**TEMPLATE DEFINITIONS USED IN SECTION 3 (TIME DOMAIN SECTION)**

***Time Domain Section template 3.0 – Point in time***

Byte No. Contents

 21-22 Hours of observational data cut-off after reference time (see Note 1)

 23 Minutes of observational data cut-off after reference time

 24 Indicator of unit of time range (see Code table 3.4)

 25-28 Forecast time in units defined by byte 24

Notes:

(1) Hours greater than 65534 will be coded as 65534.

***Time Domain Section template 3.1 – Continuous or non-continuous time interval***

Byte No. Contents

 21-28 Same as Time Domain Section template 3.0

 29-30 Year

 31 Month

 32 Day Time of end of overall time interval

 33 Hour

 34 Minute

 35 Second

 36 ntr – number of time range specifications describing the time intervals used to calculate the statistically

 processed field

 37–40 Total number of data values missing in statistical process

 ***41–52 Specification of the outermost (or only) time range over which statistical processing is done***

 41 Time statistical process used to calculate the processed field from the field at each time increment during the time range (see Code table 3.5)

 42 Type of time increment between successive fields used in the statistical processing (see Code table 3.6)

 43 Indicator of unit of time for time range over which statistical processing is done (see Code table 3.4)

 44–47 Length of the time range over which statistical processing is done, in units defined by the previous byte

 48 Indicator of unit of time for the increment between the successive fields used (see Code table 3.4)

 49–52 Time increment between successive fields, in units defined by the previous byte (see Notes 3 and 4)

***53–mm These bytes are included only if n > 1, where mm = 53 + 12 x nmax***

41+12x(ni-1) – 53+12x(ni-1) As bytes 41 to 53, next innermost step of processing ni and so on until nmax

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. 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.

**TEMPLATE DEFINITIONS USED IN SECTION 4 (HORIZONTAL DOMAIN SECTION)**

***Grid definition template 4.0 – latitude/longitude (or equidistant cylindrical, or Plate Carrée)***

Byte No. Contents

 15 Shape of the Earth (see Code table 4.1)

 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 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 4.2)

 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 Notes 1 and 5)

 68–71 Dj – j direction increment (see Notes 1 and 5)

 72 Scanning mode (flags – see Flag table 4.3)

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 106 (10–6 degrees unit).

(2) For data on a quasi-regular grid, where all the rows or columns do not necessarily have the same number of grid points, either Ni (bytes 31–34) or Nj (bytes 35–38) and the corresponding Di (bytes 64–67) or Dj (bytes 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 bytes immediately following the grid definition template (bytes [xx+1]–nn), 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 or variable spacing. The first point in each row (column) shall be positioned at the meridian (parallel) indicated by bytes 47–54. The grid points shall be evenly spaced in latitude (longitude).

(4) A scaled value of radius of spherical Earth, or major or minor axis of oblate spheroid Earth is derived from applying the appropriate scale factor to the value expressed in metres.

(5) It is recommended to use unsigned direction increments.

(6) In most cases, multiplying Ni (bytes 31–34) by Nj (bytes 35–38) yields the total number of points in the grid. However, this may not be true if bit 8 of the scanning mode flags (byte 72) is set to 1.

***Grid definition template 4.1 – rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée)***

Byte No. Contents

 15–72 Same as grid definition template 4.0 (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

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 106 (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, θp for example;

(b) The geographic longitude in degrees of the southern pole of the coordinate system, λp 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 λp degrees about the geographic polar axis, and then rotating through (90 + θp) degrees so that the southern pole moved along the (previously rotated) Greenwich meridian.

(3) See Note 3 under grid definition template 4.0.

***Grid definition template 4.2 – stretched latitude/longitude (or equidistant cylindrical, or Plate
 Carrée)***

Byte No. Contents

 15–72 Same as grid definition template 4.0 (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 106 (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 λ and latitude θ1, where:

 (1 – C2) + (1 + C2) sin θ

 θ1 = sin–1

(1 + C2) + (1 – C2) sin θ

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.

(3) See Note 3 under grid definition template 4.0.

