Welcome in the fabulous world of GRIB coding – written by users for users

Making Everything Easier

GRIB2 and EcCodes for "DUMMIES"

Learn:

How to get through the GRIB2/EcCodes jungle!

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COSMO-GM 2019

Learn more about GRIB2 and ecCodes

Everything you always wanted
to know about GRIB2 and ecCodes
but were afraid to ask

GRIB2/EcCodes in a

NUTSHELL

with practical examples

GRIB2 / EcCodes for COSMO / ICON

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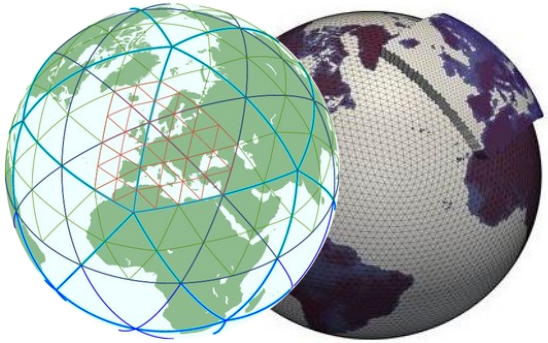

- ✓ GRIB2 structure compared to GRIB1?
- ✓ Basics, Features and Tools of EcCodes
- ✓ Interpretation and modifying of GRIB2 messages
- ✓ Coding differences ✉ What is new with GRIB2?
- ✓ FAQ / Summary + Support (💣 pitfall) / LINKS

WMO
GRIB(2) definition

GRIB? = WMO Binary Code Form: FM 92 GRIB

Standard code for forecast products

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- **GRI**dded **B**inary : Edition **0** (1985), Edition **1** (1990)
- **GRIB2 = G**eneral **R**egularly distributed **I**nformation in **B**inary form: Edition **2** (2001)

  http://www.wmo.int/pages/prog/www/WMOCodes/ManualonCodes.html

- Data encoded in GRIB consists of a continuous bit-stream made of a sequence of octets (1 octet = 8 bits).
- Self explaining, compressed, table (and template) driven format
- GRIB message contains **meta data** (explaining the product, grid,…) plus **packed data values**
- Updated twice a year: May 2019 (Version 23), November 2019 (Version 24)

- In GRIB 2 the description of the data (parameter, time, statistics, …) is **more complex** and is more template/table based
- In GRIB2 **a lot more meta data** are defined for accurate encoding
- In GRIB 2 several meta data are defined with **higher precision**
  - lat/lon are in micro-degrees
  - more (>255) vertical coordinate parameters possible
  - longer (3 vs 8 octets) GRIB message possible

Comparing GRIB1 – GRIB2

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DWD

GRIB 1
SECTION 0 Indicator (**GRIB**)

SECTION 1 Product definition
SECTION 2 Grid Description

SECTION 3 Bitmap
SECTION 4 Binary Data
SECTION 5 End (**7777**)

GRIB 2
SECTION 0 Indicator(**GRIB**,…)
SECTION 1 Identification
SECTION 2 (Local Use)
SECTION 3 Grid Definition
SECTION 4 Product Definition
SECTION 5 Data Representation
SECTION 6 Bitmap
SECTION 7 Binary Data
SECTION 8 End (**7777**)

template.3.xxx.def
template.4.xxx.def

- Each section first contains *length* and *number of section* plus content (mainly) provided via ***templates***
- Each section may contain local entries (local tables)
- Local section 2 is optional and defined by the originating center:
  - There could exist different sections 2 for one centre
  - For international exchange it is recommended NOT to use local section 2.
  - For international exchange it is recommended to waive local entries at all.

GRIB2: Grid and product templates (examples)

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DWD

Grid definition templates GDT (section 3)

Description of grid	GDT
Regular latitude / longitude	3.0
Rotated latitude / longitude (COSMO)	3.1
General unstructured grid (ICON)	3.101

Product definition templates (section 4)

4 templates for one kind of variable (here: common; extra for chemicals, tiles, aerosols, distribution function, …)	**Deter-ministic**	**Ensemble**
Point in time	PDT 4.0	PDT 4.1
Time interval	PDT 4.8	PDT 4.11

GRIB2: Templates of Section 4 (product)
WMO-Tab. 4.0 (Extract)

