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VOLUNTARY OBSERVING SHIPS (VOS) CLIMATE SUBSET PROJECT (VOSCLIM)

PROJECT DOCUMENT

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PROJECT DOCUMENT FOR THE VOLUNTARY OBSERVING SHIPS (VOS) CLIMATE SUBSET PROJECT (VOSCLIM)

1. Objectives

The primary objective of the project is to provide a high-quality subset of marine meteorological data, with extensive associated metadata, to be available in both real time and delayed mode. Eventually, it is expected that the project will transform into a long-term, operational programme. Specifically, the project gives priority to the following parameters: wind direction and speed, sea level pressure, sea surface temperature, air temperature and humidity. Data from the project will be used: to input directly into air-sea flux computations, as part of coupled atmosphere-ocean climate models; to provide ground truth for calibrating satellite observations; and to provide a high-quality reference data set for possible re-calibration of observations from the entire VOS fleet. Requirements, rationale and scientific justification for the project are detailed in **Attachment 1**.

The VSOP-NA demonstrated clearly that the quality of measurements depends significantly on the types of instruments used, their exposures and the observing practices of shipboard personnel. It made a number of substantive recommendations in these areas which, if systematically implemented, would be expected to result in VOS observations of a quality appropriate to global climate studies. For logistic reasons, it is not realistic to expect full implementation to the entire global VOS. However, it is undoubtedly feasible for a limited subset of the VOS, and the primary goal of this project is therefore to effect such a limited implementation.

2. Strategy

VOSCLIM is intended to produce high-quality data and therefore the selection of ships is a very important part of the project. This can best be done by the existing Port Meteorological Officer (PMO) network applying the criteria detailed in section 4 below.

Many modern ships will already be adequately equipped with acceptable instruments. The quality of instruments, although relevant, has, however, less effect upon the quality of data than use and exposure. It is vital that these aspects are catalogued and the catalogue kept up to date.

For data to be collected and processed in as timely a manner as possible, it is necessary to implement new logsheets (or additions to existing logsheets), whether paper or electronic, and additional codes. The new codes are to be used for parameters not currently reported. Logsheets will be collected by PMOs of the recruiting country at the first opportunity.

Strenuous efforts must be made to ensure that the instruments, observing practice and physical exposure conform to high standards as recommended in the VSOP-NA report, and that details are accurately recorded. Intercomparison with reference instruments held by PMOs could identify biases in specific instruments.

The project necessarily involves the PMO network of participating countries. Close liaison with the shipping industry, both companies and ships' masters, is essential for its success. Expertise provided through the Joint WMO/IOC Technical Commission for Oceanography and Marine Meteorology is also important and the project implementation should therefore proceed as a component activity under, and as part of the integrated observing network strategy of JCOMM. Overall scientific guidance for the project will be provided by the Ocean Observations Panel for Climate (OOPC) of GOOS/GCOS/WCRP.

3. Required accuracy of data sets based on VOS observations

The most stringent accuracy requirement is that imposed by the need to calculate heat, moisture and momentum flux values. These are required for validating the fluxes calculated by atmospheric general circulation models and also by coupled ocean-atmosphere models and for driving ocean circulation models. Flux values are also required for climate research within WCRP. A similar level of accuracy is also imposed by the need to validate satellite measurements.

The precise accuracy depends on the spatial and temporal resolution for which data are required. It also depends on the dominant physical processes, for example ocean mixed-layer deepening over a month may be dominated by one short-term event. However, if one considers for example the need to obtain a monthly mean value of the sensible and latent heat fluxes over a 500 km square of ocean to about +/-10 W/m**2 (e.g. for climate research), then the mean temperature measurements should be accurate to +/-0.2°C or better. This applies to the dry and wet bulb air temperatures and to the sea surface temperature. An equivalent requirement for the mean wind speed is about 10% or about 0.5 m/s (1 knot).

It must be emphasized that individual ship observations are not expected to meet such stringent accuracies. In any case there will always be random scatter from one measurement to the next due to smaller-scale variability in the atmosphere and the ocean. Thus is will be necessary to average sets of observations. However, if the <u>random</u> observational errors are minimized, then the areas of ocean for which adequate densities of observations are available will be increased. <u>Systematic</u> errors in the observations, on the other hand, must be identified to the level of precision suggested above, so that any such bias may be removed from the data sets.

