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:

SECTION 0		Indicator section
SECTION 1		Product definition section
SECTION 2	(	Grid description section)
SECTION 3	(	Bit-map section)
SECTION 4		Binary data section
SECTION 5		7777

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	"GRIB", length of message, GRIB edition number
1	Product definition section	Length of section, identification 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.

R E G U L A T I O N S :

92.1 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 indicators 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 **Section 0 shall always be 8 octets long.**

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.

92.6 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.

92.6.3 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:

$$Y \times 10^{D} = R + (X_i + X_j) \times 2^{E}$$

92.6.4 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:

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

92.7 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)
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 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
17	Minute
	(Octets 13–17:) Reference time of data – date and time of start of averaging or accumulation period
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	N – Number included in calculation when octet 21 (Code table 5) refers to a statistical process, such as average or accumulation; otherwise set to zero
24	Number missing from calculation in case of statistical process
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 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 100 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 1 January 2000 is the first day of the hundredth year of the twentieth century and the date of 1 January 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 × 4 octets); if present, then PL = 4NV + PV
PL	List of numbers of points in each row (length = NROWS x 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	La1 – latitude of first grid point
14–16	Lo1 – longitude of first grid point
17	Resolution and component flags (see Code table 7)
18–20	La2 – latitude of last grid point
21–23	Lo2 – 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)
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, θ_p for example;

(b) The geographic longitude in degrees of the southern pole of the coordinate system, λ_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 λ_p degrees about the geographic polar axis, and then rotating through (90 + θ_p) 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 λ and latitude θ^1, where:

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

and λ and θ 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 Dj (octets 26–27) 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	La1 – latitude of first grid point
14–16	Lo1 – longitude of first grid point
17	Resolution and component flags (see Code table 7)
18–20	La2 – latitude of last grid point
21–23	Lo2 – 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)

Octet No.	Contents
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 0–90 000; 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 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 I.2 – Bi — 8.

(8) Quasi-regular Gaussian latitude/longitude grids are defined only for subsets of global grids containing full latitude rows (360°).

(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.**

Grid definition – spherical harmonic coefficients (including rotated, stretched or stretched and rotated)

Octet No.	Contents
7–8	J – pentagonal resolution parameter
9–10	K – pentagonal resolution parameter
11–12	M – pentagonal resolution parameter
13	Representation type (see Code table 9)
14	Representation mode (see Code table 10)
15–32	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) 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 I.2 – Bi — 8.

Grid definition – polar stereographic

Octet No.	Contents
7–8	Nx – number of points along x-axis
9–10	Ny – number of points along y-axis
11–13	La1 – latitude of first grid point
14–16	Lo1 – longitude of first grid point
17	Resolution and component flags (see Code table 7)
18–20	LoV – orientation of the grid; i.e. 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)
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 0–90 000; bit 1 is set to 1 to indicate south latitude.

(4) Longitude values are limited to the range 0–360 000; 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 I.2 – Bi — 8.

(8) The resolution flag (bit 1 of Code table 7) is not applicable.

Grid definition – Mercator

Octet No.	Contents
7–8	Ni – number of points along a parallel
9–10	Nj – number of points along a meridian
11–13	La1 – latitude of first grid point
14–16	Lo1 – longitude of first grid point
17	Resolution and component flags (see Code table 7)
18–20	La2 – latitude of last grid point
21–23	Lo2 – 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	Di – longitudinal direction grid length (see Note 2)
32–34	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 0–90 000; bit 1 is set to 1 to indicate south latitude.

(4) Longitude values are limited to the range 0–360 000; 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 definition – 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	Nx – number of points along x-axis
9–10	Ny – number of points along y-axis
11–13	La1 – latitude of first grid point
14–16	Lo1– 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) Latitude and longitude are in millidegrees (thousandths of a degree).

(2) Grid lengths are in units of metres, at the secant cone intersection parallel nearest to the pole on the projection plane.

(3) Latitude values are limited to the range 0–90 000; bit 1 is set to 1 to indicate south latitude.

