

**DATA BUOY COOPERATION PANEL**

**GLOBAL DATA BUOY OBSERVATIONS  
A DBCP Implementation Strategy**

**Eleventh Edition  
2012**

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**DBCP Technical Document No. 15**

**2012**

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## FOREWORD

The Drifting Buoy Co-operation Panel (DBCP) was established in 1985, jointly by the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, as a means of enhancing cooperation, coordination and information exchange among the operators and users of drifting buoys, meteorological and oceanographic, research and operational, with a view to improving both the quantity and quality of buoy data available on the Global Telecommunications System of WMO in support of major programme requirements of the two Organizations. The Panel appointed a full-time Technical Co-ordinator in 1987, using funds provided voluntarily by panel member countries, and in 1992 its Terms of Reference were widened and its name changed to Data Buoy Co-operation Panel to reflect its work in co-coordinating all forms of ocean buoy deployments.

During the more than 25 years of its existence, the Panel has achieved great success in achieving its initial objectives. At the same time, this period has also seen remarkable advances in buoy and communications technology, as well greatly enhanced and expanded requirements for buoy data, in particular in support of global climate studies. Major global experiments such as TOGA and WOCE have clearly demonstrated the value of buoy data for this purpose, and at the same time established and refined the buoy networks needed to fulfill the scientific requirements. One of the major challenges now facing the Panel and buoy operators is to convert the buoy networks established for these experiments into long-term operational programmes.

In recognition of these new developments and expanded requirements, and in the context also of the implementation plans and requirements of the Global Ocean Observing System (GOOS) and the Global Climate Observing System (GCOS), the Panel agreed in 1997 on the need for a DBCP Implementation Strategy, which would provide an overall framework for the Panel's work, and at the same time enable it and its members to react appropriately to future developments. A draft strategy document was prepared for the Panel by Mr David Meldrum, reviewed and revised at the panel session in 1998, and is now published in this DBCP Technical Document. The strategy document will also be made available through the DBCP web server.

### **PREFACE TO Eleventh EDITION, October 2012**

It is intended that the Implementation Plan should be a dynamic document that reflects the evolution of the DBCP's aims and aspirations within the rapidly changing environment of oceanography and marine meteorology. This edition takes particular note of the outcome of the fourth Session of the Joint WMO-WIO Technical Commission for Oceanography and Marine Meteorology (JCOMM, Yeosu, Republic of Korea, 23-31 May 2012).

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## RECORD OF CHANGES

Version No	Date	Change
A	Oct. 1997	First draft
1.0	Oct. 1998	First release
2.0	Oct. 2000	Revised and updated to take account of JCOMM and developments in satellite communications
2.1	Oct. 2001	New references, graphics and textual changes
3.0	Oct. 2002	New section 3.4, updated Annexes E and F
4.0	Oct. 2003	Add paragraph 8.13, update Annex F
5.0	Oct. 2004	Updated paragraphs 2.1, 3.5, 3.8, 4.1, 4.2 and 7
6.0	Oct. 2005	Updated Intro, paragraphs 3.5, 3.8, 6.1, 6.2, 8.13
7.0	Oct. 2007	Substantial changes to include new initiatives for the Panel such as pilot projects, task teams, user workshops, training courses and other outreach activities
8.0	Oct. 2008	Consideration of WMO and IOC strategic planning; updated paragraphs 4.1, 4.2 and contact details
9.0	Oct. 2010	Consideration of the outcome of OceanOBS'09 and JCOMM-III, as well as the requirements of the developing GFCS, and new GCOS-IP 2010 update
10.0	Oct. 2011	Consideration of outcome of WMO 16 <sup>th</sup> Congress and IOC 26 <sup>th</sup> Assembly
11.0	Oct. 2012	Consideration of the outcome of JCOMM-IV

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## **GLOBAL DRIFTING BUOY OBSERVATIONS - A DBCP IMPLEMENTATION STRATEGY**

### **1. INTRODUCTION**

Oceanographers and meteorologists have used satellite-tracked drifting buoys for two decades in support of both research and operational programmes. With the exception of the Global Weather Experiment FGGE, early deployments were largely uncoordinated at an international or even national level. Co-operation between the meteorologists and the oceanographers was also practically non-existent, not only because of a lack of motivation stemming from different perceptions of the aims of drifter deployments, but also because no forum for dialogue existed. Some changes came about through the establishment of the Argos Joint Tariff Agreement (JTA), and its requirement for basic coordination of national plans, and through Argos User Conferences. However, it was not until the creation of the DBCP in response to WWW requirements for routine high quality observations from the world's oceans that positive steps were taken towards large-scale international cooperation in drifter deployment and data management.

Some time before the establishment of the DBCP, a European initiative (COST-43) was established involving the collaborative deployment of meteorological drifters in the north Atlantic and this became in due course the first regional action group - the European Group on Ocean Station (EGOS) - of the DBCP. The group retains complete autonomy in all its operational and administrative matters, but draws on the support of the DBCP through its Technical Co-ordinator, the WMO and IOC Secretariats, and its meetings. The freedom to determine its own affairs, yet benefit from association with an established and internationally recognized parent body, has been a keynote in the success and stability of EGOS, and it has become the model for subsequent drifter action groups such as IABP, IPAB, IBPIO, ISABP, TIP, GDP, NPDBAP, and OceanSITES. The EGOS has gone from strength to strength, and has now re-emerged as E-SURFMAR – the Surface Marine programme of the Network of European Meteorological Services, EUMETNET.

All this has happened against a background of the fundamental global climate change that seems likely to result from increasing concentrations of greenhouse gases. Such is the universal appreciation of the consequences of climate change that climate issues have moved to the forefront of the international political agenda. The GCOS and GOOS both owe their origins to this concern, and are responding directly to the needs, expressed in Agenda 21, by the IPCC, and in support of the FCCC, for ocean data to underpin the understanding and prediction of global climate and environmental change.

Much practical progress has been made in bringing together all sides of the oceanographic, meteorological and climate communities to define these observational requirements and the organizational structure that will assume responsibility for them, notably at the OceanObs 99<sup>1</sup>, OceanObs'09<sup>8</sup>, and JCOMM<sup>2</sup> planning and following Session meetings. This plan, consistent with WMO and IOC Strategic Planning, takes note of these requirements and defines the DBCP role in the new structure.

The Terms of Reference of the DBCP and its Technical Co-ordinator are given in [Annex F](#).

### **2. RATIONALE**

Neither global programmes such as the GCOS, GOOS, WWW, nor indeed the DBCP action groups, currently operate as funding bodies for observational networks. Instead, all commitments for the implementation of these networks are made nationally to address the requirements of these global programmes, including through the Action Groups. Any DBCP implementation strategy must attempt to reconcile the needs and aspirations of

the global programmes with those of the drifter programme operators and funders, and align with the WMO and IOC Strategic Planning. Ultimately, it is an objective of the implementation strategy to assist in the unlocking of sustained national funding in support of the wider regional and global needs, at the same time recognizing that the aims of the programme operator remain paramount. In practice, with the advent of low-cost multi-function buoys, (e.g., the WOCE / TOGA SVP-B barometer drifter, see [Annex D](#)), is no longer the insurmountable problem that it once was.

### ***The definition of requirements***

There are three major met-ocean application areas that critically depend on highly accurate observations of met-ocean parameters: (a) Numerical Weather Prediction (NWP); (b) Seasonal to Inter-annual Forecast (SIA); and (c) Met-Ocean Forecasts and Services (MOFS), including marine services and ocean mesoscale forecasting.

The observational networks requirements proposed by the DBCP Data Users and Technology Workshop<sup>3</sup> (Reading, United Kingdom, 27-28 March 2006), based on specific requirements for Numerical Weather Prediction (NWP), climate variability and predictability, ocean / climate modeling, and climate forecasts are detailed in [Annex B](#). Taking SST as an example, the WMO's World Weather Watch (WWW) seeks observations at least every three hours over a 50km to 250 km horizontal grid with accuracy better than 0.5C and timeliness better than three hours for Global NWP; Ocean / climate application requirements expressed by the Ocean Observing Panel for Climate (OOPC) are an order of magnitude coarser in space and time, but at a level of accuracy an order of magnitude higher. In essence, this means that the density of any network deployed and maintained in support of weather forecasting will be more than adequate for the perceived needs of climate monitoring, provided that the accuracy and stability of the sensors can be improved. It should also be noted that OOPC calls for new sensors (e.g., for conductivity) that are not yet operational. In this context, the OOPC suggest that any practical, achievable implementation plan be broken down into a number of elements running over differing time scales, viz the identification:

- of elements that are part of existing operational systems;
- of elements to be added now to constitute the initial observing system (either enhancements to existing operational systems or parts of existing research observing systems ready for conversion to operational status);
- and specification of observations not now readily obtainable that are urgently required and should be added as enhancements to the initial system at the earliest feasible time; and
- of future research and development likely to be needed for further expansion of the system.

This analysis is used as a basis for the plan that follows. Although this strategy is restricted to drifting buoy applications, the Panel recognizes that moored buoys, sub-surface floats and profilers will also play a fundamental role in any future ocean observation network.

These basic requirements have been endorsed and further developed by other bodies, notably by GCOS and the UNFCCC<sup>4</sup>, and fall within the remit of the Group on Earth Observation (GEO), established by the Earth Observation Summit in 2003. Climate aspects are detailed in the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC (GCOS-92, October 2004)<sup>5</sup>, and its 2010 update (GCOS-138)<sup>7</sup>. While the exact composition of the desired network has yet to be defined, a figure of 1250 drifters is achieving wide acceptance, and has been set as a target within the JCOMM Observations Programme Area strategic plan. At the same time, appropriate spatial

distribution of the 1250 units over the global ocean must be achieved and requires smart and coordinated deployment strategies.

As part of the WMO Commission for Basic Systems (CBS) Rolling Review of Requirements (RRR) process, a Statement of Guidance (SoG) for Ocean Applications was developed to specifically address the requirements for met-ocean forecasts and services. These requirements had not been properly considered until now. The SoG provides for a gap analysis and includes recommendations to address identified deficiencies to meet the user needs. The Panel will strive to address those deficiencies.

The OceanObs'09 (21-25 September 2009, Venice Italy) was organized to celebrate progress in implementing the existing initial ocean observing system, realizing societal benefits from it and highlighting its potential; and develop a process for building consensus for sustaining and evolving systematic and routine global ocean observations over the next 10 years in support of societal benefits. The Panel will address the recommendations from OceanObs'09, and in particular those from the Community White Papers<sup>8</sup> that directly relate to buoy observations. The agreed Conference Statement of OceanObs'09 in particular:

- Calls on nations and governments to fully implement by 2015 the initial global ocean observing system envisioned at OceanObs'99;
- Calls on nations and governments to commit to the implementation of systematic biogeochemical and biological observations, and to extend the international coordination of observations, archiving and dissemination to regional and coastal ecosystems, guided by the outcomes of OceanObs'09;
- Invites governments and organizations to embrace a Framework for planning and moving forward with an enhanced global sustained ocean observing system over the next decade, integrating new physical, biogeochemical, biological observations while sustaining present observations. Recommendations on this Framework, considering how to best take advantage of existing structures, will be developed by a post-Conference working group of limited duration;
- Urges the ocean observing community to increase our efforts to achieve the needed level of timely data access, sensor readiness and standards, best practices, metadata, uncertainty estimates, and integrated data set availability, and;
- Asks governments, organizations, and the ocean observing community to increase their efforts in capacity-building and education.

The Panel is addressing the priority activities for this JCOMM intersessional period as decided at the fourth JCOMM Session (JCOMM-IV, Yeosu, Republic of Korea, 23-31 May 2012) for the Observations Programme Area (OPA) as described below, with no particular order:

- a) Contribute to WIGOS Implementation;
- b) proactively engage and establish dialogue with requirements setters and writers of implementation plans (such as OOPC, the WMO RRR, and the GFCS) to set realistic priorities for the future composite ocean observing system, establish practical ways of moving forward, and together seek routes for funding;
- c) recruit additional Members / Member States, institutions and agencies, in a way that allows their activities to progress on their own priorities and to contribute to the global observing effort;



- d) identify other ocean observing communities (e.g. ocean glider operators) and marine industry fora (e.g. the World Ocean Council) that might be recruited to extend the scope and capability of ocean observation;
- e) develop synergies between observing systems to exploit the potential of joint deployment opportunities, and to foster a common approach to sensor development and best practices;
- f) develop pilot projects as a means towards the rolling out of the new platforms, sensors and technologies that will in due course become routine components of the observing network;
- g) continue capacity development activities, including training workshops, that will assist developing countries to better use ocean products and to participate more fully in the global observing effort;
- h) encourage identification and implementation of observing standards and best practices, with particular focus on developing countries, including through encouraging JCOMM members to offer new Regional Marine Instrumentation Centre (RMIC) facilities; and
- i) continue to document institutional data and meta-data management practices for each component of the observing system to advance consistent, climate-quality, seamless data delivery both in near real time and delayed mode.