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DWD

Product for horizontal level or layer	Point in time	Time intervall
Analysis / Forecast (deterministic)	0	8
Analysis / Forecast (Ensemble)	1	11
Analysis / Forecast f. chem. element (deterministisch)	40	42
Analysis / Forecast f. chem. element (Ensemble)	41	43
Analysis / Forecast f. Aerosols (incl. particel size) (deterministic)	44	46
Analysis / Forecast f. Aerosols (incl. particel size) (Ensemble)	45	47
Analysis / Forecast error	7	-
Radar product	20	-
Satellite product - Observation	31	-
Satellite product - Forecast (synthetic)	32	-
Satellite product - Forecast (synthetic) (Ensemble)	33	34
„Partioned parameter“ (used for land use classes (external parameter))	53	54
„Tile“ : detertministic / ensemble	55/62	59/63
„Distribution function“ (Dust, Ash (COSMO/ICON-ART)): det./ens.	57/67	58/68
Further ensemble products: derived, properbilities, percentile, …	++++	++++

Element coding of model fields GRIB1 vs. GRIB2

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- GRIB1: Element coding by ee (element) and tab (table)

  Example: temperature is ee=11 in tab=2 (WMO)

- GRIB2: Element coding by a triplet

  discipline

  category

  parameter

  Example: temperature is (0,0,0)

Discipline	
0	**Meteorological products**
1	Hydrological products
2	Land surface products
3	Space products
	...
10	Oceanographic products

Product discipline 0 – Meteorological products

Category	Description
0	**Temperature**
1	Moisture
2	Momentum
3	Mass
4	Short-wave radiation
5	Long-wave radiation
6	Cloud
….	…..
20	Chemical constituents

Product discipline 0 – Meteorological products,
parameter category 0: temperature

Number	**Parameter**	Units
0	**Temperature**	**K**
1	Virtual temperature	K
2	Potential temperature	K
	……	
10	Latent heat net flux	W m–2
11	Sensible heat net flux	W m–2
	……	
18	Snow temperature (top of snow)	K

REGULATION GRIB2

92.6.2 To maintain orthogonal structure of GRIB Edition 2, **parameter names** in Code table 4.2 should **not** contain **surface type** and **statistical process** as part of the name.

See WMO Table **4.2**!

ECCODES
GRIB(2) definition

Basics
Features

EcCodes

https://confluence.ecmwf.int/display/ECC/ecCodes+Home

- Standard software for GRIB at DWD
- Developed at ECMWF for de-/encoding of GRIB1 AND GRIB2
- **EcCodes** (GRIB plus BUFR) **is an evolution of GRIB_API**
- No internal knowledge of GRIB structure needed (libDWD/GRIB1: arrays for sections)
- **Each element of a grib message has an alphanumeric name (key) that can be used to access the information linked to it (value)**

  key = value approach: **shortName** = **T_2M**
  typeOfLevel = **heightAboveGround**
  level = **2**

- Flexible – local definitions for each centre possible
  - ✓ local section 2 dependent on centre
  - ✓ local extensions of tables / local templates
  - ✓ local definition file **shortName.def** for edzw (DWD)

Basics: KEYS (Key names are case sensitive!)

(see ECMWF training material)

- There are **coded** (really in GRIB message) and **computed** keys. The computed ones are invented by EcCodes and are the result of a combination of keys or just temporary.

- Keys can have different **types** :
  - INTEGER key:i, REAL key:d, CHARACTER key:s.
  - The default (native) type is displayed if only „key“ is used.

- Keys are combined in **namespaces** :
  - parameter
  - time
  - vertical
  - geography

THINGS TO KNOW ABOUT KEYS !

- The set of keys available changes from one message to another as it depends on the content of the message.

- Changing the value of some keys can cause some other keys to disappear and new keys to be available.

EcCodes feature : shortName concept

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- The „shortName“ concept consists of a set of definition files
  - **shortName**.def
  - name.def ✉ description
  - units.def ✉ unit
  - paramId.def ✉ unique identifier
- shortName, name, … are **computed** keys defined by the originating centre, NOT **coded** in the GRIB message!
- This feature is designed for easy interpretation of a grib variable
- shortName is the acronym used in output NAMELIST &GRIBOUT (COSMO) or &output_nml (ICON)
- **int2lm** / **COSMO** code uses „shortName“ **directly**

  Each variable has to be defined in the definition file shortName.def (INPUT, OUTPUT)
- **ICON** code **does not** use „shortName“ **internally**, but the **INPUT** requires the shortName key and therefore the **DWD definition files**. **OUTPUT** can be generated with internal variable names and optional with shortNames.
- ICON I/O uses „shortName“ via provided so-called **dictionary** files. These dictionaries map the ICON internal variable names to GRIB2 shortNames.

