SHIP OBSERVATIONS TEAM (SOT) IMPLEMENTATION STRATEGY

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WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)

SHIP OBSERVATIONS TEAM (SOT) IMPLEMENTATION STRATEGY

2013

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NOTES

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C O N T E N T S

RECORD OF CHANGES

Version No	Date	Author	Change
0.50	Dec. 2011	Secretariat	First draft based on SOT recommendations
0.60	17 July 2012	G. Ball	Reviewed version (main body) – comments/questions added
0.65	25 Jul. 2012	G. Ball	Reviewed version (annexes) – comments/questions added
0.70	25 Jul. 2012	Secretariat	Reviewed version – some comments/questions addressed
0.80	14 Jan. 2013	Secretariat	Some ongoing actions from SOT-6 added
0.90	13 Mar. 2013	G. Ball	Final review before submission to SOT-7
0.95	28 Mar. 2013	M: Kramp	Status maps updated; File format converted to docx

FOREWORD

The Ship Observations Team (SOT) was established in 2001, jointly by the World Meteorological Organization (WMO) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO, to build on synergies between the three Panels involved in coordinating global ship-based observing programmes, i.e. the Voluntary Observing Ship (VOS) Scheme, the Ship-of-Opportunity Programme (SOOP), and the Automated Shipboard Aerological Programme (ASAP), with a view to an eventual possible full-integration of ship-based observing systems on commercial and research vessels.

In recognition of these new developments and expanded requirements, and in the context also of the implementation plans and requirements of the Global Ocean Observing System (GOOS), the Global Climate Observing System (GCOS), the WMO Integrated Global Observing System (WIGOS), and the Global Framework for Climate Services (GFCS), the SOT agreed in 2011 at its sixth Session on the need for an SOT Implementation Strategy, which would provide an overall framework for the Team's work, and at the same time enable it and its members to react appropriately to future developments. A draft strategy document was prepared for the Team by Mr Grame Ball, reviewed and revised at the SOT session in 2013, and is now published in this JCOMM Technical Report.

This document provides the rationale for the strategy of the SOT for the implementation of the ship fleets under its responsibility in the foreseeable future. It particularly includes an overarching implementation plan, and a detailed implementation plan with clear objectives, and some performance targets.

The SOT will regularly review its mission in the light of changing research, organizational and operational imperatives, and will update this document and its terms of reference as appropriate. The SOT will continue to explore ways to expand its membership, in particular through enhanced links with countries operating ship observing fleets supporting WMO and IOC applications.

Graeme Ball
(Australia)

(Chairman of the SOT)

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SHIP OBSERVATIONS TEAM (SOT) IMPLEMENTATION STRATEGY

1. INTRODUCTION

1.1 The Ship Observations Team (SOT) was established by the WMO/IOC Joint Technical Commission for Oceanography and Marine Meteorology (JCOMM) at its first session (JCOMM-I, Akureyri, Iceland, June 2001), and renewed at its second (JCOMM-II, Halifax, Nova Scotia, Canada, September 2005), and third Sessions (JCOMM-III, Marrakech, Morocco, November 2009). It was created to build on synergies between the three Panels involved in coordinating global ship-based observing programmes addressing observational requirements of WMO and IOC applications, with a view to an eventual possible full-integration of ship-based observing systems on commercial and research vessels. The three Panels include the Voluntary Observing Ship (VOS) Scheme, the Ship-of-Opportunity Programme (SOOP), and the Automated Shipboard Aerological Programme (ASAP).

1.2 VOS ships volunteer to take surface meteorological and surface oceanographic observations while ASAP vessels acquire upper air observations over data-sparse ocean areas by means of automated radiosonde systems. Similarly, the SOOP involves volunteer merchant and scientific ships that acquire oceanographic measurements using one or more scientific instruments such as Expendable Bathythermographs (XBTs) and thermo-salinographs.

1.3 Membership to the Team is open, and comprises operators of VOS, SOOP and ASAP, as well as representatives from other groups (hereafter called SOT associated programmes) using ships as observing platforms. It also includes representatives from: monitoring centres; data management centres and bodies; INMARSAT and other communication systems; manufacturers; scientific advisory bodies; and users as appropriate.

1.4 The Terms of Reference of the SOT are given in *Annex I*.

1.5 The SOT will regularly review its mission in the light of changing research, organizational and operational imperatives, and will update this document and its terms of reference as appropriate. The SOT will continue to explore ways to expand its membership, in particular through enhanced links with countries operating ship observing fleets supporting WMO and IOC applications (***action***).

1.6 The overarching implementation plan for the SOT is provided in Annex III. Implementation Actions (referred as "(***action***)" in the text) derived from the SOT implementation strategy are proposed and detailed in the SOT Implementation Plan in Annex XI with time frame, responsible body or actor, and performance indicator.

2. RATIONALE AND USER REQUIREMENTS

2.0.1 Neither global programmes such as the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS), the IOC-WMO-UNEP-ICSU Global Ocean Observing System (GOOS), and the WMO World Weather Watch (WWW), nor indeed the SOT and its sub-Panels (i.e. the VOS Panel – VOSP–, and the SOOP Implementation Panel – SOOPIP), currently operate as funding bodies for observational networks. Instead, all commitments for the implementation of these networks are made nationally to address the requirements of these global programmes, including through the VOSP, SOOPIP, and SOT associated programmes. Any SOT implementation strategy must attempt to reconcile the needs and aspirations of the global programmes with those of the ship-based observation operators and funders, and align with the WMO and IOC Strategic Planning. Ultimately, it is an objective of the implementation strategy to assist in the unlocking of sustained national funding in support of the wider regional and global needs, at the same time recognizing that the aims of the programme operator remain paramount.

2.0.2 Although this strategy is restricted to ship-based observations, the Team recognizes that drifting buoys, moored buoys, sub-surface floats and profilers will also play a fundamental role in any future ocean observation network.

2.0.3 There are four major met-ocean application areas that critically depend on highly accurate observations of met-ocean parameters: (a) Numerical Weather Prediction (NWP); (b) Climate monitoring (such as undertaken through GCOS); (c) Seasonal to Inter-annual Forecast (SIAF); and (d) Met-Ocean Applications, including for example Met-Ocean Forecasts and Services (MOFS), marine services and ocean mesoscale forecasting.

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

2.1 Climate monitoring requirements

2.1.1 The climate monitoring requirements have been endorsed and developed by GCOS and the UNFCCC[4], and fall within the remit of the Group on Earth Observation (GEO), established by the Earth Observation Summit in 2003. Climate aspects are detailed in the Implementation Plan for the Global Observing System for Climate in Support of the United Nations Framework Convention on Climate Change (UNFCCC) (GCOS-92, October 2004)[5], and its 2010 update (GCOS-138)[7].

2.1.2 To address observational requirements, the SOT Implementation Strategy is following the JCOMM Observations Programme Area (OPA) Implementation Goals (OPA-IG), which is essentially a response of JCOMM to the GCOS Implementation Plan (GCOS-IP) on how to implement ocean observing systems according to defined targets and specific recommendations to WMO Members and IOC Member States. The OPA-IG also includes some non-climate related elements addressing the recommendations arising from the WMO Rolling Review of Requirements (RRR).

2.1.3 The SOT has reviewed the 2010 update of the GCOS Implementation Plan, and agreed that the following actions from this plan were particularly relevant to the SOT Implementation Strategy and should be addressed:

- (i) [GCOS Action O3] Improve the number and quality of climate-relevant marine surface observations from the VOS [for both marine meteorological and oceanographic Essential Climate Variables]. Improve metadata acquisition and management for as many VOS as possible through VOSClim[1], together with improved measurement systems (***action***).
- (ii) [Action O11] Implement a programme to observe sea-surface salinity to include Argo profiling floats, surface drifting buoys, SOOP ships, tropical moorings, reference moorings, and research ships (***action***).
- (iii) [Action O21] Establish plan for, and implement, global Continuous Plankton Recorder (CPR) surveys [towed from commercial vessels] (***action***).
- (iv) [Action O25] Sustain the Ship of Opportunity XBT[2]/XCTD[3] transoceanic network of about 40 sections (***action***).

2.1.4 Specific key performance indicators have also been agreed upon for the VOS and the VOS Climate component of the VOS (***action***). These are defined in Annex IV.

1 VOSClim: VOS Climate Project (now terminated, and VOSClim class of vessel introduced in the VOS Scheme)
2 XBT: Expendable BathyThermograph
3 XCTD: Expendable Conductivity/Temperature/Depth

2.1.5 The GCOS Ocean Observations Panel for Climate (OOPC) is also planning to investigate how to reconcile ocean heat content, sea level, and energy identified imbalances, with focus on the error budget and sampling requirements. The action (with high level of participation from the SOOP XBT community) would attempt to involve both the scientific community and funders of the ocean observing system, in a pilot activity to better engage funders (***action***). The JCOMM OPA is also planning to develop complementary metrics of the ongoing intensity of effort in maintaining different components of the ocean observing system.

2.1.6 The OOPC has also expressed the requirement for collecting and transmitting high temporal resolution (i.e., at least hourly) Sea Surface Temperature (SST) measurements from *in situ* sources in order to resolve the diurnal cycle of SST and the foundation temperature. The Team is moving towards establishing a Pilot Project in this regard (***action***).

2.1.7 The SOT will particularly strive to:

(i) develop metrics of intensity of effort in maintenance of the observing networks - on the Port Meteorological Officers (PMO) network, on VOSClim class growth, or on SOOP line maintenance, recalling the need to keep the metrics simple to calculate (***action***);
(ii) encourage the SOOP science community to develop XBT-based indices of currents and subsurface ocean state, and think about how they link to climate impacts on land, as a way of boosting interest in the climate community in XBT data (***action***);
(iii) encourage the Southern Ocean Observing System (SOOS) and OOPC to develop an observing strategy for the seasonal ice and under-ice zones (***action***);
(iv) encourage development at JCOMM level of metrics dealing with data quality and flow from VOS and from SOOP (***action***);
(v) identify tracking of poorly-covered VOS areas to target ship recruitment for global coverage - through reinforcement of new efforts at the JCOMM *in situ* Observations Programme Support Centre (JCOMMOPS) (***action***).

2.2 Additional requirements

2.2.1 By addressing the climate monitoring requirements while at the same time recognizing the need of operational applications for real-time data, it is believed that most of the requirements of the targeted WMO and IOC applications will be met. Yet some specific additional requirements derived from the WMO Rolling Review of Requirements (RRR) are being considered by the SOT.

2.2.2 The WMO Rolling Review of Requirements (RRR) is an exercise to develop a consensus view on the design and implementation of composite observing systems, in particular where the need and implementation occur on global or regional scales. The RRR is looking at 12 applications areas, the followings ones being particularly relevant to marine meteorological and ocean observations:

- Climate Monitoring (GCOS)
- Seasonal to Inter-annual Forecasts (SIAF);
- Ocean Applications;
- Global Numerical Weather Prediction (GNWP);
- High Resolution Numerical Weather Prediction (HRNWP);
- Nowcasting and Very Short Range Forecasting (NVSRF).

2.2.3 Looking at the statements of guidance (i.e. gap analysis) for the above applications, the SOT agreed that the non-climate requirements where gaps have been identified could be addressed as following:

(i) Increasing the number of aerological profiles for GNWP can be achieved through consolidating the ASAP Programme and through enhanced cooperation with institutions operating Research Vessels, and with the navies (***action***);

(ii) Increasing the number of VOS (***action***) will permit to address the requirements for more surface meteorological data required by GNWP, HRNWP, and NVSRF, and for heat surface flux as required by SIAF. Equatorial areas, where the atmospheric pressure signal is typically weak, would benefit from a greatly increased density of wind observations but requirements for accurate in situ pressure measurements from these regions have also been expressed by NWP at a resolution of 500km x 500 km. Spatial surface air pressure coverage is marginal for marine services applications. Mean sea level pressure is vital to detect and monitor atmospheric phenomena over the oceans (e.g., tropical cyclones) that significantly constrain shipping. Even very isolated stations may play an important role in synoptic forecasting, especially when they point out differences with NWP model outputs.

(iii) Precipitation, snow, ice thickness are measurements that cannot realistically be easily achieved by the VOS operators;

(iv) Automated wave/sea state sensors required for Ocean Applications and GNWP & HRNWP could be developed by the community. In situ wave measurements are currently too sparse in the open ocean. The vast majority of existing wave measurements are made in the coastal margins of North America and Western Europe, with a huge data void in most of the rest of the global ocean, particularly in the southern ocean and the tropics, while other existing observational systems have often considerable coverage in these areas. The JCOMM Expert Team on Wind Waves and Storm Surges (ETWS) has called for additional wave measurements comprising, at a minimum, significant wave height, peak period and 1-D spectra, hourly in real-time, for assimilation into coupled atmosphere-ocean wave models for real-time forecasting activities, and subsequent verification. These are required for Maritime Safety Services, calibration / validation of satellite wave sensors, the description of the ocean wave climate and its variability on seasonal to decadal time scales, and the role of waves in the coupled ocean-atmosphere system, and their inclusion in weather and climate models. Satellite bias correction validation requirement is for average 1000km spacing with minimum 10% / 25cm accuracy for wave height and 1 second for wave period. Considering the lack of wave data, the SOT is inviting ship operators and Team Members to increase wave measurements (mainly visual observations), particularly from open ocean areas, in the Southern Ocean, and the tropics. The SOT Task Team on Instrument Standards was requested to address feasibility (***action***);

(v) Ocean surface currents (required for SIAF) derived from the ship's position could be distributed provided the BUFR[4] template for VOS data accommodates for this. The JCOMM Data Management Programme Area (DMPA) Task Team on Table Driven Codes (TT-TDC) was requested to address the inclusion of VOS current data as part of the BUFR template for VOS data (***action***).

2.2.4 Recent studies using models that allow assimilation of non-synoptic-hour data have demonstrated the positive impact of such data. In particular, the inclusion of hourly extra-tropical surface pressure data was found to significantly, improve forecast quality, particularly in the southern hemisphere. Non-synoptic-hour data are not routinely reported by all ships (only ships with AWS systems do report hourly observations). The Team will strive to increase the number of AWS systems installed on ships. The Team will also support other technology developments, e.g., the use of adaptive sampling to increase the impact and cost effectiveness of ship observations.

2.3 SOT contribution to the implementation of WIGOS

2.3.1 The WMO Integrated Global Observing System (WIGOS) is a major contribution of the World Meteorological Organization (WMO) to address the need for more extensive and advanced information for WMO Members so that they can continue to improve service quality and service delivery. To meet the demands of the future, WMO Members must continue their legacy of

4 FM 94 BUFR GTS format: Binary Universal Form for Representation of meteorological data

contributions by taking full advantage of advances in observation and telecommunication technologies and to increase our science based understanding of the Earth and its environment: the end result being better prediction and assessment of potential impacts of weather and climate related events to provide the required information for the public and policy and decision makers.

2.3.2 The WMO Fifteenth Congress (Cg-XV, Geneva, Switzerland, 7-25 May 2007) therefore decided that the enhanced integration of the WMO observing system should be pursued as a strategic objective of the WMO. Through Resolution 50 (Cg-XVI), the WMO Sixteenth Congress (Cg-XVI, Geneva, Switzerland, 16 May – 3 June 2011) decided to implement WIGOS during the period 2012 to 2015. WIGOS will establish an integrated, comprehensive and coordinated observing system to satisfy in a cost-effective and sustained manner the evolving observing requirements of WMO Members and will enhance coordination of WMO observing systems with those of partner organizations, such as the Intergovernmental Oceanographic Commission (IOC) of the United National Educational, Scientific and Cultural Organization (UNESCO), for the benefit of society.

2.3.3 Following the legacy recommendations of the JCOMM Pilot Project for WIGOS, the SOT agreed to play the following role in the WIGOS Implementation Phase (2012-2015) to achieve better integration of marine meteorological and other appropriate oceanographic observations into WIGOS:

(i.) Referring to legacy recommendation 2, the Team agreed to contribute to the review of WMO and IOC Publications through its Task Team on Instrument Standards, and other Task Teams as appropriate (***action***);

(ii.) Referring to legacy recommendation 3, the Team invited its members to make sure that instrument/platform metadata related to ship-based observations are properly collected and made available through the appropriate channels, taking particular attention to SST and Sea Surface Salinity (SSS) data (***action***).

(iii.) Referring to legacy recommendation 4, the Team agreed to contribute to the development of JCOMM guidelines for marine instrument intercomparisons through its Task Team on Instrument Standards, and liaise with the JCOMM Observations Coordination Group (OCG) as appropriate (***action***);

(iv.) Referring to legacy recommendation 5, the Team invited its members to use the facilities offered at the WMO-IOC Regional Marine Instrument Centres (RMIC) in the view to ensure better traceability of ship observations to international standards (***action***);

(v.) Referring to legacy recommendation 6, the Team invited the manufacturers of ship-based observation instrumentation to participate in the HMEI[5] (***action***);

(vi.) Referring to legacy recommendation 9, the Team invited its members (VOS, SOOP, ASAP) and the associated programmes (IOCCP[6], GO-SHIP[7], FerryBox, OceanScope, etc.) to make sure that discovery metadata about ship-based observational data-sets are properly compiled and made available through the Ocean Data Portal (ODP) and the WMO Information System (WIS) using the required ISO-19115 profiles (***action***).

(vii.) Referring to legacy recommendation 11, the Team invited its members to comply with the WMO Quality Management Framework (QMF) and quality management principles (***action***);

(viii.) Referring to legacy recommendation 12, the Team invited the satellite data telecommunication system operators used for the collection of ship-based observations to participate in the international forum of users of satellite data telecommunication systems for

5 HMEI: Association of Hydro-Meteorological Equipment Industry
6 IOCCP: International Ocean Carbon Coordination Project of IOC
7 GO-SHIP: The Global Ocean Ship-Based Hydrographic Investigations Programme

environmental use once established (***action***);

(ix.) Referring to legacy recommendation 14, the Team agreed that organizing regular PMO workshop was an efficient mean of realizing the JCOMM Partnerships for New GEOSS Applications (PANGEA) concept (***action***);

3. SHIP FLEETS

3.0.1 In general, most current operational ship fleets contributing marine meteorological and oceanographic observations to WMO and IOC applications fall within the scope of the Voluntary Observing Ship Scheme (VOS) Panel (VOSP), the Ship of Opportunity Programme (SOOP) Implementation Panel (SOOPIP), or sub-programmes such as the Automated Shipboard Aerological Programme (ASAP), and the SOT Associated Programmes. The programmes are key to implementing and maintaining deployments in all ocean basins.

3.0.2 Appropriate spatial distribution of ship observations over the global ocean must be achieved in complement to other types of observing platforms (e.g. drifters) and requires smart and coordinated vessel recruitment strategies.

3.0.3 Ship recruitment strategies will be developed which optimize the expenditure of available resources, and which allow accurate and credible prediction of future resource requirements, and their relation to declared objectives (***action***).

3.0.4 Maps showing the status of the SOT fleets are provided in Annex VII.

3.1 Voluntary Observing Ship Scheme (VOS)

3.1.1 The Voluntary Observing Ship Scheme (VOS) primary responsibility is to fulfil marine meteorological data requirements expressed by the World Weather Watch (WWW) in terms of observational marine data that can be obtained from voluntary observing ships.

3.1.2 In recent years, the requirements of the Ocean Observing Panel for Climate (OOPC) of GOOS and GCOS have also been considered, especially through the VOS Climate Project (VOSClim), and its follow up integration of the VOSClim into the wider VOS.

3.1.3 The VOS Panel (VOSP), a sub-Panel of the SOT, is addressing the VOS implementation strategy and practical technical details.

3.1.4 The VOS Scheme is regulated through the chapter 6 – The Voluntary Observing Ship Scheme – of WMO Publication No. 471, Guide to Marine Meteorological Services.

3.1.5 In addition, specific instrument practices and methods of observations are detailed in the WMO Publication No. 8, Guide to meteorological instruments and methods of observations.

3.1.6 Recruitment of these vessels is realized through an international network of Port Meteorological Officers (PMOs).

3.1.7 There are eight types of ships in the VOS:

- (i) Selected ships;
- (ii) Selected AWS[8] ships;
- (iii) VOSClim (VOS Climate) ships;
- (iv) VOSClim AWS ships;

8 AWS: Automatic Weather Station

(v) Supplementary ships;

(vi) Supplementary AWS ships;

(vii) Auxiliary ships;

(viii) Auxiliary AWS ships.

3.1.8 Real-time data are distributed onto the Global Telecommunication system (GTS). The flow and treatment of non-real-time data is achieved through the Marine Climatological Summaries Scheme (MCSS, soon to be replaced by the Marine Climate Data System – MCDS).

3.1.9 Details about the VOS Scheme, including description of the above classes of vessels, and VOS implementation strategy with general aims, specific aims and proposed actions can be found in JCOMM TR No- 4, Rev 2 – The Voluntary Observing Ship Scheme, a framework document.

