THE VOLUNTARY OBSERVING SHIPS SCHEME

A FRAMEWORK DOCUMENT

WMO/TD-NO. 1009

JCOMM TECHNICAL REPORT NO. 4 - 2010

REVISION 2

WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)

THE VOLUNTARY OBSERVING SHIPS SCHEME

A FRAMEWORK DOCUMENT

WMO/TD-NO. 1009

JCOMM TECHNICAL REPORT NO. 4 - 2010

REVISION 2

NOTES

WMO DISCLAIMER

Regulation 42

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

Regulation 43

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

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

Tel.: +41 (0) 22 730 84 03
Fax: +41 (0) 22 730 80 40
E-mail: Publications@wmo.int

IOC (OF UNESCO) DISCLAIMER

The designations employed and the presentation of material in this publication do not imply the expression of any opinion whatsoever on the part of the Secretariats of UNESCO and IOC concerning the legal status of any country or territory, or its authorities, or concerning the delimitation of the frontiers of any country or territory.

_____

C O N T E N T S

FOREWORD

Ships of the World Meteorological Organization (WMO) Voluntary Observing Ship (VOS) scheme have always been an important component of the global observing system of the WMO, providing meteorological and oceanographic data essential to operational meteorology, maritime safety services, and a range of marine climatological applications. More recently, it has become clear that their observations can also be of critical importance to global climate studies.

In view of this importance, and at the same time of the ongoing and increasing difficulties in VOS recruitment and maintenance, the WMO Commission for Marine Meteorology (CMM, now the Joint WMO-IOC Technical Commission for Oceanography and Marine Meteorology - JCOMM) Subgroup on the VOS recognized the value of adopting a guiding strategy or framework document for the VOS. This document would provide VOS operators with a global framework in which to develop and maintain their national VOS programmes, and at the same time help to sensitize user groups and organizations to the VOS scheme in general, its structure, operations and value. A first draft of this framework document was prepared by Mr Don Linforth (Australia), and reviewed by the first session of the subgroup (Athens, March 1999). The document was revised, on the basis of comments received from participants, by Capt. Gordon Mackie (U.K.), and reviewed a final time by subgroup members.

The document was again revised in early 2008 by Mr G. Ball (Australia), Chair of the JCOMM Ship Observations Team (SOT), and Ms J. Fletcher (New Zealand), the Chair of the Voluntary Observing Ship Panel (VOSP), a sub-group of the SOT, and is now published herewith as a report in the JCOMM Technical Report series. Another revision was made in 2010 to reflect the SOT proposal, approved by JCOMM-III (November 2009) to integrate the VOSClim as part of the wider VOS Scheme through the use of a new VOSClim class. As noted above, it is hoped that this document will prove of interest and value to VOS operators and data users alike. The appreciation of WMO is extended to Mr Linforth, Capt. Mackie, Mr Ball and Ms Fletcher for their valuable contributions to its preparation.

THE VOLUNTARY OBSERVING SHIPS SCHEME

A FRAMEWORK DOCUMENT

1. INTRODUCTION

In 1853 a conference was held in Brussels to discuss the establishment of a uniform system for the collection of meteorological and oceanographic data from the oceans and the use of these data for the benefit of shipping in return. The aim was to ascertain the climatology of the oceans, or at least of the trade routes, to reduce the hazards and increase the efficiency of marine navigation.

With the advent of radio communications early in the twentieth century it became possible for observations from ships to be transmitted to meteorological offices ashore and warnings of dangerous conditions to be transmitted to ships. The International Convention for the Safety of Life at Sea specified that "the Contracting Governments undertake to encourage the collection of meteorological data by ships at sea, and to arrange for their examination, dissemination and exchange in the manner most suitable for the purpose of aiding navigation".

Meteorological services of most maritime countries made arrangements with ships regularly visiting their shores to take marine meteorological observations and transmit them to shore at no cost to the ship. The observations themselves are provided free of charge by shipping companies in return for the instrumentation and the forecasting and warning services. Hence, the name of the scheme – Voluntary Observing Ship (VOS) – which is coordinated by the VOS Panel, a sub-group of the JCOMM Ship Observations Team.

2. RATIONALE

Meteorological data are required from the seas and oceans for a number of purposes:

- they are required very quickly for the preparation of forecasts and warnings, and for the global computer models of the future state of the atmosphere;
- they are required in a delayed mode for the preparation of weekly and monthly analyses for monitoring the state of the oceans;
- they are required for climatological data banks for many purposes, e.g. design of ships and structures at sea and determination of economic shipping routes;
- they are required on a long-term basis for monitoring changes in the climate of the earth.

The data required pertain to the atmosphere above the sea (temperature, dew point, cloud, weather, visibility and pressure) and the surface of the sea (temperature, waves, currents and ice).

The requirements for forecasts and warnings are specified by the World Weather Watch of WMO, which is managed by the Commission for Basic Systems (CBS), which is also responsible for systems for management of the data (distribution on the Global Telecommunication System – GTS - and processing by the Global Data-Processing and Forecasting System - GDPFS).

The requirements for monitoring change in climate have been specified by the Ocean Observations Panel for Climate (of GOOS/GCOS/WCRP), within the context of the Climate Module of the WMO-IOC-UNEP-ICSU Global Ocean Observing System (GOOS). GOOS is also the Ocean Module of the WMO-IOC-UNEP-ICSU Global Climate Observing System (GCOS).