4. Selection of ships

It is intended that only a relatively small number of ships (a target of 200) will be used in the project. It is necessary to select those which make frequent and regular crossings of all major ocean basins, in such a way as to provide a more or less global coverage in both space and time. In addition, priority should be given to recruiting existing ASAP and /or SOOP ships to the project, as well as ships sailing in the southern ocean, Antarctic supply vessels and research ships, wherever feasible.

The choice of individual ships is best left to national VOS personnel acting through PMOs, but they must be provided with details of the ships' observing performance in the past. The initial approach should be made to shore managers at the headquarters of likely shipping lines. It will be necessary to prepare a short statement of the aims of the project and long-term benefits to the shipping industry. Ship specifications (electronic drawings, schematics, digital photographs, identification in catalogues) should be obtained by the PMOs, together with the positions of instruments (see **Attachment 2**). PMOs will need to visit individual ships to explain the project and obtain answers to the questionnaire in Attachment 3 and also to assess the likely commitment of observers to the task. Final selection of ships will take note of existing instrumentation and exposure, past performance and the general impression gained by the PMOs. Difficulties will arise where a ship is well-equipped for one parameter but not another, e.g. no anemometer but mounting a hull sensor for sea surface temperature. The value of the ship's contribution must be assessed in terms of the importance of the parameters which are acceptable.

PMOs will be required to explain the logbooks (electronic or paper), additional codes and the method of completion. Later visits will also be necessary to check that instrument exposure has not changed and discuss problems with observers. These observer "contact" visits will be extremely important in maintaining the interest of the observers and the impetus of the project. PMOs must be provided with "progress" material to leave with the observers after visits, in addition to the briefing pack used on the first visit. At a later stage in project development, consideration should be given to enhancing or upgrading instrumentation as necessary, in line with VSOP-NA recommendations.

5. Instrumentation and observations

Ideally, ships taking part in the project should have the following instrumentation and facilities:

(a) Accurate and well-exposed thermometers with precision to 0.1C;
(b) Sea surface temperature measuring instruments from hull contact sensors;
(c) Permanently-mounted, well-exposed anemometers to 0.1 m/s precision;
(d) Precision marine barometers to 0.1hPa precision, preferably connected to a static head;
(e) Electronic logbook facility, to include true wind computation, QC checks and updated encoding in the revised code forms.

It is highly unlikely that common instrumentation will be achieved, but efforts should nevertheless be made to implement those recommended in the VSOP-NA report. At the same time, the most important characteristic of all instruments remains good exposure and full documentation.

5.1 Instrument and data quality assessment

The full intercomparison of instruments is a difficult and time-consuming task. It is possible to compare typical samples of each type or source of manufacture, but often variations between members of the same type are greater than between different instruments. This problem will be addressed by intercomparison of the observations of the VOS climate subset with large-scale fields or with neighbouring ships at sea. Comparisons of real-time VOS weather observations with the predictions of Numerical Weather Prediction (NWP) models are presently carried out routinely by several national weather centres around the world. The monthly mean bias and scatter between individual ship observations and the model fields are used to identify ships that are reporting poorly or have instruments that require recalibration or replacement. This information is fed back to ships with significant scatter or bias in their observations via the PMO network. If the co-located model values for the basic meteorological variables were archived and passed to the data assembly centre this would provide valuable validation information for the ship reports. Analysis of the VOS climate subset could then be performed using a model as a comparison standard as in the VSOP-NA project. Whilst it is envisaged that NWP model data merged with individual ship reports will form the main source of information on bias and scatter for a particular ship or measurement technique, satellite data may now also form a valuable potential source of background field for certain variables. Comparison of ship observations with nearby reports from other ships is another source of validation information.

Regular checks upon the serviceability of instruments by the PMOs are essential. Calibration of temperature sensors is best performed using a water bath and it is possible to calibrate some types of wind speed sensor by mechanically rotating the propeller. Documentation of calibrations and comparisons of instruments made on visits to the ships is necessary.

5.2 Observations

The normal SHIP observation will be retained, augmented by extra code groups for additional parameters. This extra information is essential to the success of the project.

The following additional information will be needed (codes quoted in **Attachment 3**).