3.1.10 The following fleet objectives have been agreed upon for the VOS:

TABLE 1

Fleet	***Current number of ships***	***International Goal***
VOS reporting regularly	1000[9]	No specific target (i.e. recruiting as many ships as practically possible)
VOS with electronic logbooks	2073	No specific target (i.e. recruiting as many ships as practically possible)
VOS with AWS Systems	241	500
VOSClim class ships	368	Annex IV

3.1.11 Specific actions include (from JCOMM TR No. 4):

(i) Encourage maritime Members, particularly those in the southern hemisphere, to recruit VOS that travel to data-sparse areas, such as vessels proceeding to the Antarctic, including Tourism ships, or making regular voyages across the central and south-eastern Pacific Ocean (***action***);

(ii) Encourage the use of hull-attached temperature sensors for the measurement of sea-surface temperature (***action***);

(iii) Encourage the automation of observations and reporting (***action***);

(iv) Investigate with real-time monitoring centres, the value of including the height or depth of observed parameters (***action***);

(v) Prepare comprehensive guidance on observing procedures to vessels of the VOS to help standardize observing practices among national observing fleets (***action***);

(vi) Monitor observations in real-time and drawing to the attention of the appropriate Members any deficiencies in accuracy (***action***);

(vii) Extend real-time monitoring systems to cover all variables required for surface flux

9 Approximate number of ship reporting at least once per day

calculations (***action***);

(viii) Encourage more recruitment of VOSClim class vessels (e.g. following the example of the UK which upgraded ships to the VOSClim standard) (***action***);

(ix) Derive an acceptable standard scale of Beaufort wind speed equivalents (***action***);

(x) Organize training seminars and conferences for Port Meteorological Officers every 3-4 years (***action***);

(xi) Encourage national award schemes to ships and or ships' officers as recognition for high standards in taking, recording and reporting observations (***action***);

(xii) Keep under review the flow of meteorological data from ships to ensure the most efficient method of providing world-wide climatological data to users (***action***);

(xiii) Keep Members informed of advances in technology in the taking and transmission of ships' observations by means of technical notes and similar publications (***action***);

(xiv) Encourage Members to submit each quarter, all metadata that are required in WMO Publication No. 47 (***action***);

(xv) WMO to maintain an up-to-date listing of all VOS ships, name, call sign, country of recruitment etc. so that a PMO may know the status of a ship before visiting it (***action***);

(xvi) Encourage PMOs to collect INMARSAT C numbers at recruitment in the event that contact with the ships is necessary to check an observation, advise on correct coding procedures or request additional observations in storm or Tropical Cyclone conditions (***action***);

(xvii) WMO to maintain an up-to-date list of INMARSAT Land Earth Stations (LES) that accept observations free of charge to the ship, as well as the special access codes required to lodge ship's weather reports with LES (***action***);

(xviii) Encourage all research vessels to transmit meteorological observations in real-time (***action***); and

(xix) Organize an international meeting with active participation of the World Meteorological Organization (WMO), the International Maritime Organization (IMO), the International Chamber of Shipping (ICS) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO to emphasize the importance of VOS observations (***action***).

3.1.12 Some additional recommendations can be found in the OceanOBS'09 Community White Paper by Kent *et al*, the Voluntary Observing Ship Scheme[10] (***action***).

3.2 Ship of Opportunity Programme

3.2.1 The Ship Of Opportunity Programme (SOOP) primary responsibility is to fulfil upper ocean data requirements expressed by the Ocean Observing Panel for Climate (OOPC) of GOOS and GCOS in terms of observational oceanographic data that can be obtained from ships of opportunity.

10 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1664333-1-cwp4a07_rev1.pdf

3.2.2 The SOOP Implementation Panel (SOOPIP), a sub-Panel of the SOT, is addressing the SOOP implementation strategy and practical technical details.

3.2.3 Instruments involved are primarily Expendable Bathy thermographs (XBT) but also include to a lesser extend expendable Conductivity, Temperature and Depth probes (XCTD), ThermoSalinoGraphs (TSG), Acoustic Doppler Current Profilers (ADCP), Conductivity, Temperature, and Depth observing systems (CTD), and Partial pressure of CO_2 (pCO_2) observing systems. Data management is provided by the Global Temperature and Salinity Profile Programme (GTSPP) and data shared in real-time at no cost.

3.2.4 During the period 1999 to 2009, the SOOPIP has been following the recommendations from the 1999 OOPC Upper Ocean Thermal Review (UOT[11]) which considered other types of instruments providing in situ temperature profiles (e.g. Argo profiling floats, TAO moorings). As the Argo profiling float programme was developed and provided for low density upper ocean thermal profiles uniformly distributed over the world ocean, the Low Density XBT (LDX) was abandoned, and efforts were made to develop the XBT programme on Frequently Repeated (FRX[12]) and High Density (HDX[13]) modes for systematic upper ocean measurements. This climate-specific subset was build to a designed global network of 51 lines (Table 2) to provide high-accuracy measurements of the upper ocean thermal structure. Operating these 51 lines at the required sampling requires making 37000 XBT profiles per year, and reporting them on the GTS.

3.2.5 The oceanic data from the Ship of Opportunity Programme (SOOP) have been the foundation for understanding long-term changes in upper ocean heat content.

TABLE 2

Type of XBT lines	***Current number of lines***	***International Goal***
High resolution XBT lines	24	17
Frequently repeated XBT lines	22	23
Lines operated in both mode	10	11

3.2.6 The SOOPIP is now working along the lines of the recommendations described in the OceanOBS'09 Community White Paper by Goni *et al*, the Ship of Opportunity Programme[14]. Action O25 of the GCOS Implementation Plan (GCOS-138) is calling to sustain the Ship-of-Opportunity XBT/XCTD transoceanic network with about 40 sections. An XBT Science Team was formed to look at these recommendations and derive proper implementation strategy. The current XBT line responsibilities of SOOPIP participants are listed in Annex V.

3.3 Automated Shipboard Aerological Programme (ASAP)

3.3.1 The Automated Shipboard Aerological Programme (ASAP) provides data that are of vital importance to the Numerical Weather Prediction and is a cost-effective source of baseline upper-air data from the oceans in areas where such data cannot be obtained from AMDAR[15] systems,

11 see http://www.brest.ird.fr/soopip/thermal_review.html
12 Frequently Repeated lines (FRX) lines are mostly located in tropical regions to monitor strong seasonal to inter-annual thermal variability in the presence of intra-seasonal oscillations and other small scale geophysical noise. The lines typically run almost north/south, and cross the equator or intersect the low latitude eastern boundary. They are intended to capture the large scale thermal response to changes in equatorial and extra-equatorial winds. Sampling is ideally on an exactly repeating track to allow separation of temporal and spatial variability, although some spread is possible. The lines are (ideally) covered 18 times per year with an XBT drop every 100 to 150 km. An extra XBT is dropped at the 200m depth contour when crossed if possible. Volunteer observers on merchant ships do the sampling.
13 High Density lines (HDX) lines are those whose sampling criteria require boundary-to-boundary profiling, with closely spaced XBTs to resolve the spatial structure of mesoscale eddies, fronts and boundary currents. Probe spacing is typically 10-50 km. Time-series of HRX lines are as long as 13 years in the case of PX6 (Auckland-Suva). The repetition frequency is about four times per year. In most cases, a technician or scientist on board the ship makes measurements.
14 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1674371-1-cwp1674371.pdf
15 Aircraft Meteorological Data Relay

which are seen as complementary. As part of the global observing system, ASAP data can be used to support many applications, including global climate studies.

3.3.2 The original ASAP system was developed as a modular ‘containerized’ unit that could be quickly installed on, or removed from, a host ship. The system was completely housed within a specially modified standard 6.1 metre (20 foot) shipping container. This container included all necessary electronics and antennas, the balloon launching system, stowage for consumable supplies such as helium, balloons and sondes, and adequate operator workspace. It only required a suitable open deck space and connection to the ship’s power supply. The capital cost of the containerized ASAP system was found to be equal to or less than that for a new land-based aerological sounding station.

3.3.3 Containerized ASAP systems met their original design concepts and had the advantage that they could relatively easily be transferred from one ship to another. However, finding suitable ships with non-obstructed and easily accessible deck space can be difficult. Furthermore, the extra costs incurred in the maintenance of the container and its peripheral equipment, such as air conditioners and mechanical launching systems, are often restrictive.

3.3.4 In recent years an alternative system configuration, known as a ‘distributed’ system, has been developed to expand the versatility of the ASAP concept. Distributed systems are essentially limited to the required electronics which are installed in existing ship spaces accessible to the operator, usually on the bridge or nearby.

3.3.5 Manual or remote launching techniques are employed and the consumable supplies are stored in an appropriate onboard space. Alternatively a 3.05 metre (10 foot) container is now often used for both launching and stowage purposes.

3.3.6 Several impact studies confirm the positive impact of ASAP soundings on Numerical Weather Prediction (NWP). According to such studies, the SOT agreed that even small ASAP fleets can help to mitigate the impact of extreme weather. The SOT encouraged its members to investigate potential co-operations with other Met Services to set up and operate ASAP stations on board merchant vessels in line service (***action***).

3.3.7 The number of ships which routinely provide upper air soundings on the GTS throughout the year is about 20 worldwide. Occasionally there are some research vessels which perform soundings during certain research campaigns. But these activities are usually limited to some weeks. Some Naval ships also perform occasional soundings.

3.3.8 Presently there are two significant ASAP programmes: The EUMETNET[16] ASAP programme (E-ASAP) with 12-18 ships in 2009-2010, and the Japanese programme with 5 ASAP stations on research ships. Since the Japanese fleet was reduced to 2 ships in 2010, E-ASAP is currently the only considerable fleet worldwide.

3.3.9 The SOT agrees that Research Vessels (RV), and navy ships should be more often used as platforms for the making of ASAP soundings, and their data reported on GTS. Wind profiler data should also be of value and could be investigated. Collaborations between meteorological services are also encouraged to set up and operate ASAP stations on board merchant vessels in line service (**action**).

3.3.10 The ASAP programme is focusing on the following issues:

- To work effectively with countries adjacent to data-sparse ocean areas to find potential ASAP operators with routes through these areas (***action***);
- To encourage joint ventures to implement new ASAP observing programmes (***action***);

16 EUMETNET: Network of European Meteorological Services

- To continuously analyze, evaluate and implement more cost-effective means to communicate ASAP data (***action***);
- To provide advice and assistance to new ASAP operators (***action***);
- To improve efficiency in communicating data (***action***);
- To design more robust, automated and deck-based launching devices (***action***).

3.4 SOT Associated Programmes

3.4.1 The SOT is working in close association with the following project:

The International Ocean Carbon Coordination Project (IOCCP)[17]

3.4.2 The IOCCP, co-sponsored by UNESCO/IOC and the Scientific Committee on Oceanic Research (SCOR), promotes the development of a global network of ocean carbon observations for research through technical coordination and communications services, international agreements on standards and methods, and advocacy and links to the global observing system.

3.4.3 The current IOCCP goal for ship-based surface pCO_2 observations is to develop and implement a strategy that is comprised of a well-planned integrated global network of surface ocean carbon measurements, sampling at monthly or higher timescales. There are two issues, which the IOCCP would like to address within the JCOMM SOT context:

1. Obtaining access to the ships poses a significant challenge. A more coordinated interaction with shipping companies is needed. Occasionally there are multiple entities involved in a vessel's management which makes it very difficult (and often frustrating for our industrial partners) to establish who has the authority in the instrument installation context. Access to geographically desirable platforms (SOOP, VOS) remains challenging because the ships only ply certain routes and also the routes often get cancelled, sometimes on a yearly basis which significantly decreases the cost efficiency of our efforts. The IOCCP will start a systematic gathering of the related information within the carbon community and will coordinate these efforts with other observational networks (***action***).
2. The parameters most often measured on ships and moorings are pCO_2, sea surface temperature and sea surface salinity. A considerable investment is needed in sensor development in order to add important ocean surface parameters, such as total dissolved inorganic carbon, total alkalinity, dissolved nutrients, dissolved oxygen and carbon isotopes to routine measurements curricula. Development of sensors and alternative platforms like drifters, wave riders, and robotic boats is also needed to reduce ship time (costs) and provide the spatial and temporal coverage needed to resolve the seasonal and inter-annual variability in carbon fluxes for all ocean basins.

3.4.4 IOCCP also makes Temperature and Salinity measurements from ships, and it would be desirable to establish a collaboration with the SOT to permit real-time distribution of these data on the GTS (***action***). For example, the distribution of data would be facilitated if SOT members would support the cost of transmitting these data from ship to shore, and assist in their automatic quality control, encoding in appropriate GTS formats, and real-time distribution on the GTS..SOT members are encouraged to consider making such a commitment.

3.4.5 Some additional recommendations can be found in the OceanOBS'09 Community White Paper by Hood *et al*, Ship-based Repeat Hydrography: A strategy for sustained global program[18] (***action***).

The Shipboard Automated Meteorological and Oceanographic System (SAMOS) Project[19]

17 http://www.ioccp.org/
18 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1661346-1-cwp2A09.pdf
19 http://samos.coaps.fsu.edu/html/index.php

3.4.6 SAMOS aims to improve the quality of meteorological and near-surface oceanographic observations collected in-situ on research vessels (RVs). The SAMOS initiative currently focuses on meteorological and near-surface oceanographic data collected by the scientific instrument system permanently installed on RVs. The SAMOS data centre at the Florida State University (FSU) currently receives data transmissions from 26 U.S. operated RVs and two Australian RVs. Additional recruitment is underway in the U.S.

3.4.7 The SOT recognizes that, although the SAMOS initiative was not originally designed to provide meteorological and ocean observations to national oceanographic or meteorological services, the demand to have access to high-quality SAMOS data via traditional services (e.g., GTS) has grown. A plan is underway, in collaboration with the US VOS Programme, to select a subset of the RVs participating in SAMOS to develop and test procedures for placing SAMOS data on the GTS (***action***). Priority will be given to SAMOS Vessels that are not currently distributing their data on GTS, or providing poor quality metadata information.

3.4.8 SAMOS is also collaborating with the Marine Advanced Technology Education Center (Monterey, CA, USA) to develop knowledge and skills guidelines for oceanographic instrumentation technicians (see supplemental material) (***action***). The SAMOS data centre is creating a professional development program for in-service marine technicians, in partnership with the NOAA[20] Earth System Research Laboratory (ESRL). The program will focus on best practices and techniques for collection of marine meteorological observations on RVs to support ocean, atmosphere, and climate research.

3.4.9 Some additional recommendations can be found in the following OceanOBS'09 Community White Papers (***action***):

- Smith *et al*, The Data Management System for the Shipboard Automated Meteorological and Oceanographic System (SAMOS) Initiative[21].
- Smith *et al*, Automated Underway Oceanic and Atmospheric Measurements from Ships[22].

The Ferrybox Project[23]

3.4.10 Ferrybox was developed as a partnership between scientists and the companies operating ferries in waters around the world. Many of the systems have been developed to support the requirements for both scientific and marine management data.

3.4.11 The FerryBox system has now reached maturity, having been proven over many yeas of operation at different sites. Worldwide, there are many activities involving FerryBoxes and other systems on ships of opportunities (e.g. 15 ships In Europe, and some in Japan and Australia). Most of these, however, are temporary activities and operated are on a voluntary basis. There is no sustained funding in order to get reliable and comparable data over longer time periods.

3.4.12 The monitoring of air-sea fluxes of carbon dioxide (CO_2) by FerryBoxes has been coordinated through the International Ocean Carbon Coordination Project (IOCCP). It is important that this work is continued and expanded in shelf seas, where the contribution to the carbon budget is particularly difficult to predict from existing models (***action***). The FerryBox/VOS approach provides a unique way to monitor both the carbon import and export in shelf seas, and acidification in the coastal zone in a cost effective manner. Links are also being made with the OceanSCOPE[24] for the future.

3.4.13 It is recommended that FerryBox and other underway data are integrated in the *in-situ* Thematic Assemble Centre (TAC) of the European Union (EU) project MyOcean[25]. However, not

20 NOAA: National Oceanic and Atmospheric Administration
21 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1710333-1-cwp4c12.pdf
22 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1661876-1-cwp4a11.pdf
23 http://www.ferrybox.org
24 http://www.scor-int.org/Working_Groups/wg133.htm
25 http://www.myocean.eu.org/

all data owners are a member of the MyOcean consortium, as there are many of these activities related to research institutions. The provision of data from outside of the consortium is not fully clarified. Nevertheless, it is highly desirable for MyOcean applications that these data become available, at least in a delayed mode.

3.4.14 Consolidation of FerryBox systems into operational Marine Core Services (MCS) is feasible and should be considered quickly (***action***). This will promote the MCS, not only in terms of getting more data, but getting much more reliable data and a new dimension of chemical/biological information. In addition, there will be a high potential for evolution. A mechanism however must be found to sustain the funding of "routine measurements" in order to guarantee the long-term operation.

The Global Ocean Ship-Based Hydrographic Investigations Programme (GO-SHIP[26])

3.4.15 GO-SHIP is co-sponsored by the IOCCP and the Climate Variability and Predictability Program (CLIVAR), with the scientific objective of a sustained ship-based hydrography program with two closely linked components: (1) understanding and documenting the large-scale ocean water property distributions, their changes, and drivers of those changes, and (2) addressing questions of how a future ocean that will increase in dissolved inorganic carbon, become more acidic and more stratified, and experience changes in circulation and ventilation processes due to global warming, altered water cycle and sea-ice will interact with natural ocean variability.

3.4.16 A high priority for the new GO-SHIP program was to revise the 1994 WOCE[27] Hydrographic Programme manual. The GO-SHIP Repeat Hydrography Manual: A Collection of Expert Reports and Guidelines, provides detailed instructions for the high quality collection and analysis techniques of numerous ocean parameters. The goal of this effort is to promote standardized methods for a core set of parameters measured on the GO-SHIP hydrographic reference sections, although the hope is that the techniques described in this manual will be adopted by others wishing to make high quality measurements. JCOMM has highlighted the importance of the GO-SHIP revision of the 1994 WOCE Hydrographic Programme Manual. This was completed due to the efforts of expert authors and reviewers.

3.4.17 The GO-SHIP development plan for the period 2010 to 2015 is to start with the establishment of a Program Office and a Scientific Steering Committee; and reach agreements on benchmarks and timeframe for development. Network evaluation from CLIVAR decadal survey will have to be initiated as possible (2000-2010). Joint planning exercises based on network evaluation to prepare for the next decadal survey (Atlantic 2012-2014, Pacific 2015-2017, Indian 2017-2019) will also be initiated. A Data Management Committee will be established to propose a way forward for an international system of Data Assembly Centres and adopt or recommend standards for data calibration, Quality Control (QC), and metadata recording to be used for the next survey.

3.4.18 Surface weather observations can be made from ships participating in GO-SHIP using the SAMOS system. The SOT recommends that these observations should be distributed on the GTS (***action***).

The Scientific Committee on Oceanic Research (SCOR) Working Group 133 "OceanScope[28]"

3.4.18 OceanScope is a joint activity of the Scientific Committee on Oceanic Research (SCOR) and the International Association for the Physical Sciences of the Oceans (IAPSO), with the objective to develop the concept of the merchant marine vessel as a platform for integrated monitoring of the global ocean water column. Close cooperation between the shipping industries and ongoing physical, chemical, and biological programs will be needed to implement these objectives. A proposed OceanScope office will work with the shipping industry to identify vessels

26 http://www.go-ship.org/
27 WOCE: World Ocean Circulation Experiment
28 http://www.scor-int.org/Working_Groups/wg133.htm

for various routes, arrange for single-point contacts between the vessel operator and instrument service people. All data will be forwarded to the user communities as quickly as possible. The report of the WG will soon be submitted to SCOR and IAPSO for review.

3.4.19 The SOT feels that it is important to build a future program also based on existing infrastructure and institutions, including the work of the SOT (***action***). It is desirable to present a unified voice of all actors in ocean observations from commercial ships to the shipping industry.

3.4.20 Efforts will continue by the SOT and the associated programmes to involve other ship operators in the work of the SOT, and to ensure, where appropriate, that their ship data are made available to the wider community, in near real-time if possible (***action***).

4. DATA COLLECTION, PROCESSING, AND EXCHANGE

4.0.1 The SOT is promoting the free an unrestricted exchange of the ship-based observations collected through the VOS, ASAP, and SOOP, in compliance with the WMO data policy (Res. 40[29] – Cg-XII) and/or the IOC oceanographic data exchange policy (Resolution IOC-XXII-6[30]. The SOT is also working with the associated programmes to make their data available to the WMO and IOC applications in both real-time and delayed-mode.

4.0.2 The table below summarizes how the data from the VOS, ASAP, and SOOP data are collected, quality controlled, and made available to end users.

29 ftp://ftp.wmo.int/Documents/MediaPublic/Publications/Policy_docs/508_E.pdf
30 http://www.iode.org/index.php?option=com_content&task=view&id=51&Itemid=95

TABLE 3

	VOS	***ASAP***	***SOOP***
Data collection	Inmarsat SAC41[31] Iridium E-mail AIS[32] binary messages	Iridium	Inmarsat Iridium
Real-time distribution	GTS: FM-13 XIV SHIP[33] and BUFR template for VOS data	GTS: FM 36–XI Ext. TEMP SHIP[34] and BUFR template for ASAP data	GTS: FM 63–XI Ext. BATHY[35] and BUFR template for XBT & XCTD data
QC of operational data	RSMC[36] Exeter VOSClim RTMC[37]	1) ASAP Monitoring Centre (Météo France) 2) ECMWF[38] monitoring for ASAP	
QC tools	Météo France	n/a	n/a
Delayed-mode	IMMT[39]	n/a	ASCII & NetCDF[40]
Delayed mode QC	PMOs visiting ships CMs, GCCs[41] using MQCS[42] VOSClim DAC[43]	n/a	GTSPP
Archives	ICOADS[44]	NMHSs[45]	WOD[46]
Instrument/Platform metadata	WMO Publication No. 47[47] (and E-SURFMAR[48])	In development	JCOMMOPS[49]

4.1 Making of observations

4.1.1 The making of observations can be performed in the following ways:

- Manual observations
- Fully Automated Systems such as Automatic Weather Stations (AWS)

4.1.2 The manual coding of shipboard observations has been greatly aided by the use of electronic logbook (e-logbook) software and by the increased availability of satellite communications on merchant ships. E-logbook software enables the manual entry of observations into a computer capable of encoding the observation into the required GTS code, and the automatic transmission of the data onto the GTS after a minimal level of automatic Quality Control has been performed. The e-logbook for example provides screen prompts to assist with data entry, calculates the true wind, MSL pressure and dew point, etc. The SOT is promoting the use of e-logbook software whenever manual observations are made (***action***).

