**WORLD METEOROLOGICAL ORGANIZATION**

**INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)**

DATA BUOY COOPERATION PANEL

DBCP-XXVII/Doc. 6.3
(12-Sep-11)

TWENTY-SEVENTH SESSION

ITEM: 6.3

GENEVA, SWITZERLAND
26-30 SEPTEMBER 2011

ENGLISH ONLY

# REPORT BY THE TASK TEAM ON MOORED BUOYS (TT-MB)

*(Submitted by Jon Turton, Chair, TT-MB, United Kingdom)*

**Summary and purpose of the document**

This document contains the report by the chairperson of the DBCP Task Team on Moored Buoys.

**ACTION PROPOSED**

The Panel will review the information contained in this report and comment and make decisions or recommendations as appropriate. See part A for the details of recommended actions.

**Appendices**: A. Report by the Task Team on Moored Buoys

B. Terms of Reference of the DBCP Task Team on Moored Buoys

## -A- DRAFT TEXT FOR INCLUSION IN THE FINAL REPORT

6.3.1 Mr Jon Turton, Chairperson of the Task Team on Moored Buoys reported on the progress during the intersessional period.

6.3.2 The Panel recalled that the initial priority for the Task Team has been on defining the comprehensive metadata on moored buoy systems that needs to be collected (see version 1 agreed at DBCP-26). Collecting and sharing such information would help everyone to adopt best (and hopefully more consistent) practices. The Panel noted with concern that with the absence of a DBCP Technical Coordinator during the inter-sessional period it has not been possible to progress the actions recommended at DBCP-26. However, the UK Met Office and Environment Canada have initiated producing metadata for their own buoy systems in the view to eventually submit them to JCOMMOPS.

6.3.3 The Panel noted the technical developments undertaken by Canada, India, the United Kingdom, and the USA for the buoy systems they are deploying in the world oceans. It noted again the serious problem of vandalism on data buoys to be discussed under agenda item 9.4.

6.3.4 The panel noted with appreciation the development of the US National Science Foundation's Ocean Observatories (OOI) Initiative which is planning to construct a network of instruments, undersea cables, and instrumented moorings that spans the Western Hemisphere. The OOI will be a fully integrated system and will measure physical, chemical, geological, and biological phenomena in carefully selected key coastal, regional, and global areas. Global studies will be facilitated by moorings at four sites, one each in the Pacific near the Queen Charlotte Islands, the Southern Ocean near Chile, the Atlantic near Greenland, and the Atlantic off Argentina. Implementation of the Global Scale Nodes is overseen by Woods Hole Oceanographic Institution (WHOI, USA) and Scripps Institution of Oceanography (SIO, USA).

6.3.5 The meeting agreed on the following:

(i.) The Technical Coordinator is requested to follow up on actions related to the metadata issue that were agreed upon at DBCP-26 and to report at the next Panel Session (***action; TC DBCP; DBCP-28***).

6.3.6 The Panel thanked Mr Turton and members of the Task Team for their efforts. It was agreed that Mr Turton would continue as chairperson of the Task Team for the intersessional period. The full report of the Task Team is provided in Appendix A of DBCP-27 doc. 6.3 as well as in the CD-ROM accompanying the DBCP Session final report.

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Appendices: 2

# APPENDIX A

## REPORT BY THE TASK TEAM ON MOORED BUOYS

*(Submitted by Jon Turton, TT Leader)*

*This report details activities and progress made during the inter-sessional period since DBCP-26.*

## 1. Moored buoy metadata

1.1 The initial priority for the Task Team has been on defining the comprehensive metadata on moored buoy systems that needs to be collected. At present there is little or no collection of the relevant information (metadata) on the various moored buoy systems. Information is needed detailing the systems and what parameters they measure. Such information is needed by data users (e.g. who need to know heights (and depths) of measurements and whether corrections have been made) and moored buoy operators (who have an interest in the sensors and systems being used). Collecting and sharing such information would help everyone to adopt best (and hopefully more consistent) practices.

