WORLD METEOROLOGICAL ORGANIZATION

INTERGOVERNMENTAL OCEANOGRAPHIC COMMISSION (OF UNESCO)

JOINT WMO/IOC TECHNICAL COMMISSION FOR OCEANOGRAPHY AND MARINE METEOROLOGY (JCOMM)
EXPERT TEAM ON MARINE CLIMATOLOGY

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SECOND SESSION

ITEM 8.2

GENEVA, SWITZERLAND, 26 TO 27 MARCH 2007

Original: ENGLISH

MANUALS, GUIDES AND OTHER TECHNICAL PUBLICATIONS

Review of the Guide of Marine Meteorological Services

(Submitted by the Secretariat)

Summary and purpose of document

This document contains extracts from the *Manual on Marine Meteorological Services* (WMO-No. 558) and the *Guide to Marine Meteorological Services* (WMO-No. 471).

ACTION PROPOSED

The Expert Team on Marine Climatology is invited to:

(a) Review the extracts from the Manual and Guide and make a proposal on amendments to them as appropriate, based on discussion under relevant agenda items;
(b) Recommend future complete electronic availability of both documents.

Appendices: A. Marine Climatological Summaries Scheme - Extract from the *Manual on Marine Meteorological Services* (WMO-No. 558)
B. Marine Climatology - Section 6 of the *Guide to Marine Meteorological Services* (WMO-No. 471) (full electronic version not available).

(Note: Both of the Appendices are partly reconstructed electronic documents. An electronic version of the latest *Manual* was not readily available, thus Appendix A includes changes that should reflect the latest version. No electronic version of the full *Guide* is currently available, and it should be noted that this reconstruction of Section 6 includes some minor wording changes that were proposed by the ETMC-I, but not taken up by JCOMM-II, and the reconstruction differs in that respect from current printed version of the *Guide*)

DISCUSSION

Excerpts from the WMO Publication No. 558, *Manual on Marine Meteorological Services*, and the WMO Publication No. 471, *Guide to Marine Meteorological Services* are provided in Appendices A and B respectively. These excerpts include the all the revisions listed below.

While the revisions under (c.) were proposed by the ETMC-I, they inadvertently were not taken up by the JCOMM-II, and it is suggested that they be reconsidered for the upcoming JCOMM-III. Thus, is should be emphasized that that current printed version of the *Guide* does not include the revisions under (c.).

The Expert Team on Marine Climatology (ETMC) is invited to review these portions of the *Manual* and the *Guide* and to make a proposal on amendments, if necessary and/or appropriate.

(a.) Changes adopted by JCOMM-I

Recommendation 8: Adoption of IMMT-II format (*Manual* and *Guide*)
Recommendation 9: Adoption of MQCF-IV (*Manual* and *Guide*)
Recommendation 10: Additional amendments to the *Guide*
Annex to Recommendation 10:
Add at the end of the first paragraph of Section 3.2.9.2 — Minimum quality control:
Nevertheless, it is stressed that, while flagging data as doubtful is an accepted procedure, all efforts should first be made to correct those data.
Delete entirely Section 3.3.2 - Exchange of sea surface current data obtained from ships' set and drift.
Maintain Annex 6.D of the *Guide* associated with Section 3.3.2, as documented metadata of the procedures previously used.

(b.) Changes adopted by JCOMM-II

Recommendation 9: Modifications to the International Maritime Meteorological Tape (IMMT) format and Minimum Quality Control Standards (MQCS)
Annex I to Recommendation 9: IMMT-III format (*Manual* and *Guide*)
Annex II to Recommendation 9: MQCS-V (*Manual* and *Guide*)

(c.) Revisions proposed by the ETMC-I to the *Guide* (note: three typos, corrected in Appendix B, are followed by "[sic]")

Para 3.2.4 Marine meteorological observations are recorded o-board [sic] most ships in special meteorological logbooks provided by NMSs. Members operating voluntary observations [sic] ships and/or fixed ship stations should arrange for the provision of a suitable ~~form~~ of [sic] meteorological logbook which can be in hard-copy or electronic format. Details of the layout of the hard-copy logbook are to be found in Chapter 6. Paragraph 6.8.2 of this Guide.
The observations are transferred from the hard-copy logbooks to a computer compatible medium…

Para 3.2.7 ....Any form of data exchange on computer readable media may be used, ~~such as diskette.~~

Para 3.2.9.2 ... There is space in the IMMT format for ~~20~~ quality control flags

Para 3.2.9.2 ... for this purpose. Minimum quality control software is available from GCCs upon request

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Appendices: 2

APPENDIX A

EXCERPTS FROM THE EXTRACT FROM THE MANUAL ON MARINE METEOROLOGICAL SERVICES (WMO-NO. 558)

5. MARINE CLIMATOLOGICAL SUMMARIES SCHEME

NOTE: The international arrangements regarding the Marine Climatological Summaries Scheme are based on Resolution 35 (Cg-IV), Recommendation 36 (68-CMM), Recommendation 6 (CMM-VI), Recommendation 15 (CMM-VII), Recommendation 35 (79-CMM), Recommendation 6 (CMM-VIII), Recommendation 8 (CMM-VIII), Recommendation 12 (CMM-X) and Recommendation 11 (CMM-XI).

5.1 Principles

The principles of the Marine Climatological Summaries Scheme are as follows:

Principle 1
The oceans and seas are divided into eight areas of responsibility for the purpose of preparing the marine climatological summaries and with a view to continued international co-operation regarding the collection, archiving and exchange of marine data.

Principle 2
Members having assumed responsibility for the respective areas as shown in Appendix I.5 — hereinafter called responsible Members — prepare climatological summaries for their area of responsibility. The preferred method of producing summaries is the chart form. However, Members may prepare, without cost to the World Meteorological Organization, climatological summaries in tabular form for selected representative areas. The tabular form of the summaries is to be used for fixed ship stations. The procedures are specified in paragraph 5.3.

Principle 3
Two responsible Members operate global collecting centres as shown in Appendix I.6. Members operating fixed ship stations or selected, supplementary and auxiliary ship stations make available all surface observations from these stations to both global collecting centres in accordance with the procedures specified in the agreed plan. The cost of this work is borne by the Member operating the ship stations.

Principle 4
Global collecting centres ensure that minimum quality control has been applied to the data, and exchange the data collected with each other, to ensure that both have a complete data set. Global collecting centres ensure that one copy of the global (update) data is sent quarterly to those responsible Members which wish to maintain a global data set — otherwise a data set for their area of responsibility is sent to the remaining responsible Members. The cost of this work is borne by the Members operating the global collecting centres.

Principle 5
Responsible Members make available, on request, copies of marine climatological data on magnetic tape in the agreed international exchange format (IMMT). The Member making the request may be asked to bear the cost of copying the data. Other formats may be agreed between the requesting Member and the responsible Member provided that the requesting Member undertakes to bear the additional expenditure involved.

5.2 Areas of responsibility

Each responsible Member shall prepare climatological summaries of observations made after 1960 in accordance with the agreed plan (Appendix I.8), in chart form for its area of responsibility, in tabular form for a number of selected representative areas in its area of responsibility, or in tabular form for a number of fixed ship stations within its area and for fixed ship stations operated solely by the responsible Member in the area of another responsible Member.

5.2.1 Boundaries of areas of responsibility

5.2.1.1 The areas of responsibility shall be as given in Appendix I.5.

5.2.1.2 Examination of the boundaries of areas of responsibility with a view to making recommendations for adjustment shall be the responsibility of the Commission for Marine Meteorology (CMM). Such adjustments may become necessary if other Members wish to become responsible Members. Alternatively, existing responsible Members may find that it is necessary to adjust boundaries.

5.2.1.3 Adjustments of boundaries of areas of responsibility should be kept to a minimum.

5.2.2 Polar and extra-polar regions

For the purpose of marine climatological summaries, polar regions are defined as extending poleward from latitudes 60°N and 50°S, respectively.

5.2.3 Selected representative areas

NOTE: This section applies only if the tabular form of summaries is produced.

5.2.3.1 Each responsible Member shall propose a number of selected representative areas from within its assigned area of responsibility. These areas should be chosen to achieve a good density of data or because of other requirements, such as climatic gradients and related factors.

5.2.3.2 Responsible Members shall submit the list of areas selected to the president of CMM who will ensure that the final choice of the selected representative areas, proposed by the responsible Members, provides a reasonable distribution throughout all areas of responsibility.

5.2.3.3 The indices system, which is given in Appendix I.7 shall be used to code the extent and location of the selected representative areas.

5.2.3.4 The selected representative areas shall remain fixed in their size, shape and position for as many years as possible.

NOTE: The recommended maximum size of a selected area in polar regions is 50 one-degree squares.

5.2.3.5 A map (or maps) showing the distribution of the selected representative areas in each area of responsibility shall be included in the summaries for that area.

5.2.4 Fixed ship station area/ocean island stations/moored buoys and fixed platforms

5.2.4.1 The “on station” area should be defined for each fixed station. This area should consist of the smallest number of adjacent one-degree squares, centred on the nominal fixed position, which contain at least 95 per cent of the observations from the fixed station.

5.2.4.2 It should be left to the discretion of the responsible Members to publish data from ocean island stations located in data-sparse areas as supplements to the marine climatological summaries. The island data summaries should not be combined with summaries of ocean data and a warning to this effect must be included in the supplements. Data from ocean island stations should be published in the same form as for fixed ship stations.

5.3 Procedures for preparing marine climatological summaries

5.3.1 General plan

The plan for the production of marine climatological summaries is shown in Appendix I.8.

5.3.2 Layout of marine climatological summaries

5.3.2.1 CHART FORM

The layout of the marine climatological summary in chart form is given in Appendix I.9.

5.3.2.2 TABULAR FORM

The parameters to be included in the tabular form of marine climatological summaries are given in Appendices I.10, I.11 and I.12.

5.3.3 Period of marine climatological summaries

5.3.3.1 ANNUAL SUMMARIES

The routine publication of annual summaries ceased in 1981 (Recommendation 6 (CMM-VIII)). However, annual climatological summaries may be published by the responsible Members on an

optional basis, preferably in chart form. The processing of data shall be continued so that the original observations will be readily available upon request.

5.3.3.2 DECADAL SUMMARIES

Decadal climatological summaries shall be prepared for the periods 1961–70, 1971–80, 1981–90.

5.4 Minimum number of observations for the preparation of the marine climatological summaries

5.4.1 General

All available data shall be used in the preparation of annual and decadal summaries.

5.4.2 Annual summaries

5.4.2.1 The annual mean for any unit area or selected representative area should not be calculated if there are less than 10 observations from the area in any individual month.

5.4.2.2 Statistics for chart areas and frequency tables should not be prepared if there are less than 10 observations from a unit area of a chart or selected representative area or tabulation in any individual month.

5.4.2.3 For tabular summaries, the data should be listed if there are less than 40 observations from a selected representative area in any individual month and those observations have been made on less than 10 different days of the month.

5.4.2.4 For tabular summaries, the data should be summarized if there are less than 40 observations from a selected representative area in any individual month and those observations have been made on 10 or more different days of the month.

5.4.2.5 The data should be summarized in charts or tabulations if there are less than 40 observations from a selected representative area in any individual month.

5.4.3 Decadal summaries

5.4.3.1 Summaries are prepared for decadal periods and not for individual years if there are less than 40 observations from a selected representative area in any individual month.

5.4.3.2 In preparing a climatological summary for a decade or longer period, the summary for each month should be prepared by combining all available observations from that particular months for all years during the period of the summary.

5.4.3.3 It must be clearly stated in the text of the summary when data are summarized, which are known to be irregularly distributed over the 10-year period.

5.5 Parameters to be included in, and form of, the marine climatological summaries

5.5.1 Fixed ship stations

Annual and decadal summaries for fixed ship stations shall be produced in tabular form and shall contain the parameters listed in Appendix I.10.

5.5.2 Polar and extra-polar regions

5.5.2.1 ANNUAL SUMMARIES

Data for annual summaries shall be prepared either in a format suitable for publication of charts or alternatively in a format suitable for publication of tables. The type of output required in any individual year is specified in Appendix I.8.

5.5.2.2 DECADAL SUMMARIES

Decadal summaries shall be published either in chart form (preferred) or in tabular form as also indicated in Appendix I.8.

5.5.2.3 CHART FORM

Parameters to be included in the summaries which are produced in chart form are listed in Appendix I.9.

