ACTION GROUP REPORTS

(Submitted by the Action Groups)

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Appendices: A. Report by the EUCOS Surface Marine Programme (E-SURFMAR);

B. Report by the Global Drifter Programme (GDP);

C. Report by the International Arctic Buoy Programme (IABP);

D. Report by the International Buoy Programme for the Indian Ocean (IBPIO);

E. Report by the International South Atlantic Buoy Programme (ISABP);

F. Report by the DBCP-PICES North Pacific Data Buoy Advisory Panel (NPDBAP);

G. Report by the Tropical Moored Buoy Implementation Panel (TIP);

H. Report by the Ocean Sustained Interdisciplinary Timeseries Environment observation System (OceanSITES); and

I. Report by the WCRP-SCAR International Programme for Antarctic Buoys (IPAB).

APPENDIX A

REPORT BY E-SURFMAR
EUCOS-SURFACE MARINE PROGRAMME

1. Introduction

The EUMETNET Composite Observing System (EUCOS) surface marine (E-SURFMAR) programme is an optional programme involving 17 out of the 24 EUMETNET members: (Belgium, Croatia, Cyprus, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, The Netherlands, Norway, Portugal, Spain, Sweden and the United Kingdom), who fund the activity on a GNI basis. Its main objectives are to coordinate, optimise and progressively integrate the European meteorological services activities for surface observations over the sea – including drifting and moored buoys, and voluntary observing ships. E-SURFMAR is responsible for coordination of buoy activities carried out by the European meteorological services, and the programme supports a Data Buoy Manager (DBM) to manage these activities. The DBM is supported and advised by the E-SURFMAR Data Buoy Technical Advisory Group (DBTAG) which is an action group of the DBCP. The sixth annual DB-TAG meeting was held in Southampton 26-27 May 2009.

2. Operational programme

2.1 Drifting buoys

One hundred drifting buoys were deployed between July 2008 and June 2009 including **twenty** upgrades of SVP drifters. **Fifty seven** out of the SVP-B were fitted with Iridium transmitters. **Nine** SVP-BW were a contribution of Environment Canada.

Deployments in 2008/09 were carried out by research vessels, voluntary observing ships, and ships of opportunity plying the Atlantic Ocean from various ports (Canada, Iceland, France, Norway, UK, US). Drifting buoys are also regularly deployed from OWS Mike (66°N – 2°E).

Although the E-SURFMAR area of interest is mainly up to 70 °N (i.e. to the ice limits), the EUCOS area actually extends to 90 °N. **Five** SVP-B (Argos transmitters) were deployed by fall 2008 in the Arctic for IPY (International Polar Year) in addition to the 100 drifters mentioned above.

The deployments balanced the loss of buoys which occurred during the year. Over the year an average of about 100 drifting buoys were in operation in the EUCOS area of interest. The minimum number of operational drifting buoys at the end of each month in 2008-2009 was 90 (December 2008) and the maximum was 110 (June 2009).

The mean lifetime (for Air Pressure) of the SVP-B drifters was approximately 15 months (463 days). The average age of the network was 359 days at the end of August 2008 and 280 days at the end of June 2009. Eighty eight buoys failed to report air pressure measurements.

The evaluation of the Iridium communication system continued as a contribution to the DBCP drifter Iridium Pilot Project. The number of Iridium drifters deployed has increased during the year with more than 1/2 of the buoys operating now using Iridium (see Fig 1). This improves the data timeliness and also has a lower transmission cost.

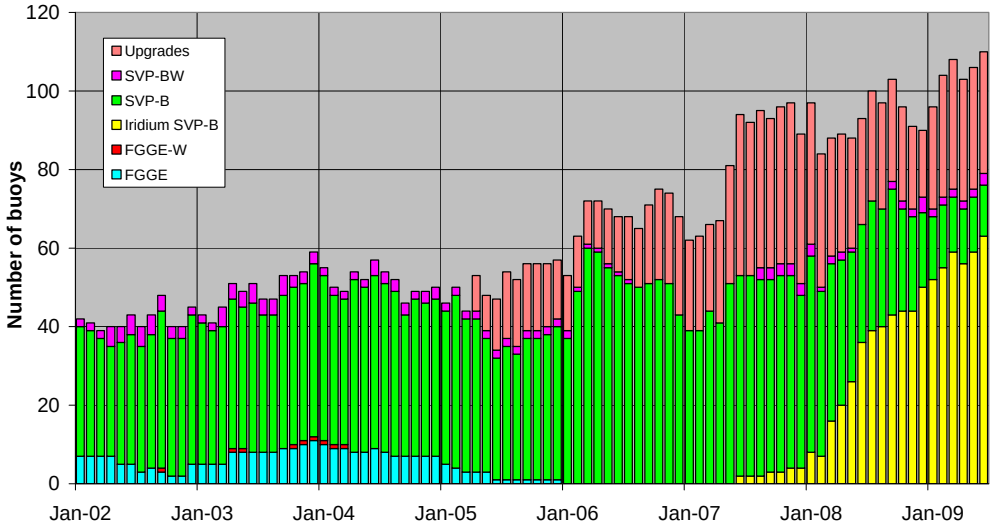


Figure 1. The number of operational EGOS/E-SURFMAR drifting buoys by the end of each month from 2002 to 2009

The availability, timeliness and quality of drifting buoy data from the EUCOS area continues to be carefully monitored.

The availability of data depends on the number of buoys operating. About 800 messages per day were received within 50 minutes in September 2008. However, more than 1,500 messages per day are being received within 50 minutes in 2009 mainly due to the use of Iridium satellite system. More than 2,500 hourly observations per day are currently (mid 2009).being reported on the GTS

The AP differences from the French model outputs showed that the target of 1% of Gross Errors was easily being achieved. The RMS of AP differences still has a seasonal variation, being higher in winter (0.8 hPa) than in summer (0.6 hPa).

Real time observations from drifting buoys are subject to routine quality monitoring. Besides monthly statistics provided by various meteorological centres for individual buoys, tools are used by Meteo-France to identify buoys reporting dubious data as quickly as possible. These tools have been enhanced. More parameters than before are Quality Controlled: humidity, wave height and period are now compared to model outputs. As for wind speed, results are presented in the form of rates rather than biases. ECMWF analyses are systematically used for all parameters in parallel to French Arpege models outputs. Mercator SST and SSS outputs are also used.
http://www.meteo.shom.fr/qctools/

2.2 Moored buoys

The E-SURFMAR design study recommended that four moored buoys were needed to meet the EUCOS requirements, i.e. providing a suitable network to improve the quality of regional NWP over Europe, and for the validation and calibration of satellite wind and wave measurements. The four E-SURFMAR moored buoys are operated by UK, Ireland, France and Spain. (i.e. three K-pattern buoys at K5, M6 and Lion and one SeaWatch buoy at Cabo Silleiro respectively).

However, monitoring of the availability, timeliness and quality of moored buoys data from the full K-series moored buoy network continues. By the end of June 2009, 12 K-pattern buoys and 15 Oceanor buoys were operating (although the Oceanor buoys are not yet being monitored).

The AEMET (Spain) is reporting data from the Cabo Silleiro buoy (as well as others operated by Puertos del Estado) to the GTS in BUFR code. During the year AEMET modified the BUFR coding to comply with the WMO BUFR template agreed for moored buoy data. The messages received in Toulouse RTH are forwarded to Exeter and Offenbach.

At present, of the 4 E-SURFMAR moored buoys, only Cabo Silleiro and K5 are able to provide directional wave spectra data. Lion is providing omni-directional wave spectra. For K5 a Triaxys spectral wave system is being used. The data are presently being archived by the Met Office in NMEA format as the ability to generate BUFR messages and issue to GTS has yet to be developed.

The availability of moored buoy data depends on the number of buoys operating. An average of 150 hourly observations per day is being reported from the offshore K-series buoys to the GTS, with about 70 messages per day from the 3 K-pattern E-SURFMAR buoys.

More than 95% of data were received by HH+50 minutes (to be compared to the EUCOS target for timeliness of 85%) for the K-pattern buoys.

The Air Pressure (AP) differences with the French model outputs shows the EUCOS target of 0.5% of Gross Errors was achieved. The RMS of AP differences are between 0.5 to 0.8 hPa.

Real time observations from moored buoys are subject to routine quality monitoring in the same way as the drifting buoys.

3. Plans

3.1 Drifting buoys

The E-SURFMAR design study recommended the deployment of an average of 175 SVP-B type drifters per year. The drifting buoy component has been fully funded by E-SURFMAR since 2006, i.e. in addition to the drifting buoy purchases, all the communication costs are funded by E-SURFMAR. Within the allocated budget more than 100 buoys (including 30 upgrades) will deployed in the E-SURFMAR area of interest in the coming twelve months. A revision of the design study will be made after the results of an OSE which will be carried out by ECMWF for a period running from December 2008 to January 2009.

The transmission of drifting buoy data through Iridium will become the standard for E-SURFMAR rather than Argos.

E-SURFMAR will continue to deploy buoys in the Arctic Ocean through IABP. The main challenge with the ice buoys is their ability to survive after being released from frozen ice.

3.2 Moored buoys

As noted earlier the E-SURFMAR design study has recommended that directional wave spectra should be provided by all four buoys and it is expected that the solution developed by the Met Office will be also installed on the Lion buoy (and in time other buoys within the K-series network). For M6 it is expected that the Irish Marine Research Institute will replace M6 with an Oceanor buoy with spectral wave capability. Cabo Silleiro, which is a SeaWatch buoy, already has direction spectral wave capability

4. Information on E-SURFMAR

There is a EUCOS website (http://www.eucos.net). Under the heading "EUCOS Public" in "EUCOS networks" there is information about E-SURFMAR. This site is the official public site for E-SURFMAR. A link will be provided from this site to provide access to publicly available documents such as the monthly and annual reports.

In addition there is a restricted working area web site for E-SURFMAR participants (http://esurfmar.meteo.fr), it is based on a collaborative scheme which allows the participants to easily create and modify certain pages on the site.

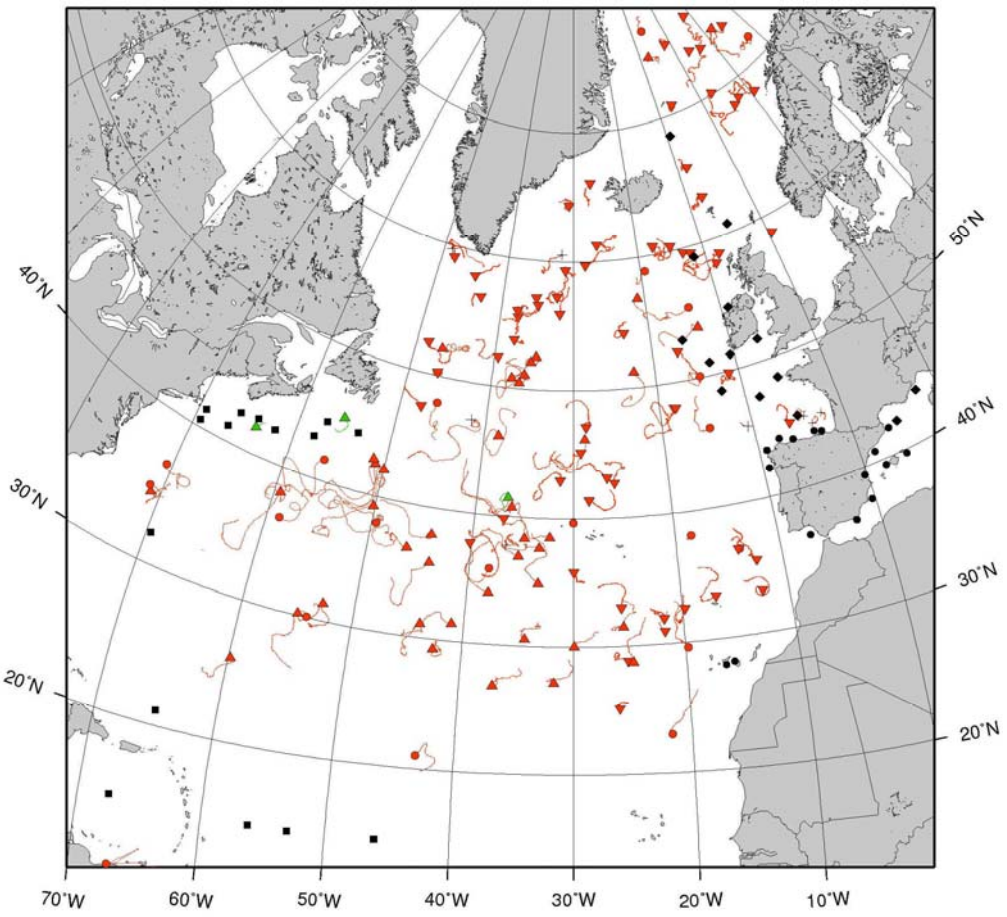


Figure 2. Operating Buoys in E-SURFMAR area
Drifting buoy trajectories and moored buoy positions (June 2009)

APPENDIX B

REPORT BY

GROBAL DRIFTER PROGRAM (GDP)

Rick Lumpkin and Mayra Pazos, NOAA/AOML
Shaun Dolk and Erik Valdes, University of Miami/CIMAS