1.2 At DBCP-26 the latest version of the metadata content specifications was endorsed as version 1 which would be published by DBCP, recognising that further evolutions will be made. TT-MB members were invited to collaborate with JCOMMOPS on an appropriate format for the submission of the moored buoy metadata, and to work with the manufacturers on the best way to collect the information for commercial moored buoy systems. The Panel also requested JCOMMOPS to develop a web interface and file upload. However, with the absence of a DBCP Technical Coordinator during the inter-sessional period it has not been possible to progress these actions, which will be addressed once the new Technical Coordinator is in post. In the meantime both UK Met Office and Environment Canada (through their Asset Management System) have made a start in compiling the requisite information for their moored buoy systems which will be submitted to JCOMMOPS in due course.

## 2. Technical developments

### 2.1 Environment Canada Moored Buoy Network

2.1.1 Environment Canada (EC) continues to operate a network of 47 moored buoys, with 21 buoys deployed on a seasonal basis (in-land lakes, or ocean areas affected by ice). All Environment Canada buoys continue to utilize the Watchman100 “payload” provided by AXYS Technologies Inc. Network availability was 97% for the last 6 months of 2010, but fell to 81% for the first 6 months of 2011 following some strong North Atlantic storms this winter that caused 2 mooring failures and other technical problems at 4 of the 9 East Coast moored buoys. All sites were repaired in spring and early summer of 2011.

2.1.2 The main technical development or upgrade to the EC moored buoy network is the implementation of SatLink2 GOES transmitters provided by SUTRON. The SatLink2 provides a higher power (40W) transmitter, ensuring reliable data transmission at higher data rates (300 or 1200 bps) with the existing omnidirectional antenna (Harsh 14A). 45 units have been procured to date, and we expect to install the new transmitters on 20-25 buoys by the end of 2011 (approx. 50% of the network). The performance of the new transmitters has been very good to date, however we continue to monitor potential problems related to using 300 bps transfer rate in rough sea conditions, as there is some limited evidence of increased parity errors, and loss of data.

2.1.3 EC has also continued dialogue with the National Data Buoy Centre Engineers in the hopes of increasing the reliability of the Harsh antennas, as these components have been identified as a weak point in our data communications. The antennas are prone to water intrusion, and are often the cause of missing, or intermittent data transfers. There are also instances when the fragile

antenna is damaged when a buoy is deployed or retrieved. We have begun work to improve the water sealing (use of silicon to improve seal) and are also evaluating an upgraded version of the Harsh antenna that uses a stainless base. NDBC have recently shared information that their efforts to build a PVC or fiberglass shield around the Harsh antenna have not been successful, as the material attenuates the signal generated by the antenna. Additional options need to be examined to either improve the current Harsh antenna, or potentially examine other antenna options that can provide a suitable and cost effective solution.

2.1.4 EC has continued to deploy and operate 2 Datawell MarkIII wave rider buoys in support of the PP-WET project. In addition to a direct comparison to the operational wave sensor on EC buoys ("strap-down" accelerometer), the moored buoys at Northeast Burgeo Bank (6M NOMAD 44255) and South Hecate Strait (3MD 46185) have been equipped with a TRIAXYS sensor (provided by AXYS Technologies). In the spring of 2011, one of the Datawell wave riders was redeployed at Halifax Harbour (3MD 44258), and we plan on redeploying the west coast wave rider to La Perouse Bank (46206) pending CCG ship availability later this fall. All resulting data from the wave observation inter-comparison are delivered to CDIP for analysis as outlined in the PP-WET project plan.

2.1.5 Finally EC is in the initial stages of developing a strategy and specification for a "next generation" moored buoy payload to replace the aging WM100 systems provided by AXYS Technologies. The goal will be to procure a new system that can be easily integrated into the existing EC buoy hulls, and use both the existing suite of sensors as well as future measurement systems. This could include directional waves, current profilers, and potentially biological sensors to meet future client requirements. The system will utilize bi-directional communication (likely via Iridium) and we will also target an extension in service interval to 18-34 months.

