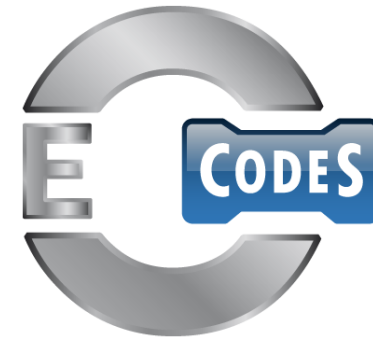


GRIB Keys

ecCodes GRIB Training Course

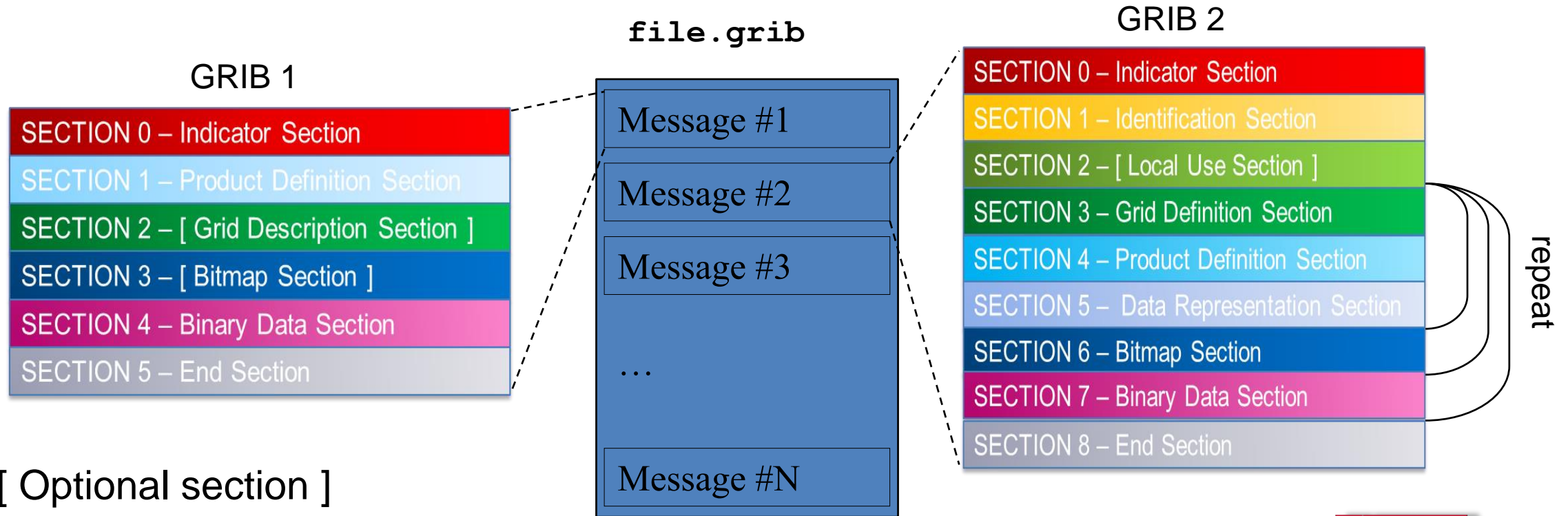
Xavier Abellan

Xavier.Abellan@ecmwf.int



GRIB format

47 52 49 42 00 00 66 01 00 00 1C 01 62 01 FF 80 33 6D 00 01 06 0C	GRIB f b "Ä3m
05 0C 00 0C 00 C8 05 00 00 00 15 00 00 00 00 00 32 02 2B 0A 00 F8	» 2 + -
01 90 80 33 C2 00 16 76 88 00 68 1A 00 76 F2 00 64 00 64 40 00 00	éÄ3- vâ h vÚ d d@
00 00 80 55 F0 80 9C 40 00 00 00 00 43 3E B0 71 00 00 00 00 00 00	ÄUÄÜ@ C>∞q
0C 08 80 11 3C 1F 09 7C 00 00 37 37 37 37	Ä < 7777



http://www.wmo.int/pages/prog/www/WMOCodes/WMO306_v12/LatestVERSION/LatestVERSION.html



GRIB edition 1 message

=====
MESSAGE 1 (length=4284072)

1-4 identifier = GRIB

5-7 totalLength = 4284072

8 editionNumber = 1

=====
SECTION_1 (length=52, padding=0) =====

1-3 section1Length = 52

4 table2Version = 128

5 centre = 98 [European Center for Medium-Range Weather Forecasts (grib1/0.table)]

6 generatingProcessIdentifier = 141

7 gridDefinition = 255

8 section1Flags = 128 [10000000]

9 indicatorOfParameter = 129 [Geopotential (m**2 s**-2) (grib1/2.98.128.table)]

10 indicatorOfTypeOfLevel = 1 [Surface (of the Earth, which includes sea surface) (grib1/3.table)]

11-12 level = 0

13 yearOfCentury = 16

14 month = 2

15 day = 24

16 hour = 0

17 minute = 0

18 unitOfTimeRange = 1 [Hour (grib1/4.table)]

...