  Each variable has to be defined in shortName.def and dictionary file
- **All COSMO centres should use the same definition files**

Meaning of shortName ?

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shortName is a „computed, edition independent key“ interpreting the defined variable, defined in „shortName.def“ for GRIB1 AND GRIB2.

GRIB1 shortName = T_2M	GRIB2 shortName = T_2M
#paramId: 500011 #2m Temperature 'T_2M' = { table2Version = 2 ; indicatorOfParameter = 11 ; indicatorOfTypeOfLevel = 105 ; level = 2 ; }	#paramId: 500011 #2m Temperature 'T_2M' = { discipline = 0 ; parameterCategory = 0 ; parameterNumber = 0 ; typeOfFirstFixedSurface = 103 ; scaleFactorOfFirstFixedSurface = 0 ; scaledValueOfFirstFixedSurface = 2 ; }

- paramId = unique identifier (paramId.def)
- GRIB1 name = GRIB2 name (name.def)
- ee/tab vs. dis/cat/par
- Level coding „height above ground“ different ✉ **typeOfLevel = ‚heightAboveGround‘**

shortName-Definition of different centers

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Variable	shortName		
	DWD centre=78	ECMWF centre=98	ECMWF products with DWD implementation
2m temperature	T_2M	2t	T_2M
Geopotential	FI	z	FI
Land cover (0=sea, 1=land)	FR_LAND	lsm	FR_LAND
Total precipitation	TOT_PREC	tp	TOT_PREC

DESIGN : Display of shortName

The ecCodes design is in a way that the shortNames defined for a special implementation (e.g. DWD) will be displayed independent of the coded centre.
This means that the DWD shortNames will be displayed also for centre=98 coded variables as long as there exists a definition.

DWD Implementation
Local configuration – local definition files

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ecCodes tool ***codes_info*** gives information of implemented version of ecCodes:

- ecCodes Version *2.12.0*
- **ECCODES_DEFINITION_PATH** (definition files)
- ECCODES_SAMPLES_PATH (sample files)

How is the DWD environment implemented?

(Get the DWD definition files from https://opendata.dwd.de/weather/lib/grib or https://github.com/COSMO-ORG/eccodes-cosmo-resources (MCH, Jean-Marie Bettems), only with github account)

1. Get **ECMWF** installation with default set of definition files (directory ***definitions***)
2. Get **DWD** definition files for the same version(for shortName etc; ***definitions.edzw***)
3. Set ECCODES_DEFINITION_PATH
   - The ECCODES_DEFINITION_PATH environment variable can be set to use local definition files instead of the definition files provided within the ECMWF distribution
   - **ECCODES_DEFINITION_PATH= < *definitions.edzw*>:< *definitions*>**
   - The library searches for each required definition file first in *definitions.edzw* and then in *definitions*
   - If the file is found in *definitions.edzw* then it is used by the decoding engine
   - The user can override all the definition files with his/her own definition files
   - In DWD *definitions.edzw* this is done mainly for parameter information

Use DWD implementation (centre=78) for COSMO partners (here: „cosmo“ (centre=250) and „lssw“ (centre=215))

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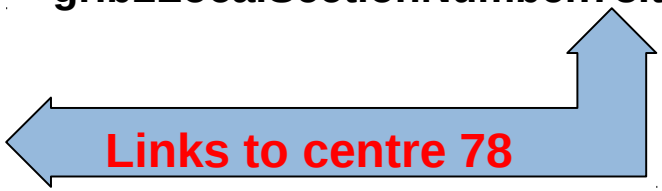
Links to centre 78 (edzw/DWD) are used for other centres to get the DWD definition files (Use „Link-Script“ provided together with DWD definitions)

Some files in directory ***definitions.edzw/grib2*** for **local section 2**:

grib2LocalSectionNumber.215.table -> grib2LocalSectionNumber.78.table
grib2LocalSectionNumber.250.table -> grib2LocalSectionNumber.78.table
grib2LocalSectionNumber.78.table
local.215.def -> local.78.def
local.250.def -> local.78.def
local.78.250.def
local.78.252.def
local.78.253.def
local.78.254.def
local.78.28.def
local.78.def



See the links in ***definitions.edzw/grib2/localConcepts*** for ***„local concept“:***

cosmo -> edzw
edzw
lssw -> edzw

✓ **shortName.def, name.def, units.def …**

WMO/ECCODES GRIB(2) definition

...