## 2.2 US National Data Buoy Centre (NDBC)

2.2.1 The United States National Oceanic and Atmospheric Administration's National Data Buoy Center NDBC reported that during this period, they operated 115 NDBC moored buoy platforms, 51 coastal marine stations, 39 deep-ocean tsunameters, and 55 Tropical Ocean Atmospheric moored buoys in the equatorial Pacific Ocean. Since the last DBCP meeting, NDBC continued work with the International Buoy Vandalism Sub-Committee to address buoy vandalism. In a meeting in Sri Lanka in March 2011, the Indian Ocean Tuna Commission (IOTA) adopted a binding measure on data buoys. The proposal was submitted by Belize and Seychelles and was strongly support by a number of the coastal states in the region. Other supporting states were India and China. This is an important move to decrease vandalism to NDBC's buoy network. The real chance for success here probably lies in helping coastal states reach out to and educate fishermen and coastal villages about the importance of data buoys, the valuable services they derive from them, and why they need to be avoided. NDBC also obtained two wave gliders for operational station keeping and comparison to moored met and ocean observations and data transmission. Deployment of the gliders occurred in the Gulf of Mexico in April 2011 near an operational weather buoy.

2.2.2 NDBC began an integration effort to test the use of medium frequency acoustic modems on the tsunameter buoys to increase the acoustic cone to allow for stronger moorings. In mid January laboratory tests were successfully completed on the new mid-frequency acoustic modems. On February 14, 2011 the mechanical designs for the high density acoustic baffle for the BPR and a low density acoustic baffle for the buoy that houses the Benthos Medium Frequency hydrophone and the electrical design to house the mid-frequency transmitter board with other electronic systems were completed. The critical design review for a tsunameter that will include the medium frequency acoustic modems is scheduled for March 29, 2011. NDBC's Pacific Tsunami Detection Network provided critical real-time data in support of tsunami warnings, watches, and advisories for the tsunami generated by the earthquake that occurred off the island of Honshu on March 11,

2011. A tsunami as high as 1 meter was detected by 10 of the tsunameter stations off the coast of Japan – and smaller tsunami signals were detected across the Pacific to the Chilean coast.

2.2.3 NDBC completed the installation of three coastal stations enhanced with automated red-tide sensors in Veracruz, Mexico on March 2, 2011. The stations are part of an Interagency Agreement (IAG) between NDBC and the US Environmental Protection Agency, Gulf of Mexico Program and are located at Sacrifice Island, La Mancha Beach, and Veracruz Harbor (SACV4, LMBV4, and VERV4), Mexico. The installations of these stations were a cooperative effort between NDBC, the Veracruz Aquarium, and the Institute of Ecology in Xalapa, Mexico. This project supports the bi-national expansion of the Harmful Algal Blooms Observing System in the Gulf of Mexico. NDBC also provided technical assistance to the Hydrographic and Oceanographic Service of the Chilean Navy (SHOA), the Chilean Tsunami Warning Provider. NDBC assisted SHOA with diagnosing problems with their Bottom Pressure Recorder (BPR) at their DART station 32401, located approximately 260 NM west-southwest of Arica, Chile. In addition, NDBC has invited the Chilean technicians to participate in an annual DART maintenance cruise onboard the R/V Melville that is scheduled for May 2011. NDBC has been processing and distributing the data from their DART since 2004.

2.2.4 NDBC presented NOAA's National Ocean Service, Center for Operational Oceanographic Products and Services, Ocean System Test and Evaluation Program the performance of the Nortek Z-Cell. The data was collected at station 42007 as part of an NDBC Nortek Cooperative Research and Development Agreement.

## 2.3 PMEL's Tropical Moored Buoy Array

### 2.3.1 Technology

2.3.1.1 China's First Institute of Oceanography (FIO) has developed a new surface mooring named Bai-Long. Designed to make air and ocean measurements comparable to ATLAS moorings, FIO has maintained Bai-Long moorings in RAMA near 8°S 100°E since February 2010. PMEL and FIO have incorporated data from the Bai-Long mooring into PMEL's Tropical Moored Buoy web pages which display and distribute RAMA data from ATLAS and TRITON moorings.