1. Program overview

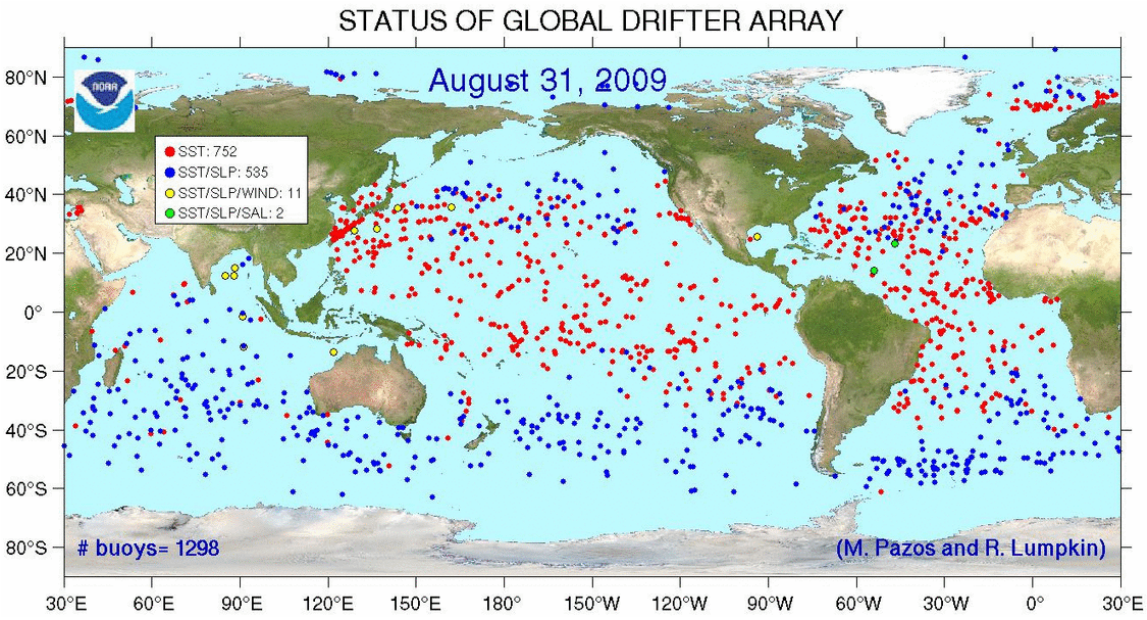
The Global Drifter Program (GDP) is the principle component of the Global Surface Drifting Buoy Array, a branch of NOAA's Global Ocean Observing System (GOOS) and a scientific project of the DBCP. Its objectives are to: 1. Maintain a global 5x5° array of 1250 satellite-tracked surface drifting buoys to meet the need for an accurate and globally dense set of in-situ observations of mixed layer currents, sea surface temperature, atmospheric pressure, winds and salinity; and 2. Provide a data processing system for scientific use of these data. These data support short-term (seasonal to interannual) climate predictions as well as climate research and monitoring.

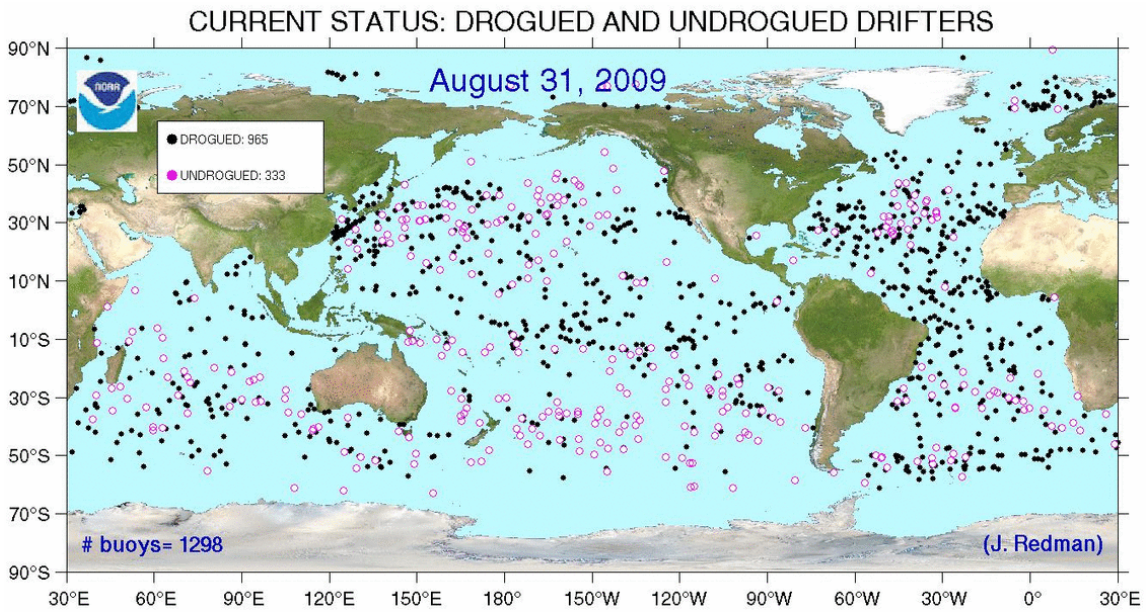
The GDP is managed with close cooperation between: Manufacturers in private industry, who build the drifters according to closely monitored specifications; NOAA's Atlantic Oceanographic and Meteorological Laboratory (AOML), which coordinates deployments, processes the data, archives the data, maintains META files describing each drifter deployed, develops and distributes data-based products, and updates the GDP website (http://www.aoml.noaa.gov/phod/gdp.html); and NOAA's Joint Institute for Marine Observations (JIMO), which supervises the industry, upgrades the technology, purchases drifters, and develops enhanced data sets. Drs. Peter Niiler (JIMO) and Rick Lumpkin (AOML) maintain liaisons between the GDP and individual research programs that deploy drifters. AOML's component of the GDP is directed by Rick Lumpkin and is composed of the Drifter Operation Center (DOC) and the Data Assembly Center (DAC).

In order to fulfill its objectives, the GDP determines areas of interest, identifies vessels which help deploy buoys while in transit, coordinates deployment locations, processes and archives data, develops and distributes data-based products and posts quality controlled data on the GDP website. Within these daily activities, the GDP works closely with various companies and institutions.

2. Current Status of the Global Drifter Array

As of 31 August 2009, the global array of GDP drifters was at 1298, with 965 (74%) drogued to measure mixed layer currents.

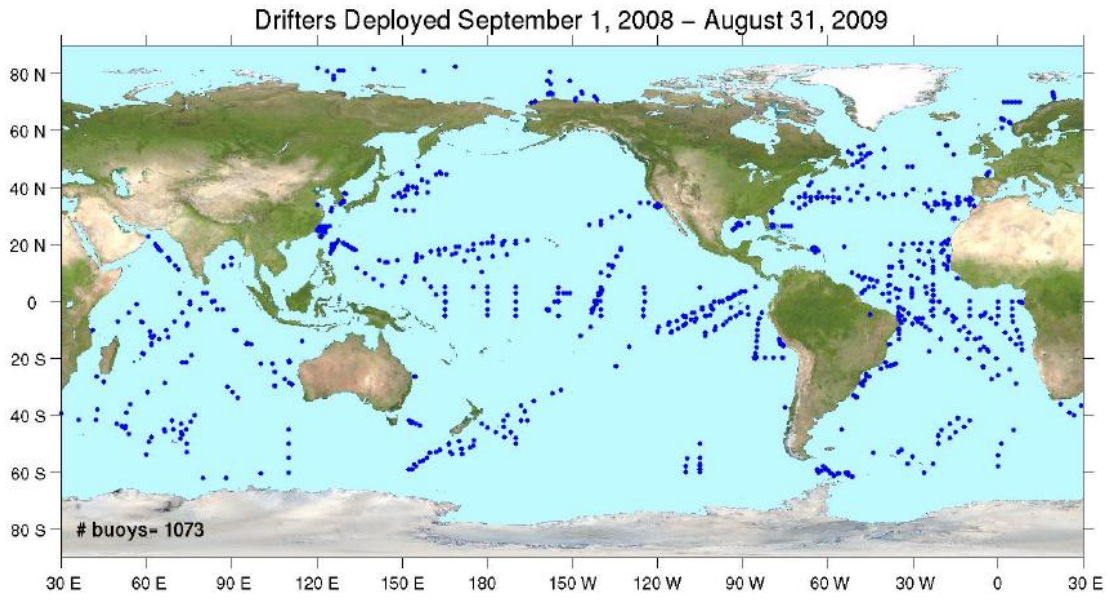




3. Operations: 2009 summary, 2010 plans

2009 Drifter Deployments

In the period 1 September 2008 to 31 August 2009, there were a total of 1073 drifters deployed, exceeding the goal of 1000 deployments. These deployments brought the total number of drifters on the GTS to 1307 by the end of August (for comparison, 1179 were on the GTS in August 2008).



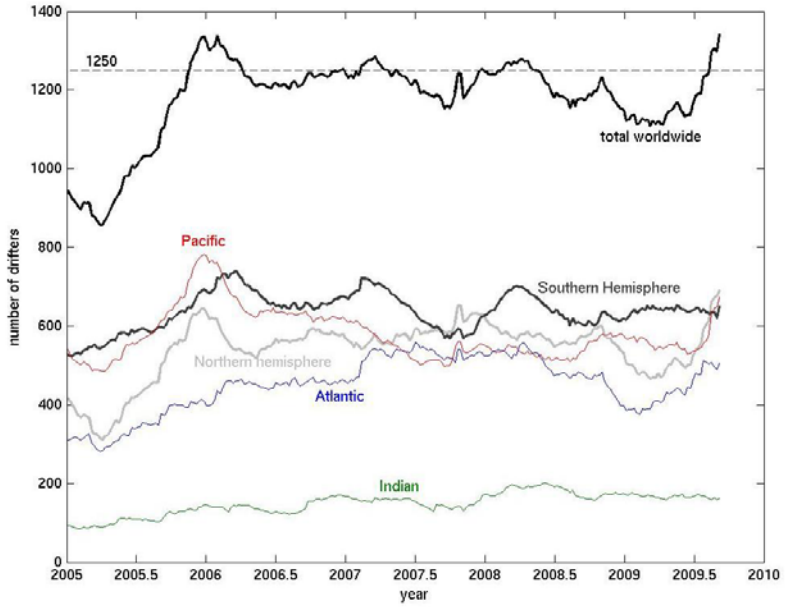
Of the 1073 drifters deployed this year, a total of 165 were classified as research drifters (Consortium Research).

2010 Deployment Plan

Operation Buoy Deployments	800
Consortium Research Buoy Deployments	200
Total Deployments in 2010	**1000**

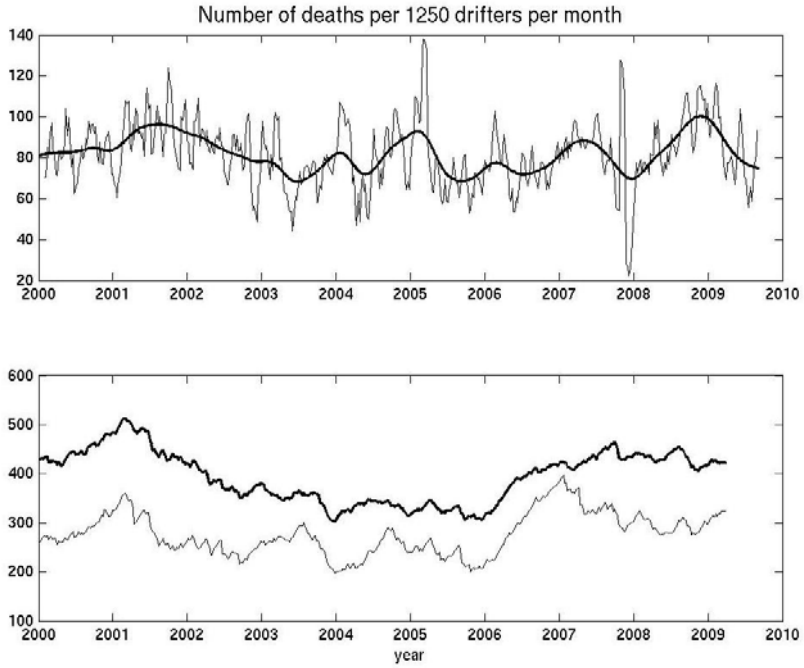
4. Analysis of the global drifter array

The number of drifters in the global array is shown below. The GDP seeks to maintain an annually averaged array size of 1250 drifters, and anticipates that variations in this number through the year will be normal due to varying deployment opportunities. The global array reached the goal of 1250 drifters in September 2005, and subsequently has fluctuated around that average. In most years these fluctuations reveal a seasonal pattern, with peaks in Boreal winter—spring and troughs in summer—fall. This seasonality reflects the variations in deployment opportunities, primarily due to dense Southern Ocean deployments during the research campaign season there. In this context, 2009 was an unorthodox year; for much of 2009, the total size of the array was smaller than 1250 drifters due to a lower number of deployments (compared to the 2005—2009 average) and an increased death rate (see below). This was addressed by an aggressive increase in deployments throughout Boreal summer, focused primarily in the Northern Hemisphere sectors of the Pacific and Atlantic Oceans. The size of the array varied from a minimum of 1108 drifters on 9 March 2009 to a maximum of 1307 drifters on 24 August 2009. The annual mean size over the period 1 September 2008 – 31 August 2009 was 1170, 80 drifters short of the 1250 goal despite the increase in deployments.



Size of global drifter array in regions. Atlantic/Indian divided at 25°E in the Southern Ocean, Atlantic/Pacific at 70°W in the Southern Ocean, Indian/Pacific at 125°E south of Timor.