What else is new with GRIB2?

- independent keys (vertical, geography)
- new product identifying keys

Independent Keys: vertical

Coding of level and layer

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In **GRIB2** "level" and "layer" are coded as follows :

Computed keys **typeOfLevel**, **level**, **topLevel**, **bottomLevel** (layer) are defined by coded keys

- typeOf*First*FixedSurface
- scaleFactorOf*First*FixedSurface
- scaledValueOf*First*FixedSurface
- typeOf*Second*FixedSurface
- scaleFactorOf*Second*FixedSurface
- scaledValueOf*Second*FixedSurface

and for layer additionally

! **GRIB2 REG 92.1.12: Items in section 3 and 4 which consists of a scale factor F and a scaled value V are related to the original value L as follows: $L \times 10^{F} = V$**

Examples + model hybrid level/layer: GRIB1 109 / 110 -> GRIB2 105 / 2*105

+ depth below land (level/layer): GRIB1 111 / 112 -> GRIB2 106 / 2*106

■Layer GRIB1(DWD): level=bottomLevel, Layer **GRIB2: level=topLevel**

typeOfLevel=„depthBelowLand" or „depthBelowLandLayer“:

- Unit is **cm** for GRIB1 and it is **m** for GRIB2.
- It is recommended to use real values by **level:d, topLevel:d, bottomLevel:d** to get the correct values for 'depth below ground' in GRIB2.

! **Correction of GRIB1 W_SO, W_SO_ICE from level to layer in GRIB2**

New coding for model levels

NEW in GRIB2: typeOf*First/Second*FixedSurface=150

typeOfLevel=generalVertical/Layer introduces new (coded) keys

- **nlev** (number of „half levels“)
- **numberOfVGridUsed** (type of vertical coordinate)
- **uuidOfVGrid** (universal unique identifier)

➔ No vertical coordinate parameters any more

➔ Replaced by GRIB2 3D height messages (HHL)

! Vertical coordinates PV (only relevant for old GME or IFS model data)

- PVPresent=1, NV>0
- Array PV(1,…,NV) contains the vertical coordinates
- Delete PV array with tool **grib_set –s deletePV=1** (this includes PVPresent=0 AND NV=0)!!
- Ordering of hybride coordinates ak,bk:

  GRIB1 (GDS): ak1,ak2,ak3,….,bk1,bk2,bk3,bk4,… („not in use in intern.exchange“)

  GRIB2 (PDS): as pairs (ak1,bk1), (ak2,bk2), (ak3,bk3),…according to WMO, but in practical it is done as in GRIB1!!

Independent Keys: geography

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typeOfGrid

(= gridType)

- regular_ll
- rotated_ll
- triangular_grid
- unstructured_grid

NOTE ■

GRIB2: *Longitudes are from 0 – 360 degrees!*

GRIB1: Longitudes and latitudes in Milli-degrees (10^{-3} degrees)

GRIB2: *Longitudes and latitudes in Micro-degrees (10^{-6} degrees)*

USE **independent key**: latitudeOfFirstGridPoint**InDegrees** …

GRIB2: Product Identifying Keys

New information (meta data) = new keys

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Key	Description/Remark	Table
significanceOfReferenceTime	Analysis (0), start of forecast (1), …	WMO: 1.2
productionStatusOfProcessedData	Entries for operations (0), parallel suite (1) and experiments (2)	WMO: 1.3
typeOfProcessedData	Classification of products : rough subdivision in analysis (0/an), forecast (1/fc), …	WMO: 1.4
typeOfGeneratingProcess	Detailed definition of generation, e.g. ‘initialization‘ (1), including local entries as ‘nudging‘ (202), ‘invariant data‘ (196), …	WMO: 4.3
backgroundGeneratingProcessIdentifier	Discrimination between main run (0), assimilation (2), pre-assimilation (1)	Local table
localDefinitionNumber	Defines local section 2 ✉ 254 (det.), 253 (ens.), 252 (ens. Prod.), 250 (COSMO), 28 (COSMO-LEPS)	Local table
localVersionNumber *localNumberOfExperiment* *localInformationNumber* *localTypeOfEnsembleForecast* *localTypeOfEnsembleProductGeneration* *localTypeOfEnsemblePostprocessing* *localDecodeDate:s ; localValidityDate:s*	Keys in local section 2 (without COSMO-LEPS keys, depending on localDefinitionNumber)	

