# Manual on Codes 

## International Codes

## VO LUME I. 2

(Annex II to W MO Technical Regulations)

## Part B - Binary Codes

Part C - Common Features to Binary and Alphanumeric Codes

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## PREFACE

Coded messages are used for the international exchange of meteorological information comprising observational data provided by the WWW Global Observing System and processed data provided by the WWW Global Data- processing System. Coded messages are also used for the international exchange of observed and processed data required in specific applications of meteorology to various human activities and for exchanges of information related to meteorology.

The codes are composed of a set of CODE FORMS and BINARY CODES made up of SYMBOLIC LETTERS (or groups of letters) representing meteorological or, as the case may be, other geophysical elements. In messages, these symbolic letters (or groups of letters) are transcribed into figures indicating the value or the state of the elements described. SPECIFICATIONS have been defined for the various symbolic letters to permit their transcription into figures. In some cases, the specification of the symbolic letter is sufficient to permit a direct transcription into figures. In other cases, it requires the use of CODE FIGURES, the specifications of which are given in CODE TABLES. Furthermore, a certain number of SYMBOLIC WORDS and SYMBOLIC FIGURE GROUPS have been developed for use as code names, code words, symbolic prefixes or indicator groups.

Rules concerning the selection of code forms to be exchanged for international purposes, and the selection of their symbolic words, figure groups and letters, are laid down in the WMO Technical Regulations, Volume I, Chapter A.2.3 (Ed. 1988). These code forms are contained in Volume I of the Manual on Codes, issued (with separate covers) as Volume I. 1 - Part A, and Volume I. 2 - Part B and Part C .

Apart from these international codes, several sets of regional codes exist which are intended only for exchanges within a given WMO Region. These codes are contained in Volume II of the Manual on Codes. This volume also contains descriptions of:

- Regional coding procedures for the use of international code forms;
- National coding practices in the use of international or regional codes of which the Secretariat has been informed;
- National code forms.

A number of special codes which are used in messages exchanged over the WWW Global Telecommunication System circuits, and which comprise ice and satellite ephemeris codes, are included in Volume II as an Appendix.

This edition of Volume I. 2 of the Manual on Codes replaces the 1995 edition.

## EDITORIAL NOTE

As a general rule, standard coding practices are printed in semi-bold roman in order to distinguish them from explanations.

Regulations are printed in semi-bold roman; explanatory notes relating to these regulations are printed in smaller type and preceded by the indication: NOTE.

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## INTRODUCTION

Volume I of the Manual on Codes contains WMO international codes for meteorological data and other geophysical data relating to meteorology; it constitutes Annex II of the WMO Technical Regulations and has therefore the status of a Technical Regulation. It is issued in two volumes with separate covers: Volume I.1, containing PART A, and Volume I.2, containing PART B and PART C.

VOLUME I. 1 (issued under separate cover):
Part A - Alphanumeric Codes consists of five sections.

## VOLUME I.2:

Part B - Binary Codes consists of the list of binary codes with their specifications and associated code tables. The standard coding procedures are distinguished by the use of the term "shall" in the English text, and by suitable equivalent terms in the French, Russian and Spanish texts. Where national practices do not conform with these regulations, Members concerned shall formally notify the Secretary-General of WMO for the benefit of other Members. Explanatory notes are sometimes added to regulations.

Part C - Common Features to Binary and Alphanumeric Codes consists of the list of table-driven alphanumeric codes with their specifications and associated code tables, and of common code tables to binary and alphanumeric codes.

The Attachments to Volume I.2, which are printed on yellow paper, do not have the status of WMO Technical Regulations and are given for information only.

## PROCEDURES FOR AMENDING THE MANUAL ON CODES

## 1. General validation and implementation procedures

1.1 Amendments to the Manual on Codes must be proposed in writing to the WMO Secretariat. The proposal shall specify the needs, purposes and requirements and include information on a contact point for technical matters.
1.2 The Expert Team on Data Representation and Codes (ET/DR\&C)*, supported by the Secretariat, shall validate the stated requirements (unless it is consequential to an amendment to the WMO Technical Regulations) and develop a draft recommendation to respond to the requirements, as appropriate.
1.3 A draft recommendation developed by the ET/DR\&C must be endorsed by the Implementation/ Coordination Team (ITC) of the Open Programme Area Group on Information Systems and Services (OPAG/ISS) prior to its consideration by CBS, which subsequently submits it for approval to the Executive Council. Draft recommendations must have followed the procedures described in paragraph 5.4.31 of the Abridged Final Report with Resolutions and Recommendations of the Extraordinary Session of the Commission for Basic Systems (WMO-No. 815) before being submitted to a CBS session. These procedures are given in section 4 below. During inter-sessional periods, the "fast track" mechanism, described in section 2 below, is used to ensure the necessary flexibility in responding to urgent requirements of users.

[^0]1.4 Updates of the Manual on Codes shall be issued as supplements only once a year in August and include all changes implemented since the previous update and those approved for implementation on the first Wednesday following 1 November.
2. Fast track mechanism for validation and implementation
2.1 Fast track mechanism shall be used during the inter-sessional periods of CBS for additions to BUFR or CREX Tables A, B, and D with associated code tables or flag tables and to code tables in GRIB, to common tables related to character codes, e.g. radiosonde entries, and to other simple additional table entries in character codes.
2.2 Draft recommendations developed by the ET/DR\&C must follow the validation procedures described in subsections 4.1, 4.2 and 4.3 below and must be endorsed by the chairperson of OPAG/ISS, the president of CBS on behalf of the Commission, and must be approved by the President of WMO on behalf of the Executive Council. However, the filling of reserved and unused entries in the existing code and flag tables are considered minor adjustments and will be effected by the Secretary-General in consultation with the president of CBS.
2.3 The implementation of amendments approved through the fast track shall normally be limited to one per year and the implementation date should be fixed as the first Wednesday following 1 November. If the chairpersons of ET/DR\&C and OPAG/ISS agree that an exceptional situation exists, a second fast track implementation can be initiated.
2.4 WMO Members shall be notified of amendments approved through the fast track timely enough to allow a period of at least three months between the receipt of the notification and the date of implementation.
3. Procedures for the correction of existing entries in the BUFR and CREX tables
3.1 If an erroneous specification of an entry is found in a BUFR or CREX table, a new descriptor should normally be added to the table through the fast track procedures and should be used instead of the old one for encoding (especially if it concerns data width). An appropriate explanation shall be added to the notes of the table to clarify the practice along with the date of the change.
3.2 This situation is considered a minor adjustment according to subsection 2.2 above.
4. Validation procedures with respect to proposed changes to WMO codes and data representation forms
4.1 The need for, and the purpose of, the proposed changes should be fully documented.
4.2 This documentation must include the results of non-operational testing of the changes as described below.
4.3 For new or modified WMO code and data representation forms, proposed changes should be tested by the use of at least two independently developed encoders and two independently developed decoders which incorporated the proposed change. Where the data originated from a necessarily unique source (for example the data stream from an experimental satellite), the successful testing of a single encoder with at least two independent decoders would be considered adequate. Results should be made available to the $E T / D R \& C$ with a view to verifying the technical specifications.
4.4 Draft recommendations to be submitted to CBS sessions must be published as pre-session documents at least three months prior to the session.

## DEFINITIONS

## Actual time of observation

(1) In the case of a surface synoptic observation, the time at which the barometer is read.
(2) In the case of upper-air observations, the time at which the balloon, parachute or rocket is actually released.

## Alpine glow

Pink or yellow colouring assumed by mountain tops opposite the Sun when it is only just below the horizon before it rises and after it sets. This phenomenon vanishes after a brief interval of blue colouring, when the Earth's shadow reaches these summits.

## Anomalous propagation

Propagation of radio energy in abnormal conditions of vertical distribution of refractive index, in association with abnormal distribution of atmospheric temperature and humidity. Use of the term is mainly confined to conditions in which abnormally large distances of propagation are attained.

Atmospheric - Sferic
Electromagnetic wave resulting from an electric discharge (lightning) in the atmosphere.

## Automatic station

Meteorological station at which instruments make and transmit observations, the conversion to code form for international exchange being made either directly or at an editing station.

## Aviation routine weather report

A statement of the observed meteorological conditions related to a specified time and location, issued on a routine basis for use in international air navigation.

BUFR - Binary universal form for the representation of meteorological data
BUFR is the name of a binary code for the exchange and storage of data.

BUFR message
A single complete BUFR entity.

## Category

The lists of sequence descriptors tabulated in BUFR or CREX Table D are categorized according to their application; categories are provided for non-meteorological sequences, for various types of meteorological sequences, and for sequences which define reports, or major subsets of reports.

Class
A set of elements tabulated together in BUFR/CREX Table B.

Condensation trails (contrails)
Clouds which form in the wake of an aircraft when the atmosphere at flying level is sufficiently cold and humid.

Coordinate class
Classes 0-9 inclusive in BUFR/CREX Table B define elements which assist in the definition of elements from subsequent classes; each of these classes is referred to as a coordinate class.

CREX - Character form for the representation and exchange of data
CREX is the name of a table-driven alphanumeric code for the exchange and storage of data.
Data description operator
Operators which define replication or the operations listed in BUFR or CREX Table C.
Data entity
A single data item.
Data subset
A set of data corresponding to the data description in a BUFR or CREX message; for observational data, a data subset usually corresponds to one observation.

## Day darkness

Sky covered with clouds with very strong optical thickness (dark clouds) having a threatening appearance.

## Descriptor

An entity entered within the Data description section to describe or define data; a descriptor may take the form of an element descriptor, a replication operator, an operator descriptor, or a sequence descriptor.

Dry thunderstorm
A thunderstorm without precipitation reaching the ground (distinct from a nearby thunderstorm with precipitation reaching the ground but not at the station at the time of observation).

Dust wall or sand wall
Front of a duststorm or sandstorm, having the appearance of a gigantic high wall which moves more or less rapidly.

## Element descriptor

A descriptor containing a code figure reference to BUFR/CREX Table B; the referenced entry defines an element, together with the units, scale factor, reference value and data width to be used to represent that element as data.

## Equatorial regions

For the purpose of the analysis codes, the region between $30^{\circ} \mathrm{N}$ and $30^{\circ} \mathrm{S}$ latitudes.
Geometric altitude
Vertical distance $(Z)$ of a level, a point or an object considered as a point, measured from mean sea level.

## Geopotential

That potential with which the Earth's gravitational field is associated. It is equivalent to the potential energy of unit mass relative to a standard level (mean sea level by convention) and is numerically equal to
the work which would be done against gravity in raising the unit mass from sea level to the level at which the mass is located.
Geopotential $\phi$ at geometric height $z$ is given by

$$
\phi=\int_{0}^{2} \operatorname{gg} d z
$$

where g is the acceleration of gravity.

## Geopotential height

Height of a point in the atmosphere expressed in units (geopotential metres) proportional to the geopotential at that height. Geopotential height expressed in geopotential metres is approximately equal to $\frac{g}{9.8}$ times the geometric height expressed in (geometric) metres, $g$ being the local acceleration of gravity. $\overline{9.8}$

Haboob
A strong wind and duststorm or sandstorm in the northern and central Sudan. Its average duration is three hours; the average maximum wind velocity is over $15 \mathrm{~m} \mathrm{~s}^{-1}$. The dust or sand forms a dense whirling wall which may be 1000 m high; it is often preceded by isolated dust whirls. Haboobs usually occur after a few days of rising temperature and falling pressure.

## Ice crust (ice slick)

(1) A type of snow crust; a layer of ice, thicker than a film crust, upon a snow surface. It is formed by the freezing of melt water or rain water which has flowed into it.
(2) See Ice rind.

Ice rind
A thin but hard layer of sea ice, river ice or lake ice. Apparently this term is used in at least two ways: (a) for a new encrustation upon old ice; and (b) for a single layer of ice usually found in bays and fjords where fresh water freezes on top of slightly colder sea water.

Instrumental wave data
Data on measured characteristics relating to period and height of the wave motion of the sea surface.

Inversion (layer)
Atmospheric layer, horizontal or approximately so, in which the temperature increases with increasing height.

Isothermal layer
Atmospheric layer through which there is no change of temperature with height.
J et stream
Flat tubular current of air, quasi-horizontal, whose axis is along a line of maximum speed and which is characterized not only by great speeds but also by strong transverse gradients of speed.

Line squall
Squall which occurs along a squall line.
Lithometeor
Meteor consisting of an ensemble of particles most of which are solid and non-aqueous. The particles are more or less suspended in the air, or lifted by the wind from the ground.

## Mountain waves

Oscillatory motions of the atmosphere induced by flow over a mountain; such waves are formed over and to the lee of the mountain or mountain chain.

## Normals

Period averages computed for over a uniform and relatively long period comprising at least three consecutive 10 -year periods.

Obscured sky
Occasions of hydrometeors or lithometeors which are so dense as to make it impossible to tell whether there is cloud above or not.

## Ocean weather station

A station aboard a suitably equipped and staffed ship that endeavours to remain at a fixed sea position and that makes and reports surface and upper-air observations and may also make and report subsurface observations.

## Operator descriptor

A descriptor containing a code figure reference to BUFR or CREX Table $C$, together with data to be used as an operand.

## Past weather

Predominant characteristic of weather which had existed at the station during a given period of time.
Persistent condensation trail
Long-lived condensation trails which have spread to form clouds having the appearance of Cirrus or patches of Cirrocumulus or Cirrostratus. It is sometimes impossible to distinguish such clouds from other Cirrus, Cirrocumulus or Cirrostratus.

Present weather
Weather existing at the time of observation, or under certain conditions, during the hour preceding the time of observation.

## Purple light

Glow with a hue varying between pink and red, which is to be seen in the direction of the Sun before it rises and after it sets and is about $3^{\circ}$ to $6^{\circ}$ below the horizon. It takes the form of a segment of a more or less large luminous disc which appears above the horizon.

## Reference value

All data are represented within a BUFR or CREX message by positive integers; to enable negative values to be represented, suitable negative base values are specified as reference values. The true value is obtained by addition of the reference value and the data as represented.

Replication descriptor
A special descriptor is reserved to define the replication operation; it is used to enable a given number of subsequent descriptors to be replicated a given number of times.

Runway visual range
The range over which the pilot of an aircraft on the centre line of the runway can see the runway markings or the lights delineating the runway or identifying its centre line.

## Sea station

An observing station situated at sea. Sea stations include ships, ocean weather stations and stations on fixed or drifting platforms (rigs, platforms, lightships and buoys).

Section
A logical subdivision of a BUFR or CREX message, to aid description and definition.

## Sequence descriptor

A descriptor used as a code figure to reference a single entry in BUFR or CREX Table D; the referenced entry contains a list of descriptors to be substituted for the sequence descriptor.

Severe line squall
Severe squall which occurs along squall line (see Line squall).

## Snow haze

A suspension in the air of numerous minute snow particles, considerably reducing the visibility at the Earth's surface (visibility in snow haze often decreases to 50 m ). Snow haze is observed most frequently in Arctic regions, before or after a snow storm.

Squall
Atmospheric phenomenon characterized by a very large variation of wind speed: it begins suddenly, has a duration of the order of minutes and decreases rather suddenly in speed. It is often accompanied by a shower or thunderstorm.

## Squall line

Fictitious moving line, sometimes of considerable extent, along which squall phenomena occur.
Sun pillar
Pillar of white light, which may or may not be continuous, which may be observed vertically above or below the Sun. Sun pillars are most frequently observed near sunrise or sunset; they may extend to about $20^{\circ}$ above the Sun, and generally end in a point. When a sun pillar appears together with a well-developed parhelic circle, a sun cross may appear at their intersection.

Synoptic hour
Hour, expressed in terms of UTC, at which, by international agreement, meteorological observations are made simultaneously throughout the globe.

## Synoptic observation

A surface or upper-air observation made at standard time.

## Synoptic surface observation

Synoptic observation, other than an upper-air observation, made by an observer or an automatic weather station on the Earth's surface.

## Template

Description of the standardized layout of a set of data entries.

## Tropical (Tropic)

Pertaining to that region of the Earth's surface lying between the Tropic of Cancer and Tropic of Capricorn at $23^{\circ} 30 \mathrm{~N}$ and S , respectively.

## Tropical cyclone

Cyclone of tropical origin of small diameter (some hundreds of kilometres) with minimum surface pressure in some cases less than 900 hPa , very violent winds and torrential rain; sometimes accompanied by thunderstorms. It usually contains a central region, known as the "eye" of the storm, with a diameter of the order of some tens of kilometres, and with light winds and more or less lightly clouded sky.

Tropical revolving storm
Tropical cyclone.

## Tropopause

(1) Upper limit of the troposphere. By convention, the "first tropopause" is defined as the lowest level at which the lapse rate decreases to $2^{\circ} \mathrm{C} \mathrm{km}^{-1}$ or less, provided also the average lapse rate between this level and all higher levels within 2 km does not exceed $2^{\circ} \mathrm{C} \mathrm{km}{ }^{-1}$.
(2) If, above the first tropopause, the average lapse rate between any level and all higher levels within 1 km exceeds $3^{\circ} \mathrm{C} \mathrm{km}^{-1}$, then a "second tropopause" is defined by the same criterion as under (1). This second tropopause may be either within or above the 1 km layer.

Twilight glow
See Purple light.
Twilight glow in the mountains (Alpenglühen)
See Alpine glow.
Unit of geopotential $\left(\mathrm{H}_{\mathrm{m}}\right)$
1 standard geopotential metre $=0.980665$ dynamic metre

where $g(z)=$ acceleration of gravity, in $\mathrm{m} \mathrm{s}^{-2}$, as a function of geometric height;
$\mathrm{z}=$ geometric height, in metres;
$\mathrm{H}_{\mathrm{m}}{ }^{\prime}=$ geopotential, in geopotential metres.

Vertical visibility
Maximum distance at which an observer can see and identify an object on the same vertical as himself, above or below.

## Whiteout

Uniformly white appearance of the landscape when the ground is snow covered and the sky is uniformly covered with clouds. An atmospheric optical phenomenon of the polar regions in which the observer appears to be engulfed in a uniformly white glow. Neither shadows, horizon, nor clouds are discernible; sense of depth and orientation are lost; only very dark, nearby objects can be seen. Whiteout occurs over an unbroken snow cover and beneath a uniformly overcast sky, when, with the aid of the snowblink effect, the light from the sky is about equal to that from the snow surface. Blowing snow may be an additional cause. The phenomenon is experienced in the air as well as on the ground.

Wind (mean wind, spot wind)
Air motion relative to the Earth's surface. Unless it is otherwise specified, only the horizontal component is considered.
(1) Mean wind: For the purpose of upper air reports from aircraft, mean wind is derived from the drift of the aircraft when flying from one fixed point to another or obtained by flying on a circuit around a fixed observed point and an immediate wind deduced from the drift of the aircraft.
(2) Spot wind: For the purpose of upper-air reports from aircraft, the wind velocity, observed or predicted, for a specified location, height and time.

Zodiacal light
White or yellowish light which spreads out, in the night sky, more or less along the zodiac from the horizon on the side on which the Sun is hidden. It is observed when the sky is sufficiently dark and the atmosphere sufficiently clear.

## PART B BINARY CODES

a. FM system of numbering binary codes
b. List of binary codes with their specifications and associated code tables ATTACHMENT: Definition of FM 94 BUFR using Backus-Naur Form

## a. FM SYSTEM OF NUMBERING BINARY CODES

Each binary code bears a number, preceded by the letters FM. This number is followed by a Roman numeral to identify the session of CBS which either approved the binary code as a new one or made the latest amendment to its previous version. A binary code approved or amended by correspondence after a session of CBS receives the number of that session.

Furthermore, an indicator term is used to designate the binary code colloquially and is therefore called a "code name".

NOTES on nomenclature:
(a) Changes and augmentations to the structure of the GRIB data representation shall be identified as different "GRIB edition numbers". The current edition number is 2 . However, GRIB edition 1 (FM92-XI Ext. GRIB) remains in use and is listed in this Manual.
Changes to the content of any of the tables, including the grid definitions, shall be identified as different "table versions". Previous tables did not exist; the version described in this edition is "Tables Version 1". I Further GRIB editions and table versions may be generated independently of one another in the future as requirements dictate;
(b) Changes and augmentations to the structure of the BUFR data representation shall be identified as different "BUFR edition numbers". The current edition number is 3 .
Changes to the content of the parameter Tables $A, B, C$ and $D$ shall be identified as different "table versions". The previous tables were Version 9; the changes described in this edition will become "Tables A, $B, C$ and D, Version 10 ".
Further BUFR editions and table versions may be generated independently of one another in the future as requirements dictate.

Important note: The CBS recommendation number defining the last amendments is added at the bottom of the pages. Side bars indicate where the last amendments affect binary codes, regulations or tables.

The FM system of numbering the binary codes, together with the corresponding code names and their reference list of CBS approved decision, is the following:

## FM SYSTEM OF BINARY CODES

FM 92-XI Ext. GRIB Processed data in the form of grid-point values expressed in binary form edition 1 (gridded binary)

Res. 4 (EC-XXXVIII), Res. 1 (EC-XL), Rec. 23 (CBS-89), approved by the President of WMO, Rec. 22 (CBS-91), approved by the President of WMO, Rec. 15 (CBS-93), approved by the President of WMO, Rec. 16 (CBS-94), approved by the President of WMO, Res. 4 (EC-XLVII), Rec. 14 (CBS-95), approved by the President of WMO, Rec. 15 (CBS-96), approved by the President of WMO and Res. 8 (EC-LI)

FM 92-XII GRIB General regularly-distributed information in binary form
Res. 4 (EC-LIII) and Rec. 9 (CBS-01), approved by the President of WMO
FM 94-XI Ext. BUFR Binary universal form for the representation of meteorological data
Res. 1 (EC-XL), Rec. 23 (CBS-89), approved by the President of WMO, Rec. 22 (CBS-91), approved by the President of WMO, Rec. 15 (CBS-93), approved by the President of WMO, Rec. 16 (CBS-94), approved by the President of WMO, Res. 4 (EC-XLVII), Rec. 14 (CBS-95), approved by the President of WMO, Rec. 15 (CBS-96), approved by the President of WMO, Res. 4 (EC-XLIX), Rec. 9 (CBS-97), approved by the President of WMO, Rec. 10 (CBS-98), approved by the President of WMO,

## FM SYSTEM OF NUMBERING BINARY CODES

Res. 8 (EC-LI), Rec. 8 (CBS-99), Rec. 9 (CBS-00), approved by the President of WMO, Res. 4 (EC-LIII) and Rec. 9 (CBS-01), approved by the President of WMO

## b. LIST OF BINARY CODES WITH THEIR SPECIFICATIONS AND ASSOCIATED CODE TABLES

FM 92-XI Ext. GRIB edition 1 (gridded binary)

Processed data in the form of grid-point values expressed in binary form

CODE FORM:


NOTES:
(1) GRIB is the name of the binary code for the exchange of processed data.
(2) The GRIB coded analysis or forecast consists of a continuous bit-stream made of a sequence of octets (1 octet = 8 bits).
(3) The octets of a GRIB message are grouped in sections:

| Section number | Name | Contents |
| :---: | :---: | :---: |
| 0 | Indicator section | "G RIB", length of message, GRIB edition number |
| 1 | Product definition section | Length of section, identific ation of the coded analysis or forecast |
| 2 | Grid description section (optional) | Length of section, grid geometry, as necessary |
| 3 | Bit-map section (optional) | Length of section; the bit per grid point, placed in suitable sequence, indicates omission (bit 0) or inclusion (bit 1) of data at respective points |
| 4 | Binary data section | Length of section and data values |
| 5 | End section | 7777 |

(4) Although the Grid description section is indicated as optional, it is strongly urged that it be included in all GRIB messages.
(5) It will be noted that the GRIB code is not suitable for visual data recognition without computer interpretation.
(6) The representation of data by means of series of bits is independent of any particular machine representation.
(7) Message and section lengths are expressed in octets. Section 0 has a fixed length of 8 octets; Section 5 has a fixed length of 4 octets. Sections 1, 2, 3 and 4 have a variable length which is included in the first three octets of each section.
(8) In the GRIB message, the bit length of "International Alphabet No. 5 " is regarded as 8 -bit, adding one bit " 0 " to the 7-bit of IA5 as the most significant bit.

## REGULATIONS:

## $92.1 \quad$ General

92.1.1 The GRIB code shall be used for the exchange of processed data expressed in binary form.
92.1.2 The GRIB code shall always contain an even number of octets.
92.1.3 The beginning and the end of the code shall be identified by 4 octets coded according to the International Alphabet No. 5 to represent, respectively, the indic ators GRIB and 7777 in Indicator section 0 and End section 5. All other octets included in the code shall represent data in binary form.
92.1.4 Each section included in the code shall always contain an even number of octets. This rule shall be applied by appending bits set to zero to the section where necessary.
92.2

Section 0 - Indicator section
92.2.1
92.2.2 The first four octets shall always be character coded according to the International Alphabet No. 5 as GRIB.
92.2.3 The remainder of the section shall contain the length of the entire GRIB message (including the Indicator section) expressed in binary form over the left-most 3 octets (i.e. 24 bits), followed by the GRIB edition number, in binary, in the remaining octet.
92.3

Section 1 - Product definition section
92.3.1 The length of the section, in units of octets, shall be expressed in binary form over the group of the first three octets of the section, that is, over 24 bits.
92.3.2 Octet 8 of the section shall be used to indicate the inclusion or the omission of Sections 2 or 3 or of both of them.
92.3.3 Octets 29-40 are reserved for future use and need not be present. Octets 41 and following are set aside for use by the originating centre.
92.4 Section 2 - Grid description section

Regulation 92.3.1 shall apply.
92.5 Section 3 - Bit-map section
92.5.1 Regulation 92.3.1 shall apply.
92.5.2 Octets 5 and 6 shall be used to indicate that the bit-map is either predetermined and not explicitly included, or that the bit-map follows.

Section 4 - Binary data section
92.6.1 Regulation 92.3.1 shall apply.
92.6.2 Data shall be coded using the minimum number of bits necessary to provide for the accuracy required by international agreement. This required accuracy/precision shall be achieved by scaling the data by multiplication by an appropriate power of 10 (which may be 0 ) prior to forming the non-negative differences, and then using the binary scaling to select the precision of the transmitted value.

Data shall be coded in the form of non-negative scaled differences from a reference value. NOTES:
(1) The reference value is normally the minimum value of the data set which is represented.
(2) The actual value $Y$ (in the units of Code table 2 ) is linked to the coded value $X$, the reference value $R$, the binary scale factor $E$ and the decimal scale factor $D$ by means of the following formula:

$$
Y \times 10^{D}=R+X \times 2^{E}
$$

(3) When second-order grid-point packing is indicated, the actual value $Y$ (in the units of Code table 2) is linked to the coded values $X_{i}$ and $X_{j}$, the reference value $R$, the binary scale factor $E$ and the decimal scale factor $D$ by means of the following formula:

$$
Y \times 10^{D}=R+\left(X_{i}+X_{j}\right) \times 2^{E}
$$

The reference value shall be represented over 4 octets as a single precision floating point number, consisting of a leading sign bit, a 7-bit characteristic and a 24-bit binary fraction.
NOTES:
(1) The characteristic is convertible to a power of 16 by subtracting 64 from its 7 -bit representation.
(2) The reference value $R$ is linked to the binary numbers $s, A, B$, representing the sign ( 1 bit) positive coded as " 0 ", negative coded as " 1 ", a biased exponent (exponent +64 ) ( 7 bits), and the mantissa ( 24 bits), by means of the following formula:

$$
R=(-1)^{s} \times 2^{(-24)} \times B \times 16^{(A-64)}
$$

Section 5 - End section
The End section shall always be 4 octets long, character coded according to the International Alphabet No. 5 as 7777.

## SPECIFICATIONS OF OCTET CONTENTS

## Notes:

(1) Octets are numbered $1,2,3$, etc., starting at the beginning of each section.
(2) In the following, bit positions within octets are referred to as bit 1 to bit 8 , where bit 1 is the most significant and bit 8 is the least significant bit. Thus, an octet with only bit 8 set to 1 would have the integer value 1 .

Section 0 - Indicator section
Octet No. Contents

| $1-4$ | GRIB (coded according to the CCITT International Alphabet No. 5) |
| :---: | :--- |
| $\mathbf{5 - 7}$ | Total length of GRIB message (including Section 0) |
| 8 | GRIB edition number (currently 1) |

## Section 1 - Product definition section

| Octet No. | Contents |
| :---: | :---: |
| 1-3 | Length of section |
| 4 | GRIB tables Version No. (currently 3 for international exchange) - Version numbers 128-254 are reserved for local use |
| 5 | Identification of originating/generating centre (see Code table $\mathbf{0}=$ Common Code table C-1 in Part C/c.) |
| 6 | Generating process identification number (allocated by originating centre) |
| 7 | Grid definition (Number of grid used - from catalogue defined by originating centre) |
| 8 | Flag (see Regulation 92.3.2 and Code table 1) |
| 9 | Indicator of parameter (see Code table 2) |
| 10 | Indicator of type of level (see Code table 3) |
| 11-12 | Height, pressure, etc. of levels (see Code table 3) |
| 13 | Year of century |
| 14 | Month |
| 15 | Day |
| 16 | Hour ${ }^{\text {der }}$ |
| 17 | Minute |
| 18 | Indicator of unit of time range (see Code table 4) |
| 19 | P1 - Period of time (number of time units) (0 for analyses or initialized analyses). Units of time given by octet 18 |
| 20 | P2 - Period of time (number of time units); or Time interval between successive analyses, initialized analyses or forecasts, undergoing averaging or accumulation. Units of time given by octet 18 |
| 21 | Time range indicator (see Code table 5) |
| 22-23 | Number included in average, when octet 21 (Code table 5) indicates an average or accumulation; otherwise set to zero |
| 24 | Number missing from averages or accumulations |
| 25 | Century of reference time of data |
| 26 | Sub-centre identification (see common Code table C-1 in Part C/c., Note (3)) |
| 27-28 | Units decimal scale factor (D) |
| 29-40 | Reserved: need not be present |
| 41-nn | Reserved for originating centre use |

Notes:
(1) Inclusion of the Section 2 - Grid description section (GDS) - is the preferred method of defining a grid.
(2) Where octet 7 defines a catalogued grid, that grid should also be defined in Section 2, provided the flag in octet 8 indicates inclusion of Section 2.
(3) Octet 7 must be set to 255 to indicate a non-catalogued grid, in which case the grid will be defined in Section 2.
(4) A negative value of $\mathbf{D}$ shall be indicated by setting the high-order bit (bit 1 ) in the left-hand octet to 1 (on).
(5) If a Grid description section is not included, then any u- or v-components of vector quantities in the message are to be resolved relative to the specified grid in the direction of increasing $x$ and $y$ (or $i$ and j) coordinates respectively.
If a Grid description section is included in the message, which is the preferred option, then octet 17 of the GDS and Code table 7 will contain component resolution information.
(6) To specify year 2000, octet 13 of the section (year of the century) shall contain a value equal to $\mathbf{1 0 0}$ and octet 25 of the section (Century of reference time data) shall contain a value equal to 20 . To specify year 2001, octet 13 of the section shall contain a value equal to 1 and octet 25 of the section shall contain a value equal to 21 (by International Convention, the date of $\mathbf{1 J}$ anuary 2000 is the first day of
the hundredth year of the twentieth century and the date of 1 J anuary 2001 is the first day of the first year of the twenty-first century); it is to be noted also that year 2000 is a leap year and that 29 February 2000 exists.

Section 2 - Grid description section

Octet No.
Contents
1-3 Length of section (octets)
4 NV - number of vertical coordinate parameters
5 PV - location (octet number) of the list of vertical coordinate parameters, if present; or
PL - location (octet number) of the list of numbers of points in each row (if no vertical coordinate parameters are present), if present; or 255 (all bits set to 1) if neither are present
6 Data representation type (see Code table 6)
7-32 Grid definition (according to data representation type - octet 6 above)
33-42 Extensions of grid definition for rotation or stretching of the coordinate system or Lambert conformal projection or Mercator projection
33-44 Extensions of grid definition for space view perspective projection
33-52 Extensions of grid definition for stretched and rotated coordinate system
PV List of vertical coordinate parameters (length $=$ NV $\times 4$ octets); if present, then PL = 4NV + PV
PL List of numbers of points in each row (length = NROWS $\times 2$ octets, where NROWS is the total number of rows defined within the grid description)

Notes:
(1) Vertical coordinate parameters are used in association with hybrid vertical coordinate systems.
(2) Hybrid systems, in the context, employ a means of representing vertical coordinates in terms of a mathematical combination of pressure and sigma coordinates. When used in conjunction with a surface pressure field and an appropriate mathematical expression, the vertical coordinate parameters may be used to interpret the hybrid vertical coordinate.
(3) Each vertical coordinate parameter is represented in 4 octets, using the scheme for representing floating point numbers described in Regulation 92.6.4.

Grid definition - latitude/longitude grid (or equidistant cylindrical, or Plate Carrée)

| Octet No. | Contents |
| :---: | :---: |
| 7-8 | Ni - number of points along a parallel |
| 9-10 | Nj - number of points along a meridian |
| 11-13 | La $\mathrm{L}_{1}$ - latitude of first grid point |
| 14-16 | $\mathrm{Lo}_{1}$ - longitude of first grid point |
| 17 | Resolution and component flags (see Code table 7) |
| 18-20 | $\mathrm{La}_{2}$ - latitude of last grid point |
| 21-23 | $\mathrm{Lo}_{2}$ - longitude of last grid point |
| 24-25 | Di - i direction increment |
| 26-27 | Dj - j direction increment |
| 28 | Scanning mode (flags - see Flag/Code table 8) |
| 29-32 | Set to zero (reserved) |
| 33-35 | Latitude of the southern pole in millidegrees (integer) |
|  | Latitude of pole of stretching in millidegrees (integer) |
| 36-38 | Longitude of the southern pole in millidegrees (integer) |
|  | Longitude of pole of stretching in millidegrees (integer) |
| 39-42 | Angle of rotation (represented in the same way as the reference value) |
|  | Stretching factor (representation as for the reference value) |

Octet No. Contents

| 43-45 | Latitude of pole of stretching in millidegrees (integer) |
| :--- | :--- |
| 46-48 | Longitude of pole of stretching in millidegrees (integer) |
| $49-52$ | Stretching factor (representation as for the reference value) |

Notes:
(1) Latitude, longitude and increments are in millidegrees.
(2) Latitude values are limited to the range 0-90 000; bit 1 is set to 1 to indicate south latitude.
(3) Longitude values are limited to the range 0-360 000; bit 1 is set to 1 to indicate west longitude.
(4) The latitude and longitude of the last grid point and the first grid point should always be given for regular grids.
(5) Where items are not given, the appropriate octet(s) should have all bits set to 1 .
(6) Three parameters define a general latitude/longitude coordinate system, formed by a general rotation of the sphere. One choice for these parameters is:
(a) The geographic latitude in degrees of the southern pole of the coordinate system, $\theta_{p}$ for example;
(b) The geographic longitude in degrees of the southern pole of the coordinate system, $\lambda_{p}$ for example;
(c) The angle of rotation in degrees about the new polar axis (measured clockwise when looking from the southern to the northern pole) of the coordinate system, assuming the new axis to have been obtained by first rotating the sphere through $\lambda_{p}$ degrees about the geographic polar axis, and then rotating through $\left(90+\theta_{p}\right)$ degrees so that the southern pole moved along the (previously rotated) Greenwich meridian.
(7) For rotated grids, the vertical coordinate parameters start at octet 43 instead of 33 .
(8) The stretching is defined by three parameters:
(a) The latitude in degrees (measured in the model coordinate system) of the "pole of stretching";
(b) The longitude in degrees (measured in the model coordinate system) of the "pole of stretching";
(c) The stretching factor C .

The stretching is defined by representing data uniformly in a coordinate system with longitude $\lambda$ and latitude $\theta^{1}$, where:

$$
\theta^{1}=\sin ^{-1} \frac{\left(1-C^{2}\right)+\left(1+C^{2}\right) \sin \theta}{\left(1+C^{2}\right)+\left(1-C^{2}\right) \sin \theta}
$$

and $\lambda$ and $\theta$ are longitude and latitude in a coordinate system in which the "pole of stretching" is the northern pole. $C=1$ gives uniform resolution, while $C>1$ gives enhanced resolution around the pole of stretching.
(9) For stretched grids, the vertical coordinate parameters start at octet 43 instead of 33.
(10) For stretched and rotated latitude/longitude grids, the vertical coordinate parameters start at octet 53.
(11) The first and last grid points may not necessarily correspond to the first and last data points, respectively, if the bit-map section is used.
(12) For data on a quasi-regular grid, in which all the rows or columns do not necessarily have the same number of grid points, either Ni (octets 7-8) or Nj (octets $9-10$ ) and the corresponding Di (octets 24-25) or $\operatorname{Dj}$ (octets $\mathbf{2 6 - 2 7}$ ) shall be coded with all bits set to 1 (missing); the actual number of points along each parallel or meridian shall be coded.
(13) A quasi-regular grid is only defined for appropriate grid scanning modes. Either rows or columns, but not both simultaneously, may have variable numbers of points. The first point in each row (column) shall be positioned at the meridian (parallel) indicated by octets 11-16. The grid points shall be evenly spaced in latitude (longitude).

| Grid definition | - Gaussian latitude/longitude grid (including rotated, stretched or stretched and rotated) |
| :---: | :---: |
| Octet No. | Contents |
| 7-8 | Ni - number of points along a parallel |
| 9-10 | Nj - number of points along a meridian |
| 11-13 | $\mathrm{La}_{1}$ - latitude of first grid point |
| 14-16 | $\mathrm{Lo}_{1}$ - longitude of first grid point |
| 17 | Resolution and component flags (see Code table 7) |
| 18-20 | $\mathrm{La}_{2}$ - latitude of last grid point |
| 21-23 | $\mathrm{Lo}_{2}$ - longitude of last grid point |
| 24-25 | Di - i direction increment |
| 26-27 | N - number of parallels between a pole and the equator |
| 28 | Scanning mode (flags - see Flag/Code table 8) |
| 29-32 | Set to zero (reserved) |
| 33-35 | Latitude of the southern pole in millidegrees (integer) Latitude of pole of stretching in millidegrees (integer) |
| 36-38 | Longitude of the southern pole in millidegrees (integer) Longitude of pole of stretching in millidegrees (integer) |
| 39-42 | Angle of rotation (represented in the same way as the reference value) Stretching factor (representation as for the reference value) |
| 43-45 | Latitude of pole of stretching in millidegrees (integer) |
| 46-48 | Longitude of pole of stretching in millidegrees (integer) |
| 49-52 | Stretching factor (representation as for the reference value) |

Notes:
(1) Latitude, longitude and increments are in millidegrees.
(2) Latitude values are limited to the range $0-90000$; bit 1 is set to 1 to indicate south latitude.
(3) Longitude values are limited to the range 0-360 000; bit 1 is set to 1 to indicate west longitude.
(4) The number of parallels between a pole and the equator is used to establish the variable (Gaussian) spacing of the parallels; this value must always be given.
(5) The latitude and longitude of the last grid point and the first grid point should always be given for regular grids.
(6) Where items are not given, the appropriate octet(s) should have all bits set to 1 .
(7) See Notes (6) to (11) under Grid definition - latitude/longitude grid (or equidistant cylindrical, or Plate Carrée) - page $1.2-\mathrm{Bi}-8$.
(8) Quasi-regular Gaussian latitude/longitude grids are defined only for subsets of global grids containing full latitude rows $\left(360^{\circ}\right)$.
(9) For data on a quasi-regular grid, in which all the rows do not necessarily have the same number of grid points, Ni (octets 7-8) and the corresponding Di (octets 24-25) shall be coded with all bits set to 1 (missing); the actual number of points along each parallel shall be coded.
(10) A quasi-regular Gaussian latitude/longitude grid is only defined for the grid scanning mode with consecutive points on parallels (bit 3 set to zero in Code table 8). The first point in each row shall be positioned at the meridian indicated by octets 14-16 and the last shall be positioned at the meridian indicated by octets 21-23. The grid points along each parallel shall be evenly spaced in longitude.


Notes:
(1) The pentagonal representation of resolution is general. Some common truncations are special cases of the pentagonal one:

| Triangular | $M=J=K$ |
| :--- | :--- |
| Rhomboidal | $K=J+M$ |
| Trapezoidal | $K=J, K>M$ |

(2) The representation type (octet 13) indicates the method used to define the norm.
(3) The representation mode (octet 14) indicates the order of the coefficients, whether global or hemispheric data are depicted, and the nature of the parameter stored (symmetric or antisymmetric).
(4) See Notes (6) to (11) under Grid definition - latitude/longitude grid (or equidistant cylindrical, or Plate Carrée) - page $\mathrm{I} .2-\mathrm{Bi}-8$.

Grid definition - polar stereographic

| Octet No. | Contents |
| :---: | :---: |
| 7-8 | $N \mathrm{~N}$ - number of points along x -axis |
| 9-10 | Ny - number of points along y -axis |
| 11-13 | $\mathrm{La}_{1}$ - latitude of first grid point |
| 14-16 | $\mathrm{Lo}_{1}$ - longitude of first grid point |
| 17 | Resolution and component flags (see Code table |
| 18-20 | LoV - orientation of the grid; i.e. the longitude the $y$-axis (or columns of the grid) $Y$-coordinate increases (the orientation particular grid) |
| 21-23 | Dx - X-direction grid length (see Note (2)) |
| 24-26 | Dy - Y-direction grid length (see Note (2)) |
| 27 | Projection centre flag (see Note (5)) |
| 28 | Scanning mode (flags - see Flag/Code table 8) |
| 29-32 | Set to zero (reserved) |

Notes:
(1) Latitude and longitude are in millidegrees (thousandths of a degree).
(2) Grid lengths are in units of metres, at the 60-degree parallel nearest to the pole on the projection plane.
(3) Latitude values are limited to the range $0-90000$; bit 1 is set to 1 to indicate south latitude.
(4) Longitude values are limited to the range $0-360000$; bit 1 is set to 1 to indicate west longitude.
(5) Octet 27 (projection centre flag): bit 1 set to 0 if North Pole is on the projection plane bit 1 set to 1 if South Pole is on the projection plane (to be set up as flag table).
(6) Where items are not given, the appropriate octet(s) should have all bits set to 1.
(7) See Note (11) under Grid definition - latitude/longitude grid (or equidistant cylindrical, or Plate Carrée) page $1.2-\mathrm{Bi}-8$.
(8) The resolution flag (bit 1 of Code table 7 ) is not applicable.

Grid definition - Mercator
Octet No. Contents

7-8 $\quad \mathrm{Ni}$ - number of points along a parallel
9-10 $\quad \mathrm{Nj}$ - number of points along a meridian
11-13 $\quad \mathrm{La}_{1}$ - latitude of first grid point
14-16 $\quad \mathrm{Lo}_{1}$ - longitude of first grid point
17 Resolution and component flags (see Code table 7)
18-20 $\quad \mathrm{La}_{2}$ - latitude of last grid point
21-23 $\mathrm{Lo}_{2}$ - longitude of last grid point
24-26 Latin - latitude(s) at which the Mercator projection cylinder intersects the Earth
27 Set to zero (reserved)
28 Scanning mode (flags - see Flag/Code table 8)
29-31 $\quad \mathrm{Di}$ - longitudinal direction grid length (see Note (2))
32-34 $\quad \mathrm{Dj}$ - latitudinal direction grid length (see Note (2))
35-42 Set to zero (reserved)

Notes:
(1) Latitude and longitude are in millidegrees (thousandths of a degree).
(2) Grid lengths are in units of metres, at the parallel specified by Latin.
(3) Latitude values are limited to the range $0-90000$; bit 1 is set to 1 to indicate south latitude.
(4) Longitude values are limited to the range $0-360000$; bit 1 is set to 1 to indicate west longitude.
(5) The latitude and longitude of the last grid point from the first grid point should always be given.
(6) Where items are not given, the appropriate octet(s) should have all bits set to 1 , the "missing" indicator.
(7) The first and last grid points may not necessarily correspond to the first and last data points, respectively, if the bit-map section is used.

| Grid d | - Lambert conformal, secant or tangent, conic or bi-polar (normal or oblique), or Albers equal-area, secant or tangent, conic or bi-polar (normal or oblique), projection |
| :---: | :---: |
| Octet No. | Contents |
| 7-8 | $N x$ - number of points along $x$-axis |
| 9-10 | Ny - number of points along y -axis |
| 11-13 | $\mathrm{La}_{1}$ - latitude of first grid point |
| 14-16 | $L^{1} \mathbf{1}_{1}$ - longitude of first grid point |
| 17 | Resolution and component flags (see Code table 7) |
| 18-20 | LoV - orientation of the grid; i.e. the east longitude value of the meridian which is parallel to the $y$-axis (or columns of the grid) along which latitude increases as the $y$-coordinate increases (the orientation longitude may or may not appear on a particular grid) |
| 21-23 | Dx - x-direction grid length (see Note (2)) |
| 24-26 | Dy - y-direction grid length (see Note (2)) |
| 27 | Projection centre flag (see Note (5)) |
| 28 | Scanning mode (flags - see Flag/Code table 8) |
| 29-31 | Latin 1 - first latitude from the pole at which the secant cone cuts the sphere |
| 32-34 | Latin 2 - second latitude from the pole at which the secant cone cuts the sphere |
| 35-37 | Latitude of the southern pole in millidegrees (integer) |
| 38-40 | Longitude of the southern pole in millidegrees (integer) |
| 41-42 | Set to zero (reserved) |
| Notes |  |
| (1) Latit | longitude are in millidegrees (thousandths of a degree). |
| (2) Grid proje | s are in units of metres, at the secant cone intersection parallel nearest to the pole on the plane. |
| (3) Latit | lues are limited to the range $0-90000$; bit 1 is set to 1 to indicate south latitude. |
| (4) Lon | values are limited to the range 0-360 000; bit 1 is set to 1 to indicate west longitude. |
| (5) Octe <br> bit 1 bit 1 bit 2 bit 2 | rojection centre flag): <br> 0 if North Pole is on the projection plane <br> 1 if South Pole is on the projection plane <br> 0 if only one projection centre is used <br> 1 if projection is bi-polar and symmetric. |
| (6) If La | Latin 2, then the projection is on a tangent cone. |
|  |  |

Grid definition - Space view perspective or orthographic

| Octet No. | Contents |
| :---: | :--- |
| $7-8$ | $\mathrm{Nx}-$ number of points along x -axis (columns) |
| $9-10$ | Ny - number of points along y -axis (rows or lines) |
| $11-13$ | Lap - latitude of sub-satellite point |
| $14-16$ | Lop - longitude of sub-satellite point |
| 17 | Resolution and component flags (see Code table 7) |
| $18-20$ | $\mathrm{dx}-$ apparent diameter of Earth in grid lengths, in x-direction |

Octet No.

## Contents

21-23 dy - apparent diameter of Earth in grid lengths, in y-direction
24-25 $\quad \mathrm{Xp}-\mathrm{x}$-coordinate of sub-satellite point
26-27 $\quad Y p-y$-coordinate of sub-satellite point
28
Scanning mode (flags - see Flag/Code table 8)
29-31 Orientation of the grid; i.e. the angle in millidegrees between the increasing $y$-axis and the meridian of the sub-satellite point in the direction of increasing latitude (see Note (3))
32-34 $\quad \mathrm{Nr}$ - altitude of the camera from the Earth's centre, measured in units of the Earth's (equatorial) radius (see Note (4))
35-36 Xo - x-coordinate of origin of sector image
37-38 $\quad$ Yo - y-coordinate of origin of sector image
39-44 Set to zero (reserved)

## Notes:

(1) It is assumed that the satellite is at its nominal position, i.e. it is looking directly at its sub-satellite point.
(2) Octets 32-34 shall be set to all ones (missing) to indicate the orthographic view (from infinite distance).
(3) It is the angle between the increasing $y$-axis and the meridian $180^{\circ} \mathrm{E}$ if the sub-satellite point is the North Pole; or the meridian $0^{\circ}$ if the sub-satellite point is the South Pole.
(4) The apparent angular size of the Earth will be given by $2 \times \operatorname{Arcsin}(1 / \mathrm{Nr})$.
(5) The horizontal and vertical angular resolutions of the sensor ( $R x$ and $R y$ ), needed for navigation equations, can be calculated from the following:

$$
\begin{aligned}
& R x=2 \times \operatorname{Arcsin}(1 / N r) / d x \\
& R y=2 \times \operatorname{Arcsin}(1 / N r) / d y
\end{aligned}
$$

| Section 3 - Bit-map section |  |
| :---: | :--- |
| Octet No. | Contents |
| 1-3 | Length of section |
| 4 | Number of unused bits at end of Section 3 |
| $5-6$ | Table reference: <br> If the octets contain zero, a bit-map follows |
|  | If the octets contain a number, it refers to a predetermined bit-map provided by the centre <br> 7- |
|  | The bit-map - contiguous bits with a bit to data point correspondence, ordered as defined <br> in the grid definition |


| Section $4-$ Binary data section |  |
| :--- | :--- |
| Octet No. | Contents |
| $1-3$ | Length of section |
| 4 | Flag (see Code table 11) (first 4 bits). Number of unused bits at end of Section 4 (last 4 bits) |
| $5-6$ | Scale factor (E) |
| $7-10$ | Reference value (minimum of packed values) |
| 11 | Number of bits containing each packed value |
| $12-$ | Variable, depending on the flag value in octet 4 |

N ote: A negative value of $E$ shall be indicated by setting the high-order bit (bit 1) in the left-hand octet to 1 (on).

## Grid-point data - simple packing

Octet No.
Contents
12- Binary data

## Spherical harmonic coefficients - simple packing

| Octet No. | Contents |
| :---: | :---: |
| 12-15 | Real part of $(0.0)$ coefficient (stored in the same manner as the reference value (octets 7-10)) |
| 16- | Binary data |
| Grid-point data - second-order packing |  |
| Octet No. | Contents |
| 12-13 | N1 - octet number at which first-order packed data begin |
| 14 | Extended flags (see Code table 11) |
| 15-16 | N2 - octet number at which second-order packed data begin |
| 17-18 | P1 - number of first-order packed values |
| 19-20 | P2 - number of second-order packed values |
| 21 | Reserved |
| 22-(xx-1) | Width(s) in bits of second-order packed values; each width is contained in 1 octet |
| xx-(N1-1) | Secondary bit-map, at least P2 bits long, padded to a whole number of octets with binary 0 |
| N1-(N2-1) | P1 first-order packed values, padded to a whole number of octets with binary 0 |
| N2-... | P2 second-order packed values |

## Notes:

(1) The binary data shall consist of P1 first-order packed values, of width given by the contents of octet 11, followed by $\mathbf{P} 2$ second-order packed values; there shall be one second-order packed value for each point of the defined grid, as modified by application of the bit-map in Section 3 - Bit-map section, if present.
(2) The width of the second-order packed values shall be indicated by the values of $\mathbf{W} \mathbf{2}_{\mathbf{j}}$ :
(a) If bit 8 of the extended flags (Code table 11) is 0 , all second-order packed values will have the same width, indicated by a single value $\mathrm{W} 2_{1}$;
(b) If bit 8 of the extended flags (Code table 11) is 1, P1 values of the widths of second-order packed values $\left(W 2_{j}, j=1 . . P 1\right)$ will be given.
(3) The secondary bit-map, starting at octet xx , shall define with corresponding 1 bits the location where the use of the first-order packed values begins with reference to the defined grid (as modified by the bitmap, Section 3, if present); the first point of the grid, as modified by the bit-map in Section 3 if present, will always be present, and a corresponding 1 shall be set in the first bit of the secondary bit-map.
(4) Where bit 7 of the extended flags (Code table 11) is 0 , the secondary bit-map shall be omitted; and implied secondary bit-map shall be inferred such that a 1 bit is set for the first point of each row (or column) of the defined grid (row by row packing).
(5) The original represented data at any point shall be obtained by scanning the points in the order defined by the grid description, as modified by the (optional) bit-map section; each first-order packed value shall remain defined until the point at which the use of a subsequent first-order packed value begins, as defined by the secondary bit-map; the unpacked value shall be obtained by applying the reference value, the binary and the decimal scales to the sum of the first- and second-order values for each point, by the following formula:

$$
Y \times 10^{D}=R+\left(X_{i}+X_{j}\right) \times 2^{E}
$$

where $X_{i}$ is the appropriate first-order packed value;
$X_{j}$ is the appropriate second-order packed value.
(6) If the number of bits $W 2_{j}$, for the appropriate subset, is zero, no values for that subset are represented; i.e. the actual value for that subset is a constant given by $R+\left(X_{i} \times 2^{E}\right)$. This is a form of run-length encoding in which a string of identical values is represented by one value; the replication count for that value is, implicitly, in the secondary bit-map.

## Spherical harmonics - complex packing

## Octet No.

Contents
12-13

## N

14-15
16
IP (where IP = int (1000 x P) )
$J^{1}$
17
$K^{1}$
18
$M^{1}$
19 Binary data
\(\left.\begin{array}{l}. <br>

.\end{array}\right\}\)\begin{tabular}{l}

| Unpacked binary data represented in 004 octets in the same way as the reference |
| :--- |
| value |
| (pairs of coefficients) | <br>

N Packed binary data
\end{tabular}

Notes:
(1) Removal of the real ( 0.0 ) coefficient considerably reduces the variability of the coefficients and results in better packing.
(2) For some spherical harmonic representations, the ( 0.0 ) coefficient represents the mean value of the parameter represented.
(3) For spherical harmonics - complex packing, $\mathbf{J}^{\mathbf{1}}, \mathbf{K}^{\mathbf{1}}, \mathbf{M}^{\mathbf{1}}$ are the pentagonal resolution parameters specifying the truncation of a subset of the data, which shall be represented unpacked (as is the reference value) and shall precede the packed data.
$P$ defines a scaling factor by which is packed not the field itself, but the modulus of $\nabla^{2 P}$ of the field, where $\nabla^{2}$ is the Laplacian operator. Thus the coefficients $\phi_{n}^{m}$ will be multiplied by $(n(n+1))^{\text {P }}$ before packing, and divided by this factor after unpacking.
$N$ is a pointer to the start of the packed data (i.e. gives octet number)

$$
\left(\mathrm{J}^{1}, \mathrm{~K}^{1}, \mathrm{M}^{1}>0 \text { and } \mathrm{P} 0,+ \text { or }-\right)
$$

The representation mode (Code figure $=\mathbf{2}$ in Code table 10) in Section 2 shall indicate this type of packing, but as Section $\mathbf{2}$ is optional, the flag field in Section 4 may also be used to indicate the more complex method.

Section 5 - End section
7777 End of message (coded according to the CCITT International Alphabet No. 5)

## CODE TABLES RELATIVE TO SECTION 1

## Code table 0 - Identification of originating/generating centre

## (See common Code table C-1 in Part C/c.)

## Code table 1 - Flag indication relative to Sections 2 and 3

| Bit No. | Value | Meaning |
| :---: | :---: | :---: |
| 1 | 0 | Section 2 omitted |
|  | 1 | Section 2 included |
| 2 | 0 | Section 3 omitted |
|  | 1 | Section 3 included |
| $3-8$ | 0 |  |

Note: Bits enumerated from left to right.

| Code figure | Field parameter | Unit |
| :---: | :---: | :---: |
| 000 | Reserved |  |
| 001 | Pressure | Pa |
| 002 | Pressure reduced to MSL | Pa |
| 003 | Pressure tendency | Pa s-1 |
| 004 | Potential vorticity | K m ${ }^{\mathbf{2}} \mathrm{kg}^{-1} \mathrm{~s}^{\mathbf{- 1}}$ |
| 005 | ICAO Standard Atmosphere reference height | m |
| 006 | Geopotential | $\mathrm{m}^{2} \mathrm{~s}^{-2}$ |
| 007 | Geopotential height | gpm |
| 008 | Geometrical height | m |
| 009 | Standard deviation of height | m |
| 010 | Total ozone | Dobson |
| 011 | Temperature | K |
| 012 | Virtual temperature | K |
| 013 | Potential temperature | K |
| 014 | Pseudo-adiabatic potential temperature | K |
| 015 | Maximum temperature | K |
| 016 | Minimum temperature | K |
| 017 | Dew-point temperature | K |
| 018 | Dew-point depression (or deficit) | K |
| 019 | Lapse rate | K m ${ }^{-1}$ |
| 020 | Visibility | m |
| 021 | Radar spectra (1) | - |
| 022 | Radar spectra (2) | - |
| 023 | Radar spectra (3) | - |
| 024 | Parcel lifted index (to $\mathbf{5 0 0} \mathbf{~ h P a}$ ) | K |
| 025 | Temperature anomaly | K |

(Code table 2 - continued)

| Code figure | Field parameter | Unit |
| :---: | :---: | :---: |
| 026 | Pressure anomaly | Pa |
| 027 | Geopotential height anomaly | gpm |
| 028 | Wave spectra (1) | - |
| 029 | Wave spectra (2) | - |
| 030 | Wave spectra (3) | - |
| 031 | Wind direction | Degree true |
| 032 | Wind speed | m s-1 |
| 033 | u-component of wind | m s-1 |
| 034 | v -component of wind | m $\mathbf{s}^{-1}$ |
| 035 | Stream function | $\mathrm{m}^{2} \mathrm{~s}^{-1}$ |
| 036 | Velocity potential | $\mathrm{m}^{2} \mathrm{~s}^{-1}$ |
| 037 | Montgomery stream function | $\mathrm{m}^{2} \mathrm{~s}^{-2}$ |
| 038 | Sigma coordinate vertical velocity | $\mathrm{s}^{-1}$ |
| 039 | Vertical velocity | Pa s ${ }^{-1}$ |
| 040 | Vertical velocity | m s-1 |
| 041 | Absolute vorticity | $\mathrm{s}^{-1}$ |
| 042 | Absolute divergence | $\mathrm{s}^{-1}$ |
| 043 | Relative vorticity | $\mathrm{s}^{-1}$ |
| 044 | Relative divergence | $\mathrm{s}^{-1}$ |
| 045 | Vertical u-component shear | $\mathrm{s}^{-1}$ |
| 046 | Vertical v-component shear | $\mathrm{s}^{-1}$ |
| 047 | Direction of current | Degree true |
| 048 | Speed of current | m s-1 |
| 049 | u-component of current | $\mathrm{m} \mathrm{s}{ }^{-1}$ |
| 050 | v -component of current | m s ${ }^{-1}$ |
| 051 | Specific humidity | kg kg ${ }^{-1}$ |
| 052 | Relative humidity | \% |
| 053 | Humidity mixing ratio | $\mathrm{kg} \mathrm{kg}^{-1}$ |
| 054 | Precipitable water | kg m-2 |
| 055 | Vapour pressure | Pa |
| 056 | Saturation deficit | Pa |
| 057 | Evaporation | kg m ${ }^{-2}$ |
| 058 | Cloud ice | kg m ${ }^{-2}$ |
| 059 | Precipitation rate | kg m-2 $\mathbf{s}^{\mathbf{- 1}}$ |
| 060 | Thunderstorm probability | \% |
| 061 | Total precipitation | kg m-2 |
| 062 | Large scale precipitation | kg m-2 |
| 063 | Convective precipitation | kg m ${ }^{-2}$ |
| 064 | Snowfall rate water equivalent | $\mathbf{k g ~ m - 2 ~} \mathrm{s}^{\mathbf{- 1}}$ |
| 065 | Water equivalent of accumulated snow depth | kg m ${ }^{-2}$ |
| 066 | Snow depth | m |
| 067 | Mixed layer depth | m |
| 068 | Transient thermocline depth | m |

(continued)
(Code table 2 - continued)

| Code figure | Field parameter | Unit |
| :---: | :---: | :---: |
| 069 | Main thermocline depth | m |
| 070 | Main thermocline anomaly | m |
| 071 | Total cloud cover | \% |
| 072 | Convective cloud cover | \% |
| 073 | Low cloud cover | \% |
| 074 | Medium cloud cover | \% |
| 075 | High cloud cover | \% |
| 076 | Cloud water | kg m ${ }^{-2}$ |
| 077 | Best lifted index (to $\mathbf{5 0 0} \mathbf{~ h P a}$ ) | K |
| 078 | Convective snow | kg m-2 |
| 079 | Large scale snow | kg m ${ }^{-2}$ |
| 080 | Water temperature | K |
| 081 | Land cover ( 1 = land, $0=$ sea) | Proportion |
| 082 | Deviation of sea level from mean | m |
| 083 | Surface roughness | m |
| 084 | Albedo | \% |
| 085 | Soil temperature | K |
| 086 | Soil moisture content | kg m ${ }^{\mathbf{- 2}}$ |
| 087 | Vegetation | \% |
| 088 | Salinity | $\mathrm{kg} \mathrm{kg}^{-1}$ |
| 089 | Density | $\mathrm{kg} \mathrm{m}^{-3}$ |
| 090 | Water run-off | kg m-2 |
| 091 | Ice cover ( $1=$ ice, $0=$ no ice) | Proportion |
| 092 | Ice thickness | m |
| 093 | Direction of ice drift | Degree true |
| 094 | Speed of ice drift | m s-1 |
| 095 | u-component of ice drift | $\mathrm{m} \mathrm{s}{ }^{-1}$ |
| 096 | $v$-component of ice drift | $\mathrm{m} \mathrm{s}^{-1}$ |
| 097 | Ice growth rate | m s-1 |
| 098 | Ice divergence | $\mathrm{s}^{-1}$ |
| 099 | Snow melt | kg m-2 |
| 100 | Significant height of combined wind waves and swell | m |
| 101 | Direction of wind waves | Degree true |
| 102 | Significant height of wind waves | m |
| 103 | Mean period of wind waves | s |
| 104 | Direction of swell waves | Degree true |
| 105 | Significant height of swell waves | m |
| 106 | Mean period of swell waves | 5 |
| 107 | Primary wave direction | Degree true |
| 108 | Primary wave mean period | 5 |
| 109 | Secondary wave direction | Degree true |
| 110 | Secondary wave mean period | 5 |
| 111 | Net short-wave radiation flux (surface) | W m ${ }^{-2}$ |
| 112 | Net long-wave radiation flux (surface) | W m ${ }^{-2}$ |

(Code table 2 - continued)

| Code figure | Field parameter | Unit |
| :---: | :---: | :---: |
| 113 | Net short-wave radiation flux (top of atmosphere) | W m ${ }^{-2}$ |
| 114 | Net long-wave radiation flux (top of atmosphere) | W m ${ }^{-2}$ |
| 115 | Long-wave radiation flux | W m ${ }^{-2}$ |
| 116 | Short-wave radiation flux | W m ${ }^{-2}$ |
| 117 | Global radiation flux | W m ${ }^{-2}$ |
| 118 | Brightness temperature | K |
| 119 | Radiance (with respect to wave number) | W m ${ }^{-1} \mathrm{sr}^{-1}$ |
| 120 | Radiance (with respect to wave length) | W m $\mathrm{m}^{-3} \mathrm{sr}^{-1}$ |
| 121 | Latent heat flux | W m ${ }^{-2}$ |
| 122 | Sensible heat flux | W m ${ }^{-2}$ |
| 123 | Boundary layer dissipation | W m ${ }^{-2}$ |
| 124 | Momentum flux, u-component | $\mathrm{N} \mathrm{m}{ }^{-2}$ |
| 125 | Momentum flux, v-component | $\mathrm{N} \mathrm{m}{ }^{-2}$ |
| 126 | Wind mixing energy | J |
| 127 | Image data |  |
| 128-254 | Reserved for originating centre use |  |
| 255 | Missing value |  |

Notes:
(1) SI units only are used for GRIB; the accuracy or precision with which the data are represented is a function of the range of the values, the decimal and/or binary scaling, and the number of bits used; GRIB enables suitable scaling factors to be selected to obviate the need to define parameters in non-SI units.
(2) The code figures 0 to 127 are used to represent parameters which are exchanged between a number of centres; since the products generated by centres can be extremely diverse, code figures 128 to 254 are reserved for definition by the originating centre and may differ from centre to centre.
(3) By convention, downward fluxes of radiation or other quantities shall be assigned negative values; upward fluxes of radiation or other quantities shall be assigned positive values.
(4) The $u$ - and $v$-components of vector quantities are defined in Code table 7.
(5) Provision is made for three types of spectra:
(1) direction and frequency;
(2) direction and radial number;
(3) radial number and radial number.
(6) The "parcel lifted index" (as defined in the International Meteorological Vocabulary (WMO-No. 182) under the listing "lifted index") is defined as the temperature difference between the ambient 500 hPa temperature (T500) and that of a parcel of air lifted from the surface (Tparcel) following the dry and moist adiabatic process. Negative values of (T500-Tparcel) suggest instability. The "best lifted index" is defined as the most unstable of a collection of parcel lifted indices, with parcel initial conditions defined for a collection of 30 hPa thick layers stacked one upon the other with the lowest resting on the ground. Commonly four to six such layers are used in the calculation.

## Code table 3 - Fixed levels or layers for which the data are included

N ote: For reserved values, or if not defined, octets $\mathbf{1 1}$ and $\mathbf{1 2}$ shall contain zero.

Octet 10
Code figure
Meaning
00 Reserved
01 Ground or water surface
02 Cloud base level
03 Level of cloud tops
04 Level of $0^{\circ} \mathrm{C}$ isotherm
05 Level of adiabatic condensation lifted from the surface
06 Maximum wind level
07 Tropopause
08 Nominal top of atmosphere
09 Sea bottom
10-19 Reserved
20 Isothermal level
21-99 Reserved
100 Isobaric surface
101 Layer between two isobaric surfaces
102 Mean sea level
103 Specified altitude above mean sea level
104 Layer between two specified altitudes above mean sea level
105 Specified height level above ground
106 Layer between two specified height levels above ground
107 Sigma level
108 Layer between two sigma levels
109 Hybrid level
110 Layer between two hybrid levels
111 Depth below land surface
112 Layer between two depths below land surface
113 Isentropic (theta) level
114 Layer between two isentropic levels
115 Level at specified pressure difference from ground to level
116 Layer between two levels at specified pressure differences from ground to level

117 Potential vorticity surface
118 Reserved

## 

Octet 11
Octet 12
Contents
Con都 $\square$

 $+2$ $\square$ $\square$

都

| (Code table 3 - continued) |  |  |  |
| :---: | :---: | :---: | :---: |
|  | Octet 10 | Octet 11 | Octet 12 |
| Code figure | Meaning | Contents |  |
| 119 | ETA* level | ETA value in $\mathbf{1 / 1 0 0 0 0}$ (2 octets) |  |
| 120 | Layer between two ETA* levels | ETA value at top of layer in $1 / 100$ | ETA value at bottom of layer in $1 / 100$ |
| 121 | Layer between two isobaric surfaces (high precision) | 1100 hPa minus pressure of top in hPa | 1100 hPa minus pressure of bottom in hPa |
| 122-124 | Reserved |  |  |
| 125 | Specified height level above ground (high precision) | Height in centimetres (2 octets) |  |
| 126-127 | Reserved |  |  |
| 128 | Layer between two sigma levels (high precision) | 1.1 minus sigma of top, in $1 / 1000$ of sigma | 1.1 minus sigma of bottom, in $1 / 1000$ of sigma |
| 129-140 | Reserved |  |  |
| 141 | Layer between two isobaric surfaces (mixed precision) | Pressure of top in kPa | 1100 hPa minus pressure of bottom in hPa |
| 142-159 | Reserved |  |  |
| 160 | Depth below sea level | Depth in m | res (2 octets) |
| 161-199 | Reserved |  |  |
| 200 | Entire atmosphere (considered as a single layer) |  |  |
| 201 | Entire ocean (considered as a single layer) |  |  |
| 202-254 | Reserved |  |  |

[^1]Code table 4 - Unit of time

| Code figure | Meaning |
| :---: | :--- |
| 0 | Minute |
| 1 | Hour |
| 2 | Day |
| 3 | Month |
| 4 | Year |
| 5 | Decade (10 years) |
| 6 | Normal (30 years) |
| 7 | Century (100 years) |
| $8-9$ | Reserved |
| 10 | 3 hours |
| 11 | 6 hours |
| 12 | 12 hours |
| $13-253$ | Reserved |
| 254 | Second |

## Code table 5 - Time range indicator

Code figure
0

1
2
3
4
5 Difference (reference time $+\mathbf{P} 2$ minus reference time $+P 1$ ) product considered valid at reference time + P2
Forecast product valid for reference time $+P 1(P 1>0)$, or Uninitialized analysis product for reference time ( $\mathrm{P} 1=0$ ), or Image product for reference time ( $\mathbf{P 1 = 0 )}$
Initialized analysis product for reference time ( $\mathrm{P} 1=0$ )
Product with a valid time ranging between reference time + P1 and reference time + P2 Average (reference time +P 1 to reference time +P 2 )
Accumulation (reference time $+\mathbf{P 1}$ to reference time $+\mathbf{P} 2$ ) product considered valid at reference time + P2

10 P1 occupies octets 19 and 20; product valid at reference time + P1
11-112 Reserved
113 Average of $\mathbf{N}$ forecasts (or initialized analyses); each product has forecast period of P1 ( $\mathbf{P 1}=0$ for initialized analyses); products have reference times at intervals of P2, beginning at the given reference time
114 Accumulation of $\mathbf{N}$ forecasts (or initialized analyses); each product has forecast period of P1 ( $\mathbf{P 1}=0$ for initialized analyses); products have reference times at intervals of P2, beginning at the given reference time
115 Average of $N$ forecasts, all with the same reference time; the first has a forecast period of P1, the remaining forecasts follow at intervals of P2
116 Accumulation of $N$ forecasts, all with the same reference time; the first has a forecast period of $\mathbf{P 1}$, the remaining forecasts follow at intervals of $\mathbf{P 2}$
117 Average of $N$ forecasts; the first has a forecast period of P1, the subsequent ones have forecast periods reduced from the previous one by an interval of P2; the reference time for
the first is given in octets 13 to 17 , the subsequent ones have reference times increased forecast periods reduced from the previous one by an interval of P2; the reference time for
the first is given in octets 13 to 17, the subsequent ones have reference times increased from the previous one by an interval of $\mathbf{P} 2$. Thus all the forecasts have the same valid time, given by the initial reference time + P1
Temporal variance, or covariance, of $\mathbf{N}$ initialized analyses; each product has forecast period of $P 1=0$; products have reference times at intervals of $P 2$, beginning at the given reference time
119 Standard deviation of N forecasts, all with the same reference time with respect to the time average of forecasts; the first forecast has a forecast period of $P 1$, the remaining forecasts follow at intervals of P2

120-122
123
124
125-254
6-9 Reserved P1, the remaing forech N forecast all with

Reserved
Average of $\mathbf{N}$ uninitialized analyses, starting at the reference time, at intervals of P2

Notes:
(1) For analysis products, or the first of a series of analysis products, the reference time (octets 13 to 17) indicates the valid time.
(2) For forecast products, or the first of a series of forecast products, the reference time indicates the valid time of the analysis upon which the (first) forecast is based.
(3) Initialized analysis products are allocated code figures distinct from those allocated to uninitialized analysis products.
(4) Code figure 10 allows the period of a forecast to be extended over two octets; this is to assist with extended range forecasts.

## (Code table 5 - continued)

(5) Where products or a series of products are averaged or accumulated, the number involved is to be represented in octets 22 and 23 of Section 1, while any number missing is to be represented in octet 24.
(6) Forecasts of the accumulation or difference of some quantity (e.g. quantitative precipitation forecasts), indicated by values of 4 or 5 in octet 21 , have a product valid time given by the reference time +P 2 ; the period of accumulation, or difference, can be calculated as P2-P1.
(7) A few examples may help to clarify the use of Code table 5: For analysis products, P 1 will be zero and the time range indicator will also be zero; for initialized products (sometimes called "zero hour forecasts"), P1 will be zero, but octet 21 will be set to 1 .
For forecasts, typically, P1 will contain the number of hours of the forecast (the unit indicator given in octet 18 would be 1) and octet 21 would contain a zero.
Code value 115 would be used, typically, for multiple day mean forecasts, all derived from the same initial conditions.
Code value 117 would be used, typically, for Monte Carlo type calculations: many forecasts valid at the same time from different initial (reference) times.
Averages, accumulations and differences get a somewhat specialized treatment. If octet 21 (Code table 5) has a value between 2 and 5 (inclusive), then the reference time $+P 1$ is the initial date/time and the reference time + P2 is the final date/time of the period over which averaging or accumulation takes place. If, however, octet 21 has a value of $113,114,115,116,117,123$ or 124 , then P 2 specifies the time interval between each of the fields (or the forecast initial times) that have been averaged or accumulated. These latter values of octet 21 require the qualities averaged to be equally separated in time; the former values, 3 and 4 in particular, allow for irregular or unspecified intervals of time between the fields that are averaged or accumulated.

## CODE TABLES RELATIVE TO SECTION 2

## Code table 6 - Data representation type

| Code figure | Meaning |
| :---: | :--- |
| 0 | Latitude/longitude grid - equidistant cylindrical or Plate Carrée projection |
| 1 | Mercator projection |
| 2 | Gnomonic projection |
| 3 | Lambert conformal, secant or tangent, conic or bi-polar, projection |
| 4 | Gaussian latitude/longitude grid |
| 5 | Polar stereographic projection |
| 6 | Universal Transverse Mercator (UTM) projection |
| 7 | Simple polyconic projection |
| 8 | Albers equal-area, secant or tangent, conic or bi-polar, projection |
| 9 | Miller's cylindrical projection |
| 10 | Rotated latitude/longitude grid |
| $11-12$ | Reserved |
| 13 | Oblique Lambert conformal, secant or tangent, conic or bi-polar, projection |
| 14 | Rotated Gaussian latitude/longitude grid |
| $15-19$ | Reserved |
| 20 | Stretched latitude/longitude grid |
| $21-23$ | Reserved |
| 24 | Stretched Gaussian latitude/longitude grid |
| $25-29$ | Reserved |

(Code table 6 - continued)

| Code figure | Meaning |
| :---: | :--- |
| 30 | Stretched and rotated latitude/longitude grids |
| $31-33$ | Reserved |
| 34 | Stretched and rotated Gaussian latitude/longitude grids |
| $35-49$ | Reserved |
| 50 | Spherical harmonic coefficients |
| $51-59$ | Reserved |
| 60 | Rotated spherical harmonic coefficients |
| $61-69$ | Reserved |
| 70 | Stretched spherical harmonics |
| $71-79$ | Reserved |
| 80 | Stretched and rotated spherical harmonic coefficients |
| $81-89$ | Reserved |
| 90 | Space view, perspective or orthographic |
| $91-191$ | Reserved |
| $192-254$ | Reserved for local use |

Code tables relative to grid definition

## Code table 7 - Resolution and component flags

| Bit No. | Value | Meaning |
| :---: | :---: | :--- |
| 1 | 0 | Direction increments not given <br> Direction increments given |
| 2 | 1 | Earth assumed spherical with radius 6367.47 km <br> Earth assumed oblate spheroidal with size as determined by IAU in 1965 <br> $(6378.160 \mathrm{~km}, 6356.775 \mathrm{~km}, \mathrm{f}=1 / 297.0)$ |
| $3-4$ | 1 | Reserved <br> Resolved $u$ - and v-components of vector quantities relative to easterly and <br> northerly directions <br> Resolved $u$ - and $v$-components of vector quantities relative to the defined <br> grid in the direction of increasing $x$ and $y(o r i a n d ~ j) ~ c o o r d i n a t e s ~ r e s p e c t i v e l y ~$ |
| Reserved - set to zero |  |  |

Flag/Code table 8 - Scanning mode

| Bit No. | Value | Meaning |
| :---: | :---: | :--- |
| 1 | 0 | Points scan in +i direction |
|  | 1 | Points scan in -i direction |
| 2 | 0 | Points scan in -j direction |
|  | 1 | Points scan in +j direction |
| 3 | 0 | Adjacent points in i direction are consecutive |
|  | 1 | Adjacent points in j direction are consecutive |

Notes:
(1) i direction: west to east along a parallel, or left to right along an X -axis.
(2) j direction: south to north along a meridian, or bottom to top along a Y -axis.

## Code table 9 - Spectral data representation type

Code figure
1

Meaning
The Associated Legendre Functions of the first kind are defined by:
$P_{n}^{m}(\mu)=\sqrt{(2 n+1) \frac{(n-m)!}{(n+m)!}} \frac{1}{2^{n} n!}\left(1-\mu^{2}\right)^{m / 2} \frac{d^{n+m}}{d \mu^{n+m}}\left(\mu^{2}-1\right)^{n}, m \geq 0$,
$P_{n}^{-m}(\mu)=P_{n}^{m}(\mu)$

A field $X(\lambda, \mu)$ is represented by:
$X(\lambda, \mu)=\sum_{m=-m}^{M} \sum_{n=|m|}^{N(m)} X_{n}^{m} P_{n}^{m}(\mu) e^{i m \lambda}$
where $\lambda$ is the longitude, $\mu$ the sine of latitude, and $X_{n}^{-m}$ the complex conjugate of $X_{n}^{m}$.

## Code table 10 - Spectral data representation mode

Code figure
1

2

Meaning
The complex numbers $X_{n}^{m}$ (see code figure 1 , Code table 9 above) are stored for $m \geq 0$ as pairs of real numbers $\operatorname{Re}\left(X_{n}^{m}\right), \operatorname{Im}\left(X_{n}^{m}\right)$ ordered with $n$ increasing from $m$ to $N(m)$, first for $m=0$ and then for $m=1,2, \ldots$. The real part of the ( 0.0 ) coefficient is stored in octets 12-15 of the Binary data section. The imaginary part of the ( 0.0 ) coefficient and the remaining coefficients are packed, and are stored in octets 16 onwards of the Binary data section.
Indicates spherical harmonics - complex packing

CODE TABLES RELATIVE TO SECTION 4
Code table 11 - Flag

| Bit No. | Value | Meaning |
| :---: | :---: | :--- |
| 1 | 0 | Grid-point data |
|  | 1 | Spherical harmonic coeffic ients |
| 2 | 0 | Simple packing |
|  | 1 | Complex or second-order packing |
| 3 | 0 | Floating point values (in the original data) are represented |
|  | 1 | Integer values (in the original data) are represented |
| 4 | 0 | No additional flags at octet 14 |
|  | 1 | Octet 14 contains additional flag bits |

(Code table 11 - continued)
The following gives the meaning of the bits in octet 14 ONLY if bit 4 is set to 1 . Otherwise octet 14 contains regular binary data.

| Bit No. | Value | Meaning <br> 5 |
| :---: | :---: | :--- |
| 6 | 0 | Reserved - set to zero |
|  | 1 | Single datum at each grid point of values at each grid point |
| 7 | 0 | No secondary bit-maps <br> Secondary bit-maps present |
| 8 | 1 | Second-order values constant width <br> Second-order values different widths |
| $9-12$ | 1 |  |
| Reserved for future use |  |  |

Notes:
(1) Bit $\mathbf{4}$ shall be set to $\mathbf{1}$ to indicate that bits $\mathbf{5}$ to $\mathbf{1 2}$ are contained in octet $\mathbf{1 4}$ of the Binary data section.
(2) Bit $\mathbf{3}$ shall be set to $\mathbf{1}$ to indicate that the data represented are integer values; where integer values are represented, any reference values, if not zero, should be rounded to integer before being applied.
(3) Where secondary bit-maps are present in the data (used in association with second-order packing and, optionally, with a matrix of values at each point), this shall be indicated by setting bit 7 to 1.
(4) The indicated meaning of bit 6 shall be retained in anticipation of the future reintroduction of a system to define a matrix of values at each grid point.

