

WORLD METEOROLOGICAL ORGANIZATION

**Introduction to
GRIB Edition1 and GRIB Edition 2**

JUNE 2003



GRIB EDITION 1 and GRIB EDITION 2

HISTORY

1. The **GRIB** code has great advantages in comparison with the traditional alphanumeric codes, like GRID or GRAF. The main features of this code, and especially in a larger extent for GRIB Edition 2 (GRIB2), are self-description, flexibility and expandability, which are fundamental in times of fast scientific and technical evolution. In addition, GRIB offers condensation (packing). The alphanumeric codes GRID offered the facility of coding one or two parameters (more in a pre agreed standard format) at one level or between two levels or in a layer. GRAF was a simplified version of GRID. GRID allows direct readability but no packing, although compression could be applied to it by usually available commercial packages. GRIB has been approved for operational use in 1985. It has been used extensively by Producers of NWP products, and de-facto users of these data like the WAFS products users.

2. There was a freeze placed on the Edition 1 of FM 92 GRIB at the request of ICAO, which is using FM 92 GRIB Edition 1 for dissemination of WAFS products. GRIB 1 has weaknesses for transmission and archiving:

- Spectral data
- Multi-dimension data
- Long-range and climate products
- Ensemble products

Also:

- Saturated parameters tables
- No convention for missing data
- IEEE not used for floating point data
- No support for small time steps
- No cross-sections
- No time-sections
- No Hovmöller Diagrams (ex. Time-longitude)
- Limited support for images.

3. There was therefore a need to develop a new Edition 2 for FM 92 GRIB. After several years of development and two years of experimentation and validation tests, the WMO approved the Edition 2 of FM 92 GRIB for an operational WMO code as from 7 November 2001. The Edition 2 of GRIB enable the coding of new products, such as the output of ensemble prediction systems, long-range forecasts, climate predictions, ensemble wave forecasts or transport models, cross-sections and Hovmöller type diagrams. GRIB2 enable the representation of new products available today and provide easy facilities for expansion and additions. The structure of the Edition 2 of GRIB is more modular and object oriented than the Edition 1 of GRIB. In that way, future extensions will not upset support software. Definitions of parameters or attributes are separated in functionality and dimension

so that items related to time, purpose, production method, space, etc. are independent (orthogonal), which makes software maintenance easier when descriptions of new products or new parameters are required. GRIB2 permits the encoding, among others, of ensemble, probability, and percentile forecasts, forecast errors fields, matrices, satellite image data, radar data, the analysis and forecast of accumulated and averaged parameters, and offers enhanced capability to describe fields involving multiple time periods. Also, GRIB 1 format is compatible within GRIB 2 and GRIB2 supports more compression schemes (in particular with the introduction of JPEG 2000 and PNG).

4. Development is still carried out for the validation of templates for the transmission of cross-sections and Hovmöller type diagrams. The first products in GRIB 2 will be produced during 2003, by EUMETSAT and ECMWF.

CODE STRUCTURE

5. In these codes the data are described in the message itself: it is the self-description feature. There will be sections at the beginning of the report, which define what data are transmitted in this message. These sections will in fact contain pointers towards elements in predefined and internationally agreed tables (stored in the official WMO Manual on Codes). Once these sections are read, the following part of the message containing the data (the Data Section) can be understood. Indeed, the characteristics (name, unit, etc.) of the parameters to be transmitted must already be defined in the tables of the WMO Manual on Codes. The "pointers" in the description sections are in fact numbers, which correspond to entries in the GRIB Code tables of the WMO Manual.