47 52 49 42	00 00 66 01	00 00 1C 01	62 01 FF 80	33 6D 00 01	06 0C	GRIB f b "Ä3m
05 0C 00 0C	00 C8 05 00	00 00 15 00	00 00 00 00	32 02 2B 0A	00 F8	» 2 + -
01 90 80 33	C2 00 16 76	88 00 68 1A	00 76 F2 00	64 00 64 40	00 00	éÄ3- v à h vÚ d d@
00 00 80 55	F0 80 9C 40	00 00 00 00	43 3E B0 71	00 00 00 00	00 00	ÄUÄU@ C>∞q
0C 08 80 11	3C 1F 09 7C	00 00 37 37	37 37			Ä < 7777

GRIB edition 2 message

===== MESSAGE 1 (length=4284160)

1-4 identifier = GRIB
 5-6 reserved = MISSING
 7 discipline = 0 [Meteorological products (grib2/tables/5/0.0.table)]
 8 editionNumber = 2
 9-16 totalLength = 4284160

===== SECTION_1 (length=21, padding=0) =====

1-4 section1Length = 21
 5 numberOfSection = 1
 6-7 centre = 98 [European Centre for Medium-Range Weather Forecasts (grib1/0.table)]
 8-9 subCentre = 0
 10 tablesVersion = 5 [Version implemented on 4 November 2009 (grib2/tables/1.0.table)]
 11 localTablesVersion = 0 [Local tables not used (grib2/tables/5/1.1.table)]
 12 significanceOfReferenceTime = 1 [Start of forecast (grib2/tables/5/1.2.table)]
 13-14 year = 2016
 15 month = 2
 16 day = 22
 17 hour = 12
 18 minute = 0
 19 second = 0
 20 productionStatusOfProcessedData = 0 [Operational products (grib2/tables/5/1.3.table)]
 21 typeOfProcessedData = 1 [Forecast products (grib2/tables/5/1.4.table)]

===== SECTION_2 (length=17, padding=0) =====

1-4 section2Length = 17

...

47 52 49 42	00 00 66 01	00 00 1C 01	62 01 FF 80	33 6D 00 01	06 0C	GRIB f	b "Ä3m
05 0C 00 0C	00 C8 05 00	00 00 15 00	00 00 00 00	32 02 2B 0A	00 F8	»	2 +
01 90 80 33	C2 00 16 76	88 00 68 1A	00 76 F2 00	64 00 64 40	00 00	éÄ3- v à h vÚ d d@	
00 00 80 55	F0 80 9C 40	00 00 00 00	43 3E B0 71	00 00 00 00	00 00	ÄUÄÜ@	C>∞q
0C 08 80 11	3C 1F 09 7C	00 00 37 37	37 37			Ä <	7777

ecCodes approach

- ecCodes uses a **key / value approach** to access the information in a GRIB message

`numberOfPointsAlongAParallel` → Number of points along a parallel

`numberOfPointsAlongAMeridan` → Number of points along a meridian

- Each key has a native type (real, integer, string)
 - conversions are provided from one type to another when possible
- The set of keys available changes from one message to another depending on:
 - the GRIB edition
 - the content of the message
- Changing a key can cause some other keys to disappear or become available

ecCodes approach

- The value of a key is not always coded in the GRIB message because it can be the result of the combination of several other keys through a given algorithm or just temporary (transient). Therefore we talk about

- **CODED** keys (coded in the message as they are)
- **COMPUTED** keys (temporary or computed from other keys)

