchum, D. Legler, A. Fischer | OCG-6 |
| 17 | 3.2.1 | (i) to consult with OOPC and the other ocean observing networks, (ii) Continue to work with glider operators worldwide on best practices and standards; (iii) continue to work on real-time and delayed-mode DM arrangements in cooperation with other relevant networks | glider community | asap |
| 18 | 3.2.2 | to work with the glider community to formulate a plan with proposals for coordination mechanisms for the *global network* [responding to global-level requirements, demonstrating and evaluating the capabilities of gliders] and the *community of practice* [common best practices and data systems, engagement with GOOS Regional Alliances and national observing activities] aspects of work with gliders, to be presented to the Management Committee for advice | OCG | JCOMM-5 |

| No. | Ref. | Action item | By whom | Deadline |
|---|---|---|---|---|
| 19 | 3.2.4 | to initiate a pilot project for Tsunami Monitoring using submarine cables, and to propose terms of reference and membership of a steering group for the pilot project to the OCG | D. Meldrum | asap |
| 20 | 4.3.4 | to organize a first teleconference and facilitate future calls regarding preparing a menu of options for the shipping industry and defining a strategy to engage them through the IMO, International Chamber of Shipping, and other organizations | M. Kramp | asap |
| 21 | 5.1.1 | to work on a common plan to summarize the roles and responsibilities of each centre, clarify overlap (and rationale for such overlap), and description of how they complement each other (e.g. JCOMMOPS is in direct contact with the platform operators, and is providing direct support to them, including with network monitoring tools and metrics on data flow; OSMC focused on system-wide metrics, EOV metrics, metrics on flow into EOV data assembly) | JCOMMOPS & OSPC | OCg-6 |
| 22 | 5.1.2 | to propose Terms of Reference of the OSMC for discussion at the next OCG meeting, for interim use and formal submission to JCOMM-5. | OCG Chair | OCG-6 |
| 23 | 5.1.3 | to compile information about the evolution of the observing networks in order to visualize with new graphical products trends of gaps of the arrays. Such tools will in particular be useful to the OOPC for making its recommendations to JCOMM | JCOMMOPS | OCG-6 |
| 24 | 5.2.1 | to develop its workplan, including (i) the general (synergetic) part, and (ii) the workplans developed by each Panel (DBCP, Argo, SOT, OceanSITEs, GO-SHIP), for regular review by the JCOMMOPS Roundtable | JCOMMOPS | OCG-6 |
| 25 | 5.2.2 | to further develop a long-range JCOMMOPS Strategy to provide services in support of JCOMM ocean observing networks | OCG Chair & Secr. | OCG-6 |
| 26 | 5.2.3 | to review the OCG-5 JCOMMOPS budget document, and to provide comments to the Secretariat | OCG members | asap |
| 27 | 5.2.4 | to make a proposal to the OCG chair regarding some principles on the type and level of services to be provided by JCOMMOPS to the Panels and the associated groups taking into account the different levels of commitments of each Panels | JCOMMOPS | OCG-6 |
| 28 | 5.3.2 | to provide a quantitative (vs. qualitative) analysis of pros and cons of moving JCOMMOPS to Brest vs. keeping it in Toulouse: e.g. to include information on the | JCOMMOPS | OCG-6 |

| ***No.*** | ***Ref.*** | ***Action item*** | ***By whom*** | ***Deadline*** |
|---|---|---|---|---|
| | | cost of moving the staff; on the impact on productivity; on what the IFREMER rent is going to be (commitment of IFREMER to be documented). | | |
| 29 | 5.3.3 | to seek commitment letters from IFREMER and CLS if JCOMMOPS has to be based in Brest | JCOMMOPS | asap |
| 30 | 5.3.5 | to finalize the TC DBCP position description and to submit it to the DBCP/OceanSITES Chairs for approval | Secr. | asap |

# ANNEX V

## REPORT BY THE DATA BUOY COOPERATION PANEL (DBCP)

*(Report submitted by Al Wallace, Chairperson, Data Buoy Cooperation Panel, and Kelly Stroker, Technical Coordinator, Data Buoy Cooperation Panel)*

## 1. OVERVIEW

The Data Buoy Cooperation Panel (DBCP) is an official joint body of the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC). It consists of the data buoy component of the Joint WMO-IOC technical Commission for Oceanography and Marine Meteorology (JCOMM) and the Global Ocean Observing System (GOOS). It increases the quantity, quality and timeliness of atmospheric and oceanographic data in ocean areas, to improve global forecasts of weather and ocean conditions, plus also to contribute to climate study and oceanographic research.

The aims of the DBCP are to:

1. review and analyse requirements for buoy data
2. coordinate and facilitate deployment programmes to meet network requirements
3. support information exchange and technology development
4. improve quantity and quality of buoy data distributed on the Global Telecommunication System (GTS)
5. initiate and support action groups and
6. liaise with relevant international/national bodies and programmes.

## 2. NETWORK STATUS

The primary objective of the DBCP is to maintain and coordinate all components of the network of over 1250 drifting buoys (with at least 50% reporting barometric pressure) and 400 moored buoys, which provide measurements such as sea-surface temperature, surface current velocity, air temperature and wind speed and direction.

The network status map for July, 2013 is shown in Figure 1. In July there were 1155 drifting buoys and 427 moored buoys reporting onto the GTS.

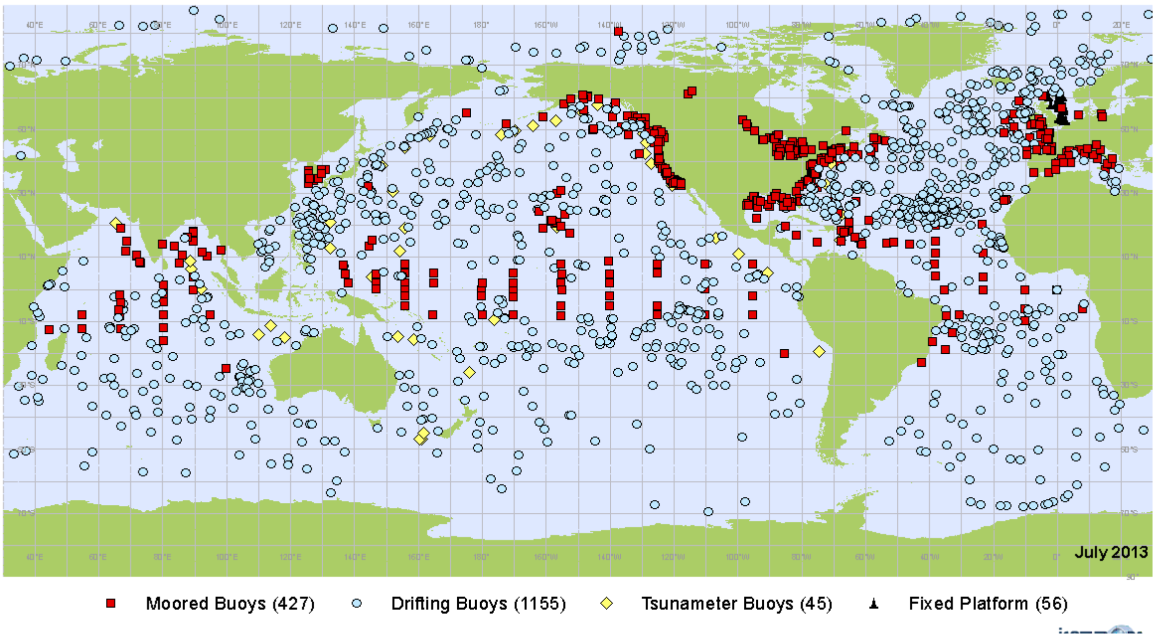



**Figure 1 - Status of the Network, July 2013.**

A primary component of the Data Buoy Cooperation Panel (DBCP) is the Global Drifter Program (GDP). The GDP is the principle component of the Global Surface Drifting Buoy Array, a branch of NOAA's Global Ocean Observing System (GOOS) and a scientific project of the Data Buoy Cooperation Panel (DBCP). Its objectives are to:

1. Maintain a global 5x5 degree array of 1250 satellite-tracked surface drifting buoys to meet the need for an accurate and globally dense set of in-situ observations of mixed layer currents, sea surface temperature, atmospheric pressure, winds and salinity, and
2. Provide a data processing system for scientific use of these data.

These data support short-term (seasonal to inter-annual) climate predictions as well as climate research and monitoring.

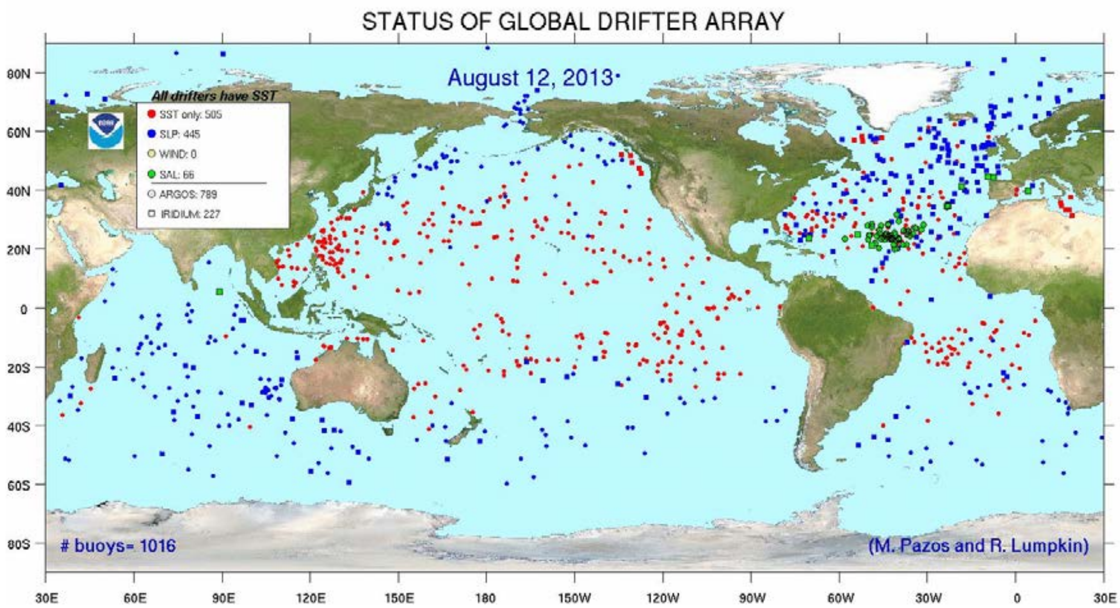


**Figure 2 - GDP component of the Global Drifter Program in August, 2013.**

The number of operational drifters has been decreasing in the past few years and this is of great concern for the community.

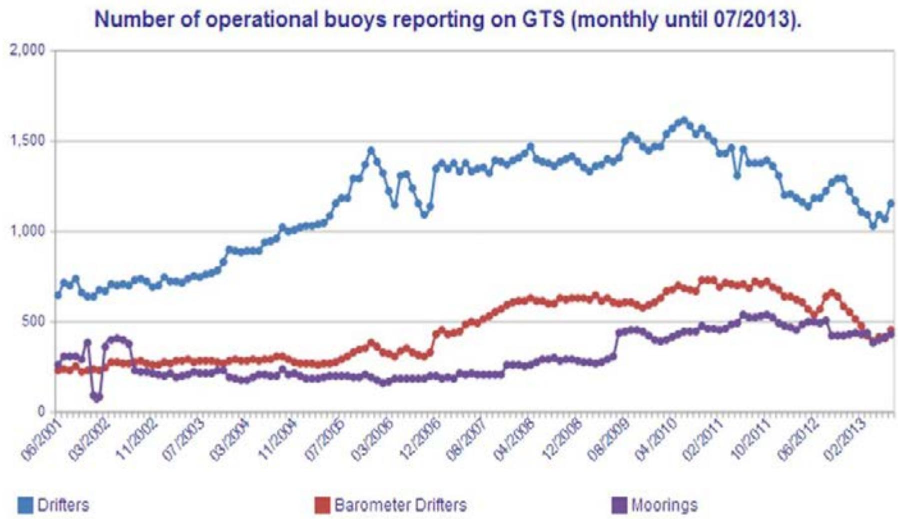


**Figure 3 - Status of the operational buoy network since 2001.**

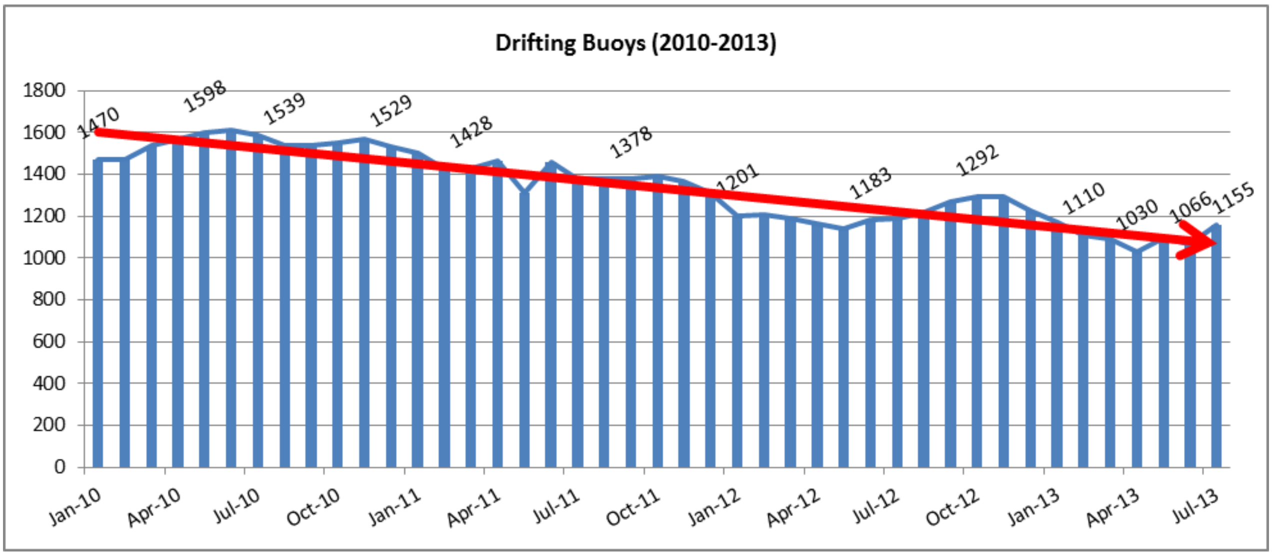



**Figure 4 - Network status of the drifting buoy array since 2010 showing a sharp decline in the number of drifters globally.**

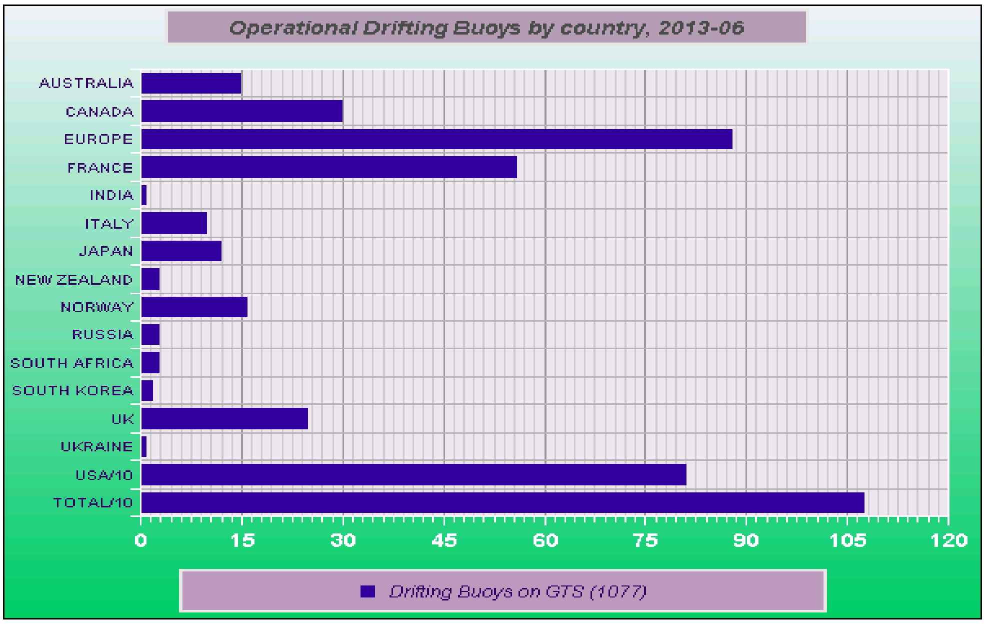



**Figure 5 - Number of drifters operational by Country**

During DBCP Sessions 27 and 28, the Panel noted with concern that drifter lifetimes have dropped below the goal of a half-life of 450 days and the over-all half-life of an average drifter has been 236 days. As noted at DBCP-28 there were 2 main issues for this decrease:
The two main factors are known to affect the drifter lifetime:

- Faulty battery packs: battery packs assembled from poor quality cells have now been eliminated from the GDP array, and are largely responsible for the dramatic lifetime decreases in 2010—2011 documented in 1.2.2. Only packs made of industrial grade Duracell batteries are used in GDP drifters. A second cause of concern is that battery packs not properly secured can result in individual cells getting damaged on deployment or due to mechanical shock while deployed. SIO is looking into ways for securing individual cells through potting. Techniques for potting battery packs need to be carefully evaluated as alkaline cells produce hydrogen during discharge so venting routes need to be designed. SIO is conducting extensive testing and the results will be communicated to the drifter community as they become available.
- Argos 2 versus Argos 3: it is now understood that some PMT modems running in Argos 2 mode are not energy efficient and shorten the drifter lifetime considerably. This factor is

partially responsible for decreased lifetimes in 2012—2013. At the time of writing, all the existing dryundeployed drifters with PMTs are being retrofitted to run as Argos 3. The operation has some risks as this will be the first large implementation of Argos 3 GDP drifters, but it was decided, based on the results of the Argos 3 pilot project, that the benefits of lower energy drain outweigh the risks of this operation. Simultaneously, an array of 175 Iridium drifters will be deployed by the GDP to compare the energy budget of the two types of drifters, i.e. Iridium vs Argos 3.

- While still at a speculation level, a likely explanation in the dramatic recent decline of the drifter's life could be linked to the increased power demand that resulted from the implementation of the PMT and the strain gauge across the board. The need for more power might exacerbate the problems connected with the structural integrity of the battery pack, where the failure of one or more cell strings (the standard GDP battery back is made of four series of 8 D cells connected in parallel to provide 56Ah) brings the battery capacity below a critical level.
- These issues are being addressed and as drifters with reliable batteries, optimized transmission strategies and more robust drogues and tethers are deployed, we anticipate the number of drogues returning towards the goal of 1250 drifters through 2013 and the drogue lifetimes of drifters deployed in 2013 to increase.

