**FM 92–XIV GRIB Geospatial Representation In Binary of fields resulting from an observation or a numerical model simulation of an observable property in a space and time domain.**

**CODE FORM:**

**Indicator Section**

**Originator Section**

**Repetitions and Index Section**

**Time Domain Section**

Horizontal Domain Section

**Vertical Domain Section**

**Generating Process Section**

**Observable Property Section**

**Data Representation Section**

**Data Section**

**Overlay Section**

**End Section**

SECTION 0

SECTION 1

SECTION 2

SECTION 3

SECTION 4

SECTION 5

SECTION 6

(repeated)

SECTION 7

SECTION 8

SECTION 9

SECTION 10

SECTION 11

**Notes:**

(1) GRIB is the name of a binary data representation form for fields representing an observable property in a geospatial and time domain which is the result of an observation or a numerical model simulation.

(2) Data encoded in GRIB consists of a continuous bit-stream made of a sequence of bytes (1 byte = 8 bits).

(3) The bytes of a GRIB message are grouped in sections:

|  |  |  |
| --- | --- | --- |
| *Section Number* | *Section Name* | *Contents* |
| 0 | Indicator Section | “GRIB”, GRIB edition number, length of message, Master tables version number |
| 1 | Originator Section | Length of section, section number, local tables version number and information for use of the originator centre |
| 2 | Repetitions and Index Section | Length of section, section number, total number of repetitions, number of distinct repetitions for each repeatable section and optional index. |
| 3 | Time Domain Section | Length of section, section number, repetition identifier and definition of time domain of the field. |
| 4 | Horizontal Domain Section | Length of section, section number, repetition identifier and description of the horizontal domain of the field. |
| 5 | Vertical Domain Section | Length of section, section number, repetition identifier and description of the vertical domain of the field. |
| 6 | Generating Process Section | Length of section, section number, repetition identifier and description of the process generating the data. |
| 7 | Observable Property Section | Length of section, section number, repetition identifier and description of the observable property. |
| 8 | Data Representation Section | Length of section, section number, repetition identifier and description of how the data values are represented. |
| 9 | Overlay Section | Length of section, section number, repetition identifier and overlay field associating a property to the field. This can be used to indicate the presence or absence of data at each point of the domain by defining a bitmap. |
| 10 | Data Section | Length of section, section number, data values. |
| 11 | End Section | “7777” |

(4) Sequences of GRIB sections 3 to 10, may be repeated within a single GRIB message. The total number of repetitions is given in section 2, along with the number of unique entries for sections 3-9. The total number of repetitions is also the number of fields encoded in the GRIB message. Multi-field messages contain more than one message while single field messages contain only one field. A GRIB messages shall contain at least one field.

(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 a series of bits is independent of any particular machine representation.

(7) Message and section lengths are expressed in bytes. Bytes are numbered 1, 2, 3, etc., starting at the beginning of each section. Therefore, byte numbers in a template refer to the respective section.

(8) Bit positions within bytes are referred to as bit 1 to bit 8, where bit 1 is the most significant and bit 8 is the least significant. Thus, an byte with only bit 8 set to 1 would have the integer value 1.

(9) As used in “GRIB”, “International Alphabet No. 5” is regarded as an 8-bit alphabet with bit 1 set to zero.

(10) The IEEE single precision floating point representation is specified in the standard ISO/IEC 559–1985 and ANSI/IEEE 754–1985 (R1991), which should be consulted for more details. The representation occupies four bytes and is:

seeeeeee emmmmmmm mmmmmmmm mmmmmmmm

where:

s is the sign bit, 0 means positive, 1 negative

e...e is an 8 bit biased exponent

m...m is the mantissa, with the first bit deleted.

The value of the number is given by the following table:

|  |  |  |
| --- | --- | --- |
| *e...e* | *m...m* | *Value of number* |
| 0 | Any | (–1)s (m...m)2–232–126 = (–1)s(m...m)2–149 |
| 1...254 | Any | (–1)s (1.0 + (m...m)2–23)2((e...e)–127) |
| 255 | 0 | Positive (s=0) or Negative (s=1) infinity |
| 255 | >0 | NaN (Not a valid Number, result of illegal operation) |

Normally, only biased exponent values from 1 through 254 inclusive are used, except for positive or negative zero which is represented by setting both the biased exponent and the mantissa to 0.

The numbers are stored with the high-order byte first. The sign bit will be the first bit of the first byte. The low-order bit of the mantissa will be the last (eighth) bit of the fourth byte.

This floating point representation has been chosen because it is in common use in modern computer hardware. Some computers use this representation with the order of the bytes reversed. They will have to convert the representation, either by reversing the bytes or by computing the floating point value directly using the above formulas.

**REGULATIONS:**

92.1 **General**

92.1.1 The GRIB code shall be used for the exchange and storage of fields representing an observable property in a geospatial and time domain which is the result of an observation or a numerical model elaboration.

92.1.2 The beginning and the end of the code shall be identified by 4 bytes coded according to the International Alphabet No. 5 to represent the indicators “GRIB” and “7777” in Indicator section 0 and End section 8, respectively. All other bytes included in the code shall represent data in binary form.

92.1.3 Each section included in the code shall always end on an byte boundary. This rule shall be applied by appending bits set to zero to the section, where necessary.

92.1.4 All bits set to “1” for any value indicates that value is missing. This rule shall not apply to packed data.

92.1.5 If applicable, negative values shall be indicated by setting the most significant bit to “1”.

92.1.6 Latitude, longitude and angle values shall be in units of 10–6 degree, except for specific cases explicitly stated in some grid definitions.

92.1.7 The latitude values shall be limited to the range 0 to 90 degrees inclusive. The orientation shall be north latitude positive, south latitude negative. Bit 1 is set to 1 to indicate south latitude.