The desirable observational network for climate monitoring purposes was specified in the Final Report of the Ocean Observing Systems Development Panel (OOSDP) in 1995, and revised in the Action Plan for Global Ocean Observations for the GOOS/GCOS in 1998. This and the observational requirements for the Global Climate Observing System atmospheric (AOPC) and ocean (OOPC) components on one hand, and for Global Numerical Weather Prediction on the other hand are listed in Tables 1 and 2 respectively. In those Tables, each requirement is expressed in terms of horizontal resolution, vertical resolution, observing cycle, delay of availability and accuracy with each parameter described in terms of goal, breakthrough (B/T) and threshold (T/H)[1]. The spatial and temporal resolution of observations required for climate is coarser than for weather forecasting.

The oceans cover about two-thirds of the surface of the earth, and for decades ships were the only means of obtaining meteorological data from them. Although there are now several other means – satellites, drifting buoys and floats, radar – ships still play a very important part. They provide ground truth for the calibration of satellite observations and make measurements not yet obtainable by other means, such as air temperature and dew point.

[1] The “threshold” is the absolute minimum requirement, i.e. the requirement level below which data have no significant impact on the application; the “goal” is the ideal requirement above which data do not bring any additional value to the application; the “breakthrough” level is an intermediate value between “threshold” and “goal“ which, if achieved, would result in a significant improvement for the targeted application. The breakthrough level is expected to be more appropriate than the “goal” from a cost-benefit point of view.

TABLE 1: OBSERVATIONAL REQUIREMENTS (GCOS)[2]

Global Climate Observing Systems (GCOS) atmospheric (AOPC) and ocean (OOPC) requirements

"Requirement from GCOS"	Horizontal Resolution			Observing Cycle			Delay of availability			Accuracy		
Parameter name	Goal	Break-through	Threshold	Goal	Break-through	Threshold	Goal	Break-through	Threshold	Goal	Break-through	Threshold
Air pressure over land surface	200 km	300 km	500 km	3 h	6 h	24 h	3 h	6 h	12 h	0.5 hPa	0.65 hPa	1 hPa
Air pressure over sea surface	200 km	300 km	500 km	3 h	6 h	24 h	3 h	6 h	12 h	0.5 hPa	0.65 hPa	1 hPa
Air specific humidity (at surface)	25 km	50 km	100 km	3 h	4 h	6 h	24 h	48 h	72 h	1 %	1.3 %	2 %
Air temperature (at surface)	25 km	50 km	100 km	3 h	6 h	12 h	24 h	36 h	48 h	0.1 K	0.15 K	0.3 K
Ocean salinity - Deep-ocean	50 km	60 km	100 km	30 d	70 d	360 d	60 d	110 d	360 d	0.002 psu	0.003 psu	0.005 psu
Ocean salinity - Upper-ocean	15 km	40 km	300 km	1 d	2 d	10 d	0.5 h	0.6 h	1 h	0.001 psu	0.002 psu	0.01 psu
Ocean surface salinity	100 km	170 km	500 km	7 d	11 d	30 d	10 d	15 d	30 d	0.05 psu	0.09 psu	0.3 psu
Ocean temperature - Deep-ocean	50 km	60 km	100 km	30 d	150 d	3600 d	60 d	110 d	360 d	0.002 K	0.003 K	0.005 K
Ocean temperature - Upper-ocean	1 km	6 km	300 km	1 d	2 d	10 d	0.5 h	0.6 h	1 h	0.001 K	0.002 K	0.01 K
Precipitation index (daily cumulative)	100 km	200 km	500 km	12 h	16 h	24 h	24 h	72 h	288 h	1 mm/d	1.3 mm/d	2 mm/d
Precipitation rate (liquid) at the surface	100 km	200 km	500 km	3 h	4 h	6 h	3 h	6 h	12 h	0.1 mm/h	0.3 mm/h	2 mm/h
Precipitation rate (solid) at the surface	100 km	200 km	500 km	3 h	4 h	6 h	3 h	6 h	12 h	0.1 mm/h	0.3 mm/h	2 mm/h
Sea surface temperature	1 km	8 km	500 km	1 h	3 h	24 h	3 h	5 h	12 h	0.1 K	0.126 K	0.2 K
Sea-ice cover	12 km	25 km	100 km	1 d	2 d	7 d	0.125 d	0.25 d	1 d	5% (Max)	6% (Max)	10% (Max)
Sea-ice thickness	100 km	170 km	500 km	1 d	2 d	7 d	1 d	3 d	24 d	0.1 cm	0.2 cm	1 cm
Significant wave height	25 km	50 km	250 km	3 h	4 h	6 h	3 h	6 h	12 h	0.1 m	0.3 m	2 m
Wind speed over sea surface (horizontal)	10 km	40 km	500 km	1 h	3 h	24 h	1 h	2 h	12 h	0.5 m/s	0.6 m/s	1 m/s
Wind vector over sea surface (horizontal)	10 km	20 km	500 km	1 h	3 h	24 h	3 h	5 h	12 h	0.5 m/s	1 m/s	5 m/s

2 : This table is only a sub-set of variables and fields available in the formal version of the database available from the WMO web site at http://www.wmo.int/pages/prog/sat/Databases.html

TABLE 2: OBSERVATIONAL REQUIREMENTS (Global NWP)[2]