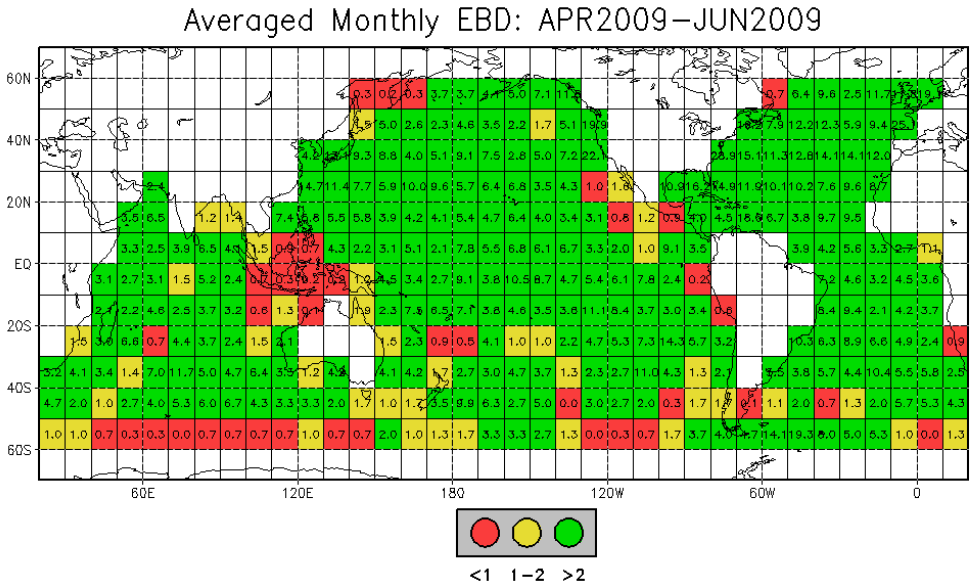
The number of drifter deaths per month, per 1250 drifters, is shown below. This is the number of drifters that must be deployed each month in order to maintain the array at 1250. As noted in last year's GDP report to the DBCP, the death rate had been increased over the last several years, from ~71 in September 2005 to ~85 in September 2008. That report ascribed the average age of the array to this increase, and predicted that the death rate should cease increasing and become more constant in 2009 barring unexpected manufacturing problems. In fact, the death rate continued to increase through late 2008, reaching a maximum of ~100, then decreased through 2009 to its current value of ~80. The overall average for 1 September 2008—31 August 2009 was 90 deaths per 1250 drifters per month, not significantly different from the average number for the previous year. The mean age of a drifter in the array has slightly decreased, from ~450 days in August 2008 to a current value of around 420 days.



Number of drifter deaths per 1250 drifters per month (top) and the mean (thick) and median (thin) age of a drifter in the global drifter array (bottom).

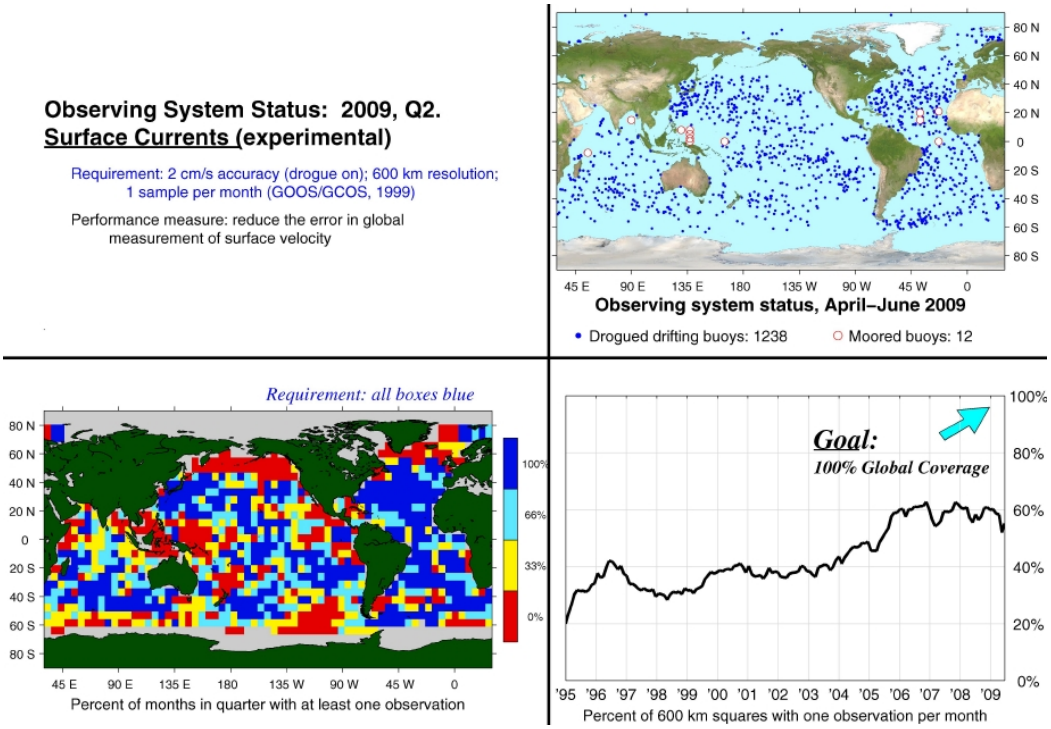
Evaluating the overall observing system for SST and ocean current measurements

The overall Global Ocean Observing System (GOOS) is evaluated for SST measurements by NOAA's National Climate Data Center (NCDC), and for near-surface current measurements by the Global Drifter Program. SST measurements are quantified by Equivalent Buoy Density (EBD), which downweighs ship measurements compared to moored and drifting buoy measurements to reflect the relative accuracy levels. Most of the spatial coverage of the GOOS is due to drifters, which fill the vast gaps between the major shipping lines, although moored buoys are invaluable for maintaining instrumentation in regions of surface divergence – particularly along the equator. Recent maps (see below) indicate that EBD is lowest in shallow, near-coastal and ice-covered regions.



Equivalent buoy density (EBD) for April-June 2009. Figure courtesy Huai-min Zhang, NOAA/NCDC.

The GOOS measures near-surface currents using moored current meters and drogued drifters, a subset of the overall drifter array due to drogue loss. Over the most recent quarter (April through June), between 50% and 60% of all 5°x5° open-ocean squares were sampled at least once. Spatially (see figure below), coverage is best in the Atlantic and subtropical North Pacific, with lowest coverage in the southeastern and subpolar north Pacific basin and in the tropical warm pool region of the western Pacific.



GOOS measurements of near-surface currents for April-June 2009 (NOAA/GDP).

5. Drifter quality evaluation

AOML Data Buoy (ADB) Comparison Study

This year, the AOML Data Buoy (ADB) comparison study results were updated for five drifter clusters deployed in 2008. In this study, drifters from four different buoy manufacturers (Clearwater Instruments Inc, Metocean Data Systems Ltd, Pacific Gyre Inc, and Technocean Inc.) are deployed in clusters in various regions throughout the world. The clusters of one drifter per manufacturer are at an initial separation of only a few meters, allowing us to cross-compare for SST quality and wind-driven slip. It is the goal of the GDP to evaluate the performance of each drifter, determine the strengths and weaknesses (if any) that exist, and communicate these results to the manufacturers. In particular, we examine the lifetime of drifter transmitters compared to the goal of 450 days (on average), and the lifetime of the drogues compared to the desired lifetime of 300 days.

The 2008 clusters were deployed on dates ranging from March 12 (cluster 1) to April 29 (cluster 5). As of the end of August 2009, the drifters had lived (i.e., transmitted data) for the number of days indicated i n the following table:

	Clusters				
Manufacturers	**1**	**2**	**3**	**4**	**5**
Clearwater	212 (Quit)	301 (Quit)	125 (Quit)	*	359 (Quit)
Technocean	50 (Quit)	236 (Gr)	*	361 (Gr)	*
Metocean	34 (Quit)	*	*	*	64 (Quit)
Pacific Gyre	*	*	*	296 (Quit)	91 (Quit)
Max. Days Possible	**506**	**485**	**469**	**467**	**457**

Stars indicate drifters that were still alive as of the end of August 2009, and "Max. Days Possible" indicate the total number of days from deployment to end August. Drifter deaths are indicated as "Quit" or "Gr", the latter indicated that the drifter ran aground. Pacific Gyre and Metocean drifters exhibited the best lifetime performance, with three out of five from each still alive after >450 days. Clearwater drifters died more rapidly, with only one still alive after >450 days and the rest dying at 125—359 days after deployment. None of the drifters failed on deployment (this is typically observed at a 3—5% rate), although two from Metocean and one from Technocean ceased transmitting in less than three months. Technocean deaths were increased by two of the drifters running aground, a problem likely exacerbated by drogue loss.

Drogue lifetime is summarized in the following table:

	Clusters				
Manufacturer	***1***	***2***	***3***	***4***	***5***
Clearwater	212* (Quit)	166	125* (Quit)	119	99
Technocean	50* (Quit)	101	100	75	200
Metocean	34* (Quit)	379	385	400	64* (Quit)
Pacific Gyre	*	354	250	296* (Quit)	12
Max. Days Possible	**506**	**485**	**469**	**467**	**457**

Stars indicate drogues still attached as of end of August 2009 (if not accompanied by a number) or when the drifter ceased transmitting (number, in days after deployment). The goal for drogue attachment is 300 days. This goal was not reached by the Clearwater and Technocean drifters, although two of the Clearwater drifters still had their drogues attached when they died after 125 and 212 days. Four of the Technocean drifters lost their drogues before dying, with a mean drogue lifetime for these drifters of 120 days. Both Metocean and Pacific Gyre drifters had large average drogue lifetime, with Pacific Gyre claiming two extremes: the fastest drogue loss, at only 12 days after deployment, and the only drifter of the study to still have the drogue attached as of late August 2009.

SSTs from the drifters were accurate and tracked each other while the drifters were in close proximity, except for one Pacific Gyre drifter, which was too cold by a constant offset of 0.45°C. One Metocean thermistor failed five days after deployment.

The GDP will continue to conduct the ADB study in 2009—2010, with more cluster deployments worldwide.

Drogue detection

The GDP has been examining submergence and strain gauge for drogue detection. As noted in earlier DBCP sessions, submergence is not implemented uniformly across manufacturers. For example, Pacific Gyre submergence typically stays at a maximum value until drogue loss, while Metocean and Technocean values fluctuate while the drogue is attached. In all cases, the submergence should drop sharply at drogue loss, but many cases were identified where submergence became small but later increased, and drogue presence was unclear. In addition, in some cases submergence has been extremely sensitive and difficult to interpret. This was most evident in the past for Technocean drifters, which in some cases became dominated by noise and could not be used to determine drogue presence.

Clearwater has used strain gauge for many years, a technique which nearly always clearly shows when the drogue is lost. As a consequence, the GDP has recommended that all manufacturers implement tether strain in their drifters for drogue detection. This was tested this year in a pilot deployment of drifters from the three US manufacturers (Clearwater, Pacific Gyre, Technocean) all bearing tether strain, implemented as communicated by Clearwater to Pacific Gyre and Technocean. The Clearwater and Technocean tether strain sensors performed well, but the Pacific Gyre sensors did not (this has subsequently been addressed by Pacific Gyre).

Meanwhile, over the last two years Technocean submergence sensors have improved dramatically and now appear to clearly indicate drogue loss. Metocean submergence sensors have also continued to perform very well, clearly indicating drogue loss. If the Pacific Gyre submergence sensors are accurately reflecting drogue presence, then they have the longest drogue life of all manufacturers.

6. Research efforts

In addition to composing a sustained part of the Global Ocean Observing System, drifters are a critical part of a number of ongoing research efforts. Here we highlight one recent study; many more are routinely cited in the scientific literature. For a full list, see the GDP references at http://www.aoml.noaa.gov/phod/dac/gdp_biblio.html.

Estimates of wind energy input in the Southern Ocean

The wind can input energy into the upper ocean at frequencies ranging from low-frequency geostrophic variations, through subinertial Ekman-layer fluctuations, to inertial and superinertial waves. The work done by the wind on the geostrophic circulation is a source of mechanical energy for the interior ocean, but published studies had not resolved how the wind works on higher frequency ageostrophic motions, nor how the generation of ageostrophic motions transfers mechanical energy to the ocean interior. This was the subject of Elipot and Gille (2009, "Estimates of wind energy input to the Ekman layer in the Southern Ocean from surface drifter data." *J. Geophys. Res.* 114 C06003, doi:10.1029/2008JC005170), who used drifter observations and wind products to address these issues in the Southern Ocean. They determined that the time-varying input exceeds that of the time-mean, that anticyclonic frequencies dominate both the wind energy input and oceanic response, and that there is a relatively modest input of energy at near-inertial frequencies – although the near-inertial input may be underestimated due to the under representation of this energy in the ¼-day kriged drifter observations.