### **3. ANALYSIS OF EXISTING DRIFTING BUOY NETWORKS**

#### **3.1 Existing networks - current status**

In general, most current operational drifter networks fall within the scope of one or other of the existing DBCP action groups. Figure 1 indicates the areas of responsibility of each action group. Two of them are global: the Global Drifter Programme, and OceanSITES.

The deployments are increasingly of SVP-B drifters, which combine quantifiable current-following characteristics with reliable measurements of atmospheric pressure and SST. At present, in excess of 1250 drifters report their data via the GTS (Figure 2 and 3); about half of these report atmospheric pressure. Regular re-seeding is needed to maintain observational density, particularly in dynamic areas such as the south Atlantic. The action groups are the key to implementing and maintaining deployments in all ocean basins. [Annex C](#) gives an example of the operating principles for an action group.

#### **3.2 Existing networks - enhancements needed in support of the GOOS, GCOS, and the WWW**

Although the statistics for data availability collected by the various operational and archiving centres do not always fully agree, and despite the completion of the global drifter array in September 2005 with the deployment of drifter “1250” offshore from Halifax, it is clear that the existing networks do not approach the required observational density in a number of areas, viz the:

- global oceans (waves);
- tropical oceans (P, waves);

- tropical Indian Ocean (wind, waves);
- Polar regions (SST, P);
- North Pacific Ocean (SST, P);
- North East Tropical Pacific Ocean (SST, P);
- Arabian Sea (SST, P);
- Gulf of Guinea (SST, P); and
- Southern Ocean south of 40 S (SST, P, waves).

Figures 4 to 7 illustrate the problem through data availability indices for specific variables as a function of expressed WWW requirements.

The JCOMM Observations Coordination Group (OCG) has made recommendations to achieve better global coverage. Deployment and re-seeding strategies will be developed which optimize the expenditure of available resources, and which allow accurate and credible prediction of future resource requirements, and their relation to declared objectives. A method has already been developed by NOAA / AOML for this purpose using a simple model to forecast the probability of having buoys in specific regions 90 days in advance.

### **3.3 *New observations urgently required***

**Surface Atmospheric pressure and wind:** Equatorial areas, where the atmospheric pressure signal is typically weak, would benefit from a greatly increased density of wind observations but requirements for accurate in situ pressure measurements from these regions have also been expressed by NWP at a resolution similar to the global drifter array (i.e., 500km x 500 km). Spatial surface air pressure coverage is marginal for marine services applications. Mean sea level pressure is vital to detect and monitor atmospheric phenomena over the oceans (e.g., tropical cyclones) that significantly constrain shipping. Even very isolated stations may play an important role in synoptic forecasting, especially when they point out differences with NWP model outputs. Plans are therefore underway to install barometers on all drifters by 2012. Whereas the equatorial Pacific is adequately sampled by the moored TAO and TRITON arrays, and the PIRATA programme is addressing the sparsity of observations in the tropical Atlantic, the Indian Ocean is currently almost devoid of accurate in situ wind measurements, although plans are being drawn up for the establishment of a moored buoy array in the area.

**High temporal resolution SST:** OOPC has also expressed the requirement for collecting and transmitting high temporal resolution (i.e., at least hourly) SST measurements of high precision and accuracy from all drifters in order to resolve the diurnal cycle of SST and the foundation temperature. The Panel established a Pilot Project in this regard.

**Wave observations:** In situ measurements are currently too sparse in the open ocean. The vast majority of existing wave measurements are made in the coastal margins of North America and Western Europe, with a huge data void in most of the rest of the global ocean, particularly in the southern ocean and the tropics, while other existing observational systems have often considerable coverage in these areas. The JCOMM Expert Team on Wind Waves and Storm Surges (ETWS, now Expert Team on Waves and Coastal Hazards Forecasting Systems – ETWCH) has called for additional wave measurements comprising, at a minimum, significant wave height, peak period and 1-D spectra, hourly in real-time, for

assimilation into coupled atmosphere-ocean wave models for real-time forecasting activities, and subsequent verification. These are required for Maritime Safety Services, calibration / validation of satellite wave sensors, the description of the ocean wave climate and its variability on seasonal to decadal time scales, and the role of waves in the coupled ocean-atmosphere system, and their inclusion in weather and climate models. Satellite bias correction validation requirement is for average 1000km spacing with minimum 10% / 25cm accuracy for wave height and 1 second for wave period. Considering the lack of wave data, the DBCP is inviting buoy operators and Panel Members to increase wave measurements, particularly from open ocean areas, in the Southern Ocean, and the tropics. Wave measurement technology issues will also be considered by the Panel.

**Sea level observations:** Tsunami and storm surge-prone basins (e.g., Bay of Bengal, Gulf of Mexico and Pacific Islands) require higher density of sea level observations accompanied by observations of atmospheric pressure, and if possible winds and other environmental parameters. The International Tsunameter Partnership<sup>9</sup> (ITP), now an Action Group of the DBCP, is supporting the establishment, effectiveness and on-going viability and enhancement of tsunami detection and warning systems using deep ocean monitoring stations (tsunameters).

### **3.4 *The observational challenge posed by 4-D assimilation schemes***

Recent studies using models that allow assimilation of non-synoptic-hour data have demonstrated the positive impact of such data. In particular, the inclusion of hourly extra-tropical buoy data was found to significantly improve forecast quality, particularly in the southern hemisphere. Non-synoptic-hour data is not routinely reported by all buoys, nor is its insertion on the GTS by CLS / Service Argos currently supported. In both cases, little change would be needed to current practice to allow these additional data to be made available to forecasters.

### **3.5 *Future research and development***

In addition to the development and proving of an accurate and reliable wind sensor, OOPC have stated a requirement for ocean surface salinity and rainfall measurements. Very few drifters currently possess this capability, and it will become an area for further research and development. In situ salinity measurements will be of great value in developing the sensors and algorithms for salinity determination by satellite.

The Panel will also support other technology developments, e.g., the use of adaptive sampling ('smart buoys') to increase the impact and cost effectiveness of data buoy observations.

The Panel also recognizes the need for research to quantify the impact of buoy observations, and to use existing current climatologies and the like to develop deployment and re-seeding strategies that optimize these impacts within defined logistical and financial constraints.

### **3.6 *Regional and national issues***

It should not be forgotten that drifter deployments continue to be made in support of both operational and research programmes, which do not fall within the sphere of influence of any of the DBCP action groups. Efforts by the DBCP and the action groups will continue, to involve these buoy operators, in the work of the Panel, and to ensure where appropriate, that their buoy data are made available to the wider community, in near real-time if possible.

### **3.7 *Deployment opportunities***

The deployment and re-seeding of a large network of data buoys poses a huge logistical problem. To date, deployments have largely been accomplished opportunistically using volunteer ships and aircraft. This system is showing increasing signs of strain, and the DBCP will actively pursue additional strategies, recognizing that the issue of funding and associated logistical effort will have to be tackled. The Panel, with SOT and Argo are supporting the recruitment of a Ship Logistics Coordinator to work with JCOMMOPS.

### **3.8 Coordination issues**

Within the above context, the regional action groups are best placed to identify the precise needs in their particular areas of responsibility and to obtain the resources required. The Panel recognizes the autonomy of these groups and does not seek to impose any additional level of management or control. The Panel will also actively pursue the creation of new action groups to take care of issues associated with particular platform types, or other non-regional issues such as tsunami detection and warning.

There are areas, however, where the Panel is best placed to advise on overall methodology and policy; such areas include:

- a) *Co-ordination of deployments in areas not covered by the Action Groups or which involve several Action Groups.*

Such areas presently include:

- The Southern Ocean;
- The Mediterranean Sea; and
- The Black Sea.

Unless there is a need to specifically establish DBCP Action Groups for those areas, it is proposed to include one or more of such buoy programmes directly within the DBCP implementation strategy and to discuss important co-ordination and implementation issues at Panel sessions where all DBCP Action Groups are normally represented. During intersessional periods, co-ordination can take place through direct exchange between buoy operators (e.g., email, DBCP internet forum), and through the Technical Co-ordinator as focal point. Specific mailing lists can be established for this purpose. In the event that such programmes eventually reach a sufficiently high level of co-ordination, and if the buoy operators express the need, it could be eventually proposed to establish new DBCP Action Groups. Initially, the following buoy programmes are now part of the DBCP implementation strategy:

- The Southern Ocean Buoy Programme (SOBP), which would maintain a network of about 300 barometer drifters South of 40S, excluding the Antarctic sea-ice zone; and
  - The Black Sea Buoy programme (BSBP).
- b) *Real-time data quality control,*
  - c) *Data management,*
  - d) *Provision of instrumental metadata for climate studies*

- e) *Other co-ordination issues such as the negotiation of bulk purchase rates for drifter hardware and communications costs.*

The role of the Panel and its Technical Co-ordinator within the proposed new JCOMM structure is discussed in section 7.

## **4. DATA COLLECTION AND EXCHANGE**

### **4.1 *The status quo***

Until recently, the vast majority of drifting buoys used the Argos satellite system for location and data collection. Argos centres in France and the USA process telemetry datasets stored on board the NOAA satellites that carry Argos. Data are quality controlled and inserted on to the GTS for use by weather forecasters and climate modellers, and for archival by the responsible data centres, if authorised by the buoy operator. Data timeliness, vital for weather forecasting, can be improved by using LUTs to access buoy data rebroadcast by the satellites in real-time. The operators of the Argos system have been attentive to the need for faster data turn round times, and have taken steps to increase the amount of LUT data that are processed by the two main centres.

An agreed share of the operating costs of the two centres (approx € 6.4 million in 2006 out of a total of € 12.2 million) is recovered under the terms of the Argos JTA, under which all non-commercial usage of the system (of which drifting buoy operators account for roughly 50%) is charged out to users at an agreed and supposedly equitable rate. The Argos costs associated with a drifter programme are significant and can be higher (except for large programmes) than the actual buoy procurement costs, following the development of inexpensive buoy hardware. The DBCP will negotiate actively to achieve the best possible terms for data buoy users.

More recently other satellite service providers have entered the arena, notably Iridium, and successful evaluation conducted through a dedicated Pilot Project. Many buoy operators are now routinely deploying Iridium drifters in the world oceans, with the benefit of providing more timely data to the operational users..

### **4.2 *Future developments***

Many new mobile satellite services are at the planning or pre-operational stage (see [http://wo.jcommops.org/cgi-bin/WebObjects/JCOMMOPS.woa/wa/menu?abbrev=J\\_SAT\\_COMM](http://wo.jcommops.org/cgi-bin/WebObjects/JCOMMOPS.woa/wa/menu?abbrev=J_SAT_COMM)), and these are attractive to buoy operators, both from the cost perspective and from the increased operational flexibility (e.g. two-way communication) that they potentially offer. Systems, which feature a continuous global coverage (e.g., those intended to supplement the existing terrestrial cell phone networks), would in addition allow a return to truly synoptic reporting of observations.

Many of these new systems will may not full operational capability, nor will buoy operators ever achieve more than minority status. Systems such as Iridium and Orbcomm, which have in fact launched services, encountered severe financial difficulties before emerging into commercial viability. Potential users of any new systems therefore need to exercise considerable caution in considering a replacement for Argos. Argos has responded with a development programme, which should greatly increase the usefulness of their system for data buoy operations. In particular, they have established a protocol for the assimilation of data from third party communications providers into their own GTS processing chain.

The Panel will, in this context, act as a focus for the exchange of practical information on the performance of the various systems, and will continue to be active in

sponsoring evaluation trials and pilot projects of new equipment and systems as they become available. As with Argos, the Panel will seek to negotiate the best possible terms for data buoy users of these systems.

## **5. DATA MANAGEMENT**

### **5.1 *Quality control***

Quality control procedures, jointly developed and implemented by the DBCP and the operators of the Argos system, currently ensure that surface observations are validated in real-time before insertion on to the GTS (see DBCP Technical Document No. 2). Sub-surface (e.g., from the TAO array) data are further quality controlled by NOAA / NDBC. Several other bodies (ECMWF, national weather and oceanographic agencies, GDC, ISDM, etc.) contribute to an active off-line assessment of data quality. A well-defined feedback mechanism ensures that any interventions arising from this off-line quality control (e.g., modifications to individual sensor transfer functions) are implemented into the real-time data processing chain in a coordinated and auditable fashion. The Panel will encourage the users of other satellite communications channels and observing systems to benefit from its experience in this regard, with a view to avoiding the many quality pitfalls that beset the acceptance of early drifting buoy data by the operational community.

### **5.2 *Data archiving***

Drifter data inserted on the GTS are routinely archived by ISDM, the IODE Responsible National Oceanographic Data Centres (RNODC) for Drifting Buoys. The DAC archives all data from the GDP, and any other drifter data that are made available to it. The Panel and its action groups will actively encourage all buoy operators to forward their data to one or other of these responsible global archives.

### **5.3 *Instrumental Metadata***

There has been an increasing demand for instrumental metadata in recent years to server a number of applications, and climate studies in particular. The DBCP has established its own metadata collection system at JCOMMOPS and is participating in the overall JCOMM efforts to integrate the management of instrument/platform metadata from ocean observation platforms, including through the provision of buoy metadata to the WMO-IOC Centres for Marine Meteorological and Oceanographic Climate Data (CMOCs)<sup>1</sup>.