5.5.2.4 TABULAR FORM

Parameters to be included in the summaries are listed in Appendices I.10, I.11 and I.12.

5.5.3 Inventory of marine climatological summaries

During the first quarter of each year, responsible Members shall send a list of marine climatological summaries which have been produced during the previous year to the Secretary-General.

5.6 Marine climatological data

5.6.1 Collection and exchange of data

5.6.1.1 Members operating fixed ship stations or selected, supplementary and auxiliary ship stations should transfer all surface observations from these stations onto magnetic tape. It is recommended that the data be arranged in the agreed format of the International Maritime Meteorological Tape (IMMT) as described in Appendix I.13. The data should be dispatched to both global collecting centres at three-monthly intervals.

5.6.1.2 The Member originating the data should notify the global collecting centres of the dispatch of the quarterly collection of data. The notification should contain details of the order in which the records are sorted.

5.6.1.3 Members may use the alternative format for maritime meteorological tapes which is given in Appendix I.14. Any alternative format must only be used by mutual agreement between the two Members which are exchanging data.

5.6.1.4 Members should ensure that magnetic tapes are 9-track and written at a density of 1600 or 6250 bpi. The tapes should be unlabelled and written in EBCDIC or ASCII with blocking factor 10.

5.6.1.5 The responsible Member should indicate clearly, in the summary, the extent to which auxiliary ship data have been used.

5.6.2 Inventory of marine climatological data

Global collection centres shall keep an inventory of all marine climatological data received from Members.

5.6.3 Quality control of data

5.6.3.1 All Members should make every effort to apply the minimum quality control procedures in Appendix I.15 before dispatching the data to the global collecting centres. These centres should ensure that this minimum quality control has been applied before making the data available to responsible Members.

5.6.3.2 Quality control of marine data by Members and responsible Members should be continued and improved. Details of national quality control schemes should be made available to responsible Members.

5.6.4 Period before 1961

5.6.4.1 The Historical Sea Surface Temperature Data (HSSTD) project provides for the collection and summarizing of marine climatological data for the period 1861 to 1960. The participants in the HSSTD project have agreed to exchange any additional digitized historical data as they become available.

5.6.4.2 Members having historical data, which are not yet included in the HSSTD project, should send those data to the appropriate participating Member. The data should be converted into the international exchange format (IMMT), or a mutually agreed format, before dispatch to the participating Member. The cost of conversion should be borne by the Member supplying the data.

6. SPECIAL MARINE CLIMATOLOGICAL INFORMATION

6.1 Principles

The principles for collection, storage and processing of special marine climatological information are

as follows:

Principle 1
International co-operative arrangements for the collection of special observations from mobile ship stations, i.e. other than those which comprise the Marine Climatological Summaries Scheme, as well as for their storage and eventual processing, include the designation of preferably one international centre suitably equipped for marine data storage and retrieval functions.

Principle 2
In order to ensure the combined use of stored ocean data obtained from special observations at mobile ship stations on the one hand and similar data obtained from measurements at oceanographic stations on the other, arrangements for the ultimate archiving of relevant data include the World Data Centres for Oceanography.

6.2 Procedures

6.2.1 Report of freak waves

NOTES: (1) A freak wave may be defined as a wave of very considerable height ahead of which there is no deep trough. Thus, it is the unusual steepness of the wave which is its outstanding feature and which makes it dangerous to shipping. Reports so far available suggest that such waves have usually occurred where a strong current flows in the opposite direction to a heavy sea and especially when it occurs near the edge of the continental shelf.

(2) International procedures are based on Recommendation 22 **(75-CMM).**

6.2.1.1 Members operating fixed ship stations or selected, supplementary and auxiliary ship stations should encourage marine observers to enter in meteorological log-books detailed information on freak waves, including a full description of the phenomenon (indicating height and horizontal distance between crest and trough, if possible), weather conditions, state of the sea and any other factors which may have influenced the state of the sea, as well as any damage sustained by the ship.

NOTE: A layout of a freak-wave report is contained in Annex II-1.B to the *Guide to Marine Meteorological Services* (WMO-No. 471).

6.2.1.2 When received, freak-wave reports should be sent to the Member which has assumed the responsibility for accepting reports from Members on freak waves, for publishing reports of special interest and for analysing the data in due time and publishing the results.

7. PROVISION OF MARINE METEOROLOGICAL INFORMATION AND EXPERT ADVICE

7.1 Principles

7.1.1 The principle for the provision of marine meteorological information and expert advice is as follows:

Principle
One of the important purposes for which marine meteorological data are preserved is their use in special applications in activities such as engineering design studies, planning of marine operations, expertise in insurance claims or official investigations regarding marine accidents, cargo ventilation studies, etc.

7.2 Procedures

7.2.1 The provision of marine meteorological and related oceanographic information and expert advice on the use and interpretation of data should be arranged according to national practices.
7.2.2 Marine meteorological data should be preserved by Members in a form which renders

these data easily accessible for use in applications requiring expert advice.

7.2.3 Members should assist each other in questions requiring marine meteorological expert advice by providing, as far as possible, the requested information in a convenient form.

7.2.4 Supply of marine meteorological data for special application purposes should be governed by the provisions on exchanges of climatological data contained in Chapter [B.1.]3 of Volume 1 of the WMO *Technical Regulations* (WMO-No. 49).

EXCERPTS FROM THE EXTRACT FROM THE MANUAL ON MARINE METEOROLOGICAL SERVICES (WMO-NO. 558)

APPENDIX I.6

(See paragraph 5.1)

GLOBAL COLLECTING CENTRES FOR MARINE CLIMATOLOGICAL SUMMARIES SCHEME

GCC Germany
Deutscher Wetterdienst
Klima und Umwelt, FE26
P.O. Box 70 04 21
D-22004 Hamburg
GERMANY
Tel: +49 40 6690 1444
Fax: +49 40 6690 1499
E-mail: gcc@dwd.de

GCC United Kingdom
Meteorological Office, S9
Saughton House
Broomhouse Drive
Edinburgh
EH11 3XQ
SCOTLAND, UK
London Road
Tel: +44 131 528 7313
Fax: +44 131 528 7345
E-mail: gcc@metoffice.com

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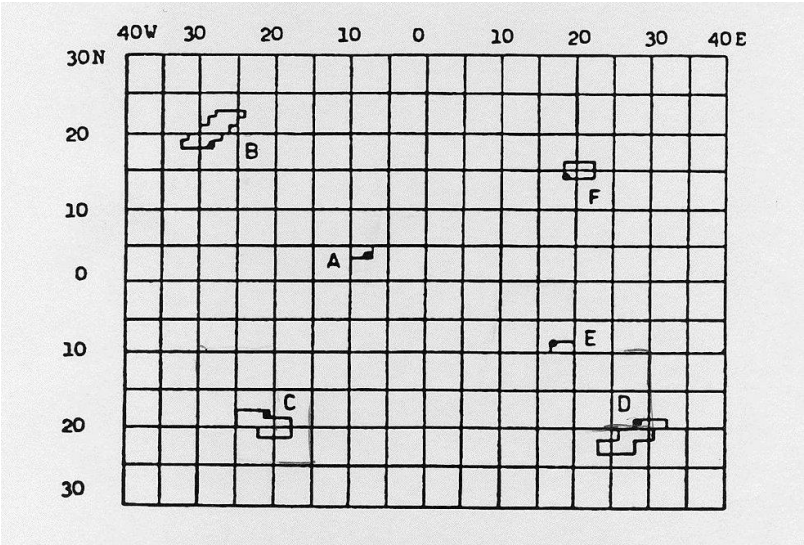
APPENDIX I.7

(See paragraph 5.2.3.3)

AREA INDICES SYSTEM FOR MARINE CLIMATOLOGICAL SUMMARIES



Representative area		A shall be coded			:	00037
"	"	B	"	"	:	01288
"	"	C	"	"	:	51281
"	"	D	"	"	:	81288
"	"	E	"	"	:	80187
"	"	F	"	"	:	31149

The following area indices systems shall be used:

(*a*) A selected representative area shall be indicated with reference to the position in the area of the 1-degree square corner which is nearest (1) to the Equator and (2) to the Greenwich meridian, in that sequence;

(*b*) A five-figure code shall be used for "area index";

(c) The first figures of the code - QL_aL_o - shall indicate the 10-degree square in which this 1-degree square is situated, where:

(i) The first figure shall be octant (code 3300);

(ii) The second figure shall be tens of the latitude of the 10-degree square;

(iii) The third figure shall be the tens of the longitude of the 10-degree square.

(*d*) The fourth and fifth figures of the code shall be the number of the 1-degree square within the 10-degree square as indicated in the above figure.

APPENDIX I.8

(See paragraph 5.3.1)

PLAN FOR THE PRODUCTION OF MARINE CLIMATOLOGICAL SUMMARIES OVER THE PERIOD 1961-1990

	FIXED STATIONS [a]	REPRESENTATIVE AREA/AREA OF RESPONSIBILITY [b]		
Period	Tables [c]	Tables [c]	Charts [b,d]	Isopleths [b,d,e]
1961-1970 Annual	X	X	0[f]	0
Decadal	X	0[g]	0[g]	0
1971-1980 Annual	0	0	0[f]	0
Decadal	X	0[g]	0[g]	0
1981-1990 Annual	0	0	0	0
Decadal	X	0[g]	0[g]	0

KEY: X - Recommended
0 - Optional

NOTES: *a* - Ocean weather stations and other fixed stations
b - Total area of responsibility
c - Summary tables (existing regulations)
d - Numerical data on charts of sea areas (marine climatological summary charts)
e - In addition to charts
f - Recommended instead of tables for responsible Members who have not yet published annual summaries
g - Published in chart or tabular form or both at the option of responsible Members

APPENDIX I.9

(See paragraph 5.3.2.1)

LAYOUT FOR MARINE CLIMATOLOGICAL SUMMARY CHARTS FOR REPRESENTATIVE AREAS

1. General

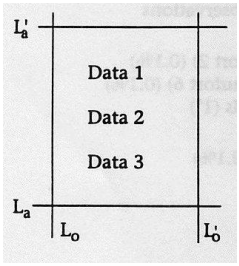
For each area of responsibility charts will be prepared in accordance with the following specifications.

2. Projection

The recommended projection for all areas except the polar regions is the Mercator projection. For the polar regions the polar stereographic projection is recommended. Where charts are produced by typewriter or line-printer systems other projections may be used.

3. Unit areas

Data will be plotted on unit areas, preferably rectangular, as shown below **(Figure not complete)**:



Data 1-3 are specified according to the element summarized

4. Dimensions of the unit areas

The unit areas containing relevant numerical data should, as far as possible, have a uniform size. In data-sparse regions unit areas as large as 5° x 10° may be necessary; for most parts of the oceans 5° x 5° squares will be suitable. In the vicinity of coasts or in semi-enclosed seas 2° x 2° or even 1° x 1° squares may be appropriate. The selection of unit areas will be undertaken by each responsible Member and will be a compromise between the available number of observations and the expected climatic gradients. The unit areas, once chosen, should be retained in all subsequent annual and decadal charts.

