Annex XII

EDITORIAL AMENDMENTS TO CHAPTER 3 OF THE GUIDE TO MARINE METEOROLOGICAL SERVICES

CHAPTER 3

MARINE CLIMATOLOGY

3.1 Introduction

Preparation of climatological charts and atlases for oceans became possible in the second half of the nineteenth century when ships' observations, recorded in special meteorological logbooks, started to become available in rapidly increasing numbers. For over 100 years these charts and atlases were prepared nationally, mainly for use by shipping; for this purpose countries used to ask for observations stored in other countries to supplement their own data sets.

The proposal for international exchange of marine data and for the preparation of marine climatological summaries originated at the third session of ~~CMM~~JCOMM in 1960 and was finally adopted by Fourth Congress of WMO in 1963. The object of the system was to establish a joint effort of all maritime nations in the preparation and publication of climatological statistics and charts for the oceans. The underlying idea was that all observations collected from ships of whatever nationality should be included. Eight countries, each with a specific ocean area of responsibility, were designated who were willing to process the data in prescribed forms and regularly publish the climatological summaries.

To improve the flow of the observational data, ~~CMM~~JCOMM at its eleventh session in 1993 decided on the establishment of two global data collecting centres and this decision was ratified by Executive Council at its 45th Session in 1993.

Marine climatology today supports transportation, engineering and the basic and applied sciences with data and information about the environment from a few tens of metres below the sea surface to a few tens of metres above. The interest in climate change and studies of air-sea interaction have increased the demand for marine climatological data. A comprehensive account of the uses of marine climatology can be found in the Guide to the Applications of Marine Climatology (WMO-No 781).

The basic sources of data are ships, buoys, satellite, aircraft and a few other specialised sensing systems such as land-based radar. New technology is having a significant impact on the traditional methods in marine climatology. Telecommunications advances have led to an increase in the amount of data captured automatically and a decrease in manual key entry requirements. High density ~~magnetic tape~~computer readable media for use on large computers is now the standard method of data exchange. Computers allow for automated quality control and data validation. Automation in analysis and mapping allows derived quantities such as heat, heat flux, wind stress and atmospheric refractivity to be computed from operationally available data. Data can be used in computer models to generate fields of sea surface temperature, pressure and wind. As well as provision on paper-based media, data can also be provided on ~~diskette~~ computer readable media for analysis on personal computers. Compact Disc — Read Only Memory (CD-ROM) technology allows a vast amount of data to be provided on one disc and the data can be displayed in chart, map or graphical form.

3.2 Marine climatological summaries

3.2.1 *General*

The establishment of the international exchange and processing arrangements described above for the "Marine Climatological Summaries Scheme", as it is called, required the cooperation of all maritime countries participating in the WMO Voluntary Observing Ships' Scheme, i.e. those which have recruited selected, supplementary or auxiliary ships. (See Chapter 6 of this Guide.)

In this system the oceans and seas are divided into areas of responsibility and eight Members (called "responsible Members") have assumed responsibility to prepare marine climatological summaries without cost to WMO. Data from fixed ship stations within the area are also included. For this purpose, the responsible Members receive, through the global collecting centres, surface observations from all Members operating voluntary observing ships and/or fixed ship stations, in their respective areas of responsibility in an internationally accepted format.

The international procedures governing the Marine Climatological Summaries Scheme have the status of Technical Regulations within WMO and are included in the Manual on MMS, Volume I, Part I, Section 5.

3.2.2 *Members responsible for the preparation of summaries*

The responsible Members and the areas allotted to them are shown in Annex 3.A to this Chapter. The boundaries of the areas of responsibility are kept under review by ~~CMM~~JCOMM. Adjustments, however, should be kept to a minimum.

Climatological summaries are prepared for a number of small areas, called "representative areas" and for fixed ship stations within the assigned area of responsibility. The representative areas were selected on the basis of the density of available data, climatic gradients and factors such as the position of fixed ship stations and island stations. There is a reasonable distribution of representative areas throughout all areas of responsibility. An example of the representative areas in one area of responsibility is shown at Annex 3.B to this Chapter. The Area Indices System is explained in Part (b) of this Annex.