### **5.4 *Data access policy***

At present, all of the archiving agencies and many of the operational and research bodies make provision for the release of drifter data to scientific and other customers. In particular, many data are available via the World-Wide Web (see [Annex E](#)), either in the form of trackplots or as datasets. In many cases, the policies relating to the release and use of these data are not immediately clear. The Panel is seeking clarification from these agencies, and from its action groups, with a view to developing a coordinated data access policy for drifter data within the letter and the spirit of the WMO data exchange policy defined in WMO Congress Resolution 40 (Cg-XII).

### **5.5 *DBCP publicity***

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<sup>1</sup> JCOMM-IV approved establishment of the National Marine Data and Information Service (NMDIS) of the China State Oceanic Administration (SOA) in Tianjin and the Deutscher Wetterdienst (DWD) in Hamburg to act as CMOCs on a trial basis.

Many suggestions have been made over the years regarding ways of publicizing the DBCP and its activities. The DBCP server on the World Wide Web has in practice, superseded most of these, and this website is now the *de facto* entry point for current information about the DBCP and its action groups.

The Panel is taking steps to ensure that resources and information are available to allow this website to be developed and updated as required.

## **6. SUPPORTING ACTIVITIES**

### **6.1 *User workshops***

The Panel recognizes the enormous importance of engaging with the many communities that impinge upon its activities, from the research organizations developing new sensors to the manufacturers that provide the products on which buoy operators depend and the user groups, both operational and research that depend on data buoy observations. To this end, it will from time to time organize workshops to draw together these communities in addressing key common issues.

### **6.2 *Capacity-Building***

In recognition of the vast experience that exists amongst its members, the wish for developing nations to become engaged in data buoy activities, and the benefits that would accrue to the Panel from developing collaborative deployment arrangements with these countries, the Panel will actively create and deliver training courses targeted at these regions. Materials developed for these courses will be added to the repositories of educational resources on websites such as Ocean Teacher (<http://ioc.unesco.org/oceanteacher>).

### **6.3 *Task Teams and Pilot Projects***

Experience has shown that specific technical or organizational issues facing the Panel are often best attacked by a small team of experts, working during intersessional periods, and that their deliberations may lead logically to coordinated evaluation activities. The Panel will continue to foster the creation of such Task Teams and Pilot Projects as an efficient way of meeting its objectives within resource constraints.

### **6.4 *Other outreach activities***

The Panel is increasingly cited as a model of a practical coordination group, capable of managing the transition of an observing system from the research laboratory to the operational arena. Other bodies frequently come to the Panel for advice and assistance, and the Panel will continue to offer every possible support to such groups, in recognition that its activities are but a component of a much wider effort.

## **7. RESOURCE REQUIREMENTS**

### **7.1 *Human resources***

Most of the success of the Panel to date in implementing its objectives is entirely due to the efforts made on its behalf by its Technical Co-ordinator, and by the support afforded to her by the buoy operators and other agencies. The Panel will build on this success by actively seeking adequate and secure resources to ensure the continued employment of its Technical Co-ordinator. In this context, the Panel will make every effort to act as a responsible

employer and will make every effort to ensure that sufficient and stable funding is in place to meet its obligations in this regard

## **7.2 Hardware and telecommunications**

The JCOMM strategic implementation workplan is calling for maintaining a network of about 1250 drifters in the global oceans, all equipped with barometers (representing a global 5°\*5° coverage, achieved in 2005). This presently represents a hardware investment of USD 4 million.

The maintenance of the network itself presents formidable re-seeding and enhancement challenges if its value is to be fully realised. Re-seeding of networks to cover buoy mortality and dispersion will require a further annual hardware commitment of 650 SVP-B (USD 2 million at current cost levels), if present drifter lifetimes and trajectories are maintained.

The initial goal of the re-seeding strategy is to tentatively maintain a homogeneous network of buoys with a 500\*500 km resolution. Considering that all operational drifters are transmitting every day via the Argos System, about 1250 PTT-years are needed to ensure data collection. At present, data telecommunication costs for small and larger buoy programmes, this would represent about USD 2 million. With increased pressure from potential competing data collection systems (e.g., Iridium) there is still a potential to substantially decrease telecommunication costs.

In recognition of the economies of scale that will flow from global annual procurements of this size, the Panel and its action groups will seek negotiations with the drifter manufacturers and the communications service providers to establish economical prices that will then be available to individual buoy operators.

## **8. THE DBCP ROLE WITHIN JCOMM, and the umbrella Organization, WMO and IOC**

In deciding an organizational structure for JCOMM, the JCOMM planning meetings have noted the Panel's success in resolving many operational and co-ordination issues regarding buoy data quality, data flow, deployment scheduling and so on, and have adopted a similar 'Observations Co-ordination Group' for the management of the JCOMM observational programme (See [Annex G](#)). Membership of this group includes the Chairperson and Technical Co-ordinator of the DBCP. The DBCP implementation strategy is consistent with the JCOMM Observing System Implementation Goals for Building a Sustained Global Ocean Observing System in Support of the Global Earth Observation System of Systems (April 2009)<sup>6</sup>. In practical terms, the DBCP Technical Co-ordinator works alongside the co-ordinators of other observing systems to implement a common approach to deployment strategy, data management and quality control, and to ensure the most efficient use of deployment opportunities. In this regard, the Panel will actively encourage the operators of other observing and satellite data collection systems to make full use of the Panel's experience and expertise in these areas.

As part of its contribution to the WMO Strategic Plan for 2012 to 2015, and particularly to Expected Result 4<sup>\*</sup>, the DBCP is committed to assisting in the development of the WMO Integrated Global Observing Systems (WIGOS), facilitating buoy data exchange through the WMO Information System (WIS). From that perspective, the Panel is committed to follow the legacy recommendations from the the Pilot Project for the integration of marine

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<sup>\*</sup> ER-4: Enhanced capabilities of Members to access, develop, implement and use integrated and interoperable Earth- and space-based observation systems for weather, climate and hydrological observations, as well as related environmental and space weather observations, based on world standards set by WMO.



and other appropriate observations into the GOS (or WIGOS Pilot Project for JCOMM). This implies the following actions by the Panel:

- Integrating DBCP Best Practices and Standards into the WIGOS. This will be achieved through: (i) contributing to the development of WIGOS Best Practices and Standards; (ii) implementing those WIGOS agreed upon Best Practices and standards; and (iii) contributing to the development of specialized and / or regional marine Instrument Centres;
- Promoting the distribution of the data in real-time through the WMO Information System (WIS);
- Promoting the provision of the delayed-mode buoy data to the RNODC/DB; and encouraging RNODC / DB and SOC / DB to develop interoperability arrangements with the WIS;
- Promoting the collection and exchange of buoy platform / instrument metadata and their provision through the Marine Climate Data System (MCDS)

The Panel is also committed to responding to the observational data requirements of the developing Global Framework for Climate Services (GFCS). From that perspective, the Panel will be working at the sustainability of the drifting and moored buoy networks already contributing to the GCOS Implementation Plan, and its 2010 update.

In addition, the Panel agrees that operational and research observing networks in Polar Regions should be integrated within the framework of the WMO Integrated Observing System (WIGOS) and the WMO Information System (WIS), be enhanced to include cryosphere related variables recognizing that a major contribution to this objective will be through development of the Global Cryosphere Watch (GCW). The Panel is committed to contribute to the Implementation phase of the GCW (2012-2019) by deploying automated observing platforms on and under the sea and ice, in order to meet the needs of NWP, hydrological services, climate studies and research programmes.

## **9. SUMMARY OF AIMS AND OBJECTIVES**

- 9.1 *The Panel will encourage its Members to assist, as appropriate, in the development of the WIGOS Pilot Project for JCOMM (i.e., integrating Best Practices, provision of the data, and discovery metadata to WIS, collection of platform / instrument metadata).*
- 9.2 *Deployment and re-seeding strategies, and associated funding mechanisms, will be developed which optimize the expenditure of available resources, and which allow accurate and credible prediction of future resource requirements, and their relation to declared objectives.*
- 9.3 *The Panel will seek to implement accurate pressure measurements using SVPBs throughout the global oceans, including tropical and polar regions.*
- 9.4 *The Panel will seek increased measurements of significant wave height, peak period and 1-D spectra, hourly in real-time, especially in the Southern and Tropical Oceans.*
- 9.5 *The Panel will actively encourage the collection and distribution of high temporal resolution SST data to meet the OOPC requirement for resolution of the diurnal SST cycle.*

- 9.6 *Further research and development will be undertaken on new sensors to observe variables such as salinity, rainfall, wind, heat flux, ocean colour and CO<sub>2</sub>.*
- 9.7 *The Panel will cooperate with the International Tsunameter Partnership (ITP) in the view to better monitor Tsunami and storm surge-prone basins (e.g., Bay of Bengal, Gulf of Mexico and Pacific Islands) through the deployment and operations of multi-purpose data buoys.*
- 9.8 *Efforts will continue by the DBCP and the action groups to involve other buoy operators in the work of the Panel, and to ensure, where appropriate, that their buoy data are made available to the wider community, in near real-time if possible.*
- 9.9 *The Panel recognizes the autonomy of its action groups and does not seek to impose any additional level of management or control.*
- 9.10 *The Panel will seek to implement the collection of instrument metadata for climate studies, for submission through the Marine Climate Data System (MCDS).*
- 9.11 *The Panel will act as a focus for the exchange of practical information on the performance of the various satellite communication systems, and will be active in sponsoring evaluation trials of new equipment and systems as they become available.*
- 9.12 *The Panel will from time to time establish dedicated Task Teams and Pilot Projects to address particular areas of interest or concern for its activities, within agreed timescales.*
- 9.13 *The Panel will engage in appropriate outreach activities, such as the organization of user workshops, the development and delivery of training courses, and the assistance of other observing system groups in the achievement of their aims.*
- 9.14 *The Panel and its action groups will actively encourage all buoy operators to forward their data to one or other of the responsible global archives.*
- 9.15 *The Panel will seek clarification of their data release policy from all agencies that distribute drifter data, and from its action groups, with a view to suggesting coordinated data access guidelines for drifter data, compatible with the WMO policy defined in Resolution 40 (Cg-XII).*
- 9.16 *In recognition of the economies of scale that will flow from global annual procurements of the size indicated by the WWW and the OOPC requirements, the Panel and its action groups will develop negotiations with the drifter manufacturers and the communications service providers to establish prices that will then be available to individual buoy operators.*
- 9.17 *The Panel will seek adequate and secure resources to ensure the continued employment of its Technical Co-ordinator.*
- 9.18 *Within the context of the proposed JCOMM operational structure, the Panel will encourage the users of other satellite communications channels and observing systems to benefit from its experience in data management and co-*

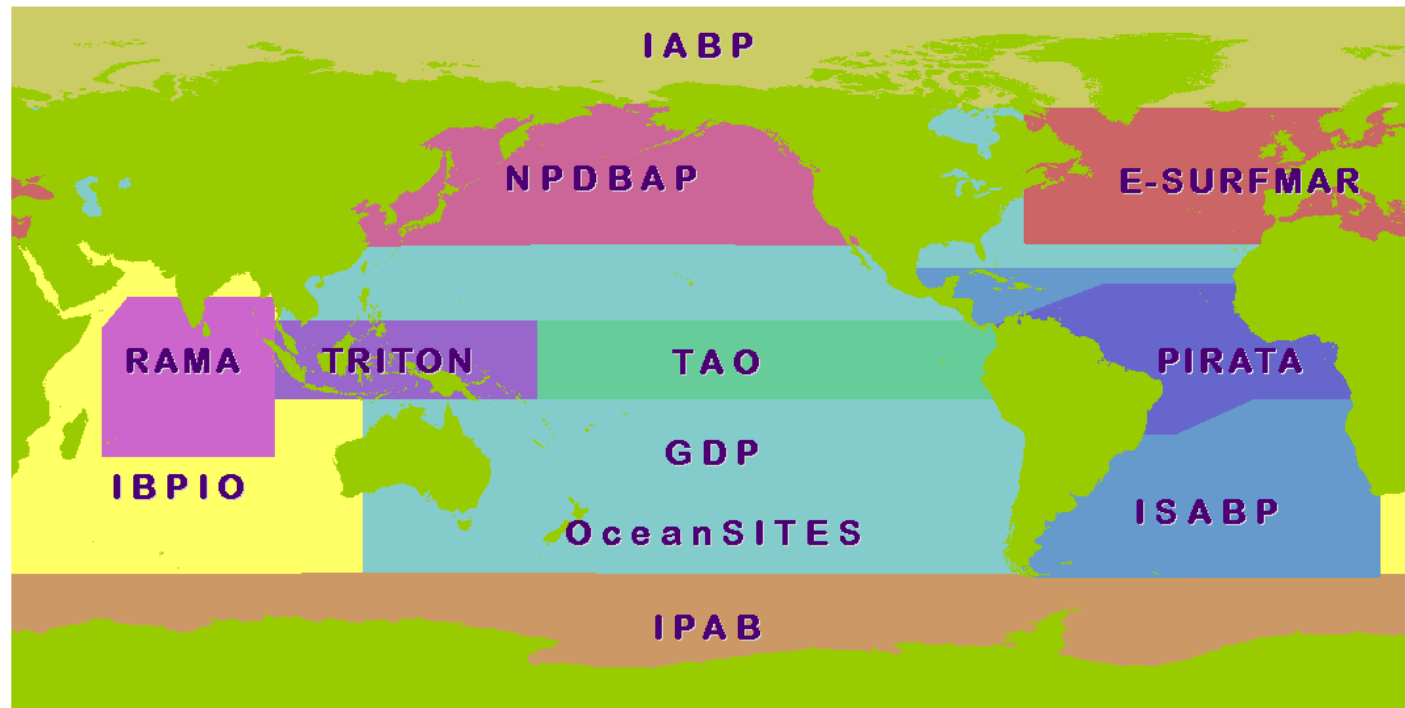
*ordination, with a view to their avoiding the many pitfalls that beset the acceptance of early drifting buoy data by the operational community.*