**Metrics** - definition and implementation progress

The global drifter array aims to maintain a global 5x5 degree array of 1250 satellite-tracked surface drifting buoys to meet the need for an accurate and globally dense set of in-situ observations of mixed layer currents, sea surface temperature, atmospheric pressure, winds and salinity. Standard SVP drifters with barometers ports are now routinely deployed and meet the need for oceanographic and metrological requirements. The goal is to maintain approximately 50% of the array equipped with barometer buoys.

Global drifter array

- 1250 drifters in 5 x 5 degree configuration
- At least 50% barometer buoys
- Drifter lifetimes of 450 days

## 3. STANDARDS AND BEST PRACTICES (DRAFT AND DOCUMENTED)

The DBCP Technical Document series makes up an important part of the standards and best practice documentation:

http://wo.jcommops.org/cgi-bin/WebObjects/JCOMMOPS.woa/wa/doc?group=DBCP_DOC

JCOMM and the WMO Integrated Global Observing Systems (WIGOS »), is seeking increased collaboration with partner organisations towards the objective of harmonized standards, and better traceability of observations to standards.

The JCOMM Catalogue of Practices and Standards is available via http://bestpractice.iode.org/ . There are also documented standards and guidelines on the Ocean Standards website .
The DBCP is contributing to this effort by compiling a list of documents available, to identify gaps in the documentation and where documents need to be updated: http://dbcp.jcommops.org/community/standards.html

On this site you will find documents on

- deployment techniques
- instrument/sensor calibration
- Manufacturer recommendations
- satellite telecomm
- GTS message formats

- quality control
- metadata
- archiving
- vandalism

An updated document on drifter best practices was submitted in the last intersessional period by the working group on Instrument Practices and Drifter Technology Development: http://www.jcommops.org/doc/DBCP/DBCP-drifter_best_practices_Final.pdf

In addition to the documents mentioned above, the DBCP has several task teams that address standards and best practices:

- DBCP Task Team on Data Management
- DBCP Task Team on Instrument Best Practices and Drifter Technology Development
- DBCP Task Team on Moored Buoys
- DBCP Task Team on Capacity Building

## 4. EVOLUTION OF NETWORK/NEW TECHNOLOGIES/SENSORS

The DBCP is undertaking several pilot projects to look at and evaluate new technologies and sensors. Information can be found here: http://dbcp.jcommops.org/overview/pilots.html

- DBCP Sea Level Atmospheric Pilot Project
  - Evaluation of the Impact of Sea Level Atmospheric Pressure Data Over the Ocean from Drifting Buoys on Numerical Weather Prediction Models

- DBCP Iridium Pilot Project
  - Evaluating the feasibility of using Iridium technology for real-time telecommunication of drifter data under various conditions.

  The primary method of real-time communication of drifter data continues to be Argos technology. However, in recent years, and driven by a pilot project initiative through the DBCP, we have seen an increase in Iridium technology. At present, July 2013, nearly 25% of the array are using Iridium to transmit data (Fig 6)

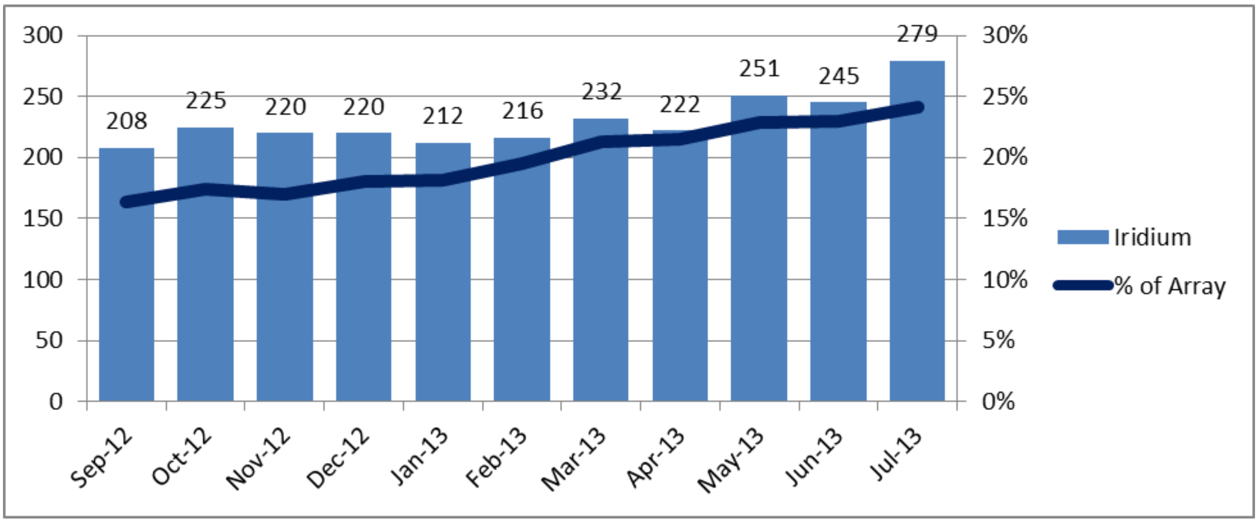



**Figure 6 - Number of drifters using Iridium Technology during the last intersessional period (Sept-2012-July-2013) and percent of the total array.**

- DBCP Argos3 Pilot Project
  - Evaluating the use of Argos 3 transmitters on operational buoys in all ocean areas.

- JCOMM Pilot Project on Wave measurement Evaluation and Tests, from moored buoys PP-WET

- Very High Resolution Sea Surface Temperature
  - To address requirements from the Group on High Resolution Sea Surface Temperature (SST) (GHRSST), and complement satellite data, the DBCP is investigating developing pilot activities to operate a sub-set drifter network providing high temporal resolution, possibly high vertical resolution in the upper mixed layer near the surface, and high accuracy SST data using GPS-equipped, un-drogued drifting buoys.

- Salinity Measurements
  - To support the Salinity Processes in the Upper Ocean (SPURS) campaign effort, 40 SVP drifting buoys equipped with salinity sensors and GPC were deployed.

- The Panel is also looking at using new technologies such as surface wave gliders

## 5. LOGISTICS AND RESOURCE ISSUES

The immediate issue facing the DBCP is the requirement to have ongoing support from a Technical Coordinator (TC). Even though working remotely from JCOMMOPS, the current TC has met all expectations of the position and has fully supported the work of the Panel. The recruitment process for a new TC has not yet started as there are a number of issues relating to the details of the employment (WMO, IOC) that need to be resolved. The desire of the Panel is to continue the employment of our TC, and options and details are still to be discussed.

The Panel is concerned about the relocation of JCOMMOPS from Toulouse to Brest. A business plan was requested to support this move, but has not yet been presented for review.

The DBCP was pleased that the Ship Logistics Coordinator position has been staffed, and looks forward to working together to address issues such as deployment opportunities. With respect to this position, the initial term of employment was for 18 months and the Panel wants to better understand the performance framework that will determine the success, and hence future, of this post.

## 6. CAPACITY BUILDING OPPORTUNITIES/REQUIREMENTS

The DBCP strongly supports capacity building efforts, and has a Task Team that leads on the development and delivery of associated workshops. Indeed, the Panel provided an initial training workshop on implementation of buoy programmes, and data management in 2007 in Ostend Belgium. The Task Team was formally established in 2008 and has actively provided capacity building opportunities. In the past year, 2 workshops were delivered: Asia 1 – in Chennai, India, Western Indian Ocean (WIO)4 - Zanzibar, Tanzania, and a third is planned for the North Pacific Ocean and Marginal Seas (NPOMS) , in Hangzhou, China. Previous capacity building events had been held for the WIO in South Africa, Mauritius, and Kenya, and for the NPOMS in South Korea. The DBCP will continue to support future workshops, and is in the planning stages for an Asia -2, potentially a WIO – 5, and is considering other requests.

## 7. ISSUES AND CHALLENGES, IDEAS FOR INTEGRATION, WAY FORWARD

The DBCP has challenges and issues related to sustainability of the global drifter network, the operation and integration of the moored buoy network, technological change, client needs, financial viability, and operational support. To maintain the global array of drifters requires ongoing annual deployments of buoys that are robust, and able to provide timely and reliable reports of multiple variables. The deployment strategies must address the observing gaps in certain oceans. Timeliness of data entry onto the GTS must be improved. This network requires the cooperation of many meteorological and oceanographic services and agencies and others to fund, deploy and operate. Network owners and operators must remain responsive to technological change and adopt new approaches once they are proven viable. The DBCP recognizes that client needs are changing, and new clients are emerging and those new requirements such as high resolution sea surface temperature, salinity, and waves from drifters will the need for innovation and introduction of new technologies. Members of the Panel have provided financial stability yet as costs rise contributions must also increase if expectations are to be met. Support from JCOMMOPS is vital to the Panel achieving its mission, and meeting client needs. The viability and sustainability of this group needs to be secured.

## ANNEX VI

## REPORT BY THE TROPICAL MOORED BUOY IMPLEMENTATION PANEL (TIP)

### 1) SUMMARY

| **Name of Action Group** | **The Tropical Moored Buoy Implementation Panel (TIP)** |
|---|---|
| **Date of report** | 31 July 2013 |
| **Overview and main requirements addressed** | The Tropical Moored Buoys Implementation Panel (TIP) oversees the design and implementation of the following components:<br>• The Tropical Atmosphere Ocean / Triangle Trans-Ocean Buoy Network (TAO / TRITON), a central component of the ENSO Observing System, deployed specifically for research and forecasting of El Niño and La Niña;<br>• The Prediction and Research Moored Array in the Tropical Atlantic (PIRATA)<br>• The Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA) |
| **Area of interest** | The tropical ocean regions as part of an integrated approach to observing the climate system to address the research needs of CLIVAR and the operational strategies of GOOS and GCOS. Pacific Ocean: 8°N to 8°S; Atlantic Ocean: 20°N to 10°S; Indian Ocean: 15°N to 25°S. |
| **Type of platform and variables measured** | Tropical moorings with surface meteorological and sub-surface oceanographic sensors measuring: Surface wind, air temperature, relative humidity, SST and SSS on all surface moorings. Air pressure, precipitation, short wave radiation, long wave radiation on some surface moorings. Sub-surface temperature profiles down to 500m-750m on all surface moorings. Salinity profiles as deep as 750m on some surface moorings. Current velocity on some moorings. Also, biogeochemical measurements, including $CO_2$ and $O_2$ on select moorings. A few moorings also have specialized instruments to measure turbulence dissipation.<br><br>Subsurface ADCP moorings measuring velocity profiles in the upper few hundred meters. Some have additional single point current meters at deeper levels. |
| **Targeted horizontal resolution** | Tropical Pacific Ocean: 72 moorings ; Tropical Atlantic Ocean: 19 moorings ; Tropical Indian Ocean: 46 moorings |
| **Chairperson/Managers** | Dr. Mike McPhaden, PMEL, USA, Chairman<br>Dr. Kentaro Ando, JAMSTEC, Japan, Vice-Chairman |
| **Coordinator** | Mr H. Paul Freitag, PMEL, USA |
| **Participants** | TAO/TRITON: NOAA National Data Buoy Center (NDBC),NOAA Pacific Marine Environmental Laboratory (PMEL), Japan Agency for Marine-Earth Science and Technology (*JAMSTEC)*<br><br>PIRATA: NOAA PMEL, NOAA Atlantic Marine Oceanographic Laboratory (AOML), L'Institut de recherche pour le développement (IRD), Meteo-France, Instituto Nacional de Pesquisas Espaciais (INPE), Diretoria de Hidrografia e Navegacao (DHN**)**<br><br>RAMA: NOAA PMEL, JAMSTEC, Indian National Center for Ocean Information Services (INCOIS), National Institute of Oceanography (NIO), Agency for the Assessment and Application of Technology |

| | |
|---|---|
| | (BPPT), Ministry of Marine Affairs and Fisheries (KKP), First Institute of Oceanography (FIO), Agulhas and Somali Current Large Marine Ecosystems (ASCLME), University of Tasmania and the Commonwealth Scientific and Industrial Research Organization (CSIRO) in Australia. |
| **Data centre(s)** | PMEL, NDBC,JAMSTEC, NIO |
| **Website** | **http://www.pmel.noaa.gov/tao/global/global.html** |
| **Meetings**<br>*(meetings held in 2012/2013; and planned in 2013/2014)* | • PIRATA-17/TACE/TAV 10-14 September 2012, Kiel, Germany<br>• CLIVAR/GOOS Indian Ocean Panel 9th Session 15-20 October, 2012, Capetown, South Africa<br>• TIP Workshop, 23-24 October, 2012, Jakarta, Indonesia<br>• CLIVAR/GOOS Indian Ocean Panel 10th Session 8-12 July, 2013, Li Jang, China<br>• PIRATA-18/TAV 22-25 October 2013, Venice, Italy<br>• Tropical Pacific Observing System Review, January 2014, location TBN |
| **Current status summary** *(July 2013)* | TAO/TRITON: 45 of 67 surface moorings reporting.<br>PIRATA: 18 of 18 surface moorings reporting.<br>RAMA: 18 of 26 surface moorings reporting. |
| **Summary of plans for 2014** | TAO/TRITON: Maintain 72 mooring array.<br>PIRATA: Maintain 18 mooring array<br>RAMA: Maintain 32 sites and add 2 more sites. |

## 2 DEPLOYMENT PLANS FOR MID-2013 TO MID-2014

TAO/TRITON: NDBC 6 cruises, JAMSTEC 1 cruise
PIRATA: AOML/PMEL 1 cruise, IRD 1 cruise, INPE 1 cruise
RAMA: PMEL/INCOIS 4 cruises, JAMSTEC 1 cruise, NIO 1 cruise, PMEL/BPPT 2 cruises, FIO/BPPT 1 cruise, PMEL/ASCLME 1 cruise

## 3 DATA MANAGEMENT

### 3.1 Distribution of the data

Most surface data are telemetered in real time via the Argos system and are placed on the GTS by the French Space Agency (CLS). These real time data plus delayed-mode data (data of higher temporal resolution than are available in real time and data from subsurface moorings) are available via web based distribution from PMEL (www.pmel.noaa.gov/tao/disdel/disdel.html), NDBC (tao.noaa.gov), JAMSTEC (www.jamstec.go.jp/jamstec/TRITON/real_time/php/top.php, http://www.jamstec.go.jp/iorgc/iomics/datadisplay/buoysummary.php?LANG=0 ), and NIO (www.nio.org/index/option/com_nomenu/task/show/tid/2/sid/18/id/5). One surface mooring (FIO) telemeters data via Iridium which are available via the web only. During the period July 2012 through June 2013 the PMEL web pages had more than 14M hits and delivered more than 371K data files in response to more than 61K user requests. In addition to web page deliveries, more than 1.4M files were delivered via FTP.

#### 3.1.1 Data policy

Data are freely available on the web and distributed via the GTS in real-time.

#### 3.1.2 Real-time data exchange

Most surface moorings are Autonomous Temperature Line Acquisition System (ATLAS) moorings which place daily mean meteorological and oceanographic observations and some (about 10 per day on average) hourly meteorological observations on the GTS using Argos2 PTTs. ATLAS Refresh systems, designed to make observations comparable to legacy ATLAS systems using newer, more commercially available sensors, transmit 10-min data via Iridium, with hourly observations placed on the GTS. TRITON and m-TRITON buoys submit hourly mean meteorological and oceanographic data to the GTS: TRITON via Argos2 PTTs and m-TRITON via Argos3 PMTs. Compared to the volume of ATLAS data received at PMEL, more than 90% is typically reported on the GTS by CLS. Most operational centers receive nearly all ATLAS data placed on the GTS, with the exception of the ECMWF which typically reports volumes of about 75%, presumably due to stricter latency criteria.

Daily average data return for the period 1 July 2012 through 30 June 2013 was 53% for TAO, 90% for TRITON, 78% for PIRATA and 65% for RAMA. Abnormally low TAO data return was in large part due to cancellation and delays in cruises. The average TAO mooring age (time period since deployment) was 15 months as of July 2013. Forty-five (45) of 55 TAO moorings have been deployed for more than the design lifetime of 12 months, with some having been deployed for as long as 29 months. Primary reasons for data loss in RAMA were a high incidence of vandalism coupled with longer mooring deployment periods at some moorings. Intense fishing activity has lead to high vandalism rates in some regions. The survival rate for ATLAS moorings in RAMA since initial deployments in 2004 is 82%, compared to 90% for TAO (1980 to 2010) and 93% for PIRATA (1997-2013). . Four RAMA moorings were not serviced due to either insufficient sea days or bad weather during a cruise. Another RAMA mooring was not serviced because the ship operator would not enter the piracy high-risk zone defined by Lloyds of London.

3.1.3 Delayed mode data exchange

Delayed mode data (*i.e.,* data retrieved after mooring recovery) are archived at the web sites listed in 3.1 above. System metadata are available at the web sites listed in 3.2 and 4 below.

The TAO web site (http://www.pmel.noaa.gov/tao/), PIRATA web site (http://www.pmel.noaa.gov/pirata/), and RAMA web site (http://www.pmel.noaa.gov/tao/rama/) provide various information including scientific background, technical information, access to RAMA data and displays, present status of the array, a bibliography of refereed publications, history of cruises, and additional information.

3.2 Data quality

Data quality control procedures are described at www.pmel.noaa.gov/tao/proj_over/qc.html for ATLAS moorings and at www.jamstec.go.jp/jamstec/TRITON/real_time/overview.php/po.php for TRITON moorings.

**4) INSTRUMENT PRACTICES**

Sensor specifications and calibration procedures are described at www.pmel.noaa.gov/tao/proj_over/sensors.shtml for ATLAS moorings, at www.jamstec.go.jp/jamstec/TRITON/real_time/overview.php/po-t3.php for TRITON moorings, and at http://www.jamstec.go.jp/iorgc/iomics/projectoverview/1_b3_eng.html for m-TRITON moorings. RAMA mooring specifications from PMEL, JAMSTEC and NIOT are also listed in the Supplement to RAMA: The Research Moored Array for African—Asian—Australian Monsoon Analysis and Prediction (McPhaden, et al., 2009)

After testing and comparison of real-time (daily averaged) and delayed mode (10-minute) data alongside ATLAS moorings for several years, NDBC's ATLAS Refresh moorings have replaced ATLAS Legacy moorings at 28 of 55 TAO sites. The remaining ATLAS sites will be replaced with Refresh systems in the coming year. Refresh systems telemeter 10-min resolution data via Iridium each hour, and data are placed on the GTS. A report on multi-year testing of ATLAS Refresh systems is nearing completion.