FM 92-XII GRIB

## CODEFORM:



## NOTES:

(1) GRIB is the name of a data representation form for general regularly-distributed information in binary.
(2) Data encoded in GRIB consists of a continuous bit-stream made of a sequence of octets ( 1 octet $=8$ bits).
(3) The octets of a GRIB message are grouped in sections:

| Section number | Name | Contents |
| :---: | :---: | :---: |
| 0 | Indicator section | "GRIB", discipline, GRIB edition number, length of message |
| 1 | Identification section | Length of section, section number, characteristics that apply to all processed data in the GRIB message |
| 2 | Local use section (optional) | Length of section, section number, additional items for local use by originating centres |
| 3 | Grid definition section | Length of section, section number, definition of grid surface and geometry of data values within the surface |
| 4 | Product definition section | Length of section, section number, description of the nature of the data |
| 5 | Data representation section | Length of section, section number, description of how the data values are represented |
| 6 | Bit-map section | Length of section, section number, indication of presence or absence of data at each of the grid points, as applicable |
| 7 | Data section | Length of section, section number, data values |
| 8 | End section | "7777" |

(4) Sequences of GRIB sections 2 to 7 , sections 3 to 7 or sections 4 to 7 may be repeated within a single GRIB message. All sections within such repeated sequences must be present and shall appear in the numerical order noted above. Unrepeated sections remain in effect until redefined.
(5) It will be noted that the GRIB code is not suitable for visual data recognition without computer interpretation.
(6) The representation of data by means of a series of bits is independent of any particular machine representation.
(7) Message and section lengths are expressed in octets. Octets are numbered 1,2,3, etc., starting at the beginning of each section. Therefore, octet numbers in a template refer to the respective section.
(8) Bit positions within octets are referred to as bit 1 to bit 8 , where bit 1 is the most significant and bit 8 is the least significant. Thus, an octet with only bit 8 set to 1 would have the integer value 1 .
(9) As used in "GRIB", "International Alphabet No. 5 " is regarded as an 8 -bit alphabet with bit 1 set to zero.
(10) The IEEE single precision floating point representation is specified in the standard ISO/IEC 559-1985 and ANS $/ / / E E E$ 754-1985 (R1991), which should be consulted for more details. The representation occupies four octets and is:
seeeeeee emmmmmmm mmmmmmm mmmmmmmm
where:
$s$ is the sign bit, 0 means positive, 1 negative
e...e is an 8 bit biased exponent
$\mathrm{m} . . . \mathrm{m}$ is the mantissa, with the first bit deleted.
The value of the number is given by the following table:

| e...e | m...m | Value of number |
| :--- | :--- | :--- |
| 0 | Any | $(-1)^{s}(\mathrm{~m} \ldots \mathrm{~m}) 2^{-232-126}=(-1)^{s}(\mathrm{~m} \ldots \mathrm{~m}) 2^{-149}$ |
| $1 \ldots 254$ | Any | $(-1)^{\mathrm{s}\left(1.0+(\mathrm{m} . . . \mathrm{m}) 2^{-23}\right) 2^{((\mathrm{e} . . . \mathrm{e})-127)}}$ |
| 255 | 0 | Positive $(\mathrm{s}=0)$ or Negative $(\mathrm{s}=1)$ infinity |
| 255 | $>0$ | NaN (Not a valid Number, result of illegal operation) |

Normally, only biased exponent values from 1 through 254 inclusive are used, except for positive or negative zero which are represented by setting both the biased exponent and the mantissa to 0 .

The numbers are stored with the high-order octet first. The sign bit will be the first bit of the first octet. The low-order bit of the mantissa will be the last (eighth) bit of the fourth octet.

This floating point representation has been chosen because it is in common use in modern computer hardware. Some computers use this representation with the order of the octets reversed. They will have to convert the representation, either by reversing the octets or by computing the floating point value directly using the above formulas.

REGULATIONS:
$92.1 \quad$ General
92.1.1 The GRIB code shall be used for the exchange and storage of general regularly-distributed information expressed in binary form.
92.1.2 The beginning and the end of the code shall be identified by 4 octets coded according to the International Alphabet No. 5 to represent the indicators "GRIB" and "7777" in Indicator section 0 and End section 8, respectively. All other octets included in the code shall represent data in binary form.

If applicable, negative values shall be indicated by setting the most signific ant bit to " 1 ".
92.1.6 Latitude, longitude and angle values shall be in units of $10^{-6}$ degree, except for specific cases explicitly stated in some grid definitions.
92.1.7 The latitude values shall be limited to the range 0 to 90 degrees inclusive. The orientation shall be north latitude positive, south latitude negative. Bit 1 is set to 1 to indicate south latitude.
92.1.8 The longitude values shall be limited to the range $\mathbf{0}$ to $\mathbf{3 6 0}$ degrees inclusive. The orientation shall be east longitude positive, with only positive values being used.
92.1.9 The latitude and longitude of the first grid point and the last grid point shall always be given for regular grids.
92.1.10 Vector components at the North and South Poles shall be coded according to the following conventions.
92.1.10.1 If the resolution and component flags in section 3 (Flag table 3.3) indicate that the vector components are relative to the defined grid, the vector components at the Pole shall be resolved relative to the grid.
92.1.10.2 Otherwise, for projections where there are multiple points at a given pole, the vector components shall be resolved as if measured an infinitesimal distance from the Pole at the longitude corresponding to each grid point. At the North Pole, the West to East (x direction) component at a grid point with longitude $\mathbf{L}$ shall be resolved along the meridian 90 degrees East of $L$, and the South to North (y direction) component shall be resolved along the meridian 180 degrees from L. At the South Pole, the West to East component at a grid point with longitude $L$ shall be resolved along the meridian 90 degrees East of $L$ and the South to North component shall be resolved along L.
92.1.10.3 Otherwise, if there is only one Pole point, either on a cylindrical projection with all but one Pole point deleted, or on any projection (such as polar stereographic) where the Pole maps to a unique point, the West to East and South to North components shall be resolved along longitudes $270^{\circ}$ and $0^{\circ}$, respectively at the North Pole and along longitudes $270^{\circ}$ and $180^{\circ}$, respectively at the South Pole.

Note: This differs from the treatment of the Poles in the WMO traditional alphanumeric codes.
92.1.11 The first and last grid points shall not necessarily correspond to the first and last data points, respectively, if the bit-map is used.
92.2 Section 0 - Indicator section
92.2.1 Section 0 shall always be $\mathbf{1 6}$ octets long.
92.2.2 The first four octets shall always be character coded ac cording to the International Alphabet No. 5 as "GRIB".

The remainder of the section shall contain reserved octets, followed by the Discipline, the GRIB edition number, and the length of the entire GRIB message (including the Indicator section).

Section 1 - Indentification section
The length of the section, in units of octets, shall be expressed over the group of the first four octets, i.e. over the first 32 bits.

The section number shall be expressed in the fifth octet.
92.9.2 Data shall be coded using the minimum number of bits necessary to provide the accuracy required by international agreement. This required accuracy/precision shall be achieved by scaling the data by multiplication by an appropriate power of 10 (the power may be 0 ) before forming the non-negative differences, and then using the binary scaling to select the precision of the transmitted value.

The data shall be packed by the method identified in Section 5.

Data shall be coded in the form of non-negative scaled differences from a reference value of the whole field plus, if applicable, a local reference value.

## NOTES:

(1) A reference value is normally the minimum value of the data set which is represented.
(2) For grid-point values, complex packing features are intended to reduce the whole size of the GRIB message (data compression without loss of information with respect to simple packing). The basic concept is to reduce data size thanks to local redundancy. This is achieved just before packing, by splitting the whole set of scaled data values into groups, on which local references (such as local minima) are removed. It is done with some overhead, because extra descriptors are needed to manage the groups characteristics. An optional pre-processing of the scaled values (spatial differencing) may also be applied before splitting into groups, and combined methods, along with use of alternate row scanning mode, are very efficient on interpolated data.
(3) For spectral data, complex packing is provided for better accuracy of packing. This is because many spectral coefficients have small values (regardless of the sign), especially for large wave numbers. The first principle is not to pack a subset of coefficients, associated with small wave numbers so that the amplitude of the packed coefficients is reduced. The second principle is to apply an operator to the remaining part of the spectrum: with appropriate tuning it leads to a more homogeneous set of values to pack.
(4) The original data value $Y$ (in the units of Code table 4.2) can be recovered with the formula:

$$
\mathrm{Y} \times 10^{\mathrm{D}}=\mathrm{R}+(\mathrm{X} 1+\mathrm{X} 2) \times 2^{\mathrm{E}}
$$

For simple packing and all spectral data
$\mathrm{E}=$ Binary scale factor,
D = Decimal scale factor
R = Reference value of the whole field,
$\mathrm{X} 1=0$,
X2 $=$ Scaled (encoded) value.
For complex grid-point packing schemes, E, D and R are as above, but
$\mathrm{X} 1=$ Reference value (scaled integer) of the group the data value belongs to,
X2 $=$ Scaled (encoded) value with the group reference value (X1) removed.
Section 8 - End section
92.10.1 The end section shall always be 4 octets long, character coded according to the International Alphabet No. 5 as "7777".

## SPECIFICATIONS OF OCTET CONTENTS

## Section 0 - Indicator section

| Octet No. | Contents |
| :---: | :--- |
| $1-4$ | GRIB (coded according to the International Alphabet No. 5) |
| $5-6$ | Reserved |
| 7 | Discipline - GRIB Master table number (see Code table 0.0) |
| 8 | GRIB edition number (currently 2) |
| $9-16$ | Total length of GRIB message in octets (including Section 0) |


| Octet No. | Contents |
| :---: | :---: |
| 1-4 | Length of section in octets (21 or nn) |
| 5 | Number of section ("1") |
| 6-7 | Identification of originating/generating centre (see Common Code table C-1) |
| 8-9 | Identification of originating/generating subcentre (allocated by originating/generating centre) |
| 10 | GRIB Master tables version number (see Code table 1.0) (currently 1) |
| 11 | GRIB Local tables version number (see Code table 1.1) |
| 12 | Signific ance of reference time (see Code table 1.2) |
| 13-14 | Year (4 digits) |
| 15 | Month |
| 16 | Day Reference time of d |
| 17 | Hour $\quad$ Reference time of data |
| 18 | Minute |
| 19 | Second |
| 20 | Production status of processed data in this GRIB message (see Code table 1.3) |
| 21 | Type of processed data in this GRIB message (see Code table 1.4) |
| 22-nn | Reserved: need not be present |

Section 2 - Local use section

| Octet No. | Contents |
| :---: | :--- |
| $1-4$ | Length of section in octets (nn) |
| 5 | Number of section ("2") |
| $6-\mathrm{nn}$ | Local use |

Section 3 - Grid definition section
Octet No.
1-4 Length of section in octets (nn)
5 Number of section ("3")
$6 \quad$ Source of grid definition (see Code table 3.0 and Note 1)
7-10 Number of data points
11 Number of octets for optional list of numbers defining number of points (see Note 2)
12 Interpretation of list of numbers defining number of points (see Code table 3.11)
13-14 Grid definition template number (= $N$ ) (see Code table 3.1)
15-xx Grid definition template (see Template 3.N, where $N$ is the grid definition template number given in octets 13-14)
$[x x+1]-n n \quad$ Optional list of numbers defining number of points (see Notes 2, 3 and 4)
Notes:
(1) If octet 6 is not zero, octets $15-x x$ ( $15-\mathrm{nn}$ if octet 11 is zero) may not be supplied. This should be documented with all bits set to 1 (missing value) in the grid definition template number.
(2) An optional list of numbers defining number of points is used to document a quasi-regular grid, where the number of points may vary from one row to another (row being defined as adjacent points in a coordinate line, so this is dependent from data layout). In such a case, octet 11 is non zero and gives the number of octets on which each number of points is encoded. For all other cases, such as regular grids, octets 11 and 12 are zero and no list is appended to the grid definition template.
(3) If a list of numbers defining number of points is present, it is appended at the end of the grid definition template (or directly after the grid definition template number if the template is missing), the length of the
list is given by the grid definition. When the grid definition template is present, the length is given according to bit 3 of scanning mode flag octet (length is Nj or Ny for flag value O ). List ordering is implied by data scanning.
(4) Depending on code value given in octet 12, the list of numbers defining the number of points corresponds either to the coordinate lines as given in the grid definition, or to a full circle.

## Section 4 - Product definition section

```
Octet No. Contents
    1-4 Length of section in octets (nn)
    5 Number of section ("4")
    6-7 Number of coordinate values after template (see Note 1)
    8-9 Product definition template number (see Code table 4.0)
10-xx Product definition template (see Template 4.X, where }X\mathrm{ is the product definition template
    number given in octets 8-9)
[xx+1]-nn Optional list of coordinate values (see Notes 2 and 3)
```

Notes:
(1) Coordinate values are intended to document the vertical discretization associated with model data on hybrid coordinate vertical levels. A number of zero in octets 6-7 indicates that no such values are present. Otherwise the number corresponds to the whole set of values.
(2) Hybrid systems, in this context, employ a means of representing vertical coordinates in terms of a mathematical combination of pressure and sigma coordinates. When used in conjunction with a surface pressure field and an appropriate mathematical expression, the vertical coordinate parameters may be used to interpret the hybrid vertical coordinate.
(3) Hybrid coordinate values, if present, should be encoded in IEEE 32-bit floating point format. They are intended to be encoded as pairs.

## Section 5 - Data representation section

```
Octet No.
Contents
    1-4 Length of section in octets (nn)
        5 Number of section ("5")
    6-9 Number of data points where one or more values are specified in Section 7 when a bit map
        is present, total number of data points when a bit map is absent.
10-11 Data representation template number (see Code table 5.0)
12-nn Data representation template (see Template 5.X, where X is the data representation
                template number given in octets 10-11)
```

Section 6 - Bit-map section

| Octet No. | Contents |
| :---: | :--- |
| $1-4$ | Length of section in octets (nn) |
| 5 | Number of section ("6") |
| 6 | Bit-map indicator (see Code table 6.0 and the Note) |
| $7-\mathrm{nn}$ | Bit-map |

Note: If octet 6 is not zero, the length of the section is 6 and octets 7 -nn are not present.

## Section 7 - Data section

```
Octet No.
    1-4 Length of section in octets (nn)
        5 Number of section ("7")
    6-nn Data in a format described by data template 7.X, where X is the data representation
        template number given in octets 10-11 of Section 5.
    Section 8- End section
Octet No. Contents
    1-4 "7777" (coded according to the International Alphabet No. 5.)
```


## TEMPLATE DEFINITIONS USED IN SECTION 3

## Grid definition template 3.0 - latitude/longitude (or equidistant cylindrical, or Plate Carrée)

| Octet No. | Contents |
| :---: | :--- |
| 15 | Shape of the Earth (see Code table 3.2) |
| 16 | Scale factor of radius of spherical Earth |
| $17-20$ | Scaled value of radius of spherical Earth |
| 21 | Scale factor of major axis of oblate spheroid Earth |
| $22-25$ | Scaled value of major axis of oblate spheroid Earth |
| 26 | Scale factor of minor axis of oblate spheroid Earth |
| $27-30$ | Scaled value of minor axis of oblate spheroid Earth |
| $31-34$ | $\mathrm{Ni}-$ number of points along a parallel |
| $35-38$ | Nj - number of points along a meridian |
| $39-42$ | Basic angle of the initial production domain (see Note 1) |
| $43-46$ | Subdivisions of basic angle used to define extreme longitudes and latitudes, and direction |
|  | increments (see Note 1) |
| $47-50$ | La1 - latitude of first grid point (see Note 1) |
| $51-54$ | Lo1 - longitude of first grid point (see Note 1) |
| 55 | Resolution and component flags (see Flag table 3.3) |
| $56-59$ | La2 - latitude of last grid point (see Note 1) |
| $60-63$ | Lo2 - longitude of last grid point (see Note 1) |
| $64-67$ | Di - i direction increment (see Note 1) |
| $68-71$ | Dj - j direction increment (see Note 1) |
| 72 | Scanning mode (flags - see Flag table 3.4) |

## Notes:

(1) Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes, and direction increments. For these last six descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).
(2) For data on a quasi-regular grid, in which all the rows or columns do not necessarily have the same number of grid points, either Ni (octets 31-34) or Nj (octets 35-38) and the corresponding Di (octets 64-67) or Dj (octets 68-71) shall be coded with all bits set to 1 (missing). The actual number of points along each parallel or meridian shall be coded in the octets immediately following the grid definition template (octets $[x x+1]-n n$ ), as described in the description of the grid definition section.
(3) A quasi-regular grid is only defined for appropriate grid scanning modes. Either rows or columns, but not both simultaneously, may have variable numbers of points. The first point in each row (column) shall be positioned at the meridian (parallel) indicated by octets 47-54. The grid points shall be evenly spaced in latitude (longitude).

Grid definition template 3.1 - rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée)

| Octet No. | Contents |
| :---: | :--- |
| $15-72$ | Same as grid definition template $\mathbf{3 . 0}$ (see Note 1) |
| $73-76$ | Latitude of the southern pole of projection |
| $77-80$ | Longitude of the southern pole of projection |
| $81-84$ | Angle of rotation of projection |

(continued)

## (Grid definition template 3.1 - continued)

Notes:
(1) Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes, and direction increments. For these last six descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).
(2) Three parameters define a general latitude/longitude coordinate system, formed by a general rotation of the sphere. One choice for these parameters is:
(a) The geographic latitude in degrees of the southern pole of the coordinate system, Thetap for example;
(b) The geographic longitude in degrees of the southern pole of the coordinate system, Lambdap for example;
(c) The angle of rotation in degrees about the new polar axis (measured clockwise when looking from the southern to the northern pole) of the coordinate system, assuming the new axis to have been obtained by first rotating the sphere through Lambdap degrees about the geographic polar axis, and then rotating through ( $90+$ Thetap) degrees so that the southern pole moved along the (previously rotated) Greenwich meridian.

## Grid definition template 3.2 - stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée)

Octet No. Contents
15-72 Same as grid definition template 3.0 (see Note 1)
73-76 Latitude of the pole of stretching
77-80 Longitude of the pole of stretching
81-84 Stretching factor
Notes:
(1) Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes, and direction increments. For these last six descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).
(2) The stretching is defined by three parameters:
(a) The latitude in degrees (measured in the model coordinate system) of the "pole of stretching";
(b) The longitude in degrees (measured in the model coordinate system) of the "pole of stretching"; and
(c) The stretching factor C in units of $10^{-6}$ represented as an integer.

The stretching is defined by representing data uniformly in a coordinate system with longitude $Y$ and latitude X1, where:

$$
\theta^{1}=\sin ^{-1} \frac{\left(1-C^{2}\right)+\left(1+C^{2}\right) \sin \theta}{\left(1+C^{2}\right)+\left(1-C^{2}\right) \sin \theta}
$$

and $Y$ and $X$ are longitude and latitude in a coordinate system in which the "pole of stretching" is the northern pole. $C=1$ gives uniform resolution, while $C>1$ gives enhanced resolution around the pole of stretching.

## Grid definition template 3.3 - stretched and rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée)

Octet No. Contents
15-72 Same as grid definition template 3.0 (see Note 1)
73-76 Latitude of the southern pole of projection
77-80 Longitude of the southern pole of projection
81-84 Angle of rotation of projection
85-88 Latitude of the pole of stretching
89-92 Longitude of the pole of stretching
93-96 Stretching factor

Notes:
(1) Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes, and direction increments. For these last six descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).
(2) See Note (2) under grid definition template 3.1 - rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée).
(3) See Note (2) under grid definition template 3.2 - stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée).

Grid definition template 3.10 - Mercator

| Octet No. | Contents |
| :---: | :--- |
| 15 | Shape of the Earth (see Code table 3.2) |
| 16 | Scale factor of radius of spherical Earth |
| $17-20$ | Scaled value of radius of spherical Earth |
| 21 | Scale factor of major axis of oblate spheroid Earth |
| $22-25$ | Scaled value of major axis of oblate spheroid Earth |
| 26 | Scale factor of minor axis of oblate spheroid Earth |
| $27-30$ | Scaled value of minor axis of oblate spheroid Earth |
| $31-34$ | Ni - number of points along a parallel |
| $35-38$ | Nj - number of points along a meridian |
| $39-42$ | La1 - latitude of first grid point |
| $43-46$ | Lo1 - longitude of first grid point |
| 47 | Resolution and component flags (see Flag table 3.3) |
| $48-51$ | LaD - latitude(s) at which the Mercator projection intersects the Earth (Latitude(s) where Di |
| $52-55$ | and Dj are spec ified) |
| $56-59$ | La2 - latitude of last grid point |
| 60 | Scanning mode (flags - see Flag table 3.4) |
| $61-64$ | Orientation of the grid, angle between i direction on the map and the Equator (see Note 1) |
| $65-68$ | Di - longitudinal direction grid length (see Note 2) |
| $69-72$ | Dj - latitudinal direction grid length (see Note 2) |

Notes:
(1) Limited to the range of 0 to 90 degrees; if the angle of orientation of the grid is neither 0 nor 90 degrees, Di and Dj must be equal to each other.
(2) Grid lengths are in units of $10^{-3} \mathrm{~m}$, at the latitude specified by LaD.

Grid definition template 3.20 - polar stereographic projection

Octet No.
Contents
15
16
17-20
21
22-25
26
27-30
31-34
35-38
39-42
43-46
47
48-51
52-55
56-59
60-63
64
65

Shape of the Earth (see Code table 3.2)
Scale factor of radius of spherical Earth
Scaled value of radius of spherical Earth
Scale factor of major axis of oblate spheroid Earth
Scaled value of major axis of oblate spheroid Earth
Scale factor of minor axis of oblate spheroid Earth
Scaled value of minor axis of oblate spheroid Earth
$N x$ - number of points along the $x$-axis
Ny - number of points along the y -axis
La1 - latitude of first grid point
Lo1 - longitude of first grid point
Resolution and component flags (see Flag table 3.3 and Note 1)
LaD - latitude where Dx and Dy are specified
LoV - orientation of the grid (see Note 2)
Dx - x-direction grid length (see Note 3)
Dy - y-direction grid length (see Note 3)
Projection centre flag (see Flag table 3.5)
Scanning mode (see Flag table 3.4)
Notes:
(1) The resolution flags (bits 3-4 of Flag table 3.3) are not applicable.
(2) LoV is the longitude value of the meridian which is parallel to the y-axis (or columns of the grid) along which latitude increases as the y-coordinate increases (the orientation longitude may or may not appear on a particular grid).
(3) Grid length is in units of $10^{-3} \mathrm{~m}$ at the latitude specified by LaD.
(4) Bit 2 of the projection flag is not applicable to the polar stereographic projection.

Grid definition template 3.30 - Lambert conformal
Contents
15 Shape of the Earth (see Code table 3.2)
16 Scale factor of radius of spherical Earth
17-20 Scaled value of radius of spherical Earth

21
22-25
26
27-30
31-34
35-38
39-42
43-46
47
48-51
52-55 LoV - longitude of meridian parallel to $y$-axis along which latitude increases as the
56-59
$y$-coordinate increases
Scale factor of major axis of oblate spheroid Earth
Scaled value of major axis of oblate spheroid Earth
Scale factor of minor axis of oblate spheroid Earth
Scaled value of minor axis of oblate spheroid Earth
$N x$ - number of points along the $x$-axis
$N y$ - number of points along the $y$-axis
La1 - latitude of first grid point
Lo1 - longitude of first grid point
Resolution and component flags (see Flag table 3.3)
LaD - latitude where Dx and Dy are specified

Dx - x-direction grid length (see Note 1)
(Grid definition template 3.30 - continued)

| Octet No. | Contents |
| :---: | :--- |
| $60-63$ | Dy - y-direction grid length (see Note 1) |
| 64 | Projection centre flag (see Flag table 3.5) |
| 65 | Scanning mode (see Flag table 3.4) |
| $66-69$ | Latin 1 - first latitude from the pole at which the secant cone cuts the sphere |
| $70-73$ | Latin $2-$ second latitude from the pole at which the secant cone cuts the sphere |
| $74-77$ | Latitude of the southern pole of projection |
| $78-81$ | Longitude of the southern pole of projection |

Notes:
(1) Grid lengths are in units of $10^{-3} \mathrm{~m}$, at the latitude specified by LaD.
(2) If Latin $1=$ Latin 2 , then the projection is on a tangent cone.
(3) The resolution flags (bits 3-4 of Flag table 3.3) are not applicable
(4) LoV is the longitude value of the meridian which is parallel to the $y$-axis (or columns of the grid) along which latitude increases as the y-coordinate increases (the orientation longitude may or may not appear on a particular grid).

## Grid definition template 3.40 - Gaussian latitude/longitude

| Octet No. | Contents |
| :---: | :--- |
| 15 | Shape of the Earth (see Code table 3.2) |
| 16 | Scale factor of radius of spherical Earth |
| $17-20$ | Scaled value of radius of spherical Earth |
| 21 | Scale factor of major axis of oblate spheroid Earth |
| $22-25$ | Scaled value of major axis of oblate spheroid Earth |
| 26 | Scale factor of minor axis of oblate spheroid Earth |
| $27-30$ | Scaled value of minor axis of oblate spheroid Earth |
| $31-34$ | Ni - number of points along a parallel |
| $35-38$ | Nj - number of points along a meridian |
| $39-42$ | Basic angle of the initial production domain (see Note 1) |
| $43-46$ | Subdivisions of basic angle used to define extreme longitudes and latitudes, and direction |
|  | increments (see Note 1) |
| $47-50$ | Lal - latitude of first grid point (see Note 1) |
| $51-54$ | Lo1 - longitude of first grid point (see Note 1) |
| 55 | Resolution and component flags (see Flag table 3.3) |
| $56-59$ | La2 - latitude of last grid point (see Note 1) |
| $60-63$ | Lo2 - longitude of last grid point (see Note 1) |
| $64-67$ | Di - i direction increment (see Note 1) |
| $68-71$ | N - number of parallels between a pole and the Equator (see Note 2) |
| 72 | Scanning mode (flags - see Flag table 3.4) |

Notes:
(1) Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes, and direction increments. For these last six descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).
(2) The number of parallels between a pole and the Equator is used to establish the variable (Gaussian) spacing of the parallels; this value must always be given.

## Grid definition template 3.41 - rotated Gaussian latitude/longitude

Octet No.
Contents
15-72 Same as grid definition template 3.40 (see Note 1)
73-76 Latitude of the southern pole of projection
77-80 Longitude of the southern pole of projection
81-84 Angle of rotation of projection

Notes:
(1) Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes, and direction increments. For these last six descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).
(2) The number of parallels between a pole and the Equator is used to establish the variable (Gaussian) spacing of the parallels; this value must always be given.
(3) See Note (2) under grid definition template 3.1 - rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée).

## Grid definition template 3.42 - stretched Gaussian latitude/longitude

Octet No.
Contents
15-72 Same as grid definition template 3.40 (see Note 1)
73-76 Latitude of the pole of stretching
77-80 Longitude of the pole of stretching
81-84 Stretching factor

Notes:
(1) Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes, and direction increments. For these last six descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).
(2) The number of parallels between a pole and the Equator is used to establish the variable (Gaussian) spacing of the parallels; this value must always be given.
(3) See Note (2) under grid definition template 3.2 - stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée).

## Grid definition template 3.43 - stretched and rotated Gaussian latitude/longitude

## Contents

15-72 Same as grid definition template 3.40 (see Note 1)
73-76 Latitude of the southern pole of projection
77-80 Longitude of the southern pole of projection
81-84 Angle of rotation of projection
85-88 Latitude of the pole of stretching
89-92 Longitude of the pole of stretching
93-96 Stretching factor

## (Grid definition template 3.43 - continued)

## Notes:

(1) Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes, and direction increments. For these last six descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).
(2) The number of parallels between a pole and the Equator is used to establish the variable (Gaussian) spacing of the parallels; this value must always be given.
(3) See Note (2) under grid definition template 3.1 - rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée)
(4) See Note (2) under grid definition template 3.2 - stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée)

## Grid definition template 3.50 - spherical harmonic coefficients

Octet No.
Contents
15-18 J - pentagonal resolution parameter
19-22 K - pentagonal resolution parameter
23-26
M - pentagonal resolution parameter
27 Representation type indicating the method used to define the norm (see Code table 3.6).
28 Representation mode indicating the order of the coefficients (see Code table 3.7)
Note: The pentagonal representation of resolution is general. Some common truncations are special cases of the pentagonal one:

| Triangular: | $M=J=K$ |
| :--- | :--- |
| Rhomboidal: | $K=J+M$ |
| Trapezoidal: | $K=J, K>M$ |

Grid definition template 3.51 - rotated spherical harmonic coefficients

Octet No.

## Contents

15-28 Same as grid definition template 3.50
29-32 Latitude of the southern pole of projection
33-36 Longitude of the southern pole of projection
37-40 Angle of rotation of projection
Notes:
(1) See the Note under grid definition template 3.50 - spherical harmonic coefficients.
(2) See Note (2) under grid definition template 3.1 - rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée).

Grid definition template 3.52 - stretched spherical harmonic coefficients

## Contents

15-28 Same as grid definition template 3.50
29-32 Latitude of the pole of stretching
33-36 Longitude of the pole of stretching
37-40 Stretching factor
(Grid definition template 3.52 - continued)
Notes:
(1) See the Note under grid definition template 3.50 - spherical harmonic coefficients.
(2) See Note (2) under grid definition template 3.2 - stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée).

Grid definition template 3.53 - stretched and rotated spherical harmonic coefficients
Octet No.
Contents
15-28 Same as grid definition template 3.50
29-32 Latitude of the southern pole of projection
33-36 Longitude of the southern pole of projection
37-40 Angle of rotation of projection
41-44 Latitude of pole of stretching
45-48 Longitude of pole of stretching
49-52 Stretching factor
Notes:
(1) See the Note under grid definition template 3.50 - spherical harmonic coefficients.
(2) See Note (2) under grid definition template 3.1 - rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée).
(3) See Note (2) under grid definition template 3.2 - stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée).

Grid definition template 3.90 - space view perspective or orthographic

| Octet No. | Contents |
| :---: | :---: |
| 15 | Shape of the Earth (see Code table 3.2) |
| 16 | Scale factor of radius of spherical Earth |
| 17-20 | Scaled value of radius of spherical Earth |
| 21 | Scale factor of major axis of oblate spheroid Earth |
| 22-25 | Scaled value of major axis of oblate spheroid Earth |
| 26 | Scale factor of minor axis of oblate spheroid Earth |
| 27-30 | Scaled value of minor axis of oblate spheroid Earth |
| 31-34 | Nx - number of points along x -axis (columns) |
| 35-38 | Ny - number of points along y-axis (rows or lines) |
| 39-42 | Lap - latitude of sub-satellite point |
| 43-46 | Lop - longitude of sub-satellite point |
| 47 | Resolution and component flags (see Code table 3.3) |
| 48-51 | $\mathbf{d x}$ - apparent diameter of Earth in grid lengths, in x -direction |
| 52-55 | dy - apparent diameter of Earth in grid lengths, in $\mathbf{y}$-direction |
| 56-59 | Xp - x-coordinate of sub-satellite point (in units of 10-3 grid length expressed as an integer) |
| 60-63 | Yp - y-coordinate of sub-satellite point (in units of 10-3 grid length expressed as an integer) |
| 64 | Scanning mode (flags - see Flag table 3.4) |
| 65-68 | Orientation of the grid; i.e. the angle between the increasing $y$-axis and the meridian of the sub-satellite point in the direction of increasing latitude (see Note 3) |
| 69-72 | Nr - altitude of the camera from the Earth's centre, measured in units of the Earth's (equatorial) radius multiplied by a scale factor of $10^{6}$ (see Notes 4 and 5) |
| 73-76 | Xo - x-coordinate of origin of sector image |
| 77-80 | Yo - y-coordinate of origin of sector image |

## (Grid definition template 3.90 - continued)

Notes:
(1) It is assumed that the satellite is at its nominal position, i.e. it is looking directly at its sub-satellite point.
(2) Octets 69-72 shall be set to all ones (missing) to indicate the orthographic view (from infinite distance).
(3) It is the angle between the increasing $y$-axis and the meridian $180^{\circ} \mathrm{E}$ if the sub-satellite point is the North Pole; or the meridian $0^{\circ}$ if the sub-satellite point is the South Pole.
(4) The apparent angular size of the Earth will be given by $2 \times \arcsin \left(\left(10^{6}\right) / \mathrm{Nr}\right)$.
(5) For orthographic view from infinite distance, the value of Nr should be encoded as missing (all bits set to 1 ).
(6) The horizontal and vertical angular resolutions of the sensor ( $R x$ and $R y$ ), needed for navigation equation, can be calculated from the following:

$$
\begin{aligned}
& \mathrm{Rx}=2 \times \arcsin \left(\left(10^{6}\right) / \mathrm{Nr}\right) / \mathrm{dx} \\
& \mathrm{Ry}=2 \times \arcsin \left(\left(10^{6}\right) / \mathrm{Nr}\right) / \mathrm{dy}
\end{aligned}
$$

## Grid definition template 3.100 - triangular grid based on an icosahedron (see Attachment, Volume I.2, Part B, Att.GRIB)

Octet No.
Contents
35-38
$32 \quad$ Grid point position (see Code table 3.8)
33 Numbering order of diamonds (flags - see Flag table 3.9)
34 Scanning mode for one diamond (flags - see Flag table 3.10)
$\mathbf{n 2}$ - exponent of $\mathbf{2}$ for the number of intervals on main triangle sides
n3 - exponent of 3 for the number of intervals on main triangle sides
ni - number of intervals on main triangle sides of the icosahedron nd - Number of diamonds
Latitude of the pole point of the ic osahedron on the sphere Longitude of the pole point of the icosahedron on the sphere Grid point position (see Code table 3.8)
Numbering order of diamonds (flags - see Flag table 3.9)
Scanning mode for one diamond (flags - see Flag table 3.10)
nt - total number of grid points

Notes:
(1) For more details see Attachment, Volume I.2, Part B, Att.GRIB - Definition of the triangular grid based on an icosahedron.
(2) The origin of the grid is an icosahedron with 20 triangles and 12 vertices. The triangles are combined to nd quadrangles, the so-called diamonds (e.g. if nd $=10$, two of the icosahedron triangles form a diamond, and if $n d=5,4$ icosahedron triangles form a diamond). There are two resolution values called $n 2$ and n3 describing the division of each triangle side. Each triangle side is divided into ni equal parts, where $n i=3^{n 3} \times 2^{n 2}$ with n3 either equal to 0 or to 1 . In the example of the Attachment, the numbering order of the rectangles is anti-clockwise with a view from the pole point on both hemispheres. Diamonds 1 to 5 are northern hemisphere and diamonds 6 to 10 are southern hemisphere.
(3) The exponent of 3 for the number of divisions of triangle sides is used only with a value of either 0 or 1 .
(4) The total number of grid points for one global field depends on the grid point position. If e.g. the grid points are located at the vertices of the triangles, then $n t=(n i+1) \times(n i+1) \times n d$ since grid points at diamond edges are contained in both adjacent diamonds and for the same reason the pole points are contained in each of the five adjacent diamonds.

Grid definition template 3.110 - Equatorial azimuthal equidistant projection
Contents

15
16
17-20
21
22-25
26
27-30
31-34
35-38
39-42
43-46
47
48-51
52-55
56
57

Shape of the Earth (see Code table 3.2)
Scale factor of radius of spherical Earth
Scaled value of radius of spherical Earth
Scale factor of major axis of oblate spheroid Earth
Scaled value of major axis of oblate spheroid Earth
Scale factor of minor axis of oblate spheroid Earth
Scaled value of minor axis of oblate spheroid Earth
$N x$ - number of points along $x$-axis
Ny - number of points along y -axis
La1 - latitude of tangency point (centre of grid)
Lo1 - longitude of tangency point
Resolution and component flags (see Flag table 3.3)
Dx - x-direction grid length in units of $10^{-3} \mathrm{~m}$ as measured at the point of the axis
Dy - y-direction grid length in units of $10^{-3} \mathrm{~m}$ as measured at the point of the axis
Projection centre flag
Scanning mode (see Flag table 3.4)

Grid definition template 3.120 - azimuth-range projection
Contents
15-18 $\quad \mathrm{Nb}$ - number of data bins along radials (see Note)
19-22 $\quad \mathrm{Nr}$ - number of radials
23-26 La1 - latitude of centre point
27-30 Lo1 - longitude of centre point
31-34 Dx - spacing of bins along radials
35-38 Dstart - offset from origin to inner bound
$39 \quad$ Scanning mode (flags - see Flag table 3.4)
40-(39+4Nr) For each of Nr radials:
( $40+4(\mathrm{X}-1))-(41+4(\mathrm{X}-1))$ Azi - starting azimuth, degrees $\times 10$ (degrees as north)
$(42+4(X-1))-(43+4(X-1))$ Adelta - azimuthal width, degrees $\times 100$ (+ clockwise, - counterclockwise), with $X=1$ to Nr

N ote: A data bin is a data point representing the volume centred on it.

Grid definition template 3.1000 - cross-section grid with points equally spaced on the horizontal
Preliminary note: This template is simply experimental, was not validated at the time of publication and should be used only for bilateral previously-agreed tests

Octet No.
15 Shape of the Earth (see Code table 3.2)
16 Scale factor of radius of spherical Earth
17-20 Scaled value of radius of spherical Earth
21 Scale factor of major axis of oblate spheroid Earth
22-25 Scaled value of major axis of oblate spheroid Earth
26 Scale factor of minor axis of oblate spheroid Earth
27-30 Scaled value of minor axis of oblate spheroid Earth
(Grid definition template 3.1000 - continued)

| 31-34 | Number of horizontal points |
| :---: | :--- |
| $35-38$ | Basic angle of the initial production domain (see Note) |
| $39-42$ | Subdivisions of basic angle used to define extreme longitudes and latitudes (see Note) |
| $43-46$ | La1 - latitude of first grid point (see Note) |
| $47-50$ | Lo1 - longitude of first grid point (see Note) |
| 51 | Scanning mode (flags - see Flag table 3.4) |
| $52-55$ | La2 - latitude of last grid point (see Note) |
| $56-59$ | Lo2 - longitude of last grid point (see Note) |
| 60 | Type of horizontal line (see Code table 3.20) |
| $61-62$ | Number of vertical points |
| 63 | Physical meaning of vertical coordinate (see Code table 3.15) |
| 64 | Vertical dimension coordinate values definition (see Code table 3.21) |
| $65-66$ | NC - Number of coefficients or values used to specify vertical coordinates |
| $67-(66+$ NC $\times 4)$ | Coefficients to define vertical dimension coordinate values in functional form, or the explicit |
|  | coordinate values (IEEE 32-bit floating-point values) |

Note: Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes. For these last descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).

Grid definition template 3.1100 - Hovmöller diagram grid with points equally spaced on the horizontal

Preliminary note: This template is simply experimental, was not validated at the time of publication and should be used only for bilateral previously-agreed tests

| Octet No. | Contents |
| :---: | :--- |
| 15 | Shape of the Earth (see Code table 3.2) |
| 16 | Scale factor of radius of spherical Earth |
| $17-20$ | Scaled value of radius of spherical Earth |
| 21 | Scale factor of major axis of oblate spheroid Earth |
| $22-25$ | Scaled value of major axis of oblate spheroid Earth |
| 26 | Scale factor of minor axis of oblate spheroid Earth |
| $27-30$ | Scaled value of minor axis of oblate spheroid Earth |
| $31-34$ | Number of horizontal points |
| $35-38$ | Basic angle of the initial production domain (see Note) |
| $39-42$ | Subdivisions of basic angle used to define extreme longitudes and latitudes (see Note) |
| $43-46$ | La1 - latitude of first grid point (see Note) |
| $47-50$ | Lo1 - longitude of first grid point (see Note) |
| 51 | Scanning mode (flags - see Flag table 3.4) |
| $52-55$ | La2 - latitude of last grid point (see Note) |
| $56-59$ | Lo2 - longitude of last grid point (see Note) |
| 60 | Type of horizontal line (see Code table 3.20) |
| $61-64$ | NT - number of time steps |
| 65 | Unit of offset from reference time (see Code table 4.4) |
| $66-69$ | Offset from reference of first time (negative value when first bit set) |

(Grid definition template 3.1100 - continued)

| 70 | Type of time increment (see Code table 4.11) |
| :---: | :--- |
| 71 | Unit of time increment (see Code table 4.4) |
| $72-75$ | Time increment (negative value when first bit set) |
|  | 76-82 $\quad$ Last date/time |
| $76-77$ | Year |
| 78 | Month |
| 79 | Day |
| 80 | Hour |
| 81 | Minute |
| 82 | Second |

Note: Basic angle of the initial production domain and subdivisions of this basic angle are provided to manage cases where the recommended unit of $10^{-6}$ degrees is not applicable to describe the extreme longitudes and latitudes. For these last descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and $10^{6}$ ( $10^{-6}$ degrees unit).

## Grid definition template $\mathbf{3 . 1 2 0 0}$ - time section grid

Preliminary note: This template is simply experimental, was not validated at the time of publication and should be used only for bilateral previously-agreed tests
Octet No. Contents
15-18 NT - number of time steps
$19 \quad$ Unit of offset from reference time (see Code table 4.4)
20-23 Offset from reference of first time (negative value when first bit set)
24 Type of time increment (see Code table 4.11)
$25 \quad$ Unit of time increment (see Code table 4.4)
26-29 Time increment (negative value when first bit set)
30-36 Last date/time
30-31 Year
32 Month
33 Day
34 Hour
35 Minute
36 Second
37-38 Number of vertical points
$39 \quad$ Physical meaning of vertical coordinate (see Code table 3.15)
$40 \quad$ Vertical dimension coordinate values definition (see Code table 3.21)
41-42 NC - number of coefficients or values used to specify vertic al coordinates
43-(42+NC $\times 4$ ) Coefficients to define vertical dimension coordinate values in functional form, or the explicit coordinate values (IEEE 32-bit floating-point values)

## TEMPLATE DEFINITIONS USED IN SECTION 4

Product definition template 4.0 - analysis or forecast at a horizontal level or in a horizontal layer at a point in time

| Octet No. | Contents |
| :---: | :--- |
| 10 | Parameter category (see Code table 4.1) |
| 11 | Parameter number (see Code table 4.2) |
| 12 | Type of generating process (see Code table 4.3) |
| 13 | Background generating process identifier (defined by originating centre) |
| 14 | Analysis or forecast generating process identifier (defined by originating centre) |
| $15-16$ | Hours of observational data cutoff after reference time (see Note) |
| 17 | Minutes of observational data cutoff after reference time |
| 18 | Indicator of unit of time range (see Code table 4.4) |
| $19-22$ | Forecast time in units defined by octet 18 |
| 23 | Type of first fixed surface (see Code table 4.5) |
| 24 | Scale factor of first fixed surface |
| $25-28$ | Scaled value of first fixed surface |
| 29 | Type of second fixed surface (see Code table 4.5) |
| 30 | Scale factor of second fixed surface |
| $31-34$ | Scaled value of second fixed surface |

Note: Hours greater than 65534 will be coded as 65534 .

Product definition template 4.1 - individual ensemble forecast, control and perturbed, at a horizontal level or in a horizontal layer at a point in time

| Octet No. | Contents |
| :---: | :--- |
| 10 | Parameter category (see Code table 4.1) |
| 11 | Parameter number (see Code table 4.2) |
| 12 | Type of generating process (see Code table 4.3) |
| 13 | Background generating process identifier (defined by originating Centre) |
| 14 | Forec ast generating process identifier (defined by originating Centre) |
| $15-16$ | Hours after reference time of data cutoff (see Note) |
| 17 | Minutes after reference time of data cutoff |
| 18 | Indicator of unit of time range (see Code table 4.4) |
| $19-22$ | Forec ast time in units defined by octet 18 |
| 23 | Type of first fixed surface (see Code table 4.5) |
| 24 | Scale factor of first fixed surface |
| $25-28$ | Scaled value of first fixed surface |
| 29 | Type of second fixed surface (see Code table 4.5) |
| 30 | Scale factor of second fixed surface |
| $31-34$ | Scaled value of second fixed surface |
| 35 | Type of ensemble forecast (see Code table 4.6) |
| 36 | Perturbation number |
| 37 | Number of forecasts in ensemble |

N ote: Hours greater than 65534 will be coded as 65534.

Product definition template 4.2 - derived forecasts based on all ensemble members at a horizontal level or in a horizontal layer at a point in time

| Octet No. | Contents |
| :---: | :--- |
| 10 | Parameter category (see Code table 4.1) |
| 11 | Parameter number (see Code table 4.2) |
| 12 | Type of generating process (see Code table 4.3) |
| 13 | Background generating process identifier (defined by originating centre) |
| 14 | Forecast generating process identifier (defined by originating centre) |
| $15-16$ | Hours after reference time of data cutoff (see Note) |
| 17 | Minutes after reference time of data cutoff |
| 18 | Indicator of unit of time range (see Code table 4.4) |
| $19-22$ | Forecast time in units defined by octet 18 |
| 23 | Type of first fixed surface (see Code table 4.5) |
| $\mathbf{2 4}$ | Scale factor of first fixed surface |
| $\mathbf{2 5 - 2 8}$ | Scaled value of first fixed surface |
| $\mathbf{2 9}$ | Type of second fixed surface (see Code table 4.5) |
| $\mathbf{3 0}$ | Scale factor of second fixed surface |
| $\mathbf{3 1 - 3 4}$ | Scaled value of second fixed surface |
| $\mathbf{3 5}$ | Derived forecast (see Code table 4.7) |
| $\mathbf{3 6}$ | Number of forecasts in ensemble |
| N o e $:$ | Hours greater than 65534 will be coded as 65534. |

Product definition template 4.3 - derived forecasts based on a cluster of ensemble members over a rectangular area at a horizontal level or in a horizontal layer at a point in time
Octet No. Contents
$10 \quad$ Parameter category (see Code table 4.1)
$11 \quad$ Parameter number (see Code table 4.2)
12 Type of generating process (see Code table 4.3)
13 Background generating process identifier (defined by originating centre)
14 Forecast generating process identifier (defined by originating centre)
15-16 Hours after reference time of data cutoff (see Note)
17 Minutes after reference time of data cutoff
18 Indicator of unit of time range (see Code table 4.4)
19-22 Forecast time in units defined by octet 18
23 Type of first fixed surface (see Code table 4.5)
24 Scale factor of first fixed surface
25-28 Scaled value of first fixed surface
29 Type of second fixed surface (see Code table 4.5)
30 Scale factor of second fixed surface
31-34 Scaled value of second fixed surface
35 Derived forecast (see Code table 4.7)
36 Number of forecasts in the ensemble (N)
37 Cluster identifier
38 Number of cluster to which the high resolution control belongs
39 Number of cluster to which the low resolution control belongs
(Product definition template 4.3 - continued)

| Octet No. | Contents |
| :---: | :--- |
| 40 | Total number of clusters |
| 41 | Clustering method (see Code table 4.8) |
| $42-45$ | Northern latitude of cluster domain |
| $46-49$ | Southern latitude of cluster domain |
| $50-53$ | Eastern longitude of cluster domain |
| $54-57$ | Western longitude of cluster domain |
| $58-(57+N)$ | List of $N$ ensemble forecast numbers |

Note: Hours greater than 65534 will be coded as 65534 .

Product definition template 4.4 - derived forecasts based on a cluster of ensemble members over a circular area at a horizontal level or in a horizontal layer at a point in time

| Octet No. | Contents |
| :---: | :--- |
| 10 | Parameter category (see Code table 4.1) |
| 11 | Parameter number (see Code table 4.2) |
| 12 | Type of generating process (see Code table 4.3) |
| 13 | Background generating process identifier (defined by originating centre) |
| 14 | Forecast generating process identifier (defined by originating centre) |
| $15-16$ | Hours after reference time of data cutoff (see Note) |
| 17 | Minutes after reference time of data cutoff |
| 18 | Indicator of unit of time range (see Code table 4.4) |
| $19-22$ | Forecast time in units defined by octet 18 |
| 23 | Type of first fixed surface (see Code table 4.5) |
| 24 | Scale factor of first fixed surface |
| $25-28$ | Scaled value of first fixed surface |
| 29 | Type of second fixed surface (see Code table 4.5) |
| 30 | Scale factor of second fixed surface |
| $31-34$ | Scaled value of second fixed surface |
| 35 | Derived forecast (see Code table 4.7) |
| 36 | Number of forecasts in the ensemble (N) |
| 37 | Cluster identifier |
| 38 | Number of cluster to which the high resolution control belongs |
| 39 | Number of cluster to which the low resolution control belongs |
| 40 | Total number of clusters |
| 41 | Clustering method (see Code table 4.8) |
| $42-45$ | Latitude of central point in cluster domain |
| $46-49$ | Longitude of central point in cluster domain |
| $50-53$ | Radius of cluster domain |
| $54-53+N)$ | List of $N$ ensemble forecast numbers |

N ote: Hours greater than 65534 will be coded as 65534.

```
Product definition template 4.5 - probability forecasts at a horizontal level or in a horizontal layer at a point in time
\begin{tabular}{cl} 
Octet No. & \multicolumn{1}{c}{ Contents } \\
10 & Parameter category (see Code table 4.1) \\
11 & Parameter number (see Code table 4.2) \\
12 & Type of generating process (see Code table 4.3) \\
13 & Background generating process identifier (defined by originating centre) \\
14 & Forecast generating process identifier (defined by originating centre) \\
\(15-16\) & Hours after reference time of data cutoff (see Note) \\
17 & Minutes after reference time of data cutoff \\
18 & Indicator of unit of time range (see Code table 4.4) \\
\(19-22\) & Forecast time in units defined by octet 18 \\
23 & Type of first fixed surface (see Code table 4.5) \\
24 & Scale factor of first fixed surface \\
\(25-28\) & Scaled value of first fixed surface \\
29 & Type of second fixed surface (see Code table 4.5) \\
30 & Scale factor of second fixed surface \\
\(31-34\) & Scaled value of second fixed surface \\
35 & Forecast probability number \\
36 & Total number of forecast probabilities \\
37 & Probability type (see Code table 4.9) \\
38 & Scale factor of lower limit \\
\(39-42\) & Scaled value of lower limit \\
43 & Scale factor of upper limit \\
\(44-47\) & Scaled value of upper limit
\end{tabular}
Note: Hours greater than 65534 will be coded as 65534 .
Product definition template 4.6 - percentile forecasts at a horizontal level or in a horizontal layer at a point in time
```

Octet No.

## Contents

Parameter category (see Code table 4.1)
Parameter number (see Code table 4.2)
Type of generating process (see Code table 4.3)
Background generating process identifier (defined by originating centre)
Forecast generating process identifier (defined by originating centre)
Hours after reference time of data cutoff (see Note)
Minutes after reference time of data cutoff
Indic ator of unit of time range (see Code table 4.4)
Forecast time in units defined by octet 18
Type of first fixed surface (see C ode table 4.5)
Scale factor of first fixed surface
Scaled value of first fixed surface
Type of sec ond fixed surface (see Code table 4.5)
Scale factor of second fixed surface
Scaled value of second fixed surface
Percentile value (from $\mathbf{1 0 0 \%}$ to 0\%)

```
N ote: Hours greater than 65534 will be coded as 65534.
```

Product definition template 4.7 - analysis or forecast error at a horizontal level or in a horizontal layer at a point in time

| Octet No. | Contents |
| :---: | :--- |
| 10 | Parameter category (see Code table 4.1) |
| 11 | Parameter number (see Code table 4.2) |
| 12 | Type of generating process (see Code table 4.3) |
| 13 | Background generating process identifier (defined by originating centre) |
| 14 | Analysis or forecast generating process identifier (defined by originating centre) |
| $15-16$ | Hours after reference time of data cutoff (see Note) |
| 17 | Minutes after reference time of data cutoff |
| 18 | Indicator of unit of time range (see Code table 4.4) |
| $19-22$ | Forecast time in units defined by octet 18 |
| 23 | Type of first fixed surface (see Code table 4.5) |
| 24 | Scale factor of first fixed surface |
| $25-28$ | Scaled value of first fixed surface |
| 29 | Type of second fixed surface (see Code table 4.5) |
| 30 | Scale factor of second fixed surface |
| $31-34$ | Scaled value of second fixed surface |

N ote: Hours greater than 65534 will be coded as 65534.

Product definition template 4.8 - average, accumulation and/or extreme values or other statistically-processed values at a horizontal level or in a horizontal layer in a continuous or non-continuous time interval

| Octet No. | Contents |
| :---: | :--- |
| 10 | Parameter category (see Code table 4.1) |
| 11 | Parameter number (see Code table 4.2) |
| 12 | Type of generating process (see Code table 4.3) |
| 13 | Background generating process identifier (defined by originating centre) |
| 14 | Analysis or forecast generating process identifier (defined by originating centre) |
| $15-16$ | Hours after reference time of data cutoff (see Note 1) |
| 17 | Minutes after reference time of data cutoff |
| 18 | Indicator of unit of time range (see Code table 4.4) |
| $19-22$ | Forecast time in units defined by octet 18 (see Note 2) |
| 23 | Type of first fixed surface (see Code table 4.5) |
| 24 | Scale factor of first fixed surface |
| $25-28$ | Scaled value of first fixed surface |
| 29 | Type of second fixed surface (see Code table 4.5) |
| 30 | Scale factor of second fixed surface |
| $31-34$ | Scaled value of second fixed surface |
| $35-36$ | Year |
| 37 | Month |
| 38 | Day |
| 39 | Hour |
| 40 | Minute |
| 41 | Second |$\}$

(continued)
(Product definition template 4.8 - continued)

| Octet No. | Contents |
| :---: | :---: |
| 42 | $n$ - number of time range specifications describing the time intervals used to calculate the statistic ally-processed field |
| 43-46 | Total number of data values missing in statistical process |
|  | 47-58 Specification of the outermost (or only) time range over which statistical processing is done |
| 47 | Statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 4.10) |
| 48 | Type of time increment between successive fields used in the statistical processing (see Code table 4.11) |
| 49 | Indicator of unit of time for time range over which statistical processing is done (see Code table 4.4) |
| 50-53 | Length of the time range over which statistical processing is done, in units defined by the previous octet |
| 54 | Indicator of unit of time for the increment between the successive fields used (see Code table 4.4) |
| 55-58 | Time increment between successive fields, in units defined by the previous octet (see Note 3) |
|  | 59-nn These octets are included only if $\mathrm{n}>1$, where $\mathrm{nn}=\mathbf{4 6 + 1 2 \times n}$ |
| 59-70 | As octets 47 to 58, next innermost step of processing |
| 71-nn | Additional time range specifications, included in accordance with the value of $n$. Contents as octets 47 to 58 , repeated as necessary |

Notes:
(1) Hours greater than 65534 will be coded as 65534 .
(2) The reference time in section 1 and the forecast time together define the beginning of the overall time interval.
(3) An increment of zero means that the statistical processing is the result of a continuous (or near continuous) process, not the processing of a number of discrete samples. Examples of such continuous processes are the temperatures measured by analogue maximum and minimum thermometers or thermographs and the rainfall measured by a rain gauge.
(4) The reference and forecast times are successively set to their initial values plus or minus the increment, as defined by the type of time increment (one of octets 48, 60, 72 ...). For all but the innermost (last) time range, the next inner range is then processed using these reference and forecast times as the initial reference and forecast time.

## Product definition template 4.9 - probability forecasts at a horizontal level or in a horizontal layer in a continuous or non-continuous time interval

Preliminary note: This template was not validated at the time of publication and should be used with caution. Please report any use to the WMO Secretariat (World Weather Watch Basic Systems Department) to assist for validation

Octet No.

## Contents

Parameter category (see Code table 4.1)
Parameter number (see Code table 4.2)
12 Type of generating process (see Code table 4.3)
13 Background generating process identifier (defined by originating centre)
14 Forecast generating process identifier (defined by originating centre)
15-16 Hours after reference time of data cutoff (see Note 1)
17 Minutes after reference time of data cutoff
(Product definition template 4.9 - continued)

| Octet No. | Contents |
| :---: | :---: |
| 18 | Indicator of unit of time range (see Code table 4.4) |
| 19-22 | Forecast time in units defined by octet 18 (see Note 2) |
| 23 | Type of first fixed surface (see Code table 4.5) |
| 24 | Scale factor of first fixed surface |
| 25-28 | Scaled value of first fixed surface |
| 29 | Type of second fixed surface (see Code table 4.5) |
| 30 | Scale factor of second fixed surface |
| 31-34 | Scaled value of second fixed surface |
| 35 | Forecast probability number |
| 36 | Total number of forecast probabilities |
| 37 | Probability type (see Code table 4.9) |
| 38 | Scale factor of lower limit |
| 39-42 | Scaled value of lower limit |
| 43 | Scale factor of upper limit |
| 44-47 | Scaled value of upper limit |
| 48-49 | Year of end of overall time interval |
| 50 | Month of end of overall time interval |
| 51 | Day of end of overall time interval |
| 52 | Hour of end of overall time interval |
| 53 | Minute of end of overall time interval |
| 54 | Second of end of overall time interval |
| 55 | $n$ - number of time range specifications describing the time intervals used to calculate the statistically-processed field |
| 56-59 | Total number of data values missing in the statistical process |
|  | 60-71 Specification of the outermost (or only) time range over which statistical processing is done |
| 60 | Statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 4.10) |
| 61 | Type of time increment between successive fields used in the statistical processing (see Code table 4.11) |
| 62 | Indicator of unit of time for time range over which statistical processing is done (see Code table 4.4) |
| 63-66 | Length of the time range over which statistical processing is done, in units defined by the previous octet |
| 67 | Indicator of unit of time for the increment between the successive fields used (see Code table 4.4) |
| 68-71 | Time increment between successive fields, in units defined by the previous octet (see Note 3) |
|  | 72-nn These octets are included only if $\mathrm{n}>1$, where $\mathrm{nn}=59+\mathbf{1 2 \times n}$ |
| 72-83 | As octets 60 to 71, next innermost step of processing |
| 84-nn | Additional time range specifications, included in accordance with the value of $n$. Contents as octets 60 to 71 , repeated as necessary. |
| Notes: |  |
| (1) Hours greater than 65534 will be coded as 65534. |  |
| (2) The inter | ce time in section 1 and the forecast time together define the beginning of the overall time |

## (Product definition template 4.9 - continued)

(3) An increment of zero means that the statistical processing is the result of a continuous (or near continuous) process, not the processing of a number of discrete samples. Examples of such continuous processes are the temperatures measured by analogue maximum and minimum thermometers or thermographs and the rainfall measured by a rain gauge. The reference and forecast times are successively set to their initial values plus or minus the increment, as defined by the type of time increment (one of octets $46,58,70 \ldots$...). For all but the innermost (last) time range, the next inner range is then processed using these reference and forecast times as the initial reference and forecast time.

Product definition template 4.10 - percentile forecasts at a horizontal level or in a horizontal layer in a continuous or non-continuous time interval

Preliminary note: This template was not validated at the time of publication and should be used with caution. Please report any use to the WMO Secretariat (World Weather Watch Basic Systems Department) to assist for validation
Octet No. Contents
$10 \quad$ Parameter category (see Code table 4.1)
$11 \quad$ Parameter number (see Code table 4.2)
12 Type of generating process (see Code table 4.3)
13 Background generating process identifier (defined by originating centre)
14 Forecast generating process identifier (defined by originating centre)
15-16 Hours after reference time of data cutoff (see Note 1)
17 Minutes after reference time for data cutoff
18 Indicator of unit of time range (see Code table 4.4)
19-22 Forecast time in units defined by previous octet (see Note 2)
23 Type of first fixed surface (see Code table 4.5)
24 Scale factor of first fixed surface
25-28 Scaled value of first fixed surface
$29 \quad$ Type of second fixed surface (see Code table 4.5)
$30 \quad$ Scale factor of second fixed surface
31-34 Scaled value of second fixed surface
$35 \quad$ Percentile value (from $100 \%$ to $0 \%$ )
36-37 Year of end of overall time interval
38 Month of end of overall time interval
39 Day of end of overall time interval
40 Hour of end of overall time interval
41 Minute of end of overall time interval
42 Second of end of overall time interval
$43 n-$ number of time range specifications describing the time intervals used to calculate the statistically-processed field
44-47 Total number of data values missing in the statistical process
48-59 Specification of the outermost (or only) time range over which statistical processing is done
48 Statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 4.10)
Type of time increment between successive fields used in the statistical processing (see Code table 4.11)
Indicator of unit of time for time range over which statistical processing is done (see Code table 4.4)
(Product definition template 4.10 - continued)

| 51-54 | Length of the time range over which statistical processing is done, in units defined by the previous octet |
| :---: | :---: |
| 55 | Indicator of unit of time for the increment between the successive fields used (see Code table 4.4) |
| 56-59 | Time increment between successive fields, in units defined by the previous octet (see Note 3) |
|  | 60-nn These octets are included only if $\mathrm{n}>1$, where $\mathrm{nn}=47+12 \times n$ |
| 60-71 | As octets 48-59, next innermost step of processing |
| 72-nn | Additional time range specifications, included in accordance with the value of $n$. Contents as octets 48 to 59 , repeated as necessary. |

Notes:
(1) Hours greater than 65534 will be coded as 65534 .
(2) The reference time in section 1 and the forecast time together define the beginning of the overall time interval.
(3) An increment of zero means that the statistical processing is the result of a continuous (or near continuous) process, not the processing of a number of discrete samples. Examples of such continuous processes are the temperatures measured by analogue maximum and minimum thermometers or thermographs and the rainfall measured by rain gauge.

Product definition template 4.20 - radar product

| Octet No. | Contents |
| :---: | :--- |
| 10 | Parameter category (see Code table 4.1) |
| 11 | Parameter number (see Code table 4.2) |
| 12 | Type of generating process (see Code table 4.3) |
| 13 | Number of radar sites used |
| 14 | Indicator of unit of time range |
| $15-18$ | Site latitude (in $10^{-6}$ degree) |
| $19-22$ | Site longitude (in $10^{-6}$ degree) |
| $23-24$ | Site elevation (metres) |
| $25-28$ | Site ID (alphanumeric) |
| $29-30$ | Site ID (numeric) |
| 31 | Operating mode (see Code table 4.12) |
| 32 | Reflectivity calibration constant (tenths of dB) |
| 33 | Quality control indicator (see Code table 4.13) |
| 34 | Clutter filter indicator (see Code table 4.14) |
| 35 | Constant antenna elevation angle (tenths of degree true) |
| $36-37$ | Accumulation interval (minutes) |
| 38 | Reference reflectivity for echo top (dB) |
| $39-41$ | Range bin spacing (metres) |
| $42-43$ | Radial angular spacing (tenths of degree true) |

Product definition template 4.30 - satellite product

Octet No.
Contents
$10 \quad$ Parameter category (see Code table 4.1)
$11 \quad$ Parameter number (see Code table 4.2)
12

Type of generating process (see Code table 4.3) (continued)
(Product definition template 4.30 - continued)

| 13 | Observation generating process identifier (defined by originating centres) |
| :--- | :--- |
| 14 | Number of contributing spectral bands (NB) |

Repeat the following 10 octets for each contributing band ( $\mathrm{nb}=1, \mathrm{NB}$ )
( $15+10(\mathrm{nb}-1))-(16+10(\mathrm{nb}-1))$ Satellite series of band nb (code table defined by originating/generating centre)
$(17+10(n b-1))-(18+10(n b-1)) \quad$ Satellite numbers of band nb (code table defined by originating/generating centre)
(19+10(nb-1)) Instrument types of band nb (code table defined by originating/generating centre)
(20+10(nb-1)) Scale factor of central wave number of band nb


Product definition template 4.254 - CCITT IA5 character string
Octet No.
Contents
$10 \quad$ Parameter category (see Code table 4.1)
$11 \quad$ Parameter number (see Code table 4.2)
12-15 Number of characters

Product definition template 4.1000 - cross-section of analysis and forecast at a point in time
Preliminary note: This template is simply experimental, was not validated at the time of publication and should be used only for bilateral previously-agreed tests
Octet No.
Contents
$10 \quad$ Parameter category (see Code table 4.1)
$11 \quad$ Parameter number (see Code table 4.2)
12 Type of generating process (see Code table 4.3)
13 Background generating process identifier (defined by originating centre)
14 Analysis or forec ast generating process identifier (defined by originating centre)
15-16 Hours of observational data cutoff after reference time (see Note)
17 Minutes of observational data cutoff after reference time
18 Indicator of unit of time range (see Code table 4.4)
19-22 Forecast time in units defined by octet 18
N o te: Hours greater than 65534 will be coded as 65534 .

Product definition template 4.1001 - cross-section of averaged or otherwise statisticallyprocessed analysis or forecast over a range of time

Preliminary note: This template is simply experimental, was not validated at the time of publication and should be used only for bilateral previously-agreed tests
Octet No.
Contents
$10 \quad$ Parameter category (see Code table 4.1)
11 Parameter number (see Code table 4.2)
12 Type of generating process (see Code table 4.3)
13 Background generating process identifier (defined by originating centre)
(Product definition template 4.1001 - continued)
14 Analysis or forecast generating process identifier (defined by originating centre)
15-16 Hours of obsenvational data cutoff after reference time (see Note 1)
17 Minutes of observational data cutoff after reference time
18 Indicator of unit of time range (see Code table 4.4)
19-22 Forecast time in units defined by octet 18
23-26 Total number of data values missing in the statistical process
27-38 Specification of the outermost (or only) time range over which statistical processing is done
27 Statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 4.10)
28 Type of time increment between successive fields used in the statistical processing (see Code table 4.11)
29
Indicator of unit of time for time range over which statistical processing is done (see Code yable 4.4)
30-33 Length of the time range over which statistical processing is done, in units defined by the previous octet
34 Indicator of unit of time for the increment between the successive fields used (see Code table 4.4)
35-38 Time increment between successive fields, in units defined by the previous octet (see Note 2)
Notes:
(1) Hours greater than 65534 will be coded as 65534 .
(2) An increment of zero means that the statistical processing is the result of a continuous (or near continuous) process, not the processing of a number of discrete samples. Examples of such continuous processes are the temperatures measured by analogue maximum and minimum thermometers or thermographs and the rainfall measured by a rain gauge.

Product definition template 4.1002 - cross-section of analysis and forecast, averaged or otherwise statistically processed over latitude or longitude

Preliminary note: This template is simply experimental, was not validated at the time of publication and should be used only for bilateral previously-agreed tests

| Octet No. | Contents |
| :---: | :--- |
| 10 | Parameter category (see Code table 4.1) |
| 11 | Parameter number (see Code table 4.2) |
| 12 | Type of generating process (see Code table 4.3) |
| 13 | Background generating process identifier (defined by originating centre) |
| 14 | Analysis or forecast generating process identifier (defined by originating centre) |
| $15-16$ | Hours of observational data cutoff after reference time (see Note) |
| 17 | Minutes of observational data cutoff after reference time |
| 18 | Indicator of unit of time range (see Code table 4.4) |
| $19-22$ | Forecast time in units defined by octet 18 |
| 23 | Horizontal dimension processed (see Code table 4.220) |
| 24 | Treatment of missing data (e.g. below ground) (see Code table 4.221) |
| 25 | Type of statistical processing (see Code table 4.10) |
| $26-29$ | Start of range |
| $30-33$ | End of range |
| $34-35$ | Number of values |

Note: Hours greater than 65534 will be coded as 65534.

Product definition template 4.1100 - Hovmöller-type grid with no averaging or other statistical processing

Preliminary note: This template is simply experimental, was not validated at the time of publication and should be used only for bilateral previously-agreed tests

Octet No.
Contents
10
11
12
13
14
15-16
17
18
19-22
23
24
25-28
29
30
31-34

Parameter category (see Code table 4.1) Parameter number (see Code table 4.2)
Type of generating process (see Code table 4.3) Background generating process identifier (defined by originating centre) Analysis or forec ast generating process identifier (defined by originating centre) Hours of observational data cutoff after reference time (see Note) Minutes of observational data cutoff after reference time Indicator of unit of time range (see Code table 4.4) Forecast time in units defined by octet 18 Type of first fixed surface (see Code table 4.5) Scale factor of first fixed surface Scaled value of first fixed surface Type of second fixed surface (see Code table 4.5) Scale factor of second fixed surface Scaled value of second fixed surface

N ote: Hours greater than 65534 will be coded as 65534 .

Product definition template 4.1101 - Hovmöller-type grid with averaging or other statistical processing

Preliminary note: This template is simply experimental, was not validated at the time of publication and should be used only for bilateral previously-agreed tests. (Octets 35-50 are very similar to octets 43-58 of product definition template 4.8, but the meaning of some fields differs slightly)

## Octet No. Contents

10
11
12
13
14
15-16 Hours of observational data cutoff after reference time (see Note 1)
17 Minutes of observational data cutoff after reference time
18 Indic ator of unit of time range (see Code table 4.4)
19-22 Forecast time in units defined by octet 18 (see Note 2)
23 Type of first fixed surface (see Code table 4.5)
24 Scale factor of first fixed surface
25-28 Scaled value of first fixed surface
29 Type of second fixed surface (see Code table 4.5)
30 Scale factor of second fixed surface
31-34 Scaled value of second fixed surface
35-38 Total number of data values missing in the statistical process
(Product definition template 4.1101 - continued)

39

40

41

42-45
46
47-50

Statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 4.10)
Type of time increment between successive fields used in the statistical processing (see Code table 4.11)
Indicator of unit of time for time range over which statistical processing is done (see Code table 4.4)
Length of the time range over which statistical processing is done, in units defined by the previous octet
Indicator of unit of time for increment between the successive fields used (see Code table 4.4)
Time increment between successive fields, in units defined by the previous octet (see Note 3)

Notes:
(1) Hours greater than 65534 will be coded as 65534 .
(2) Reference $=$ reference time (section 1) + forecast range (PDT) + offset and increments from reference time (GDT).
(3) An increment of zero means that the statistical processing is the result of a continuous (or near continuous) process, not the processing of a number of discrete samples. Examples of such continuous processes are the temperatures measured by analogue maximum and minimum thermometers or thermographs and the rainfall measured by a rain gauge.

## TEMPLATE DEFINITIONS USED IN SECTION 5

## Data representation template 5.0 - Grid point data - simple packing

| Octet No. | Contents |
| :---: | :--- |
| $12-15$ | Reference value (R) (IEEE 32-bit floating-point value) |
| $16-17$ | Binary scale factor (E) |
| $18-19$ | Decimal scale factor (D) |
| 20 | Number of bits used for each packed value for simple packing, or for each group reference <br> value for complex packing or spatial differencing |
| 21 | Type of original field values (see Code table 5.1) |

## Data representation template 5.1 - matrix values at grid point - simple packing

Preliminary note: This template was not validated at the time of publication and should be used with caution. Please report any use to WMO Secretariat (World Weather Watch Basic Systems Department) to assist for validation

Octet No. Contents
12-21 Same as data representation template 5.0
220 , no matrix bit maps present; 1-matrix bit maps present
23-26 Number of data values encoded in Section 7
27-28 NR - first dimension (rows) of each matrix
29-30 NC - second dimension (columns) of each matrix
$31 \quad$ First dimension coordinate value definition (Code table 5.2)
32 NC1 - number of coefficients or values used to specify first dimension coordinate function
33 Second dimension coordinate value definition (Code table 5.2)
34 NC2 - number of coefficients or values used to specify second dimension coordinate function
$35 \quad$ First dimension physical significance (Code table 5.3)
36 Second dimension physical significance (Code table 5.3)
37-(36+NC1×4) Coefficients to define first dimension coordinate values in functional form, or the explicit coordinate values (IEEE 32-bit floating-point value)
(37+NC 1×4)-(36+4(NC 1+NC 2))
Coefficients to define second dimension coordinate values in functional form, or the explicit coordinate values (IEEE 32-bit floating-point value)

Notes:
(1) This form of representation enables a matrix of values to be depicted at each grid point; the two dimensions of the matrix may represent coordinates expressed in terms of two elemental parameters (e.g. direction and frequency for wave spectra). The numeric values of these coordinates, beyond that of simple subscripts, can be given in a functional form, or as a collection of explicit numbers.
(2) Some simple coordinate functional forms are tabulated in Code table 5.2. Where a more complex coordinate function applies, the coordinate values shall be explicitly denoted by the inclusion of the actual set of values rather than the coefficients. This shall be indicated by a code figure 0 from Code table 5.2; the number of explicit values coded shall be equal to the appropriate dimension of the matrix for which values are presented and they shall follow octet 36 in place of the coefficients.

## (Data representation template 5.1 - continued)

(3) Matrix bit maps will be present only if indicated by octet 22. If present, there shall be one bit map for each grid point with data values, as defined by the primary bit map in Section 6, each of length (NR $\times N$ ) bits: a bit set to 1 will indicate a data element at the corresponding location within the matrix. Bit maps shall be represented end-to-end, without regard for octet boundaries; the last bit map shall, if necessary, be followed by bits set to zero to fill any partially used octet.
(4) Matrices restricted to scanning in the $+i$ direction (left to right) and in the $-j$ direction (top to bottom).

## Data representation template 5.2 - grid point data - complex packing

Octet No.

## Contents

12-21 Same as data representation template 5.0
22 Group splitting method used (see Code table 5.4)

23
24-27
28-31
32-35 NG - number of groups of data values into which field is split
36
37 Reference for group widths (see Note 12)
Number of bits used for the group widths (after the reference value in octet $\mathbf{3 6}$ has been removed)

42
43-46
47

38-41 Reference for group lengths (see Note 13)
Reference for group lengths (see Note 13)
Length increment for the group lengths (see Note 14)
True length of last group
Number of bits used for the scaled group lengths (after subtraction of the reference value given in octets 38-41 and division by the length increment given in octet 42)

Notes:
(1) Group lengths have no meaning for row by row packing, where groups are coordinate lines (so the grid description section and possibly the bit-map section are enough); for consistency, associated field width and reference should then be encoded as 0 .
(2) For row by row packing with a bit-map, there should always be as many groups as rows. In case of rows with only missing values, all associated descriptors should be coded as zero.
(3) Management of widths into a reference and increments, together with management of lengths as scaled incremental values, are intended to save descriptor size (which is an issue as far as compression gains are concerned).
(4) Management of explicitly missing values is an alternative to bit-map use within Section 6 ; it is intended to reduce the whole GRIB message size.
(5) There may be two types of missing value(s), such as to make a distinction between static misses (for instance, due to a land/sea mask) and occasional misses.
(6) As an extra option, substitute value(s) for missing data may be specified. If not wished (or not applicable), all bits should be set to 1 for relevant substitute value(s).
(7) If substitute value(s) are specified, type of content should be consistent with original field values (floatingpoint - and then IEEE 32-bit encoded-, or integer).
(8) If primary missing values are used, such values are encoded within appropriate group with all bits set to 1 at packed data level.
(9) If secondary missing values are used, such values are encoded within appropriate group with all bits set to 1 , except the last one set to 0 , at packed data level.
(10) A group containing only missing values (of either type) will be encoded as a constant group (null width, no associated data) and the group reference will have all bits set to 1 for primary type, and all bits set to 1 , except the last bit set to 0 , for secondary type.

## (Data representation template 5.2 - continued)

(11) If necessary, group widths and/or field width of group references may be enlarged to avoid ambiguities between missing value indicator(s) and true data.
(12) The group width is the number of bits used for every value in a group.
(13) The group length ( L ) is the number of values in a group.
(14) The essence of the complex packing method is to subdivide a field of values into NG groups, where the values in each group have similar sizes. In this procedure, it is necessary to retain enough information to recover the group lengths upon decoding. The NG group lengths for any given field can be described by $\mathrm{Ln}=\mathrm{ref}+\mathrm{Kn} \times$ len_inc, $\mathrm{n}=1, \mathrm{NG}$, where ref is given by octets $38-41$ and len_inc by octet 42 . The NG values of $K$ (the scaled group lengths) are stored in the data section, each with the number of bits specified by octet 47 . Since the last group is a special case which may not be able to be specified by this relationship, the length of the last group is stored in octets 43-46.

## Data representation template 5.3 - grid point data - complex packing and spatial differencing

Octet No.

## 12-47

48
49

## Contents

Same as data representation template 5.2 Order of spatial differencing (see Code table 5.6) Number of octets required in the data section to specify extra descriptors needed for spatial differencing (octets 6-ww in data template 7.3)

## Notes:

(1) Spatial differencing is a pre-processing before group splitting at encoding time. It is intended to reduce the size of sufficiently smooth fields, when combined with a splitting scheme as described in data representation template 5.2. At order 1 , an initial field of values $f$ is replaced by a new field of values $g$, where $g_{1}=f_{1}, g_{2}=f_{2}-f_{1}, \ldots, g_{n}=f_{n}-f_{n-1}$. At order 2 , the field of values $g$ is itself replaced by a new field of values $h$, where $h_{1}=f_{1}, h_{2}=f_{2}, h_{3}=g_{3}-g_{2}, \ldots, h_{n}=g_{n}-g_{n-1}$. To keep values positive, the overall minimum of the resulting field (either $g_{\min }$ or $h_{\min }$ ) is removed. At decoding time, after bit string unpacking, the original scaled values are recovered by adding the overall minimum and summing up recursively.
(2) For differencing of order $n$, the first $n$ values in the array that are not missing are set to zero in the packed array. These dummy values are not used in unpacking.

Data representation template 5.50 - spectral data - simple packing

| Octet No. | Contents |
| :---: | :--- |
| 12-15 | Reference value (R) (IEEE 32-bit floating-point value) |
| $16-17$ | Binary scale factor (E) |
| $18-19$ | Decimal scale factor (D) |
| 20 | Number of bits used for each packed value (field width) |
| $21-24$ | Real part of (0.0) coefficient (IEEE 32-bit floating-point value) |

Notes:
(1) Removal of the real part of ( 0.0 ) coefficient from packed data is intended to reduce the variability of the coefficients, in order to improve packing accuracy.
(2) For some spectral representations, the ( 0.0 ) coefficient represents the mean value of the parameter represented.

## Data representation template 5.51 - spherical harmonics data - complex packing

Octet No.
12-20
21-24
25-26
27-28
29-30
31-34
35

Contents
Same as data representation template 5.50
P - Laplacian scaling factor (expressed in $10^{-6}$ units)
$J_{s}-$ pentagonal resolution parameter of the unpacked subset (see Note 1)
$K_{S}$ - pentagonal resolution parameter of the unpacked subset (see Note 1)
$M_{S}$ - pentagonal resolution parameter of the unpacked subset (see Note 1)
$\mathrm{T}_{\mathrm{S}}$ - total number of values in the unpacked subset (see Note 1)
Precision of the unpacked subset (see Code table 5.7)

Notes:
(1) The unpacked subset is a set of values defined in the same way as the full set of values (on a spectrum limited to $\mathrm{J}_{\mathrm{S}}, \mathrm{K}_{\mathrm{S}}$ and $\mathrm{M}_{\mathrm{S}}$ ), but on which scaling and packing are not applied. Associated values are stored in octets 6 onwards of Section 7.
(2) The remaining coefficients are multiplied by $(\mathrm{n} \times(\mathrm{n}+1))^{\mathrm{P}}$, scaled and packed. The operator associated with this multiplication is derived from the Laplacian operator on the sphere.
(3) The retrieval formula for a coefficient of wave number n is then:
$Y=\left(R+X \times 2^{E}\right) \times 10^{-D} \times(n \times(n+1))^{-P}$ where $X$ is the packed scaled value associated with the coefficient.