31 http://www.wmo.int/pages/prog/amp/mmop/inmarsat_les.html
32 AIS: Automatic Identification System
33 Report of surface observation from a sea station
34 Upper-level pressure, temperature, humidity and wind report from a sea station
35 Report of bathythermal observation
36 RSMC: Regional Specialized Regional Centre
37 RTMC: VOSClim Real Time Monitoring Centre (operated by USA)
38 European Centre for Medium-Range Weather Forecasts
39 IMMT: International Maritime Meteorological Tape format
40 NetCDF: Network Common Data Format
41 GCCs: Global Collecting Centres (operated by UK and Germany)
42 MQCS: Minimum Quality Control Standard
43 DAC: Data Assembly Centre
44 ICOADS: International Comprehensive Ocean-Atmosphere Data Set (USA)
45 NMHSs: National Meteorological and Hydrological Services
46 WOD: World Ocean Database (USA)
47 http://www.wmo.int/pages/prog/www/ois/pub47/pub47-home.htm
48 E-SURFMAR: Surface Marine programme of the Network of European Meteorological Services, EUMETNET - http://esurfmar.meteo.fr/doc/vosmetadata/index.php
49 http://www.jcommops.org/soop/soop_report.html

4.1.3 Full guidance on the basic meteorological instruments suitable for use onboard ships making observations under the Voluntary Observing Ships Scheme, together with advice on methods of observations, is provided in the Guide to Meteorological Instruments and Methods of Observation (WMO-No. 8), Part II, Chapter 4, Marine observations. Some additional guidance is also given in WMO No. 471, Chapter 6.

4.1.4 The SOOP Operations Guide provides information on the making of XBT observations.

4.2 Data Collection (ship to shore)

4.2.1 The SOT is promoting an increased use of high data rate satellite data telecommunication on-board ships (e.g. Iridium) (***action***).

4.2.2 VOS Operators are requested to use the list of approved "prST"[50] communication types when submitting their national VOS lists to WMO Publication No. 47 (***action***).

INMARSAT

4.2.3 Ship reports can be transmitted to an Inmarsat Land Earth Station (LES) which has been authorized to accept such reports. These reports should always be sent via Special Access Code 41 (or a national alternative) to ensure they are automatically routed to the Meteorological Service at no cost to the ship The NMS of the country operating the LES pays the cost of the ship-to-shore transmission in these circumstances. There are several LESs in each satellite footprint and they are listed, together with the area from which they will accept reports in WMO-No. 9, Volume D, Part B, Coastal Radio Stations Accepting Ships' Weather Reports. To place a limit on the costs incurred by an NMS, a LES may be authorized to accept reports only from ships within a designated area of ocean. These limits should be drawn to the attention of the relevant ship's officers when recruiting a ship under the Voluntary Observing Ships Scheme. The list of Inmarsat-C Land Earth Stations accepting Code 41 messages is provided on the WMO website[51].

4.2.4 An increasing number of ships are now willing to use their Inmarsat systems to send their weather reports by email direct to the Meteorological Services. In such cases, however, the cost of the transmission will be incurred by the ship owner, so it must be ensured that they are willing to accept such costs. In addition, the Meteorological service must establish a secure system for the receipt and routing of the reports through their message switching systems.

4.2.5 Ship weather reports received at an a National Meteorological Centre (NMC) from INMARSAT Land Earth Stations (LES) and coastal radio stations should be assembled into meteorological bulletins and transmitted over the GTS with minimum delay. Some Centres transmit a bulletin of available ship weather reports every 15 minutes. Because ship weather reports are a vital input to a variety of forecast models runs, it is important that these data from different parts of the world are received with minimum delay.

Service Argos

4.2.6 Service Argos is a system for the receipt of data from automatic weather stations by orbiting satellites, and has been used for many years to collect data from drifting buoys and profiling floats. The data are sent from the satellite to ground stations for processing and distribution on the GTS.

Other satellite data telecommunication providers

50 See document of Pub47 at http://www.bom.gov.au/jcomm/vos/documents/pub47_documentation_version4.pdf ; Code Table 1601, prST, Transmission system for sending weather reports.
51 http://www.wmo.int/pages/prog/amp/mmop/inmarsat_les.html

4.2.7 There are now private satellite data telecommunication service providers that offer the possibility to collect ship observations via specific satellite systems (e.g. Iridium). The data can be transmitted in free format to shore, and the Member recruiting the ship will be responsible for converting the raw data to geo-physical units, and applying the necessary quality control procedures before disseminating the data on the GTS.

4.3 Instrument and ship metadata

4.3.1 There has been an increasing demand for instrumental metadata in recent years to serve a number of applications, and climate studies in particular. VOS metadata are essentially collected through the WMO Publication No. 47 (Pub47[47]) and details can be found in JCOMM TR-No. 4, WMO No. 471, Chapter 6, and in the document describing the format of Pub47.

4.3.2 The metadata from some of the ASAP and SOOP ships also being recruited as VOS ships are also recorded in Pub47.

4.3.3 A specific metadata collection scheme is currently being designed for the ASAP ships and instruments (***action***).

4.3.4 Metadata for SOOP ships are collected via JCOMMOPS and made available from its website[49].

4.4 GTS distribution of the data

4.4.1 The GTS distribution of the data is performed from shore after some data processing, quality control, and encoding of the observations received from the ships using satellite data telecommunication systems (e.g. using Inmarsat SAC41[51], email or some other commercial satellite service). The GTS codes used for the distribution of the data are listed in Table 3 above. In addition, Thermosalinograph (TSG) data are reported on GTS using FM 62-VIII Ext. TRACKOB[52].

4.4.2 The SOT is making efforts to transition to Table Driven Codes, and FM 94–XIV BUFR[53] in particular (***action***). For that purpose, the following BUFR templates have been proposed as detailed in the table below.

52 Report of marine surface observation along a ship's track
53 Binary Universal Form for the Representation of Meteorological Data

TABLE 4

Template	***Use***	***Status & comment(s)***
B/C10 - Regulations for reporting SHIP data in TDCF (TM308009)	Traditional VOS data	Operational. The use of the B/C10 could be regarded as a first practical step to ensure migration to BUFR for the VOS data.
B/C25 - Regulations for reporting TEMP, TEMP SHIP, TEMP MOBIL data in Table Driven Code Form (TDCF) (TM309052)	Traditional ASAP data	Operational
Synoptic reports from sea stations suitable for SHIP observation data from VOS stations	VOS data and metadata	In validation. Using this BUFR template for VOS data is recommended as far as practicable (instead of B/C10), since it includes many metadata fields that are most useful to the end users (e.g. anemometer height).
New BUFR template for XBT Temperature Profile data, version 9.3	XBT data and metadata	updated in June 2010; in validation Reflects the requirements for GTS distribution of XBT data and metadata well. However, formal validation of the Template by the CBS is still pending.
TRACKOB data (TM308010)	TSG data and metadata	Operational
EUCOS[54] template for radiosonde data with geopotential height as the vertical coordinate	ASAP data from E-ASAP	In validation

4.4.3 Collaboration between the SOT, the DBCP, and the DMPA Task Team on Table Driven Codes (TT-TDC) has been quite effective on GTS coding issues, and changes have been proposed to the XBT/XCTD, and VOS BUFR templates. The TT-TDC is now looking at BUFR common sequences that are needed to report oceanographic and meteorological information from marine platforms, including required metadata.

4.4.4 The WMO Commission for Basic Systems (CBS) has recommended that the observation practice elements of the Manual on Codes be identified and passed to the OPAG-IOS for inclusion in observing standards documentation. The SOT requested the Task Team on Instrument Standards to look at those ship-based related practices elements, identify appropriate publication(s) to which the identified observation practices should be relocated, and make recommendations to the CBS as appropriate (***action***).

The SOT has proposed the following plan for the migration of VOS data distribution to BUFR:

54 EUCOS: EUMETNET Composite Observing System

TABLE 5

Time frame	*Action*	*By*
2011 – 2012	Validation of BUFR template for VOS data	candidate operational centres
July – Dec. 2011	Software developments by SOT members for the adaptation of national data processing systems to permit the encoding of BUFR reports for VOS data; and beginning of operational distribution of VOS reports in BUFR format	SOT members
2012	Transition period where the VOS data will be distributed in both FM-13 SHIP and FM-94 BUFR format	SOT members
End of 2012	Migration to BUFR completed, and stopping of GTS distribution of VOS data in FM13 SHIP format	SOT members

Preservation of VOS data

4.4.5 The Expert Team on Marine Climatology (ETMC), at its third session (ETMC-III), established an *ad hoc* group to prepare a report on the Preservation of Voluntary Observing Ship (VOS) Data as Reported at Three Levels[55]. Based on the group's recommendations, the SOT agreed with the following:

4.4.6 Regarding Observing practices and the shipboard recording of observations (***action***):

i. The SOT agreed to continue to advocate for improved "best practices" and archival policies by WMO in terms of (a) publication maintenance (e.g. updating through the use of supplements), and (b) historical publication preservation.

ii. The SOT endorsed continuing efforts by NOAA's Climate Database Modernization Program (CDMP) and related international initiatives, e.g. RECovery of Logbooks And International Marine data (RECLAIM; Wilkinson et al. 2010) and Atmospheric Circulation Reconstructions over the Earth (ACRE), to rescue and make publicly available historical national and international documentation related to VOS observing practices.

iii. The SOT emphasized the importance to marine climatology of safeguarding old (expired) e-logbook documentation, formats, and software.

iv. The SOT emphasized again the importance of the rescue of historical buoy and ODAS metadata, which may be at risk of permanent loss due to media degradation, organizational changes, etc. The Team invited its members, and DBCP members to make sure that those metadata are properly rescued

4.4.7 Regarding the transmission of observations in real-time from ship to shore (***action***):

i. The SOT agreed to liaise with the E-SURFMAR's VOS Technical Advisory Group (VOS-TAG) and in the view to reconcile the different views and methods. It is recommended to limit the number of ship to shore transmission formats that are used by SOT members, and to provide proper documentation on such format at a central location, preferably JCOMMOPS.

ii. The SOT agreed that it would be acceptable to continue the informal use of an FM 13-like code (i.e. essentially assuming "ownership" of the code after WMO/CBS officially discontinues it, and thus including the potential for future expansions and modifications) as a useful component of the proposed solutions.

iii. The SOT requested the Task Team on Instrument Standards to liaise with the ETMC ad hoc

55 At the ETMC-III meeting it was recognized that, with respect to the preservation of the real-time data, there are three different levels of observations (A) Observing practices and the recording of the observations on-board the ship; (B) Transmission of the observations in real-time from ship to shore. While it was not proposed to standardize the format(s) used for the transmission of VOS data from ship to shore, ETMC felt that it would be useful to provide guidance regarding the elements that should be transmitted, on a variable-by-variable basis; and (C) Transmission of the observations in real-time onto the GTS in BUFR format.

group in the view to make further recommendations to the SOT at its Seventh Session.

4.4.8 Regarding Real-time GTS transmission of observations in BUFR format (***action***):

i. The SOT strongly endorses the adoption of features of the new VOS BUFR template that supports the recommendations from the JCOMM Data Management Strategy, including for BUFR to “more fully incorporate JCOMM considerations, including software reliability, human readability, and the archival and exchange of historical and delayed-mode data in its originally reported form.” The SOT requested the DMPA Task Team on Table Driven Codes to address these issues.

ii. The SOT agreed that it should seek to better connect all JCOMM-related groups that currently work on this problem and try to reach a consensus, as well as designating clear leadership (e.g. possibly to TT-TDC). Expanded use of modern electronic collaboration systems (e.g. Google Docs, ThinkFree, etc.) could potentially be very useful and speed up the results.

4.5 Ship masking issue

4.5.1 The “ship masking” issue relates to ship owners and masters’ concerns with regard to data exchange, because ship call signs and position data eventually appear on some public web sites. This issue is primarily related to the Voluntary Observing Ship (VOS) Scheme, but not exclusively. Ship operators justify their concerns because of acts of piracy in certain regions, and because of commercial competitiveness (e.g. fisheries). To address these concerns, the use of ship’s call sign masking schemes for the data distributed on the GTS have been approved by the WMO Executive Council under certain conditions. See background information in this issue in Annex IX.

4.5.2 Japan and USA have implemented masking schemes according to Resolution 27 (EC-LIX) whereby the ship’s identification is replaced by the letters “SHIP” in the GTS FM 13-XIV SHIP reports, and put in place parallel distribution systems with restricted access to GTS reports containing the unmasked ship’s identification. Other Members, such as Australia, and European countries participating in E-SURFMAR have implemented masking schemes where the ship’s call sign is replaced by a unique alphanumeric identity allocated nationally, and consistent with the recommendations from the Ship Observations Team. Details about those masking schemes can be obtained from the WMO Secretariat. Following the recommendations from SOT-IV, the JCOMM *in situ* Observing Platform Support Centre (JCOMMOPS) was asked to develop and implement a secured database to cross reference masked call signs (MASK[56]) with unmasked call signs (REAL[57]).

4.5.3 Members/Member States have been invited (i) to upgrade their data processing and quality monitoring systems according to the various schemes that have been put in place, and (ii) to provide the WMO Secretariat with information regarding their national activities and needs in terms of quality monitoring for VOS data and climate studies based on VOS data, and to nominate a focal point for each of those activities requiring access to the JCOMMOPS database of MASK/REAL call signs. The nominated focal points are provided with access codes for accessing the database.

4.5.4 The SOT also established a Task Team on Callsign Masking and Encoding for progressing this issue and for seeking adoption of a universally accepted solution (***action***). It is currently working at proposing to encrypt the ship’s identification within BUFR reports to be

56 MASK: the ship’s call sign is masked using a unique identification number in place of the real ship’s call sign in FM-13-XI Ext. SHIP reports that are distributed on the GTS. This unique identification number is allocated nationally or regionally. Allocation of unique numbers is coordinated regionally in case a group of countries from a region agrees to use the same scheme. The name of the NMHS recruiting country (i.e. not the country of the ship’s registration) can be part of the masked call sign. To avoid confusion with ODAS and buoy numbers, the unique Identification Numbers should start with an alphabetic letter.

57 REAL: The actual (real) ship’s call sign is used in FM-13-XI Ext. SHIP reports that are distributed on the GTS.

distributed on the GTS, and to provide only the legitimate users of the data with the decrypting keys.

4.6 Collection of delayed mode VOS data

4.6.1 Under the Marine Climatological Summaries Scheme (MCSS), delayed mode VOS data – formatted in the International Marine Meteorological Tape-format (IMMT) – are collected by the two Global Collecting Centres (GCCs) in Germany and the United Kingdom through a network of Contributing Members (CMs). CMs are required to apply Minimum Quality Control Standard (MQCS) before submitting the data to the GCCs. It is recommended that all CMs record observations in IMMT-4 format and apply MQCS-6 quality control checking to make use of increased coding capabilities. All CMs are encouraged to submit their observations, and if their ships do not record in a logbook, they should submit their MQCS checked GTS data. This will give Responsible Members (RMs) the opportunity to check data with higher quality control for their archives and further processes.

4.6.2 The two GCCs were established in 1993 through Recommendation 11 (CMM-XI) to: (i) collect all marine climatological data observed worldwide; (ii) ensure that minimum quality control procedures are applied; (iii) generate complete and duplicate global data sets; and (iv) provide these data sets to the Responsible Members under the MCSS. The GCCs ensure these data meet the Minimum Quality Control Standards (MQCS) and, four times a year (at the beginning of April, July, October and January), re-distribute the data to the eight RMs. It is important that the GCCs work in close co-operation and apply identical procedures. This ensures that even in the event one centre fails, the data flow can continue unaffected.

4.6.3 The eight RMs (Germany; Hong Kong, China; India; Japan; Russia; the Netherlands; UK; and the USA) are assigned a specific area of responsibility for which they are to manage and archive delayed mode VOS data. Any queries/data requests regarding these areas are to be directed to the appropriate RM.

4.6.4 The MCSS is undergoing a substantial modernization process to include sources of marine meteorological and oceanographic data in addition to the VOS data, and it is expected that the MCSS will eventually become obsolete and replaced by a JCOMM Marine Climate Data System (MCDS); the SOT should play an active role in its development (***action***).

4.6.5 The SOT and the associated programmes will actively encourage all ship operators to forward their data to one or other of the responsible global archives (***action***).

4.7 Monitoring of VOS data

4.7.1 The Regional Specialized Meteorological Centre (RSMC) of the United Kingdom Metoffice in Exeter is acting as CBS Lead Centre for monitoring the quality of surface marine observations, including therefore VOS data distributed onto the Global Telecommunication System. It routinely produces monthly and biannual quality reports as well as providing essential feedback to VOS operators regarding the quality of the data delivered by VOS ships.

4.7.2 The Met Office (RSMC Exeter) compiles and distributes lists of ships that have produced suspect observations each month. The lists are also available via the Met Office web site[58]. The SOT routinely reviews and agrees on the monitoring criteria that are used by the RSMC Exeter (see Annex X for the current criteria). National VOS Programme Managers should ensure that the monthly monitoring statistics and the VOSClim suspect list from the UK Metoffice are provided to PMOs for immediate action as necessary (***action***).

4.7.3 The Met Office also produces monthly lists of monitoring statistics for all VOS. To maintain up to date lists of ships, the Met Office uses the latest data downloaded from the online

58 http://research.metoffice.gov.uk/research/nwp/observations/monitoring/index.html

E-SURFMAR VOS Metadata database, as well as the latest WMO Pub47 data. In addition, it uses the masked call sign data available from the JCOMMOPS FTP site[59].

4.7.4 Timeliness information for VOS reports received at the Met Office is also made available from the observation monitoring web site[60] in graphical format. Nowadays, the majority of ship reports continue to be received promptly, with over 50% received within 15 minutes and 90% within 60 minutes of the observation time. Timeliness information for individual ships is also available from the website.

4.7.5 The Met Office had made its annual VOS ranking scheme results available on its website for all VOS. The scheme ranks the VOS ships in terms of the timeliness, quantity and quality of their reports. This has been used to assess the annual performance of UK VOS and for determining which individual ships should be presented with awards.

4.7.6 E-SURMFAR is also making quality monitoring tools available to the VOS community.

4.7.7 VOS Operators are encouraged to become familiar with the UK Metoffice and E-SURFMAR quality monitoring tools, and use them as appropriate. In particular, noting that the E-SURFMAR tools can reference a particular ships, VOS operators should check the metadata of their VOS ships within the E-SURFMAR database and make changes directly if necessary, or submit corrected Pub47 metadata to WMO. (***action***).

4.7.8 Additional monitoring about the status of the VOS fleet is provided by JCOMMOPS (Annex VII).

4.8 Monitoring of VOSClim data

4.8.1 The Real-Time Monitoring Centre (RTMC) for the VOSClim project is also operated by the Met Office, United Kingdom. The RTMC produces monthly suspect lists and monitoring statistics for all VOSClim class ships using the ship lists maintained on the VOSClim website and the criteria shown in Annex X. VOSClim suspect lists are distributed to the JCOMMOPS mailing lists (PMO and VOS). VOSClim ships' observations and the associated co-located model data are also transferred to the VOSClim Data Assembly Center (DAC[61]).

4.8.2 The US NOAA National Climatic Data Centre (NCDC) acts as the Data Assembly Centre (DAC) for the VOSClim fleet. NCDC maintains several archives in support of the VOSClim fleet and hosts a web presence[62] for access to project information and data. The archive consists of three data streams:

- GTS - near-real time collection of ship observations
- BUFR – ship observations plus model fields
- GCC – Global Collection Centres delayed mode ship observations

4.8.3 VOSClim observations from all streams are captured based on the most current ship list[63] available. Ship observations are transmitted over the Global Telecommunication System (GTS) under a variety of WMO bulletin headers. BUFR[64] ship observations are transmitted daily via GTS under WMO abbreviated header "IZZX40" from the United Kingdom Met Office.

4.8.4 The DAC reports each quarter to the Global Collecting Centres (GCCs) on the number of delayed mode VOSClim observations parsed from the delayed mode files distributed to the RMs. This information is used in the GCC annual reports.

59 ftp://mask2real:vosmask@ftp.jcommops.org/mask2real.csv
60 http://research.metoffice.gov.uk/research/nwp/observations/monitoring/marine/TOR/index.html
61 http://www.ncdc.noaa.gov/oa/climate/vosclim/vosclim.html
62 http://www.ncdc.noaa.gov/oa/climate/vosclim/vosclim.html
63 http://www1.ncdc.noaa.gov/pub/data/vosclim/vosclimshiplist.xls
64 BUFR: Binary Universal Form for the Representation of Meteorological Data

4.8.5 All observations are decoded into the International Maritime Meteorological Archive (IMMA) format[65] and placed on the project web site[62].

4.8.6 Data access is available in text file format and anonymous FTP. The text files are stored on an FTP server divided by data source, year, and month. This simpler access is easier to maintain by the DAC and supports automated download of data. The URL for web access[66] allows viewing of the data directly by any browser. For an automated download, the data are available on an anonymous FTP site[67]. In either location, separate folders exist for each year beginning with 2001. Also available for download from the FTP site is the VOSClim Ship List in MS Excel format; award pictures; ship pictures; and the statistics and suspect ship reports.

4.9 Monitoring of ASAP data

4.9.1 ASAP monitoring determines the operational performance and data quality of the ASAP. It is achieved through the following activities:

- ASAP monitoring by the European Centre for Medium-Range Weather Forecasts (ECMWF). ECMWF monitors the ASAP data on a daily and monthly basis.

- The ASAP Monitoring Centre was established by Météo France, as agreed at the Seventh Session of the former ASAP Co-ordination Committee in 1995. Since that time, Météo France has routinely provided annual monitoring report on behalf of the ASAP. Quarterly monitoring reports have been provided by Météo France since 2009 and included in SOT annual reports. The quarterly frequency is more appropriate to give to the ASAP operators the opportunity to correct quickly difficulties in the data dissemination.

4.9.2 According to the monitoring report, the quality of the ASAP reports is generally of a high standard, with only a small percentage of erroneous data. Few corrupted call signs can be seen from time to time. The SOT has recommended the following:

(i) ASAP ship operators should be very careful about setting their software to prevent incorrect positioning of the launching point (***action***).