China's First Institute of Oceanography (FIO) implemented the 8°S 100°E RAMA site in February 2010 and has maintained the site on an annual basis since then. The FIO mooring, named Bai-

Long was designed to make air and ocean measurements comparable to ATLAS moorings. PMEL and FIO have incorporated data from the Bai-Long mooring into PMEL's Tropical Moored Buoy web pages which display and distribute RAMA data from ATLAS and TRITON moorings.

PMEL's T-Flex mooring system, intended to replace the legacy ATLAS moorings in tropical research arrays, which is essentially equivalent to ATLAS, while using more commercially available components and providing higher temporal resolution data in real time. Six prototype systems have been deployed for comparison with ATLAS systems. Replacement of some ATLAS systems in PIRATA and/or RAMA with T-Flex systems will begin in 2014.

The new T-Flex and Bai-Long mooring systems telemeter data via Iridium. Methods to submit data from these systems onto the GTS are being developed.

## 5) OTHER ISSUES

### 5.1 RAMA Implementation

As of July 2013 the number of RAMA sites implemented stands at 32 (70% complete). Two new sites were implemented between August 2012 and July 2013. Two additional sites are planned for the coming year, subject to availability of ship time.

Between July 2012 and June 2013, 159 sea days were provided by India, Japan, Indonesia, South Africa, Australia and China in support of RAMA. During this period 29 RAMA moorings were serviced. As of July 30, 2013, 18 of 26 surface moorings were reporting data. Eight surface moorings had not been serviced for more than one year. Two moorings had gone adrift and had not yet been replaced.

### 5.2 PIRATA Extensions

A Southeast PIRATA Extension site which had not been occupied in several years was reestablished in 2013 and will be maintained annually.

### 5.3 Array enhancements

Meteo-France provides barometers maintain surface pressure measurements at 4 RAMA sites and 1 PIRATA site.

$CO_2$ measurements are made on several TAO moorings by PMEL (http://www.pmel.noaa.gov/co2/moorings/) and on several PIRATA buoys by LOCEAN (http://www.lodyc.jussieu.fr/CO2tropiques/). $O_2$ measurements are made by the Leibniz Institute of Marine Sciences at the University of Kiel (IFM-GEOMAR). The University of Tasmania has provided fluorometers for deployments at two RAMA sites. . Bai-Long moorings have included $CO_2$ measurements since 2012. A $CO_2$ system supported by the Bay of Bengal Large Marine Ecosystem Project (BOBLME) will be deployed on a RAMA mooring in November 2013.

Oregon State University deployed dissipation measuring instruments (known as ChiPods) distributed on 3 RAMA moorings in 2011. Additional ChiPod deployments are being planned or proposed on a number of RAMA or PIRATA moorings.

### 5.4 International cooperation and capacity building

A number of formal bilateral agreements exist among agencies of the United States, India, Indonesia, Australia and ASCMLE to help complete and sustain RAMA. Several of these are due to be renewed in the coming year.

To facilitate and coordinate resources that may be applied to the Indian Ocean Observing System, an IndOOS Resource Forum (IRF) was established in 2009. The Forum held its fourth meeting in July 2013 in Li Jang, China, in coordination with the 10th CLIVAR/GOOS Indian Ocean Panel session.

The Korea Institute of Ocean Science & Technology (KIOST) plans to deploy subsurface ADCP near TAO moorings along 165ºE. First deployments are planned for the summer or 2013. This work is being conducted under the context of a Joint Project Agreement between NOAA and the Ministry of Land, Transport and Maritime Affairs, Republic of Korea. The third NOAA-KIOST Ocean Climate Seminar was held in Seattle in May 2013.

JAMSTEC's Dr. Iwao Ueki visited PMEL from April, 2012, to March, 2013, strengthening the long-term ties between the 2 agencies. Mr Huiwu Wang from FIO visited PMEL for 3 months in fall 2012 to collaborate on mooring technology and data processing procedures. NOAA hosted a capacity building workshop in Indonesia (October 22-24, 2012) and also site visits in the US by Indonesian scientists to the National Coastal Data Development Center (NCDDC) and NDBC (September 17-25, 2012.) Engineers from NIOT will visit PMEL and NDBC in August 2013.

5.5 TAO Transition

All TAO sites will have been deployed with NDBC's ATLAS Refresh mooring systems by the end of 2014, marking the completion of the transition of TAO operations and maintenance from PMEL to NDBC.

5.6 Research experiments

The US is conducting a multi-year (2008-2014) process study within RAMA with the addition of 9 subsurface ADCP moorings in the region spanning 2.5°N to 4°S and 78°E to 83°E.

The Monsoon Onset Monitoring and its Social and Ecosystem Impacts (MOMSEI) is a Southeast Asia GOOS (SEAGOOS) pilot project under IOC-WESTPAC. MOMSEI aims at observing boreal summer monsoon onset and understanding the role of ocean in this process. Observations include field surveys over the eastern equatorial Indian Ocean and the Bay of Bengal.

5.7 Vandalism

Damage to buoys and theft of instrumentation continues to be a concern, especially at sites near areas of intense fishing activity such as the far eastern and western equatorial Pacific, the Gulf of Guinea and equatorial Indian Ocean. In response, some TRITON sites which have been vandalized heavily are now deployed without meteorological sensors.

5.8 Piracy

In addition to vandalism, well-publicized piracy events have resulted in the suspension of RAMA implementation off Africa and in the Arabian Sea. Lloyds of London defines an Exclusion Zone (EZ) north of 12°S and west of 78°E in which additional premiums apply to insure commercial vessels. INCOIS contracted Sea Marshalls to be stationed aboard MoES RAMA cruises with the EZ. South Africa would not permit the RV Algoa to enter the EZ in 2013. Although pirate attacks have diminished in the past 1-2 years, both in number and distance from Somalia, Lloyds has not reduced the area of the EZ. Pirate attacks in the Gulf of Guinea have increased in number and are of concern for future PIRATA cruises in that region.

| | 2010 | 2011 | 2012 | 2013 (through July) |
|---|---|---|---|---|
| Vessels Hijacked | 51 | 27 | 7 | 0 |
| Vessels Boarded | 16 | 17 | 1 | 0 |
| Vessels Fired Upon/ | 119 | 122 | 24 | 4 |

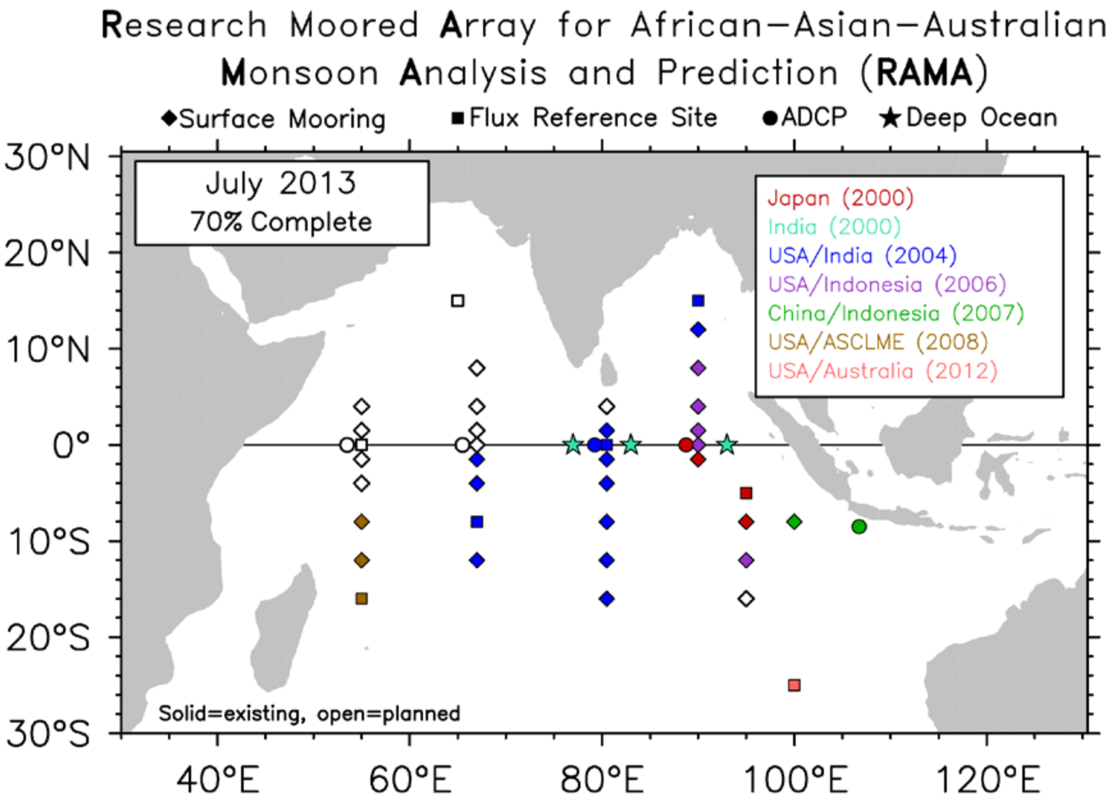
| | | | | |
|---|---|---|---|---|
| Attempted Boarding | | | | |

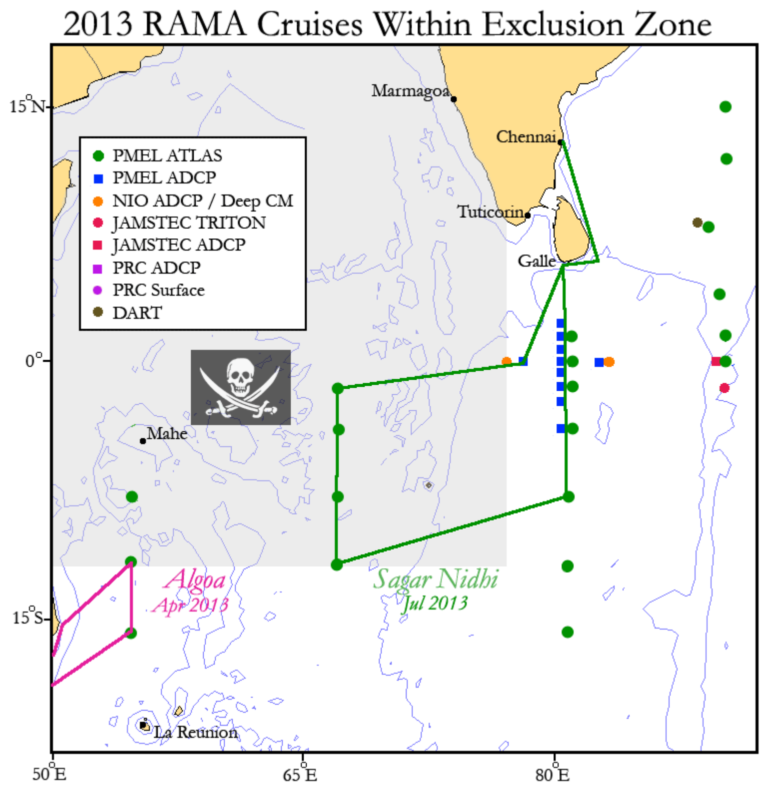
*Source: U.S. Office of Naval Intelligence*

---

**Annex**

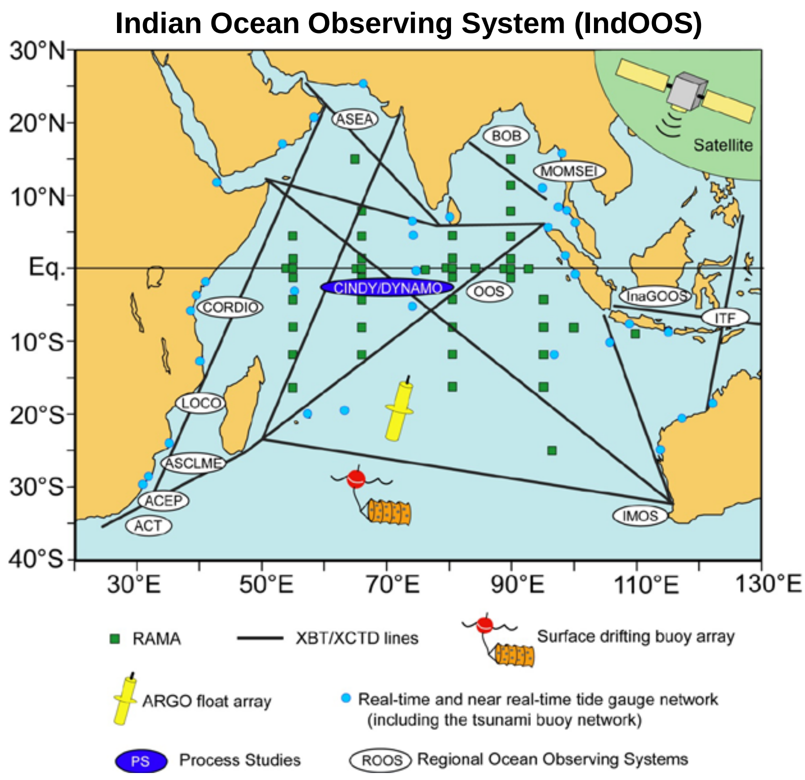
**RAMA Implementation Status**






2013 RAMA cruises within or near the Lloyds of London Piracy Exclusion Zone (shaded area). Sea Marshals were aboard the RV Sagar Nidhi in July 2013 (green line). The agency operating RV Algoa did not permit entry into the Exclusion Zone in April 2013 (magenta line). As a result the RAMA mooring at 8°S, 55°E was not replaced.

---




---

## ANNEX VII

## REPORT BY THE GLOBAL SEA LEVEL OBSERVING SYSTEM (GLOSS)

*(Report provided by Gary Mitchum)*

The last GLOSS GE-XII was held from 9-11 November 2011 in Paris and the next expert meeting (GLOSS-GE XIII) will be held in Liverpool (UK) from 30 October – 1 November 2013 back to back with the 80 year anniversary workshop for the Permanent Service for Mean Sea Level (PSMSL). Since its start in 1985 GLOSS has expanded beyond the original aim of providing tide gauge data for understanding the recent history of global sea level rise and for studies of interannual to multi-decadal variability. Tide gauges are now playing a greater role in regional tsunami warning systems and for operational storm surge monitoring. The GLOSS tide gauge network is also important for the ongoing calibration and validation of satellite altimeter time series, and as such is an essential observing component for assessing global sea level change.

Significant milestones for the programme are as follows:

- A Waves & Water Level workshop was held in Paris as part the GLOSS GE-XII (7-11 November 2011) to try and build stronger ties between GLOSS and surge and wave community.
- Data recovery was discussed at the Fourth of the JCOMM Observations Coordination Group in Hobart, Australia in April 2011. In 2001 GLOSS carried out an inventory study of sea level data in need of rescue. This exercise was repeated in 2011/2012 and the findings were reported in Caldwell et al. (2012) http://www.unesco.org/new/en/communication-and-information/events/calendar-of-events/events-websites/the-memory-of-the-world-in-the-digital-age-digitization-and-preservation/presentations-day-1/ . The new study did provide for some substantial new findings including several stations uncovered by David Jay and Stefan Talke in the US National Archives.
- The status of the GLOSS Core networks will be made more transparent to outside users, and this will serve as a *de facto* metric for the health of the program.
- The quality control manual for sea level data was completed for GLOSS GE XII meeting and will be published in 2013/2014.
- IOC/GLOSS hosted the WCRP workshop “Understanding Sea Level Rise and Variability” (6-9 June 2006. The proceeding/book from that workshop was published in June 2010 and has been widely cited. A follow on workshop WCRP/IOC Workshop on Regional Sea Level Change was convened from 7 - 9 February 2011 at IOC (Report available http://www.ioc-cd.org/index.php?option=com_oe&task=viewDocumentRecord&docID=7252).
- The IOC Manual on Sea Level Measurement and Interpretation has been translated to Arabic and was published in 2012 (http://unesdoc.unesco.org/images/0014/001477/147773a.pdf) .

An update of the GLOSS Implementation Plan has been completed (http://unesdoc.unesco.org/images/0021/002178/217832e.pdf) . The plan will provide a blueprint for the next 5 years. Some of the aims of the plan are:

- Expand the number of continuos GPS stations co-located with sea level stations in the GLOSS Core Network
- All sea level stations in the GLOSS Core Network to report data in near real time
- Monitoring in support of water level hazards (e.g., tsunamis, storm surge)
- Improved database capabilities

The number of sea level stations reporting to the GLOSS Data Centres has increased markedly over past last ten years, particularly for stations that report in near real-time. Just over 75% of the GLOSS Core Network (GCN) of 293 stations can be considered operational, and there are focused efforts to address the remaining 25% of stations not currently on-line. Since that GLOSS has adopted a common metadata standard (GLOSS Data Centers meeting, Honolulu 2010), and is in the process of implementing across all data centers. The next steps are to adopt common services for distributing the data.

Our present goal is to improve data integration for the benefit of end users. Towards this end:

- Develop a single source for obtaining data from all GLOSS data suppliers.
- Developing a metadata rich format to help users to better understand the data.
- Using netCDF "aggregation" techniques to allow users to side-step handling many files.
- Making sure that data can be used by more communities, for more purposes.
- Insuring that data will be more readily found through popular search portals.

GLOSS contributes actively to the development of tsunami warning systems in the Pacific and Indian Oceans, and in the Mediterranean and the Caribbean. Following the 2004 Indian Ocean Tsunami, more than 50 GLOSS stations in the Indian Ocean were upgraded to real time data reporting. Several Indian Ocean countries further densified their national sea level networks (India, Indonesia, Kenya, Maldives and Mauritius). GLOSS is working to develop the sea level networks in the Caribbean and North Africa. Progress is slower here due to a lack of funding.

Some additional highlights of progress since the last report:

- GLOSS has participated and contributed to the report from the Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG): Inter-ICG Task Team 1 on Sea Level Monitoring for Tsunami (http://unesdoc.unesco.org/images/0019/001939/193911e.pdf )
- IOC/GLOSS has organized sea level network maintenance in the Indian Ocean Tsunami Warning System through contract with University of Hawaii Sea Level Center (2005-2014) .
- GLOSS has also participated in several tsunami related proposals that have had a sea level component (i.e., Caribbean and Oman). Six new stations will be installed in Haiti, Guatemala, Nicaragua, St Kitts & Nevis, Cayman Island, St Vincent. Seven new sea level stations were installed in Oman as part of the Oman-UNESCO project to develop a National Multi-hazard Early Warning System.
- Since 2008 the number of co-located stations with GLOSS Core Network stations have increased from about 135 to 192 enabling estimation of vertical land movement rates supporting satellite altimeter calibration and science and research efforts aimed to determine absolute global sea level rise rates.
- India now provides real time sea level data from a number of GLOSS Core Network stations in support of tsunami monitoring.
- The IOC Sea Level Station Monitoring Facility web service has been widely used by the tsunami community. For example, during the 11 March 2011 Japan tsunami the web site received 2,901,945 web hits (about 65 times more than a normal day). High hit rates were also encountered during the 2010 Chile tsunami.