APPENDIX C

REPORT BY
THE INTERNATIONAL ARCTIC BUOY PROGRAMME (IABP)

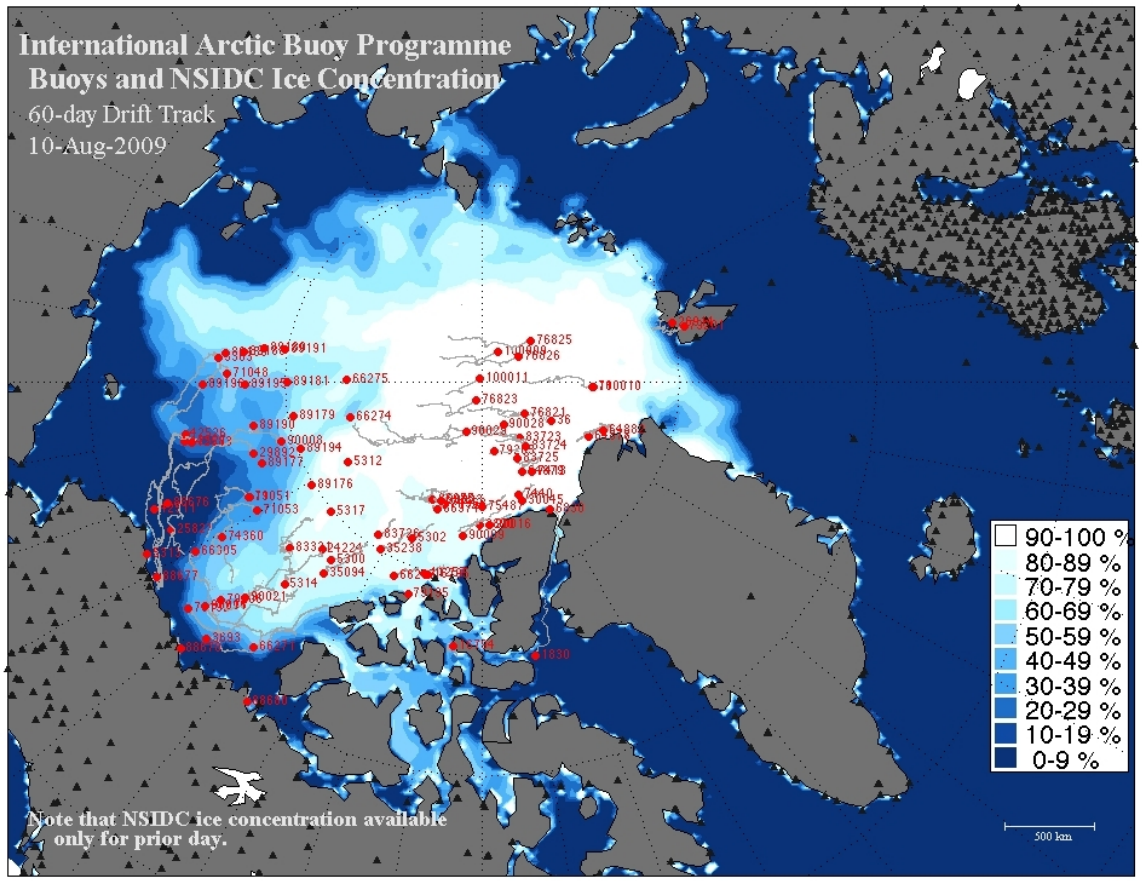
Participants of the IABP continue to work together to maintain a network of drifting buoys on the ice of the Arctic Basin to provide meteorological and oceanographic data for real-time operational requirements and research purposes including support to the World Climate Research Programme (WCRP) and the World Weather Watch (WWW) Programme. *http://iabp.apl.washington.edu*

IABP Program Buoy Status 9 August 2009

- The daily buoy status report for 9 August 2009 shows 89 buoys, 3 of which appear to be grounded: one on the shores of the north coast of Alaska and 2 on the shores of Spitsbergen.
- The number of buoys in the Arctic increased significantly during the International Polar Years (March 2007 – March 2009)
- There continues to be several ice thickness and oceanographic buoys in the array.
- The number of buoys on the Eurasian side of the pole on ice and/or in water remains low
- Many of the buoys on the basin are now "southern, blue water" buoys such as SVP buoys whereas even 5 years ago, only "white water" (ice) buoys were used.

	2006 7 August	**2007 17 August**	**2008 15 August**	**2009 9 August**
Ocean Profiling POPS or ITP	2	9	7	11
Ice Mass Balance	6	8	9	5
Surface air temperature and surface air pressure	27	33	30	25
Surface air temperature	2	1	1	1
Surface air pressure	2	8	20	40
Position only	4	30	23	6
Russian manned station			NP 35	NP 36
Total Numbers of buoys	**43**	**89**	**91**	**89**

Buoy map with 60-day buoy track and ice concentration 10August 2009
from International Arctic Buoy Programme web page http://iabp.apl.washington.edu

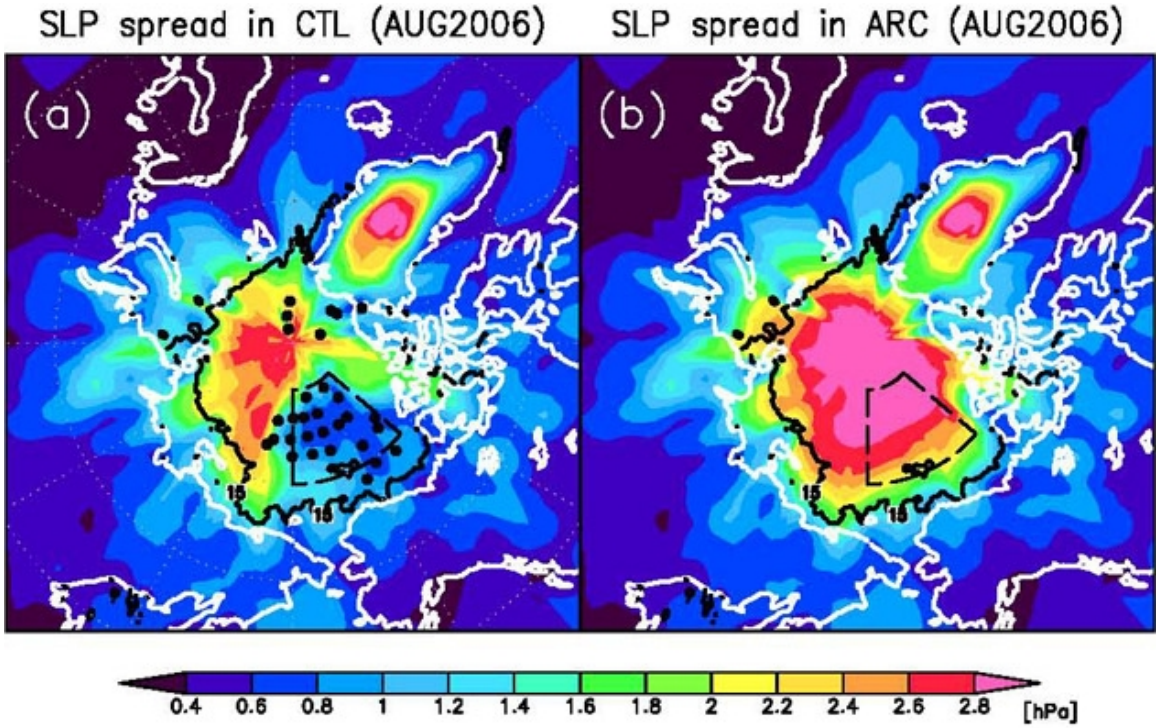


Impact of sea level pressure measurements from IABP buoys

The paper *Impact of observations from Arctic drifting buoys on the reanalysis of surface fields*, Jun Inoue et al, published in the Geophysical Research, Volume 36, 2009 shows the valuable of the data from the buoys in producing accurate wind and pressure fields for the arctic basin.

Analysis ensemble spread of Sea Level Pressure in August 2006.
Figure (a) shows results where buoy data is included. Figure (b) shows results where no buoy data is used.

Dots depict positions of arctic drifting buoys. The thick line denotes ice concentration grater than 15%.



Issues / Discussion parallel that of past few years

- Challenges to sustain IABP network
  - Increasing area of First-Year Ice and Open Water during summer
  - Getting buoys on ice / in water in the Eurasian Arctic
- How does the IABP fit into the Sustained Arctic Observing Network (SAON)? – IABP Participants believe that the IABP supports a sustained Arctic observing network and see it as the foundation of such a network, since it is the longest, continuously standing observing program for the Arctic.
- Working with researchers such as those in DAMOCLES programs to obtain data that did not get onto the GTS for the IABP and GTS archives**.**
- Buoys on ice / in water but not on GTS – Efforts to have all those putting buoys on ice / in water the arctic basin to have the data posted to GTS in real time is ongoing.

New field planning website courtesy CliC and IARC: www.iceplan.org

- One-stop shop for Arctic sea ice field planning coordination
- Want to include all expeditions where buoys are to be deployed
- Sponsored by CliC - Hajo Eicken / CliC sea ice working group - and IARC - Jenny Hutchings, website coordinator
- Hope to encourage further collaborations and pave the way for coordinated sea ice data collection

IABP Program for 2010

- Number of buoys may decrease as IPY activity decreases
- Likely to see more buoys of the type that can survive the freeze-thaw cycle such as SVP buoys and AXIB (**A**irdroppable e**X**pendable Ice Beacon) buoys
- Air deployments remain integral to the program's success
- Likely to see more buoys using iridium for communication in place of Argos

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APPENDIX D

REPORT BY
THE INTERNATIONAL BUOY PROGRAMME FOR THE INDIAN OCEAN (IBPIO)

1. Introduction

The International Buoy Programme for the Indian Ocean (IBPIO) was formally established at a meeting in La Reunion in 1996. The primary objective of the IBPIO is to establish and maintain a network of platforms in the Indian Ocean to provide meteorological and oceanographic data for both real time and research purposes.

The programme is self-sustaining, supported by voluntary contributions from the participants in the form of equipment and services (such as communications, deployment, storage, archiving, co-ordination...).

There are presently eleven organisations formally participating in the IBPIO:

- Australian Bureau of Meteorology (ABOM);
- Eduardo Mondlane University (EMU) Mozambique;
- Global Drifter Program of NOAA/AOML (GDP), USA;
- Kenya Meteorological Department (KMD);
- Meteo-France;
- National Institute of Oceanography (CSIR/NIO), India;
- National Institute of Ocean Technology (DoD/NIOT), India;
- Navoceano, USA;
- South African Weather Service (SAWS);
-Tropical Moored Buoy Implementation Panel (TIP);
- Indian National Centre for Ocean Information Services (INCOIS)

2. Programme meetings

The twelfth Programme Committee meeting of the IBPIO will be held in Paris, France, on 26 September 2009, prior to DBCP-25. The eleventh Programme Committee meeting of the IBPIO was held on 11 October 2008 in Cape Town, Republic of South Africa, in conjunction with DBCP-24.

3. Operational programme

3.1 Drifting buoys

Since the beginning of the programme 1397 drifting buoys (460 SVP and 806 SVP-B) Lagrangian drifters) have been deployed at sea.

152 drifting buoys were deployed between June 2008 and July 2009. All were Lagrangian drifters, of which about **2/3** measured air pressure (SVP-B).

Participants in the IBPIO contribute to the programme in various ways: the provision of buoys (ABOM, GDP, Meteo-France, Navoceano and NIO); the funding of barometer upgrades to SVP drifters provided by GDP (ABOM and Meteo-France); deployment arrangements (all); co-ordination (Meteo-France) and data transmission (Meteo-France and SAWS).

Many of the deployments in 2008/09, as in previous years, were carried out by research vessels and ships of opportunity plying the Indian Ocean from ports in Australia, India, South Africa, La Reunion (France) and Kenya. Some ship voyages to remote islands were also used for deployments in the southern latitudes: Heard Island from Australia; Amsterdam, Kerguelen and Crozet Islands from La Reunion; and Marion Island from South Africa.

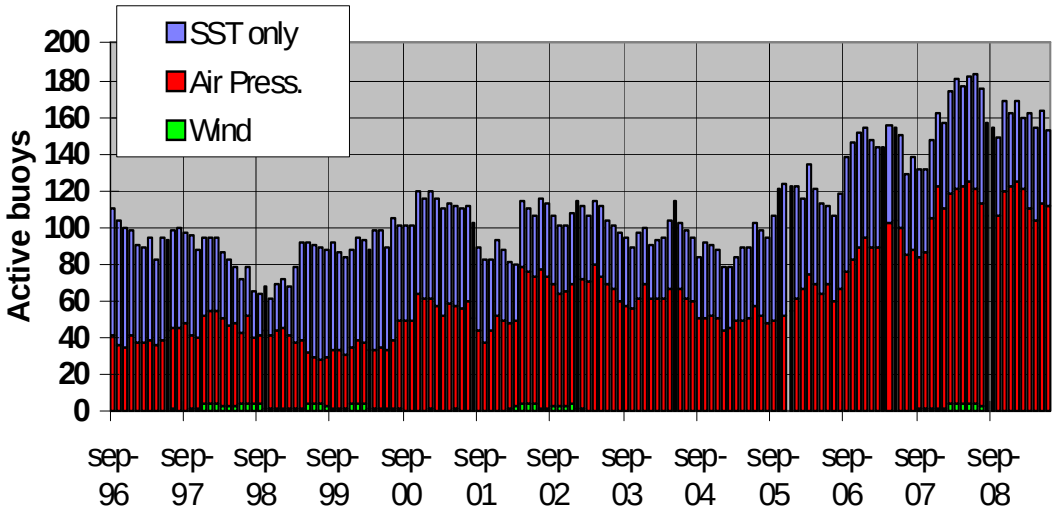

Figure 1. The number of operational IBPIO drifting buoys by parameters measured

The number of operational buoys providing AP measurements remained above 100 from November 2007, and reached a maximum of 124 in January 2009 (about 2/3 of the total).

The number of buoys measuring SST only - in addition to their position – was about 1/3 of the total (minimum 39 by February 2009, maximum 62 by July 2008). There were only a few drifting buoys reporting wind parameters during the year.

During the period from July 2008 to June 2009, 49 buoys owned by SAWS or GDP migrated from the South Atlantic Ocean and/or Southern seas to the IBPIO area of interest. In contrast, the number of buoys that escaped to the south of Australia was 34 during the same period. Some of these escaping buoys were deployed near the SE boundary of IBPIO. The Indian Ocean benefits from a natural convergence that directs the buoys coming from the South Atlantic to the middle of the South Indian Ocean.

Owner	SST only	Air Pressure	Wind
Australian Bureau of Meteorology	1	21	0
Global Drifter Program	40	84*	0
SAWS	0	0	0
Météo-France	0	0	0
NIO	0	7	0
INCOIS	0	0	0
Total	**41**	**112**	**0**

Table 1. Operational drifting buoys (i.e. reporting onto the GTS) at the end of June 2009
**** including drifters upgraded by ABOM and Meteo-France***

Most drifting buoys use the Argos system to report their data, however a small number (4) of buoys fitted with Iridium transmitters were deployed in support of the DBCP Iridium Pilot Project. Iridium offers the advantages of better timeliness and lower cost per message.