## TEMPLATE DEFINITIONS USED IN SECTION 7

## Data template 7.0 - grid point data - simple packing

| Octet No. | Contents |
| :---: | :---: |
| 6-nn | Binary data values - binary string, with each (scaled) data value |

## Data template 7.1 - matrix values at grid point - simple packing

Preliminary note: This template was not validated at the time of publication and should be used with caution. Please report any use to WMO Secretariat (World Weather Watch Basic Systems Department) to assist for validation
Octet No.
Contents
6-nn Binary data values - binary string, with each (scaled) data value
Note: Group descriptors mentioned above may not be physically present; if associated field width is 0 .

Data template 7.2 - grid point data - complex packing

| Octet No. | Contents |
| :--- | :--- |
| $6-x x$ | NG group reference values (X1 in the decoding formula), each of which is encoded using <br> the number of bits specified in octet 20 of data representation template 5.0 . Bits set to zero <br> shall be appended as necessary to ensure this sequence of numbers ends on an octet <br> boundary |
| $[x x+1]-y y$ | NG group widths, each of which is encoded using the number of bits specified in octet 37 <br> of data representation template 5.2 . Bits set to zero shall be appended as necessary to <br> ensure this sequence of numbers ends on an octet boundary |
| $[y y+1]-z z$ | NG scaled group lengths, each of which is encoded using the number of bits specified in <br> octet 47 of data representation template 5.2 . Bits set to zero shall be appended as neces- <br> sary to ensure this sequence of numbers ends on an octet boundary (see Note 14 of data <br> representation template 5.2) |
| $[z z+1]-n n$ | Packed values (X2 in the decoding formula), where each value is a deviation from its respec- <br> tive group reference value |

Notes:
(1) Group descriptors mentioned above may not be physically present; if associated field width is 0 .
(2) Group lengths have no meaning for row by row packing; for consistency, associated field width should then be encoded as 0 . So no specific test for row by row case is mandatory at decoding software level to handle encoding/decoding of group descriptors.
(3) Scaled group lengths, if present, are encoded for each group. But the true last group length (unscaled) should be taken from data representation template.
(4) For groups with a constant value, associated field width is 0 , and no incremental data are physically present.

Data template 7.3 - grid point data - complex packing and spatial differencing

Octet No.
6-ww
[ww+1]-xx

Contents
First value(s) of original (undifferenced) scaled data values, followed by the overall minimum of the differences. The number of values stored is $\mathbf{1}$ greater than the order of differentiation, and the field width is described at octet 49 of data representation template 5.3 (see Note 1) NG group reference values (X1 in the decoding formula), each of which is encoded using the number of bits specified in octet 20 of data representation template 5.0. B its set to zero shall be appended where necessary to ensure this sequence of numbers ends on an octet boundary
$[x x+1]-n n \quad$ Same as for data representation template 7.2
Notes:
(1) Referring to the notation in Note (1) of data representation template 5.3, at order 1 , the values stored in octets $6-w w$ are $g_{1}$ and $g_{\text {min }}$. At order 2 , the values stored are $h_{1}, h_{2}$, and $h_{\text {min }}$.
(2) Extra descriptors related to spatial differencing are added before the splitting descriptors, to reflect the separation between the two approaches. It enables to share software parts between cases with and without spatial differencing.
(3) The position of overall minimum after initial data values is a choice that enables less software management.
(4) Overall minimum will be negative in most cases. First bit should indicate the sign: 0 if positive, 1 if negative.

Data template 7.50 - spectral data - simple packing
Octet No.
Contents
6-nn Binary data values - binary string, with each (scaled) data value

Data template 7.51 - spherical harmonics - complex packing
Octet No.
Contents
6-( $\left.5+1 \times T_{S}\right) \quad$ Data values from the unpacked subset (IEEE floating-point values on I octets)
$\left(6+I \times T_{S}\right)-n n \quad B i n a r y$ data values - binary string, with each (scaled) data value out of the unpacked subset

Notes:
(1) Values ordering within the unpacked subset is defined according to the source of grid definition associated with the data.
(2) Number of octets associated with each value of the unpacked subset (I) is defined in Code table 5.7 , according to the actual value in octet 35 of data representation template 5.51.
(3) Values ordering within the packed data is done according to the source of grid definition, skipping the values processed in the unpacked subset.

## CODE TABLE USED IN SECTION 0

Code table 0.0 - Discipline of processed data in the GRIB message, number of GRIB Master table

## Code figure

Meaning
0 Meteorological products
1 Hydrological products
2 Land surface products
3 Space products
4-9 Reserved
10 Oceanographic products
11-191 Reserved
192-254 Reserved for local use
255 Missing

## CODE TABLES USED IN SECTION 1

Code table 1.0 - GRIB master tables version number

Meaning
0 Experimental
1 Initial operational version number
2-254 Future operational version numbers
255 Local table used

Code table 1.1 - GRIB local tables version number

| Code figure | Meaning |
| :---: | :--- |
| 0 | Local tables not used |
| $\mathbf{1 - 2 5 4}$ | Number of local tables version used |
| 255 | Missing |

Code table 1.2 - Significance of reference time
Code figure
Meaning
0 Analysis
1 Start of forecast
2 Verifying time of forecast
3 Observation time
4-191 Reserved
192-254 Reserved for local use
255
Missing

Code table 1.3 - Production status of data

| Code figure | Meaning |
| :---: | :--- |
| 0 | Operational products |
| 1 | Operational test products |
| 2 | Research products |
| 3 | Re-analysis products |
| $4-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |

```
Code table 1.4 - Type of data
Code figure Meaning
    O Analysis products
    1 Forecast products
    2 Analysis and forecast products
    3 Control forecast products
    4 Perturbed forecast products
    5 Control and perturbed forecast products
    6 Processed satellite observations
    7 Processed radar observations
    8-191 Reserved
    192-254 Reserved for local use
    255
    Missing
```

Note: An initialized analysis is considered a zero-hour forecast.

## CODE AND FLAG TABLES USED IN SECTION 3

## Code table 3.0 - Source of grid definition

$0 \quad$ Specified in Code table 3.1
1 Predetermined grid definition Defined by originating centre
2-191 Reserved
192-254 Reserved for local use
255 A grid definition does not apply to this product

Code table 3.1 - Grid definition template number

| Code figure | Meaning | Comments |
| :---: | :---: | :---: |
| 0 | Latitude/longitude | Also called equidistant cylindrical, or Plate Carrée |
| 1 | Rotated latitude/longitude |  |
| 2 | Stretched latitude/longitude |  |
| 3 | Stretched and rotated latitude/longitude |  |
| 4-9 | Reserved |  |
| 10 | Mercator |  |
| 11-19 | Reserved |  |
| 20 | Polar stereographic projection | Can be south or north |
| 21-29 | Reserved |  |
| 30 | Lambert conformal | Can be secant or tangent, conical or bipolar (also called Albers equal-area) |
| 31-39 | Reserved |  |
| 40 | Gaussian latitude/longitude |  |
| 41 | Rotated Gaussian latitude/longitude |  |
| 42 | Stretched Gaussian latitude/longitude |  |
| 43 | Stretched and rotated Gaussian latitude/longitude |  |
| 44-49 | Reserved |  |
| 50 | Spheric al harmonic coefficients |  |
| 51 | Rotated spherical harmonic coefficients |  |
| 52 | Stretched spherical harmonic coefficients |  |
| 53 | Stretched and rotated spherical harmonic coefficient |  |
| 54-89 | Reserved |  |
| 90 | Space view perspective or orthographic |  |
| 91-99 | Reserved |  |
| 100 | Triangular grid based on an icosahedron |  |
| 101-109 | Reserved |  |
| 110 | Equatorial azimuthal equidistant projection |  |
| 111-119 | Reserved |  |
| 120 | Azimuth-range projection |  |
| 121-999 | Reserved |  |
| 1000 | Cross-section grid with points equally spaced on the | horizontal |
| 1001-1099 | Reserved |  |

(Code table 3.1 - continued)

| Code figure | Meaning Comments |
| :---: | :---: |
| 1100 | Hovmöller diagram grid with points equally spaced on the horizontal |
| 1101-1199 | Reserved |
| 1200 | Time section grid |
| 1201-32767 | Reserved |
| 32768-65534 | Reserved for local use |
| 65535 | Missing |
| Code table 3.2 - Shape of the Earth |  |
| Code figure | Meaning |
| 0 | Earth assumed spherical with radius $=6367.47$ km |
| 1 | Earth assumed spherical with radius specified by data producer |
| 2 | Earth assumed oblate spheroid with size as determined by IAU in 1965 (major axis = 6378.160 km , minor axis = $6356.775 \mathrm{~km}, \mathrm{f}=\mathbf{1 / 2 9 7 . 0}$ ) |
| 3 | Earth assumed oblate spheroid with major and minor axes specified by data producer |
| 4 | Earth assumed oblate spheroid as defined in IAG-GRS80 model (major axis = 6378137.0 m , minor axis = $6356752.314 \mathrm{~m}, \mathrm{f}=\mathbf{1 / 2 9 8 . 2 5 7} 222$ 101) |
| 5 | Earth assumed represented by WGS84 (as used by ICAO since 1998) |
| 6 | Earth assumed spherical with radius of $6371 \mathbf{2 2 9 . 0}$ m |
| 7-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |

Note: WGS84 is a geodetic system that uses IAG-GRS80 as a basis.

Flag table 3.3 - Resolution and component flags

| Bit No. | Value | Meaning |
| :---: | :---: | :---: |
| 1-2 |  | Reserved |
| 3 | 0 | i direction increments not given |
|  | 1 | i direction increments given |
| 4 | 0 | j direction increments not given |
|  | 1 | j direction increments given |
| 5 | 0 | Resolved $u$ - and $v$ - components of vector quantities relative to easterly and northerly directions |
|  | 1 | Resolved $\mathbf{u}$ - and v - components of vector quantities relative to the defined grid in the direction of increasing $x$ and $y$ (or $i$ and $j$ ) coordinates, respectively |
| 6-8 |  | Reserved - set to zero |

Flag table 3.4 - Scanning mode

| Bit No. | Value | Meaning |
| :---: | :---: | :--- |
| 1 | 0 | Points of first row or column scan in the $+\mathrm{i}(+x)$ direction |
|  | 1 | Points of first row or column scan in the $-\mathrm{i}(-x)$ direction |
| 2 | 0 | Points of first row or column scan in the $-j(-y)$ direction |
|  | 1 | Points of first row or column scan in the $+j(+y)$ direction |
| 3 | 0 | Adjacent points in $i(x)$ direction are consecutive |
|  | 1 | Adjacent points in $j(y)$ direction is consec utive |
| 4 | 0 | All rows scan in the same direction |
|  | 1 | Adjacent rows scans in the opposite direction |
| $5-8$ |  | Reserved |

Notes:
(1) i direction: west to east along a parallel or left to right along an $x$-axis.
(2) j direction: south to north along a meridian, or bottom to top along a y-axis.
(3) If bit number 4 is set, the first row scan is as defined by previous flags.

Flag table 3.5 - Projection centre

| Bit No. | Value | Meaning |
| :---: | :---: | :--- |
| 1 | 0 | North Pole is on the projection plane |
|  | 1 | South Pole is on the projection plane |
| 2 | 0 | Only one projection centre is used |
|  | 1 | Projection is bi-polar and symmetric |

## Code table 3.6 - Spectral data representation type

Code figure
1

Meaning
The associated Legendre functions of the first kind are defined by:

$$
\begin{aligned}
& \mathbf{P}_{\mathbf{n}}^{\mathbf{m}}(\mu)=\sqrt{(\mathbf{2 n}+\mathbf{1}) \frac{(\mathbf{n}-\mathbf{m})!}{(\mathbf{n}+\mathbf{m})!}} \frac{\mathbf{1}}{2^{\mathbf{n}} \mathbf{n} \mathbf{n}}\left(\mathbf{1}-\mu^{\mathbf{2}}\right)^{\mathbf{m} / 2} \frac{\mathbf{d}^{\mathbf{n}+\mathbf{m}}}{\mathbf{d} \mu^{\mathbf{n}+\mathbf{m}}}\left(\mu^{\mathbf{2}}-\mathbf{1}\right)^{\mathbf{n}}, \mathbf{m} \geq \mathbf{0} \\
& \mathbf{P}_{\mathbf{n}}^{-\mathbf{m}}(\mu)=\mathbf{P}_{\mathbf{n}}^{\mathbf{m}}(\mu)
\end{aligned}
$$

A field $F(\lambda, \mu)$ is represented by:

$$
\mathbf{F}(\lambda, \mu)=\sum_{\mathbf{m}=-\mathbf{m}}^{\mathbf{M}} \sum_{\mathbf{n}=|\mathbf{m}|}^{\mathbf{N}(\mathbf{m})} F_{\mathbf{n}}^{m_{n}} \mathbf{P}_{\mathbf{n}}^{m}(\mu) e^{i m \lambda}
$$

where $\lambda$ is the longitude, $\mu$ the sine of latitude, and $F_{n}^{-m}$ the complex conjugate of $F_{n}^{m}$

## Code table 3.7 - Spectral data representation mode

Code figure
Meaning
0
Reserved
$1 \quad$ The complex numbers $F_{n}^{m}$ (see code figure 1 in Code table 3.6) are stored for $m \geq 0$ as pairs of real numbers $\operatorname{Re}\left(F_{n}^{m}\right), \operatorname{Im}\left(F_{n}^{m}\right)$ ordered with $n$ increasing from $m$ to $N(m)$, first for $m=0$ and then for $m=1,2, \ldots . M$ (see Note)
2-254 Reserved
255 Missing

N o te: Values of $N(m)$ for common truncation cases:
Triangular:
$M=J=K$
$N(m)=J$
Rhomboidal:
$K=J+M$,
$N(m)=J+m$
Trapezoidal:
$K=J, K>M$,
$N(m)=J$

Code table 3.8 - Grid point position

Code figure
Meaning
Grid points at triangle vertices
1 Grid points at centres of triangles
2 Grid points at midpoints of triangle sides
3-191 Reserved
192-254 Reserved for local use
255 Missing

Flag table 3.9 - Numbering order of diamonds as seen from the corresponding pole

| Bit No. | Value | Meaning |
| :---: | :---: | :--- |
| 1 | 0 | Clockwise orientation |
|  | 1 | Anti-clockwise (i.e. counter-clockwise) orientation <br> Resenved |
| $2-8$ |  |  |

Flag table 3.10 - Scanning mode for one diamond

| Bit No. | Value | Meaning |
| :---: | :---: | :--- |
| 1 | 0 | Points scan in + i direction, i.e. from pole to Equator |
|  | 1 | Points scan in $-i$ direction, i.e. from Equator to pole |
| 2 | 0 | Points scan in $+j$ direction, i.e. from west to east |
|  | 1 | Points scan in $-j$ direction, i.e. from east to west |
| 3 | 0 | Adjacent points in i direction are consecutive |
|  | 1 | Adjacent points in j direction are consecutive <br> Reserved |
| $4-8$ |  |  |

## Code table 3.11 - Interpretation of list of numbers defining number of points

Code figure
0
There is no appended list
1 Numbers define number of points corresponding to full coordinate circles (i.e. parallels), coordinate values on each circle are multiple of the circle mesh, and extreme coordinate values given in grid definition (i.e. extreme longitudes) may not be reached in all rows
2

3-254 Reserved
255 Numbers define number of points corresponding to coordinate lines delimited by extreme coordinate values given in grid definition (i.e. extreme longitudes) which are present in each row

Missing

## Code table 3.15 - Physical meaning of vertical coordinate

| Code figure <br> $0-19$ | Value | Meaning |
| :---: | :--- | :--- |
| 20 | Reserved |  |
| $21-99$ | Remperature | K |
| 100 | Pressure | Pa |
| 101 | Pressure deviation from mean sea level | Pa |
| 102 | Altitude above mean sea level | m |
| 103 | Height above ground (see Note 1) | m |
| 104 | Sigma coordinate |  |
| 105 | Hybrid coordinate |  |
| 106 | Depth below land surface | m |
| 107 | Potential temperature (theta) | K |
| 108 | Pressure deviation from ground to level | Pa |
| 109 | Potential vorticity | K m |
| 110 | Geometrical height | m |
| 111 | Eta coordinate (see Note 2) |  |
| 112 | Geopotential height | gpm |
| $113-159$ | Reserved |  |
| 160 | Depth below sea level | m |
| $161-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Notes:
(1) Negative values associated to this coordinate will indicate depth below ground surface. If values are all below surface, use of entry 106 is recommended, with positive coordinate values instead.
(2) The Eta vertical coordinate system involves normalizing the pressure at some point on a specific level by the mean sea level pressure at that point.

## Code table 3.20 - Type of horizontal line <br> Code figure Meaning <br> 0 Rhumb <br> 1 Great circle <br> 2-191 Reserved <br> 192-254 Reserved for local use <br> 255 Missing

Code table 3.21 - Vertical dimension coordinate values definition
Code figure
Meaning
0 Explicit coordinate values set
1 Linear coordinates
$\mathrm{f}(1)=\mathbf{C} 1$
$f(n)=f(n-1)+C 2$
2-10 Reserved
11 Geometric coordinates
$f(1)=C 1$
$f(n)=C 2 \times f(n-1)$
12-191 Reserved
192-254 Reserved for local use
255 Missing

## CODE TABLES USED IN SECTION 4

## Code table 4.0 - Product definition template number

Code figure
Meaning

0
1

2 Derived forecasts based on all ensemble members at a horizontal level or in a horizontal layer at a point in time
3 Derived forecasts based on a cluster of ensemble members over a rectangular area at a horizontal level or in a horizontal layer at a point in time
4 Derived forecasts based on a cluster of ensemble members over a circular area at a horizontal level or in a horizontal layer at a point in time
5 Probability forecasts at a horizontal level or in a horizontal layer at a point in time
6
7
8
$9 \quad$ Probability forecasts at a horizontal level or in a horizontal layer in a continuous or noncontinuous time interval
10 Percentive forecasts at a horizontal level or in a horizontal layer in a continuous or noncontinuous time interval
11-19 Reserved
20 Radar product
21-29 Reserved
30 Satellite product
31-253 Reserved
254 CCITT IA5 character string
255-999
1000 Cross-section of analysis and forecast at a point in time
1001 Cross-section of averaged or otherwise statistically-processed analysis or forecast over a range of time
1002 Cross-section of analysis and forecast, averaged or otherwise statistically-processed over latitude or longitude
1003-1099
1100 Hovmöller-type grid with no averaging or other statistical processing
1101 Hovmöller-type grid with averaging or other statistical processing
1102-32767 Reserved
32768-65534 Reserved for local use
65535
Analysis or forecast at a horizontal level or in a horizontal layer at a point in time Individual ensemble forecast, control and perturbed, at a horizontal level or in a horizontal layer at a point in time Percentile forecasts at a horizontal level or in a horizontal layer at a point in time Analysis or forecast error at a horizontal level or in a horizontal layer at a point in time Average, accumulation, extreme values or other statistically-processed values at a horizontal level or in a horizontal layer in a continuous or non-continuous time interval

Reserved

Reserved

Missing

## Code table 4.1 - Category of parameters by product discipline

Product discipline 0 - Meteorological products

## Category

0

## 1

2
3
4
5

## 6

7
8
9 Kice
9 Temperature probabilities
10 Moisture probabilities
11 Momentum probabilities
12 Mass probabilities
13 Aerosols
14 Trace gases (e.g. ozone, $\mathrm{CO}_{2}$ )
15 Radar
16 Forecast radar imagery
17 Electrodynamics
18 Nuclear/radiology
19 Physical atmospheric properties
20-189 Reserved
190 CCITT IA5 string
191 Miscellaneous
192-254 Reserved for local use
255

Description
Temperature
Moisture
Momentum
Mass
Short-wave radiation
Long-wave radiation
Cloud
Thermodynamic stability indices
Kinematic stability indices

Missing

Product discipline 1 - Hydrological products

| Category | Description |
| :---: | :--- |
| 0 | Hydrology basic products |
| 1 | Hydrology probabilities |
| $2-191$ | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |

(Code table 4.1 - continued)

Product discipline 2 - Land surface products

| Category | Description |
| :---: | :--- |
| 0 | Vegetation/biomass |
| 1 | Agri-/aquacultural special poducts |
| 2 | Transportation-related products |
| 3 | Soil products |
| $4-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |

## Product discipline 3 - Space products

| Category | Description |
| :---: | :--- |
| 0 | Image format products (see Note 1) |
| 1 | Quantitative products (see Note 2) |
| 2-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |

Notes:
(1) Data are numeric without units, although they might be given quantitative meaning through a code table defined external to this document. The emphasis is on a displayable "picture" of some phenomenon, perhaps with certain enhanced features. Generally, each datum is an unsigned, one octet integer, but some image format products might have another datum size. The size of a datum is indicated in Section 5.
(2) Data are in specified physical units.

Product discipline 10 - Oceanographic products

| Category | Description |
| :---: | :--- |
| 0 | Waves |
| 1 | Currents |
| 2 | Ice |
| 3 | Surface properties |
| 4 | Sub-surface properties |
| $5-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |

## Code table 4.2 - Parameter number by product discipline and parameter category

Product discipline 0 - Meteorological products, parameter category 0: temperature

| Number | Parameter | Units |
| :---: | :---: | :---: |
| 0 | Temperature | K |
| 1 | Virtual temperature | K |
| 2 | Potential temperature | K |
| 3 | Pseudo-adiabatic potential temperature or equivalent potential temperature | K |
| 4 | Maximum temperature | K |
| 5 | Minimum temperature | K |
| 6 | Dew-point temperature | K |
| 7 | Dew-point depression (or deficit) | K |
| 8 | Lapse rate | K m ${ }^{\mathbf{- 1}}$ |
| 9 | Temperature anomaly | K |
| 10 | Latent heat net flux | W m ${ }^{-2}$ |
| 11 | Sensible heat net flux | W m ${ }^{-2}$ |
| 12 | Heat index | K |
| 13 | Wind chill factor | K |
| 14 | Minimum dew-point depression | K |
| 15 | Virtual potential temperature | K |
| 16-191 | Reserved |  |
| 192-254 | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 1: moisture

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Specific humidity | $\mathrm{kg} \mathrm{kg}^{-1}$ |
| 1 | Relative humidity | $\%$ |
| 2 | Humidity mixing ratio | $\mathrm{kg} \mathrm{kg}^{-1}$ |
| 3 | Precipitable water | $\mathrm{kg} \mathrm{m}^{-2}$ |
| 4 | Vapor pressure | Pa |
| 5 | Saturation deficit | Pa |
| 6 | Evaporation | $\mathrm{kg} \mathrm{m}^{-2}$ |
| 7 | Precipitation rate | $\mathrm{kg} \mathrm{m}^{-2} \mathrm{~s}^{-1}$ |
| 8 | Total precipitation | $\mathrm{kg} \mathrm{m}^{-2}$ |
| 9 | Large-scale precipitation (non-convective) | $\mathrm{kg} \mathrm{m}^{-2}$ |
| 10 | Convective precipitation | $\mathrm{kg} \mathrm{m}^{-2}$ |
| 11 | Snow depth | m |
| 12 | Snowfall rate water equivalent | $\mathrm{kg} \mathrm{m}^{-2} \mathbf{~ s}^{-1}$ |
| 13 | Water equivalent of accumulated snow depth | $\mathrm{kg} \mathrm{m}^{-2}$ |
| 14 | Convective snow | $\mathrm{kg} \mathrm{m}^{-2}$ |

(Code table 4.2 - continued)

| Number | Parameter | Units |
| :---: | :---: | :---: |
| 15 | Large-scale snow | kg m-2 |
| 16 | Snow melt | kg m-2 |
| 17 | Snow age | day |
| 18 | Absolute humidity | $\mathrm{kg} \mathrm{m}^{-3}$ |
| 19 | Precipitation type | (Code table 4.201) |
| 20 | Integrated liquid water | kg m-2 |
| 21 | Condensate | $\mathbf{k g ~ k g}^{-1}$ |
| 22 | Cloud mixing ratio | kg kg-1 |
| 23 | Ice water mixing ratio | kg kg-1 |
| 24 | Rain mixing ratio | kg kg-1 |
| 25 | Snow mixing ratio | kg kg-1 |
| 26 | Horizontal moisture convergence | $\mathrm{kg} \mathrm{kg}^{-1} \mathrm{~s}^{-1}$ |
| 27 | Maximum relative humidity | \% |
| 28 | Maximum absolute humidity | $\mathrm{kg} \mathrm{m}^{-3}$ |
| 29 | Total snowfall | m |
| 30 | Precipitable water category | (Code table 4.202) |
| 31 | Hail | m |
| 32 | Graupel (snow pellets) | $\mathbf{k g ~ k g - 1}$ |
| 33-191 | Reserved |  |
| 192-254 | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 2: momentum

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Wind direction (from which blowing) | Degree true |
| 1 | Wind speed | $\mathrm{m} \mathrm{s}^{-1}$ |
| 2 | u-component of wind | $\mathrm{m} \mathrm{s}^{-1}$ |
| 3 | v-component of wind | $\mathrm{m} \mathrm{s}^{-1}$ |
| 4 | Stream function | $\mathrm{m}^{2} \mathrm{~s}^{-1}$ |
| 5 | Velocity potential | $\mathrm{m}^{2} \mathrm{~s}^{-1}$ |
| 6 | Montgomery stream function | $\mathrm{m}^{2} \mathrm{~s}^{-1}$ |
| 7 | Sigma coordinate vertical velocity | $\mathbf{s}^{-1}$ |
| 8 | Vertical velocity (pressure) | $\mathrm{Pa} \mathrm{s}^{-1}$ |
| 9 | Vertical velocity (geometric) | $\mathrm{m} \mathrm{s}^{-1}$ |
| 10 | Absolute vorticity | $\mathbf{s}^{-1}$ |
| 11 | Absolute divergence | $\mathrm{s}^{-1}$ |
| 12 | Relative vorticity | $\mathrm{s}^{-1}$ |
| 13 | Relative divergence | $\mathrm{s}^{-1}$ |
| 14 | Potential vorticity | $\mathrm{K} \mathrm{m}^{2} \mathrm{~kg}^{-1} \mathrm{~s}^{-1}$ |
| 15 | Vertical u-component shear | $\mathrm{s}^{-1}$ |
| 16 | Vertical v-component shear | $\mathrm{s}^{-1}$ |

(Code table 4.2 - continued)

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 17 | Momentum flux, u-component | $\mathrm{N} \mathrm{m}^{-2}$ |
| 18 | Momentum flux, v-component | $\mathrm{N} \mathrm{m}^{-2}$ |
| 19 | Wind mixing energy | J |
| 20 | Boundary layer dissipation | W m |
| 21 | Maximum wind speed | $\mathrm{m} \mathrm{s}^{-1}$ |
| 22 | Wind speed (gust) | $\mathrm{m} \mathrm{s}^{-1}$ |
| 23 | u-component of wind (gust) | $\mathrm{m} \mathrm{s}^{-1}$ |
| 24 | v-component of wind (gust) | $\mathrm{m} \mathrm{s}^{-1}$ |
| $25-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 3: mass

| Number | Parameter |  |
| :---: | :--- | :--- |
| 0 | Pressure | Pnits |
| 1 | Pressure reduced to MSL | Pa |
| 2 | Pressure tendency | $\mathrm{Pa} \mathrm{s}^{-1}$ |
| 3 | ICAO Standard Atmosphere Reference Height | m |
| 4 | Geopotential | $\mathrm{m}^{\mathbf{2} \mathbf{s}^{-2}}$ |
| 5 | Geopotential height | gpm |
| 6 | Geometric height | m |
| 7 | Standard deviation of height | m |
| 8 | Pressure anomaly | Pa |
| 9 | Geopotential height anomaly | gpm |
| 10 | Density | kg m |
| 11 | Altimeter setting | Pa |
| 12 | Thickness | m |
| 13 | Pressure altitude | m |
| 14 | Density altitude | m |
| $15-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 4: short-wave radiation

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Net short-wave radiation flux (surface) | $\mathbf{W ~ m}^{-2}$ |
| 1 | Net short-wave radiation flux (top of atmosphere) | $\mathbf{W ~ m}^{-2}$ |
| 2 | Short-wave radiation flux | $\mathbf{W ~ m}^{-2}$ |
| 3 | Global radiation flux | $\mathbf{W ~ m}^{-2}$ |
| 4 | Brightness temperature | K |

(Code table 4.2 - continued)

| 5 | Radiance (with respect to wave number) | $\mathrm{W} \mathrm{m}^{\mathbf{- 1}} \mathbf{~ s r}^{\mathbf{1}}$ |
| :---: | :--- | :---: |
| $\mathbf{6}$ | Radiance (with respect to wave length) | $\mathrm{W} \mathrm{m}^{-\mathbf{3}} \mathbf{~ s r}^{\mathbf{1}}$ |
| $\mathbf{7 - 1 9 1}$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 5: long-wave radiation

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Net long-wave radiation flux (surface) | $\mathrm{W} \mathrm{m}^{-2}$ |
| 1 | Net long-wave radiation flux (top of atmosphere) | $\mathrm{W} \mathrm{m}^{-2}$ |
| 2 | Long-wave radiation flux | $\mathrm{W} \mathrm{m}^{-2}$ |
| $3-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 6: cloud

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Cloud ice | $\mathbf{k g ~ m}^{-\mathbf{2}}$ |
| 1 | Total cloud cover | $\%$ |
| 2 | Convective cloud cover | $\%$ |
| 3 | Low cloud cover | $\%$ |
| 4 | Medium cloud cover | $\%$ |
| 5 | High cloud cover | $\%$ |
| 6 | Cloud water | $\mathbf{k g ~ m}^{-\mathbf{2}}$ |
| 7 | Cloud amount | $\%$ |
| 8 | Cloud type | (Code table 4.203) |
| 9 | Thunderstorm maximum tops | m |
| 10 | Thunderstorm coverage | (Code table 4.204) |
| 11 | Cloud base | m |
| 12 | Cloud top | m |
| 13 | Ceiling | m |
| $14-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline $0-\begin{aligned} & \text { Meteorological products, parameter category 7: thermodynamic stability } \\ & \text { indices }\end{aligned}$
Number
Parameter
Units
Parcel lifted index (to 500 hPa ) K
Best lifted index (to $\mathbf{5 0 0} \mathbf{~ h P a}$ ) K
$K$ index K
(continued)
(Code table 4.2 - continued)

| 3 | KO index | K |
| :---: | :--- | :--- |
| 4 | Total totals index | K |
| 5 | Sweat index | Numeric |
| 6 | Convective available potential energy | $\mathrm{J} \mathrm{kg}^{-1}$ |
| 7 | Convective inhibition | $\mathrm{J} \mathrm{kg}^{-1}$ |
| 8 | Storm relative helicity | $\mathrm{J} \mathrm{kg}^{-1}$ |
| 9 | Energy helicity index | Numeric |
| $10-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 13: aerosols

| Number | Parameter | Units |
| :---: | :--- | :---: |
| 0 | Aerosol type | (Code table 4.205) |
| $1-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 14: trace gases

| Number | Parameter | Units |
| :---: | :--- | :---: |
| 0 | Total ozone | Dobson |
| $1-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 15: radar

| Number | Parameter | Units |
| :--- | :--- | :--- |
| 0 | Base spectrum width | $\mathrm{m} \mathrm{s}^{-1}$ |
| 1 | Base reflectivity | dB |
| 2 | Base radial velocity | $\mathrm{m} \mathrm{s}^{-1}$ |
| 3 | Vertically-integrated liquid | $\mathrm{kg} \mathrm{m}^{-1}$ |
| 4 | Layer-maximum base reflectivity | dB |
| 5 | Precipitation | $\mathrm{kg} \mathrm{m}^{-\mathbf{2}}$ |
| 6 | Radar spectra (1) | - |

(Code table 4.2 - continued)

| Number | Parameter |  |
| :---: | :--- | :---: |
| 7 | Radar spectra (2) | - |
| $\mathbf{8}$ | Radar spectra (3) | - |
| $9-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 18: nuclear/radiology

| Number | Parameter |  |
| :---: | :--- | :--- |
| 0 | Air concentration of Caesium 137 | Units |
| 1 | Air concentration of lodine 131 | $\mathrm{~Bq} \mathrm{~m} \mathrm{~m}^{-3}$ |
| 2 | Air concentration of radioactive pollutant | $\mathrm{Bq} \mathrm{m}^{-3}$ |
| 3 | Ground deposition of Caesium 137 | $\mathrm{Bq} \mathrm{m}^{-2}$ |
| 4 | Ground deposition of lodine 131 | $\mathrm{~Bq} \mathrm{~m}^{-2}$ |
| 5 | Ground deposition of radioactive pollutant | $\mathrm{Bq} \mathrm{m}^{-2}$ |
| $6-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 0 - Meteorological products, parameter category 19: physical atmospheric properties

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Visibility | m |
| 1 | Albedo | $\%$ |
| 2 | Thunderstorm probability | $\%$ |
| 3 | Mixed layer depth | m |
| 4 | Volcanic ash | (Code table 4.206) |
| 5 | Icing top | m |
| 6 | Icing base | m |
| 7 | Icing | (Code table 4.207) |
| 8 | Turbulence top | m |
| 9 | Turbulence base | m |
| 10 | Turbulence | (Code table 4.208) |
| 11 | Turbulent kinetic energy | J kg |
| 12 | Planetary boundary-layer regime | (Code table 4.209) |
| 13 | Contrail intensity | (Code table 4.210) |
| 14 | Contrail engine type | (Code table 4.211) |
| 15 | Contrail top | m |
| 16 | Contrail base | m |
| $17-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

(continued)
(Code table 4.2 - continued)

Product discipline 0 - Meteorological products, parameter category 253: ASCII character string

Number
0
1-191
192-254
255

Parameter
Arbitrary text string
Reserved
Resenved for local use
Missing

Units
CCITTIA5

Product discipline 1 - Hydrological products, parameter category 0: hydrology basic products

Number
0

1

2
3
4
5-191
192-254
255

Parameter
Flash flood guidance
(Encoded as an accumulation over a floating subinterval of time between the reference time and valid time)
Flash flood runoff
(Encoded as an accumulation over a floating subinterval of time)
Remotely-sensed snow cover
Elevation of snow-covered terrain
Snow water equivalent per cent of normal
Reserved
Reserved for local use
Missing

Units
$\mathrm{kg} \mathrm{m}^{-2}$
kg m-2
(Code table 4.215)
(Code table 4.216)
\%

Notes:
(1) Remotely-sensed snow cover is expressed as a field of dimensionless, thematic values. The currently accepted values are for no-snow/no-cloud, 50, for clouds, 100, and for snow, 250 (see Code table 4.215).
(2) A data field representing snow coverage by elevation portrays at which elevations there is a snow pack. The elevation values typically range from 0 to 90 in 100-metre increments. A value of 253 is used to represent a no-snow/no-cloud data point. A value of 254 is used to represent a data point at which snow elevation could not be estimated because of clouds obscuring the remote sensor (when using aircraft or satellite measurements).
(3) Snow water equivalent per cent of normal is stored in per cent of normal units. For example, a value of 110 indicates 110 per cent of the normal snow water equivalent for a given depth of snow.
(Code table 4.2 - continued)

Product discipline 1 - Hydrological products, parameter category 1: hydrology probabilities

| Number | Parameter |  | Units |
| :---: | :---: | :---: | :---: |
| 0 | Conditional per cent precipitation amount fractile for an overall period (Encoded as an accumulation) | kg m-2 |  |
| 1 | Per cent precipitation in a sub-period of an overall period <br> (Encoded as per cent accumulation over the sub-period) | \% |  |
| 2 | Probability of 0.01 inch of precipitation (POP) | \% |  |
| 3-191 | Reserved |  |  |
| 192-254 | Reserved for local use |  |  |
| 255 | Missing |  |  |

Product discipline 2 - Land surface products, parameter category 0: vegetation/biomass

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Land cover (1 = land, 2 = sea) | Proportion |
| 1 | Surface roughness | m |
| 2 | Soil temperature | K |
| 3 | Soil moisture content | $\mathrm{kg} \mathrm{m}^{-2}$ |
| 4 | Vegetation | $\%$ |
| 5 | Water runoff | $\mathrm{kg} \mathrm{m}^{-\mathbf{2}}$ |
| 6 | Evapotranspiration | $\mathrm{kg}^{-2} \mathbf{~ s}^{-1}$ |
| 7 | Model terrain height | $\mathrm{m}^{2}$ |
| 8 | Land use | (Code table 4.212) |
| $9-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 2 - Land surface products, parameter category 3: soil products

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Soil type | (Code table 4.213) |
| 1 | Upper layer soil temperature | $\mathrm{K}^{2}$ |
| 2 | Upper layer soil moisture | $\mathrm{kg} \mathrm{m}^{-3}$ |
| 3 | Lower layer soil moisture | $\mathrm{kg} \mathrm{m}^{-3}$ |
| 4 | Bottom layer soil temperature | K |
| $5-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

(Code table 4.2 - continued)

Product discipline 3 - Space products, parameter category 0: image format products

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Scaled radiance | Numeric |
| 1 | Scaled albedo | Numeric |
| 2 | Scaled brightness temperature | Numeric |
| 3 | Scaled precipitable water | Numeric |
| 4 | Scaled lifted index | Numeric |
| 5 | Scaled cloud top pressure | Numeric |
| 6 | Scaled skin temperature | Numeric |
| $7-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 3 - Space products, parameter category 1: quantitative products

| Number | Parameter | Units |
| :---: | :--- | :---: |
| 0 | Estimated precipitation | $\mathbf{k g ~ m}^{-\mathbf{2}}$ |
| $\mathbf{1 - 1 9 1}$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 10 - Oceanographic products, parameter category 0: waves

| Number | Parameter |  |
| :---: | :--- | :--- |
| 0 | Wave spectra (1) | - |
| 1 | Wave spectra (2) | - |
| 2 | Wave spectra (3) | - |
| 3 | Significant height of combined wind waves | m |
|  | and swell |  |
| 4 | Direction of wind waves | Degree true |
| 5 | Significant height of wind waves | m |
| 6 | Mean period of wind waves | s |
| 7 | Direction of swell waves | Degree true |
| 8 | Significant height of swell waves | m |
| 9 | Mean period of swell waves | s |
| 10 | Primary wave direction | Degree true |
| 11 | Primary wave mean period | s |
| 12 | Secondary wave direction | Degree true |
| 13 | Secondary wave mean period | s |
| $14-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

(Code table 4.2 - continued)

Product discipline 10 - Oceanographic products, parameter category 1: currents

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Current direction | Degree true |
| 1 | Current speed | $\mathrm{m} \mathrm{s}^{-1}$ |
| 2 | u-component of current | $\mathrm{m} \mathrm{s}^{-1}$ |
| 3 | v-component of current | $\mathrm{m} \mathrm{s}^{-1}$ |
| $4-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 10 - Oceanographic products, parameter category 2: ice

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Ice cover | Proportion |
| 1 | Ice thickness | m |
| 2 | Direction of ice drift | Degree true |
| 3 | Speed of ice drift | $\mathrm{m} \mathrm{s}^{-1}$ |
| 4 | u-component of ice drift | $\mathrm{m} \mathrm{s}^{-1}$ |
| 5 | v-component of ice drift | $\mathrm{m} \mathrm{s}^{-1}$ |
| 6 | Ice growth rate | $\mathrm{m} \mathrm{s}^{-1}$ |
| 7 | Ice divergence | $\mathrm{s}^{-1}$ |
| $8-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 10 - Oceanographic products, parameter category 3: surface properties

| Number | Parameter | Units |
| :---: | :--- | :--- |
| 0 | Water temperature | m |
| 1 | Deviation of sea level from mean |  |
| $2-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |

Product discipline 10 - Oceanographic products, parameter category 4: sub-surface properties

| Number | Parameter |  |
| :---: | :--- | :--- |
| 0 | Main thermocline depth | $\mathbf{m}$ |
| 1 | Main thermocline anomaly | $\mathbf{m}$ |
| 2 | Transient thermocline depth | $\mathbf{m}$ |
| 3 | Salinity | $\mathbf{k g ~ k g}^{-1}$ |
| $4-191$ | Reserved |  |
| $192-254$ | Reserved for local use |  |
| 255 | Missing |  |


| Code table 4.3 - Type of generating process |  |  |
| :---: | :---: | :---: |
| Code figure | Meaning |  |
| 0 | Analysis |  |
| 1 | Initialization |  |
| 2 | Forecast |  |
| 3 | Bias corrected forecast |  |
| 4 | Ensemble forecast |  |
| 5 | Probability forecast |  |
| 6 | Forecast error |  |
| 7 | Analysis error |  |
| 8 | Observation |  |
| 9-191 | Reserved |  |
| 192-254 | Reserved for local use |  |
| 255 | Missing |  |
| Code table 4.4 - Indicator of unit of time range |  |  |
| Code figure | Meaning |  |
| 0 | Minute |  |
| 1 | Hour |  |
| 2 | Day |  |
| 3 | Month |  |
| 4 | Year |  |
| 5 | Decade (10 years) |  |
| 6 | Normal (30 years) |  |
| 7 | Century (100 years) |  |
| 8-9 | Reserved |  |
| 10 | 3 hours |  |
| 11 | 6 hours |  |
| 12 | 12 hours |  |
| 13 | Second |  |
| 14-191 | Reserved |  |
| 192-254 | Reserved for local use |  |
| 255 | Missing |  |
| Code table 4.5 - Fixed surface types and units |  |  |
| Code figure | Meaning | Unit |
| 0 | Reserved |  |
| 1 | Ground or water surface | - |
| 2 | Cloud base level | - |
| 3 | Level of cloud tops | - |
| 4 | Level of $0^{\circ} \mathrm{C}$ isotherm | - |
| 5 | Level of adiabatic condensation lifted from the surface | - |
| 6 | Maximum wind level | - |
| 7 | Tropopause | - |
| 8 | Nominal top of the atmosphere | - |
| 9 | Sea bottom | - |

## (Code table 4.5 - continued)

| Code figure | Meaning | Unit |
| :---: | :---: | :---: |
| 10-19 | Reserved |  |
| 20 | Isothermal level | K |
| 21-99 | Reserved |  |
| 100 | Isobaric surface | Pa |
| 101 | Mean sea level |  |
| 102 | Specific altitude above mean sea level | m |
| 103 | Specified height level above ground | m |
| 104 | Sigma level | "sigma" value |
| 105 | Hybrid level | - |
| 106 | Depth below land surface | m |
| 107 | Isentropic (theta) level | K |
| 108 | Level at specified pressure difference from ground to level | Pa |
| 109 | Potential vorticity surface | K m $\mathbf{2}^{\mathbf{k g}}{ }^{\mathbf{- 1}} \mathrm{s}^{\mathbf{- 1}}$ |
| 110 | Reserved |  |
| 111 | Eta level (see Note) | - |
| 112-116 | Reserved |  |
| 117 | Mixed layer depth | m |
| 118-159 | Reserved |  |
| 160 | Depth below sea level | m |
| 161-191 | Reserved |  |
| 192-254 | Reserved for local use |  |
| 255 | Missing |  |

Note: The Eta vertical coordinate system involves normalizing the pressure at some point on a specific level by the mean sea level pressure at that point.

## Code table 4.6 - Type of ensemble forecast

| Code figure | Meaning |
| :---: | :--- |
| 0 | Unperturbed high-resolution control forec ast |
| 1 | Unperturbed low-resolution control forecast |
| 2 | Negatively perturbed forecast |
| 3 | Positively perturbed forecast |
| $4-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |

## Code table 4.7 - Derived forecast

| Code figure | Meaning |
| :---: | :--- |
| 0 | Unweighted mean of all members |
| 1 | Weighted mean of all members |
| 2 | Standard deviation with respect to cluster mean |
| 3 | Standard deviation with respect to cluster mean, normalized |
| $4-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |

```
Code table 4.8 - Clustering method
Code figure Meaning
    0 Anomaly correlation
    1 Root mean square
    2-191 Reserved
192-254 Reserved for local use
    255 Missing
Code table 4.9 - Probability type
Code figure
    Meaning
    0 Probability of event below lower limit
    1 Probability of event above upper limit
    2 Probability of event between lower and upper limits (the range includes the lower limit but
        not the upper limit)
    3 Probability of event above lower limit
    4 Probability of event below upper limit
    5-191 Reserved
    192-254 Reserved for local use
    255 Missing
Code table 4.10 - Type of statistical processing
Code figure
                            Meaning
    O Average
    1 Accumulation
    2 Maximum
    3 Minimum
    4 Difference (value at the end of time range minus value at the beginning)
    5 Root mean square
    6 Standard deviation
    7 Covariance (temporal variance)
    8 Difference (value at the start of time range minus value at the end)
    9 Ratio
10-191 Resemed
192-254 Reserved for local use
    255 Missing
```


## Code table 4.11 - Type of time intervals

| Code figure | Meaning |
| :---: | :---: |
| 0 | Reserved |
| 1 | Successive times processed have same forecast time, start time of forecast is incremented |
| 2 | Successive times processed have same start time of forecast, forec ast time is incremented |
| 3 | Successive times processed have start time of forecast incremented and forecast time decremented so that valid time remains constant |
| 4 | Successive times processed have start time of forecast decremented and forecast time incremented so that valid time remains constant |
| 5 | Floating subinterval of time between forecast time and end of overall time interval |
| 6-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |

Note: Code figure 5 applies to instances where a single time subinterval was used to calculate the statistically-processed field. The exact starting and ending times of the subinterval are not given, but it is known that it is contained inclusively between the beginning time and the ending time of the overall interval.

Code table 4.12 - Operating mode

| Code figure | $\quad$ Meaning |
| :---: | :--- |
| 0 | Maintenance mode |
| 1 | Clear air |
| 2 | Precipitation |
| 3-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |

## Code table 4.13 - Quality control indicator

| Code figure | Meaning |
| :---: | :--- |
| 0 | No quality control applied |
| 1 | Quality control applied |
| 2-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |

## Code table 4.14 - Clutter filter indicator

| Code figure | $\quad$ Meaning |
| :---: | :--- |
| 0 | No clutter filter used |
| 1 | Clutter filter used |
| $2-191$ | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |


| Code table $4.201-$ Precipitation type |  |
| :---: | :--- |
| Code figure | $\quad$ Meaning |
| 0 | Reserved |
| 1 | Rain |
| 2 | Thunderstorm |
| 3 | Freezing rain |
| 4 | Mixed/ice |
| 5 | Snow |
| $6-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |

Code table 4.202 - Precipitable water category
Code figure Meaning
0-191 Reserved
192-254 Reserved for local use
255 Missing
Code table 4.203 - Cloud type
Code figure

0
1
2
3
4
5
6
7
8
C irrocumulus

Cumulonimbus - ground-based fog beneath the lowest layer
Stratus - ground-based fog beneath the lowest layer
Stratocumulus - ground-based fog beneath the lowest layer
Cumulus - ground-based fog beneath the lowest layer
Altostratus - ground-based fog beneath the lowest layer
Nimbostratus - ground-based fog beneath the lowest layer
Altocumulus - ground-based fog beneath the lowest layer
Cirrostratus - ground-based fog beneath the lowest layer
Cirrocumulus - ground-based fog beneath the lowest layer
Cirrus - ground-based fog beneath the lowest layer
Reserved
Unknown
Reserved for local use
Missing

N o te: Code figures 11-20 indicate all four layers were used and ground-based fog is beneath the lowest layer.

| Code table $4.204-$ Thunderstorm coverage |  |
| :---: | :--- |
| Code figure | Meaning |
| 0 | None |
| 1 | Isolated (1-2\%) |
| 2 | Few (3-5\%) |
| 3 | Scattered (16-45\%) |
| 4 | Numerous (>45\%) |
| $5-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |


| Code table 4.205 - Aerosol type |  |
| :---: | :---: |
| Code figure | Meaning |
| 0 | Aerosol not present |
| 1 | Aerosol present |
| $2-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |

Code table 4.206 - Volcanic ash

| Code figure | $\quad$ Meaning |
| :---: | :--- |
| 0 | Not present |
| 1 | Present |
| 2-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |


| Code table 4.207 - Icing |  |
| :---: | :--- |
| Code figure | $\quad$ Meaning |
| 0 | None |
| 1 | Light |
| 2 | Moderate |
| 3 | Severe |
| $4-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |


| Code table 4.208 - Turbulence |  |
| :---: | :---: |
| Code figure | Meaning |
| 0 | None (smooth) |
| 1 | Light |
| 2 | Moderate |
| 3 | Severe |
| 4 | Extreme |
| 5-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |
| Code table 4.209 - Planetary boundary-layer regime |  |
| Code figure | Meaning |
| 0 | Reserved |
| 1 | Stable |
| 2 | Mechanically-driven turbulence |
| 3 | Forced convection |
| 4 | Free convection |
| 5-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |
| Code table 4.210 - Contrail intensity |  |
| Code figure | Meaning |
| 0 | Contrail not present |
| 1 | Contrail present |
| 2-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |
| Code table 4.211 - Contrail engine type |  |
| Code figure | Meaning |
| 0 | Low bypass |
| 1 | High bypass |
| 2 | Non-bypass |
| 3-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |

## Code table 4.212 - Land use

| Code figure | $\quad$ Meaning |
| :---: | :--- |
| 0 | Reserved |
| 1 | Urban land |
| 2 | Agriculture |
| 3 | Range land |
| 4 | Deciduous forest |
| 5 | Coniferous forest |
| 6 | Forest/wetland |
| 7 | Water |
| 8 | Wetlands |
| 9 | Desert |
| 10 | Tundra |
| 11 | Ice |
| 12 | Tropical forest |
| 13 | Savannah |
| $14-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |

## Code table 4.213 - Soil type

Code figure
Meaning
0
Reserved
1 Sand
2 Loamy sand
3 Sandy loam
4 Silt loam
5 Organic (redefined)
6 Sandy clay loam
7 Silt clay loam
8 Clay loam
9 Sandy clay
10 Silty clay
11 Clay
12-191 Reserved
192-254 Reserved for local use
255
Missing

| Code figure | Meaning |
| :---: | :---: |
| 0-49 | Reserved |
| 50 | No-snow/no-cloud |
| 51-99 | Reserved |
| 100 | Clouds |
| 101-249 | Reserved |
| 250 | Snow |
| 251-254 | Reserved for local use |
| 255 | Missing |
| Code table 4.216-Elevation of snow-covered terrain |  |
| Code figure | Meaning |
| 0-90 | Elevation in increments of 100 m |
| 91-253 | Reserved |
| 254 | Clouds |
| 255 | Missing |
| Code table 4.220 - Horizontal dimension processed |  |
| Code figure | Meaning |
| 0 | Latitude |
| 1 | Longitude |
| 2-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |
| Code table 4.221 - Treatment of missing data |  |
| Code figure | Meaning |
| 0 | Not included |
| 1 | Extrapolated |
| 2-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |

## CODE TABLES USED IN SECTION 5

Code table 5.0 - Data representation template number

## Code figure

Meaning
$0 \quad$ Grid point data - simple packing
1 Matrix value at grid point - simple packing
2 Grid point data - complex packing
3 Grid point data - complex packing and spatial differencing
4-49 Reserved
50 Spectral data - simple packing
51 Spherical harmonics data - complex packing
52-191 Reserved
192-254 Reserved for local use
255

Missing

Code table 5.1 - Type of original field values

| Code figure | $\quad$ Meaning |
| :---: | :--- |
| 0 | Floating point |
| 1 | Integer |
| 2-191 | Reserved |
| 192-254 | Reserved for local use |
| 255 | Missing |

Code table 5.2 - Matrix coordinate value function definition

Code figure
Meaning
0 Explicit coordinate values set
1 Linear coordinates

$$
f(1)=C 1
$$

$$
f(n)=f(n-1)+C 2
$$

2-10 Reserved
11 Geometric coordinates

$$
\begin{aligned}
& f(1)=C 1 \\
& f(n)=C 2 \times f(n-1)
\end{aligned}
$$

12-191 Reserved
192-254 Reserved for local use
255

Code table 5.3 - Matrix coordinate parameter

| Code figure | Meaning |
| :---: | :--- |
| 1 | Direction degrees true |
| 2 | Frequency $\left(s^{-1}\right)$ |
| 3 | Radial number (2pi/lambda) $\left(\mathrm{m}^{-1}\right)$ |
| $4-191$ | Reserved |
| $192-254$ | Reserved for local use |
| 255 | Missing |

```
Code table 5.4 - Group splitting method
Code figure
    Meaning
    0 Row by row splitting
    1 General group splitting
    2-191 Reserved
192-254 Reserved for local use
    255
    Missing
```

Code table 5.5 - Missing value management for complex packing

Code figure
Meaning
$0 \quad$ No explicit missing values included within data values
$1 \quad$ Primary missing values included within data values
2 Primary and secondary missing values included within data values
3-191 Reserved
192-254 Reserved for local use 255

Missing

Code table 5.6 - Order of spatial differencing

Code figure
Meaning
0 Reserved
1 First-order spatial differencing
2 Second-order spatial differencing
3-191 Reserved
192-254 Reserved for local use
255

Missing

Code table 5.7 - Precision of floating-point numbers
Code figure
Meaning
0 Reserved
1 IEEE 32-bit (I=4 in Section 7)
2 IEEE 64-bit (I=8 in Section 7)
3
IEEE 128-bit (I=16 in Section 7)
4-254 Reserved
255 Missing

## CODE TABLE USED IN SECTION 6

Code table 6.0 - Bit map indicator

Code figure
Meaning
0 A bit map applies to this product and is specified in this Section
1-253 A bit map pre-determined by the originating/generating Centre applies to this product and is not specified in this Section
A bit map defined previously in the same "GRIB" message applies to this product
A bit map does not apply to this product

## ATTACHMENT

## DEFINITION OF A TRIANGULAR GRID BASED ON AN ICOSAHEDRON

A triangular grid based on an icosahedron was first introduced in a meteorological model by Sadourny, et al. (1968) and Williamson (1969). The approach outlined here, especially the code implementation, is based on the work of Baumgardner (1995).

To construct the triangular grid based on an icosahedron, the unit-sphere, i.e. a sphere with radius 1 , is divided into 20 spherical triangles of equal size by placing a plane icosahedron into the sphere (Figure 1). The 12 vertices of the icosahedron touch the sphere, one vertex coincides with the north pole (NP), the opposite one with the south pole (SP), for simplicity.

The 12 vertices are connected by great circles to form 20 main spherical triangles. Since each of the 12 vertices is surrounded by five main spherical triangles (Figure 2), the angles between two sides of the main triangles are $2 \pi / 5$ or $72^{\circ}$.


Figure 1 - Plane icosahedron consisting of 20 plane triangles.


Figure 2 - The five main spherical triangles at the north pole

## ATTACHMENT



Figure 3 - One main spherical triangle at the north pole.
The length $w$ of a main triangle side follows from Figure 3 and equation (1):

$$
\begin{equation*}
\cos \frac{1}{2} \mathrm{w}=\frac{\cos \frac{\pi}{5}}{\sin 2 \frac{\pi}{5}}=\frac{1}{2 \sin \frac{\pi}{5}} \tag{1}
\end{equation*}
$$

Thus $w \approx 1.107$ 149. On the unit-sphere, $w$ is identical to $\pi / 2 \operatorname{minus} \varphi$ with the latitude $\varphi$ of the lower corner of the triangle. Thus $w$ is a measure of the latitude of the lower vertices of the triangle in Figure 3.

Two adjacent main spherical triangles are combined to form a "diamond", i.e. a logical square block. Five of the diamonds originate from the north pole and five from the south pole. The numbering and order of the diamonds are outlined in Figure 4.


Figure 4 - The 20 main spherical triangles combined to 10 diamonds.

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Diamonds 1 to 5 are the "northern" ones, i.e. they start at the north pole, while diamonds 6 to 10 start at the south pole. The so-called home vertex of each diamond (in the order $1,6,2,7,3,8,4,9,5,10$ ) is shifted by $\pi / 5$ to the east starting at $-\pi / 5$ for the first diamond. Thus the 10 home vertices have the geographical coordinates ( $\lambda$ and $\varphi$ ) on the unit-sphere as presented in Table 1.

Table 1
Geographical coordinates ( $\lambda$ and $\varphi$ ) of the home vertices of the 10 diamonds

| Diamond \# | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $\lambda$ | $-\pi / 5$ | $\pi / 5$ | $3 \pi / 5$ | $5 \pi / 5$ | $-3 \pi / 5$ | 0 | $2 \pi / 5$ | $4 \pi / 5$ | $-4 \pi / 5$ | $-2 \pi / 5$ |
| $\varphi$ | $\pi / 2-w$ | $\pi / 2-w$ | $\pi / 2-w$ | $\pi / 2-w$ | $\pi / 2-w$ | $w-\pi / 2$ | $w-\pi / 2$ | $w-\pi / 2$ | $w-\pi / 2$ | $w-\pi / 2$ |

A Cartesian coordinate system is placed into the unit-sphere with the origin in the centre of the sphere, the $z$-axis towards the north pole and the $x$-axis in the direction of the Greenwich meridian. The Cartesian coordinates ( $x, y, z$ ) of a point on the unit-sphere follow from equation (2):

$$
\begin{gathered}
x=\cos \lambda \cos \varphi=\cos \lambda \sin w \\
y=\sin \lambda \cos \varphi=\sin \lambda \sin w \\
z=\sin \varphi=\cos w
\end{gathered}
$$

Thus the two pole vertices have the Cartesian coordinates $(0,0,1)$ and $(0,0,-1)$, respectively.
The geographical coordinates $(\lambda, \varphi)$ of a point on the unit-sphere with the Cartesian coordinates ( $x, y, z$ ) follow from equation (3) which may be derived from equation (2):

$$
\begin{equation*}
\lambda=\arctan \frac{y}{x} \tag{3}
\end{equation*}
$$

For the grid generation, the sides $(w)$ of the 20 main triangles are iteratively subdivided into ni equal parts to form sub-triangles. Each point in a main triangle is now surrounded by six triangles (Figure 5) and is, therefore, in the centre of a hexagon (see also Figure 6). However, the points which form the vertices of the icosahedron


Figure 5 - Spherical triangular grids for different values ni of the subdivision of the main spherical triangles.


Figure 6 - Polygons which represent the area of representativeness of a triangular grid-point.
are surrounded by only five triangles and therefore these 12 special points are the centres of pentagons. For the first subdivision, w may be divided into three parts, later on, only bisections are allowed. This restriction is due to the use of a multi-grid (MG) solver for the Helmholtz equations in the semi-implicit time stepping. MG solvers work efficiently with such mesh refinements. Thus the number (ni) of subdivisions of $w$ is factorized according to equation (4):

$$
\begin{equation*}
n i=3^{n 3} 2^{n 2} \tag{4}
\end{equation*}
$$

with $n 3=0$ or 1 and $n 2 \geq 0$. Figure 5 shows the resulting grids for $n i=1,2,4$ and 8 , i.e. $n 2=0,1,2,3$ with $n 3=0$.
The model grid-points (nodes) are located at the vertices of the triangles; thus there are (ni+1) ${ }^{2}$ grid-points within one diamond. Of these $(n i+1)^{2}$ grid-points, $n i \times n i$ are "uniquely" identified with each diamond; one extra row and column is shared between neighbouring diamonds.

On Earth with a mean radius $R_{E}=6371229 \mathrm{~m}$, the length ( L ) of a side of a main triangle is $L=W R_{E}=7053898 \mathrm{~m}$. The mesh size $(\Delta)$ of the triangular grid with ni equal intervals on the side of a main triangle is not constant within a diamond but varies by 20 per cent at most on the sphere and is approximately given by using equation (5). For example, for ni $=32, \Delta$ varies between 220 and 263 km , for $\mathrm{ni}=64, \Delta$ varies between 110 and 132 km and for $\mathrm{ni}=128, \Delta$ varies between 55 and 66 km :

$$
\begin{equation*}
\Delta \approx \frac{\mathrm{w} \mathrm{R}_{\mathrm{E}}}{\mathrm{ni}} \tag{5}
\end{equation*}
$$

The number $N$ of grid-points, not counting the common edges of the diamond, is given by equation (6):

$$
\begin{equation*}
N=10 n i^{2}+2 \tag{6}
\end{equation*}
$$

Table 2a gives the mesh size , the number ( N ) of grid-points and the time step ( $\Delta \mathrm{t}$ ) for different values of ni , if only bisections are performed, i.e. $n i=2^{n 2}$. The time step $(\Delta t)$ is calculated under the assumption that an air parcel does not leave the region of the six surrounding triangles during the period of twice the time step, i.e. $2 \Delta t<h / v_{\text {Max }}$, with the height $(h)$ of the spherical triangle (which is the shortest distance for leaving a triangle) and $v_{\text {Max }}$, the maximum wind speed ( $\approx 125 \mathrm{~m} \mathrm{~s}^{-1}$ ) assuming that the fast gravity waves are treated semi-implicitly. The height $(h)$ of a spherical triangle approximately follows from equation (7) and is about 5 per cent smaller than the mesh size ( $\Delta$ ):

$$
\begin{equation*}
h \approx \arcsin \left(\sin \frac{w}{n i} \sin \frac{2 \pi}{5}\right) R_{E} \tag{7}
\end{equation*}
$$

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Table 2a
Mesh size ( $\Delta$ ), height (h), number ( N ) of grid-points and time step ( $\Delta \mathrm{t}$ ) for the spherical triangular mesh using only bisections

| ni | 16 | 32 | 64 | 128 | 256 |
| :--- | ---: | ---: | ---: | ---: | ---: |
| $\Delta(\mathrm{~km})$ | 441 | 220 | 110 | 55 | 28 |
| $\mathrm{~h}(\mathrm{~km})$ | 420 | 210 | 105 | 52 | 26 |
| N | 2562 | 10242 | 40962 | 163842 | 655362 |
| $\Delta \mathrm{t}(\mathrm{s})$ | 1600 | 800 | 400 | 200 | 100 |

Table 2b
Mesh size ( $\Delta$ ), height ( h ), number ( N ) of grid-points and time step ( $\Delta \mathrm{t}$ ) for the spherical triangular mesh using first a trisection followed by bisections

| ni | 12 | 24 | 48 | 96 | 192 |
| :--- | ---: | ---: | ---: | ---: | ---: |
| $\Delta(\mathrm{~km})$ | 588 | 294 | 147 | 73 | 37 |
| $\mathrm{~h}(\mathrm{~km})$ | 559 | 279 | 140 | 69 | 35 |
| N | 1442 | 5762 | 23042 | 92162 | 368642 |
| $\Delta \mathrm{t}(\mathrm{s})$ | 2200 | 1100 | 550 | 275 | 138 |

Each grid-point is representative for a spherical polygon with six vertices (Figure 6) except the 12 vertices of the icosahedron which are surrounded by five triangles only. The grid-point indices are defined as presented in Figure 7.

The start address $(0,1)$ reflects the philosophy that the $\mathrm{ni} \times$ ni grid-points which are "uniquely" identified within each diamond have the indices 1 to ni for rows and columns. The extra row and column needed for communication between neighbouring diamonds is lying in one case at the beginning of the first coordinate and in the other case at the end of the second. Thus points outside the range ( $1: \mathrm{ni}, 1: \mathrm{ni}$ ) belong to the neighbouring diamonds and have to be communicated during each time step. Grid-point ( 0,1 ), respectively, is the north pole for diamonds 1 to 5 , and the south pole for diamonds 6 to 10 .

The calculation of the subdivision of the great circle between two points $P_{1}$ (with location vector $x_{1}$ ) and $P_{2}$ (with location vector $x_{2}$ ) can be derived from Figure 8.

Since $x_{1}$ and $x_{2}$ define the great circle plane through $P_{1}$ and $P_{2}$, all points $(P)$ with the location vector $(x)$ on the great circle may be written as a linear combination of $x_{1}$ and $x_{2}$ :

$$
\begin{equation*}
x=\alpha x_{1}+\beta x_{2} \tag{8}
\end{equation*}
$$



Figure 7 - Grid-point indices for a northern (left) and southern (right) diamond.


Figure 8 - Calculation of the subdivision of the great circle through the points $P_{1}$ and $P_{2}$ on the unit-sphere.
The coefficients $\alpha$ and $\beta$ are derived from the condition that x is a vector on the unit-sphere and the angle between x and $\mathrm{x}_{1}$ is given by $\gamma \vartheta$ with $\gamma$ between 0 and 1 and $\vartheta$ being the angle between $\mathrm{x}_{1}$ and $\mathrm{x}_{2}$, i.e. the length of the great circle between $P_{1}$ and $P_{2}$ :

$$
\begin{align*}
& x \mathrm{xx}=1=\alpha^{2}+\beta^{2}+2 \alpha \beta \cos \vartheta \\
& \mathrm{xx} \mathrm{x}_{1}=\cos (\gamma \vartheta)=\alpha+\beta \cos \vartheta \tag{9}
\end{align*}
$$

Substituting $\alpha$ from the second equation into the first one, the coefficients follow from equation (10):

$$
\begin{gather*}
\alpha=\frac{\sin ((1-\gamma) \vartheta)}{\sin \vartheta}  \tag{10}\\
\beta=\frac{\sin (\gamma \vartheta)}{\sin \vartheta}
\end{gather*}
$$

The angle $\vartheta$ between $x_{1}$ and $x_{2}$ follows from the scalar product $x_{1} \times x_{2}$ or by calculating the distance (d) between $\mathrm{x}_{1}$ and $\mathrm{x}_{2}$ and observing that $\sin \vartheta / 2=\mathrm{d} / 2$.

The grid-point coordinates ( $x, y, z$ ) of all triangle vertices on the unit-sphere are derived from equation (8) using the coefficients of equation (10). The (ni +1$)^{2}$ grid-points in a diamond form the vertices of 2 ni 2 triangles (Figure 9) and half of those point northward and half southward.

To calculate the coordinates $\left(x_{c}, y_{c}, z_{c}\right)$ of the triangle centres $P_{c}$, the coordinates of the three triangle vertices $P_{1}, P_{2}$ and $P_{3}$ are summed and normalized as in equation (11):

$$
\begin{gather*}
x_{c}=\left(x_{1}+x_{2}+x_{3}\right) x_{N} \\
y_{c}=\left(y_{1}+y_{2}+y_{3}\right) x_{N} \\
z_{c}=\left(z_{1}+z_{2}+z_{3}\right) x_{N}  \tag{11}\\
\quad \text { with }
\end{gather*}
$$

$$
x_{N}=\frac{1}{\sqrt{\left(x_{1}+x_{2}+x_{3}\right)^{2}+\left(y_{1}+y_{2}+y_{3}\right)^{2}+\left(z_{1}+z_{2}+z_{3}\right)^{2}}}
$$

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Figure $9-$ The 2 ni $^{2}$ triangles in a diamond defined by the $(n i+1)^{2}$ vertices for $n i=4$.
The area of the $2 \mathrm{ni}^{2}$ triangles in a diamond can be calculated by using equation (12) which is due to Huilier. The triangle sides are denoted by $a, b$ and $c$. On the unit-sphere, the excess angle is equal to the area of the spherical triangle:

$$
\begin{equation*}
\tan \frac{\varepsilon}{4}=\sqrt{\tan \frac{\mathrm{s}}{2} \tan \frac{\mathrm{~s}-\mathrm{a}}{2} \tan \frac{\mathrm{~s}-\mathrm{b}}{2} \tan \frac{\mathrm{~s}-\mathrm{c}}{2}} \tag{12}
\end{equation*}
$$

with:

$$
s=\frac{1}{2}(a+b+c)
$$

Since each grid-point is surrounded by six triangles (five triangles at the 12 special points), the grid-point is the centre of a hexagon (pentagon at the 12 special points) as is illustrated in Figure 10. The coordinates of


Figure 10 - Hexagon connected to a grid-point of the triangular mesh.
the vertices of the hexagon, i.e. points $Q_{1}, Q_{2}, \ldots, Q_{6}$, are in a good approximation given by averaging the Cartesian coordinates of the three surrounding triangles vertices and normalizing to unit length, thus they follow from equation (11).

The grid-point in the centre of the hexagon is denoted by 0 , the six surrounding triangles (and their vertices) by 1 to 6 counting counter-clockwise. We define point $Q_{i}$, i.e. a vertex of the hexagon, equidistant from the three vertices $P_{0}, P_{i}$, and $P_{i+1}$ such that $Q_{i}$ and $Q_{i+1}$ is the perpendicular bisection of the great circle $P_{0} P_{i+1}$ (Figure 10). The coordinates of $Q_{i}$ are needed for the calculation of the topographical fields like orography, land fraction, roughness length as mean values over the area of the hexagons. Here, high-resolution datasets are averaged over the hexagon area.

## FM 94-XII BUFR <br> Binary universal form for the representation of meteorological I data

## REPRESENTATION FORM:

| SECTION 0 | Indicator section |
| :--- | :--- |
| SECTION 1 | Identific ation section |
| SECTION 2 | ( Optional section |
| SECTION 3 | Data description section |
| SECTION 4 | Data section |
| SECTION 5 | $\mathbf{7 7 7 7}$ |

## NOTES:

(1) BUFR is the name of a binary code for the exchange and storage of data.
(2) The BUFR message consists of a continuous bit-stream made of a sequence of octets ( 1 octet $=8$ bits).
(3) The terms "BUFR message" and "section" describe logical entities to assist BUFR definition.
(4) A BUFR message consists of one or more subsets of related meteorological data defined, described and represented by a single BUFR entity. For observational data, each data subset usually corresponds to one observation
(5) The octets of a BUFR message are grouped in sections:

| Section <br> number | Name | Contents |
| :---: | :--- | :--- |
| 0 | Indicator section | "BUFR", length of message, BUFR edition number |
| 1 | Identification section | Length of section, identific ation of the message <br> 2 |
| Optional section | Length of section and additional items for local use by automatic data <br> processing centres <br> Length of section, number of data subsets, data category flag, data <br> compression flag and a collection of descriptors which define the <br> form and content of individual data elements |  |
| 3 | Data description section | Length of section and binary data |
| 4 | Data section | 7777 |

(6) It will be noted that the BUFR representation is not suitable for visual data recognition without computer interpretation.
(7) The representation of data by means of a series of bits is independent of any particular machine representation.
(8) Message and section lengths are expressed in octets. Section 0 has a fixed length of 8 octets; Section 5 has a fixed length of 4 octets. Sections $1,2,3$ and 4 have a variable length which is included in the first three octets of each section.
(9) In the BUFR message, the bit length for "International Alphabet No. 5 " is regarded as 8 -bit, adding one bit " 0 " to the 7 -bit of IA5 as the most significant bit.

| 94.1 | General |
| :---: | :---: |
| 94.1.1 | The BUFR form shall be used for the binary representation of meteorological data for exchange and storage. BUFR is partic ularly suitable for meteorological data that cannot be represented using FM 92 GRIB. |
| 94.1.2 | The beginning and the end of the code form shall be identified by 4 octets coded according to the International Alphabet No. 5 to represent, respectively, the indicators BUFR and 7777 in Indicator section 0 and End section 5. All other octets included in the code shall represent data in binary form. |
| 94.1.3 | Each section included in the code form shall always contain an even number of octets. This rule shall be applied by appending bits set to zero to the section where necessary. |
| 94.1.4 | By convention, reserved values in Sections 1 to 4 shall be set to zero. |
| 94.1.5 | Missing values shall be set to fields of all ones (e.g. each octet shall be set to 11111111 binary). This shall apply to code tables as well as data elements; flag tables shall be augmented to contain a missing indicator bit where this is deemed to be necessary. This regulation does not apply to the data description operator qualifiers in Class 31 of Table $\mathbf{B}$. |
| 94.1.6 | The convention for representing missing data for compressed data within the binary Data section shall be to set the corresponding increments to fields of all ones. |
| 94.1.7 | When a local reference value for a set of element values for compressed data is represented as all ones, this shall imply that all values in the set are missing. |
| 94.2 | Section 0 - Indicator section |
|  | Section 0 shall be 8 octets long. Octets 1 to 4 shall be character coded according to the International Alphabet No. 5 as BUFR. The remainder of the section shall contain the length of the entire BUFR message (including the Indicator section) expressed in binary form over octets 5 to $\mathbf{7}$ (i.e. 24 bits), followed by the BUFR edition number, in binary, in octet 8 . |
| 94.3 | Section 1 - Identification section |
| 94.3.1 | The length of the section, in units of octets, shall be expressed in binary form over the group of the first three octets of the section. |
| 94.3.2 | Octet 8 of the section shall be used to indicate the inclusion or the omission of Section 2. |
| 94.4 | Section 2 - Optional section |
| 94.4.1 | Regulation 94.3 .1 shall apply. |
| 94.4.2 | Octet 5 and subsequent octets shall contain additional items as may be defined within each centre for its own use. |
| 94.5 | Section 3 - Data description section |
| 94.5.1 | Regulation 94.3.1 shall apply. |

Data description syntax for BUFR
94.5.3.1 Data description shall consist of one or more descriptors. Each descriptor shall occupy 2 octets and contain 3 parts: F (2 bits), X ( 6 bits) and Y ( 8 bits).
94.5.3.2 If $\mathrm{F}=0$, the descriptor shall be called an "element descriptor". An element descriptor shall define a single data item by reference to Table $B$.

## NOTES:

(1) X denotes the Table $\mathbf{B}$ class, Y denotes the element within that class. The corresponding data item is depicted according to the definition contained in Table B, unless otherwise modified.
(2) The definition(s) of one or more data item(s) may be modified by means of data description operators.

Element descriptors corresponding to the following classes in Table B shall remain in effect until superseded by redefinition:

| Class |  |
| :---: | :--- |
| 01 | Identification |
| 02 | Instrumentation |
| 03 | Reserved |
| 04 | Location (time) |
| 05 | Location (horizontal - 1) |
| 06 | Location (horizontal - 2) |
| 07 | Location (vertical) |
| 08 | Significance qualifiers |
| 09 | Reserved |

N OTE: Redefinition is effected by the occurrence of element descriptors which contradict the preceding element descriptors from these classes. If two or more elements from the same class do not contradict one another, they all apply.
94.5.3.5 The definition of line, areas, volumes and more complex time attributes shall be accomplished using descriptors from class 04 to 07 in association with suitable descriptors from class 08.
94.5.3.6 The consecutive occurrence of two or more non-identical element descriptors from classes 04 to 07 inclusive shall infer that all such elements remain in effect until redefined, unless such elements define an increment.
94.5.3.7 Data items defined by element descriptors in class 10 or above shall not behave as coordinates with respect to subsequent data.

Any occurrence of an element descriptor from classes 04 to 07 inclusive which defines an increment shall indicate that the location corresponding to that class be incremented by the corresponding data value.

If a BUFR message is made up of more than one subset, each subset shall be treated as though it was the first subset encountered.

## The replication operation

If $\mathbf{F}=1$, the descriptor shall be called a "replication descriptor". For this case, $X$ shall indicate the number of descriptors to be repeated, and $Y$ the total number of occurrences (replications) of the repeated subsequence.
A value of $\mathbf{Y}=\mathbf{0}$ associated with the replication descriptor shall indicate delayed replication. In this case, the replication data description operator shall be completed by the next element descriptor, which shall define a data item indicating the number of replications. This descriptor may also indicate (by its value of $Y$ ) that the following datum is to be replicated together with the following descriptor.
Time or location increment descriptors, from classes 04 to 07 inclusive, may be associated with replication descriptors in the following way: when an increment descriptor immediately precedes a replication descriptor, or is separated from it by one or more operator descriptors from Table $\mathbf{C}$, this shall infer that all such increments be applied for each replication; the application of the increments shall have effect from the beginning of each defined replication, including the first.

Further operations on element and sequence descriptors
If $\mathbf{F}=\mathbf{2}$, the descriptor shall be called an "operator descriptor". An operator descriptor shall define an operation by reference to Table $C$.

## NOTES:

(1) X denotes the value corresponding to an operator defined within Table $\mathbf{C}$.
(2) $Y$ contains a value to be used as an operand in completing the defined operation.

When the $Y$ operand of any operator descriptor, or a count associated with it, refers to a specific number of descriptors preceding the operator, this shall infer that those preceding descriptors are all from Table B or C, i.e. all references to Table D descriptors shall have been completely resolved. Any forward reference to descriptors shall infer that the descriptors are enumerated as they are found in the original record, i.e. Table D descriptors are not expanded.

A data present bit-map shall be defined as a set of $\mathbf{N}$ one bit values corresponding to $\mathbf{N}$ data entities described by N element descriptors (including element descriptors for delayed replication, if present); the data description of a data present bit-map is comprised of a replication operator followed by the element descriptor for the data present indicator.

## NOTES:

(1) Where an operator descriptor requires a data present bit-map of length N to complete the operator definition, the $\mathbf{N}$ consecutive element descriptors which correspond to the $\mathbf{N}$ data entities to which the $N$ bit values refer shall end with the element descriptor which immediately precedes the first such operator, or with the element descriptor which immediately precedes the first occurrence of such an operator following the occurrence of a cancel backward reference operator.
(2) All references to previously defined element descriptors effected through the application of operators which are qualified by data present bit-maps shall refer to the element descriptors concerned including any modifications resulting from change data width, change reference value, and change scale factor.
(3) The define data present bit-map for re-use operator enables a data present bit-map to be defined and later re-used; the definition of a data present bit-map shall remain defined until the occurrence of a cancel defined data present bit-map operator or a cancel backward data reference operator.
(4) Where an operator descriptor is qualified by a data present bit-map of length $\mathbf{N}$ there shall be defined a number of values of the type indicated by that operator together with subsequent appropriate element descriptors; the number of values defined shall correspond to the number of bits set to zero in the data present bit-map; the description of each data item shall be obtained by substituting the appropriate element descriptors, modified by the operator, at each subsequent occurrence of a marker operator.

Indirect reference to descriptors
If $\mathbf{F}=3$, the descriptor shall be called a "sequence descriptor". A sequence descriptor shall define a list of element descriptors, replication descriptors, operator descriptors and/or sequence descriptors by reference to Table $D$.

N O T E: X denotes the Table D category, Y denotes the entry whithin the category. Table D entries contain lists of commonly associated descriptors for convenience.

A sequence descriptor shall be equivalent to the corresponding list of descriptors in Table $\mathbf{D}$.
Section 4 - Data section
Regulation 94.3.1 shall apply.
Reported values shall be coded using the number of bits for each parameter indicated by reference to the sequence descriptors, replication descriptors, operator descriptors, element descriptors and associated tables.

Values shall be coded in the order indicated by the sequence descriptors, replication descriptors, operator descriptors and element descriptors.