- Aliases are available for some of the keys

`numberOfPointsAlongAParallel` → `Ni` or `Nx` or `numberOfColumns`

`numberOfPointsAlongAMeridan` → `Nj` or `Ny` or `numberOfRows`

Keys and parameters for GRIB – THE Reference

- GRIB Parameters Database

- <http://apps.ecmwf.int/codes/grib/param-db>

- GRIB keys

- <http://apps.ecmwf.int/codes/grib/format/grib1/>

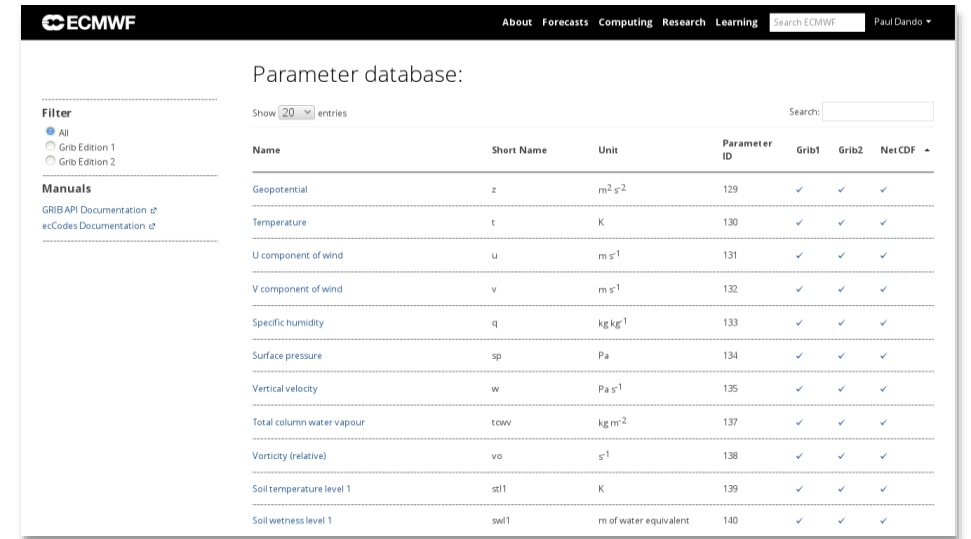
- <http://apps.ecmwf.int/codes/grib/format/grib2/>

- <http://apps.ecmwf.int/codes/grib/format/edition-independent/>

- Disclaimer

The official copy of the FM-92 GRIB document from which the relevant information contained in the following pages is copied can be obtained from the WMO web site:

<http://www.wmo.int/pages/prog/www/WMOCodes.html>



The screenshot shows the ECMWF Parameter database interface. It includes a search bar, a filter section with radio buttons for 'All', 'Grib Edition 1', and 'Grib Edition 2', and a 'Manuals' section with links to 'GRIB API Documentation' and 'ecCodes Documentation'. The main part of the interface is a table with the following columns: Name, Short Name, Unit, Parameter ID, Grib1, Grib2, and NetCDF. The table contains 11 rows of parameters, each with a checkmark in the Grib1, Grib2, and NetCDF columns.

Name	Short Name	Unit	Parameter ID	Grib1	Grib2	NetCDF
Geopotential	z	m ² s ⁻²	129	✓	✓	✓
Temperature	t	K	130	✓	✓	✓
U component of wind	u	m s ⁻¹	131	✓	✓	✓
V component of wind	v	m s ⁻¹	132	✓	✓	✓
Specific humidity	q	kg kg ⁻¹	133	✓	✓	✓
Surface pressure	sp	Pa	134	✓	✓	✓
Vertical velocity	w	Pa s ⁻¹	135	✓	✓	✓
Total column water vapour	tcwv	kg m ⁻²	137	✓	✓	✓
Vorticity (relative)	vo	s ⁻¹	138	✓	✓	✓
Soil temperature level 1	std1	K	139	✓	✓	✓
Soil wetness level 1	sw1	m of water equivalent	140	✓	✓	✓

ecCodes keys

- GRIB Tools: the easiest way to inspect a GRIB file and to find the keys:
 - `grib_ls` to get a summary of the content
 - `grib_dump` to get a more detailed view
- We will cover the tools later on in the course
- Most of what will follow will make more sense once you've had more hands-on experience!

Namespaces

- A namespace is a name for a set of keys
- A key belonging to a namespace can be get/set by prefixing it with the namespace or simply without any prefix:
 - `time.step == step`
 - `parameter.paramId == paramId`
- Several namespaces are available e.g.
 - parameter
 - time
 - geography
 - vertical
 - statistics

ecCodes keys – file related

Key name	Description
count	Message number in a file
countTotal	Message number in a set of files
offset	Position in bytes of the start of a message in a file

ecCodes keys – data values

Key name	Description
values	array of all the data values and missing values
numberOfCodedValues	number of values coded in the data section (excluding missing values)
numberOfPoints	number of grid points or size of the values array
numberOfMissing	number of missing values
max, min, average...	statistical information about the field
...	

