TEMPLATE DEFINITIONS USED IN SECTION 1

Identification template 1.0 - calendar definition

Octet No.	*Contents*	*Status*
24	*Type of calendar (see Code table 1.6)*	*Validation*

Identification template 1.1 - Paleontological offset

Octet No.	*Contents*	*Status*
24-25	*Number of tens of thousands of years of offset*	*Validation*

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

Octet No.	Contents	Status
64-67	Di - i direction increment (see Note 1)	Operational
64-67	*Di - i direction increment (see Note 1 and x)*	*to Operational*
68-71	Dj - j direction increment (see Note 1)	Operational
68-71	*Dj - j direction increment (see Note 1 and x)*	*to Operational*

[to Operational] (x) It is recommended to use unsigned direction increments.

Grid definition template 3.4 - variable resolution latitude/longitude

Octet No.	*Contents*	*Status*
15	*Shape of the earth (see Code table 3.2)*	*Validation*
16	*Scale factor of radius of spherical earth*	*Validation*
17-20	*Scaled value of radius of spherical earth*	*Validation*
21	*Scale factor of major axis of oblate spheroid earth*	*Validation*
22-25	*Scaled value of major axis of oblate spheroid earth*	*Validation*
26	*Scale factor of minor axis of oblate spheroid earth*	*Validation*
27-30	*Scaled value of minor axis of oblate spheroid earth*	*Validation*
31-34	*Ni - number of points along a parallel*	*Validation*
35-38	*Nj - number of points along a meridian*	*Validation*
39-42	*Basic angle of the initial production domain (see Note 1)*	*Validation*
43-46	*Subdivisions of basic angle used to define extreme longitudes and latitudes, and direction increments (see Note 1)*	*Validation*
47	*Resolution and component flags (see Flag table 3.3 and Note 2)*	*Validation*
48	*Scanning mode (flags - see Flag table 3.4)*	*Validation*
49-ii	*List of longitudes (see Notes 1 and 3)*	*Validation*
(ii+1)-jj	*List of latitudes (see Notes 1 and 3)*	*Validation*

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 longitudes and latitudes. For these descriptors, unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and 10^{6} (10^{-6} degrees unit).

(2) The resolution flag (bit 3-4 of Flag table 3.3) is not applicable.

(3) The list of Ni longitudes and Nj latitudes shall be coded in the octets immediately following the Grid definition template in octets 49 to ii and octets ii+1 to jj respectively, where ii = 48 + 4Ni and jj = 48 + 4Ni + 4Nj

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

Grid definition template 3.5 - variable resolution rotated latitude/longitude

Octet No.	*Contents*	*Status*
15-48	*Same as Grid definition template 3.4 (see Note 1)*	*Validation*
49-52	*Latitude of the southern pole of projection*	*Validation*
53-56	*Longitude of the southern pole of projection*	*Validation*

57-60	*Angle of rotation of projection*	*Validation*
61-ii	*List of longitudes (see Notes 1 and 3)*	*Validation*
(ii+1)-jj	*List of latitudes (see Notes 1 and 3)*	*Validation*

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 longitudes and latitudes. For these descriptors, the unit is equal to the ratio of the basic angle and the subdivisions number. For ordinary cases, zero and missing values should be coded, equivalent to respective values of 1 and 10^6 (10^{-6} degrees unit).

(2) Three parameters define a general latitude/longitude coordinate system, formed by a general rotation of the sphere. One choice for these parameters is:

(a) The geographic latitude in degrees of the southern pole of the coordinate system, e.g θ_p;

(b) The geographic longitude in degrees of the southern pole of the coordinate system, e.g λ_p;

(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 ($90 + \theta_p$) degrees so that the southern pole moved along the (previously rotated) Greenwich meridian.

(3) For the list of Ni longitude bounds and Nj latitude bounds at the end of the section
ii = 60 + 4Ni and jj = 60 + 4Ni +4Nj