## NOTES:

(1) Where more than one data subset is included in a single BUFR message without data compression:
(i) The first set of data values shall be in the order defined by the data description, and shall represent the first data subset;
(ii) Subsequent sets of data values shall also be in the order defined by the data description, representing subsequent data subsets.
(2) Where more than one data subset is included in a single BUFR message, data compression may be used as follows:
(i) Values for each data element are grouped into sets, and the sets shall be in the order defined by the data description; the first value in each set shall represent a minimum value for the set; for character data the first value in the set shall be set to all bits zero; however, if the character data values in all subsets are identical, the first value shall represent the character string; this value is termed a "local reference value", $\mathrm{R}^{0}$, with respect to the subsequent set of data;
(ii) Local reference values shall be coded according to Regulation 94.6.2;
(iii) If all values of an element are missing, $R^{0}$ shall be coded with all bits set to $1 \mathbf{s}$;
(iv) The local reference value shall be followed by a 6-bit quantity specifying the number of bits for each increment or for character data, specifying the number of octets representing the character string. However, if the character data values in all subsets are identical, sub-note (vii) shall apply;
(v) Actual values, V , will then be obtained as:

$$
\mathbf{V}=\mathbf{R}+\mathbf{R}^{\mathbf{0}}+\mathrm{I}
$$

where $R=$ table reference value
$R^{0}=$ local reference value
I = increment;
(vi) Missing values will be denoted by setting all bits of the corresponding I to $1 \mathbf{s}$;
(vii) Data elements all having the same value throughout a set shall be signified by coding the number of bits required for storing I as zero; in such cases, the increments shall be omitted;
(viii) When operators qualified by a data present bit-map are present, it is required that the length and contents of the bit-map shall be identical for each data subset if data compression is to be used.

Section 5 - End section
The End section shall always be 4 octets long, character coded according to the International Alphabet No. 5 as 7777.

## SPECIFICATIONS OF OCTET CONTENTS

## Notes:

(1) Octets are numbered $1,2,3$, etc., starting at the beginning of each section.
(2) In the following, bit positions within octets are referred to as bit 1 to bit 8 , where bit 1 is the most significant and bit 8 is the least significant bit. Thus, an octet with only bit 8 set to 1 would have the integer value 1.

Section 0 - Indicator section

| Octet No. | Contents |
| :---: | :--- |
| $1-4$ | BUFR (coded according to the CCITT International Alphabet No. 5) |
| $5-7$ | Total length of BUFR message (including Section 0 ) |
| 8 | BUFR edition number (currently 3 ) |

Section 1 - Identification section

Octet No.
1-3 Length of section

I 11 Version number of master table used (currently 10 for WMO FM 94 BUFR tables - see Note (2))
Version number of local tables used to augment the master table in use - see Note (2)
13 Year of century
14
15
Month
Day Hour Minute Reserved for local use by ADP centres

Notes:
(1) If a BUFR message is corrected, the corrected message shall be represented in full with the update sequence number incremented by one. Operator 204 Y qualified by descriptor 031021 may be used to indicate which value or values were corrected.
(2) BUFR master tables may be defined for scientific disciplines other than meteorology - such other disciplines shall be indicated by non-zero numeric values in octet 4 . Values are to be developed.
Each revision of the master tables shall be given a new version number. Local tables shall define those parts of the master table which are reserved for local use, thus version numbers of local tables may be changed at will by the originating centre.
(3) To specify year 2000, octet 13 of the section (Year of the century) shall contain a value equal to $\mathbf{1 0 0}$. To specify year 2001, octet 13 of the section shall contain a value equal to 1 (by international Convention, the date of 1 J anuary 2000 is the first day of the hundredth year of the twentieth century and the date of $\mathbf{1 ~ J}$ anuary 2001 is the first day of the first year of the twenty-first century); it is to be noted also that year 2000 is a leap year and that 29 February 2000 exists.

## Section 2 - Optional section

| Octet No. | Contents |
| :---: | :--- |
| 1-3 | Length of section |
| 4 | Set to zero (reserved) |
| $5-$ | Reserved for local use by ADP centres |

## Section 3 - Data description section

| Octet No. | Contents |  |
| :---: | :--- | :--- |
| $1-3$ |  | Length of section |
| 4 | Set to zero (reserved) |  |
| $5-6$ | Number of data subsets |  |
| 7 | Bit $1=1$ | Observed data |
|  | $=0$ | Other data |
|  | Bit $2=1$ | Compressed data |
|  | $=0$ | Non-compressed data |

8- A collection of element descriptors, replication descriptors, operator descriptors and sequence descriptors, which define the form and contents of individual data elements comprising one data subset in the Data section

Notes:
(1) The collection of descriptors, beginning at octet 8 , is called the "data description".
(2) Each descriptor occupies 2 octets and contains 3 parts:

| $F$ | $X$ |
| :---: | :---: |
| 2 bits | 6 bits |

```
Y
8 bits
```

(3) If $F=0$, the descriptor is an element descriptor. The values of $X$ and $Y$ refer directly to a single entry in Table $B, X$ indicating the class and $Y$ the entry within that class.
(4) If $\mathrm{F}=1$, the descriptor is a replication descriptor defining the replication data description operator according to Regulations 94.5.4.1 and 94.5.4.2. The values of $X$ and $Y$ define the scope of the operator and the number of replications, respectively. If $Y=0$, delayed replication is defined; the next element descriptor will define a data item giving the number of replications; this descriptor may also indicate (by its value of Y ) that the following datum is to be replicated together with the following descriptor.
(5) If $F=2$, the descriptor is an operator descriptor. The value of $X$ indicates an operation in Table $C$. The meaning of $Y$ depends on the operation.
(6) If $F=3$, the descriptor is a sequence descriptor. The values of $X$ and $Y$ refer directly to a single entry in Table D. Each entry in Table D contains a list of element descriptors, data description operators, and/or sequence descriptors. A sequence descriptor is defined to be equivalent to the corresponding list of descriptors at the Table D entry.
(7) "Other data", as identified in octet 7, could, for example, be forecast information generated from a numerical model.

## Section 4 - Data section

Octet No.
Contents

| $1-3$ | Length of Data section (octets) |
| :---: | :--- |
| 4 | Set to zero (reserved) |
| $5-$ | Binary data as defined by sequence descriptors |

Notes:
(1) The binary data in non-compressed form may be described as follows:
$\mathrm{R}_{11}, \mathrm{R}_{12}, \mathrm{R}_{13}, \ldots \mathrm{R}_{1 \mathrm{~s}}$
$R_{21}, R_{22}, R_{23}, \ldots R_{2 s}$
$R_{n 1}, R_{n 2}, R_{n 3}, \ldots R_{n s}$
where $R_{i j}$ is the $j^{\mathrm{t}}$ value of the $\mathrm{ith}^{\text {th }}$ data subset, s is the number of values per data subset, and n is the number of data subsets in the BUFR message; the data subsets each occupy an identical number of bits, unless delayed replication is used, and are not necessarily aligned on octet boundaries.
(2) The binary data in compressed form may be described as follows:
$\mathrm{R}_{1}^{0}$, NBINC $_{1}, \mathrm{I}_{11}, \mathrm{I}_{12}, \ldots \mathrm{I}_{1 n}$
$\mathrm{R}_{2}^{0}, \mathrm{NBINC}_{2}, \mathrm{I}_{21}, \mathrm{I}_{22}, \ldots \mathrm{I}_{2 n}$
$R_{s}^{0}$, NBINC $_{s}, I_{s 1}, I_{s 2}, \ldots I_{s n}$
where $R_{1}^{0}, R_{2}^{0}, \ldots R_{s}^{0}$ are local reference values for the set of values for each data element (number of bits as Table B). NBINC ${ }_{1} \ldots$ NBINC $_{s}$ contain, as 6 -bit quantities, the number of bits occupied by the increments $\left(\mathrm{I}_{11} \ldots \mathrm{I}_{1 n}\right) \ldots\left(\mathrm{I}_{51} \ldots \mathrm{I}_{\mathrm{sn}}\right) . \mathrm{s}$ is the number of data elements per data subset and n is the number of data subsets per BUFR message. If $\mathrm{NBINC}_{\mathbf{1}}=\mathbf{0}$, all values of element I are equal to $\mathbf{R}_{\mathbf{1}}^{\mathbf{0}}$; in such cases, the increments shall be omitted. For character data, NBINC shall contain the number of octets occupied by the character element. However, if the character data in all subsets are identical NBINC $=0$.
(3) Associated fields are treated as separate data items and precede the data;

e.g. | ASSOCIATED FIELDS | DATA |
| :---: | :---: |
| $N$ bits | $M$ bits |

Binary data with associated fields may be described as follows:
$A_{11}, R_{11}, A_{12}, R_{12}, \ldots A_{1 s}, R_{1 s}$
$A_{21}, R_{21}, A_{22}, R_{22}, \ldots A_{2 s}, R_{2 s}$
$A_{n 1}, R_{n 1}, A_{n 2}, R_{n 2}, \ldots A_{n s}, R_{n s}$
where $A_{i j} R_{i j}$ is the $j^{\text {th }}$ combined associated field value and data value of the $i^{\text {th }}$ data subset, $s$ is the number of values per data subset, and n is the number of data subsets in the BUFR message.
(4) Binary data in compressed form with associated fields may be described as follows:
$A_{1}^{0}, \operatorname{NBINC}_{A 1}, I_{A 11}, I_{A 12}, \ldots I_{A 1 n}$
$R_{1}^{0}, N B I N C_{R 1}, I_{R 11}, I_{R 12}, \ldots I_{R 1 n}$
$\mathrm{A}_{\mathrm{s}}^{0}$, NBINC $_{\text {As }}, \mathrm{I}_{\mathrm{As} 1}, \mathrm{I}_{\mathrm{As} 2}, \ldots \mathrm{I}_{\mathrm{Asn}}$
$\mathrm{R}_{\mathrm{s}^{0}}^{0}, \mathrm{NBINC}_{R s}, \mathrm{I}_{\mathrm{Rs} 1}, \mathrm{I}_{\mathrm{Rs} 2}, \ldots \mathrm{I}_{\mathrm{Rsn}}$
where $A_{1}^{0}, R_{1}^{0}, \ldots A_{s}^{0}, R_{s}^{0}$ are local reference values for the set of associated field values and the set of values for each data element.
$R^{0}$ uses bit length from Table B. $A^{0}$ uses bit length from descriptor 204 YYY .

## Section 5 - End section

Octet No. Contents<br>1-4 $\quad 7777$ (coded according to the CCITT International Alphabet No. 5)

## BUFR TABLES, CODE TABLES AND FLAG TABLES

FM 94 BUFR refers to three types of tables: BUFR tables, code tables and flag tables.

## BUFR tables

Tables containing information used to describe, classify and define the contents of a BUFR message are called BUFR tables. Four BUFR tables are defined: Tables $A, B, C$ and $D$. Entry numbering shall be the same in BUFR tables and CREX tables (see definition of FM 95 CREX in Part C, Common Features to Binary and Alphanumeric Codes) for the same entity represented. Table B entries shall be listed in the common BUFR/CREX Table B. Table D common sequences shall not be defined in both BUFR Table D and CREX Table $D$, unless otherwise a conversion between both Tables $D$ is not simple, that is, the conversion is not completed by simple replacement of part " $F$ " of each descriptor. A new BUFR Table $D$ sequence shall be assigned a number not used by any CREX Table $D$ sequence. Similarly, if a CREX Table $D$ sequence is not defined in BUFR Table $D$, it shall be assigned a number not used by any BUFR sequence.

## Code tables and flag tables

BUFR Table B defines some elements by means of code tables or flag tables. Within this general description are included code tables referenced by code figures, and flag tables where each bit is set to 0 or 1 to indicate a false or true value with respect to a specific criterion. The concept of a flag table is especially useful where combinations of criteria are represented. Within BUFR, all code tables and flag tables refer to elements defined within BUFR Table B; they are numbered according to the $X$ and $Y$ values of the corresponding Table $B$ reference.

## BUFR TABLE RELATIVE TO SECTION 1

| BUFR Table A - Data category |  |
| :---: | :--- |
| Code | Meaning |
| figure |  |
| 0 | Surface data - land |
| 1 | Surface data - sea |
| 2 | Vertical soundings (other than satellite) |
| 3 | Vertical soundings (satellite) |
| 4 | Single level upper-air data (other than satellite) |
| 5 | Single level upper-air data (satellite) |
| 6 | Radar data |
| 7 | Synoptic features |
| 8 | Physical/chemical constituents |
| 9 | Dispersal and transport |
| 10 | Radiological data |
| 11 | BUFR tables, complete replacement or update |
| 12 | Surface data (satellite) |
| $13-19$ | Reserved |
| 20 | Status information |
| 21 | Radiances (satellite measured) |
| $22-30$ | Reserved |
| 31 | Oceanographic data |
| $32-100$ | Reserved |
| 101 | Image data |
| $102-239$ | Reserved |
| $240-254$ | For experimental use |
| 255 | Indicator for local use, with sub-category |

N o te: In data category 255, the local data category may be described by BUFR, Section 1, octet 10.

## BUFR TABLES RELATIVE TO SECTION 3

| BUFR/CREX Table B - Classification of elements |  |  |  |
| :---: | :---: | :---: | :---: |
| F | x | Class | Comments |
| 0 | 00 | BUFR table entries |  |
| 0 | 01 | Identification | Identifies origin and type of data |
| 0 | 02 | Instrumentation | Defines instrument types used |
| 0 | 03 | Reserved |  |
| 0 | 04 | Location (time) | Defines time and time derivatives |
| 0 | 05 | Location (horizontal - 1) | Defines geographical position, including horizontal derivatives, in association with class 06 (first dimension of horizontal space) |
| 0 | 06 | Location (horizontal - 2) | Defines geographical position, including horizontal derivatives, in association with class 05 (second dimension of horizontal space) |
| 0 | 07 | Location (vertical) | Defines height, altitude, pressure level, including vertical derivatives of position |
| 0 | 08 | Significance qualifiers | Defines special character of data |
| 0 | 09 | Reserved |  |
| 0 | 10 | Vertical elements and pressure | Height, altitude, pressure and derivatives observed or measured, not defined as a vertical location |
| 0 | 11 | Wind and turbulence | Wind speed, direction, etc. |
| 0 | 12 | Temperature |  |
| 0 | 13 | Hygrographic and hydrological elements | Humidity, rainfall, snowfall, etc. |
| 0 | 14 | Radiation and radiance |  |
| 0 | 15 | Physical/chemical constituents |  |
| 0 | 19 | Synoptic features |  |
| 0 | 20 | Observed phenomena | Defines present/past weather, special phenomena, etc. |
| 0 | 21 | Radar data |  |
| 0 | 22 | Oceanographic elements |  |
| 0 | 23 | Dispersal and transport |  |
| 0 | 24 | Radiological elements |  |
| 0 | 25 | Processing information |  |
| 0 | 26 | Non-coordinate location (time) | Defines time and time derivatives that are not coordinates |
| 0 | 27 | Non-coordinate location (horizontal - 1) | Defines geographical positions, in conjunction with class 28, that are not coordinates |
| 0 | 28 | Non-coordinate location (horizontal - 2) | Defines geographical positions, in conjunction with class 27, that are not coordinates |
| 0 | 29 | Map data |  |
| 0 | 30 | Image |  |
| 0 | 31* | Data description operator qualifiers | Elements used in conjunction with data description operators |
| 0 | 33 | Quality information |  |
| 0 | 35 | Data monitoring information |  |
| *This class does not exist in CREX. |  |  | (continued) |
| 2001 edition |  |  | I.2-BUFR/CREX Table B - 1 |

## Notes:

(1) Where a code table or flag table is appropriate, "code table" or "flag table", respectively is entered in the UNITS column.
(2) The code tables and flag tables associated with Table B are numbered to correspond with the $\mathrm{F}, \mathrm{X}$ and Y part of the table reference.
(3) To encode values into BUFR, the data (with units as specified in the UNITS column) must be multiplied by 10 to the power SCALE. Then subtract the REFERENCE VALUE to give the coded value found in Section 4 of the BUFR message. For example, a measured latitude is -45.76 degrees. The coarse accuracy descriptor is 005002 and the encoded value is $-45.76 \times 10^{2}-(-9000)=4424$.
(4) Where UNITS are given as CCITT IA5, data shall be coded as character data left justified within the field width indicated using CCITT International Alphabet No. 5, and blank filled to the full field width indic ated.
(5) Classes 48 to 63 are reserved for local use; all other classes are reserved for future development.
(6) Entries 192 to 255 within all classes are reserved for local use.
(7) The use of local descriptors, as defined in Notes (5) and (6), in messages intended for non-local or international exchange is strongly discouraged. They should be kept to the barest minimum possible and must also be by-passed by the use of descriptor 206 YYY.
(8) First-order statistics are included in Table B only when they are produced, as such, by the observing system.
Class 00 - BUFR/CREX table entries

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F* $\mathbf{X}$ Y |  |  |  |  |  |  |  | haracters) |
| 000001 | Table A: entry | CCITT IA5 | 0 | 0 | 24 | Character | 0 | 3 |
| 000002 | Table A: data category description, line 1 | CCITT IA5 | 0 | 0 | 256 | Character | 0 | 32 |
| 000003 | Table A: data category description, line 2 | CCITT IA5 | 0 | 0 | 256 | Character | 0 | 32 |
| 0000005 | BUFR/CREX edition number | CCITT IA5 | 0 | 0 | 24 | Character | 0 | 3 |
| 000010 | F descriptor to be added or defined | CCITT IA5 | 0 | 0 | 8 | C haracter | 0 | 1 |
| 000011 | $X$ descriptor to be added or defined | CCITT IA5 | 0 | 0 | 16 | Character | 0 | 2 |
| 000012 | Y descriptor to be added or defined | CCITT IA5 | 0 | 0 | 24 | Character | 0 | 3 |
| 000013 | Element name, line 1 | CCITT IA5 | 0 | 0 | 256 | Character | 0 | 32 |
| 000014 | Element name, line 2 | CCITT IA5 | 0 | 0 | 256 | Character | 0 | 32 |
| 000015 | Units name | CCITT IA5 | 0 | 0 | 192 | Character | 0 | 24 |
| 000016 | Units scale sign | CCITT IA5 | 0 | 0 | 8 | Character | 0 | 1 |
| 000017 | Units scale | CCITT IA5 | 0 | 0 | 24 | Character | 0 | 3 |
| 000018 | Units reference sign | CCITT IA5 | 0 | 0 | 8 | Character | 0 | 1 |
| 000019 | Units reference value | CCITT IA5 | 0 | 0 | 80 | Character | 0 | 10 |
| 000020 | Element data width | CCITT IA5 | 0 | 0 | 24 | Character | 0 | 3 |
| $0 \quad 00030$ | Descriptor defining sequence | CCITT IA5 | 0 | 0 | 48 | Character | 0 | 6 |

* For CREX descriptors $\mathrm{F}=\mathrm{B}$, not 0 .
Class 01 - BUFR/CREX Identification

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \mathbf{Y}$ |  |  |  |  |  |  |  | haracters) |
| 001001 | WMO block number | Numeric | 0 | 0 | 7 | Numeric | 0 | 2 |
| 001002 | WMO station number | Numeric | 0 | 0 | 10 | Numeric | 0 | 3 |
| 001003 | WMO Region number/geographical area | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 001004 | WMO Region sub-area (see Note 9) | Numeric | 0 | 0 | 3 | Numeric | 0 | 1 |
| 001005 | Buoy/platform identifier | Numeric | 0 | 0 | 17 | Numeric | 0 | 5 |
| 001006 | Aircraft flight number | CCITT IA5 | 0 | 0 | 64 | Character | 0 | 8 |
| 001007 | Satellite identifier | Code table | 0 | 0 | 10 | Code table | 0 | 4 |
| 001008 | Aircraft registration number | CCITT IA5 | 0 | 0 | 64 | Character | 0 | 8 |
| 0001009 | Type of commercial aircraft | CCITT IA5 | 0 | 0 | 64 | Character | 0 | 8 |
| 001010 | Stationary buoy platform identifier; e.g. C-MAN buoys | CCITT IA5 | 0 | 0 | 64 | Character | 0 | 8 |
| 0001011 | Ship or mobile land station identifier | CCITT IA5 | 0 | 0 | 72 | Character | 0 | 9 |
| 001012 | Direction of motion of moving observing platform | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| 001013 | Speed of motion of moving observing platform | $\mathbf{m s}^{\mathbf{- 1}}$ | 0 | 0 | 10 | $\mathrm{m} \mathrm{s}^{\mathbf{- 1}}$ | 0 | 3 |
| 0001014 | Platform drift speed (high precision) | m s ${ }^{-1}$ | 2 | 0 | 10 | m s ${ }^{-1}$ | 2 | 4 |
| 001015 | Station or site name | CCITT IA5 | 0 | 0 | 160 | Character | 0 | 20 |
| 0001018 | Short station or site name | CCITT IA5 | 0 | 0 | 40 | Character | 0 | 5 |
| 001019 | Long station or site name | CCITT IA5 | 0 | 0 | 256 | Character | 0 | 32 |
| 001020 | WMO Region sub-area | Numeric | 0 | 0 | 4 | Numeric | 0 | 2 |
| 001021 | Synoptic feature identifier | Numeric | 0 | 0 | 14 | Numeric | 0 | 4 |
| 001022 | Name of feature (see Note 11) | CCITT IA5 | 0 | 0 | 224 | Character | 0 | 28 |
| 001025 | Storm identifier | CCITT IA5 | 0 | 0 | 24 | Character | 0 | 3 |



[^2]| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| $\begin{array}{lll}0 & 01 & 063\end{array}$ | ICAO location indicator | CCITT IA5 | 0 | 0 | 64 | C haracter | 0 | 8 |
| 0001064 | Runway designator | CCITT IA5 | 0 | 0 | 32 | C haracter | 0 | 4 |
| $\begin{array}{llll}0 & 01 & 075\end{array}$ | Tide station identification | CCITT IA5 | 0 | 0 | 40 | C haracter | 0 | 5 |
| $\begin{array}{llll}0 & 01 & 080\end{array}$ | Ship line number according to SOOP | CCITT IA5 | 0 | 0 | 32 | C haracter | 0 | 4 |
| $\begin{array}{lll}0 & 01 & 085\end{array}$ | Observing platform manufacturer's model | CCITT IA5 | 0 | 0 | 160 | Character | 0 | 20 |
| 0001086 | Observing platform manufacturer's serial number | CCITT IA5 | 0 | 0 | 256 | C haracter | 0 | 32 |

Notes:
(1) The storm identifier (descriptor 001025 ) has the following meaning: the first two characters shall be a numeric sequence number assigned by the originator of the message; the third character is a letter indicating the ocean basin where the storm is located, as follows:

W NW Pacific Ocean
E NE Pacific Ocean to $140^{\circ} \mathrm{W}$
C NE Pacific Ocean $140^{\circ} \mathrm{W}-180^{\circ} \mathrm{W}$
L N Atlantic Ocean, including Caribbean and Gulf of Mexico
A N Arabian Sea
B Bay of Bengal
S S Indian Ocean
P S Pacific Ocean
F RSMC Nadi's zone in South Pacific
U Australia
0 South China Sea
T East China Sea
There is no requirement that differing observers coordinate sequence numbers even though they both may be reporting the same storm.
(2) WMO storm name (descriptor 001027 ): the storm name nameless shall be used in those cases where an identifiable tropical disturbance has not reached tropical storm strength and has not been assigned an official name.
(3) Where a centre other than the originating centre generates quality information, replacement or substitute values, and/or statistical information, the centre may be indicated by using 001033.
(4) A generating centre may wish to indicate a reference to the application that generated quality information, etc.; it may use descriptor 001032 for this purpose. However, the corresponding code tables will vary from centre to centre.
(Class 01 - continued)
(5) Code table 001032 is to be generated by each centre.
(6) The components of absolute platform velocity ( $001041,001042,001043$ ) are defined as follows:

- First component: From the Earth's centre to 0 degree longitude at the Equator: velocity of the platform along this line relative to the Earth's centre.
- Second component: From the Earth's centre to 90 degrees East longitude at the Equator: velocity of the platform along this line relative to the Earth's
- centre.
(7) Third component: From the Earth's centre to the north pole: velocity of the platform along this line relative to the Earth's centre.
orbits. Geostationary orbits would require greater data widths for distance and slightly less for speed.
(8) Left handed $x$, y and z axes have been chosen for descriptors 001041,001042 and 000043 .
(9) Descriptor 001020 should be used instead of 001004 for encoding this element.
(10) Descriptor $001 \mathbf{0 3 3}$ shall be used instead of descriptor 001031 for encoding originating/generating centre. Code table 0001034 is to be established by
the associated originating/generating centre identified by descriptor 001033 and provided to the Secretariat for publication.
(11) For 001022 , the character string representing the "Name of feature" should be of the form: "Type of phenomenon" - "Location or geographical name"
(e.g. "volcano - Popocatepetl", "oil fire - Kuwait").
Class 02 - BUFR/CREX Instrumentation

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| $F \quad X \quad Y$ |  |  |  |  | (Bits) |  |  | (C haracters) |
| $\begin{array}{lll}0 & 02 & 001\end{array}$ | Type of station | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{lll}0 & 02 & 002\end{array}$ | Type of instrumentation for wind measurement | Flag table | 0 | 0 | 4 | Flag table | 0 | 2 |
| $0 \begin{array}{lll}0 & 02 & 003\end{array}$ | Type of measuring equipment used | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 02 \quad 004$ | Type of instrumentation for evaporation measurement or type of crop for which evapotranspiration is reported | Code table | $0$ | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 005\end{array}$ | Precision of temperature observation | K | 2 | 0 | 7 | K | 2 | 3 |
| $0 \begin{array}{lll}0 & 02 & 011\end{array}$ | Radiosonde type | Code table | 0 | 0 | 8 | Code table | 0 | 3 |
| $0 \begin{array}{lll}0 & 02 & 012\end{array}$ | Radiosonde computational method | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \begin{array}{lll}0 & 02 & 013\end{array}$ | Solar and infrared radiation correction | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 0002014 | Tracking technique/status of system used | Code table | 0 | 0 | 7 | Code table | 0 | 3 |
| $\begin{array}{llll}0 & 02 & 015\end{array}$ | Radiosonde completeness | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \begin{array}{lll}0 & 02 & 019\end{array}$ | Satellite instruments | Code table | 0 | 0 | 11 | Code table | 0 | 4 |
| $0 \begin{array}{lll}0 & 02 & 020\end{array}$ | Satellite classification | Code table | 0 | 0 | 9 | Code table | 0 | 3 |
| $\begin{array}{llll}0 & 02 & 021\end{array}$ | Satellite instrument data used in processing* | Flag table | 0 | 0 | 9 | Flag table | 0 | 3 |
| 0002022 | Satellite data-processing technique used | Flag table | 0 | 0 | 8 | Flag table | 0 | 3 |
| $\begin{array}{lll} 0 & 02 & 023 \end{array}$ | Satellite-derived wind computation method | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 02024$ | Integrated mean humidity computational method | Code table | 0 | 0 | 4 | Code table | 0 | 2 |

[^3](Class 02 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 002025 | Satellite channel(s) used in computation | Flag table | 0 | 0 | 25 | Flag table | 0 | 9 |
| $\begin{array}{lll}0 & 02026\end{array}$ | Cross-track resolution | m | 2 | 0 | 12 | m | 2 | 4 |
| $\begin{array}{llll}0 & 02 & 027\end{array}$ | Along-track resolution | m | 2 | 0 | 12 | m | 2 | 4 |
| $\begin{array}{llll}0 & 02 & 028\end{array}$ | Segment size at nadir in x -direction | m | 0 | 0 | 18 | m | 0 | 6 |
| $\begin{array}{llll}0 & 02 & 029\end{array}$ | Segment size at nadir in y -direction | m | 0 | 0 | 18 | m | 0 | 6 |
| $\begin{array}{llll}0 & 02 & 030\end{array}$ | Method of current measurement | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 0002031 | Duration and time of current measurement | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 032\end{array}$ | Indicator for digitization | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| 0002033 | Method of salinity/depth measurement | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 02 & 034\end{array}$ | Drogue type | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 035\end{array}$ | Cable length |  | 0 | 0 | 9 | m | 0 | 3 |
| $\begin{array}{llll}0 & 02 & 036\end{array}$ | Buoy type | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 02 & 037\end{array}$ | Method of tidal observation | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 02 & 038\end{array}$ | Method of sea-surface temperature measurement | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{lll} 0 & 02 \quad 039 \end{array}$ | Method of wet-bulb temperature measurement | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 002040 | Method of removing velocity and motion of platform from current | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{lll} 0 & 02 & 041 \end{array}$ | Method for estimating reports related to synoptic features | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| 002044 | Indicator for method of calculating spectral wave data | Code table | 0 | 0 | 4 | Code table | 0 | 2 |

(Class 02 - continued)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 002045 | Indicator for type of platform | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 002046 | Wave measurement instrumentation | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 002048 | Satellite sensor indicator | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 02049$ | Geostationary satellite dataprocessing technique used | Flag table | 0 | 0 | 8 | Flag table | 0 | 3 |
| 002050 | Geostationary sounder satellite channels used | Flag table | 0 | 0 | 20 | Flag table | 0 | 7 |
| 002051 | Indicator to specify observing method for extreme temperatures | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 002052 | Geostationary imager satellite channels used | Flag table | 0 | 0 | 6 | Flag table | 0 | 2 |
| 002053 | GOES-I/M brightness temperature characteristics | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 002054 | GOES-I/M soundings parameter characteristics | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 002055 | Geostationary soundings statistical parameters | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{lll}0 & 02056\end{array}$ | Geostationary soundings accuracy statistics | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 02057$ | Origin of first-guess information for GOES-I/M soundings | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 002058 | Valid times of first-guess information for GOES-I/M soundings | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{lll} 0 & 02 \quad 059 \end{array}$ | Origin of analysis information for GOES-I/M soundings | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 002060 | Origin of surface information for GOES-I/M soundings | Code table | 0 | 0 | 4 | Code table | 0 | 2 |

(Class 02 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | $\begin{gathered} \text { DATA } \\ \text { WIDTH } \end{gathered}$ | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 002061 | Aircraft navigational system | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 002062 | Type of aircraft data relay system | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 063\end{array}$ | Aircraft roll angle | Degree | 2 | -18000 | 16 | Degree | 2 | 5 |
| $\begin{array}{llll}0 & 02 & 064\end{array}$ | Aircraft roll angle quality | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 02 & 065\end{array}$ | ACARS ground-receiving station | CCITT IA5 | 0 | 0 | 40 | Character | 0 | 5 |
| 002070 | Original specification of latitude/longitude | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{lll}0 & 02 & 091\end{array}$ | Entry sensor 4/20 mA | A | 0 | 4 | 10 | A | 4 | 3 |
| $\begin{array}{llll}0 & 02 & 100\end{array}$ | Radar constant* | dB | 1 | 0 | 12 | dB | 1 | 4 |
| $\begin{array}{llll}0 & 02 & 101\end{array}$ | Type of antenna | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 102\end{array}$ | Antenna height above tower base | m | 0 | 0 | 8 | m | 0 | 3 |
| $\begin{array}{llll}0 & 02 & 103\end{array}$ | Radome | Flag table | 0 | 0 | 2 | Flag table | 0 | 1 |
| $\begin{array}{llll}0 & 02 & 104\end{array}$ | Antenna polarization | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 105\end{array}$ | Maximum antenna gain | dB | 0 | 0 | 6 | dB | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 106\end{array}$ | 3-dB beamwidth | Degree | 1 | 0 | 6 | Degree | 1 | 2 |
| $\begin{array}{llll}0 & 02 & 107\end{array}$ | Sidelobe suppression | dB | 0 | 0 | 6 | dB | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 108\end{array}$ | Crosspol discrimination (on axis) | dB | 0 | 0 | 6 | dB | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 109\end{array}$ | Antenna speed (azimuth) | Degree $\mathbf{s}^{\mathbf{- 1}}$ | 2 | 0 | 12 | Degree $\mathbf{s}^{\mathbf{- 1}}$ | 2 | 4 |
| $\begin{array}{llll}0 & 02110\end{array}$ | Antenna speed (elevation) | Degree s ${ }^{-1}$ | 2 | 0 | 12 | Degree s ${ }^{-1}$ | 2 | 4 |
| $\begin{array}{llll}0 & 02 & 111\end{array}$ | Radar incidence angle | Degree | 1 | 0 | 10 | Degree | 1 | 4 |
| $\begin{array}{llll}0 & 02112\end{array}$ | Radar look angle | Degree | 1 | 0 | 12 | Degree | 1 | 4 |

[^4]This constant is used to normalize the signal to the equivalent $\mathbf{1 0 0} \mathbf{~ k m}$ range.
(Class 02 - continued)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VaLUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 002113 | Number of azimuth looks | Numeric | 0 | 0 | 4 | Numeric | 0 | 2 |
| 0002114 | Antenna effective surface area | $\mathrm{m}^{2}$ | 0 | 0 | 15 | $\mathrm{m}^{2}$ | 0 | 5 |
| $\begin{array}{llll}0 & 02 & 121\end{array}$ | Mean frequency | Hz | -8 | 0 | 7 | Hz | -8 | 3 |
| $\begin{array}{llll}0 & 02 & 122\end{array}$ | Frequency agility range | Hz | -6 | -128 | 8 | Hz | -6 | 3 |
| $\begin{array}{lll}0 & 02 & 123\end{array}$ | Peak power | W | -4 | 0 | 7 | W | -4 | 3 |
| $\begin{array}{llll}0 & 02 & 124\end{array}$ | Average power | W | -1 | 0 | 7 | W | -1 | 3 |
| $\begin{array}{llll}0 & 02 & 125\end{array}$ | Pulse repetition frequency | Hz | -1 | 0 | 8 | Hz | -1 | 3 |
| $\begin{array}{lll}0 & 02 & 126\end{array}$ | Pulse width | S | 7 | 0 | 6 | s | 7 | 2 |
| $\begin{array}{llll}0 & 02 & 127\end{array}$ | Receiver intermediate frequency | Hz | -6 | 0 | 7 | Hz | -6 | 3 |
| $\begin{array}{llll}0 & 02 & 128\end{array}$ | Intermediate frequency bandwidth | Hz | -5 | 0 | 6 | Hz | -5 | 2 |
| $\begin{array}{llll}0 & 02 & 129\end{array}$ | Minimum detectable signal | dB | 0 | -150 | 5 | dB | 0 | 3 |
| $\begin{array}{llll}0 & 02 & 130\end{array}$ | Dynamic range | dB | 0 | 0 | 7 | dB | 0 | 3 |
| $\begin{array}{llll}0 & 02 & 131\end{array}$ | Sensitivity time control (STC) | Flag table | 0 | 0 | 2 | Flag table | 0 | 1 |
| $\begin{array}{llll}0 & 02 & 132\end{array}$ | Azimuth pointing accuracy | Degree | 2 | 0 | 6 | Degree | 2 | 2 |
| $\begin{array}{lll}0 & 02 & 133\end{array}$ | Elevation pointing accuracy | Degree | 2 | 0 | 6 | Degree | 2 | 2 |
| $\begin{array}{llll}0 & 02 & 134\end{array}$ | Antenna beam azimuth | Degree | 2 | 0 | 16 | Degree | 2 | 5 |
| $\begin{array}{llll}0 & 02 & 135\end{array}$ | Antenna elevation | Degree | 2 | -9000 | 15 | Degree | 2 | 5 |
| $\begin{array}{llll}0 & 02 & 136\end{array}$ | Range processed by range attenuation correction | m | -3 | 0 | 16 | m | -3 | 5 |
| $\begin{array}{llll}0 & 02 & 140\end{array}$ | Satellite radar beam azimuth angle | Degree | 0 | 0 | 9 | Degree | 0 | 3 |
| $\begin{array}{llll}0 & 02 & 141\end{array}$ | Measurement type | CCITT IA5 | 0 | 0 | 24 | Character | 0 | 3 |
| $\begin{array}{llll}0 & 02 & 142\end{array}$ | Ozone instrument serial number/ identification | CCITT IA5 | 0 | 0 | 32 | Character | 0 | 4 |
| $\begin{array}{lll}0 & 02 & 143\end{array}$ | Ozone instrument type | Code table | 0 | 0 | 7 | Code table | 0 | 3 |
| $\begin{array}{llll}0 & 02 & 144\end{array}$ | Light source type for Brewer spectrophotometer | Code table | 0 | 0 | 4 | Code table | 0 | 2 |

(Class 02 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  | (Characters) |
| $0 \quad 02145$ | Wave length setting for Dobson instruments | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 02146$ | Source conditions for Dobson instruments | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 02148$ | Data collection and/or location system | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $\begin{array}{lll}0 & 02 & 149\end{array}$ | Type of data buoy | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02150\end{array}$ | TOVS/ATOVS/AVHRR instrumentation channel number | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $\begin{array}{lll}0 & 02 & 151\end{array}$ | Radiometer identifier | Code table | 0 | 0 | 11 | Code table | 0 | 4 |
| $\begin{array}{llll}0 & 02 & 152\end{array}$ | Satellite instrument used in data processing (see Note 6) | Flag table | 0 | 0 | 31 | Flag table | 0 | 10 |
| $\begin{array}{lll}0 & 02 & 153\end{array}$ | Satellite channel centre frequency | Hz | -8 | 0 | 26 | Hz | -8 | 8 |
| $\begin{array}{llll}0 & 02 & 154\end{array}$ | Satellite channel band width | Hz | -8 | 0 | 26 | Hz | -8 | 8 |
| $\begin{array}{llll}0 & 02 & 163\end{array}$ | Height assignment method | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 164\end{array}$ | Tracer correlation method | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 02 & 166\end{array}$ | Radiance type | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 167\end{array}$ | Radiance computational method | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 168\end{array}$ | Hydrostatic pressure of lower end of cable (thermistor string) | Pa | -3 | 0 | 16 | KPa | 0 | 5 |
| $\begin{array}{lll}0 & 02 & 169\end{array}$ | Anemometer type | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 02 & 172\end{array}$ | Product type for retrieved atmospheric gases | Code table | 0 | 0 | 8 | Code table | 0 | 3 |
| $0 \quad 02190$ | Lagrangian drifter submergence (\% time submerged) | \% | 0 | 0 | 7 | \% | 0 | 3 |

(Class 02 - continued)
Notes (1) This class shall contain elements to describe the instrumentation used to obtain the meteorological elements reported.
(2) This class may also contain elements relating to observational procedures.
(3) Some indication of expected accuracy may be implied in conjunction with certain elements in this class.
(4) Note that descriptor 002140 is the azimuth angle measured anticlockwise from satellite heading vector.
(5) In descriptor $002142: 0$ zone instrument serial number/identification is four characters long. For J apanese Dobsons instruments, omit the leading digit(s).
(6) Descriptor 002019 should be used instead of descriptor 002152 for single satellite instrument identification.
Class 04 - BUFR/CREX Location (time)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F X Y |  |  |  |  |  |  |  | (Characters) |
| 004001 | Year | Year | 0 | 0 | 12 | Year | 0 | 4 |
| 004002 | Month | Month | 0 | 0 | 4 | Month | 0 | 2 |
| 004003 | Day | Day | 0 | 0 | 6 | Day | 0 | 2 |
| 004004 | Hour | Hour | 0 | 0 | 5 | Hour | 0 | 2 |
| 004005 | Minute | Minute | 0 | 0 | 6 | Minute | 0 | 2 |
| 004006 | Second | Second | 0 | 0 | 6 | Second | 0 | 2 |
| 004011 | Time increment | Year | 0 | -1024 | 11 | Year | 0 | 4 |
| $\begin{array}{llll}0 & 04 & 012\end{array}$ | Time increment | Month | 0 | -1024 | 11 | Month | 0 | 4 |
| 0004013 | Time increment | Day | 0 | -1024 | 11 | Day | 0 | 4 |
| 004014 | Time increment | Hour | 0 | -1024 | 11 | Hour | 0 | 4 |
| 004015 | Time increment | Minute | 0 | -2048 | 12 | Minute | 0 | 4 |
| 004016 | Time increment | Second | 0 | -4096 | 13 | Second | 0 | 4 |
| 004017 | Reference time period for accumulated or extreme data | Minute | 0 | -1440 | 12 | Minute | 0 | 4 |
| 004021 | Time period or displacement | Year | 0 | -1024 | 11 | Year | 0 | 4 |
| 004022 | Time period or displacement | Month | 0 | -1024 | 11 | Month | 0 | 4 |
| 004023 | Time period or displacement | Day | 0 | -1024 | 11 | Day | 0 | 4 |
| 004024 | Time period or displacement | Hour | 0 | -2048 | 12 | Hour | 0 | 4 |
| $\begin{array}{llll}0 & 04 & 025\end{array}$ | Time period or displacement | Minute | 0 | -2048 | 12 | Minute | 0 | 4 |
| 004026 | Time period or displacement | Second | 0 | -4096 | 13 | Second | 0 | 4 |
| 004031 | Duration of time relating to following value | Hour | 0 | 0 | 8 | Hour | 0 | 3 |
| 004032 | Duration of time relating to following value | Minute | 0 | 0 | 6 | Minute | 0 | 2 |
| 004041 | Time difference, UTC -LMT (see Note 6) | Minute | 0 | -1440 | 12 | Minute | 0 | 4 |

(Class 04 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  | (Characters) |
| 004043 | Day of the year | Day | 0 | 0 | 9 | Day | 0 | 3 |
| 004053 | Number of days with precipitation equal to or more than 1 mm | Numeric | 0 | 0 | 6 | Numeric | 0 | 2 |
| 0004065 | Short time increment | Minute | 0 | -128 | 8 | Minute | 0 | 2 |
| 0004073 | Short time period or displacement | Day | 0 | -128 | 8 | Day | 0 | 2 |
| 0004074 | Short time period or displacement | Hour | 0 | -128 | 8 | Hour | 0 | 2 |
| $0 \quad 04075$ | Short time period or displacement | Minute | 0 | -128 | 8 | Minute | 0 | 2 |

[^5]FM 94 BUFR, FM 95 CREX
Class 05 - BUFR/CREX Location (horizontal - 1)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F X Y |  |  |  |  |  |  |  | Characters) |
| 005001 | Latitude (high accuracy) | Degree | 5 | -9000000 | 25 | Degree | 5 | 7 |
| 005002 | Latitude (coarse accuracy) | Degree | 2 | -9000 | 15 | Degree | 2 | 4 |
| 005011 | Latitude increment (high accuracy) | Degree | 5 | -9000000 | 25 | Degree | 5 | 7 |
| 0005012 | Latitude increment (coarse accuracy) | Degree | 2 | -9000 | 15 | Degree | 2 | 4 |
| $\begin{array}{llll}0 & 05 & 021\end{array}$ | Bearing or azimuth | Degree true | 2 | 0 | 16 | Degree true | 2 | 5 |
| $\begin{array}{llll}0 & 05 & 022\end{array}$ | Solar azimuth | Degree true | 2 | 0 | 16 | Degree true | 2 | 5 |
| 005030 | Direction (spectral) | Degree | 0 | 0 | 12 | Degree | 0 | 4 |
| $\begin{array}{llll}0 & 05 & 031\end{array}$ | Row number | Numeric | 0 | 0 | 12 | Numeric | 0 | 4 |
| $\begin{array}{llll}0 & 05 & 033\end{array}$ | Pixel size on horizontal - 1 | m | -1 | 0 | 16 | m | -1 | 5 |
| $\begin{array}{llll}0 & 05 & 034\end{array}$ | Along track row number | Numeric | 0 | 0 | 11 | Numeric | 0 | 4 |
| 005036 | Ship transect number according to SOOP | Numeric | 0 | 0 | 7 | Numeric | 0 | 2 |
| 005040 | Orbit number | Numeric | 0 | 0 | 24 | Numeric | 0 | 8 |
| 005041 | Scan line number | Numeric | 0 | 0 | 8 | Numeric | 0 | 3 |
| 0005042 | Channel number | Numeric | 0 | 0 | 6 | Numeric | 0 | 2 |
| 0005043 | Field of view number | Numeric | 0 | 0 | 8 | Numeric | 0 | 3 |
| $\begin{array}{llll}0 & 05 & 052\end{array}$ | Channel number increment | Numeric | 0 | 0 | 5 | Numeric | 0 | 2 |
| 005053 | Field of view number increment | Numeric | 0 | 0 | 5 | Numeric | 0 | 2 |

[^6]Class 06 - BUFR/CREX Location (horizontal - 2)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  |  |
| 006001 | Longitude (high accuracy) | Degree | 5 | -18000000 | 26 | Degree | 5 | 8 |
| 006002 | Longitude (coarse accuracy) | Degree | 2 | -18000 | 16 | Degree | 2 | 5 |
| 006011 | Longitude increment (high accuracy) | Degree | 5 | -18000000 | 26 | Degree | 5 | 8 |
| 0006012 | Longitude increment (coarse accuracy) | Degree | 2 | -18000 | 16 | Degree | 2 | 5 |
| 0006021 | Distance | m | -1 | 0 | 13 | m | -1 | 4 |
| 006030 | Wave number (spectral) | rad m-1 | 5 | 0 | 13 | rad m ${ }^{-1}$ | 5 | 4 |
| 0006031 | Column number | Numeric | 0 | 0 | 12 | Numeric | 0 | 4 |
| 0006033 | Pixel size on horizontal - 2 | m | -1 | 0 | 16 | m | -1 | 5 |
| 0006034 | Cross-track cell number | Numeric | 0 | 0 | 7 | Numeric | 0 | 3 |
| $0 \quad 06040$ | Radius of confidence | m | 0 | 0 | 13 | m | 0 | 4 |

[^7]FM 94 BUFR, FM 95 CREX
Class 07 - BUFR/CREX Location (vertical)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  |  |
| 007001 | Height of station | m | 0 | -400 | 15 | m | 0 | 5 |
| 007002 | Height or altitude | m | -1 | -40 | 16 | m | -1 | 5 |
| 007003 | Geopotential | $\mathrm{m}^{\mathbf{2}} \mathrm{s}^{-2}$ | -1 | -400 | 17 | $\mathrm{m}^{\mathbf{2}} \mathrm{s}^{-2}$ | -1 | 6 |
| $\begin{array}{llll}0 & 07 & 004\end{array}$ | Pressure | Pa | -1 | 0 | 14 | Pa | -1 | 5 |
| 0007005 | Height increment | m | 0 | -400 | 12 | m | 0 | 4 |
| 0007006 | Height above station | m | 0 | 0 | 15 | m | 0 | 5 |
| $\begin{array}{llll}0 & 07 & 007\end{array}$ | Height | m | 0 | -1000 | 17 | m | 0 | 6 |
| $\begin{array}{llll}0 & 07 & 008\end{array}$ | Geopotential | $\mathrm{m}^{\mathbf{2}} \mathrm{s}^{-2}$ | 0 | -10000 | 20 | $\mathrm{m}^{\mathbf{2}} \mathrm{s}^{-2}$ | 0 | 7 |
| $\begin{array}{llll}0 & 07 & 009\end{array}$ | Geopotential height | gpm | 0 | -1000 | 17 | gpm | 0 | 5 |
| 0007021 | Elevation (see Note 1) | Degree | 2 | -9000 | 15 | Degree | 2 | 5 |
| $\begin{array}{llll}0 & 07 & 022\end{array}$ | Solar elevation | Degree | 2 | -9000 | 15 | Degree | 2 | 5 |
| $\begin{array}{llll}0 & 07 & 024\end{array}$ | Satellite zenith angle | Degree | 2 | -9000 | 15 | Degree | 2 | 5 |
| $\begin{array}{llll}0 & 07 & 025\end{array}$ | Solar zenith angle | Degree | 2 | -9000 | 15 | Degree | 2 | 5 |
| 0007061 | Depth below land surface | m | 2 | 0 | 14 | m | 2 | 5 |
| $\begin{array}{llll}0 & 07 & 062\end{array}$ | Depth below sea/water surface | m | 1 | 0 | 17 | m | 1 | 6 |
| $0 \quad 07064$ | Height above station (sensor height artific ially corrected) (see Note 2) | m | 0 | 0 | 4 | m | 0 | 2 |
| 007070 | Drogue depth | m | 0 | 0 | 10 | m | 0 | 4 |

(2) Height above station at which sensor height is artificially corrected to standard value using formula. For example, standard height for wind is 10 metres but anemometers or buoys are placed at much lower height; such height is sometimes corrected using a formula.
Class 08 - BUFR/CREX Significance qualifiers

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  | haracters) |
| 008001 | Vertical sounding signific ance | Flag table | 0 | 0 | 7 | Flag table | 0 | 3 |
| 008002 | Vertical significance (surface observations) | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $0 \quad 08003$ | Vertical significance (satellite observations) | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| 0008004 | Phase of aircraft flight | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 0008005 | Meteorological attribute significance | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 08 & 006\end{array}$ | Ozone vertical sounding significance | Flag table | 0 | 0 | 9 | Flag table | 0 | 3 |
| $\begin{array}{lll}0 & 08 & 007\end{array}$ | Dimensional significance | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 08008$ | Radiation vertical sounding significance | Flag table | 0 | 0 | 9 | Flag table | 0 | 3 |
| 0008011 | Meteorological feature | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 08 & 012\end{array}$ | Land/sea qualifier | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| 0008013 | Day/night qualifier | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 08 & 014\end{array}$ | Qualifier for runway visual range | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 008016 | Change qualifier of a trend-type forecast or an aerodrome forecast | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 008017 | Qualifier of the time when the forecast change is expected | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{lll}0 & 08 & 018\end{array}$ | SEAWINDS land/ice surface type | Flag table | 0 | 0 | 17 | Flag table | 0 | 6 |
| $0 \quad 08020$ | Total number of missing entities (with respect to accumulation or average) | Numeric | 0 | 0 | 16 | Numeric | 0 | 5 |
| $\begin{array}{lll}0 & 08 & 021\end{array}$ | Time significance | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $0 \quad 08022$ | Total number (with respect to accumulation or average) | Numeric | 0 | 0 | 16 | Numeric | 0 | 5 |

(Class 08 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 008023 | First-order statistics | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 08 & 024\end{array}$ | Difference statistics | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $\begin{array}{lll}0 & 08 & 025\end{array}$ | Time difference qualifier | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 08030$ | Manual on Codes (Volume I.1, Section C) C ode table from which data are derived | Numeric | 0 | 0 | 13 | Numeric | 0 | 4 |
| $\begin{array}{lll}0 & 08 & 031\end{array}$ | Data category - CREX table A | Numeric | 0 | 0 | 8 | Numeric | 0 | 3 |
| $\begin{array}{llll}0 & 08 & 033\end{array}$ | Method of derivation of percentage confidence | Code table | 0 | 0 | 7 | Code table | 0 | 3 |
| $\begin{array}{lll}0 & 08 & 035\end{array}$ | Type of monitoring exercise | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 008036 | Type of centre or station performing monitoring | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 008051 | Qualifier for number of missing values in calculation of statistic | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $0 \quad 08052$ | Condition for which number of days of occurrence follows | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $\begin{array}{lll}0 & 08 & 053\end{array}$ | Day of occurrence qualifier | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 08 & 060\end{array}$ | Sample scanning mode significance | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{lll}0 & 08 & 070\end{array}$ | TOVS/ATOVS product qualifier | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 08 & 072\end{array}$ | Pixel(s) type | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 0 | Ascending/descending orbit qualifier | Code table | 0 | 0 | 2 | Code table | 0 | 1 |

[^8](4) Difference statistics are difference values; they have dimensions similar to the corresponding reported values with respect to units, but assume a range centred
(6) Descriptor 008033 is to be used by preceding the element 033007 as part of quality control information in order to specify the method used to calculate
the percentage confidence.

FM 94 BUFR, FM 95 CREX
Class 10 - BUFR/CREX Non-coordinate location (vertical)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  | Characters) |
| 010001 | Height of land surface | m | 0 | -400 | 15 | m | 0 | 5 |
| 010002 | Height | m | -1 | -40 | 16 | m | -1 | 5 |
| 010003 | Geopotential | $\mathrm{m}^{2} \mathrm{~s}^{-2}$ | -1 | -400 | 17 | $\mathrm{m}^{2} \mathrm{~s}^{-2}$ | -1 | 6 |
| $0 \quad 10004$ | Pressure | Pa | -1 | 0 | 14 | Pa | -1 | 5 |
| 010007 | Height | m | 0 | -1000 | 17 | m | 0 | 6 |
| $0 \quad 10008$ | Geopotential | $\mathrm{m}^{2} \mathrm{~s}^{-2}$ | 0 | -10000 | 20 | $\mathrm{m}^{\mathbf{2}} \mathrm{s}^{-2}$ | 0 | 7 |
| 010009 | Geopotential height | gpm | 0 | -1000 | 17 | gpm | 0 | 5 |
| 010010 | Minimum pressure reduced to mean sea level | Pa | -1 | 0 | 14 | Pa | -1 | 5 |
| $0 \quad 10011$ | Maximum pressure reduced to mean sea level | Pa | -1 | 0 | 14 | Pa | -1 | 5 |
| $0 \quad 10031$ | In direction of the North Pole, distance from the Earth's centre | m | 2 | -1073741824 | 31 | m | 2 | 10 |
| $0 \quad 10040$ | Number of retrieved layers | Numeric | 0 | 0 | 10 | Numeric | 0 | 4 |
| $0 \quad 10050$ | Standard deviation altitude | m | 2 | 0 | 16 | m | 2 | 5 |
| $0 \quad 10051$ | Pressure reduced to mean sea level | Pa | -1 | 0 | 14 | Pa | -1 | 5 |
| $0 \quad 10052$ | Altimeter setting (QNH) | Pa | -1 | 0 | 14 | Pa | -1 | 5 |
| $0 \quad 10060$ | Pressure change | Pa | -1 | -1024 | 11 | Pa | -1 | 4 |
| $0 \quad 10061$ | 3-hour pressure change | Pa | -1 | -500 | 10 | Pa | -1 | 4 |
| $0 \quad 10062$ | 24-hour pressure change | Pa | -1 | -1000 | 11 | Pa | -1 | 4 |
| $0 \quad 10063$ | Characteristic of pressure tendency | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 10 \quad 070$ | Indicated aircraft altitude | m | 0 | -400 | 16 | m | 0 | 5 |

[^9]Class 11 - BUFR/CREX Wind and turbulence

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 011001 | Wind direction | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| 011002 | Wind speed | m sis | 1 | 0 | 12 | m s ${ }^{-1}$ | 1 | 4 |
| 011003 | u-component | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | -4096 | 13 | m s ${ }^{-1}$ | 1 | 4 |
| 011004 | v-component | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | -4096 | 13 | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | 4 |
| 011005 | w-component | Pa s ${ }^{-1}$ | 1 | -512 | 10 | Pa s ${ }^{-1}$ | 1 | 4 |
| 011006 | w-component | m s ${ }^{-1}$ | 2 | -4096 | 13 | $\mathrm{m} \mathrm{s}^{-1}$ | 2 | 4 |
| $0 \quad 11010$ | Wind direction associated with wind speed which follows | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $0 \quad 11011$ | Wind direction at 10 m | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $0 \begin{array}{lll}0 & 11 & 012\end{array}$ | Wind speed at 10 m | m s ${ }^{-1}$ | 1 | 0 | 12 | m s ${ }^{-1}$ | 1 | 4 |
| $0 \begin{array}{lll}0 & 11 & 013\end{array}$ | Wind direction at 5 m | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $0 \begin{array}{lll}0 & 11 & 014\end{array}$ | Wind speed at 5 m | m sis | 1 | 0 | 12 | m s-1 | 1 | 4 |
| 011016 | Extreme counterclockwise wind direction of a variable wind | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $0 \quad 11017$ | Extreme clockwise wind direction of a variable wind | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| 011019 | Steadiness of wind (see Note 6) | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $\begin{array}{llll}0 & 11 & 021\end{array}$ | Relative vorticity | $\mathbf{s}^{-1}$ | 9 | -65536 | 17 | $\mathbf{s}^{-1}$ | 9 | 6 |
| 011022 | Divergence | $\mathrm{s}^{-1}$ | 9 | -65536 | 17 | $\mathrm{s}^{-1}$ | 9 | 6 |
| $\begin{array}{llll}0 & 11 & 023\end{array}$ | Velocity potential | $\mathrm{m}^{\mathbf{2}} \mathrm{s}^{-1}$ | -2 | -65536 | 17 | $\mathrm{m}^{\mathbf{2}} \mathrm{s}^{-1}$ | -2 | 6 |
| $0 \begin{array}{llll}0 & 11 & 031\end{array}$ | Degree of turbulence | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 11 & 032\end{array}$ | Height of base of turbulence | m | -1 | -40 | 16 | m | -1 | 5 |
| $0 \begin{array}{lll}0 & 11 & 033\end{array}$ | Height of top of turbulence | m | -1 | -40 | 16 | m | -1 | 5 |
| $0 \quad 11034$ | Vertical gust velocity | $\mathrm{m} \mathrm{s}^{\mathbf{- 1}}$ | 1 | -1024 | 11 | $\mathrm{m} \mathrm{s}^{\mathbf{- 1}}$ | 1 | 4 |

(Class 11 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| $0 \begin{array}{lll}0 & 11 & 035\end{array}$ | Vertical gust acceleration | $\mathrm{m} \mathrm{s}^{-2}$ | 2 | -8192 | 14 | $\mathrm{m} \mathrm{s}^{-2}$ | 2 | 5 |
| $0 \quad 11036$ | Maximum derived equivalent vertical gust speed | m s-1 | 1 | 0 | 10 | m s ${ }^{-1}$ | 1 | 4 |
| $\begin{array}{llll}0 & 11 & 037\end{array}$ | Turbulence index | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $0 \quad 11038$ | Time of occurrence of peak eddy dissipation rate | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $0 \begin{array}{lll}0 & 11 & 040\end{array}$ | Maximum wind speed (mean wind) | m s ${ }^{-1}$ | 1 | 0 | 12 | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | 4 |
| $0 \begin{array}{lll}0 & 11 & 041\end{array}$ | Maximum wind speed (gusts) | m s ${ }^{-1}$ | 1 | 0 | 12 | $\mathrm{m} \mathrm{s}{ }^{-1}$ | 1 | 4 |
| $0 \begin{array}{lll}0 & 11 & 042\end{array}$ | Maximum wind speed (10-minute mean wind) | m sil | 1 | 0 | 12 | $\mathbf{m ~ s}{ }^{-1}$ | 1 | 4 |
| $0 \begin{array}{lll}0 & 11 & 043\end{array}$ | Maximum wind gust direction | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $\begin{array}{llll}0 & 11 & 044\end{array}$ | Mean wind direction for surface 1500 m ( 5000 feet) | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $0 \quad 11045$ | Mean wind speed for surface 1500 m (5 000 feet) | $\mathrm{m} \mathrm{s}^{\mathbf{- 1}}$ | 1 | 0 | 12 | $\mathbf{m s}^{\mathbf{- 1}}$ | 1 | 4 |
| $0 \begin{array}{lll}0 & 11 & 046\end{array}$ | Maximum instantaneous wind speed | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | 0 | 12 | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | 4 |
| $\begin{array}{llll}0 & 11 & 047\end{array}$ | Maximum instantaneous wind speed over 10 minutes | m s ${ }^{-1}$ | 1 | 0 | 12 | m s ${ }^{-1}$ | 1 | 4 |
| $0 \quad 11049$ | Standard deviation of wind direction | Degree true | 0 | 0 | 9 |  | 0 | 3 |
| $\begin{array}{lll} 0 & 11 & 050 \end{array}$ | Standard deviation of horizontal wind speed | $\mathrm{m} \mathrm{~s}^{-1}$ | 1 | 0 | 12 | $\mathrm{m} \mathrm{~s}^{-1}$ | 1 | 4 |
| $\begin{array}{lll} 0 & 11 & 051 \end{array}$ | Standard deviation of vertical wind speed | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | 0 | 8 | $\mathbf{m ~ s}^{-1}$ | 1 | 3 |
| $\begin{array}{lll}0 & 11 & 052\end{array}$ | Formal uncertainty in wind speed | m s-1 | 2 | 0 | 13 | m s ${ }^{-1}$ | 2 | 5 |
| $\begin{array}{llll}0 & 11 & 053\end{array}$ | Formal uncertainty in wind direction | Degree true | 2 | 0 | 15 | Degree true | 2 | 5 |
| $0 \quad 11061$ | Absolute wind shear in $\mathbf{1} \mathbf{~ k m}$ layer below |  | 1 | 0 | 12 | m s ${ }^{-1}$ | 1 | 4 |

(Class 11 - continued)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 011062 | Absolute wind shear in $1 \mathbf{k m}$ layer above | $\mathrm{m} \mathrm{s}^{\mathbf{- 1}}$ | 1 | 0 | 12 | $\mathrm{m} \mathrm{s}^{\mathbf{- 1}}$ | 1 | 4 |
| $0 \quad 11070$ | Designator of the runway affected by wind shear (including ALL) | CCITT IA5 | 0 | 0 | 32 | Character | 0 | 4 |
| $0 \begin{array}{lll}0 & 11 & 071\end{array}$ | Turbulent vertical momentum flux | $\mathrm{m}^{2} \mathrm{~s}^{-2}$ | 3 | -128 | 14 | $\mathrm{m}^{\mathbf{2}} \mathrm{s}^{-2}$ | 3 | 5 |
| $\begin{array}{llll}0 & 11 & 072\end{array}$ | Turbulent vertical buoyancy flux | K m s-1 | 3 | -128 | 11 | K m s-1 | 3 | 4 |
| $0 \begin{array}{lll}0 & 11 & 073\end{array}$ | Turbulent kinetic energy | $\mathrm{m}^{2} \mathrm{~s}^{-2}$ | 2 | -1024 | 13 | $\mathrm{m}^{2} \mathrm{~s}^{-2}$ | 2 | 4 |
| $\begin{array}{llll}0 & 11 & 074\end{array}$ | Dissipation energy | $\mathrm{m}^{2} \mathrm{~s}^{-2}$ | 2 | -1024 | 10 | $\mathrm{m}^{\mathbf{2}} \mathrm{s}^{-2}$ | 2 | 4 |
| $0 \quad 11075$ | Mean turbulence intensity (eddy dissipation rate) | $\mathrm{m}^{2 / 3} \mathrm{~s}^{-1}$ | 2 | 0 | 8 | $\mathrm{m}^{2 / 3} \mathrm{~s}^{-1}$ | 2 | 3 |
| $0 \quad 11076$ | Peak turbulence intensity (eddy dissipation rate) | $\mathrm{m}^{2 / 3} \mathrm{~s}^{-1}$ | 2 | 0 | 8 | $\mathrm{m}^{2 / 3} \mathrm{~s}^{-1}$ | 2 | 3 |
| $0 \begin{array}{lll}0 & 11 & 081\end{array}$ | Model wind direction at 10 m | Degree true | 2 | 0 | $16$ | Degree true | 2 | 5 |
| $0 \quad 11082$ | Model wind speed at 10 m | $\mathrm{m} \mathrm{~s}^{-1}$ | 2 | 0 | 14 | $\mathrm{m} \mathrm{~s}^{-1}$ | 2 | 4 |

Notes:
(2) South to north v-components shall be assigned positive values.
(3) Upward w-components shall be assigned positive values where units are $\mathbf{m ~ s}^{\mathbf{- 1}}$.
(4) Downward w-components shall be assigned positive values where units are $\mathrm{Pa} \mathrm{s}^{\mathbf{- 1}}$.
$\begin{array}{cl}\text { Speed } & \text { Direction } \\ \text { Missing } & \text { Missing }\end{array}$
Missing
0
$\begin{array}{ll}>0 & 1-360^{\circ} \\ >0 & \text { Missing }\end{array}$
$\begin{array}{cc}\text { Missing } & 1-360^{\circ} \\ >0 & 0\end{array}$
(6) The steadiness factor (descriptor 011019 ) is the ratio of speed of the monthly mean vector wind to the speed of the monthly mean scalar wind expressed
as a percentage. It is reported to the nearest one per cent.
Class 12 - BUFR/CREX Temperature

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH (Bits) | UNIT | SCALE | DATA WIDTH (Characters) |
| F $\quad \mathbf{X}$ |  |  |  |  |  |  |  |  |
| 012001 | Temperature/dry-bulb temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012002 | Wet-bulb temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012003 | Dew-point temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012004 | Dry-bulb temperature at 2 m | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012005 | Wet-bulb temperature at 2 m | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012006 | Dew-point temperature at $\mathbf{2} \mathbf{~ m}$ | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| $\begin{array}{llll}0 & 12 & 007\end{array}$ | Virtual temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012011 | Maximum temperature, at height and over period specified | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| $0 \quad 12012$ | Minimum temperature, at height and over period specified | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| $0 \quad 12013$ | Ground minimum temperature, past 12 hours | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| $0 \quad 12014$ | Maximum temperature at 2 m , past 12 hours | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| $0 \quad 12015$ | Minimum temperature at 2 m , past 12 hours | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| $0 \quad 12016$ | Maximum temperature at $\mathbf{2} \mathbf{m}$, past 24 hours | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| $0 \quad 12017$ | Minimum temperature at 2 m , past 24 hours | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| $\begin{array}{llll}0 & 12 & 021\end{array}$ | Maximum temperature at 2 m | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 022\end{array}$ | Minimum temperature at $\mathbf{2 m}$ | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| 012030 | Soil temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| $\begin{array}{llll}0 & 12 & 051\end{array}$ | Standard deviation temperature | K | 1 | 0 | 10 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |

(Class 12 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F X Y |  |  |  |  |  |  |  | haracters |
| 012052 | Highest daily mean temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012053 | Lowest daily mean temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012061 | Skin temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012062 | Equivalent black body temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012063 | Brightness temperature | K | 1 | 0 | 12 | ${ }^{\circ} \mathrm{C}$ | 1 | 3 |
| 012064 | Instrument temperature | K | 1 | 0 | 12 | K | 1 | 4 |
| 012065 | Standard deviation brightness temperature | K | 1 | 0 | 12 | K | 1 | 4 |
| $\begin{array}{lll}0 & 12 & 071\end{array}$ | Coldest cluster temperature | K | 1 | 0 | 12 | K | 1 | 4 |
| $\begin{array}{llll}0 & 12 & 072\end{array}$ | Radiance | W m-2 sr ${ }^{-1}$ | 6 | 0 | 31 | W m-2 sr ${ }^{\mathbf{1}}$ | 6 | 9 |
| $\begin{array}{llll}0 & 12 & 075\end{array}$ | Spectral radiance | W m-3 $\mathrm{sr}^{-1}$ | -3 | 0 | 16 | W m-3 $\mathrm{sr}^{-1}$ | -3 | 5 |
| $\begin{array}{llll}0 & 12 & 076\end{array}$ | Radiance | W m-2 sr ${ }^{-1}$ | 3 | 0 | 16 | W m-2 sr ${ }^{\mathbf{1}}$ | 3 | 5 |
| $\begin{array}{llll}0 & 12 & 101\end{array}$ | Temperature/dry-bulb temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 102\end{array}$ | Wet-bulb temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 103\end{array}$ | Dew-point temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 104\end{array}$ | Dry-bulb temperature at $\mathbf{2 m}$ | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 105\end{array}$ | Web-bulb temperature at 2 m | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 106\end{array}$ | Dew-point temperature at 2 m | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 107\end{array}$ | Virtual temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| 012111 | Maximum temperature, at height and over period specified | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| 012112 | Minimum temperature, at height and over period specified | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{lll}0 & 12 & 113\end{array}$ | Ground minimum temperature, past 12 hours | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| 012114 | Maximum temperature at 2 m , past 12 hours | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |

FM 94 BUFR, FM 95 CREX
(Class 12 - continued)

|  | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TABLE REFERENCE |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH (Bits) | UNIT | SCALE | DATA WIDTH (Characters) |
| F $\quad \mathbf{X}$ |  |  |  |  |  |  |  |  |
| O 12115 | Minimum temperature at $\mathbf{2} \mathbf{m}$, past 12 hours | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| 012116 | Maximum temperature at $\mathbf{2} \mathbf{m}$, past 24 hours | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| 012117 | Minimum temperature at 2 m , past 24 hours | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 130\end{array}$ | Soil temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 152\end{array}$ | Highest daily mean temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 153\end{array}$ | Lowest daily mean temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 161\end{array}$ | Skin temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 162\end{array}$ | Equivalent black body temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 163\end{array}$ | Brightness temperature | K | 2 | 0 | 16 | ${ }^{\circ} \mathrm{C}$ | 2 | 4 |
| $\begin{array}{llll}0 & 12 & 164\end{array}$ | Instrument temperature | K | 2 | 0 | 16 | K | 2 | 5 |
| $0 \begin{array}{llll}0 & 12 & 171\end{array}$ | Coldest cluster temperature | K | 2 | 0 | 16 | K | 2 | 5 |

(1) Where the expression "at height and over period specified" is entered under element name, an appropriate vertical location shall be specified using
descriptors from class 07, together with an appropriate period using descriptors from class $\mathbf{0 4}$.
(2) Descriptor 012076 should be used instead of descriptor 012072 to encode radiance.
Class 13 - BUFR/CREX Hygrographic and hydrological elements

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 013001 | Specific humidity | kg kg-1 | 5 | 0 | 14 | $\mathbf{k g ~ k g}^{-1}$ | 5 | 5 |
| $\begin{array}{llll}0 & 13 & 002\end{array}$ | Mixing ratio | $\mathbf{k g ~ k g}{ }^{-1}$ | 5 | 0 | 14 | $\mathrm{kg} \mathrm{kg}^{-1}$ | 5 | 5 |
| $\begin{array}{llll}0 & 13 & 003\end{array}$ | Relative humidity | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $\begin{array}{llll}0 & 13 & 004\end{array}$ | Vapour pressure | Pa | -1 | 0 | 10 | Pa | -1 | 4 |
| $\begin{array}{llll}0 & 13 & 005\end{array}$ | Vapour density | $\mathrm{kg} \mathrm{m}^{-3}$ | 3 | 0 | 7 | kg m ${ }^{-3}$ | 3 | 3 |
| $\begin{array}{llll}0 & 13 & 006\end{array}$ | Mixing heights | m | -1 | -40 | 16 | m | -1 | 5 |
| $\begin{array}{llll}0 & 13 & 007\end{array}$ | Minimum relative humidity | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $\begin{array}{llll}0 & 13 & 008\end{array}$ | Maximum relative humidity | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $\begin{array}{llll}0 & 13 & 011\end{array}$ | Total precipitation/total water equivalent | kg m-2 | 1 | -1 | 14 | $\mathbf{k g ~ m - 2 ~}$ | 1 | 5 |
| $\begin{array}{lll}0 & 13 & 012\end{array}$ | Depth of fresh snow | m | 2 | -2 | 12 | m | 2 | 4 |
| $\begin{array}{llll}0 & 13 & 013\end{array}$ | Total snow depth |  | 2 | -2 | 16 | m | 2 | 5 |
| $0 \quad 13014$ | Rainfall/water equivalent of snow (averaged rate) | $\mathbf{k g ~ m}{ }^{-2} \mathbf{s}^{-1}$ | 4 | 0 | 12 | $\mathbf{k g ~ m} \mathbf{m}^{\mathbf{- 2}} \mathbf{s}^{\mathbf{- 1}}$ | 4 | 4 |
| $\begin{array}{lll}0 & 13 & 015\end{array}$ | Snowfall (averaged rate) | $\mathrm{m} \mathrm{s}^{-1}$ | 7 | 0 | 12 | $\mathrm{m} \mathrm{s}^{-1}$ | 7 | 4 |
| $\begin{array}{llll}0 & 13 & 016\end{array}$ | Precipitable water | kg m-2 | 0 | 0 | 7 | kg m-2 | 0 | 3 |
| $\begin{array}{llll}0 & 13 & 019\end{array}$ | Total precipitation past 1 hour | kg m-2 | 1 | -1 | 14 | kg m ${ }^{-2}$ | 1 | 4 |
| $\begin{array}{llll}0 & 13 & 020\end{array}$ | Total precipitation past 3 hours | kg m-2 | 1 | -1 | 14 | kg m-2 | 1 | 5 |
| $\begin{array}{llll}0 & 13 & 021\end{array}$ | Total precipitation past 6 hours | kg m-2 | 1 | -1 | 14 | kg m ${ }^{-2}$ | 1 | 5 |
| $\begin{array}{lll}0 & 13 & 022\end{array}$ | Total precipitation past 12 hours | kg m-2 | 1 | -1 | 14 | kg m-2 | 1 | 5 |
| $\begin{array}{lll}0 & 13 & 023\end{array}$ | Total precipitation past 24 hours | kg m-2 | 1 | -1 | 14 | $\mathrm{kg} \mathrm{m}^{-2}$ | 1 | 5 |
| $\begin{array}{llll}0 & 13 & 031\end{array}$ | Evapotranspiration | kg m-2 | 0 | 0 | 7 | kg m-2 | 0 | 3 |
| $\begin{array}{llll}0 & 13 & 032\end{array}$ | Evaporation/evapotranspiration | kg m-2 | 1 | 0 | 8 | kg m-2 | 1 | 3 |
| $\begin{array}{llll}0 & 13 & 033\end{array}$ | Evaporation/evapotranspiration | kg m-2 | 1 | 0 | 10 | $\mathbf{k g ~ m}{ }^{\mathbf{- 2}}$ | 1 | 4 |
| $\begin{array}{llll}0 & 13 & 038\end{array}$ | Superadiabatic indicator | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 13 & 039\end{array}$ | Terrain type (ice/snow) | Code table | 0 | 0 | 3 | Code table | 0 | 1 |

(Class 13 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \mathbf{Y}$ |  |  |  |  |  |  |  | (Characters) |
| $\begin{array}{lll}0 & 13 & 041\end{array}$ | Pasquill-Gifford stability category | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 13 & 042\end{array}$ | Parcel lifted index (to 500 hPa ) |  | 0 | -20 | 6 |  | 0 | 2 |
| $\begin{array}{llll}0 & 13 & 043\end{array}$ | Best lifted index (to $\mathbf{5 0 0} \mathbf{~ h P a}$ ) | K | 0 | -20 | 6 | K | 0 | 2 |
| $\begin{array}{llll}0 & 13 & 051\end{array}$ | Frequency group, precipitation | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 13 & 052\end{array}$ | Highest daily amount of precipitation | kg m-2 | 1 | -1 | 14 | kg m-2 | 1 | 5 |
| $\begin{array}{llll}0 & 13 & 055\end{array}$ | Intensity of precipitation | kg min $\mathbf{s}^{\mathbf{- 1}}$ | 4 | 0 | 8 | $\mathrm{mm} \mathrm{h}^{-1}$ | 1 | 4 |
| $\begin{array}{llll}0 & 13 & 058\end{array}$ | Size of precipitating element | m | 4 | 0 | 7 | mm | 1 | 3 |
| $\begin{array}{llll}0 & 13 & 059\end{array}$ | Number of flashes (thunderstorm) | Numeric | 0 | 0 | 7 | Numeric | 0 | 3 |
| 013060 | Total accumulated precipitation | kg m-2 | 1 | -10 | 17 | kg m-2 | 1 | 5 |
| $0 \begin{array}{llll}0 & 13 & 071\end{array}$ | Upstream water level | m | 2 | 0 | 14 | m | 2 | 4 |
| $\begin{array}{llll}0 & 13 & 072\end{array}$ | Downstream water level | m | 2 | 0 | 14 | m | 2 | 4 |
| $0 \begin{array}{llll}0 & 13 & 073\end{array}$ | Maximum water level | m | 2 | 0 | 14 | m | 2 | 4 |
| $\begin{array}{llll}0 & 13 & 080\end{array}$ | Water pH | pH unit | 1 | 0 | 10 | pH unit | 1 | 3 |
| $\begin{array}{llll}0 & 13 & 081\end{array}$ | Water conductivity | Siemens $\mathbf{m}^{\mathbf{- 1}}$ | 3 | 0 | 14 | Siemens $\mathbf{m}^{\mathbf{- 1}}$ | 3 | 4 |
| $\begin{array}{llll}0 & 13 & 082\end{array}$ | Water temperature | K | 1 | 0 | 12 | K | 1 | 4 |
| $\begin{array}{llll}0 & 13 & 083\end{array}$ | Dissolved oxygen | Kg m-3 | 6 | 0 | 15 | kg m-3 | 6 | 5 |
| 013084 | Turbidity | Lumen | 0 | 0 | 14 | Lumen | 0 | 4 |
| $0 \quad 13085$ | Oxydation Reduction Potential (ORP) | V | 3 | 0 | 14 | V | 3 | 4 |

[^10](Class 13 - continued)
(3) The "parcel lifted index" (as defined in the International Meteorological Vocabulary (WMO-No. 182) under the listing "lifted index") is defined as the temperature difference between the ambient 500 hPa temperature ( T 500 ) and that of a parcel of air lifted from the surface (Tparcel) following the dry and moist adiabatic process. Negative values of (T500-Tparcel) suggest instability. The "best lifted index" is defined as the most unstable of a collection of parcel lifted indices, with parcel initial conditions defined for a collection of 30 hPa thick layers stacked one upon the other with the lowest resting on the ground. Commonly four to six such layers are used in the calculation.
Since the two lifted indices ( 042 and 043 ) are defined as temperature differences, they may take on negative values, even though the units are kelvin; hence the non-zero reference value.
(5) Descriptor 013033 should be used instead of descriptor 013032 to encode evaporation/evapotranspiration.
Class 14 - BUFR/CREX Radiation and radiance

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 014001 | Long-wave radiation, integrated over 24 hours | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | -2048 | 12 | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | 4 |
| $0 \quad 14 \quad 002$ | Long-wave radiation, integrated over period specified | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | -2048 | 12 | $\mathrm{J} \mathbf{m}^{\mathbf{- 2}}$ | -3 | 4 |
| $0 \quad 14003$ | Short-wave radiation, integrated over 24 hours | $\boldsymbol{J} \mathbf{m}^{\mathbf{- 2}}$ | -3 | -2048 | 12 | $\boldsymbol{J} \mathbf{m}^{\mathbf{- 2}}$ | -3 | 4 |
| $0 \quad 14 \quad 004$ | Short-wave radiation, integrated over period specified | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | -2048 | 12 | $\mathrm{J} \mathbf{m}^{\mathbf{- 2}}$ | -3 | 4 |
| $0 \quad 14 \quad 011$ | Net long-wave radiation, integrated over 24 hours | $\mathbf{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | -2048 | 12 | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | 4 |
| $0 \quad 14 \quad 012$ | Net long-wave radiation, integrated over period specified | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | -2048 | 12 | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | 4 |
| $0 \quad 14 \quad 013$ | Net short-wave radiation, integrated over 24 hours | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | -2048 | 12 | $\mathrm{J} \mathbf{m}^{\mathbf{- 2}}$ | -3 | 4 |
| $0 \quad 14 \quad 014$ | Net short-wave radiation, integrated over period specified | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -3 | -2048 | 12 | $\mathrm{J} \mathbf{m}^{\mathbf{- 2}}$ | -3 | 4 |
| $0 \quad 14 \quad 015$ | Net radiation, integrated over 24 hours | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -4 | -16384 | 15 | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -4 | 5 |
| $0 \quad 14016$ | Net radiation, integrated over period specified | $\mathbf{J} \mathrm{m}^{\mathbf{- 2}}$ | -4 | -16384 | 15 | $\mathrm{J} \mathbf{m}^{\mathbf{- 2}}$ | -4 | 5 |
| $\begin{array}{llll}0 & 14 & 017\end{array}$ | Instantaneous long-wave radiation | W m ${ }^{-2}$ | -3 | -2048 | 12 | W m-2 | -3 | 4 |
| $\begin{array}{llll}0 & 14 & 018\end{array}$ | Instantaneous short-wave radiation | W m ${ }^{-2}$ | -3 | -2048 | 12 | W m ${ }^{-2}$ | -3 | 4 |
| $\begin{array}{llll}0 & 14 & 019\end{array}$ | Surface albedo | \% | 0 | 0 | 7 |  | 0 | 3 |
| $0 \quad 14 \quad 020$ | Global solar radiation, integrated over 24 hours | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -4 | 0 | 15 | $\mathrm{J} \mathbf{m}^{\mathbf{- 2}}$ | -4 | 5 |
| $0 \quad 14021$ | Global radiation, integrated over period specified | $\boldsymbol{J} \mathrm{m}^{\mathbf{- 2}}$ | -4 | 0 | 15 | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -4 | 5 |