Global Numerical Weather Prediction

"Requirement from Global NWP"	Horizontal Resolution			Observing Cycle			Delay of availability			Accuracy		
Parameter name	Goal	Break-through	Threshold	Goal	Break-through	Threshold	Goal	Break-through	Threshold	Goal	Break-through	Threshold
Air pressure over sea surface	15 km	100 km	500 km	1 h	6 h	12 h	0.1 h	0.5 h	6 h	0.5 hPa	.99 hPa	1 hPa
Air specific humidity (at surface)	15 km	50 km	250 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	2 %	5 %	10 %
Air temperature (at surface)	15 km	50 km	250 km	1 h	6 h	12 h	0.1 h	0.5 h	6 h	0.5 K	1 K	2 K
Cloud base height	5 km	15 km	50 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	0.2 km	.5 km	1 km
Cloud cover	5 km	15 km	50 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	5% (Max)	10% (Max)	20% (Max)
Cloud top height	5 km	15 km	50 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	0.2 km	.5 km	1 km
Dominant wave direction	15 km	50 km	250 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	10 °	15 degrees	30 degrees
Dominant wave period	15 km	50 km	250 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	0.25 s	.5 s	1 s
Ocean salinity - upper ocean	5 km	100 km	250 km	1 d	30 d	60 d	3 h	24 h	120 h	0.1 psu	0.2 psu	0.3 psu
Ocean surface salinity	5 km	100 km	250 km	1 d	30 d	60 d	3 h	24 h	120 h	0.1 psu	0.2 psu	0.3 psu
Ocean temperature - upper ocean	5 km	100 km	250 km	1 d	2 d	30 d	3 h	24 h	120 h	0.3 K	0.5 K	1 K
Precipitation index (daily cumulative)	10 km	30 km	100 km	1 h	3 h	12 h	24 h	120 h	720 h	0.5 mm/d	2 mm/d	5 mm/d
Precipitation rate (liquid) at the surface	5 km	15 km	50 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	0.1 mm/h	.5 mm/h	1 mm/h
Precipitation rate (solid) at the surface	5 km	15 km	50 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	0.1 mm/h	.5 mm/h	1 mm/h
Sea surface temperature	5 km	15 km	250 km	3 h	24 h	120 h	3 h	24 h	120 h	0.3 K	.5 K	1 K
Sea-ice cover	5 km	15 km	100 km	0.125 d	1 d	5 d	0.125 d	1 d	5 d	5% (Max)	10% (Max)	20% (Max)
Sea-ice surface temperature	5 km	15 km	250 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	0.5 K	1 K	4 K
Sea-ice thickness	15 km	50 km	250 km	1 d	5 d	30 d	1 d	5 d	30 d	20 cm	50 cm	100 cm
Sea-ice type	10 km	25 km	100 km	0.125 d	1 d	5 d	0.125 d	1 d	5 d	4 classes	3 classes	2 classes
Significant wave height	15 km	50 km	250 km	1 h	3 h	12 h	0.1 h	0.5 h	6 h	0.1 m	.3 m	0.5 m
Wind profile (vertical component) - Higher stratosphere & mesosphere (HS & M)	15 km	200 km	500 km	1 h	6 h	12 h	0.1 h	0.5 h	6 h	1 cm/s	4.99 cm/s	5 cm/s
Wind speed over sea surface (horizontal)	15 km	100 km	250 km	1 h	6 h	12 h	0.1 h	0.5 h	6 h	0.5 m/s	1.5 m/s	2 m/s
Wind vector over sea surface (horizontal)	15 km	100 km	250 km	1 h	6 h	12 h	0.1 h	0.5 h	6 h	0.5 m/s	2 m/s	3 m/s

3. THE EXISTING SCHEME

There are eight types of ships in the VOS:

(i) Selected ships;

(ii) Selected AWS ships;

(iii) VOSClim (VOS Climate) ships;

(iv) VOSClim AWS ships;

(v) Supplementary ships;

(vi) Supplementary AWS ships;

(vii) Auxiliary ships;

(viii) Auxiliary AWS ships.

A Selected ship is a mobile ship station equipped with sufficient certified meteorological instruments for making observations, transmits regular weather reports and enters the observations in a meteorological logbook. It should have at least a barometer, a thermometer to measure SST, a psychrometer (for air temperature and humidity), a barograph and possibly an anemometer.Most of the VOS are selected ships.

A Selected AWS ship is a mobile ship station equipped with an Automatic Weather Station (AWS) system comprising certified meteorological instruments to measure at least at least air pressure, pressure change, temperature and humidity. Optional sensors would include wind speed and direction and sea temperature measurement. The AWS may or may not have the facility for manual input of the visual elements, and transmit reports at least three hourly or more frequently. The AWS should have the facility to log the data.

A VOSClim ship is a mobile ship station equipped with sufficient certified meteorological instruments for making observations, transmits regular and timely weather reports, enters the observations in an International Maritime Meteorological Tape (IMMT) compliant electronic logbook including the extra VOSClim delayed-mode groups, and has a proven record of providing high quality observations. A VOSClim ship should have at least a barometer, a thermometer to measure SST, a psychrometer (for air temperature and humidity), a barograph and possibly an anemometer. The full range of metadata must be maintained in WMO No. 47, the full suite of digital images, sketches and drawings must be available, and the delayed-mode IMMT data must be submitted to the Global Collecting Centres (GCCs) according to the procedures described in Chapter 3 of the WMO Guide to Marine Meteorological Services (WMO No. 471). It is highly desirable for a VOSClim ship to be inspected at less than six monthly intervals.