92.1.8 The longitude values shall be limited to the range 0 to 360 degrees inclusive. The orientation shall be east longitude positive, with only positive values being used.

92.1.9 The latitude and longitude of the first grid point and the last grid point shall always be given for regular grids.

92.1.10 Vector components at the North and South Poles shall be coded according to the following conventions.

92.1.10.1 If the resolution and component flags in section 4 (Flag table 4.2) indicate that the vector components are relative to the defined grid, the vector components at the Pole shall be resolved relative to the grid.

92.1.10.2 Otherwise, for projections where there are multiple points at a given pole, the vector components shall be resolved as if measured an infinitesimal distance from the Pole at the longitude corresponding to each grid point. At the North Pole, the West to East (x direction) component at a grid point with longitude L shall be resolved along the meridian 90 degrees East of L, and the South to North (y direction) component shall be resolved along the meridian 180 degrees from L. At the South Pole, the West to East component at a grid point with longitude L shall be resolved along the meridian 90 degrees East of L and the South to North component shall be resolved along L.

92.1.10.3 Otherwise, if there is only one Pole point, either on a cylindrical projection with all but one Pole point deleted, or on any projection (such as polar stereographic) where the Pole maps to a unique point, the West to East and South to North components shall be resolved along longitudes 270° and 0°, respectively at the North Pole and along longitudes 270° and 180°, respectively at the South Pole.

 Note: This differs from the treatment of the Poles in the WMO traditional alphanumeric codes.

92.1.11 The first and last grid points shall not necessarily correspond to the first and last data points, respectively, if the bit-map is used.

92.1.12 Items in sections 3 and 4 which consist of a scale factor F and a scaled value V are related to the original value L as follows:

L × 10F = V

92.2 **Section 0 – Indicator Section**

92.2.1 Section 0 shall always be 14 bytes long.

92.3 **Section 1 – Originator Section**

92.3.1 The length of the section, in units of bytes, shall be expressed over the group of the first four bytes, i.e. over the first 32 bits.

92.3.2 The section number shall be expressed in the fifth byte.

92.4 **Section 2 – Repetitions and Index section**

92.4.1 Regulations 92.3.1 and 92.3.2 shall apply.

92.5 **Section 3 – Time Domain section**

92.5.1 Regulations 92.3.1 and 92.3.2 shall apply.

92.5.2 The section unique identifier (SUI) shall be expressed in bytes 6 to 7 as an unsigned integer. SUI is a unique identifier within the message for the section. Repeated sections can just refer back to the first instance by using the same SUI, without the need to explicitly repeat the section in full. In this case the length of section will be 7 bytes.

92.6 **Section 4 – Horizontal Domain Section**

92.6.1 Regulations 92.3.1, 92.3.2 and 92.5.2 shall apply.

92.7 **Section 5 – Vertical Domain Section**

92.7.1 Regulations 92.3.1, 92.3.2 and 92.5.2 shall apply.

92.8 **Section 6 – Generating Process Section**

92.8.1 Regulations 92.3.1, 92.3.2 and 92.5.2 shall apply.

92.9 **Section 7 – Observable Property Section**

92.9.1 Regulations 92.3.1, 92.3.2 and 92.5.2 shall apply.

92.10 **Section 8 – Data Representation Section**

92.10.1 Regulations 92.3.1, 92.3.2 and 92.5.2 shall apply.

92.11 **Section 9 – Overlay Section**

92.11.1 Regulations 92.3.1, 92.3.2 and 92.5.2 shall apply.

92.12 **Section 10 – Data Section**

92.12.1 Regulations 92.3.1 and 92.3.2 shall apply.

92.12.2 Data shall be coded using the minimum number of bits necessary to provide 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 (the power may be 0) before forming the non-negative differences, and then using the binary scaling to select the precision of the transmitted value.

92.12.3 The data shall be packed by the method identified in section 8.

92.12.4 Data shall be coded in the form of non-negative scaled differences from a reference value of the whole field plus, if applicable, a local reference value.

Notes:

(1) A reference value is normally the minimum value of the data set which is represented.

(2) For grid-point values, complex packing features are intended to reduce the whole size of the GRIB message (data compression without loss of information with respect to simple packing). The basic concept is to reduce data size thanks to local redundancy. This is achieved just before packing, by splitting the whole set of scaled data values into groups, on which local references (such as local minima) are removed. It is done with some overhead, because extra descriptors are needed to manage the groups’ characteristics. An optional pre-processing of the scaled values (spatial differencing) may also be applied before splitting into groups, and combined methods, along with use of alternate row scanning mode, are very efficient on interpolated data.

(3) For spectral data, complex packing is provided for better accuracy of packing. This is because many spectral coefficients have small values (regardless of the sign), especially for large wave numbers. The first principle is not to pack a subset of coefficients, associated with small wave numbers so that the amplitude of the packed coefficients is reduced. The second principle is to apply an operator to the remaining part of the spectrum: with appropriate tuning it leads to a more homogeneous set of values to pack.

(4) The original data value Y can be recovered with the formula:

Y × 10D = R + (X1 + X2) × 2E

For simple packing and all spectral data

E = Binary scale factor

D = Decimal scale factor

R = Reference value of the whole field

X1 = 0

X2 = Scaled (encoded) value.

 For complex grid-point packing schemes, E, D and R are as above, but

X1 = Reference value (scaled integer) of the group the data value belongs to

X2 = Scaled (encoded) value with the group reference value (X1) removed.

92.13 **Section 11 – End section**

92.13.1 The end section shall always be 4 bytes long, character coded according to the International Alphabet No. 5 as “7777”.