Ship's parameters

-Ship's speed over ground at time of observation	Code 1
-Ship's heading at time of observation	Code 2
-Height of deck cargo above summer maximum load line	Code 3
-Departure of summer maximum load line from actual sea level	Code 4

Wind (for ships with anemometers)

-Uncorrected (i.e. relative) speed and direction	Code 5
	Code 6

6. Data collection and verification

It is intended that the project should provide timely and complete information. To this end, and to ensure that no reports (or information contained in these reports) from participating ships are lost, data will be submitted in both real time and delayed mode. Real time data submission will be in the form of reports on the GTS in the SHIP code. In support of the project, the standard SHIP code will be augmented with additional optional groups in Section 2, as detailed in **Attachment 3**. Reports from participating ships will be inserted onto the GTS in the normal manner. It is the responsibility of the Data Assembly Centre (see Section 7.2 below) to identify and extract these reports on the basis of a published and continuously updated list of call signs of participating ships.

In addition, all observations will be recorded for delayed mode submission in either paper or electronic logbooks. Paper logbooks will be specially designed for the project, and will include all the additional information transmitted with the real time reports. The recruiting country will digitise these observations in revised IMMT format, apply the agreed minimum QC procedures, and forward the digital data sets to the Data Assembly Centre (on diskette or via internet) with a minimum delay. Electronic logbooks will necessitate some extension to existing procedures (e.g. TurboWIN). When these logbooks are collected by recruiting countries, they should be carefully screened for duplicates before full data sets are compiled and forwarded as detailed above.

The project will also require real time observational data monitoring, and comparison with model fields. To this end, a Real Time Monitoring Centre has been established by the U.K. Meteorological Office (which already undertakes such monitoring of ship observations on a routine basis). Observations from participating ships will be identified by this centre, and associated with co-located model field values. These data sets will also be transferred on a regular basis to the Data Assembly Centre. Terms of reference for this monitoring centre are given in **Attachment 4**.

Note that all observations under the project should also continue to be sent to the GCCs in the normal manner, as part of the MCSS.

7. Data Management procedures

7.1 Instrument exposure and other metadata

To achieve the accuracies described in section 3, it is vital to have information about the exposure of instruments and the actions necessary to allow for that exposure, as well as other metadata as detailed in the VSOP-NA recommendations. Details of metadata, including digital imagery, instrument exposure and date of any changes, and ratings of the quality of instrument exposures, will be stored in a master index of ships. This will be developed as a supplement to, but separate from the main ship catalogue (WMO-No. 47). The catalogue will be continuously updated and made available through the Data Assembly Centre, as well as distributed in hard copy form (loose-leaf) to all PMOs through the national contact points. This catalogue will contain details of the instrument locations for each ship in an agreed format. The catalogue will also contain details of the results of regular ship inspections by PMOs.

7.2 Data assembly

The data collected during the project will be collected, quality controlled and archived by the project Data Assembly Centre. The data assembly centre will create and maintain a relational database so that the information on instrument types, exposure and observing practice can be automatically associated with each observation. The database should be freely accessible to registered users. Terms of reference for the data assembly centre are given in **Attachment 4**. The National Climatic Data Center, NOAA, USA, will undertake this task.

8. Project management

The nature and scope of the project necessitate the involvement of a number of national Meteorological Services which have recruited substantial numbers of VOS operating worldwide. In particular the active participation at least of Argentina, Australia, Canada, China, France, Germany, Japan, Netherlands, New Zealand, United Kingdom and the USA is essential to the success of the project. Overall management of the project will be undertaken by a Management Group, comprising representatives of all participating countries and the OOPC. The Management Group will also require the involvement/support of the WMO Secretariat in discharging its functions. This group will have responsibility for project supervision, development of specific activities and sub-projects, allocation of responsibilities for action, review of progress, preparation of periodic reports including recommendations, and deciding on any other actions as may be necessary for the successful continuation of the project. The chairman of the Management Group will also be Project Leader, with responsibilities to act as a focal point for the project and on behalf of the Management Group, as necessary, as well as to undertake other tasks as indicated in this Project Document.

Members of the Management Group will also act as national focal points for the project, with responsibility for implementation of the project at the national level, for reporting to the Project Leader as appropriate, for agreeing to project modifications, as necessary, and for undertaking other tasks as given in this Project Document, in particular the sub-projects allocated to specific national Meteorological Services. From the national focal points, responsibilities for action will devolve to PMOs and others within national Meteorological Services and ultimately to the ships' masters. The list of project focal points is given in **Attachment 5**.