- 9.19 *The Panel will note the deliberations of the UN Convention on the Law of the Sea (UNCLOS) and the provisions of the Antarctic Treaty, as amended by the Madrid Protocol (1991), with regard to data buoy operations.*
- 9.20 *The Panel will regularly review its mission in the light of changing research, organizational and operational imperatives, and will update this document and its terms of reference as appropriate. The Panel will continue to explore ways to expand its membership, in particular through enhanced links with countries operating drifting and moored buoy or profiling float observational programmes supporting WMO and IOC applications.*

## 10. REFERENCES:

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4. The Second Report of the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC, 2003. GCOS-82, WMO/TD No 1143, WMO, Geneva- [http://www.wmo.int/pages/prog/gcos/Publications/gcos-82\\_2AR.pdf](http://www.wmo.int/pages/prog/gcos/Publications/gcos-82_2AR.pdf)
5. GCOS-92, October 2004, Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC - [http://www.wmo.int/pages/prog/gcos/Publications/gcos-92\\_GIP.pdf](http://www.wmo.int/pages/prog/gcos/Publications/gcos-92_GIP.pdf)
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7. GCOS-138, August 2010, The 2010 Update of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC - <http://www.wmo.int/pages/prog/gcos/Publications/gcos-138.pdf>
8. OceanObs'09 Papers are available from <http://www.oceanobs09.net/>
9. The International Tsunameter Partnership (ITP) was established under the auspices of the IOC International Cooperation Group for the Indian Ocean Tsunami Warning and Mitigation System (IGC / IOTWS).

## FIGURES



**Regional Action Groups:**

**E-SURFMAR:** EUCOS Surface Marine Programme

**IABP:** International Arctic Buoy Programme

**IBPIO:** International Buoy Programme for the Indian Ocean

**Global Action Groups (not shown on the map):**

**GDP:** Global Drifter Programme

**OceanSITES:** Global deep ocean time-series reference stations

**IPAB:** WCRP-SCAR International Programme for Antarctic Buoy

**ISABP:** International South Atlantic Buoy Programme

**NPDBAP:** DBCP-PICES North Pacific Data Buoy Advisory Panel (North 30°N)

**TIP:** Tropical Moored Buoy Implementation Panel (includes PIRATA and TAO/TRITON Arrays)

*Figure 1: DBCP Action Groups in 2012.*

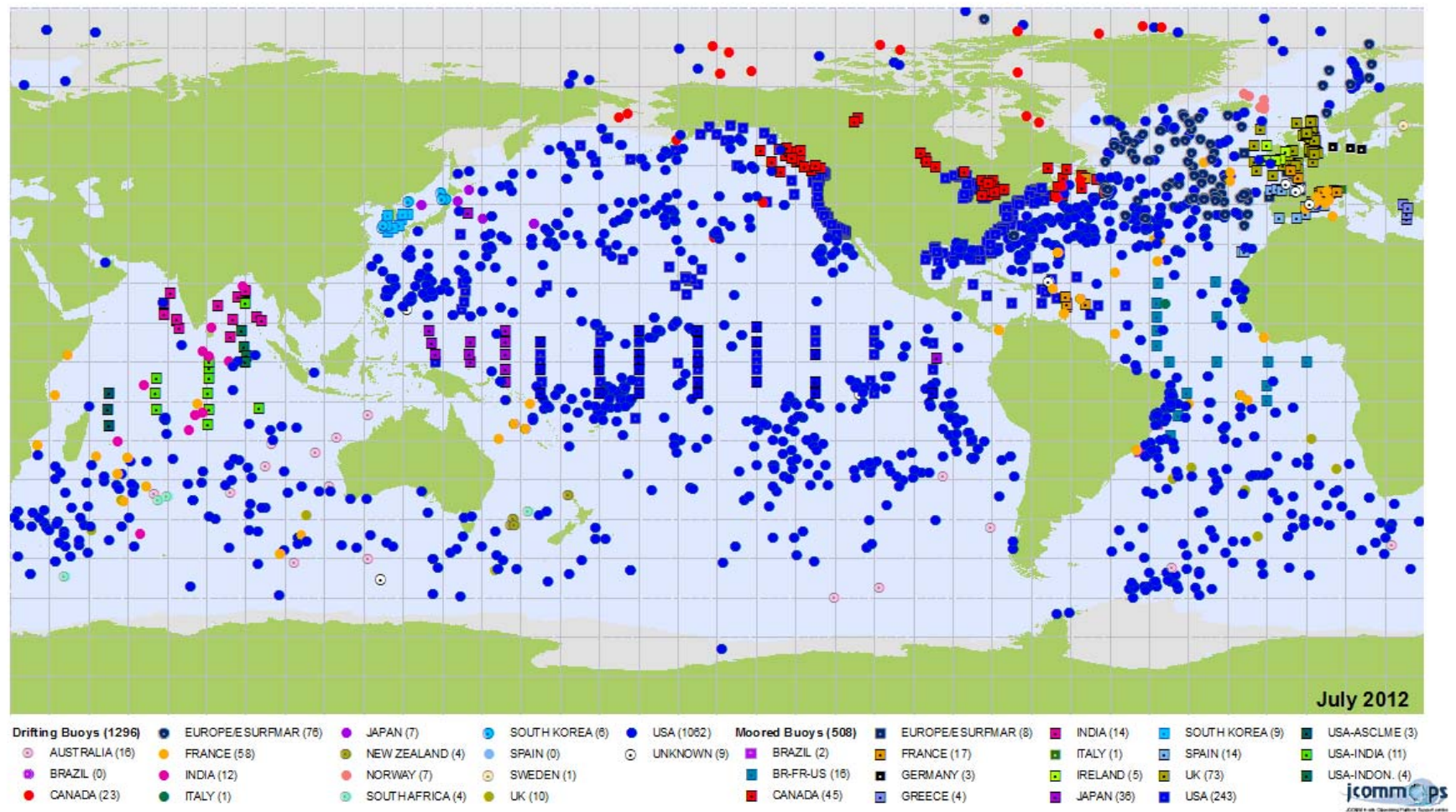
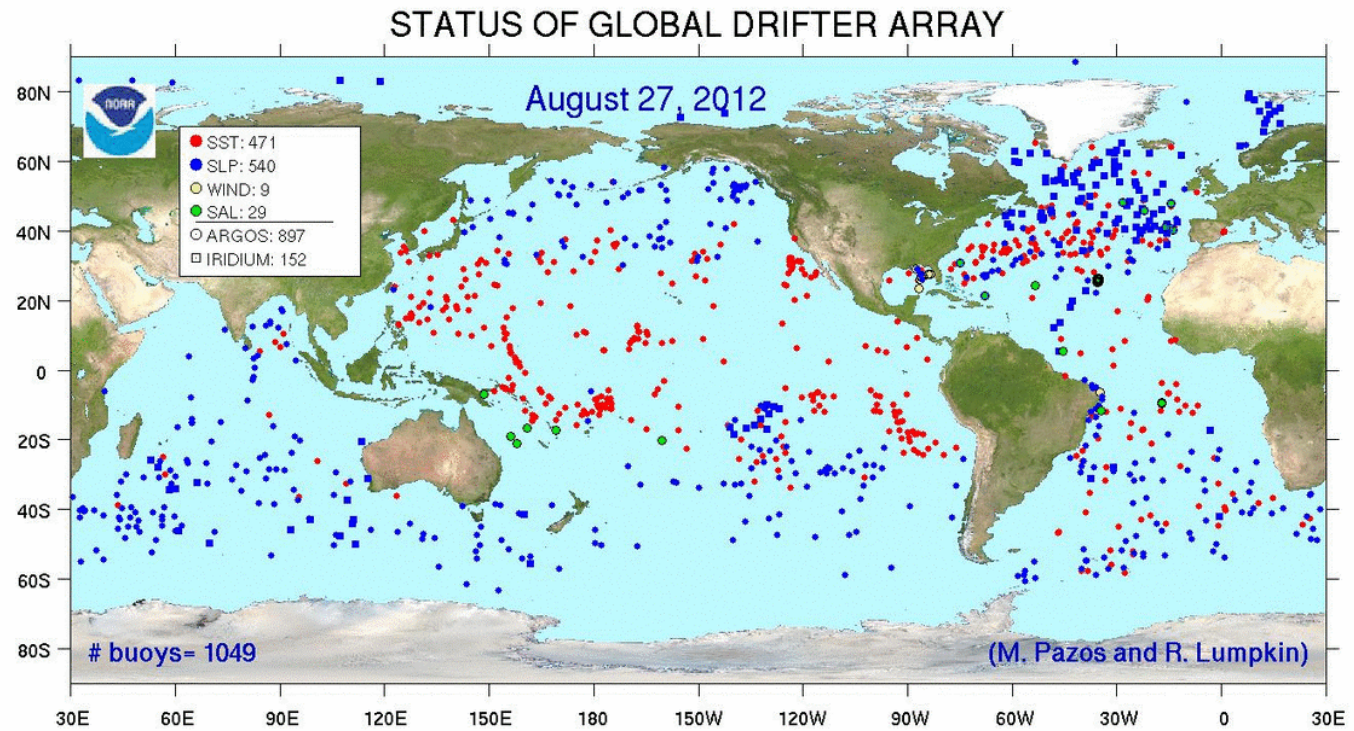


Figure 2. DBCP Status by country, June 2012.



**Figure 3.** The Global GTS drifter array in August 2012, by courtesy of the Global Drifter Center, NOAA-AOML.

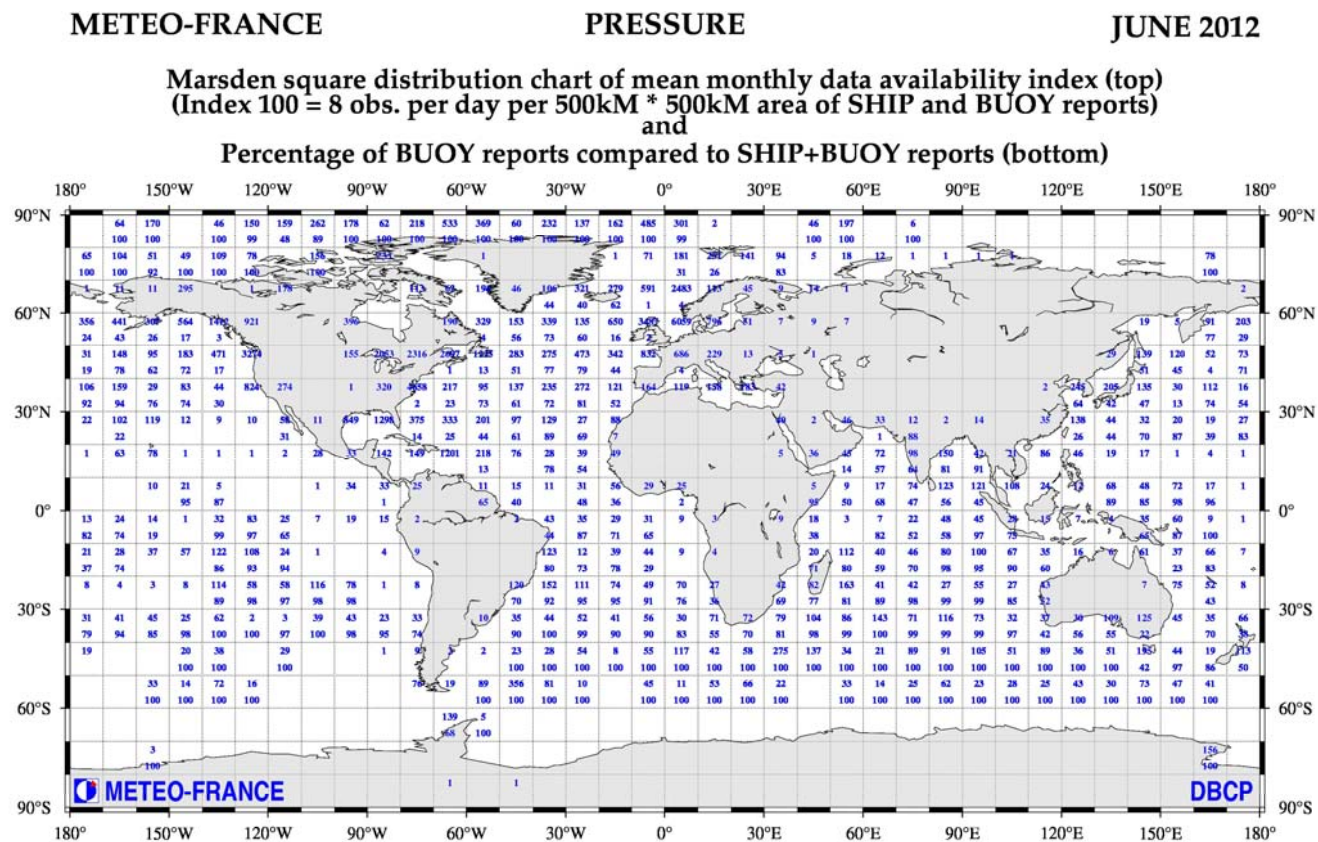


Figure 4. GTS data availability, June 2012 – Surface atmospheric pressure (by courtesy of Météo France).