A VOSClim AWS ship is a mobile ship station equipped with an AWS system comprising certified meteorological instruments to measure at least air pressure, pressure change, temperature and humidity. Optional sensors would include wind speed and direction and sea temperature measurement. The AWS may have a facility for manual input of the visual elements, and transmit reports at least three hourly or more frequently. The AWS must have the facility to log the data including the additional IMMT delayed-mode VOSClim groups. The full range of metadata must be maintained in WMO No. 47, the full suite of digital images, sketches and drawings must be available, and the delayed-mode IMMT data must be submitted to the GCCs according to the procedures described in Chapter 3 of the WMO No. 471. It is highly desirable for a VOSClim ship

to be inspected at less than six monthly intervals.

A Supplementary ship is a mobile ship station equipped with a limited number of certified meteorological instruments for making observations. It transmits regular weather reports and enters the observations in a meteorological logbook.

A Supplementary AWS ship is a mobile ship station equipped with an AWS system comprising a limited number of certified meteorological instruments and reporting regularly.The AWS should at least measure air pressure.

An Auxiliary ship is a mobile ship station normally without certified meteorological instruments, which transmits in a reduced code form or in plain language, either on a routine basis or on request, in certain data sparse areas and under certain conditions.

An Auxiliary AWS ship is a mobile ship station equipped with an AWS system comprising non-certified meteorological instruments and reporting regularly. The AWS should at least measure air pressure.

TABLE 3: THE ELEMENTS OBSERVED BY THE VARIOUS TYPES OF VOS

	Selected[3]	*VOSClim*[3]	*Supplementary*[3]	*Auxiliary*[3]
Present and past weather	x	x	x	x
Wind direction and speed	x	x	x	x
Cloud amount	x	x	x	x
Cloud type and height of base	x	x	x	
Visibility	x	x	x	x
Temperature	**x**	**x**	x	x
Humidity (dew point)	**x**	**x**		
Atmospheric pressure	**x**	**x**	**x**	x
Pressure Tendency	**x**	**x**		
Ship's course and speed	**x**	**x**		
Sea surface temperature	x	x		
Period and heights of wind waves	x	x		
Direction, period and height of swell	x	x		
Sea ice and/or icing (if appropriate)	x	x	x	x
Special phenomena (if appropriate)	x	x		
Max height of deck cargo above the SLL		**x**		
Height difference from the SLL to the water line		**x**		
Course of ship over ground		**x**		
Ship's ground speed		**x**		
Ship's heading		**x**		

Ships are recruited by Members of WMO, usually through Port Meteorological Officers (PMO), who recruit if possible into their VOS fleets ships of all flags, not just those on their national register. Ships are recruited on the basis of the willingness of the ships' officers to perform the observations and the regular route followed by the ship. A Member will generally recruit ships

3 : Are indicated in bold the elements required by both automated (i.e. AWS sub-class) and non-automated systems; otherwise the element is only required for non-automated systems.

which regularly visit ports in the country concerned. Recruited ships are usually on the national register of the Member, but may be on a foreign register, in which case the meteorological service of the country of registry is informed. Ships' observations are generally made at the standard synoptic hours of 0000, 0600, 1200 and 1800 UTC and are sent to a meteorological service as by INMARSAT-C or email communication. In the case of INMARSAT C, the cost of transmission is paid by the meteorological service of the receiving country. Observations at the intermediate reporting times of 0300, 0900, 1500 and 2100 UTC are also welcomed, and observers are urged to report at any UTC hour if they missed the standard or intermediate reporting times or if weather conditions varied markedly from that forecast.

A list of VOS and their instrumentation is kept up to date by the Secretariat of WMO, and included in the WMO Publication No. 47, on the basis of information supplied by Members. Pub47 is available at http://www.wmo.int/pages/prog/www/ois/pub47/pub47-home.htm
Metadata, including full details of the observational site (e.g. height and exposure of the instrument), are absolutely essential to a correct interpretation and use of the observations.

TABLE 4: THE NUMBER OF SHIPS BELONGING TO THE VOS[4]

Year	*Selected*	*Supplementary*	*Auxiliary*	*Other*	*Total*
1987	4642	1470	1274		7386
1988	4438	1420	1344		7202
1989	4664	1436	1439		7539
1990	4645	1412	1434		7491
1991	4647	1434	1369		7450
1992	4608	1332	1422		7362
1993	4512	1374	1430		7316
1994	4092	1386	1197		6675
1995	4124	1332	1270		6726
1996	4171	1311	1270		6752
1997	4187	1285	1287		6759
1998	4230	1375	1457		7062
1999	4244	1334	1514		7092
2000	4185	1299	1482		6966
2001	4179	1276	1483		6938
2002	4133	1272	1491		6896
2003	4006	1156	1443		6605
2004	3963	848	936	112	5859
2005	3482	908	888	151	5429
2006	3444	967	503	132	5046
2007	3441	928	414	50	4833
2008	2510	311	191	1266	4278
2009	3321	471	270	192	4254

4. DATA MANAGEMENT

Marine meteorological observations have traditionally been recorded on board most ships in special meteorological registers (logbooks) provided by national Meteorological Services. The logbooks are collected by the Port Meteorological Officer of the recruiting country and the observations are transferred from the logbooks to magnetic media, in a standard, internationally agreed, format. Increasing numbers of ships are now using Electronic Logbook Software, eg

4 : The VOSClim class, and the AWS sub-class didn't exist prior to 2010 and their numbers are therefore not indicated in this table for this period.