***Grid definition template 4.3 – stretched and rotated latitude/longitude (or equidistant cylindrical,
 or Plate Carrée)***

Byte No. Contents

 15–72 Same as grid definition template 4.1 (see Note 1)

 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 106 (10–6 degrees unit).

(2) See Note 2 under grid definition template 4.1 – rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée).

(3) See Note 2 under grid definition template 4.2 – stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée).

(4) See Note 3 under grid definition template 4.0.

***Grid definition template 4.10 – Mercator***

Byte No. Contents

 15 Shape of the Earth (see Code table 4.1)

 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 4.2)

 48–51 LaD – latitude(s) at which the Mercator projection intersects the Earth (Latitude(s) where Di
 and Dj are specified)

 52–55 La2 – latitude of last grid point

 56–59 Lo2 – longitude of last grid point

 60 Scanning mode (flags – see Flag table 4.3)

 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 m, at the latitude specified by LaD.

(3) A scaled value of radius of spherical Earth, or major or minor axis of oblate spheroid Earth, is derived by applying the appropriate scale factor to the value expressed in metres.

***Grid definition template 4.12 – transverse Mercator***

Byte No. Contents

 15 Shape of the Earth (see Code table 4.1)

 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 i-axis

 35–38 Nj – number of points along j-axis

 39–42 LaR – geographic latitude of reference point

 43–46 LoR – geographic longitude of reference point

 47 Resolution and component flags (see Flag table 4.2)

 48–51 m – scale factor at reference point ratio of distance on map to distance on spheroid
 (IEEE 32-bit floating-point values)

 52–55 XR – false easting, i-direction coordinate of reference point in units of 10–2 m

 56–59 YR – false northing, j-direction coordinate of reference point in units of 10–2 m

 60 Scanning mode (flags – see Flag table 4.3)

 61–64 Di – i-direction increment length in units of 10–2 m

 65–68 Dj – j-direction increment length in units of 10–2 m

 69–72 x1 – i-direction coordinate of the first grid point in units of 10–2 m

 73–76 y1 – j-direction coordinate of the first grid point in units of 10–2 m

 77–80 x2 – i-direction coordinate of the last grid point in units of 10–2 m

 81–84 y2 – j-direction coordinate of the last grid point in units of 10–2 m

***Grid definition template 4.20 – polar stereographic projection***

Byte No. Contents

 15 Shape of the Earth (see Code table 4.1)

 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 the x-axis

 35–38 Ny – number of points along the y-axis

 39–42 La1 – latitude of first grid point

 43–46 Lo1 – longitude of first grid point

 47 Resolution and component flags (see Flag table 4.2 and Note 1)

 48–51 LaD – latitude where Dx and Dy are specified

 52–55 LoV – orientation of the grid (see Note 2)

 56–59 Dx – x-direction grid length (see Note 3)

 60–63 Dy – y-direction grid length (see Note 3)

 64 Projection centre flag (see Flag table 4.4)

 65 Scanning mode (see Flag table 4.3)

Notes:

(1) The resolution flags (bits 3–4 of Flag table 4.2) 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 m at the latitude specified by LaD.

(4) Bit 2 of the projection flag is not applicable to the polar stereographic projection.

(5) A scaled value of radius of spherical Earth, or major or minor axis of oblate spheroid Earth, is derived by applying the appropriate scale factor to the value expressed in metres.

***Grid definition template 4.30 – Lambert conformal***

Byte No. Contents

 15 Shape of the Earth (see Code table 4.1)

 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 the x-axis

 35–38 Ny – number of points along the y-axis

 39–42 La1 – latitude of first grid point

 43–46 Lo1 – longitude of first grid point

 47 Resolution and component flags (see Flag table 4.2)

 48–51 LaD – latitude where Dx and Dy are specified

 52–55 LoV – longitude of meridian parallel to y-axis along which latitude increases as the
 y-coordinate increases

 56–59 Dx – x-direction grid length (see Note 1)

 60–63 Dy – y-direction grid length (see Note 1)

 64 Projection centre flag (see Flag table 4.4)

 65 Scanning mode (see Flag table 4.3)

 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 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 4.2) 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).