(4) Longitude values are limited to the range 0–360 000; 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
bit 2 set to 0 if only one projection centre is used
bit 2 set to 1 if projection is bi-polar and symmetric.

(6) If Latin 1 = Latin 2, then the projection is on a tangent cone.

(7) The resolution flag (bit 1 of Code table 7) is not applicable.

Grid definition – Space view perspective or orthographic

Octet No.	Contents
7–8	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	dx – apparent diameter of Earth in grid lengths, in x-direction
21–23	dy – apparent diameter of Earth in grid lengths, in y-direction
24–25	Xp – x-coordinate of sub-satellite point
26–27	Yp – 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	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	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°E if the sub-satellite point is the North Pole; or the meridian 0° if the sub-satellite point is the South Pole.

(4) The apparent angular size of the Earth will be given by 2 x Arcsin (1/Nr).

(5) The horizontal and vertical angular resolutions of the sensor (Rx and Ry), needed for navigation equations, can be calculated from the following:

Rx = 2 x Arcsin (1/Nr) / dx
Ry = 2 x Arcsin (1/Nr) / dy

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: 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
7–	The bit-map – contiguous bits with a bit to data point correspondence, ordered as defined 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

Note: 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 P2 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 $W2_j$:

- (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 $W2_1$;
- (b) If bit 8 of the extended flags (Code table 11) is 1, P1 values of the widths of second-order packed values ($W2_j$, j = 1..P1) 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 bit-map, 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:

$$Y \times 10^D = R + (X_i + X_j) \times 2^E$$

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 $W2_j$, 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 $R + (X_i \times 2^E)$. 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	IP (where IP = int (1000 x P))
16	J^1
17	K^1
18	M^1
19	Binary data
. . .	Unpacked binary data represented in 004 octets in the same way as the reference value (pairs of coefficients)
N	Packed binary data

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, J^1, K^1, M^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 ∇^{2P} of the field, where ∇^2 is the Laplacian operator. Thus the coefficients ϕ_n^m will be multiplied by $(n(n+1))^P$ 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)

(J^1, K^1, M^1 > 0 and P 0, + or –)

The representation mode (Code figure = 2 in Code table 10) in Section 2 shall indicate this type of packing, but as Section 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 table 2 – *Indicator of parameter*

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^2 kg^{-1} s^{-1}
005	ICAO Standard Atmosphere reference height	m
006	Geopotential	m^2 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 500 hPa)	K
025	Temperature anomaly	K

(continued)

(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	$m\ s^{-1}$
035	Stream function	$m^2\ s^{-1}$
036	Velocity potential	$m^2\ s^{-1}$
037	Montgomery stream function	$m^2\ s^{-2}$
038	Sigma coordinate vertical velocity	s^{-1}
039	Vertical velocity	$Pa\ s^{-1}$
040	Vertical velocity	$m\ s^{-1}$
041	Absolute vorticity	s^{-1}
042	Absolute divergence	s^{-1}
043	Relative vorticity	s^{-1}
044	Relative divergence	s^{-1}
045	Vertical u-component shear	s^{-1}
046	Vertical v-component shear	s^{-1}
047	Direction of current	Degree true
048	Speed of current	$m\ s^{-1}$
049	u-component of current	$m\ s^{-1}$
050	v-component of current	$m\ s^{-1}$
051	Specific humidity	$kg\ kg^{-1}$
052	Relative humidity	%
053	Humidity mixing ratio	$kg\ kg^{-1}$
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	$kg\ m^{-2}\ s^{-1}$
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	$kg\ m^{-2}\ s^{-1}$
065	Water equivalent of accumulated snow depth	$kg\ m^{-2}$
066	Snow depth	m
067	Mixed layer depth	m
068	Transient thermocline depth	m
069	Main thermocline depth	m
070	Main thermocline anomaly	m

(continued)

(Code table 2 – continued)