The availability of data depends on the number of buoys operating in the area. The number of reports with AP received within 50 minutes still remains at about 20% per day. About 2500 (AP) hourly observations per day have been reported on the GTS, reaching a maximum of more than 2700 by January 2009.

The timeliness at HH+100 minutes is about 60%.

Real time observations from drifting buoys are subject to routine quality monitoring. Besides monthly statistics provided by various meteorological centres for individual buoys, tools are used by Meteo-France to identify buoys reporting dubious data as quickly as possible. These tools have been enhanced. More parameters than before are Quality Controlled: humidity, wave height and period are now compared to model outputs. As for wind speed, results are presented in the form of rates rather than biases. ECMWF analysis is systematically used for all parameters in parallel to Arpege French models outputs. Mercator SST and SSS outputs are also used. http://www.meteo.shom.fr/qctools/

3.2 Moored buoys

The Department of Ocean Development (DoD), now known as Ministry of Earth Sciences (MoES), Government of India, through the National Institute of Ocean Technology (NIOT), has established the National Data Buoy Programme (NDBP) to collect real-time meteorological and oceanographic data from moored data buoys in Indian waters.

With the objectives of measuring different met-ocean parameters such as Wind Speed & Direction, Atmospheric Pressure, Air Temperature, Humidity, Conductivity, Sea Surface Temperature, Current Speed & Direction and Wave Parameters, and to create a good data base for Weather Prediction / Early Cyclone Warning, Ocean State Model Calibration, Climate Research, Satellite Data Validation, Port Development / Navigational Use, Engineering / offshore project and Safety of Life at Sea, a variety of categorized data buoys such as Met buoys, Ocean buoys, Environmental buoys and Port buoys have been developed and deployed.

Prior to 2008, the ocean observation systems group worked on a network of 40 moored buoys. Due to the shallow water buoys being more prone for vandalism, MoES decided that an optimal network of only 12 deep sea buoys will be maintained as per user specified locations and parameters. Reference platforms at one or two locations are planned for shallow water measurements. Hence in 2009, the team is now working to establish and maintain a network of 12 deep sea buoys, comprising 5 recently deployed in the Arabian Sea, and 7 planned for deployment in the Bay of Bengal by September 2009. In June 2009, four buoys were operational (WMO Id's 23097, 23101, 23171, 23494,) and the real-time data were transmitted by IMMARSAT/INSAT. The surface meteorological data are distributed on the GTS in FM 18 BUOY code by IMD (Bulletin header SSVX01 DEMS).

The Japan Agency for Marine-Earth Science and Technology (JAMSTEC) maintains a subsurface ADCP mooring near 0° 90 °E. This mooring, which reports data in delay mode, was first deployed in 2000. Two TRITON buoys are also maintained by JAMSTEC. These buoys were first deployed in the eastern tropical Indian Ocean in November 2001 at 5°S 95°E (WMO Id. 53056) and 1.5°S 90°E (WMO Id. 53057). The moorings are serviced on an annual basis. In the March 2009 JAMSTEC replaced the two surface mooring sites with newly developed m-TRITON buoys which are based the TRITON technology and report

on the same WMO Id. One of the m-TRITON moorings telemeters data using the newly developed Argo3 PMT.

India's National Institute of Oceanography (NIO) began deploying Deep Ocean moorings in 2000. They presently maintain 3 sites along the equator at 77°E, 83°E, and 93°E. Data from these subsurface moorings are available in delay mode,

Building upon the tropical mooring networks of India and Japan, the CLIVAR/GOOS Indian Ocean Panel (IOP) developed a plan in 2004 for the Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction (RAMA), a new observational network designed to address outstanding scientific questions related to Indian Ocean variability and the monsoons. The plan consists of a basin scale network of 46 deep ocean moorings that, like TAO/TRITON and PIRATA, provide essential data to complement other existing satellite and in situ observations in the region. Nations that have provided mooring equipment, ship time, personnel, and/or logistic support so far include the United States, Japan, India, Indonesia, China, France and the Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project, a consortium of 9 African countries funded by the Global Environment Facility (GEF) and implemented by the United Nations Development Programme (UNDP).

The United States began a sustained Indian Ocean mooring program in October/November 2004 by the deployment of 1 subsurface and 3 surface moorings with ship time provided by India's DoD (now MoES). US supported sites increased to 11 (9 surface, 1 subsurface) by June 2008 with ship time provided by India, Indonesia and France. At that time the total number of RAMA sites included the US sites, plus the 3 supported by Japan, 3 by India, and 1 by China for a total of 18 of 46, or 39% complete.

Between July 2008 and June 2009 the number of sites at which moorings have been deployed increased by 4. These include 2 moorings deployed from India's Sagar Nidhi along 80.5 ºE at 4 ºS and 8 ºS and 2 moorings deployed from the Fridtjof Nansen (ASCLME) in November 2008 along 55 ºE at 8 ºS and 12 ºS. As of June 2009 the number of RAMA sites implemented stands at 22 of 46, or 48% complete.

The combination of heavy vandalism and moorings being deployed for long periods between maintenance cruises resulted in data return rates significantly lower than those for the tropical moored buoy arrays in the Pacific and Atlantic Oceans. Difficulty in obtaining timely and sufficient sea days has lead to many RAMA moorings being deployed longer than their intended 12 months. For example 4 moorings deployed along 90°E in September/October 2007 will not be revisited until July 2009 (22 months). As of June 2009, 9 of 16 surface moorings were reporting on the GTS (WMO ID's 14040, 14041, 14042, 23001, 23002, 23003, 23009, 53005, 53056). The loss of data emphasizes the need for sustained and regular ship support for the mooring program to succeed and for measures to combat vandalism.

To address the problem of theft of instrumentation, PMEL moorings deployed since September 2007 have employed hardware that requires special tools. The efficacy of this approach awaits future mooring recoveries. In a parallel effort, two moorings deployed in August 2008 contained no meteorological sensors and the buoys were modified to discourage vandals from boarding or attaching lines to the buoy. Most sea surface and subsurface measurements from these "conehead" buoys continue to be telemetered after 11 months.

Between July 2008 and June 2009 110 sea days were provided in support of RAMA; 70 days by India, 22 days by Japan, 10 days by ASCLME and 8 days by France. A realistic estimate of sea days necessary to fully maintain the completed array is 200 days per year. Formal bilateral agreements are either under development or approved between agencies in the various partner countries to help complete and sustain the array.

In addition to vandalism, recent well-publicized piracy events have resulted in the suspension of RAMA implementation off Africa and in the Arabian Sea.

4. Plans

IBPIO participants are regularly encouraged to increase their contributions of buoys, or to fund barometers to equip SVP drifters provided by GDP. Meteo-France and ABOM have funded barometer upgrades in the Indian Ocean since 1996 and 2000 respectively. Some Iridium drifters will be deployed for evaluation during the next intersessional period.

4.1 Tropics

Efforts are aimed mainly at filling data gaps in the tropical regions, primarily during the Tropical Cyclone seasons. In the southern tropical area the buoys are provided by NOAA/GDP and routinely include about 10 barometer upgrades funded by Meteo-France. The ABOM plans to deploy 9 drifting buoys between the central Indian Ocean and the Australian coast. NIO plans to continue to provide and deploy drifters in the Arabian Sea and in the Bay of Bengal (about 15 in 2009-2010).

RAMA implementation and maintenance will continue in the coming year: MOUs with Indian and Indonesia will provide 90 or more sea days annually; Surface moorings at 3 new sites (4°N 80.5°E, 12°S 80.5°E and 12°S 67°E) are scheduled to be deployed in August 2009. The conehead moorings deployed the year before will be replaced by similar moorings which have been enhanced with a prototype surface met package; Informal agreements will provide continuing collaboration with ASCLME, with a new mooring to be deployed at 16°S 55°E, expanding their support from 2 to 3 sites; JAMSTEC plans to deploy a third m-TRITON mooring at 8°S 95°E in November 2009; China plans to deploy a surface mooring at a new site (8°S 100°E) in late 2009; and France will support additional barometric pressure measurements at 4 RAMA sites. As security concerns are addressed further implementation may proceed.

4.2 Sub-tropics and Mid-latitudes

In the Southern part of the Indian Ocean (South of 35S), the deployment of SVP-B drifters provided by GDC and upgraded by Meteo-France (about 20 units a year) should continue. The ABOM plans to deploy 13 SVP-B drifters in this area over the next 12 months including 8 upgrades. These deployments will be supported by the RV Marion Dufresne during her rotations between La Reunion, Crozet, Kerguelen and Amsterdam Islands.

In addition to the drifters upgraded by Meteo-France and ABOM, GDC plans to provide at least 15 SVP-B drifters (upgraded by SIO) for deployment in the Southern Indian Ocean.

In the sub-tropics (between the Tropic of Capricorn and 35S) the ABOM will deploy 6 SVP-B, including 2 near the Indian Ocean Gyre.

The SAWS, through the PMO in Cape Town, continues to coordinate the deployment of drifters on behalf of GDP, ABOM and Meteo-France from voyages to Marion Island (4 voyages every year, March, April, August and November). The ABOM plans to provide 2 SVP-B buoys for deployment from the scheduled voyages in 2010.

As in previous years, the GDP remains the biggest contributor to the IBPIO. Many of the drifters are standard SVP that only measure SST in addition to the surface current deduced from their movement.

5. Information on the IBPIO

IBPIO information is available on the World Wide Web at *http://www.meteo.shom.fr/ibpio/*. The main pages give a description of the programme, its objectives and management, listings of participants and links to related subjects such as DBCP data quality control information. Some pages are updated monthly with buoy trajectories and deployment log. Buoy status tables are updated less frequently.

A promotional leaflet on the IBPIO can be obtained from the Chairman or the Programme Co-ordinator.

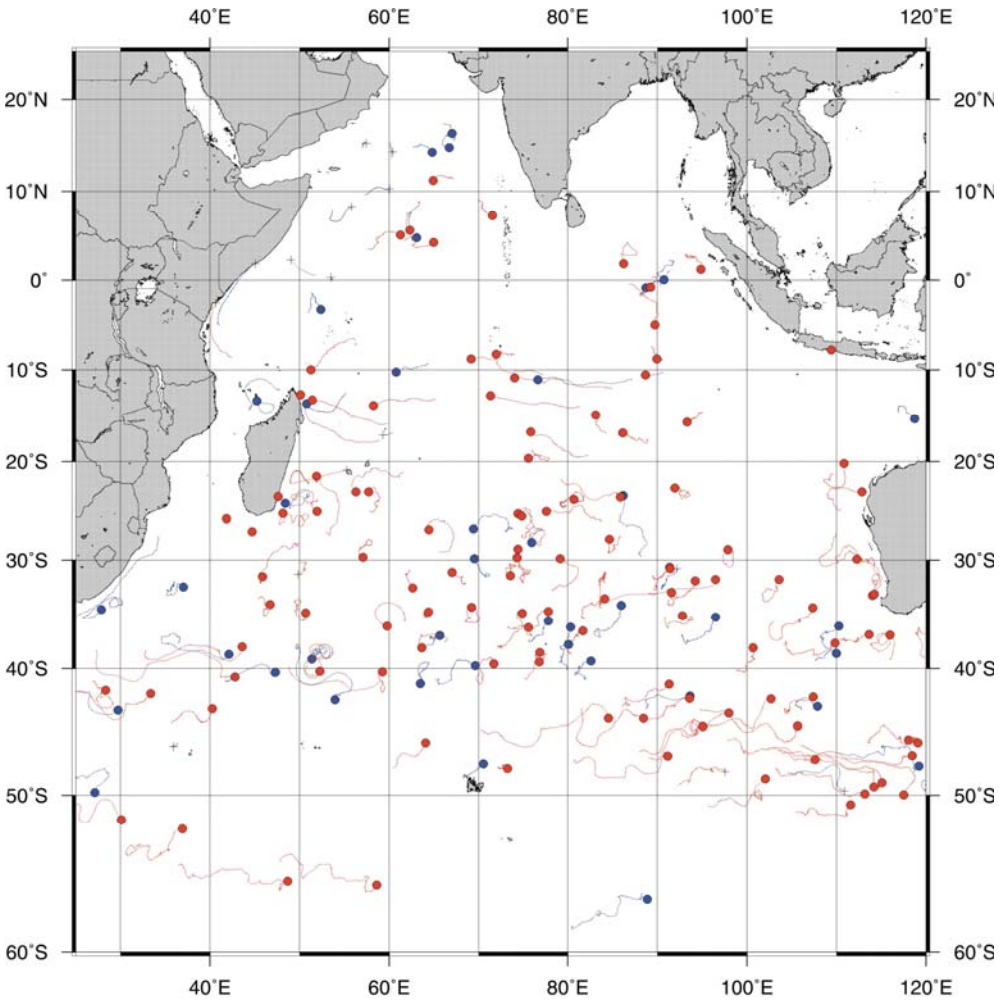

Figure 3. Buoys drifting in the Indian Ocean
June 2009

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APPENDIX E

REPORT BY
THE INTERNATIONAL SOUTH ATLANTIC BUOY PROGRAMME (ISABP)

1. Program Overview

The International South Atlantic Buoy Programme (ISABP) was established in 1993 to address the problem of data sparseness in the South Atlantic Ocean. The main objective of ISABP is to establish and maintain a network of platforms in the Tropical and South Atlantic Ocean in order to provide meteorological and oceanographic data for both real-time and research purposes. The task includes support to the World Weather Watch Programme (WWW), the Global Climate Observing System (GCOS), the World Climate Research Programme (WCRP), and the Global Ocean Observing System (GOOS), as well as to the research activities of participating institutions.