Grid definition template 3.11 - rotated Mercator projection

Octet No.	Contents	Status
15	*Shape of the earth (see Code table 3.2)*	*Validation*
16	*Scale factor of radius of spherical earth*	*Validation*
17-20	*Scaled value of radius of spherical earth*	*Validation*
21	*Scale factor of major axis of oblate spheroid earth*	*Validation*
22-25	*Scaled value of major axis of oblate spheroid earth*	*Validation*
26	*Scale factor of minor axis of oblate spheroid earth*	*Validation*
27-30	*Scaled value of minor axis of oblate spheroid earth*	*Validation*
31-34	*Ni - number of points along a parallel*	*Validation*
35-38	*Nj - number of points along a meridian*	*Validation*
39-42	*La1 - latitude of first grid point*	*Validation*
43-46	*Lo1 - longitude of first grid point*	*Validation*
47	*Resolution and component flags (see Flag table 3.3)*	*Validation*
48-51	*LaD -latitude(s) at which the Mercator projection intersects the Earth (latitude(s) where Di and Dj are specified)*	*Validation*
52-55	*La2 - latitude of last grid point*	*Validation*
56-59	*Lo2 - longitude of last grid point*	*Validation*
60	*Scanning mode (flags - see Flag table 3.4)*	*Validation*
61-64	*Orientation of the grid, angle between i direction on the map and the equator (see Note 1)*	*Validation*
65-68	*Di - longitudinal direction grid length (see Note 2)*	*Validation*
69-72	*Dj - latitudinal direction grid length (see Note 2)*	*Validation*
73-76	*La0 - geographical latitude of the point to be brought to the origin of the projection, in the case of a rotation of the sphere prior to the projection*	*Validation*
77-80	*Lo0 - geographical longitude of the point to be brought to the origin of the projection, in the case of a rotation of the sphere prior to the projection*	*Validation*
81-84	*beta – tilting angle of the sphere around the origin point of the rotated sphere*	*Validation*
85-nn	*List of number of points along each meridian or parallel (These octets are only present for quasi-regular grids as described in Notes 2 and 3 of GDT 3.1)*	*Validation*

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 from applying appropriate scale factor to the value expressed in metres.

(4) Transformation formulas from geographical (lat,lon) = (θ,λ) to projected grid point coordinates (x,y) :

$$\sin(\theta') = \cos(\theta_0)\sin(\theta) - \sin(\theta_0)\cos(\theta)\cos(\lambda - \lambda_0)$$

$$\cos(\theta') = \sqrt{1 - \sin^2(\theta')}$$

$$C' = \cos(\theta')\cos(\lambda') = \sin(\theta_0)\sin(\theta) + \cos(\theta_0)\cos(\theta)\cos(\lambda - \lambda_0)$$

$$S' = \cos(\theta')\sin(\lambda') = \cos(\theta)\sin(\lambda - \lambda_0)$$

$$\theta'' = \arcsin[\cos(\beta)\sin(\theta') + \sin(\beta)S']$$

$$\cos(\lambda'') = \frac{C'}{\cos(\theta'')}$$

$$\sin(\lambda'') = -\frac{1}{\cos(\theta'')}[\sin(\beta)\sin(\theta') - \cos(\beta)S']$$

$$x = a\lambda''$$

$$y = -a.\ln[tg(\frac{\pi}{4} - \frac{\theta''}{2})]$$

Reverse transformation formulas from gridpoint (x,y) to (lat,lon):

$$\lambda'' = \frac{x}{a}$$

$$\theta'' = \frac{\pi}{2} - 2.arctg\ [\exp(-\frac{y}{a})]$$

$$\sin(\theta'') = \frac{1 - \exp(-2y/a)}{1 + \exp(-2y/a)}$$

$$\sin(\theta') = \cos(\theta_0)\sin(\theta) - \sin(\theta_0)\cos(\theta)\cos(\lambda - \lambda_0)$$

$$\cos(\theta') = \sqrt{1 - \sin^2(\theta')}$$

$$C' = \cos(\theta'')\cos(\lambda'')$$

$$S' = \sin(\beta)\sin(\theta'') + \cos(\beta)\cos(\theta'')\sin(\lambda'')$$

$$\theta = \arcsin[\cos(\theta_0)\sin(\theta') + \sin(\theta_0)C']$$

$$\cos(\lambda - \lambda_0) = \frac{1}{\cos(\theta)}[-\sin(\theta_0)\sin(\theta') + \cos(\theta_0)C']$$

$$\sin(\lambda - \lambda_0) = \frac{S'}{\cos(\theta)}$$

Where:

- *La0 is θ_0*
- *Lo0 is λ_0*
- *Beta is β*
- *x and y are metric coordinates in the i and j direction, in standard units (m). (x,y) = (0,0) corresponds to the coordinate of the reference point (La0,Lo0), provided this point is kept as the centre of the grid point domain.*
- *the other variables are intermediate ones. More explanation can be found in the Technical Note by P. Bénard (2011), "rotated/tilted Mercator geometry in Aladin".*

