THE VOLUNTARY OBSERVING SHIPS SCHEME

A FRAMEWORK DOCUMENT

WMO/TD-No. 1009

JCOMM Technical Report No. 4

WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)

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N O T E

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C O N T E N T S

FOREWORD

Ships of the WMO Voluntary Observing Ships (VOS) scheme have always been an important component of the global observing system of 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 JCOMM (formerly CMM) 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 final revised document is now published herewith as a report in the JCOMM Technical Report series. As noted above, it is hoped that it will prove of interest and value to VOS operators and data users alike. The appreciation of WMO is extended to Mr Linforth, Capt. Mackie and all subgroup members for their valuable contributions to its preparation.

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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 service. Hence the name of the scheme – Voluntary Observing Ships (VOS) – which is coordinated by the World Meteorological Organisation

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, 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, pressure) and the surface of the sea (temperature, waves, currents, 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, which is also responsible for systems for management of the data (distribution on the GTS and processing by the GDPS).
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 GOOS (which is the Ocean Module of 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 desirable observational network for World Weather Watch are shown in Table 1. The spatial and temporal resolution of observations required for climate is coarser than for weather forecasting.

TABLE 1: OBSERVATIONAL REQUIREMENTS

	World Weather Watch			*Ocean Observing System for Climate*		
Variable	***Spatial Resolution***	***Temporal Resolution***	***Accuracy***	***Spatial Resolution***	***Temporal Resolution***	***Accuracy***
Atmospheric Pressure	100km	1h	9.5hPa	250km	1 day	1hPa
Wind	100km	1h	$2ms^{-1}$	2° x 2°	1-2 per day	$2ms^{-1}$
Air Temperature	100km	1h	1°C			
Sea Surface Temperature	100km	1 day	0.5°C	500km	1 week	0.1-0.3°C
Wave height	100km	1h	0.5m			
Sea Ice extent				~30km	1 day	10-30km

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.

3. THE EXISTING SCHEME

There are three types of ships in the VOS:

- selected ships
- supplementary ships
- auxiliary ships

A selected ship is equipped with sufficient certified meteorological instruments for making observations, transmits regular weather reports and enters the observations in meteorological logbooks. It should have at least a barometer, a thermometer for sea-surface temperature, a psychrometer and a barograph. Most of the VOS are selected ships.

A supplementary ship is equipped with a limited number of certified meteorological instruments for making observations, transmits regular weather reports and enters the observations in meteorological logbooks.

An auxiliary ship is without certified meteorological instruments and transmits reports in a reduced code or in plain language, either as a routine or on request, in certain areas or under certain conditions. Auxiliary ships usually report from data-sparse areas outside the regular shipping lanes.

TABLE 2: THE ELEMENTS OBSERVED BY THE VARIOUS TYPES OF VOS

	Selected	*Supplementary*	*Auxiliary*
Present and past weather	x	x	x
Wind direction and speed	x	x	x
Cloud amount	x	x	x
Cloud type and height of base	x	x	
Visibility	x	x	x
Temperature	x	x	x
Humidity (dew point)	x		
Atmospheric pressure	x	x	x
Pressure Tendency	x		
Ship's course and speed	x		
Sea surface temperature	x		
Direction, period and heights of waves	x		
Sea ice and/or icing	x	x	x
Special phenomena	x		

Ships are recruited by Members of WMO, usually through Port Meteorological Officers, 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 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 made at the standard synoptic hours of 0000, 0600, 1200 and 1800 UTC and are sent to a meteorological service as soon as they are made, either by radio telephony to a coast radio station, by telex over radio, or by INMARSAT-C. In each case the cost of transmission is paid by the meteorological service of the receiving country. With the cessation of radio telegraphy in many parts of the world in 1999, INMARSAT is the prime means of transmission of ship's observations. INMARSAT transmission allows all observations to be transmitted immediately, whereas transmission by radio telegraphy could only be done during the hours of duty of the ship's radio officer.

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, and is made available on diskette, and in an annual publication. Metdata, 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 3: THE NUMBER OF SHIPS BELONGING TO THE VOS

Year	*Selected*	*Supplementary*	*Auxiliary*	*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

4. DATA MANAGEMENT

Marine meteorological observations are 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 being equipped with personal computers and software which stores the observations on diskette in the internationally agreed format. This avoids data transfer from logbook to magnetic media, a source of possible errors.