2.3.1.2 Building on the Flex mooring system developed for use on high-latitude Ocean Climate Stations (OCS), PMEL has developed a new mooring system named TFlex, intended to replace the legacy ATLAS moorings in tropical research arrays. TFlex observations are essentially equivalent to ATLAS, using more commercially available components and provide higher temporal resolution data in real time. The first prototype system was deployed for comparison and testing in March 2011 within a few miles of an ATLAS system at 12°S 93°E. Under the terms of an IA between the US and Indonesia, TFlex supports both RAMA and the Indonesian Global Ocean Observing System (InaGOOS).

2.3.1.3 The new TFlex and Bia-Long mooring systems telemeter data via Iridium. Methods to submit data from these systems onto the GTS have yet to be established.

### 2.3.2 Metadata and Information Exchange

2.3.2.1 The Tropical Moored Buoy Implementation Panel (TIP) held its tenth session (TIP-10) on September 26, 2010, at the Scottish Association for Marine Science (SAMS) in Oban, Scotland. The meeting was held immediately prior to the 26th session of the Data Buoy Cooperation Panel (DBCP-26) at the same location. TIP-10 established a technical coordination group (TCG) to facilitate the flow of technical and logistical information among the many agencies involved in TAO/TRITON, PIRATA and RAMA.

2.3.2.2 A new RAMA web site (http://www.pmel.noaa.gov/tao/rama/) was released in April 2011. The site provides scientific background, technical information, access to RAMA data and displays, present status of the array, a bibliography of refereed publications, history of cruises, and additional information. Included in the technical information are instrument specifications and nominal heights and depths for ATLAS, TRITON, m-TRITON, and India's National Institute of Oceanography (NIO) Deep Ocean moorings (http://www.pmel.noaa.gov/tao/rama/bams_appendix.pdf). The TIP-TCG would like to extend this information to include additional tropical mooring systems (e.g., Bai-Long, TFlex and NDBC's ATLAS Refresh).

## 2.4 US National Science Foundation's Ocean Observatories Initiative (NSF-OOI)

2.4.1 The NSF-OOI will construct a network of instruments, undersea cables, and instrumented moorings that spans the Western Hemisphere. The OOI will be a fully integrated system and will measure physical, chemical, geological, and biological phenomena in carefully selected key coastal, regional, and global areas. Global studies will be facilitated by moorings at four sites, one each in the Pacific near the Queen Charlotte Islands, the Southern Ocean near Chile, the Atlantic near Greenland, and the Atlantic off Argentina. Implementation of the Global Scale Nodes is overseen by Woods Hole Oceanographic Institution and Scripps Institution of Oceanography.

2.4.2 Three of the four Global Arrays (Southern Ocean, Irminger Sea, and Argentine Basin) will have all platforms provided by the CGSN (Coastal and Global Scale Nodes). The forth array at Ocean Station Papa will be occupied in collaboration with the National Oceanic and Atmospheric Administration (NOAA). NOAA maintains a surface mooring there, and CGSN will deploy the hybrid profiler mooring adjacent to it, the two flanking subsurface moorings to complete a triangular array, and three gliders. The Global Arrays are described in more detail below.

<u>Southern Ocean, SW of Chile</u>

Location: 55°S, 90°W; Water Depth: 4800 meters
Mooring Types: Acoustically Linked Surface Mooring with Subsurface Hybrid Profiler Mooring and Mesoscale Flanking Mooring Pair
Description of Infrastructure:
• One acoustically-linked Global Surface Mooring, with high-power (fuel cell) buoy and high-bandwidth (active antenna) satellite telemetry
• One Global Hybrid Profiler mooring with one wire-following profiler operating and one surface-piercing profiler
• Two subsurface Mesoscale Flanking Moorings with fixed sensors and acoustic communications to gliders
• Acoustic telemetry link with transducer 10m below the surface buoy
• Inductive telemetry link within upper 1000m of the Surface Mooring
• Three gliders with extended endurance and acoustic communications to the Mesoscale Flanking Moorings