Grid definition template 3.12 - transverse Mercator

Octet No.	*Contents*	*Status*
15	*Shape of the Earth (see Code table 3.2)*	*Validation*
16	*Scale factor of radius of spherical Earth*	*Validation*
17-20	*Scaled value of radius of spherical Earth*	*Validation*
21	*Scale factor of major axis of oblate spheroid Earth*	*Validation*
22-25	*Scaled value of major axis of oblate spheroid Earth*	*Validation*
26	*Scale factor of minor axis of oblate spheroid Earth*	*Validation*
27-30	*Scaled value of minor axis of oblate spheroid Earth*	*Validation*
31-34	*Ni - number of points along i-axis*	*Validation*
35-38	*Nj - number of points along j-axis*	*Validation*
39-42	*LaR - geographic latitude of reference point*	*Validation*
43-46	*LoR - geographic longitude of reference point*	*Validation*
47	*Resolution and component flags (see Flag table 3.3)*	*Validation*
48-51	*m - scale factor at reference point ratio of distance on map to distance on*	*Validation*
52-55	*XR - false easting, i-direction coordinate of reference point in units of 10-2 m*	*Validation*

56-59	*YR - false northing, j-direction coordinate of reference point in units of 10-2 m*	*Validation*
60	*Scanning mode (flags - see Flag table 3.4)*	*Validation*
61-64	*Di - i-direction increment length in units of 10-2 m*	*Validation*
65-68	*Dj - j-direction increment length in units of 10-2 m*	*Validation*
69-72	*x1 - i-direction coordinate of the first grid point in units of 10-2 m*	*Validation*
73-76	*y1 - j-direction coordinate of the first grid point in units of 10-2 m*	*Validation*
77-80	*x2 - i-direction coordinate of the last grid point in units of 10-2 m*	*Validation*
81-84	*y2 - j-direction coordinate of the last grid point in units of 10-2 m*	*Validation*

Grid definition template 3.40 - Gaussian latitude/longitude

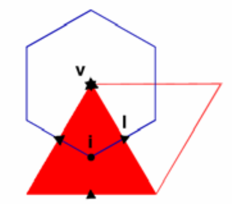
Octet No.	Contents	Status
64-67	Di - i direction increment (see Note 1)	Operational
64-67	*Di - i direction increment (see Notes 1 and x)*	*to Operational*

[to Operational] (x) It is recommended to use unsigned direction increments.

Grid definition template 3.101 - general unstructured grid

Octet No.	*Contents*	*Status*
15	*Shape of the Earth (see Code table 3.2)*	*Validation*
16-18	*Number of grid used (defined by originating centre)*	*Validation*
19	*Number of grid in reference (to allow annotating for Arakawa C-grid on arbitrary grid) (see Note)*	*Validation*
20-35	*UUID of horizontal grid*	*Validation*

Note: The number given refers to a specific grid required for formulating differential operators. The grid may consist of a centre and an arbitrary surrounding polygon. As model variables may be defined on vertices of the polygons or in the middle of a polygon edge this generates some different grid descriptions, because each of those is defining their own centre and surrounding polygon. Each of these dependent grids needs their own set of centre longitude/latitude and the longitude/latitude of the boundary polygon vertices. The following picture shows a triangle as base, a hexagon around the triangle's vertices and a quadrilateral around the edge mid points..



(a) triangles (i) (pressure, temperature,..)
(b) quadrilaterals (l) (wind velocity ..)
(c) hexagons (or pentagons respectively) (v) (vorticity, ...)

TEMPLATE DEFINITIONS USED IN SECTION 4

Product definition template 4.48 - analysis or forecast at a horizontal level or in a horizontal layer at a point in time for optical properties of aerosol

Octet No.	Contents	Status
10	Parameter category (see Code table 4.1)	Validation
11	Parameter number (see Code table 4.2)	Validation
12-13	Aerosol type (see Code table C-14)	Validation
14	Type of interval for first and second size (see Code table 4.91)	Validation
15	Scale factor of first size	Validation
16-19	Scaled value of first size in metres	Validation
20	Scale factor of second size	Validation
21-24	Scaled value of second size in metres	Validation
25	Type of interval for first and second wavelength (see Code table 4.91)	Validation
26	Scale factor of first wavelength	Validation
27-30	Scaled value of first wavelength in metres	Validation
31	Scale factor of second wavelength	Validation
32-35	Scaled value of second wavelength in metres	Validation
36	Type of generating process (see Code table 4.3)	Validation
37	Background generating process identifier (defined by originating centre)	Validation
38	Analysis or forecast generating processes identifier (defined by originating centre)	Validation
39-40	Hours of observational data cut-off after reference time (see Note 1)	Validation
41	Minutes of observational data cut-off after reference time	Validation
42	Indicator of unit of time range (see Code table 4.4)	Validation
43-46	Forecast time in units defined by octet 42	Validation
47	Type of first fixed surface (see Code table 4.5)	Validation
48	Scale factor of first fixed surface	Validation
49-52	Scaled value of first fixed surface	Validation
53	Type of second fixed surface (see Code table 4.5)	Validation
54	Scale factor of second fixed surface	Validation
55-58	Scaled value of second fixed surface	Validation