The data are then sent, at approximately three-month intervals, to global collecting centres in Germany and the United Kingdom. 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 at monthly and six-monthly intervals to 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 its Subgroup on Voluntary Observing Ships. The Terms of Reference of this Subgroup are:

(a) Propose and, as necessary, take specific actions to enhance implementation of the recommendations of the VSOP-NA relating to VOS operations;

(b) Review the status of the VOS world-wide and propose actions to enhance ship recruitment;

(c) Review and analyse requirements for VOS data as expressed by the WWW, WCP, GOOS, GCOS and in support of marine services;

(d) Review and recommend on shipboard instrumentation, siting and observing practices;

(e) Review, maintain and update, as necessary, technical guidance material relating to the VOS and PMOs;

(f) Propose actions to enhance PMO standards and operations and contribute, as required, to PMO training.

(g) Liaise with the Subgroup on Marine Climatology, the ad hoc Group on the GMDSS, and the Ship-of-Opportunity Programme Implementation Panel on matters relating to VOS management and operations.

(h) Review marine telecommunications, facilities and procedures for observational data collection and propose actions, as necessary, for improvements and/or enhanced applications.

7. CURRENT PROBLEMS

7.1 Number of Ships

As can be seen from Table 2, the number of VOS is decreasing. This is due to a decrease in the number of ships in general as cargo ships have become larger and regular passenger liners have been replaced by cruise ships. This has been compensated in part by reduced time in port with modern cargo-handling methods.

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 GMDSS the requirement to carry a ship's radio officer no longer exists and the ship's 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. There is a lack of observations in many parts of the tropics and in the southern hemisphere. Only one report in the month was received from waters south of 40S, away from the main trade routes, and none at all from many areas.

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. There are different methods of converting Beaufort numbers to quantitative wind speeds. Inaccuracies in this are causing problems in estimating the heat flux at the air-sea interface, which is of importance in modelling the climate of the earth.

8. AUTOMATION OF OBSERVATIONS

In order to reduce the workload on ships' officers several means of automation of the observations have been developed. In one form the observations are still taken manually but then entered into a personal computer which then calculates the true wind, the mean sea level pressure (correcting for the height of the bridge) and the dew point. The computer can also perform some simple quality control, code the observations for transmission, and format the observation in logbook format for digitisation. The computer diskette can be placed in the INMARSAT terminal for transmission without re-keying. However, care has to be taken that this process does not adversely affect the ship's network PC and/or its communication carriage requirement under SOLAS.

Another form of automation is the Marine Data Collection Platform, which consists of a handheld computer, air temperature and air pressure sensor, transmitter and antenna. The coded observation is entered in the computer and collected by Service Argos satellite. In this case the logbook still has to be entered manually. However, it should be borne in mind that all shipboard

automation systems require maintenance, and resources to cover this aspect should be considered during resource and budgetary planning.

It is extremely difficult to automate all the observations. Proper 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, and wind speed needs to be corrected to the standard level. The equipment for automated measurement of visibility, weather, clouds and wave height can difficult to accommodate on board small ships. 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. National meteorological services may have a certain reluctance to invest in ship AWS installations when there is no guarantee that a ship will continue trading in their area of forecasting responsibility.

Installation of wave height meters using microwave Doppler radar has taken place on a number of VOS, and development is underway of a consolidated, console based, automatic maritime meteorological observation system. New instrumentation is becoming available with automatic visibility measurement of present weather, including precipitation, snow, precipitation intensity and fog, this technology being expected to be cheaper and more compact.

9. RELATION TO THE GOOS

The observations from VOS make an important contribution to the GOOS. JCOMM and its Subgroup on the VOS 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.

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;

and

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

Specific Aims are:

(a) to make use of every suitable ship to obtain data from the parts of the oceans from which little data is 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 VSOP-NA;

(d) to monitor observations received from ships and take action to rectify any deficiencies in accuracy which are detected.

(e) to use changes in technology to improve the flow and treatment of the meteorological data obtained from ships;

(f) to maintain marine-trained Port Meteorological Officers in the major ports of the world;

(g) to maintain close collaboration with the organisation and implementation of the GOOS/GCOS.

Actions

(a) Encourage maritime Members, particularly those in the southern hemisphere, to recruit VOS which travel to data-sparse areas, such as vessels proceeding to the Antarctic, or making regular voyages across the central and south-eastern Pacific Ocean; IMO/MSC has issued a circular highlighting this requirement.