(5) A scaled value of radius of spherical Earth, or major or minor axis of oblate spheroid Earth, is derived by applying the appropriate scale factor to the value expressed in metres.

***Grid definition template 4.31 – Albers equal area***

Byte No. Contents

 15 Shape of the Earth (see Code table 4.1)

 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 the x-axis

 35–38 Ny – number of points along the y-axis

 39–42 La1 – latitude of first grid point

 43–46 Lo1 – longitude of first grid point

 47 Resolution and component flags (see Flag table 4.2)

 48–51 LaD – latitude where Dx and Dy are specified

 52–55 LoV – longitude of meridian parallel to y-axis along which latitude increases as the
 y-coordinate increases

 56–59 Dx – x-direction grid length (see Note 1)

 60–63 Dy – y-direction grid length (see Note 1)

 64 Projection centre flag (see Flag table 4.4)

 65 Scanning mode (see Flag table 4.3)

 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 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 4.2) 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).

(5) A scaled value of radius of spherical Earth, or major or minor axis of oblate spheroid Earth, is derived by applying the appropriate scale factor to the value expressed in metres.

***Grid definition template 4.40 – Gaussian latitude/longitude***

Byte No. Contents

 15 Shape of the Earth (see Code table 4.1)

 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 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 4.2)

 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 Notes 1 and 5)

 68–71 N – number of parallels between a pole and the Equator (see Note 2)

 72 Scanning mode (flags – see Flag table 4.3)

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 106 (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) A scaled value of radius of spherical Earth, or major or minor axis of oblate spheroid Earth, is derived by applying the appropriate scale factor to the value expressed in metres.

(4) 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 bytes 47–54. The grid points shall be evenly spaced in latitude (longitude).

(5) It is recommended to use unsigned direction increments.

***Grid definition template 4.41 – rotated Gaussian latitude/longitude***

Byte No. Contents

 15–72 Same as grid definition template 4.40 (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 106 (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 4.1 – rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée).

(4) See Note 4 under grid definition template 4.40.

***Grid definition template 4.42 – stretched Gaussian latitude/longitude***

Byte No. Contents

 15–72 Same as grid definition template 4.40 (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 106 (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 4.2 – stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée).

(4) See Note 4 under grid definition template 3.40.

***Grid definition template 4.43 – stretched and rotated Gaussian latitude/longitude***

Byte No. Contents

 15–72 Same as grid definition template 4.41 (see Note 1)

 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 106 (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 4.1 – rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée).

(4) See Note 2 under grid definition template 4.2 – stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée).

(5) See Note 4 under grid definition template 4.40.

***Grid definition template 4.50 – spherical harmonic coefficients***

Byte 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 4.5)

 28 Representation mode indicating the order of the coefficients (see Code table 4.6)

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 4.51 – rotated spherical harmonic coefficients***

Byte No. Contents

 15–28 Same as grid definition template 4.50

 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 4.50 – spherical harmonic coefficients.

(2) See Note 2 under grid definition template 4.1 – rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée).

***Grid definition template 4.52 – stretched spherical harmonic coefficients***

Byte No. Contents

 15–28 Same as grid definition template 4.50

 29–32 Latitude of the pole of stretching

 33–36 Longitude of the pole of stretching

 37–40 Stretching factor

Notes:

(1) See the Note under grid definition template 4.50 – spherical harmonic coefficients.

(2) See Note 2 under grid definition template 4.2 – stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée).

***Grid definition template 4.53 – stretched and rotated spherical harmonic coefficients***

Byte No. Contents

 15–28 Same as grid definition template 3.51

 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 4.50 – spherical harmonic coefficients.

(2) See Note 2 under grid definition template 4.1 – rotated latitude/longitude (or equidistant cylindrical, or Plate Carrée).

(3) See Note 2 under grid definition template 4.2 – stretched latitude/longitude (or equidistant cylindrical, or Plate Carrée).