Following the initial implementation co-ordination meeting, most of the project organization and implementation may be achieved by correspondence. However, some further meetings will be necessary, to assess progress at appropriate intermediate stages and, if necessary, to refine various aspects of the project. Decisions will also eventually be required on transforming the project into an ongoing programme. An initial action plan for the project is given in **Attachment 6**.

9. Information exchange

Extensive and frequent information exchange is an essential aspect of the project. This exchange must take place among participants (including the focal points, PMOs and ships crews) and with users. A primary means for such exchange will be a special project web site, implemented and maintained by the DAC, with contributions to be made by both participants and users (see terms of reference for the DAC in **Attachment 4**). Information to be made available through the web site will include:

- metadata catalogue of participating ships
- regular project update reports
- monitoring and data application results
- data catalogues
- a project newsletter for participating ships
- links to other relevant web sites
- project focal points and other relevant contact details
- the project document and other publications
- any other information relevant to the project

The project newsletter for participating ships is an important means of regularly informing ships crews of the status of the project in general and of their own specific contributions, as well as of the applications of project data. It should thereby help to maintain interest and enthusiasm among these crews. Contributions to the newsletter should come from all participating ship operators, the DAC and monitoring centre, users and ships crews themselves whenever possible. These contributions should be sent to the project leader and Secretariat so as to allow preparation of a newsletter at least every six months (January and July). The newsletter will be transmitted by the Secretariat in electronic form to the DAC, where it will be made available on the web site in a suitable format to allow downloading by participating operators for printing and distribution to ships.

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Attachment 1

Scientific requirements and justification

1. The evolving requirements for Voluntary Observing Ship data

1.1 Introduction

For well over 100 years, the weather observations from merchant ships have been used to define our knowledge of the marine climate. This function continues within the Voluntary Observing Ships (VOS) programme as the Marine Climatological Summaries Scheme. However the main emphasis of the VOS programme has traditionally been the provision of data required for atmospheric weather forecasting. Today, the initialisation of numerical weather prediction models remains an important use of weather reports from the VOS. However recent trends, such as the increasing availability of data from satellite sensors, and the increased concern with regard to climate analysis and prediction, are making further requirements for data from the VOS.

That there is a growing need for higher quality data from a sub-set of the VOS has been identified by, *inter alia*, the Ocean Observing System Development Panel (OOSDP, 1995), the Ocean Observations Panel for Climate (OOPC, 1998), and the JSC/SCOR Working Group on Air Sea Fluxes (WGASF, 2000). The justification for improved surface meteorological data was also discussed in detail at the recent Conference on the Ocean Observing System for Climate (see paper by Taylor et al. 1999). Here we shall give examples of the requirements, the present state of the art and the potential improvements.

1.2 Examples of evolving requirements for VOS data

A. SATELLITE DATA VERIFICATION

Satellite borne sensors are now used routinely for, for example, determining sea surface temperature (SST), sea waves, and surface wind velocity. Compared to *in situ* measurements, these remotely sensed data provide better spatial coverage of the global oceans. However the data are derived from empirical algorithms and a very limited number of individual sensors. In this respect, an important role for VOS data is the detection of biases in the remote sensed data due to instrument calibration changes or changing atmospheric transmission conditions. For example, the SST analyses produced by the US National Centers for Environmental Prediction (NCEP) are used at a number of operational weather forecasting centres including the ECMWF. The NCEP analyses (Reynolds and Smith, 1994) use SST data from satellite sensors that have been initially calibrated against drifting buoy data. VOS and buoy data are used to detect and correct biases in the satellite data caused, for example, by varying atmospheric aerosol loading due to volcanic eruptions. Without these real time bias corrections, errors of several tenths K or more can occur in satellite derived SST values (Reynolds, 1999). For satellite verification purposes the need is for a dataset of accurate data with known error characteristics.