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

(c) Investigate with users of sea surface temperature data the value of including in the reporting code an indicator of the method of measurement;

(d) Encourage the use of small computers on board ship for calculation of true wind, sea level pressure and dew point;

(e) Investigate with real-time monitoring centres the value of including in the reporting code an indicator of ship's draft or "height of eye";

(f) Prepare a reference booklet to provide step-by-step guidance on observing procedures to vessels of the VOS to help standardise observing practices among national observing fleets;

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

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

(i) Increase the frequency of the distribution of the results of real-time monitoring to monthly;

(j) Study the development of a high-quality subset of VOS for GOOS/GCOS purposes;

(k) Investigate the inclusion of relative wind speed and direction in logbook reports;

(l) Derive an acceptable standard scale of Beaufort wind speed equivalents;

(m) Organise training seminars and conferences for Port Meteorological Officers;

(n) Maintain a system of awards to ships' officers for excellence in observations, as an encouragement towards high observation standards. *Note:* With automated systems and consequently the cessation of the requirement to maintain an manuscript logbook, a new approach to this aspect has to be considered.

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

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

(q) Encourage Members to submit as much precise metadata as possible to be included in WMO publication No. 47.

(r) Provide PMOs with access to up-to-date on-line listing of all VOS ships, name, call sign, country of recruitment etc so that status is known before visiting;

(s) Provide PMOs with current list of ships INMARSAT C numbers so that they can contact ships at sea when necessary to check observations, advise on correct coding procedures or request additional observations in storm or Tropical Cyclone conditions;

(t) Information on the Global CES which accept observations free of charge, together with the details of the required CES access codes and OBS format should be made available to PMOs;

(u) Consider any means available of simplifying /shortening ship code;

(v) Encourage all research vessels to transmit meteorological observations in real-time;

(w) Organise an international meeting with active participation of WMO, IMO, ICS and IOC to emphasise the importance of VOS observations;

(x) Develop a strategy whereby all WMO Members regularly receive observations in their region of interest.

Coordination of the VOS will continue to be the responsibility of the JCOMM Subgroup on the VOS and the flow and treatment of non-real-time data the responsibility of the JCOMM Subgroup on Marine Climatology. In the longer term, any new JCOMM structure established to deal with marine observing networks and data management in an integrated way will continue to have responsibilities covering these two aspects of VOS coordination and management.

Finally, the appendix to this document contains information illustrating how one particular National Meteorological Service and VOS operator (Météo France) is responding to the implementation strategy. This information may also be of benefit to other operators.

APPENDIX

CURRENT STATUS – MÉTÉO-FRANCE VOS

The existing scheme in France

On 1st January 1999, Météo-France had 93 selected ships.

Table 1

Onboard system	Number of ships
Automatic observation and transmission, storage observation on diskette (BATOS system and VAISALA)	11
Observations are automatically determined, but computing and transmission and not automated (POMMAR system), logbooks are used	38
Not automated, conventional measurement, logbooks are used	44

The sea surface temperature is measured in different ways:

Table 2

Way of use	Number of Ships
Water Inlet	82
Bucket	4
Any other method	1
No measure	6

Nowadays, transmissions are made through INMARSAT. By this means, most of them arrive at the Toulouse RTH (LFPW) in time for operational use.

Data Management

Automatic systems use diskette and for the others, ships' officers send their logbooks to Météo-France.

Real time data quality

Météo-France monitors ships' observations in Toulouse and if there is a deficiency, the Port Meteorological Officer visits the ship to correct the deficiency as soon as possible.

Coordination

Météo-France is developing a new automatic station (RADOME) for its land-based network. This station should equip VOS after adaptation to the marine environment. This action will be implemented after completion of the land network equipment (2002).

A manual for VOS operations has just been written. Météo-France plans to translate it into English because most of the ships' officers are English speaking.

The meteorological logbook has just been re-edited in French and in English.

Guidance for sea observation is planned: some people are working on it.

It is difficult to keep Port Meteorological officers in duty, so people from other offices (meteo? others?) must to do this job (e.g. the meteorological office in Aix fulfils the task of the PMO in Marseille). Limitations in staff availability have led Météo-France to reduce the number of PMOs (e.g.: Marseilles).

Current problems

Météo-France manages more automated observations and transmission systems so the decrease of number of VOS or crew would not cause any problem. New automatic stations will be used in 2002.

The decrease of VOS has been compensated by better transmissions: the SCEM received 32500 observations from ships in 1996 and 44800 in 1998.

In France, wind is always measured and not estimated.

Automation of observations

Nowadays, on French VOS, there is only one automatic system BATOS which is installed on 10 ships.

Implementation strategy

Specific aims:

(a) Météo-France receives currently more Mediterranean and Atlantic observations than from the world ocean. However Météo-France also receives from a PMO in La Reunion very good records.

(b) For a few years, Météo-France has worked on developing BATOS and in the future will work with Radome.

Some actions already underway:

Météo-France, prefers water intake to measure sea temperature.

Small computers are used for various on-board calculations for French ships.

There is a system of awards to ships' officers and Météo-France pays meteorological officers for each observation and transmission made.