***Grid definition template 4.90 – space view perspective or orthographic***

Byte No. Contents

 15 Shape of the Earth (see Code table 4.1)

 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 Flag table 4.2)

 48–51 dx – apparent diameter of Earth in grid lengths, in x-direction

 52–55 dy – apparent diameter of Earth in grid lengths, in 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 4.3)

 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 106 (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

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) Bytes 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°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 ((106)/Nr).

(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 (Rx and Ry), needed for navigation equation, can be calculated from the following:

 Rx = 2 x arcsin ((106)/Nr)/dx

 Ry = 2 x arcsin ((106)/Nr)/dy

(7) A scaled value of radius of spherical Earth, or major or minor axis of oblate spheroid Earth, is derived by applying the appropriate scale factor to the value expressed in metres.

(8) General reference information pertaining to the projections used for satellite data can be found in Section 4.4 of "LRIT/
HRIT Global Specification", Doc. No. CGMS 03, issue 2.6, dated 12 August 1999 ([http://www.eumetsat.int/Home/Main/
AboutEUMETSAT/International Relations/CGMS/groups/cps/documents/document/pdf\_cgms\_03.pdf](http://www.eumetsat.int/Home/Main/AboutEUMETSAT/International%20Relations/CGMS/groups/cps/documents/document/pdf_cgms_03.pdf), page 20 onwards).

***Grid definition template 4.110 – equatorial azimuthal equidistant projection***

Byte No. Contents

 15 Shape of the Earth (see Code table 4.1)

 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

 35–38 Ny – number of points along y-axis

 39–42 La1 – latitude of tangency point (centre of grid)

 43–46 Lo1 – longitude of tangency point

 47 Resolution and component flags (see Flag table 4.2)

 48–51 Dx – x-direction grid length in units of 10–3 m as measured at the point of the axis

 52–55 Dy – y-direction grid length in units of 10–3 m as measured at the point of the axis

 56 Projection centre flag

 57 Scanning mode (see Flag table 4.3)

Note: A scaled value of radius of spherical Earth, or major or minor axis of oblate spheroid Earth, is derived by applying the appropriate scale factor to the value expressed in metres.

***Grid definition template 4.120 – azimuth-range projection***

Byte No. Contents

 15–18 Nb – number of data bins along radials (see Note)

 19–22 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 Scanning mode (flags – see Flag table 3.4)

 *40–(39+4Nr) For each of Nr radials*

 (40+4(X–1))–(41+4(X–1)) Azi – starting azimuth, degrees x 10 (degrees as north)

 (42+4(X–1))–(43+4(X–1)) Adelta – azimuthal width, degrees x 100 (+ clockwise, – counterclockwise),
 with X = 1 to Nr

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

***Grid definition template 4.140*** – ***Lambert azimuthal equal area projection***

Byte 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 the x-axis

 35–38 Ny – number of points along the y-axis

 39–42 La1 – latitude of first grid point

 43–46 Lo1 – longitude of first grid point

 47–50 Standard parallel

 51–54 Central longitude

 55 Resolution and component flags (see Flag table 3.3)

 56–59 Dx – x-direction grid length (see Note)

 60–63 Dy – y-direction grid length (see Note)

 64 Scanning mode (see Flag table 3.4)

Note: Grid lengths are in units of 10–3 m, at the latitude specified by the standard parallel.