(Class 14 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| $\begin{array}{lll}0 & 14 & 022\end{array}$ | Diffuse solar radiation, integrated over 24 hours | $\mathrm{J}^{\mathbf{m}}{ }^{\mathbf{2}}$ | -4 | 0 | 15 | $\mathrm{J}^{\mathbf{m}}{ }^{\mathbf{- 2}}$ | -4 | 5 |
| $0 \quad 14 \quad 023$ | Diffuse solar radiation, integrated over period specified | $\boldsymbol{J} \mathbf{m}^{\mathbf{- 2}}$ | -4 | 0 | 15 | J m ${ }^{-2}$ | -4 | 5 |
| $0 \quad 14 \quad 024$ | Direct solar radiation, integrated over 24 hours | $\boldsymbol{J} \mathbf{m}^{\mathbf{- 2}}$ | -4 | 0 | 15 | J m ${ }^{-2}$ | -4 | 5 |
| $0 \quad 14 \quad 025$ | Direct solar radiation, integrated over period specified | $\boldsymbol{J} \mathbf{m}^{\mathbf{- 2}}$ | -4 | 0 | 15 | $\mathrm{J} \mathrm{m}^{\mathbf{- 2}}$ | -4 | 5 |
| $\begin{array}{lll}0 & 14 & 026\end{array}$ | Albedo at the top of clouds | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $\begin{array}{llll}0 & 14 & 027\end{array}$ | Albedo | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $\begin{array}{llll}0 & 14 & 028\end{array}$ | Global solar radiation (high accuracy), integrated over period specified | $\mathrm{J} \mathrm{m}^{-2}$ | -2 | 0 | 16 | J m ${ }^{\mathbf{- 2}}$ | -2 | 5 |
| $0 \quad 14 \quad 029$ | Diffuse solar radiation (high accuracy), integrated over period specified | $\mathrm{J} \mathrm{m}^{-2}$ | -2 | 0 | 16 | $\mathrm{J}^{\mathbf{m}}{ }^{\mathbf{- 2}}$ | -2 | 5 |
| $\begin{array}{llll}0 & 14 & 030\end{array}$ | Direct solar radiation (high accuracy), integrated over period specified | $\mathrm{J} \mathrm{m}^{-2}$ | -2 | 0 | 16 | J m ${ }^{\mathbf{- 2}}$ | -2 | 5 |
| $\begin{array}{lll}0 & 14 & 031\end{array}$ | Total sunshine | Minute | 0 | 0 | 11 | Minute | 0 | 4 |
| $\begin{array}{lll}0 & 14 & 032\end{array}$ | Total sunshine | Hour | 0 | 0 | 10 | Hour | 0 | 4 |
| $\begin{array}{llll}0 & 14 & 033\end{array}$ | Total sunshine | \% | 0 | 0 | 9 | \% | 0 | 3 |
| $\begin{array}{llll}0 & 14 & 034\end{array}$ | Sunshine over period specified | Minute | 0 | 0 | 11 | Minute | 0 | 4 |
| $\begin{array}{llll}0 & 14 & 042\end{array}$ | Bidirectional reflectance |  | 0 | 0 | 7 |  | 0 | 3 |
| $\begin{array}{llll}0 & 14 & 045\end{array}$ | Channel radiance | W m $\mathrm{m}^{-2} \mathrm{sr}^{\mathbf{1}} \mathrm{cm}^{-1}$ | 0 | 0 | 11 | W m $\mathrm{m}^{-2} \mathrm{sr}^{1} \mathrm{~cm}^{-1}$ | 0 | 4 |
| $\begin{array}{llll}0 & 14 & 051\end{array}$ | Direct solar radiation integrated over last hour | J m ${ }^{-2}$ | -3 | 0 | 14 | J m ${ }^{\mathbf{- 2}}$ | -3 | 4 |

(Class 14 - continued)
(1) Downward radiation shall be assigned negative values.
2) Upward radiation shall be assigned positive values.
(3) Where the expression "period specified" is entered under element name, an appropriate period shall be specified using descriptors from class 04. (4) Channel radiance (0 14045 ) uses cm to represent the wave number.
Class 15 - BUFR/CREX Physical/chemical constituents

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  |  |
| 015001 | Ozone | DU | 0 | 0 | 10 | DU | 0 | 4 |
| $\begin{array}{lll}0 & 15 & 002\end{array}$ | Air mass (slant path at $\mathbf{2 2 ~ k m}$ ) | Numeric | 2 | 0 | 10 | Numeric | 2 | 3 |
| $0 \quad 15003$ | Measured ozone partial pressure (sounding) | Pascal | 4 | 0 | 9 | nbar | 0 | 3 |
| 015004 | Ozone sounding correction factor (CF) | Numeric | 3 | 0 | 11 | Numeric | 3 | 4 |
| 015005 | Ozone p | DU | 0 | 0 | 10 | DU | 0 | 3 |
| 015011 | Log 10 of integrated electron density | $\log \left(\mathrm{m}^{-2}\right)$ | 3 | 14000 | 13 | $\log \left(m^{-2}\right)$ | 3 | 4 |
| $\begin{array}{llll}0 & 15 & 015\end{array}$ | Maximum image spectral component before normalization | Numeric | 0 | 0 | 31 | Numeric | 0 | 10 |
| $0 \quad 15020$ | Integrated ozone density | kg m ${ }^{\mathbf{- 2}}$ | 8 | 0 | 21 | $\mathbf{K g ~ m}{ }^{\mathbf{- 2}}$ | 8 | 7 |

Notes:
(1) 015003 is partial pressure of ozone, measured at the pressure level identified by 007004 .
(2) 015004 (CF) is defined as:
here TOI is the integrated ozone value obtained "simultaneously to a sounding" from a Dobson or Brewer spectrophotometer at the site or "nearby" and TOS is the total ozone obtained from the sounding. TOS is the sum of the integrated ozone below the lowest pressure level reached by the sounding and the estimate of the amount above. In the absence of any spectrophotometer measurement, CF = Missing value.
(3) 015005 is the value obtained as the result of the vertical integration of the sounding values ( 015003 ) measured below the lowest pressure level reached by the sonde, multiplied by 015004 .
(4) $D U=$ Dobson unit.
Class 15 - BUFR/CREX Physical/chemical constituents

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  |  |
| 015001 | Ozone | DU | 0 | 0 | 10 | DU | 0 | 4 |
| $\begin{array}{lll}0 & 15 & 002\end{array}$ | Air mass (slant path at $\mathbf{2 2 ~ k m}$ ) | Numeric | 2 | 0 | 10 | Numeric | 2 | 3 |
| $0 \quad 15003$ | Measured ozone partial pressure (sounding) | Pascal | 4 | 0 | 9 | nbar | 0 | 3 |
| 015004 | Ozone sounding correction factor (CF) | Numeric | 3 | 0 | 11 | Numeric | 3 | 4 |
| 015005 | Ozone p | DU | 0 | 0 | 10 | DU | 0 | 3 |
| 015011 | Log 10 of integrated electron density | $\log \left(\mathrm{m}^{-2}\right)$ | 3 | 14000 | 13 | $\log \left(m^{-2}\right)$ | 3 | 4 |
| $\begin{array}{llll}0 & 15 & 015\end{array}$ | Maximum image spectral component before normalization | Numeric | 0 | 0 | 31 | Numeric | 0 | 10 |
| $0 \quad 15020$ | Integrated ozone density | kg m ${ }^{\mathbf{- 2}}$ | 8 | 0 | 21 | $\mathbf{K g ~ m}{ }^{\mathbf{- 2}}$ | 8 | 7 |

Notes:
(1) 015003 is partial pressure of ozone, measured at the pressure level identified by 007004 .
(2) 015004 (CF) is defined as:
here TOI is the integrated ozone value obtained "simultaneously to a sounding" from a Dobson or Brewer spectrophotometer at the site or "nearby" and TOS is the total ozone obtained from the sounding. TOS is the sum of the integrated ozone below the lowest pressure level reached by the sounding and the estimate of the amount above. In the absence of any spectrophotometer measurement, CF = Missing value.
(3) 015005 is the value obtained as the result of the vertical integration of the sounding values ( 015003 ) measured below the lowest pressure level reached by the sonde, multiplied by 015004 .
(4) $D U=$ Dobson unit.
Class 19 - BUFR/CREX Synoptic features

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | $\begin{aligned} & \text { DATA } \\ & \text { WIDTH } \end{aligned}$ | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| $\begin{array}{lll}0 & 19 & 001\end{array}$ | Type of synoptic feature | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $0 \quad 19002$ | Effective radius of feature |  | -2 | 0 | 12 |  | -2 | 4 |
| $0 \quad 19003$ | Wind speed threshold | $\mathrm{m} \mathrm{s}^{-1}$ | 0 | 0 | 8 | $\mathrm{m} \mathrm{s}^{-1}$ | 0 | 3 |
| $0 \quad 19004$ | Effective radius with respect to wind speeds above threshold | m | -2 | 0 | 12 | m | -2 | 4 |
| $\begin{array}{lll}0 & 19 & 005\end{array}$ | Direction of motion of feature | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $0 \quad 19006$ | Speed of motion of feature | m sis | 2 | 0 | 14 | m s ${ }^{-1}$ | 2 | 5 |
| $\begin{array}{llll}0 & 19 & 007\end{array}$ | Effective radius of feature | m | -3 | 0 | 12 | m | -3 | 4 |
| $\begin{array}{llll}0 & 19 & 008\end{array}$ | Vertical extent of circulation | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $\begin{array}{lll}0 & 19 & 009\end{array}$ | Effective radius with respect to wind speeds above threshold (large storms) | m | -3 | 0 | 12 |  | -3 | 4 |
| $0 \quad 19010$ | Method for tracking the centre of synoptic feature | Code table | 0 | 0 | 4 | Code table | 0 | 2 |

Class 20 - BUFR/CREX Observed phenomena

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 020001 | Horizontal visibility | m | -1 | 0 | 13 | m | -1 | 4 |
| 020002 | Vertic al visibility | m | -1 | 0 | 7 | m | -1 | 3 |
| $0 \quad 20003$ | Present weather (see Note 1) | Code table | 0 | 0 | 9 | Code table | 0 | 3 |
| 020004 | Past weather (1) (see Note 2) | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| 020005 | Past weather (2) (see Note 2) | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| 020008 | Cloud distribution for aviation | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| 020009 | General weather indicator (TAF/METAR) | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 020010 | Cloud cover (total) | \% | 0 | 0 | 7 | \% | 0 | 3 |
| 020011 | Cloud amount | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 020012 | Cloud type | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| 020013 | Height of base of cloud | m | -1 | -40 | 11 | m | -1 | 4 |
| $0 \quad 20014$ | Height of top of cloud | m | -1 | -40 | 11 | m | -1 | 4 |
| 020015 | Pressure at base of cloud | Pa | -1 | 0 | 14 | Pa | -1 | 5 |
| 020016 | Pressure at top of cloud | Pa | -1 | 0 | 14 | Pa | -1 | 5 |
| 020017 | Cloud top description | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 020018 | Tendency of runway visual range | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| 020019 | Significant present or forec ast weather | CCITT IA5 | 0 | 0 | 72 | Character | 0 | 9 |
| 020020 | Significant recent weather phenomena | CCITT IA5 | 0 | 0 | 32 | Character | 0 | 4 |
| 020021 | Type of precipitation | Flag table | 0 | 0 | 30 | Flag table | 0 | 10 |
| 020022 | Character of precipitation | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 020023 | Other weather phenomena | Flag table | 0 | 0 | 18 | Flag table | 0 | 6 |
| 020024 | Intensity of phenomena | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $0 \quad 20025$ | Obscuration | Flag table | 0 | 0 | 21 | Flag table | 0 | 7 |
| 020026 | Character of obsc uration | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 20027$ | Phenomena occurrence | Flag table | 0 | 0 | 9 | Flag table | 0 | 3 |

(Class 20 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 020031 | Ice deposit (thickness) | m | 2 | 0 | 7 | m | 2 | 3 |
| $0 \quad 20032$ | Rate of ice accretion | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 020033 | Cause of ice accretion | Flag table | 0 | 0 | 4 | Flag table | 0 | 2 |
| $0 \quad 20034$ | Sea ice concentration | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $0 \quad 20035$ | Amount and type of ice | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 20036$ | Ice situation | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 20 & 037\end{array}$ | Ice development | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $0 \quad 20038$ | Bearing of ice edge (see Note 3) | Degree true | 0 | 0 | 12 | Degree true | 0 | 3 |
| 020039 | Ice distance |  | -1 | 0 | 13 | m | -1 | 4 |
| $0 \quad 20041$ | Airframe icing | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 020051 | Amount of low clouds | \% | 0 | 0 | 7 | \% | 0 | 3 |
| 020052 | Amount of middle clouds | \% | 0 | 0 | 7 | \% | 0 | 3 |
| 020053 | Amount of high clouds | \% | 0 | 0 | 7 | \% | 0 | 3 |
| 020061 | Runway visual range (RVR) | m | 0 | 0 | 12 | m | 0 | 4 |
| 020062 | State of the ground (with or without snow) | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| 020063 | Special phenomena | Code table | 0 | 0 | 10 | Code table | 0 | 4 |
| $0 \quad 20070$ | Minimum number of atmospherics | Numeric | 0 | 0 | 7 | Numeric | 0 | 3 |
| $0 \quad 20071$ | Accuracy of fix and rate of atmospherics | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 020081 | Cloud amount in segment | \% | 0 | 0 | 7 | \% | 0 | 3 |
| 020082 | Amount segment cloud free | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $0 \quad 20090$ | Special clouds | Code table | 0 | 0 | 4 | Code table | 0 | 2 |

(Class 20 - continued)
Notes :
(1) When encoding present weather reported from an automatic weather station, the appropriate combination of descriptors $020021,020022,020023,020$
$024,020025,020026$ and 020027 should be used and preferred. Descriptor 020003 should be used only when descriptors mentioned above are not
applicable.
(2) When encoding past weather reported from an automatic weather station, the appropriate combination of descriptors $020021,020022,020023,020024$,
020025,020026 and 020027 should be used and preferred. Descriptors 020004 or 020005 should be used only when descriptors mentioned above
are not applicable.
(3) The data width for descriptor 020038 originally defined to be 12 is wrong. 9 bits are sufficient as for all the other "degree true" quantities. However, the
12-bit width is maintained for historical consistency.
Class 21 - BUFR/CREX Radar data

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  | (Characters) |
| 021001 | Horizontal reflectivity | dB | 0 | -64 | 7 | dB | 0 | 3 |
| 021002 | Vertical reflectivity | dB | 0 | -64 | 7 | dB | 0 | 3 |
| 021003 | Differential reflectivity | dB | 1 | -5 | 7 | dB | 1 | 3 |
| 021005 | Linear depolarization ratio | dB | 0 | -65 | 6 | dB | 0 | 2 |
| 021006 | Circular depolarization ratio | dB | 0 | -65 | 6 | dB | 0 | 2 |
| 0221011 | Doppler mean velocity in x -direction | m s ${ }^{-1}$ | 0 | -128 | 8 | m s ${ }^{-1}$ | 0 | 3 |
| 0221012 | Doppler mean velocity in $\mathbf{y}$-direction | $\mathrm{m} \mathrm{s}^{-1}$ | 0 | -128 | 8 | m s ${ }^{-1}$ | 0 | 3 |
| 0221013 | Doppler mean velocity in $\mathbf{z}$-direction | m sil | 0 | -128 | 8 | m s ${ }^{-1}$ | 0 | 3 |
| 0221014 | Doppler mean velocity (radial) | m sis | 1 | -4096 | 13 | m s ${ }^{-1}$ | 1 | 4 |
| 0221017 | Doppler velocity spectral width | m s ${ }^{-1}$ | 1 | 0 | 8 | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | 3 |
| $\begin{array}{llll}0 & 21 & 021\end{array}$ | Echo tops | m | -3 | 0 | 4 | m | -3 | 2 |
| 021030 | Signal to noise ratio | dB | 0 | -32 | 8 | dB | 0 | 3 |
| 021031 | Vertic ally-integrated liquid-water content | kg m-2 | 0 | 0 | 7 | kg m-2 | 0 | 3 |
| 0221036 | Radar rainfall intensity | $\mathrm{m} \mathrm{s}^{-1}$ | 7 | 0 | 12 | $\mathrm{m} \mathrm{s}^{-1}$ | 7 | 4 |
| 0221041 | Bright-band height | m | -2 | 0 | 8 | m | -2 | 3 |
| 021051 | Signal power above 1 mW | dB | 0 | -256 | 8 | dB | 0 | 3 |
| 021062 | Backscatter | Decibels | 2 | -5000 | 13 | dB | 2 | 4 |
| 021063 | Radiometric resolution (noise value) | \% | 1 | 0 | 10 | \% | 1 | 4 |
| 021064 | Clutter noise estimate | Numeric | 0 | 0 | 8 | Numeric | 0 | 3 |
| $\begin{array}{llll}0 & 21 & 065\end{array}$ | Missing packet counter | Numeric | 0 | -127 | 8 | Numeric | 0 | 3 |
| 021066 | Wave scatterometer product confidence data | Flag table | 0 | 0 | 12 | Flag table | 0 | 4 |
| $\begin{array}{lll}0 & 21 & 067\end{array}$ | Wind product confidence data | Flag table | 0 | 0 | 13 | Flag table | 0 | 5 |
| 021068 | Radar altimeter product confidence data | Flag table | 0 | 0 | 8 | Flag table | 0 | 3 |
| 021069 | SST product confidence data | Flag table | 0 | 0 | 10 | Flag table | 0 | 4 |

(Class 21 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  | (Characters) |
| 021070 | SST product confidence data (SADIST-2) | Flag table | 0 | 0 | 23 | Flag table | 0 | 6 |
| 021071 | Peakiness | Numeric | 0 | 0 | 16 | Numeric | 0 | 5 |
| 0210072 | Satellite altimeter calibration status | Flag table | 0 | 0 | 4 | Flag table | 0 | 2 |
| 021073 | Satellite altimeter instrument mode | Flag table | 0 | 0 | 9 | Flag table | 0 | 3 |
| 021075 | Image spectrum intensity | Numeric | 0 | 0 | 8 | Numeric | 0 | 3 |
| 021076 | Representation of intensities | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 0821077 | Altitude correction (ionosphere) | m | 3 | 0 | 14 | m | 3 | 5 |
| $\begin{array}{llll}0 & 21 & 078\end{array}$ | Altitude correction (dry troposphere) | m | 3 | 0 | 9 | m | 3 | 3 |
| 021079 | Altitude correction (wet troposphere) | m | 3 | 2000 | 10 | m | 3 | 4 |
| 021080 | Altitude correction (calibration constant) | m | 3 | 0 | 11 | m | 3 | 4 |
| 021081 | Open loop correction (height-time loop) | m | 3 | 0 | 10 | m | 3 | 4 |
| 021082 | Open loop correction (auto gain control) | dB | 3 | -3000 | 14 | dB | 3 | 5 |
| 021085 | ATSR sea surface temperature across-track band number | Numeric | 0 | 0 | 4 | Numeric | 0 | 2 |
| 021091 | Radar signal Doppler spectrum Oth moment | dB | 0 | -100 | 8 | dB | 0 | 3 |
| 021092 | RASS signal Doppler spectrum 0th moment, referring to RASS signal | dB | 0 | -100 | 8 | dB | 0 | 3 |
| 0210101 | Number of vector ambiguities | Numeric | 0 | 0 | 3 | Numeric | 0 | 1 |
| $0 \begin{array}{lll}0 & 21 & 102\end{array}$ | Index of selected wind vector | Numeric | 0 | 0 | 3 | Numeric | 0 | 1 |
| $0 \quad 21103$ | Total number of sigma-0 measurements | Numeric | 0 | 0 | 5 | Numeric | 0 | 2 |
| $0 \quad 21104$ | Likelihood computed for solution | Numeric | 3 | -30000 | 15 | Numeric | 3 | 5 |

(Class 21 - continued)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  | Characters) |
| 021105 | Normalized radar cross-section | dB | 2 | -10000 | 14 | dB | 2 | 5 |
| $0 \quad 21106$ | Kp variance coefficient (alpha) | Numeric | 3 | 0 | 14 | Numeric | 3 | 5 |
| $0 \quad 21107$ | Kp variance coefficient (beta) | Numeric | 8 | 0 | 16 | Numeric | 8 | 5 |
| $0 \quad 21109$ | SEAWINDS wind vector cell quality | Flag table | 0 | 0 | 17 | Flag table | 0 | 6 |
| 021110 | Number of inner-beam sigma-0 (forward of satellite) | Numeric | 0 | 0 | 6 | Numeric | 0 | 2 |
| $0 \quad 21111$ | Number of outer-beam sigma-0 (forward of satellite) | Numeric | 0 | 0 | 6 | Numeric | 0 | 2 |
| $0 \quad 21112$ | Number of inner-beam sigma-0 (aft of satellite) | Numeric | 0 | 0 | 6 | Numeric | 0 | 2 |
| $0 \quad 21113$ | Number of outer-beam sigma-0 (aft of satellite) | Numeric | 0 | 0 | 6 | Numeric | 0 | 2 |
| $0 \begin{array}{lll}0 & 21 & 114\end{array}$ | Kp variance coefficent (gamma) | dB | 3 | -140000 | 18 | dB | 3 | 6 |
| $0 \quad 21115$ | SEAWINDS sigma-0 quality | Flag table | 0 | 0 | 17 | Flag table | 0 | 6 |
| 021116 | SEAWINDS sigma-0 mode | Flag table | 0 | 0 | 17 | Flag table | 0 | 6 |
| $0 \quad 21117$ | Sigma-0 variance quality control | Numeric | 2 | 0 | 16 | Numeric | 2 | 5 |
| $0 \begin{array}{lll}0 & 21 & 118\end{array}$ | Attenuation correction on sigma-0 | dB | 2 | -10000 | 14 | dB | 2 | 5 |
| $0 \quad 21119$ | Wind scatterometer geophysical model function | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 21 & 120\end{array}$ | Probability of rain | Numeric | 3 | 0 | 10 | Numeric | 3 | 4 |
| $\begin{array}{llll}0 & 21 & 121\end{array}$ | SEAWINDS NOF* rain index | Numeric | 0 | 0 | 8 | Numeric | 0 | 3 |
| $0 \quad 21122$ | Attenuation correction on sigma-0 (from tB) | dB | 2 | -10000 | 14 | dB | 2 | 5 |
| $0 \quad 21123$ | SEAWINDS normalized radar cross-section | dB | 2 | -30000 | 15 | dB | 2 | 5 |

* NOF $=$ Normalized objective function.

FM 94 BUFR, FM 95 CREX
Class 22 - BUFR/CREX Oceanographic elements

| TABLE <br> REFERENCE <br> $\mathbf{y}$ | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 022001 | Direction of waves | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| 022002 | Direction of wind waves | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| 0222003 | Direction of swell waves | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| 0222004 | Direction of current | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| 0222011 | Period of waves |  | 0 | 0 | 6 | s | 0 | 2 |
| 022012 | Period of wind waves | s | 0 | 0 | 6 | 5 | 0 | 2 |
| $\begin{array}{lll}0 & 22 & 013\end{array}$ | Period of swell waves | s | 0 | 0 | 6 | s | 0 | 2 |
| 0222021 | Height of waves | m | 1 | 0 | 10 | m | 1 | 4 |
| 022022 | Height of wind waves | m | 1 | 0 | 10 | m | 1 | 4 |
| 0222023 | Height of swell waves | m | 1 | 0 | 10 | m | 1 | 4 |
| $\begin{array}{llll}0 & 22 & 025\end{array}$ | Standard deviation wave height | m | 2 | 0 | 10 | m | 2 | 4 |
| 022026 | Standard deviation of significant wave height | m | 2 | 0 | 10 | m | 2 | 4 |
| $\begin{array}{lll}0 & 22 & 031\end{array}$ | Speed of current | $\mathrm{m} \mathrm{s}^{-1}$ | 2 | 0 | 13 | $\mathrm{m} \mathrm{s}^{-1}$ | 2 | 4 |
| 0222035 | Tidal elevation with respect to local chart datum | m | 2 | 0 | 14 | m | 2 | 4 |
| 022036 | Meteorological residual tidal elevation (surge or offset) | m | 2 | 0 | 14 | m | 2 | 4 |
| 0222037 | Tidal elevation with respect to national land datum | m | 3 | -10000 | 15 | m | 3 | 5 |
| 0222038 | Tidal elevation with respect to local chart datum | m | 3 | -10000 | 15 | m | 3 | 5 |
| $\begin{array}{lll} 0 & 22 & 039 \end{array}$ | Meteorological residual tidal elevation (surge or offset) | m | 3 | -5000 | 12 | m | 3 | 4 |
| 022040 | Meteorological residual tidal elevation (surge or offset) | m | 3 | -5000 | 14 | m | 3 | 5 |

(Class 22 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  | (Characters) |
| 022041 | Sea-surface temperature (15-day running mean) | K | 1 | 0 | 12 | K | 1 | 4 |
| 022042 | Sea/water temperature | K | 1 | 0 | 12 | K | 1 | 4 |
| 022043 | Sea/water temperature | K | 2 | 0 | 15 | K | 2 | 5 |
| 022044 | Sound velocity | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | 0 | 14 | $\mathrm{m} \mathrm{s}^{-1}$ | 1 | 5 |
| 022045 | Sea/water temperature | K | 3 | 0 | 19 | K | 3 | 6 |
| 022050 | Standard deviation sea-surface temperature | K | 2 | 0 | 8 | K | 2 | 3 |
| $\begin{array}{lll}0 & 22 & 055\end{array}$ | Float cycle number | Numeric | 0 | 0 | 10 | Numeric | 0 | 3 |
| 022056 | Direction of profile | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| 022061 | State of the sea | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 022062 | Salinity | Part per thousand | 2 | 0 | 14 | Part per thousand | 2 | 5 |
| 022063 | Total water depth |  | 0 | 0 | 14 | m | 0 | 5 |
| 022064 | Salinity | Part per thousand | 3 | 0 | 17 | Part per thousand | 3 | 6 |
| 022065 | Water pressure | Pa | -3 | 0 | 17 | Pa | -3 | 6 |
| 022066 | Water conductivity | S m ${ }^{-1}$ | 6 | 0 | 26 | S m ${ }^{\mathbf{- 1}}$ | 6 | 8 |
| $\begin{array}{llll}0 & 22 & 067\end{array}$ | Instrument type for water temperature profile measurement | Code table | 0 | 0 | 10 | Code table | 0 | 4 |
| 022068 | Water temperature profile recorder types | Code table | 0 | 0 | 7 | Code table | 0 | 3 |
| 022070 | Significant wave height | m | 2 | 0 | 13 | m | 2 | 4 |
| 022071 | Spectral peak wave period | s | 1 | 0 | 9 | s | 1 | 3 |
| 022072 | Spectral peak wave length | m | 0 | 0 | 13 | m | 0 | 4 |
| $\begin{array}{llll}0 & 22 & 073\end{array}$ | Maximum wave height | m | 2 | 0 | 13 | m | 2 | 4 |
| 022074 | Average wave period | s | 1 | 0 | 9 | s | 1 | 3 |
| 022075 | Average wave length | m | 0 | 0 | 13 | m | 0 | 4 |

(Class 22 - continued)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 022076 | Direction from which dominant waves are coming | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $0 \quad 22077$ | Directional spread of dominant wave | Degree | 0 | 0 | 9 | Degree | 0 | 3 |
| $\begin{array}{llll}0 & 22 & 078\end{array}$ | Duration of wave record | s | 0 | 0 | 12 | s | 0 | 4 |
| 0222079 | Length of wave record | m | 0 | 0 | 16 | m | 0 | 5 |
| $\begin{array}{llll}0 & 22 & 080\end{array}$ | Waveband central frequency | Hz | 3 | 0 | 10 | Hz | 3 | 4 |
| 0222081 | Waveband central wave number | $\mathrm{m}^{-1}$ | 5 | 0 | 13 | $\mathrm{m}^{\mathbf{- 1}}$ | 5 | 4 |
| 022082 | Maximum non-directional spectral wave density | $\mathrm{m}^{2} \mathrm{~s}$ | 2 | 0 | 20 | $\mathrm{m}^{2} \mathrm{~s}$ | 2 | 7 |
| 022083 | Maximum non-directional spectral wave number | $\mathrm{m}^{3}$ | 2 | 0 | 20 | $\mathrm{m}^{3}$ | 2 | 7 |
| 022084 | Band containing maximum nondirectional spectral wave density | Numeric | 0 | 0 | 7 | Numeric | 0 | 3 |
| 0222085 | Spectral wave density ratio | Numeric | 0 | 0 | 7 | Numeric | 0 | 3 |
| $0 \quad 22086$ | Mean direction from which waves are coming | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $\begin{array}{lll} 0 & 22 & 087 \end{array}$ | Principal direction from which waves are coming | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| $0 \quad 22088$ | First normalized polar coordinate from Fourier coefficients | Numeric | 2 | 0 | 7 | Numeric | 2 | 3 |
| $0 \quad 22 \quad 089$ | Second normalized polar coordinate from Fourier coefficients | Numeric | 2 | 0 | 7 | Numeric | 2 | 3 |
| 022090 | Non-directional spectral estimate by wave frequency | $\mathrm{m}^{2} \mathrm{~s}$ | 2 | 0 | 20 | $\mathrm{m}^{2} \mathrm{~s}$ | 2 | 7 |
| $\begin{array}{lll} 0 & 22 & 091 \end{array}$ | Non-directional spectral estimate by wave number | $\mathrm{m}^{3}$ | 2 | 0 | 20 | $\mathrm{m}^{3}$ | 2 | 7 |
| 022092 | Directional spectral estimate by wave frequency | $\mathrm{m}^{2} \mathrm{rad}^{-1} \mathrm{~s}$ | 2 | 0 | 20 | $\mathrm{m}^{2} \mathrm{rad}^{-1} \mathrm{~s}$ | 2 | 7 |

(Class 22 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X}$ |  |  |  |  |  |  |  | haracters |
| 022093 | Directional spectral estimate by wave number | $\mathrm{m}^{4}$ | 2 | 0 | 20 | $\mathrm{m}^{4}$ | 2 | 7 |
| 022094 | Total number of wave bands | Numeric | 0 | 0 | 7 | Numeric | 0 | 3 |
| 022095 | Directional spread of individual waves | Degree | 0 | 0 | 8 | Degree | 0 | 3 |
| 022096 | Spectral band width | $\mathbf{s}^{-1}$ | 3 | 0 | 4 | $\mathbf{s}^{-1}$ | 3 | 2 |
| 022097 | Mean wavelength > 731 m of image spectrum at low wave numbers | m | 0 | 0 | 14 | m | 0 | 5 |
| 022098 | Wavelength spread (wavelength $>731 \mathrm{~m}$ ) at low wave numbers | m | 0 | 0 | 14 | m | 0 | 5 |
| 022099 | Mean direction at low wave numbers (wavelength > 731 m ) | Degree true | 0 | 0 | 9 | Degree true | 0 | 3 |
| 022100 | Direction spread at low wave numbers (wavelength > 731 m ) | Degree | 0 | 0 | 9 | Degree | 0 | 3 |
| 022101 | Total energy (wavelength > 731 m ) at low wave numbers | Numeric | 0 | 0 | 31 | Numeric | 0 | 10 |
| 022120 | Tide station automated water level check | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| 022121 | Tide station manual water level check | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $0 \quad 22122$ | Tide station automated meteorological data check | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| 022123 | Tide station manual meteorological data check | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| 022141 | Sea-surface temperature (15-day running mean) | K | 2 | 0 | 15 | K | 2 | 5 |

(Class 22 - continued)
(1) The significant wave height is defined as four times the square root of the energy spectrum integrated over direction and frequency. It corresponds to about
the height that one-third of all waves exceed.
(2) The dominant wave is the one that has the maximum energy in the energy spectrum.
(3) Mean wave direction is the angle alpha 1 and principal wave direction is the angle alpha 2, in the expression $S(f$, alpha) approximately equals:
$c_{11} \times\left(0.5+r_{1} \times \cos\right.$ (alpha-alpha 1$)+r_{2} \times \cos (2$ (alpha-alpha 2$\left.\left.)\right)\right) /$ pi
in which $S\left(f\right.$, alpha) is the wave directional spectrum and $c_{11}$ is the non-directional spectrum, and the right hand side of this expression is the first two terms
of the Fourier series expansion of $S$ (f, alpha). If the mean and principal directions differ significantly (e.g. more than 15 degrees) for a given frequency, crossing
seas are indicated.
(4) Descriptor 022040 should be used instead of 022039 for encoding meteorological residual tidal elevation (surge or offset).
(5) Additional information:
022097 nominal input range $0-10000$
022098 nominal input range $0-10000$
022099 nominal input range $0-359$
022100 nominal input range $0-359$
022101 nominal input range $0-2 \times 106$, but may be greater because of uncertainty.
(6) Descriptors $022001,022002,022003$ : the direction given in these entries is the direction which waves are coming from.
(7) Descriptor 022004 : the direction given in this entry is the direction towards which current is flowing.
(8) Wind waves and waves reporting standards:
Direction
Missing
1-360
Missing
$1-360$

$$
\begin{aligned}
& \text { Speed } \\
& \frac{-}{V} \\
& 000 \cdot \frac{0_{N}^{N}}{\sum_{i}^{N}}
\end{aligned}
$$

## Observation

No observation
Calm
Normal observation
Speed only
"Light and variable"
Class 23 - BUFR/CREX Dispersal and transport


FM 94 BUFR, FM 95 CREX
Class 24 - BUFR/CREX Radiological elements

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathrm{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 024001 | Estimate of amount of radioactivity released up to specified time | Bq* | -11 | 0 | 28 | Bq* | -11 | 9 |
| $\begin{array}{lll}0 & 24 & 002\end{array}$ | Estimated maximum potential release | Bq | -11 | 0 | 28 | Bq | -11 | 9 |
| 024003 | Composition of release | Code table | 0 | 0 | 5 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 24 & 004\end{array}$ | Element name | CCITT IA5 | 0 | 0 | 16 | Character | 0 | 2 |
| $\begin{array}{llll}0 & 24 & 005\end{array}$ | Isotope mass | Numeric | 0 | 0 | 9 | Numeric | 0 | 3 |
| $\begin{array}{llll}0 & 24 & 011\end{array}$ | Dose | mS $\mathrm{v}^{* / * *}$ | 2 | 0 | 32 | mSv*/** | 2 | 10 |
| 024012 | Trajectory dose (defined location and expected time of arrival) | mSv | 2 | 0 | 32 | mSv | 2 | 10 |
| 024013 | Gamma dose in air along the main transport path (defined location and time period) | mSv | 2 | 0 | 32 | mSv | 2 | 10 |
| $0 \quad 24021$ | Air concentration (of named isotope type including gross beta) | Bq m ${ }^{-3}$ | 2 | 0 | 32 | Bq m ${ }^{-3}$ | 2 | 10 |
| 024022 | Concentration in precipitation (of named isotope type) | Bq $\mathbf{1}^{\mathbf{- 1}}$ | 2 | 0 | 32 | $\mathrm{Bq}^{-1}$ | 2 | 10 |
| $\begin{array}{lll}0 & 24 & 023\end{array}$ | Pulse rate of beta radiation | $\mathbf{s}^{-1}$ | 1 | 0 | 14 | $\mathrm{s}^{-1}$ | 1 | 4 |
| $\begin{array}{llll}0 & 24 & 024\end{array}$ | Pulse rate of gamma radiation | $\mathbf{s}^{-1}$ | 1 | 0 | 14 | $\mathbf{s}^{\mathbf{- 1}}$ | 1 | 4 |

N ote: Useful ranges used above:
$0^{1011} \mathrm{~Bq}$ to $10^{19} \mathrm{~Bq}$ for releases;
$10^{-2} \mathrm{~Bq}$ to $10^{7} \mathrm{~Bq}$ and $10^{-2} \mathrm{mSv}$ to $10^{7} \mathrm{mSv}$ for concentration and doses.

Relationship,
$1 \mathrm{Ci}=3.7 \times 10^{10} \mathrm{~Bq}$
$1 \mathrm{rem}=0.01 \mathrm{~Sv}$

Old special
unit and symbol
curie (Ci)
curie (Ci)
n other
SI units
J $\mathbf{k g}^{-1}$

* New named unit

New named unit
and symbol
becquerel (Bq)
** Millisievert
Class 25 - BUFR/CREX Processing information

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 025001 | Range-gate length | m | -1 | 0 | 6 | m | -1 | 2 |
| $\begin{array}{lll}0 & 25 & 002\end{array}$ | Number of gates averaged | Numeric | 0 | 0 | 4 | Numeric | 0 | 2 |
| $\begin{array}{lll}0 & 25 & 003\end{array}$ | Number of integrated pulses | Numeric | 0 | 0 | 8 | Numeric | 0 | 3 |
| $\begin{array}{lll}0 & 25 & 004\end{array}$ | Echo processing | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{lll}0 & 25 & 005\end{array}$ | Echo integration | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{lll}0 & 25 & 006\end{array}$ | $Z$ to $R$ conversion | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 25 & 007\end{array}$ | $Z$ to $R$ conversion factor | Numeric | 0 | 0 | 12 | Numeric | 0 | 4 |
| $\begin{array}{llll}0 & 25 & 008\end{array}$ | Z to R conversion exponent | Numeric | 2 | 0 | 9 | Numeric | 2 | 3 |
| 025009 | Calibration method | Flag table | 0 | 0 | 4 | Flag table | 0 | 2 |
| 025010 | Clutter treatment | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| 025011 | Ground occultation correction (screening) | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{lll}0 & 25 & 012\end{array}$ | Range attenuation correction | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{lll}0 & 25 & 013\end{array}$ | Bright-band correction | Flag table | 0 | 0 | 2 | Flag table | 0 | 1 |
| $\begin{array}{lll}0 & 25 & 014\end{array}$ | Azimuth clutter cut-off (see Note) | Numeric | 0 | 0 | 12 | Numeric | 0 | 4 |
| $\begin{array}{llll}0 & 25 & 015\end{array}$ | Radome attenuation correction | Flag table | 0 | 0 | 2 | Flag table | 0 | 1 |
| $\begin{array}{llll}0 & 25 & 016\end{array}$ | Clear-air attenuation correction | dB m ${ }^{-1}$ | 5 | 0 | 6 | dB m ${ }^{-1}$ | 5 | 2 |
| $\begin{array}{lll}0 & 25 & 017\end{array}$ | Precipitation attenuation correction | Flag table | 0 | 0 | 2 | Flag table | 0 | 1 |
| $\begin{array}{llll}0 & 25 & 018\end{array}$ | A to $\mathbf{Z}$ law for attenuation factor | Numeric | 7 | 0 | 6 | Numeric | 7 | 2 |
| $\begin{array}{lll}0 & 25 & 019\end{array}$ | A to $\mathbf{Z}$ law for attenuation exponent | Numeric | 2 | 0 | 7 | Numeric | 2 | 3 |
| $\begin{array}{lll}0 & 25 & 020\end{array}$ | Mean speed estimation | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 25 & 021\end{array}$ | Wind computation enhancement | Flag table | 0 | 0 | 8 | Flag table | 0 | 3 |
| $\begin{array}{lll}0 & 25 & 025\end{array}$ | Battery voltage |  | 1 | 0 | 9 | V | 1 | 3 |
| $0 \quad 25030$ | Running mean sea-surface temperature usage | Code table | 0 | 0 | 2 | Code table | 0 | 1 |

(Class 25 - continued)

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | Characters) |
| $\begin{array}{lll}0 & 25032\end{array}$ | Wind profiler mode information* | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| 025033 | Wind profiler submode information* | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $0 \quad 25034$ | Wind profiler quality control test results* | Flag table | 0 | 0 | 4 | Flag table | 0 | 2 |
| 025036 | Atmospherics location method | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 25 & 040\end{array}$ | $\mathrm{CO}_{2}$ wind product derivation | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 25041$ | Moving platform direction reporting method | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| 025042 | Moving platform speed reporting method | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| 025043 | Wave sampling interval (time) | s | 4 | 0 | 15 | s | 4 | 5 |
| $\begin{array}{llll}0 & 25 & 044\end{array}$ | Wave sampling interval (space) | m | 2 | 0 | 14 | m | 2 | 5 |
| $\begin{array}{llll}0 & 25 & 045\end{array}$ | HIRS channel combination | Flag table | 0 | 0 | 21 | Flag table | 0 | 7 |
| $\begin{array}{llll}0 & 25 & 046\end{array}$ | MSU channel combination | Flag table | 0 | 0 | 5 | Flag table | 0 | 2 |
| $\begin{array}{llll}0 & 25 & 047\end{array}$ | SSU channel combination | Flag table | 0 | 0 | 4 | Flag table | 0 | 2 |
| $\begin{array}{llll}0 & 25 & 048\end{array}$ | AMSU-A channel combination | Flag table | 0 | 0 | 16 | Flag table | 0 | 6 |
| $\begin{array}{llll}0 & 25 & 049\end{array}$ | AMSU-B channel combination | Flag table | 0 | 0 | 6 | Flag table | 0 | 2 |
| 025051 | AVHRR channel combination | Flag table | 0 | 0 | 7 | Flag table | 0 | 3 |
| $\begin{array}{llll}0 & 25 & 053\end{array}$ | Observation quality | Flag table | 0 | 0 | 12 | Flag table | 0 | 4 |
| 025060 | Software identification | Numeric | 0 | 0 | 14 | Numeric | 0 | 5 |
| 025070 | Major frame count | Numeric | 0 | 0 | 4 | Numeric | 0 | 2 |
| $\begin{array}{llll}0 & 25 & 071\end{array}$ | Frame count | Numeric | 0 | 0 | 5 | Numeric | 0 | 2 |
| $0 \quad 25075$ | Satellite antenna corrections version number | Numeric | 0 | 0 | 5 | Numeric | 0 | 2 |
| 025076 | Log-10 of (Temperature-radiance central wave number) for ATOVS | $\operatorname{Log~m}{ }^{-1}$ | 8 | 0 | 30 | $\boldsymbol{l o g} \mathrm{m}^{-1}$ | 8 | 10 |

[^11]FM 94 BUFR, FM 95 CREX
(Class 25 - continued)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F X Y |  |  |  |  | (Bits) |  |  | (Characters) |
| $\begin{array}{lll}0 & 25077\end{array}$ | Bandwidth correction coefficient 1 for ATOVS | Numeric | 5 | -100000 | 18 | Numeric | 5 | 7 |
| 025078 | Bandwidth correction coefficient 2 for ATOVS | Numeric | 5 | 0 | 17 | Numeric | 5 | 6 |
| $\begin{array}{lll}0 & 25 & 079\end{array}$ | Albedo-radiance solar filtered irradiance for ATOVS | W m-2 | 4 | 0 | 24 | W m ${ }^{-2}$ | 4 | 8 |
| 025080 | Albedo-radiance equivalent filter width for ATOVS | m | 10 | 0 | 14 | m | 10 | 5 |
| $\begin{array}{lll}0 & 25 & 085\end{array}$ | Fraction of clear pixels in HIRS FOV | Numeric | 0 | 0 | 7 | Numeric | 0 | 3 |
| $\begin{array}{llll}0 & 25 & 086\end{array}$ | Depth correction indicator | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 25 & 091\end{array}$ | Structure constant of the refraction index ( $c_{n}{ }^{2}$ ) | dB | 3 | -18192 | 13 | dB | 3 | 5 |
| $\begin{array}{lll}0 & 25 & 092\end{array}$ | Acoustic propagation velocity | $\mathrm{m} \mathrm{s}^{-1}$ | 2 | 28000 | 14 | $\mathrm{m} \mathrm{s}^{-1}$ | 2 | 5 |
| $\begin{array}{lll}0 & 25 & 093\end{array}$ | RASS computation correction | Flag table | 0 | 0 | 8 | Flag table | 0 | 3 |
| $\begin{array}{lll} 0 & 25 & 100 \end{array}$ | XBT/XCTD fall rate equation coefficient a | Numeric | 5 | 0 | 20 | Numeric | 5 | 6 |
| $0 \quad 25101$ | XBT/XCTD fall rate equation coefficient b | Numeric | 5 | -500000 | 21 | Numeric | 5 | 6 |

[^12]

|  | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| TABLE REFERENCE |  | UNIT | SCALE | REFERENCE Value | DATA WIDTH (Bits) | UNIT | SCALE | DATA WIDTH (Characters) |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  |  |
| 026001 | Principal time of daily reading in UTC of maximum temperature | Hour | 1 | 0 | 12 | Hour | 1 | 3 |
| 026002 | Principal time of daily reading in UTC of minimum temperature | Hour | 1 | 0 | 12 | Hour | 1 | 3 |
| 026003 | Time difference | Minute | 0 | -1440 | 12 | Minute | 0 | 4 |
| 026010 | Hours included | Flag table | 0 | 0 | 26 | Flag table | 0 | 9 |

N ote: Descriptor 026003 is to be used with 008025 (time difference qualifier).
Class 27 - BUFR/CREX Non-coordinate location (horizontal - 1)

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F X Y |  |  |  |  |  |  |  |  |
| 027001 | Latitude (high accuracy) | Degree | 5 | -9000000 | 25 | Degree | 5 | 7 |
| $0 \quad 27002$ | Latitude (coarse accuracy) | Degree | 2 | -9000 | 15 | Degree | 2 | 4 |
| 027003 | Alternate latitude (coarse accuracy) | Degree | 2 | -9000 | 15 | Degree | 2 | 4 |
| 027004 | Alternate latitude (high accuracy) | Degree | 5 | -9000000 | 25 | Degree | 5 | 7 |
| 027020 | Satellite location counter | Numeric | 0 | 0 | 16 | Numeric | 0 | 5 |
| 027021 | Satellite sublocation dimension | Numeric | 0 | 0 | 16 | Numeric | 0 | 5 |
| 027031 | In direction of 0 degrees longitude, distance from the Earth's centre | m | 2 | -1073741824 | 31 | m | 2 | 10 |

[^13]| Class 28 - BUFR/CREX Non-coordinate location (horizontal - 2) |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| TABLE REFERENCE |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| $\begin{array}{lll}0 & 28 & 001\end{array}$ | Longitude (high accuracy) | Degree | 5 | -18000000 | 26 | Degree | 5 | 8 |
| 028002 | Longitude (coarse accuracy) | Degree | 2 | -18000 | 16 | Degree | 2 | 5 |
| $\begin{array}{llll}0 & 28 & 003\end{array}$ | Alternate longitude (coarse accuracy) | Degree | 2 | -18000 | 16 | Degree | 2 | 5 |
| $\begin{array}{llll}0 & 28 & 004\end{array}$ | Alternate longitude (high accuracy) | Degree | 5 | -18000000 | 26 | Degree | 5 | 8 |
| 028031 | In direction 90 degrees East, distance from the Earth's centre |  | 2 |  | 31 |  | 2 | 10 |

 (2) The value for descriptor 028031 has been chosen to be suitable for polar orbiting satellites in approximately Sun-synchronous orbits. Geostationary orbits would require greater data widths for distance and slightly less for speed.
(3) Left handed $\mathrm{x}, \mathrm{y}$ and z axes have been chosen for descriptor 028031 .

FM 94 BUFR, FM 95 CREX
Class 29 - BUFR/CREX Map data

| TABLE REFERENCE | ELEMENT NAME | BUFR |  |  |  | Crex |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCEVALUE | DATA WIDTH (Bits) | UNIT | SCALE | $\begin{gathered} \text { DATA } \\ \text { WIDTH } \\ \text { (Characters) } \end{gathered}$ |
| F X Y |  |  |  |  |  |  |  |  |
| 029001 | Projection type | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 029002 | Coordinate grid type | Code table | 0 | 0 | 3 | Code table | 0 | 1 |

Class 30 - BUFR/CREX Image

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | $\begin{aligned} & \text { DATA } \\ & \text { WIDTH } \end{aligned}$ | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 030001 | Pixel value (4 bits) | Numeric | 0 | 0 | 4 | Numeric | 0 | 2 |
| $0 \quad 30002$ | Pixel value (8 bits) | Numeric | 0 | 0 | 8 | Numeric | 0 | 3 |
| $0 \quad 30004$ | Pixel value (16 bits) | Numeric | 0 | 0 | 16 | Numeric | 0 | 5 |
| $0 \begin{array}{lll}0 & 30 & 021\end{array}$ | Number of pixels per row | Numeric | 0 | 0 | 12 | Numeric | 0 | 4 |
| $0 \quad 30022$ | Number of pixels per column | Numeric | 0 | 0 | 12 | Numeric | 0 | 4 |
| $\begin{array}{llll}0 & 30 & 031\end{array}$ | Picture type | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $0 \quad 30032$ | Combination with other data | Flag table | 0 | 0 | 16 | Flag table | 0 | 6 |

Notes:
2) In order to distinguish unambiguously the cases of missing data and saturated pixels, $n$-bit image data should be encoded using a data width of $n+1$. Where such a descriptor is not already available in Class 30, operator descriptor 201 YYY should be used to modify the data width of the existing entry as required.
Class 31 - BUFR Data description operator qualifiers

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| 031000 | Short delayed descriptor replication factor | Numeric | 0 | 0 | 1 |  |  |  |
| $0 \quad 31001$ | Delayed descriptor replication factor | Numeric | 0 | 0 | 8 |  |  |  |
| $\begin{array}{lll} 0 & 31 & 002 \end{array}$ | Extended delayed descriptor replication factor | Numeric | 0 | 0 | 16 |  |  |  |
| $0 \quad 31011$ | Delayed descriptor and data repetition factor | Numeric | 0 | 0 | 8 |  | xistent | CREX |
| $0 \quad 31012$ | Extended delayed descriptor and data repetition factor | Numeric | 0 | 0 | 16 |  |  |  |
| $\begin{array}{lll}0 & 31 & 021\end{array}$ | Associated field significance | Code table | 0 | 0 | 6 |  |  |  |
| 0 | Data present indicator | Flag table | 0 | 0 | 1 |  |  |  |

(1) The "delayed descriptor and data repetition factor" is intended for run-length encoding (e.g. scanning an image). It specifies a count $N$ which applies to both descriptor and data, i.e. the value of the single element defined by the following descriptor is repeated $N$ times (at intervals already specified).
(2) Descriptor $0 \mathbf{3 1} 031$, used in conjunction with quality control or statistics operators $\mathbf{2} \mathbf{2 2} \mathbf{Y Y Y}$ through $\mathbf{2} \mathbf{3 2 Y Y Y}$, shall indicate the presence of quality due is set to zero. It may be used in conjunction present/not present indicators, forming a data present bit-map as defined in Regulation 94.5.5.3. This makes it possible to present quality control information and statistical information for selected data corresponding to element descriptors which precede the 222 to 32 YYY operators.
(3) Other applications of the data present indicator may be developed.
Class 33 - BUFR/CREX Quality information

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  | (Bits) |  |  | (Characters) |
| $0 \begin{array}{lll}0 & 33 & 001\end{array}$ | Reserved |  |  |  |  |  |  |  |
| $\begin{array}{llll}0 & 33 & 002\end{array}$ | Quality information | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 33 & 003\end{array}$ | Quality information | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $0 \begin{array}{lll}0 & 33 & 004\end{array}$ | Reserved |  |  |  |  |  |  |  |
| $\begin{array}{llll}0 & 33 & 007\end{array}$ | Per cent confidence | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $0 \quad 33020$ | Quality control indication of following value | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $\begin{array}{lll}0 & 33 & 021\end{array}$ | Quality of following value | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 33 & 022\end{array}$ | Quality of buoy satellite transmission | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 33 & 023\end{array}$ | Quality of buoy location | Code table | 0 | 0 | 2 | Code table | 0 | 1 |
| 0333024 | Station elevation quality mark (for mobile stations) | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 33 & 025\end{array}$ | ACARS interpolated values | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 33 & 026\end{array}$ | Moisture quality | Code table | 0 | 0 | 6 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 33 & 027\end{array}$ | Location quality class (range of radius of 66 \% confidence) | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 33 & 030\end{array}$ | Scan line status flags for ATOVS | Flag table | 0 | 0 | 24 | Flag table | 0 | 8 |
| $\begin{array}{llll}0 & 33 & 031\end{array}$ | Scan line quality flags for ATOVS | Flag table | 0 | 0 | 24 | Flag table | 0 | 8 |
| $\begin{array}{llll}0 & 33 & 032\end{array}$ | Channel quality flags for ATOVS | Flag table | 0 | 0 | 24 | Flag table | 0 | 8 |
| $\begin{array}{llll}0 & 33 & 033\end{array}$ | Field of view quality flags for ATOVS | Flag table | 0 | 0 | 24 | Flag table | 0 | 8 |
| $\begin{array}{llll}0 & 33 & 035\end{array}$ | Manual/automatic quality control | Code table | 0 | 0 | 4 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 33 & 036\end{array}$ | Nominal confidence threshold | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $\begin{array}{llll}0 & 33 & 037\end{array}$ | Wind correlation error | Flag table | 0 | 0 | 20 | Flag table | 0 | 7 |
| $\begin{array}{llll}0 & 33 & 040\end{array}$ | Confidence interval | \% | 0 | 0 | 7 | \% | 0 | 3 |
| $\begin{array}{llll}0 & 33 & 041\end{array}$ | Attribute of following value | Code table | 0 | 0 | 2 | Code table | 0 | 1 |

Class 35 - BUFR/CREX Data monitoring information

| TABLE REFERENCE | ELEMENT NAME | B UFR |  |  |  | CREX |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  |  | UNIT | SCALE | REFERENCE VALUE | DATA WIDTH | UNIT | SCALE | DATA WIDTH |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |  |  |  | Characters) |
| 035000 | FM and regional code number | Code table | 0 | 0 | 10 | Code table | 0 | 3 |
| 030001 | Time-frame for monitoring | Code table | 0 | 0 | 3 | Code table | 0 | 1 |
| 0305011 | Number of reports actually received | Numeric | 0 | 0 | 14 | Numeric | 0 | 4 |
| $\begin{array}{llll}0 & 35 & 021\end{array}$ | Bulletin being monitored (TTAAii) | C haracter | 0 | 0 | 48 | Character | 0 | 6 |
| $\begin{array}{llll}0 & 35 & 022\end{array}$ | Bulletin being monitored (YYGGgg) | C haracter | 0 | 0 | 48 | Character | 0 | 6 |
| 035030 | Discrepancies in the availability of expected data | Code table | 0 | 0 | 4 | Code table | 0 | 1 |
| $\begin{array}{llll}0 & 35 & 031\end{array}$ | Qualifier on monitoring results | Code table | 0 | 0 | 7 | Code table | 0 | 2 |
| $\begin{array}{llll}0 & 35 & 032\end{array}$ | Cause of missing data | Code table | 0 | 0 | 4 | Code table | 0 | 1 |
| 03035 | Observation and collection deficiencies | Code table | 0 | 0 | 7 | Code table | 0 | 2 |
| 035034 | Statistical trends for availability of data (during the survey period(s)) | Code table | 0 | 0 | 3 | Code table | 0 | 1 |

## BUFR Table C - Data description operators

| $\begin{array}{r} \text { TA } \\ \text { REFE } \end{array}$ | $\begin{aligned} & \text { LE } \\ & \text { ENCE } \end{aligned}$ | OPERAND | OPERATOR NAME | OPERATION DEFINITION |
| :---: | :---: | :---: | :---: | :---: |
| F | X |  |  |  |
| 2 | 01 | Y | Change data width | Add (Y-128) bits to the data width given for each data element in Table B, other than C CITT IA5 (character) data, code or flag tables |
| 2 | 02 | Y | Change scale | Add Y-128 to scale in Table B for elements which are not code or flag tables |
| 2 | 03 | Y | Change reference values | Subsequent element descriptors define new reference values for corresponding Table B entries. Each new reference value is represented by Y bits in the Data section. Definition of new reference values is concluded by coding this operator with $\mathbf{Y}=255$. Negative reference values shall be represented by a positive integer with the left-most bit (bit 1) set to 1 |
| 2 | 04 | Y | Add associated field | Precede each data element with $Y$ bits of information. This operation associates a data field (e.g. quality control information) of $Y$ bits with each data element |
| 2 | 05 | Y | Signify character | Y characters (CCITT International Alphabet No. 5) are inserted as a data field of $Y \times 8$ bits in length |
| 2 | 06 | Y | Signify data width for the immediately following local descriptor | $Y$ bits of data are described by the immediately following descriptor |
| 2 | 21 | YYY | Data not present | Data values present in Section 4 (Data section) corresponding to the following YYY descriptors shall be limited to data from classes 1-9, and class 31 |
| 2 | 22 | 000 | Quality information follows | The values of class 33 elements which follow relate to the data defined by the data present bit-map |
| 2 | 23 | 000 | Substituted values operator | The substituted values which follow relate to the data defined by the data present bit-map |
| 2 | 23 | 255 | Substituted values marker operator | This operator shall signify a data item containing a substituted value; the element descriptor for the substituted value is obtained by the application of the data present bit-map associated with the substituted values operator |
| 2 | 24 | 000 | First order statistical values follow | The statistical values which follow relate to the data defined by the data present bit-map |
| 2 | 24 | 255 | First order statistical values marker operator | This operator shall signify a data item containing a first order statistical value of the type indicated by the preceding 008023 element descriptor; the element descriptor to which the first order statistic relates is obtained by the application of the data present bit-map associated with the first order statistical values follow operator; first order statistical values shall be represented as defined by this element descriptor |

(continued)
(BUFR Table C - continued)

| $\begin{array}{r} \text { TA } \\ \text { REFE } \end{array}$ | LE <br> ENCE | OPERAND | OPERATOR NAME | OPERATION DEFINITION |
| :---: | :---: | :---: | :---: | :---: |
| F | X |  |  |  |
| 2 | 25 | 000 | Difference statistical values follow | The statistical values which follow relate to the data defined by the data present bit-map |
| 2 | 25 | 255 | Difference statistical values marker operator | This operator shall signify a data item containing a difference statistical value of the type indicated by the preceding 008024 element descriptor; the element descriptor to which the first order statistic relates is obtained by the application of the data present bit-map associated with the difference statistical values follow operator; difference statistic al values shall be represented as defined by this element descriptor, but with a reference value of $\mathbf{- 2 n}$ and a data width of $(n+1)$, where $n$ is the data width given by the original descriptor. This special reference value allows the statistical difference values to be centred around zero |
| 2 | 32 | 000 | Replaced/retained values follow | The replaced/retained values which follow relate to the data defined by the data present bit-map |
| 2 | 32 | 255 | Replaced/retained value marker operator | This operator shall signify a data item containing the original of an element which has been replaced by a substituted value. The element descriptor for the retained value is obtained by the application of the data present bit-map associated with the substituted values operator |
| 2 | 35 | 000 | Cancel backward data reference | This operator terminates all previously defined backward reference and cancels any previously defined data present bit-map; it causes the next data present bit-map to refer to the data descriptors which immediately precede the operator to which it relates |
| 2 | 36 | 000 | Define data present bit-map | This operator defines the data present bit-map which follows for possible re-use; only one data present bitmap may be defined between this operator and the cancel use defined data present bit-map operator |
| 2 | 37 | 000 | Use defined data present bit-map | This operator causes the defined data present bitmap to be used again |
| 2 | 37 | 255 | Cancel use defined data present bit-map | This operator cancels the re-use of the defined data present bit-map |

## Notes:

(1) The operations specified by operator descriptors $201,202,203$ and 204 remain defined until cancelled or until the end of the data subset.
(2) If change scale is used, then it may be necessary for the originator of the message to supply an appropriately rescaled reference value and data width.
(3) Cancellation of the use of the redefined value shall be effected by the inclusion of the appropriate operand with $Y$ set to 0 . The value shall then revert to the original Table $B$ value.
(BUFR Table C - continued)
(4) Nesting of operator descriptors must guarantee unambiguous interpretation; in particular, operators defined within a set of replicated descriptors must be cancelled or completed within that set.
(5) Nesting of the operator descriptor 204 is defined such that:
(a) Each new definition adds to the currently defined associated field;
(b) Each cancellation (20400) cancels only the most recently defined addition to the associated field.
(6) When the descriptor $\mathbf{2} \mathbf{0 4} \mathbf{Y Y Y}$ is to be used, it shall precede the first of the data descriptors to which it applies.
(7) The data description operator 204 YYY shall be followed immediately by the descriptor 031021 to indicate the meaning of the associated fields.
(8) In the data stream, the 6 bits described by 031021 shall precede the YYY bits.
(9) Once an associated field has been established and given meaning, the meaning may be changed by a reapplication of descriptor 031021 . The associated field needs not to be cancelled in order to change the meaning. Further, if an associated field is cancelled, and then re-established, it must be given a meaning by a proper application of the 031021 descriptor, as described in Notes (5) to (8), i.e. a previous assignment of meaning does not remain in force when the associated field is cancelled.
(10) Data description operators shall not be applied to Table B, class 31 entries.
(11) The operation 205 permits the inclusion of plain language.
(12) The operator 206 Y allows for the inclusion of local descriptors in a message, with their associated data, which can then be by-passed by a receiver of the message. It can be applied to element descriptors ( $F=0$ ) only.
(13) If "replaced/retained" values are indicated, this shall imply that the data element in the original part of the message has been replaced with a (presumably) better value; the original value has been retained in the message following the replaced/retained operator. If multiple replacements for the same data element are to be included, they shall be ordered such that the original datum shall be last, the first replacement shall precede it, the next precede that, etc. Each (set of) replaced/retained data values shall be indicated by the inclusion of the 232000 operator.
(14) If "substituted values" are indicated, this shall imply that the data element in the original part of the message is thought to be of poor quality. However, it has been left in the original message as received; an improved value has been placed within the message following the substituted values operator. If multiple substitutions for the same data element are to be included, they shall be ordered such that the first substitution shall be first, the next substitution shall follow it, the next follow that, etc. Thus, the (presumed) "best" value will be found at the end of the collection of substituted values. Each (set of) substituted data values shall be indicated by the inclusion of the $\mathbf{2} \mathbf{2 3 0 0 0} 0$ operator.
(15) Operator 221 YYY allows for the construction of a BUFR message containing only coordinate (classes 1-9), delayed replication (class 31) and quality control information. The message could be linked back to the original data-containing message by comparison of the coordinate information in the two messages, or, in a local context, through "database" information in Section 2.
(16) First-order statistics have values with a similar range and the same dimensions as the corresponding reported values (e.g. maxima, minima, means, etc.).
(17) Difference statistics are difference values; they have dimensions the same as the corresponding reported values with respect to units, but assume a range centred on zero (e.g. the difference between reported and analysed values, the difference between reported and forecast values, etc.).
(18) No operator descriptors are reserved for local use.
BUFR Table $\mathbf{D}$ - List of common sequences
F $X \quad$ Category of sequences
300 BUFR table entries sequences
301 Location and identification sequences
302 Meteorological sequences common to surface data
303 Meteorological sequences common to vertical soundings data
304 Meteorological sequences common to satellite observations
305 Meteorological or hydrological sequences common to hydrological observations
306 Meteorological or oceanographic sequences common to oceanographic observations
307 Surface report sequences (land)
308 Surface report sequences (sea)
309 Vertical sounding sequences (conventional data)
310 Vertical sounding sequences (satellite data)
$3 \quad 11 \quad$ Single level report sequences (conventional data)
$3 \quad 12$ Single level report sequences (satellite data)
$3 \quad 13$ Sequences common to image data
314 Reserved
315 Oceanographic report sequences
$3 \quad 16$ Synoptic feature sequences
$3 \quad 18$ Radiological report sequences
321 Radar report sequences

Notes:
(1) From a conceptual point of view, Table D is not necessary:
(a) The Data description section can fully and completely describe the data using only element descriptors, operator descriptors and the rules of description;
(b) Such a means of defining the data would involve considerable overheads in terms of the length of the Data description section. Table D is a device to reduce these overheads;
(c) Each entry within Table D contains a list of descriptors. Each sequence descriptor that references to Table D may be "expanded" by replacing it with the list corresponding to that entry. The process of "expansion" is well defined, provided it results in a set of element descriptors and operator descriptors;
(d) Descriptors listed in entries to Table D may themselves refer to Table D, provided no circularity results on repeated expansion;
(e) The initial Table D has been limited to lists of descriptors likely to be used frequently. Every attempt has been made not to produce initial tables that are too comprehensive. Minor differences of reporting practice can be accommodated by not endeavouring to reduce each observation type to a single descriptor. Indeed, much more flexibility is retained if the Data description section is envisaged as containing three or four descriptors.
(2) It should be noted that, initially, effort has been concentrated on the requirements for observational data. Extensions to forecast data, time series data, products, etc., follow logically, and can be added at an appropriate future date.
(3) Category 1 contains common sequences of non-meteorological descriptors; categories 2 to 6 contain common sequences of meteorological descriptors; categories 7 to 21 contain sequences which define reports, or major subsets of reports.
(4) Underwater soundings are included, with some minor omissions, to illustrate the facility to describe data of slightly different contents.
(5) Satellite data have been split to maximize the benefits of data compression. Compound combinations may easily be defined using the descriptors available.
(6) Satellite observation data benefit enormously from being split into fragments (1, 2, 3 . . 7), then applying data compression to many locations within each fragment. Again, BUFR flexibility enables compound forms to be defined if desired.

## Category 00 - BUFR table entries sequences

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 00 | 002 | 0 | $\begin{aligned} & 00 \\ & 00 \end{aligned}$ | $\begin{aligned} & 002 \\ & 003 \end{aligned}$ | Table A category, line 1 Table A category, line 2 |
| 3 | 00 | 003 | 0 0 0 | $\begin{aligned} & 00 \\ & 00 \\ & 00 \end{aligned}$ | $\begin{aligned} & 010 \\ & 011 \\ & 012 \end{aligned}$ | F, part descriptor <br> X , part descriptor <br> Y, part descriptor |
| 3 | 00 | 004 | 3 0 0 0 0 0 0 0 0 | 00 <br> 00 <br> 00 <br> 00 <br> 00 <br> 00 <br> 00 <br> 00 <br> 00 | $\begin{aligned} & 003 \\ & 013 \\ & 014 \\ & 015 \\ & 016 \\ & 017 \\ & 018 \\ & 019 \\ & 020 \end{aligned}$ | Element name, line 1 Element name, line 2 Units name Units scale sign Units scale Units reference sign Units reference value Element data width |
| 3 | 00 | 010 | 3 1 0 0 | $\begin{aligned} & 00 \\ & 01 \\ & 31 \\ & 00 \end{aligned}$ | 003 <br> 000 <br> 001 <br> 030 | Table $D$ descriptor to be defined Delayed replication of 1 descriptor Delayed descriptor replication factor Descriptor defining sequence |

Notes:
(1) These entries include the facility to update the Table A code figure and data description.
(2) It is better to use different class 00 descriptors for the defining and defined elements, in the same way as different descriptors correspond to pressure considered as a coordinate and pressure measured at a given point; otherwise special rules would be needed to interpret such message.
Entries 000010 to 000012 define $F, X$ and $Y$ for Tables B and D; entry 000030 is a descriptor used as data and provides the $F, X$ and $Y$ values defining a sequence for Table $D$ entries.
(3) It could be argued that, as only additions are possible, only complete lines should be allowed; but it is conceivable that local areas will require changes as well as additions, so it is better and in any case clearer to provide descriptions for all the fields.

## Category 01 - Location and identification sequences

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 01 | 001 | 0 | $\begin{aligned} & 01 \\ & 01 \end{aligned}$ | $\begin{aligned} & 001 \\ & 002 \end{aligned}$ | WMO block number WMO station number |
| 3 | 01 | 002* | 0 0 0 | 01 01 01 | $\begin{aligned} & 003 \\ & 004 \\ & 005 \end{aligned}$ | WMO Region number WMO Region sub-area Buoy/platform identifier |
| 3 | 01 | 003 | 0 0 0 | 01 01 01 | $\begin{aligned} & 011 \\ & 012 \\ & 013 \end{aligned}$ | Ship's call sign <br> Direction of motion of moving observing platform Speed of motion of moving observing platform |
| 3 | 01 | 011 | 0 0 0 | 04 04 04 | $\begin{aligned} & 001 \\ & 002 \\ & 003 \end{aligned}$ | Year <br> Month <br> Day |
| 3 | 01 | 012 | 0 | $\begin{aligned} & 04 \\ & 04 \end{aligned}$ | $\begin{aligned} & 004 \\ & 005 \end{aligned}$ | Hour Minute |
| 3 | 01 | 013 | 0 0 0 | 04 04 04 | $\begin{aligned} & 004 \\ & 005 \\ & 006 \end{aligned}$ | Hour Minute Second |
| 3 | 01 | 021 | 0 0 | $\begin{aligned} & 05 \\ & 06 \end{aligned}$ | $\begin{aligned} & 001 \\ & 001 \end{aligned}$ | $\left.\begin{array}{l}\text { Latitude } \\ \text { Longitude }\end{array}\right\}$ high accuracy |
| 3 | 01 | 022 | 0 0 0 | $\begin{aligned} & 05 \\ & 06 \\ & 07 \end{aligned}$ | $\begin{aligned} & 001 \\ & 001 \\ & 001 \end{aligned}$ | Latitude Longitude Height of station accuracy |
| 3 | 01 | 023 | 0 | $\begin{aligned} & 05 \\ & 06 \end{aligned}$ | $\begin{aligned} & 002 \\ & 002 \end{aligned}$ | $\left.\begin{array}{l}\text { Latitude } \\ \text { Longitude }\end{array}\right\}$ coarse accuracy |
| 3 | 01 | 024 | 0 0 0 | $\begin{aligned} & 05 \\ & 06 \\ & 07 \end{aligned}$ | $\begin{aligned} & 002 \\ & 002 \\ & 001 \end{aligned}$ | Latitude Longitude Height of station |
| 3 | 01 | 025 | 3 0 3 | $\begin{aligned} & 01 \\ & 04 \\ & 01 \end{aligned}$ | $\begin{aligned} & 023 \\ & 003 \\ & 012 \end{aligned}$ | Latitude and longitude (coarse accuracy) <br> Day <br> Time |
| 3 | 01 | 026 | 3 0 0 0 0 0 0 | $\begin{aligned} & 01 \\ & 04 \\ & 04 \\ & 04 \\ & 04 \\ & 04 \\ & 04 \end{aligned}$ | 021 <br> 003 <br> 003 <br> 004 <br> 004 <br> 005 <br> 005 | Latitude and longitude (high accuracy) <br> (Time period in days) <br> (Time period in hours) <br> (Time period in minutes) |

[^14](continued)
(Category 01 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 01 | 031 | 3 | 01 | 001 | WMO block and station number |
|  |  |  | 0 | 02 | 001 | Type of station |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
|  |  |  | 3 | 01 | 022 | Latitude and longitude (high accuracy), height of station |
| 3 | 01 | 032 | 3 | 01 | 001 | WMO block and station number |
|  |  |  | 0 | 02 | 001 | Type of station |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
|  |  |  | 3 |  |  | Latitude and longitude (coarse accuracy), height of station |
|  |  |  |  |  |  | (Buoy/platform - fixed) |
| 3 | 01 | 033 | 0 | 01 | 005 | Buoy/platform identifier |
|  |  |  | 0 | 02 | 001 | Type of station |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
|  |  |  | 3 | 01 | 021 | Latitude and longitude (high accuracy) |
|  |  |  |  |  |  | (Buoy/platform - fixed) |
| 3 | 01 | 034 | 0 | 01 | 005 | Buoy/platform identifier |
|  |  |  | 0 | 02 | 001 | Type of station |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
|  |  |  | 3 | 01 | 023 | Latitude and longitude (coarse accuracy) |
|  |  |  |  |  |  | (Buoy/platform - moving) |
| 3 | 01 | 035* | 0 | 01 | 005 | Buoy/platform identifier |
|  |  |  | 0 | 01 | 012 | Direction of motion of moving observing platform |
|  |  |  | 0 | 01 | 013 | Speed of motion of moving observing platform |
|  |  |  | 0 | 02 | 001 | Type of station |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
|  |  |  | 3 | 01 | 023 | Latitude and longitude (coarse accuracy) |
|  |  |  |  |  |  | (Ship) |
| 3 | 01 | 036 | 3 | 01 | 003 | Ship's call sign and motion |
|  |  |  | 0 | 02 | 001 | Type of station |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | $01$ | 012 | Time |
|  |  |  |  |  | 023 | Latitude and longitude (coarse accuracy) |

[^15](Category 01 - continued)

| REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 01 | 037 | 3 |  |  | (Land station for vertical soundings) |
|  |  |  | 3 | 01 | 001 | WMO block and station number |
|  |  |  | 0 | 02 | 011 | Radiosonde type |
|  |  |  | 0 | 02 | 012 | Radiosonde computational method |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
|  |  |  | 3 | 01 | 022 | Latitude and longitude (high accuracy), height of station |
| 3 | 01 | 038 |  |  |  | (Land station for vertical soundings) |
|  |  |  | 3 | 01 | 001 | WMO block and station number |
|  |  |  | 0 | 02 | 011 | Radiosonde type |
|  |  |  | 0 | 02 | 012 | Radiosonde computational method |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
|  |  |  | 3 | 01 | 024 | Latitude and longitude (coarse accuracy), height of station |
| 3 | 01 | 039 |  |  |  | (Ship for vertic al soundings) |
|  |  |  | 3 | 01 | 003 | Ship's call sign and motion |
|  |  |  | 0 | 02 | 011 | Radiosonde type |
|  |  |  | 0 | 02 | 012 | Radiosonde computational method |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
|  |  |  | 3 | 01 | 023 | Latitude and longitude (coarse accuracy) |
| 3 | 01 | 040 | 3 | 01 | 003 | Ship's call sign and motion |
|  |  |  | 0 | 02 | 011 | Radiosonde type |
|  |  |  | 0 | 02 | 012 | Radiosonde computational method |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
|  |  |  | 3 | 01 | 024 | Latitude and longitude (coarse accuracy), height of station |
| 3 | 01 | 041 | 0 | 01 | 007 | Satellite identifier |
|  |  |  | 0 | 02 | 021 | Satellite instrument data used in processing |
|  |  |  | 0 | 02 | 022 | Satellite data processing technique used |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 012 | Time |
| 3 | 01 | 042 | 3 | 01 | 041 | Satellite identifier, data used, and data processing technique; date/time |
|  |  |  | 3 | 01 | 021 | Latitude, longitude |
| 3 | 01 | 043 | 0 | 01 | 007 | Satellite identifier |
|  |  |  | 0 | 02 | 023 | Cloud motion computational method |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 013 | Time |
|  |  |  | 3 |  | 021 | Latitude, longitude |

(continued)
(Category 01 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 01 | 044 | 0 | 01 | 007 | Satellite identifier |
|  |  |  | 0 | 02 | 024 | Integrated mean humidity computational method |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 013 | Time |
|  |  |  | 3 | 01 | 021 | Latitude, longitude |
|  |  |  |  |  |  | (S atellite location and velocity) |
| 3 | 01 | 045 | 3 | 01 | 011 | Year, month, day |
|  |  |  | 3 | 01 | 012 | Time (hour, minute) |
|  |  |  | 2 | 01 | 138 | Change width to 16 bits |
|  |  |  | 2 | 02 | 131 | Change scale to 3 |
|  |  |  | 0 | 04 | 006 | Second |
|  |  |  | 2 | 01 | 000 | Change width back to Table B |
|  |  |  | 2 | 02 | 000 | C hange scale back to Table B |
|  |  |  | 3 | 04 | 030 | Location relative to the Earth's centre |
|  |  |  | 3 | 04 | 031 | Velocity relative to the Earth's centre |
| 3 | 01 | 046 | 0 | 01 | 007 | Satellite identifier |
|  |  |  | 0 | 01 | 012 | Direction of motion of moving observing platform |
|  |  |  | 0 | 02 | 048 | Satellite sensor indicator |
|  |  |  | 0 | 21 | 119 | Wind scatterometer geophysical model function |
|  |  |  | 0 | 25 | 060 | Software identification |
|  |  |  | 2 | 02 | 124 | Change scale |
|  |  |  | 0 | 02 | 026 | Cross-track resolution |
|  |  |  | 0 | 02 | 027 | Along-track resolution |
|  |  |  | 2 | 02 | 000 | Change scale back to Table B |
|  |  |  | 0 | 05 | 040 | Orbit number |
|  |  |  |  |  |  | (ERS product header) |
| 3 | 01 | 047 | 0 | 01 | 007 | Satellite identifier |
|  |  |  | 0 | 25 | 060 | Software identification |
|  |  |  | 0 | 01 | 033 | Originating/generating centre |
|  |  |  | 0 | 01 | 034 | Originating/generating sub-centre |
|  |  |  | 0 | 01 | 012 | Direction of motion of moving observation platform |
|  |  |  | 3 | 01 | 045 | Satellite location and velocity |
|  |  |  | 0 | 02 | 021 | Satellite instrument data used in processing |
|  |  |  | 3 | 01 | 011 | Date (year, month, day) |
|  |  |  | 3 | 01 | 012 | Time (hour, minute) |
|  |  |  | 2 | 01 | 138 | Change bit width to 16 bits |
|  |  |  | 2 | 02 | 131 | Change scale to 3 |
|  |  |  | 0 | 04 | 006 | Second |
|  |  |  | 2 | 01 | 000 | Change width back to Table B |
|  |  |  | 2 | 02 | 000 | Change scale back to Table B |
|  |  |  | 3 | 01 | 023 | Location (latitude, longitude) |
|  |  |  |  |  |  | (Radar parameters) |
| 3 | 01 | 048 | 0 | 02 | 104 | Antenna polarization |
|  |  |  | 0 | 02 | 121 | Mean frequency |
|  |  |  | 0 | 02 | 113 | Number of azimuth looks |
|  |  |  | 0 | 02 | 026 | Cross-track resolution |

(Category 01 - continued)

\begin{tabular}{|c|c|c|c|c|c|c|}
\hline \multicolumn{3}{|r|}{TABLE REFERENCE} \& \multicolumn{3}{|r|}{\multirow[t]{2}{*}{TABLE REFERENCES}} \& \multirow[t]{2}{*}{ELEMENT NAME} <br>
\hline F \& X \& Y \& \& \& \& <br>
\hline \multicolumn{2}{|l|}{\multirow[t]{10}{*}{$$
\begin{array}{cc}
3 & 01 \\
\text { (continued) }
\end{array}
$$}} \& \multirow[t]{10}{*}{048} \& 0 \& 02 \& 027 \& Along-track resolution <br>
\hline \& \& \& 0 \& 02 \& 111 \& Radar incidence angle <br>
\hline \& \& \& 0 \& 02 \& 140 \& Satellite radar beam azimuth angle <br>
\hline \& \& \& 2 \& 02 \& 127 \& C hange scale to -1 <br>
\hline \& \& \& 0 \& 01 \& 013 \& Radar platform velocity <br>
\hline \& \& \& 2 \& 02 \& 126 \& Change scale to -2 <br>
\hline \& \& \& 0 \& 07 \& 001 \& Radar platform altitude <br>
\hline \& \& \& 2 \& 02 \& 000 \& Change scale to Table B <br>
\hline \& \& \& 0 \& 25 \& 010 \& Clutter treatment <br>
\hline \& \& \& 0 \& 21 \& 064 \& Clutter noise estimate <br>
\hline \multirow{5}{*}{3} \& \multirow{5}{*}{01} \& \multirow{5}{*}{049} \& \& \& \& (Radar beam data) <br>
\hline \& \& \& 0 \& 02 \& $$
\begin{aligned}
& 111 \\
& 112
\end{aligned}
$$ \& Radar incidence angle Radar look angle <br>
\hline \& \& \& 0 \& 02
21 \& $$
\begin{aligned}
& 112 \\
& 062
\end{aligned}
$$ \& Radar look angle Backscatter <br>
\hline \& \& \& 0 \& 21 \& 063 \& Radiometric resolution (Noise value) <br>
\hline \& \& \& 0 \& 21 \& 065 \& Missing packet counter <br>
\hline \multirow[t]{6}{*}{3} \& \multirow[t]{6}{*}{01} \& \multirow[t]{6}{*}{051} \& 0 \& 01 \& 006 \& Aircraft identifier <br>
\hline \& \& \& 0 \& 02 \& 061 \& Navigational system <br>
\hline \& \& \& 3 \& 01 \& 011 \& Date <br>
\hline \& \& \& 3 \& 01 \& 012 \& Time <br>
\hline \& \& \& 3 \& 01 \& 021 \& Latitude, longitude <br>
\hline \& \& \& 0 \& 08 \& 004 \& Phase of aircraft flight <br>
\hline \multirow[t]{8}{*}{3

3} \& \multirow[t]{7}{*}{01} \& \multirow[t]{8}{*}{055} \& 0 \& 01 \& 005 \& Buoy/platform identifier <br>
\hline \& \& \& 0 \& 02 \& 001 \& Type of station <br>
\hline \& \& \& 3 \& 01 \& 011 \& Date <br>
\hline \& \& \& 3 \& 01 \& 012 \& Time ${ }^{\text {dim }}$ d <br>
\hline \& \& \& 3 \& 01 \& 021 \& Latitude and longitude (high accuracy) <br>
\hline \& \& \& 0 \& 01

01 \& $$
\begin{aligned}
& 012 \\
& 014
\end{aligned}
$$ \& Direction of motion of moving observing platform Platform drift speed (high precision) <br>

\hline \& \& \& 0 \& 01 \& \& Platform drift speed (high precision) <br>
\hline \& \multirow[t]{4}{*}{01} \& \& \& \& \& (Radar location(s)) <br>
\hline \multirow[t]{3}{*}{3} \& \& \multirow[t]{3}{*}{062} \& 1 \& 01 \& 000 \& Delayed replication of 1 descriptor <br>
\hline \& \& \& 0
3 \& 31

01 \& $$
\begin{aligned}
& 001 \\
& 001
\end{aligned}
$$ \& Replication factor WMO block and station number <br>

\hline \& \& \& \& \& \& <br>
\hline \multirow[t]{9}{*}{3

3} \& \multirow[t]{8}{*}{01} \& \multirow[t]{8}{*}{065} \& 0 \& 01 \& 006 \& Aircraft flight number (see Note) <br>
\hline \& \& \& 0 \& 01 \& 008 \& Aircraft registration number (see Note) <br>
\hline \& \& \& 0 \& 02 \& 001 \& Type of station <br>
\hline \& \& \& 0 \& 02 \& 002 \& Type of instrumentation for wind measurement <br>
\hline \& \& \& 0 \& 02 \& 005 \& Precision of temperature observation <br>
\hline \& \& \& 0 \& 02 \& 062 \& Type of aircraft data relay system <br>
\hline \& \& \& 0 \& 02 \& 070 \& Original specification of latitude/longitude <br>
\hline \& \& \& 0 \& 02 \& 065 \& ACARS ground receiving station <br>
\hline \& \multirow{7}{*}{01} \& \multirow{7}{*}{066} \& \& \& \& (ACARS location) <br>
\hline \multirow[t]{6}{*}{3} \& \& \& 3 \& 01 \& 011 \& Year, month, day <br>
\hline \& \& \& 3 \& 01 \& 013 \& Hour, minute, second <br>
\hline \& \& \& 3 \& 01 \& 023 \& Latitude and longitude (coarse accuracy) <br>
\hline \& \& \& 0 \& 07 \& 004 \& Pressure <br>
\hline \& \& \& 0 \& 02 \& 064 \& Aircraft roll angle quality <br>
\hline \& \& \& 0 \& 08 \& 004 \& Phase of aircraft flight <br>
\hline
\end{tabular}

(continued)
(Category 01 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
|  | 01 | 071 |  |  |  | (Satellite identifier/Generating resolution) |
| 3 |  |  | 0 | 01 | 007 | Satellite identifier |
|  |  |  | 0 | 01 | 031 | Generating centre |
|  |  |  | 0 | 02 | 020 | Satellite classification |
|  |  |  | 0 | 02 | 028 | Segment size at nadir in X direction |
|  |  |  | 0 | 02 | 029 | Segment size at nadir in $\mathbf{Y}$ direction |
| 3 | 01 | 072 |  |  |  | (Satellite identification) |
|  |  |  | 3 | 01 | 071 | Satellite identification, Generation resolution |
|  |  |  | 3 | 01 | 011 | Date |
|  |  |  | 3 | 01 | 013 | Time |
|  |  |  | 3 |  | 021 | Latitude, longitude |

## Notes:

(1) As supplied by originating sub-center ARINC, this value is a pseudo-value rather than the actual value. The relationship between this pseudo value and the true value is known only by ARINC.
(2) Descriptors from 301041 to 301049 and 301062,301071 , and 301072 should not be used in CREX for transmission.