All responsible Members are represented on the ~~CMM~~JCOMM Working Group on Marine Climatology, which keeps the Marine Climatological Summaries Scheme under review, particularly with regard to the rapidly changing technology in the processing, storage and supply of large volumes of data.

3.2.3 *Global Collecting Centres*

Two responsible Members (Germany and the United Kingdom) operate Global Collecting Centres, which receive ships' observations from all Members. These centres then supply the data to the responsible Members. Two centres are maintained so that a data set will still be available in the event of some catastrophe happening at one Centre.

The global collecting centres ensure that minimum quality control has been applied to the data, and then supply, every three months, data to the responsible Members relevant to each one's area of responsibility. The global collecting centres will provide a global data set to those responsible Members who wish to receive it.

The data are then sent to both global collecting centres, i.e. two copies of each data set are required, one for each centre. The data should be dispatched at three-monthly intervals. The Member sending the data should notify the global collecting centres of the dispatch of the data, and advise details of the order in which the data are sorted.

3.2.4 *The flow of observational data to responsible Members*

Marine meteorological observations are recorded on board most ships in special meteorological logbooks provided by national Meteorological Services. Members operating voluntary observing ships and/or fixed ship stations should arrange for the provision of a suitable form of meteorological logbook. Details of the layout of the logbook are to be found in Chapter 6, paragraph 6.8.1 of this Guide.

The observations are transferred from the log-books to a computer-compatible medium, in a standard internationally agreed format. Every effort should be made to apply minimum quality control to the data. Details of this transfer and associated quality control are to be found in paragraphs 3.2.8 and 3.2.9 below.

An increasing number of ships are being equipped with a personal computer and a program which stores the observations on diskette in the internationally agreed format. This avoids manual data transfer from logbook to the computer-compatible medium and a source of possible errors.

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3.2.5 *Preparation of marine climatological summaries*

The detailed procedures for the preparation of marine climatological summaries are described in the Manual on MMS, Volume I, Part I, Section 5.3. Summaries are prepared in both tabular and chart form, and normally include air and sea surface temperature, dew-point temperature, visibility, weather, wind direction and speed, atmospheric pressure, clouds and waves. A necessary minimum number of observations is specified before a mean can be calculated for a given area. Routine publication of annual summaries ceased in 1981, although they are available on request and responsible Members may still publish them if they wish. Decadal climatological summaries are prepared for each decade 1961–70, 1971–80, 1981–90. In view of the importance ascribed to this work by ~~CMM~~JCOMM, Members are encouraged to continue their publication.

3.2.6 *Availability of summaries and observational data*

Responsible Members keep the Secretariat informed of the availability of their marine climatological data and published summaries so that an inventory can be compiled annually and circulated to Members for information.

Responsible Members will make available, on request, copies of the data at the cost of copying. The data will be on ~~magnetic tape~~computer readable media in the international exchange format, unless another format has been agreed between the requesting and responsible Members.

Orders for marine climatological summaries, or for observational data, should be addressed directly to the responsible Member concerned and not to the Secretariat.

3.2.7 *Data exchange formats*

It is essential to use standard data formats to facilitate international exchange of data for climatological purposes, particularly when so much of the processing is automated. The standard format for provision of data to responsible Members is the International Maritime Meteorological Tape (IMMT) format. ~~If exchanged on magnetic tape, this tape should be 9-track and written at a density of 1 600 or 6 250 bits per inch. The tapes should be unlabelled and written in EBCDIC of ASCII with blocking factor 10.~~ Other forms of data exchange may be used, such as diskettes, provided the format of the data complies with the details as set out in Annex 3.C to this Chapter. The technology for data transfer is changing rapidly, and it will be necessary for the means of data exchange to keep up with the current technology.

A second format, which may be used for national and bilateral exchange of data, is set out in Annex 3.D. Any alternative format must only be used by mutual agreement between the two Members which are exchanging data.

Members wishing to exchange their observational data on media other than magnetic tape, e.g. print-outs in the case of very small numbers of observations, or diskette, or tape cartridge, should arrange for their exchange on a bilateral basis.