6. The layout of the GRIB1 and GRIB 2 are the following:

GRIB1

SECTION 0 Indicator **section**
 SECTION 1 Product definition section
 SECTION 2 (**Grid description section**)
 SECTION 3 (Bit-map section)
 SECTION 4 Binary data **section**
 SECTION 5 7777 (End **section**)

GRIB2

SECTION 0 **Indicator Section**
 SECTION 1 **Identification Section**
 SECTION 2 (**Local Use Section**)
 SECTION 3 **Grid Definition Section**
 SECTION 4 **Product Definition Section**
 SECTION 5 **Data Representation Section**
 SECTION 6 (**Bit-map Section**)
 SECTION 7 **Binary Data Section**
 SECTION 8 **End Section**

7. The layout of GRIB2 Code Form is the following:

FM 92-XII GRIB - General Regularly-distributed Information in Binary form

CODE FORM:

SECTION 0	Indicator Section			
SECTION 1	Identification Section			
SECTION 2	(Local Use Section)			}
				}
SECTION 3	Grid Definition Section		}	}
			}	}
SECTION 4	Product Definition Section	}	}	}
		}	}	}
SECTION 5	Data Representation Section	}	}	}
		}	}	}
SECTION 6	Bit-map Section	}	}	}
		}	}	}
SECTION 7	Data Section	}	}	}
		}	}	}
SECTION 8	End Section			

8. Sections 0 in GRIB1 and 0 and 1 in GRIB2 are short sections, which identify the message. Section 2 in GRIB2 is an optional section that can be used to transmit any information or parameters for national purpose. It is somehow the equivalent of national groups in traditional alphanumeric codes.

9. Section 1 in GRIB1 defines time or time periods, parameter, level(s) and the grid used. It can be a pre-defined grid, just referenced by a number. If the grid is not defined already, the report must contain Section 2 which will define the grid according to predefined templates listed in the WMO Manual (e.g.: Mercator, Polar stereographic). Section 3 contains a "bit" map. If data is present at this grid point (listed in rows), the corresponding bit is set to 1. Section 4 starts by the definition of the packing scheme used (e.g. spherical harmonic coefficient, simple packing, complex packing, second order packing).

10. GRIB uses the concept of Template: "Description of the standardized layout of a set of data entities"

GRIB 1

SECTION 0 Indicator section

SECTION 1 Product definition section **Unique standard template**

SECTION 2 (Grid description section) **One of the standard templates describing a type of Grid**

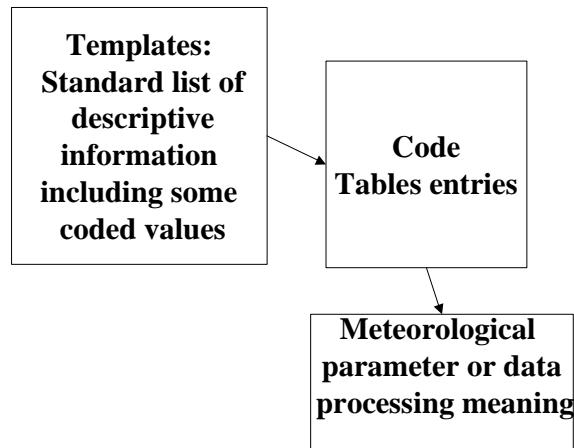
SECTION 3 (Bit-map section)

SECTION 4 Binary data section

SECTION 5 7777 (End section)

Filled standard templates described the data

GRIB Tables



SECTION 2: GRID DESCRIPTION SECTION (GDS)

Octet no.	Content
1 - 3	Length in octets of the Grid Description Section
4	NV, the number of vertical coordinate parameters
5	PV, the location (octet number) of the list of vertical coordinate parameters, if present or PL, the location (octet number) of the list of numbers of points in each row (when no vertical parameters are present), if present or 255 (all bits set to 1) if neither are present
6	Data representation type (See Code table 6)
7 - 32	Grid definition (according to data representation type - octet 6 above)
33-42	Extensions of grid definition for rotation or stretching of the coordinate system or Lambert conformal projection or Mercator projection
33-44	Extensions of grid definition for space view perspective projection
33-52	Extensions of grid definition for stretched and rotated coordinate system