Code figure	Field parameter	Unit
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 500 hPa)	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^{-2}
087	Vegetation	%
088	Salinity	kg kg^{-1}
089	Density	kg 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	m s^{-1}
096	v-component of ice drift	m s^{-1}
097	Ice growth rate	m s^{-1}
098	Ice divergence	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	s
107	Primary wave direction	Degree true
108	Primary wave mean period	s
109	Secondary wave direction	Degree true
110	Secondary wave mean period	s
111	Net short-wave radiation flux (surface)	W m^{-2}
112	Net long-wave radiation flux (surface)	W m^{-2}
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}

(continued)

(Code table 2 – continued)

Code figure	Field parameter	Unit
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} sr^{-1}
120	Radiance (with respect to wave length)	W m^{-3} 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	N m^{-2}
125	Momentum flux, v-component	N 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:
- (a) direction and frequency;
- (b) direction and radial number;
- (c) 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*

Note: **For reserved values, or if not defined, octets 11 and 12 shall contain zero.**

Octet 10		Octet 11	Octet 12
Code figure	Meaning	Contents	
00	Reserved		
01	Ground or water surface		
02	Cloud base level		
03	Level of cloud tops		
04	Level of 0°C isotherm		

(continued)

(Code table 3 – continued)

Code figure	Octet 10 Meaning	Octet 11 Contents	Octet 12
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	Temperature in 1/100 K	
21–99	Reserved		
100	Isobaric surface	Pressure in hPa (2 octets)	
101	Layer between two isobaric surfaces	Pressure of top in kPa	Pressure of bottom in kPa
102	Mean sea level		
103	Specified altitude above mean sea level	Altitude in metres (2 octets)	
104	Layer between two specified altitudes above mean sea level	Altitude of top in hm	Altitude of bottom in hm
105	Specified height level above ground	Height in metres (2 octets)	
106	Layer between two specified height levels above ground	Height of top in hm	Height of bottom in hm
107	Sigma level	Sigma value in 1/10 000 (2 octets)	
108	Layer between two sigma levels	Sigma value of top in 1/100	Sigma value of bottom in 1/100
109	Hybrid level	Level number (2 octets)	
110	Layer between two hybrid levels	Level number of top	Level number of bottom
111	Depth below land surface	Depth in centimetres (2 octets)	
112	Layer between two depths below land surface	Depth of upper surface in cm	Depth of lower surface in cm
113	Isentropic (theta) level	Potential temperature in K (2 octets)	
114	Layer between two isentropic levels	475 K minus theta of top in K	475 K minus theta of bottom in K
115	Level at specified pressure difference from ground to level	Pressure difference in hPa (2 octets)	
116	Layer between two levels at specified pressure differences from ground to level	Pressure difference from ground to top level in hPa	Pressure difference from ground to bottom level in hPa
117	Potential vorticity surface	10^{-9} K m^2 kg^{-1} s^{-1}	
118	Reserved		
119	ETA* level	ETA value in 1/10000 (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

(continued)

(Code table 3 – continued)

Code figure	Octet 10 Meaning	Octet 11 Contents	Octet 12 Contents
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 metres (2 octets)	
161–199	Reserved		
200	Entire atmosphere (considered as a single layer)		
201	Entire ocean (considered as a single layer)		
202–209	Reserved		
210	Isobaric surface (high precision)	Pressure in Pa (2 octets)	
211–254	Reserved for local use		
255	Missing		

* 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 – *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	Quarter of an hour
14	Half an hour
15–253	Reserved
254	Second