<u>Irminger Sea, SE of Greenland</u>
Location: 60°N, 39°W; Water Depth: 2800 meters
Mooring Types: Acoustically Linked Surface Mooring with Subsurface Hybrid Profiler Mooring and Mesoscale Flanking Mooring Pair
Description of Infrastructure:
• One acoustically-linked Global Surface Mooring, with standard power (wind and solar) buoy and Iridium satellite telemetry
• One Global Hybrid Profiler mooring with one wire-following profiler and one surfacepiercing profiler
• Two subsurface Mesoscale Flanking Moorings with fixed sensors and acoustic

communications to gliders
• Acoustic telemetry link with transducer 10m below the surface buoy
• Inductive telemetry link within upper 1000 m of the Surface Mooring
• Three gliders with extended endurance and acoustic communications to the Mesoscale Flanking Moorings

Argentine Basin
Location: 42°S, 42°W; Water Depth: 5200 meters
Mooring Types: Acoustically Linked Surface Mooring with Subsurface Hybrid Profiler Mooring and Mesoscale Flanking Mooring Pair
Description of Infrastructure:
• One acoustically-linked Global Surface Mooring, with standard power (wind and solar) buoy and Iridium satellite telemetry
• One Global Hybrid Profiler mooring with one wire-following profiler and one surfacepiercing profiler
• Two subsurface Mesoscale Flanking Moorings with fixed sensors and acoustic communications to gliders
• Acoustic telemetry link with transducer 10m below the surface buoy
• Inductive telemetry link within upper 1000 m of the Surface Mooring
• Three gliders with extended endurance and acoustic communications to the Mesoscale Flanking Moorings

Station Papa, North Pacific
Location: 50°N, 145°W; Water Depth: 4250 meters
Mooring Types: Subsurface Hybrid Profiler Mooring with Mesoscale Flanking Mooring Pair
Description of Infrastructure:
• One Global Hybrid Profiler mooring with one wire- following profiler and one surfacepiercing profiler
• Two subsurface Mesoscale Flanking Moorings with fixed sensors and acoustic communications to gliders
• Three gliders with extended endurance and acoustic communications to the Mesoscale Flanking Moorings

## 2.5 Indian Moored Data Buoy Programme

2.5.1 Time series observations are vital to improve the understanding of ocean dynamics and its variability and establishment and maintenance of Data Buoy Network for measurement of met-ocean parameters in Indian Seas to monitor the Marine Environment and to improve weather and Ocean Forecast. Under this moored buoy programme 59 operations, 14 cruises involving 270 ship days, 2,900 man days, 18,000 nm of sailing distance in Bay of Bengal, Arabian Sea and Indian Ocean during 2010 - 2011. The Buoy Network was re-established successfully on January 2011 before the committed period of March 2011. In order to measure sub surface data upto 500m water depth along with met - ocean data to transmit real time for monsoonal studies next generation of moored buoy systems are established in 6 locations in deep waters in Bay of Bengal with one in Andaman Sea.

2.5.2 Indigenized data buoy CPU developed for industry standard was deployed at BD06 location is functional and providing data from July 2010 to date and collected data. On the request of Department of Environment and Forest successfully deployed Coral Reef Buoy in Mahatma Gandhi Marine National Park, Andaman & Nicobar Islands during February 2011. The buoy is fitted with meteorological sensors, water quality sensor to monitor the coral reef environment. The environmental sensors stopped after 4 or 6 weeks due to marine fouling. The mooring is

experiencing severe current. The mooring designed to have double anchor and a shore anchor to withstand high current, wave and wind loading in Andaman island and is being closely monitored.

