(8 May 2013)

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)	to Operational

Identification template 1.1 – Paleontological offset

Octet No.	Contents	Status
24–25	Number of tens of thousands of years of offset	to Operational

Identification template 1.2 – Calendar definition and paleontological offset

Octet No.	Contents	Status
24	Type of calendar (see Code table 1.6)	to Operational
25–26	Number of tens of thousands of years of offset	to Operational

TEMPLATE DEFINITIONS USED IN SECTION 3

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 grid point (x,y) to (lat,lon):

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

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

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

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

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

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

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

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

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

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

Where:

a. La0 is θ_0
b. Lo0 is λ_0
c. Beta is β
d. 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 center of the grid point domain.
e. 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 3.1010 – 4–D trajectory grid definition

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
31–32	Number of horizontal points in slice (see Note 1)	Validation
33–34	Number of vertical points in slice (see Note 1)	Validation
35–38	Di – slice horizontal grid length (see Note 2)	Validation
39–42	Dj – slice vertical grid length (see Note 2)	Validation
43–46	Pi – horizontal location of trajectory point within slice (see Note 3)	Validation
47–50	Pj – vertical location of trajectory point within slice (see Note 3)	Validation
51	Scanning mode (flags – see Flag table 3.4) (see Note 1)	Validation
52–53	NW – Number of way points (see Note 4)	Validation
	54–(53+NW×24) Waypoint descriptions to define 4-D coordinates	Validation
	Waypoint descriptions:	Validation
30+(N×24+0–N×24+3)	LaN – latitude of Nth trajectory way point	Validation
30+(N×24+4–N×24+7)	LoN – longitude of Nth trajectory way point	Validation
30+(N×24+8)	Type of Nth's trajectory way point surface (see Code table 4.5 and Note 5)	Validation
30+(N×24+9)	Scale factor of Nth's trajectory way point surface	Validation
30+(N×24+10–N×24+13)	Scaled value of Nth's trajectory way point surface	Validation
30+(N×24+14)	Indicator of unit of time range (see Code table 4.4)	Validation
30+(N×24+15–N×24+18)	Waypoint time in units defined by octet N×24+14 (see Note 6)	Validation
30+(N×24+19–N×24+22)	Number of slices per trajectory segment (see Note 7)	Validation
30+(N×24+23)	Number of additional leading and trailing slices (see Note 8)	Validation

Notes:

(1) Horizontal and vertical points in slice indicate orthogonal grid slice perpendicular to point along the trajectory segment. Therefore scanning mode describes scanning within single slice.

(2) Grid lengths are in units of 10^{-3} m. Trajectory is always positioned in the centre of the slice.

(3) Location of trajectory point within slice is in units of 10^{-3} m relative from first grid point of this slice.

(4) Type of line for way segments is assumed to be Great Circle.

(5) Each of waypoints can be in different types of surface coordinates. For the purpose of light transition level, point of transition can be repeated in both meters above surface and isobaric level equivalent to height reduction based on QNH valid for FIR at that moment. Waypoint can be also repeated for stopover on the trajectory with same 3-D coordinates but different waypoint time. First point of transition level or stopover description can have MISSING slices in this case.

(6) Waypoint time is relative to reference time of data defined in Section 1.

(7) Slices are defined as perpendicular planes which are equidistantly spaced along the trajectory segment. First slice is always located in first point of trajectory segment and last slice in last point of trajectory segment. Therefore minimum number of slices is 2, unless set to MISSING (for last point of trajectory or for transition level repeated point).

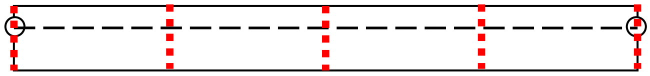

Figure 3: Example of trajectory segment with 5 slices (circles represent trajectory waypoints)

(8) Number of leading slices is same as number of trailing slices, and represents additional slices outside the trajectory segment but within its direction using same equidistant spacing as for corresponding trajectory segment itself.

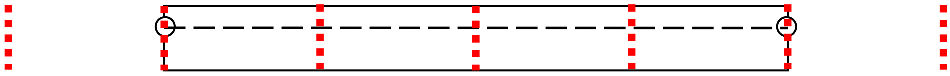

Figure 4: Example of trajectory segment with 5 slices and 1 leading and trailing slice (circles represent trajectory waypoints)

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

TEMPLATE DEFINITIONS USED IN SECTION 4

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 process 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.

Product definition template 4.1010 – 4-D trajectory

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 process identifier (defined by originating centre)	Validation
15–16	Hours of observational data cutoff after reference time (see Note)	Validation
17	Minutes of observational data cutoff after reference time	Validation

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

Product definition template 4.1011 – 4-D trajectory ensemble forecast, control and perturbed

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	Forecast generating process identifier (defined by originating Centre)	Validation
15–16	Hours after reference time of data cut-off (see Note)	Validation
17	Minutes after reference time of data cut-off	Validation
18	Type of ensemble forecast (see Code table 4.6)	Validation
19	Perturbation number	Validation
20	Number of forecasts in ensemble	Validation

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

Product definition template 4.1015 – 4-D trajectory probability forecasts

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	Forecast generating process identifier (defined by originating centre)	Validation
15–16	Hours after reference time of data cut-off (see Note)	Validation
17	Minutes after reference time of data cut-off	Validation
18	Forecast probability number	Validation
19	Total number of forecast probabilities	Validation
20	Probability type (see Code table 4.9)	Validation
21	Scale factor of lower limit	Validation
22–25	Scaled value of lower limit	Validation
26	Scale factor of upper limit	Validation
27–30	Scaled value of upper limit	Validation

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

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 and Blue Book, May 1997.

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