2. Operational Program

During the intersessional period, cooperation and coordination between participants have continued in the form of equipment (drifters), storage, deployment opportunities, communications, data dissemination and archiving. The GDP continues to offer the opportunity to upgrade to barometer drifters, thus the increase in the number of drifters with barometric pressure sensor in the area. There is also a network of fixed stations and profiling floats in the area, providing data in real time via the Global Telecommunication System (GTS).

3. Data Coverage

Drifters

A total of 245 drifters were deployed in the ISABP region from September 1, 2008 – August 31, 2009 of which 9 failed on deployment (200 SVP, 44 SVPB and 1 SVPB + salinity). Deployments were carried out by the Drifter Operations Center at AOML, US Navy, Brazilian Navy, South Africa Weather Service, Fisheries Departments of Tristan da Cuhna and Falkland Islands. All drifter data were disseminated on the GTS soon after deployments occurred.

In the past, it has been very difficult to deploy drifters east of the AX-8 line, in the Gulf of Guinea region and in the Eastern Subtropical region, due to lack of deployment opportunities. The only way to populate these regions is to deploy drifters close to shore, because they will flow westward and leave the area. This year, there were three ships that were able to deploy in these hard to reach areas, the R/V Endeavor, the R/V Explorer (Semester at Sea ship) and the USS Nashville, which is the US Navy's Africa Partnership Station, with its ongoing international efforts to promote maritime awareness in African Nations and to populate this area of poor coverage. XBT and Argo floats were also deployed. Participants from the

West African nations carried out some of the deployments (Figure 1.)

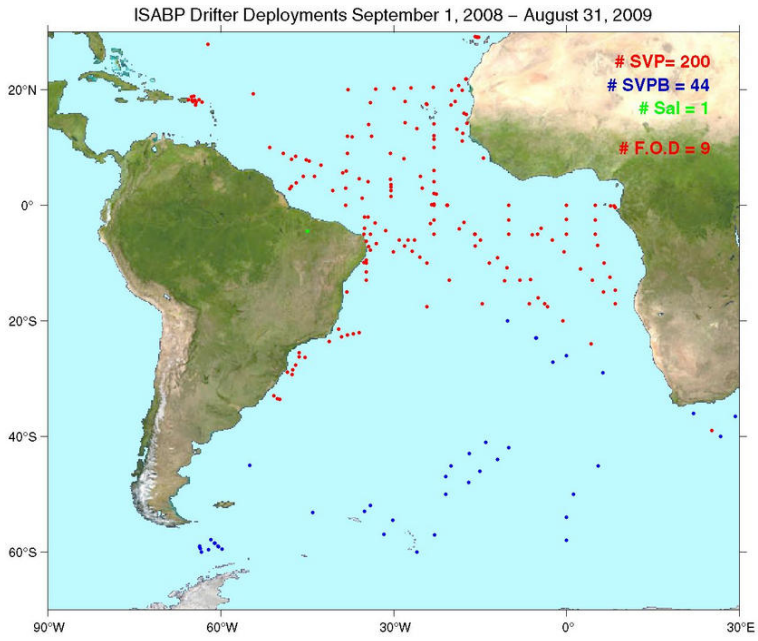

Figure 1.

At the end of August 31, 2009, there were a total of 321 drifters in the ISABP region of which 1 95 were SVP and 126 SVPB. An increase from last year's totals: 184 SVP, and 107 SVPB (Figure 2).

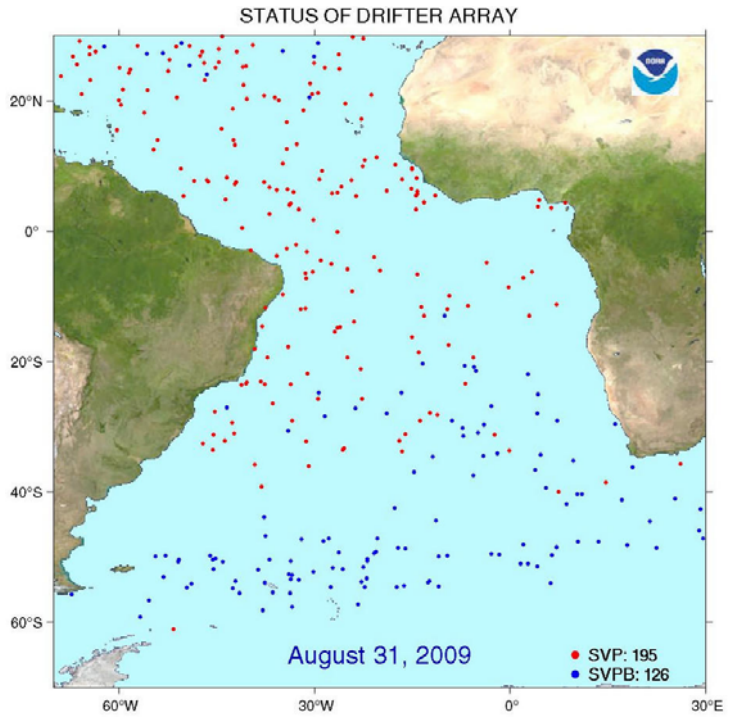

Figure 2.

Once again drifter data proved to be very useful, when on May 31, 2009 a plane plummeted into the ocean off the northeast coast of Brazil with 216 passengers and 12 crew members aboard and disappeared while crossing the Atlantic Ocean in route from Rio de Janeiro, to Paris. Several drifters were found in the

general area of the crash and their data were obtained and used on real time to estimate how far the currents had carried floating debris from the crash site to help locate any human bodies or other remaining from the crash. To further populate the region and obtain higher resolution current measurements, the Hydrographic Center of the Brazilian Navy deployed six more drifters near the crash site on June 14th.

4. Fixed Stations

In May and June the Navy Hydrographic Center (CHM), Brazil, deployed two moored buoys of Platform type and one moored buoy of Costal type. The coastal buoy, suffered from a navigation incident in July, and was brought to shore. It is being prepared for redeployment by early October 2009. All data was reported on the GTS.

There is one AWS in Gough, Marion Islands and in Antarctica. One fix buoy in Tristan da Cunha and Southern Thule Islands that get replaced every year and the old one deployed.

5. New Member

This year the Servicio de Oceanografia, Hidrografia y Meteorologia de la Armada (SOHMA) from Uruguay has joined ISABP.

6. 2010 Deployment Plans

The GDP will continue to fund the upgrade opportunity of SVP drifters to barometer drifters. The GDP has the following deployments projected through May 31, 2010:

Tropical Atlantic (30°N – 20°S):	150 drifters (15 SVPB)
Extra Tropical Atlantic (20°S – 40°S):	35 drifters (5 SVPB)
South Atlantic (40°S – 60°S):	65 drifters (all SVPB)

Brazilian DHN (Directorate of Hydrographic and Navigation) confirmed the availability of ship time to deploy up to one hundred and twenty drifters in the Tropical and South Atlantic regions with the support of Brazilian Navy vessels in the area, and promised to upgrade some SVP to SVPB.

Argentina is looking into innovative ways to get instruments into the country. Even though things look promising, a commitment to carry out deployments next year cannot be made at the time of this report.

SAWS will strive to continue working together with other groups in the region to expand the buoy n etwork in this area.

7. Next ISABP meeting

The next ISABP meeting will take place in Buenos Aires, Argentina, 15-16 April 2010.

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APPENDIX F

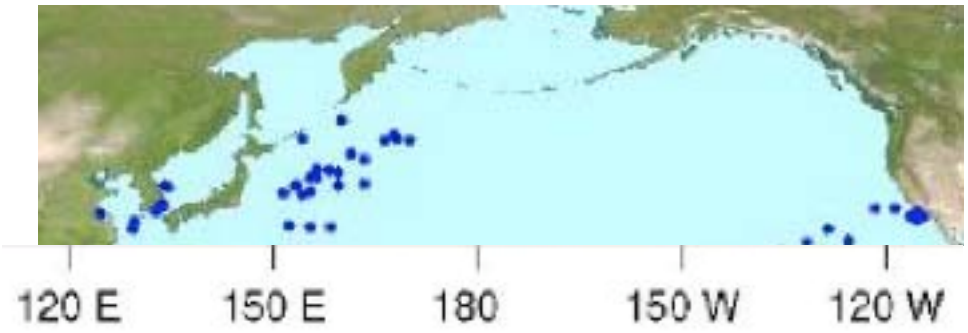
REPORT BY

THE DBCP-PICES NORTH PACIFIC DATA BUOY ADVISORY PANEL (NPDBAP)

North Pacific Buoy Deployment Locations

from

1 September, 2008 to 31 August, 2009



2008-2009 Results and Current Status

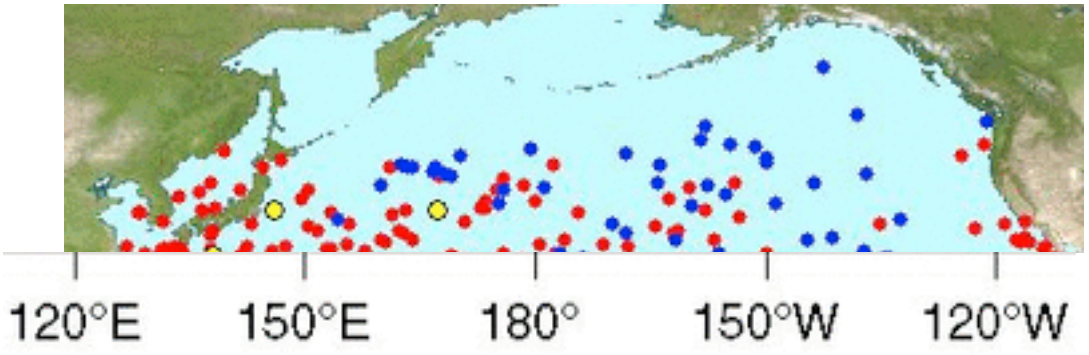
Between 1 September, 2008 and 31 August of 2009, there were a total of 63 buoys deployed north of 30°, between 110°E and 110°W. Of these 63 deployments in the North Pacific, 28 of these buoys were SVP drifters (44%), 13 were SVPG drifters (21%) and the remaining 22 buoys were SVPB drifters (35%).

It is apparent by looking at these results that the goal of having 50 SVPB buoys deployed in this region was not met. In fact, 38 more SVPB buoys were needed to meet the 2009 goal.

Current North Pacific Buoy Locations

as of

07 September, 2009



2009-2010 North Pacific Deployment Plan

The current plan which calls for the deployment of 50 SVPB drifters in the North Pacific region between September 2009 and August 2010 will not only help populate the area, but also decrease the average age of active buoys.

Northwest Pacific	
120E to 145E	0 SVPB
145E to 160E	22 SVPB
161E to 175E	18 SVPB
Northwest Pacific Total:	40 SVPB
North-Central Pacific	
176E to 175W	4 SVPB
174W to 165W	4 SVPB
164W to 150W	2 SVPB
North-Central Pacific Total:	10 SVPB
Northeast Pacific	
149W to 135W	0 SVPB
134W to 125W	0 SVPB
124W to 110W	0 SVPB
Northeast Pacific Toatal:	0 SVPB
North Pacific SVPB Deployment Total:	50 SVPB

Research Vessel (R/V) and Voluntary Observation Ship (VOS) Deployments

Buoys will continue to be deployed by Research Vessels and VOS. The GDP will work to coordinate deployment efforts with Research vessels operated by Canada, Japan, Korea, China and the United States, in addition to acquiring and maintaining lasting relationships with various VOS vessels that transit the area.

SVPB Upgrade Opportunity

The GDP provides an opportunity for Meteorological agencies to add barometers to SVP drifters deployed in the North Atlantic. More information can be found on the DBCP website under SVPB Upgrade Opportunity link.

• http://www.dbcp.noaa.gov/dbcp/svpb_upgrade.html

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APPENDIX G

REPORT BY

THE TROPICAL MOORED BUOY IMPLEMENTATOIN PANER (TIP)

The Global Tropical Moored Buoy Array is a multi-national effort to provide data in real-time for climate research and forecasting. Major components include the TAO/TRITON array in the Pacific, PIRATA in the Atlantic, and RAMA in the Indian Ocean. The primary data telemetered in real time from surface moorings in the arrays are daily or hourly mean surface measurements (wind speed and direction, air temperature, relative humidity and sea surface temperature and salinity) and subsurface temperatures. ATLAS and TRITON moorings provide optional enhanced measurements, which include precipitation, short and long wave radiation, barometric pressure, salinity, and ocean currents. These enhancements provide heat, moisture and momentum flux measurements at 4 TAO, 1 TRITON, 4 PIRATA and 4 (at present) RAMA moorings. High temporal resolution (10-min or hourly) measurements are available in delayed mode.

TAO/TRITON, PIRATA and RAMA all support the Ocean Sustained Interdisciplinary Timeseries Environment observation System (OceanSITES), a worldwide network of deep water reference stations providing high temporal resolution data in real time for ocean research and environmental forecasting. Embedded within these arrays are the specially instrumented reference sites for air-sea heat, moisture and momentum fluxes mentioned above. PMEL has developed a web page specifically designed for the distribution of OceanSITES data and products from the Tropical Moored Buoy Arrays. Several moorings also support OceanSITES observatories for carbon and biological measurements in collaboration with PMEL's CO_2 Program, the LOCEAN CO_2 Program at the University of Paris VI, and MBARI's Biological Oceanography Group.

More information on TAO/TRITON, PIRATA, and RAMA along with data display and dissemination are available on the web at http://www.pmel.noaa.gov/tao/global/global.html.