GLOSS has sought to define land motion at tide gauges through collaborations with IGS (originally the International GPS Service for Geodynamics, now the International GNSS Service) and the TIGA project (Tide Gauge Benchmark Monitoring Project ). GPS and DORIS (Doppler Orbitography Integrated by Satellite) measurements at tide gauges are expected to increase in the coming years through specific initiatives and by the continued overall growth of the ITRF (International Terrestrial Reference Frame). TIGA provides an important linkage of the tide gauge and geodetic communities in this effort. Results from a status survey on co-located tide gauges and continuous GPS stations are available at http://www.sonel.org/-CGPS-TG-Survey-.html. In connection with the eleventh session of the GLOSS Group of Experts (GLOSS-GE-XI, May 2009), a Workshop on Precision Observations of Vertical Land Motion at Tide Gauges was convened. The aim of the workshop was to develop a coordinated plan for a new initiative to install and upgrade continuous GPS stations co-located with critical sea level stations in the GLOSS Core Network and Long-term Time series (LTT) networks. Detailed information is available at http://ioc-goos.org/glossgexi. See also http://www.ggos-portal.org/lang_en/GGOS-

Portal/EN/Themes/SeaLevel/seaLevel.html for further information about sea level observation and linkage to the Global Geodetic Observing System.

The GLOSS programme has benefited by the collaboration of the UNESCO/IOC and the Flanders Marine Institute (VLIZ, Kingdom of Belgium) to develop the earlier mentioned web-based global sea level station monitoring service (see http://www.ioc-sealevelmonitoring.org). The web portal provides a view of the GLOSS and other sea level datasets received in real time from different network operators and different communication channels. The service provides information about the operational status of real time sea level stations as well as a display service for quick inspection of the raw data stream. The number of real time sea level stations that the IOC Sea Level Station Monitoring Facility tracks has grown from about 320 stations (1 Jan 2010) to 717 stations (1 September 2013) and with 120 national agencies or institutions provide data to this web-site.

The GLOSS programme continues to support training and technical advisory activities carried out with national tide gauge agencies and partner programmes including the regional tsunami warning systems.

The most recent course was the CARIBE-EWS/GLOSS sea level training course from 4-9 June 2012 (Merida, Mexico). Two courses are in planning for the Caribbean (to be held in Puerto Rico) and for the Indian Ocean and SW Pacific (to be held in Thailand).

## ANNEX VIII

## REPORT BY THE SHIP OBSERVATIONS TEAM (SOT)

### 1. NETWORK STATUS

#### Voluntary Observing Ship (VOS) scheme

The VOS presently comprises 3359 ships drawn from 25 VOS Operating nations. The VOS fleet size is therefore less than half the size it was a decade ago.

Despite the falling number of ships in the VOS the number of observations continues to rise with approximately 1.9 million observations in 2012. This rise is primarily due to the increased move to automation and hourly observations. 286k additional observations are from unidentified ships, and ~80% of these are from ships reporting under the anonymous call sign SHIP and cannot therefore be monitored by the RSMC for data quality.

The JCOMM implementation goal to improve the number and quality of climate standard observations is being achieved, albeit at a slow pace. The number of VOS Climate class ships currently stands at approximately 450 ships representing just over 12% of the global fleet in terms of ship numbers. The existing JCOMM implementation goal of 250 VOSClim ships was met several years ago and needs to be updated with a smarter metric

The challenge is to maintain an active manually reporting VOS fleet at a time when major VOS operating countries are planning to significantly automate their VOS, often at the expense of the additional visually observed climate parameters. Recruiting ships into the new VOS Ancillary Pilot Project class may help avoid this decline in the longer term but risks a decrease in data quality.

#### Ship of Opportunity Programme (SOOP)

The JCOMM Ship Of Opportunity Programme (SOOP) produces oceanographic sampling from (mostly) merchant ships, using mainly eXpendable BathyThermographs (XBT), but also of eXpendable Conductivity Temperature Depth (XCTD), Acoustic Doppler Current Profilers (ADCP), ThermoSalinoGraphs (TSG), and Continuous Plankton Recorders (CPR). Presently, only the XBT network is based on recommendations from international and regional panels, presented at OceanObs09, and involves repeat sampling at regular intervals along pre-determined routes, denominated lines or transects. The global eXpendable BathyThermograph (XBT) network addresses both scientific and operational goals that contribute to the building of a sustained ocean observing system. The main mission is the collection of upper ocean temperature profiles mostly from volunteer vessels. The XBT deployments are designated by their spatial and temporal sampling goals or modes of deployment (Low Density, Frequently Repeated, and High Density or High Resolution) and sample along repeated, scientifically important transects, on either large or small spatial scales, or at special locations such as boundary currents and chokepoints. These observations are complemented by or complementary to other observational programs, such as Argo, the surface drifter array, pCO2 system network, satellite altimetry, etc. Multi-national reviews of the XBT network were carried out at the 1999 and 2009 OceanObs Conferences. Given the advances in the Argo program, the global XBT network is now focused on high resolution monitoring of fronts, eddies, boundary currents and heat transport and not exclusively on the broad-scale upper ocean thermal field.

The accomplishment and maintenance of the recommended transects are highly dependent on ship traffic, recruitments, budget, and scientific and operational needs However, similar to the VOS, the SOOP is currently encountering problems in achieving its objectives primarily because of continuous unforeseen ship movements resulting in route changes or the suspension of trade on some routes. Some of the main changes that occurred during the last two years are linked to the more emphasis given to the implementation of XBT transects in High Density mode, which data are largely used by the scientific community.

Approximately 20,000 XBTs are being deployed every year, of which roughly 15,000 correspond to the XBT network and are mostly transmitted in real-time and ingested into operational data bases. There are approximately 40 ships participating in the maintenance of the XBT network and 30 ships transmitting TSG data. Specific TSG transects were not recommended by the scientist tasked with reviewing the underway ocean observations. Data reporting and monitoring becomes crucial to assess performance.

**Automated Shipboard Aerological Programme (ASAP)**

After the reduction of the Japanese ASAP fleet from 5 to 2 research ships in 2010, there is only one significant ASAP fleet left: The European (EUMETNET) E-ASAP fleet with 18 ships plus one 'laid up' station in NE Iceland (operated as land station since 2010). E-ASAP is mainly based on a fleet of 15 commercial vessels in regular service between Europe and North America (plus two research ships and one hospital ship).
The Japanese Met Service JMA operates an ASAP station on the research vessel RYOFU MARU in the western north Pacific and seas adjacent to Japan. JAMSTEC (JAPAN AGENCY FOR MARINE-EARTH SCIENCE AND TECHNOLOGY) operates a station on the oceanographic research vessel MIRAI. In total, 272 soundings were received from the Japanese ASAP ships in 2012.
The German research vessel POLARSTERN operates in polar regions in the summer periods (Apr-Sep in the Arctic, Oct-Mar in the Antarctic) and provided 362 soundings in 2012. Other research vessels contribute occasionally to the global distribution of upper air soundings on the GTS.
In total, around 5120 soundings were received in 2012 from all ASAP stations worldwide. The distribution is as follows:

- 86% E-ASAP,
- 7% RV POLARSTERN,
- 7% RV MIRAI, RV RYOFU MARU, and RV ROGER REVELLE.

The spatial distribution is shown in figure 1.

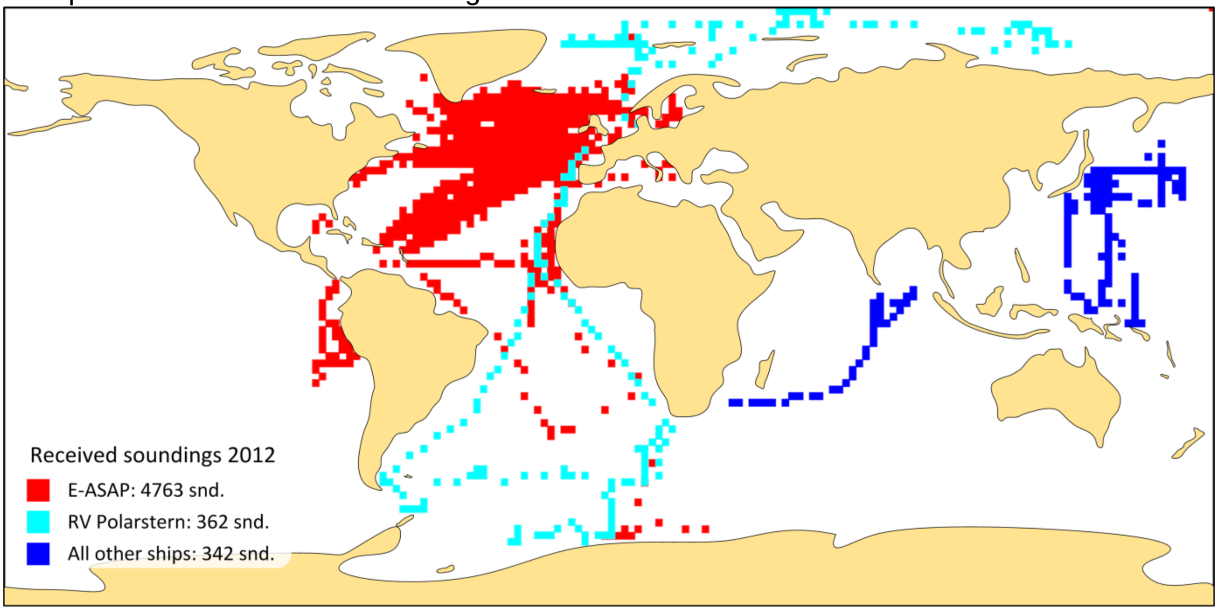



Figure 6. Distribution of global ASAP soundings from sailing ships in 2012.

There are no global requirements for ASAP soundings and no specific sensors or radiosondes. The quality targets for the E-ASAP stations are set by EUMETNET:

- 95% of all soundings are to be received by HH+100.
- 90% of all soundings are to achieve 100 hPa height.
- 75% of all soundings are to achieve 50 hPa height.

Most of the E-ASAP stations report TEMP and high resolution (10 sec level) BUFR data.

## 2. METRICS - DEFINITION AND IMPLEMENTATION PROGRESS

### VOS

Three KPI s were introduced at SOT-6

- The KPI for 25% of the global active VOS to be upgraded to VOSClim Class by SOT-7 was just met (global active VOS being defined as the number or Pub47 VOS reporting at least once/moth). Each month approximately 1500 ships submit at least one obs.
- The KPI for less than 3% of VOSClim ships being flagged as suspect for air pressure is being met
- The KPI for 95% of VOSClim observations being received within 120 minutes is also being met
- These KPIs will continue to be measured. Decisions taken at SOT-7 to tighten the VOSClim monitoring criteria are likely to impact on compliance with the quality KPI which is already close.

A new KPI was introduced at SOT-8 for at least 25% of the active VOS fleet (registered on the E-SURFMAR database) to be VOSClim class by SOT-8.

It is unrealistic to expect all VOS to be upgraded to VOSClim e.g. as simple ship borne AWS systems don't report the additional VOSClim parameters, and as Auxiliary class ships use their own instruments. However the 60% of the fleet that fall into the 'Selected' VOS class could be upgraded when suitable and need to be increasingly targeted by PMOs.

A key issue is the fact that scientific advisers state that VOSClim data is not being fully utilised because the volume of available data is too small to form a useable climate quality dataset. In an effort to help increase this volume, Ships are therefore being encouraged to self-recruit to increase the volume (but won't be considered as formal recruits until all required VOSClim criteria are met).

Smarter metrics are needed to assess overall VOS quality, and to compare the quality of automated and manual VOS data. RMS values for parameters for such as pressure need to be maintained on a monthly/annual basis to assess ongoing quality trends in the global and national VOS fleets and to identify problem areas.

New metrics are also needed to measure PMO inspection activity and data transmissions. Data collected in the annual SOT national reports, if properly collated and displayed, with help provide a clearer snapshot of VOS network activity and help with making decisions on the future evolution of the global VOS and need for PMO resources [ The new SOT coordinator should be able help with this]
Recent improvements to JCOMMOPS status maps will help with targeting future VOS recruits to fill data sparse areas. There is a particular need to fill data voids, such as those in the Southern Oceans and Antarctica, which are traditionally served only by a few research ships. Efforts need to be made to recruit more ships operating in these areas and to equip them with AWS systems

### SOOP

Most of the XBT observations transmitted in real-time undergo an automatic quality control process and are transmitted into the GTS. Quality controlled delayed-mode XBT data supplied by XBT Operators are distributed by NOAA/NODC and by Coriolis.

Metadata from XBT observations are critical, particularly for current studies of XBT fall rate equation. Metadata for TSG observations is also critical, particularly the calibration coefficients for delayed-mode data quality control.

NOAA/NODC and Coriolis are the repository of all XBT observations and they coordinate the delayed-time data management. Support for a high quality delayed time data processing done by the GTSPP program is needed to take full advantage of this large upper ocean temperature data set.

**ASAP**

The process chain from the observations at the radiosonde to receiving on the GTS is based on three main steps:

- Transmission of the data from the radiosonde to the receiver on board the ship.
- Transmission of the coded reports to the receiving data centre.
- Transmission of the reports to the GTS.

The measurements are transmitted from the radiosonde in flight to the receiver on board the ship via telemetry link. Pressure, temperature, and humidity and measured at the sensor and wind speed/direction is calculated from the GPS position at the measurement height. First reports are generated when the balloon achieves 100 hPa height (usually after around one hour after launch). The reports (TEMP A and TEMP B) are transmitted to shore via satellite. Next reports (TEMP C and TEMP D) are generated and transmitted to shore when the maximum height is reached. This procedures ensures that sounding data up to 100 hPa are transmitted to the Met Service when the sounding is still ongoing. The details of satellite communication between ship and Met Service and the transmission from the Met Services to the GTS depend on the ASAP operating country.
Considering the E-ASAP fleet with 85% of all active ASAP stations as standard, the route of the data from the sonde sensor to the GTS is as follows:

- radio transmission of data from the radiosonde to the receiving station on board the ship at 2 sec levels,
- generating TEMP and High Resolution BUFR reports at the sounding computer on board the ship at 100 hPa level and maximum height,
- automatic email transmission of TEMP and high resolution BUFR reports to the operating Met Service via Iridium (as soon as the reports are generated),
- transmission of the reports from the receiving Met Service to the next GTS link (as soon as the reports are received). Most soundings are received on the GTS within HH+90.
  The two Japanese ASAP ships transmit the sounding data to shore via Inmarsat-C and DCP. Transmission to the GTS shows a delay of around 150 min after the main synoptic hours (HH+150).

## 3. STANDARDS AND BEST PRACTICES

**VOS**

VOS Instrument types and standards are well documented, and considerable efforts have been made by major VOS operators in recent years to update their WMO Pub47 metadata records (which are now recorded in the E-SURFMAR Metadata database). However, on-going efforts are needed to ensure that metadata records are maintained up to date and that ships are made inactive when they no longer participate [The SOT coordinator can help with this]

The VOS framework document WMO/TD 1009 was updated in 2012, and WMO Pub 471 was updated in 2009 to reflect new VOS Classes. Both remain valid. The CIMO Guide (WMO Pub no 8) is being updated by the TT on instrument standards and remains valid.

It is recommended that the JCOMM Catalogue of Practices and Standards should serve as the primary resource to determine which guides and manuals are current and need to be kept under review by JCOMM.

The VOS Website acts as a comprehensive resource for all information needed by VOS operators and PMOs to maintain efficient VOS and VOSClim fleets. Minor updates were proposed after SOT-7.

VOS data is routinely monitored by the Met Office who act as the RSMC (for VOS) and RTMC (for VOSCLIM). Monthly reports and suspect lists are circulated and published on the web. New tighter monitoring criteria have been agreed for VOS, VOSClim and AWS ships and it is planned to introduce these in January 2014. Comprehensive data monitoring tools are also provided by E-SURFMAR/Meteo France which allow QC reports to be auto-generated to enable PMOs to provide comprehensive quality feedback to ships officers

Ship design recommendations have been drafted by SOT and have been raised with the ICS and WOC

A redraft of the VOS brochure has been finalised and it is planned to develop a VOS promotional poster

To help encourage best practices and to promote the VOS it is intended to develop a VOS questionnaire directed at VOS observers and ship owners. The aim will be to assess the performance of the VOS Scheme and to identify issue that need to be addressed to improve VOS operations.

**SOOP**

Data transmitted in real-time go through different quality control procedures depending on their transmission method. One working group within CLIVAR/GSOP (Global Synthesis and Observations Panel) is endeavouring to standardise procedures.

Real-time monitoring of TSG data are routinely performed using the quality control guidance provided by the Global Ocean Surface Underway Data (GOSUD). The identification of anomalous TSG-derived salinity data may help identify problems such as bio fouling.

**ASAP**

An ASAP station is made up of three major components:

- Sounding equipment: radiosonde, receiver, sounding computer, software.
- Launcher: device to fill and launch the balloon with the attached radiosonde.
- Transmitting equipment: transceiver, antenna and software to transmit the sounding data to the Met Service via satellite transmission.

Launchers are either semi-automated (e.g. container with pneumatic launcher) or fully manual. Generally, soundings are to be performed at the main synoptic hours 00, 06, 12, and/or 18 UTC. Most ships provide soundings at 00 and 12 UTC. Launch time of the balloon is around 85 to 60 min before the main synoptic hour.
Sounding operations are usually conducted by crew members with limited experience and knowledge of upper air sounding systems. Taking into account the total number of launches on board versus the received soundings on the GTS, the average output (GTS/Launches ratio) on board merchant vessels is 80-90%. Main reasons for failed launches are

- Technical problems of the equipment due to the permanent vibrations on board,
- Unfavourable wind conditions at 15-20 knots sailing speed,
- Inexperienced operators, and
- Poor satellite communication.