B. CLIMATE CHANGE STUDIES

The VOS data are being increasingly used for climate change studies. Assembled into large data bases (such as the Comprehensive Ocean Atmosphere Data Set, COADS, Woodruff et al., 1993) the observations have been used, for example, to quantify global changes of sea and marine air temperature (Folland and Parker, 1995). Based on such studies, the recommendations of the Intergovernmental Panel on Climate Change (Houghton et al., 1990) have led to politically important international agreements such as the UN Framework Convention on Climate Change. However the detection of climate trends in the VOS data has only been possible following the careful correction, as far as is possible, of varying observational bias due to the changing methods of observation. For example sea temperature data have different bias errors depending on whether they were obtained using wooden buckets from sailing ships, canvas buckets from small steam ships, or engine room intake thermometers on large container ships. For the present, and for the future, it is important that we better document the observing practices that are used.

C. CLIMATE RESEARCH AND CLIMATE PREDICTION

Coupled numerical models of the atmosphere and ocean are increasingly being used for climate research and climate change prediction. Because the time and space scales for circulation features in the atmosphere and the ocean are very different, the ocean surface is an important interface for model verification. The simulated air-sea fluxes of heat, water and momentum must be shown to be realistic if there is to be confidence in the model predictions. At present the uncertainty in our knowledge of these surface fluxes is of a similar order to the spread in the model predictions (WGASF, 2000). Partly this is due to the limitations of the parameterisation formulae used to calculate the fluxes. Verification of the model predictions of near surface meteorological variables (air temperature, humidity, SST etc.) against high quality *in situ* observations from moored "flux" buoys and specially selected VOS is required (e.g. Send et al. 1999, Taylor et al. 1999a).

2. The State-of-the-Art for VOS observations

2.1 What is needed?

These relatively new applications for VOS data imply a need to minimise the errors present in the observations. For example, 10 Wm^{-2} is often quoted as a target accuracy for determining the heat fluxes; it is about 10% of the typical interannual variability of the wintertime turbulent heat fluxes in mid to high latitudes. To achieve such accuracy implies that the basic meteorological fields are known to about –0.2°C for the SST, dry and wet bulb temperatures (or about 0.3 g/kg for specific humidity) and that the winds be estimated to –10% or better, say about 0.5 m/s. These are stringent requirements which we do not expect to be met by an individual VOS observation. Enough observations must be averaged to reduce the errors to the required level. The more accurate the individual VOS observations, the less averaging will be needed. Nor is averaging alone enough; corrections must also be applied for the systematic errors in the data set.

In terms of the longer term ocean heat balance even an accuracy of 10 Wm^{-2} is not adequate. A flux of 10 Wm^{-2} over one year would, if stored in the top 500m of the ocean, heat that entire layer by about 0.15°C. Temperature changes on a decadal timescale are at most a few tenths of a degree (e.g. Parilla et al., 1994) so the global mean heat budget must balance to better than a few Wm^{-2}. It is unlikely that such accuracy will ever be achieved using VOS data either alone, or combined with other data sources. Thus the calculated flux fields must be adjusted, using "inverse analysis", to satisfy various integral constraints. Inverse analysis techniques rely on detailed knowledge of the error characteristics of the data; information which is poorly known at present for the VOS data set. Thus there is an urgent need to better define the accuracy of VOS data.

2.2 What is presently achieved?

To attempt to quantify the random error in VOS observations, Kent et al. (1999) determined the root-mean-square (rms) error for VOS reports of the basic meteorological variables. Table 1 shows the minimum, maximum and mean error values for individual ship observations calculated for 30° x 30° areas of the global ocean. It is obvious that individual ship observations can not achieve the desired accuracy and that the average of many observations is needed. For example, to reduce a typical temperature error of 1.4C to the desired 0.2C requires some 50 independent observations; more when natural variability is taken into account. Sufficient observations are obtained for adequate monthly mean values in well-sampled regions like the North Atlantic but in data sparse regions acceptable accuracy cannot be achieved.

The Voluntary Observing Ship Special Observing Programme - North Atlantic project, VSOP-NA (Kent et al., 1993a), was an attempt to determine the systematic errors in VOS data. For a subset of 46 VOS, the instrumentation used was documented (Kent & Taylor, 1991), and extra information included with each report. The output from an atmospheric forecast model was used as a common standard for comparison. The results were analysed according to instrument type and exposure, ship size and nationality and other factors, and relative biases were determined. For example it was found that SST values from engine intake thermometers were biased warm compared to other methods (Kent et al. 1993a), and that daytime air temperatures were too warm due to solar heating (Kent et al. 1993b). It could be shown that the dew point temperature was not biased by the latter error (Kent and Taylor, 1996) but, compared to aspirated psychrometer readings, the dew point was biased high when obtained from fixed thermometer screens.