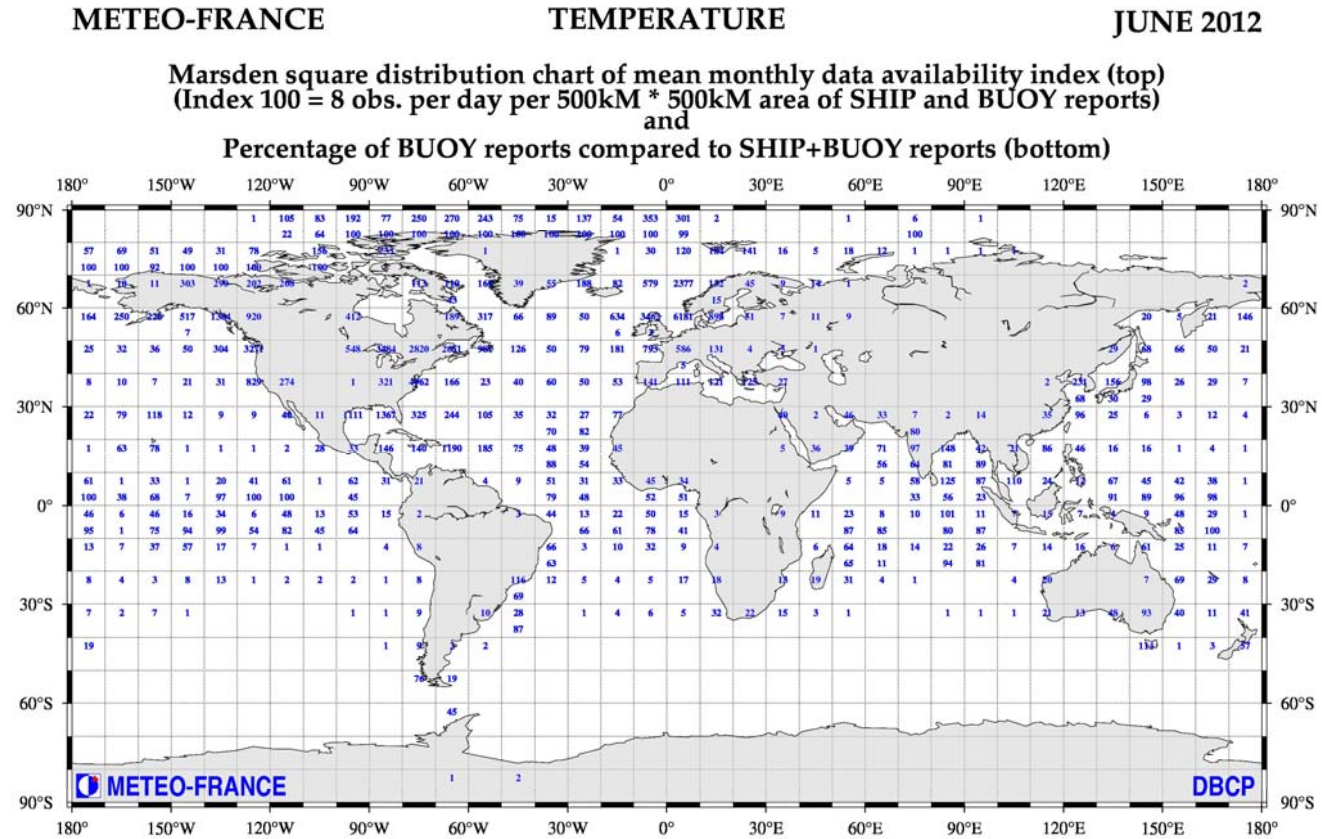


Figure 5. GTS data availability, June 2012 – Air temperature (by courtesy of Météo France).



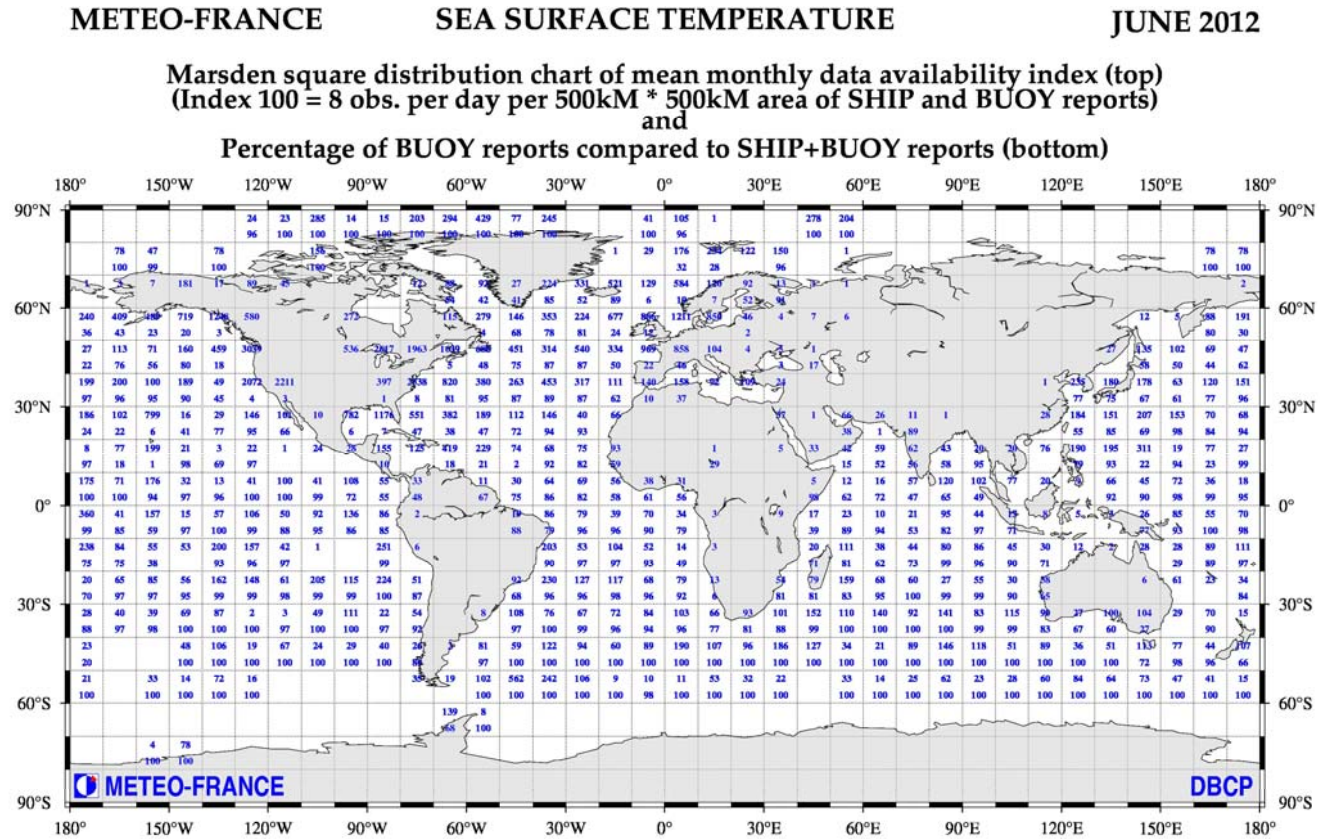


Figure 6. GTS data availability, June 2012– Sea surface temperature (by courtesy of Météo France).

METEO-FRANCE

WIND

JUNE 2012

Marsden square distribution chart of mean monthly data availability index (top)  
(Index 100 = 8 obs. per day per 500kM \* 500kM area of SHIP and BUOY reports)

and

Percentage of BUOY reports compared to SHIP+BUOY reports (bottom)

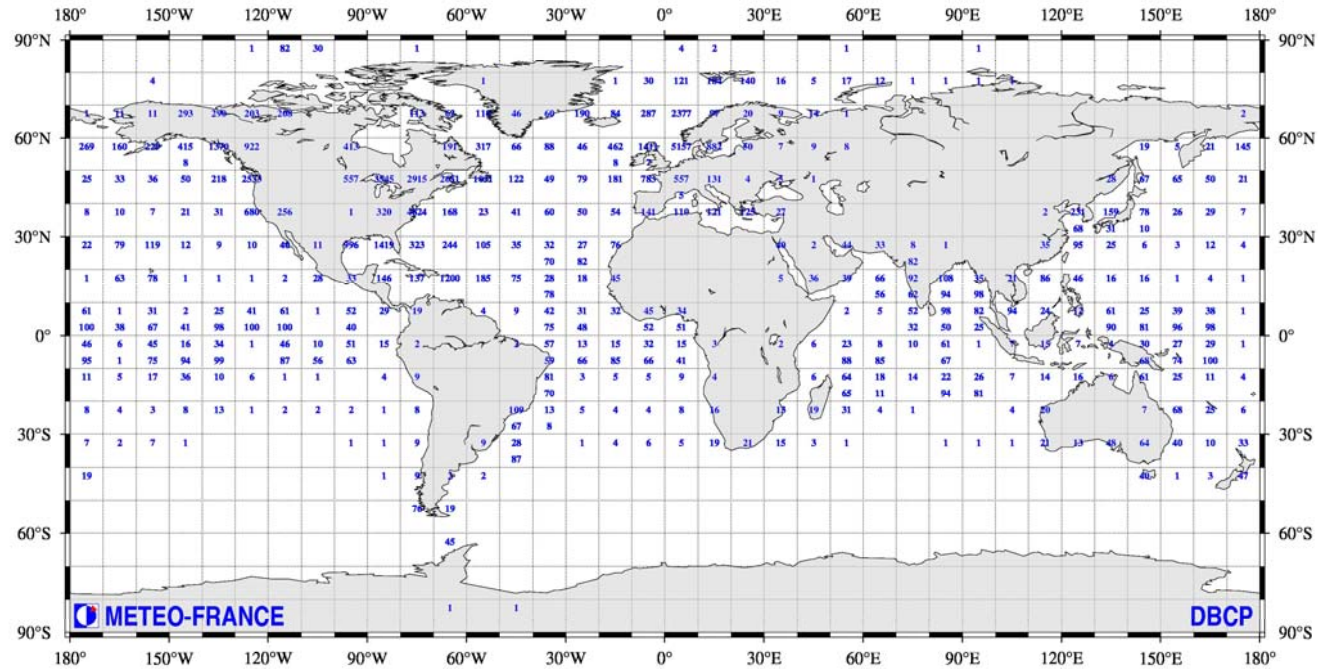


Figure 7. GTS data availability, June 2012 – surface wind (by courtesy of Météo France).