GRIB 1 Grids

- 0 Latitude/Longitude Grid also called Equidistant Cylindrical or Plate Carree projection
- 1 Mercator Projection
- 2 Gnomonic Projection
- 3 Lambert Conformal, secant or tangent, conical or bipolar, projection
- 4 Gaussian Latitude/Longitude Grid
- 5 Polar Stereographic projection
- 6 Universal Transverse Mercator (UTM) projection
- 7 Simple polyconic projection
- 8 Albers equal-area, secant or tangent, conic or bi-polar, projection
- 9 Miller's cylindrical projection
- 10 Rotated latitude/longitude grid
- 11-12 *Reserved*
- 13 Oblique Lambert conformal, secant or tangent, conical or bipolar, projection
- 14 Rotated Gaussian latitude/longitude grid
- 15-19 *Reserved*
- 20 Stretched latitude/longitude grid
- 21-23 *Reserved*
- 24 Stretched Gaussian latitude/longitude grid
- 25-29 *Reserved*
- 30 Stretched and rotated latitude/longitude grid
- 31-33 *Reserved*
- 34 Stretched and rotated Gaussian latitude/longitude grid
- 35-49 *Reserved*
- 50 Spherical harmonic coefficients
- 51-59 *Reserved*
- 60 Rotated spherical harmonic coefficients
- 61-69 *Reserved*
- 70 Stretched spherical harmonics
- 71-79 *Reserved*
- 80-89 Stretched and rotated spherical harmonic coefficients
- 90 Space view perspective or orthographic
- 91-191 *Reserved*
- 192-254 *Reserved for local use*

11. A GRIB 1 message enables the transmission of one single field on a single grid at a single level or layer. In GRIB2, Section 3 defines the grid which will be used, however the whole set of sections 3 to 7 can be repeated allowing for different types of grid in the message (same for 2 to 7 if local parameters need to be defined) and thus allowing the coding of multi-grid, multi-product, multi-level and multi-parameter fields in a single message. Section 4 will define the product (parameter) and sections 4 to 7 can be repeated, if we have several parameters transmitted with the same grid. Section 5 will define the data representation type (packing scheme used). Sections 6 define the presence of data at each grid point, as applicable, and the data themselves are in section 7 (section 6 and 7 are like 3 and 4 in GRIB1). Standard templates predefined in the WMO Code Manual enable the accurate definition of grid, products and packing. Value of metadata or parameter are listed in the templates referencing Code tables (see Figure 1). These Code tables defined in the Manual are organised in a modular hierarchical ensemble, which allow for easy expansion and additions.

<u>Section</u>	<u>Section Name</u>	<u>Section Contents</u>
Section 0:	Indicator Section	“GRIB”, Discipline, GRIB Edition number, Length of message
Section 1:	Identification Section	Length of section, section number, characteristics that apply to all processed data in the GRIB message
Section 2:	Local Use Section (optional)	Length of section, section number, additional items for local use by originating centres
Section 3:	Grid Definition Section	Length of section, section number, definition of grid surface and geometry of data values within the surface
Section 4:	Product Definition Section	Length of Section, section number, description of the nature of the data
Section 5:	Data Representation Section	Length of section, section number, description of how the data values are represented
Section 6:	Bit-Map Section	Length of section, section number, indication of presence or absence of data at each grid point, as applicable
Section 7:	Data Section	Length of section, section number, data values
Section 8:	End Section	“7777”

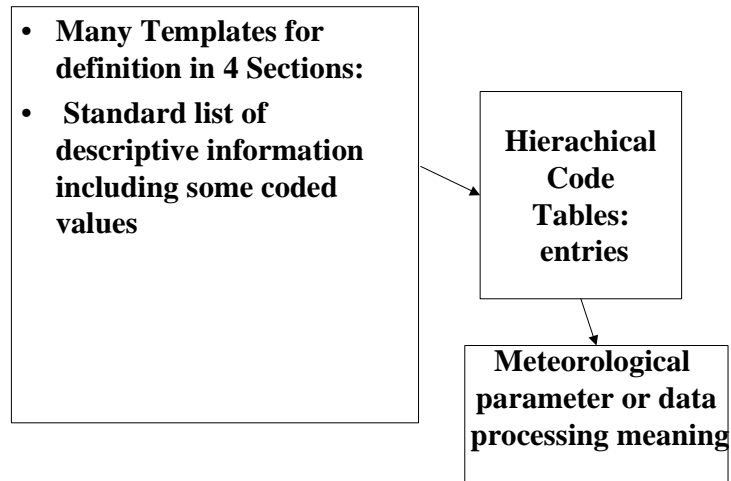
12. In GRIB2, when there is a requirement for transmission of new parameters or new data types, new elements will simply be added to the set of Tables in the Manual (to be agreed by CBS). Table driven codes can transmit an infinity of information. There is total flexibility. Definition of new «codes» as such is no more necessary. Expansion of tables is sufficient. Procedures and regulations are fixed. An edition number is associated for every new layout (not a frequent change). Edition number of the format (layout of the message) and version number of the tables are transmitted in the message itself (in Indicator and Identification sections) and enable the treatment of old archived data.