2.5.3 Data buoy as a reference platform was deployed off Agatti, Lakshadweep and is functional from March 2011 with dual mast and redundant wind & humidity sensors for the first time. This is a challenging task to integrate and to deploy such a buoy system. This mooring has a shore anchor and is experiencing sever wave and wind loads. As a part of Inter Calibration exercise on the request of UNESCO-IOC global Pilot Project on Wave Measurement and Evaluation Test (PP-WET) is initiated. One waverider buoy and data buoy were successfully deployed in April 2011 Off Agatti Both Data buoy and waverider buoy are working satisfactorily and inter comparison exercise is in progress.

2.5.4 Best of Practice method manual was prepared and is being followed using inputs from PMEL NOAA and vetted by NOAA NDBC to obtain quality data from moored buoys. As a part of this activity protective hood, hidden antenna and surveillance camera were adopted. To avoid vandalism, the old design of hood was modified into conical shaped Hood. In the earlier design, it has flat at the top of the hood, which enables the person to stand over it and break the Components of the Buoy. In order to overcome the vandalism of Antenna fitted on top of the sensor mast of the buoy it was fitted inside a hood for data buoys and three designs were evolved.

2.5.6 INMARSAT communication is approved by Indian Government. Important factors that decide the most appropriate satellite communication link to be used for buoy systems are: (a) power consumption of the transceiver electronics, (b) high data rate and (c) low latency. INMARSAT terminal operates at a low data rate of 600 bps with high power consumption of 2W in standby mode and 23W in transmit mode. Due to the inherent disadvantages of high power consumption & low data rate it was observed on a number of occasions that (i) the battery on the buoys need frequent replacements, which is very tedious due to non-availability of ship time as well as (ii) high data latency and data gaps while operating in tsunami event mode. IRIDIUM communication is used in more than 90 % of the tsunami buoys operating globally. IRIDIUM satellite terminal supports 2400bps with very low power consumption of 250mW in standby mode and around 2.5W in transmit mode.

2.5.7 Vandalism. A major challenge faced by this project is ‘vandalism of surface buoys’, destruction of solar panels, destruction of transmission units, destruction of sensors mounted on a 3 m tall mast on met-ocean data buoys, etc. Vandalism of these valuable ocean data buoys has been, and remains, a significant problem in many ocean areas. Simple acts of vandalism of these buoys, both deliberate and accidental, and problems linked with fishing are major ongoing problems in many parts of the world. For example, incidents of buoys caught in trawl-nets or entangled in fishing lines are fairly frequent. Several efforts were made such as awareness to Indian fishermen, by distribution of pamphlets, Buoy identification through WMO Identification code, Buoys are fitted with beacon lights as per international standard IALA code, Radar reflector as per standard, also special technological changes like slippery smooth, Protective hood to avoid tie-up by boats, Difficult to remove fixtures / fasteners. Also these buoy locations are notified through Mariners notice sent to Naval Hydrographic Organization, Monthly status report are sent to Navy and Coast Guard etc. These buoys are expensive and their set-up in the sea is a time-consuming exercise. Therefore, any loss of the buoys hampers global climate research, meteorological forecasts considerably. Further, it can also undermine the capacity to detect and warn the natural disasters and thus jeopardize the lives of millions of people. To address the issue of safety of data buoys and tsunami buoys, there is an urgent need for regional cooperation and regionally coordinated effort to protect these buoys.

2.5.8 Regional Workshop on *“Establishing a Cooperative Mechanism for Protection of Met-ocean Data and Tsunami Buoys in the Northern Indian Ocean Region” was* organized by the National Institute of Ocean Technology (NIOT) and the Bay of Bengal Programme – Inter Governmental Organization (BOBP-IGO) at NIOT Campus, Chennai from 6 – 7 May 2011. A total of 84 delegates

representing 53 Organization participated in the Regional Workshop. The delegates included Government representatives from eight countries surrounding the Bay of Bengal *viz.*, Bangladesh, India, Indonesia, Malaysia, Maldives, Myanmar, Sri Lanka and Thailand; Inter-Governmental Organizations such as the United Nations Educational, Scientific and Cultural Organization-Intergovernmental Oceanographic Commission (UNESCO-IOC) and South Asia Co-operative Environment Programme (SACEP); Industry representative from USA, UK, Norway and India; and NGOs and Civil Society Organizations.. The major outcome is formation of regional working group and effective strategy so that information on buoy deployments are communicated to the countries in the Bay of Bengal region

2.5.9 Piracy in Arabian Sea **-** In recent days, piracy issue in Arabian Sea is affecting the servicing and deployment work in Arabian Sea.