5. Specification of elements to be presented on summary charts:

Chart	Data	Element (resolution/unit)
	1	Mean air temperature (T, 0.1°C)
I	2	Standard deviation of air temperature[1] (σ_T, 0.1°C)
	3	Number of observations of air temperature (N_T)
	1	Mean sea-surface temperature (T_W, 0.1°)
II	2	σ_{TW}(0.1°C)
	3	N_{Td}
Chart	Data	Element (resolution/unit)
	1	Mean dew-point temperature (T_d, 0.1°C)
III	2	σ_{Td} (0.1°C)
	3	N_{Td}
	1	Mean air-sea temperature difference (T-T_W) (ΔT, 0.1°C)
IV	2	$\sigma_{\Delta T}$ (0.1°C)
	3	$N_{\Delta T}$

	1	Mean sea-level pressure (P, 0.1 hPa)
V	2	σ_p (0.1 hPa)
	3	N_p
	1	Median wind speed (f_{50}, 0.1 m s^{-1})
VI	2	Standard deviation of wind speed (σ_f, 0.1 m s^{-1})
	3	Steadiness of wind[2]
	1	Prevailing wind direction[3]
VII	2	Number of wind-speed observations (N_f)
	3	Number of measured wind-speed observations
	1	% of light winds (≤ 3 m s^{-1}, ≤ Beaufort 2) (0.1%)
VIII	2	% of strong winds (≥ 11 m s^{-1}, ≥ Beaufort 6) (0.1%)
	3	Prevailing direction[3] of strong winds (1°)
	1	% gales (≥ 17 m s^{-1}, ≥ Beaufort 8) (0.1%)
IX	2	Prevailing direction[3] of gales (1°)
	3	–
	1	Median wave height[4] (H_{50}, 0.5 m)
X	2	σ_H (0.1m)
	3	N_H
	1	% waves ≤ 1. 5 m (0.1%)
XI	2	% waves ≥ 4 m (0.1%)
	3	% waves ≥ 6 m (0.1%)
	1	% wave periods[4] ≥ 6 s (1 s)
XII	2	Prevailing swell direction[3] (1°)
	3	Number of swell observations
	1	% observations with rain or dizzle[5] (0.1%)
XIII	2	% observations with other forms of precipitation[6] (0.1%)
	3	Number of present weather observations
	1	% total cloud amount ≤ 2/8 (0.1%)
XIV	2	% total cloud amount ≤ 6/8[7] (0.1%)
	3	Number of total cloud observations
	1	% visibility < 1 km (VV = 90-93) (0.1%)
XV	2	% visibility ≥ 10 km (VV = 97-99) (0.1%)
	3	Number of visibility observations
	1	Mean latitude of observations (L_a, 0.1°)
XVI	2	Mean longitude of observations (L_o, 0.1°)
	3	Total number of observations

Chart	Data	Element (resolution/unit)
	1	σ_{La} (0.1°)
XVII	2	σ_{Lo} (0.1°)
	3	Total number of observations
	1	Number of reports of icing
XVIII	2	% potential moderate or severe superstructure icing[8] (0.1%)
	3	Number of observations containing air temperature and wind speed

NOTES: (1) $$\sigma = \left\{ \frac{\left[\sum_{i=1}^{N} \left(x_i - \bar{x} \right) \right]}{N-1} \right\}^{1/2}$$ where *x* is the value of an individual observation.

vector average,

(2) Steadiness =

scalar average.

(3) A resultant vector mean direction with each speed set equal to 1.

(4) Height of sea or swell.

(5) (ww = 50-67, 80-82).

(6) (ww = 68-99 except 80-82, 98).

(7) N = 6, 7, 8, 9.

(8) ff ≥ 11 m s^{-1}, TTT ≤ 2°C.

6. Production of charts

Monthly and annual charts will be produced as specified above. Mean values and standard deviations are to be computed from the total numbers of observations in all cases (i.e., for the annual charts, the annual means and standard deviations will be computed from the sums of the individual observed values). Parameters for decadal charts will be computed in the same manner.

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APPENDIX I.10

(See paragraph 5.3.2.2)

PARAMETERS TO BE INCLUDED IN MARINE CLIMATOLOGICAL SUMMARIES FOR FIXED SHIP STATIONS

Table 1 - Mean position of all observations

This table is not included in summaries for fixed ship stations.

Table 2 - Air temperature

(*a*) Monthly means;
(*b*) Mean for the year, computed from monthly means;
(*c*) Extremes with dates and hours of occurrence and 5, 25, 50, 75 and 95 percentile values for each month;
(*d*) Number of observations.

Table 3 - Dew-point temperature

(*a*) Monthly means;
(*b*) Mean for the year, computed from monthly means;
(*c*) Extremes with dates and hours of occurrence and 5, 25, 50, 75 and 95 percentile values for each month;
(*d*) Number of observations.

Table 4 - Sea-surface temperature

(*a*) Monthly means;
(*b*) Mean for the year, computed from monthly means;
(*c*) Extremes with dates and hours of occurrence and 5, 25, 50, 75 and 95 percentile values for each month;
(*d*) Number of observations.

Table 5 - Air-sea temperature difference

(*a*) Monthly means;
(*b*) Mean for the year, computed from monthly means;
(c) Extremes with dates and hours of occurrence and 5, 25, 50, 75 and 95 percentile values for each month;
(*d*) Number of observations.

Table 6 - Visibility

(*a*) Percentage frequency for each month for each code figure 90-99 inclusive (WMO code table 4377);
(*b*) Annual percentage frequency for each code figure 90-99 inclusive;
(*c*) Number of days for each month and for the year with VV = 90-93 and/or W = 4;
(*d*) Number of observations.

Table 7 - Weather

(*a*) Number of days for each month with precipitation, i.e. days when one or more of the ww or W code figures (WMO codes tables 4500 and 4677) listed in subsections (*b*) to (*e*) were reported (excluding ww = 17, 98);
(*b*) Number of days for each month with rain and/or drizzle (ww = 20, 21, 24, 25, 50-67, 80-82; W = 5, 6, 8);
(c) Number of days for each month with snow or snow and rain (ww = 22, 23, 26, 68-79, 83-86; W = 7);
(*d*) Number of days for each month with hail (ww = 27, 87-90);
(*e*) Number of days for each month with thunderstorms (ww = 17, 29, 91-99; W = 9);
(*f*) Number of days for each month with:
  (i) Gales (Beaufort force ≥ 8);
  (ii) Storms (Beaufort force ≥ 10);
  (iii) Hurricane force winds (Beaufort force = 12);
(g) Number of complete observing days for items (*a*) to (*f*);
(*h*) Total number of days annually for each item (*a*) to (*f*);
(*i*) Monthly percentage frequency of occurrence of precipitation at the time of observation (ww = 50-97, 99);
(*j*) Annual percentage frequency of occurrence of precipitation at the time of observation (ww = 50-97, 99);
(*k*) Number of observations for items (*i*) and (*j*);
(*l*) If measured, monthly and annual amount of precipitation;
(*m*) Annual percentage frequency of occurrence of each individual ww code figure 50-97, 99.

NOTE: It is recommended that the number of days with precipitation etc. be obtained by making appropriate entries in the log-book at the end of each day, as shown in the following example:

Precipitation	Rain or drizzle	Snow or rain and snow	Hail	Thunder	Fog	Gale	Storm	Hurricane
√	√		√		√			

In order to facilitate the computation of the monthly and annual totals, these entries can be punched in fixed columns as "I" on a "day-card". If this is done, the sorting of the international maritime punch cards by the various combinations of ww and W is avoided and an accurate total obtained.

Table 8 - Wind direction and speed

(*a*) Monthly percentage frequencies for the following ranges of speed:
- (i) 0 to 4 knots;
- (ii) 5 to 9 knots;
- (iii) 10 to 14 knots;
- (iv) 15 to 19 knots;
- (v) 20 to 24 knots;
- (vi) 25 to 29 knots;
- (vii) 30 to 39 knots;
- (viii) 40 to 49 knots, etc;

and for directions by sectors of 30°, true north bisecting the first sector;

(*b*) Monthly total of observations for each sector irrespective of speed;

(c) Monthly percentage frequency of occurrence of observations for each range of speed irrespective of direction;

(*d*) Mean monthly wind speed in knots, derived from all wind-speed observations;

(*e*) Mean wind speed for the year, computed from monthly means;

(*f*) Number of observations corresponding to item (*d*);

(*g*) Highest wind speed for each month and for the year, with dates and hours of occurrence;

(*h*) Vector mean wind for each month and its components (W to E and S to N directions taken as positive).

Table 9 - Sea-level pressure

(*a*) Monthly means for each hour of observation;

(*b*) Monthly means for all hours of observation;

(*c*) Mean for the year, computed from monthly means;

(*d*) Number of observations;

(*e*) Extremes with dates and hours of occurrence and 5, 25, 50, 75 and 95 percentile values for each month.

Table 10 - Cloud

(*a*) Monthly mean total amount for each hour of observation;

(*b*) Monthly mean for all hours of observation;

(*c*) Monthly mean for all hours of observation in respect of low cloud only (defined as cloud for which h is any code figure (WMO code table 1600) from 0 to 8 inclusive);

(*d*) Monthly percentage frequency of observations in the following ranges of total cloud amount (all hours of observing combined):
- (i) 2 oktas or less;
- (ii) 3 to 5 oktas inclusive;
- (iii) 6 to 7 oktas;
- (iv) 8 oktas;

(*e*) As item (*d*), but for low cloud only;

(*f*) Percentage frequency of height of low cloud for each month, subdivided into ranges corresponding to WMO code table 1600;

(*g*) Same for the year for items (*a*) to (*f*) inclusive computed from the monthly means or frequencies;

(*h*) Number of observations.

Table 11 - Waves

(*a*) Seasonal tables, with the first-mentioned parameter arranged along the vertical, containing:
- (i) Number of observations of any combination of wave height and period irrespective of direction;
- (ii) Number of observations of any combination of wave direction and height irrespective of period;
- (iii) Number of observations of any combination of wave direction and period irrespective of height;
- (iv) Number of observations of any wave height irrespective of period and direction;
- (v) Number of observations of any wave period irrespective of height and direction;
- (vi) Number of observations of any wave direction irrespective of height and period;
- (vii) Total number of observations;

(*b*) The following seasons shall be used:
- (i) December (of the previous year), January, February, March;

(ii) April, May;
(iii) June, July, August, September;
(iv) October, November;

(*c*) Starting with data for 1971, wave data should be provided in sets of three tables: direction versus height, direction versus period and height versus period, with a line or column “undetermined” with respect to wave period and direction, respectively;

NOTE: For the period 1961-1970, data are provided as shown in Figure 1.

(*d*) Only waves with greatest height should be selected. If two waves in the same observation have equal height, the one with the largest period should be selected. If the periods are also equal or undetermined, the direction of the second wave reported should be used;

(*e*) In ten-year summaries the tables as indicated under (*a*) to (*c*) above should be included on a monthly basis and, in addition, for seasonal tables as shown in Figure 1.

*

* *

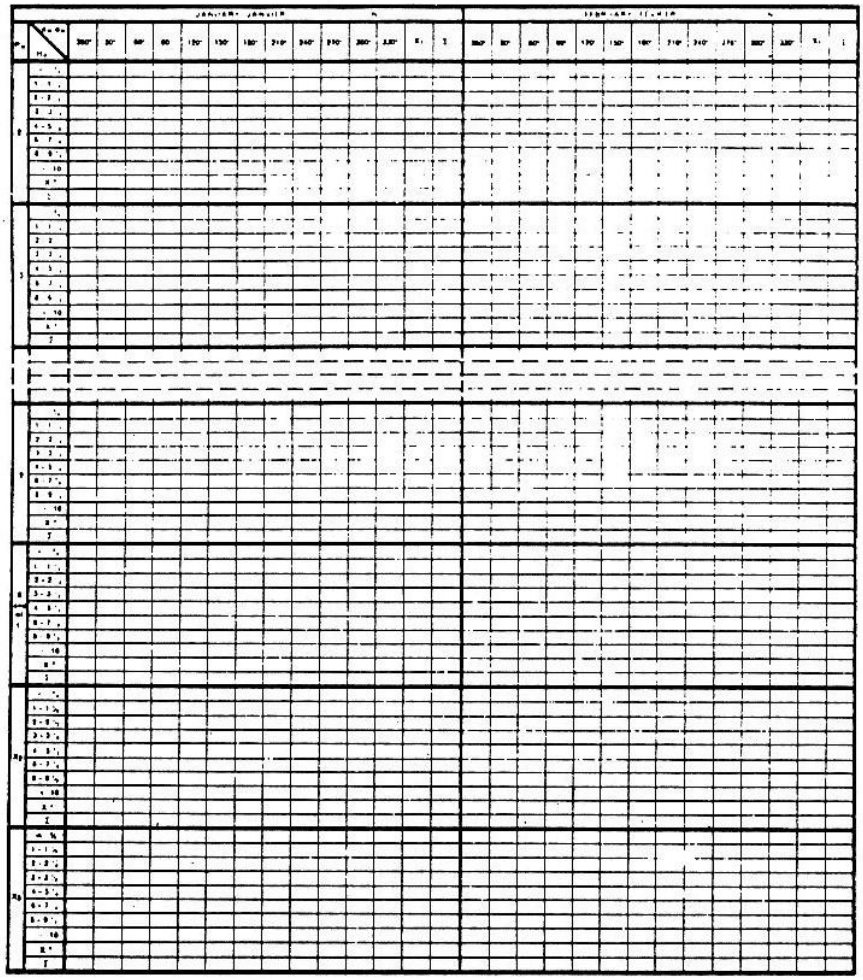

Figure 1 – Monthly percentage frequency of wave directions by specified periods and heights

Legend

X* : Period and direction observed, but not wave height.