ecCodes keys – parameter

- The definition of the parameter is very different in the two editions

GRIB 1 keys	GRIB 2 keys
centre	discipline
table2Version	parameterCategory
indicatorOfParameter	parameterNumber
levelType	typeOfFirstFixedSurface
level	scaleFactorOfFirstFixedSurface
...	scaledValueOfFirstFixedSurface
	typeOfSecondFixedSurface
	scaleFactorOfSecondFixedSurface
	scaledValueOfSecondFixedSurface
	productDefinitionTemplateNumber
	...

ecCodes keys – parameter

- ecCodes provides some **edition-independent** keys to identify a parameter

Key name	Example value
paramId	151
shortName	msl
centre	ecmf (or 98)
name	Mean sea level pressure
unit	Pa

- This set of keys is the parameter *namespace*

ecCodes keys – time

Start of forecast run	Example values
dataDate	20160224 (YYYYMMDD)
dataTime	0, 600, 1200, 1800

Forecast step	Example values
stepType	instant, accum, avg, max, min, ...
stepUnits	s, m, h, 3h, 6h, 12h, D, M, Y, 10Y, 30Y, C
startStep	0, 3, ...
endStep (= step)	0, 3, ..
stepRange	3-6, 6 (“startStep-endStep” , “endStep”)

Validity of the forecast	Example values
validityDate	20160224 (YYYYMMDD)
validityTime	0, 300, 1200, 1800

ecCodes keys – vertical and geography

Vertical namespace	Example values
typeOfLevel	hybrid, surface, depthBelowLandLayer, isobaricInhPa, ...
level	0, 1, 137, 1000, 850, ...

Geography namespace	Example values
Ni (Nx)	720
Nj (Ny)	361
gridType	reduced_gg, regular_ll, sh, ...
latitudeOfFirstGridPointInDegrees	90.0, 55.5, ...
longitudeOfFirstGridPointInDegrees	0.0, 350.0, ...
latitudeOfLastGridPointInDegrees	-90.0, 35.0, ...
longitudeOfLastGridPointInDegrees	360.0, 50.0, ...
iDirectionIncrementInDegrees	0.5, ...
jDirectionIncrementInDegrees	0.5, ...
N	640, 320, ...
...	...

ecCodes keys – geography arrays

- latitudes, longitudes
 - array with all the latitudes/longitudes for each point of the grid
- latLonValues
 - array with all the latitudes/longitudes/values for each point of the grid
 - (lat1,lon1,value1,lat2,lon2,value2,...,latN,lonN,valueN)

ecCodes keys – gridTypes

- For GRIB edition 1 and 2 :

- regular_ll
- reduced_ll
- mercator
- lambert
- polar_stereographic
- UTM
- simple_polyconic
- albers
- miller
- rotated_ll
- stretched_ll
- stretched_rotated_ll
- regular_gg
- rotated_gg
- stretched_gg

- stretched_rotated_gg
- reduced_gg
- sh
- rotated_sh
- stretched_sh
- stretched_rotated_sh
- space_view

- For edition 2 only:

- triangular_grid
- equatorial_azimuthal_equidistant
- azimuth_range
- cross_section
- Hovmoller
- time_section
- lambert_azimuthal_equal_area

ecCodes keys – gridType

- For the following gridTypes a list of the latitudes and longitudes of the grid points can be obtained with `grib_get_data` (tools) and through a `grib_iterator` in C/F90/Python.

<code>regular_ll</code>	regular latitude-longitude
<code>reduced_ll</code>	reduced latitude-longitude
<code>regular_gg</code>	regular gaussian
<code>lambert</code>	lambert conformal
<code>polar_stereographic</code>	polar stereographic
<code>space_view</code>	space view perspective

ecCodes keys – packingType

- For GRIB edition 1 and 2:
 - grid_simple
 - grid_simple_matrix
 - grid_second_order
 - spectral_complex
 - spectral_simple
- For edition 2 only:
 - grid_simple_log_preprocessing
 - grid_jpeg
 - grid_png
 - grid_ieee

ecCodes keys – MARS

- There is a namespace consisting of all the MARS keywords:

Key name	Example values
date	20160224 (YYYYMMDD)
time	0000, 0600, 1200, 1800
step	3, 6, 9, 12, ...
class	od, ...
stream	oper, enfo, ...
expver	0001
type	an, fc, cf, pf, ...
levtype	sfc, pl, ml
levelist	500, 850, ...
param	151.128

Questions?