## ANNEX A

### ACRONYMS

AOML	NOAA Atlantic Oceanographic and Meteorological Laboratory (USA)
ASAP	Automated Shipboard Aerological Programme
CB	Capacity-Building
CBS	WMO Commission for Basic Systems
Cg	WMO Congress
CLIVAR	Climate Variability and Predictability (WCRP)
CLS	Collecte Localisation Satellites (France)
CMM	Centre de Météorologie Marine (Météo-France)
COST	European Cooperation in the field of Scientific and Technical Research
DAC	Data Assembly Center (of the WOCE Surface Velocity Programme)
DBCP	WMO-IOC Data Buoy Co-operation Panel
EC	Executive Council (of WMO or IOC as appropriate)
ECMWF	European Centre for Medium-range Weather Forecasts
EGOS	European Group on Ocean Stations (a former DBCP Action Group now merged into E-SURFMAR)
E-SURFMAR	Surface Marine programme of the Network of European Meteorological Services, EUMETNET (a DBCP Action Group)
ETWS	JCOMM Expert Team on Wind Waves and Storm Surges
EUMETNET	The Network of European Meteorological Services
FGGE	First Global GARP Experiment
FCCC	Framework Convention on Climate Change
GARP	Global Atmospheric Research Programme
GCOS	WMO-IOC-UNEP-ICSU Global Climate Observing System
GDC	Global Drifter Center (of the GDP)
GDP	Global Drifter Programme (a DBCP Action Group)
GEO	Group on Earth Observation
GFCS	Global Framework for Climate Services
GLOSS	JCOMM Global Sea Level Observing System
GOOS	WMO-IOC-UNEP-ICSU Global Ocean Observing System
GTS	Global Telecommunication System
IABP	International Arctic Buoy Programme (a DBCP Action Group)
IBPIO	International Buoy Programme in the Indian Ocean (a DBCP Action Group)
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
IODE	International Oceanographic Data and Information Exchange (of IOC)
IPAB	WCRP-SCAR International Programme for Antarctic Buoys (a DBCP Action Group)
IPCC	Intergovernmental Panel on Climate Change
ISABP	International South Atlantic Buoy Programme (a DBCP Action Group)
ISDM	Integrated Science Data Management (Canada, formerly MEDS)
ITP	International Tsunameter Partnership
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM in situ Observing Platform Support centre
JTA	Argos Joint Tariff Agreement
LUT	Local User Terminal
MEDS	Marine Environmental Data Service (Canada, now ISDM)
META-T	JCOMM Water Temperature instrument/platform Metadata Pilot Project
NDBC	NOAA National Data Buoy Center (USA)
NOAA	National Oceanographic and Atmospheric Administration (USA)
NOS	NOAA National Ocean Service (USA)
NPDBAP	DBCP-PICES North Pacific Data Buoy Advisory Panel (a DBCP Action Group)
NWP	Numerical Weather Prediction

OceanSITES	OCEAN Sustained Interdisciplinary Timeseries Environment Observation System (a DBCP Action Group)
OCG	JCOMM Observations Coordination Group
OCO	Office of Climate Observation (USA)
ODAS	Ocean Data Acquisition System
OOPC	GOOS-GCOS-WCRP Ocean Observations Panel for Climate
OOSDP	Ocean Observing System Development Panel
PICES	North Pacific Marine Science Organization
PIRATA	Pilot Research Moored Array in the Tropical Atlantic (of TIP)
PMO	Port Meteorological Officer
PMT	Platform Messaging Transceivers (Argos)
PTT	Platform Transmitter Terminal (Argos)
RNODC	IODE Responsible National Oceanographic Data Center (operated by ISDM, Canada)
ROC	Unique Responsible Organization representing a Country or a group of Countries (in the Argos JTA framework as of JTA-XXVII)
SCAR	Scientific Committee on Antarctic Research
SOBP	DBCP Southern Ocean Buoy Programme
SOOP	JCOMM Ship Of Opportunity Programme
SOC / DB	JCOMM Specialized Oceanographic Centre for Drifting Buoys (operated by Météo-France)
SOT	JCOMM Ship Observations Team
SST	Sea Surface Temperature
SVP	Surface Velocity Programme
SVP-B	SVP Barometer drifter
TAO	Tropical Atmosphere Ocean Array (of TIP)
TC	Technical Co-ordinator (of the DBCP)
TIP	Tropical moored buoy Implementation Panel (a DBCP Action Group)
TOGA	Tropical Ocean Global Atmosphere Programme
TRITON	Triangle Trans-Ocean buoy network (of TIP)
UNCLOS	United Nations Convention on the Law of the Sea
UNFCCC	United Nations Framework Convention on Climate Change
USD	United States Dollar
VOS	Voluntary Observing Ship Scheme
VOSclim	VOS Climate Project
WCP	World Climate Programme
WCRP	World Climate Research Programme
WIS	WMO Information System
WIGOS	WMO Integrated Global Observing System
WMO	World Meteorological Organization
WOCE	World Ocean Circulation Experiment
WWW	World Weather Watch

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**ANNEX B**

**OBSERVATIONAL REQUIREMENTS**

These requirements are based on realistic implementation targets for important variables measured with in situ ocean networks, and follow recommendations from the DBCP Data Users and Technology Workshop (Reading, United Kingdom, 27-28 March 2006).

The table has been compiled taking into account requirements for Numerical Weather Prediction, climate variability and predictability, ocean / climate modeling, and climate forecast.

<b>Variable</b>	<b>Horizontal resolution</b>	<b>Time resolution</b>	<b>Timeliness</b>	<b>Accuracy</b>
<b>SST</b>	5 °	1 H	3 H	0.2 C
<b>SSS</b>	200 km	10 days	3 H	0.1 psu
<b>Wind</b>	2°	1 – 2 days	3 H	0.1 to 1 m/s
<b>T profiles (Argo)</b>	3°	10 days	3 H	0.001 C
<b>Velocity (derived from drifters)</b>	600 km	1 month	6 H	2 cm/s
<b>Ice velocity</b>	200 km	1 day	3 H	1 cm/s

Specific requirements for the WWW, GOOS, and GCOS can be found in the WMO CEOS database, which is available on-line from the WMO website:( <http://www.wmo-sat.info/db/> ).

## **ANNEX C**

### **EXAMPLE OPERATING PRINCIPLES OF A DBCP ACTION GROUP**

#### **OPERATING PRINCIPLES OF THE ISABP**

##### **The ISABP strives to:**

- Maintain a data network over the South Atlantic Ocean using in situ ocean platforms such as island weather stations, moored buoys and in particular drifting buoys;
- Establish and maintain data collection and data communication facilities, and ensure that the necessary quality control is undertaken according to DBCP guidelines;
- Distribute basic meteorological and oceanographic data from the network at operationally useful time-scales over the Global Telecommunication System;
- Arrange for the archival of data from the network and for the provision of archived data sets to programme participants;
- Liaise on technical aspects of buoy development and operational matters; and
- Continually review the effectiveness of the programme in satisfying data requirements of the users.

##### **Operational area:**

The operational area is the Tropical and South Atlantic Ocean.

##### **Variables:**

Atmospheric pressure, sea-surface temperature and buoy location are reported. Additional variables such as air temperature, atmospheric pressure tendency, wind speed and direction, and surface and sub-surface oceanographic variables, especially waves, are viewed as highly desirable.

##### **Data archiving:**

All basic meteorological and oceanographic data from drifting buoys in the programme are archived by the Marine Environmental Data Service (Canada), as the Intergovernmental Oceanographic Commission (IOC) responsible national oceanographic data centre for drifting buoys.

Other buoy data quality control and archival activities are relevant to the programme, in particular those of the Global Drifter Centre in Miami.

##### **Basic network density:**

To be consistent with the requirements stated by the World Weather Watch, we attempt to provide a network of the basic variables with data points spaced at approximately 250 km intervals over the operational area. As far, as is practicable, sufficient platforms are deployed to achieve and maintain this density, taking into account other observing system components.

**Buoy recovery and refurbishment:**

Participants retain ownership of their buoys. While no specific plans for buoy recovery are made, agencies are encouraged to make arrangements, as appropriate, for the recovery, refurbishment and re-deployment of buoys, which drift ashore, or which, in other ways, no longer contribute to the goals of the programme.

**Data acquisition and distribution:**

All buoys in the basic network are equipped with transmitters to enable basic meteorological and oceanographic data to be transmitted in real-time (synoptic or asynoptic mode). As a preferred approach:

- Data are collected and located via the Argos systems;
- All basic meteorological and oceanographic data are coded in the approved WMO code form for buoys;
- Data collected through the Argos system are inserted by CLS / Service Argos into the Global Telecommunication System;
- Data collected by the participants through other means may also be inserted on the Global Telecommunications System; and
- The programme seeks to establish and maintain, as necessary, Argos Local User Terminals (LUTs) covering the area.

**Duration:**

The programme will operate for an initial five-year period with formal review by the participants after three years leading to a decision on its continuation.

**Funding arrangements:**

The programme will be self-sustaining, supported by contributions in the form of equipment, services (such as communications, development, archiving or co-ordination) or monetary contribution. The participants will make suitable arrangements for administration of monetary contribution.

**Meetings:**

An annual meeting of the participants will be held at a location to be determined by them. All the participants are eligible to attend at their own expense.

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## ANNEX D

### SPECIFICATIONS OF THE SVPB “BAROMETER” DRIFTER

#### 1. INTRODUCTION

The SVPB drifter is basically a standard SVP drifter to which an air pressure port has been added (figure 1). Both standard SVP and SVPB drifters are proven and reliable designs and have been deployed at sea in large quantities for oceanographic research and operational meteorological programmes (e.g., WOCE, TOGA, WWW). SVPB is capable of accurately measuring sea surface currents ( $\pm 1$  cm/s) in 10 M/S winds, sea surface temperature ( $\pm 0.1$  C), and atmospheric pressure ( $\pm 1$  hPa). Nominal lifetime is 18 months.

Design of the SVPB is regularly being upgraded to take advantage of new technologies and therefore to improve its overall reliability and lifetime. In latest design, the following changes have been proposed:

- Reduced Size hull (32cm); and
- 490 cm long drogue, 61cm in diameter

A construction manual, which does not mention above modifications has been produced and published by the DBCP (DBCP Technical Document No. 4). Manual has been revised in 2005 to reflect recent changes. Free copies can be obtained from the Technical Co-ordinator of the DBCP. A revised version of the manual is on the DBCP website.

#### 2. SURFACE CURRENT MEASUREMENT

For measuring surface velocity, standard SVP buoys have been designed to be good Lagrangian drifters (buoys which follow the water motion well) and very specific requirements of drogue and surface float design have been developed (large holey sock drogue, spherical floats and thin wire tethers, etc.). Laboratory and at sea tests have been conducted to guarantee the reliability of SVP drifter measurements.

The slip (i.e., the motion of the centre of the drogue relative to the moving water parcel) has been minimized. Many phenomena can induce slip; the main ones are wind stress, surface gravity wave effects and vertical shear of currents. Therefore, tests have been conducted on various shapes of floats and drogues (NOAA data report 1990). These tests show that the most efficient shapes are small, spherically-symmetric surface and sub-surface floats, thin-wire tethers and a large semi-rigid drogue. The drogues which have high drag coefficient and stable water following characteristics are the TRISTAR (Niiler, *et al.*, 1987) and the Holey Sock (Nath, *et al.*, 1979). The drag area ratio is the drag coefficient of the drogue times the frontal area divided by the sum of the products of the drag coefficient and the largest projected frontal areas of floats and tethers. A drag area ratio for the drifter greater than 40 will give the instrument the capability to make current measurements accurate to within 2 cm/s. Using a correction formula, a wind correction will then improve this accuracy to 1 cm/s if the wind is known within 4 m/s

#### 3. DROGUE DETECTOR (SUBMERSION SWITCH)

A drogue detector is necessary for ascertaining if the drogue is still attached. A drifter without a drogue is of little value for surface velocity measurements. Since the surface float goes under the water more often when the drogue is attached, one principle is to install a submersion detector (switch) on the surface float and to analyze the time series in order to



deduce if the drogue is still attached. Another principle is to use strain sensor where the drogue is attached to the drifter.

#### **4. SEA SURFACE TEMPERATURE MEASUREMENT**

The SVPB drifter is also equipped with a sea surface temperature sensor that is designed to make measurements accurate to 0.1 Celsius. Experience gained with the standard SVP drifter has been used. To obtain this accuracy, tests show that one must install the temperature sensor outside the hull of the drifter float. Also, calibrations of a number of thermistors while connected to the electronics circuitry in a test tank in various ranges of temperatures must be done. Only these kind of tests and calibrations can provide accurate coefficients to be used to convert raw data (resistance) into physical values (Celsius) within +/- 0.1 Celsius. The lifetime of the sensor will exceed that of the transmitter.

#### **5. ATMOSPHERIC PRESSURE MEASUREMENT**

The air pressure port has been designed to withstand frequent immersion with no loss of accuracy. The port is elevated to some height above the float itself to avoid Venturi effects caused by airflow over the curved float surface. The total surface of the mast is lower than 10% of the total frontal area so that wind stress does not induce a substantial slip effect compared to the one induced through the hull itself. The design is based on a port used on moored buoys by the United Kingdom Meteorological Office, which has had extensive field tests in the wind tunnel. Internal baffling is provided against submergence surges and sufficient back up volume of air assures that water does not enter the barometer duct.

The barometer port design is based on the following rationale:

- (i) Field observations indicate that the surface float of the SVP Lagrangian drifter is pulled under the water to a depth of 1-2 m at the crests of wind waves, therefore an overpressure of 200 hPa can be expected on the barometer. Data from the submergence switch on drifters in WOCE Heavy Weather Drifter Test (Sybrandy and Niiler, 1991) indicate that they spend about 20-30% of the time under the water in winds in excess of 15 m/s. Upon resurfacing, the port has to clear from sea-water quickly and completely. Flaps and valves to close a port will fail or become encrusted. An inverted port, with sufficient backup volume of air which can be compressed upon submergence so the water is kept out of the barometer air duct was incorporated in the design;
- (ii) A long air pressure duct to the barometer can collect condensation in the extreme changes of moisture and temperature which occur in synoptic weather systems. This problem was solved by placing the barometer very close to and above the air intake. Specially configured barometers were made for this application for GDC by several manufacturers;
- (iii) In a wind stream, the surface float produces a lowering of air pressure due to the Bernouilli effect. In 10 m/s wind, this effect produces less than 0.1 hPa pressure lowering at a distance of one radius of a sphere. The barometer port air intake is placed on a mast 24 cm above the top of the sphere. A second Bernouilli effect is produced by the airflow around the mast. This problem has been studied extensively, and a tabular windshield, with air intake holes inside an inserted, second sleeve is adopted (Osmund and Painting, 1984); and
- (iv) The sampling and averaging scheme for the air pressure has to be sensitive to when the port is under the water. Tests have run at sea under 15 m/s wind conditions off San Diego, California, USA (WOCE / TOGA Lagrangian Drifter with barometer port,

May 1991, Sybrandy and Niiler) where pressure was sampled at 2Hz inside the surface float. A laboratory standard barometer of identical construction was used to obtain data at identical rates about 3 meters above sea level in a semi-enclosed laboratory on a ship. No significant wind effects, or delay times, were observed on the barometer port response on the surface float in the water.