**TEMPLATE DEFINITIONS USED IN SECTION 5 (VERTICAL DOMAIN SECTION)**

***Vertical Coordinate definition template 5.0 – Vertical level***

Byte No. Contents

 10 Type of first fixed surface (see Code table 5.1)

 11 Scale factor of first fixed surface

 12–15 Scaled value of first fixed surface

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

***Vertical Coordinate definition template 5.1 – Vertical layer***

Byte No. Contents

 10 Type of first fixed surface (see Code table 5.1)

 11 Scale factor of first fixed surface

 12–15 Scaled value of first fixed surface

 16 Type of second fixed surface (see Code table 5.1)

 17 Scale factor of second fixed surface

 18–21 Scaled value of second fixed surface

**TEMPLATE DEFINITIONS USED IN SECTION 6 (GENERATING PROCESS SECTION)**

***Product definition template 6.0 – Forecast or analysis***

Byte No. Contents

 11 Type of generating process (see Code table 6.1)

 12 Generating Process Identifier (managed by the originating Centre)

***Product definition template 6.1 – Individual ensemble forecast, control and perturbed***

Byte No. Contents

 11 Type of generating process (see Code table 6.1)

 12 Generating Process Identifier (managed by the originating Centre)

14-15 Number of members in ensemble

 13 Type of ensemble member (see Code table 6.2)

 16-17 Member Number

***Product definition template 6.2 – Statistical post-processing of all ensemble members***

Byte No. Contents

 11 Type of generating process (see Code table 6.1)

 12 Generating Process Identifier (managed by the originating Centre)

14-15 Number of members in ensemble

 13 Type of statistical post-processing of ensemble members (see Code table 6.3)

**TEMPLATE DEFINITIONS USED IN SECTION 7 (OBSERVABLE PROPERTY SECTION)**

***Observable Property Template 7.0 – Simple Observable Property***

Byte No. Contents

 8 Parameter Discipline (see Code table 7.1)

 9 Parameter Category (see Code table 7.2)

 10-11 Parameter Number (see Code table 7.3)

 12-15 Units conversion scale factor (ucs) (see Note 1)

 16-19 Units conversion offset (uco) (see Note 1)

Notes:

1. Units conversion scale factor (ucs) and offset (uco) shall be used to encode fields in units different from the units reported in table 7.3. If the values encoded in the GRIB message are *ve* , the values in the units provided in table 7.2 shall be: *v=ucs \* ve+ uco .*

***Observable Property*** *Template 7.1 – Atmospheric chemical constituents*

Byte No. Contents

8-19 Same as OPT 6.0, including Notes.

20-21 Atmospheric chemical constituent type (see Common Code table C–14)

***Observable Property Template 7.2 – Aerosol***

Byte No. Contents

8-19 Same as OPT 7.0, including Notes.

20-21 Aerosol type (see Common Code table C–14)

 22 Type of interval for first and second size (see Code table 7.4)

 23 Scale factor of first size

 24-27 Scaled value of first size in metres

 28 Scale factor of second size

 29-32 Scaled value of second size in metres

***Observable Property Template 7.3 – Aerosol optical properties***

Byte No. Contents

8-32 Same as OPT 7.2, including Notes.

 33 Type of interval for first and second wavelength (see Code table 7.4)

 34 Scale factor of first wavelength

 35-38 Scaled value of first wavelength in metres

 39 Scale factor of second wavelength

 40-43 Scaled value of second wavelength in metres

**TEMPLATE DEFINITIONS USED IN SECTION 8 (DATA REPRESENTATION SECTION)**

***Data representation template 8.0 – Grid point data – simple packing***

Note: For most templates, details of the packing process are described in Regulation 92.9.4.

Byte No. Contents

 14–17 Reference value (R) (IEEE 32-bit floating-point value)

 18–19 Binary scale factor (E)

 20–21 Decimal scale factor (D)

 22 Number of bits used for each packed value for simple packing, or for each group reference
 value for complex packing or spatial differencing

 23 Type of original field values (see Code table 8.1)

Note: Negative values of E or D shall be represented according to Regulation 92.1.5.

***Data representation template 8.2 – Grid point data – complex packing***

Note: For most templates, details of the packing process are described in Regulation 92.9.4.

Byte No. Contents

 14–23 Same as data representation template 8.0

 24 Group splitting method used (see Code table 8.2)

 25 Missing value management used (see Code table 8.3)

 26–29 Primary missing value substitute

 30–33 Secondary missing value substitute

 35–37 NG – number of groups of data values into which field is split

 38 Reference for group widths (see Note 12)

 39 Number of bits used for the group widths (after the reference value in byte 36 has been
 removed)

 40–43 Reference for group lengths (see Note 13)

 44 Length increment for the group lengths (see Note 14)

 45–48 True length of last group

 49 Number of bits used for the scaled group lengths (after subtraction of the reference value
 given in bytes 40–43 and division by the length increment given in byte 44)

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 (floating-point - 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.