TAO/TRITON

The Tropical Atmosphere Ocean/Triangle Trans-Ocean Buoy Network (TAO/TRITON) moored buoy array is a central component of the ENSO Observing System, deployed specifically for research and forecasting of El Niño and La Niña. The Array consists of 55 ATLAS moorings maintained by the National Data Buoy Center (NDBC) and the Pacific Marine Environmental Laboratory (PMEL), 12 TRITON moorings maintained by the Japan Agency for Marine-Earth Science and Technology (JAMSTEC), and 5 subsurface Acoustic Doppler Current Profiler (ADCP) moorings (4 maintained by NDBC and 1 by JAMSTEC). In addition to these core moorings, there are several moorings deployed as enhancements, including 3 TRITON moorings in the far western tropical Pacific along 130□E and 137□E, and test sites maintained by NDBC for mooring refresh development.

At present (August 2009), weak El Nino conditions prevail in the tropical Pacific, with tropical Pacific sea surface temperature anomalies generally more than 0.5 ºC extending over most of the eastern half of the basin. Westerly wind anomalies have been prominent in the western basin recently. The most recent (August 6, 2009) EL *NIÑO/SOUTHERN OSCILLATION (ENSO) DIAGNOSTIC DISCUSSION* issued by NOAA's Climate Predication Center states that "El Niño is expected to strengthen and last through the Northern Hemisphere Winter 2009-2010."

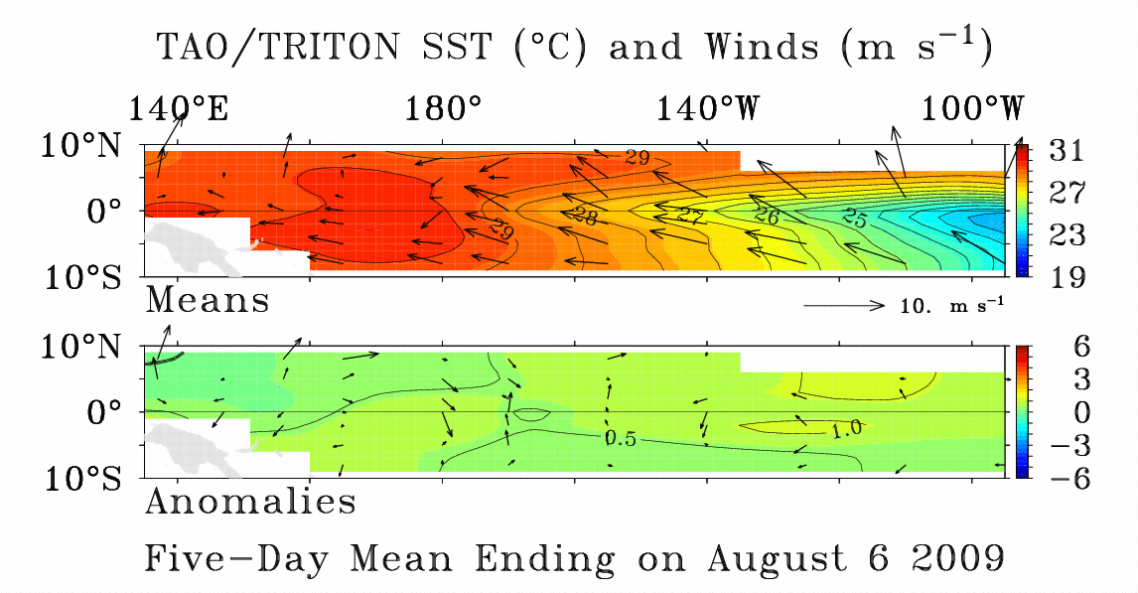

Figure 1. Sea surface temperature (contours) and surface wind velocity (arrows) from the TAO/TRITON mooring array. The upper panel shows the measured values and the lower panel shows the difference from climatological values. TAO/TRITON mooring locations are at the base of the wind vectors.

TAO/TRITON data return has declined, with an overall value for real-time primary data availability of 81% for the time period 1 October 2008 to 5 August 2009. Data return for a similar period last year was 87%. (Data return statistics for the period 1 October 2008 to 30 September 2009 will be available at the time of the Panel meeting.) Damage to moorings and sensors due to fishing activity continues to be of concern. This damage accounts for a significant amount of data loss, especially in the far eastern and far western portions of the Pacific basin. Funding and ship time are also areas of concern (see below).

NDBC has been responsibility for TAO field operations since January 1, 2007, while instrument preparation remains at PMEL. NDBC is developing a "refreshed" ATLAS system comprised of more "off-the-shelf" components. Prototype refreshed systems are presently deployed alongside PMEL ATLAS moorings at five sites in the TAO array. Delayed-mode analysis of data from one recovered refresh system is underway. Since October 2008 (the beginning of the US fiscal year [FY] which runs through the following September) there have been 4 TAO cruises (3 on NOAA Ship Ka'imimoana and one on NOAA Ship Ron Brown) with two additional cruises (Ka'imimoana and RV Wecoma) scheduled for August/September 2009. Traditionally, 8 cruises per year were required to keep mooring deployment lengths within their design life of 12 months and to replace failed or damaged sensors mid-deployment. The reduction in NOAA sea days for 2009 (about 20% less than for 2008) has resulted in 10 moorings presently deployed for 13 months or more, and lower data return as noted above.

JAMSTEC cruises in February and April 2009 serviced 6 Pacific TRITON moorings. Additional TRITON moorings will be serviced in November 2009.

PIRATA

The Prediction and Research Moored Array in the Tropical Atlantic (PIRATA) continued in a 17 surface mooring and one subsurface ADCP mooring configuration in 2009. Mooring preparation, data processing and evaluation are provided by the US. Ship time for mooring maintenance is provided by Brazil, France and the US. Cruises are staffed by US, French and Brazilian technicians.

PIRATA real-time primary data return for the time period 1 October 2008 to 5 August 2009 was 85%. PIRATA data return has typically been lower than that for TAO, primarily due to a greater relative amount of vandalism (concentrated in the Gulf of Guinea) and a smaller array size, although the occurrence of vandalism can be episodic (perhaps in response to the abundance of fish and number of fishermen). That PIRATA data return exceeds TAO in 2009 is presumably a reflection of fewer than normal TAO sites being maintained and the relatively high data return in PIRATA by historical standards.

Four FY 2009 PIRATA cruises have been completed (123 days in total) and a fifth is scheduled for September 2009. On one of the cruises NOAA chartered 29 days on France's RV Antea in October 2008 to replace the days lost due to cancellation of a cruise on NOAA's Ron Brown in April 2008.

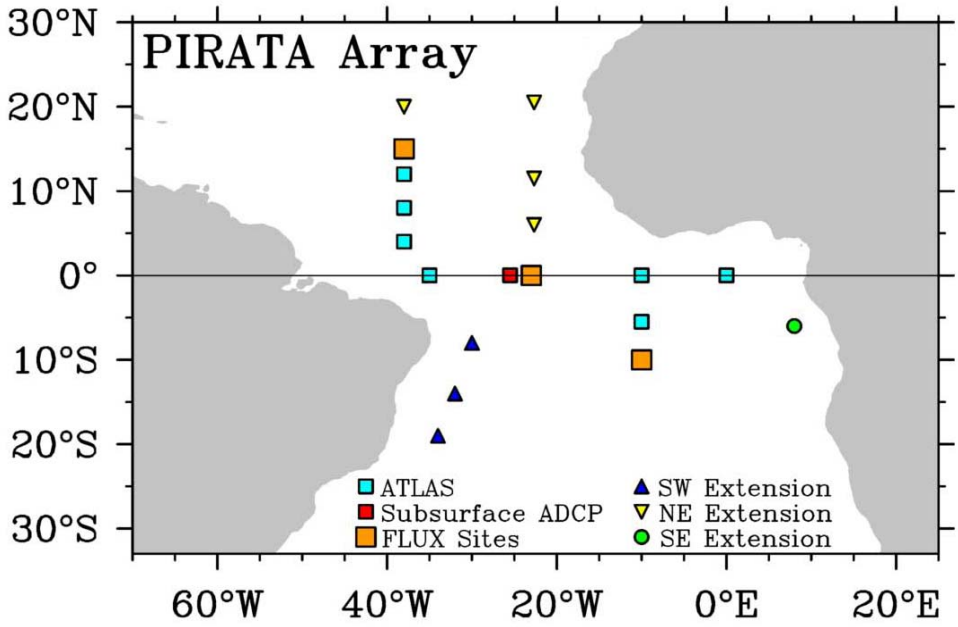

Figure 2. Mooring locations within PIRATA.

RAMA

The CLIVAR/GOOS Indian Ocean Panel (IOP) developed a plan in 2004 for a new observational network designed to address outstanding scientific questions related to Indian Ocean variability and the monsoons. The moored buoy component of the network (given the name Research Moored Array for African-Asian-Australian Monsoon Analysis and Prediction, or RAMA, in 2007) consists of a basin scale network of 46 deep ocean moorings that, like TAO/TRITON and PIRATA, provide essential data to complement other existing satellite and in situ observations in the region.

Nations providing support for RAMA include the United States, Japan, India, Indonesia, China, and France. Additional support was provided in the past year from the Agulhas and Somali Current Large Marine Ecosystems (ASCLME) Project, a consortium of 9 African nations (Comoros, Kenya, Madagascar, Mauritius, Mozambique, Seychelles, Somalia, South Africa and Tanzania). Under current plans the number of occupied RAMA sites will have increased by 4 in FY 2009. By the end of FY 2009 moorings will have been deployed at 24 of the 46 sites (implementation 52% complete). The array then will include 16 ATLAS (US), 3 Deep Ocean (India), 2 TRITON (Japan), and 3 subsurface ADCP (1 each, US, Japan and China). France has provided instrumentation to add barometric pressure to 4 RAMA moorings in the southern portion of the array for enhanced cyclone forecasting.

140 sea days will have been provided in support of RAMA in FY 2009; 88 days by India, 20 days by Japan, 22 days by Indonesia and 10 days by ASCLME. Difficulty in obtaining timely and sufficient sea days

has lead to many RAMA moorings being deployed longer than their intended 12 months. For example, 4 moorings deployed in September/October 2007 along 90ºE were not revisited until July/August 2009 (18-19 months). A realistic estimate of sea days necessary to fully maintain the completed array is 200 days per year. Formal bilateral agreements are either under development or approved between agencies in the various partner countries to help complete and sustain the array. Implementing agreements were approved between the US and India in September 2008, the US and Indonesia in May 2009, the US and Japan in June 2009. A US/ASCLME agreement is pending.

Several additional RAMA sites are planned for implementation in FY2010: The US and ASCLME will add 3 ATLAS moorings south of the equator along 55ºE. Plans for RAMA implementation at and north of the equator along 55ºE have been put on hold in face of the well publicized piracy in the area. The US and India may add additional ATLAS moorings along 67ºE and 80.5ºE. JAMSTEC will deploy an m-TRITON mooring at 8ºS 95ºE. (The m-TRITON is based on the TRITON technology, but employs a smaller buoy providing a wider range of deployment opportunities. The JAMSTEC surface moorings presently at 2 other RAMA sites are also of the m-TRITON design.) China's First Institute of Oceanography will deploy a surface mooring at 8ºS 100ºE.

To address the problem of theft of instrumentation, 2 moorings deployed in August 2008 contained no meteorological sensors on buoys modified in a "conehead" shape to discourage vandals from boarding or attaching lines to the buoy. To date, subsurface data from these conehead moorings has been nearly complete, suggesting that the anti-vandalism design modification has been effective. These moorings will be replaced in September 2009, again with modified buoy design, but with the addition of a single meteorological sensor package to measure wind, air temperature, relative humidity, precipitation and barometric pressure.

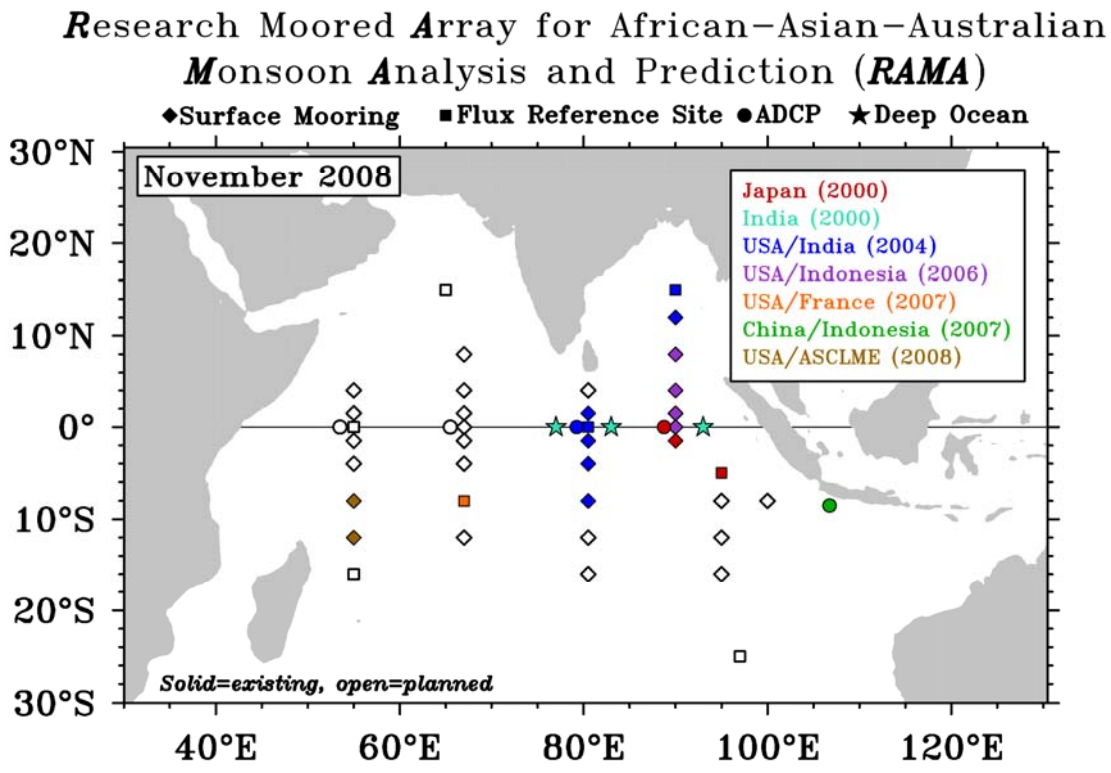

Figure 3. Mooring locations within RAMA. Solid symbols indicate sites implemented as of November 2008.