The sensor itself is an AIR SB-1A model. It is a ceramic diaphragm capacitance sensor equipped with a built-in temperature compensating circuit. AIR sensors have been carefully tested for WOCE and finally proved reliable (Payne *et al*, IMET). Accuracy is +/- 1 hPa with a stability of +/- 1 hPa over a one-year period. Sensor output is digital in tenths of hPa.

Data are sampled at 1 Hz, and averaged over a 160 seconds period. A dedicated despiking algorithm was designed to remove from the average these air pressure measurements made while the barometer port is submerged.

The latest average of every hour is stored on-board. The last 12 hourly measurements are memorized on-board and transmitted through Argos using multiplexing techniques. It is expected that the full series of 24 hourly measurements will be recovered every day. Hence, the latest available air pressure and tendency measurements (real-time) as well as the synoptic air pressure measurements can be distributed on GTS (deferred-time).

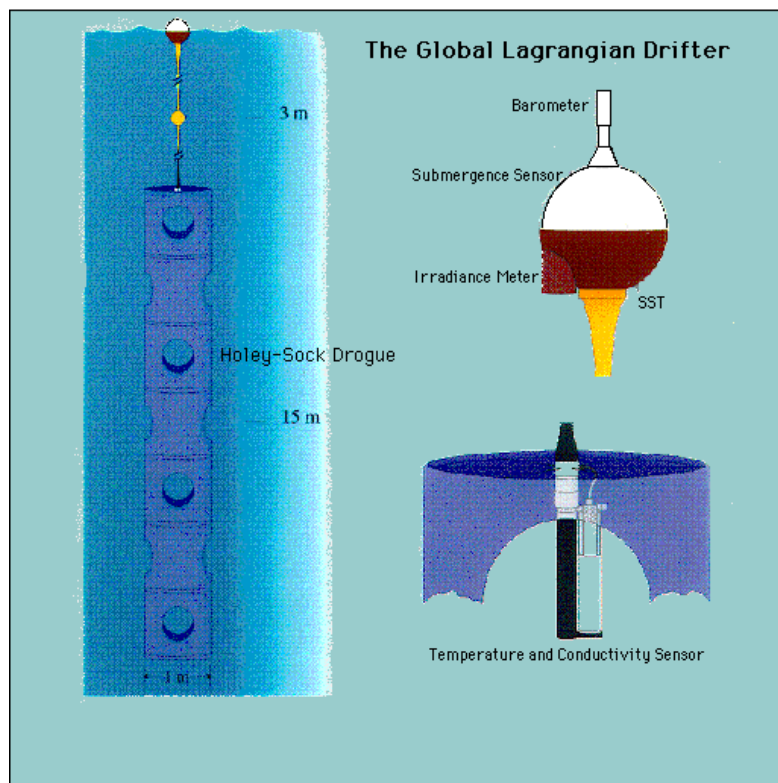


Diagram displaying the low-cost Global Lagrangian Drifter on the left hand side, and schematics of the sensor attachments (barometer, submergence, SST, irradiance and SEACAT), on the right hand side. Most drifters are also equipped with drogue sensors that indicate drogue loss. Buoys without drogues do not depict ocean currents accurately, because the drifter becomes susceptible to wave and wind action. Drifters transmit sensor data to satellites that determine the buoy's position and relay the data to Argos ground stations. Service Argos provides raw drifter data to the DAC where the data is processed and distributed.

**Figure 1:** The Minimet drifter. The SVPB drifter does not have the irradiance meter nor sub-

surface temperature and conductivity sensor. The standard SVP drifter does not have the barometer as well. Latest designs omit the subsurface float.

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## ANNEX E

### CONTACT INFORMATION AND WORLD-WIDE WEB ADDRESSES

#### **The Data Buoy Co-operation Panel**

Observing Systems Division  
Observing and Information Systems Department  
World Meteorological Organization  
CP 2300  
CH-1211 GENEVA 2  
Switzerland  
Tel.: +41 22 730 8223  
Fax: +41 22 730 8021  
E-mail: echartpentier@wmo.int

#### **DBCP Technical Co-ordinator**

JCOMMOPS  
8-10 rue Hermès  
Parc Technologique du Canal  
31526 RAMONVILLE SAINT-AGNE  
France  
Tel: +33 561 39 47 82  
Fax: +33 561 75 10 14  
E-mail: support@jcommops.org

<b>DBCP home page</b>	<a href="http://www.jcommops.org/dbcp/">http://www.jcommops.org/dbcp/</a>
<b>WMO home page</b>	<a href="http://www.wmo.int/">http://www.wmo.int/</a>
<b>GCOS home page</b>	<a href="http://www.wmo.int/pages/prog/gcos/">http://www.wmo.int/pages/prog/gcos/</a>
<b>GOOS home page</b>	<a href="http://ioc.unesco.org/goos/">http://ioc.unesco.org/goos/</a>
<b>OOSDP Final Report</b>	<a href="http://ocean.tamu.edu/oosdp/FinalRept/">http://ocean.tamu.edu/oosdp/FinalRept/</a>
<b>E-SURFMAR home page</b>	<a href="http://surfmar.meteo.fr/wikisurf/index.php/Main_Page">http://surfmar.meteo.fr/wikisurf/index.php/Main_Page</a>
<b>IABP home page</b>	<a href="http://iabp.apl.washington.edu/">http://iabp.apl.washington.edu/</a>
<b>IPAB home page</b>	<a href="http://www.ipab.aq">http://www.ipab.aq</a>
<b>ISABP home page</b>	<a href="http://www.dbcp.noaa.gov/dbcp/isabp/index.html">http://www.dbcp.noaa.gov/dbcp/isabp/index.html</a>
<b>IBPIO home page</b>	<a href="http://www.meteo.shom.fr/ibpio/">http://www.meteo.shom.fr/ibpio/</a>
<b>GDC home page</b>	<a href="http://www.aoml.noaa.gov/phod/dac/gdc.html">http://www.aoml.noaa.gov/phod/dac/gdc.html</a>
<b>ISDM home page</b>	<a href="http://www.meds-sdmm.dfo-mpo.gc.ca/">http://www.meds-sdmm.dfo-mpo.gc.ca/</a>
<b>NPDBAP home page</b>	<a href="http://npdbap.noaa.gov/">http://npdbap.noaa.gov/</a>
<b>TIP home page</b>	<a href="http://www.pmel.noaa.gov/tao/proj_over/tip/newpanel.html">http://www.pmel.noaa.gov/tao/proj_over/tip/newpanel.html</a>

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## ANNEX F

### TERMS OF REFERENCE OF THE DBCP AND ITS TECHNICAL CO-ORDINATOR

*(as approved by the JCOMM Co-Presidents on behalf of the Commission, 24 July 2012, per Resolution 3 (JCOMM-4))*

#### Part A

The Data Buoy Co-operation Panel shall:

Consider the expressed needs of the international meteorological and oceanographic communities for real-time or archival data from ocean-data buoys on the high seas, as well as rigs and platforms reporting surface marine meteorological and oceanographic data and request action from its members, the Technical Co-ordinator or Action Groups to meet these needs;

1. Co-ordinate activity on existing programmes so as to optimize the provision and timely receipt of good quality data and metadata from them;
  2. Propose, organize and implement, through the co-ordination of national contributions, the expansion of existing programmes or the creation of new ones to supply such data;
  3. Support and organize as appropriate such Action Groups as may be necessary to implement the deployment of data gathering buoys to meet the expressed needs of oceanographic and meteorological programmes such as WWW, WCRP, GOOS, GCOS, GFCS, WIS, and WIGOS;
  4. Encourage the initiation of national contributions to data buoy programmes from countries which do not make them;
  5. Promote data exchange, including the insertion of all available and relevant platform data and metadata into the Global Telecommunication System, and the submission of data and metadata to the appropriate archives;
  6. Promote the exchange of information on data buoy activities and encourage the development and transfer of appropriate technology;
  7. Ensure that other bodies actively involved in buoy use are informed of the workings of the Panel and encourage, as appropriate, their participation in the Panel deliberations;
  8. Make and regularly review arrangements to secure the services of a Technical Co-ordinator with the terms of reference given in Part B;
  9. Report formally to the Joint WMO / IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM), and participate in and contribute to an integrated global operational ocean observing system, implemented and co-ordinated through JCOMM; and
  10. Submit annually to the Executive Councils of the WMO and the IOC, to JCOMM and to other appropriate bodies of WMO and IOC, a report that shall include summaries of the existing and planned buoy deployments and data flow.
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## Part B

### **Terms of Reference for the Technical Co-ordinator of the DBCP (Approved by WMO Resolution 4 (WMO EC-LXII) and UNESCO/IOC Resolution XVII-6)**

The Technical Co-ordinator of the Data Buoy Co-operation Panel shall:

1. Under the direction of the Data Buoy Co-operation Panel take all possible steps within the competence of the Panel to assist in the successful achievement of its aims;
  2. Assist in the development, implementation, and management of quality control procedures for relevant observing platforms;
  3. Assist in setting up suitable arrangements for notifying the appropriate user communities of changes in the functional status of relevant operational observing platforms;
  4. Assist in the standardization of relevant observing platform formats, sensor accuracy, etc.;
  5. Assist when requested with the development of cooperative arrangements for buoy deployment;
  6. Assist in the clarification and resolution of issues between Service Argos and ~~buoy~~ relevant observing platforms operators;
  7. Assist in promoting the insertion of all available and relevant observing platform data into the Global Telecommunications System;
  8. Supply information about buoy developments and applications to the WMO and IOC Secretariats and assist the Data Buoy Co-operation Panel to promote an international dialogue between oceanographers and meteorologists;
  9. Coordinate and monitor the flow of relevant observing platform data into appropriate permanent archives.
-

## ANNEX G

### JCOMM STRUCTURE

- 1) The JCOMM Management Committee (MAN), comprised of
    - (a) The two co-presidents of the Commission;
    - (b) The Programme Area coordinators;
    - (c) Leader on Quality Management;
    - (d) Leader on Capacity Development and on Requirements;
    - (e) Leader on contribution to GFCS;
    - (f) Senior representatives of GOOS, GCOS, - IODE, and the IOC Working Group on Tsunamis and Other Hazards Related to Sea-Level Warning and Mitigation Systems (TOWS-WG);
  
  - 2) The Observations Programme Area (OPA):
    - 2.1 The Observations Coordination Group (OCG)
    - 2.2 The Data Buoy cooperation Panel (DBCP)
    - 2.3 The Ship Observations Team (SOT)
    - 2.4 The Global Sea Level Observing System (GLOSS) Group of Experts (GLOSS-GE)
  
    - 2.5 Associated Programmes:
      - 2.5.1 The Argo Profiling float programme
      - 2.5.2 OCEAN Sustained Interdisciplinary Timeseries Environment observation System (OceanSITES, also an Action Group of the DBCP)
      - 2.5.3 The International Ocean Carbon Coordination Project (IOCCP)
  
  - 3) The Data Management Programme Area (DMPA):
    - 3.1 The Data Management Coordination Group (DMCG)
    - 3.2 The IODE-JCOMM Expert team on Data Management Practices (ETDMP)
    - 3.3 The Expert Team on Marine Climatology (ETMC)
  
  - 4) The Services and Forecasting Systems Programme Area (SFSPA):
    - 4.1 The Services and Forecasting Systems Coordination Group (SFSCG);
    - 4.2 The Expert Team on Maritime Safety Services (ETMSS);
    - 4.3 Expert Team on Waves and Coastal Hazards Forecasting Systems (ETWCH);
    - 4.4 The Expert Team on Sea Ice (ETSI);
    - 4.5 The Expert Team on Operational Ocean Forecasting Systems (ETOOFS)
  
  - 5) The JCOMM/CLIVAR/CCI Expert Team on Climate Change Detection and Indices (ETCCDI)
  
  - 6) The JCOMM *in situ* Observing Programme Support Centre (JCOMMOPS)
-

**TERMS OF REFERENCE AND GENERAL MEMBERSHIP OF THE  
OBSERVATIONS COORDINATION GROUP AND  
SHIP, DATA BUOY AND SEA LEVEL OBSERVATIONS TEAMS**  
*(as approved at JCOMM-IV, Yeosu, Republic of Korea, 23-31 May 2012)*

**1. OBSERVATIONS COORDINATION GROUP**

The Observations Coordination Group shall:

- (a) Keep under review and advise on the effectiveness, coordination and operation of the Observations work programme, including performance measured against scientific requirements, delivery of raw data, marine telecommunications, measurement standards, logistics and resources;
- (b) Provide advice to JCOMM and to Observations Teams on possible solutions for newly-identified requirements, consulting, as appropriate, with relevant scientific groups, the Commission for Basic Systems and the Commission for Instruments and Methods of Observation;
- (c) Coordinate with appropriate bodies to ensure the JCOMM contribution towards the development of the WMO Integrated Global Observing System;
- (d) Review in situ data requirements and recommend changes, as appropriate, taking into account the continuing development of satellite observations and their capabilities;
- (e) Coordinate the development of standardized, high quality observing practices and instrumentation and prepare recommendations for JCOMM;
- (f) With concurrence of the Co-presidents of JCOMM, establish and create expert teams, task teams, and pilot projects, as appropriate, to undertake the work of the Observations Programme Area;
- (g) Examine trade-offs and use of new and improved observation techniques/developments against: (i) relevant requirements for variables within Global Climate Observing System, Global Ocean Observing System, the WMO Commission for Basic Systems rolling review of requirements and the Global Observing System; and (ii) available resources;
- (h) Liaise with, and input to, Commission for Basic Systems activities regarding the consolidated requirements database and operational satellites;
- (i) Liaise with, and input to, Commission for Instruments and Methods of Observation activities regarding instruments and methods of observation;
- (j) Identify capacity development requirements related to the programme area;
- (k) Identify requirements on satellite data and information in the meteorological and ocean domains related to the Programme Area.