Category 02 - Meteorological sequences common to surface data

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 02 | 001 | 0 | 10 | 004 | Pressure (at station level) |
|  |  |  | 0 | 10 | 051 | Pressure reduced to mean sea level |
|  |  |  | 0 | 10 | 061 | 3-hour pressure change |
|  |  |  | 0 | 10 | 063 | Characteristic of pressure tendency |
|  |  |  |  |  |  | (High altitude station) |
| 3 | 02 | 002 | 0 | 10 | 004 | Pressure (at station level) |
|  |  |  | 0 | 07 | 004 | Pressure level |
|  |  |  | 0 | 10 | 003 | Geopotential of pressure level |
|  |  |  | 0 | 10 | 061 | 3-hour pressure change |
|  |  |  | 0 | 10 | 063 | Characteristic of pressure tendency |
| 3 | 02 | 003 | 0 | 11 | 011 | Wind direction ( 10 m ) |
|  |  |  | 0 | 11 | 012 | Wind speed ( 10 m ) |
|  |  |  | 0 | 12 | 004 | Temperature ( 2 m ) |
|  |  |  | 0 | 12 | 006 | Dew point (2 m) |
|  |  |  | 0 | 13 | 003 | Relative humidity |
|  |  |  | 0 | 20 | 001 | Horizontal visibility |
|  |  |  | 0 | 20 | 003 | Present weather |
|  |  |  | 0 | 20 | 004 | Past weather (1) |
|  |  |  | 0 | 20 | 005 | Past weather (2) |
|  |  |  |  |  |  | (General cloud information) |
| 3 | 02 | 004 | 0 | 20 | 010 | Cloud cover (total) |
|  |  |  | 0 | 08 | 002 | Vertical signific ance |
|  |  |  | 0 | 20 | 011 | Cloud amount |
|  |  |  | 0 | 20 | 013 | Height of base of cloud |
|  |  |  | 0 | 20 | 012 | Cloud type |
|  |  |  | 0 | 20 | 012 | Cloud type |
|  |  |  | 0 | 20 | 012 | Cloud type |
| 3 | 02 | 005 | 0 | 08 | 002 | Vertic al signific ance |
|  |  |  | 0 | 20 | 011 | Cloud amount |
|  |  |  | 0 | 20 | 012 | Cloud type |
|  |  |  | 0 | 20 | 013 | Height of base of cloud |
| 3 | 02 | 006 | 0 | 10 | 004 | Pressure (at station level) |
|  |  |  | 0 | 10 | 051 | Pressure reduced to mean sea level |
|  |  |  | 0 | 10 | 062 | 24-hour pressure change |
|  |  |  | 0 | 10 | 063 | Characteristic of pressure tendency |
|  |  |  |  |  |  | (Low altitude station) |
| 3 | 02 | 011 | 3 | 02 | 001 | Pressure and pressure change |
|  |  |  | 3 | 02 | 003 | Wind, temperature, humidity, visibility, weather |
|  |  |  | 3 | 02 | 004 | Significant cloud layer |

(continued)
(Category 02 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 02 | 012 |  |  |  | (High altitude station) |
|  |  |  | 3 | 02 | 002 | Pressure and pressure change |
|  |  |  | 3 | 02 | 003 | Wind, temperature, humidity, visibility, weather |
|  |  |  | 3 | 02 | 004 | Significant cloud information |
| 3 | 02 | 013 | 3 | 02 | 006 | Pressure and pressure change |
|  |  |  | 3 | 02 | 003 | Wind, temperature, humidity, visibility, weather |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Delayed descriptor replication factor |
|  |  |  | 3 | 02 | 005 | Cloud layer information |
| 3 | 02 | 021 | 0 | 22 | 001 | Direction of waves |
|  |  |  | 0 | 22 | 011 | Period of waves |
|  |  |  | 0 | 22 | 021 | Height of waves |
| 3 | 02 | 022 | 0 | 22 | 002 | Direction of wind waves |
|  |  |  | 0 | 22 | 012 | Period of wind waves |
|  |  |  | 0 | 22 | 022 | Height of wind waves |
| 3 | 02 | 023 | 0 | 22 | 003 | Direction of swell waves |
|  |  |  | 0 | 22 | 013 | Period of swell waves |
|  |  |  | 0 | 22 | 023 | Height of swell waves |
| 3 | 02 | 024 | 3 | 02 | 022 | Wind waves |
|  |  |  | 1 | 01 | 002 | Replicate 1 descriptor 2 times |
|  |  |  | 3 | 02 | 023 | Swell waves (2 systems of swell) |
| 3 | 02 | 051 | 0 | 10 | 004 | Pressure |
|  |  |  | 0 | 10 | 051 | Pressure reduced to mean sea level |
|  |  |  | 0 | 07 | 004 | Pressure (vertical location) |
|  |  |  | 0 | 10 | 003 | Geopotential |
|  |  |  | 0 | 12 | 004 | Dry-bulb temperature at $\mathbf{2 m}$ |
|  |  |  | 0 | 12 | 051 | Standard deviation temperature |
|  |  |  | 0 | 12 | 016 | Maximum temperature at 2 m , past 24 hours |
|  |  |  | 0 | 12 | 017 | Minimum temperature at 2 m , past 24 hours |
|  |  |  | 0 | 13 | 004 | Vapour pressure |
|  |  |  | 1 | 02 | 004 | Replicate 2 descriptors 4 times |
|  |  |  | 0 | 08 | 051 | Qualifier for number of missing values in calculation of statistic |
|  |  |  | 0 | 08 | 020 | Total number of missing entities (with respect to accumulation or average) |

Category 03 - Meteorological sequences common to vertical soundings data

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 03 | 001 | 0 0 0 | 07 11 11 | $\begin{aligned} & 003 \\ & 001 \\ & 002 \end{aligned}$ | Geopotential Wind direction Wind speed |
| 3 | 03 | 002 | 0 0 0 | $\begin{aligned} & 07 \\ & 11 \\ & 11 \end{aligned}$ | $\begin{aligned} & 004 \\ & 001 \\ & 002 \end{aligned}$ | Pressure Wind direction Wind speed |
| 3 | 03 | 003 | 0 0 0 0 | 07 10 12 12 | 004 <br> 003 <br> 001 <br> 003 | Pressure <br> Geopotential <br> Temperature <br> Dew point |
| 3 | 03 | 004 | 0 0 0 0 0 0 | 07 10 12 12 11 11 | 004 <br> 003 <br> 001 <br> 003 <br> 001 <br> 002 | Pressure Geopotential Temperature Dew point Wind direction Wind speed |
| 3 | 03 | 011 | 0 0 0 0 | 07 08 11 11 | 003 <br> 001 <br> 001 <br> 002 | Geopotential <br> Vertical sounding significance <br> Wind direction <br> Wind speed |
| 3 | 03 | 012 | 0 0 0 0 | 07 08 11 11 | 004 <br> 001 <br> 001 <br> 002 | Pressure <br> Vertical sounding significance <br> Wind direction <br> Wind speed |
| 3 | 03 | 013 | 0 0 0 0 0 0 0 | 07 08 10 12 13 11 11 | 004 <br> 001 <br> 003 <br> 001 <br> 003 <br> 001 <br> 002 | Pressure <br> Vertical sounding significance <br> Geopotential <br> Temperature <br> Relative humidity <br> Wind direction <br> Wind speed |
| 3 | 03 | 014 | 0 0 0 0 0 0 0 | $\begin{aligned} & 07 \\ & 08 \\ & 10 \\ & 12 \\ & 12 \\ & 11 \\ & 11 \end{aligned}$ | 004 <br> 001 <br> 003 <br> 001 <br> 003 <br> 001 <br> 002 | Pressure <br> Vertic al sounding significance <br> Geopotential <br> Temperature <br> Dew point <br> Wind direction <br> Wind speed |

(continued)
(Category 03 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 03 | 021 | 0 | $\begin{aligned} & 07 \\ & 07 \\ & 04 \\ & 31 \end{aligned}$ | $\begin{aligned} & 004 \\ & 004 \\ & 007 \\ & 021 \end{aligned}$ | Pressure (1) <br> Pressure (2) defines layer <br> Add associated field of 7 bits <br> Additional field significance |
| 3 | 03 | 022 | 3 0 2 | $\begin{aligned} & 03 \\ & 10 \\ & 04 \end{aligned}$ | $\begin{aligned} & 021 \\ & 003 \\ & 000 \end{aligned}$ | Layer, quality <br> Geopotential (layer mean thickness) <br> Cancel the added associated field |
| 3 | 03 | 023 | 3 0 2 | $\begin{aligned} & 03 \\ & 12 \\ & 04 \end{aligned}$ | $\begin{aligned} & 021 \\ & 001 \\ & 000 \end{aligned}$ | Layer, quality <br> Temperature (layer mean) <br> Cancel the added associated field |
| 3 | 03 | 024 | 3 0 2 | $\begin{aligned} & 03 \\ & 13 \\ & 04 \end{aligned}$ | $\begin{aligned} & 021 \\ & 016 \\ & 000 \end{aligned}$ | Layer, quality <br> Precipitation water <br> Cancel the added associated field |
| 3 | 03 | 025 | 0 2 0 0 2 | $\begin{aligned} & 02 \\ & 04 \\ & 31 \\ & 12 \\ & 04 \end{aligned}$ | $\begin{aligned} & 025 \\ & 007 \\ & 021 \\ & 063 \\ & 000 \end{aligned}$ | Satellite channel <br> Add associated field of 7 bits <br> Additional field signific ance <br> Brightness temperature <br> Cancel the added associated field |
| 3 | 03 | 026 | 0 0 2 0 0 2 | $\begin{aligned} & 07 \\ & 08 \\ & 04 \\ & 31 \\ & 12 \\ & 04 \end{aligned}$ | $\begin{aligned} & 004 \\ & 003 \\ & 007 \\ & 021 \\ & 001 \\ & 000 \end{aligned}$ | Pressure <br> Vertical signific ance Add associated field of 7 bits Additional field signific ance Temperature Cancel the added associated field |
| 3 | 03 | 027 | 0 2 0 0 2 | $\begin{aligned} & 07 \\ & 04 \\ & 31 \\ & 10 \\ & 04 \end{aligned}$ | $\begin{aligned} & 004 \\ & 007 \\ & 021 \\ & 003 \\ & 000 \end{aligned}$ | Pressure <br> Add associated field of 7 bits Additional field significance Geopotential Cancel the added associated field |
| 3 | 03 | 031 | 0 0 0 0 0 0 | $\begin{aligned} & 07 \\ & 08 \\ & 07 \\ & 07 \\ & 08 \\ & 12 \end{aligned}$ | $\begin{aligned} & 004 \\ & 003 \\ & 021 \\ & 022 \\ & 012 \\ & 061 \end{aligned}$ | Pressure <br> Vertical significance (base of sounding) <br> Elevation (local zenith) <br> Solar elevation (solar zenith) <br> Land/sea qualifier <br> Skin temperature |
| 3 | 03 | 032 | 0 0 | $\begin{aligned} & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 011 \\ & 016 \end{aligned}$ | Cloud amount <br> Pressure at top of cloud |
| 3 | 03 | 033 | 0 | $\begin{aligned} & 20 \\ & 20 \end{aligned}$ | $\begin{aligned} & 010 \\ & 016 \end{aligned}$ | Cloud cover (total) <br> Pressure at the top of cloud <br> (Wind sequence) |
| 3 | 03 | 041 | 0 0 0 0 0 0 0 0 | $\begin{aligned} & 02 \\ & 02 \\ & 07 \\ & 11 \\ & 11 \\ & 02 \\ & 02 \\ & 12 \end{aligned}$ | $\begin{aligned} & 152 \\ & 023 \\ & 004 \\ & 001 \\ & 002 \\ & 153 \\ & 154 \\ & 071 \end{aligned}$ | Geostationary satellite instrument used Cloud motion computational method <br> Pressure <br> Wind direction <br> Wind speed <br> Satellite channel centre frequency <br> Satellite channel band width <br> Coldest cluster T |

Note: Descriptors from 303021 to 303027 are not available in CREX.

Category 04 - Meteorological sequences common to satellite observations

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 04 | 001 | 0 | 08 | 003 | Vertic al signific ance |
|  |  |  | 0 | 10 | 004 | Pressure |
|  |  |  | 0 | 12 | 001 | Temperature |
|  |  |  | 0 | 11 | 001 | Wind direction |
|  |  |  | 0 | 11 | 002 | Wind speed |
| 3 | 04 | 002 | 0 | 08 | 003 | Vertical signific ance |
|  |  |  | 0 | 10 | 004 | Pressure |
|  |  |  | 0 | 11 | 001 | Wind direction |
|  |  |  | 0 | 11 | 002 | Wind speed |
| 3 | 04 | 003 | 0 | 08 | 003 | Vertical signific ance |
|  |  |  | 0 | 12 | 001 | Temperature |
| 3 | 04 | 004 | 0 | 08 | 003 | Vertical signific ance |
|  |  |  | 0 | 10 | 004 | Pressure |
|  |  |  | 0 | 20 | 010 | Cloud cover (total) |
|  |  |  | 0 | 12 |  | Temperature |
| 3 | 04 | 005 | 0 | 02 | 024 | Integrated mean humidity computational method |
|  |  |  | 0 | 07 | 004 | Pressure (1) |
|  |  |  | 0 | 07 | 004 | Pressure (2) defines layer |
|  |  |  | 0 | 13 | 003 | Relative humidity |
| 3 | 04 | 006 | 0 | 14 | 001 |  |
|  |  |  | 0 | 14 | 001 | Incoming long-wave radiation |
|  |  |  | 0 | 14 | 003 | Outgoing short-wave radiation |
|  |  |  |  |  |  | (GOES-1/M info) |
| 3 | 04 | 011 | 0 | 02 | 163 | Height assignment method |
|  |  |  | 0 | 02 | 164 | Tracer correlation method |
|  |  |  | 0 | 08 | 012 | Land/sea qualifier |
|  |  |  | 0 | 07 | 024 | Satellite zenith angle |
|  |  |  | 0 | 02 | 057 | Origin of first guess information |
|  |  |  | 0 | 08 | 021 | Time signific ance |
|  |  |  | 0 | 04 | 001 | Year |
|  |  |  | 0 | 04 | 002 | Month |
|  |  |  | 0 | 04 | 003 | Day |
|  |  |  | 0 | 04 | 004 | Hour |
|  |  |  | 0 | 08 | 021 | Time signific ance |
|  |  |  | 0 | 04 | 024 | Time period or displacement |
|  |  |  | 1 | 10 | 004 | Replicate 10 descriptors 4 times |
|  |  |  | 0 | 08 | 021 | Time signific ance |
|  |  |  | 0 | 04 | 004 | Hour |
|  |  |  | 0 | 04 | 005 | Minute |
|  |  |  | 0 | 04 | 006 | Second |
|  |  |  | 0 | 08 | 021 | Time signific ance |
|  |  |  | 0 | 04 | 004 | Hour |

(continued)
(Category 04 - continued)

| REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | F $\quad$ X | Y |  |  |  |  |
| $\begin{array}{cc} 3 & 04 \\ \text { (continued) } \end{array}$ |  | 011 | 0 | 04 | 005 | Minute |
|  |  | 0 | 04 | 006 | Second |  |
|  |  | 0 | 11 | 001 | Wind direction |  |
|  |  | 0 | 11 | 002 | Wind speed |  |
|  |  | 1 | 03 | 010 | Replicate 3 descriptors 10 times |  |
|  |  | 0 | 02 | 163 | Height assignment method |  |
|  |  | 0 | 07 | 004 | Pressure |  |
|  |  | 0 | 12 | 001 | Temperature |  |
| 3 | 04 |  | 030 |  |  |  | (Location of platform) |
|  |  |  |  | 0 | 27 | 031 | In direction of 0 degree longitude, distance from the Earth's centre |
|  |  |  |  | 0 | 28 | 031 | In direction of 90 degrees East longitude, distance from the Earth's centre |
|  |  |  |  | 0 | 10 | 031 | In direction of North Pole, distance from Earth's centre |
| 3 | 04 |  | 031 |  |  |  | (Speed of platform) |
|  |  |  |  | 0 | 01 | 041 | Absolute platform velocity - first component |
|  |  |  |  | 0 | 01 | 042 | Absolute platform velocity - second component |
|  |  | 0 |  | 01 | 043 | Absolute platform velocity - third component |
| 3 | 04 | 032 |  |  |  | (Cloud fraction) |
|  |  |  | 0 | 02 | 153 | Satellite channel centre frequency |
|  |  |  | 0 | 02 | 154 | Satellite channel band width |
|  |  |  | 0 | 20 | 081 | Cloud amount in segment |
|  |  |  | 0 | 20 | 082 | Amount segment cloud free |
|  |  |  | 0 | 20 | 012 | Cloud type |
| 3 | 04 | 033 |  |  |  | (Clear sky radiance) |
|  |  |  | 0 | 02 | 152 | Satellite instrument used in data processing |
|  |  |  | 0 | 02 | 166 | Radiance type |
|  |  |  | 0 | 02 | 167 | Radiance computational method |
|  |  |  | 0 | 02 | 153 | Satellite channel centre frequency |
|  |  |  | 0 | 02 | 154 | Satellite channel band width |
|  |  |  | 0 | 12 | 075 | Spectral radiance |
|  |  |  | 0 | 12 | 076 | Radiance |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
| 3 | 04 | 034 | 1 | 02 | 004 | Replic ating next two descriptors 4 times |
|  |  |  | 0 | 27 | 001 | Latitude (high accuracy) |
|  |  |  | 0 | 28 | 001 | Longitude (high accuracy) |
|  |  |  | 0 | 07 | 022 | Solar elevation |
|  |  |  | 0 | 05 | 043 | Field of view number |
|  |  |  | 0 | 20 | 010 | Cloud cover (total) |
|  |  |  | 0 | 20 | 016 | Pressure at top of cloud |
|  |  |  | 0 | 33 | 003 | Quality information table |
|  |  |  | 0 | 10 | 040 | Number of retrieved layers |

## Category 05 - Meteorological or hydrological sequences common to hydrological observations

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 05 | 003 |  |  |  | (SADC-HYCOS measurement array definition) |
|  |  |  | 3 | 01 | 012 | Hour, minute of first single measurement minus increment |
|  |  |  | 0 | 04 | 065 | Short time increment - time interval between measurements |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 05 | 001 | Single measurement |
| 3 | 05 | 006 |  |  |  | (MEDHYCOS measurement) |
|  |  |  | 0 | 13 | 072 | Downstream water level |
|  |  |  | 0 | 13 | 082 | Water temperature |
|  |  |  | 0 | 13 | 019 | Precipitation last hour |
|  |  |  | 0 | 12 | 001 | Air temperature |
|  |  |  | 0 | 13 | 073 | Maximum water height observed |
|  |  |  | 0 | 13 | 060 | Total accumulated precipitation |
| 3 | 05 | 007 |  |  |  | (MEDHYCOS report) |
|  |  |  | 3 | 01 | 029 | Identification |
|  |  |  | 3 | 01 | 012 | Hour, minute (time of first measurement) |
|  |  |  | 0 | 04 | 065 | Short time increment - time interval between measurements |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 05 | 006 | Single measurement |
| 3 |  | 008 |  |  |  | (AOCHYCOS - Chad measurement) |
|  | 05 |  | 3 | 05 | 006 | Same as MEDHYCOS type measurement |
|  |  |  | 0 | 12 | 030 | Soil temperature at -50 cm |
| 3 | 05 | 009 |  |  |  | (AOCHYCOS - Chad report) |
|  |  |  | 3 | 01 | 029 | Identification |
|  |  |  | 3 | 01 | 012 | Hour, minute (time of first measurement) |
|  |  |  | 0 | 04 | 065 | Short time increment - time interval between measurements |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 05 | 008 | Single measurement |
|  | 05 | 011 |  |  |  | (MEDHYCOS report type 2) |
| 3 |  |  | 3 | 01 | 029 | Identification |
|  |  |  | 3 | 01 | 012 | Hour, minute (time of first measurement) |
|  |  |  | 0 | 04 | 065 | Short time increment - time interval between measurements |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 05 | 010 | Single measurement |

(continued)


Category 06 - Meteorological or oceanographic sequences common to oceanographic observations

| tABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 06 | 001 | 0 | 02 | 032 | Indic ator for digitization |
|  |  |  | 1 | 02 | 000 | Delayed replication of 2 descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 07 | 062 | Depth below sea surface |
|  |  |  | 0 | 22 | 042 | Subsurface sea temperature |
| 3 | 06 | 002 | 0 | 02 | 031 | Method of current measurement |
|  |  |  | 0 | 22 | 004 | Direction of current |
|  |  |  | 0 | 22 | 031 | Speed of current |
| 3 | 06 | 003 | 0 | 02 | 002 | Wind instrumentation |
|  |  |  | 0 | 11 | 011 | Wind direction (10 m) |
|  |  |  | 0 | 11 | 012 | Wind speed (10 m) |
|  |  |  | 0 | 12 | 004 | Dry-bulb temperature ( $\mathbf{2} \mathbf{~ m}$ ) |
| 3 | 06 | 004 | 0 | 02 | 032 | Indic ator for digitization |
|  |  |  | 0 | 02 | 033 | Method of salinity/depth measurement |
|  |  |  | 1 | 03 | 000 | Delayed replication of 3 descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 07 | 062 | Depth below sea surface |
|  |  |  | 0 | 22 | 043 | Subsurface sea temperature |
|  |  |  | 0 | 22 | 062 | Salinity |
| 3 | 06 | 005 | 0 | 02 | 031 | Method of current measurement |
|  |  |  | 1 | 03 | 000 | Delayed replication of 3 descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 07 | 062 | Depth below sea surface |
|  |  |  | 0 | 22 | 004 | Direction of current |
|  |  |  | 0 | 22 | 031 | Speed of current |
|  |  |  |  |  |  | (Under water sounding (optional) parameters) |
| 3 | 06 | 006 | 3 | 06 | 003 | Surface wind and temperature |
|  |  |  | 3 | 06 | 002 | Current |
|  |  |  | 0 | 22 | 063 | Total water depth |
|  |  |  |  |  |  | (Buoy spare block parameters) |
| 3 | 06 | 007 | 0 | 01 | 012 | Direction of motion of moving observing platform |
|  |  |  | 0 | 01 | 014 | Platform drift speed (high precision) |
|  |  |  | 3 | 06 | 008 | Buoy instrumentation |
|  |  |  | 0 | 04 | 024 | Time period |
|  |  |  | 0 | 27 | 003 | Alternate latitude |
|  |  |  | 0 | 28 | 003 | Alternate longitude |

(continued)
(Category 06 - continued)

| table REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 06 | 008 |  |  |  | (Buoy instrumentation parameters) |
|  |  |  | 0 | 02 | 034 | Drogue type |
|  |  |  | 0 | 02 | 035 | Cable length |
|  |  |  | 0 | 02 | 036 | Buoy type |
| 3 | 06 | 023 | 0 | 01 | 015 | Station or site name |
|  |  |  | 3 | 01 | 023 | Latitude, longitude |
|  |  |  | 3 | 01 | 011 | Year, month, day |
|  |  |  | 3 | 01 | 012 | Hour, minute |
|  |  |  | 0 | 22 | 038 | Tidal level with respect to local chart datum |
|  |  |  | 0 | 22 | 039 | Meteorological residual tidal elevation |
|  |  |  | 0 | 22 | 120 | Tide station automated water level check |
|  |  |  |  | 22 | 121 | Tide station manual water level check |

## Category 07 - Surface report sequences (land)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 07 | 001 | 3 3 | $\begin{aligned} & 01 \\ & 02 \end{aligned}$ | $\begin{aligned} & 031 \\ & 011 \end{aligned}$ | (Low altitude station) <br> Identification, type, date/time, position (high accuracy), height Basic surface report |
| 3 | 07 | 002 | 3 3 | $\begin{aligned} & 01 \\ & 02 \end{aligned}$ | $\begin{aligned} & 032 \\ & 011 \end{aligned}$ | (Low altitude station) Identification, type, date/time, position (coarse accuracy), height Basic surface report |
| 3 | 07 | 003 | 3 | 07 | 001 | (Low altitude station) <br> Location (high accuracy) and basic report |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 02 | 005 | Cloud layer information |
| 3 | 07 | 004 |  |  |  | (Low altitude station) |
|  |  |  | 3 | 07 | 002 | Location (coarse accuracy) and basic report |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 02 | 005 | Cloud layer information |
| 3 | 07 | 005 |  |  |  | (Low altitude station) |
|  |  |  | 3 | 07 | 001 | Location (high accuracy) and basic report |
|  |  |  | 1 | 01 | 004 | Replicate 1 descriptor 4 times |
|  |  |  | 3 |  | 005 | Cloud layer information (4 layers) |
| 3 | 07 | 006 |  |  |  | (Low altitude station) |
|  |  |  | 3 | 07 |  | Location (coarse accuracy) and basic report |
|  |  |  | 1 | 01 | 004 | Replicate 1 descriptor 4 times |
|  |  |  | 3 | 02 | 005 | Cloud layer information (4 layers) |
| 3 | 07 | 007 |  |  |  | (High altitude station) |
|  |  |  | 3 3 | $\begin{aligned} & 01 \\ & 02 \end{aligned}$ | $\begin{aligned} & 031 \\ & 012 \end{aligned}$ | Identific ation, type, date/time, position (high accuracy), height Basic surface report |
| 3 | 07 | 008 |  |  |  | (High altitude station) |
|  |  |  | 3 3 | $\begin{aligned} & 01 \\ & 02 \end{aligned}$ | $\begin{aligned} & 032 \\ & 012 \end{aligned}$ | Identification, type, date/time, position (coarse accuracy), height Basic surface report |
| 3 | 07 | 009 | 3 3 | $\begin{aligned} & 01 \\ & 02 \end{aligned}$ | $\begin{aligned} & 031 \\ & 013 \end{aligned}$ | Identific ation, type, date/time, position (high accuracy), height Basic surface report |
| 3 | 07 | 011 |  |  |  | (Main part of data for representation of METAR/SPECI code in BUFR) |
|  |  |  | 0 | 01 02 | $\begin{aligned} & 063 \\ & 001 \end{aligned}$ | ICAO location indicator CCCC <br> Type of station (AUTO) |
|  |  |  | 3 | 01 | 011 | Year, month, day (YY) |
|  |  |  | 3 | 01 | 012 | GG, gg |
|  |  |  | 3 | 01 | 024 | Latitude-longitude (coarse accuracy), height of station |
|  |  |  | 0 | 07 | 006 | Height above station (= height of an anemometer) |

(continued)
(Category 07 - continued)

| TABLE REFERENCE |  |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | F | X | Y |  |  |  |  |  |
| $\begin{array}{cc} 3 & 07 \\ \text { (continued) } \end{array}$ |  |  | 011 | 0 | 11 | 001 | Wind direction | ddd |
|  |  |  | 0 | 11 | 016 | Extreme counterclockwise wind direction of a variable wind | $d_{n} d_{n} d_{n}$ |
|  |  |  | 0 | 11 | 017 | Extreme clockwise wind direction of a variable wind | $d_{x} d{ }^{\text {d }}{ }_{x}$ |
|  |  |  | 0 | 11 | 002 | Wind speed | ff |
|  |  |  | 0 | 11 | 041 | Maximum wind speed (gusts) | $\mathbf{f}_{\mathrm{m}} \mathrm{f}_{\mathrm{m}}$ |
|  |  |  | 0 | 07 | 006 | Height above station (= height of a thermometer) |  |
|  |  |  | 0 | 12 | 001 | Temperature | T'T' |
|  |  |  | 0 | 12 | 003 | Dew-point temperature | $\mathrm{T}^{\prime} \mathrm{T}^{\prime}{ }_{d}$ |
|  |  |  | 0 | 10 | 052 | Altimeter setting (QNH) | $\mathbf{P}_{\mathbf{H}} \mathrm{P}_{\mathbf{H}} \mathrm{P}_{\mathbf{H}} \mathrm{P}_{\mathbf{H}}$ |
|  |  |  | 0 | 20 | 009 | General Weather Indic ator TAF/METAR |  |
| 3 |  |  |  |  |  |  |  | ( $\mathrm{D}_{\mathrm{V}} \mathrm{VVVV}$ ) |  |
|  |  | 07 |  | 012 | 1 | 03 | 000 | Delayed replication of 3 descriptors |  |
|  |  | 0 |  |  | 31 | 001 | Number of replication (up to 3) |  |
|  |  | 0 |  |  | 08 | 023 | First order statistics |  |
|  |  | 0 |  |  | 05 | 021 | Direction of visibility observed |  |
|  |  | 0 |  |  | 20 | 001 | Horizontal visibility | VVVV |
| 3 |  |  |  | 07 | 013 |  |  |  | $\left(D_{R} D_{R} V_{R} V_{R} V_{R} V_{R}\right)$ |  |
|  |  | 1 |  |  |  | 06 | 000 | Delayed replication of 6 descriptors |  |
|  |  | 0 |  |  |  | 31 | 001 | Number of replication (up to 4) |  |
|  |  | 0 | 01 |  |  | 064 | Runway designator | $D_{R} D_{R}$ |
|  |  | 0 | 08 |  |  | 014 | Qualification for runway visual range |  |
|  |  | 0 | 20 |  |  | 061 | Runway visual range | $V_{R} V_{R} V_{R} V_{R}$ |
|  |  | 0 | 08 |  |  | 014 | Qualification for runway visual range |  |
|  |  | 0 | 20 |  |  | 061 | Runway visual range | $\mathrm{V}_{\mathrm{R}} \mathrm{V}_{\mathrm{R}} \mathrm{V}_{\mathrm{R}} \mathrm{V}_{\mathrm{R}}$ |
|  |  | 0 | 20 |  |  | 018 | Tendency of runway visual range |  |
| 3 |  |  | 07 |  |  |  |  | (wiw) |  |
|  |  | 014 |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |  |
|  |  | 0 |  | 31 | 001 | Number of replication (up to 3) |  |
|  |  | 0 |  | 20 | 019 | Significant present weather | w'w' |
| 3 |  |  | 07 | 015 |  |  |  | (Clouds group(s)) |  |
|  |  | 1 |  |  | 01 | 000 | Delayed replication of 1 descriptor |  |
|  |  | 0 |  |  | 31 | 001 | Number of replication |  |
|  |  | 3 |  |  | 02 | 005 | $\left(N_{s} N_{s} N_{s}, \mathbf{C C}, h_{5} h_{s} h_{s}\right)$ |  |
|  |  | 0 |  |  | 20 | 002 | Vertical visibility | VVh ${ }_{5} \mathrm{~h}_{5} \mathrm{~h}_{\text {s }}$ |
| 3 |  |  | 07 | 016 |  |  |  | (REw w ) |  |
|  |  | 1 |  |  | 01 | 000 | Delayed replication of 1 descriptor |  |
|  |  | 0 |  |  | 31 | 001 | Number of replication (up to 3) |  |
|  |  | 0 |  |  | 20 | 020 | Significant recent weather phenomena | REw'w' |

(Category 07 - continued)

| REFERENCE |  |  | TABLE REFERENCES |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  | element name |  |
|  |  |  |  |  |  | (Wind shear on runways(s)) |  |
| 3 | 07 | 017 | 1 | 01 | 000 | Delayed replication of 1 descriptor |  |
|  |  |  | 0 | 31 | 001 | Number of replication |  |
|  |  |  | 0 | 11 | 070 | Runway designator of the runway affected by wind shear (including ALL) | WS RWYD $\mathrm{R}^{\text {d }}$ R |
|  |  |  |  |  |  | (Trend-type landing forecast) |  |
| 3 | 07 | 018 | 0 | 08 | 016 | Change qualifier of a trend-type forecast or an aerodrome forecast | TTTTT |
|  |  |  | 1 | 02 | 000 | Delayed replication of 2 descriptors |  |
|  |  |  | 0 | 31 | 001 | Number of replication (up to 2) |  |
|  |  |  | 0 | 08 | 017 | Qualifier of the time when the forecast change is expected (FM, TL, AT) | TT |
|  |  |  | 3 | 01 | 012 | GG, gg |  |
|  |  |  | 1 | 04 | 000 | Delayed replication of 4 descriptor |  |
|  |  |  | 0 | 31 | 001 | Number of replication (up to 1) |  |
|  |  |  | 0 | 07 | 006 | Height above station |  |
|  |  |  | 0 | 11 | 001 | Wind direction | ddd |
|  |  |  | 0 | 11 | 002 | Wind speed | ff |
|  |  |  | 0 | 11 | 041 | Maximum wind speed (gusts) | $\mathbf{f}_{\mathbf{m}} \mathrm{f}_{\mathrm{m}}$ |
|  |  |  | 0 | 20 | 009 | General Weather Indicator |  |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |  |
|  |  |  | 0 | 31 | 001 | Number of replication (up to 1) |  |
|  |  |  | 0 | 20 | 001 | Horizontal visibility | VVVV |
|  |  |  | 3 | 07 | 014 | w'w' |  |
|  |  |  |  |  |  | (Short METAR/SPECI) |  |
| 3 | 07 | 020 | 3 | 07 | 011 | Main part of data |  |
|  |  |  | 3 | 07 | 014 | w'w' |  |
|  |  |  | 3 | 07 | 016 | REw'w' |  |
|  |  |  |  |  |  | (Total sequence for representation of META | code in BUFR) |
| 3 | 07 | 021 | 3 | 07 | 011 | Main part of data |  |
|  |  |  | 3 | 07 | 012 | $\mathrm{D}_{\mathrm{v}} \mathrm{VVVV}$ |  |
|  |  |  | 3 | 07 | 013 | $D_{R} D_{R} V_{R} V_{R} V_{R} V_{R}$ |  |
|  |  |  | 3 | 07 | 014 | $W^{\prime \prime} w^{\prime}$ |  |
|  |  |  | 3 | 07 | 015 | Clouds group(s) |  |
|  |  |  | 3 | 07 | 016 | REw'w' |  |
|  |  |  | 3 | 07 | 017 | Wind shear on runway(s) |  |
|  |  |  | 3 | 07 | 018 | Trend-type landing forecast |  |
|  |  |  | 3 | 07 | 015 | Clouds group(s) |  |

Category 08 - Surface report sequences (sea)

| TABLE REFERENCE |  |  | tABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 08 | 001 |  |  |  | (Buoy/platform - fixed) |
|  |  |  | 3 | 01 | 033 | Identific ation, type, date/time, position (high accuracy) |
|  |  |  | 3 | 02 | 011 | Basic surface report |
|  |  |  | 0 | 22 | 042 | Sea-surface temperature |
| 3 | 08 | 002 |  |  |  | (Buoy/platform - fixed) |
|  |  |  | 3 | 01 | 034 | Identification, type, date/time, position (coarse accuracy) |
|  |  |  | 3 | 02 | 011 | Basic surface report |
|  |  |  | 0 | 22 | 042 | Sea-surface temperature |
| 3 | 08 | 003 |  |  |  | (Buoy/platform - moving) |
|  |  |  | 3 | 01 | 035 | Identification, movement, type, date/time, position (coarse accuracy) |
|  |  |  | 3 | 02 | 011 | Basic surface report |
|  |  |  | 0 | 22 | 042 | Sea-surface temperature |
| 3 | 08 | 004 |  |  |  | (Ship) |
|  |  |  | 3 | 01 | 036 | Identific ation, movement, type, date/time, position (coarse accuracy) |
|  |  |  | 3 | 02 | 011 | Basic surface report |
|  |  |  | 0 | 22 | 042 | Sea-surface temperature |
| 3 | 08 | 005 | 3 | 08 | 004 | Basic ship report |
|  |  |  | 3 | 02 | 024 | Wind waves and swell waves |
| 3 | 08 | 006 |  |  |  | (Buoy Section 1 optional parameters) |
|  |  |  | 0 | 10 | 004 | Pressure |
|  |  |  | 0 | 10 | 061 | 3-hour pressure change |
|  |  |  | 0 | 10 | 063 | Characteristic of pressure tendency |
|  |  |  | 0 | 11 | 001 | Wind direction |
|  |  |  | 0 | 11 | 002 | Wind speed |
|  |  |  | 0 | 12 | 004 | Dry-bulb temperature at 2 m |
|  |  |  | 0 | 13 | 003 | Relative humidity |
|  |  |  | 0 | 22 | 042 | Sea temperature |
| 3 | 08 | 007 | 3 | 01 | 055 | Identification, movement type, date/time, position (high accuracy) |
|  |  |  | 3 | 02 | 011 | Basic surface report |
|  |  |  | 0 | 07 | 062 | Depth below sea/water surface |
|  |  |  | 0 | 22 | 042 | Sea/water temperature |

N ote : Descriptor 308007 should be used instead of 308003 to encode moving buoy/platform information.

## Category 09 - Vertical sounding sequences (conventional data)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
|  | 09 | 001 |  |  |  | (Vertical wind profile) |
| 3 |  |  | 3 | 01 | 037 | Identific ation, etc. (land station, high accuracy position) |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 011 | Winds at heights |
| 3 | 09 | 002 |  |  |  | (Vertical wind profile) |
|  |  |  | 3 | 01 | 038 | Identification, etc. (land station, coarse accuracy position) |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 011 | Winds at heights |
| 3 | 09 | 003 |  |  |  | (Vertical wind profile) |
|  |  |  | 3 | 01 | 037 | Identification, etc. (land station, high accuracy position) |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 012 | Winds at pressure levels |
| 3 | 09 | 004 |  |  |  | (Vertical wind profile) |
|  |  |  | 3 | 01 | 038 | Identification, etc. (land station, coarse accuracy position) |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 012 | Winds at pressure levels |
| 3 | 09 | 005 |  |  |  | (Vertical sounding with relative humidity) |
|  |  |  | 3 | 01 | 037 | Identification, etc. (land station, high accuracy position) |
|  |  |  | 3 | 02 | 004 | Significant cloud information |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 013 | Pressure, geopotential, temperature and wind data |
| 3 | 09 | 006 |  |  |  | (Vertical sounding with relative humidity) |
|  |  |  | 3 | 01 | 038 | Identification, etc. (land station, coarse accuracy position) |
|  |  |  | 3 | 02 | 004 | Significant cloud information |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 013 | Pressure, geopotential, temperature and wind data |
| 3 | 09 | 007 |  |  |  | (Vertical sounding with dew-point data) |
|  |  |  | 3 | 01 | 037 | Identification, etc. (land station, high accuracy position) |
|  |  |  | 3 | 02 | 004 | Significant cloud information |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 014 | Pressure, geopotential, temperature and wind data |

(Category 09 - continued)

| REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 09 | 008 |  |  |  | (Vertical sounding with dew-point data) |
|  |  |  | 3 | 01 | 038 | Identification, etc. (land station, coarse accuracy position) |
|  |  |  | 3 | 02 | 004 | Significant cloud information |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 014 | Pressure, geopotential, temperature and wind data |
| 3 | 09 | 011 |  |  |  | (Vertical wind profile) |
|  |  |  | 3 | 01 | 039 | Ship's identification, etc. |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 011 | Winds at heights |
| 3 | 09 | 012 |  |  |  | (Vertical wind profile) |
|  |  |  | 3 | 01 | 039 | Ship's identification, etc. |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  |  | 03 | 012 | Winds at pressure levels |
| 3 | 09 | 013 |  |  |  | (Vertical sounding with relative humidity) |
|  |  |  | 3 | 01 | 039 | Ship's identification, etc. |
|  |  |  | 3 | 02 | 004 | Significant cloud information |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 013 | Pressure, geopotential, temperature and wind data |
| 3 | 09 | 014 |  |  |  | (Vertical sounding with dew-point data) |
|  |  |  | 3 | 01 | 039 | Ship's identification, etc. |
|  |  |  | 3 | 02 | 004 | Significant cloud information |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 014 | Pressure, geopotential, temperature and wind data |
|  | 09 | 015 |  |  |  | (Vertical wind profile) |
| 3 |  |  | 3 | 01 | 040 | Ship's identification, etc. |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 011 | Winds at heights |
| 3 | 09 | 016 |  |  |  | (Vertical wind profile) |
|  |  |  | 3 | 01 | 040 | Ship's identification, etc. |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 012 | Winds at pressure levels |

(Category 09 - continued)

| TABLE <br> REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 09 | 017 |  |  |  | (Vertical sounding with relative humidity) |
|  |  |  | 3 3 | 02 | $\begin{aligned} & 040 \\ & 004 \end{aligned}$ | Ship's identification, etc. Signific ant cloud information |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 013 | Pressure, geopotential, temperature and wind data |
| 3 | 09 | 018 |  |  |  | (Vertical sounding with dew-point data) |
|  |  |  | 3 | 01 | 040 | Ship's identification, etc. |
|  |  |  | 3 | 02 | 004 | Signific ant cloud information |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 014 | Pressure, geopotential, temperature and wind data |
| 3 | 09 | 019 |  |  |  | (Wind profiler - wind data sounding) |
|  |  |  | 3 | 01 | 031 | Identification, etc. |
|  |  |  | 0 | 02 | 003 | Type of measuring equipment used |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 03 | 011 | Winds at heights |
| 3 | 09 | 020 |  |  |  | (Wind profiler - Cartesian coordinates) |
|  |  |  | 3 | 01 | 031 | Identific ation, etc. |
|  |  |  | 0 | 02 | 003 | Type of measuring equipment used |
|  |  |  | 1 | 04 | 000 | Delayed replication of 4 descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 07 | 003 | Geopotential |
|  |  |  | 0 | 11 | 003 | u-component |
|  |  |  | 0 | 11 | 004 | v-component |
|  |  |  | 0 | 11 | 005 | w-component |
| 3 | 09 | 030 |  |  |  | (Ozone sonde flight data) |
|  |  |  | 0 | 15 | 004 | Ozone sounding correction factor |
|  |  |  | 0 | 15 | 005 | Ozone p |
|  |  |  | 1 | 04 | 000 | Delayed replication of 4 descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 04 | 015 | Time increment since launch time, if needed, in minutes |
|  |  |  | 0 | 08 | 006 | Ozone vertical sounding significance |
|  |  |  | 0 | 07 | 004 | Pressure |
|  |  |  | 0 | 15 | 003 | Measured ozone partial pressure |

Category 10 - Vertical sounding sequences (satellite data)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 10 | 001 | 3 | 01 | 042 | (Satellite - brightness temperature) Identification, method, date/time |
|  |  |  | 3 | 03 | 031 | Significance data, land/sea, skin temperature |
|  |  |  | 3 | 03 | 032 | Cloud |
|  |  |  | 1 | 01 | 026 | Replicate 1 descriptor 26 times |
|  |  |  | 3 | 03 | 025 | Satellite channel and brightness temperature |
| 3 | 10 | 002 |  |  |  | (Satellite - low level) |
|  |  |  | 3 | 01 | 042 | Identific ation, method, date/time |
|  |  |  | 3 | 03 | 031 | Significance data, land/sea, skin temperature |
|  |  |  | 3 | 03 | 032 | Cloud |
|  |  |  | 1 | 01 | 009 | Replicate 1 descriptor 9 times |
|  |  |  | 3 | 03 | 023 | Layer mean temperature |
| 3 | 10 | 003 |  |  |  | (Satellite - high level) |
|  |  |  | 3 | 01 | 042 | Identification, method, date/time |
|  |  |  | 3 | 03 | 031 | Significance data, land/sea, skin temperature |
|  |  |  | 3 | 03 | 032 | Cloud |
|  |  |  | 1 | 01 | 006 | Replicate 1 descriptor 6 times |
|  |  |  | 3 | 03 | 023 | Layer mean temperature |
| 3 | 10 | 004 |  |  |  | (Satellite - precipitable water) |
|  |  |  | 3 | 01 | 042 | Identific ation, method, date/time |
|  |  |  | 3 | 03 | 031 | Significance data, land/sea, skin temperature |
|  |  |  | 3 | 03 | 032 | Cloud |
|  |  |  | 1 | 01 | 003 | Replicate 1 descriptor 3 times |
|  |  |  | 3 | 03 | 024 | Precipitable water |
| 3 | 10 | 005 | 3 | 01 | 042 | Identific ation, method, date/time |
|  |  |  | 3 | 03 | 031 | Significance data, land/sea, skin temperature |
|  |  |  | 3 | 03 | 033 | Cloud |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Delayed descriptor replication factor |
|  |  |  | 3 | 03 | 025 | Satellite channel and brightness temperature |
| 3 | 10 | 006 | 3 | 01 | 042 | Identification, method, date/time |
|  |  |  | 3 | 03 | 031 | Significance data, land/sea, skin temperature |
|  |  |  | 3 | 03 | 033 | Cloud |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Delayed descriptor replication factor |
|  |  |  | 3 | 03 | 023 | Layer mean temperature |
| 3 | 10 | 007 | 3 | 01 | 042 | Identification, method, date/time |
|  |  |  | 3 | 03 | 031 | Significance data, land/sea, skin temperature |
|  |  |  | 3 | 03 | 033 | Cloud |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Delayed descriptor replication factor |
|  |  |  | 3 | 03 | 024 | Precipitable water |

(continued)
(Category 10 - continued)

|  | REFERENCE |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 10 | 008 |  |  |  | (ATOVS HIRS report) |
|  |  |  | 3 | 10 | 011 | ATOVS field of view variables |
|  |  |  | 1 | 01 | 019 | Replicate 1 descriptor 19 times |
|  |  |  | 3 | 10 | 012 | ATOVS channel variables |
|  |  |  | 0 | 02 | 150 | TOVS/ATOVS/AVHRR instrumentation channel number |
|  |  |  | 0 | 25 | 079 | Albedo-radiance solar filtered irradiance for ATOVS |
|  |  |  | 0 | 25 | 080 | Albedo-radiance equivalent filter width for ATOVS |
|  |  |  | 0 | 33 | 032 | Channel quality flags for ATOVS |
|  |  |  | 0 | 14 | 045 | Channel radiance |
| 3 | 10 | 009 |  |  |  | (ATOVS AMSU-A report) |
|  |  |  | 3 | 10 | 011 | ATOVS field of view variables |
|  |  |  | 1 | 01 | 015 | Replicate 1 descriptor 15 times |
|  |  |  | 3 | 10 | 012 | ATOVS channel variables |
| 3 | 10 | 010 |  |  |  | (ATOVS AMSU-B report) |
|  |  |  | 3 | 10 | 011 | ATOVS field of view variables |
|  |  |  | 1 | 01 | 005 | Replicate 1 descriptor 5 times |
|  |  |  | 3 | 10 | 012 | ATOVS channel variables |
| 3 | 10 | 011 |  |  |  | (ATOVS field of view variables) |
|  |  |  | 0 | 08 | 070 | TOVS/ATOVS product qualifier |
|  |  |  | 0 | 01 | 033 | Identification of originating/generating centre |
|  |  |  | 0 | 01 | 034 | Identification of originating/generating centre |
|  |  |  | 0 | 08 | 070 | TOVS/ATOVS product qualifier |
|  |  |  | 0 | 01 | 033 | Identification of originating/generating centre |
|  |  |  | 0 | 01 | 034 | Identification of originating/generating centre |
|  |  |  | 0 | 01 | 007 | Satellite Id |
|  |  |  | 0 | 02 | 048 | Satellite sensor indicator |
|  |  |  | 0 | 05 | 040 | Orbit number |
|  |  |  | 0 | 25 | 075 | Satellite antenna corrections version number |
|  |  |  | 2 | 01 | 133 | Change width |
|  |  |  | 0 | 05 | 041 | Scan line number |
|  |  |  | 2 | 01 | 000 | Change width |
|  |  |  | 0 | 05 | 043 | Field of view number |
|  |  |  | 0 | 25 | 070 | Major frame count |
|  |  |  | 0 | 33 | 030 | Scan line status flags for ATOVS |
|  |  |  | 0 | 33 | 031 | Scan line quality flags for ATOVS |
|  |  |  | 0 | 04 | 001 | Year |
|  |  |  | 0 | 04 | 002 | Month |
|  |  |  | 0 | 04 | 003 | Day |
|  |  |  | 0 | 04 | 004 | Hour |
|  |  |  | 0 | 04 | 005 | Minute |
|  |  |  | 2 | 02 | 131 | Change scale |
|  |  |  | 2 | 01 | 138 | Change width |
|  |  |  | 0 | 04 | 006 | Second |
|  |  |  | 2 | 01 | 000 | Change width |
|  |  |  | 2 | 02 | 000 | Change scale |
|  |  |  | 0 | 05 | 001 | Latitude |
|  |  |  | 0 | 06 | 001 | Longitude |

(Category 10 - continued)

(continued)
(Category 10 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| $\underset{\text { (continued) }}{3} 1013$ |  |  | 0 | 14 | 027 | Albedo |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 14 | 027 | Albedo |
|  |  |  | 0 | 02 | 150 | TOVS/ATOVS/AVHRR instrumentation channel number |
|  |  |  | 0 | 08 | 023 | First order statistics |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 14 | 027 | Albedo |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 14 | 027 | Albedo |
|  |  |  | 0 | 02 | 150 | TOVS/ATOVS/AVHRR instrumentation channel number |
|  |  |  | 0 | 08 | 023 | First order statistics |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 14 | 027 | Albedo |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 14 | 027 | Albedo |
|  |  |  | 2 | 02 | 000 | C hange scale |
|  |  |  | 2 | 01 | 000 | Change width |
|  |  |  | 2 | 01 | 132 | Change width |
|  |  |  | 2 | 02 | 129 | Change scale |
|  |  |  | 0 | 02 | 150 | TOVS/ATOVS/AVHRR instrumentation channel number |
|  |  |  | 0 | 08 | 023 | First order statistics |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 12 | 063 | B rightness temperature |
|  |  |  | 0 | 02 | 150 | TOVS/ATOVS/AVHRR instrumentation channel number |
|  |  |  | 0 | 08 | 023 | First order statistics |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 0 | 08 | 023 | First order statistics |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 0 | 02 | 150 | TOVS/ATOVS/AVHRR instrumentation channel number |
|  |  |  | 0 | 08 | 023 | First order statistics |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 0 | 08 | 072 | Pixel(s) type |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 2 | 02 | 000 | Change scale |
|  |  |  | 2 | 01 | 000 | Change width |
| 3 | 10 |  |  |  |  | (Satellite - geostationnary wind data) |
|  |  | 014 | 3 | 01 | 072 | Satellite identification, date, time, latitude, longitude |
|  |  |  | 3 | 03 | 041 | Wind sequence |
|  |  |  | 3 | 04 | 011 | GOES-I/M information |

(Category 10 - continued)

| table REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 10 | 015 |  |  |  | (Meteosat radiance data) |
|  |  |  | 3 | 01 | 072 | Satellite identification |
|  |  |  | 0 | 07 | 024 | Satellite zenith angle |
|  |  |  | 0 | 10 | 002 | Height |
|  |  |  | 3 | 03 | 041 | Wind sequence |
|  |  |  | 1 | 01 | 003 | Replicate next descriptor 3 times |
|  |  |  | 3 | 04 | 032 | Cloud fraction |
|  |  |  | 0 | 02 | 152 | Satellite instrument used in data processing |
|  |  |  | 0 | 02 | 024 | Integrated mean humidity computational method |
|  |  |  | 0 | 07 | 004 | Pressure |
|  |  |  | 0 | 07 | 004 | Pressure |
|  |  |  | 0 | 13 | 003 | Relative humidity |
|  |  |  | 1 | 01 | 003 | Replicate next descriptor 3 times |
|  |  |  | 3 | 04 | 033 | Clear sky radiance |
| 3 | 10 | 016 |  |  |  | (Meteosat Second Generation (MSG) radiance data) |
|  |  |  | 3 | 01 | 072 | Satellite identification |
|  |  |  | 0 | 07 | 024 | Satellite zenith angle |
|  |  |  | 0 | 10 | 002 | Height |
|  |  |  | 3 | 03 | 041 | Wind sequence |
|  |  |  | 1 | 01 | 012 | Replicate next descriptor 12 times |
|  |  |  | 3 | 04 | 032 | Cloud fraction |
|  |  |  | 0 | 02 | 152 | Satellite instrument used in data processing |
|  |  |  | 0 | 02 | 024 | Integrated mean humidity computational method |
|  |  |  | 0 | 07 | 004 | Pressure |
|  |  |  | 0 | 07 | 004 | Pressure |
|  |  |  | 0 | 13 | 003 | Relative humidity |
|  |  |  | 1 | 01 | 012 | Replicate next descriptor 12 times |
|  |  |  | 3 | 04 | 033 | Clear sky radiance |
|  | 10 |  |  |  |  | (Retrieved ozone data) |
| 3 |  | 020 | 3 | 10 | 022 |  |
|  |  |  | 3 | 01 | 011 | Year, month, day |
|  |  |  | 3 | 01 | 013 | Hour, minute, second |
|  |  |  | 3 | 01 | 021 | Latitude, longitude (high accuracy) |
|  |  |  | 3 | 04 | 034 |  |
|  |  |  | 3 | 10 | 021 |  |
| 3 | 10 | 021 | 1 | 08 | 000 | Delayed replication of 8 next descriptors |
|  |  |  | 0 | 31 | 001 | Delayed descriptor replication factor |
|  |  |  | 2 | 01 | 131 | Change data width |
|  |  |  | 2 | 02 | 129 | Change scale |
|  |  |  | 0 | 07 | 004 | Pressure |
|  |  |  | 0 | 07 | 004 | Pressure |
|  |  |  | 2 | 02 | 000 | Change scale to Table B |
|  |  |  | 2 | 01 | 000 | Change data width to Table B |
|  |  |  | 0 | 15 | 020 | Integrated ozone density |
|  |  |  | 0 | 10 | 002 | Height |

(continued)
(Category 10 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 10 | 022 | 0 0 0 0 | $\begin{aligned} & 01 \\ & 02 \\ & 01 \\ & 02 \end{aligned}$ | $\begin{aligned} & 007 \\ & 019 \\ & 033 \\ & 172 \end{aligned}$ | Satellite identifier <br> Satellite instrument used <br> Identification of originating/generating centre <br> Product type for retrieved atmospheric gases |

Category 11 - Single level report sequences (conventional data)

| REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 11 | 001 |  |  |  | (Aircraft reports) |
|  |  |  | 3 | 01 | 051 | ASDAR aircraft identifier, navigational system, date/time, position, phase of aircraft flight |
|  |  |  | 0 | 07 | 002 | Altitude |
|  |  |  | 0 | 12 | 001 | Temperature |
|  |  |  | 0 | 11 | 001 | Wind direction |
|  |  |  | 0 | 11 | 002 | Wind speed |
|  |  |  | 0 | 11 | 031 | Degree of turbulence |
|  |  |  | 0 | 11 | 032 | Height of base of turbulence |
|  |  |  | 0 | 11 | 033 | Height of top of turbulence |
|  |  |  | 0 | 20 | 041 | Airframe icing |
| 3 | 11 | 002 |  |  |  | (ACARS reports) |
|  |  |  | 3 | 01 | 065 | ACARS identification |
|  |  |  | 3 | 01 | 066 | ACARS location |
|  |  |  | 3 | 11 | 003 | ACARS standard reported variables |
|  |  |  | 3 | 11 | 004 | ACARS supplementary reported variables |
| 3 |  | 003 |  |  |  | (ACARS standard reported variables) |
|  | 11 |  | 0 | 10 | 070 | Indicated aircraft altitude |
|  |  |  | 0 | 11 | 001 | Wind direction |
|  |  |  | 0 | 11 | $002$ | Wind speed |
|  |  |  | 0 | 12 | 001 |  |
|  |  |  | 0 | 13 | $002$ | Mixing ratio |
| 3 | 11 | 004 |  |  |  | (ACARS supplementary reported variables) |
|  |  |  | 1 | 01 |  | Delayed replication of one descriptor |
|  |  |  | 0 | 31 | 000 | Short delayed descriptor replication factor |
|  |  |  | 0 | 11 | 034 | Vertical gust velocity |
|  |  |  | 1 | 01 | 000 | Delayed replication of one descriptor |
|  |  |  | 0 | 31 | 000 | Short delayed descriptor replication factor |
|  |  |  | 0 | 11 | 035 | Vertical gust acceleration |
|  |  |  | 1 | 01 | 000 | Delayed replication of one descriptor |
|  |  |  | 0 | 31 | 000 | Short delayed descriptor replication factor |
|  |  |  | 0 | 11 | 075 | Mean turbulence intensity (eddy dissipation rate) |
|  |  |  | 1 | 01 | 000 | Delayed replication of one descriptor |
|  |  |  | 0 | 31 | 000 | Short delayed descriptor replication factor |
|  |  |  | 0 | 11 | 076 | Peak turbulence intensity (eddy dissipation rate) |
|  |  |  | 1 | 01 | 000 | Delayed replication of one descriptor |
|  |  |  | 0 | 31 | 000 | Short delayed descriptor replication factor |
|  |  |  | 0 | 33 | 025 | ACARS interpolated values |
|  |  |  | 1 | 01 | 000 | Delayed replication of one descriptor |
|  |  |  | 0 | 31 | 000 | Short delayed descriptor replication factor |
|  |  |  | 0 | 33 | 026 | Mixing ratio quality |

## Category 12 - Single level report sequences (satellite data)


(continued)
(Category 12 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 12 | 013 |  |  |  | (HIRS brightness temperatures - channel 20) |
|  |  |  | 0 | 05 | 042 | Channel number |
|  |  |  | 2 | 02 | 129 | Change scale |
|  |  |  | 2 | 01 | 135 | Change width |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 2 | 01 | 000 | Change width |
|  |  |  | 2 | 02 | 000 | Change scale |
| 3 | 12 | 014 |  |  |  | (HIRS satellite data) |
|  |  |  | 3 | 12 | 010 | Orbital information, Part I |
|  |  |  | 3 | 12 | 011 | Orbital information, Part II |
|  |  |  | 1 | 05 | 056 | Replicate 5 descriptors 56 times |
|  |  |  | 3 | 01 | 023 | Latitude and longitude (coarse accuracy) |
|  |  |  | 0 | 05 | 042 | Channel number |
|  |  |  | 0 | 05 | 052 | Channel number increment |
|  |  |  | 3 | 12 | 012 | HIRS brightness temperatures - channels 1-19 |
|  |  |  | 3 | 12 | 013 | HIRS brightness temperature - channel 20 |
| 3 |  | 015 |  |  |  | (MSU brightness temperatures - channels 1-4) |
|  | 12 |  | 1 | 09 | 011 | Replicate 9 descriptors 11 times |
|  |  |  | 3 | 01 | 023 | Latitude and longitude (coarse accuracy) |
|  |  |  | 0 | 05 | 042 | Channel number |
|  |  |  | 0 | 05 | 052 | Channel number increment |
|  |  |  | 2 | 02 | 129 | Change scale |
|  |  |  | 2 | 01 | 132 | Change width |
|  |  |  | 1 | 01 | 004 | Replicate 1 descriptor 4 times |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 2 | 02 | 000 | Change scale |
|  |  |  | 2 | 01 | 000 | Change width |
| 3 | 12 | 016 |  |  |  | (MSU satellite data) |
|  |  |  | 3 | 12 | 010 | Orbital information, Part I |
|  |  |  | 3 | 12 | 011 | Orbital information, Part II |
|  |  |  | 3 | 12 | 015 | MSU brightness temperatures - channels 1-4 |
| 3 | 12 | 017 |  |  |  | (SSU brightness temperatures - channels 1-3) |
|  |  |  | 1 | 09 | 008 | Replicate 9 descriptors 8 times |
|  |  |  | 3 | 01 | 023 | Latitude and longitude (coarse accuracy) |
|  |  |  | 0 | 05 | 042 | Channel number |
|  |  |  | 0 | 05 | 052 | Channel number increment |
|  |  |  | 2 | 02 | 129 | Change scale |
|  |  |  | 2 | 01 | 132 | Change width |
|  |  |  | 1 | 01 | 003 | Replicate 1 descriptor 3 times |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 2 | 02 | 000 | Change scale |
|  |  |  | 2 | 01 | 000 | Change width |
| 3 | 12 | 018 |  |  |  | (SSU satellite data) |
|  |  |  | 3 | 12 | 010 | Orbital information, Part I |
|  |  |  | 3 | 12 | 011 | Orbital information, Part II |
|  |  |  | 3 | 12 | 017 | SSU brightness temperatures - channels 1-3 |

(Category 12 - continued)

| REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 12 | 019 | 3 | 01 | 047 | (Wave scatterometer product with width change for wave number (spectral)) Product header |
|  |  |  | 3 | 01 | 048 | Radar parameters |
|  |  |  | 0 | 15 | 015 | Maximum spectrum composition before normalisation |
|  |  |  | 0 | 29 | 002 | Coordinate grid type |
|  |  |  | 0 | 21 | 076 | Representation of intensities |
|  |  |  | 1 | 06 | 012 | Repeat next 6 descriptors 12 times |
|  |  |  | 2 | 01 | 129 | Change width to 14 bits |
|  |  |  | 0 | 06 | 030 | Wave number (spectral) |
|  |  |  | 2 | 01 | 000 | Change width to Table B |
|  |  |  | 1 | 02 | 012 | Repeat next 2 descriptors 12 times |
|  |  |  | 0 | 05 | 030 | Direction (spectral) |
|  |  |  | 0 | 21 | 075 | Image spectrum intensity |
|  |  |  | 0 | 21 | 066 | Wave scatterometer product confidence data |
|  |  |  |  |  |  | (Wave scatterometer product) |
| 3 | 12 | 020 | 3 | 01 | 047 | Product header |
|  |  |  | 3 | 01 | 048 | Radar parameters |
|  |  |  | 0 | 15 | 015 | Maximum spectrum composition before normalization |
|  |  |  | 0 | 29 | 002 | Coordinate grid type |
|  |  |  | 0 | 21 | 076 | Representation of intensities |
|  |  |  | 1 | 04 | 012 | Repeat next 4 descriptors 12 times |
|  |  |  | 0 | 06 | 030 | Wave number (spectral) |
|  |  |  | 1 | 02 | 012 | Repeat next 2 descriptors 12 times |
|  |  |  | 0 | 05 | 030 | Direction (spectral) |
|  |  |  | 0 | 21 | 075 | Spectral intensity |
|  |  |  | 0 | 21 | 066 | Wave scatterometer product confidence data |
|  |  |  |  |  |  | (Wind scatterometer product) |
| 3 | 12 | 021 | 3 | 01 | 047 | Product header |
|  |  |  | 1 | 01 | 003 | Repeat 1 descriptor 3 times |
|  |  |  | 3 | 01 | 049 | Radar beam data |
|  |  |  | 0 | 11 | 012 | Wind speed at 10 m |
|  |  |  | 0 | 11 | 011 | Wind direction at 10 m |
|  |  |  | 0 | 21 | 067 | Wind product confidence data |
|  |  |  |  |  |  | (Radar altimeter product) |
| 3 | 12 | 022 | 3 | 01 | 047 | Product header |
|  |  |  | 0 | 08 | 022 | Number in average |
|  |  |  | 0 | 11 | 012 | Wind speed |
|  |  |  | 0 | 11 | 050 | Standard deviation of horizontal wind speed |
|  |  |  | 0 | 22 | 070 | Significant wave height |
|  |  |  | 0 | 22 | 026 | Standard deviation of significant wave height |
|  |  |  | 3 | 12 | 041 | Altitude |
|  |  |  | 0 | 10 | 050 | Standard deviation of altitude |
|  |  |  | 0 | 21 | 068 | Radar altimeter product confidence data |
|  |  |  | 0 | 21 | 071 | Peakiness |
|  |  |  | 0 | 21 | 072 | Altimeter calibration status |
|  |  |  | 0 | 21 | 073 | Altimeter instrument mode |

(continued)
(Category 12 - continued)

| TABLE REFERENCE |  |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
|  | F | X | Y |  |  |  |  |
| $\begin{array}{cc} 3 & 12 \\ \text { (continued) } \end{array}$ |  |  | 022 | 3 | 12 | 042 | Altitude corrections |
|  |  |  | 0 | 21 | 062 | Backscatter |  |
|  |  |  | 0 | 15 | 011 | Log 10 of integrated electron density |  |
| 3 |  |  |  |  |  |  |  | (ATSR sea surface temperature product) |
|  |  | 12 |  | 023 | 3 | 01 | 047 | Product header |
|  |  | 1 | 03 |  | 003 | Repeat 3 descriptors 3 times |  |
|  |  | 0 | 08 |  | 022 | Number in average |  |
|  |  | 0 | 12 |  | 061 | Skin temperature |  |
|  |  | 0 | 22 |  | 050 | Standard deviation of sea surface temperature |  |
|  |  | 0 | 21 |  | 069 | SST product confidence data |  |
|  |  | 0 | 21 |  | 085 | ATSR sea surface temperature across-track band number |  |
| 3 |  |  |  |  |  |  |  | (Wave scatterometer product enhanced) |
|  |  | 12 | 024 | 3 | 12 | 020 | (Wave scatterometer product) |
|  |  | 0 |  | 08 | 060 | Sample scanning mode significance - range |  |
|  |  | 0 |  | 08 08 | 022 | Number in sample <br> Sample scanning mode signification - horizontal |  |
|  |  | 0 |  | 08 | 022 | Number in sample |  |
|  |  | 0 |  | 25 | 014 | Azimuth clutter cut-off |  |
|  |  | 0 |  | 22 | 101 | Total energy (wavelength > 731 m ) |  |
|  |  | 0 |  | 22 | 097 | Mean wavelength of image spectrum |  |
|  |  | 0 |  | 22 | 098 | Wavelength spread (wavelength > 731 m ) |  |
|  |  | 0 |  | 22 | 099 | Mean direction (wavelength > 731 m ) |  |
|  |  | 0 |  | 22 | 100 | Direction spread (wavelength $>731 \mathrm{~m}$ ) |  |
|  |  |  |  |  |  |  | (Wave scatterometer enhanced product (with change of width for wave number (spectral)) |
| 3 |  |  | 12 | 025 | 3 | 12 | 019 | Wave scatterometer product with width change for wave number (spectral) |
|  |  | 0 |  |  | 08 | 060 | Sample scanning mode significance - range |
|  |  | 0 |  |  | 08 | 022 | Number in sample |
|  |  | 0 |  |  | 08 | 060 | Sample scanning mode significance - horizontal |
|  |  | 0 |  |  | 08 | 022 | Number in sample |
|  |  | 0 |  |  | 25 | 014 | Azimuth clutter cut-off |
|  |  | 0 |  |  | 22 | 101 | Total energy (wavelength > 731 m ) |
|  |  | 0 |  |  | 22 | 097 | Mean wavelength of image spectrum |
|  |  | 0 |  |  | 22 | 098 | Wavelength spread (wavelength > 731 m ) |
|  |  | 0 |  |  | 22 | 099 | Mean direction (wavelength > 731 m ) |
|  |  | 0 |  |  | 22 | 100 | Direction spread (wavelength $>731 \mathrm{~m}$ ) |
|  |  |  |  |  |  |  | (QUIKSCAT data) |
| 3 |  |  | 12 | 026 | 3 | 01 | 046 |  |
|  |  | 3 |  |  | 01 | 011 | Date |
|  |  | 3 |  |  | 01 | 013 | Time |
|  |  | 3 |  |  | 01 | 023 | Location |
|  |  | 3 |  |  | 12 | 031 |  |
|  |  | 1 |  |  | 01 | 004 | Replicate 1 descriptor 4 times |
|  |  | 3 |  |  | 12 | 030 |  |

(Category 12 - continued)

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(Category 12 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| $\underset{\text { (continued) }}{3} 12$ |  | 028 | 3 | 21 | 028 |  |
|  |  | 0 | 21 | 113 | Number of outer-beam sigma-0 (aft of satellite) |  |
|  |  | 3 | 01 | 023 |  |  |
|  |  | 3 | 21 | 028 |  |  |
| 3 | 12 |  | 030 | 2 | 01 | 130 | C hange data width |
|  |  |  |  | 2 | 02 | 129 | C hange scale |
|  |  |  |  | 0 | 11 | 012 | Wind speed at 10 m |
|  |  | 2 |  | 02 | 000 | Change scale back to Table B |
|  |  | 2 |  | 01 | 000 | Change data width to Table B |
|  |  | 0 |  | 11 | 052 | Formal uncertainty in wind speed |
|  |  | 2 |  | 01 | 135 | C hange data width |
|  |  | 2 |  | 02 | 130 | Change scale |
|  |  | 0 |  | 11 | 011 | Wind direction at 10 m |
|  |  | 2 |  | 02 | 000 | Change scale back to Table B |
|  |  | 2 |  | 01 | 000 | Change data width to Table B |
|  |  | 0 |  | 11 | 053 | Formal uncertainty in wind direction |
|  |  | 0 |  | 21 | 104 | Likelihood computed for solution |
| 3 | 12 | 031 | 0 | 05 | 034 | Along-track row number |
|  |  |  | 0 | 06 | 034 | Cross-track cell number |
|  |  |  | 0 | 21 | 109 | SEAWINDS wind vector cell quality |
|  |  |  | 0 | 11 | 081 | Model wind direction at 10 m |
|  |  |  | 0 | 11 | 082 | Model wind speed at 10 m |
|  |  |  | 0 | 21 | 101 | Number of vector ambiguities |
|  |  |  | 0 | 21 | 102 | Index of selected wind vector |
|  |  |  | 0 | 21 | 103 | Total number of sigma-0 measurements |
| 3 | 12 | 032 | 0 | 21 | 120 | Probability of rain |
|  |  |  | 0 | 21 | 121 | SEAWINDS NOF rain index |
|  |  |  | 0 | 13 | 055 | Intensity of precipitation |
|  |  |  | 0 | 21 | 122 | Attenuation correction on sigma-0 (from tB) |
| 3 | 12 | 033 | 0 | 02 | 104 | Antenna polarization |
|  |  |  | 0 | 08 | 022 | Total number (with respect to accumulation) |
|  |  |  | 0 | 12 | 063 | Brightness temperature |
|  |  |  | 0 | 12 | 065 | Standard deviation brightness temperature |
|  |  |  |  |  |  | (Altitude) |
| 3 | 12 | 041 | 2 | 01 | 141 | C hange width to 28 bits |
|  |  |  | 2 | 02 | 130 | Change scale to 2 |
|  |  |  | 0 | 07 | 001 | Altitude |
|  |  |  | 2 | 01 | 000 | Change width back to Table B |
|  |  |  | 2 | 02 | 000 | Change scale back to Table B |
|  |  |  |  |  |  | (Altitude corrections) |
| 3 | 12 | 042 | 0 | 21 | 077 | Altitude correction, ionosphere |
|  |  |  | 0 | 21 | 078 | Altitude correction, dry troposphere |

(Category 12 - continued)

| TABLE REFERENCE | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: |
| F $\quad \mathbf{X} \quad \mathbf{Y}$ |  |  |  |  |
| $\underset{\text { (continued) }}{3} 042$ | 0 0 0 0 | $\begin{aligned} & 21 \\ & 21 \\ & 21 \\ & 21 \end{aligned}$ | $\begin{aligned} & 079 \\ & 080 \\ & 081 \\ & 082 \end{aligned}$ | Altitude correction, wet troposphere <br> Altitude correction, calibration constant <br> Open loop height-time loop calibration correction <br> Open loop automatic gain control calibration correction |

Notes:
(1) Separation of single level satellite data into sets of BUFR messages helps compression and results in efficient data transmission and storage.
(2) Each BUFR message may contain data for a number of locations; the BUFR compression technique involves negligible overheads for data items that are invariant.
(3) Compound BUFR messages may be described within the data description section, if required (e.g. $301041,304001,304002,304003,304004,304005,304006)$.