X_1 : Period and height observed, but not wave direction.

X_2 : Direction and height observed, but not wave period.

N : Number of observations.

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APPENDIX I.11

(See paragraph 5.3.2.2)

PARAMETERS TO BE INCLUDED IN MARINE CLIMATOLOGICAL SUMMARIES FOR SELECTED REPRESENTATIVE AREAS IN EXTRA-POLAR REGIONS

Table 1 - Mean position of all observations

(*a*) Monthly mean position of all observations;

(*b*) Mean position for the year as calculated from the monthly mean positions.

Table 2 - Air temperature

(*a*) Monthly means;

(*b*) Mean for the year, computed from monthly means;

(*c*) Frequency table in 1°C steps based on the intervals 0.0 to 0.9°C (positive values), -0.1 to -1.0°C (negative values), e.g. 9.0 to 9.9°C, -1.1 to -2.0°C;

(*d*) Monthly and annual total number of observations.

NOTE: The unused higher and lower ranges need not be printed; all intervals between the extreme annual ranges should be retained.

Table 3 - Dew-point temperature

(*a*) Monthly means;

(*b*) Mean for the year, computed from monthly means;

(*c*) Frequency table in 1°C steps based on the intervals 0.0 to 0.9°C (positive values), -0.1 to -1.0°C (negative values), e.g. 9.0 to 9.9°C, -1.1 to -2.0°C;

(*d*) Monthly and annual total number of observations.

NOTE: See note under Table 2.

Table 4 - Sea-surface temperature

(*a*) Monthly means;

(*b*) Mean for the year, computed from monthly means;

(*c*) Frequency table in 1°C steps based on the intervals 0.0 to 0.9°C (positive values), -0.1 to -1.0°C (negative values), e.g. 9.0 to 9.9°C, -1.1 to -2.0°C;

(*d*) Monthly and annual total number of observations.

NOTE: See note under Table 2.

Table 5 - Air-sea temperature differences

(*a*) Monthly means;

(*b*) Mean for the year, computed from monthly means;

(*c*) Frequency table in 1°C steps based on the intervals 0.0 to 0.9°C (positive values), -0.1 to -1.0°C (negative values), e.g. 9.0 to 9.9°C, -1.1 to -2.0°C;

(*d*) Monthly and annual total number of observations.

NOTE: See note under Table 2.

Table 6 - Visibility

(*a*) Number of observations for each month for each code figure 90-99 (WMO code table 4377);

(*b*) Total number of observations for the year for each code 90-99;

(*c*) Monthly and annual total of observations.

Table 7 - Weather

(a) Monthly number of occasions with rain or drizzle at the time of observation (ww = 50-67, 80-82 (WMO code table 4677));

(*b*) Monthly number of occasions with snow or snow and rain at the time of observation (ww = 68-79, 83-86);

(*c*) Monthly number of occasions with hail at the time of observation (ww = 87-90);

(*d*) Monthly number of occasions with thunderstorms at the time of observation (ww = 17, 91-99);

(*e*) Monthly number of observations with:

(i) Gales (Beaufort force ≥ 8);

(ii) Storms (Beaufort force ≥ 10);

(iii) Hurricane force winds (Beaufort force = 12) at the time of observation;

(*f*) Monthly number of occasions of precipitation at the time of observation (ww = 50-97, 99);

(*g*) Annual number of occasions for each item (*a*) to (*f*);

(*h*) Monthly and annual total number of observations.

NOTES: (1) A column "VIS < 1 km" (visibility less than 1 km) should be added between the "precipitation" column and the "total number of observations" column.

(2) Responsible Members may include additional non-standard tables for those phenomena which are of importance for particular climatic regions as an appendix to the summary.

Table 8 - Wind direction and force

(*a*) Monthly number of observations for each month for each Beaufort number 0, 1, 2, etc., and for directions by sectors of 30°, true north bisecting the first sector;

(*b*) Monthly total of observations for each sector irrespective of wind force;

(*c*) Monthly number of observations for each Beaufort number irrespective of direction;

(*d*) Mean monthly wind force according to the Beaufort scale, derived from all wind observations;

(*e*) Mean wind force for the year, computed from monthly means;

(*f*) Monthly and annual total number of observations.

NOTE: The column "mean force in Beaufort" should be left blank until an appropriate method of representing such a mean is determined.

Table 9 - Sea-level pressure

(*a*) Monthly means for all hours of observation;

(*b*) Mean for the year, computed from monthly means;

(*c*) Frequency table in:

(i) 2-hPa steps between 0° and 30° latitude, based on the intervals 0.0 to 1.9 hPa, e.g. 990.0 to 991.9 hPa;

(ii) 4-hPa steps N of 30°N and S of 30°S, based on the intervals 0.0 to 3.9 hPa, e.g. 996.0 to 999.9 hPa;

(*d*) Monthly and annual total number of observations.

NOTES: (1) At the bottom of the table, lines should be added showing pressure averages by hour for the 0000, 0600, 1200 and 1800 UTC observations; an account of the number of observations should be included under each list of pressure averages.

(2) See note under Table 2.

Table 10 - Cloud

(*a*) Monthly mean of total cloud amount;

(*b*) Monthly mean amount for low cloud only (defined as cloud for which h is any code figure from 0 to 8 inclusive (WMO code table 1600));

(*c*) Monthly and annual number of observations in the following ranges of total cloud amount:

(i) 2 oktas or less;

(ii) 3 to 5 oktas inclusive;

(iii) 6 to 7 oktas;

(iv) 8 oktas;

(d) Mean for the year for items (a) and (b), computed from monthly means;

(e) Monthly and annual total of observations.

NOTE: The table should include the following note: 'Mean low cloud' means amount for low cloud only (defined as cloud for which h is any code figure from 0 to 8 inclusive (WMO code table 1600))".

Table 11 - Waves

Tables as for fixed stations.

APPENDIX I.12

(See paragraph 5.3.2.2)

PARAMETERS TO BE INCLUDED IN MARINE CLIMATOLOGICAL SUMMARIES FOR SELECTED REPRESENTATIVE AREAS IN POLAR REGIONS

Table 1 - Mean position of all observations

(*a*) Monthly mean position of all observations;

(*b*) Mean position for the year as calculated from the monthly mean positions.

Table 2 - Air temperature

(*a*) Monthly means;

(*b*) Frequency table in 3°C steps based on the intervals 0.0 to 2.9°C (positive values), -0.1 to -3.0°C (negative values), or where and when necessary in 1°C steps based on the intervals 0.0 or 0.9°C (positive values), -0.1 to -1.0°C (negative values);

(*c*) Extreme values should be included when 3°C steps are used under (*b*);

(*d*) Standard deviations, if the number of observations is sufficiently large;

(*e*) Monthly number of observations.

Table 3 - Dew-point temperature

This table is not included.

Table 4 - Sea-surface temperature

(*a*) Monthly means;

(*b*) Frequency table in 1°C steps based on the intervals 0.0 to 0.9°C (positive values), -0.1 to -1.0°C (negative values), e.g. 9.0 to 9.9°C, -1.1 to -2.0°C;

(*c*) Monthly number of observations.

Table 5 - Air-sea temperature difference

(*a*) Monthly means;

(*b*) Frequency table in 1°C steps based on the intervals 0.0 to 0.9°C (positive values), -0.1 to -1.0°C (negative values), e.g. 9.0 to 9.9°C, -1.1 to -2.0°C;

(*c*) Monthly number of observations.

Table 6 - Visibility

(*a*) Number of observations for each month for each code figure 90-99 (WMO code table 4377);

(*b*) Monthly number of observations.

Table 7 - Weather

(*a*) Monthly number of occasions with rain or drizzle at the time of observation (ww =50-67, 80-82 (WMO code table 4677));

(*b*) Monthly number of occasions with snow or snow and rain at the time of observation (ww = 68-79, 83-86);

(*c*) Monthly number of occasions with hail at the time of observation (ww = 87-90);

(*d*) Monthly number of occasions with current or recent thunderstorms with or without precipitation at the time of observation (ww = 17, 91-99);

(*e*) Monthly number of observations with:

(i) Gales (Beaufort force ≥ 8);

(ii) Storms (Beaufort force ≥ 10);

(iii) Hurricane force winds (Beaufort force = 12);

(*f*) Monthly number of occasions of precipitation at the time of observation (ww = 50-97, 99);

(*g*) Monthly number of occasions of visibility less than 1 km;

(*h*) Monthly number of observations.

Table 8 - Wind direction and force

(a) Monthly number of observations for each month for each Beaufort number 0, 1, 2, etc., and for direction by sectors of 30°, true north bisecting the first sector;

(*b*) Monthly total of observations for each sector irrespective of wind force;

(*c*) Monthly total of observations for each Beaufort number irrespective of direction;

(*d*) Monthly number of observations.

Table 9 - Sea-level pressure

(*a*) Monthly means and extremes for all hours of observation;

(*b*) Frequency table in 4 hPa steps, based on the intervals 0.0 to 3.9 hPa, e.g. 996.0 to 999.9 hPa;

(*c*) Standard deviations, if the number of observations is sufficiently large;

(*d*) Monthly number of observations.

Table 10 - Cloud

(*a)* Monthly mean of total cloud amount;

(*b*) Monthly mean amount for low cloud only (defined as cloud for which h is any code figure from 0 to 8 inclusive (WMO code table 1600));

(*c*) Monthly number of observations in the following ranges of total cloud amount:

(i) 2 oktas or less;

(ii) 3 to 5 oktas inclusive;

(iii) 6 to 7 oktas;

(iv) 8 oktas;

(*d*) Monthly number of observations.

Table 11 - Waves

List of original observations or, where number of observations is sufficient, seasonal tables as for fixed ship stations.

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APPENDIX I.13

(See paragraph 5.6.1.1)

LAYOUT FOR THE INTERNATIONAL MARITIME METEOROLOGICAL TAPE (IMMT) [VERSION IMMT-3]

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	Quadrant 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 meters per second, hundreds omitted; values in excess of 99 knots are to be indicated in units of meters per second and i_W encoded accordingly; the method of estimation or measurement and the units used (knots or meters 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
19	35-37	$T_dT_dT_d$	Dew-point temperature	Tenths of degrees Celsius
20	38-41	PPPP	Air Pressure	Tenths of hectopascals

Element Number	*Character Number*	*Code*	*Element*	*Coding procedure*
21	42-43	ww	Present weather	WMO code table 4677 or 4680
22	44	W_1	Past weather	WMO code table 4561 or 4531
23	45	W_2	Past weather	WMO code table 4561 or 4531
24	46	N_h	Amount of lowest clouds	As reported for C_L or, if no C_L cloud is present, for C_M, in oktas; WMO code table 2700
25	47	C_L	Genus of C_L clouds	WMO code table 0513
26	48	C_M	Genus of C_M clouds	WMO code table 0515
27	49	C_H	Genus of C_H clouds	WMO code table 0509
28	50	s_n	Sign of sea-surface temperature	WMO code table 3845
29	51-53	$T_WT_WT_W$	Sea surface temperature	Tenth of degrees Celsius
30	54		Indicator for sea-surface temperature measurement	0 - Bucket thermometer 1 - Condenser inlet 2 - Trailing thermistor 3 - Hull contact sensor 4 - "Through hull" sensor 5 - Radiation thermometer 6 - Bait tanks thermometer 7 - Others
31	55		Indicator for wave measurement	Shipborne wave recorder: 0 - Wind sea and swell estimated; 1 - Wind sea and swell measured; 2 - Mixed wave measured, swell estimated; 3 - Other combinations measured and estimated Buoy: 4 - Wind sea and swell measured; 5 - Mixed wave measured, swell estimated; 6 - Other combinations measured and estimated Other measurement system: 7 - Wind sea and swell measured; 8 - Mixed wave measured, swell estimated; 9 - Other combinations measured and estimated
32	56-57	P_WP_W	Period of wind waves or of measured waves	Whole seconds; show 99 where applicable in accordance with Note (3) under specification of P_WP_W in the Manual on Codes
33	58-59	H_WH_W	Height of wind waves or of measured waves	Half-meter values. Examples: Calm or less than $^1/_4$m to be encoded 00; $3^1/_2$m to be encoded 07; 7m to be encoded 14; $11^1/_2$m to be encoded 23
34	60-61	$d_{W1}d_{W1}$	Direction of predominant swell waves	Tens of degrees, WMO code table 0877; encoded 00 or 99 where applicable. Blanks = No observation of waves attempted
35	62-63	$P_{W1}P_{W1}$	Period of predominant swell waves	Whole seconds; encoded 99 where applicable (see under element 32)
36	64-65	$H_{W1}H_{W1}$	Height of predominant swell waves	Half-meter values (see under element 33)
37	66	I_S	Ice accretion on ships	WMO code table 1751
38	67-68	E_SE_S	Thickness of ice accretion	In centimeters
39	69	R_S	Rate of ice accretion	WMO code table 3551
40	70		Source of observation	0 - Unknown 1 - Logbook 2 - Telecommunication channels 3 - Publications (National) 4 - Logbook 5 - Telecommunication channels 6 – Publications (International data exchange)