**General Membership**

The Membership is selected to ensure an appropriate range of expertise and to maintain an appropriate geographical representation.

Programme Area/Observations coordinator (Observations Coordination Group chairperson)  
Observations Coordination Group vice-chairperson  
Chairperson Ship Observations Team



Chairperson Data Buoy Cooperation Panel  
Chairperson Global Sea Level Observing System (GLOSS) Group of Experts  
Representative of Argo Steering Team  
Representative of International Ocean Carbon Coordination Project  
Representative of OceanSITES  
Representative of the Global Ocean Ship-based Hydrographic Investigations Program

Additional experts may be invited as appropriate to lead the range of Observations Programme Area activities, on a self-funded basis, and in general with no resource implications to JCOMM;

The Data Management Programme Area Coordinator as well as the Services and Forecasting Systems Programme Area Coordinator will be invited to participate in Observations Coordination Group sessions, to ensure full coordination of cross-PA programmes and activities; The JCOMM In Situ Observing Platform Support Centre (JCOMMOPS) will participate in the work and the meetings of the Coordination Group.

## **2. SHIP OBSERVATIONS TEAM**

### **Terms of Reference**

The Ship Observations Team shall:

- (a) Respond to requirements for ship-based observational data expressed by relevant existing international programmes and/or systems in support of marine services, and coordinate actions to implement and maintain the networks to satisfy these requirements;
- (b) Provide continuing assessment of the extent to which those requirements are being met;
- (c) Develop methodology for constantly controlling and improving the quality of data;
- (d) Review marine telecommunication facilities and procedures for observational data collection, as well as technology and techniques for data processing and transmission, and propose actions as necessary for improvements and enhanced application;
- (e) Coordinate Port Meteorological Officer (PMO)/ship greeting operations globally, propose actions to enhance PMO standards and operations, and contribute as required to PMO and observers training;
- (f) Review, maintain and update as necessary technical guidance material relating to ship observations and Port Meteorological Officers;
- (g) Liaise and coordinate as necessary with other JCOMM programme areas and expert teams, as well as with other interested parties;
- (h) Participate in the planning activities of the appropriate observing system experiments and major international research programmes as the specialist group on observations based onboard ships, including Voluntary Observing Ships, Ships-Of-Opportunity and research ships;
- (i) Seek new opportunities for deploying various kinds of measuring devices as recommended by the relevant panels and widely publicise those opportunities;

- (j) Develop as necessary new pilot projects and/or operational activities and establish new specialized panels as required;
- (k) Carry out other activities as agreed by participating Members/Member States to implement and operate the SOT programme and to promote and expand it internationally.

### ***Terms of Reference of Component Panels***

#### **Ship-of-Opportunity Implementation Panel (SOOPIP)**

The Ship-of-Opportunity Implementation Panel (SOOPIP) coordinates the installation and deployment of instrumentation from Ships of Opportunity that travel in fixed transects, and in particular coordinates the implementation of regional and basin-wide instrumentation that measure physical, chemical and biological parameters, such as XBTs, TSGs, and CPR. Its terms of reference are to:

- (a) Review, recommend on and, as necessary, coordinate the implementation of specialized shipboard instrumentation and observing practices dedicated, but not limited, to temperature and salinity measurements;
- (b) Coordinate the exchange of technical information on relevant oceanographic equipment and expendables, development, functionality, reliability and accuracy, and survey new developments in instrumentation technology and recommended practices;
- (c) Ensure the distribution of available programme resources to ships to meet the recommended sampling network in the most efficient way;
- (d) Ensure the transmission of data in real time from participating ships; ensure that delayed mode data are distributed in a timely manner (within 24 hours of the observations) to data processing centres;
- (e) Maintain, through the SOT chairperson, appropriate inventories, monitoring reports and analyses, performance indicators and information exchange facilities;
- (f) Provide guidance to the coordinator in supporting the Ship-of-Opportunity Programme (SOOP);
- (g) Prepare annually a report on the status of SOOP operations, data availability and data quality;
- (h) Where relevant, serve as a platform for other observational programmes;
- (i) Maintain close communications with the scientific community;
- (j) Support the formation of an XBT Science Team dedicated to meet and discuss on a periodic basis results and ongoing research performed with XBT observations.

#### **Voluntary Observing Ship Panel**

The Voluntary Observing Ship (VOS) Panel shall:

- (a) Review, recommend and coordinate the implementation of new and improved specialized shipboard meteorological instrumentation, siting and observing practices, as well as of associated software;

- (b) Support the development and maintenance of new pilot projects;
- (c) Oversee the upgrade of ships to VOSClim standard, and encourage other new ships to be recruited to the VOSClim class;
- (d) Develop and implement activities to enhance ship recruitment, including promotional brochures and training videos;
- (e) Prepare annually a report on the status of VOS operations, data availability and data quality.

### **General Membership**

- Chairperson of the Ship Observations Team, selected by the Commission
- Chairpersons of the SOOPIP and Voluntary Observing Ship Panel, selected by the Commission
- Open membership, comprising operators of VOS and SOOP, representatives of monitoring centres, data management centres and bodies, representatives of the International Mobile Satellite Organization and other communications satellite systems, representatives of manufacturers, representatives of science advisory bodies and users as appropriate.

The JCOMM In Situ Observing Platform Support Centre will participate in the work and the meetings of the Ship Observations Team.

## **3. DATA BUOY OBSERVATIONS TEAM**

### **Data Buoy Cooperation Panel**

#### **Terms of Reference**

Existing Terms of Reference for the Data Buoy Cooperation Panel (DBCP), the Tropical Moored Buoy Implementation Panel (TIP) and action groups. The DBCP terms of reference will be kept under review by the panel, with any changes proposed to be considered by the Management Committee, with a view to their approval by the Co-presidents on behalf of the Commission.

#### **General Membership**

Open membership, comprising existing DBCP members, action groups, TIP.

JCOMMOPS will participate in the work and the meetings of the Team.

## **4. SEA LEVEL OBSERVATIONS TEAM**

### **GLOSS Group of Experts**

#### **Terms of Reference**

Existing terms of reference as determined by the IOC Executive Council.

#### **General Membership**

Existing GLOSS Group of Experts and GLOSS Scientific Sub-group.

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**ANNEX H**

**TECHNICAL DOCUMENTS ISSUED WITHIN THE DATA BUOY COOPERATION PANEL SERIES**

<b>No.</b>	<b>Title</b>	<b>Year of first issue</b>	<b>Last revision and year</b>
1	DBCP Annual Report for 1994	1995	
2	Reference Guide to the GTS Sub-system of the Argos Processing System	1995	Rev. 1.6, 2005
3	Guide to Data collection and Location Services Using Service Argos	2011	Rev. 1, 2011
4	WOCE Surface Velocity Programme Barometer Drifter Construction Manual	1995	Rev. 2.2, 2009
5	Surface Velocity Programme Joint Workshop on SVPB drifter evaluation	1995	
6	DBCP Annual Report for 1995	1996	
7	Developments in buoy technology and enabling methods (DBCP workshop, Pretoria, Oct. 1996)	1996	
8	Guide to moored buoys and other ocean data acquisition systems	1997	
9	DBCP Annual report for 1996	1997	
10	Development in buoy and communications technologies (DBCP workshop, Henley on Thames, Oct. 1996)	1997	
11	DBCP Annual report for 1997	1998	
12	Developments in buoy technology and data applications (DBCP workshop, La Réunion, Oct. 97)	1998	
13	DBCP Annual report for 1998	1999	
14	Variety in buoy technology and data applications (DBCP workshop, Marathon, Florida, Oct. 98)	1999	
15	Global drifting buoy observations, A DBCP Implementation Strategy	1999	Rev. 11, 2012
16	DBCP Annual Report for 1999	2000	
17	Developments in Moored and Drifting Buoy Design, Programmes, Sensors, and Communications (DBCP Workshop, Wellington, Oct. 1999)	2000	
18	DBCP Annual report for 2000	2001	
19	Developments in buoy technology, communications, and data applications (DBCP Workshop, Victoria, Oct. 2000)	2001	
20	DBCP Annual report for 2001	2002	
21	Dev. in buoy technology, communications, science and data applications (DBCP Workshop, Perth, Oct. 2001)	2002	
22	Research, applications and developments involving data buoys (DBCP Workshop, Martinique, Oct. 2002)	2003	
23	DBCP Annual report for 2002	2003	
24	Research, Applications and Developments involving data buoys (DBCP Workshop, Angra Dos Reis, Brazil, October 2003)	2004	
25	DBCP Annual report for 2003	2004	
26	DBCP Annual report for 2004	2005	
27	DBCP Annual report for 2005	2006	
28	JCOMM TR No. 35. Application of collected data, Presentations at the DBCP Technical Workshop, Chennai, India, 18-19 October 2004 - Web only ( <a href="#">web</a> )	2006	
29	JCOMM TR No. 37. Application of collected data, Presentations at the DBCP Technical Workshop, Buenos Aires, Argentina, 17-18 October 2005 - Web only ( <a href="#">web</a> )	2006	
30	Technological Developments and Applications of Data Buoys for Tsunami Monitoring Systems, Hurricane and Storm Surge Prediction, Presentations at the DBCP Technical Workshop, La Jolla, 16-17 October 2006 - Web only ( <a href="#">web</a> )	2007	
31	DBCP Annual report for 2006	2007	

No.	Title	Year of first issue	Last revision and year
32	Presentations at the DBCP Scientific and Technical Workshop, Jeju, Republic of Korea, 15-16 October 2007 – CD-ROM & Web only ( <a href="#">web</a> )	2008	
33	DBCP Annual report for 2007 – CD-ROM & Web only ( <a href="#">web</a> )	2008	
33	Annual Report for 2007 ( <a href="#">web</a> )	2008	
34	Presentations made at the DBCP scientific and technical workshop, Cape Town, Republic of South Africa, 13 October 2008 ( <a href="#">web</a> )	2008	
35	Annual report for 2008 ( <a href="#">web</a> )	2009	
36	Presentations at the DBCP Scientific and Technical Workshop, Paris, France, 28 September 2009 ( <a href="#">web</a> )	2010	
37	Guide to buoy data quality control tests to perform in real-time by a GTS data processing centre ( <a href="#">web</a> )	2010	
38	Annual report for 2009 ( <a href="#">web</a> )	2010	
39	Presentations at the DBCP Scientific and Technical Workshop, Oban, United Kingdom, 27 September 2010 ( <a href="#">web</a> )	2011	
40	Annual report for 2010 (web)	2011	
41	Ocean Data Buoy Vandalism - Incidence, Impact and Responses ( <a href="#">web</a> )	2011	
42	Sea Surface Salinity Quality Control processes for potential use on Data Buoy observations ( <a href="#">web</a> )	2011	
43	Presentations at the DBCP Scientific and Technical Workshop, Geneva, Switzerland, 26 September 2011 ( <a href="#">web</a> )	2011	
44	Annual report for 2011 ( <a href="#">web</a> )	2012	
45	Presentations at the DBCP Scientific and Technical Workshop, Fremantle, Australia, 2 October 2012 ( <a href="#">web</a> )	2012	

**These publications can be ordered from: Technical Co-ordinator of the DBCP, JCOMMOPS, 8-10 rue Hermès, Parc Technologique du Canal, F-31526 RAMONVILLE SAINT-AGNE, France – E- mail: [support@jcommops.org](mailto:support@jcommops.org) – Telefax: +33 5 61 75 10 14**

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