2.5.10 NOAA – NDBC Training **-** Capacity Building on "Moored Buoy Data Management and Quality Control" offered by two experts Mr Walter Henry McCall and Mr Micheal Nolan Huguet from National Data Buoy Centre(NDBC) – NOAA, USA was successfully completed during 18th – 29th April 2011 and two days training was organised for NIOT, INCOIS & IITM staff. It is jointly agreed to conduct these event annually. Participated in the *JCOMM* Marine Instrumentation *Workshop* for the Asia Pacific *Region* from 11 to 13 July 2011 at Tianjin, *China*

## 2.6 Met Office moored buoy network

2.6.1 The Met Office moored buoy network presently includes 7 operational deep ocean buoys to the west of the British Isles from the north of Scotland to Biscay (K7, K5, K4, K2, K1, Brittany and Gascogne). The two buoys in Biscay (Brittany and Gascogne) are operated in collaboration with Meteo-France. These buoys are funded through the Public Weather Service Programme, apart from K7 which is mainly funded by the offshore oil and gas industry. A further 2 inshore buoys are operated off the coast of South Wales for the Milford Haven Port Authority and QinetiQ.

2.6.2 As the buoys are replaced (nominally every 2 years) upgrades are being rolled out into the network. All the buoys have dual sensors (other than the wave sensor), dual control electronics and dual satellite transmitters, with systems cross-linked for maximum resilience. The ageing Meteosat DCPs are becoming increasingly unreliable and difficult to maintain, so on all the buoys except K1 we now have a single DCP and an Iridium system. The plan is to replace the old DCPs with new Sutron DCPs that are upgradeable for high rate transmissions.

2.6.3 Following a trial of sonic anemometers in 2009, dual WindSonics have been installed on all deployments from 2010. At present we have a single sonic (with Vector instruments cup and vane system) on K2 and Turbot Bank, with dual sonics on K4, K5, K7, Brittany, Gascogne and Aberporth. K1, which has been in the water since 2006 still has a dual Vector Instruments system.

2.6.4 A TRIAXYS spectral wave system has been operated on K5 since August 2008, returning data via Iridium. The K5 buoy was replaced in June 2011 by one with a new TRIAXYS directional spectral wave system configured to return the 'first-5' parameters (as recommended by PP-WET) over a reduced number (32) of frequency bands. Spectral wave data is reported every 3-hours, energy budget limitation means that more frequent sampling is not possible. The data will shortly be available on GTS in WMO FM94 BUFR format. Compared to the previous K5 deployment the TRIAXYS sampling is better synchronized with the Datawell heave sensor meaning a more rigorous comparison of the measurements can be made. The intention is to deploy similar TRIAXYS systems on the buoys at K7, Brittany and Gascogne later in the year, units for the latter 2 buoys having been purchased by Meteo-France. (Being much further south, hourly sampling should be possible on Brittany and Gascogne.)

2.6.5 A pre-operational surface moored buoy was deployed in June 2010 in collaboration with the

National Oceanography Centre (NOC) at the OceanSITES Porcupine Abyssal Plain (PAP) site (WMO#62442). The buoy is a modified K-series buoy with a single meteorological system (hence is much less resilient to a single failure) alongside a NOC designed system to return sub-surface oceanographic data in real-time from an instrument frame on the mooring at 30 m below the surface. The oceanographic data are made available in WMO TESAC format as well as through the PAP mooring web-site (http://www.noc.soton.ac.uk/pap/). After around 8-months the oceanographic data collection had to be switched off as the system had drained the batteries, the single met system later failed in May 2011. In August 2011 the buoy was visited and fresh batteries installed allowing the oceanographic system to resume data transmission and the meteorological system to be revived (although the wave sensor was damaged. The intention is to replace the modified K-series buoy with a new design system in 2012.