Element Number	*Character Number*	*Code*	*Element*	*Coding procedure*
41	71		Observation platform	0 - unknown 1 - Selected ship 2 - Supplementary ship 3 - Auxiliary ship 4 - Automated station/data buoy 5 - Fixed sea station 6 - Coastal station 7 - Aircraft 8 - Satellite 9 - Others ....
42	72-78		Ship identifier	Ship's call sign or other identifier encoded as follows: 7 characters call sign Columns 72–78 6 characters call sign Columns 72–77 5 characters call sign Columns 72–76 4 characters call sign Columns 72–75 3 characters call sign Columns 72–74
43	79-80		Country which has recruited	According to the two-character alphabetical codes assigned by the ship the International Organization for Standardization (ISO)
44	81		National use	
45	82		Quality control indicator	0 - No quality control (QC) 1 - Manual QC only 2 - Automated QC only /MQC (no time-sequence checks) 3 - Automated QC only (inc. time sequence checks) 4 - Manual and automated QC (superficial; no automated time-sequence checks) 5 - Manual and automated QC (superficial; including time-sequence checks) 6 - Manual and automated QC (intensive, including automated time-sequence checks) 7 & 8 - Not used 9 - National system of QC (information to be furnished to WMO)
46	83	i_x	Weather data indicator	1 - Manual 4 - Automatic If present and past weather data included Code tables 4677 and 4561 used 7 - Automatic If present and past weather data included Code tables 4680 and 4531 used
47	84	i_R	Indicator for inclusion or omission of precipitation data	WMO code table 1819
48	85-87	RRR	Amount of precipitation which has fallen during the period preceding the time of observation, as indicated by t_R	WMO code table 3590
49	88	t_R	Duration of period of reference for amount of precipitation, ending at the time of the report	WMO code table 4019
50	89	s_W	Sign of wet-bulb temperature	0 - positive or zero measured wet-bulb temperature 1 - negative measured wet-bulb temperature 2 - iced measured wet-bulb temperature 5 - positive or zero computed wet-bulb temperature 6 - negative computed wet-bulb temperature 7 - iced computed wet-bulb temperature
51	90-92	$T_bT_bT_b$	Wet-bulb temperature	In tenths of degree Celsius, sign given by element 50
52	93	a	Characteristic of pressure tendency during the three hours preceding the time of observation	WMO code table 0200

Element Number	*Character Number*	*Code*	*Element*	*Coding procedure*
53	94-96	ppp	Amount of pressure tendency at station level during the three hours preceding the time of observation	In tenths of hectopascal
54	97	D_S	True direction of resultant displacement of the ship during the three hours preceding the time of observation	WMO code table 0700
55	98	v_S	Ship's average speed made good during the three hours preceding the time of observation	WMO code table 4451
56	99-100	$d_{w2}d_{w2}$	Direction of secondary swell waves	Tens of degrees, WMO code table 0877; encoded 00 or 99 where applicable. Blanks = No observation of waves attempted
57	101-102	$P_{w2}P_{w2}$	Period of secondary swell waves	Whole seconds; encoded 99 where applicable (see under element 32)
58	103-104	$H_{w2}H_{w2}$	Height of secondary swell waves	Half-meter values (see under element 33)
59	105	c_i	Concentration or arrangement of sea ice	WMO code table 0639
60	106	S_i	Stage of development	WMO code table 3739
61	107	b_i	Ice of land origin	WMO code table 0439
62	108	D_i	True bearing of principal ice edge	WMO code table 0739
63	109	z_i	Present ice situation and trend of conditions over the preceding three hours	WMO code table 5239
64	110		FM 13 code version	0 = previous to FM 24-V 1 = FM 24-V 2 = FM 24-VI Ext. 3 = FM 13-VII 4 = FM 13-VIII 5 = FM 13-VIII Ext. 6 = FM 13-IX 7 = FM 13-IX Ext. 8 = FM 13-X, etc.
65	111		IMMT version	0 = IMMT version just prior to version number being included 1 = IMMT-1 (in effect from Nov. 1994) 2 = IMMT-2 (in affect from Jan. 2003) 3 = IMMT-3 (in affect from Jan. 2007) 4 = IMMT-4 (next version) etc.
66	112	Q_1	Quality control indicator for (h)	0 - no quality control (QC) has been performed in this element 1 - QC has been performed; element appears to be correct 2 - QC has been performed; element appears to be inconsistent with other elements 3 - QC has been performed; element appears to be doubtful 4 - QC has been performed; element appears to be erroneous 5 - The value has been changed as a result of QC 6 - 8 Reserve 9 - The value of the element missing
67	113	Q_2	QC indicator for (VV)	- idem -
68	114	Q_3	QC indicator for (clouds: elements 12, 24–27)	- idem -
69	115	Q_4	QC indicator for (dd)	- idem -
70	116	Q_5	QC indicator for (ff)	- idem -

Element Number	*Character Number*	*Code*	*Element*	*Coding procedure*
71	117	Q_6	QC indicator for (TTT)	- idem -
72	118	Q_7	QC indicator for ($T_dT_dT_d$)	- idem -
73	119	Q_8	QC indicator for (PPPP)	- idem -
74	120	Q_9	QC indicator for (weather: elements 21–23)	- idem -
75	121	Q_{10}	QC indicator for ($T_WT_WT_W$)	- idem -
76	122	Q_{11}	QC indicator for (P_WP_W)	- idem -
77	123	Q_{12}	QC indicator for (H_WH_W)	- idem -
78	124	Q_{13}	QC indicator for (swell: elements 34–36, 56–58)	- idem -
79	125	Q_{14}	QC indicator for (i_RRRRt_R)	- idem -
80	126	Q_{15}	QC indicator for (a)	- idem -
81	127	Q_{16}	QC indicator for (ppp)	- idem -
82	128	Q_{17}	QC indicator for (D_S)	- idem -
83	129	Q_{18}	QC indicator for (v_S)	- idem -
84	130	Q_{19}	QC indicator for ($t_bt_bt_b$)	- idem -
85	131	Q_{20}	QC indicator for ships' position	- idem -
86	132	Q_{21}	Minimum quality control standards (MQCS) version identification	1 = MQCS- I (Original version, Feb. 1989) CMM-X 2 = MQCS-II (Version 2, March 1997) CMM-XII 3 = MQCS-III (Version 3, April 2000) SGMC-VIII 4 = MQCS-IV (Version 4, June 2001) JCOMM-I 5 = MQCS-V (Version 5, July 2004) ETMC-I etc.

Additional Requirements for the VOSCLIM Project

87	133-135	HDG	Ship's heading; the direction to which the bow is pointing, referenced to true North.	(000-360); e.g. 360 = North 000 = No Movement 090 = East
88	136-138	COG	Ship's ground course; the direction the vessel actually moves over the fixed earth and referenced to True North	(000-360); e.g. 360 = North 000 = No Movement 090 = East
89	139-140	SOG	Ship's ground speed; the speed the vessel actually moves over the fixed earth.	(00-99); Round to nearest whole knot
90	141-142	SLL	Maximum height in meters of deck cargo above Summer maximum load line.	(00-99); report to nearest whole meter

Element Number	*Character Number*	*Code*	*Element*	*Coding procedure*
91	143-145	$s_L$hh	Departure of reference level (Summer maximum load line) from actual sea level. Consider the difference positive when the Summer maximum load line is above the level of the sea and negative if below the water line.	Position 143 (s_L) sign position;- 0 = positive or zero, 1 = negative Positions 144-145 (hh); (00-99) is the difference to the nearest whole meter between the Summer maximum load line and the sea level.
92	146-148	RWD	Relative wind direction in degrees off the bow	Relative wind direction; e.g. 000 = no apparent relative wind speed (calm conditions on deck). Reported direction for relative wind = 001-360 degrees in a clockwise direction off the bow of the ship. When directly on the bow, RWD = 360.
93	149-151	RWS	Relative wind speed reported in units indicated by i_W (knots or m/s)	Reported in either whole knots or whole meters per second (e.g. 010 knots or 005 m/s). Units established by i_W as indicated in Character Number 27.

Note: Since the relative wind speed can be greater than the true wind speed e.g., i_W indicates knots and ff = 98, the relative wind speed may be 101 knots; therefore, three positions must be allocated since i_W cannot be adjusted and the relative wind speed converted to meters per second as is done in element 15.

94	152	Q_{22}	Quality control indicator for (HDG)	0 - no quality control (QC) has been performed in this element 1 - QC has been performed; element appears to be correct 2 - QC has been performed; element appears to be inconsistent with other elements 3 - QC has been performed; element appears to be doubtful 4 - QC has been performed; element appears to be erroneous 5 - The value has been changed as a result of QC 6 - 8 Reserve 9 - The value of the element missing
95	153	Q_{23}	QC indicator for (COG)	- idem –
96	154	Q_{24}	QC indicator for (SOG)	- idem –
97	155	Q_{25}	QC indicator for (SLL)	- idem –
98	156	Q_{26}	QC indicator for (s_L)	- idem –
99	157	Q_{27}	QC indicator for (hh)	- idem –
100	158	Q_{28}	QC indicator for (RWD)	- idem –
101	159	Q_{29}	QC indicator for (RWS)	- idem -

Note: Most of the codes (groups of letters) in the IMMT format with the exception of those added for the VOSCLIM project are defined in the Manual on Codes (WMO Pub. No. 306) as they basically mirror the code groups used in FM 13-X Ship code. Because CBS was not persuaded to expand the FM 13-X Ship code for the VOSCLIM project the additional observed elements (selected codes) will not appear in WMO Manual on Codes (Pub. 306). Therefore an effort was made to select unique codes (groups of letters) not defined in WMO Pub. 306 for the elements added to the IMMT-2 format version modified for the VOSCLIM project. This was deliberately done to try and prevent a difference in meaning for a given code group (identical symbolic letters) in Pub. 306 versus that in IMMT. Presumably none of the Character Code formats will be altered in the future by CBS.