3.2.8 *The historical sea surface temperature data project*

Because of the importance of the sea temperature in climatic change, the Historical Sea Surface Temperature Data Project has compiled a comprehensive, homogeneous set of sea surface temperature data for the period from 1861 to 1960 (i.e. for the century preceding the beginning of the Marine Climatological Summaries Scheme). A User's Guide to the Data and Summaries of the Project has been published as Marine Meteorology and Related Oceanographic Activities Report No. 13 (WMO/TD-No. 36).

Members having historical data which have not been included in the Project should send those data to the global collecting centres in the IMMT format. The data should be accompanied by documentation describing the source of the data, the precision of the original observations and conversion algorithms. For example, if the original observations recorded the visibility in terms of poor, moderate, good etc. an explanation is needed of how these terms have been converted into distances in kilometres.

3.2.9 *Quality control*

3.2.9.1 GENERAL

The accuracy of data is of primary importance to climatological computations and scientific investigations. It is essential that marine data are quality controlled before exchange. Quality control means the checking of the content, including identification groups, of observational data to ensure its accuracy. Quality control procedures for climatological data in general are described in the Guide to Climatological Practices (WMO-No. 100). Quality control has been incorporated in WMO's CLICOM (CLImate COMputing) programme, and can be used for small marine data sets. A discussion of quality control of marine data can be found in Chapter 3 of Guide to the Applications of Marine Climatology (WMO-No 781).

Errors can arise:

(a) On board ship by misreading an instrument, malfunction of a~~n automatic~~ sensor, or in entering the observation in the logbook;

(b) In transcribing the data on to ~~magnetic tape~~computer readable media.

In the case where the data are taken from SHIP reports on the GTS, errors can arise in transmission.

3.2.9.2 MINIMUM QUALITY CONTROL

The primary responsibility for the quality control of data rests with the national Meteorological Service from which the data originated. All Members should make every effort to apply the minimum quality control procedures described in Annex 3.E before dispatching the data to the global collecting centres. This quality control includes checks that the observation of each element is within the possible range, that the change in position between observations is within reasonable limits, that call sign and country code have been included. There is space in the IMMT format for 20 quality control flags. These indicators show whether the element has been flagged as doubtful or whether it has been corrected. A problem which often arises is deciding whether an observation is an error or an actual extreme value. Generally care should be exercised in correcting doubtful values; suspect observations may be real extremes of special meteorological interest.

Meteorological logbooks can be scrutinised manually before data transfer to eliminate obvious observational and recording errors. However the minimum quality control should be carried out after transfer to ~~magnetic tape~~computer readable media to allow for transcription errors. The quality control is best carried out automatically by computer and programmes are available for this purpose.

It is of the utmost importance that Members should make adequate provision for quality control of data to ensure that they are as free from error as possible. The global collecting centres ensure that this minimum quality control has been carried out, and further quality control may be applied to the data by the responsible Members.

3.3 Special marine climatological information

In addition to the elements in the IMMT format, which are used in the production of standard marine climatological summaries, there are other observations of interest to many marine interests. Two specific observation systems which have been instituted relate to freak waves and to sea-surface current data.

3.3.1 *Reports of freak waves*

The occurrence of unusual waves, and occasional distress to vessels as a result, has been noted at times over many years, but accurate observations are rare. A freak wave may be defined as a wave of very considerable height ahead of which there is a deep trough. It is the unusual steepness of the wave which is its outstanding feature and which makes it dangerous to shipping. All marine observers, at fixed or mobile stations, are encouraged to observe and report any such occurrences.

Guidelines for reporting freak waves can be found at Chapter 6, Annex 6.C of this Guide. Procedures for the dealing with reports of freak waves are given in the Manual on MMS, Volume I, Part I, Section 6.2.1

3.3.2 *Exchange of sea-surface current data obtained from ships' set and drift*

To increase our knowledge and prepare climatic charts of the general surface circulation of the oceans, more information is required on sea-surface currents. The current can be derived from the ship's set and drift, and this does not require special instrumentation; any ship willing to participate can contribute to the data base. Guidelines for giving instructions to vessels for the collection of these data are included in Chapter 6, Annex 6.D of this Guide.

The International Surface Current Data Centre (ISCDC) is located in the United Kingdom. The ISCDC receives data on ~~magnetic tape~~computer readable media and completes quality control after receipt. National Meteorological Services may wish to check observations before passing to the ISCDC. The procedures covering the collection and exchange of these data, and the functions of the ISCDC are given in the Manual on MMS, Volume I, Part I, Section 6.2.2.