Extensive use of Templates in GRIB 2:

- SECTION 0 **Indicator Section**
- SECTION 1 **Identification Section**
- SECTION 2 **(Local Use Section)**
- SECTION 3 **Grid Definition Section = *Grid Definition Template (GDT)* - Standard list**
- SECTION 4 **Product Definition Section = *Product Definition Template (PDT)* - Standard list**
- SECTION 5 **Data Representation Section = *Data Representation Template (DRT)* - Standard list**
- SECTION 6 **(Bit-map Section)**
- SECTION 7 **Binary Data Section starting with *Data template (DT)***

Filled standard templates described the data

GRIB 2 Tables



GRIB 2 Grids

0	Latitude/longitude	Also called equidistant cylindrical, or Plate Carree.
1	Rotated latitude/longitude	
2	Stretched latitude/longitude	
3	Stretched and rotated latitude/longitude	
4-9	<i>Reserved</i>	
10	Mercator	
11-19	<i>Reserved</i>	
20	Polar stereographic	can be south or north.
21-29	<i>Reserved</i>	
30	Lambert Conformal	can be secant or tangent, conical or bipolar.
31-39	<i>Reserved</i>	
40	Gaussian latitude/longitude	
41	Rotated Gaussian latitude/longitude	
42	Stretched Gaussian latitude/longitude	
43	Stretched and rotated Gaussian latitude/longitude	
44-49	<i>Reserved</i>	
50	Spherical harmonic coefficients	
51	Rotated spherical harmonic coefficients	
52	Stretched spherical harmonic coefficients	
53	Stretched and rotated spherical harmonic coefficients	
54-89	<i>Reserved</i>	
90	Space view perspective orthographic.	
91-99	<i>Reserved</i>	
100	Triangular grid based on an icosahedron	
101-109	<i>Reserved</i>	
110	Equatorial azimuthal equidistant projection	
111-119	<i>Reserved</i>	
120	Azimuth-range projection	
121- 999	<i>Reserved</i>	
1000	Cross-section grid, with points equally spaced on the horizontal	
1001-1099	<i>Reserved</i>	
1100	Hovmöller diagram grid, with points equally spaced on the horizontal	

1101- 1199	<i>Reserved</i>
1200	Time section grid
1201-32767	<i>Reserved</i>
32768-65534	Reserved for local use
65535	Missing

USE OF GRIB2

13. GRIB2 contains all the parameter and products definitions enabling the coding of new products generated today by meteorological data processing centres. Fields like climatology and forecast products of ensemble prediction systems and long-range prediction, which necessitate the use of statistical values, can be easily coded. Furthermore the use of repetitive structures in a GRIB2 message, which allows the coding of multi-grid, multi-product, multi-level and multi-parameter fields, permit the transmission (in a big file indeed) of bulky output products generated by ensemble and long-range forecasting.

SOFTWARE

14. At CBS Ext.2002), ECMWF indicated that they will make software (FORTRAN and C language) running under UNIX and LINUX, for encoding/decoding GRIB1and/or GRIB2, available free of charge for WMO Members. Starting in 2003, the software can be downloaded from their Web site with appropriate documentation. ECMWF would upgrade the Code Tables and the programmes on the Web site, when necessary, and would provide some limited remote assistance after email queries.