APPENDIX I.14

(See paragraph 5.6.1.3)

LAYOUT FOR MARITIME METEOROLOGICAL TAPE FOR POSSIBLE USE IN NATIONAL AND BILATERAL DATA EXCHANGE

Element No.	Element	Character No.
1	Format and temperature indicator (i_T) (Same as Col. 1 of IMMPC)	1
2	AA	2-3
3	MM	4-5
4	YY	6-7
5	GG	8-9
6	i_w	10
7	Q	11
8	$L_aL_aL_a$	12-14
9	$L_oL_oL_o$	15-17
10	Indicator for h and VV	18
11	h	19
	Q_1	20
12	VV	21-22
	Q_2	23
13	N	24
	Q_3	
14	dd	25-26
	Q_4	27
15	ff	28-29
	Q_5	30
16	s_n	31
17	TTT	32-34
	Q_6	35
18	Sign of reported wet-bulb or dew-point temperature	36
19	Wet-bulb/dew-point temperature	37-39
	Q_7	40
20	PPPP	41-44
	Q_8	45
21	ww	46-47
22	W_1	48
23	W_2	49
	Q_9	50
24	N_h	51
25	C_L	52
Element No.	Element	Character No.
26	C_M	53

27	C_H	54
	Q_3	55
28	s_n	56
29	$T_wT_wT_w$	57-59
	Q_{10}	60
30	Indicator for SST measurement	61
31	Indicator for wave measurement	62
32	P_wP_w	63-64
	Q_{11}	65
33	H_wH_w	66-67
	Q_{12}	68
34	$d_{w1}d_{w1}$	69-70
35	$P_{w1}P_{w1}$	71-72
36	$H_{w1}H_{w1}$	73-74
	Q_{13}	
37	I_s	75
38	E_sE_s	76-77
39	R_s	78
40	Source of observation	79
41	Observation platform	80
42	Ship identifier	81-87
43	Country which has recruited ship	88-89
44	Quality control indicator	90
45	i_x	91
46	National use	92
47	i_R	93
48	RRR	94-96
	Q_{14}	97
49	t_R	98
50	Sign of computed wet-bulb or dew-point temperature	99
51	Computed wet-bulb or dew-point temperature	100-102
52	a	103
	Q_{15}	104
53	ppp	105-107
	Q_{16}	108
54	D_s	109
	Q_{17}	110
55	v_s	111
	Q_{18}	112

Element No.	Element	Character No.
56	$d_{W2}d_{w2}$	113-114
57	$P_{w2}P_{w2}$	115-116
58	$H_{w2}H_{w2}$	117-118

	Q_{13}	119
59	c_i	120
60	S_i	121
61	b_i	122
62	D_i	123
63	z_i	124

Quality control indicators (Q_1 to Q_{18}) for elements indicated in brackets

Q_1 (h)	20
Q_2 (VV)	23
Q_3 (clouds: elements 13, 24-27	55
Q_4 (dd)	27
Q_5 (ff)	30
Q_6 (TTT)	35
Q_7 (wet bulb/dew point)	40
Q_8 (PPPP)	45
Q_9 (weather: elements 21, 22, 23)	50
Q_{10} ($T_wT_wT_w$)	60
Q_{11} (P_wP_w)	65
Q_{12} (H_wH_w)	68
Q_{13} (swell: elements 34-36, 56-58)	119
Q_{14} (i_R RRR t_R)	97
Q_{15} (a)	104
Q_{16} (ppp)	108
Q_{17} (D_s)	110
Q_{18} (v_s)	112

Specifications for quality control indicators Q_1 to Q_{18}

0	No quality control (QC) has been performed on this element
1	QC has been performed; element appears to be correct
2	QC has been performed; element appears to be inconsistent with other element
3	QC has been performed; element appears to be doubtful
4	QC has been performed; element appears to be erroneous
5	The value has been changed as a result of QC
6 - 8	Reserve
9	The value of the element is missing

_____

APPENDIX I.15

(See paragraph 5.6.3.1)

MINIMUM QUALITY CONTROL STANDARDS
MQCS-V (Version 5)

Δ = space (ASCII 32)

Element	Error	Action
1	$i_T \neq 3 – 5, Δ$	Correct manually otherwise = Δ
2	AAAA ≠ valid year	Correct manually otherwise reject
3	MM ≠ 01 - 12	Correct manually otherwise reject
4	YY ≠ valid day of month	Correct manually otherwise reject
5	GG ≠ 00 - 23	Correct manually otherwise reject
6	Q ≠ 1, 3, 5, 7	Correct manually and $Q_{20} = 5$, otherwise $Q_{20} = 4$
	Q = Δ	$Q_{20} = 2$
7	$L_aL_aL_a$ ≠ 000-900	Correct manually and $Q_{20} = 5$, otherwise $Q_{20} = 4$
	$L_aL_aL_a$ = ΔΔΔ	$Q_{20} = 2$
8	$L_oL_oL_oL_o$ ≠ 0000-1800	Correct manually and $Q_{20} = 5$, otherwise $Q_{20} = 4$
	$L_oL_oL_oL_o$ = ΔΔΔΔ	$Q_{20} = 2$
	$L_aL_aL_a = L_oL_oL_oL_o$ = ΔΔΔ(Δ)	Correct manually otherwise reject
Time sequence checks		
	Change in latitude > 0.7o /hr	Correct manually otherwise Q20 = 3
	Change in longitude > 0.7o /hr when lat. 00-39.9	Correct manually otherwise Q20 = 3
	Change in longitude > 1.0o /hr when lat. 40-49.9	Correct manually otherwise Q20 = 3
	Change in longitude > 1.4o /hr when lat. 50-59.9	Correct manually otherwise Q20 = 3
	Change in longitude > 2.0o /hr when lat. 60-69.9	Correct manually otherwise Q20 = 3
	Change in longitude > 2.7o /hr when lat. 70-79.9	Correct manually otherwise Q20 = 3
9		No checking
10	h ≠ 0-9	Correct manually and $Q_1 = 5$, otherwise $Q_1 = 4$
	h = Δ	$Q_1 = 9$
11	VV ≠ 90-99	Correct manually and $Q_2 = 5$, otherwise $Q_2 = 4$
	VV = ΔΔ	$Q_2 = 9$
12	N ≠ 0-9, Δ	Correct manually and $Q_3 = 5$, otherwise $Q_3 = 4$
	N < Nh	Correct manually and $Q_3 = 5$, otherwise $Q_3 = 2$
13	dd ≠ 00-36, 99	Correct manually and $Q_4 = 5$, otherwise $Q_4 = 4$
	dd = ΔΔ	$Q_4 = 9$
	<u>dd versus ff</u>	
	dd = 00, ff ≠ 00	Correct manually and Q_4 or $Q_5 = 5$ otherwise $Q_4 = Q_5 = 2$
	dd ≠ 00, ff = 00	Correct manually and Q_4 or $Q_5 = 5$ otherwise $Q_4 = Q_5 = 2$

Element	Error	Action
14	$i_W \neq 0, 1, 3, 4$	Correct manually, otherwise $Q_5 = Q_{29} = 4$
15	ff > 80 knots	Correct manually and $Q_5 = 5$, otherwise $Q_5 = 3$
	ff = ΔΔ	$Q_5 = 9$
16	$s_n \neq 0, 1$	Correct manually, otherwise $Q_6 = 4$

17	TTT = ΔΔΔ	$Q_6 = 9$
	If -25 > TTT >40 then when Lat. < 45.0	
	TTT < -25	$Q_6 = 4$
	TTT > 40	$Q_6 = 3$
	when Lat. 45.0	
	TTT < -25	$Q_6 = 3$
	TTT > 40	$Q_6 = 4$

TTT versus humidity parameters

	TTT < WB (wet bulb)	Correct manually and $Q_6 = 5$, otherwise $Q_6 = Q_{19} = 2$
	TTT < DP (dew point)	Correct manually and $Q_6 = Q_7 = 5$, otherwise $Q_6 = Q_7 = 2$
18	$s_t \neq$ 0, 1, 2, 5, 6, 7	Correct manually, otherwise $Q_7 = 4$
19	DP > WB	Correct manually and $Q_7 = 5$, otherwise $Q_7 = Q_{19} = 2$
	DP > TTT	Correct manually and $Q_7 = 5$, otherwise $Q_7 = Q_6 = 2$
	WB = DP = ΔΔΔ	$Q_7 = 9$
20	930 > PPPP > 1050 hPa	Correct manually and $Q_8 = 5$, otherwise $Q_8 = 3$
	870 > PPPP > 1070 hPa	Correct manually and $Q_8 = 5$, otherwise $Q_8 = 4$
	PPPP = ΔΔΔΔ	$Q_8 = 9$
21	ww = 22-24, 26, 36-39, 48, 49, 56, 57, 66-79, 83-88	Correct manually and $Q_9 = 5$, otherwise $Q_9 = 4$
	93-94 and latitude <20°	Correct manually and $Q_9 = 5$, otherwise $Q_9 = 3$
	if $i_x = 7$:	
	$w_a w_a$ = 24 - 25, 35, 47 - 48, 54-56, 64-68, 70-78, 85-87 and latitude <20°	Correct manually and $Q_9 = 5$, otherwise $Q_9 = 4$
22, 23	W_1 or W_2 = 7 and latitude <20°	Correct manually and $Q_9 = 5$, otherwise $Q_9 = 4$
	$W_1 < W_2$	Correct manually and $Q_9 = 5$, otherwise $Q_9 = 2$
	$W_1 = W_2$ = ww = ΔΔΔΔ	$Q_9 = 9$
24-27	N = 0, and $N_h C_L C_M C_H \neq$ 0000	Correct manually and $Q_3 = 5$, otherwise $Q_3 = 2$
	N = Δ, and $N_h C_L C_M C_H \neq$ ΔΔΔΔ	Correct manually and $Q_3 = 5$, otherwise $Q_3 = 2$
	N = 9, and not (Nh =9 and $C_L C_M C_H$ = ΔΔΔ	Correct manually and $Q_3 = 5$, otherwise $Q_3 = 2$
	N= Δ and $N_h C_L C_M C_H$ = ΔΔΔΔ	$Q_3 = 9$
28	$s_n \neq$ 0, 1	Correct manually otherwise $Q_{10} = 4$
29	$T_W T_W T_W$ = ΔΔΔΔ	$Q_{10} = 9$
	if -2.0 > $T_W T_W T_W$ > 37.0 then when Lat. < 45.0	
	$T_W T_W T_W$ < -2.0	Control manually and $Q_{10} = 5$, otherwise $Q_{10} = 4$
	$T_W T_W T_W$ > 37.0	Control manually and $Q_{10} = 5$, otherwise $Q_{10} = 3$
	when Lat. ≥ 45.0	
	$T_W T_W T_W$ < -2.0	Control manually and $Q_{10} = 5$, otherwise $Q_{10} = 3$
	$T_W T_W T_W$ > 37.0	Control manually and $Q_{10} = 5$, otherwise $Q_{10} = 4$

Element	Error	Action
30	Indicator ≠ 0-7, Δ	Correct manually, otherwise Δ
31	Indicator ≠ 0-9, Δ	Correct manually, otherwise Δ
32	20 < $P_W P_W$ < 30	$Q_{11} = 3$
	$P_W P_W$ ≥ 30 and ≠ 99	$Q_{11} = 4$
	$P_W P_W$ = ΔΔ	$Q_{11} = 9$

33	$35< H_wH_w < 50$	$Q_{12} = 3$
	$H_wH_w \geq 50$	$Q_{12} = 4$
	$H_wH_w =$ ΔΔ	$Q_{12} = 9$
34	$d_{W1}\, d_{W1} \neq$ 00-36, 99	Correct manually and $Q_{13} = 5$, otherwise $Q_{13} = 4$
	$swell_1 = swell_2 =$ Δ	$Q_{13} = 9$
35	$25 < P_{w1}P_{w1} < 30$	$Q_{13} = 3$
	$P_{w1}P_{w1} \geq 30$ and ≠ 99	$Q_{13} = 4$
36	$35 < H_{w1}H_{w1} < 50$	$Q_{13} = 3$
	$H_{w1}H_{w1} \geq 50$	$Q_{13} = 4$
37	$I_s \neq$ 1-5, Δ	Correct manually, otherwise Δ
38	$E_sE_s \neq$ 00-99, ΔΔ	Correct manually, otherwise ΔΔ
39	$R_s \neq$ 0-4, Δ	Correct manually, otherwise Δ
40	Source ≠ 0-6	Correct manually, otherwise Δ
41	Platform ≠ 0-9	Correct manually, otherwise Δ
42	No call sign	Insert manually, mandatory entry
43	No country code	Insert manually
44		No Quality Control
45	Q ≠ 0-6, 9	Correct manually, otherwise Δ
46	$i_X \neq$ 1-7	Correct manually, otherwise Δ
47	i_R = 0-2 and RRR = 000, ΔΔΔ	Correct manually, otherwise $Q_{14} = 4$
	i_R = 3 and RRR ≠ ΔΔΔ	Correct manually, otherwise $Q_{14} = 2$
	i_R =4 and RRR ≠ ΔΔΔ	Correct manually, otherwise $Q_{14} = 2$
	$i_R \neq$0- 4	Correct manually, otherwise $Q_{14} = 4$
48	RRR ≠ 001 - 999 and i_R = 1, 2	Correct manually and $Q_{14} = 5$, otherwise $Q_{14} = 2$
49	$t_R \neq$ 0-9, Δ	Correct manually and $Q_{14} = 5$, otherwise $Q_{14} = 4$
50	$s_W \neq$ 0, 1, 2, 5, 6, 7	Correct manually, otherwise $Q_{19} = 4$
51	WB < DP	Correct manually and $Q_{19} = 5$, otherwise $Q_{19} = Q_7$=2
	WB = ΔΔΔ	$Q_{19} = 9$
	WB > TTT	Correct manually and $Q_{19} = 5$, otherwise $Q_{19} = Q_6 = 2$
52	a ≠ 0-8	Correct manually and $Q_{15} = 5$, otherwise $Q_{15} = 4$
	a = 4 and ppp ≠ 000	Correct manually and Q_{15} or $Q_{16} = 5$, otherwise $Q_{15}=Q_{16}$=2
	a =1,2,3,6,7,8 and ppp=000	Correct manually and Q_{15} or $Q_{16} = 5$, otherwise $Q_{15}=Q_{16} = 2$
	a = Δ	$Q_{15} = 9$
53	250 ≥ ppp > 150	Correct manually and $Q_{16} = 5$, otherwise $Q_{16} = 3$
	ppp > 250	Correct manually and $Q_{16} = 5$ otherwise $Q_{16} = 4$
	ppp = ΔΔΔ	$Q_{16} = 9$
54	$D_s \neq$ 0-9	Correct manually and $Q_{17} = 5$, otherwise $Q_{17} = 4$
	D_s = Δ	$Q_{17} = 9$