ECCODES
GRIB(2) definition

Tools

TOOLS – Interpreting and modifying GRIB messages

Help for syntax: grib_<tool> -h codes_<tool> -h

codes_info Information of implemented version of ecCodes
- ECCODES_DEFINITION_PATH (definition files)
- ECCODES_SAMPLES_PATH (sample files)

grib_ls List (short) of content
grib_dump Complete list of content
grib_count Number of messages in a file

grib_get Get key information
grib_set Set (modify) keys

grib_copy Copies the content of GRIB files printing values of some keys

TOOLS grib_ls / grib_dump

„List“ or „Dump“ of GRIB-Files:

grib_ls List of (meta) data content

grib_ls –p key1,key2,key3 file1

With key:s, key:l, key:d the output type is CHARACTER, INTEGER or REAL, for example: centre:s = edzw, centre:l = 78

■ **WARNING**: Default-List differs for GRIB1/2 and DWD/EZMW !

grib_dump comprehensive content of keys and their values (coded and computed)

grib_dump –O file1 *octet mode* (only coded keys!)

(WMO documentation style dump)

TOOLS grib_ls examples

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grib_ls file.grib2 ✉ defaults

edition	centre	date	dataType	gridType	typeOfLevel	level	stepRange	shortName	packingType
2	edzw	20160114	fc	rotated_ll	heightAboveGround	2	3	RELHUM_2M	grid_simple
2	edzw	20160114	fc	rotated_ll	surface	0	0-3	TOT_PREC	grid_simple
2	edzw	20160114	fc	rotated_ll	heightAboveGround	10	2-3	VMAX_10M	grid_simple
2	edzw	20160114	fc	rotated_ll	heightAboveGround	2	2-3	TMAX_2M	grid_simple
2	edzw	20160114	fc	rotated_ll	heightAboveGround	2	2-3	TMIN_2M	grid_simple
2	edzw	20160114	fc	rotated_ll	heightAboveGround	2	3	T_2M	grid_simple
2	edzw	20160114	fc	rotated_ll	surface	0	3	PS	grid_simple
2	edzw	20160114	fc	rotated_ll	isobaricInhPa	250	3	T	grid_simple
2	edzw	20160114	fc	rotated_ll	isobaricInhPa	500	3	T	grid_simple
2	edzw	20160114	fc	rotated_ll	isobaricInhPa	850	3	T	grid_simple
2	edzw	20160114	fc	rotated_ll	isobaricInhPa	1000	3	T	grid_simple

grib_ls file.grib1 ✉ grib_ls for GRIB1 : different output compared to GRIB2 (see above)

edition	centre	typeOfLevel	levels	dataDate	stepRange	shortName	packingType	gridType
1	edzw	hybridLayer	1-2	20160114	3	U	grid_simple	rotated_ll
1	edzw	hybridLayer	2-3	20160114	3	U	grid_simple	rotated_ll
1	edzw	hybridLayer	3-4	20160114	3	U	grid_simple	rotated_ll
1	edzw	hybridLayer	4-5	20160114	3	U	grid_simple	rotated_ll

grib_ls -PdateTime,centre:l file.grib1 ✉ additional keys dateTime and centre:l

dateTime	centre	edition	centre	typeOfLevel	levels	dataDate	stepRange	shortName	packingType	gridType
201601140000	78	1	edzw	hybridLayer	38-39	20160114	3	CLC	grid_simple	rotated_ll
201601140000	78	1	edzw	hybridLayer	39-40	20160114	3	CLC	grid_simple	rotated_ll
201601140000	78	1	edzw	hybridLayer	40-41	20160114	3	CLC	grid_simple	rotated_ll