## 4. EVOLUTION OF NETWORK/NEW TECHNOLOGIES/SENSORS

**VOS**

According to SOT reports approximately 336 ship borne AWS are in use by ~20 nations. This number is set to increase significantly in the next few years and will potentially have a marked impact on the traditional VOS and will challenge its ‘Voluntary’ nature. Several of the major VOS operators (e.g. Germany, Netherlands etc) already have plans to automate their ships and to significantly reduce the size of their traditional manned VOS fleets.

Although at least a half of the AWS systems currently in use have a facility to manually add visual observations to the AWS sensor data, this is rarely being done. However, linking the AWS to recognised electronic logbook displays will help encourage observers to add the visual observations. This is already being planned for the new European Common AWS (EUCAWS) which is being developed by E-SURFMAR and will be prototype tested next year. EUCAWS systems will link to new TurboWin + e-logbook software (which is currently being beta tested).

The use of e-logbooks on VOS has peaked in the last couple of years and is used by the vast majority of the fleet. It is considered that the use of hardcopy logs should be ceased as they require manual digitization of the data and do not have the level of quality control afforded by e-logbooks.

The new TurboWin+ software is web enabled allowing data to be sent directly to a NMS server and avoiding the need for PMOs to upgrade software on board. Unfortunately a limited number of ships currently have web access on board and not all shipowners will be willing to allow their officers to use the internet on the bridge. However the software can also be used as a stand-alone version on the ships computer. It includes an AMVER module and can also be linked to Vaisala barometers to allow a pressure trace to be displayed (thereby avoiding the need for VOS operators to supply ships with barographs in future).

New AMVERSEAS Version 9 used primarily by US VOS is also now almost ready for operational use. As with TurboWin it is VOSClim compliant and collects the delayed mode observations in IMMT format ready for submission to the Global Collection Centres (GCC) .

Data transmission is another area where changes are taking place. The majority of ship AWS systems are now moving to cheaper Iridium SBD satellite communications that also provide global coverage. Meanwhile manual VOS are gradually migrating away from traditional Inmarsat SAC 41 and are increasingly using their own ship email to send observations (thereby reducing NMS costs). Other systems such as half compression are also being promoted by some European VOS operators as a means of reducing costs.

**SOOP**

Improved and new technologies are continually explored and tested in the SOOP operations, such as autolaunchers (AL) for different types of XBTs, (AL) built to support a larger number (above 20) of XBTs, Bluetooth technology for transmission of data from the AL to the on-board computer, and AL powered with a solar-powered battery.

Two tests of a prototype Climate Quality XBT probe that can obtain temperature profiles with accuracy similar to Argo profiling floats have been carried out. The effort to develop this prototype is being lead by Sippican in collaboration with NOAA/AOML and is expected to last at least two more years.

**ASAP**

The ASAP stations use technologies which are well implemented and established at land based radiosonde stations, except transmission of the data via satellite links. There are no special sensors or sounding technologies.
Despite occasional transfers of ASAP stations from one ship to another, the E-ASAP fleet of 18 ships is stable for several years. Other ASAP operating countries reduced their activities.

## 5. LOGISTICS AND RESOURCE ISSUES

### VOS

The increasing reliance of new technologies on board VOS will also impact on the traditional PMO role which will increasing require technical, IT or engineering competencies. This then brings into question the ability or willingness of PMOs to service the traditional manual VOS and to train the observers on an ongoing basis. To increase PMO (and shipowner) awareness of AWS systems consideration will be given to convening an international ship borne AWS workshop.

Distribution of the PMO network is far from ideal. Major shipping ports like Singapore and Rotterdam are now served by only one or two PMOs, while other areas such as the Mediterranean have very limited PMO presence and other areas regularly visited by VOS, such as the Arabian Gulf, have no PMO coverage at all. Moreover many PMOs are part time employees and often have very little actual contact with the VOS.
Economic downturns have also put pressure on NMS and PMO resources and on ability to fund and maintain the instruments loaned to VOS. Such pressures bring into question the long standing efforts being made by JCOMM to increase participation in the VOS Scheme and PMO networks.

It is suggested therefore that increased involvement and linkage with major shipowners will be needed to ensure the VOS Scheme prospers in future years.

### SOOP

Limited funding and problems associated to ship traffic and routes makes it extremely difficult to achieve the desired sampling goals on some transects. For example, the FR transects in the North Pacific that were dropped during 2010 and have not been reinstated. Although very difficult to estimate it could be stated that this Program needs approximately 50% of additional funding (in addition to solving other logistics issues) in order to accomplish all the High Density transects recommended by the international community.

A large number of XBTs deployed by non-US agencies are the result of donations from the US (NOAA), thereby making the operation highly dependent on the continuing support of one single institution. However, this international collaboration has translated during the last years into enhanced and closer collaboration among some institutions. International collaboration is key to the success to the implementation of the XBT network, where the operations are related to ship recruiting, deployment of probes, data transmission, data quality control, and archiving.

Monthly maps of XBT observations are provided through: http://www.jcommops.org/sot/maps.

In addition, a new web page, hosted by NOAA/AOML, has been implemented by the newly formed XBT Science Team, to distribute information on XBTs:
http://www.aoml.noaa.gov/phod/goos/xbtscience/index.php
Web tools to monitor real-time data flow into the GTS from XBTs (http://www.aoml.noaa.gov/phod/GTS/XBT/) and TSG (http://www.aoml.noaa.gov/phod/GTS/TSG/) continue being used.

Other sites, such as http://goos142.amverseas.noaa.gov/db/xbtplotapp.html permit the monitoring of SEAS transmissions into the GTS.

These tools are routinely used to monitor and track the deployment of XBTs and of TSG observations. However, they are restricted to data only transmitted into the GTS.

### ASAP

Specific challenges for ASAP operations are the resupply logistics of consumables (radiosondes, balloons, helium) and routine technical maintenance of the stations on board (also at night or

weekend, if necessary). Resupplies have to be provided in due time during short berthing times of the ships.
Generally, the maintenance and repair effort for radiosonde stations on board seagoing ships is higher and more cost-intensive than for land stations. Shortage of helium on the world market is a problem since there are no options to store large amounts of helium in the ports.

## 6. CAPACITY BUILDING OPPORTUNITIES/REQUIREMENTS

### VOS

Drifter donation Programme has been available to developing countries for two years and clearly defined criteria have been established and documented. Unfortunately the VOS-DP Programme Evaluation Committee has received very limited response from interested developing countries.

The most promising development has been in the data sparse Polynesian Islands where a PMO ‘buddy’ has been assigned. Possibilities to develop VOS programmes in East and West Africa have also been proposed but again nothing has come to fruition.

Whilst the concept of donating an autonomous battery powered deck ‘drifter’ remains valid it may now be more appropriate to aim to provide developing countries with simple ‘plug and play’ autonomous ship AWS system (especially if solar powered).
PMO workshops have traditionally been used to promote PMO/VOS activities in developing countries. SOT has agreed that another International PMO workshop should be convened although it is understood that limited WMO funding will be available for participation.

The TT on VOS promotion will investigate the potential for using video for promoting the VOS. Perhaps videos (and video conferencing) may also have capacity building potential.

To be effective capacity building for the established VOS needs to be targeted at data sparse areas that are served by shipping. However the proposed introduction on a new Ancillary Class of VOS opens up the possibility of recruiting a wider variety of different ship types (including yachts, fishing vessels etc.) albeit with a lesser data quality. Initiatives such as the Met Office’s Weather Observations Website (WOW) may also have future potential to encourage amateur marine observers to submit weather reports in a more interactive manner, especially in coastal areas.

### SOOP

Several tools, including installation and operation manuals continue being updated as reference for crew members and ship riders to operate XBT equipment and for technicians to install and maintain TSG equipment. Through international collaboration, XBT probes and equipment donations, the goals of the XBT network continue to be met for the high density mode of deployment.

### ASAP

Competence and knowledge of ASAP operations is mainly concentrated in the participating countries of the E-ASAP fleet, specifically in Germany, France and Denmark. Central management of E-ASAP is situated at the Deutscher Wetterdienst in Germany on behalf of EUMETNET.
The Deutscher Wetterdienst operates 10 out of 18 shipboard stations and acts as focal point for any ASAP issues. All E-ASAP operations are fully financed by EUMETNET. Focus of E-ASAP is the North Atlantic (70°W-40°E, 10°N-90°N). A limited number of up to 10% of all soundings are to be performed in other areas as contribution to the World Weather Watch. Capacity building proposals depend on the interest of other countries to implement, contribute, and/or participate in shipboard radio soundings.

## 7. ISSUES AND CHALLENGES, IDEAS FOR INTEGRATION, WAY FORWARD

### VOS

In the short term migration to BUFR is the most pressing issue. BUFR template for VOS has been developed but awaits validation. NMS will be increasing under pressure cease to international exchange of data in traditional SHIP code in accordance with the migration timeframe and some will be aiming to turn off TAC feeds in November next year.

BUFR will also allow the ENCODE system of encryption to be introduced at last hopefully mitigating against the concerns of ship owners that the positions of their ships will be known to unscrupulous third parties. It has been confirmed that NMS will be regarded as a 'single' user in so far as ENCODE is concerned, but the stipulations that NMS will need to follow to ensure that the encryption keys are secure have yet to be defined. Operationally decisions will eventually need to be made about the level to which encryption should be used by the VOS in future and on the future use of the current use of MASK and SHIP call signs

In the longer term VOS activities should take into account developments currently under way at IMO, in particular those related to e-navigation. Weather observing is encouraged by the SOLAS convention but there are no specific requirements for meteorological equipment on ships to be carried or calibrated. Integration of ships electronic systems under the e-navigation approach might therefore open the door to ships being equipped with calibrated barometers, anemometers that can supply feeds to AIS, electronic charts, etc. and make that data available ashore. It is considered therefore that JCOMM should follow and interact more closely with IMO developments and submit proposals where appropriate. Such developments will also necessitate closer JCOMM linkage with major ship owners and associated bodies e.g. ICS and IACS

VOS Data quality is also an area where improvements are needed. Manned VOS data is often significantly poorer than automated data (e.g. RMS pressure values of ~1.2 hPa compared with ~0.8hPa for automatics. Improved instrumentation and tighter quality monitoring will help, but to eliminate human error on manned VOS a more efficient means of blocking poor quality data before it is put on the GTS is needed

The use of ship AWS systems on VOS introduces a natural synergy with the AWS systems that are in use on data buoys and offshore installations that come under the remit of DBCP. There will therefore be an increasing need for communication and harmonisation between the two groups (and potentially a need for a common forum to address technical automation issues).

### SOOP

The most important matters that relate to the SOOP and that need to be addressed and/or implemented by the SOOPIP and/or XBT Science Team and/or the CLIVAR/GSTP are:

- Recommendation of new fall rate equation coefficients for historical XBT data;
- Assessment of temperature and depth errors in the XBT historical data base;
- Improve communications of scientific results showing the value of the SOOP-derived observations;
- Support of new technology for XBT probes, launchers, and data acquisition systems;
- Support the integration of the diverse observations obtained from ships of the SOOP and from other observational platforms.

### ASAP

It is expected the E-ASAP will remain the dominant ASAP fleet worldwide. All decisions on the future and strategy of E-ASAP will be made by EUMETNET. So far no further countries expressed their interest in setting up an ASAP programme which is based on routine sounding operations on board commercial vessels in regular service.

# ANNEX IX

## REPORT BY THE ARGO PROFILING FLOAT PROGRAMME

*(Report provided by Dean Roemmich and Susan Wijffels (Argo Steering Team Co-Chairs), Howard Freeland (Argo Director), Mathieu Belbeoch (Argo Technical Coordinator)*

## 1. STATUS OF ARGO IMPLEMENTATION

### a. Status of the Argo float array

Argo deployed over 900 floats in 2012, bringing the total number deployed since 2000 to over 9000. Of these there are more than 3600 active Argo floats maintained by over 20 countries, (Figure 1) with the US Argo Program operating more than half of these. In late 2012 Argo obtained its millionth temperature/salinity profile.

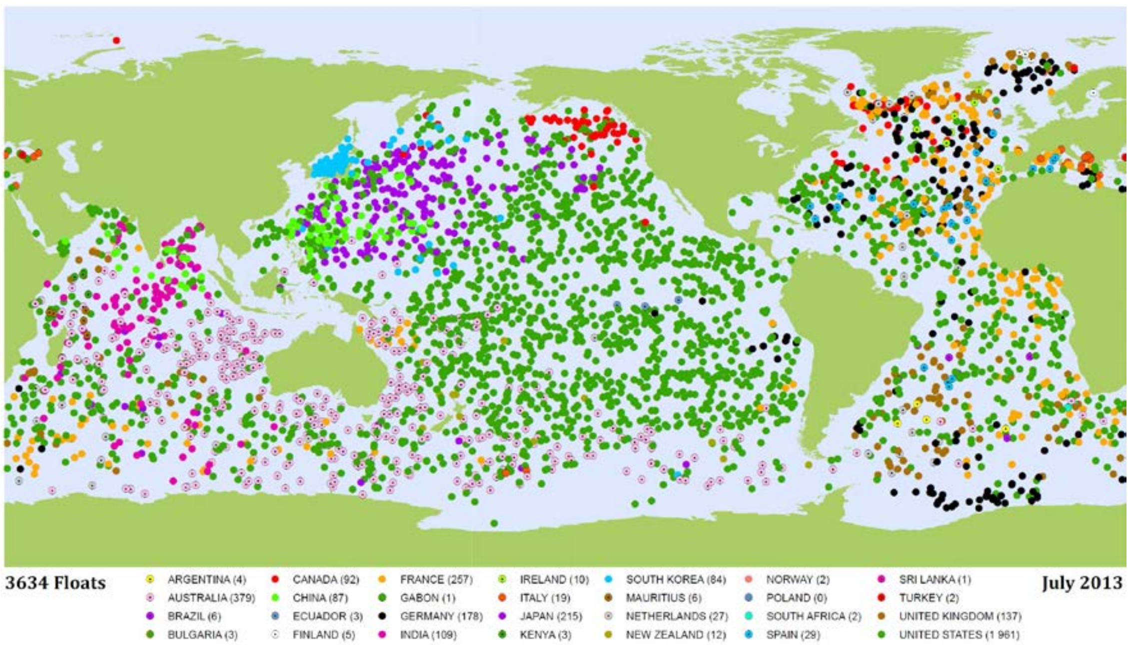



FIGURE 1: LOCATIONS OF ACTIVE ARGO FLOATS BY COUNTRY

The original Argo design called for 1 float every 3° by 3° of latitude/longitude (or 4 floats in every 6° by 6° square, Figure 2) in the open global ocean deeper than 2000m. While this density has been achieved for most of the target regions, some remain under-sampled – particularly the high southern latitudes, the South Atlantic and the central subarctic North Pacific. The Argo community is working with the new JCOMMOPS Ships Coordinator to source deployment opportunities for these and other regions, and to coordinate the use of ships for float deployments and other observing system activities. For some regions leasing ship time is the only option and Argo seeks partnerships with other programs in this activity.

A rapid and major change to the Argo data stream is being driven by the availability and decreasing cost of high-bandwidth 2-way satellite communication options. Around 23% (>900 floats) of the array is now delivering highly vertically resolved (2db) profiles. In addition to providing high vertical resolution data, these floats have greatly shortened surface times (~20 mins) and are consequently less susceptible to many hazards including grounding/beaching, bio-fouling, incidental collision or pick-up, and equatorial surface-layer divergence.

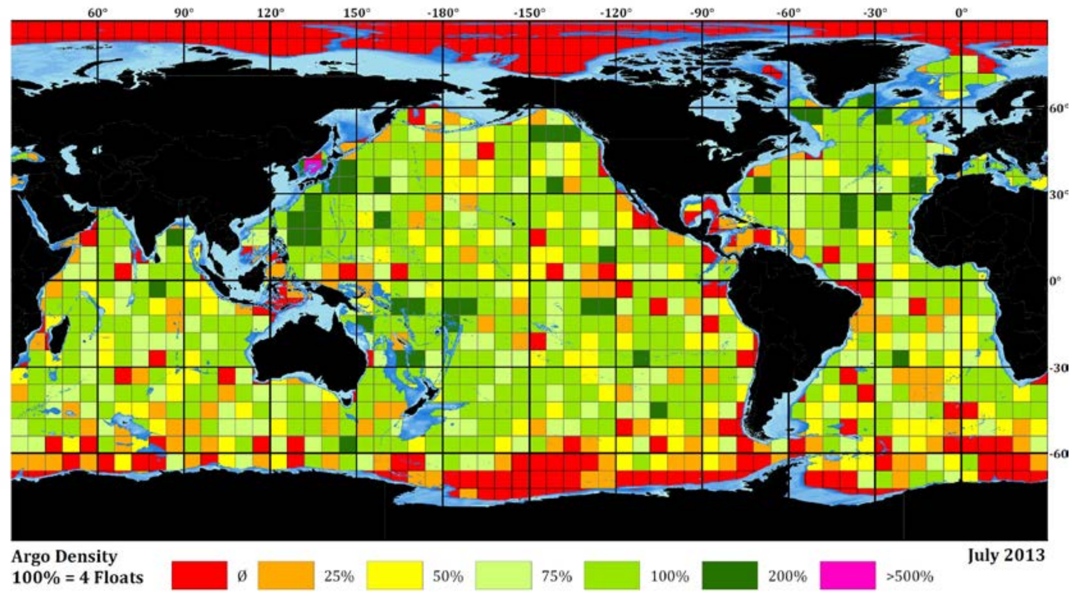



FIGURE 2: PERCENT OF ORGINAL CORE DESIGN, 6°X6° BOXES (100% = 4 FLOATS) ACHIEVED IN JULY 2013. GAPS REMAIN IN THE SOUTHERN OCEAN SUBTROPICAL ATLANTIC AND MID ARCTIC PACIFIC

## 2. STATUS OF ARGO DATA MANAGEMENT

The increasing complexity of Argo (and related pilot programs) data streams requires adaptation of the Argo data system and its formats. More highly resolved profiles required revisiting real-time data tests, near surface and exotic sensors have required adding another vertical axis to data files and the apparently simple task of describing a data stream and its associated meta and technical data (so that it is machine parseable) have all been time consuming issues the Argo Data teams have had to deal with. While most teams have been able to cope in processing profile data in realtime (both to the GTS and via the GDACs) and delivering high quality Delayed Mode data, all are suffering under the strain. As a result, most have not been able to easily progress updating and improving the quality of Argo trajectory data – a key component of Argo's original mission. Until more resources are brought into the data system, Argo's ability to ingest and distribute novel and complex new data streams will remain limited.

Despite these challenges, the Argo Data Team has achieved a major upgrade in Argo's data format with V3.0 files now being generated and the Global Data Assembly Centres are prepared to receive, check and distribute these. V3.0 includes the ability to store extra axes, more standard technical and meta-data, more complete trajectory files and is CF compliant.