(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 Ln = ref + Kn x len\_inc, n = 1, NG, where ref is given by bytes 40–43 and len\_inc by byte 44. The NG values of K (the scaled group lengths) are stored in the data section, each with the number of bits specified by byte 49. 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 bytes 45–48.

(15) See data template 8.2 and associated Notes for complementary information.

***Data representation template 8.3 – Grid point data – complex packing and spatial differencing***

Note: For most templates, details of the packing process are described in Regulation 92.9.4.

Byte No. Contents

 14–49 Same as data representation template 8.2

 50 Order of spatial differencing (see Code table 8.4)

 51 Number of bytes required in the data section to specify extra descriptors needed for spatial
 differencing (bytes 6–ww in data template 8.2)

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 8.2. At order 1, an initial field of values f is replaced by a new field of values g, where g1 = f1, g2 = f2 – f1, …, gn = fn – fn–1. At order 2, the field of values g is itself replaced by a new field of values h, where h1 = f1, h2 = f2, h3 = g3 – g2, …, hn = gn – gn–1. To keep values positive, the overall minimum of the resulting field (either gmin or hmin) 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.

(3) See data template 7.3 and associated Notes for complementary information.

***Data representation template 8.4 – Grid point data – IEEE floating point data***

Byte No. Contents

 14 Precision (see Code table 5.7)

***Data representation template 8.40 – Grid point data – JPEG 2000 code stream format***

Note: For most templates, details of the packing process are described in Regulation 92.9.4.

Byte No. Contents

 14–17 Reference value (R) (IEEE 32-bit floating-point value)

 18–19 Binary scale factor (E)

 20–21 Decimal scale factor (D)

 22 Number of bits required to hold the resulting scaled and referenced data values (i.e. depth
 of the grayscale image) (see Note 2)

 23 Type of original field values (see Code table 8.1)

 24 Type of compression used (see Code table 8.6)

 25 Target compression ratio, M:1 (with respect to the bit-depth specified in byte 22), when
 byte 22 indicates lossy compression. Otherwise, set to missing (see Note 3)

Notes:

(1) The purpose of this template is to scale the grid point data to obtain the desired precision, if appropriate, and then subtract out the reference value from the scaled field as is done using data representation template 8.0. After this, the resulting grid point field can be treated as a grayscale image and is then encoded into the JPEG 2000 code stream format. To unpack the data field, the JPEG 2000 code stream is decoded back into an image, and the original field is obtained from the image data as described in Regulation 92.9.4, Note 4.

(2) The JPEG 2000 standard specifies that the bit-depth must be in the range of 1 to 38 bits.

(3) The compression ratio M:1 (e.g. 20:1) specifies that the encoded stream should be less than ((1/M) x depth x number of data points) bits, where depth is specified in byte 22 and the number of data points in bytes 8-11 of the data representation section.

(4) The order of the data points should remain as specified in the scanning mode flags (Flag table 4.3) set in the appropriate grid definition template, even though the JPEG 2000 standard specifies that an image is stored starting at the top left corner. Assuming that the encoding software is expecting the image data in raster order (left to right across rows for each row), users should set the image width to Ni (or Nx) and the height to Nj (or Ny) if bit 3 of the scanning mode flag equals 0 (adjacent points in i (x) order), when encoding the "image". If bit 3 of the scanning mode flags equals 1 (adjacent points in j (y) order), it may be advantageous to set the image width to Nj (or Ny) and the height to Ni (or Nx).

(5) This template should not be used when the data points are not available on a rectangular grid, such as occurs if some data points are bit-mapped out or if section 4 describes a quasi-regular grid. If it is necessary to use this template on such a grid, the data field can be treated as a one-dimensional image where the height is set to 1 and the width is set to the total number of data points specified in bytes 9-11.

(6) Negative values of E or D shall be represented according to Regulation 92.1.5.