TurboWin, OBSJMA, SEAS, to compile and record their observations in the internationally agreed format. These data are periodically collected by the Port Meteorological Officer on diskette or USB stick.

The data are then sent, at approximately three-month intervals, to global collecting centres in Germany and the United Kingdom in support of the Marine Climatological Summaries Scheme (MCSS). These centres ensure that minimum quality control has been applied to the data, and then, every three months, supply data to eight Members, each with a specific area of responsibility for the preparation of climatological summaries.

5. REAL-TIME DATA QUALITY

PMOs visit VOS calling at their ports to check the instrumentation, calibrate the barometer, supply stationery such as barograph charts or logbooks as required, and discuss any observational problems with the Master and officers.

The quality of VOS reports is monitored by several major meteorological centres, primarily the U.K. Meteorological Office. Results of this monitoring are compiled and distributed monthly to VOS operators and PMOs, who are expected to take follow-up actions to correct deficiencies.

6. COORDINATION

The Scheme is coordinated by the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology (JCOMM) through the VOS Panel. The Terms of Reference of the VOSP are:

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

2. Support the development and maintenance of pilot projects such as VOSClim[5];

3. Develop and implement activities to enhance ship recruitment, including promotional brochures, training videos, etc.; and

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

7. CURRENT PROBLEMS

7.1 Number of Ships

As can be seen from Table 4, the number of VOS is decreasing. This is due in part to cargo ships becoming larger but fewer in numbers, increased changes of routes and ships' personnel which make recruitment difficult, as well as the removal of non-performing ships from the VOS.

7.2 Reduced Crews

Although ships have become larger, the crews have become smaller. Ships' officers have less time in which to make observations, e.g. under the IMO Global Maritime Distress and Safety System (GMDSS) the requirement to carry a ship's radio officer no longer exists and the ship's

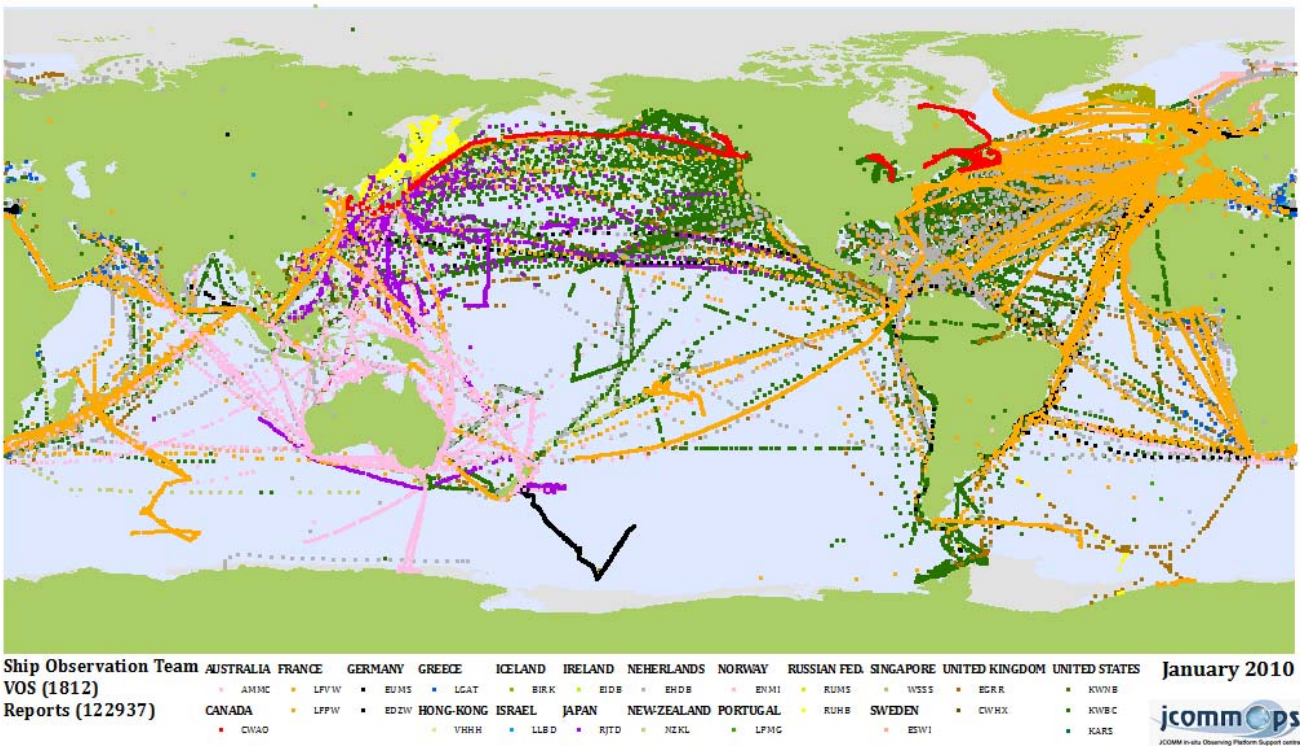
[5] VOSClim: VOS Climate Project. VOSClim is a project within JCOMM's Voluntary Observing Ships' Scheme that ceased in 2010 but which has then been integrated as an ongoing activity as part of the wider VOS through the use of the VOSClim class of vessel. It aims to provide a high-quality subset of marine meteorological data, with extensive associated metadata, to be available in both real-time and delayed mode to support global climate studies.

deck officers (observing officers) now have to carry out communications work. This is being overcome to some extent by automation of the observations.