(ii) ASAP ship operators should try to update their transmission systems in order to be able to transmit high-resolution BUFR messages (***action***).

4.9.3 Additional monitoring about the status of the ASAP fleet is provided by JCOMMOPS (Annex VII).

4.10 Monitoring of SOOP data

4.10.1 The Global Temperature and Salinity Profile Programme (GTSPP[68]) is a joint program of the International Oceanographic Data and Information Exchange committee (IODE) and JCOMM with the following objectives:

- Provide a timely and complete data and information base of ocean temperature and salinity profile data of known and documented quality.
- Implement data flow monitoring systems for improving the capture and timeliness of real time and delayed mode data.
- Improve and implement agreed and uniform quality control and duplicates management systems.

65 http://www.ncdc.noaa.gov/oa/documentlibrary/vosclim/R2.5-imma_short.pdf
66 http://www.ncdc.noaa.gov/oa/climate/vosclim/vosclimdata.html
67 ftp://ftp.ncdc.noaa.gov/pub/data/vosclim *(anonymous FT site)*
68 http://www.nodc.noaa.gov/GTSPP/

- Facilitate the development and provision of a wide variety of useful data, analyses, and information products to clients.

4.10.2 GTSPP takes all Temperature and Salinity profile data into account, including XBTs from SOOP ships, Argo data, tropical moored buoy data, and some CTDs (Conductivity, Temperature and Depth) (e.g. profiles derived from marine mammals). GTSPP contributes to the JCOMM Observations Programme Area metrics by providing required information on Temperature and Salinity profile data.

4.10.3 GTSPP also collaborates with the WOD (World Ocean Database) and CCHDO (CLIVAR & Carbon Hydrographic Data Office) in support of Argo reference data set. GTSPP is working with the IODE Ocean Data Portal (ODP) project to make the GTSPP data available at ODP's Web site[69], and collaborates with NOAA's Environmental Research Division's Data Access Program (ERDDAP) to make the data available via the web[70].

4.10.4 There is a need for ongoing Scientific QC of the global collection of upper ocean temperature data. Funding limitations, however, might restrict the quality of the data archived by the National Oceanographic Data Center (NODC). In the WOCE period, the NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML, USA) (Atlantic Ocean), the Scripps Institution of Oceanography (SIO, USA) (Pacific Ocean) and the Commonwealth Scientific and Industrial Research Organization (CSIRO, Australia) (Indian Ocean) performed Scientific-standard QC of all Upper Ocean Thermal data in their respective ocean basins. They currently provide high quality QC of their own data stream, unfortunately leaving many profiles in the data base of questionable quality. The SOT therefore encourages national funding bodies to consider on-going funding of this QC as a high priority because of the importance of this data globally (***action***).

4.10.5 Additional monitoring of the status of the SOOPIP fleet is provided by JCOMMOPS (Annex VII). In particular, JCOMMOPS routinely collects metadata about the XBT profiles completed, and provides an estimates of how the actual SOOP sampling compares to the scientific requirements. The SOT urges the SOOP operators to regularly provide the SOT Technical Coordinator at JCOMMOPS as soon as possible with the required SOOP metadata permitting the compilation of the SOOP survey (***action***).

4.11 Other sources of data

Surface underway ocean data

4.11.1 The Global Ocean Surface Underway Data Pilot Project (GOSUD[71]) is an Intergovernmental Oceanographic Commission (IOC) programme designed as an end-to-end system for surface ocean data collected by ships at sea. The goal of the GOSUD Project is to develop and implement a system for acquisition and management of these data. Currently, the parameters involved are sea surface salinity and sea surface temperature.

4.11.2 Recently, major work has been performed on tools and methods to enable the generation of delayed mode datasets of a higher quality, and to visualize existing, near real time datasets. The GOSUD project is seeking scientists or data managers that could help with data assessment.

4.11.3 As highlighted in the Global Climate Observing System (GCOS) Implementation Plan (GCOS-138), there is an need for surface data and sea surface salinity data. GOSUD has proven the feasibility of data collection, quality control maintaining a global archive of Sea Surface Salinity (SSS). The robustness of the project is effective, and most of the partners have been involved in the Project since it began in 2001. The number of partners involved in the project must however increase (***action***). The objective for 2012-2013 is to recruit research vessels that could transmit SSS data in either near real time or after the ship reaches port. This could be either non quality

69 http://odp.oceandataportal.net/odp/
70 http://coastwatch.pfeg.noaa.gov/erddap/tabledap/erdGtsppBest.html
71 http://www.gosud.org

controlled data or processed in delayed mode data. The GOSUD project requires that IODE national representatives support the project by providing SSS data, either by opening their archives or by providing recent data. The first priority will be directed at research vessels or merchant ships that operate on regular lines.

4.11.4 The SOT recommends that its members support the project by distributing information on GOSUD within their country. Potential contributors can participate by either providing data to the project or by providing scientific or data management expertise that could enhance the quality of the GOSUD dataset and /or enlarge the network.

4.11.5 The SOT recommends distributing the software that has been developed by IRD – France- to produce the delayed mode dataset (***action***).

5. SUPPORTING ACTIVITIES

5.1 Port Meteorological Officers

5.1.1 In recruiting voluntary observing ships and assisting them in their meteorological work, direct contact with ships' officers is often needed to provide them with instructive material and other documents, to inspect meteorological instruments on board ships, to collect completed hardcopy logbooks and to download log files from electronic logbooks, and to provide feedback on the quality of their observations. For this purpose, Port Meteorological Officers (PMOs), ideally with seagoing experience, should be appointed at the main ports routinely visited by observing ships. The role of the PMO is described in WMO 471, Chapter 6.

5.2 Coordination issues

5.2.1 Within the above context, the SOT programmes and associated programmes are best placed to identify the precise needs in their particular areas of responsibility and to obtain the resources required.

5.2.3 There are other areas where the Team is best placed to advise on overall methodology and policy; including:

- Providing information and guidance on higher level requirements of international programmes of interest to WMO and IOC applications;
- Addressing cross-cutting issues and synergies in the view to propose common solutions.

5.2.3 The SOT is also served by a part-time Technical Coordinator (TC, see Annex VIII) – based at the JCOMM *in situ* Observations Programme Support centre (JCOMMOPS) – who provides a valuable coordination and support service to the component programs of the SOT. The role of the TC is to provide ongoing support to meet the operational requirements of the component panels of the SOT, such as: liaison and international focus, problem resolution, information exchange, quality monitoring, network monitoring and network review. More specifically the SOT Technical Coordinator (TC):

- Maintains liaison with current VOS, SOOP and ASAP Operators;
- Provides a focus for contact by other international programmes and new programme operators;
- Provides problem resolution, in particular for problems related to GTS traffic;
- Facilitates information exchange, in particular through the JCOMMOPS website;
- Maintains quality control systems, in particular the VOS QCRelay;
- Provides network monitoring, in particular the XBT SOOP;

- Provides network review, in particular the XBT SOOP; and
- Maintains the MASK[56] vs. REAL[57] callsign lookup table to support callsign masking.

5.2.4 In practical terms, the SOT Technical Co-ordinator works alongside the co-ordinators of other observing systems to implement a common approach to deployment strategy, data management and quality control, and to ensure the most efficient use of deployment opportunities. In this regard, the SOT actively encourages the operators of other observing and satellite data collection systems to make full use of the SOT's experience and expertise in these areas (***action***).

5.2.5 Longer-term future requirements for JCOMMOPS in support of the SOT also include distribution of XBT probes from the JCOMM XBT Probe Pool.

5.2.6 The SOT strongly recommends that Members/Member States contribute to the funding of the SOT Technical Coordinator's position, and to JCOMMOPS, in order to ensure enhancement and sustainability of those functions (***action***).

5.3 Recruitment strategies

5.3.1 The recruitment of ships poses a huge logistical problem, and often depends of factors outside of the scope of the WMO and IOC communities (e.g. ships changing routes, ships changing owners, acts of piracy, commercial or security concerns of the shipping companies).

5.3.2 While a uniform coverage of the oceans is desirable, this is difficult to achieve in view of the large differences in the density of shipping traffic. This traffic is comparatively dense in the northern hemisphere, but this is not the case in the tropics or in the southern hemisphere. Consequently, greater attention should be given to the recruitment of voluntary observing ships in these areas (***action***).

5.3.3 The recruitment of ships is showing increasing signs of strain, and the SOT will actively pursue additional strategies, recognizing that the issue of funding and associated logistical effort will have to be tackled (***action***).

5.3.4 Criteria for recruitment of vessels are details in WMO No. 471, Chapter 6.

5.4 Capacity-Building and user workshops

5.4.1 In recognition of the vast experience that exists amongst its members, the desire for developing nations to become engaged in ship-based observation activities, and the benefits that would accrue to the SOT from developing collaborative arrangements with these countries, the SOT will actively create and deliver training workshops targeted at these regions (***action***). A good example of such workshops are the international workshops for PMOs.

5.4.2 Materials developed for these workshops will be added to the repositories of educational resources on websites such as Ocean Teacher (http://ioc.unesco.org/oceanteacher) (***action***).

5.4.3 The SOT recognizes the enormous importance of engaging with the many communities that impinge upon its activities, from the research organizations developing new sensors to the manufacturers that provide the products on which the ship operators depend and the user groups, both operational and research that depend on ship-based observations. To this end, it will, from time to time, organize scientific and technical workshops to draws together these communities in addressing key common issues (***action***). Typically such workshops are organized in conjunction with regular SOT Sessions.

5.4.4 The SOT has established the DBCP/SOT drifter donation programme (VOS-DP) to assist developing countries in setting up embryonic national VOS Scheme programmes, whereby the donated drifter would be installed onboard a newly recruited ship as an autonomous AWS to provide a low cost, quality observation solution. WMO Members or IOC Member States interested in joining the VOS Scheme are eligible to receive a drifter donated by the Global Drifter Programme (GDP) under certain conditions. The scheme and conditions to participate is details in Annex VI.

5.5 Task Teams and Pilot Projects

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

5.6 Assistance to other programmes

5.6.1 The voluntary fleets under the VOS, SOOP, and ASAP are the primary vehicle for the deployment of drifting buoys, Argo profiling floats, and in some case (Research Vessels) for the servicing of moored buoys in the high seas. The SOT will continue the cooperation with these other programmes to assist them with their activities using ship resources (***action***).

5.7 Other outreach activities

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

6. RESOURCE REQUIREMENTS

6.1 Human resources

6.1.1 The SOT is relying partly on the services provided by the SOT Technical Coordinator (as well as by the support afforded to him by the buoy operators and other agencies) for implementing its objectives. The SOT will continue to actively seek adequate and secure resources to ensure the continued employment of its Technical Co-ordinator (***action***). In this context, the SOT, in collaboration with other Panels and Groups supporting the JCOMMOPS, will make every effort to act as a responsible employer and will make every effort to ensure that sufficient and stable funding is in place to meet its obligations in this regard.

6.2 Hardware and procurement

6.2.1 JCOMM-II decided to establish a common fund for ship consumables; to provide a mechanism to Member States to increase resources committed to supplying expendables for ship observations in support of international implementation plans. The purpose was initially to focus on XBTs, but other consumables could be added over time. An official letter from the Chairperson of the SOT to the WMO should authorize proposed expenditures if sufficient commitments are made to the Trust Fund.

6.2.3 Enquires made nationally by some Members/Member States to provide funds to this common fund have been unsuccessful, mainly because of the lack of mechanisms available to accomplish this type of operation. Meanwhile, NOAA continues to provide funds to purchase XBT probes at a reduced price and provide them to international partners (France, Australia, Brazil, and South Africa). The number of probes donated by NOAA is currently about 2000 per year, and is likely to increase in the future. These probes account for approximately 15% of probes deployed globally, and 100% of the probes deployed by France, Brazil, and South Africa. These steps will continue as no contributions are made to this Trust Fund. SOOPIP still has to formulate a workplan for the XBTs to be purchased by the Trust Fund, should donations be received.

6.2.4 Members/Member States are urged to consider contributing to the Trust Fund for consumables (***action***).

7. THE SOT ROLE WITHIN JCOMM, AND THE UMBRELLA ORGANIZATION, WMO AND IOC

7.1 Since its establishment by JCOMM-I in 2011, the SOT has been successful in resolving many operational and co-ordination issues regarding ship data quality, data flow, deployment scheduling and so on. Synergies and cross cutting issues between the three sub-Panels, and with the associated programmes have been explored, and many recommendations made by SOT sessions on the way forward in the view to build on those synergies, share resources, and develop a more integrated, more efficient, and cost-effective observing system using ship fleets.

7.2 The SOT implementation strategy is consistent with the JCOMM Observing System Implementation Goals for Building a Sustained Global Ocean Observing System in Support of the Global Earth Observation System of Systems (GEOSS)[6].

7.3 As part of its contribution to the WMO Strategic Plan for 2012 to 2015, and particularly to Expected Result 4[72], the SOT is committed to assisting in the development of the WMO Integrated Global Observing Systems (WIGOS), facilitating ship data exchange through the WMO Information System (WIS). From that perspective, the SOT is committed to follow the legacy recommendations from the Pilot Project for the integration of marine and other appropriate observations into the GOS (or WIGOS Pilot Project for JCOMM) as described in Section 2.3 above.

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

7.5 In addition, the SOT agrees that operational and research observing networks in Polar Regions should be integrated within the framework of the WMO Integrated Observing System (WIGOS) and the WMO Information System (WIS), be enhanced to include cryosphere related variables recognizing that a major contribution to this objective will be through development of the Global Cryosphere Watch (GCW). While ship routes are now becoming open from time to time because of global warming, the SOT is committed to contribute to the Implementation phase of the GCW (2012-2019) by recruiting ships sailing in the polar regions (***action***).

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

ANNEX I

TERMS OF REFERENCE OF THE JCOMM SHIP OBSERVATIONS TEAM

(Excerpt from the Annex to Resolution 2 (JCOMM-III), Terms of Reference and General Membership of the Coordination Group and Teams of the Observations Programme Area)

2. Ship Observations Team Terms of reference

The Ship Observations Team shall:

(a) Respond to requirements for ship-based observational data expressed by relevant existing international programmes and/or systems in support of marine services, and coordinate actions to implement and maintain the networks to satisfy these requirements;

(b) Provide continuing assessment of the extent to which those requirements are being met;

(c) Develop methodology for constantly controlling and improving the quality of data;

(d) Review marine telecommunication facilities and procedures for observational data collection, as well as technology and techniques for data processing and transmission, and propose actions as necessary for improvements and enhanced application;

(e) Coordinate Port Meteorological Officer (PMO)/ship greeting operations globally, propose actions to enhance PMO standards and operations, and contribute as required to PMO and observers training;

(f) Review, maintain and update as necessary technical guidance material relating to ship observations and Port Meteorological Officers;

(g) Liaise and coordinate as necessary with other JCOMM programme areas and expert teams, as well as with other interested parties;

(h) Participate in the planning activities of the appropriate observing system experiments and major international research programmes as the specialist group on observations based onboard ships, including Voluntary Observing Ships, Ships-of-Opportunity, ships from the Automated Shipboard Aerological Programme, and research ships;

(i) Seek new opportunities for deploying various kinds of measuring devices as recommended by the relevant panels and widely publicize those opportunities;

(j) Develop as necessary new pilot projects and/or operational activities and establish new specialized panels as required;

(k) Carry out other activities as agreed by participating Members/Member States to implement and operate the SOT programme and to promote and expand it internationally.

Terms of reference of Component Panels

Ship-of-Opportunity Programme Implementation Panel

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

(a) Review, recommend on and, as necessary, coordinate the implementation of specialized shipboard instrumentation and observing practices dedicated, but not limited, to temperature and salinity measurements;

(b) Coordinate the exchange of technical information on relevant oceanographic equipment and expendables, development, functionality, reliability and accuracy, and survey new developments in instrumentation technology and recommended practices;

(c) Ensure the distribution of available programme resources to ships to meet the recommended sampling network in the most efficient way;

(d) Ensure the transmission of data in real time from participating ships; ensure that delayed mode data are distributed in a timely manner (within 24 hours of the observations) to data processing centres;

(e) Maintain, through the SOT chairperson, appropriate inventories, monitoring reports and analyses, performance indicators and information exchange facilities;

(f) Provide guidance to the coordinator in supporting the Ship-of-Opportunity Programme (SOOP);

(g) Prepare annually a report on the status of SOOP operations, data availability and data quality;

(h) Where relevant, serve as a platform for other observational programmes;

(i) Maintain close communications with the scientific community;

(j) Support the formation of a SOOP Science Team dedicated to meet and discuss on a periodic basis results and ongoing research performed with XBT observations.

Automated Shipboard Aerological Programme Panel

The Automated Shipboard Aerological Programme (ASAP) Panel is terminated and all of its outstanding and proposed future activities passed to the SOT Task Team on ASAP established by the Ship Observations Team at its fourth session. Decisions regarding the management of the ASAP trust fund are transferred to the SOT.

Voluntary Observing Ship Panel

The Voluntary Observing Ship (VOS) Panel shall:

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

(b) Support the development and maintenance of new pilot projects;

(c) Oversee the transition of ships from the Voluntary Observing Ship Climate Project (VOSClim) status to the VOSClim class within the VOS, and encourage other suitable ships to be upgraded to the VOSClim class;

(d) Develop and implement activities to enhance ship recruitment, including promotional brochures and training videos;

(e) Prepare annually a report on the status of VOS operations, data availability and data quality.

General membership

Chairperson of the Ship Observations Team, selected by the Commission

Chairpersons of the SOOPIP and Voluntary Observing Ship Panel, selected by the Commission

Open membership, comprising operators of VOS and SOOP, representatives of monitoring centres, data management centres and bodies, representatives of the International Mobile Satellite

Organization and other communications satellite systems, representatives of manufacturers, representatives of science advisory bodies and users as appropriate.

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

ANNEX II

SOT TASK TEAMS

Name	***Chair***	***Terms of Reference and membership***
Task Team on ASAP	Mr Rudolf KROCKAUER E-ASAP Programme Manager Deutscher Wetterdienst Bernhard-Nocht-Strasse 76 20359 Hamburg Germany Tel: +49 40 6690 1580 Fax: +49 40 6690 1496 Email: Rudolf.Krockauer@dwd.de	See website *(See also the ASAP National Focal Points the web)*
Task Team on Instrument Standards	Mr Henry KLETA Senior Field Service Engineer Deutscher Wetterdienst Frahmredder 95 22393 Hamburg Germany Tel: +49 (40) 6690-2160 Fax: +49 (40) 6690-2099 Email: Henry.Kleta@dwd.de	See website
Task Team on Metadata for WMO No. 47	Mr Graeme BALL Manager, Marine Operations Group Australian Bureau of Meteorology 700 Collins Street Docklands GPO Box 1289 Melbourne VIC 3001 Australia Tel: +61-3 9669 4203 Fax: +61-3 9669 4168 Email: g.ball@bom.gov.au	See website
Task Team on Satellite Communications Systems	Mr Pierre BLOUCH E-SURFMAR Programme Manager Météo France, Paris Centre de météorologie marine 13 rue du Chatellier CS 12804 F-29228 Brest cedex 2 France Tel: +33 (0) 2 98 22 18 52 Fax: +33 (0) 2 98 22 18 49 Email: pierre.blouch@meteo.fr	See website
Task Team on VOS Recruitment and Programme Promotion	Ms Sarah North Marine Networks Manager Met Office FitzRoy Road Exeter Devon	See website

	EX1 3PB United Kingdom Tel: +44 (0) 1392 885 617 Fax: +44 (0) 1392 885 681 Email: sarah.north@metoffice.gov.uk	
Task Team on Callsign Masking and encoding	Mr Graeme BALL (see details above)	See website
SOT Advisory Group on Coding	Mr Graeme BALL (see details above)	See website

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ANNEX III

OVERARCHING SOT IMPLEMENTATION PLAN

1. Structure

1.1. The Ship Observations Team (SOT) consists of a group of enduring and successful data collection programmes, comprising:

1.1.1. The Voluntary Observing Ships (VOS) scheme,
1.1.2. The Ship-of-Opportunity Programme (SOOP),
1.1.3. The Automated Shipboard Aerological Programme (ASAP).

2. Objectives

2.1. To manage, coordinate and, wherever possible, integrate these programmes to support a range of well defined operational and research applications.
2.2. To liaise and coordinate with other groups that use volunteer ships as environmental observing platforms, with a view to their participation in SOT.
2.3. To foster greater national coordination between agencies involved in similar or related marine observing programmes.

3. Working Arrangements

3.1. SOT meets approximately every 2 years and incorporates separate, but plenary sessions of:

3.1.1. the Voluntary Observing Ship Panel (VOSP), including the VOS Climate Project (VOSClim), and
3.1.2. the Ship-of-Opportunity Implementation Panel (SOOPIP).

3.2. Issues and reports that are of interest to all programmes are addressed during the Common Session of SOT.

3.3. The Common Session of SOT is presided over by the chairperson of SOT.

3.4. Issues and reports that are relevant to a particular programme or special project are addressed during the Panel Session appropriate to that programme or project.

3.5. The Panel Sessions are presided over by the chairpersons of VOSP and SOOPIP as appropriate.

3.6. Much of the work of SOT is achieved during the inter-sessional period by Task Teams established to examine and make recommendations about specific issues. Task Teams work predominantly by email and report at SOT.

3.7. Scientific advice and guidance to SOT is provided by panels and bodies for climate and operational meteorology, including;

3.7.1. GCOS/GOOS/WCRP Ocean Observations Panel for Climatology (OOPC),
3.7.2. CLIVAR Global Synthesis and Observations Panel (GSOP)
3.7.3. WMO Commission for Basic Systems (CBS).