Argo also has increased its monitoring of timeliness, anomalous data (both compared to satellite and other surrounding data), pressure biases, and more rigorous adherence to format requirements. Most Argo data are now distributed in BUFR on the GTS.

## 3. STATUS OF ARGO INTERNATIONAL COORDINATION

Argo's Technical Coordinator, Mathieu Belbeoch, is now one of the most senior members of the JCOMMOPs team. Argo is committed to the joint centre and to having a team there that works across several programs. For Argo in particular, the operational aspect of the Argo Information Centre in notifying and tracking floats requires continuous manning. Strong collaboration on identifying and coordinating deployment opportunities remains a vital role for the joint centre.

International coordination of Argo has just received a major boost through the appointment of Dr. Howard Freeland (recently retired from Department of Fisheries and Oceans, Canada) as a part time Argo Director. Dr. Freeland with work with the IOC GOOS office, AIC and AST co- chairs to improve the uptake of Argo data, raise awareness of the program across sectors and broaden the support for Argo among nations. As Assistant Argo Director, Megan Scanderbeg (S.I.O.) continues to provide support to the Argo Steering Team and Argo Data Management Team, and to the Argo Director and AST Co-Chairs, and to build and maintain the AST web site (http://www-argo.ucsd.edu) for improved visibility and communications within Argo and across Argo user communities.

## 4. STATUS OF ARGO DATA UTILIZATION

The Argo dataset has become one of the major resources in modern oceanography, rapidly growing in the following functions:

***Basic research:*** Argo data are being used in a broad range of basic research, spanning timescales from days (e.g. tropical cyclone heat and freshwater balance) to a century (e.g. global ocean heat content) and topics including air-sea interaction, mesoscale eddies, ocean circulation, water mass formation and spreading, seasonal cycles, modes of climate variability including ENSO, and others. In 2012 alone, 245 peer-reviewed papers using Argo data were published (Figure 3).

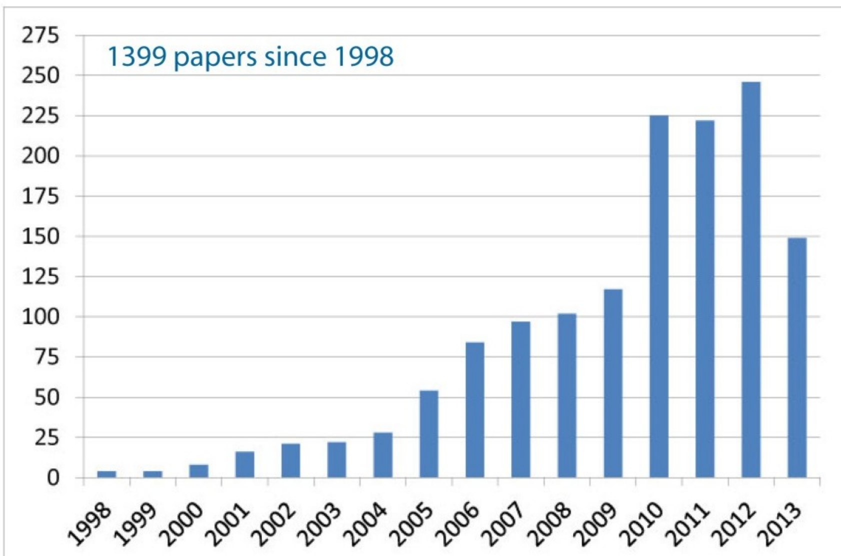



FIGURE 3: RESEARCH PUBLICATIONS USING ARGO DATA (LAST UPDATED AUGUST 15, 2013; http://www.argo.ucsd.edu/Bibliography.html).

***Operational modeling:*** Operational centres around the world are using Argo data in ocean reanalyses and for initialization of short-term ocean forecast models as well as coupled models in seasonal to decadal forecasting. Argo is the primary subsurface ocean dataset used in today's global ocean models, and Argo-dominated climatologies are now used to initialize coupled modeling systems.

***National and international climate assessment***: Climate assessments such as the recently released BAMS State of the Climate in 2012 and the soon-to-be-released IPCC 5$^{th}$ Assessment Working Group I Report, are now heavily relying on Argo for global measures such as ocean heat content and near-surface salinity changes. Argo data are now used both to compare the modern era with historical datasets and also to describe climate-relevant ocean variability within Argo's first decade, 2004-2013.

***Education:*** The Argo dataset is widely used in graduate education, having already contributed to about 50 Ph.D. theses around the world (a compilation is under construction). Data products, such as the Argo Global Marine Atlas and Google Earth Argo mapping, have been developed to enable and encourage uptake of Argo at the undergraduate and high school levels. Argo education programs are being implemented in several regions.

## 5. METRICS - DEFINITION AND IMPLEMENTATION PROGRESS

The following measures are relevant to the performance of the Argo Program, though they provide only a limited view. Moreover, because of the present and ongoing re-evaluation of Argo's requirements (Section 4e, below), the target float numbers are undergoing modifications and the resources for new targets have not been committed. For each metric, the present (July 2013) score is shown in parentheses.

- Number of active floats (3634).
- Number of floats deployed in last 12 months (906)
- Percentage of 3°x3° boxes in "original design" with at least 3 profiles (66%)
- Number of T/S profiles per month (9912 on GTS, 11512 at GDACs)
- Total length of water column sampled (pending)
- Percentage of real-time data available within 24 hours (GTS 84%, median 9 hours; GDACs 87%, 13 hours)
- Percentage of eligible delayed-mode data delivered within 1 year (79% of profiles > 1 year old)

These and other measures are routinely tracked by the Argo Information Centre, with plots available at http://argo.jcommops.org/maps.html .

## 6. STANDARDS AND BEST PRACTICES

Argo's standards and best practices are defined by the Argo Steering Team, the Argo Data Management Team and through Argo Technical Workshops.

Argo's data system standards are documented in the Argo Data Management Handbook. Recommended practices in Argo data management are described in the Argo DAC Cookbook. For procedures in Delayed-Mode Quality Control, see the Argo Quality Control Manual. All of these documents are available at http://www.argodatamgt.org/Documentation .

With respect to profiling float best practices, a complicating factor is the diversity of float types in use by Argo. For APEX floats, forming the majority of Argo instruments, see the APEX User Group Report http://www.argo.ucsd.edu/apex_users_group.pdf .

## 7. EVOLUTION OF NETWORK/NEW TECHNOLOGIES/SENSORS

The evolution of profiling float technology and development of new sensors is enabling valuable new potential enhancements of the Argo Program.

**a. Deep Argo.** Prototype deep Argo floats have been deployed successfully to depths up to 6000 m. While these carried extended-depth versions of present profiling float CTDs, a new ultra-stable deep CTD is being developed in parallel with the float work. Further prototype and pilot-array deployments are planned and will be used to determine the float density and sampling characteristics of a Deep Argo array.

**b. Bio-Argo, Biogeochemical-Argo.** Dissolved oxygen is the most mature “extra” sensor, both in terms of sensor stability and in data management protocols. There are about 200 active Argo floats with oxygen sensors, and much smaller numbers with nitrate, bio-optical, and pH sensors. Argo continues to cooperate with and encourage Bio-Argo and BGC-Argo program development. A limitation is that data management protocols and manpower are needed for all new sensors on Argo floats for Argo to remain in compliance with its open data policy.

**c. High latitude sampling.** Several technical advances, including high-bandwidth communications, ice-avoidance algorithms in float controller software, and acoustic location capability for under-ice floats in the Weddell Sea, result in increasing feasibility of Argo coverage in seasonal ice zones. Limitations remain, including the cost of under-ice location capability, and shortage of deployment opportunities in the high latitude oceans.

**d. Surface layer sampling.** Floats with bi-directional communications can profile closer to the sea surface (~1 m) for both temperature and salinity, because profile-to-profile pressure drift is slow enough to avoid sampling though the air-sea interface (a source of CTD fouling). Such floats as well as others that collect non-pumped temperature data, or use an auxiliary non-pumped CTD, are now being used to obtain near-surface data. The effort is motivated by interactions with the Global High Resolution Temperature Project and the SMOS and Aquarius satellite salinity missions.

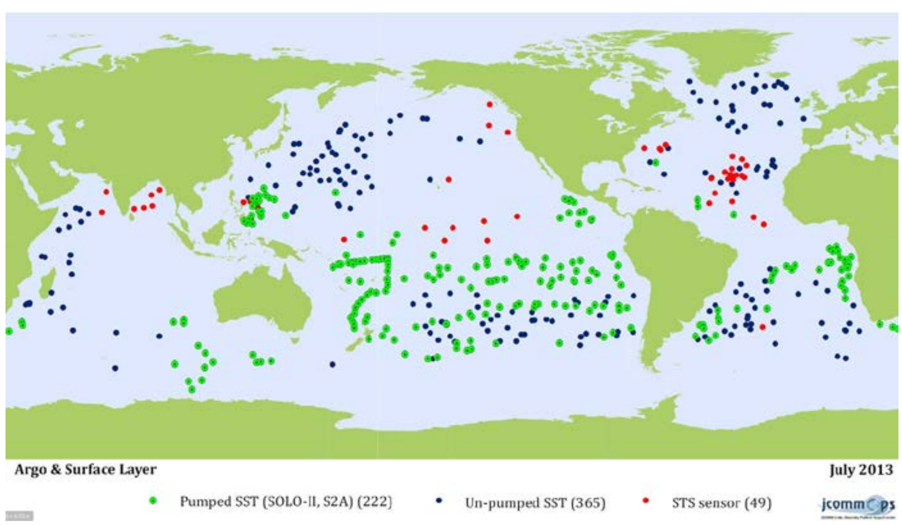



FIGURE 4: LOCATIONS OF FLOATS PILOTING NEAR SURFACE MEASUREMENTS. PUMPED IS WHERE BOTH NORMAL TEMPERATURE AND SALINITY MEASURMENTS ARE TAKEN CLOSER TO THE SURFACE, UNPUMPED IS WHERE ONLY THE THERMISTER IS READ RIGHT UP AND THROUGH SURFACING AND STS IS WHERE ADDITIONAL SENSORS ARE USED TO MEASURE THROUGH SURFACING.

**e. Evolving the global Argo array.** The Argo Steering Team is working with the community on evolving the design of the Argo array. Advances in float and satellite communications are opening up new areas to Argo-like sampling such as the high latitude oceans and marginal seas. Moreover, signal-to-noise considerations suggest higher density sampling would be valuable in western boundary current regions and in the equatorial bands. These ideas grew out of recommendations at OceanObs09 and were brought to the Argo community and discussed at the 4th Argo Science Workshop held in conjunction with 20 Years of Radar Altimetry, September, 2012, Venice, Italy. They were further discussed and endorsed by the Argo Steering Team (AST-14) in March 2013. Preliminary calculations suggest this would require a further 1000 active floats – thus Global Argo would be a 4000 float array, as illustrated schematically in Figure 5.

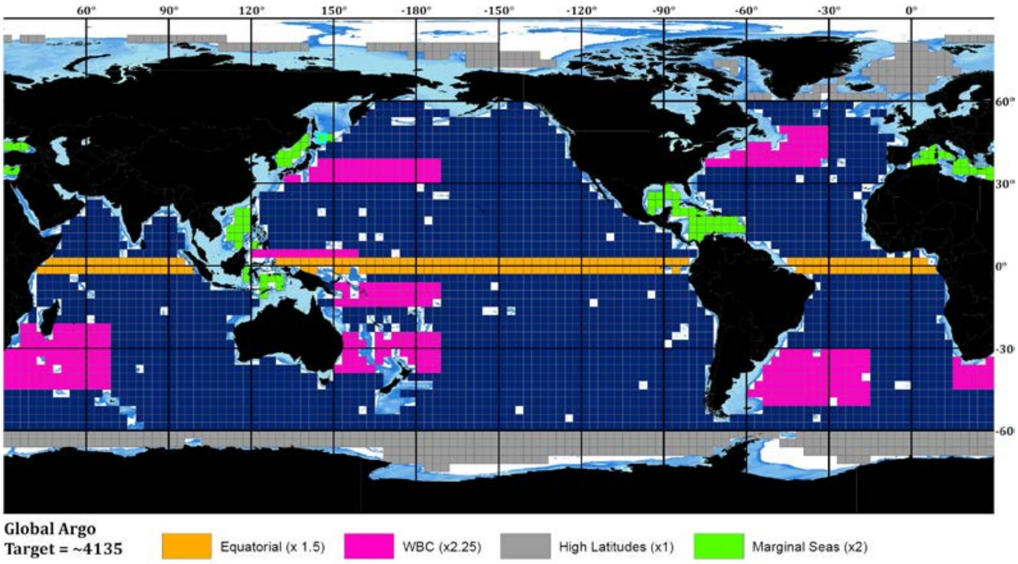



FIGURE 5: DRAFT SCHEMATIC DIAGRAM SHOWING EXTENSION OF ORIGINAL ARGO SAMPLING, AT 1 FLOAT PER 3°X3° SQUARE, TO HIGH LATITUDES, AND AT HIGHER RESOLUTION (DETERMINED BY REGIONAL PARTNERS) TO MARGINAL SEAS. ENHANCED COVERAGE, AT 2 FLOATS PER 3°X3° SQUARE, IS RECOMMENDED FOR WESTERN BOUNDARY CURRENT (WBC) AND EQUATORIAL REGIONS. THE DEEP ARGO GLOBAL ARRAY HAS NOT YET BEEN DESIGNED.

## 8. LOGISTICS AND RESOURCE ISSUES

In most Argo national programs the budgets have been frozen for about a decade. Argo has managed to survive and succeed only because technical advances have greatly lengthened the lifetime of Argo floats, offsetting the inflationary losses in funding. This is not sustainable. Further, new sampling enhancements requiring additional floats (Section 4e above) and expansion of Argo into the deep ocean (4a) could only be implemented with new resources.

While most Argo deployments are carried out by opportunistic use of research and commercial shipping, this is not sufficient to deploy the array in the remotest regions of the oceans where research vessels seldom visit and there is no commercial shipping. Dedicated deployment opportunities, such as the 1214 Argo floats deployed so far by RV *Kaharoa*, are critical, but so far only a few nations are sustaining these remote deployments.

Argo has invested a greater percentage of its resources (between 10 and 15%) in data management activities than previous large oceanographic programs, and the Argo Data Management System is acclaimed for its innovation and high standards. However, the national data managers at the core of this effort are fully occupied with present demands, and any new requirements, whether for additional sensor data streams, improved trajectory files, or extensive reprocessing, require additional proportionate manpower.

## 9. CAPACITY BUILDING, INCLUDING EDUCATION

Argo is extensively involved in capacity building including education activities, largely carried out by individual Argo National Programs on a regional basis. Outreach activities include training workshops held by Argo Regional Centres (ARCs, http://www.argo.ucsd.edu/ARC.html). The Pacific Island GOOS Coordinator is partially supported by Argo to identify and implement regionally prioritized applications using Argo data (http://www.sprep.org/pi-goos). Education and outreach activities, and tools developed by Argo to facilitate education applications, are described at http://www.argo.ucsd.edu/Educational_use.html . Innovative outreach/education web sites using Argo include "Mon océan et moi" (http://www.monoceanetmoi.com/web/index.php/en/) and "Way Down South" http://waydownsouth.wikispaces.com/ .

## 10. ISSUES AND CHALLENGES, IDEAS FOR INTEGRATION, WAY FORWARD

The need for Argo, or for equivalent ocean observations, extends beyond the timescales of individual careers, and constitutes a multi-generational undertaking (e.g. Wunsch et al, 2013, PNAS). Mechanisms must be found to ensure continuity, consistency, and further improvement in Argo and other elements of the integrated ocean observing system.

Argo has major intersections with nearly all elements of the ocean observing system. Coordination by JCOMM OPS and the JCOMM OCG are recognized and valuable. Much of the coordination at key interfaces such as Argo/GO-SHIP, Argo/DBCP, Argo/Altimetry, and others, remains informal. These activities should be encouraged and rewarded.

About 1/3 of all Argo floats are presently inside EEZs, and sampling in EEZs is critical for the global objectives of the Argo Program. Nevertheless, not all nations have concurred with the deployment of Argo floats in EEZs. Moreover, IOC guidelines on the drift of floats into EEZs are sufficiently burdensome as to have discouraged float deployments by smaller national programs in specific regions. It is difficult to envision how Argo can be sustained without an international consensus on these issues.

**ANNEX X**

# REPORT BY THE OCEANSITES

*(Report prepared by Robert Weller, Uwe Send, and Kelly Stroker)*

OceanSITES is a volunteer aggregation of existing time series observing efforts. As such it includes considerable diversity. Diversity of purpose as well as diversity of instrumentation. Thus, it is quite difficult for such a heterogeneous network to apply, in the same fashion as other elements of the observing system, the same tools for assessment.

*Network status – measured against requirements with details of variables (scales, accuracies, application)*

As noted above, OceanSITES is an aggregate of sustained time series sites initiated and maintained for different reasons and against different requirements. The OceanSITES science team is working to develop requirements for each of the several networks embedded within the OceanSITES program. As examples of these, there are: 1) surface moorings instrumented to provide air-sea fluxes known as Flux Reference Sites, and 2) subsurface moorings with multidisciplinary instrumentation aimed at integrated observing of biogeochemical as well as physical variability. The OceanSITES science team also acts in response to identified requirements; the requirement for deep ocean temperature data is being met by OceanSITES raising funding for temperature/conductivity instruments to be deployed at depths greater than 2,000 m on OceanSITES moorings.

Flux reference sites: the requirement is to observe all components necessary to compute the air-sea exchanges of heat, freshwater, and momentum by the bulk formulae. Thus, each surface buoy must observe: incoming longwave and shortwave radiation, barometric pressure, wind speed and direction, air temperature and humidity, sea surface temperature and salinity, surface currents, and rainfall. Specific horizontal scales are not an issue. Instead, coverage of key and characteristic sites is the goal. The global array design aims to occupy sufficient sites with geographic distribution to observe: 1) the characteristic air-sea regimes (e.g., trade winds, high latitudes, central basin), 2) data sparse sites (e.g., Southern Ocean), and 3) sites of extreme air-sea exchanges (e.g. warm western boundary currents exposed to cold air outbreaks).