The ISCDC provides each year a copy of the stored data to the World Data Centres for Oceanography, and will provide copies of the stored data on request for the usual charges for data retrieval.

3.3.3 *Special techniques for other parameters*

Requirements arise for information on other parameters, or for more detailed analyses of some parameters included above. Waves are among the most complex and important elements at the surface of the sea. In addition to visual observations from ships, they can be measured by wave recorders on fixed platforms. Wave climatologies are often derived by means of hindcasts, whereby all available historical data (predominantly wind data) is re-analysed for input into suitable wind and wave computer models for calculation of the wave characteristics. More information on these techniques can be found in the Guide to Wave Analysis and Forecasting (WMO-No. 702) and in the Guide to the Applications of Marine Climatology (WMO-No. 781).

The extreme value of elements such as wind, wind gusts and waves is of great interest for coastal engineering and there are statistical means of estimating the extreme value from a set of observations. However the problem is that in an extreme weather event, ~~ground based~~ sensors are often destroyed or damaged, while the feedback signal to a satellite is so attenuated that it is impossible to determine a reliable extreme value. Thus a set of observations may not indicate the true extremes which have been experienced.

Sea-surface temperature, radiant flux, cloud and some wind data can be extracted from special satellite data sets. A far greater coverage of sea surface temperature data can be obtained by satellite than from ships which mostly travel regular shipping lanes. However, observations from ship and from satellite are not directly compatible. The satellite measures the temperature of the very top of the sea, the ship measures the temperature ~~at a depth of hundreds of~~ from a few centimetres down to several metres. The two measurements can be very different, particularly in calm weather. Special techniques have been developed to homogenize the two types of observation.

The requirement for a climatology of some elements, required more for global climate studies than marine purposes alone, is not yet able to be satisfied, e.g. for precipitation over the ocean.

3.4 Presentation of climatological data

3.4.1 *General*

Climatological data can be presented in many different forms. They can be shown as long-term averages or as mean values for particular months. They usually include frequencies of occurrence of extremes or other values which are thought to be critical with respect to particular operations. Analyses can disclose statistical relationships between parameters such as wind speed and direction, wave height and period, fog and air/sea temperature difference, etc. Optimum time and space scales are often dictated by the necessary statistical tests for homogeneity of data applied with a realistic understanding of the requirements. Even so, the factor of data availability often forces compromise. Automated treatment of marine data allows the objective production of analysed charts and gridded data fields. This allows easier compilation of climatological summaries over greater time spans. A comprehensive treatment of the analysis, presentation and interpretation of marine climatological data can be found in the Guide to the Applications of Marine Climatology (WMO-No. 781).

Marine data comes from many varied sources and periods from varied instruments. Care needs to be taken in the combination of data from varied sources, and prime attention must be given to consistency and continuity, and to scrutiny of historical data, especially when long periods are being considered. Care must be taken with the combination of standard and non-standard period statistics, and with the use of satellite, buoy and ocean weather station data as reference levels or with extrapolation into data-sparse regions.

3.4.2 *Climatological charts*

The layout for marine climatological summary charts for representative areas is shown in the Manual on MMS, Volume I, Part I, Appendix I.9. There are many other ways of displaying the data in chart form, and several national Meteorological Services have published marine climatological charts and atlases based on data observed in periods since 1860. These charts were prepared primarily to serve marine navigation, but contain useful information for fisheries and other marine operations. Data are usually presented for individual months as an average over the entire period for which data were available. The Mercator projection has usually been used, but others may be employed for special requirements, and charts may also include numerical data, graphs, isopleths and other additional data presentation.

Elements covered by these charts may include:

(a) Surface wind: Frequency distribution of wind speeds in 8 points of the compass (wind rose); wind directions, mean vector of wind speed and prevailing wind direction; frequencies of light winds, gales and storms; bivariate normal statistics;

(b) Surface currents: The same presentation as for wind, including frequencies of currents exceeding certain speeds;

(c) Waves (sea and swell): Wave charts of frequencies of total wave height, usually the higher or a combination of sea and swell. Swell charts depict frequencies of short, medium and long swell in 4 or 8 directions (compass points). Wave charts based on data observed since 1949 (when a new code allowed more detail to be given in ships' observations of waves) give frequencies of waves exceeding given height limits in various directions and sometimes also indications of wave periods.