4. Status

4.1. The three programme panels of SOT continue to explore opportunities to integrate their sampling programmes. An example of this, although still in its infancy, is the work by the *Task Team on VOS Recruitment and Programme Promotion* to develop design guidelines for ship builders that will provide the infrastructure on new ships to meet a variety of current and future sampling requirements.

4.2. Greater cooperation and coordination between the programmes is providing increased opportunities to deploy drifting buoys and profiling floats. National VOS, SOOP and ASAP operators are encouraged to provide JCOMMOPS (JCOMM in-situ Observing Platform Support Centre) with details about potential deployment opportunities that may be provided by their ships.

4.3. The traditional role of the PMO in servicing only VOS vessels is changing as a result of programme integration. This is particularly evident in countries where the PMOs also provide a ship-greeting service to oceanographic observation ships.

4.4. PMOs also support regional buoy and float deployment programmes in addition to their own national programmes. This directly supports the objectives of the Data Buoy Cooperation Panel (DBCP) and its Regional Action Groups, and also the Argo Science Team (AST).

4.5. Cooperation and coordination between the programmes, as well as with other groups that use volunteer ships as observing platforms, is helping to ensure that the better reporting and more obliging vessels are not being over-tasked.

4.6. A benefit of improved national coordination, although this might be a long-term strategy in some participating countries, combined with the greater use of PMOs to recruit sampling vessels, is the reduction in the number of visitors to ships with sampling programme requests.

4.7. Cooperation with other groups that use ships as observing platforms is raising the awareness of:

4.7.1. The need for comprehensive observer/operator training and re-training.
4.7.2. Data standards.
4.7.3. Equipment standards.
4.7.4. Equipment calibration.
4.7.5. Data processing methods, including quality control and quality monitoring,
4.7.6. Data reporting methods.

4.8. SOT, through the Secretariat, liaises with the relevant international bodies such as the International Ocean Carbon Coordination Project (IOCCP), and Seakeepers International.

4.9. JCOMMOPS provides monitoring and on-going programme support to SOOPIP (and DBCP), and is becoming increasingly active in supporting the VOS Scheme.

ANNEX IV

KEY PERFORMANCE INDICATORS (KPIS) FOR VOS AND VOSCLIM

KPI	*Definition*	*Type*	*Target*
1	Percentage of VOSClim ships in the global active VOS[1]	Quantity	> 25%
2	Percentage of VOS ships to meet the reporting criteria of an ‘Active ship’ by providing an average of 20 Observations per month	Quantity	100%
3	Percentage of VOSClim class ships per month being flagged on the Suspect List for Air Pressure	Quality	< 3%
4	Percentage of VOSClim class observations to be received within 120 minutes	Timeliness	> 95%

1 The global active VOS is defined as the number of VOS registered in the Pub47 and reporting at least once per month – Today there are about 2000 such ships.

ANNEX V

XBT LINE RESPONSIBLITIES

XBT TRANSECT IMPLEMENTATION RESPONSIBILITIES

The table below provides information on the institutions taking the lead in one or more aspects of the implementation of the XBT transects as agreed at SOT-VI (2011).

Transect	Agency	Status	Year
AX01	5, 1, 23	Active	
AX02	1, 23	Active	
AX03	10	Active	
AX04		Active	
AX07	1	Active	1995
AX08	1, 6	Active	2000
AX10	1	Active	1997
AX11	10	Active	
AX15	5	Active	
AX18	1, 11, 6	Active	2002
AX19	1	Active	
AX20	5, 1, 23	Active	
AX22	2, 1, 11	Active	1996
AX25	1, 6, 20	Active	2004
AX29	1		
AX32	1, 3	Active	1981
AX34			
AX97	1, 13	Active	2004
PX02	9	Active	
PX04	7		
PX05	2, 16, 17, 7	Active	2009
PX06	2, 7, 1	Active	1986
PX08	2, 1	Active	2004
PX09	2, 1	Active	1987
PX10	2, 1	Active	1991
PX11	9	Active	
PX12	7	Active	
PX13	2, 7, 1	Active	1986
PX18	1		
PX21			
PX26	1		
PX30	4, 2, 7	Active	1991
PX31	2, 7, 1	Active	1986
PX32	4	Active	
PX33	4	Active	
PX34	4, 2	Active	1991
PX36			
PX37	2, 1	Active	1991
PX38	2	Active	1993
PX39	25	Active	
PX40	8, 17	Active	1998
PX44	2, 1	Active	1991
PX45	8, 16	Active	
PX46	16		
PX50	18, 2		1993
PX53	9	Active	

Agency key

1 USA-AOML
2 USA-SIO
3 USA-NMFS
4 AUS-CSIRO
5 FRA-IRD/BREST
6 ZAF-UCT
7 FRA-IRD/NOUMEA
8 JPN-TOHOKU-U
9 AUS-BOM
10 GER-BSH
11 ARG-SHN
12 IND-NIO
13 BRA-FURG
14 UK-UKMO
15 IND
16 JPN-JMA
17 JPN-JAMSTEC
18 NZL-MSNZ
19 JPN
20 UK-BAS
21 IT-ENEA
22 IT-INOGS
23 FRA-UParis

PX81	2		1997	24 CY–U.Cyprus 25 CAN-DFO
IX01	9, 1	Active		
IX02		Active		
IX06	6			
IX08	12		1992	
IX09	14, 17			
IX10	14, 16, 17			
IX12	9	Active		
IX14	12	Active	1990	
IX15	2, 4, 6	Active	1994	
IX21	2, 4, 6	Active	1994	
IX22	9	Active		
IX28	4, 2	Active	1993	
IX29		Active		
IX31	2			
MX01	21, 9	Active		
MX02	21, 9	Active		
MX04	21, 9	Active		
MX05	21, 22	Active		
MX07	21, 24	Active		

ANNEX VI

VOS DONATION PROGRAMME

DBCP/SOT DRIFTER DONATION PROGRAMME IN SUPPORT OF THE VOS SCHEME FOR DEVELOPING COUNTRIES (VOS-DP)

The Fourth International Port Meteorological Officer Conference (PMO-IV), and support to Global Ocean Observations using Ship Logistics (8-10 December 2010, Orlando, Florida, USA) recommended to initiate a DBCP/SOT drifter donation programme (VOS-DP) to assist developing countries in setting up embryonic national VOS[1] programmes whereby the donated drifter would be installed onboard a newly recruited ship as an autonomous AWS to provide a low cost, quality observation solution. Some countries expressed interest in participating in this programme (see Annex A).

WMO Members or IOC Member States interested in joining the VOS Scheme are eligible to receive a drifter donated by the Global Drifter Programme (GDP) under the following conditions:

- The country is a developing country and has currently no VOS programme;
- The country must identify one or two suitable vessels as prime candidates for installing a “deck drifter” on-board;
- The country shall designate a National Contact Point (NCP) to JCOMMOPS (support@jcommops.org) responsible for managing and operating the embryo national VOS programme;
- The NCP shall request JCOMMOPS to propose a Port Meteorological Officer (PMO) who can assist with regards to the collection of ship metadata, and setting up the VOS programme;
- The ship metadata for WMO Publication No. 47[2] should be initially collected and provided to the designated PMO. In particular, the route(s) (see Annex C) of each ship, and the reason for selecting each ship shall be indicated;
- The designated PMO shall notify the Chair of the VOS-DP Programme Evaluation Committee (PEC) (see Annex D for Terms of Reference and membership) when the country is ready to receive the drifter.
- Following decision by the Chair of the PEC, the donor, a participant in the Global Drifter Programme (GDP), will provide the drifter free of charge to the country, and pay for shipping and the associated satellite data telecommunication costs.
- All other related costs shall be supported by the country receiving the drifter.
- All custom issues shall be cleared by the country receiving the drifter. If required (e.g. for custom clearance), JCOMMOPS will issue a letter to formalize the donation

Annex B provides for a template of milestones required to track progress when a developing country is participating in the VOS-DP.

Annex E provides a simple guide for VOS start-up countries participating in the VOS-DP.

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1 http://www.bom.gov.au/jcomm/vos/
2 http://www.wmo.int/pages/prog/www/ois/pub47/pub47-home.htm

ANNEX A OF ANNEX V

COUNTRIES WHICH EXPRESSED INTEREST IN PARTICIPATING IN THE DBCP/SOT DRIFTER DONATION PROGRAMMME AT PMO-IV:

- Kenya
- Chile
- Bahamas
- Gambia
- Peru
- Guatemala
- Indonesia

POTENTIAL DRIFTER DONORS:

- Meteorological Services, Canada
- NOAA Atlantic Oceanographic and Meteorological Laboratory (AOML), USA

CANDIDATES AND PMOS WILLING TO ASSIST:

Developing country receiving drifter	***Candidate National Contact Points (NCP)***	***Buddy PMO***
Bahamas	Godfrey BURNSIDE - Godfrey.burnside@gmail.com	Ms Paula RYCHTAR - Paula.Rychtar@noaa.gov Mr Robert NIEMEYER - pmojax@noaa.gov
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Chile	LCdr Alejandro DE LA MAZA - adelamazad@dgtm.cl	Mr Tim KENEFICK - pmochs@noaa.gov
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Kenya	Mr David MWARUMA - davidmwaruma@gmail.com	Mr David DELLINGER - pmomia@noaa.gov Mr Brian HOLMES - pmolax@noaa.gov
Peru	Ms Amanda Yolanda LAPA POCOMUCHA - alapa@senamhi.gob.pe	Mr Chris FAKES - pmohou@noaa.gov

ANNEX B OF ANNEX V

TEMPLATE OF MILESTONES REQUIRED TO TRACK PROGRESS

No.	***Step***	***By***	***Status***
1	National Contact Point (NCP) notified to JCOMMOPS	NCP	
2	Requirements provided to NCP	JCOMMOPS	
3	Candidate ship(s) identified	NCP	
4	NCP provides information to JCOMMOPS and requests assistance from a PMO	NCP	
5	Buddy PMO proposed by the VOS-DP Programme Evaluation Committee (PEC)	PEC	
6	Ship metadata provided to the assisting PMO for each ship, including route, and rationale for recruitment	NCP	
7	Buddy PMO checks metadata and coordinates necessary corrections with the national contact point	Buddy PMO	
8	Buddy PMO notifies the committee about readiness of the candidate country	Buddy PMO	
9	Evaluation by the committee	PEC	
10	Decision by the committee	PEC	
11	Drifter purchased and shipped by donor to the country	Donor	
12	Customs cleared by receiving country	NCP	
13	Drifter received and checked by NCP	NCP	
14	Discussions with recruited vessel for preparing drifter installation	NCP	
15	Drifter installation onboard the ship	NCP	
16	Drifter turned on, and data checked	NCP	
17	NCP requests service Argos to distribute the data on GTS in FM-13 SHIP format[1]	NCP & Donor	
18	Data monitored by JCOMMOPS	JCOMMOPS	
	NCP checks for receipt of buoy data at his local forecast centre[2]	NCP	
19	GTS distribution stopped in case of systematic errors; or bias correction in case this can be done	NCP & Donor	
20	NCP to provide feedback to the ship on the usefulness of the buoy data[3]	NCP	
21	Recovery of the drifter in case of failure or batteries dead	NCP	
22	Drifter shipped back to the donor for evaluation/refurbishment	NCP	

Note: JCOMMOPS should be regularly informed on progress of each milestone so that it can effectively assist and promote the initiative.

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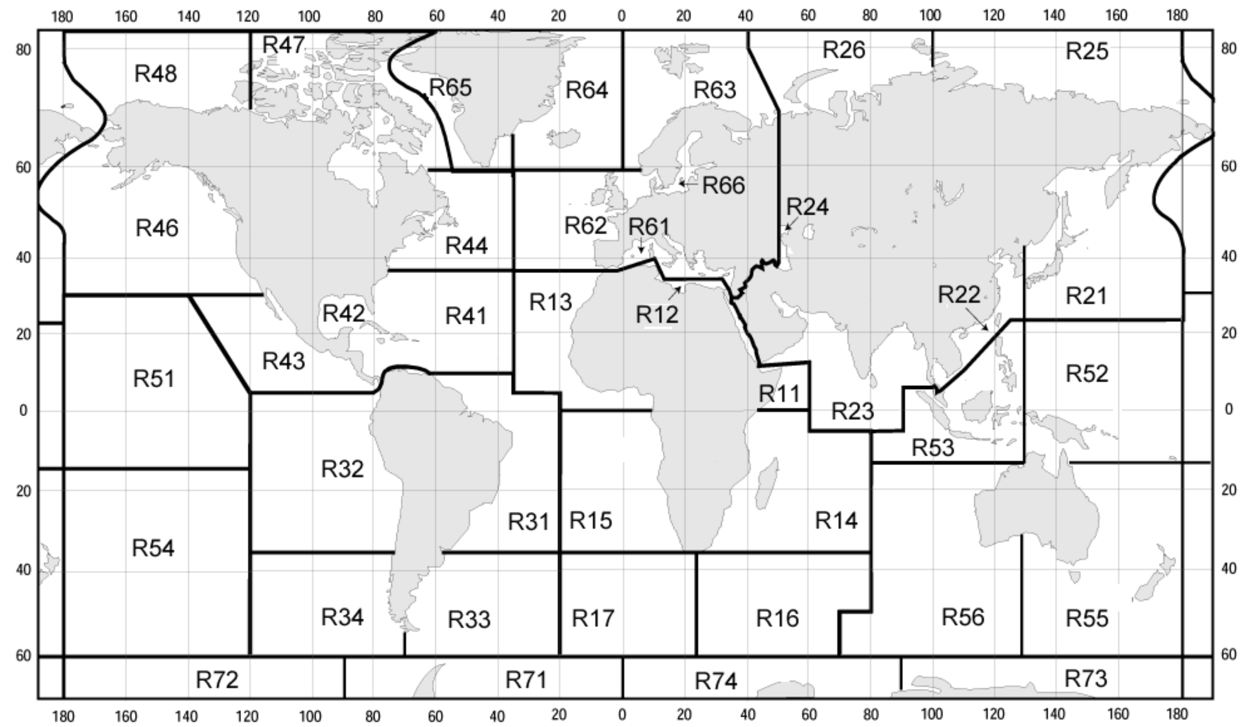
1 Including provision of calibration curves, ship's call sign, GTS bulletin headers, and height of the drifter on the deck of the ship; as of 2013, FM-94 BUFR format shall be used instead
2 This is to ensure that the country receiving the drifter is able to receive and use the data for local applications
3 This to build cooperation and trust with the ship

ANNEX C OF ANNEX V

VOS ROUTES[1]

1802

Rte **Route**



Code	**Description/marine area**
R90	More than 10 separate marine areas (see Note 2).
R91	Inland sea or river (see Note 3).
R92	Variable or no fixed route (see Note 2).

Note 1 A maximum of 10 marine areas visited by the ship can be reported individually, otherwise use R90.

Note 2 For R90 or R92, specify the most visited marine area(s) by the ship in the footnote if this can be determined, e.g. “most visited - R62, R41”.

Note 3 For R91, specify the location in the footnote, e.g. “Black Sea”, “Mackenzie River”.

Note 4 Use footnotes as necessary to provide more detail, e.g. “coastal service”, “fixed location”.

Note 5 If using the semi-colon delimited metadata exchange format, include the relevant marine area in the footnote if more than one **rte** is defined, e.g. “R73 – Austral Summer only”, otherwise format the footnote as shown in the examples for Notes 2 – 4.

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1 From WMO Publication No. 47

ANNEX D OF ANNEX V

TERMS OF REFERENCE AND MEMBERSHIP OF THE VOS-DP[1] PROGRAMME EVALUATION COMMITTEE (PEC)

The VOS-DP Programme Evaluation Committee (PEC) shall:

1. Collect all applications from developing countries willing to participate in the VOS-DP;
2. Evaluate the applications;
3. Communicate with the applicants and provide information about requirements as necessary;
4. Propose a Buddy Port Meteorological Officer (PMO) for assisting the applicant with regard to the collection of ship metadata, and setting up the VOS programme;
5. Decide whether applicants are eligible to receive one or more drifter(s);
6. Prepare and maintain a simple guide for VOS start-up countries which will cover the following:
   - Ship selection
   - Obtaining shipping company permission
   - Recording metadata
   - Buoy installation
   - Height offsets for barometer processing
   - GTS data distribution and QC monitoring.

In addition,

1. Applicants shall communicate with the PEC through JCOMMOPS;
2. JCOMMOPS shall record all relevant information collected from the applicants and make it available to the PEC through dedicated web pages; dedicated tracking tools shall also be developed;
3. The designated Buddy PMO shall notify the Chair of the PEC when the country is ready to receive the drifter.

Membership:

Name	***Country/Agency***	***Email***
Sarah North (action Chair, PEC)	United Kingdom, Metoffice	sarah.north@metoffice.gov.uk
Graeme Ball	Australia/BOM	G.Ball@bom.gov.au
Mathieu Belbéoch	JCOMMOPS	belbeoch@jcommops.org
Etienne Charpentier	WMO	echarpentier@wmo.int
Shaun Dolk	USA/NOAA	Shaun.Dolk@noaa.gov
Rick Lumpkin	USA/NOAA	Rick.Lumpkin@noaa.gov
Chris Marshall	Canada/MSC	Chris.Marshall@ec.gc.ca
Paula Rychtar	USA/NOAA	Paula.Rychtar@noaa.gov
John Wasserman	USA/NOAA	john.wasserman@noaa.gov

1 DBCP/SOT drifter donation programme in support of the VOS Scheme for developing countries

ANNEX E OF ANNEX V

GUIDE FOR VOS START-UP COUNTRIES PARTICIPATING IN THE VOS-DP[1]

1. Ship Selection

a. Liaise with NMS Forecasting Centre to determine the preferred sea area for observations
b. Use JCOMMOPS VOS maps ftp://ftp.jcommops.org/sot/VOS/Maps to identify data sparse areas where observations are needed
c. Use local port and shipping information to find ships which trade in the area of interest
d. Prioritize suitable ships by considering length of time at sea (long sea time with short port stays is preferable to maximize useful observations), ease of visiting at a local port, the language spoken by ship's personnel, and any information about the shipping company.
e. Select one or two ships to follow up

2. Obtaining Shipping Company Permission

a. Contact shipping company or shipping agent to explain the VOS-DP programme
b. Use the VOS advertising tools such as, the SOT PowerPoint presentation, the VOS brochure, the Maritime Safety Committee MSC Circ 1293, all available from the VOS website http://www.bom.gov.au/jcomm/vos/information.html
c. Explain that the only requirement from the ship is some space on a deck with a clear view of the sky, on which to install a buoy approximately 60 cm in diameter.
   i. The buoy is a self-contained system, with its own power and satellite transmitter
d. Explain that the atmospheric pressure data from the buoy will assist local forecasters in the preparation of marine forecasts and warnings
e. Request permission to install a buoy on their ship
f. Request permission to visit the ship to discuss the installation with the Master and crew and to select a suitable installation site

3. Recording Metadata

a. Visit the ship, taking care to comply with the security and safety regulations for the port and the ship
b. Meet with the Master to discuss the installation and to select a suitable site
c. With assistance from the Ship's Officers, and reference to the General Arrangement Plan and the list of 'Ships Particulars', record the ship's metadata in accordance with WMO Pub 47 requirements. For metadata instructions, refer to: http://www.bom.gov.au/jcomm/vos/documents/pub47_documentation_version3.pdf
d. Send the metadata to designated Buddy PMO for checking
e. Send the checked metadata to WMO pub47@wmo.int after the buoy has been installed
   i. Future metadata to be updated at least quarterly intervals following Pub 47 requirements

4. Buoy Installation

a. Record the Buoy Identification number – this is currently a 5 digit number usually painted on the antenna or hull
b. To keep the buoy batteries cool, the buoy should be painted white. Take care not to block the barometer breathing holes at the base of the antenna with paint
c. The buoy should be installed in an upright manner, it could be lashed to a railing, or secured in a wooden box arrangement to prevent it rolling about.

1 DBCP/SOT drifter donation programme in support of the VOS Scheme for developing countries

d. Activate the buoy following the manufacturer's instructions, this is generally done by removing a magnet from the hull
e. When installed, determine height of the buoy/barometer above the sea level. Measure this height from ship plans, or drop a string to the water to measure the distance. This method is suitable for a small ship where the draft does not change much. For larger ships apply an average draft to compute an average height above sea level. The buoy barometer height is metadata element brmH, recorded to 0.1 metres

5. Height offsets for Barometer Processing

a. Advise Buddy PMO and Buoy Donor that buoy has been activated
b. Advise Buoy number, Ship name, Ship callsign, Ship position, and buoy height above sea level to Buddy PMO and Buoy Donor
c. Request Buoy Donor to put buoy on GTS in FM-13 SHIP format, with barometer height offset applied in the Technical File
d. Request Buoy Donor to advise the name of the GTS Bulletin that the buoy data will be disseminated in.