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APPENDIX H

REPORT BY THE OCEAN SUSTAINED INTERDISCIPLINARY TIMESERIES ENVIRONMENT OBSERVATION SYSTEM (OCEANSITES)

Status and update on OceanSITES

The OceanSITES project for a global network of open-ocean long-term timeseries sites has evolved significantly in several aspects.

Due to the project office support available for OceanSITES at JCOMMOPS, the status of the global system could finally be updated, by contacting all known operators of open-ocean timeseries sites. As a result, a new inventory of sites, together with short descriptions and global maps, are now available. Shown below in figure 1 is the status of operating sites as of 2009, altogether there are over 100.

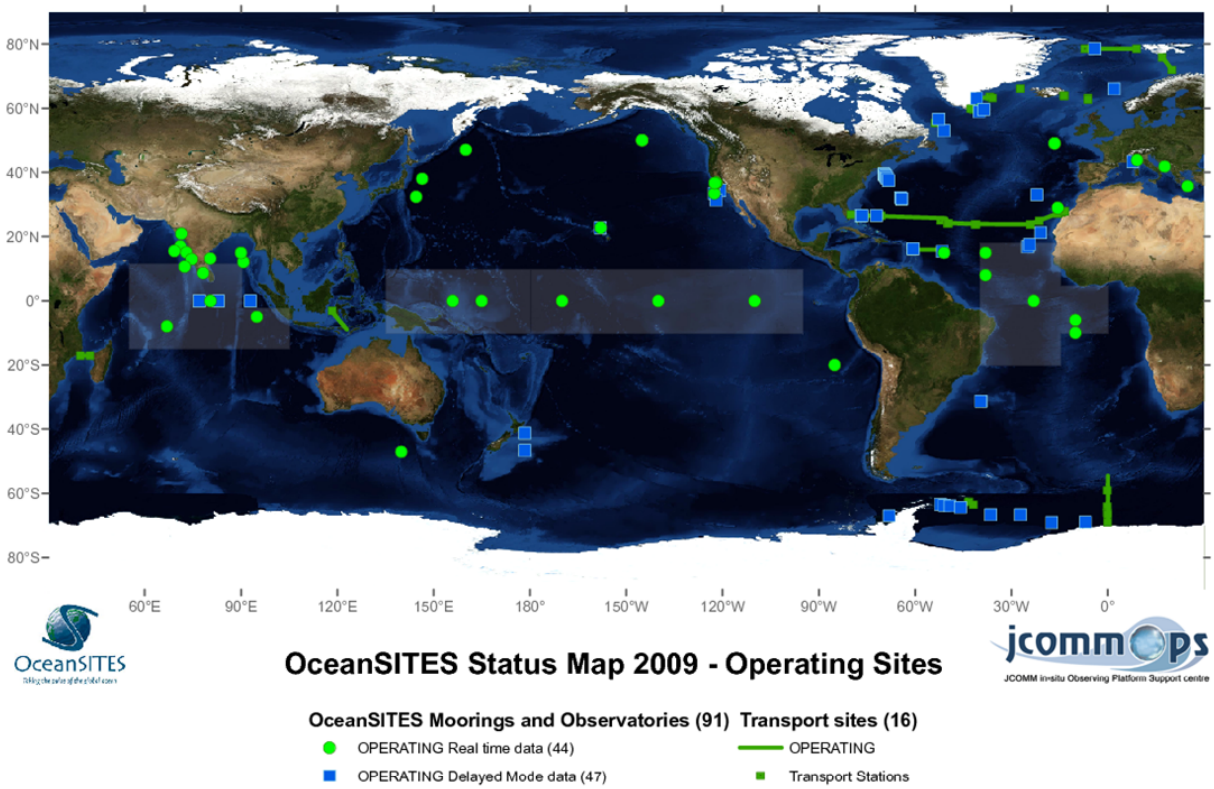

Figure 1: Presently operating sites coded by data available in real-time or delayed-mode.

A Google Earth overlay (kmz file) is available at the website www.oceansites.org, which provides interactive information about each site. More work is underway to provide additional functionality from the Google Earth interface.

The membership of the Steering Team was opened to all operators or principal investigators of sites in the system, and at the same time an Executive Committee was formed. Membership of the Data Management Team was reduced to the active participants who contribute to discussions and meetings, and an alternative group/email list was created which keeps others and data centers informed about developments in the data management effort, data formats, data inventories, etc.

A very well attended joint meeting by the Steering Team and the Data Management Team was held in Venice/Italy during 17-19 September 2009. At that meeting the vision for a core/backbone system of equivalent multi-disciplinary sites was refined and re-endorsed, shown in figure 2.

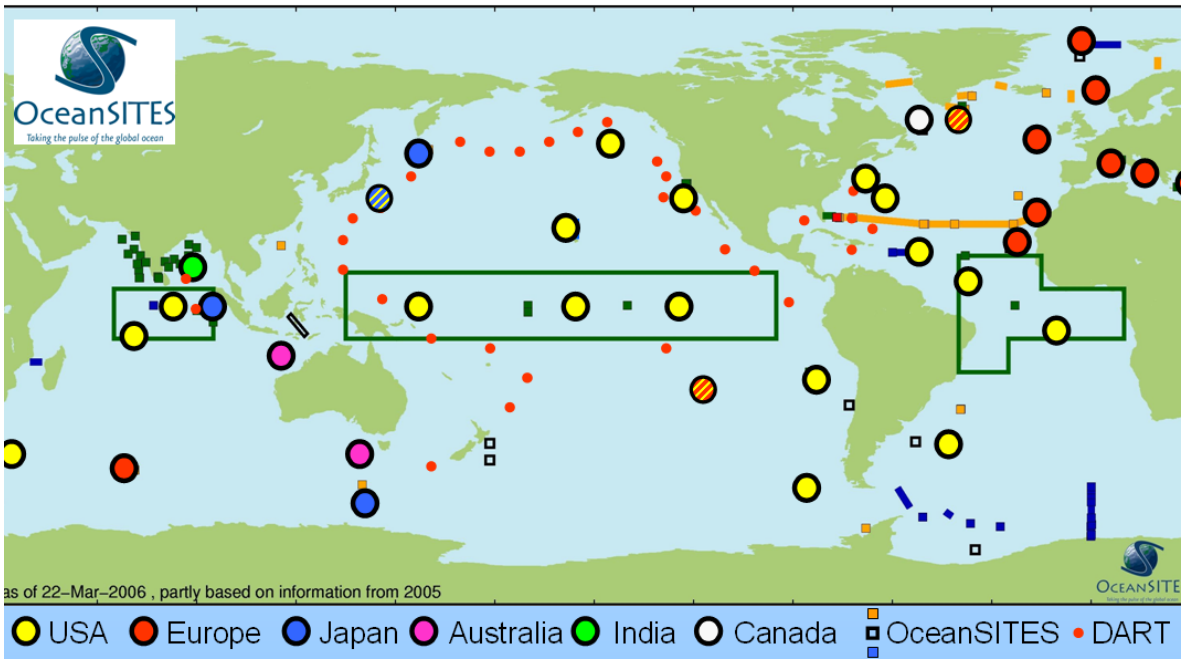

Figure 2: Vision for sites that could be upgraded to be equivalent and real-time at minimal extra cost.

A break-through decision was reached at that meeting, endorsed in the end also by all representatives of the biogeochemical community, to make real-time data available even if no good quality-control procedures are in place. This has now paved the way to disseminate real-time pCO2, pH, and bio-optical data for example.

Another milestone was reached in Venice by the Data Management Team deciding that it was mature and independent enough now to hold its own meetings, separate from the Steering Team, and ideally leap-frogging it so that major advances could take place twice per year. In addition, monthly web-based teleconferences were started by the Data Team in order to make constant progress on data issues and on making increasing amounts of data available. These meetings are now routine and well-attended. This culminated in the first own international in-person meeting of the Data Management Team in Paris during 25-26 March 2010, where many outstanding technical issues were resolved. This will now allow the data system to start operating fully. In addition to real-time data flow, historical data from existing timeseries sites are being added. In particular, 40 years of data from Hawaii, Bermuda, and CalCOFI will soon be available from OceanSITES.

The OceanSITES data system is also being offered for use by other communities or projects who are looking for a central place and mechanism to collect and disseminate their timeseries data, as long as they provide their data in the correct format with the agreed QC procedures. Typically these are short-duration (2 years or less) records which thus do not fall into the OceanSITES definition. Examples are air-sea flux reference timeseries from mooring deployments at important global locations, or CLIVAR process experiment mooring data. This was agreed at a CLIVAR GSOP meeting in Tokyo in November 2009, where OceanSITES has a permanent representative.

OceanSITES further received a large amount of visibility and community recognition at the OceanObs09 conference in Venice, featuring in many community white papers and plenary presentations. It is clear now that OceanSITES will remain a central element of the future global ocean observing system, especially with the increased emphasis on biogeochemistry and ecosystems, where OceanSITES will make major contributions. The current vision map for OceanSITES, showing all operating and planned/funded sites for the near future, is shown in figure 3.

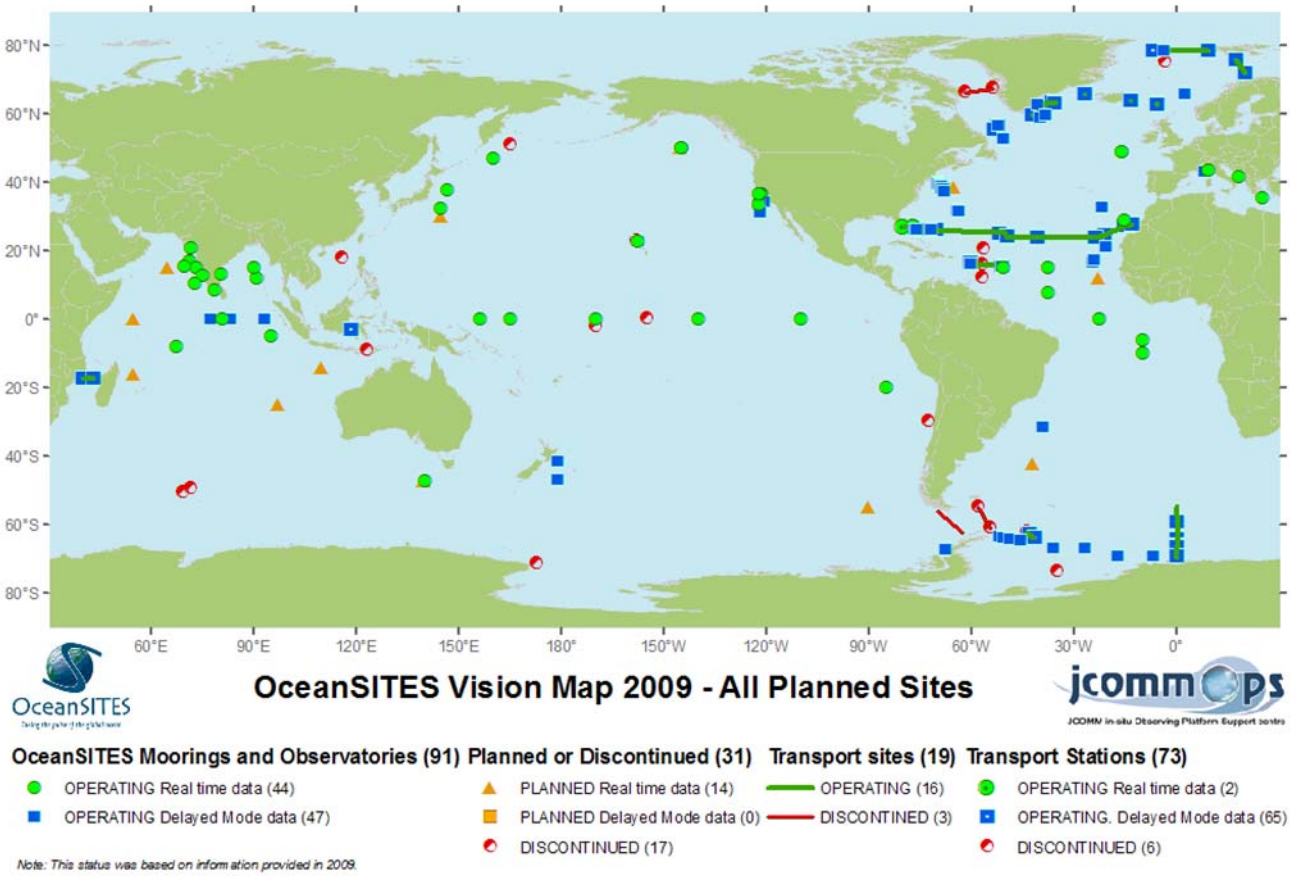

Figure 3: Presently operating and planned/funded sites, as well as discontinued ones.

Funding for the OceanSITES project office at JCOMMOPS remains a problem, so far still the only commitments are from the USA and from Australia.

APPENDIX I

REPORT BY THE WCRP-SCAR INTERNATIONAL PROGRAMME FOR ANTARCTIC BUOYS (IPAB)

No report had been submitted by the IPAB at the time of preparing this report.

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