7.3 Spatial Coverage

The geographical distribution of ships' weather observations in a typical month is shown in Figure 1. The location of the major trade routes of the world is obvious, as is the heavy concentration of observations in the Northern Hemisphere and the large data sparse areas in the Southern Hemisphere.

FIGURE 1: CURRENT STATUS OF GLOBAL VOS NETWORK (JANUARY 2010)



7.4 Accuracy of Observations

The Special Observing Project for the North Atlantic (VSOP-NA) revealed many sources of inaccuracy in ships' observations, e.g. in relation to exposure of the instruments, calculation of true wind from observed wind and ship's velocity, differing means of measuring sea surface temperature.

7.5 The Beaufort Scale

The Beaufort Scale of wind speed was devised in the eighteenth century with reference to the behaviour of a fully-rigged sailing ship.

Whilst the Beaufort Scale at best gives only an estimate of the 'true wind' speed, many National Meteorological Services (NMS) still prefer to use the Beaufort Scale in preference to ship's-own anemometers that generally suffer from a lack of regular servicing and calibration.

8. AUTOMATION OF OBSERVATIONS

In an effort to reduce the workload on ships' officers, several means of automation of the

observations have been developed. Using Electronic Logbook Software, the observations are still taken manually but then entered into a software package which then calculates the true wind, the mean sea level pressure (correcting for the height of the bridge) and the dew point. This same software can also perform quality control, code the observation for transmission, and format the observation in logbook format for digitisation. If this software is run on a ship's personal computer, care must be taken, to ensure this process does not adversely affect the ship's network PC and/or its communication carriage requirement under the International Convention for the Safety of Life at Sea (SOLAS).

Increasingly, many NMS are equipping ships with an Automatic Weather Station (AWS) that may either operate totally in stand-alone mode, or accept manual input of the visual parameters (cloud, weather, sea and swell) via a computer. The best locations for sensors are not easy to find, particularly for wind and dew point. Most sites for an anemometer sensor will be affected by wind flow distortion over the superstructure.

An additional factor is that the changing nature of international shipping creates problems in selecting a vessel that is likely to stay on the same trade route for a predetermined period. NMS may be reluctant to invest in ship AWS installations when there is no guarantee that a ship will continue trading in their area of forecasting responsibility.

9. RELATION TO THE GOOS

The observations from the VOS make an important contribution to the GOOS. The VOS Panel will work in close collaboration with the general organisation and implementation of the GOOS. Scientific advice on the VOS, particularly relating to the role of VOS observations in global climate studies, will be provided by the GOOS/GCOS/WCRP Ocean Observations Panel for Climate (OOPC).

10. IMPLEMENTATION STRATEGY

The ***General Aims*** are:

a. To obtain accurate meteorological data from the oceans for preparation of meteorological forecasts and warnings for shipping on the oceans;

   i. monitoring the state of the oceans;
   ii. provision of climatological data for the oceans;
   iii. research into changes in the climate of the earth;

b. To provide data as far as possible in accordance with the specified spatial, temporal and accuracy requirements of the GOOS/GCOS.

The *Specific Aims* are:

a. To make use of every suitable ship to obtain data from the parts of the oceans from which little data are currently received;

b. To keep up with changes in technology in the automation of the taking and transmission of meteorological observations from ships and to encourage improved practice;

c. To improve the accuracy of ships' observations as recommended by the VOSP-NA;

d. To upgrade as many ships as practicable to VOSClim class status.

e. To monitor observations received from ships and take action to rectify any deficiencies in accuracy that are detected;

f. To use changes in technology to improve the flow and treatment of the meteorological data obtained from ships;

g. To maintain marine-trained Port Meteorological Officers at the major ports of the world; and

h. To maintain close collaboration with the organization and implementation of the GOOS/GCOS.

Actions:

1. 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;

2. Encourage the use of hull-attached temperature sensors for the measurement of sea-surface temperature;

3. Encourage the automation of observations and reporting;

4. Investigate with real-time monitoring centres the value of including the height or depth of observed parameters;

5. Prepare comprehensive guidance on observing procedures to vessels of the VOS to help standardise observing practices among national observing fleets;

6. Monitor observations in real-time and drawing to the attention of the appropriate Members any deficiencies in accuracy;

7. Extend real-time monitoring systems to cover all variables required for surface flux calculations;

8. Encourage more recruitment of VOSClim class vessels;

9. Derive an acceptable standard scale of Beaufort wind speed equivalents;

10. Organise training seminars and conferences for Port Meteorological Officers every 3-4 years;

11. Encourage national award schemes to ships and or ships' officers as recognition for high standards in taking, recording and reporting observations;

12. Keep under review the flow of meteorological data from ships to ensure the most efficient method of providing world-wide climatological data to users;

13. Keep Members informed of advances in technology in the taking and transmission of ships' observations by means of technical notes and similar publications;

14. Encourage Members to submit each quarter, all metadata that are required in WMO Publication No. 47.

15. 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;

16. 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;

17. 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;

18. Encourage all research vessels to transmit meteorological observations in real-time; and

19. 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.

Coordination of the VOS will continue to be the responsibility of the JCOMM VOS Panel and the flow and treatment of non-real-time data the responsibility of the JCOMM Expert Team on Marine Climatology (ETMC).