6. GTS data distribution and QC monitoring

a. Advise local NMS to ensure arrangements are made to receive the GTS bulletin containing the buoy data.
b. Use monitoring tools to check the pressure data from the buoy. Tools found at http://www.meteo.shom.fr/qctools/

In conjunction with the above information, refer to the VOS website
http://www.bom.gov.au/jcomm/vos/
and the Quick Reference Guide for PMOs
http://www.bom.gov.au/jcomm/vos/quick_reference_pmo.html

February 2011

ANNEX VII

STATUS MAPS

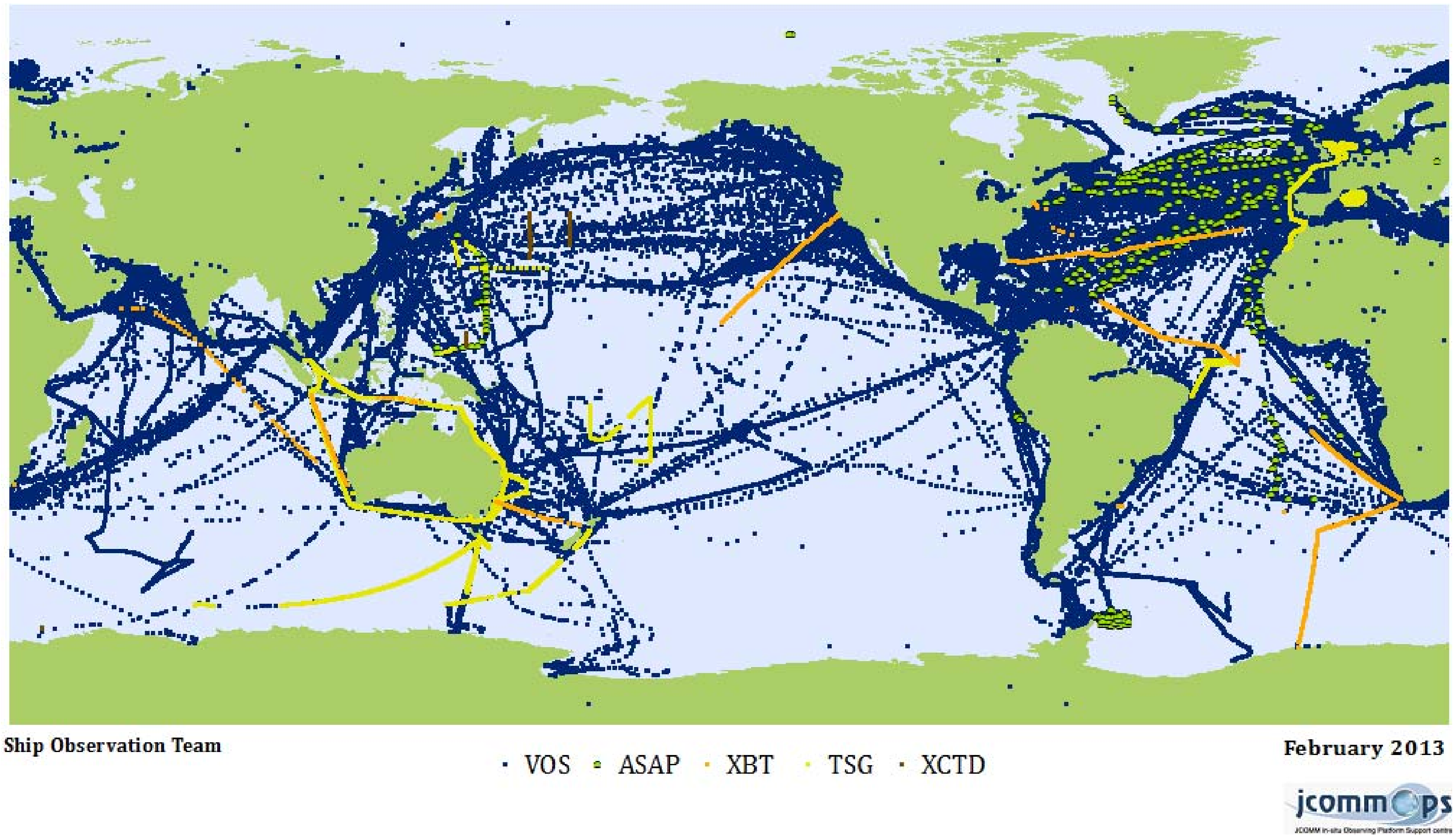

Figure 1: SOT reports in February 2013

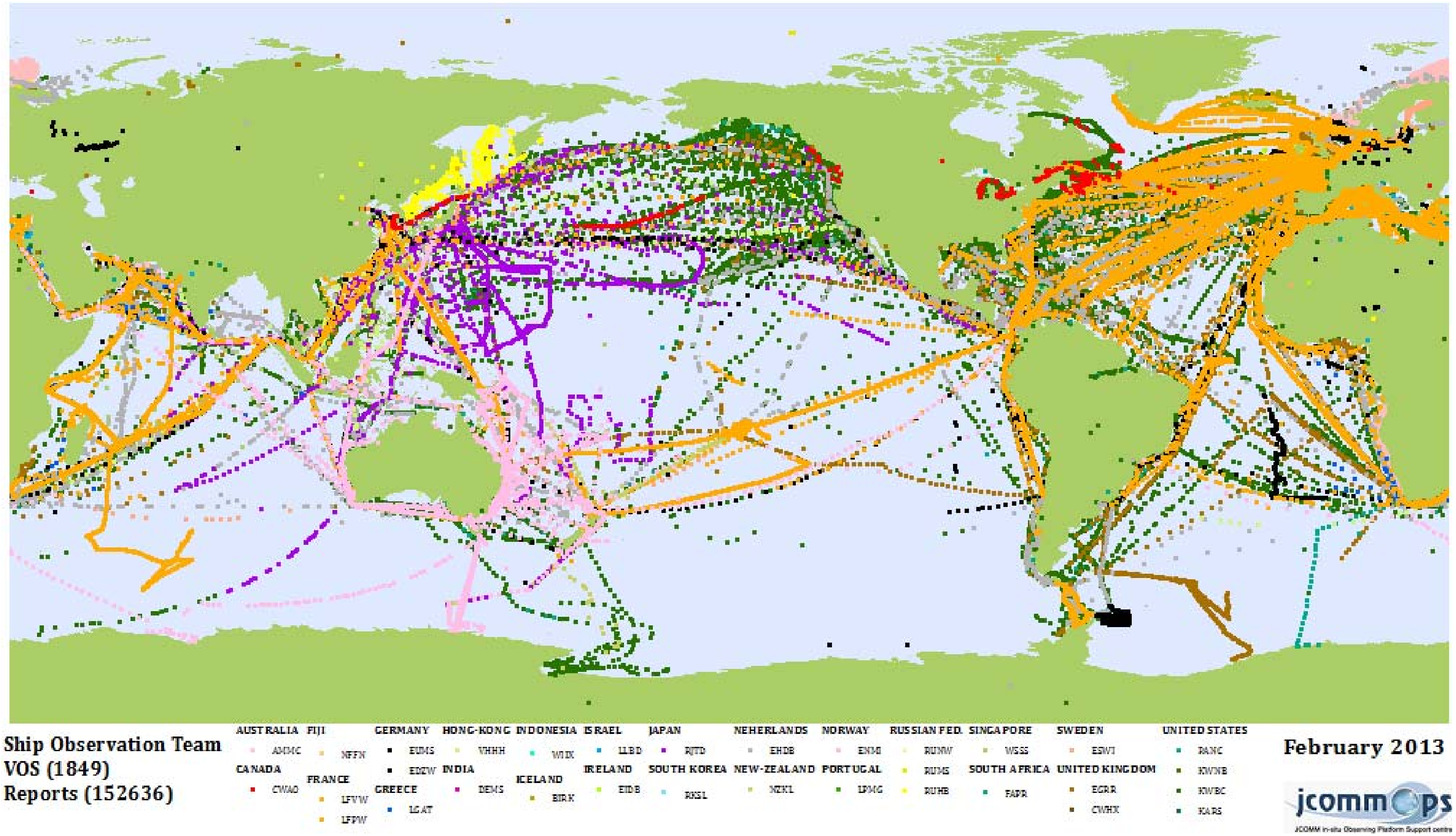

Figure 2: VOS reports distributed on GTS in February 2013

Figure 3: VOS reports distributed on GTS in February 2013

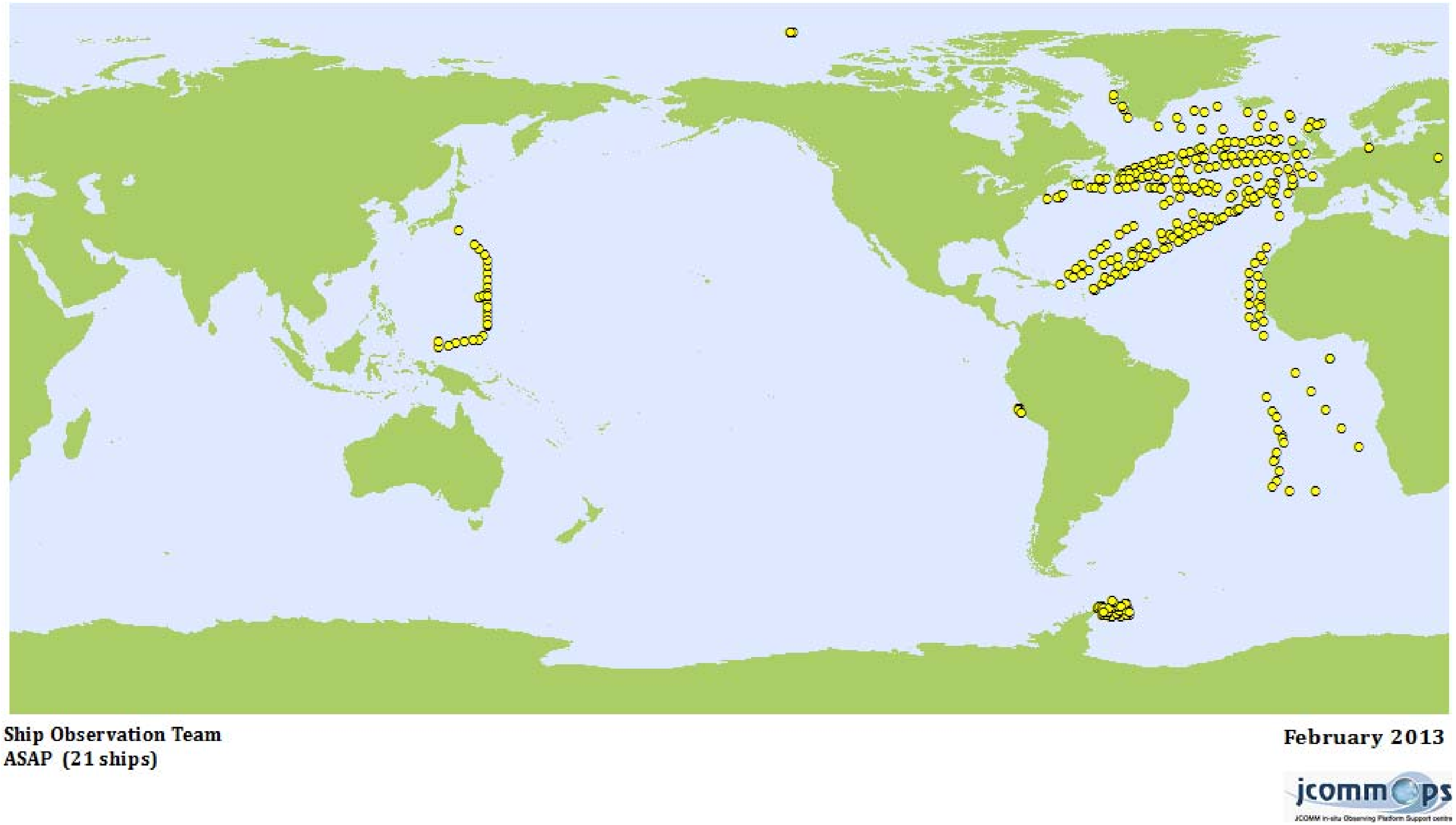

Figure 4: ASAP Aerological Profiles distributed on GTS in February 2013

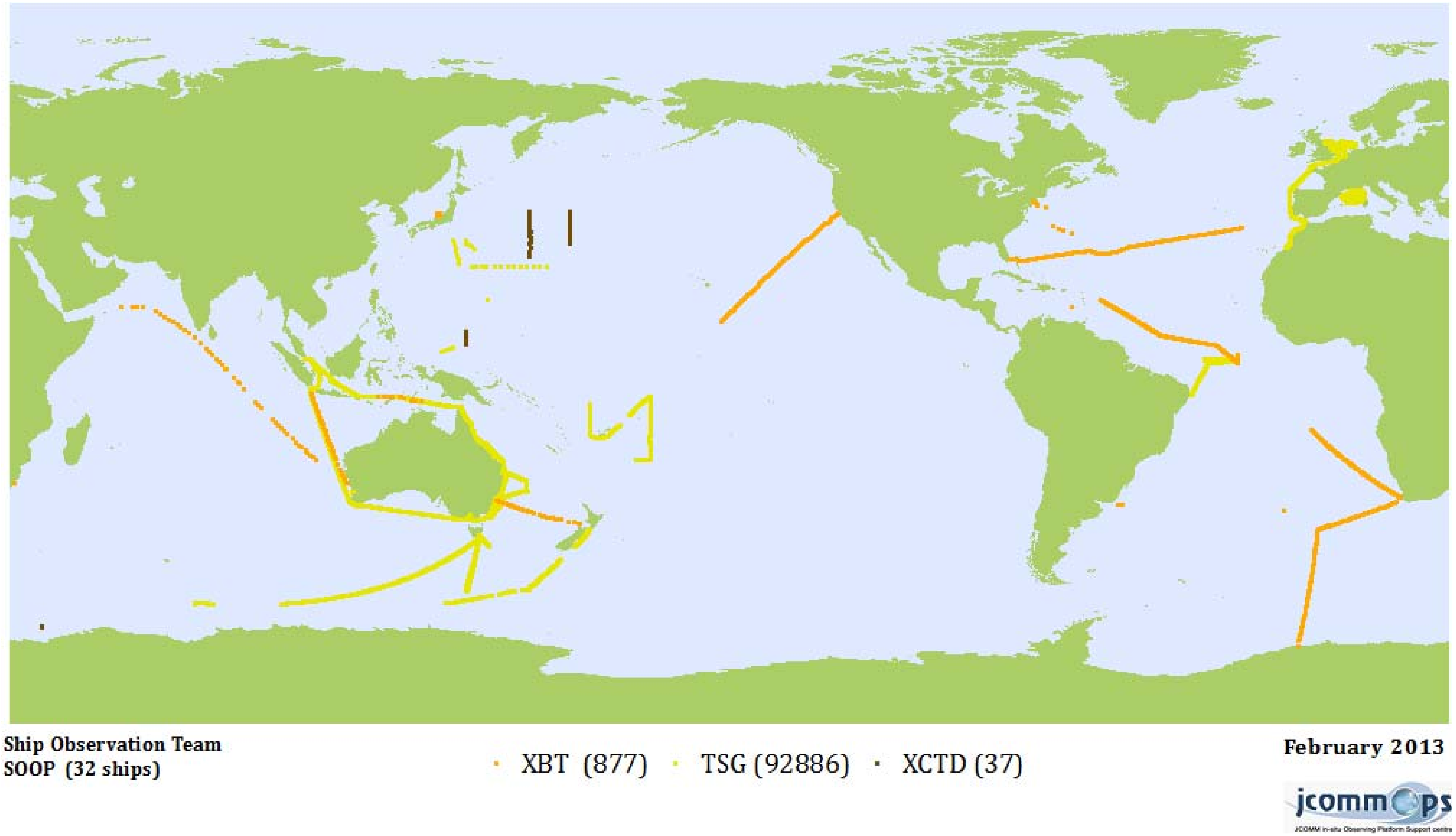

Figure 5: SOOP reports in February 2013

ANNEX VIII

CONTACT POINTS

Ship Observations Team (SOT)

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View the list of SOT National Focal Points

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View the list of VOSP members
View the list of Port Meteorological Officers

Ship of Opportunity Implementation Panel (SOOPIP)

Chair, SOOPIP
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Task Teams of the Ship Observations Team – See Annex II

ANNEX IX

BACKGROUND INFORMATION ON SHIP MASKING

The "ship masking" issue relates to ship owners and masters' concerns with regard to Voluntary Observing Ship (VOS) data exchange, because ship call signs and position data eventually appear on some public web sites. They justify their concerns because of piracy acts in certain regions as well as because of commercial competitiveness reasons (e.g. fisheries). The VOS data appear on the web sites because (i) VOS data are being distributed in real time on the Global Telecommunication System (GTS) of the World Weather Watch (WWW) and made available to all NMHS, (ii) marine data are defined as "essential" data according to WMO resolution 40[1] (Cg-XII), and (iii) "essential" data are provided on a free and unrestricted basis according to this resolution so private companies can legally access the data from NMHS. VOS data which are assimilated in real time by NHMS from the GTS into Numerical Weather Prediction models are essential for the provision of services in support of the protection of life and property and the well-being of all nations, as well as critical for global climate studies. Participation by maritime companies in the VOS scheme is done on a voluntary basis. Because of such concerns, ship owners and masters may withdraw their vessels from the VOS scheme because of the risk of having ship reports, including call signs and positions being made freely available on websites not controlled by NMHSs.

This serious problem, if not adequately addressed, could therefore ultimately lead to a substantial decrease in the number of recruited VOS ships and threaten the programme.

At the same time, unique ship identification is absolutely needed for the following activities:

(i) **Quality monitoring** (real-time and delayed mode). In order to monitor the quality of series of observations provided by a given ship and in particular to identify ships reporting systematic errors, it is necessary for the monitoring centres to identify the ship in a unique way.

(ii) **Quality information feedback** to appropriate national focal points, and Port Meteorological Officers (real-time and delayed mode). Ship's identification cross referenced with the list of ships operated by the Members states (i.e. WMO Publication number 47) is required in order to identify the appropriate national focal point or Port Meteorological Officer.

(iii) **Global climate studies** (delayed mode). Access to ship metadata is necessary for global climate studies. Metadata are available from WMO publication number 47. It is therefore necessary to crosscheck the ship's unique identification with its corresponding records in the WMO publication.

The Regional Specialized Meteorological Centre (RSMC), Exeter is acting as CBS Lead Centre for monitoring the quality of surface marine observations and is routinely producing a biannual report on such quality as well as providing essential feedback to VOS operators regarding the quality of the data delivered by VOS ships. The MetOffice quality monitoring activities for VOS data are made on real time as well as delayed mode data. It provides for an independent source of quality information regarding ships operated by other countries. The Met Office is also acting as Real-Time Monitoring Centre (RTMC) for the VOSClim project. VOSClim as started providing a high-quality subset of marine meteorological data to support global climate studies. It is essential that the activities of RSMC, Exeter in this regard can be continued under any proposed VOS GTS data distribution scheme.

Restricting real-time ship's position and call sign access to users outside of the World Weather Watch system would satisfy the concerns of ship owners and masters. However, restricting real-

1 WMO resolution 40 (Cg-XII) states: "…Members shall provide on a free and unrestricted basis essential data and products which are necessary for the provision of services in support of the protection of life and property and the well-being of all nations, particularly those basic data and products, as, at a minimum, described in Annex 1 to this resolution, required to describe and forecast accurately weather and climate, and support WMO Programmes; … "

time data access to the ship's call sign only would not completely address the concerns of these companies operating ships in data sparse areas where the ship traffic is low and where ships' tracks do appear clearly on plotted maps of VOS observations received from the GTS.

Based on above information and rationale, in 2006 the WMO Executive Council adopted Resolution 7 (EC-LVIII) which recommends (i) Members which, in consultation with ship owners, wish to protect the identity of VOS may implement ship call sign masking, for a trial period of one year, a process which would facilitate open distribution of masked data on the GTS; and (ii) all Members implementing such a process to provide for the secure exchange of ship call signs and reports affected by the masking process, so as to assist in resolving real time monitoring and climate analysis problems.

In 2007, the Executive Council further adopted Resolution 27 (EC-LIX) recommending in particular that Members who, in consultation with ship owners, wish to protect the identity of VOS may extend the trial period for the implementation of their current callsign masking schemes as per Resolution 7 (EC-LVIII). All Members implementing such a process were asked (i) to provide for the secure exchange of ITU callsigns and reports affected by the masking process, (ii) to assist in the timely resolving of real time monitoring and climate analysis problems, and (iii) to minimize the technical implications on the Quality Monitoring of Marine Data set by the Commission for Basic System (CBS) Lead Centre. The Resolution also asked the Secretary-General, to continue the High Level Dialogue, involving affected Members, the International Maritime Organization, the International Chamber of Shipping, shipping companies, and other relevant Organizations and technical commissions (e.g., JCOMM, CBS and CCI), in order to review the implementation and impact of masking.

In compliance with Resolution 27 (EC-LIX), the following masking schemes and terminology have been proposed by the SOT:

SHIP masking: A generic call sign using the four letters "SHIP" is used in place of the ship's call sign in FM-13-XI Ext. SHIP reports that are distributed on the GTS.

MASK: the ship's call sign is masked using a unique identification number in place of the real ship's call sign in FM-13-XI Ext. SHIP reports that are distributed on the GTS. This unique identification number is allocated nationally or regionally. Allocation of unique numbers is coordinated regionally in case a group of countries from a region agrees to use the same scheme. The name of the NMHS recruiting country (i.e. not the country of the ship's registration) can[2] be part of the masked call sign. To avoid confusion with ODAS and buoy numbers, the unique Identification Numbers should start with an alphabetic letter.

ENCODE: The actual call sign plus the date/time groups are encoded (encrypted) within the VOS reports issued by the ships (date/time is included in the encrypted part to make that group vary from one report to the next); the date/time group is also being provided separately without encryption to permit use of the observations by users outside of the WMO community. Traditional open-source encryption methods use a public key for encoding and a private key for decoding. Private key is known by all WMO Members but is not made available outside of the meteorological community.

REAL: The actual (real) ship's call sign is used in FM-13-XI Ext. SHIP reports that are distributed on the GTS.

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2 Perhaps the SOT should discuss whether indicating the country name should be mandatory or whether for example the first two characters should provide for the country name with letters XX for example being used for those recruiting countries reluctant to show their names as part of the identification.

ANNEX X

CRITERIA USED FOR THE MONITORING OF VOS AND VOSCLIM DATA

1) CRITERIA USED BY THE RSMC, EXETER, FOR MONTHLY MONITORING OF MARINE SURFACE OBSERVATIONS (INCL. VOS DATA)

Monitoring procedures

Period	:One calendar month.
Data monitored	:Reports from each unique identifier for ships, fixed buoys and platforms.
Standard of comparison	:Background field from Exeter global model.
Observation times	:All hours
Elements monitored	:Mean sea level pressure (hPa).
	:Wind speed (ms^{-1}).
	:Wind direction (degrees).
	:Air temperature (^oC).
	:Relative Humidity (%).
	:Sea surface temperature (^oC).
Parameters monitored	
NOBS	:Number of observations received, excluding duplicates.
%GE	:Percentage of observations with gross errors.
%REJ	:Percentage of observations flagged, excluding those with gross errors.
SD	:Standard deviation of difference of observations from background values, excluding those with gross errors.
BIAS	:Mean difference of observations from background values, excluding those with gross errors (N.B. a positive bias indicates the wind observation is veered to the background).
RMS	:Root Mean Square difference of observations from background values, excluding those with gross errors.