(7) JPEG 2000 should not be used for bit-mapped or quasi-regular grid data.

***Data representation template 8.41 – Grid point data – Portable Network Graphics (PNG) format***

Note: For most templates, details of the packing process are described in Regulation 92.9.4.

Byte 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 required to hold the resulting scaled and referenced data values (i.e. depth
 of the image) (see Note 2)

 21 Type of original field values (see Code table 8.1)

Notes:

(1) The purpose of this template is to scale the grid point data to obtain the desired precision, if appropriate, and then
subtract out the reference value from the scaled field, as is done using data representation template 8.0. After this, the resulting grid point field can be treated as an image and is then encoded into PNG format. To unpack the data field, the PNG stream is decoded back into an image, and the original field is obtained from the image data as described in Regulation 92.9.4, Note 4.

(2) PNG does not support all bit-depths in an image, so it is necessary to define which depths can be used and how they are to be treated. For grayscale images, PNG supports depths of 1, 2, 4, 8 or 16 bits. Red-Green-Blue (RGB) colour images can have depths of 8 or 16 bits with an optional alpha sample. Valid values for byte 20 can be:

 1, 2, 4, 8, or 16 : Treat as grayscale image

 24 : Treat as RGB colour image (each component having 8-bit depth)

 32 : Treat as RGB w/ alpha sample colour image (each component having 8-bit depth)

(3) The order of the data points should remain as specified in the scanning mode flags (Flag table 4.3) set in the appropriate grid definition template, even though the PNG standard specifies that an image is stored starting at the top left corner and scans each row from left to right, starting with the top row. Users should set the image width to Ni (or Nx) and the height to Nj (or Ny) if bit 3 of the scanning mode flag equals 0 (adjacent points in i (x) order), when encoding the "image". If bit 3 of the scanning mode flags equals 1 (adjacent points in j (y) order), it may be advantageous to set the image width to Nj (or Ny) and the height to Ni (or Nx).

(4) This template should not be used when the data points are not available on a rectangular grid, such as occurs if some data points are bit-mapped out or if section 3 describes a quasi-regular grid. If it is necessary to use this template on such a grid, the data field can be treated as a one-dimensional image where the height is set to 1 and the width is set to the total number of data points specified in bytes 8-11.

(5) Negative values of E or D shall be represented according to Regulation 92.1.5.

***Data representation template 8.50 – Spectral data – simple packing***

Note: For most templates, details of the packing process are described in Regulation 92.9.4.

Byte 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.

(3) Negative values of E or D shall be represented according to Regulation 92.1.5.

***Data representation template 8.51 – Spherical harmonics data – complex packing***

Note: For most templates, details of the packing process are described in Regulation 92.9.4.

Byte No. Contents

 12–20 Same as data representation template 8.50

 21–24 P – Laplacian scaling factor (expressed in 10–6 units)

 25–26 JS – pentagonal resolution parameter of the unpacked subset (see Note 1)

 27–28 KS – pentagonal resolution parameter of the unpacked subset (see Note 1)

 29–30 MS – pentagonal resolution parameter of the unpacked subset (see Note 1)

 31–34 TS – total number of values in the unpacked subset (see Note 1)

 35 Precision of the unpacked subset (see Code table 8.5)

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 JS, KS and MS), but on which scaling and packing are not applied. Associated values are stored in bytes 6 onwards
of Section 10.

(2) The remaining coefficients are multiplied by (n x (n+1))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 = (R + X x 2E) x10–D x (n x (n+1))–P where X is the packed scaled value associated with the coefficient.

**TEMPLATE DEFINITIONS USED IN SECTION 8 (OVERLAY SECTION)**

***Overlay Template 9.0 – Bitmap***

Byte No. Contents

11–nn Bitmap – Contiguous bits with a bit to data point correspondence, ordered as defined in Section 4. A bit set to 1 implies the presence of a data value at the corresponding data point, whereas a value of 0 implies the absence of such a value.

Note: If byte 6 is not zero, the length of the section is 6 and bytes 7–nn are not present.