_____

APPENDIX A

LIST OF ACRONYMS

AOPC	Atmospheric Observations Panel for Climate (of GCOS/WCRP)
ASAP	Automated Shipboard Aerological Programme
ASAPP	Automated Shipboard Aerological Programme Panel (of SOT)
AWS	Automatic Weather Station
CBS	Commission for Basic Systems (of WMO)
CMM	Commission for Marine Meteorology (of WMO, now JCOMM)
ETMC	Expert Team on Marine Climatology
GCOS	Global Climate Observing System (of ICSU, IOC, UNEP, WMO)
GDPFS	Global Data Processing and Forecasting System (of CBS)
GMDSS	Global Maritime Distress and Safety System (of IMO)
GOOS	Global Ocean Observing System (of ICSU, IOC, UNEP, WMO)
GTS	Global Telecommunication System (of WWW)
ICS	International Chamber of Shipping
ICSU	International Council for Science
IMO	International Maritime Organization
INMARSAT	International maritime satellite private company
IOC	Intergovernmental Oceanographic Commission (of UNESCO)
JCOMM	Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology
JCOMMOPS	JCOMM in situ Observing Platform Support Centre
LES	Land Earth Station (INMARSAT)
NMS	National Meteorological Service
NWP	Numerical Weather Prediction
OOPC	Ocean Observation Panel for Climate (of GOOS, GCOS, WCRP)
PMO	Port Meteorological Officer
SHIP	GTS Report of surface observation from a Sea Station (FM-13)
SOLAS	International Convention for the Safety of Life at Sea
SOT	Ship Observations Team (of JCOMM)
SST	Sea Surface Temperature
UNEP	United Nations Environment Programme
UNESCO	United Nations Educational, Scientific and Cultural Organization
USB	Universal Serial Bus
UTC	Universal Time Coordinated
VOS	Voluntary Observing Ship
VOSP	Voluntary Observing Ship Panel (of SOT)
VOSClim	Voluntary Observing Ships Climate Subset Project
VSOP-NA	VOS Special Observing Project-North Atlantic
WCRP	World Climate Research Programme (of ICSU, IOC, WMO)
WMO	World Meteorological Organization
WWW	World Weather Watch (of WMO)

APPENDIX B

JOINT WMO/IOC TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY TECHNICAL REPORT SERIES

No.	Title	WMO/TD-No.	Issued
52	11th international workshop on wave hindcasting and forecasting and 2nd coastal hazard symposium Halifax, Canada, 18-23 October, 2009.	WMO/TD-No. 1553	2010
51	SOT Annual Report for 2009	WMO/TD-No. 1525	Pending
50	JCOMM-III – Scientific Lectures – ***Website only***	WMO/TD-No. 1518	2009
49	Proceedings of the 2nd Ice Analysts Workshop, Rostock, Norway 15-19 June 2009 – ***Website only***	WMO/TD-No. 1517	2009
48	Project report, Pilot Project for the Integration of marine meteorological and other appropriate oceanographic observations into the WMO Integrated Global Observing System (WIGOS)	WMO/TD-No. 1515	Pending
47	JCOMM Technical Workshop on Wave Measurements from Buoys, 2-3 October 2008, New York City, USA	WMO/TD-No. 1466	2008
46	SOT Annual Report for 2008	WMO/TD-No. 1459	2008
45	Proceedings of the 3rd JCOMM Workshop on Advances in Marine Climatology, Gdynia, Poland, 6-9 May 2008	WMO/TD-No. 1445	2008
44	Proceedings of **1)** 1st JCOMM Scientific & Technical Symposium on Storm Surges, Seoul, Korea 2-6 Oct. 2007 **2)** 10th International Workshop on Wave Hindcasting & Forecasting & Coastal Hazard Symposium , North Shore Oahu, Hawaii, 11-16 November 2007 – ***CD ROM***	WMO/TD-No. 1442	2008
43	Proceedings of the Ice Analysts Workshop, Rostock, Germany 12-17 June 2008 – ***CD ROM***	WMO/TD-No. 1441	2008
42	Proceedings of the OGP/JCOMM/WCRP Workshop on Climate Change & the Offshore Industry Geneva, 27-29 May 2008 – ***CD ROM***	WMO/TD-No. 1440	2008
41	SOT Annual report for 2007	WMO/TD-No. 1431	2008

No.	Title	WMO/TD-No.	Issued
40	JCOMM Data Management Plan	WMO/TD-No. 1426	2008
39	JCOMM Expert Team on Marine Accident Emergency Support (ETMAES), First Session - National Reports (Angra dos Reis, Brazil, 29-31 January 2007) - **Website only**	WMO/TD-No. 1399	2007
38	JCOMM Expert Team on Maritime Safety Services (ETMSS), Second Session - National Reports (Angra dos Reis, Brazil, 24-27 January 2007) - **Website only**	WMO/TD-No. 1398	2007
37	Application of collected data, Presentations at the DBCP Technical Workshop, Buenos Aires, Argentina, 17-18 October 2005 – **Website only**	WMO/TD-No. 1388	2006
36	SOT Annual Report for 2006	WMO/TD-No. 1394	2007
35	Application of collected data, Presentations at the DBCP Technical Workshop, Chennai, India, 18-19 October 2004 – **Website only**	WMO/TD-No. 1387	2006
34	Ninth International Workshop on Wave Hindcasting and Forecasting (Victoria, Canada, 24-29 September 2006) – ***CD ROM***	WMO-TD. No. 1368	2007
33	Techniques and Benefits of Satellite Data and Wave Models, J.-M. Lefèvre, J.-R. Bidlot and S. Abdalla	WMO/TD-No. 1357	2006
32	SOT Annual Report for 2005 – ***CD ROM***	WMO/TD-No. 1346	2006
31	Manual on Sea Level, Measurement and Interpretation, Volume IV: An Update to 2006	WMO/TD-No. 1339	2006
30	Verification of Operational Global and Regional Wave Forecasting Systems against Measurements from Moored Buoys, by J.-R. Bidlot and M.W. Holt	WMO/TD-No. 1333	2006
29	Eighth International Workshop on Wave Hindcasting and Forecasting (North Shore, Oahu, Hawaii, 14-19 November 2004)	WMO/TD-No. 1319	2006
28	Third International Workshop for Port Meteorological Officers (Hamburg, Germany, 23-24 March 2006 – ***CD ROM***	WMO/TD-No. 1318	2006
27	An International Seminar to Celebrate the Brussels Maritime Conference of 1853 - An Historical Perspective of Operational Marine Meteorology and Oceanography - Proceedings - ***CD ROM***	WMO/TD-No. 1226	2004
26	Automated Shipboard Aerological Programme (ASAP) - Annual Report for 2003	WMO/TD-No. 1224	2004
25	Second International Workshop for Port	WMO/TD-No. 1216	2004