Table 1 - RMS Error Estimates: The uncertainty quoted in the mean error is derived from the weighted sum of the error variances (from Kent et al. 1999)

Observed Field	RMS Error:		
	Min.	Max.	Mean
Surface Wind Speed (m/s)	1.3	2.8	2.1 ± 0.2
Pressure (mb)	1.2	7.1	2.3 ± 0.2
Air Temperature (°C)	0.8	3.3	1.4 ± 0.1
Sea Surface Temperature (°C)	0.4	2.8	1.5 ± 0.1
Specific Humidity (g/kg)	0.6	1.8	1.1 ± 0.2

Some of the VOS in the VSOP-NA project reported anemometer estimated, relative wind speed in addition to the calculated true wind speed. Kent et al. (1991) showed that a major cause of error was the calculation of the true wind speed. Only 50% of the reported winds were within 1 m/s of the correct value, 30% of the reports were more than 2.5 m/s incorrect. For wind direction, only 70% were within ±10° of the correct direction and 13% were outside ±50°. These were large, needless errors which significantly degraded the quality of the anemometer winds. A similar conclusion was reached by Gulev (1999). Preliminary results from a questionnaire distributed to 300 ships' officers showed that only

27% of them used the correct method to compute true wind. The problem is not confined to VOS observations. A majority of the wind data sets obtained from research ships during the World Ocean Circulation Experiment showed errors in obtaining true wind values (Smith et al., 1999).

2.3 How can the situation be improved?

Consider as an example, wind velocity. The typical rms error for a wind speed observation shown in Table 1 (about 2.1 m/s) was achieved after instrumental observations had been corrected for the height of the anemometer above the sea surface (using data from the List of Selected Ships, "WMO47") and the visual observations corrected using the Lindau (1995) version of the Beaufort scale. For the observations as reported, the errors were nearly 20% greater - about 2.5 m/s. Alone, this change in mean accuracy decreases the number of observations required to obtain a reliable mean by a factor of 2/3rds. The quality of the anemometer winds can be further improved by using an automated method of true wind calculation such as the TurboWin system developed at KNMI. The effect on the anemometer measurements of the air-flow disturbance around the ships' hull and superstructure can be investigated using computational fluid dynamics (CFD) modelling of the airflow (Yelland et al., 1998). While it would be impracticable to model all the VOS, it is believed that typical values for the resulting error can be estimated given knowledge of the anemometer position and the overall geometry of the ship (Taylor et al. 1999b).

Similarly for the other observed variables correction schemes can be devised. For example, air temperature errors due to daytime heating of the ship depend on the solar radiation and the relative wind speed (Kent et al. 1993b). Josey et al., (1999) found that correcting the various known biases changed the climatological monthly mean heat flux by around –15 Wm^{-2} varying with area and season. For climate studies these represent significant changes.

3. Conclusions

Most of the potential improvements discussed above require detailed, accurate documentation on the methods of observation. Some of this information is available in the List of Selected Ships (WMO47) which should be augmented with information similar to that collected for the ships which participated in the VSOP-NA. Improved meta-data with regard to the ship and observing practices, and improved quality control of the observations, are the initial priorities for the VOS Climate project. Other desirable enhancements to the VOS system include increased use of automatic coding, and improved instrumentation. These are being introduced on an increasing number of VOS, and future implementation on the ships participating in the VOS climate subset should be anticipated.

The successful implementation of the VOS Climate project will represent an important contribution to the Ocean Observing System for Climate as defined by the OOSDP (1995) and the OOPC (1998).

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Attachment 2

INFORMATION REQUIRED ON FIRST RECONNAISSANCE

This information will be obtained by PMOs and, for those ships selected, be forwarded to the Data Assembly Centre for compilation of the metadata catalogue, to be made available to all participating services.

Air temperature

(a) Type of screen or housing;
(b) Type of thermometer and make;
(c) Method of estimating humidity, giving type and make of instrument used (could include sling psychrometer);
(d) Measurement location of thermometers onboard ship.