Code table 5 – *Time range indicator*

Code figure	Meaning
0	Forecast product valid for reference time + P1 (P1 > 0), or Uninitialized analysis product for reference time (P1 = 0), or Image product for reference time (P1 = 0)
1	Initialized analysis product for reference time (P1 = 0)
2	Product with a valid time ranging between reference time + P1 and reference time + P2
3	Average (reference time + P1 to reference time + P2)
4	Accumulation (reference time + P1 to reference time + P2) product considered valid at reference time + P2
5	Difference (reference time + P2 minus reference time + P1) product considered valid at reference time + P2
6	Average (reference time - P1 to reference time - P2)
7	Average (reference time - P1 to reference time + P2)
8–9	Reserved
10	P1 occupies octets 19 and 20; product valid at reference time + P1
11–50	Reserved
51	Climatological mean value: multiple year averages of quantities which are themselves means over some period of time (P2) less than a year. The reference time (R) indicates the date and time of the start of a period of time, given by R to R + P2, over which a mean is formed; N indicates the number of such period-means that are averaged together to form the climatological value, assuming that the N period-mean fields are separated by one year. The reference time indicates the start of the N-year climatology. If P1 = 0 then the data averaged in the basic interval P2 are assumed to be continuous, i.e. all available data are simply averaged together. If P1 = 1 (the unit of time – octet 18, Code table 4 – is not relevant here) then the data averaged together in the basic interval P2 are valid only at the time (hour, minute) given in the reference time, for all the days included in the P2 period. The units of P2 are given by the contents of octet 18 and Code table 4.
52–112	Reserved
113	Average of N forecasts (or initialized analyses); each product has forecast period of P1 (P1 = 0 for initialized analyses); products have reference times at intervals of P2, beginning at the given reference time
114	Accumulation of N forecasts (or initialized analyses); each product has forecast period of P1 (P1 = 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 P1, the remaining forecasts follow at intervals of P2
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 from the previous one by an interval of P2. Thus all the forecasts have the same valid time, given by the initial reference time + P1
118	Temporal variance, or covariance, of N initialized analyses; each product has forecast period of P1 = 0; products have reference times at intervals of P2, 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 P1, the remaining forecasts follow at intervals of P2
120–122	Reserved

(continued)

(Code table 5 – continued)

Code figure	Meaning
123	Average of N uninitialized analyses, starting at the reference time, at intervals of P2
124	Accumulation of N uninitialized analyses, starting at the reference time, at intervals of P2
125	Standard deviation of N forecasts, all with the same reference time with respect to time average of the time tendency of forecasts; the first forecast has a forecast period of P1, the remaining forecasts follow at intervals of P2
126–127	Reserved
128–254	Reserved for local use
255	Missing

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.

(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 + P2; 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, P1 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 + P1 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 P2 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

(continued)

(Code table 6 – continued)

Code figure	Meaning
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
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
	1	Direction increments given
2	0	Earth assumed spherical with radius 6367.47 km
	1	Earth assumed oblate spheroidal with size as determined by IAU in 1965 (6378.160 km, 6356.775 km, f = 1/297.0)
3–4		Reserved
5	0	Resolved u- and v-components of vector quantities relative to easterly and northerly directions
	1	Resolved 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	0	Reserved – set to zero

(continued)

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	Meaning
1	The Associated Legendre Functions of the first kind are defined by:

$$P_n^m(\mu) = \sqrt{(2n+1)\frac{(n-m)!}{(n+m)!}}\ \frac{1}{2^n n!}\ (1-\mu^2)^{m/2}\ \frac{d^{n+m}}{d\mu^{n+m}}\ (\mu^2-1)^n, \ \ m \geq 0,$$

$$P_n^{-m}(\mu) = P_n^m(\mu)$$

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

$$X(\lambda,\mu) = \sum_{m=-m}^{M} \sum_{n=|m|}^{N(m)} X_n^m P_n^m(\mu)\, e^{im\lambda}$$

where λ is the longitude,
μ the sine of latitude,
and X_n^{-m} the complex conjugate of X_n^m.

Code table 10 – *Spectral data representation mode*

Code figure	Meaning
1	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 $\mathrm{Re}(X_n^m)$, $\mathrm{Im}(X_n^m)$ ordered with n increasing from m to N(m), first for m = 0 and then for m = 1, 2, . . . M. 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.
2	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 coefficients
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

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
5		Reserved – set to zero
6	0	Single datum at each grid point
	1	Matrix of values at each grid point
7	0	No secondary bit-maps
	1	Secondary bit-maps present
8	0	Second-order values constant width
	1	Second-order values different widths
9–12		Reserved for future use

Notes:

(1) Bit 4 shall be set to 1 to indicate that bits 5 to 12 are contained in octet 14 of the Binary data section.

(2) Bit 3 shall be set to 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.