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| WORLD METEOROLOGICAL ORGANIZATION  COMMISSION FOR BASIC SYSTEMS  -----------------------------  FIRST MEETING OF  INTER-PROGRAMME EXPERT TEAM ON CODES MAINTENANCE  GENEVA, SWITZERLAND, 24 - 28 JULY 2017 |  | IPET-CM-I / Doc. 2.6 (10)  (12. 7. 2017)  -------------------------  ITEM 2.7  ENGLISH ONLY |

GRIB edition 3

**Templates for spherical harmonics**

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**Summary and Purpose of Document**

Template components and template for spherical harmonics are proposed.

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**ACTION PROPOSED**

The Team is asked to review the proposal and accept it for validation.

**DISCUSSIONS**

Horizontal domain and data representation components for spherical harmonics are proposed with the aim to be as close as possible to the GRIB2 representation.

**PROPOSAL**

***Horizontal Domain Template Component 4.15 – Spherical harmonic coefficients***

|  |  |
| --- | --- |
| Byte No. | Contents |
| 1-2 | J – pentagonal resolution parameter (1) |
| 3-4 | K – pentagonal resolution parameter (1) |
| 5-6 | M – pentagonal resolution parameter (1) |
| 7 | Representation type indicating the method used to define the norm (see Code table 4.x) |
| 8 | Representation mode indicating the order of the coefficients (see Code table 4.y) |

Notes:

(1) unsigned

(2) 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

**Code table 4.x** – *Spectral data representation type*

Code figure Meaning

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

 = 



A field F*(λ,* μ) is represented by:



where is the longitude,

 the sine of latitude,

and  the complex conjugate of 

**Code table 4.y** – *Spectral data representation mode*

Code figure Meaning

0 Reserved

1 The complex numbers (see code figure 1 in Code table 3.6) are stored for m ≥ 0 as   
 pairs of real numbers Re(), Im() ordered with n increasing from m to N(m), first for   
 m = 0 and then for m = 1, 2, ... M (see Note)

2–254 Reserved

255 Missing

Note: Values of N(m) for common truncation cases:

Triangular: M = J = K, N(m) = J

Rhomboidal: K = J + M, N(m) = J + m

Trapezoidal: K = J, K > M, N(m) = J

***Horizontal Domain Template 4.y1 – Spherical harmonic coefficients on ellipsoidal planet***

|  |  |
| --- | --- |
| Component Code | Component Name |
| 4.0 | Ellipsoid of revolution defined with axis lengths |
| 4.15 | Spherical harmonic coefficients |

***Horizontal Domain Template 4.y2 – Rotated Spherical harmonic coefficients on ellipsoidal planet***

|  |  |
| --- | --- |
| Component Code | Component Name |
| 4.0 | Ellipsoid of revolution defined with axis lengths |
| 4.15 | Spherical harmonic coefficients |
| 4.2 | Rotation of latitude/longitude coordinate system |

***Data Representation Template Component 8.2 – Spherical harmonics coefficients, simple packing***

|  |  |
| --- | --- |
| Byte No. | Contents |
| 1-4 | Reference value (R) (IEEE 32-bit floating-point value) |
| 5-6 | Binary scale factor (E) |
| 7-8 | Decimal scale factor (D) |
| 9 | Number of bits used for each packed value |
| 10-13 | Real part of (0.0) coefficient (IEEE 32-bit floating-point value) |

Notes:

(1) Removal of the real part of (0.0) coefficient from packed data is intended to reduce the variability of the coefficients, in order to improve packing accuracy.

(2) For some spectral representations, the (0.0) coefficient represents the mean value of the parameter represented.

***Data Representation Template Component 8.3 – Spherical harmonics coefficients, complex packing***

|  |  |
| --- | --- |
| Byte No. | Contents |
| 1-4 | P – Laplacian scaling factor (expressed in 10–6 units) |
| 5-6 | JS – pentagonal resolution parameter of the unpacked subset (see Note 1) |
| 7-8 | KS – pentagonal resolution parameter of the unpacked subset (see Note 1) |
| 9-10 | MS – pentagonal resolution parameter of the unpacked subset (see Note 1) |
| 11-14 | TS – total number of values in the unpacked subset (see Note 1) |
| 15 | Precision of the unpacked subset (see Code table 8.z) |

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 octets 6 onwards   
of Section 7.

(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.

***Data Representation Template 4.z1 – Spherical harmonic coefficients, simple packing***

|  |  |
| --- | --- |
| Component Code | Component Name |
| 8.2 | Spherical harmonics coefficients, simple packing |

***Data Representation Template 4.z1 – Spherical harmonic coefficients, complex packing***

|  |  |
| --- | --- |
| Component Code | Component Name |
| 8.3 | Spherical harmonics coefficients, complex packing |