No.	Title	WMO/TD-No.	Issued
	Meteorological Officers - ***CD ROM***		
24	Ice Chart Colour Code Standard	WMO/TD-No. 1215	2004
23	SIGRID-3: A Vector Archive Format for Sea Ice Charts	WMO/TD-No. 1214	2004
22	Proceedings of CLIMAR-II - Second JCOMM Workshop on Advances in Marine Climatology (Brussels, Belgium, 17-22 November 2003) - ***CD ROM***	WMO/TD-No. 1199	2004
21	Workshop on Wind Wave and Storm Surge Analysis and Forecasting for Caribbean Countries (Dartmouth, Canada, 16-20 June 2003) - ***CD ROM***	WMO/TD-No. 1171	2003
20	JCOMM Ship Observations Team, Second Session - National Reports (London, United Kingdom, 28 July - 1 August 2003) - **Website only**	WMO/TD-No. 1170	2003
19	Automated Shipboard Aerological Programme (ASAP) - Annual Report for 2002	WMO/TD-No. 1169	2003
18	JCOMM Expert Team on Maritime Safety Services (ETMSS), First Session - National Reports (Lisbon, Portugal, 11-14 September 2002) - **Website only**	WMO/TD-No. 1135	2002
17	JCOMM Ship Observations Team, First Session - National Reports (Goa, India, 25 February - 2 March 2002) - **Website only**	WMO/TD-No. 1121	2002
16	Scientific and Technical Workshop of the JCOMM Ship Observations Team - Presentations at the first session of the Ship Observations Team (Goa, India, 26 February 2002) - ***CD ROM***	WMO/TD-No. 1118	2002
15	Automated Shipboard Aerological Programme (ASAP) - Annual Report for 2001	WMO/TD-No. 1112	2002
14	Operational Oceanography - Scientific Lectures at JCOMM-I (Akureyri, Iceland, June 2001)	WMO/TD-No. 1086	2001
13	Advances in the Applications of Marine Climatology - The Dynamic Part of the WMO Guide to the Applications of Marine Climatology - ***CD ROM***	WMO/TD-No. 1081	2003
12	Automated Shipboard Aerological Programme (ASAP) – Annual Report for 2000	WMO/TD-No. 1069	2001
11	JCOMM Capacity Building Strategy	WMO/TD-No. 1063	2001
10	Proceedings of CLIMAR99 - WMO Workshop on Advances in Marine Climatology (Vancouver, Canada, 8-15 September 1999) -	WMO/TD-No. 1062	2003

No.	Title	WMO/TD-No.	Issued
	CD ROM		
9	Estimation of Extreme Wind Wave Heights	WMO/TD-No. 1041	2000
8	Oceanographic and Marine Meteorological Observations in the Polar Regions - A Report to the Joint WMO/IOC Technical Commission on Oceanography and Marine Meteorology	WMO/TD-No. 1032	2000
7*	Proceedings of a Workshop on Mapping and Archiving of Sea Ice Data – The Expanding Role of Radar, Ottawa, Canada, 2-4 May 2000	WMO/TD-No. 1027	2000
6	Automated Shipboard Aerological Programme (ASAP) – Annual Report for 1999	WMO/TD-No. 1011	2000
5	Voluntary Observing Ships (VOS Climate Subset Project (VOSCLIM) – Project Document)	WMO/TD-No. 1010	2000
	Revision 1	WMO/TD-No. 1042	2001
	Revision 2 - **Website only**	WMO/TD-No. 1122	2002
4	The Voluntary Observing Ships Scheme – A Framework Document	WMO/TD-No. 1009	2000
	Revision 1		2008
3*	JCOMM Ship-of-opportunity Programme Implementation Panel, Third Session, La Jolla, CA, USA, 28-31 March 2000 – SOOP Status Reports – SOOP Scientific and Technical Developments	WMO/TD-No. 1005	2000
2	Meeting of Experts on a JCOMM/GOOS Polar Region Strategy, Geneva, Switzerland, 6-8 December 1999 - Status Reports from Existing Polar Region Observing Systems	-	2000
1*	First Transition Planning Meeting - St Petersburg, Russian Federation, 19-23 July 1999 – Status Reports from JCOMM Component Bodies and Activities	-	1999