GROSS ERROR LIMIT	:15 hPa	(pressure)
	:25 ms^{-1}	(vector wind)
	:15 ^oC	(air temperature)
	:50%	(relative humidity)
	:10 ^oC	(sea surface temperature)

SELECTION CRITERIA :NOBS >= 20 , and one or more of the following:

1.Bias	>=	4 hPa	(pressure)
	>=	5 ms^{-1}	(wind speed)
	>=	30 degrees	(direction)
	>=	4 ^oC	(air temperature)
	>=	15%	(relative humidity)
	>=	3 ^oC	(SST)
2.SD	>=	6 hPa	(pressure)
	>=	80 degrees	(direction)
	>=	6 ^oC	(air temperature)
	>=	25%	(relative humidity)
	>=	5 ^oC	(SST)
3.PGE	>=	25	

N.B. Observations of wind direction are only included in the wind direction statistics if the observed or background wind speed is greater than 5 ms^{-1}

2) CRITERIA USED BY THE RTMC FOR VOSCLIM SUSPECT LIST

Monitoring centre: Met Office, UK.

All VOS-Clim ship data are monitored: against background 6-hour forecast fields for all variables except SST, for which analyzed fields from the previous day are used.

Key to table below

NumObs : number of observations from the ship during the month
%GE   : percentage of obs with gross errors (for GE limits see below)
StdDvn : standard deviation of obs-background, excluding obs with gross errors
Bias   : mean obs-background, excluding obs with gross errors
RMS   : root mean square of obs-background, excluding obs with gross errors

Suspect selection criteria for each variable:
At least 20 observations from the ship and one or more of the following:-
%GE > 10%
|Bias| > Bias limit (see below)
StdDvn > StdDvn limit (see below)

Limits:	Press. (hPa)	Wind Speed (m/s)	Direct. (deg)	Air Temp. (deg C)	Rel.Hum. (%)	SST (deg C)
Bias limit	2.5	5	30	2.0	12	2.0
StdDvn limit	5.0	10	60	4.0	20	4.0
GE limit	15.0	25	150	10.0	50	10.0

ANNEX XI

SOT IMPLEMENTATION PLAN

No.	Ref.	Type		By	Time frame	Performance Indicator (if applicable)
1	2.3.3(ix) 3.1.11(x) 5.1 5.4.1 5.4.3	Capacity Building	Organize regular (every 3-4 years) PMO workshops as an efficient mean of realizing the JCOMM PANGEA concept. Organize scientific and technical workshops together with SOT Sessions	SOT	Every 4 years	Actual frequency of workshops
2	5.4.2	Capacity Building	Add to the repositories of educational resources on websites such as Ocean Teacher the materials developed for Capacity Building workshop (e.g PMO, Scientific and Technical workshops)	SOT	Ongoing	Number of SOT materials on OceanTeacher
3	3.3.10	Capacity Building/ASAP	Provide advice and assistance to new ASAP operators	ASAP	Ongoing	Number of new ASAP programmes
4	SOT-5/III-2.1.1.5	Data Management/Data Collection	NMHS operating VOS AWS to make arrangements to ensure that all observations, including hourly observations are inserted onto the GTS for global dissemination	VOS	Ongoing	Percentage of hourly observations from VOS distributed on GTS
5	4.6.5	Data Management/Delayed mode	The SOT and the associated programmes will actively encourage all ship operators to forward their data to one or other of the responsible global archives.	SOT	Ongoing	Evolution of archived ship observations within ICOADS
6	4.11.5	Data management/Delayed mode	Distribute the TSG software that has been developed by IRD –France- to produce the delayed mode dataset.	SOT	Ongoing	
7	4.6.4 SOT-6/9.4.5(1)	Data Management/Delayed mode	SOT to take an active role in the MCDS development and participate in the TT-MCDS Modernize the VOS delayed mode data flow as part of the MCDS development	ETMC	2020	MCDS in place
8	SOT-5/I-2.1.6	Data Management/Delayed mode	to contribute to feeding the JCOMM extreme wave database events when such events are observed by data buoys and are recorded by Team Members	SOT	Ongoing	Number of wave records from ships in extreme wave database
9	3.4.13	Data Management/Ferrybox	In situ TAC Ferrybox data of the EU Project MyOcean should be made available at least in delayed mode	Ferrybox	Ongoing	Number of Ferrybox ships reporting in delayed mode to ICOADS

10	3.4.20	Data Management/GTS	Efforts will continue by the SOT and the associated programmes to involve other ship operators in the work of the SOT, and to ensure, where appropriate, that their ship data are made available to the wider community, in near real-time if possible.	SOT	Ongoing	Number of ships from associated programmes reporting on GTS
11	2.2.3(v)	Data Management/GTS	Include VOS ocean surface current data as part of the BUFR template for VOS data	TT-TDC	2013	Number of ocean surface current data distributed on GTS
12	3.4.18	Data management/GTS	Distribute surface weather observations of GO-SHIP using SAMOS on the GTS	GO-SHIP	2015	Number of GO-SHIP vessels using SAMOS reporting on GTS
13	4.1.2	Data management/GTS	E-logbook software should be used as much as possible whenever manual VOS observations are made	VOS	Ongoing	Percentage of e-logbook in VOS fleet
14	4.4.2	Data Management/GTS	Complete migration to table driven codes	TT-TDC, SOT, VOS, SOOP, ASAP	Nov. 2012	Percentage of VOS, SOOP, and ASAP ships reporting in BUFR
15	4.5.4	Data Management/GTS	Propose ship's identification encryption scheme for ship-based observations distributed on GTS using BUFR	TT-Masking	2012	Encryption achieved
16	4.9.2(ii)	Data Management/GTS	ASAP ship operators should try to update their transmission systems in order to be able to transmit high-resolution BUFR messages	ASAP	ASAP	Percentage of ASAP ships distributing HR data
17	4.10.4	Data Management/SOOP	National funding bodies should consider on-going funding of scientific QC of upper ocean thermal data from SOOP a high priority because of the importance of this data globally.	SOOP	2015	Global QC system implemented
18	2.2.3(i) 3.3.6 3.3.10	Implementation/ASAP	Investigate potential co-operations with other Met Services to set up and operate ASAP stations on board merchant vessels in line service, and encourage joint ventures to implement new ASAP observing programmes (e.g. work effectively with countries adjacent to data-sparse ocean areas to find potential ASAP operators with routes through these areas). Increase number of ASAP profiles through consolidating the ASAP Programme and through enhanced cooperation with institutions operating Research Vessels, and with the navies.	ASAP	2012-2015	Number of ASAP profiles reported on GTS per year

19	5.6.1 5.2.4	Implementation/Collaborations	Develop cooperation with Argo, DBCP, and other partners in the view to assist them in their activities using ship resources Encourage the operators of other observing and satellite data collection systems to make full use of the SOT's experience and expertise in these areas	SOT	2012	Ship coordinator recruited
20	SOT-5/I-2.5.6-(v)	Implementation/Collaborations	Provide any ocean instrument deployment opportunities to the Technical Coordinators at JCOMMOPS using support@jcommops.org	SOT	Ongoing	Number of deployment opportunities available at JCOMMOPS
21	6.2.4 SOT-5/IV-2.4.3 SOT-6/13.3.5.2	Implementation/Collaborations	to consider contributing to the Trust Fund for consumables	SOOP	Ongoing	Funds available in TF
22	SOT-6/12.2.5	Implementation/Collaborations	Provide the VOS website webmaster (currently Graeme Ball) with links of national VOS or PMO web sites for their inclusion in the VOS website	VOS National Focal Points	Ongoing	
23	5.2.6 6.1.1	Implementation/Coordination	Contribute funding to the SOT Technical Coordinator's position, and to JCOMMOPS in order to assure enhancement and sustainability of those functions.	Members/Member states	Ongoing	Sustained SOT TC position
24	3.4.12	Implementation/Ferrybox	Continue and expand to shelf seas the monitoring of air-sea fluxes of carbon dioxide (CO_2) by FerryBoxes	IOCCP	Ongoing	
25	3.4.3(1)	Implementation/IOCCP	Start a systematic gathering of information on ship, and their routes within the carbon community, and coordinate these efforts with other observational networks	IOCCP	2012	Information available
26	3.4.5	Implementation/IOCCP	Follow guidelines from the OceanOBS'09 Community White Paper by Hood *et al*, Ship-based Repeat Hydrography: A strategy for sustained global program[1].	IOCCP	Ongoing	
27	3.4.19	Implementation/OceanScope	Build a future OceanScope program based on existing infrastructure and institutions, including the work of the SOT in order to eventually present a unified voice of all actors in ocean observations from commercial ships to the	OceanScope	2015	Program in place

1 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1661346-1-cwp2A09.pdf

			shipping industry.			
28	7.5	Implementation/Polar	While ship routes are now becoming open from time to time because of global warming, the SOT is committed to contribute to the Implementation phase of the GCW (2012-2019) by recruiting ships sailing in the polar regions	SOT	Ongoing	Number of ships reporting form polar regions
29	3.4.7	Implementation/SAMOS	Select a subset of the RVs participating in SAMOS to develop and test procedures for placing SAMOS data on the GTS	SAMOS	2012	Number of SAMOS ships reporting on GTS
30	3.4.9	Implementation/SAMOS	Follow guidelines from the following OceanOBS'09 Community White Papers: • Smith *et al*, The Data Management System for the Shipboard Automated Meteorological and Oceanographic System (SAMOS) Initiative[2]. • Smith *et al*, Automated Underway Oceanic and Atmospheric Measurements from Ships[3].	SAMOS	Ongoing	
31	3.0.4 5.3.3	Implementation/Ship recruitment	Developed ship recruitment strategies, which optimize the expenditure of available resources, and which allow accurate and credible prediction of future resource requirements, and their relation to declared objectives	SOT	2015	Ship recruitment strategy available
32	3.1.11(i) 5.3.2 SOT-5/III-4.2.4	Implementation/Ship recruitment	Encourage maritime Members, particularly those in the southern hemisphere, to recruit VOS that travel to data-sparse areas, such as vessels proceeding to the Antarctic, or making regular voyages across the central and south-eastern Pacific Ocean Investigate the option of establishing PMO offices in the Arctic region and discuss with maritime companies as appropriate	VOS	Ongoing	Number of ships reporting from the Southern Hemisphere Number of ships reporting from Arctic reigon
33	3.1.11(xi) SOT-5/III-3.1.8 SOT-6/9.1.1.7	Implementation/Ship recruitment	Encourage national award schemes to ships and or ships' officers as recognition for high standards in taking, recording and reporting observations. Consider performance rankings when issuing	SOT	Ongoing	Number of awards distributed to ships

2 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1710333-1-cwp4c12.pdf
3 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1661876-1-cwp4a11.pdf

			awards to their individual VOS fleets			
34	3.1.11(xviii)	Implementation/Ship recruitment	Encourage all research vessels to transmit meteorological observations in real-time	SOT	Ongoing	Number of RV reporting on GTS
35	3.1.11(xix)	Implementation/Ship recruitment	Organise an international meeting with active participation of the World Meteorological Organization (WMO), the International Maritime Organization (IMO), the International Chamber of Shipping (ICS) and the Intergovernmental Oceanographic Commission (IOC) of UNESCO to emphasise the importance of VOS observations	WMO Secr.	2015	High Level meeting organized
36	5.3.3	Implementation/Ship recruitment	Actively pursue additional strategies for the recruitment of ship, recognizing that the issue of funding and associated logistical effort will have to be tackled.	SOT	Ongoing	Ship recruitment strategy available
37	2.1.3(iv)	Implementation/SOOP	Sustain the Ship of Opportunity XBT/XCTD transoceanic network of about 40 sections.	SOOP	2012-2015	Data submitted to archive. Percentage coverage of the sections.
38	3.2.6	Implementation/SOOP	Follow guidelines from OceanOBS'09 Community White Paper by Goni *et al*, the Ship of Opportunity Programme[4].	SOOP	Ongoing	
39	2.1.7(i) 5.1	Implementation/SOT	Develop metrics of intensity of effort in maintenance of the observing networks - on the Port Meteorological Officers (PMO) network, on VOSClim class growth, or on SOOP line maintenance, recalling the need to keep the metrics simple to calculate.	SOT Chair	2013	Metrics available
40	2.1.7(iv)	Implementation/SOT	Encourage development at JCOMM level of metrics dealing with data quality and flow from VOS and from SOOP	VOSP & SOOPIP Chairs	2013	Metrics available
41	1.5	Implementation/Strategy	The SOT will regularly review its mission in the light of changing research, organizational and operational imperatives, and will update its Implementation Strategy and its terms of reference as appropriate. The SOT will continue to explore ways to expand its membership, in particular through enhanced links with countries operating ship observing fleets supporting WMO and IOC applications.	SOT	Ongoing	SOT Implementation Strategy up to date
42	2.1.4	Implementation/VOS	Develop and implement the VOS according to	VOS	2012-	Annex IV

4 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1674371-1-cwp1674371.pdf

	2.1.3(1) 2.2.3(ii) 3.1.11(viii) 5.3 SOT-6/7.7.3 SOT-6/7.1.1.4 SOT-6/ 7.2.1.3		the performance indicators proposed by SOT-VI Improve the number and quality of climate-relevant marine surface observations from the VOS [for both marine meteorological and oceanographic Essential Climate Variables]. Improve metadata acquisition and management for as many VOS as possible through VOSClim, together with improved measurement systems. Encourage more recruitment of VOSClim class vessels Follow example of the UK to upgrade ships to the VOSClim standard		2015	
43	3.1.11(iii)	Implementation/VOS	Encourage the automation of observations and reporting, and increase the number of AWS installed onboard ships to 500.	VOS	2012-2015	Number of AWS installed on VOS
44	3.1.12	Implementation/VOS	Follow guidelines from OceanOBS'09 Community White Paper by Kent *et al*, the Voluntary Observing Ship Scheme[5].	VOS	Ongoing	
45	SOT-6/9.1.1.9	Implementation/VOS	JCOMMOPS REAL vs. MASK Database needs to be kept up to date. VOS operators using REAL masking scheme to provide quarterly up to date information on REAL vs MASK to JCOMMOPS	VOS	Ongoing	
46	3.3.9	Implementation/ASAP	Collaborations between meteorological services are also encouraged to set up and operate ASAP stations on board merchant vessels in line service	ASAP	Ongoing	
47	3.3.10	Instrumentation/ASAP	Design more robust, automated and deck-based launching devices	ASAP	2015	New launching devices available
48	3.4.14	Instrumentation/Ferrybox	Consolidate FerryBox systems into operational Marine Core Services (MCS), and investigate how to find a mechanism for a sustainable funding of such "routine measurements" in order to guarantee the long-term operation.	Ferrybox	2015	
49	2.3.3(iii) SOT-6/10.2.1(3)	Instrumentation/Intercomparisons	Contribute to development of JCOMM guidelines for marine instrument intercomparisons	TT-IS	2015	JCOMM Guidelines for marine instrument intercomparisons available
50	2.3.3(v)	Instrumentation/Manufacturers	Participate in the HMEI	Manufacturers	Ongoing	Number of ship

5 https://abstracts.congrex.com/scripts/jmevent/abstracts/FCXNL-09A02a-1664333-1-cwp4a07_rev1.pdf

						observation instrument manufacturers participating in HMEI
51	2.1.3(iii)	Instrumentation/Plankton	Establish plan for, and implement, global Continuous Plankton Recorder (CPR) surveys [towed from commercial vessels]. Note: Sir Alistair Hardy Foundation for Ocean Science (SAHFOS) had prepared a proposal to expand the CPR network globally, which if successful would create a focal point for CPR observations.	SOOP	2013	Publication of internationally agreed plans; establishment of agreements/frameworks for coordination of sustained global Continuous Plankton Recorder surveys; implementation according to plan.
52	SOT-6/10.2.5	Instrumentation/Radiometers	Install infrared radiometers on-board ships and sustain such observations in the view to support Satellite calibration and validation strategies and provide observations which are independent of individual satellite instrument programmes to ensure the ability to link climate records across potential satellite data gaps	SOT	Ongoing	
53	2.3.3(i) 3.1.11(v)	Instrumentation/Practices	Review WMO and IOC Publications to make sure they reflect state of the art SOT practices Prepare comprehensive guidance on observing procedures to vessels of the VOS to help standardise observing practices among national observing fleets	TT-IS	2015	Number of publications updated
54	3.4.8	Instrumentation/Practices	Develop knowledge and skills guidelines for oceanographic instrumentation technicians (see supplemental material).	SAMOS	2015	skills guidelines for oceanographic instrumentation technicians available
55	4.4.4	Instrumentation/Practices	To identify ship-based related practices elements of the Manual on Codes, identify appropriate publication(s) to which the identified observation practices should be relocated, and make recommendations to the CBS OPAG-IOS as appropriate for inclusion in observing standards documentation	TT-IS	2012	Practices included in appropriate documentation
56	4.4.6 4.4.7 4.4.8 SOT-	Instrumentation/Practices	Follow the recommendations from the ETMC *ad hoc* group on data preservability regarding Observing practices and the shipboard recording of observations	SOT	2015	Recommendations followed and data preserved

	6/9.2.4.4(3) SOT-6/9.3.4 & 9.3.8					
57	3.4.4	Instrumentation/Salinity	Establish a collaboration of the SOT with the IOCCP to permit real-time distribution of SST and SSS data on the GTS (e.g. things would be facilitated if SOT members could support the cost of transmitting these data from ship to shore, and assist for their automatic quality control, encoding in appropriate GTS formats, and effective GTS distribution in real-time)	SOT, IOCCP	2015	Number of IOCCP ships reporting SST/SSS data on GTS
58	2.1.3(ii) 4.11.3	Instrumentation/Salinity	Increase the number of vessels reporting sea-surface salinity to complement similar observations provided by Argo profiling floats, surface drifting buoys, tropical moorings, reference moorings. Very few ships currently possess this capability, and it will become an area for further research and development. In situ salinity measurements will be of great value in developing the sensors and algorithms for salinity determination by satellite. Enlarge GOSUD partnership (objective for 2012-2013 is to recruit research vessels that could transmit SSS data either in near real time or after the ship reached the port. This could be either non quality controlled data or processed in delayed mode data; SOT members are invited to support the project by distributing information on GOSUD in their country; Potential contributors can be identified either by providing data to the project or by providing scientific or data management expertise that could enhance the quality of the GOSUD dataset and /or enlarge the network.)	VOS, SOOP, GOSUD	2013	Number of SSS observations available at International Data Centres.
59	2.1.6 3.1.11(ii)	Instrumentation/SST	Establish a Pilot Project for providing high resolution SST data from ships Encourage the use of hull-attached temperature sensors for the measurement of sea-surface temperature	SOT	2013	Number of ships reporting HRSST
60	2.3.3(iv)	Instrumentation/Traceability	Use the facilities offered at the WMO-IOC	SOT	Ongoing	

	SOT-6/10.2.1(4) SOT-6/10.2.3		Regional Marine Instrument Centres (RMIC) in the view to ensure better traceability of ship observations to international standards Participate at the RMIC workshops once organized			
61	2.2.3(iv)	Instrumentation/Waves	Increase wave measurements from ships (mainly visual observations), particularly from open ocean areas, in the Southern Ocean, and the tropics	TT-IS	2013	Number of wave observations from ships in the Southern Ocean and the Tropics
62	3.1.11(ix)	Instrumentation/Wind	Derive an acceptable standard scale of Beaufort wind speed equivalents	VOS	2015	Standard scale of Beaufort wind speed available
63	4.3.3	Metadata/ASAP	Develop an instrument/platform metadata collection scheme for ASAP	ASAP	2015	ASAP metadata collection scheme in place
64	2.3.3(vi) SOT-6/10.2.1(6)	Metadata/Discovery	Make sure that discovery metadata about ship-based observational data-sets, including in particular those collected through the associated programmes (IOCCP, GO-SHIP, FerryBox, OceanScope, etc.), are properly compiled and made available through the ODP and the WIS using the required ISO-19115 profiles	SOT	2015	Ship observation datasets interoperable with ODP and/or WIS
65	3.1.11(iv) 4.3	Metadata/Instrumentation	Investigate with real-time monitoring centres the value of including the height or depth of observed parameters	SOT	2013	
66	3.1.11(xiv) 3.1.11(xv) 4.3 5.1.1 SOT-5/III-2.5.1.3 SOT-6/6.4.6(7)	Metadata/Instrumentation	Encourage Members to submit each quarter, but preferable monthly all metadata that are required in WMO Publication No. 47 WMO to maintain an up-to-date listing of all VOS ships, name, call sign, country of recruitment etc. so that a PMO may know the status of a ship before visiting it. Members to use the VOS Pub-47 metadata generation tools within their own NMS as appropriate.	VOS, WMO Secr.	Ongoing	WMO Publication 47 up to date
67	4.10.5 SOT-6/12.1.4	Metadata/SOOP	The SOT urges the SOOP operators to regularly provide the SOT Technical Coordinator at JCOMMOPS as soon as possible with the required SOOP metadata permitting the compilation of the SOOP survey	SOOP	Ongoing	
68	SOT-6/10.2.1(2)	Metadata/Instrumentation	Make sure that instrument/platform metadata related to ship-based observations are properly	SOT members	Ongoing	

			collected and made available through the appropriate channels, taking particular attention to SST and SSS data			
69	4.2.2	Metadata/Satcom	to use the list of approved "prST"[50] communication types when submitting their national VOS lists to WMO Publication No. 47	VOS operators	Ongoing	
70	3.1.11(vi) 3.1.11(vii) 3.1.11(xii)	Monitoring	Monitor observations in real-time and drawing to the attention of the appropriate Members any deficiencies in accuracy. Extend real-time monitoring systems to cover all variables required for surface flux calculations. Keep under review the flow of meteorological data from ships to ensure the most efficient method of providing world-wide climatological data to users	RSMC, RTMC, JCOMMOPS	Ongoing	
71	4.7.7 SOT-6/7.1.1.5	Monitoring/VOS	VOS Operators are encouraged to become familiar with the UK Metoffice and E-SURFMAR quality monitoring tools, and use them as appropriate. In particular, noting that the E-SURFMAR tools can reference a particular ships, VOS operators should check the metadata of their VOS ships within the E-SURFMAR database and make changes directly if necessary, or submit corrected Pub47 metadata to WMO.	VOS Operators	Ongoing	
72	4.7.2 SOT-6/7.2.1.6 SOT-6/9.1.1.12	Monitoring/VOS	National VOS Programme Managers should ensure that the monthly monitoring statistics and the VOSClim suspect list are provided to PMOs for immediate action as necessary	VOS Operators	Ongoing	
73	3.3.10	Monitoring/ASAP	Continuously analyse, evaluate and implement more cost-effective means to communicate ASAP data	ASAP	Ongoing	
74	4.9.2(i)	Monitoring/ASAP	ASAP ship operators should be very careful about setting their software to prevent incorrect positioning of the launching point.	ASAP	Ongoing	Percentage of successful launches
75	2.1.7(v)	Monitoring/VOS	Identify tracking of poorly-covered VOS areas to target ship recruitment for global coverage - through reinforcement of new efforts at	JCOMMOPS	2012-2015	Number of ship obs. In Southern Hemisphere