Element	**Error**	**Action**
55	$V_s \neq$ 0-9	Correct manually and $Q_{18} = 5$, otherwise $Q_{18} = 4$
	V_s = Δ	$Q_{18} = 9$
56	$d_{W2}d_{W2} \neq$ 00-36, 99, ΔΔ	Correct manually and $Q_{13} = 5$, otherwise $Q_{13} = 4$
57	$25 < P_{W2}P_{W2} < 30$	$Q_{13} = 3$
	$P_{W2}P_{W2} \geq 30$ and ≠ 99	$Q_{13} = 4$
58	$35 < H_{W2}H_{W2} < 50$	$Q_{13} = 3$
	$H_{W2}H_{W2} \geq 50$	$Q_{13} = 4$
59	$c_i \neq$ 0-9, Δ	Correct manually, otherwise Δ
60	$S_i \neq$ 0-9, Δ	Correct manually, otherwise Δ
61	$b_i \neq$ 0-9, Δ	Correct manually, otherwise Δ
62	$D_i \neq$ 0-9, Δ	Correct manually, otherwise Δ
63	$z_i \neq$ 0-9, Δ	Correct manually, otherwise Δ

86	Minimum Quality Control Standards (MQCS) version identification	1= MQCS-I (Original version, 1989) 2= MQCS-II (Version 2, March 1997) 3= MQCS-III (Version 3, April 2000) 4= MQCS-IV (Version 4, June 2001) 5= MQCS-V (Version 5, July 2004)	CMM-X CMM XII SGMC-VIII JCOMM-I ETMC-I
87	HDG ≠ 000-360	correct manually and Q_{22} = 5, otherwise Q_{22} = 4	
	HDG = ΔΔΔ	Q_{22} = 9	
88	COG ≠ 000-360	correct manually and Q_{23} = 5, otherwise Q_{23} = 4	
	COG = ΔΔΔ	Q_{23} = 9	
89	SOG ≠ 00 - 99	correct manually and Q_{24} = 5, otherwise Q_{24} = 4	
	SOG = ΔΔ	Q_{24} = 9	
	SOG > 33	correct manually and Q_{24} = 5, otherwise Q_{24} = 3	
90	SLL ≠ 00-99	correct manually and Q_{25} = 5, otherwise Q_{25} = 4	
	SLL = ΔΔ	Q_{25} = 9	
	SLL > 32	correct manually and Q_{25} = 5, otherwise Q_{25} = 3	
91	s_L ≠ 0,1	correct manually and Q_{26} = 5, otherwise Q_{26} = 4	
	s_L = Δ	Q_{26} = 9	
	hh ≠ 00 – 99	correct manually and Q_{27} = 5, otherwise Q_{27} = 4	
	hh = ΔΔ	Q_{27} = 9	
	hh >= 13	correct manually and Q_{27} = 5, otherwise Q_{27} = 3	
	hh < -01	correct manually and Q_{27} = 5, otherwise Q_{27} = 4	
92	RWD ≠ 000 - 360, 999	correct manually and Q_{28} = 5, otherwise Q_{28} = 4	
	RWD = ΔΔΔ	Q_{28} = 9	
93	RWS ≠ 000 - 999	correct manually and Q_{29} = 5, otherwise Q_{29} = 4	
	RWS = ΔΔΔ	Q_{29} = 9	
	RWS > 110 kts	correct manually and Q_{29} = 5, otherwise Q_{29} = 3	

Element	**Error**	**Action**
	RWD versus RWS	
	RWD = 000, RWS ≠ 000	correct manually and Q_{28} or Q_{29} = 5, otherwise Q_{28} = Q_{29} = 2
	RWD ≠ 000, RWS = 000	correct manually and Q_{28} or Q_{29} = 5, otherwise Q_{28} = Q_{29} = 2

Specifications for quality control Indicators Q_1 to Q_{29}

0	No quality control (QC) has been performed on this element
1	QC has been performed; element appears to be correct
2	QC has been performed; element appears to be inconsistent with other elements
3	QC has been performed; element appears to be doubtful
4	QC has been performed; element appears to be erroneous

5 The value has been changed as a result of QC

6 reserved for GCC

7 reserved for GCC

8 Reserve

9 The value of the element is missing

APPENDIX I.16

(see paragraph 5.6.4.3)

HISTORICAL SEA-SURFACE TEMPERATURE (HSST)DATA EXCHANGE FORMAT

CD	MSQ	Q	LAT	LON	YR	MO	DA	HR	WIND DIRECT	WIND SPD	AIR TEMP	SEA TEMP	AREA
XXX	XXX	X	XXX	XXXX	XXX	XX	XX	XX	iXX	iXXX	XXX	XXX	XXXX

Field	Column	Element *
001	1-3	Card deck number in TDF-11
002	4-6	Marsden 10° square
003	7	Quadrant
004	8-10	Latitude
005	11-14	Longitude
006	15-17	Year (last three digits, i.e. 927 = 1927)
007	18-19	Month
008	20-21	Day
009	22-23	Hour - UTC
010	24-26	Wind direction and indicator
011	27-30	Wind speed and indicator
012	31-33	Air temperature
013	34-36	Sea-surface temperature
014	37-40	Area

* TDF-11 describes elements
Logical rec. = 40
Blocking factor = 100

*

* *

HSST Data Set - Extended format for Atlantic and Indian Oceans and Mediterranean Data

CHARACTER UK/US	NOTATION NL/DL		RECORD IDENTIFIER	
1		H		
2		M	Historical Marine Data	
3		D		
4			Identifies the origin of the tape	
5				
6	1		Octant	
7	2			
8	3		Square number	
9	4			
10	5		Month	
11	6			
12	7		Year	
13	8			
14	9			
15	10		Latitude	
16	11	Position		
17	12	Unit and tenths	Longitude	
18	13			
19	14			
20	15		Day of month	
21	16			
22	17		Hour of day (00-23 UTC)	
23	18	+, -		
24	19			
25	20		Sea temperature (tenths of °C)	
26	21			
27	22	+, -		
28	23			
29	24		Air temperature (tenths of °C)	
30	25			
31	26	+, -, e	e = Ice	
32	27			
33	28		Wet-bulb temperature (tenths of °C)	
34	29			
35	30			000 = calm
36	31		Wind direction (whole degrees)	990 = variable
37	32			999 = missing
38	33			
39	34		Wind speed (tenths of m/s)	
40	35			
41	36			
42	37			
43	38		Barometric pressure (tenths of hPa)	
44	39			
45	40			
46	41		Total cloud amount (oktas)	
47	42		Flags for sea temperature	
48	43		Flags for air temperature	
49	44		Flags for wind	
50	45	F sus 1		
51	46	F sus 2	Flags for suspect values	

Codes for flag characters

Flags for sea temperatures and state of wet bulb

F sea

0	Sea temperature measured to 0.1°F accuracy
1	Sea temperature measured to 0.1°C accuracy
2	Sea temperature measured to 0.5°F accuracy
3	Sea temperature measured to 0.5°C accuracy
4	Sea temperature measured to 1°F or 1°C accuracy
5)	
6)	As for codes 0-4, but also the wet bulb is not frozen,
7)	even when showing temperature below freezing point
8)	
9)	

Flags for dry-bulb and wet-bulb temperatures

F air

0	Air temperatures measured to 0.1°F accuracy
1	Air temperatures measured to 0.1°C accuracy
2	Air temperatures measured to 0.5°F accuracy
3	Air temperatures measured to 0.5°C accuracy
4	Air temperatures measured to 1°F or 1°C accuracy
5)	
6)	As for codes 0-3, but temperatures were measured by an
7)	aspirated or whirling psychrometer
8)	
9	Original units of temperature or accuracy unknown

Flags for wind observations

0	360 point compass	
1	36 point compass	
2	32 point compass	Wind speed measured
3	16 point compass	
4	8 point compass	
5)		
6)	As for codes 0-4, but wind speed estimated or converted	
7)	from Beaufort force, or method of observation unknown	
8)		
9)		

Flags for suspect values of sea temperature, air temperature and wind

F sus 1

0	No suspect element
+1	Sea temperatures > 97°F (36.1°C)
+2	Dry bulb or wet bulb not in range -5°F to 99.9°F (-20.5°C to 37.7°C) or wet bulb > dry bulb
+4	Wind direction 990 (variable) and wind speed > 5 kt

Flags for suspect values of pressure and cloud amount

F sus 2

0	No suspect pressure or cloud amount
+1	Pressure < 940 or > 1050 (pressures < 800 or > 1080 have been rejected)
+2	Cloud amount not reported
+4	Additional observation at the same time in the same 1° square, though not identical

The values of F sus 1 and F sus 2 may also be 3, 5, 6 or 7. This means that more than one value is suspect, and the code figures have been added together for the suspect values.

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APPENDIX B

MARINE CLIMATOLOGY - SECTION 3 OF THE GUIDE TO MARINE METEOROLOGICAL SERVICES (WMO-NO. 471)

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 mainly for use by shipping were prepared nationally, obliging countries 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 JCOMM (formerly CMM) in 1960 and was finally adopted by Fourth Congress in 1963. The objective 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 to process the data in prescribed forms and regularly publish the climatological summaries.

To improve the flow of the observational data, 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 forty-fifth Session in 1993.

Marine climatology today supports transportation, engineering and the basic and applied sciences with data and information about the environment from tens of metres below, to a few tens of metres above the sea surface. 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 specialized 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 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 computer readable media for analysis on personal computers. Advances in computer technology allows a vast amount of data to be provided on one disc and the data can be displayed in chart, map or graphic 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 scheme the oceans and seas are divided into areas of responsibility and eight Members

(known as 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. In order to prepare these summaries, the global collection centres supply Responsible Members surface observations in an internationally accepted format from all Members operating voluntary observing ships and/or fixed ship stations in their respective areas of responsibility.

The international procedures governing the Marine Climatological Summaries Scheme have the status of Technical Regulations within WMO and are included in the *Manual on Marine Meteorological Services*, 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 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 according to all areas of responsibility. An example of the representative areas in one area of responsibility is shown in Annex 3.B to this Chapter. The Area Indices System is also explained in Annex 3.B.

All responsible Members are represented on the JCOMM's Data Management Coordination Group, 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 (GCCs)

Two responsible Members (Germany and the United Kingdom) operate Global Collecting Centres (GCCs), 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.

GCCs ensure that minimum quality control bas been applied to the data, and then supply, every three months, data to the Responsible Members relevant to each one's area of responsibility. They will also provide a global data set to those Responsible Members who wish to receive it.

The data are then sent to both GCCS, 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 GCCs of the dispatch of the data and provide 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 onboard most ships in special meteorological logbooks provided by NMSs. Members operating voluntary observing ships and/or fixed ship stations should arrange for the provision of a suitable meteorological logbook which can be in hard-copy or electronic format. Details of the layout of the hard-copy logbook are to be found in Chapter 6, paragraph 6.8.1 of this *Guide.*

The observations are transferred from the hard-copy logbooks 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 ibis 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 software which stores the observations on computer readable media in the internationally agreed format. This avoids a source of possible errors in the manual data transfer from logbook to the computer-compatible medium.

3.2.5 Preparation of marine climatological summaries

The detailed procedures for the preparation of marine climatological summaries are described in the *Manual on Marine Meteorological Services,* 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 the former CMM, Members are encouraged to continue publishing these summaries.

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 bc on computer readable media in the international exchange format, unless another format bas 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 net 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. Any form of data exchange on computer readable media may be used, 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 the means of data exchange needs 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 arc exchanging data.