## Category 13 - Sequences common to image data

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 13 | 009 |  |  |  | (Radar reflectivity values) |
|  |  |  | 0 | 21 | 001 | Horizontal reflectivity |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 21 | 001 | Horizontal reflectivity |
| 3 | 13 | 010 |  |  |  | (Radar rainfall intensities) |
|  |  |  | 0 | 21 | 036 | Radar rainfall intensity |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 21 | 036 | Radar rainfall intensity |
| 3 | 13 | 031 |  |  |  | (Non run-length encoded row for Pixel value (4 bits)) |
|  |  |  | 0 | 06 | 002 | First longitude location minus one increment |
|  |  |  | 0 | 06 | 012 | Longitude increment |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 002 | Extended replication factor |
|  |  |  | 0 | 30 | 001 | Pixel value (4 bits) |
| 3 | 13 | 032 |  |  |  | (Non run-length encoded picture data for Pixel value (4 bits)) |
|  |  |  | 0 | 05 | 002 | First latitude location minus one increment |
|  |  |  | 0 | 05 | 012 | Latitude increment (signed value so cannot cross pole) |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 002 | Extended replication factor |
|  |  |  | 3 | 13 | 031 | Non run-length encoded row |
| 3 | 13 | 041 |  |  |  | (Run-length encoded row for Pixel value (4 bits)) |
|  |  |  | 0 | 06 | 002 | First longitude location minus one increment |
|  |  |  | 1 | 10 | 000 | Delayed replication of 10 descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 1 | 04 | 000 | Delayed replication of 4 descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 06 | 012 | Longitude increment |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 012 | Repetition factor |
|  |  |  | 0 | 30 | 001 | Pixel value (4 bits) |
|  |  |  | 0 | 06 | 012 | Longitude increment |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 30 | 001 | Pixel value (4 bits) |
| 3 | 13 | 042 |  |  |  | (Run-length encoded picture data for Pixel value (4 bits)) |
|  |  |  | 0 | 05 | 002 | First latitude location minus one increment |
|  |  |  | 0 | 05 | 012 | Latitude increment (signed value so cannot cross pole) |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 002 | Extended replication factor |
|  |  |  | 3 | 13 | 041 | Run-length encoded row |

(continued)
(Category 13 - continued)

| table REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 13 | 043 |  |  |  | (Run-length encoded picture data for Pixel value (4 bits), regular grid) |
|  |  |  | 0 | 06 | 002 | First longitude location minus one increment |
|  |  |  | 0 | 05 | 002 | First latitude location minus one increment |
|  |  |  | 0 | 05 | 012 | Latitude increment |
|  |  |  | 1 | 12 | 000 | Delayed replication of $\mathbf{1 2}$ descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 1 | 10 | 000 | Delayed replication of 10 descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 1 | 04 | 000 | Delayed replication of 4 descriptors |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 06 | 012 | Longitude increment |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 011 | Repetition factor |
|  |  |  | 0 | 30 | 001 | Pixel value (4 bits) |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 30 | 001 | Pixel value (4 bits) |

## Category 15 - Oceanographic report sequences



Category 16 - Synoptic feature sequences

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 16 | 001 | 3 | 01 | 011 | Year, month, day |
|  |  |  | 0 | 04 | 004 | Hour |
|  |  |  | 3 | 01 | 023 | Latitude and longitude (coarse accuracy) |
|  |  |  | 0 | 01 | 021 | Synoptic feature identifier |
|  |  |  | 0 | 02 | 041 | Method for estimating reports related to synoptic features |
|  |  |  | 0 | 19 | 001 | Type of synoptic feature |
|  |  |  | 0 | 10 | 051 | Pressure reduced to mean sea level |
|  |  |  | 0 | 19 | 002 | Effective radius of feature |
|  |  |  | 0 | 19 | 003 | Wind speed threshold ( $15 \mathrm{~m} \mathrm{~s}^{-1}$ typically) |
|  |  |  | 0 | 19 | 004 | Effective radius with respect to wind speeds above threshold |
|  |  |  |  |  |  | (Header) |
| 3 | 16 | 002 | 0 | 08 | 021 | Data time (analysis) |
|  |  |  | 0 | 04 | 001 | Year |
|  |  |  | 0 | 04 | 002 | Month |
|  |  |  | 0 | 04 | 003 | Day |
|  |  |  | 0 | 04 | 004 | Hour |
|  |  |  | 0 | 04 | 005 | Minute |
|  |  |  | 0 | 01 | 033 | Originating/generating centre |
|  |  |  | 0 | 08 | 021 | Validity time (fcst) |
|  |  |  | 0 | 04 | 001 | Year |
|  |  |  | 0 | 04 | 002 | Month |
|  |  |  | 0 | 04 | 003 | Day |
|  |  |  | 0 | 04 | 004 | Hour |
|  |  |  | 0 | 04 | 005 | Minute |
|  |  |  | 0 | 07 | 002 | Flight level (altitude) (base of chart layer) |
|  |  |  | 0 | 07 | 002 | Flight level (altitude) (top of chart layer) |
|  |  |  |  |  |  | ( ${ }^{\text {et stream) }}$ |
| 3 | 16 | 003 | 1 | 10 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 08 | 011 | Meteorological feature (jet stream value) |
|  |  |  | 0 | 08 | 007 | Dimensional significance (value for line) |
|  |  |  | 1 | 04 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 05 | 002 | Latitude (coarse) |
|  |  |  | 0 | 06 | 002 | Longitude (coarse) |
|  |  |  | 0 | 10 | 002 | Flight level (altitude) |
|  |  |  | 0 | 11 | 002 | Wind speed |
|  |  |  | 0 | 08 | 007 | Dimensional signific ance (cancel) |
|  |  |  | 0 | 08 | 011 | Meteorological feature (cancel/end of object) |
|  |  |  |  |  |  | (Turbulence) |
| 3 | 16 | 004 | 1 |  |  | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 08 | 011 | Meteorological feature (value for turbulence) |
|  |  |  | 0 | 08 | 007 | Dimensional signific ance (value for area) |
|  |  |  | 0 | 07 | 002 | Flight level (altitude) (base of layer) |
|  |  |  | 0 | 07 | 002 | Flight level (altitude) (top of layer) |

(continued)
(Category 16 - continued)

|  | REFERENCE |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | F $\quad$ X | Y |  |  |  |  |
| $\begin{array}{cc} 3 & 16 \\ \text { (continued) } \end{array}$ |  | 004 | 1 | 02 | 000 | Delayed replication |
|  |  | 0 | 31 | 001 | Replication |  |
|  |  | 0 | 05 | 002 | Latitude (coarse) |  |
|  |  | 0 | 06 | 002 | Longitude (coarse) |  |
|  |  | 0 | 11 | 031(1) | Degree of turbulence |  |
|  |  | 0 | 08 | 007 | Dimensional signific ance (cancel) |  |
|  |  | 0 | 08 | 011 | Meteorological feature (cancel/end of object) |  |
|  |  |  |  |  | (Storm) |  |
| 3 | 16 |  | 005 | 1 | 08 | 000 | Delayed replication |
|  |  |  |  | 0 | 31 | 001 | Replication |
|  |  |  |  | 0 | 08 | 005 | Meteorological attribute significance (storm centre) |
|  |  |  |  | 0 | 08 | 007 | Dimensional significance (value for point) |
|  |  |  |  | 0 | 05 | 002 | Latitude (coarse) |
|  |  |  |  | 0 | 06 | 002 | Longitude (coarse) |
|  |  |  |  | 0 | 01 | 026 | WMO storm name (use "UNKNOWN" for a sandstorm) |
|  |  | 0 |  | 19 | 001 | Synoptic features (value for type of storm) |
|  |  | 0 |  | 08 | 007 | Dimensional significance (cancel) |
|  |  | 0 |  | 08 | 005 | Meteorological attribute significance (cancel/end of object) |
|  |  |  |  |  |  | (Cloud) |
| 3 <br>  <br>  <br>  <br> 3 | 16 | 006 | 1 | 12 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 08 | 011 | Meteorological feature (value for cloud) |
|  |  |  | 0 | 08 | 007 | Dimensional signific ance (value for area) |
|  |  |  | 0 | 07 | 002 | Flight level (altitude) (base of layer) |
|  |  |  | 0 | 07 | 002 | Flight level (altitude) (top of layer) |
|  |  |  | 1 | 02 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 05 | 002 | Latitude (coarse) |
|  |  |  | 0 | 06 | 002 | Longitude (coarse) |
|  |  |  | 0 | 20 | 011(2) | Cloud amount |
|  |  |  | 0 | 20 | 012 | Cloud type |
|  |  |  | 0 | 08 | 007 | Dimensional signific ance (cancel) |
|  |  |  | 0 | 08 | 011 | Meteorological feature (cancel/end of object) |
|  |  |  |  |  |  | (Front) |
| 3 | 16 | 007 | 1 | 10 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 08 | 011(3) | Meteorological feature (value for type of front) |
|  |  |  | 0 | 08 | 007 | Dimensional signific ance (value for line) |
|  |  |  | 1 | 04 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 05 | 002 | Latitude (coarse) |
|  |  |  | 0 | 06 | 002 | Longitude (coarse) |
|  |  |  | 0 | 19 | 005 | Direction of feature |
|  |  |  | 0 | 19 | 006 | Speed of feature |
|  |  |  | 0 | 08 | 007 | Dimensional signific ance (cancel) |
|  |  |  | 0 | 08 | 011 | Meteorological feature (cancel/end of object) |

(Category 16 - continued)

| table REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 16 | 008 |  |  |  | (Tropopause) |
|  |  |  | 1 | 11 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 08 | 001 | Vertical signific ance (bit 3 set for tropopause) |
|  |  |  | 0 | 08 | 007 | Dimensional significance (value for point) |
|  |  |  | 0 | 08 | 023(4) | Statistic (type of tropopause value) |
|  |  |  | 1 | 03 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 05 | 002 | Latitude (coarse) |
|  |  |  | 0 | 06 | 002 | Longitude (coarse) |
|  |  |  | 0 | 10 | 002 | Height/altitude |
|  |  |  | 0 | 08 | 023 | Statistic (cancel) |
|  |  |  | 0 | 08 | 007 | Dimensional signific ance (cancel) |
|  |  |  | 0 | 08 | 001 | Vertical significance (cancel/end of object) |
|  | 16 | 009 |  |  |  | (Airframe icing area) |
| 3 |  |  | 1 | 11 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 08 | 011 | Meteorological feature (value for airframe icing) |
|  |  |  | 0 | 08 | 007 | Dimensional signific ance (value for area) |
|  |  |  | 0 | 07 | 002 | Flight level (altitude) (base of layer) |
|  |  |  | 0 | 07 | 002 | Flight level (altitude) (top of layer) |
|  |  |  | 1 | 02 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 05 | 002 | Latitude (coarse) |
|  |  |  | 0 | 06 | 002 | Longitude (coarse) |
|  |  |  | 0 | 20 | 041 | Airframe icing (type of airframe icing) |
|  |  |  | 0 | 08 | 007 | Dimensional significance (cancel) |
|  |  |  | 0 | 08 | 011 | Meteorological feature (cancel/end of object) |
|  | 16 | 010 |  |  |  | (Name of feature) |
| 3 |  |  | 1 | 07 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 08 | 011 | Meteorologic al feature |
|  |  |  | 0 | 08 | 007 | Dimensional significance (value for point) |
|  |  |  | 0 | 01 | 022 | Name of feature |
|  |  |  | 0 | 05 | 002 | Latitude (coarse) |
|  |  |  | 0 | 06 | 002 | Longitude (coarse) |
|  |  |  | 0 | 08 | 007 | Dimensional signific ance (cancel) |
|  |  |  | 0 | 08 | 011 | Meteorological feature (cancel/end of object) |
|  | 16 |  |  |  |  | (Volcano erupting) |
| 3 |  | 011 | 1 | 16 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |
|  |  |  | 0 | 08 | 011 | Meteorological feature (value for special clouds) |
|  |  |  | 0 | 01 | 022 | Name of feature (volcano name) |
|  |  |  | 0 | 08 | 007 | Dimensional significance (value for point) |
|  |  |  | 1 | 02 | 000 | Delayed replication |
|  |  |  | 0 | 31 | 001 | Replication |

(continued)
(Category 16 - continued)

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | F X | Y |  |  |  |  |
| $\begin{array}{cc} 3 & 16 \\ \text { (continued) } \end{array}$ |  | 011 | 0 | 05 | 002 | Latitude (coarse) |
|  |  | 0 | 06 | 002 | Longitude (coarse) |  |
|  |  | 0 | 08 | 021 | Time significance (eruption starting time) |  |
|  |  | 0 | 04 | 001 | Year |  |
|  |  | 0 | 04 | 002 | Month |  |
|  |  | 0 | 04 | 003 | Day |  |
|  |  | 0 | 04 | 004 | Hour |  |
|  |  | 0 | 04 | 005 | Minute |  |
|  |  | 0 | 20 | 090 | Special clouds (clouds from volcanic eruptions) |  |
|  |  | 0 | 08 | 021 | Time significance (cancel) |  |
|  |  | 0 | 08 | 007 | Dimensional significance (cancel) |  |
|  |  | 0 | 08 | 011 | Meteorological feature (cancel/end of object) |  |
| 316 |  |  |  |  |  | (Forecast data) |
|  |  | 022 | 0 | 01 | 032 | Generating application (NWP model name, etc. code table defined by originating/generating centre) |
|  |  | 0 | 02 | 041 | Method for estimating reports related to synoptic feature |  |
|  |  | 0 | 19 | 001 | Type of synoptic feature |  |
|  |  | 0 | 19 | 010 | Method for tracing of the centre of synoptic feature |  |
|  |  | 1 | 18 | 000 | Delayed replication of 18 descriptors |  |
|  |  | 0 | 31 | 001 | Replication factor |  |
|  |  | 0 | 08 | 021 | Time significance (forecast) |  |
|  |  | 0 | 04 | 014 | Time increment (hour) |  |
|  |  | 0 | 08 | 005 | Surface synoptic feature significance |  |
|  |  | 3 | 01 | 023 | Latitude (coarse accuracy), longitude (coarse accuracy) |  |
|  |  | 0 | 19 | 005 | Direction of motion of feature |  |
|  |  | 0 | 19 | 006 | Speed of motion of feature |  |
|  |  | 0 | 10 | 004 | Pressure |  |
|  |  | 0 | 11 | 041 | Maximum wind speed (gust: e.g. used in the United States) |  |
|  |  | 0 | 08 | 021 | Time significance (forecast time averaged) |  |
|  |  | 0 | 04 | 075 | Time period (minutes) |  |
|  |  | 0 | 11 | 040 | Maximum wind speed (mean wind) |  |
|  |  | 0 | 19 | 008 | Vertical extent of feature |  |
|  |  | 1 | 05 | 004 | Replicate 5 descriptors 4 times |  |
|  |  | 0 | 05 | 021 | Starting bearing or azimuth |  |
|  |  | 0 | 05 | 021 | Ending bearing or azimuth |  |
|  |  | 1 | 02 | 002 | Replicate 2 descriptors 2 times |  |
|  |  | 0 | 19 | 003 | Wind speed threshold |  |
|  |  | 0 | 19 | 004 | Effective radius with respect to wind speed above threshold |  |

Notes:
(1) For MOD OCNL SEV code as 12 (extreme in clear air) or 13 (extreme in cloud).
(2) Code table values : FRQ = code figure 8 (8 oktas)
$\begin{array}{ll}: \text { OCNL EMBD } & =\text { code figure } 6(6 \mathrm{oktas}) \\ : \text { ISOL } & =\text { code figure } 2(2 \text { oktas }) \text { when the cloud }=\mathrm{Cb} .\end{array}$
(3) Front direction (towards which the front is moving) must always be given as it is needed for plotting purposes. A front direction with a front speed of zero would indicate a slow front. A value in the code table exists to represent a quasi-stationary front.
(4) The statistic is to determine whether the following tropopause levels are minimum, maximum or spot values (missing code value).

## Category 18 - Radiological report sequences

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | X | Y |  |  |  |  |
| 3 | 18 | 001 | 3 | $\begin{aligned} & 01 \\ & 24 \end{aligned}$ | $\begin{aligned} & 025 \\ & 011 \end{aligned}$ | Latitude and longitude (coarse accuracy), day and time Dose |
| 3 | 18 | 003 | 3 0 0 0 | 01 24 24 24 | $\begin{aligned} & 026 \\ & 005 \\ & 004 \\ & 021 \end{aligned}$ | Latitude and longitude (high accuracy), time periods in days, hours and minutes <br> Isotope mass <br> Element name <br> Air concentration |
| 3 | 18 | 004 | 3 0 0 0 0 0 | $\begin{aligned} & 01 \\ & 04 \\ & 13 \\ & 24 \\ & 24 \\ & 24 \end{aligned}$ | $\begin{aligned} & 025 \\ & 023 \\ & 011 \\ & 005 \\ & 004 \\ & 022 \end{aligned}$ | Latitude and longitude (coarse accuracy), day and time <br> Time period or displacement <br> Total precipitation/total water equivalent <br> Isotope mass <br> Element name <br> Concentration in precipitation |

## Category 21 - Radar report sequences

| TABLE REFERENCE |  |  | TABLE REFERENCES |  |  | ELEMENT NAME |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | x | Y |  |  |  |  |
| 3 | 21 | 001 | 0 | 02 | 101 | (Wind profiler - antenna characteristics) Type of antenna |
|  |  |  | 0 | 02 | 114 | Antenna effective surface area |
|  |  |  | 0 | 02 | 105 | Maximum antenna gain |
|  |  |  | 0 | 02 | 106 | 3-dB beamwidth |
|  |  |  | 0 | 02 | 107 | Sidelobe suppression |
|  |  |  | 0 | 02 | 121 | Mean frequency |
| 3 | 21 | 003 |  |  |  | (Wind profiler - moment data) |
|  |  |  | 0 | 21 | 051 | Signal power above 1 mW |
|  |  |  | 0 | 21 | 014 | Doppler mean velocity (radial) |
|  |  |  | 0 | 21 | 017 | Doppler velocity spectral width |
|  |  |  | 0 | 21 | 030 | Signal to noise ratio |
| 3 | 21 | 004 |  |  |  | (Wind profiler - moment data sounding) |
|  |  |  | 3 | 01 | 031 | Identification, type, date/time, position (high accuracy), height |
|  |  |  | 0 | 02 | 003 | Type of measuring equipment used |
|  |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 3 | 21 | 003 | Wind profiler - moment data |
| 3 | 21 | 005 |  |  |  | (Transmitter-receiver characteristics) |
|  |  |  | 0 | 25 | 004 | Echo processing |
|  |  |  | 0 | 02 | 121 | Mean frequency |
|  |  |  | 0 | 02 | 122 | Frequency agility range |
|  |  |  | 0 | 02 | 123 | Peak power |
|  |  |  | 0 | 02 | 124 | Average power |
|  |  |  | 0 | 02 | 125 | Pulse repetition frequency |
|  |  |  | 0 | 02 | 126 | Pulse width |
|  |  |  | 0 | 02 | 127 | Receiver intermediate frequency |
|  |  |  | 0 | 02 | 128 | Intermediate frequency bandwidth |
|  |  |  | 0 | 02 | 129 | Minimum detectable signal |
|  |  |  | 0 | 02 | 130 | Dynamic range |
|  |  |  | 0 | 02 | 131 | Sensitivity time control |
| 3 | 21 | 006 |  |  |  | (Integration characteristics) |
|  |  |  | 0 | 25 | 001 | Range-gate length |
|  |  |  | 0 | 25 | 002 | Number of gates averaged |
|  |  |  | 0 | 25 | 003 | Number of integrated pulses |
|  |  |  | 0 | 25 | 005 | Echo integration |
| 3 | 21 | 007 |  |  |  | (Corrections) |
|  |  |  | 0 | 25 | 009 | Calibration method |
|  |  |  | 0 | 25 | 010 | Clutter treatment |
|  |  |  | 0 | 25 | 011 | Ground occultation correction |
|  |  |  | 0 | 25 | 012 | Range attenuation correction |
|  |  |  | 0 | 25 | 013 | Bright-band correction |
|  |  |  | 0 | 25 | 015 | Radome attenuation correction |
|  |  |  | 0 | 25 | 016 | Clear-air attenuation correction |
|  |  |  | 0 | 25 | 017 | Precipitation attenuation correction |

(continued)
(Category 21 - continued)

| REFERENCE |  |  | TABLE REFERENCES |  |  | element name |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | x | Y |  |  |  |  |
| 3 | 21 | 008 |  |  |  | (Z to R conversion) |
|  |  |  | 0 | 25 | 006 | Z to R conversion |
|  |  |  | 0 | 25 | 007 | Z to R conversion factor |
|  |  |  | 0 | 25 | 008 | Z to R conversion exponent |
|  | 21 | 009 |  |  |  | (A to Z law ) |
| 3 |  |  | 0 | 25 | 018 | A to Z law for attenuation factor |
|  |  |  | 0 | 25 | 019 | A to Z law for attenuation exponent |
|  | 21 | 010 |  |  |  | (Antenna characteristics) |
| 3 |  |  | 0 | 02 | 101 | Type of antenna |
|  |  |  | 0 | 07 | 002 | Altitude of the tower base |
|  |  |  | 0 | 02 | 102 | Antenna height above tower base |
|  |  |  | 0 | 02 | 103 | Radome |
|  |  |  | 0 | 02 | 104 | Antenna polarization |
|  |  |  | 0 | 02 | 105 | Maximum antenna gain |
|  |  |  | 0 | 02 | 106 | 3-dB beamwidth |
|  |  |  | 0 | 02 | 107 | Sidelobe suppression |
|  |  |  | 0 | 02 | 108 | Crosspol discrimination (on axis) |
|  |  |  | 0 | 02 | 109 | Antenna speed (azimuth) |
|  |  |  | 0 | 02 | 110 | Antenna speed (elevation) |
|  |  |  | 0 | 02 | 132 | Azimuth pointing accuracy |
|  |  |  | 0 | 02 | 133 | Elevation pointing accuracy |
| 3 | 21 | 011 |  |  |  | (G eneral characteristics) |
|  |  |  | 0 | 30 | 031 | Picture type |
|  |  |  | 0 | 30 | 032 | Combination with other data |
|  |  |  | 0 | 29 | 002 | Coordinate grid type |
|  | 21 | 012 |  |  |  | (Antenna elevations) |
| 3 |  |  | 1 | 01 | 000 | Delayed replication of 1 descriptor |
|  |  |  | 0 | 31 | 001 | Replication factor |
|  |  |  | 0 | 02 | 135 | Antenna elevation |
|  | 21 | 021 |  |  |  | (Basic information (system/site header) on wind profiler/RASS) |
| 3 |  |  | 0 | 02 | 003 | Type of measuring equipment used |
|  |  |  | 0 | 02 | 101 | Type of antenna |
|  |  |  | 2 | 01 | 130 | Change width to 8 bits |
|  |  |  | 0 | 02 | 106 | 3-dB beam width |
|  |  |  | 2 | 01 | 000 | Change width to Table B |
|  |  |  | 2 | 01 | 132 | Change width to 11 bits |
|  |  |  | 2 | 02 | 130 | Change scale to -6 |
|  |  |  | 0 | 02 | 121 | Mean frequency |
|  |  |  | 2 | 02 | 000 | Change scale to Table B |
|  |  |  | 2 | 01 | 000 | Change width to Table B |
|  |  |  | 2 | 01 | 133 | Change width to 11 bits |
|  |  |  | 2 | 02 | 129 | Change scale to 0 |
|  |  |  | 0 | 25 | 001 | Range-gate length |
|  |  |  | 2 | 02 | 000 | Change scale to Table B |
|  |  |  | 2 | 01 | 000 | Change width to Table B |

(Category 21 - continued)

(continued)
(Category 21 - continued)

|  | REFERENCE |  | table references |  |  | element name |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| F | F x | Y |  |  |  |  |
| $\underset{\text { (continued) }}{3}$ |  | 025 | 0 | 21 | 017 | Doppler velocity spectral width, referring to RASS signal |
|  |  | 2 | 02 | 000 | Change scale to Table B |  |
|  |  | 2 | 01 | 000 | Change width to Table B |  |
|  | 21 |  | 026 |  |  |  | (RASS data - fluxes) |
|  |  |  |  | 0 | 07 | 007 | Height |
|  |  | 2 |  | 04 | 001 | Add associated field of 1 bit in length |
|  |  | 0 |  | 31 | 021 | Associated field significance |
|  |  | 0 |  | 12 | 007 | Virtual temperature |
|  |  | 0 |  | 25 | 091 | Structure constant of the refraction index ( $\mathrm{C}_{\mathrm{n}}{ }^{2}$ ) |
|  |  | 0 |  | 11 | 071 | Turbulent vertical momentum flux |
|  |  | 0 |  | 11 | 072 | Turbulent vertical buoyancy flux |
|  |  | 0 |  | 11 | 073 | Turbulent kinetic energy |
|  |  | 0 |  | 11 | 074 | Dissipation energy |
|  |  | 2 |  | 04 | 000 | C ancel add associated field |
| 321 |  | 027 | 0 | 21 | 118 | Attenuation correction on sigma-0 |
|  |  | 2 | 02 | 129 | Change scale |  |
|  |  | 2 | 01 | 132 | Change data width |  |
|  |  | 0 | 02 | 112 | Radar look angle |  |
|  |  | 2 | 01 | 000 | C hange data width to Table B |  |
|  |  | 2 | 01 | 131 | Change data width |  |
|  |  | 0 | 02 | 111 | Radar incidence angle |  |
|  |  | 2 | 01 | 000 | C hange data width to Table B |  |
|  |  | 2 | 02 | 000 | Change scale back to Table B |  |
|  |  | 0 | 02 | 104 | Antenna polarization |  |
|  |  | 0 | 21 | 105 | Normalized radar cross-section |  |
|  |  | 0 | 21 | 106 | Kp variance coefficient (alpha) |  |
|  |  | 0 | 21 | 107 | Kp variance coefficient (beta) |  |
|  |  | 0 | 21 | 114 | Kp variance coefficient (gamma) |  |
|  |  | 0 | 21 | 115 | SEAWINDS sigma-0 quality |  |
|  |  | 0 | 21 | 116 |  |  |
|  |  | 0 | 08 | 018 | SEAWINDS land/ice surface type |  |
|  |  | 0 | 21 | 117 | Sigma-0 variance quality control |  |
| $3 \quad 21$ |  |  | 028 | 0 | 21 | 118 | Attenuation correction on sigma-0 |
|  |  | 2 |  | 02 | 129 | Change scale |
|  |  | 2 |  | 01 | 132 | Change data width |
|  |  | 0 |  | 02 | 112 | Radar look angle |
|  |  | 2 |  | 01 | 000 | Data width back to Table B |
|  |  | 2 |  | 01 | 131 | Change data width |
|  |  | 0 |  | 02 | 111 | Radar incidence angle |
|  |  | 2 |  | 01 | 000 | Data width back to Table B |
|  |  | 2 |  | 02 | 000 | Scale back to Table B |
|  |  | 0 |  | 02 | 104 | Antenna polarization |
|  |  | 0 |  | 21 | 123 | SEAWINDS normalized radar cross-section |
|  |  | 0 |  | 21 | 106 | Kp variance coefficient (alpha) |
|  |  | 0 |  | 21 | 107 | Kp variance coefficient (beta) |
|  |  | 0 |  | 21 | 114 | Kp variance coefficient (gamma) |
|  |  | 0 |  | 21 | 115 | SEAWINDS sigma-0 quality flag |
|  |  | 0 |  | 21 | 116 | SEAWINDS sigma-0 mode flag |
|  |  | 0 |  | 08 21 | 018 117 | SEAWINDS land/ice surface flag |
|  |  | 0 |  | 21 | 117 | Sigma-0 variance quality control |

## CODE TABLES AND FLAG TABLES ASSOCIATED WITH BUFR/CREX TABLE B

Note: In developing code tables associated with BUFR/CREX Table B to specify units of elements, the following principles should be applied:
(a) Code tables specifying the units for an element which is defined, in the Manual on Codes, by a single symbolic letter shall be compatible with the relevant existing WMO code tables;
(b) Code tables combining two or more existing WMO code tables to specify the units for an element which is defined, in the Manual on Codes, by a group of symbolic letters shall be compatible with the combined code figures of the relevant group of symbolic letters;
(c) Code tables combining two or more existing WMO code tables to specify the units for an element which is defined, in the Manual on Codes, by different symbolic letters shall be compatible with the code figures of the relevant symbolic letters, with successive tens or hundreds values added, as appropriate;
(d) Code tables and flag tables should only be used for reporting qualitative information. Quantitative information should be reported as observed using entries in Table B. "Data description operators" from Table C should be applied when a "scale change" or "data width change" is required;
(e) Reference to existing specification(s) and code table(s) in the Manual on Codes, with explanation of possible deviations, shall be given in an additional table annexed to the code tables associated with BUFR/CREX Table B.
001003
WMO Region number/geographical area
Code figure
$0 \quad$ Antarctica
1 Region I
2
3
4
5
6
7
Region II
Region III
Region IV
Region V
Region VI
Missing value

## 001007

Satellite identifier (See common Code table C-5 in Part C/c.)
001031
Identification of originating/generating centre (See common Code table C-1 in Part C/c.)
001033
Identification of originating/generating centre (See common Code table C-1 in Part C/c.)
001034
Identification of originating/generating sub-centre
(To be defined by centres themselves -
See common Code table C-1 in Part C/c.)

## 001036

## Agency in charge of operating the observing platform <br> (The first three digits represent the ISO country code)

| Code figure |  |
| :---: | :---: |
| 0-036000 | Reserved |
| 036001 | Australia, Bureau of Meteorology (BOM) |
| 036002 | Australia, J oint Australian Facility for Ocean Observing Systems (JFOOS) |
| 036003 | Australia, the Commonwealth Scientific and Industrial Research Organization (CSIRO) |
| 036004-124000 | Reserved |
| 124001 | Canada, Marine Environmental Data Service (MEDS) |
| 124002 | Canada, Institute of Ocean Sciences (IOS) |
| 124003-156000 | Reserved |
| 156001 | China, The State Oceanic Administration |
| 156002 | China, Second Institute of Oceanography, State Oceanic Administration |
| 156003 | China, Institute of Ocean Technology |
| 156004-250000 | Reserved |
| 250001 | France, Institut de Recherche pour le Développement (IRD) |
| 250002 | France, Institut Français de Recherche pour l'Exploitation de la mer (IFREMER) |
| 250003-276000 | Reserved |
| 276001 | Germany, B undesamt fuer Seeschiffahrt und Hydrographie (BSH) |
| 276002 | Germany, Institut fuer Meereskunde, Kiel |
| 276003-356000 | Reserved |
| 356001 | India, National Institute of Oceanography (NIO) |
| 356002 | India, National Institute for Ocean Technology (NIOT) |
| 356003 | India, National Centre for Ocean Information Service |
| 356004-392000 | Reserved |
| 392001 | J apan, J apan Meteorological Agency (J MA) |
| 392002 | J apan, Frontier Observational Research System for Global Change |
| 392003 | J apan, J apan Marine Science and Technology Centre (J AMSTEC) |
| 392004-410000 | Reserved |
| 410001 | Republic of Korea, Seoul National University |
| 410002 | Republic of Korea, Korea Ocean Research and Development Institute (KORDI) |
| 410003 | Republic of Korea, Meteorological Research Institute |
| 410004-540000 | Reserved |
| 540001 | New Caledonia, Institut de Recherche pour le Développement (IRD) |
| 540002-554000 | Reserved |
| 554001 | New Zealand, National Institute of Water and Atmospheric Research (NIWA) |
| 554002-643000 | Reserved |
| 643001 | Russia, State Oceanographic Institute of Roshydromet |
| 643002 | Russia, Federal Service for Hydrometeorology and Environmental Monitoring |
| 643003-724000 | Reserved |
| 724001 | Spain, Instituto Español de Oceanografía |
| 724002-826000 | Reserved |
| 826001 | United Kingdom, Hydrographic Office |
| 826002 | United Kingdom, Southampton Oceanography Centre (SOC) |
| 826003-840000 | Reserved |


| (Code table 001036 - continued) |  |
| :--- | :--- |
| Code figure |  |
| 840001 | USA, NOAA Atlantic Oceanographic and Meteorologic al Laboratories (AOML) |
| 840002 | USA, NOAA Pacific Marine Environmental Laboratories (PMEL) |
| 840003 | USA, Scripps Institution of Oceanography (SIO) |
| 840004 | USA, Woods Hole Oceanographic Institution (WHOI) |
| 840005 | USA, University of Washington |
| 840006 | USA, Naval Oceanographic Office |
| $840007-1048574$ | Reserved |
| 1048575 | Missing value |

# 002001 <br> Type of station 

```
Code figure
    0 Automatic
    1 Manned
    2 Hybrid: both manned and automatic
    3
    Missing value
```


## 002002 <br> Type of instrumentation for wind measurement

```
Bit No. Type of instrumentation and original units for wind measurement (measured in \(\mathrm{m} \mathrm{s}^{-1}\) unless otherwise indicated)
1 Certified instruments
Originally measured in \(\mathbf{k m ~ h} \mathbf{h}^{\mathbf{- 1}}\)
Missing value
```


## 002003

Type of measuring equipment used

Code figure

| 0 | Reserved |
| :---: | :--- |
| 0 | Pressure instrument associated with wind measuring equipment |
| 1 | Optical theodolite |
| 2 | Radio theodolite |
| 3 | Radar |
| 4 | VLF-Omega |
| 5 | Loran-C |
| 6 | Wind profiler |
| 7 | Satellite navigation |
| 8 | Radio-acoustic Sounding System (RASS) |
| 9 | Sodar |
| $10-13$ | Reserved |
| 14 | Pressure instrument associated with wind measuring equipment but pressure element |
| 15 | failed during ascent |
| 15 | Missing value |

## 002004

Type of instrumentation for evaporation measurement or type of crop for which evapotranspiration is reported

| Code figure | Instrumentation or crop type | Type of data |
| :---: | :---: | :---: |
| 0 | USA open pan evaporimeter (without cover) |  |
| 1 | USA open pan evaporimeter (mesh covered) |  |
| 2 | GGI-3000 evaporimeter (sunken) | Evaporation |
| 3 | $20 \mathrm{~m}^{2}$ tank |  |
| 4 | Others |  |
| 5 | Rice |  |
| 6 | Wheat |  |
| 7 | Maize | Evapotranspiration |
| 8 | Sorghum |  |
| 9 | Other crops |  |
| 10-14 | Reserved |  |
| 15 | Missing value |  |

> 002011
> Radiosonde type
> (See common Code table $\mathrm{C}-2$ in Part $\mathrm{C} / \mathrm{c}$.)

## 002012 <br> Radiosonde computational method <br> (To be developed)

## 002013 <br> Solar and infrared radiation correction

Code figure
0 No correction

1 CIMO solar corrected and CIMO infrared corrected
2 CIMO solar corrected and infrared corrected
3 CIMO solar corrected only
4 Solar and infrared corrected automatically by radiosonde system
5 Solar corrected automatically by radiosonde system
6 Solar and infrared corrected as specified by country
7 Solar corrected as specified by country
8-14 Reserved
15 Missing value

# 002014 <br> Tracking technique/status of system used <br> (See common Code table C-7 in Part C/c.) 

## 002015 <br> Radiosonde completeness

| Code figure |  |
| :---: | :--- |
| 0 | Reserved |
| 1 | Pressure only radiosonde |
| 2 | Pressure only radiosonde plus transponder |
| 3 | Pressure only radiosonde plus radar reflector |
| 4 | No-pressure radiosonde plus transponder |
| 5 | No-pressure radiosonde plus radar reflector |
| $6-14$ | Reserved |
| 15 | Missing value |

002019
Satellite instruments
(See common Code table C-8 in Part C/c.)

# 002020 <br> Satellite classification 

| Code figure |  |
| :---: | :--- |
| 0 | Nimbus |
| 1 | VTPR |
| 2 | Tiros 1 (Tiros, NOAA-6 to NOAA-13) |
| 3 | Tiros 2 (NOAA-14 onwards) |
| 31 | DMSP |
| 61 | EUMETSAT Polar System (EPS) |
| 91 | ERS |
| 121 | ADEOS |
| 241 | GOES |
| 271 | GMS |
| 301 | INSAT |
| 331 | METEOSAT Operational Programme (MOP) |
| 332 | METEOSAT Transitional Programme (MTP) |
| 333 | METEOSAT Second Generation Programme (MSG) |
| 351 | GOMS |
| 381 | FY-2 |
| $382-510$ | Reserved |
| 511 | Missing value |

## 002021

Satellite instrument data used in processing
Bit No.
$1 \quad$ High-resolution infrared sounder (HIRS)
2 Microwave sounding unit (MSU)
3
4
5
6
7
8
All 9
Stratospheric sounding unit (SSU)
AMI wind mode
AMI wave mode
AMI image mode
RADAR altimeter
ATSR
Missing value

## 002022

Satellite data-processing technique used
Bit flags denoting the elements included in processing sounding data.
Bit No.
1 Processing technique not defined
2 Automated statistical regression
3 Clear path
4 Partly cloudy path
5 Cloudy path
6-7 Reserved
All 8 Missing value
Notes:
(1) Clear path means the sounding has been generated from clear radiances derived from actual clear spot measurements. Tropospheric and stratospheric HIRS data, as well as MSU and SSU data, have been used.
(2) Partly cloudy path means the sounding has been generated from clear radiances which have been calculated from partly cloudy spots. Tropospheric and stratospheric HIRS data, as well as MSU and SSU data, have been used.
(3) Cloudy path means the sounding has been generated only from stratospheric HIRS data, MSU data and SSU data. Tropospheric HIRS data have not been used because of cloudy conditions.

## 002023

## Satellite derived wind computation method

## Code figure

| 0 | Reserved |
| :---: | :--- |
| 1 | Wind derived from cloud motion observed in the infrared channel |
| 2 | Wind derived from cloud motion observed in the visible channel |
| 3 | Wind derived from cloud motion observed in the water vapour channel |
| 4 | Wind derived from motion observed in a combination of spectral channels |
| 5 | Wind derived from motion observed in the water vapour channel in clear air |
| 6 | Wind derived from motion observed in the ozone channel |
| 7 | Wind derived from motion observed in water vapour channel (cloud or clear air not <br> specified) <br> $8-14$ |
| 15 | Reserved |
| Missing value |  |

## 002024 <br> Integrated mean humidity computational method

| Code figure |  |
| :---: | :--- |
| 0 | Reserved |
| 1 | Table with full range of humidity variation in layer |
| 2 | Regression technique on 2 humidity values in layer |
| $3-14$ | Resenved |
| 15 | Missing value |

## 002025

## Satellite channel(s) used in computation

Bit flags denoting the instrument and/or channels used in obtaining various physical parameters. If, in any grouping of parameters, all bits $=0$, then no retrieval was made for that parameter or set of parameters.

(Code table 002025 - continued)
Group 5 - Channel combinations used to obtain mean temperatures for the layers 100 to $70 \mathrm{hPa}, \mathbf{7 0}$ to $50 \mathrm{hPa}, 50$ to $\mathbf{3 0} \mathrm{hPa}, 30$ to $\mathbf{1 0} \mathrm{hPa}, 10$ to $\mathbf{5} \mathbf{h P a}$, 5 to $\mathbf{2 h P a , ~} 2$ to $\mathbf{1} \mathrm{hPa}$, 1 to 0.4 hPa

| Bit No. | Instrument (channels) |  |  |
| :---: | :---: | :---: | :---: |
| $\mathbf{2 1}$ | HIRS* |  |  |
| $\mathbf{2 2}$ | SSU |  |  |
| $\mathbf{2 3}$ | MSU (3, 4) |  |  |
| $\mathbf{2 4}$ | Reserved |  |  |
| All $\mathbf{2 5}$ | Missing value |  |  |
|  |  |  |  |
| Note : | HIRS* is equivalent to: HIRS channels | 1 | $\left(669 \mathrm{~cm}^{-1}\right)$ |
|  |  | 2 | $\left(679 \mathrm{~cm}^{-1}\right)$ |
|  |  | 3 | $\left(690 \mathrm{~cm}^{-1}\right)$ |
|  |  | 4 | $\left(2358 \mathrm{~cm}^{-1}\right)$ |


|  | 002030 |
| :--- | :--- |
|  |  |
| Method of current measurement |  |

## 002031

## Duration and time of current measurement

Code figure
0 Reserved

1 Instantaneous

2
3
4
5
6
7
8
9
10

Averaged over 3 minutes or less
Averaged over more than 3 minutes, but 6 at the most Averaged over more than 6 minutes, but 12 at the most Instantaneous
Averaged over 3 minutes or less
Averaged over more than 3 minutes, but 6 at the most Averaged over more than 6 minutes, but 12 at the most Vector or Doppler current profiling method not used Reserved
between $\mathbf{H - 1}$ and $\mathbf{H}$
between $\mathbf{H - 2}$ and $\mathbf{H - 1}$
(continued)
(Code table 002031 - continued)

## Code figure

| 11 | 1 hour or less |
| :---: | :--- |
| 12 | More than 1 hour but 2 at the most |
| 13 | More than 2 hours but 4 at the most |
| 14 | More than 4 hours but 8 at the most |
| 15 | More than 8 hours but 12 at the most |
| 16 | More than 12 hours but 18 at the most |
| 17 | More than 18 hours but 24 at the most |
| 18 | Reserved |
| 19 | Drift method not used |
| $20-30$ | Reserved |
| 31 | Missing value |

Notes:
(1) Code figures 1-9: Duration and time of current measurement (vector or Doppler current profiling method).
(2) Code figures 11-19: Period of current measurement (drift method).
(3) $\mathrm{H}=$ Time of observation.

## 002032 <br> Indicator for digitization

Code figure
$0 \quad$ Values at selected depths (data points fixed by the instrument or selected by any other method)
1 Values at selected depths (data points taken from traces at significant depths)
2
3

## Reserved

Missing value

## 002033

Method of salinity/depth measurement

## Code figure

$0 \quad$ No salinity measured

1 In situ sensor, accuracy better than 0.02\%
2 In situ sensor, accuracy less than 0.02\% 0
3 Sample analysis
4-6 Reserved
7 Missing value

## 002034

Drogue type

| Code figure |  |
| :---: | :--- |
| 0 | Unspecified drogue |
| 1 | Holey sock |
| 2 | TRISTAR |
| 3 | Window shade |
| 4 | Parachute |
| 5 | Non-Lagrangian sea anchor |
| $6-30$ | Reserved (to be developed) |
| 31 | Missing value |

## 002036 <br> Buoy type

Code figure
$0 \quad$ Drifting buoy
1 Fixed buoy
2
3
Sub-surface float (moving)
Missing value

## 002037

## Method of tidal observation

Code figure
0 Reserved
1 Manual reading from vertical tide staff
2 Manual reading from single automatic recorder at station
3 Manual reading from multiple automatic recorders at station
Automatic reading from single automatic recorder at station without level reference check
Automatic reading from single automatic recorder at station with level reference check, or from multiple automatic recorders
6 Reserved
$7 \quad$ Missing value

## 002038 <br> Method of sea-surface temperature measurement

| Code figure |  |
| :---: | :--- |
| 0 | Ship intake |
| 1 | Bucket |
| 2 | Hull contact sensor |
| 3 | Reversing thermometer |
| 4 | STD/CTD sensor |
| 5 | Mechanical BT |
| 6 | Expendable BT |
| 7 | Digital BT |
| 8 | Thermistor chain |
| 9 | Infrared scanner |
| 10 | Microwave scanner |
| $11-14$ | Reserved |
| 15 | Missing value |
|  |  |
|  |  |
|  |  |

## 002040

Method of removing velocity and motion of platform from current

| Code figure |  |  |
| :---: | :---: | :---: |
| 0 | Ship's motion removed by averaging | Ship's velocity remove |
| 1 | Ship's motion removed by motion compensation | by bottom tracking |
| 2 | Ship's motion not removed |  |
| 3 | Ship's motion removed by averaging |  |
| 4 | Ship's motion removed by motion compensation | by navigation |
| 5 | Ship's motion not removed |  |
| 6 | Doppler current profiling method not used |  |
| 7-14 | Reserved |  |
| 15 | Missing value |  |

## 002041 <br> Method for estimating reports related to synoptic features

Code figure
$0 \quad$ Information based on manual analysis

1
2
3
4-9
10
11-62
63

Reserved for future use
Longuet-Higgins (1964)
Longuet-Higgins (F3 method)
Maximum likelihood method
Maximum entropy method
Reserved
Missing value

## 002045 <br> Indicator for type of platform

Code figure
Sea station
1
Automatic data buoy
2
Aircraft
3 Satellite
4-14 Reserved
15 Missing value

## 002046 <br> Wave measurement instrumentation

| Code figure |  |
| :---: | :--- |
| 0 | Reserved for future use |
| 1 | Heave sensor |
| 2 | Slope sensor |
| $3-14$ | Reserved |
| 15 | Missing value |

## 002048 <br> Satellite sensor indicator

Code figure

| 0 | HIRS |
| :---: | :--- |
| 1 | MSU |
| 2 | SSU |
| 3 | AMSU-A |
| 4 | AMSU-B |
| 5 | AVHRR |
| 6 | SSMI |
| 7 | NSCAT |
| 8 | SEAWINDS |
| $9-14$ | Reserved |
| 15 | Missing value |

## 002049

Geostationary satellite data-processing technique used
Bit No.
1 Processing technique not defined
2 Simultaneous physical retrieval
3 Clear sounding
$4 \quad$ Cloudy sounding
5-7 Reserved for future use
All 8 Missing value

Notes:
(1) Clear sounding indicates the sounding has been generated from a set of clear radiances using all available sounder radiances
(2) Cloudy sounding indicates that sufficient clear radiances could not be identified in the sounding area. The sounding is calculated from the cloud top (cloud pressure greater than or equal to 780 hPa ) upwards.

|  |  | 0 |
| :---: | :---: | :---: |
|  |  | 02050 |
|  |  | Geostationary sounder satellite channels used |
| Bit No. | Channel | Central wavelength (micrometers) |
| 1 | 1 | 14.71 |
| 2 | 2 | 14.37 |
| 3 | 3 | 14.06 |
| 4 | 4 | 13.64 |
| 5 | 5 | 13.37 |
| 6 | 6 | 12.66 |
| 7 | 7 | 12.02 |
| 8 | 8 | 11.03 |
| 9 | 9 | 9.71 |
| 10 | 10 | 7.43 |
| 11 | 11 | 7.02 |
| 12 | 12 | 6.51 |
| 13 | 13 | 4.57 |
| 14 | 14 | 4.52 |
| 15 | 15 | 4.45 |
| 16 | 16 | 4.13 |
| 17 | 17 | 3.98 |
| 18 | 18 | 3.74 |
| 19 | 19 | 0.969 |
| All 20 | Missing value |  |

N o te: Beginning with the first bit position (high order bit), if the bit position is set to one, then the channel is used. If the bit position is set to zero, then the channel is not used.

Indicator to specify observing method for extreme temperatures
Code figure

| 0 | Reserved |
| :---: | :--- |
| 1 | Maximum/minimum thermometers |
| 2 | Automated instruments |
| 3 | Thermograph |
| $4-14$ | Reserved |
| 15 | Missing value |


|  | 0 | 02052 |
| :---: | :---: | :---: |
|  |  |  |
|  |  |  |
|  | Geostationary imager satellite channels used |  |
| Bit No. | Channel | Central wavelength (micrometers) |
| 1 | 1 | $0.55-0.75$ |
| 2 | 2 | 3.9 |
| 3 | 3 | 6.7 |
| 4 | 4 | 10.7 |
| 5 | 5 | 12.0 |
| All 6 | Missing value |  |

Note: Beginning with the first bit position (high order bit), if the bit position is set to one, then the channel is used. If the bit position is set to zero, then the channel is not used.

## 002053 <br> GOES-1/M brightness temperature characteristics

Code figure
$0 \quad$ Observed brightness temperature
1

2
3
4-14
15

Brightness temperature with bias correction applied
Brightness temperature calculated from first guess
Brightness temperature calculated from sounding
Reserved
Missing value

## 002054

GOES-I/M soundings parameter characteristics
Code figure
$0 \quad$ Parameter derived using observed sounder brightness temperatures
1 Parameter derived using observed imager brightness temperatures
2 Parameter derived using first guess information
3 Parameter derived using NMC analysis information
4 Parameter derived using radiosonde information
5-14 Reserved
15 Missing value

## 002055 <br> Geostationary soundings statistical parameters

Code figure
0 Statistics generated comparing retrieval versus radiosonde

## 002057

Origin of first guess information for GOES-I/M soundings
Code figure
$0 \quad$ Nested Grid Model (NGM)
1 Aviation Model (AVN)
5 Climatology

6-14 Reserved
15 Missing value


# 002061 <br> Aircraft navigational system 

Code figure

| 0 | Inertial navigation system |
| :---: | :--- |
| 1 | OMEGA |
| 2-6 | Reserved |
| 7 | Missing value |

## 002062 <br> Type of aircraft data relay system

Code figure
0 ASDAR

1 ASDAR (ACARS also available but not operative)
2 ASDAR (ACARS also available and operative)

3
4
5 ACARS (ASDAR also available and operative)
6-14 Reserved
15 Missing value

## 002064

Aircraft roll angle quality
Code figure Meaning
0 Good
1 Bad
2 Resenved
$3 \quad$ Missing value

Note: Bad is currently defined as a roll angle $>5$ degrees from vertical.

## 002070 <br> Original specification of latitude/longitude

Code figure
$0 \quad$ Actual location in seconds

1
2
3
4
5
6
7
8

Actual location in minutes
Actual location in degrees
Actual location in decidegrees
Actual location in centidegrees
Referenced to checkpoint in seconds
Referenced to checkpoint in minutes
Referenced to checkpoint in degrees
Referenced to checkpoint in decidegrees
Referenced to checkpoint in centidegrees
Actual location in tenths of a minute
Referenced to checkpoint in tenths of a minute
Resenved
Missing value

002101

## Type of antenna

## Code figure

$0 \quad$ Centre front-fed paraboloid
1 Offset front-fed paraboloid
2
3
Centre Cassegrain paraboloid
Offset Cassegrain paraboloid

## Planar array

Coaxial-collinear array
Yagi elements array
Mic rostrip
8-13 Reserved
14 Other
15

Missing value

## 002103

Radome

Bit No.
1 Radar antenna is protected by a radome
All 2

# 002104 <br> Antenna polarization 

| Code figure |  |
| :---: | :---: |
| 0 | Horizontal polarization |
| 1 | Vertical polarization |
| 2 | Right circular polarization |
| 3 | Left circular polarization |
| 4 | Horizontal and vertical polarization |
| 5 | Right and left circular polarization |
| 6-14 | Reserved |
| 15 | Missing value |
|  | 002131 |
|  | Sensitivity time control (STC) |
| Bit No. |  |
| 1 | STC operational |
| All 2 | Missing value |
|  | 002143 |
|  | Ozone instrument type |
| Code figure |  |
| 0 | Reserved |
| 1 | Brewer spectrophotometer |
| 2 | Caver Teichert |
| 3 | Dobson |
| 4 | Dobson (Japan) |
| 5 | Ehmet |
| 6 | Fecker telescope |
| 7 | Hoelper |
| 8 | J odmeter |
| 9 | Filter Ozonometer M-83 |
| 10 | Mast |
| 11 | Oxford |
| 12 | Paetzold |
| 13 | Regener |
| 14 | Reserved for future use |
| 15 | Vassy filter Ozonometer |
| 16 | Carbon iodide |
| 17 | Surface ozone bubbler |
| 18 | Filter Ozonometer M-124 |
| 19 | ECC sonde |
| 20-126 | Reserved |
| 127 | Missing value |

## 002144 <br> Light source type for Brewer spectrophotometer

```
Code figure
        0 Direct Sun
        1 Direct Sun, attenuator #1
        2 Direct Sun, attenuator #2
        3 Focussed Moon
        4 Focussed Sun
        5 Focussed Sun corrected with adjacent sky measurements
        6 Zenith Sky
        7-14 Reserved
        15 Missing value
Note: Entries 1 and 2 should not be used.
```


## 002145

Wavelength setting for Dobson instruments

## Code figure

0 Wavelengths AD ordinary setting
1 Wavelengths BD ordinary setting
2 Wavelengths CD ordinary setting
3 Wavelengths CC' ordinary setting
4 Wavelengths AD focussed image
5 Wavelengths BD focussed image
6 Wavelengths CD focussed image
7 Wavelengths CC'focussed image
8-14 Reserved
15 Missing value

## 002146 <br> Source condition for Dobson instruments

Code figure

| 0 | On direct Sun |
| :---: | :--- |
| 1 | On direct Moon |
| 2 | On blue zenith Sky |
| 3 | On zenith cloud (uniform stratified layer of small opacity) |
| 4 | On zenith cloud (uniform or moderately variable layer of medium opacity) |
| 5 | On zenith cloud (uniform or moderately variable layer of large opacity) |
| 6 | On zenith cloud (highly variable opacity, with or without precipitation) |
| 7 | On zenith cloud (fog) |
| 8 | On zenith haze |
| 9 | On direct sun through thin cloud, fog or haze |
| $10-14$ | Reserved |
| 15 | Missing value |

## 002148

Data collection and/or location system
Code figure
0 Reserved

Argos
GPS
GOES DCP
METEOSAT DCP
5-30 Reserved
31 Missing value

## 002149

Type of data buoy

| Code figure |  |
| :---: | :--- |
| 0 | Unspecified drifting buoy |
| 1 | Standard Lagrangian drifter (Global Drifter Programme) |
| 2 | Standard FGGE type drifting buoy <br> (non-Lagrangian meteorological drifting buoy) <br> 3 |
|  | Wind measuring FGGE type drifting buoy |
| (non-Lagrangian meteorological drifting buoy) |  |
| 4 | Ice float |
| $5-7$ | Reserved |
| 8 | Unspecified sub-surface float |
| 9 | SOFAR |
| 10 | ALACE |
| 11 | MARVOR |
| 12 | RAFOS |
| $13-15$ | Reserved |
| 16 | Unspecified moored buoy |
| 17 | Nomad |
| 18 | 3-metre discus |
| 19 | 10-12-metre discus |
| 20 | ODAS 30 series |
| 21 | ATLAS (e.g. TAO area) |
| 22 | TRITON buoy |
| 23 | Reserved |
| 24 | Omnidirectional waverider |
| 25 | Directional waverider |
| 26 | Sub-surface ARGO float |
| $27-62$ | Reserved |
| 63 | Missing value |
|  |  |

FM 94 BUFR

002150
TOVS/ATOVS/AVHRR instrumentation channel number

| Code figure |  | Code figure |  |
| :---: | :--- | :---: | :--- |
| 0 | Reserved | 28 | AMSU-A 1 |
| 1 | HIRS 1 | 29 | AMSU-A 2 |
| 2 | HIRS 2 | 30 | AMSU-A 3 |
| 3 | HIRS 3 | 31 | AMSU-A 4 |
| 4 | HIRS 4 | 32 | AMSU-A 5 |
| 5 | HIRS 5 | 33 | AMSU-A 6 |
| 6 | HIRS 6 | 34 | AMSU-A 7 |
| 7 | HIRS 7 | 35 | AMSU-A 8 |
| 8 | HIRS 8 | 36 | AMSU-A 9 |
| 9 | HIRS 9 | 37 | AMSU-A 10 |
| 10 | HIRS 10 | 38 | AMSU-A 11 |
| 11 | HIRS 11 | 39 | AMSU-A 12 |
| 12 | HIRS 12 | 40 | AMSU-A 13 |
| 13 | HIRS 13 | 41 | AMSU-A 14 |
| 14 | HIRS 14 | 42 | AMSU-A 15 |
| 15 | HIRS 15 | 43 | AMSU-B 1 |
| 16 | HIRS 16 | 44 | AMSU-B 2 |
| 17 | HIRS 17 | 45 | AMSU-B 3 |
| 18 | HIRS 18 | 46 | AMSU-B 4 |
| 19 | HIRS 19 | 47 | AMSU-B 5 |
| 20 | HIRS 20 | 48 | AVHRR 1 |
| 21 | MSU 1 | 49 | AVHRR 2 |
| 22 | MSU 2 | 50 | AVHRR 3a |
| 23 | MSU 3 | 51 | AVHRR 3b |
| 24 | MSU 4 | 52 | AVHRR 4 |
| 25 | SSU 1 | 53 | AVHRR 5 |
| 26 | SSU 2 | 63 | Reserved |
| 27 | SSU 3 | Missing value |  |

## 002151

Radiometer identifier

| Code figure |  |
| :---: | :--- |
| 0 | HIRS |
| 1 | MSU |
| 2 | SSU |
| 3 | AMSU-A1-1 |
| 4 | AMSU-A1-2 |
| 5 | AMSU-A2 |
| 6 | AMSU-B |
| 7 | AVHRR |
| $8-2046$ | Reserved |
| 2047 | Missing value |

## 002152

Satellite instrument used in data processing

| Bit No. |  |
| :---: | :--- |
| 1 | High-resolution infrared sounder (HIRS) |
| 2 | Microwave sounding unit (MSU) |
| 3 | Stratospheric sounding unit (SSU) |
| 4 | AMI wind mode |
| 5 | AMI wave mode |
| 6 | AMI image mode |
| 7 | RADAR altimeter |
| 8 | ATSR |
| 9 | Geostationary imager |
| 10 | Geostationary sounder |
| 11 | Geostationary Earth radiation (GERB) |
| $12-30$ | Reserved |
| All 31 | Missing value |

## 002163

Height assignment method
Code figure

0
1
2
3
4
5
6
7
8
9

Reserved
IRW height assignment
WV height assignment
$\mathrm{H}_{2} \mathrm{O}$ intercept height assignment
$\mathrm{CO}_{2}$ slicing height assignment
Low pixel max gradient
Higher pixel max gradient
Primary height assignment
Layer thickness assignment
Cumulative contribution function - 10 per cent height
Cumulative contribution function - $\mathbf{5 0}$ per cent height
Cumulative contribution function - $\mathbf{9 0}$ per cent height
Cumulative contribution function - height of maximum gradient
Reserved
Missing value

## 002164

Tracer correlation method
Code figure
$0 \quad$ LP - Norms least square minimum
1 EN - Euclidean norm with radiance correlation
2 CC - Cross correlation
3-6 Reserved
7 Missing value

|  | 002166 <br> Radiance type |
| :---: | :---: |
| Code figure |  |
| 0 | Type not defined |
| 1 | Automated statistical regression |
| 2 | Clear path |
| 3 | Partly cloudy path |
| 4 | Cloudy path |
| 5-14 | Reserved |
| 15 | Missing value |
|  | $002167$ <br> Radiance computational method |
| Code figure |  |
| 0 | Method not defined |
| 1 | 1b raw radiance |
| 2 | Processed radiance |
| 3-14 | Reserved |
| 15 | Missing value |
|  | $002169$ <br> Anemometer type |
| Code figure |  |
| 0 | Cup rotor |
| 1 | Propeller rotor |
| 2 | Wind Observation Through Ambient Noise (WOTAN) |
| 3-14 | Reserved |
| 15 | Missing value |
|  | $002172$ <br> Product type for retrieved atmospheric gases |
| Code figure |  |
| 0 | Reserved |
| 1 | Retrieval from a nadir sounding |
| 2 | Retrieval from a limb sounding |
| 3-254 | Reserved |
| 255 | Missing value |

# 008001 <br> Vertical sounding significance 

Bit No.
1 Surface

Standard level
Tropopause level
Maximum wind level
Significant level, temperature
Significant level, wind
Missing value

## 008002 <br> Vertical significance (surface observations)

Code figure

| 0 | Observing rules for base of lowest cloud and cloud types of FM 12 SYNOP and FM 13 |
| :--- | :--- |
| SHIP apply |  |
| 1 | First significant layer |
| 2 | Second significant layer |
| 3 | Third significant layer |
| 4 | Cumulonimbus layer |
| 5 | Ceiling |
| 6 | Clouds not detected below the following height(s) |
| 7 | Low cloud |
| 8 | Middle cloud |
| 9 | High cloud |
| $0-62$ | Reserved |
| 63 | Missing value |

## 008003

Vertical significance (satellite observations)
Code figure
Surface
Base of satellite sounding
Cloud top
Tropopause
Precipitable water
Sounding radiances
Mean temperatures
Ozone
8-62 Reserved
63 Missing value

# 008004 <br> Phase of aircraft flight 

Code figure

| $0-1$ | Reserved |
| :---: | :--- |
| 2 | Unsteady (UNS) |
| 3 | Level flight, routine observation (LVR) |
| 4 | Level flight, highest wind encountered (LVW) |
| 5 | Ascending (ASC) |
| 6 | Descending (DES) |
| 7 | Missing value |

## 008005 <br> Meteorological attribute significance

Code figure

| 0 | Automatic |
| :---: | :--- |
| 0 | Reserved |
| 1 | Storm centre |
| 2 | Outer limit or edge of storm |
| 3 | Location of maximum wind |
| $4-14$ | Reserved |
| 15 | Missing value |

## 008006

Ozone vertical sounding significance

## Bit No.

1 Surface

2
3
4
5
6
7
8
All 9

Standard level
Tropopause level
Prominent maximum level
Prominent minimum level
Minimum pressure level
Reserved
Level of undetermined significance
Missing value

# 008007 <br> Dimensional significance 

Code figure

| 0 | Point |
| :---: | :--- |
| 1 | Line |
| 2 | Area |
| 3 | Volume |
| $4-14$ | Reserved |
| 15 | Missing value |

Note: A consecutive sequence of 2 or more of location coordinates, such as latitude and longitude pairs, defines a line or polygon. Points shall be joined in the order given in the message. Any area described will fall left of the drawn boundary in the direction established by the order of the points given in the message. This definition is for simple non-intersecting polygons without holes.

## 008008 <br> Radiation vertical sounding significance

| Bit No. |  |
| :---: | :--- |
| 1 | Surface |
| 2 | Standard level |
| 3 | Tropopause level |
| 4 | Level of beta radiation maximum |
| 5 | Level of gamma radiation maximum |
| 6 | Minimum pressure level |
| 7 | Reserved |
| 8 | Level of undetermined significance |
| All 9 | Missing value |

## 008011 <br> Meteorological feature

Code figure
$0 \quad$ Quasi-stationary front at the surface
1 Quasi-stationary front above the surface
2 Warm front at the surface
3
4
5
6
7
8
9
10
Warm front above the surface
Cold front at the surface
Cold front above the surface
Occlusion
Instability line
Intertropical front
Convergence line
J et stream
(continued)
(Code table 008011 - continued)
Code figure

| 11 | Cloud clear |
| :---: | :--- |
| 12 | Cloud |
| 13 | Turbulence |
| 14 | Storm |
| 15 | Airframe icing |
| 16 | Phenomenon |
| 17 | Volcano |
| 18 | Atmospherics |
| 19 | Reserved |
| 20 | Special clouds |
| $21-62$ | Reserved |
| 63 | Missing value |

## 008012 <br> Land/sea qualifier

Code figure
0 Land

1 Sea
2 Coast
3 Missing value

## 008013

Day/night qualifier
Code figure
$0 \quad$ Night

1 Day
2 Reserved
3 Missing value

# 008014 <br> Qualifier for runway visual range 

Code figure

| 0 | $10-m i n u t e ~ m e a n ~ v a l u e ~$ | - normal value |
| :---: | :--- | :--- |
| 1 | $10-$ minute mean value | - above the upper limit for assessments of RVR (P) |
| 2 | 10-minute mean value | - below the lower limit for assessments of RVR (M) |
| 3 | one-minute minimum value | - normal value |
| 4 | one-minute minimum value | - above the upper limit for assessments of RVR (P) |
| 5 | one-minute minimum value | - below the lower limit for assessments of RVR (M) |
| 6 | one-minute maximum value | - normal value |
| 7 | one-minute maximum value | - above the upper limit for assessments of RVR (P) |
| 8 | one-minute maximum value | - below the lower limit for assessments of RVR (M) |
| $9-14$ | Resemed |  |
| 15 | Missing value |  |

## 008016

Change qualifier of a trend-type forecast or an aerodrome forecast
Code figure
NOSIG
1
2
3

4-6
7
BECMG
TEMPO
FM
Reserved
Missing value

## 008017

Qualifier of the time when the forecast change is expected
Code figure

| 0 | FM |
| :--- | :--- |
| 1 | TL |
| 2 | AT |
| 3 | Missing value |

# 008018 <br> SEAWINDS land/ice surface type 

## Bit No.

1 Land is present
2
3-10
Surface ice map indicates ice is present
Reserved
Ice map data not available
12
Attenuation map data not available
Reserved
Missing value

## 008021 <br> Time significance

Code figure

## Reserved

Time series
Time averaged
Accumulated
Forecast
Forecast time series
Forecast time averaged
Forec ast accumulated
Ensemble mean
Ensemble mean time series
Ensemble mean time averaged
Ensemble mean accumulated
Ensemble mean forecast
Ensemble mean forecast time series
Ensemble mean forecast time averaged
Ensemble mean forecast accumulated
Analysis
Start of phenomenon
Radiosonde launch time
Start of orbit
End of orbit
Time of ascending node
Time of occurrence of wind shift
Monitoring period
Agreed time limit for report reception
Nominal reporting time
I 26 Time of last known position
27 First guess
28 Start of scan
29 End of scan
(Code table 008021 - continued)
Code figure
30
Reserved
31 Missing value
Notes:
(1) "Time averaged" indicates that values are continuously averaged over a period of time.
(2) "Ensemble mean" indicates that a number of distinct values corresponding to a set of time locations are averaged.
(3) Time significance must be qualified by appropriate time periods being specified.

|  | 008023 <br> First order statistics |
| :---: | :--- |
| Code figure |  |
| $0-1$ | Reserved |
| 2 | Maximum value |
| 3 | Minimum value |
| 4 | Mean value |
| 5 | Median value |
| 6 | Modal value |
| 7 | Mean absolute error |
| 8 | Reserved |
| 9 | Best estimate of standard deviation (N-1) |
| 10 | Standard deviation (N) |
| 11 | Harmonic mean |
| 12 | Root-mean-square vector error |
| $13-31$ | Reserved |
| 32 | Vector mean |
| $33-62$ | Reserved for local use |
| 63 | Missing value |

Note: All first order statistics are in the units defined by the original data descriptors.

## 008024

Difference statistics

## Code figure

| 0-1 | Reserved |
| :---: | :--- |
| 2 | Observed minus maximum |
| 3 | Observed minus minimum |
| 4 | Observed minus mean |
| 5 | Observed minus median |
| 6 | Observed minus mode |
| $7-10$ | Reserved |
| 11 | Observed minus climatology (anomaly) |
| 12 | Observed minus analysed value |

(continued)
(Code table 008024 - continued)
Code figure
13 Observed minus initialized analysed value
14 Observed minus forecast value
15-20 Reserved
21 Observed minus interpolated value
22 Observed minus hydrostatically calculated value
23-31 Reserved
32-62 Reserved for local use
63 Missing value
Notes:
(1) Difference statistics are difference values; they have dimensions the same as the corresponding reported values with respect to units, but assume a range centred on zero (e.g., the difference between reported and analysed values, the difference between reported and forecast values, etc.).
(2) Where observed minus forecast values are represented, the period of the forecast shall be indicated by an appropriate descriptor from class 4.

008025
Time difference qualifier
Code figure
$0 \quad$ Universal Time Coordinated (UTC) minus Local Standard Time (LST)
1 Local Standard Time
2 Universal Time Coordinated (UTC) minus Satellite clock
3-4 Reserved
5 Time difference from edge of processing segment
6-14 Reserved
15 Missing value

## 008033 <br> Method of derivation of percentage confidence

Code figure
0 Reserved
1 Percentage confidence calculated using cloud fraction
2 Percentage confidence calculated using standard deviation of temperature
3-126 Reserved
127 Missing value

# 008035 <br> Type of monitoring exercise 

Code figure
0 Global
1 Regional
2
3
4
5
6
National
Special
Bilateral
Reserved
Reserved
Missing value

## 008036

Type of centre or station performing monitoring
Code figure 0 1
2
3
4
5
6
7
WMO Secretariat
WMO
RSMC
NMC
RTH
Observing site
Other
Missing value

## 008051

Qualifier for number of missing values in calculation of statistic
Code figure
1 Pressure
Temperature
Extreme temperature
Vapour pressure
Precipitation
Sunshine duration
Missing value

## 008052 <br> Condition for which number of days of occurrence follows

Code figure
0 Mean wind speed over a 10-minute period observed or recorded equal to or more than $10 \mathrm{~m} \mathrm{~s}^{-1}$ or 20 knots

Mean wind speed over a 10 -minute period observed or recorded equal to or more than $20 \mathrm{~m} \mathrm{~s}^{-1}$ or 40 knots
Mean wind speed over a 10 -minute period observed or recorded equal to or more than $30 \mathrm{~m} \mathrm{~s}^{-1}$ or 60 knots
Maximum temperature less than 273.2 K
Maximum temperature equal to or more than 298.2 K
Maximum temperature equal to or more than 303.2 K
Maximum temperature equal to or more than 308.2 K
Maximum temperature equal to or more than 313.2 K
Minimum temperature less than 273.2 K
Maximum temperature equal to or more than 273.2 K
Precipitation equal to or more than $1.0 \mathrm{~kg} \mathrm{~m}^{-2}$
Precipitation equal to or more than $5.0 \mathbf{k g ~ m}^{-2}$
Precipitation equal to or more than $10.0 \mathbf{k g ~ m}^{-2}$
Precipitation equal to or more than $50.0 \mathbf{k g ~ m}^{-2}$
Precipitation equal to or more than $100.0 \mathbf{k g ~ m}^{-2}$
Precipitation equal to or more than $150.0 \mathbf{k g ~ m}^{-2}$
Snow depth more than 0.00 m
Snow depth more than 0.01 m
Snow depth more than 0.10 m
Snow depth more than 0.50 m
Horizontal visibility less than 50 m
Horizontal visibility less than 100 m
Horizontal visibility less than 1000 m
Hail
Thunderstorm
Reserved
Missing value

## 008053

Day of occurrence qualifier
Code figure
$0 \quad$ Value occurred on only one day in the month
1 Value occurred on more than one day in the month
2
3

# 008060 <br> Sample scanning mode significance 

Code figure

| 0 | Reserved |
| :---: | :--- |
| 1 | Range |
| 2 | Azimuth |
| 3 | Horizontal |
| 4 | Vertical |
| $5-14$ | Reserved |
| 15 | Missing value |

## 008070 <br> TOVS/ATOVS product qualifier

Code figure
Reserved
Reserved
Earth located instrument counts, calibration coefficients and housekeeping (level 1b)
Earth located calibrated radiances (level 1c)Mapped to a common footprint, Earth located calibrated radiances (level 1d)
Resenved
Missing value
008072
Pixel(s) type
Code figure

| 0 | Mixed |
| :---: | :--- |
| 1 | Clear |
| 2 | Cloudy |
| 3-6 | Reserved |
| 7 | Missing value |

# 008075 <br> Ascending/descending orbit qualifier 

Code figure
$0 \quad$ Ascending orbit
1 Descending orbit
Reserved
Missing value

## 010063

## Characteristic of pressure tendency

Code figure
$9 \quad$ Vector or Doppler current profiling method not used
0 Increasing, then decreasing; atmospheric pressure the same or higher than three hours ago 1 Increasing, then steady; or increasing, then increasing more slowly
2
Increasing (steadily or unsteadily)
Decreasing or steady, then increasing; or increasing, then increasing more rapidly
4 Steady; atmospheric pressure the same as three hours ago
5 Decreasing, then increasing; atmospheric pressure the same or lower than three hours ago
6 Decreasing, then steady; or decreasing, then decreasing more slowly
7 Decreasing (steadily or unsteadily)
8 Steady or increasing, then decreasing; or decreasing, then decreasing more rapidly
9-14 Reserved
15 Missing value

Notes:
(1) In reports from automatic stations, code figure 2 shall be used when tendency is positive, $\mathbf{7}$ when negative, and 4 when pressure is the same as three hours before.
(2) In reports from tropical stations reporting 24-hour pressure changes, code figure $\mathbf{2}$ shall be used when tendency is positive, 7 when negative, and 4 when pressure is the same as 24 hours before.

## 011031 <br> Degree of turbulence

Code figure
Reserved

0 Nil
1
2

| Nil <br> Light | in cloud |
| :---: | :---: |
|  |  |
| Moderate |  |
| Severe |  |
|  |  |
| Light | in clear air |
| Moderate |  |
| Severe |  |
| Nil |  |
| Light | cloud/clear air not specified |
| Moderate |  |
| Severe |  |
| Extreme, in clear air |  |
| Extreme, in cloud |  |
| Extreme, cloud/clear air not specified |  |
| Missing value |  |


|  |  | 011037 <br> Turbulence index |
| :---: | :---: | :---: |
| Code figure | Average value of eddy dissipation rate (ave) ( $\mathrm{m}^{2 / 3} \mathrm{~s}^{-1}$ ) | Peak value of eddy dissipation rate (peak) ( $\mathrm{m}^{2 / 3} \mathrm{~s}^{-1}$ ) |
| 0 | ave < 0.1 | peak < 0.1 |
| 1 | ave < 0.1 | $0.1<=$ peak < 0.2 |
| 2 | $0.1<=$ ave < 0.2 | $0.1<=$ peak < 0.2 |
| 3 | ave <0.1 | $0.2<=$ peak < 0.3 |
| 4 | $0.1<=$ ave < 0.2 | 0.2 <= peak < 0.3 |
| 5 | $0.2<=$ ave < 0.3 | $0.2<=$ peak < 0.3 |
| 6 | ave < 0.1 | $0.3<=$ peak < 0.4 |
| 7 | $0.1<=$ ave < 0.2 | $0.3<=$ peak < 0.4 |
| 8 | 0.2 <= ave < 0.3 | $0.3<=$ peak < 0.4 |
| 9 | $0.3<=$ ave < 0.4 | 0.3 <= peak < 0.4 |
| 10 | ave < 0.1 | $0.4<=$ peak < 0.5 |
| 11 | $0.1<=$ ave < 0.2 | $0.4<=$ peak < 0.5 |
| 12 | 0.2 <= ave < 0.3 | $0.4<=$ peak < 0.5 |
| 13 | $0.3<=$ ave < 0.4 | $0.4<=$ peak < 0.5 |
| 14 | $0.4<=$ ave < 0.5 | $0.4<=$ peak < 0.5 |
| 15 | ave < 0.1 | $0.5<=$ peak < 0.8 |
| 16 | $0.1<=$ ave < 0.2 | $0.5<=$ peak < 0.8 |
| 17 | $0.2<=$ ave < 0.3 | $0.5<=$ peak < 0.8 |

(continued)
(Code table 011037 - continued)

| Code figure | Average value of eddy <br> dissipation rate (ave) <br> $\left(\mathrm{m}^{2 / 3} \mathrm{~s}^{-1}\right)$ | Peak value of eddy <br> dissipation rate (peak) <br> $\left(\mathrm{m}^{2 / 3} \mathrm{~s}^{-1}\right)$ |
| :---: | :--- | :--- |
| 18 | $0.3<=$ ave $<0.4$ | $0.5<=$ peak $<0.8$ |
| 19 | $0.4<=$ ave $<0.5$ | $0.5<=$ peak $<0.8$ |
| 20 | $0.5<=$ ave $<0.8$ | $0.5<=$ peak $<0.8$ |
| 21 | ave $<0.1$ | $0.8<=$ peak |
| 22 | $0.1<=$ ave $<0.2$ | $0.8<=$ peak |
| 23 | $0.2<=$ ave $<0.3$ | $0.8<=$ peak |
| 24 | $0.3<=$ ave $<0.4$ | $0.8<=$ peak |
| 25 | $0.4<=$ ave $<0.5$ | $0.8<=$ peak |
| 26 | $0.5<=$ ave $<0.8$ | $0.8<=$ peak |
| 27 | $0.8<=$ ave | $0.8<=$ peak |
| 28 | Nil | Nil |
| $29-62$ | Reserved | Reserved |
| 63 | Missing value | Missing value |

## 011038 <br> Time of occurrence of peak eddy dissipation rate

| Code figure | Minutes prior to <br> observation time $(\min )$ |
| :---: | :---: |
| 0 | $\min <1$ |
| 1 | $1<=\min <2$ |
| 2 | $2<=\min <3$ |
| 3 | $3<=\min <4$ |
| 4 | $4<=\min <5$ |
| 5 | $5<=\min <6$ |
| 6 | $6<=\min <7$ |
| 7 | $7<=\min <8$ |
| 8 | $8<=\min <9$ |
| 9 | $9<=\min <10$ |
| 10 | $10<=\min <11$ |
| 11 | $11<=\min <12$ |
| 12 | $12<=\min <13$ |
| 13 | $13<=\min <14$ |
| 14 | $14<=\min <15$ |
| 15 | No timing information available |
| $16-30$ | Reserved |
| 31 | Missing value |

# 013038 <br> Superadiabatic indicator 

Code figure
0 Not superadiabatic
1 Superadiabatic
2 Reserved
3 Missing value

## 013039

Terrain type (ice/snow)

## Code figure

0 Sea ice
1 Snow on land
2-6 Reserved
7 Missing value

013041
Pasquill-Gifford stability category
Code figure
1 A

2 A - B
3 B
4 B - C
5 C
6 D
7 E
$8 \quad F$
9 G
10-14 Reserved
15 Missing value

## 013051 <br> Frequency group, precipitation

Code figure
$0 \quad$ Smaller than any value in the 30-year period
1 In the first quintile
2 In the second quintile
3 In the third quintile
4 In the fourth quintile
5 In the fifth quintile
6 Greater than any value in the 30-year period
7-14 Reserved
15 Missing value

# 019001 <br> Type of synoptic feature 

Code figure

| 0 | Depression or low (extratropic al) |
| :---: | :--- |
| 1 | Tropical depression |
| 2 | Tropical storm |
| 3 | Severe tropical storm |
| 4 | Typhoon |
| $5-9$ | Reserved |
| 10 | Dust/sandstorm |
| $11-62$ | Reserved |
| 63 | Missing value |

Note: New local names for storms of various strengths shall be added as necessary.