Sea-surface temperature

(a) Method of measurement, e.g. bucket, engine room intake, hull sensor, trailing thermistor or any other;
(b) Type of thermometer used;
(c) For non-bucket, location of instrument, e.g. distance inboard or depth below reference level;
(d) If a bucket is used, details of type and insulation;
(e) For bucket, agreed location of measurement. Also need location of nearby engine room and other discharges.

Wind

(a) Type of anemometer used, including whether fixed or portable;
(b) Location of anemometer and height above reference level;
(c) Averaging time used for wind speed;
(d) Units used in measuring wind speed;
(e) Is a correction applied for ship's speed and direction: if yes give details of method;
(f) How is the ship's instantaneous speed measured.

Pressure

(a) Type of barometer/barograph;
(b) Location and height above reference level;
(c) Height of pressure head above reference level (if P.H. fitted).

NOTES: (1) The location of instruments should be marked on ship's drawings, in addition to detailed written descriptions and photographs (JPEG) of such locations by the PMOs. The descriptions should also give details of any permanent structural features which will affect the observation, e.g. water outfalls, airflow obstructions, air conditioning vents, etc.

(2) The reference level to be used will be the summer maximum load line.

Attachment 3

EXTRA INFORMATION WITH EACH OBSERVATION

Ship parameters

Code 1	ss	Instantaneous ship's speed in knots at time of observation
Code 2	DD	Ship's heading in tens of degrees true
Code 3	LL	Maximum height in metres of deck cargo above summer maximum load line
Code 4	hh	Departure of summer maximum load line from actual sea level (m)

Wind

Code 5	ff	Relative speed in knots or m/s (in conformity with wind code indicator)
Code 6	DD	Relative wind direction in tens of degrees (00 to 36) off the bow.

This information will be included in Section 2 of the SHIP code, in optional groups to be introduced after the ICE groups. The groups will be prefixed by CLIM, and will be of the form 1ssDD 2LLhh 3ffDD, to be extended as required.

Attachment 4

REAL TIME MONITORING CENTRE

Terms of Reference

1. Extract GTS reports of project ships (by call sign) and decode (including additional project data).
2. Associate project observed variables (pressure, air temperature, humidity, SST, wind speed and direction) for each project ship with co-located model field values (4 times daily).
3. Compile data sets of observations and associated model field values and transfer to the Data Assembly Centre (daily/monthly).
4. Provide existing ship monitoring statistics for all VOS to Data Assembly Centre.

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DATA ASSEMBLY CENTRE

Terms of Reference

1. Extract GTS reports of project ships (by call sign) and decode (including additional project data).
2. Receive the real time reports from the Real Time Monitoring Centre
3. Collect delayed mode reports of project ships from participants.
4. Merge real time and delayed mode reports, eliminate duplicates and compile a complete project data set.
5. Collect metadata and survey reports for project ships and compile a complete data set.
6. Make project data sets available to users on request.
7. Maintain a project web site, information exchange mechanism and electronic newsletter.

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Attachment 5

LIST OF FOCAL POINTS

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Attachment 6

PRELIMINARY ACTION PLAN

ACTION	WHOM	WHEN
1. Agree project leader and national focal points	Meeting	Done
2. Identify and agree Real Time Monitoring Centre/terms of reference	UKMO/NCEP	February 2000
3. Identify and agree Data Assembly Centre/terms of reference	NCDC/DWD/UKMO	February 2000
4. Implement agreed SHIP code change	WMO/CBS	6 months
5. Implement agreed IMMT format change	WMO/JCOMM	April 2000
6. Develop and implement required electronic and paper log changes	KNMI/USA, participants, WMO	6 months (dependant on 4 and 5)
7. Develop, agree, distribute draft project promotional material	P. Taylor, V. Zegowitz, WMO with participants	March 2000
8. Finalize project plan	WMO, Project Leader	February 2000
9. Design/agree ship survey/ship inspection report form	SOC, BOM, NWS, Project Leader, with participants	March 2000
10. Design Metadata catalogue (No. 47) supplement	WMO, DAC, JCOMM	August 2000
11. Design ship award, project name and project logo	V. Zegowitz, Project Leader, WMO, participants	July 2000
12. Undertake preliminary ship identification	Participants	Before next meeting
13. Convene second project meeting	WMO, Project Leader, DAC to host	September/ October 2000