Biogeochemical sites: a key goal is to observe transformation of matter and fluxes of elements (C/carbonate system, O2, N, P…) mediated by biological processes from the sunlit surface layer to the deep sea floor. Processes like primary productivity, respiration, remineralization, detoxification are important ecosystem functions and in many respects valuable services for mankind. All major observation components are represented within the OceanSites observatory network but several parameters are measured only at a subset of the ~50 sites that observe biogeochemical / ecosystem variables. The main focus so far is on the upper ocean carbonate system components with special emphasis on $pCO_2$ and air-sea fluxes of $CO_2$. Measurements focusing on upper water column productivity (e.g., nutrients, light, photopigments, plankton biomass and composition) are also common and often also include organic matter export (i.e., water column organic particle concentration and vertical fluxes), allowing to estimate carbon sequestration of the seafloor. Additional observational efforts are required to assess the fate of organic matter at the seafloor including ecosystem functions like remineralization and burial but also the characterization of deep ocean and seafloor communities' and their biodiversity. Such observations are so far restricted to single sites although the relevance of these deep ocean ecosystem services are now being broadly recognized. Furthermore, assessing the past, current and future functions of oceanic regimes under climate change and other human impacts is an important task.

*Metrics - definition and implementation progress*

Flux reference sites: The observing methodology should strive for accuracy in net heat flux of 2 W $m^{-2}$ in order to observe long-term trends in net heat flux associated with climate change. The global array design aims to occupy sufficient sites with geographic distribution to observe: 1) the characteristic air-sea regimes (e.g., trade winds, high latitudes, central basin), 2) data sparse sites (e.g., Southern Ocean), and 3) sites of extreme air-sea exchanges (e.g. warm western boundary currents exposed to cold air outbreaks). By doing so the intent is to identify and reduce errors in present model and gridded flux products, to ground truth remote sensing, to validate models, to provide independent high accuracy sustained time series of air-sea fluxes, and to advance the understanding of the ocean's role in climate. At present the tropical belts and the trade wind regimes of the Pacific and Atlantic are instrumented. Work to begin instrumenting high latitude and high amplitude sites in in progress in the form of the IMOS mooring south of Tasmania, KEO, and PAPA.

Biogeochemical sites: The complexity of the topic and the specific questions addressed by the individual groups needs multiple harmonized observation strategies for ocean biogeochemistry. For example, observing ocean acidification requests another approach than assessing carbon sequestration into the deep sea floor. There is, however, a strong will within the OceanSITES community to define essential variables and observe them at a network of stations. The so-called MOIN initiative ('Minimalist OceanSITES Interdisciplinary Network') suggests to observe a basic set of physical and biogeochemical variables at fixed-point moorings in selected representative biogeochemical provinces of the world ocean. The goal would be to quantify primary productivity, CO2 and O2 dynamics in relation to air-sea fluxes as well as to mixed layer and nutrient dynamics. Other option that could be targeted in parallel and is discussed in connection to an OceanSITES white paper on biogeochemical and ecosystem observations is to define a small number of biogeo/ecosystem 'supersites' and join forces and scientific expertise within OceanSITES in order to extend observations below the mixed layer all the way down to the seafloor. Observations at these sites would then need to address the full suite of investigations of ecosystem function including biodiversity.

The most basic biogeochemical parameters used in carbon and nitrogen budgets and biogeochemical models are primary productivity, remineralization and carbon export and burial. These carbon and nitrogen based measures rely on a good understanding of seasonal variations in nutrient supplies, hydrography and biodiversity of ocean realms and are classically established by combinations of surface to depth fixed point observatories and ship-based surverys, validating satellite assessment of ocean color, measuring mixed layer depth, and its chlorophyll content, as well as particle sedimentation by traps. Oxygen, CO2 and nitrate sensors are new tools to better assess primary production as key biogeochemical parameter.

*Standards and best practices (draft and documented)*

OceanSITES is in the process of maturing its website. One goal is to use the website is the means of archiving and sharing standards and best practices. At present, OceanSITES uses technical and scientific literature as key resources.

Flux Reference Sites: standards and best practices documentation

*Bigorre, S. P., R. A. Weller, J. B. Edson, and J. D. Ware (2013), A surface mooring for air-sea interaction research in the Gulf Stream. Part 2: Analysis of the observations and their accuracies, Journal of Atmospheric and Oceanic Technology.*

*Bradley, F., and C. Fairall, 2006: A guide to making climate quality meteorological and flux measurements at sea. NOAA Tech.Memo. OAR PSD-311, 81 pp.*

*Colbo, K., and R. A. Weller (2009), Accuracy of the IMET sensor package in the subtropics, Journal of Atmospheric and Oceanic Technology, 26, 1867-1890.*

*Weller, R. A., F. Bradley, and R. Lukas (2004), The interface or air-sea flux component of the TOGA Coupled Ocean-Atmosphere Response Experiment and it impact on subsequent air-sea interaction studies, Journal of Atmospheric and Oceanic Technology, 21, 223-257.*

*Weller, R. A., S. P. Bigorre, J. Lord, and J. D. Ware (2012), A surface mooring for air-sea interaction research in the Gulf Stream. Part I: Mooring design and instrumentation, Journal of Atmospheric and Oceanic Technology, 29, 1363-1376.*

Biogeochemical Sites: standards and best practices documentation

*Adornato, L. & Co-Authors (2010). In Situ Nutrient Sensors for Ocean Observing Systems in: Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society (Vol. 2), Venice, Italy, 21-25 September 2009, Hall, J., Harrison, D.E. & Stammer, D., Eds., ESA Publication WPP-306, doi:10.5270/OceanObs09.cwp.01*

*Byrne, R.H., DeGrandpre, M.D., Short, R.T., Martz, T.R., Merlivat, L., McNeil, C., Sayles, F.L., Bell, R. and Fietzek, Peer (2010) Sensors and Systems for in situ Observations of Marine Carbon Dioxide System Variables In: Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society. , ed. by Hall, J., Harrison, D.E. and Stammer, D. ESA Publication, WPP-306 . OceanObs'09, Venice, Italy, p. 8. DOI 10.5270/OceanObs09.cwp.13.*

*Gruber, N., Körtzinger, Arne, Borges, A., Claustre, H., Doney, S. C., Feely, R. A., Hood, M., Ishii, M., Kozyr, A., Monteiro, P., Nojiri, Y., Sabine, C. L., Schuster, U., Wallace, Douglas W.R. and Wanninkhof, R. (2010) Towards An Integrated Observing System For Ocean Carbon and Biogeochemistry At a Time of Change Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society. , ed. by Hall, J., Harrison, D.E. and Stammer, D. ESA Publication, WPP-306 . OceanObs'09, Venice, Italy, p. 8. DOI 10.5270/OceanObs09.pp.18.*

*Larkin, K.E., Ruhl, H.A., Bagley, P., Benn, A., Bett, B.J., Billett, D.S.M., Boetius, A., Chevaldonné, P., Colaço, A., Copley, J., Danovaro, R., Escobar-Briones, E., Glover, A., Gooday, A.J., Hughes, J.A., Kalogeropoulou, V., Kitazato, H., Kelly-Gerreyn, B.A., Klages, M., Lampadariou, N., Lejeusne, C., Perez, T., Priede, I.G., Rogers, A., Sarradin, P.M., Sarrazin, J., Soltwedel, T., Soto, E.H., Thatje, S., Tselepides, A., van den Hove, S., Tyler, P.A., Vanreusel, A. and Wenzhöfer, F. (2010) Benthic Biology Time-Series in the Deep Sea: Indicators of Change In: Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society (Vol. 2), Venice, Italy, 21-25 September 2009, Hall, J., Harrison, D.E. & Stammer, D., Eds., ESA Publication WPP-306, doi:10.5270/OceanObs09.cwp.52.*

*O'Dor, R. & Co-Authors (2010). Bringing Life to Ocean Observation In: Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society (Vol. 1), Venice, Italy, 21-25 September 2009, Hall, J., Harrison, D.E. & Stammer, D., Eds., ESA Publication WPP-306, doi:10.5270/OceanObs09.pp.29*

*Sieracki, M. & Co-Authors (2010). Optical Plankton Imaging and Analysis Systems for Ocean Observation In: Proceedings of OceanObs'09: Sustained Ocean Observations and Information for Society (Vol. 2), Venice, Italy, 21-25 September 2009, Hall, J., Harrison, D.E. & Stammer, D., Eds., ESA Publication WPP-306, doi:10.5270/OceanObs09.cwp.81*

*Evolution of network/new technologies/sensors*

Flux Reference Sites: The Flux Reference Sites will evolve and grow with the addition of the U.S. NSF's high latitude sites in the Irminger Sea, the Argentine Basin, and at 55°S, 90°W. There are also plans for a site in the Bay of Bengal. The forward path for technology involves surface buoys capable of delivering more power and higher bandwidth, using that power in part for direct covariance flux observations of heat, momentum, moisture, and $CO_2$ flux and surface wave measurements and being able to host additional sensors. Work continues on meteorological sensor technology and on improving performance in the face of buoy motion, flow distortion around the buoy structure and over the sea surface, vandalism, salt spray, and sea birds. Deployment of systems making concurrent bulk formula and direct covariance flux observations will support continued work on flux parameterizations.

Biogeochemical Sites: In the current network a focus of long-term biogeochemical observatories is in the Atlantic (Arctic to Antarctic sector), as well as in tropical / subtropical regions of the Pacific (Hawaii) and Indic ocean. The evolution of the network of biogeochemical observations will depend on the strategic decisions made in the process of the current discussions. New technologies and sensors in the field include imaging technologies and image processing software for automated organism recognition, reliable sensors for nutrients (e.g., nitrate and ammonium) and pCO2, underwater eddy correlation instruments for non-destructive benthic flux measurements, high resolution sonar for estimates of plankton and nekton, passive acoustics for marine mammal detection and tracking. While seafloor infauna observations will depend on traditional sampling, novel molecular techniques for routine biodiversity assessment (e.g., DNA barcoding) become available.

*Logistics and resource issues*

Flux Reference Sites: Flux reference sites require dedicated ship time for at sea calibration and intercomparison. Ideally, new sensor sets are deployed prior to recovery of sensor sets in the water and an additional sensor set on the ship allows for intercomparisons at sea to identify environmental degradation, calibration drifts and other issues. These are, together, with pre and post-calibration critical steps, but they require ship days to be funded to do so. At present, Flux Reference Sites need to be visited once a year; this makes a demand on resources due to the wide spread and at time remotely located nature of the Flux Reference Site array.

Biogeochemical Sites: As mentioned above, only a limited number of essential variables for biogeochemical observations (e.g., oxygen, $pCO_2$, photopigments, some nutrients) can be measured with sensors while many of the most important require high-maintenance instruments (e.g., particle traps, cameras), wet chemical methods (e.g., direct measurement of primary production, most nutrients), as well as traditional shipboard sampling and time consuming sample analysis. Biogeochemical sites need to be regularly visited by ships to exchange sediment traps and to combine ecological and chemical surveys for complex derived parameters and biodiversity assessments with some continuous measurements such as fluorescence, oxygen, CO2. So far only very few parameters can be automated beyond a year, and sediment traps remain a key tool in assessing ecosystem function and carbon export. Hence, in depth observational work is highly demanding with respect to shiptime, personnel, as well as scientific expertise.

*Capacity building opportunities/requirements*

Flux Reference Sites: There has been good international dialog and technology exchange on surface mooring, surface buoy, and meteorological and air-sea flux sensors. The opportunity exists to promote dialog on calibration and data processing (quality control, flux algorithms) among those campaigning surface buoys in OceanSITES and, perhaps, operationally under DBCP. Because present errors in model-based fluxes are significant and larger than the 4 W $m^{-2}$ greenhouse gas warming metric, it would be useful to establish target requirements that can be met now that, when met, show that a given flux reference site meaningfully identifies errors in model-based surface meteorological and flux fields.

Biogeochemical Sites: The complexity of the topic is reflected in a lively discussion on strategies and essential variables for ocean biogeochemistry and ecosystem observations. Important steps forward were taken during the OceanObs'09 meeting and in the framework of the Deep Ocean Observing Strategy with substantial contributions by the OceanSITES consortium. Most biogeochemical measurements are labor intensive, and need a lot of post-processing, especially in the realm of phyto- and zooplankton identification and quantification,

*Issues and challenges, ideas for integration, way forward*

The OceanSITES array is an in-situ array. A major challenge is the ship time needs for servicing the sites. The diverse OceanSITES arrays are maintained largely without coordination across the arrays or with other elements of the ocean observing system (e.g. repeat hydrography, tsunami warning buoys). There exists the potential for integration across elements and across national and institutional efforts that would make for a more efficient and effective approach.

---

# ANNEX XI

## REPORT BY THE GO-SHIP

*(Report prepared by Bernadette Sloyan, GO-SHIP co-chair and Martin Kramp, GO-SHIP coordinator)*

The GO-SHIP principal scientific objectives are: (1) understanding and documenting the large-scale ocean water property distributions, their changes, and drivers of those changes, and (2) addressing questions of how a future ocean that will increase in dissolved inorganic carbon, become more acidic and more stratified, and experience changes in circulation and ventilation processes due to global warming, altered water cycle and sea-ice will interact with natural ocean variability

1. Network Status – measured against requirements with details of variables

- 2003-2012 Decadal Survey

The second decadal survey was completed. All sections were occupied within the 2003-2012 period. The decadal survey included once-per-decade sections in all ocean basins and higher frequency sections in the Southern Ocean (Drake Passage and South of Australia and Africa) and high latitude North Atlantic Ocean and Arctic Ocean. The northern Indian Ocean sections (I01W and E, I02 and I07N) were not completed due to security risks. These sections still remain part of the global survey, although uncertainty remains about when they will next be completed.

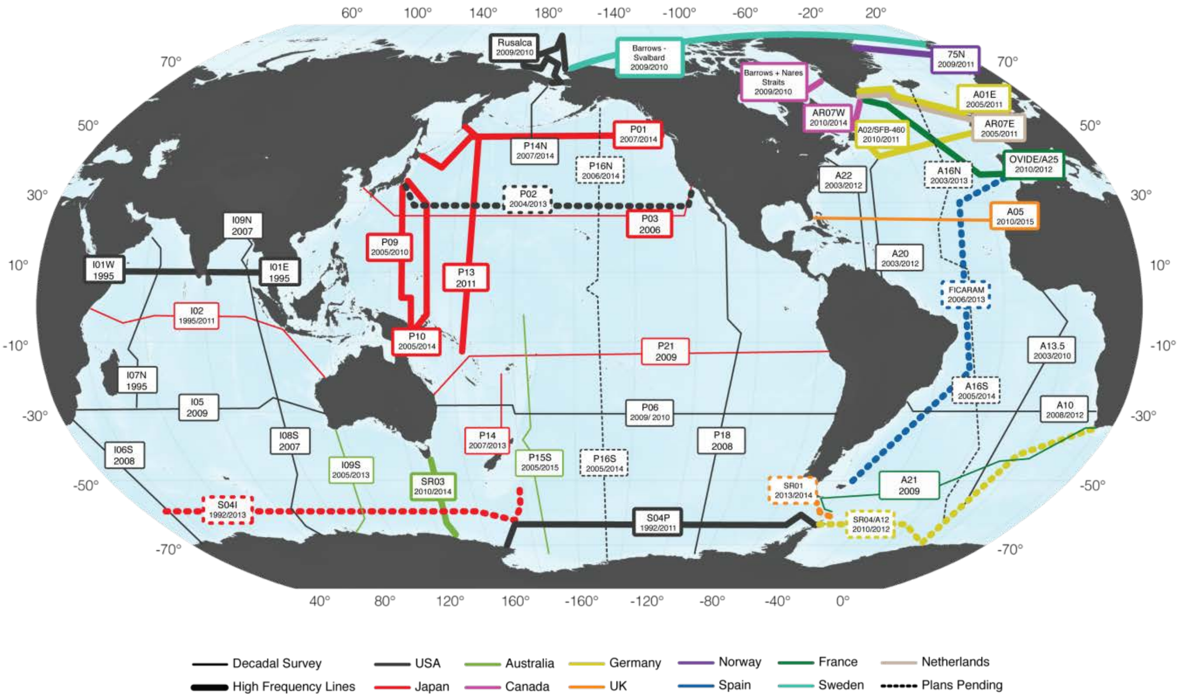



Figure 1: GO-SHIP sections most recently completed and planned occupations.

Most data are available at CDIAC (carbon) and CCHDO (CTD and most bottle data). We are continuing to contact PIs to ensure all data is available at the data centres.

The time-series of ocean properties derived from the global decadal survey provided significant insight into the importance of the ocean in climate and climate variability. For example, these data have documented substantial changes in the oceanic inorganic carbon content, driven by both the uptake of anthropogenic $CO_2$ and natural variability ; evidence of large-scale changes in oceanic oxygen concentrations; near global-scale warming of abyssal waters of Antarctic origin, and freshening of these waters in deep basins adjacent to Antarctica; intensification of the global hydrological cycle; reduction in the lower limb of the Meridional overturning circulation; and estimates of water mass formation rate.

Additional to the global survey (figure 1), GO-SHIP through Toste Tanhua, was involved in the MEDSHIP. MEDSHIP is a consortium of countries involved in developing a long-term ship-based sampling of the Mediterranean Sea.

- 2012-2023 Decadal survey

The 3rd decadal survey has begun. We have complete sections in the Atlantic (A20 and A22 occupied in 2012) and North Pacific (P02 occupied in 2013). The tables below provide information on planned and or funding status of the sections. We are actively gathering information on the status of national plans to update these tables (see http://www.go-ship.org/CruisePlans.html). To this end, we have developed a document to capture information on the parameters that will be collected on each voyage (see http://www.go-ship.org/Cruise-Notice.pdf). This form has been distributed to national representatives for completion.