2.6.6 In July 2011, a new moored buoy was deployed in Weymouth Bay in support of the 2012 Olympic Games sailing events, funded through LOCOG (the London Organising Committee of the Olympic and Paralympic Games). The buoy is built on a XJF Plastic DB300 (3m) hull with dual AXYS Watchman 500 systems each returning observations every 30 minutes (offset by 15 minutes) with a single TRIAXYS sensor for wave measurement. The buoy should be operated through to the completion of the Games. Also a single system buoy has been built up on a smaller XJF hull ready for trialling at Turbot Bank as a potential replacement for the existing K-series buoy.

2.6.7 Plans for 2011 include the building and proving of new buoy systems over the coming winter. Systems will be built up on new plastic hulls manufactured by Orchid Plastics and Hydrosphere (Mobilis). It expected that the AXYS WatchMan 500 will be used as the data collection platform. In particular, it is planned that one of these new buoys will be deployed in collaboration with Plymouth Marine Laboratory (PML) at the E1 site in the Western Channel Observatory (http://www.westernchannelobservatory.org.uk/buoys.php). The intention is to replace the existing PML E1 buoy with a more resilient system built onto a Mobilis hull able to operate through the winter months. The buoy will have both oceanographic and meteorological capability provided by PML and the Met Office respectively.

2.6.8 The Met Office continues to collaborate with the Irish Marine Institute and Met Eireann on the operation of the Irish Buoy Network. The network utilizes Met Office designed K-series buoys but these are being replaced with Fugro-Oceanor buoys, which are now operated at M4 and M6. We also facilitate the delivery to GTS of data from the buoy operated by the Jersey Met Department.

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## APPENDIX B

### TERM OF REFERENCE OF THE TASK TEAM ON MOORED BUOYS

*(as adopted at DBCP-XXIV)*

***The DBCP Task Team on Moored Buoys shall:***

1. Review and document operational moored buoy systems and their underlying requirements;

2. Liaise with the different communities deploying moorings, including TIP, OceanSITES, seabed observatories, as well as national moored buoy programmes (coastal and global), and promote the development of multi-disciplinary mooring systems;

3. Liaise with the GOOS Scientific Steering Committee (GSSC) and its technical sub-panel for Integrated Coastal Observations (PICO) to facilitate synergy between advances in GOOS implementation and the development of operational capabilities, in particular, for sustained coastal observations, analysis and related services by using mooring systems;

4. Liaise with the JCOMM Expert Team on Wind Waves and Storm Surges (ETWS) regarding the need for in situ wave observations;

5. Compile information on opportunities for the deployment and / or servicing of moored buoys;

6. Monitor technological developments for moored data buoys and liaise with the Task Team on Technological Developments on satellite data telecommunication aspects;

7. Review all relevant WMO and IOC Publications on Instrument Best Practices (e.g., JCOMM, CIMO) to make sure they are kept up to date, address WIGOS issues, and comply with Quality Management terminology;

8. Provide the DBCP Executive Board or the DBCP with technical advice needed for developing moored buoy programmes, including the issues above; and

9. Report to the DBCP Executive Board and the DBCP at its biennial Sessions, with periodically updated Workplans supporting implementation.

***Membership:***

The membership is open to all Panel members. The Chairperson, appointed by the Panel, has selected the following team members:

- Mr Jon Turton, UK MetOffice (TT Chairperson);
- Dr Bill Burnett, NOAA / NDBC;
- Mr Richard L. Crout, NOAA / NDBC;
- Mr Paul Freitag, NOAA / PMEL;
- Dr Robert Jensen, USACE;
- Mr Chris Marshall, Environment Canada;
- Mr Chris Meinig, NOAA / PMEL;
- Mr Ariel Troisi, SHN;
- Mr R. Venkatesan, NIOT;
- Mr Al Wallace, MSC, and;
- Dr Uwe Send, SIO.