## 019008 <br> Vertical extent of circulation

Code figure

| 0 | Reserved |
| :---: | :--- |
| 1 | Shallow (top of circulation below 700-hPa level) |
| 2 | Medium (top between 700-hPa and 400-hPa level) |
| 3 | Deep (top above 400-hPa level) |
| $4-6$ | Reserved |
| 7 | Missing value |

## 019010

Method for tracking the centre of synoptic feature code figure
Code figure
1 Minimum value of sea level pressure
2 Maximum value of $\mathbf{8 5 0} \mathbf{h P a}$ relative vorticity
3-14 Reserved
15 Missing value

## 020003

Present weather

| 00-49 | No precipitation at the station at the time of observation |  |
| :---: | :---: | :---: |
| 00-19 | No precipitation, fog, ice fog (except for 11 and 12), duststorm, sandstorm, drifting or blowing snow at the station* at the time of observation or, except for 09 and 17, during the preceding hour |  |
| Code figure |  |  |
|  | $\begin{aligned} & 00 \\ & 01 \\ & 02 \\ & 03 \end{aligned}$ | $\left.\begin{array}{l}\text { Cloud development not observed or not observable } \\ \text { Clouds generally dissolving or becoming less developed } \\ \begin{array}{l}\text { State of sky on the whole unchanged } \\ \text { Clouds generally forming or developing }\end{array}\end{array}\right\}$ <br> Characteristic change of the state of sky during the past hour |
|  | 04 05 06 | Visibility reduced by smoke, e.g. veldt or forest fires, industrial smoke or volcanic ashes Haze <br> Widespread dust in suspension in the air, not raised by wind at or near the station at the time of observation |
|  | 07 | Dust or sand raised by wind at or near the station at the time of observation, but no welldeveloped dust whirl(s) or sand whirl(s), and no duststorm or sandstorm seen; or, in the case of sea stations and coastal stations, blowing spray at the station |
|  | 08 | Well-developed dust whirl(s) or sand whirl(s) seen at or near the station during the preceding hour or at the same time of observation, but no duststorm or sandstorm |
|  | 09 | Duststorm or sandstorm within sight at the time of observation, or at the station during the preceding hour |
| 10 |  | Mist |
| 11 |  | Patches shallow fog or ice fog at the station, whether on land or sea, |
| 12 |  | More or less continuous $\int$ not deeper than about 2 metres on land or 10 metres at sea |
| 13 |  | Lightning visible, no thunder heard |
| 14 |  | Precipitation within sight, not reaching the ground or the surface of the sea |
| 15 |  | Precipitation within sight, reaching the ground or the surface of the sea, but distant, i.e. estimated to be more than 5 km from the station |
| 16 |  | Precipitation within sight, reaching the ground or the surface of the sea, near to, but not at the station |
| 17 |  | Thunderstorm, but no precipitation at the time of observation |
| 18 |  | Squalls ${ }^{\text {at }}$ or within sight of the station during the preceding hour or at the time |
| 19 |  | Funnel cloud(s)** $\int$ of observation |
| 20-29 |  | Precipitation, fog, ice fog or thunderstorm at the station during the preceding hour but not at the time of observation |
| 20 |  | Drizzle (not freezing) or snow grains |
| 21 |  | Rain (not freezing) |
| 22 |  | Snow |
| 23 |  | Rain and snow or ice pellets $\quad$ not falling as shower(s) |
| 24 |  | Freezing drizzle or freezing rain |
| 25 |  | Shower(s) of rain |

[^16]

[^17](Code table 020003 - continued)
Code figure

| 57 | Drizzle, freezing, moderate or heavy (dense) |  |
| :---: | :---: | :---: |
| 58 | Drizzle and rain, slight |  |
| 59 | Drizzle and rain, moderate or heavy |  |
| 60-69 | Rain |  |
| 60 | $\left.\begin{array}{l}\text { Rain, not freezing, intermittent } \\ \text { Rain, not freezing, continuous }\end{array}\right\}$ slight at time of observation | slight at time of observation |
| 61 |  |  |
| 62 | $\left.\begin{array}{l}\text { Rain, not freezing, intermittent } \\ \text { Rain, not freezing, continuous }\end{array}\right\}$ moderate at time of observation |  |
| 63 |  |  |  |
| 64 | $\left.\begin{array}{l}\text { Rain, not freezing, intermittent } \\ \text { Rain, not freezing, continuous }\end{array}\right\}$ heavy at time of observation |  |
| 65 |  |  |  |
| 66 | Rain, freezing, slight |  |
| 67 | Rain, freezing, moderate or heavy |  |
| 68 | Rain or drizzle and snow, slight |  |
| 69 | Rain or drizzle and snow, moderate or heavy |  |
| 70-79 | Solid precipitation not in showers |  |
| 70 | Intermittent fall of snowflakes $\}$ slight at time of observation | slight at time of observation |
| 71 | Continuous fall of snowflakes |  |
| 72 | $\left.\begin{array}{l}\text { Intermittent fall of snowflakes } \\ \text { Continuous fall of snowflakes }\end{array}\right\}$ moderate at time of observation |  |
| 73 |  |  |  |
| 74 | $\left.\begin{array}{l}\text { Intermittent fall of snowflakes } \\ \text { Continuous fall of snowflakes }\end{array}\right\}$ heavy at time of observation |  |
| 75 |  |  |  |
| 76 | Diamond dust (with or without fog) |  |
| 77 | Snow grains (with or without fog) |  |
| 78 | Isolated star-like snow crystals (with or without fog) |  |
| 79 | Ice pellets |  |


| 80-99 | Showery precipitation, or precipitation with current or recent thunderstorm |
| :---: | :---: |
| 80 | Rain shower(s), slight |
| 81 | Rain shower(s), moderate or heavy |
| 82 | Rain shower(s), violent |
| 83 | Shower(s) of rain and snow mixed, slight |
| 84 | Shower(s) of rain and snow mixed, moderate or heavy |
| 85 | Snow shower(s), slight |
| 86 | Snow shower(s), moderate or heavy |
| 87 | Shower(s) of snow pellets or small hail, with or without [- slight |
| 88 | rain or rain and snow mixed $\quad\{$ - moderate or heavy |
| 89 | Shower(s) of hail, with or without rain or rain and snow [- slight |
| 90 | mixed, not associated with thunder $\quad$ - moderate or heavy |
| 91 | Slight rain at time of observation |
| 92 | Moderate or heavy rain at time of observation ${ }^{\text {T }}$ Thunderstorm |
| 93 | Slight snow, or rain and snow mixed or hail* at time of observation $\}_{\text {during }} \begin{aligned} & \text { dur } \\ & \text { hour but not at time }\end{aligned}$ |
| 94 | Moderate or heavy snow, or rain and snow mixed or hail* at time of observation of observation |

[^18]| Code figure |  |
| :---: | :---: |
| 95 | Thunderstorm, slight or moderate, without hail*, but with rain and/or snow at time of observation |
| 96 | Thunderstorm, slight or moderate, with hail* at time of observation |
| 97 | Thunderstorm, heavy, without hail*, but with rain and/or snow at time of observation <br> Thunderstorm at time of observation |
| 98 | Thunderstorm combined with duststorm or sandstorm at time of observation |
| 99 | Thunderstorm, heavy, with hail* at time of observation |
|  | Present weather reported from an automatic weather station |
| 100 | No significant weather observed |
| 101 | Clouds generally dissolving or becoming less developed during the past hour |
| 102 | State of sky on the whole unchanged during the past hour |
| 103 | Clouds generally forming or developing during the past hour |
| 104 | Haze or smoke, or dust in suspension in the air, visibility equal to, or greater than, $\mathbf{1} \mathbf{~ k m}$ |
| 105 | Haze or smoke, or dust in suspension in the air, visibility less than $\mathbf{1} \mathbf{~ k m}$ |
| 106-109 | Reserved |
| 110 | Mist |
| 111 | Diamond dust |
| 112 | Distant lightning |
| 113-117 | Reserved |
| 118 | Squalls |
| 119 | Reserved |
|  | Code figures 120-126 are used to report precipitation, fog (or ice fog) or thunderstorm at the station during the preceding hour but not at the time of observation |
| 120 | Fog |
| 121 | PRECIPITATION |
| 122 | Drizzle (not freezing) or snow grains |
| 123 | Rain (not freezing) |
| 124 | Snow |
| 125 | Freezing drizzle or freezing rain |
| 126 | Thunderstorm (with or without precipitation) |
| 127 | BLOWING OR DRIFTING SNOW OR SAND |
| 128 | Blowing or drifting snow or sand, visibility equal to, or greater than, 1 km |
| 129 | Blowing or drifting snow or sand, visibility less than $\mathbf{1} \mathbf{~ k m}$ |
| 130 | FOG |
| 131 | Fog or ice fog in patches |
| 132 | Fog or ice fog, has become thinner during the past hour |
| 133 | Fog or ice fog, no appreciable change during the past hour |
| 134 | Fog or ice fog, has begun or become thicker during the past hour |
| 135 | Fog, depositing rime |
| 136-139 | Reserved |

[^19](Code table 020003 - continued)

| Code figure |  |
| :---: | :---: |
| 140 | PRECIPITATION |
| 141 | Precipitation, slight or moderate |
| 142 | Precipitation, heavy |
| 143 | Liquid precipitation, slight or moderate |
| 144 | Liquid precipitation, heavy |
| 145 | Solid precipitation, slight or moderate |
| 146 | Solid precipitation, heavy |
| 147 | Freezing precipitation, slight or moderate |
| 148 | Freezing precipitation, heavy |
| 149 | Reserved |
| 150 | DRIZZLE |
| 151 | Drizzle, not freezing, slight |
| 152 | Drizzle, not freezing, moderate |
| 153 | Drizzle, not freezing, heavy |
| 154 | Drizzle, freezing, slight |
| 155 | Drizzle, freezing, moderate |
| 156 | Drizzle, freezing, heavy |
| 157 | Drizzle and rain, slight |
| 158 | Drizzle and rain, moderate or heavy |
| 159 | Reserved |
| 160 | RAIN |
| 161 | Rain, not freezing, slight |
| 162 | Rain, not freezing, moderate |
| 163 | Rain, not freezing, heavy |
| 164 | Rain, freezing, slight |
| 165 | Rain, freezing, moderate |
| 166 | Rain, freezing, heavy |
| 167 | Rain (or drizzle) and snow, slight |
| 168 | Rain (or drizzle) and snow, moderate or heavy |
| 169 | Reserved |
| 170 | SNOW |
| 171 | Snow, slight |
| 172 | Snow, moderate |
| 173 | Snow, heavy |
| 174 | Ice pellets, slight |
| 175 | Ice pellets, moderate |
| 176 | Ice pellets, heavy |
| 177-179 | Reserved |
| 180 | SHOWER (S) or INTERMITTENT PRECIPITATION |
| 181 | Rain shower(s) or intermittent rain, slight |
| 182 | Rain shower(s) or intermittent rain, moderate |
| 183 | Rain shower(s) or intermittent rain, heavy |

(continued)

| (Code table $0 \mathbf{0 0} \mathbf{0 0 3}$ - continued) <br> Code figure <br> 184 | Rain shower(s) or intermittent rain, violent |
| :--- | :--- |
| 185 | Snow shower(s) or intermittent snow, slight |
| 186 | Snow shower(s) or intermittent snow, moderate |
| 187 | Snow shower(s) or intermittent snow, heavy |
| $188-189$ | Reserved |
|  |  |
| 190 | THUNDERSTORM |
| 191 | Thunderstorm, slight or moderate, with no precipitation |
| 192 | Thunderstorm, slight or moderate, with rain showers and/or snow showers |
| 193 | Thunderstorm, slight or moderate, with hail |
| 194 | Thunderstorm, heavy, with no precipitation |
| 195 | Thunderstorm, heavy, with rain showers and/or snow showers |
| 196 | Thunderstorm, heavy, with hail |
| $197-198$ | Reserved |
| 199 | Tornado |

Present weather (in addition to present weather report from either a manned or an automatic station)

Decile 200-209

| 200-203 | Not used |
| :---: | :--- |
| 204 | Volcanic ash suspended in the air aloft |
| 205 | Not used |
| 206 | Thick dust haze, visibility less than 1 km |
| 207 | Blowing spray at the station |
| 208 | Drifting dust (sand) |
| 209 | Wall of dust or sand in distance (like habob) |

Decile 210-219

| 210 | Snow haze |
| :---: | :--- |
| 211 | Whiteout |
| 212 | Not used |
| 213 | Lightning, cloud to surface |
| $214-216$ | Not used |
| 217 | Dry thunderstorm |
| 218 | Not used |
| 219 | Tornado cloud (destructive) at or within sight of the station during the preceding hour or |
|  | at time of observation |

Decile 220-229
220 Deposition of volcanic ash
221 Deposition of dust or sand
222 Deposition of dew
223 Deposition of wet snow
224 Deposition of soft rime
225 Deposition of hard rime

## (Code table 020003 - continued)

Code figure
226 Deposition of hoar frost
227 Deposition of glaze
228 Deposition of ice crust (ice slick)
229 Not used
Decile 230-239
230 Duststorm or sandstorm with temperature below $0^{\circ} \mathrm{C}$
231-238 Not used
239 Blowing snow, impossible to determine whether snow is falling or not
Decile 240-249
240 Not used

241 Fog on sea
$242 \quad$ Fog in valleys
243 Arctic or Antarctic sea smoke
244 Steam fog (sea, lake or river)
245 Steam fog (land)
246 Fog over ice or snow cover
247 Dense fog, visibility 60-90 m
248 Dense fog, visibility $30-60 \mathrm{~m}$
249 Dense fog, visibility less than 30 m
Decile 250-259


Decile 260-269

| 260 |
| :--- |
| 261 |
| 262 |
| 263 |
| 264 |
| 265 |
| 266 |
| 267 |
| $268-269$ |$\quad$ Rain, rate of fall \(\quad\left\{\begin{array}{l}less than 1.0 \mathrm{~mm} \mathrm{~h}^{-1} <br>

1.0-1.9 \mathrm{~mm} \mathrm{~h}^{-1} <br>
2.0-3.9 \mathrm{~mm} \mathrm{~h}^{-1} <br>
4.0-7.9 \mathrm{~mm} \mathrm{~h}^{-1} <br>
8.0-15.9 \mathrm{~mm} \mathrm{~h}^{-1} <br>
16.0-31.9 \mathrm{~mm} \mathrm{~h}^{-1} <br>
32.0-63.9 \mathrm{~mm} \mathrm{~h}^{-1} <br>
64.0 \mathrm{~mm} \mathrm{~h}^{-1} or more\end{array}\right\}\).

## (Code table 020003 - continued)

Decile 270-279

270
271
272
273
274
275
276
277
278
279
less than $1.0 \mathrm{~cm} \mathrm{~h}^{-1}$
$1.0-1.9 \mathrm{~cm} \mathrm{~h}^{-1}$
$2.0-3.9 \mathrm{~cm} \mathrm{~h}^{-1}$
$4.0-7.9 \mathrm{~cm} \mathrm{~h}^{-1}$
$8.0-15.9 \mathrm{~cm} \mathrm{~h}^{-1}$
$16.0-31.9 \mathrm{~cm} \mathrm{~h}^{-1}$
$32.0-63.9 \mathrm{~cm} \mathrm{~h}^{-1}$
$64.0 \mathrm{~cm} \mathrm{~h}^{-1}$ or more
Snow or ice crystal precipitation from a clear sky
Wet snow, freezing on contact

Decile 280-299
280 Precipitation of rain
281 Precipitation of rain, freezing
282 Precipitation of rain and snow mixed
283 Precipitation of snow
284 Precipitation of snow pellets or small hail
285 Precipitation of snow pellets or small hail, with rain
286 Precipitation of snow pellets or small hail, with rain and snow mixed
287 Precipitation of snow pellets or small hail, with snow
288 Precipitation of hail
289 Precipitation of hail, with rain
$290 \quad$ Precipitation of hail, with rain and snow mixed
291 Precipitation of hail, with snow
292 Shower(s) or thunderstorm over sea
293 Shower(s) or thunderstorm over mountains
294-299 Not used
300-507 Reserved
508 No significant phenomenon to report, present and past weather omitted
509 No observation, data not available, present and past weather omitted
510 Present and past weather missing, but expected
511 Missing value
Notes:
(1) The middle portion of this code table (code figures 100-199) includes terms on several levels to cover simple and increasingly complex automatic stations.
(2) Generic terms for weather (e.g. fog, drizzle) are intended for use at automatic stations capable of determining types of weather but no other information. Generic terms are included in the code table using all capital letters.
(3) Code figures for generic precipitation (code figures 140-148) are arranged in order of increasing complexity. For example, a very simple station that can sense only the presence or absence of precipitation would use code figure 140 (precipitation). At the next level, an automatic station capable of sensing amount but not type would use code figure 141 or 142. An automatic station capable of sensing gross type (liquid, solid, freezing) and amount would use code figures 143-148. An automatic station capable of reporting actual types of precipitation (e.g. drizzle or rain), but not the amount, would use the appropriate whole decile number (e.g. 150 for generic drizzle, 160 for generic rain).

## 020 004/0 20005

Past weather (1) and (2)
Code figure
$0 \quad$ Cloud covering ${ }^{1} / 2$ or less of the sky throughout the appropriate period
1 Cloud covering more than $1 / 2$ of the sky during part of the appropriate period and covering ${ }^{1} / 2$ or less during part of the period
Cloud covering more than $1 / 2$ of the sky throughout the appropriate period
Sandstorm, duststorm or blowing snow
Fog or ice fog or thick haze
Drizzle
Rain
Snow, or rain and snow mixed
Shower(s)
Thunderstorm(s) with or without precipitation
No significant weather observed
VISIBILITY REDUCED
Blowing phenomena, visibility reduced
FOG
PRECIPITATION
Drizzle
Rain
Snow or ice pellets
Showers or intermittent precipitation
Thunderstorm
Reserved
Missing value
Note: The weather descriptions in code figures 10 to 19 are progressively complex, to accommodate the different levels of weather discrimination capability of various automatic stations. Stations having only basic sensing capability may use the lower code figures and basic generic descriptions (shown in capital letters). Stations with progressively higher discrimination capability shall use the more detailed descriptions (higher codes).

## 020008

## Cloud distribution for aviation

Code figure

| 0 | Sky clear |  |
| :--- | :--- | :--- |
| 1 | Few |  |
| 2 | Scattered |  |
| 3 | Broken |  |
| 4 | Overcast |  |
| 5 | Reserved |  |
| 6 | Scattered/broken | (Many forecasts use scattered/broken or broken/overcast |
| 7 | Broken/overcast | followed by cloud type(s)) |

(Code table 020008 - continued)
Code figure

| 8 | Isolated | (Used on aviation charts to describe the cloud type Cb) |
| :---: | :---: | :---: |
| 9 | Isolated embedded | (Used on aviation charts to describe the cloud type Cb) |
| 10 | Occasional | (Used on aviation charts to describe the cloud type Cb) |
| 11 | Occasional embedded | (Used on aviation charts to describe the cloud type Cb) |
| 12 | Frequent | (Used on aviation charts to describe the cloud type Cb) |
| 13 | Dense | (Used on aviation charts to describe cloud that would cause sudden changes in visibility (less than $\mathbf{1 0 0 0} \mathbf{m}$ )) |
| 14 | Layers |  |
| 15-30 | Reserved |  |
| 31 | Missing value |  |

## 020009

General Weather Indicator (TAF/METAR)
Code figure

## Reserved

NSC Nil Significant Cloud
CAVOK
SKC Sky Clear
NSW Nil Significant Weather
5-14
Reserved
Missing value

## 020011

Cloud amount
Code figure

| 0 | 0 | 0 |
| :---: | :--- | :--- |
| 1 | 1 okta or less, but not zero | $1 / 10$ or less, but not zero |
| 2 | 2 oktas | $2 / 10-3 / 10$ |
| 3 | 3 oktas | $4 / 10$ |
| 4 | 4 oktas | $5 / 10$ |
| 5 | 5 oktas | $6 / 10$ |
| 6 | 6 oktas | $7 / 10-8 / 10$ |
| 7 | 7 oktas or more, but not 8 oktas | $9 / 10$ or more, but not $10 / 10$ |
| 8 | 8 oktas | $10 / 10$ |
| 9 | Sky obscured by fog and/or other meteorological phenomena |  |
| 10 | Sky partially obscured by fog and/or other meteorological phenomena |  |
| 11 | Scattered |  |

(Code table 020011 - continued)
Code figure

| 12 | Broken |
| :--- | :--- |
| 13 | Few |
| 14 | Reserved |
| 15 | Cloud cover is indiscernible for reasons other than fog or other meteorological <br> phenomena, or observation is not made |
|  |  |

Notes:
(1) For use of code figure 15, see Regulation 12.1.4.
(2) "Clear" and "overcast" are coded by 0 and 8 , respectively.

|  | 020012 <br> Cloud type |
| :---: | :---: |
| Code figure |  |
| 0 | Cirrus (Ci) |
| 1 | Cirrocumulus (Cc) |
| 2 | Cirrostratus (Cs) |
| 3 | Altocumulus (Ac) |
| 4 | Altostratus (As) |
| 5 | Nimbostratus ( Ns ) |
| 6 | Stratocumulus (Sc) |
| 7 | Stratus (St) |
| 8 | Cumulus (Cu) |
| 9 | Cumulonimbus (Cb) |
| 10 | No $\mathrm{C}_{\mathrm{H}}$ clouds |
| 11 | Cirrus fibratus, sometimes uncinus, not progressively invading the sky |
| 12 | Cirrus spissatus, in patches or entangled sheaves, which usually do not increase and sometimes seem to be the remains of the upper part of a Cumulonimbus; or Cirrus castellanus or floccus |
| 13 | Cirrus spissatus cumulonimbogenitus |
| 14 | Cirrus uncinus or fibratus, or both, progressively invading the sky; they generally thicken as a whole |
| 15 | Cirrus (often in bands) and Cirrostratus, or Cirrostratus alone, progressively invading the sky; they generally thicken as a whole, but the continuous veil does not reach 45 degrees above the horizon |
| 16 | Cirrus (often in bands) and Cirrostratus, or Cirrostratus alone, progressively invading the sky; they generally thicken as a whole; the continuous veil extends more than $\mathbf{4 5}$ degrees above the horizon, without the sky being totally covered |
| 17 | Cirrostratus covering the whole sky |
| 18 | Cirrostratus not progressively invading the sky and not entirely covering it |
| 19 | Cirrocumulus alone, or Cirrocumulus predominant among the $\mathrm{C}_{\mathbf{H}}$ clouds |
| 20 | No $\mathrm{C}_{\mathrm{M}}$ clouds |
| 21 | Altostratus translucidus |
| 22 | Altostratus opacus or Nimbostratus |
| 23 | Altocumulus translucidus at a single level |
| 24 | Patches (often lenticular) of Altocumulus translucidus, continually changing and occurring at one or more levels |


| (Code table 020 | 012 - continued) |
| :---: | :--- |
| Code figure |  |
| 25 | Altocumulus translucidus in bands, or one or more layers of Altocumulus translucidus or <br> opacus, progressively invading the sky; these Altocumulus clouds generally thicken as a <br> whole |
| 26 | Altocumulus cumulogenitus (or cumulonimbogenitus) |
| 26 | Altocumulus translucidus or opacus in two or more layers, or Altocumulus opacus in a <br> single layer, not progressively invading the sky, or Altocumulus with Altostratus or |
| Nimbostratus |  |

[^20]

```
(Code table 0 20 021 - continued)
Bit No.
\begin{tabular}{cl}
14 & Hail \\
15 & Glaze \\
16 & Rime \\
17 & Soft rime \\
18 & Hard rime \\
19 & Clear ice \\
20 & Wet snow \\
21 & Hoar frost \\
22 & Dew \\
\(23-29\) & Reserved \\
All 30 & Missing value
\end{tabular}
```

Note: Mixed precipitation is indicated by setting to one the bits of all the observed single types of precipitation.

## 020022 <br> Character of precipitation

Code figure
0 No precipitation
1 Continuous
2 Intermittent
3 Shower
4 Not reaching ground
5 Deposition
6-14 Reserved
15 Missing value

## 020023 <br> Other weather phenomena

Bit No.

| 1 | Dust/sand whirl |
| :--- | :--- |
| 2 | Squalls |
| 3 | Sandstorm |
| 4 | Duststorm |
| 5 | Lightning - cloud to surface |
| 6 | Lightning - cloud to cloud |
| 7 | Lightning - distant |
| 8 | Thunderstorm |

## (Code table 020023 - continued)

Bit No.
9 Funnel cloud not touching surface
10 Funnel cloud touching surface
11 Spray
12-17 Reserved
All 18 Missing value

## 020024 <br> Intensity of phenomena

| Code figure |  |
| :---: | :--- |
| 0 | No phenomena |
| 1 | Light |
| 2 | Moderate |
| 3 | Heavy |
| 4 | Violent |
| $5-6$ | Reserved |
| 7 | Missing value |

## 020025

Obscuration
Bit No.

| 1 | Fog |
| :---: | :--- |
| 2 | Ice fog |
| 3 | Steam fog |
| $4-6$ | Reserved |
| 7 | Mist |
| 8 | Haze |
| 9 | Smoke |
| 10 | Volcanic ash |
| 11 | Dust |
| 12 | Sand |
| 13 | Snow |
| $14-20$ | Reserved |
| All 21 | Missing value |

```
                                    020026
                                    Character of obscuration
Code figure
        O No change
        1 Shallow
        2 Patches
        3 Partial
        4 Freezing
        L Low drifting
        B Blowing
        7 Increasing
        8 Decreasing
        9 In suspension in the air
        10 Wall
        11 Dense
        12 Whiteout
        13-14 Reserved
        15 Missing value
```


## 020026 <br> Character of obscuration

```
Code figure
\begin{tabular}{cl}
0 & No change \\
1 & Shallow \\
2 & Patches \\
3 & Partial \\
4 & Freezing \\
5 & Low drifting \\
6 & Blowing \\
7 & Increasing \\
8 & Decreasing \\
9 & In suspension in the air \\
10 & Wall \\
11 & Dense \\
12 & Whiteout \\
\(13-14\) & Reserved \\
15 & Missing value
\end{tabular}
```


## 020027 <br> Phenomena occurrence

```
Bit No.
1 At time of observation
2
3 In time period for past weather \(W_{1} W_{2}\)
4 In time period specified
5-6 Reserved
7 At the station
8 In the vicinity
All \(9 \quad\) Missing value
Note: Phenomenon in this flag table means any phenomenon, including precipitation and obscuration.
```


## 020032 <br> Rate of ice accretion

| Code figure |  |
| :---: | :--- |
| 0 | Ice not building up |
| 1 | Ice building up slowly |
| 2 | Ice building up rapidly |
| 3 | Ice melting or breaking up slowly |
| 4 | Ice melting or breaking up rapidly |
| $5-6$ | Reserved |
| 7 | Missing value |

## 020033 <br> Cause of ice accretion

Bit No.
1 Icing from ocean spray
2
3
All 4
lcing from fog
Icing from rain
Missing value

## 020034 <br> Sea ice concentration

Code figure

0
1

2

3

4

5

6


No sea ice in sight
beyond limit of visibility

Sea ice present in concentrations less than $3 / 10(3 / 8)$, open water or very open pack ice $4 / 10$ to $6 / 10$ (3/8 to less than $6 / 8$ ), open pack ice
7/10 to $8 / 10$ (6/8 to less than 7/8), close pack ice
9/10 or more, but not 10/10 (7/8 to less than $8 / 8$ ), very close pack ice
Strips and patches of pack ice with open water between
Strips and patches of close or very close pack ice with areas of lesser concentration between
Fast ice with open water, very open or open pack ice to seaward of the ice boundary
Fast ice with close or very close pack ice to seaward of the ice boundary Reserved
Unable to report, because of darkness, lack of visibility, or because ship is more than 0.5 nautical mile away from ice edge
Reserved
Missing value

## 020035 <br> Amount and type of ice

Code figure
$0 \quad$ No ice of land origin

1
2
3
4
5
6
7
8
9

Code figure

1-5 icebergs, no growlers or bergy bits
6-10 icebergs, no growlers or bergy bits
11-20 icebergs, no growlers or bergy bits
Up to and including $\mathbf{1 0}$ growlers and bergy bits - no icebergs
More than $\mathbf{1 0}$ growlers and bergy bits - no icebergs
1-5 icebergs, with growlers and bergy bits
6-10 icebergs, with growlers and bergy bits
11-20 icebergs, with growlers and bergy bits
More than $\mathbf{2 0}$ icebergs, with growlers and bergy bits - a major hazard to navigation Resenved
Unable to report, because of darkness, lack of visibility or because only sea ice is visible Missing value

## 020036

Ice situation
Ship in open water with floating ice in sight
Ship in easily penetrable ice; conditions improving
Ship in easily penetrable ice; conditions not changing
Ship in easily penetrable ice; conditions worsening
Ship in ice difficult to penetrate; conditions improving
Ship in ice difficult to penetrate; conditions not changing
Ship in ice difficult to penetrate and conditions worsening. Ice forming and floes freezing
together
Ship in ice difficult to penetrate and conditions worsening. Ice under slight pressure
Ship in ice difficult to penetrate and conditions worsening. Ice under moderate or severe
pressure
Ship in ice difficult to penetrate and conditions worsening. Ship beset
Reserved
Unable to report, because of darkness or lack of visibility
Missing value

## 020037

Ice development
Code figure
0 New ice only (frazil ice, grease ice, slush, shuga)
Nilas or ice rind, less than 10 cm thick
Young ice (grey ice, grey-white ice), $10-30 \mathrm{~cm}$ thick
Predominantly new and/or young ice with some first-year ice
Predominantly thin first-year ice with some new and/or young ice
All thin first-year ice ( $\mathbf{3 0 - 7 0} \mathbf{~ c m}$ thick)
Predominantly medium first-year ice ( $\mathbf{7 0 - 1 2 0} \mathbf{c m}$ thick) and thick first-year ice ( $\mathbf{~} \mathbf{1 2 0} \mathbf{~ c m}$ thick) with some thinner (younger) first-year ice
All medium and thick first-year ice
Predominantly medium and thick first-year ice with some old ice (usually more than 2 metres thick)
Predominantly old ice
Reserved
30 Unable to report, because of darkness, lack of visibility or because only ice of land origin is visible or because ship is more than 0.5 nautical mile away from ice edge
31 Missing value

## 020041

Airframe icing
Code figure

| 0 | No icing |
| :---: | :--- |
| 1 | Light icing |
| 2 | Light icing in cloud |
| 3 | Light icing in precipitation |
| 4 | Moderate icing |
| 5 | Moderate icing in cloud |
| 6 | Moderate icing in precipitation |
| 7 | Severe icing |
| 8 | Severe icing in cloud |
| 9 | Severe icing in precipitation |
| 10 | Trace of icing |
| 11 | Trace of icing in cloud |
| 12 | Trace of icing in precipitation |
| $13-14$ | Reserved |
| 15 | Missing value |

## 020062 <br> State of the ground

## Code figure

0 Surface of ground dry (without cracks and no appreciable amount of dust or loose sand)
1 Surface of ground moist

2

7 Thin cover of loose dry dust or sand covering ground completely
8 Moderate or thick cover of loose dry dust or sand covering ground completely
$9 \quad$ Extremely dry with cracks
10 Ground predominantly covered by ice
11 Compact or wet snow (with or without ice) covering less than one-half of the ground
12 Compact or wet snow (with or without ice) covering at least one-half of the ground but ground not completely covered
13 Even layer of compact or wet snow covering ground completely
14 Uneven layer of compact or wet snow covering ground completely
15 Loose dry snow covering less than one-half of the ground
16 Loose dry snow covering at least one-half of the ground but ground not completely covered
17 Even layer of loose dry snow covering ground completely
18 Uneven layer of loose dry snow covering ground completely
19 Snow covering ground completely; deep drifts
20-30 Reserved
31 Missing value
without snow or measurable ice cover
with snow or measurable ice cover

Notes:
(1) The definitions in code numbers 0 to 2 and 4 apply to representative bare ground and numbers 3,5 to 9 and 10 to 19 to an open representative area.
(2) In all instances the highest code figures applicable are to be reported.
(3) In the above code table, whenever reference is made to ice, it also includes solid precipitation other than snow.

# 020063 <br> Special phenomena <br> (To be developed) 

## 020071

Accuracy of fix and rate of atmospherics

| Code figure | Accuracy of fix (estimated error) | Repetition rate |
| :---: | :--- | :--- |
| 0 | No assessment | No assessment |
| 1 | Less than 50 km | Less than 1 per second |
| 2 | Between 50 and 200 km | Less than 1 per second |
| 3 | More than 200 km | Less than 1 per second |
| 4 | Less than 50 km | 1 or more per second |
| 5 | Between 50 and 200 km | 1 or more per second |
| 6 | More than 200 km | 1 or more per second |
| 7 | Less an 50 km | Rate so rapid number cannot be counted |
| 8 | Between 50 and 200 km | Rate so rapid number cannot be counted |
| 9 | More than 200 km | Rate so rapid number cannot be counted |
| $10-14$ | Reserved |  |
| 15 | Missing value |  |

020090<br>Special clouds

Code figure

| 0 | Reserved |
| :---: | :--- |
| 1 | Nacreous clouds |
| 2 | Noctilucent clouds |
| 3 | Clouds from waterfalls |
| 4 | Clouds from fires |
| 5 | Clouds from volcanic eruptions |
| $6-14$ | Reserved |
| 15 | Missing |

## 021066 <br> Wave scatterometer product confidence data

Bit No.
1 Processing equipment not working
2 Equipment failed
3 PRF code changed during image generation
4 Sampling window changed during image generation
5 Gain changed during image generation
$6 \quad$ Chirp replica exceeds specified value
7 Input data mean and standard deviation of in-phase and quadrature out of range
8 Doppler centroid confidence > MMCC value
9 Doppler centroid absolute value > PRF/2
10 Doppler ambiguity confidence < MMCC value
11 Output data mean and standard deviation $=<$ MMCC value
All 12 Missing value
Notes:
(1) MMCC is Mission Management Control Centre.
(2) PRF is Pulse Repetition Frequency.

## 021067 <br> Wind product confidence data

Bit No.
1 No forebeam calculation
2 No midbeam calculation
3
4
5
6
No aftbeam calculation
Forebeam arcing detected
Midbeam arcing detected
Aftbeam arcing detected
7 Any beam noise content above or equal to threshold
8
9
Land (any land in cell footprint)
Autonomous ambiguity removal not used
10 Meteorological background not used
11 Minimum residual exceeded threshold
12 Frame checksum error detected
All 13 Missing value

## 021068 <br> Radar altimeter product confidence data

Bit No.
1 Standard deviation of wind speed outside MMCC limit
2
3
4
5
6
7
All 8
Note: MMCC is Mission Man
Note: MMCC is Mission Management Control Centre.

## 021069

## SST product confidence data

Bit No.
$1 \quad 12.0 \mu \mathrm{~m}$ channel present in source data
2
3
4
5
6
7

All 10
$11.0 \mu \mathrm{~m}$ channel present in source data
$3.7 \mu \mathrm{~m}$ channel present in source data
$1.6 \mu \mathrm{~m}$ channel present in source data
Cloud identification used $1.6 \mu \mathrm{~m}$ histogram reflectance cloud test
$1.6 \mu \mathrm{~m}$ histogram reflectance cloud test used dynamic threshold
Sun glint detected by $1.6 \mu \mathrm{~m}$ reflectance cloud test
$3.7 \mu \mathrm{~m}$ channel used in sea-surface temperature retrieval
Sea-surface temperature derivation used daytime data (night-time if zero)
Missing value

## 021070 <br> SST product confidence data (SADIST-2)

Bit No.
1-9 Nadir-only view SST retrieval used 3.7 micron channel (one bit per 10-arcmin cell)
Cell 1: nadir-only view SST used 3.7 micron channel
Cell 2: nadir-only view SST used 3.7 micron channel
Cell 3: nadir-only view SST used 3.7 micron channel
Cell 4: nadir-only view SST used 3.7 micron channel
Cell 5: nadir-only view SST used 3.7 micron channel
Cell 6: nadir-only view SST used 3.7 micron channel
Cell 7: nadir-only view SST used 3.7 micron channel Cell 8: nadir-only view SST used 3.7 micron channel Cell 9: nadir-only view SST used 3.7 micron channel


## (Code table 021070 - continued)

## Bit No.

10-18 Dual view SST retrieval used 3.7 micron channel (one bit per 10-arcmin cell)

## No.

Cell 1: dual view SST used 3.7 micron channel
Cell 2: dual view SST used 3.7 micron channel
Cell 3: dual view SST used 3.7 micron channel
Cell 4: dual view SST used 3.7 micron channel
Cell 5: dual view SST used 3.7 micron channel
Cell 6: dual view SST used 3.7 micron channel
Cell 7: dual view SST used 3.7 micron channel
Cell 8: dual view SST used 3.7 micron channel
Cell 9: dual view SST used 3.7 micron channel

| Cell numbering: |  |  |
| :---: | :---: | :---: |
|  |  |  |
| NW |  | NE |
|  | 89 | 9 |
|  | 56 |  |
| 1 | 23 | 3 |
| SW |  | SE |

Nadir view contains day-time data (night if zero)
Forward view contains day-time data (night if zero)
Record contains contributions from instrument scans acquired when ERS platform not in yaw-steering mode
Record contains contributions from instrument scans for which product confidence data show quality is poor or unknown
Missing value

## 021072

Satellite altimeter calibration status

Height error correction applied instead of open loop calibration Microwave sounder used for troposphere correction AGC output correction applied instead of open loop calibration Missing value

## 021073

Satellite altimeter instrument mode
Bit No.
1 Blank data record
Blank data record
Test
Calibration (closed loop)
BITE
Acquisition on ice
Acquisition on ocean
Tracking on ice
Tracking on ocean
Missing value

## 021076 <br> Representation of intensities

Code figure

| 0 | Linear |
| :---: | :--- |
| 1 | Logarithmic (base e) |
| 2 | Logarithmic (base 10) |
| $3-6$ | Reserved |
| 7 | Missing value |

## 021109

SEAWINDS wind vector call quality
Bit No.
1 Not enough good sigma-0 available for wind retrieval
2
Poor azimuth diversity among sigma-0 for wind retrieval
3-7
8
9
10
11
12
13-16
All 17

## Reserved

Some portion of wind vector cell is over land
Some portion of wind vector cell is over ice
Wind retrieval not performed for wind vector cell
Reported wind speed is greater than $30 \mathrm{~m} \mathrm{~s}^{-1}$
Reported wind speed is less than or equal to $\mathbf{3 ~ m ~ s}{ }^{-1}$
Reserved
Missing value

## 021115

SEAWINDS sigma-0 quality

## Bit No.

Sigma-0 measurement is not usable
Signal to noise ratio is low
Sigma-0 is negative
Sigma-0 is outside of acceptable range
Scatterometer pulse quality is not acceptable
Sigma-0 cell location algorithm does not converge
Frequency shift lies beyond the range of the x factor table
Spacecraft temperature is beyond calibration coefficient range No applicable altitude records were found for this sigma-0 Interpolated ephemeris data are not acceptable for this sigma-0 Reserved
Missing value

## 021116 <br> SEAWINDS sigma-0 mode

## Bit No.

$1 \quad$ Calibration/measurement pulse flag (1)
2
3
4
5
6
7
8
9
10
11
12
13
14
15
Calibration/measurement pulse flag (2)
Outer antenna beam
Sigma-0 cell is aft of spacecraft
Current mode (1)
Current mode (2)
Effective gate width - slice resolution (1)
Effective gate width - slice resolution (2)
Effective gate width - slice resolution (3)
Low resolution mode - whole pulse data
Scatterometer electronic subsystem B
Alternate spin rate - $19.8 \mathbf{~ r p m}$
Receiver protection on
Slices per composite flag (1)
Slices per composite flag (2)
Slices per composite flag (3)
Missing value

## 021119

Wind scatterometer geophysical model function
Code figure

| 0 | Reserved |
| :---: | :--- |
| 1 | SASS |
| 2 | SASS2 |
| 3 | NSCAT0 |
| 4 | NSCAT1 |
| 5 | NSCAT2 |
| 6 | QSCAT0 |
| 7 | QSCAT1 |
| $8-30$ | Reserved |
| 31 | CMOD1 |
| 32 | CMOD2 |
| 33 | CMOD3 |
| 34 | CMOD4 |
| 35 | CMOD5 |
| $36-62$ | Reserved |
| 63 | Missing value |

## 022056 <br> Direction of profile

Code figure

| 0 | Upwards profile |
| :--- | :--- |
| 1 | Downwards profile |
| 2 | Horizontal |
| 3 | Missing value |

## 022061

State of the sea

Height in metres
0
$0-0.1$
$0.1-0.5$
$0.5-1.25$
$1.25-2.5$
$2.5-4$
$4-6$
$6-9$
$9-14$
Over 14

10-14
15

Calm (glassy)
Calm (rippled)
Smooth (wavelets)
Slight
Moderate
Rough
Very rough
High
Very high
Phenomenal
Reserved
Missing value

## Notes:

(1) These values refer to well-developed wind waves of the open sea. While priority shall be given to the descriptive terms, these height values may be used for guidance by the observer when reporting the total state of agitation of the sea resulting from various factors such as wind, swell, currents, angle between swell and wind, etc.
(2) The exact bounding height shall be assigned for the lower code figure; e.g., a height of $\mathbf{4} \mathbf{m}$ is coded as 5.

## 022067

Instrument type for water temperature profile measurement
(See common Code Table C-3)

# 022068 <br> Water temperature profile recorder types <br> (See common Code Table C-4) 

## 022120

Tide station automated water level check

Code figure

## Good data

Maximum (high) water level limit exceeded
Minimum (low) water level limit exceeded
Rate of change limit for water level exceeded
Flat limit for water level exceeded
Observed minus predicted water level value limit exceeded
Observed value from primary water level sensor minus backup water level sensor
Value exceeded specified tolerance from expected value
Water level QA parameter (sigmas and/or outliers) limits exceeded
Sea temperature outside of expected range
Multiple QC checks (above) failed
No automated water level checks performed
Reserved
Missing value

## 022121

Tide station manual water level check
Code figure

## Operational

Possible clogging problem or otherwise degraded water level data
Possible datum shift
Unknown status of water level sensor
Suspected or known sea temperature sensor problem
Multiple possible problems (above)
Bad data - DO NOT DISSEMINATE!
No manual water level checks performed

31 Reserved
Missing value

## 022122

Tide station automated meteorological data check
Code figure
Good data from all sensors
Wind direction outside of allowable range
Wind speed outside of expected range
Barometric pressure outside of expected range
Air temperature outside of expected range
Multiple sensors failed QC checks
No automated meteorologic al data checks performed
Reserved
Missing value

## 022123

Tide station manual meteorological data check
Code figure
0 Operational
Suspected or known problem with wind sensor
Suspected or known problem with barometric pressure sensor
Suspected or known problem with air temperature sensor
Unknown status of all sensors
Suspected or known problems with multiple sensors
Bad data - DO NOT DISSEMINATE!
No manual meteorological data checks performed

31 Reserved
Missing value

# 023001 <br> Accident early notification - article applicable 

Code figure

| 0 | Reserved |
| :---: | :--- |
| 1 | Articles 1 and 2 |
| 2 | Article 3 |
| 3 | Article 5.2 |
| $4-6$ | Reserved |
| 7 | Missing value |

## 023002

Activity or facility involved in incident

| Code figure |  |
| :---: | :--- |
| 0 | Reserved |
| 1 | Nuclear reactor on ground |
| 2 | Nuclear reactor at sea |
| 3 | Nuclear reactor in space |
| 4 | Nuclear fuel facility |
| 5 | Radioactive waste management facility |
| 6 | Transport of nuclear fuel or radioactive waste |
| 7 | Storage of nuclear fuel or radioactive waste |
| 8 | Manufacture of radio-isotopes |
| 9 | Use of radio-isotopes |
| 10 | Storage of radio-isotopes |
| 11 | Disposal of radio-isotopes |
| 12 | Transport of radio-isotopes |
| 13 | Use of radio-isotopes for power generation |
| $14-29$ | Reserved |
| 30 | Other |
| 31 | Missing value |

## 023003

Type of release
Code figure
0 No release

1 Release to atmosphere
2
3
4
5
6
7
Release to water
Release to both atmosphere and water
Expected release to atmosphere
Expected release to water
Expected release to both atmosphere and water
Missing value

## 023004 <br> Countermeasures taken near border

Code figure

| 0 | No countermeasures |
| :---: | :--- |
| 1 | Evacuation |
| 2 | Sheltering |
| 3 | Prophylaxis |
| 4 | Water |
| $5-6$ | Reserved |
| 7 | Missing value |

## 023005 <br> Cause of incident

Code figure
$0 \quad$ Incident State does not understand what happened
1 Incident State knows the cause of the incident
2
3
Reserved
Missing value

| Code figure |  |
| :---: | :--- |
| 0 | No improvement |
| 1 | Unstable |
| 2 | No deterioration |
| 3 | Improving |
| 4 | Stable |
| 5 | Deteriorating |
| 6 | Reserved |
| 7 | Missing value |

# 023007 <br> Characteristics of release 

Code figure

| 0 | No release |
| :---: | :--- |
| 1 | Release has stopped |
| 2 | Release |
| 3 | Release is continuing |
| $4-6$ | Reserved |
| 7 | Missing value |

# 023 008/0 23009 <br> State of current or expected release 

Code figure

Particulate
Mixture of gaseous and partic ulate
Missing value

## 023016

Possibility of significant chemical toxic health effect
Code figure
No significant chemical toxic health effect
1
2
3
Significant chemical toxic health effect possible
Reserved
Missing value

## 023018 <br> Release behaviour over time

Code figure
0 Release no longer occurring

1
2
3
4
5-6
7 Missing value

## 023031

Possibility that plume will encounter precipitation in State in which incident occurred

Code figure
$0 \quad$ Plume will not encounter rain in incident State
1
Plume will encounter rain in incident State
Reserved
Missing value

## 023032

Plume will encounter change in wind direction and/or speed flag
Code figure
$0 \quad$ No significant change expected within the next six hours
Anticipated significant change expected within the next six hours
Reserved
Missing value

# 024003 <br> Composition of release 

| Code figure |  |
| :---: | :--- |
| 0 | Noble gases |
| 1 | lodines |
| 2 | Caesiums |
| 3 | Transuranics |
| $4-30$ | Reserved |
| 31 | Missing value |


|  | $025004$ <br> Echo processing |
| :---: | :---: |
| Code figure |  |
| 0 | Incoherent |
| 1 | Coherent (Doppler) |
| 2 | Reserved |
| 3 | Missing value |
|  | 025005 |
|  | Echo integration |
| Code figure |  |
| 0 | Logarithm - 2.5 dB |
| 1 | Linear |
| 2 | Special |
| 3 | Missing value |
|  | 025006 |
|  | Z to R conversion |
| Code figure |  |
| 0 | ZH to R conversion |
| 1 | (ZH, ZDR) to ( $\mathrm{NO}, \mathrm{DO}$ ) to R |
| 2 | ( $\mathbf{Z}(\mathrm{F} 1), \mathrm{Z}$ (F2)) to attenuation to R |
| 3-5 | Reserved |
| 6 | Other |
| 7 | Missing value |
|  | 025009 |
|  | Calibration method |
| Bit No. |  |
| 1 | None |
| 2 | Calibration target or signal |
| 3 | Against raingauges |
| 4 | Against other instruments (distrometer - attenuation) |
| All 4 | Missing value |

# 025010 <br> Clutter treatment 

| Code figure |  |
| :---: | :--- |
| 0 | None |
| 1 | Map |
| 2 | Insertion of higher elevation data and map |
| 3 | Analysis of the fluctuating logarithm signal (clutter detection) |
| $\mathbf{4}$ | Extraction of the fluctuating part of linear signal (clutter suppression) |
| $\mathbf{5}$ | Clutter suppression - Doppler |
| $\mathbf{6}$ | Multiparameter analysis |
| $\mathbf{7 - 1 4}$ | Reserved |
| $\mathbf{1 5}$ | Missing value |

## 025011

Ground occultation correction (screening)
Code figure
0 None

1 Map of correction factors
2
3
Interpolation (azimuth or elevation)
Missing value

## 025012 <br> Range attenuation correction

Code figure
0 Hardware
1
2
Software
Hardware and software
Missing value

## 025013

Bright-band correction
Bit No.
1 Bright-band correction
All 2
Missing value

## 025015 <br> Radome attenuation correction

| Bit No. |  |
| :---: | :--- |
| 1 | Radome attenuation correction |
| All 2 | Missing value |

All 2
Missing value

## 025017 <br> Precipitation attenuation correction

Bit No.
1 Precipitation attenuation correction
All 2
Missing value

## 025020 <br> Mean speed estimation

Code figure

| 0 | FFT (fast Fourier transform) |
| :--- | :--- |
| 1 | PPP (pulse-pair processing) |
| 2 | VPC (vector-phase change) |
| 3 | Missing value |

025021
Wind computation enhancement

| Bit No. |  |
| :---: | :--- |
| 1 | Simple average |
| 2 | Consensus average |
| 3 | Median check |
| 4 | Vertical consistency check |
| 5 | Other |
| $6-7$ | Reserved |
| All 8 | Missing value |

# 025030 <br> Running mean sea-surface temperature usage 

## Code figure

0
1
2
3

Running mean sea-surface temperature not used because usage criteria not met
Running mean sea-surface temperature not used because data not available
Running mean sea-surface temperature used as predictor
Missing value

## 025032

NOAA wind profiler mode information

## Code figure

## Reserved

1
2
3
Data from low mode
Data from high mode
Missing value

## 025033

NOAA wind profiler submode information
Code figure
Wind profiler operating in submode A
1 Wind profiler operating in submode B
2
3
Reserved
Missing value

## 025034

NOAA wind profiler quality control test results
Bit No. $\quad$ Meaning ( $1=$ true; $0=$ false $)$
Test A performed and failed
Test B performed and failed
Test results inconclusive
Missing value

## 025036 <br> Atmospherics location method

Code figure
0 Network of several direction-finders operating on the same individual atmospherics
1 Network of several arrival-time stations operating on the same individual atmospherics
2-5 Reserved
6 Single station range bearing technique
7-14 Reserved
15 Missing value

## 025040 <br> $\mathrm{CO}_{2}$ wind product derivation

Code figure
0 Non-specific mode
1 First guess data
Cloud data
Average vector data
4 Primary data
5
6
7
9-14
15

## Guess data

Vector data
Tracer data; this image
Tracer data to next image
Reserved
Missing value

## 025041 <br> Moving platform direction reporting method

Code figure
$0 \quad$ Direction originally reported in true degrees
1 Direction originally reported using Code table 0700, FM 13
2 Resenved
$3 \quad$ Missing value
Note: Where the original reporting method is as indicated by code figure 1 , the following conversion is recommended to obtain a suitable data value corresponding to descriptor 001 012:
Reported value Data value
$0 \quad 0$
$1 \quad 45$
290
3135
4180
$5 \quad 225$
$6 \quad 270$
$7 \quad 315$
$8 \quad 360$
$9 \quad 511$

## 025042 <br> Moving platform speed reporting method

Code figure
0 Speed originally reported in metres per second
1 Speed originally reported using Code table 4451, FM 13
2 Reserved
3 Missing value
Note: Where the original reporting method is as indicated by code figure 1, the following conversion is recommended to obtain a suitable data value corresponding to descriptor 001013 : Reported value Data value
$0 \quad 0$
$1 \quad 1$
24
$3 \quad 7$
$4 \quad 9$
$5 \quad 12$
$6 \quad 14$
$7 \quad 17$
$8 \quad 19$
$9 \quad 21$
/ 1023

## 025045

HIRS channel combination
Bit No.
1-20 Beginning with first bit position (high order bit), if bit position is set to 1 , then channel is present if bit position is set to 0 , then channel is not present
All 21 Missing value

## 025046

MSU channel combination

## Bit No.

| 1-4 | Beginning with first bit position (high order bit), <br> if bit position is set to 1, then channel is present <br> if bit position is set to 0, then channel is not present |
| :--- | :--- |
| All 5 | Missing value |

## 025047 <br> SSU channel combination

## Bit No.

1-3 Beginning with first bit position (high order bit), if bit position is set to 1 , then channel is present if bit position is set to 0 , then channel is not present Missing value

## 025048 <br> AMSU-A channel combination

Bit No.
1-15 Beginning with first bit position (high order bit), if bit position is set to 1 , then channel is present if bit position is set to 0 , then channel is not present Missing value

## 025049

AMSU-B channel combination
Bit No.
1-5 Beginning with first bit position (high order bit), if bit position is set to 1 , then channel is present if bit position is set to 0 , then channel is not present Missing value

## 025051

## AVHRR channel combination

Bit No.

| 1-6 | Beginning with first bit position (high order bit), <br> if bit position is set to 1 , then channel is present <br> if bit position is set to 0 , then channel is not present <br> Missing value |
| :--- | :--- |

# 025053 <br> Observation quality 

Bit No.

| 1 | Good |
| :---: | :--- |
| 2 | Redundant |
| 3 | Questionable |
| 4 | Bad |
| 5 | Experimental |
| 6 | Precipitating |
| $7-11$ | Reserved |
| All 12 | Missing value |

## 025086 <br> Depth correction indicator

Code figure
0 Depths are not corrected
1 Depths are corrected
2 Reserved
3 Missing value

## 025093 <br> RASS computation correction

Bit No.
1 No correction
2
3-6
7
All 8
Vertical velocity correction
Reserved
All corrections
Missing value

## 026010

Hours included

## Bit No.

$1 \quad 0100$ included

0100 included 0200 included 0300 included 0400 included 0500 included 0600 included 0700 included 0800 included 0900 included 1000 included 1100 included 1200 included 1300 included 1400 included 1500 included 1600 included 1700 included 1800 included 1900 included 2000 included 2100 included 2200 included 2300 included 2400 included Unknown mixture of hours Missing value

## 029001

## Projection type

| Code figure |  |
| :---: | :--- |
| 0 | Gnomonic projection |
| 1 | Polar stereographic projection |
| 2 | Lambert's conformal conic projection |
| 3 | Mercator's projection |
| 4 | Scanning cone (radar)* |
| $5-6$ | Reserved |
| 7 | Missing value |

* Projection type 4 indicates a Cartesian grid placed directly on the scanning cone defined by the azimuthal sweep of the radar.

|  |  |
| :---: | :--- |
|  |  |
| Code figure |  |
| 0 | Cartesian |
| 1 | Polar |
| 2 | Other |
| $3-6$ | Reserved |
| 7 | Missing value |


|  |  |
| :---: | :--- |
|  |  |
| Code figure |  |
| 0 | PPI |
| 1 | Composite |
| 2 | CAPPI |
| 3 | Vertical section |
| 4 | Alphanumeric data |
| 5 | Map of subject clutter |
| 6 | Map |
| 7 | Test picture |
| 8 | Comments |
| 9 | Map of ground occultation |
| 10 | Map of radar beam height |
| $11-13$ | Reserved |
| 14 | Other |
| 15 | Missing value |

030031
Picture type

030032
Combination with other data

## Bit No.

1 Map

9-14 Reserved

All 16

Lightning data
Map
Satellite IR
Satellite VIS
Satellite WV
Satellite multispectral
Synoptic observations
Forecast parameters

Other data
Missing value

## 031021 <br> Associated field significance

| Code figure |  |  |
| :---: | :---: | :---: |
| 0 | PPI |  |
| 0 | Reserved |  |
| 1 | 1-bit indicator of quality | 0 = good |
|  |  | 1 = suspect or bad |
| 2 | 2-bit indicator of quality | 0 = good |
|  |  | 1 = slightly suspect |
|  |  | 2 = highly suspect |
|  |  | 3 = bad |
| 3-5 | Reserved |  |
| 6 | Quality control flag according to GTSPP |  |
|  | 0 = Unqualified |  |
|  | 1 = Correct value (all checks passed) |  |
|  | $\mathbf{2}$ = Probably good but value inconsistent with statistics (differ from climatology) |  |
|  | 3 = Probably bad (spike, gradient, ... if other tests passed) |  |
|  | 4 = Bad value, impossible value (out of scale, vertical instability, constant profile) |  |
|  | 5 = Value modified during quality control |  |
|  | 6-7 = Not used (reserved) |  |
|  | 8 = Interpolated value |  |
|  | 9 = Missing value |  |
| 7 | Percentage confidence |  |
| 8-20 | Reserved |  |
| 21 | 1-bit indicator of correction | 0 = original value |
|  | (see Note 2) | 1 = substituted/corrected value |
| 22-62 | Reserved for local use |  |
| 63 | Missing value |  |

Notes:
(1) Associated field significance shall be used initially in conjunction with the quality of observed data.
(2) The code figure 21 may be used within corrected messages with the substituted/corrected values identified.
(3) Further applications may be developed.

## 031031 <br> Data present indicator

| Bit No. | Value |  |
| :---: | :---: | :--- |
| 1 | 0 | Data present |
|  | 1 | Data not present |

# 033002 <br> Quality information 

Code figure
0 Data not suspect
1 Data suspect
2
3
Reserved
Quality information not given

# 033003 <br> Quality information 

Code figure
0 Data not suspect
1 Data slightly suspect
2 Data highly suspect
3 Data considered unfit for use
4-6 Reserved
7 Quality information not given

|  | Quality control indication of following value <br>  <br>  <br> Code figure <br> 0 |
| :---: | :--- |
| 1 | Good |
| 1 | Inconsistent |
| 2 | Doubtful |
| 3 | Wrong |
| 4 | Not checked |
| 5 | Has been changed |
| 6 | Reserved |
| 7 | Missing value |

# 033021 <br> Quality of following value 

Code figure
$0 \quad$ Within limits
1 Outside limits

## Reserved

Missing value

## 033022 <br> Quality of buoy satellite transmission

Code figure
Good (several identical reports have been received)
Dubious (no identical reports have been received)
Reserved
Missing value

## 033023 <br> Quality of buoy location

Code figure
$0 \quad$ Reliable (location was made over two satellite passes)
1 Latest known (no location over the corresponding pass)
2
3
Dubious (location made over one pass only; a second solution is possible in 5 per cent of the cases)
Missing value

## 033024

## Station elevation quality mark (for mobile stations)

Code figure
Reserved
Excellent - within 3 metres
Good - within 10 metres
Fair - within 20 metres
Poor - more than 20 metres
Excellent - within 10 feet
Good - within 30 feet
Fair - within 60 feet
Poor - more than 60 feet
9-14
Reserved
15 Missing value

## 033025 <br> ACARS interpolated values

Code figure
$0 \quad$ Time interpolated, latitude and longitude reported

## 033026 <br> Moisture quality

Code figure

Reserved
63
Normal operations - measurement mode
Normal operations - non-measurement mode

## Small RH

Humidity element is wet
Humidity element contaminated
Heater fail
Heater fail and wet/contaminated humidity element
At least one of the input parameters used in the calculation of mixing ratio is invalid
Numeric error

Missing value

033027
Location quality class (range of radius of 66\% confidence)
Code figure
Radius $\geq 1500$ m
$500 \mathrm{~m} \leq$ Radius < $\mathbf{1 5 0 0} \mathbf{m}$
$250 \mathrm{~m} \leq$ Radius < 500 m
Radius < $\mathbf{2 5 0} \mathbf{m}$
3
Reserved
Missing value

## 033030 <br> Scan line status flags for ATOVS

Bit No.
1 Do not use scan for product generation
2
3
4
5
6
7
Time sequence error detected with this scan
Data gap precedes this scan
No calibration
No Earth location
First good time following a clock update

8-23
Instrument status changed with this scan
Reserved
All 24 Missing value

Note: If bit is set to 1 then statement is true.

## 033031 <br> Scan line quality flags for ATOVS

## Bit No.

1 Time field is bad but can probably be inferred from the previous good time

2
3

4
5
6

7
8
9
10
11
12
13
14
15
16
17

## 18

19

## 20

21
22-23
All 24


 Time field is bad and can't be inferred from the previous good time
This record starts a sequence that is inconsistent with previous times (i. e. there is a time discontinuity). This may or may not be associated with a spacecraft clock update (see scan line status flags for ATOVS)
Start of a sequence that apparently repeats scan times that have been previously accepted
Scan line was not calibrated because of bad time
Scan line was calibrated using fewer than the preferred number of scan lines because of proximaty to start or end of data or to a data gap
Scan line was not calibrated because of bad or insufficient PRT data
Scan line was calibrated but with marginal PRT data
Some uncalibrated channels on this scan
Uncalibrated due to instrument mode
Questionable calibration because of antenna position error of space view
Questionable calibration because of antenna position error of black body
Not Earth located because of bad time
Earth location questionable because of questionable time code (see time problem code
bits)

Earth location questionable - only marginal agreement with reasonableness check
Earth location questionable - fails reasonableness check
Earth location questionable because of antenna position check
Scan line calibration cold black body
Scan line calibration warm black body
Scan line calibration space view

## Earth view

Reserved
Missing value

## (Code table 033031 - continued)

Notes:
(1) If bit is set to 1 then statement is true.
(2) Bits 1-4 represent time problem code. All bits off implies the scan time is as expected.
(3) Bits 5-10 represent calibration problem code. All bits set to zero indicated normal calibration. Where any of bits 5, 7, 10 are set, secondary calibration coefficients have been used.
(4) Bits 11-17 represent Earth location problem code. All bits set to zero implies the Earth location was normal.

## 033032 <br> Channel quality flags for ATOVS

| Bit No. |  |
| :---: | :--- |
| 1 | No good blackbody counts for scan line |
| 2 | No good space view counts for this line |
| 3 | No good PRTs for this line |
| 4 | Some bad blackbody view counts for this line |
| 5 | Some bad space view counts for this line |
| 6 | Some bad PRT temps on this line |
| $7-23$ | Reserved (bits set to zero) |
| All 24 | Missing value |

Note: All bits off implies a good calibration.

## 033033

Field of view quality flags for ATOVS
Bit No.
1 Set if secondary calibration used
2-21 Bit $\mathbf{n}$ set to 1 if brightness temperature in channel $\mathbf{n - 1}$ is physically unreasonable or has not been calculated due to calibration problems
22 Set if all the channels are missing
23 Suspect
All 24 Missing value
Notes:
(1) All bits off implies a good calibration.
(2) Bits 2-21 used for HIRS, but only bits 2-16 used for AMSU-A and only bits 2-6 used for AMSU-B.

## 033035 <br> Manual/automatic quality control

Code figure
$0 \quad$ Automatic quality control passed and not manually checked

## 033037

## Wind correlation error

## Bit No.

| 1 | U departure from guess |
| :---: | :--- |
| 2 | V departure from guess |
| 3 | U and V departure from guess |
| 4 | U acceleration |
| 5 | V acceleration |
| 6 | U and V acceleration |
| 7 | Possible land feature |
| 8 | U acceleration and possible land feature |
| 9 | V acceleration and possible land feature |
| 10 | U and V acceleration and possible land feature |
| 11 | Bad wind guess |
| 12 | Correlation failure |
| 13 | Search box off edge of area |
| 14 | Target box off edge of area |
| 15 | Pixel brightness out of bounds (noisy line) |
| 16 | Target outside of latitude/longitude box |
| 17 | Target outside of pressure minimum/maximum |
| 18 | Autoeditor flagged slow vector |
| 19 | Autoeditor flagged vectors |
| All 20 | Missing value |

## 033041 <br> Attribute of following value

Code figure
The following value is the true value
1 The following value is higher than the true value the measurement hit the lower limit of the instrument)
2 The following value is lower than the true value (the measurement hit the higher limit of the instrument)
3
Missing value

## (Code table 033041 - continued)

Note: This descriptor will be associated with visibility data or height of cloud data to specify if the value is bounded. If the reported data is the true value, the code figure is 0 . However, the measurement can hit the limit of the instrument measurement capability. If the reported value is higher than the true value, the code figure is 1 ; if the reported value is lower than the true value, the code figure is 2 .

## 035000 <br> FM and Regional Code number

| Code figure <br> $000-099$ |  |
| :---: | :--- |
| International FM Codes |  |
| 100-199 | RA I Codes |
| 300-299 | RA II Codes |
| $400-499$ | RA III Codes |
| $500-599$ | RA IV Codes |
| $600-699$ | RA V CI Codes |
| $700-799$ | Antarctic Codes |
| $800-999$ | Reserved |
| $1000-1022$ | Not used |
| 1023 | Missing value |

## 035001

Time-frame for monitoring
Code figure
Real time
Near-real time
Non-real time
Reserved
Reserved
Reserved
Reserved
Missing value

## 035030

Discrepancies in the availability of expected data
Code figure
No discrepancies
1

2
3
4
5
6
7
8
9-14
15
Non-compliance with standard and recommended practices and procedures including those of monitoring
Catalogues of meteorological bulletins not updated in a timely manner Incorrect routeing directories
Lack of flexibility in the routeing arrangements
Deficiencies in the operation of GTS centres and circuits
Loss of data or delays in relaying data on the GTS
Routeing of data different from the routeing provided in the plan Various malpractices
Reserved
Missing value

## 035031 <br> Qualifier on monitoring results

Code figure
1 Sufficient and all of acceptable quality

Sufficient but partly of acceptable quality Insufficient but all of acceptable quality Insufficient and of unac ceptable quality Some messages not complete Suspect or wrongly coded groups could not be interpreted confidently Gross coding errors
Transmission sequential order not observed
Report completely garbled and thus discarded
Deficiencies identified and rectified
Deficiencies identified but not rectified
Deficiencies not identified
Measuring errors
Mutual inconsistency
Temporal inconsistency
Forecast error
Bias
Improve system of quality control
Expand training programmes
20-98 Reserved
99-122
Not used
Missing value

## 035032 <br> Cause of missing data

Code figure
1 Data groups missing due to radio fading
2 Data groups missing due to outage of centre

9 Some observing programmes ceased
10-14 Not used
15

# 035033 <br> Observation and collection deficiency 

Code figure
1 No deficiency
Observations not made regularly
Observations not made at right time
Observations made but not disseminated
Observations made and sent to incorrect users
Collection not received
Collection transmitted late
Collection not transmitted
Difficulties in HF propagation and selection of suitable frequency
Difficulties in maintenance of communication equipment at remote stations
No alternative arrangement for routeing meteorological observation

Not used
123 Missing value

## 035034

Statistical trends for availability of data (during the survey period(s))

## Code figure

1 Slight improvement

## ATTAC HMENT

## DEFINITION OF FM 94 BUFR USING BACKUS－NAUR FORM

## 1．INTRODUCTION

The Backus－Naur Form（BNF）is a powerful and unambiguous means of defining a representation form． The notation used is as follows：

```
<lower case letters>
<UPPER CASE LETTERS>
::=
<entity>
<entity 1\rangle\langleentity 2\rangle
<---><<-->
<--\rangle(n)
\langle-->0
\langle-- ->*
<--\rangle+
an entity defined to be comprised of other entities
an "atomic" or "terminal" entity, not defined in terms of
other entities
is comprised of
specific occurrence of an entity
entity 1 followed by entity 2
alternative entities
exactly n occurrences
optional entity (zero or one)
zero or more occurrences
one or more occurrences
```


## 2．DEFINITION OF FM 94 BUFR

In the following，BNF is used to define BUFR from a＂top down＂approach．

## 2．1 BUFR message

| 〈BUFR message〉 | $::=$ |
| ---: | :--- |
|  | 〈indicator section〉 |
|  | 〈identification section〉 |
|  | 〈optional section〉o |
|  | 〈data description section〉 |
|  | 〈data section〉 |
|  | 〈END OF BUFR MESSAGE〉 |
| 〈END OF BUFR MESSAGE〉 | $::=$ |
| string＂7777＂ |  |

## 2．2 Indicator section

| $\langle$ indicator section〉 | $::=$ | $\langle$ START OF BUFR MESSAGE〉 |
| :--- | ---: | :--- |
|  | 〈total length of BUFR message〉 |  |
|  | 〈BUFR edition number〉 |  |

## 2．3 Identification section

〈identification section〉
〈LENGTH OF SECTION〉

〈BUFR MASTER TABLE〉
〈originating centre number〉
〈UPDATE SEQUENCE NUMBER〉

〈OPTIONAL SECTION FLAG〉

〈RESERVED FLAG〉
〈BUFR DATA CATEGORY〉

〈BUFR DATA SUB－CATEGORY〉

〈version number of master table used〉
〈version number of local tables used〉
〈YEAR OF CENTURY〉
〈MONTH〉
〈DAY〉
〈HOUR〉
〈MINUTE〉
＜optional part＞
〈PADDING〉

## 2．4 Optional section

〈optional section〉
 section length is a multiple of 2 octets

```
::=\langleLENGTH OF SECTION\rangle
    <RESERVED OCTET〉
    <entity for local use by ADP centres>
    <PADDING>*
```

〈RESERVED OCTET〉
〈entity for local use by ADP centres〉

## 2．5 Data description section

| 〈data description section＞ | ：：＝〈LENGTH OF SECTION〉 <br> 〈RESERVED OCTET〉 <br> 〈NUMBER OF DATA SUBSETS〉 <br> 〈description section flags〉 <br> 〈subset data description〉 |
| :---: | :---: |
| 〈NUMBER OF DATA SUBSETS〉 | $::=16$－bit unsigned integer indicating the number of subsets of data contained in the BUFR message |
| ＜description section flags〉 | $::=\langle O B S E R V E D$ DATA FLAG〉〈COMPRESSED DATA FLAG〉〈RESERVED FLAG〉（6） |
| 〈OBSERVED DATA FLAG〉 | ：：＝1－bit flag -1 indicates oberved data； 0 indicates other data |
| 〈COMPRESSED DATA FLAG〉 | ：：＝1－bit flag -1 indicates compressed data； 0 indicates non－compressed data |
| ＜RESERVED FLAG〉 | $::=6$－bit flag－reserved for future use（set to 0） |
| 〈subset data description〉 | ：：＝＜descriptor＞＋ |
| 〈descriptor〉 | ：：＝〈element descriptor〉｜〈replication descriptor〉｜〈operator descriptor〉｜〈sequence descriptor〉 |
| 〈element descriptor〉 | ：：＝＜table b reference〉 |
| 〈replication descriptor〉 | $::=\langle D E S C R I P T O R$ CODE $\rangle$ <br> 〈REPLICATION SCOPE〉 <br> 〈NUMBER OF REPLICATIONS〉 <br> 〈table b reference〉 0 |
| 〈DESCRIPTOR CODE〉 | $::=2$－bit unsigned integer defining the descriptor type <br> －value 1 |
| 〈REPLICATION SCOPE〉 | $::=6$－bit unsigned integer defining the number of subsequent descriptors to be replicated |
| 〈NUMBER OF REPLICATIONS〉 | $::=8$－bit unsigned integer defining the number of times the descriptors within the scope are to be replicated－if 0 ，the next element descriptor relates to a data item containing the number of replications |
| ＜operator descriptor＞ | ：：＝＜table c reference＞ |
| 〈data description operator〉 | ：：＝〈replication descriptor〉｜〈replication descriptor〉〈element descriptor〉｜〈operator descriptor〉｜〈operator descriptor〉〈element descriptor〉 |
| 〈sequence descriptor〉 | ：：＝〈table d reference〉 |

## 2．6 BUFR Table B

| ＜table b） | ：：＝〈table b entry＞＋ |
| :---: | :---: |
| ＜table b entry＞ | ：：＝〈table b reference〉 |
|  | 〈ELEMENT NAME〉 |
|  | 〈UNITS NAME〉 |
|  | 〈UNITS SCALE SIGN〉 |
|  | 〈UNITS SCALE〉 |
|  | 〈UNITS REFERENCE SIGN〉 |
|  | 〈UNITS REFERENCE VALUE〉 |
|  | 〈ELEMENT DATA WIDTH〉 |
| 〈table b reference〉 | ：：＝＜DESCRIPTOR CODE〉 |
|  | 〈CLASS NUMBER〉 |
|  | 〈ELEMENT NUMBER〉 |
| 〈DESCRIPTOR CODE〉 | $::=2$－bit unsigned integer－value 0 |
| 〈CLASS NUMBER〉 | $::=6$－bit unsigned integer－indicating table $b$ class |
| 〈ELEMENT NUMBER〉 | $::=8$－bit unsigned integer－indicating table $b$ element |
| 〈ELEMENT NAME〉 | $::=$ 〈first line of element name〉〈second line of element name〉 |
| 〈first line of element name〉 | $::=$ first 32 characters of element name |
| 〈second line of element name〉 | ：：＝next 32 characters of element name |
| 〈UNITS NAME〉 | $::=24$－character name of SI units used：entered as ＂CODE TABLE＂if data values reference to a code； as＂FLAG TABLE＂if values reference to a flag；as ＂NUMERIC＂if values are non－dimensional；as ＂CCITT IA5＂if values are characters |
| 〈UNITS SCALE SIGN〉 | $::=1$－bit sign of units scale value（ $0=$ positive $)$ |
| 〈UNITS SCALE〉 | $::=7$－bit unsigned integer giving the power of 10 by which the original data element in the units given by〈UNITS NAME〉 is to be multiplied to give the value found in the BUFR message |
| 〈UNITS REFERENCE SIGN〉 | $::=1$－bit sign of units reference value（ $0=$ positive $)$ |
| 〈UNITS REFERENCE VALUE〉 | $::=31$－bit unsigned integer containing the data element reference value，scaled according to the units scale |
| 〈ELEMENT DATA WIDTH〉 | $::=8$－bit unsigned integer indicating data width in bits |

## 2．7 BUFR Table C

| ＜table c＞ | ：：＝〈table c entry ${ }^{+}$ |
| :---: | :---: |
| ＜table c entry＞ | ：：＝〈table c reference〉 |
|  | 〈OPERAND＞ |
|  | 〈OPERATOR NAME〉 |
|  | 〈OPERATION DEFINITION〉 |
| 〈table c reference〉 | ：：＝＜DESCRIPTOR CODE〉 |
|  | 〈OPERATION CODE〉 |
| 〈DESCRIPTOR CODE〉 | ：：＝2－bit unsigned integer－value 2 |

〈OPERATION CODE〉

〈OPERAND〉 $::=8$－bit unsigned integer value，to be used as an

〈OPERATOR NAME〉
〈OPERATION DEFINITION〉
operand as indicated by the operation definition
$::=6$－bit unsigned integer indicating the intended operation
：：＝40－character operator name
$::=$ rules defining the operation to be performed

## 2．8 BUFR Table D

＜table d〉
〈table d entry〉

〈table d reference〉

〈DESCRIPTOR CODE〉
〈CATEGORY NUMBER〉
〈SEQUENCE NUMBER〉
：：＝〈table d entry〉＋
：：＝〈table d reference〉
〈descriptor〉 〈descriptor〉＋
：：＝〈DESCRIPTOR CODE〉
〈CATEGORY NUMBER〉
〈SEQUENCE NUMBER〉
$::=2$－bit unsigned integer－value 3
$::=6$－bit unsigned integer indicating table d category
$::=8$－bit unsigned integer indicating table $d$ sequence list

## 2．9 Data section

〈data section〉
：：＝〈LENGTH OF SECTION〉
〈RESERVED OCTET〉
〈binary data as defined by sequence descriptors〉
〈PADDING〉＊

## 3．DEFINITION OF EXCHANGE FORMS FOR BUFR TABLES

3．1 Format for international exchange of Table B
＜table b〉
〈table b entry〉
：：＝〈table b entry〉＋
：：＝〈DESCRIPTOR FLAG〉
〈CLASS NUMBER〉
〈ELEMENT NUMBER〉
〈ELEMENT NAME LINE 1〉
〈ELEMENT NAME LINE 2〉
〈UNITS NAME〉
〈UNITS SCALE SIGN〉
〈UNITS SCALE〉
〈UNITS REFERENCE SIGN〉
〈UNITS REFERENCE VALUE〉
〈ELEMENT DATA WIDTH〉
〈DESCRIPTOR FLAG〉
〈CLASS NUMBER〉
：：＝1－digit integer as 1 character
$::=2$－digit integer as 2 characters

| 〈ELEMENT NUMBER〉 | $::=3$－digit integer as 3 characters |
| :---: | :---: |
| 〈ELEMENT NAME LINE 1〉 | $::=$ Line 1 of name as 32 characters |
| 〈ELEMENT NAME LINE 2＞ | $::=$ Line 2 of name as 32 characters |
| 〈UNITS NAME〉 | $::=$ units in 24 characters，or＂CODE TABLE＂，＂FLAG TABLE＂，＂NUMERIC＂or＂CCITT IA5＂ |
| 〈UNITS SCALE SIGN〉 | $::=$ sign of units scale as 1 character |
| 〈UNITS SCALE〉 | $::=3$－digit unsigned integer as 3 characters giving the power of 10 by which the original data element in the units given by 〈UNITS NAME〉 is to be multiplied to give the value found in the BUFR message |
| 〈UNITS REFERENCE SIGN〉 | $::=$ sign of units reference value as 1 character |
| 〈UNITS REFERENCE VALUE〉 | $::=10$－digit unsigned integer as 10 characters |
| 〈ELEMENT DATA WIDTH〉 | ：：＝3－digit unsigned integer as 3 characters |

Notes：
（1）All characters shall be represented as upper case characters using CCITT IA5（International Alphabet No．5）．
（2）FORTRAN notation shall be used to represent units；thus $\mathrm{m}^{2} \mathrm{~s}^{-2}$ will be represented as $\mathrm{M}^{*} 2 / S^{*} 2$ ，etc．
（3）Each table b entry shall be represented using 95 characters．

## 3．2 Format for international exchange of Table D

〈Table d〉
〈Table d entry〉

〈F DESCRIPTOR〉
〈X DESCRIPTOR〉
〈Y DESCRIPTOR〉
〈SEQUENCE DESCRIPTOR〉

```
::=\langleTable d entry\rangle+
::= <F DESCRIPTOR\rangle
    <X DESCRIPTOR>
    〈Y DESCRIPTOR`
    <SEQUENCE DESCRIPTOR〉*
::= 1-digit integer F descriptor as 1 character
::= 2-digit integer X descriptor as 2 characters
::= 3-digit integer Y descriptor as 3 characters
::= 6-digit integer table reference as 6 characters
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[^0]:    * The ET/DR\&C and the OPAG/ISS are, in the year 2000, the current bodies dealing with data representation and codes within CBS. If they were replaced by other bodies performing the same function, the same rules would apply, by replacing the means of the entities approximately.

[^1]:    * The ETA vertical coordinate system involves normalizing the pressure at some point on a specific level by the mean sea level pressure at that point.

[^2]:    * Descriptor 001027 should be used instead of 001026 to encode this element.

[^3]:    * Descriptor 002152 should be used instead of 002021 for encoding this element.

[^4]:    * This constant is defined as follows: $\mathbf{Z}=\mathbf{P}+$ radar constant where $Z=$ the reflectivity of target in beam direction (dBZ);

[^5]:    Notes: required), followed by period for averaging or accumulation
    (3) Time periods or displacements and time increments require an initial time location to be defined prior to their use, followed where appropriate by a time
    (4) The time location, when used with forecast values, shall indicate the time of the initial state for the forecast, or the beginning of the forecast period; when used with ensemble means of forecast values, the time location shall indicate the initial state or the beginning of the first forecast over which ensemble means are derived.
    (5) Negative time periods or displacements shall be used to indicate time periods or displacements preceding the currently defined time. (6) Descriptor 004041 has been replaced by the combination of 008025 and 026003 and should not be used for encoding this element. (7) All times are Universal Time Coordinated (UTC) unless otherwise noted.

[^6]:    Notes:
    (1) Values of latitude and latitude increments are limited to the range -90 degrees to +90 degrees.
    (2) South latitude shall be assigned negative values.
    (3) North to south increments shall be assigned negative values.
    (4) Bearing or azimuth shall only be used with respect to a stated location, and shall not redefine that location.
    (5) The Pixel size on horizontal - 1 is given at location where map scale factor is unity.

[^7]:    Notes:
    (1) Values of longitude are limited to the range -180 degrees to +180 degrees
    (2) West longitude shall be assigned negative values.
    (3) East to west increments shall be assigned negative values.
    (4) Distance shall only be used with respect to a stated location and a bearing, azimuth or elevation; it shall not redefine that location.
    (5) The Pixel size on horizontal - 2 is given at location where map scale factor is unity.

[^8]:    (for example over a time period) the total number of values from which the accumulated or averaged values are obtained may be represented using reference 008022
    (2) A previously defined significance may be cancelled by transmitting a "missing" from the appropriate code or flag table.
    (3) First-order statistics have values with a similar range and the same dimensions as the corresponding reported values (e.g., maxima, minima, means, etc.).

[^9]:    (1) Vertic al elements and pressure shall be used to define values of these elements independent of the element or variable denoting the vertical coordinate. (2) The value for descriptor 010031 has been chosen to be suitable for polar orbiting satellites in approximately Sun-synchronous orbits. Geostationary orbits would require greater data widths for distance and slightly less for speed.
    (3) Left handed $\mathrm{x}, \mathrm{y}$ and z axes have been chosen for descriptor 010031 .

[^10]:    A precipitation value of $\mathbf{- 0 . 1} \mathrm{kg} \mathrm{m}^{-2}$ before scaling ( -1 after scaling or in CREX) shall indicate a "trace" (non-measurable, less than $0.05 \mathrm{~kg} \mathrm{~m}^{\mathbf{- 2}}$ ). (2) A snow depth value of $\mathbf{- 0 . 0 1} \mathbf{m}$ before scaling ( -1 after scaling or in CREX) shall indicate a little (less than 0.005 m ) snow. A value of $-0.02 \mathrm{~m}(-2$ after scaling or in CREX) shall indic ate "snow cover not continuous".

[^11]:    * The meaning of these quantities may be obtained from the originator of the data.

[^12]:    Note: 025014 nominal input range 0-2300.

[^13]:    (1) The alternate latitude may be used when the computation of the position yields multiple solutions and there is no a priori way to distinguish between them. (2) The satellite location counter is calculated as:
    counter $=$ superswath no. x $1000+$ box no. $\times 10+$ minibox no.
    (3) The satellite sublocation dimension is calculated as:
    4) The value for descriptor 027031 has been chosen to be suitable for polar orbiting satellites in approximately Sun-synchronous orbits. Geostationary orbits would require greater data widths for distance and slightly less for speed.
    (5) Left handed $x, y$ and $z$ axes have been chosen for descriptor 027031 .

[^14]:    * Descriptor 301002 should not be used.

[^15]:    *Descriptor 301055 should be used instead of 301035 to encode moving buoy/platform information.

[^16]:    * The expression "at the station" refers to a land station or a ship.
    ** Tornado cloud or water-spout.

[^17]:    * Hail, small hail, snow pellets.

[^18]:    * Hail, small hail, snow pellets.

[^19]:    * Hail, small hail, snow pellets.

[^20]:    * "Bad weather" denotes the conditions which generally exist during precipitation and a short time before and after.