(d) Visibility: Frequencies of visibility of less than 1 km (fog) and other ranges;

(e) Precipitation and cloud cover: Precipitation given as frequencies or percentages of the number of hours during which precipitation was observed. Frequencies of various degrees of cloud cover (total and low) and heights;

(f) Temperatures, air and sea surface: Isotherms at regular intervals, mean values and standard deviations of the frequency distribution for small areas; percentage occurrence of critical threshold values;

(g) Humidity: Mean values of dew-point temperature; various statistics involving relative humidity, wet bulb and dew point;

(h) Air pressure; pressure systems: Isobars and, on some atlases, frequencies of deep extratropical cyclones with depiction of storm tracks;

(i) Tropical cyclones: Frequencies of occurrence, tracks of individual cyclones, distribution for the months of the year, intensities and intensity changes during the life history of a cyclone etc.;

(j) Sea ice and icebergs: The geographical distribution of different types of sea ice and of icebergs for each month, charts of probability of various positions of ice edge and boundaries of ice patterns with different ice compactness, ice convergence and divergence zones etc.;

(k) Derived quantities: Heat flux, transport data, refractivity, superstructure icing potential, atmospheric stability etc.

3.4.3 *Atlases and CD-ROMs*

The Executive Council at its 38th session in 1986 approved a recommendation of CCl (which had the agreement of ~~CMM~~JCOMM) that the marine section of the World Climatic Atlas was no longer required. This decision was taken in view of the existence of a number of other global and regional marine climatic atlases. Individual Members are encouraged to prepare such atlases.

~~Compact disc — Read Only Memory (CD-ROM)~~Modern computer technology allows a vast amount of data to be provided on one disc and the data can be displayed in chart, map or graphical form. CD-ROMs are becoming available which display marine climatological data in at least some of the ways described in paragraph 3.4.2 above.

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ANNEX 3.C

LAYOUT FOR THE INTERNATIONAL MARITIME METEOROLOGICAL TAPE (IMMT) [VERSION IMMT-1]

(See paragraph 3.2.7)

NOTE: Blanks entered in a record represent missing data

Element Number	Character Number	Code	Element	Coding procedure
1	1	i_T	Format/temperature indicator	3=IMMT format with temperatures in tenths of °C 4=IMMT format with temperatures in halves of °C 5=IMMT format with temperatures in whole °C
2	2–5	AAAA	Year UTC	Four digits
3	6–7	MM	Month UTC	01 - 12 January to December
4	8–9	YY	Day UTC	01 - 31
5	10–11	GG	Time of observation	Nearest whole hour UTC, WMO specifications
6	12	Q_c	Ouadrant of the globe	WMO code table 3333
7	13–15	$L_aL_aL_a$	Latitude	Tenths of degrees, WMO specifications
8	16–19	$L_oL_oL_oL_o$	Longitude	Tenths of degrees
9	20		Cloud height (h) and visibility (VV) measuring indicator	0 - h and VV estimated 1 - h measured, VV estimated 2 - h and VV measured 3 - h estimated, VV measured
10	21	h	Height of clouds	WMO code table 1600
11	22–23	VV	Visibility	WMO code table 4377
12	24	N	Cloud amount	Oktas, WMO code table 2700; show 9 where applicable
13	25–26	dd	True wind direction	Tens of degrees, WMO code table 0877; show 00 or 99 where applicable
14	27	i_w	Indicator for wind speed	WMO code table 1855
15	28–29	ff	Wind speed	Tens and units of knots or metres per second, hundreds omitted; values in excess of 99 knots are to be indicated in units of metres per second and I_w encoded accordingly; the method of estimation or measurement and the units used (knots or metres per second) are indicated in element 14
16	30	s_n	Sign of temperature	WMO code table 3845
17	31–33	TTT	Air temperature	Tenths of degrees Celsius
18	34	s_t	Sign of dew-point temperature	0 - positive or zero measured dew-point temperature 1 - negative measured dew-point temperature 2 - iced measured dew-point temperature 5 - positive or zero computed dew-point temperature 6 - negative computed dew-point temperature 7 - iced computed dew-point temperature

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ANNEX 6.D

GUIDELINES FOR THE OBSERVATION AND RECORDING OF SEA CURRENT DATA ON BOARD SHIP, AND AN EXAMPLE OF A SPECIAL LOG SHEET

(Reference paragraph 6.4.5)

(i) Guidelines

1. *Introduction*

The knowledge which we now posses regarding surface currents in the world seas is, for the most part, based on information from current observations taken on board ships.