**ATLANTIC**

| *Section* | *Description (ship track)* | *Most Recent Occupations* | *Next Occupation* |
|---|---|---|---|
| A01E/AR7E | Greenland to Ireland | 2011<br>H. van Aken<br>Netherlands | |
| A01W / AR7W | From Labrador to Greenland 53°N 56°W to 61°N 48°W; 1/year (spring) | 2011<br>M. Rhein<br>Germany | 2014 |
| A02 (SFB-460) | ~ 48° N, Ireland to St John's Bay, Canada. | 2010-13<br>M. Rhein<br>Germany | 2010-13<br>M. Rhein<br>Germany |
| A05 | 24° N (note: this line is part of the UK RAPID program with repeats every ~ 5 years). | 2010<br>Brian A King<br>UK,<br>2010<br>P. Velez<br>Spain | 2015 |
| A9 1/2 | 24°S | 2009<br>B. King<br>UK | |
| A10 | 30°S | 2011<br>M. Baringer<br>USA | |
| A12 | Capetown to the Antarctic continent along the prime meridian; often done in a pair with SR04. | 2008<br>E. Fahrbach / H. De Baar<br>Germany / Netherlands<br>2011<br>E. Fahrbach / M. Hoppema<br>Germany / Netherlands | |
| A13.5 | 0°; Cape Town to Ghana | 2003<br>M. Hoppema<br>Germany<br>2010<br>J. Bullister<br>USA | |
| A16N | 20-25° W Iceland to 5° S | 2011 | 2013 |

| | | | |
|---|---|---|---|
| | | Brian King<br>UK | R. Wanninkhof<br>USA |
| A16S | 25-35° W, 5° S to 60° S | 2005<br>R. Wanninkhof<br>USA | 2013<br>L. Talley<br>USA |
| A20 | 52°W | 2003<br>J. Toole<br>USA | 2012<br>Michael McCartney<br>USA |
| A21 | Drake Passage | 2009<br>E. McDonagh<br>UK<br>2009<br>C. Provost<br>France (full physics, chem., and tracers) | |
| A22 | 66°W | 2003<br>T. Joyce<br>USA | 2012<br>Ruth Curry<br>USA |
| FICARAM (A17) | Ushuaia - Cartagena (Spain), following part of the line WOCE A17 and from 10°S to 36°N along 28°W | 2006<br>A. Rios<br>Spain | 2013<br>A. Rios<br>Spain |
| OVIDE (A25) | Iberian Peninsula - Greenland | 2008<br>A. Rios<br>Spain<br>2010<br>H. Mercier<br>France | |
| SR1b (eastern passage) | Drake Passage (note: SR1b repeated annually with CTD, SADCP, LADCP) | 2010<br>E. McDonagh<br>UK | 2013/2014 |
| SR04 | Section from tip of Antarctic Peninsula to Kapp Norvegia (approx 12° W) along the northern edge of the Weddell gyre (nominally 60° S) | 2011<br>E. Fahrbach / M. Hoppema<br>Germany / Netherlands | |

**PACIFIC**

| ***Section*** | ***Description (ship track)*** | ***Most Recent Occupations*** | ***Next Occupation*** |
|---|---|---|---|
| P01 | 47° N | 2007<br>T. Kawano<br>Japan | 2014 |
| P02 | 30° N | 2013<br>J. Swift<br>USA | |
| P03 | 24°N; Okinawa to San Diego. | 2006<br>Kawano, Murata, and Watanabe<br>Japan | To be conducted by JMA.<br>Japan |
| P06 | 30°S | 2009/2010<br>Ruth Curry/A. MacDonald | |

| | | | |
|---|---|---|---|
| | | USA | |
| P09 | 137°E | 2010<br>T. Nakano | |
| P10 | 147°E | 2012<br>T. Kawano<br>Japan | Japan |
| P13 | 165°E | 2011<br>T. Nakano<br>Japan | |
| P14N | Aleutians intersection with P01 and Northward. | 2007<br>T. Kawano and A. Murata<br>Japan | Plan is for approximately decadal occupation of P14 by Japan. |
| P14S/C | 174°E (done along with S04I / S04P) | 2013<br>T. Kawano<br>Japan | 2013<br>T. Kawano<br>Japan |
| P15S | Equator - 50°S 175°W (strategy calls for section to go to 67°S when possible). | 2009<br>B. Sloyan<br>Australia | 2015/2016<br>Australia |
| P16S | 150°W (55°N-15°S / 15°S to ice S) | 2005<br>B. Sloyan and J. Swift<br>USA | 2014<br>R. Feely/L. Talley<br>USA |
| P16N | | 2006<br>R. Feely<br>USA | 2014<br>R. Feely/L. Talley<br>USA |
| P18 | 110° W | 2008<br>J. Bullister and G. Johnson<br>USA | |
| P21 | 17°S | 2009<br>A. Murata<br>Japan | Plan is for decadal occupations<br>Japan |
| SR03 | Tasmania to Antarctic Continent, 140 - 145°E | 2010<br>S. Rintoul<br>Australia | |
| S04P (modified) | Nominal 67°S; McMurdo to Punta Arenas; connects to S04I and SR04 (Atlantic) | 2011<br>J. Swift<br>USA | |

**INDIAN**

| *Section* | *Description (ship track)* | *Most Recent Occupations* | *Next Occupation* |
|---|---|---|---|
| I01E | 8° N, Sri Lanka to Singapore | 1995<br>H. Bryden<br>USA | |
| I01W | 8° N, Oman to Sri Lanka | 1995<br>J. Morrison<br>USA | |
| I02 + I10 | I02 (10° S) + I10 (8° - 25° S at 111° E) *note: may be changed to I8N + I5E + I10 for security reasons | 2011<br>A. Murata<br>Japan<br>Postponed indefinitely for security reasons | |

| | | | |
|---|---|---|---|
| I05 | 32° S, Durban to Freemantle | 2009<br>J. Swift<br>USA | |
| I06S | 30° E Cape Town to Antarctic Continent | 2008<br>K. Speer<br>USA | |
| I07N | 65° - 55° E, Oman to Mauritius | 1995<br>J. Toole/D. Olson<br>USA<br>Postponed indefinitely for security reasons | |
| I08S | 95 - 82° E from 27° S to Antarctic Continent | 2007<br>J. Swift<br>USA | |
| I09N | 95° E, 28 - 4° S | 2007<br>J. Sprintall<br>USA | |
| I09S | 115° E | 2012<br>S. Rintoul<br>Australia | |
| S04I | Section connecting I09S and S04P at ~ 60° S; S04/S04I + P14S, 62° S (33.5° E-168° E) + 174° E | 2013<br>T. Kawano<br>Japan | |

**ARCTIC**

| ***Section*** | ***Description (ship track)*** | ***Most Recent Occupations*** | ***Next Occupation*** |
|---|---|---|---|
| 75*N | Iceland - Greenland. | 2011<br>T. Johannessen and A. Olsen<br>Norway | |
| Barrows and Nares Straits | Barrow Strait (74.09° N 90.44° W to 74.83° N 93.00° W); Nares Strait (occupied irregularly) | 2010<br>J. Hamilton<br>Canada | |
| Barrow to Svalbard | Barrow Alaska to Svalbard Norway | 2012<br>L. Anderson<br>Sweden | |
| Davis Straits | Baffin Island to Greenland | 2010<br>C. Lee and K. Azetsu-Scott<br>USA and Canada | |
| RUSALCA | Bering and Chukchi Seas | 2010<br>R. Woodgate<br>USA | |

## 2. Metrics – definition and implementation progress

We are currently assessing the most appropriate way to track the implementation progress of GO-SHIP. Given the decadal time-frame of the program we are discussing a number of metrics to assess the program progress during the decadal period. These metrics will be (1) proposal for occupation of section submitted to national funding organisation; (2) approved funding for section; (3) ship-time has been secured; (4) section observation are underway; (5) section completed and (6) data is available via data centres.

This multi-layered assessment of progress of the decadal survey will enable more complete reporting of the program. We envisage that this information will be available in graphical form such that a complete picture of the state of the observing system can be viewed in multiple ways.

## 3. Standards and best practices

GO-SHIP standard and best practices are outlined in the GO-SHIP Repeat Hydrography Manual (http://www.go-ship.org/HydroMan.html ). The manual addresses both physical and biogeochemical parameters. We are involved in the SCOR working group proposal: Towards harmonization of global oceanic nutrient data (http://www.scor-int.org/2013EC/Nutrients.pdf).

## 4. Evolution of network/new technologies/sensors

In addition to GO-SHIP standard parameters collected as part of the survey, GO-SHIP provides a platform to test and evaluate new technologies, observation techniques and sensors. We wrote a supporting letter for an US NSF proposal for the collection of turbulent mixing observations on GO-SHIP sections. The GO-SHIP survey provides the perfect opportunity to assess the potential of this new technology - full-depth observations of mixing in the ocean from an instrument attached to the CTD/rosette package.

GO-SHIP supports the side-by-side XBT and CTD comparisons needed to ensure the appropriate fall-rate correction of the XBT network and the deployment of Argo floats in the global ocean.

## 5. Logistics and resource issues

The GO-SHIP committee held a number of teleconference meetings in 2011 and 2012. These were organised by Maciej at IOCCP, whom provided valueable help to the GO-SHIP committee. Much of these discussion centred on completion of the program plan and defining the role of a project coordinator and how to fill and fund this position.

Since OCG-4, Matthieu Belbeoch (JCOMMOPS) has actively pursued the JCOMMOPS ship coordinator position. The GO-SHIP committee met in early 2012 to discuss the option of the JCOMMOPS Ship coordinator filling some GO-SHIP coordinator goals and how to provide financial support for this position. It was agreed that GO-SHIP would provide financial support to the JCOMMOPS Ship Coordinator position. The GO-SHIP committee, via Bernadette Sloyan, worked with Matthieu and others to update the position description to include GO-SHIP coordination, and interview and recruitment of the Ship Coordinator. This process was concluded with Martin Kramp taking up the position on 4 February 2013.

Martin has been a great asset to GO-SHIP since joining JCOMMOPS. He has met with the key members of the committee (Bernadette Sloyan and Chris Sabine), been involved in teleconferences with CCHDO, now regularly up-dates the web site, communicated with the GO-SHIP committee, and wider community.

The goal of GO-SHIP is now to ensure continued funding of Martin's position.

## 6. Capacity building opportunities/requirements

GO-SHIP recognizes that new capacity is now available with a number of nations commissioning and operating global class research vessels. To reach and develop this new capacity we have expanded our committee to include representatives from Brazil, South Africa and New Zealand. We are actively seeking input and discussion with China, India and Korea. We hope to have representatives from these countries join the GO-SHIP committee and/or attend GO-SHIP meetings.

In the current decadal survey capacity building activities such as multi-nations collaboration on sections will be strongly support by GO-SHIP. We hope that this will ease pressure on ship resource in some nations and build capacity in nations that have ships but limited measurement capability.

7. Issues and challenges, ideas for integration, way forward

Issues and Challenges: (1) Funding of GO-SHIP sections are within each national research budgets. Therefore the ability of nations to support sections will require continued financial support within national research budgets. (2) GO-SHIP needs to review the list of standard parameter collected and accuracy of these observations. (3) Ensure that all data are submitted and accessible within the GO-SHIP specified time limits. (4) Provide leadership for the development of an International data centre for LADCP and SADCP data

Way Forward: (1) GO-SHIP, in conjunction IOCCP, will hold a committee meeting on 21 February 2014; (2) GO-SHIP and IOCCP will host a Town Hall meeting at Ocean Sciences 2014; (3) We will establish regular committee meetings (teleconference).

# ANNEX XII

## GLOBAL ALLIANCE OF CPR SURVEYS (GACS)

*(Report provided by Graham Hosie)*

GACS was established in September 2011 with the overall goal of understanding changes in plankton biodiversity at ocean basin scales through a global network of CPR surveys. GACS has a number of specific aims, which include:

- to develop a global Continuous Plankton Recorder (CPR) database
- to produce a regular Ecological Status Report for global plankton biodiversity
- to ensure that common standards and methodologies are maintained
- to provide an interface for plankton biodiversity with other global ocean observation programmes
- to set up and maintain a website for publicity and data access
- to facilitate new CPR surveys and develop capacity building procedures
- to facilitate secondments of CPR scientists between GACS institutions.

Nine regional surveys have joined GACS. The global database has been developed, as well as the website www.globalcpr.org. The second annual Status Report is being prepared. Working groups on standards/methodologies and database are established. GACS has established links or formal affiliations with a number of key stakeholders including, SCOR, SCAR, GOOS, SOOS, POGO and PICES.

New regional surveys have been established around South Africa, Japan, Australia and New Zealand. However, there are large areas of the world's oceans, notably the sub-tropical and tropical regions of the Atlantic, Pacific and Indian Oceans where there are no regular CPR surveys or plankton monitoring in general. GACS aims to improve coverage in those areas and hence has the specific aims mentioned above of facilitating new surveys and capacity building.

*Network status – measured against requirements with details of variables (scales, accuracies, application)*

CPR coverage of the North Atlantic and North Sea is extensive, temporally and spatially. Data have been collected since 1931. Tows are now extending into the Arctic. Tows have been conducted around the rim of the North Pacific from Vancouver to Alaska to northern Japan for nearly two decades. Tows in the Southern Ocean, predominantly south of the Sub-Antarctic Front, have operated since 1991, and provide near circum-Antarctic coverage. Major gaps are Amundsen and Bellingshausen Seas in the Pacific sector and the Weddell Sea. New regional surveys have been established around South Africa, Japan, eastern Australia and New Zealand. However, there are large areas of the world's oceans, notably the sub-tropical and tropical regions of the Atlantic, Pacific and Indian Oceans where there are no regular CPR surveys. GACS aims to improve coverage in those areas and hence has the specific aims mentioned above of facilitating new surveys and capacity building. Most surveys work on a 10 nautical mile resolution. The Southern Ocean, Australian and New Zealand surveys work on 5 nautical mile resolution to address finer scale changes in plankton in relation to frontal zones. CPR data have been used at regional levels to understand variation in spatial patterns, bioregionalisation, MPA assessment, seasonal and inter-annual trends, regime shifts, phenological shifts, predator-prey relations, detecting and mapping invasive species and harmful algal blooms, microplastics, and impacts of pollution, eutrophication, ocean warming and acidification. Collectively, the annual GACS Global Marine Ecological Status Reports cover reports from the regional surveys, biogeographic shifts, phenological change, changes in biodiversity, invasive species, eutrophication and HABs, microplastics and ocean acidification.

*Metrics - definition and implementation progress*

Each regional survey has a set of metrics for taxa unique to their respective region. GACS has developed a set of metrics that can be applied to all regional datasets that permits a global assessment of change across regions. These include total mesozooplankton abundance, ratio of diatoms to dinoflagellates, and Average Copepod Community Size (ACCS) (Richardson et al. 2006). ACCS is a weighted mean calculated as mean size of an adult female of a species of copepod multiplied by the abundance of that species, summed for all species and divided by the total number of all copepods. The premise for this metric is the hypothesis that warming oceans will see a shift in dominance to smaller, warm-water species (tropical species are smaller than polar species) which would be verified in a decrease in ACCS values. Metrics for assessing phenological change are being considered but for the moment this index will be the most limited to the few CPR surveys with a long enough time series to establish potentially subtle changes in timing.

*Standards and best practices (draft and documented)*

The CPR is a standardised machine using standardised mesh size set more than 80 years ago. The CPR has gone through a few minor changes to the external design and internal mechanism to take advantage of better materials and improve reliability, but otherwise the dimensions, apertures, gearing and functionality have remained unchanged. SAHFOS maintains detailed manuals on methodologies and practices for the maintenance and service of units, deployment at sea, post-cruise processing of samples, counting and taxonomic standards and methods for data logging and analyses. These manuals guide both day-today operations and training of new personnel. Similarly, other surveys following on from SAHFOS also define and maintain procedures unique for their region, especially in relation to taxonomic standards. GACS has a Working Group on Standards and Methodologies to ensure the CPR standards are maintained to guarantee data compatibility and comparability and address QA/QC issues. A related Database Working Group also applies and addresses standards in relation to database maintenance and data QA/QC.

*Evolution of network/new technologies/sensors*

The original CPR survey started by Sir Alister Hardy has now been going for 82 years. It has played and essential role in helping establish the other regional surveys. The focus now, through GACS, is to fill in the large ocean gaps identified above. GACS has been liaising with India to develop new CPR Surveys in the Arabian Sea and Bay of Bengal. We have a member on GACS representing South America aimed at developing a mid-Atlantic Survey. The SAHFOS has taken the lead in developing genetic/molecular methods that can be applied to CPR samples, current and archived, with considerable success. A molecular group is embedded in the SAHFOS team. Similarly, there is a group active in SAHFOS and supported by the GACS community to develop and add new instruments to the CPR to gather physical/chemical data to complement the CPR data. This includes micro-samplers to collect water for biological analyses. Miniaturisation of temperature, salinity, fluorometry units for use in biologgers on marine predators (mammals and penguins) has resulted in some very compact physical oceanographic recorders that can also be used on the CPR without affecting the efficiency of the CPR and subsequent data stream. The additional instrumentation is important to supplement data collected by merchant ships of opportunity which do not collect physical/environmental data on route. Research vessels that tow CPR units, notably in the Southern Ocean, usually have sophisticated underway recording systems that routinely collect environmental data. The instrumentation programme is part of the GACS philosophy of going global and going complete.

*Logistics and resource issues*

The CPR units are moderately cheap at ~USD50,000 per set (towed body and three recording mechanisms) and with proper maintenance they will last for decades making the units exceptionally cost effective. Overall, the CPR programme is recognised as the most cost effective method of rapidly and routinely surveying plankton biodiversity over ocean basin scales. The establishment of a survey does require some initial outlay that may limit the establishment of surveys by developing nations. GACS aims to provide assistance and advice to new surveys to make establishment easier. A major resource concern is the training and retaining of taxonomic specialists necessary to process the samples, i.e. identification and counting of plankton. This is a combination of diminishing research funds and the continuing loss of taxonomic expertise, common across biological disciplines. Most of the CPR surveys rely on the goodwill of merchant shipping companies to tow the CPR at no cost. However, routes are sometimes lost when they are cancelled or there is a change in ownership of vessels or ageing vessels are decommissioned and scrapped. The CPR community has the benefit of expertise of staff at SAHFOS skilled in finding and negotiating new vessels/routes. The Southern Ocean CPR work primarily uses supply and research vessels which are supported by national Antarctic agencies, and also receives support from and patronage of SCAR.

*Capacity building opportunities/requirements*

An aim of GACS is to enhance capacity, and exchange between labs to standardise procedures and protocols. As noted above one of the specific aims of GACS is directed at capacity building to increase the pool of expertise and facilitate new surveys. Training in various aspects of CPR work (maintenance and preparation of CPRS, use at sea, processing of samples, data management and analysis) has been routinely conducted at SAHFOS. Training has also been conducted in other centres in Tasmania, Japan, New Zealand and Brazil as required.

*Issues and challenges, ideas for integration, way forward*

The main issues and challenges are filling the regional gaps identified above and securing support funds for all the existing surveys as well as GACS itself, to ensure continued delivery of this essential service. In terms of integration, we have already published results demonstrating the ability to combine and co-analyse CPR and satellite acquired data (e.g. sea surface temperature, chlorophyll, sea surface height, sea ice concentration and extent) to identify variation in biographic patterns. Hot and cold spots can be identified and related to fishery areas and predator foraging zones. Other data sets can be combined with the CPR data, e.g. local underway environmental and biological hydro-acoustic data. Various modelling methods, GAMM, GDM, BRT, habitat niche models, network analysis, have been successfully applied to combined data sets.

*[page left intentionally blank]*