			JCOMMOPS.			
76	5.7.1	Outreach	Continue to offer every possible support to other groups	SOT	Ongoing	Number of programmes associated to SOT
77	2.3.3(vii) SOT-6/10.2.1(7)	Quality Management	Comply with the WMO Quality Management Framework (QMF) and quality management principles	SOT	Ongoing	
78	2.1.7(iii)	Requirements	Encourage the Southern Ocean Observing System (SOOS) and OOPC to develop an observing strategy for the seasonal ice and under-ice zones;	SOT Chair	2013	Strategy on seasonal ice and under-ice zones available
79	2.1.5	Requirements/SOOP	investigate how to reconcile ocean heat content, sea level, and energy identified imbalances, with focus on the error budget and sampling requirements (attempt to involve both the scientific community and funders of the ocean observing system, in a pilot activity to better engage funders)	XBT Science Team	2012-2015	Metrics to be proposed
80	2.1.7(ii)	Requirements/SOOP	Develop XBT-based indices of currents and subsurface ocean state, and think about how they link to climate impacts on land, as a way of boosting interest in the climate community in XBT data.	XBT Science Team	2013	Number of indices
81	2.3.3(viii)	Satcomm	Participate in the international forum of users of satellite data telecommunication systems for environmental use once established	Satellite data telecom operators	Ongoing	
82	3.1.11(xvi) 3.1.11(xvii) 5.1	Satcomm	Encourage PMOs to collect INMARSAT C numbers at recruitment in the event that contact with the ships is necessary to check an observation, advise on correct coding procedures or request additional observations in storm or Tropical Cyclone conditions WMO to maintain an up-to-date list of INMARSAT Land Earth Stations (LES) that accept observations free of charge to the ship, as well as the special access codes required to lodge ship's weather reports with LES	VOS	Ongoing	SAC41 list of codes up to date
83	3.3.10	Satcomm	Improve efficiency in communicating data	SOT	Ongoing	
84	4.2.1	Satcomm	Use increasingly high data rate satellite data telecommunication on-board ships (e.g. Iridium)	SOT	Ongoing	
85	3.1.11(xiii)	Technology	Keep Members informed of advances in technology in the taking and transmission of	SOT	Ongoing	Number of relevant publications/documents

			ships' observations by means of technical notes and similar publications			
86	5.5.1	Technology development	Foster the creation of Task Teams and Pilot Projects as an efficient way of meeting the SOT objectives within resource constraints.	SOT	Ongoing	Number of Task Teams and Pilot Projects

ANNEX XII

PUBLICATIONS AND REFERENCES

No.	Title	Web
WMO No. 558	Manual on Marine Meteorological Services	
WMO No. 471	Guide to Marine Meteorological Services (Chapter 6 describing the VOS Scheme is available on the	√
WMO No. 8	Guide to Meteorological Instruments and Methods of Observation	√
WMO No. 544	Manual on the Global Observing System	√
WMO No. 488	Guide to the Global Observing System	√
IOC Manuals and Guide No. 22, 2010 edition	GTSPP Real-Time Quality Control Manual	√
JCOMM TR No. 4, rev. 2	VOS Framework document	√
	Users guide for thermosalinograph installation and maintenance aboard a ship	√
	XBT Best Practices Guide	√
	XBT fall rate report	

SOT Annual Reports

JCOMM TR No.	Title	Web
54	Ship Observations Team (SOT) - Annual report for 2010	√
51	Ship Observations Team (SOT) annual report for 2009	√
46	Ship Observations Team (SOT) annual report for 2008	√
41	Ship Observations Team, Annual report for 2007	√
36	Ship Observations Team, Annual report for 2006	√
32	Ship Observations Team, Annual report for 2005	√
26	Automated Shipboard Aerological Programme (ASAP) - Annual Report for 2003	(.doc) (.pdf), p. 4, 5, 6
19	Automated Shipboard Aerological Programme (ASAP) - Annual Report for 2002	(.doc) (.pdf), p. 4, 5, 6
15	Automated Shipboard Aerological Programme (ASAP) - Annual Report for 2001	(.doc) (.pdf), pp. 4, 5, 6
12	Automated Shipboard Aerological Programme (ASAP) – Annual Report for 2000	(.doc) (.pdf) Pages 2 (.xls), 4 (.pdf), 23 (.gif), 24 (.gif), 25 (.gif), 26 (.gif), 27 (.gif), 28 (.gif), 29 (.gif), 30 (.gif), 31 (.gif), 32 (.gif)
6	Automated Shipboard Aerological Programme (ASAP) – Annual Report for 1999	(.doc) (.pdf), Pages 3 (.xls) (.pdf), 4 (.tif) (.pdf), 30 (.pdf), 31 (.pdf), 32 (.pdf), 33 (.pdf), 34 (.pdf), 35 (.pdf), 36 (.pdf), 37 (.pdf), 38 (.pdf)

Websites

Website	Acronym	URL
Ship Observations Team	SOT	http://sot.jcommops.org
Voluntary Observing Ship Scheme	VOS	http://www.bom.gov.au/jcomm/vos/
Ship of Opportunity Programme	SOOP	http://www.jcommops.org/soopip/
Automated Shipboard Aerological Programme	ASAP	http://www.jcommops.org/sot/asap/
Joint WMO-IOC Technical Commission for Oceanography and	JCOMM	http://www.jcomm.info

Marine Meteorology		
JCOMM in situ Observations Programme Support Centre	JCOMMOPS	http://www.jcommops.org
Global Ocean Observing System	GOOS	http://www.ioc-goos.org/
Global Climate Observing System	GCOS	http://gcos.wmo.int/
WMO Integrated Global Observing System	WIGOS	http://www.wmo.int/wigos
Global Framework for Climate Services	GFCS	http://www.wmo.int/pages/gfcs/gfcs_en.html
WMO Rolling Review of Requirements	RRR	http://www.wmo.int/egos

References

1. Smith, N (ed), 2000. OceanObs 99 Conference Statement, 28 pp. WMO, Geneva.
2. The Second Report of the Adequacy of the Global Observing Systems for Climate in Support of the UNFCCC, 2003. GCOS-82, WMO/TD No 1143, WMO, Geneva- http://www.wmo.int/pages/prog/gcos/Publications/gcos-82_2AR.pdf
3. GCOS-92, October 2004, Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC - http://www.wmo.int/pages/prog/gcos/Publications/gcos-92_GIP.pdf
4. JCOMM Observing System Implementation Goals for Building a Sustained Global Ocean Observing System in Support of the Global Earth Observation System of Systems (JCOMM-III, November 2009)
5. GCOS-138, August 2010, The 2010 Update of the Implementation Plan for the Global Observing System for Climate in Support of the UNFCCC - http://www.wmo.int/pages/prog/gcos/Publications/gcos-138.pdf
6. OceanObs'09 Papers are available from http://www.oceanobs09.net/

LIST OF ACRONYMS

ACRE	Atmospheric Circulation Reconstructions over the Earth
ADCP	Acoustic Doppler Current Profilers
AIS	Automatic Identification System
AMDAR	Aircraft Meteorological Data Relay
AOML	NOAA Atlantic Oceanographic and Meteorological Laboratory (USA)
AOPC	Atmospheric Observation Panel for Climate
AP	Air Pressure
Argo	International profiling float programme (not an acronym)
asap	As soon as possible
ASAP	Automated Shipboard Aerological Programme
ASCII	American Standard Code for Information Interchange
AST	Argo Steering Team
ATLAS	Autonomous Temperature Line Acquisition System
AWS	Automatic Weather Station
BATHY	FM 63–XI Ext. BATHY report of bathythermal observation
BOM	Bureau of Meteorology (Australia)
BUFR	FM 94 BUFR GTS format: Binary Universal Form for Representation of meteorological data
BUOY	FM 18 BUOY GTS format: Report of a buoy observation
CB	Capacity-Building
CBS	Commission for Basic Systems (WMO)
CCHDO	CLIVAR and Carbon Hydrographic Data Office
CCl	Commission for Climatology (CCl)
CDI	SeaDataNET Common Data Index
CDMP	Climate Database Modernization Programme (USA)
Cg	Congress (WMO)
CIMO	Commission on Instruments and Methods of Observation (WMO)
CLIVAR	Climate Variability and Predictability (WCRP)
CM	Contributing Member (of MCSS)
CMM	Commission for Marine Meteorology (now replaced by JCOMM)
CO_2	Carbon dioxide
CPR	Continuous Plankton Recorder
CSIRO	Commonwealth Scientific and Industrial Research Organisation
CSV	Comma Separated Values format
CTD	Conductivity, Temperature, and Depth observing systems
DAC	Data Assembly Centre
DAR	Data Access and Retrieval
DB	Data Buoy
DBCP	Data Buoy Co-operation Panel (WMO-IOC)
DCP	Data Collection Platform
DCPC	Data Collection or Production Centre (of WIS infrastructure)
DCS	Data Collection System
DMCG	JCOMM Data Management Coordination Group
DMPA	JCOMM Data Management Programme Area
DOI	Digital Object Identifier
E2E	End-to-End Data Management
E-ASAP	EUMETNET ASAP Programme
EC	Executive Council
ECMWF	European Centre for Medium-Range Weather Forecasts
EEZ	Exclusive Economic Zone
ENCODE (masking)	Ship identification masking scheme whereby the actual call sign plus the date/time groups are encoded (encrypted) within the VOS reports issued by the ships (date/time is included in the encrypted part to make that group vary from one report to the next); the date/time group is also being provided separately without encryption to permit use of the observations by users outside of the WMO community. Traditional open-source encryption methods use a public key for encoding and a private key for decoding. Private key is known by all WMO Members but is not made available outside of the meteorological community.
EOV	Essential Ocean Variable
ER	Expected Result
ERDDAP	NOAA’s Environmental Research Division's Data Access Program

ESRL	NOAA Earth System Research Laboratory (USA)
E-SURFMAR	Surface Marine programme of the Network of European Meteorological Services, EUMETNET
ET-EGOS	CBS Expert Team on the Evolution of the Global Observing System
ETMC	Expert Team on Marine Climatology (JCOMM)
ETWS	Expert Team on Wind Waves and Storm Surge (JCOMM)
EU	European Union
EUCOS	EUMETNET Composite Observing System
EUMETNET	Network of European Meteorological Services
EUMETSAT	European Organization for the Exploitation of Meteorological Satellites
EuroSITES	European integrated network of open ocean multidisciplinary observatories
FAO	Food and Agriculture Organization
FG	First Guess Field
FRX	Frequently Repeated XBT line
FSU	Florida State University (USA)
FTP	File Transfer Protocol
GAW	Global Atmosphere Watch
GCC	Global Collecting Centre (of MCSS)
GCOS	Global Climate Observing System
GCOS-IP	Implementation Plan for the Global Observing System for Climate in Support of the United Nations Framework Convention on Climate Change
GCW	Global Cryosphere Watch
GDAC	Global Data Assembly / Acquisition Centre
GDP	Global Drifter Programme
GEO	Group on Earth Observations
GEOSS	Global Earth Observation System of Systems
GFCS	Global Framework for Climate Services
GHRSST	Group for High Resolution SST
GISC	Global Information System Centres (of WIS infrastructure)
GLOSS	Global Sea-level Observing System (JCOMM)
GMDSS	Global Maritime Distress and Safety System
GNWP	Global NWP
GODAE	Global Ocean Data Assimilation Experiment (GOOS)
GOOS	Global Ocean Observing System (IOC, WMO, UNEP, ICSU)
GOS	Global Observing System (WMO)
GO-SHIP	
GOSUD	Global Ocean Surface Underway Data Pilot Project
GPS	Global Positioning System
GSM	Global System for Mobile Communications
GTS	Global Telecommunication System (of WWW of WMO)
GTSPP	Global Temperature and Salinity Profile Programme
HDX	High Density XBT line
HMEI	Association of Hydro-Meteorological Equipment Industry
HRPT	High Resolution Picture Transmissions
HRNWP	High Resolution NWP
HRSST	DBCP/GHRSST High Resolution SST Pilot Project
HTTP	HyperText Transfer Protocol
IAPSO	International Association for the Physical Sciences of the Oceans
ICOADS	International Comprehensive Ocean-Atmosphere Data Set (USA)
ICS	International Chamber of Shipping
ICSU	International Council for Science
ICT-IOS	Implementation / Coordination Team on the Integrated Observing System (CBS)
ID	Identification Number
IGDDS	Integrated Global Data Dissemination Service (satellite)
IHO	International Hydrographic Organization
IMEI	International Mobile Equipment Identity
IMMT	International Maritime Meteorological Tape
IMO	International Maritime Organization
IMOP	WMO Programme for Instruments and Methods of Observation
INSPIRE	Infrastructure for Spatial Information in Europe
IOC	Intergovernmental Oceanographic Commission of UNESCO
IOCCP	International Ocean Carbon Coordination Project of IOC
IODE	International Oceanographic Data and Information Exchange (IOC)

IOS	Integrated Observing Systems
IP	Implementation Plan
IPET-DRC	CBS Inter Programme Expert Team on Data Representation and Codes
IPY	International Polar Year (2007-2008)
ISO	International Organization for Standardization
IT	Information Technology
JCOMM	Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology
JCOMM-III	Third Session of JCOMM, Marrakech, Morocco, 4-12 November 2009
JCOMMOPS	JCOMM *in situ* Observations Programme Support Centre
KML	Keyhole Markup Language
LDCs	Least Developed Countries
LDP	ODP light Data Provider
LDX	Low Density XBT line
LES	Land Earth Station
M&G	Manual and Guides
MAN	JCOMM Management Committee
MASK (masking)	Ship identification masking scheme whereby the ship's call sign is masked using a unique identification number in place of the real ship's call sign in FM-13-XI Ext. SHIP reports that are distributed on the GTS. This unique identification number is allocated nationally or regionally. Allocation of unique numbers is coordinated regionally in case a group of countries from a region agrees to use the same scheme. The name of the NMHS recruiting country (i.e. not the country of the ship's registration) can be part of the masked call sign. To avoid confusion with ODAS and buoy numbers, the unique Identification Numbers should start with an alphabetic letter.
MCP	Marine Community Profile
MCDS	Marine Climate Data System
MCS	Marine Core Services
MCS	Marine Climatological Summary
MCSS	Marine Climatological Summaries Scheme (WMO)
META-T	Water Temperature instrument/platform Metadata Pilot Project (JCOMM)
MOFS	Met-Ocean Forecasts and Services
MOU	Memorandum of Understanding
MQCS	Minimum Quality Control Standards
MSC	Meteorological Services of Canada
NAVOCEANO	Naval Oceanographic Office (USA)
NC	National Centre (of WIS infrastructure)
NCDC	NOAA National Climatic Data Center (USA)
NCEP	NOAA National Center for Environmental Prediction (USA)
NCOSM	SOA National Centre of Ocean Standards and Metrology (China)
NDBC	National Data Buoy Centre (of NOAA, USA)
NESDIS	NOAA National Environmental Satellite Data and Information Service (USA)
NetCDF	Network Common Data Form
NFP	National Focal Point
NMC	National Meteorological Centre
NMDIS	SOA National Marine Data and Information Service (China)
NMHS	National Meteorological and Hydrological Service
NOAA	National Oceanic and Atmospheric Administration (USA)
NODC	IODE National Oceanographic Data Centre
NVSRF	Nowcasting and Very Short Range Forecasting
NWP	Numerical Weather Prediction
NWS	NOAA National Weather Service (USA)
OceanSITES	OCEAN Sustained Interdisciplinary Timeseries Environment observation System
OCG	Observations Coordination Group (JCOMM)
OCO	NOAA Office of Climate Observation (USA)
ODP	Ocean Data Portal (IODE)
ODS	Ocean Data Standards process
OGC	Open Geospatial Consortium
OOPC	Ocean Observations Panel for Climate (GCOS-GOOS-WCRP)
OPA	Observations Programme Area (JCOMM)
OPA-IG	OPA Implementation Goals
OPAG	Open Programme Area Group
OPAG-IOS	CBS OPAG on the Integrated Global Observing System
OSE	Observing System Experiment

OSMC	NOAA Observing System Monitoring Center (USA)
OT	OceanTeacher
OTN	Ocean Tracking Network
PA	Programme Area (of JCOMM)
PANGEA	Partnerships for New GEOSS Applications (JCOMM)
pCO_2	Partial pressure of CO_2
PMO	Port Meteorological Officer
PMT	Platform Messaging Transceivers
PO	Project Office
POGO	Partnership for Observation of the Global Oceans
QA	Quality Assurance
QC	Quality Control
QM	Quality Management
QMF	WMO Quality Management Framework
QMS	Quality Management System
RA	WMO Regional Association
REAL (masking)	Ship identification masking scheme whereby the actual (real) ship's call sign is used in FM-13-XI Ext. SHIP reports that are distributed on the GTS.
RECLAIM	RECovery of Logbooks And International Marine data
RM	Responsible Member (of MCSS)
RMIC	WMO-IOC Regional Marine Instrument Centre
RMS	Root Mean Square
RRR	Rolling Review of Requirements (WMO)
RSMC	Regional Specialized Monitoring Centre
RTMC	VOSClim Real-Time Monitoring Centre
RV	Research Vessel
SAMOS	Shipboard Automated Meteorological and Oceanographic System
SC	Steering Committee
SCAR	Scientific Committee on Antarctic Research
SCG	Services Coordination Group (JCOMM)
SCOR	Scientific Committee on Oceanic Research
SDN	SeaDataNet
SeaDataNet	Pan-European infrastructure for Ocean and Marine Data Management
SFSPA	JCOMM Services and Forecasting Systems Programme Area
SHIP (masking)	Ship identification masking scheme whereby a generic call sign using the four letters "SHIP" is used in place of the ship's call sign in FM-13-XI Ext. SHIP reports that are distributed on the GTS.
SHIP (report)	FM-13 Ext. SHIP report of surface observation from a sea station
SIAF	Seasonal to Inter-annual Forecast
SIO	Scripps Institution of Oceanography (University of California, USA)
SLP	Sea Level Pressure
SOA	State Oceanic Administration (China)
SoG	Statements of Guidance
SOOP	Ship-Of-Opportunity Programme (JCOMM)
SOOPIP	SOOP Implementation Panel (JCOMM)
SOOS	Southern Ocean Observing System
SOT	Ship Observations Team (JCOMM)
SSS	Sea Surface Salinity
SST	Sea-Surface Temperature
TAC	Thematic Assemble Centre (TAC)
TAO	Tropical Atmosphere Ocean network of tropical moorings
TC	Technical Coordinator
TD	Technical Document
TDCF	Table Driven Code Form
TEMP SHIP	FM 36-XI Ext. TEMP SHIP report of upper-level pressure, temperature, humidity and wind report from a sea station
TOGA	Tropical Atmosphere and Global Ocean programme
ToR	Terms of Reference
TR	Technical Report
TSG	Thermosalinograph
TT	Task Team
TT-TDC	Task Team on Table Driven Codes (JCOMM/DMPA)
UN	United Nations

UNEP	United Nations Environment Programme
UNESCO	United National Educational, Scientific and Cultural Organization
UNFCCC	United Nations Framework Convention on Climate Change
UOT	Upper Ocean Thermal review
URL	Uniform Resource Locator
USA	United States of America
USD	United States Dollar
VCP	Voluntary Cooperation Programme
VOS	Voluntary Observing Ship (WMO)
VOSClim	VOS Climate Project
VOS-DP	VOS Donation Programme
VOSP	VOS Panel
VOS-TAG	E-SURFMAR VOS Technical Advisory Group
W3C	World Wide Web Consortium
WCC-3	World Climate Conference 3
WCRP	World Climate Research Programme
WDC	ICSU World Data Centre (ICSU system of WDCs is now replaced by the ICSU World Data System)
WIGOS	WMO Integrated Global Observing System
WIP	WIGOS Implementation Plan
WIS	WMO Information System
WMO	World Meteorological Organization (UN)
WOA	World Ocean Atlas
WOCE	World Ocean Circulation Experiment
WOD	World Ocean Database (USA)
WWW	World Weather Watch (WMO)
XBT	Expendable BathyThermograph
XCTD	Expendable Conductivity/Temperature/Depth
XML	Extensible Markup Language