The systematic collection of surface current information had already begun in the middle of the nineteenth century. The famous Lieutenant Matthew F. Maury, of the U.S. Navy, was one of the first who saw the importance of gathering wind and current data from ship logbooks. In 1845, he published the first of a series of “Wind and current charts”.

For constructing current charts, as many observations as possible are required, covering many years. As the variability of local currents can be examined only on the basis of a large number of observations, and as the number needed has not been reached for any place at sea, there is still a great need of current observations, especially from areas less frequented by ships outside the major shipping lanes. More observations are also needed to establish, year to year, variations in currents, as some of these are of great significance for marine science, e.g., the El Niño. The only way of obtaining enough observations is by the cooperation of voluntary observers.

By making and reporting observations of currents experienced, the seaman not only gains practical knowledge himself, but benefits shipping generally by adding to our statistical knowledge, so that up-to-date information can be published.

2. *Methods of ocean-current observations and some definitions*

The method of making current observations is to calculate the difference between the dead reckoning (DR) position of the ship after making due allowance for leeway, and the position by a reliable astronomical, land, radio, radar, electronic or satellite fix. The result is the set and drift over the ocean floor experienced by the ship during the interval since the previous reliable fix was obtained, and applies to a mean depth of about half the ship’s draught.

The ~~sea~~ set *of current* is the direction in which it acts; that is the direction toward which it flows. So, the current set is from the DR position to the fix.

The *drift of a current* is the distance measured in nautical miles from the DR position to the fix.

The *leeway* is the angular difference between the ship’s cource and the ship’s direction of movement through the water (i.e., the direction shown by the wake). Leeway occurs when a ship is subjected by the wind to a pressure from a beam. The angle is rarely more than a few degrees, but there is a considerable loss of accuracy in the observation of current if a realistic allowance is not made for leeway.

The *“FROM”* position is the true position at the beginning of the stretch over which the current is calculated.

The *“TO”* position is the true position at the end of the stretch over which the current is calculated.

The dead reckoning (DR) position is the position of the ship determined by applying to the last well determined position (the “FROM” position), the run that has since been made, using only the true courses steered (corrected for leeway, if necessary) and the distance run, as determined by log or engine revolutions, without considering current. It is important that the true course is corrected for the influence of the wind, so that the difference between the DR position and the true fix is caused only by the current.

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ANNEX 6.H

MARITIME METEOROLOGICAL PUBLICATIONS PRODUCED BY NATIONAL SERVICES AND INTERNATIONAL ORGANIZATIONS OF INTEREST TO SEAFARERS AND MARINE OBSERVERS

(Reference: paragraph 6.11)

Title of Publication	Editions per year	Country of origin	Language
Boletín Climático Marino	3	Cuba	Sp.
Met Mar	4	France	F
Guide de l'Observateur Meteorologiste en Mer	1	France	F
Der Wetterlotse	6	Germany	German
Newsletter for Hong Kong V.O.S.	2	Hong Kong	E
Ship and Maritime Meteorology (Fune to Kaijou Kishou)	3	Japan	Japanese
~~Monthly Bulletin, North Sea~~	~~12~~	~~Netherlands~~	~~E~~
Schip en Werf de Zee	11	Netherlands	Dutch
Meteorologisch Informatie Bulletin Maritiem	4	Netherlands	Dutch
Monthly Weather Summary	12	Qatar	E
Marine Observer	4	United Kingdom	E
IMO News	4	United Kingdom	E
Mariners Weather Log	4	United States	E
Storm Data	12	United States	E
WMO Bulletin	4	Switzerland	E, F, R, Sp.

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