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

Product definition template 4.50 - analysis or forecast of a multi component parameter or matrix element at a point in time

Octet No.	Contents	Status
10	Parameter category (see Code table 4.1)	Validation
11	Parameter number (see Code table 4.2)	Validation
12	Type of generating process (see Code table 4.3)	Validation
13	Background generating process identifier (defined by originating centre)	Validation
14	Analysis or forecast generating processes identifier (defined by originating centre)	Validation
15-16	Hours of observational data cut-off after reference time (see Note 1)	Validation
17	Minutes of observational data cut-off after reference time	Validation
18	Indicator of unit of time range (see Code table 4.4)	Validation
19-22	Forecast time in units defined by octet 18	Validation
23	Type of first fixed surface (see Code table 4.5)	Validation
24	Scale factor of first fixed surface	Validation
25-28	Scaled value of first fixed surface	Validation
29	Type of second fixed surface (see Code table 4.5)	Validation
30	Scale factor of second fixed surface	Validation
31-34	Scaled value of second fixed surface	Validation

35	*First dimension physical significance (Code table 5.3) (see Note 2)*	*Validation*
36	*Second dimension physical significance (Code table 5.3) (see Note 2)*	*Validation*
37-40	*First dimension coordinate value (IEEE 32-bit floating-point value)*	*Validation*
41-44	*Second dimension coordinate value (IEEE 32-bit floating-point value)*	*Validation*
45-48	*First dimension (rows) of the complete matrix (see Note 3)*	*Validation*
49-52	*Second dimension (columns) of the complete matrix (see Note 3)*	*Validation*

Notes:

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

(2) In case of ocean wave spectra e.g., according to Code table 5.3, the physical significance values are 1 (Direction Degrees true) and 2 (Frequency (s^{-1}).

(3) The dimensions define the number of GRIBs needed for reconstruction of a complete matrix (e.g. wave spectrum) at one or more grid points. In case of vectors (1-dim-matrices), the second dimension must be set to 1 and the second dimension physical significance must be set to 255 (missing). In case of multi component parameter (e.g. no matrix or vector element), first and second dimension are set to 1.

TEMPLATE DEFINITIONS USED IN SECTION 5

Data representation template 5.42 - Grid point and spectral data - CCSDS szip

Octet No.	Contents	Status
12-15	Reference value (R) (IEEE 32-bit floating-point value)	Validation
16-17	Binary scale factor (E)	Validation
18-19	Decimal scale factor (D)	Validation
20	Number of bits required to hold the resulting scaled and referenced data values.	Validation
21	Type of original field values (see Code table 5.1)	Validation
22	szip options mask	Validation
23	szip bits per pixel	Validation
24-25	szip pixels per block	Validation
26-27	szip pixels per scan line	Validation

Notes:

(1) The intent of this template is to scale the grid point data to obtain desired precision, if appropriate, and then subtract out reference value from the scaled field as is done using Data Representation Template 5.0. After this, the resulting grid point field can be treated as a grayscale image and is then encoded into the CCSDS szip code stream format. To unpack the data field, the CCSDS szip 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 Consultative Committee for Space Data Systems (CCSDS) szip is the standard used by space agencies for the compression of scientific data transmitted from satellites and other space instruments. CCSDS szip is a very fast predictive compression algorithm based on the extended-Rice algorithm, it uses Golomb-Rice codes for entropy coding. The sequence of prediction errors is divided into blocks. Each block is compressed using a two-pass algorithm. In the first pass the best coding method for the whole block is determined. In the second pass, output of the marker of the selected coding method as a side information is done along with prediction errors encoded. The coding methods include:

- *Golomb-Rice codes of a chosen rank*
- *Unary code for transformed pairs of prediction errors*
- *Fixed-length natural binary code if the block is found to be incompressible*
- *Signaling to the decoder empty block if all prediction errors are zeroes*

A detailed description can be found in:

Consultative Committee for Space Data Systems: Lossless Data Compression.

CCSDS Recommendation for Space System Data Standards,

CCSDS 121.0-B-1, Blue Book, May 1997.

Note: CCSDS szip is often confused with a general-purpose compression utility by Schindler, which is also called szip.

TEMPLATE DEFINITIONS USED IN SECTION 7

None