Members wishing to exchange their observational data on other computer readable media or in print-outs in the case of very small numbers of observations 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 bas 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). The results can bc consulted in the *User's Guide to the Data and Summaries of the Historical Sea Surface Temperature Data Project* (MMROA Report No. 13, WMO/TD-No. 36).

Members with historical data which have not been included in the Project should send those data to GCCs 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 as poor, moderate, or good, an explanation is needed on how these terms are expressed in distances of 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 consists of 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 bas 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).

However, errors can occur when:

(a) Misreading an on board instrument, a sensor malfunction, or in entering the observation in the logbook;
(b) Transcribing the data on to computer readable media.

In the event that 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 NMS where 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 GCCS. This quality control includes checks that the observation of catch element is within the possible range, and that the change in position between observations is within reasonable limits, and that call sign and country code have been included. There is space in the IMMT format for quality control flags. These indicators show whether the element that has been flagged is doubtful or whether it bas 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.

Nevertheless, it is stressed that, while flagging data as doubtful is an accepted procedure, all efforts should first be made to correct those data.

Meteorological logbooks can be scrutinized manually before data transfer to eliminate obvious observational and recording errors. However the minimum quality control should be carried out after transfer to computer readable media to allow for transcription errors. The quality control is best carried out automatically by computer and software are available for this purpose. Minimum quality control software is available from GCCs upon request.

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. GCCs ensure that this minimum quality control bas been carried out and thai further quality controi may bc 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 Report of freak waves

The occurrence of unusual waves and the occasional distress to vessels that may follow bas 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 in Chapter 6, Annex 6.C of this *Guide*. Procedures for the dealing with reports of freak waves are given in the *Manual on Marine Meteorological Services*, Volume I, Part I, Section 6.2.1

3.3.2 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, 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 lie extracted from special satellite data sets. A fat 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 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. 78 1).

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, as well as 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 Marine Meteorological Services*, Volume I, Part I, Appendix I.9. There are many other ways of displaying the data in chart form, and several NMSs 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 bas usually been used, but others may be employed for special requirements. These charts may also include numerical data, graphs, isopleths and other additional data presentation. Elements covered by these charts may include, among others:

(a) Surface wind: Frequency distribution of wind speeds on the eight 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 four or eight 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 bouts 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;
(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;
(k) Derived quantities: Heat flux, transport data, refractivity, superstructure icing potential, atmospheric stability.

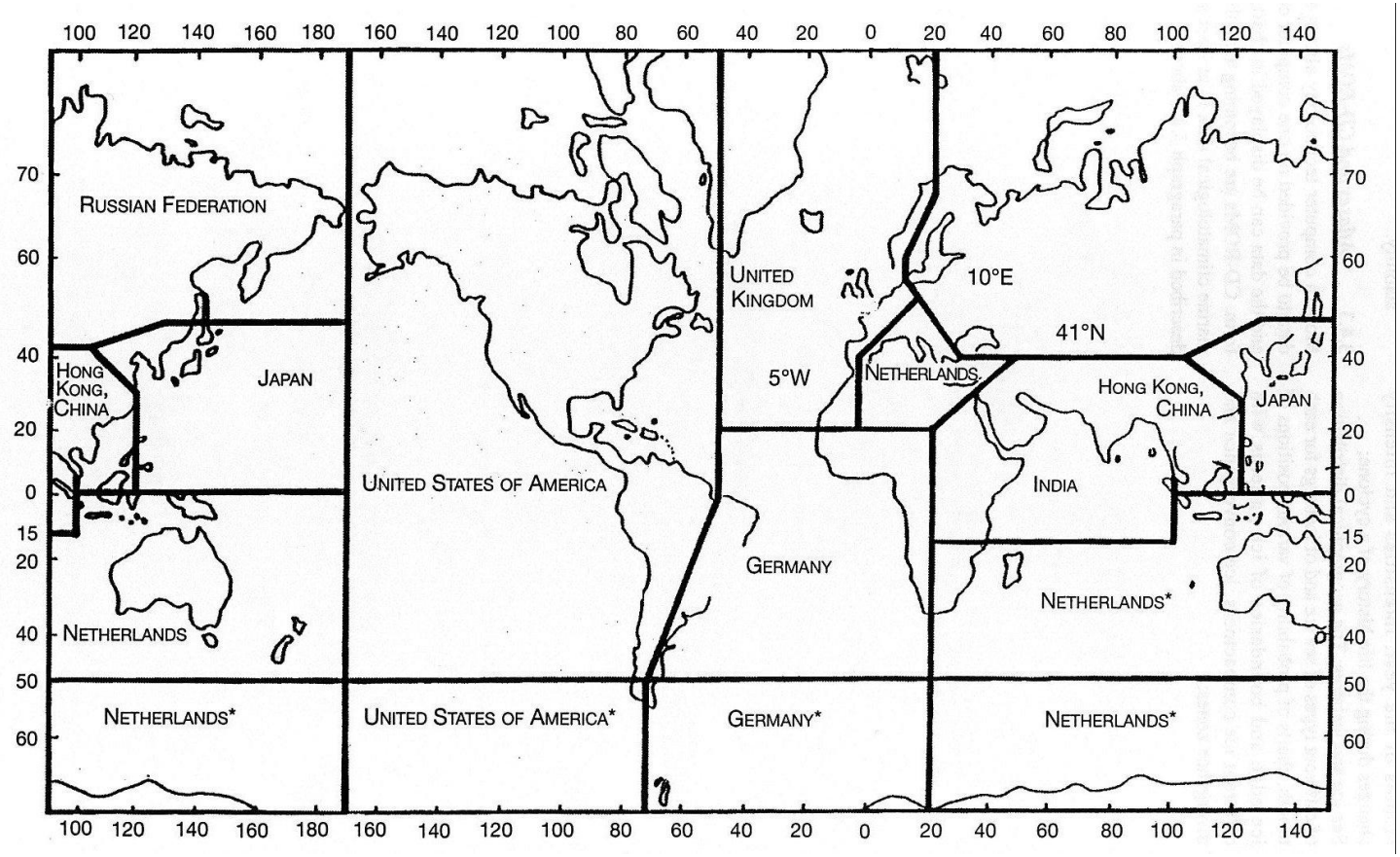
3.4.3 Atlases and CD-ROMs

Modern computer technology allows a vast amount of data to be provided on one computer compatible media and the data can be displayed in chart, map or graphic 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.

ANNEX 3.A

AREAS OF RESPONSIBILITY AND RESPONSIBLE MEMBERS FOR CLIMATOLOGICAL SUMMARIES

(Reference paragraph 3.2.2)



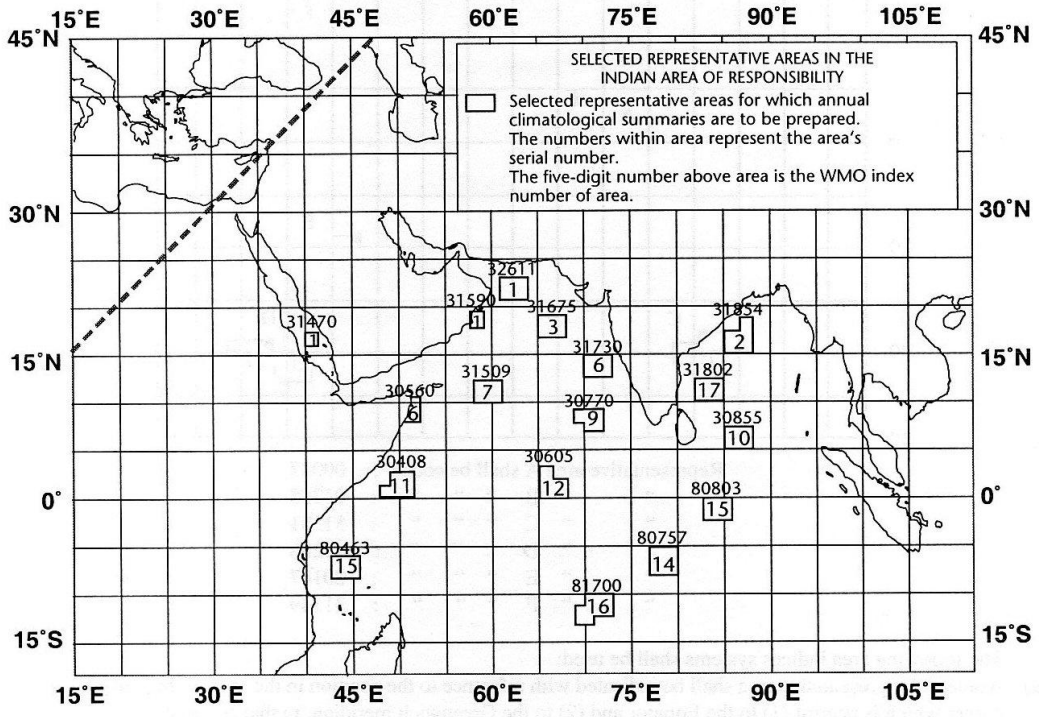
*The Russian Federation is responsible for the compilation of a complete data set and the preparation of the summaries for the sea routes.

ANNEX 3.B

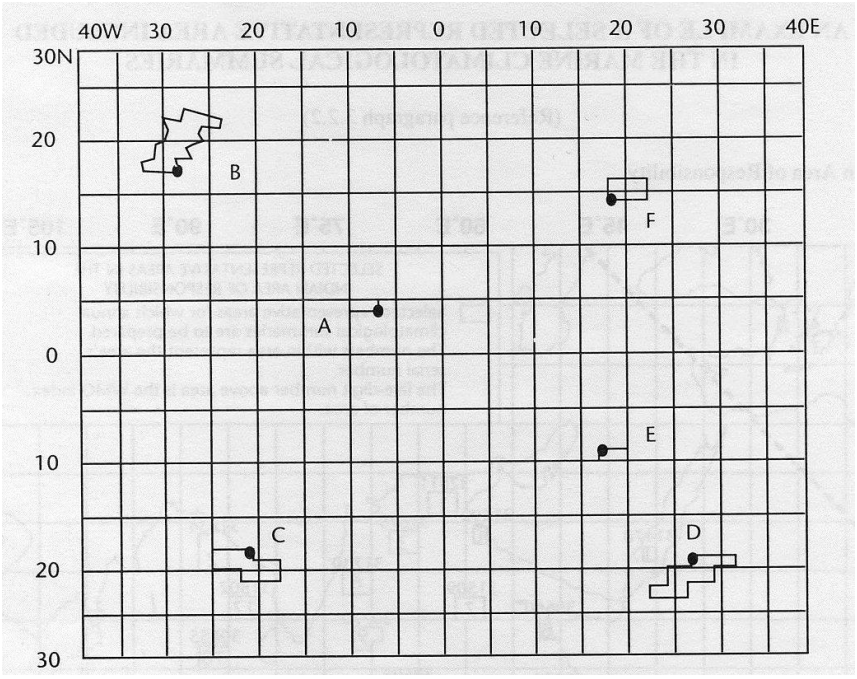
AN EXAMPLE OF A SELECTED REPRESENTATIVE AREA INCLUDED IN THE MARINE CLIMATOLOGICAL SUMMARIES

(Reference paragraph 3.2.2)

a. The Indian Area of Responsibility



AREAS INDICES SYSTEM FOR MARINE CLIMATOLOGICAL SUMMARIES



Representative area	A	shall	be	coded	:	00037
"	"	B	"	"	:	01288
"	"	C	"	"	:	51281
"	"	D	"	"	:	81288
"	"	E	"	"	:	80187
"	"	F	"	"	:	31149

The following area indices systems shall be used:

(*a*) A selected representative area shall be indicated with reference to the position in the area of the 1-degree square corner which is nearest (1) to the Equator and (2) to the Greenwich meridian, in that sequence;

(*b*) A five-figure code shall be used for "area index";

(c) The first figures of the code - QL_aL_o - shall indicate the 10-degree square in which this 1-degree square is situated, where:

(i) The first figure shall be octant (code 3300);

(ii) The second figure shall be tens of the latitude of the 10-degree square;

(iii) The third figure shall be the tens of the longitude of the 10-degree square.

(*d*) The fourth and fifth figures of the code shall be the number of the 1-degree square within the 10-degree square as indicated in the above figure.

ANNEX 3.C

LAYOUT FOR THE INTERNATIONAL MARITME METEOROLOGICAL TAPE (IMMT) [VERSION IMMT-3]

(See paragraph 3.2.7)

=> See APPENDIX I.13 of Appendix A (above).