TOOLS grib_ls examples „namespace“

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grib_ls -n parameter –wcount=13 laf2019032600 **(w = where; -wcount=13 -> 13 th field)**

centre	paramId	shortName	units	name
cosmo	500028	U	m s-1	U-Component of Wind

grib_ls -n time –wcount=13 lbff00030000

dataDate	dataTime	stepUnits	stepType	stepRange	startStep	endStep	validityDate	validityTime
20190326	0000	h	instant	3	3	3	20190326	300
			(accum	0-3	0	3)		

grib_ls -n vertical –wcount=13 laf2019032600

typeOfLevel	topLevel	bottomLevel
generalVerticalLayer	4	5

grib_ls -n geography –wcount=13 laf2019032600

Ni Nj iScansNegatively jScansPositively jPointsAreConsecutive latitudeOfFirstGridPointInDegrees longitudeOfFirstGridPointInDegrees latitudeOfLastGridPointInDegrees longitudeOfLastGridPointInDegrees iDirectionIncrementInDegrees jDirectionIncrementInDegrees latitudeOfSouthernPoleInDegrees longitudeOfSouthernPoleInDegrees angleOfRotationInDegrees gridType bitmapPresent

81 71 0 1 0
-16.125 344.281 -11.75 349.281
0.0625 0.0625
-40 10 0
rotated_ll 0

TOOLS grib_dump examples

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grib_dump –w count=1 -O file.grib2 ✉ **octal presentation of first field (extract)**

```
#==============   MESSAGE 1 ( length=349567 )          ==============
1-4      identifier = GRIB
5-6      reserved = MISSING
7     discipline = 0 [Meteorological products  (grib2/tables/16/0.0.table) ]
8     editionNumber = 2
9-16      totalLength = 349567
======================   SECTION_1 ( length=21, padding=0 )    ======================
…
6-7      centre = 78 [Offenbach  (RSMC)  (grib2/centre.table) ]
….
12   significanceOfReferenceTime = 1 [Start of forecast  (grib2/tables/16/1.2.table) ]
13-14     year = 2016
15   month = 1
16   day = 14
17   hour = 0
18   minute = 0
19   second = 0
20   productionStatusOfProcessedData = 9 [Uncertainties in ensembles of regional reanalysis project test  (UERRA)  (grib2/tables/16/1.3.table) ]
21   typeOfProcessedData = 1 [Forecast products  (grib2/tables/16/1.4.table , grib2/tables/local/edzw/1/1.4.table) ]
======================   SECTION_3 ( length=84, padding=0 )    ======================  SECTION_2 not defined
……definition of grid ……..
======================   SECTION_4 ( length=34, padding=0 )    ======================
…
8-9      productDefinitionTemplateNumber = 0 [Analysis or forecast at a horizontal level or in a horizontal layer at a point in time  (grib2/tables/16/4.0.table ,
grib2/tables/local/edzw/1/4.0.table) ]
22   parameterCategory = 1 [Moisture  (grib2/tables/16/4.1.0.table , grib2/tables/local/edzw/1/4.1.0.table) ]
11   parameterNumber = 1 [Relative humidity  (%)  (grib2/tables/16/4.2.0.1.table , grib2/tables/local/edzw/1/4.2.0.1.table) ]
12   typeOfGeneratingProcess =2 [Forecast  (grib2/tables/16/4.3.table , grib2/tables/local/edzw/1/4.3.table) ]
13   backgroundProcess = 255 [missing (grib2/tables/local/edzw/1/backgroundProcess.table) ]
14   generatingProcessIdentifier = 135 [c2_fc  (old name: LM2MO)  (grib2/tables/local/edzw/1/generatingProcessIdentifier.table) ]
…..
18   indicatorOfUnitOfTimeRange = 1 [Hour  (grib2/tables/16/4.4.table) ]
19-22     forecastTime = 3
23   typeOfFirstFixedSurface = 103 [Specified height level above ground  (m)  (grib2/tables/16/4.5.table , grib2/tables/local/edzw/1/4.5.table) ]
24   scaleFactorOfFirstFixedSurface = 0
25-28     scaledValueOfFirstFixedSurface = 2
29   typeOfSecondFixedSurface = 255 [Missing (grib2/tables/16/4.5.table , grib2/tables/local/edzw/1/4.5.table) ]
30   scaleFactorOfSecondFixedSurface = MISSING
31-34     scaledValueOfSecondFixedSurface = MISSING
```

TOOLS grib_dump examples

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grib_dump –w count=1 file.grib2 ✉ including presentation of “computed keys” for first field in message

```
#==============   MESSAGE 1 ( length=349567 )          ==============
GRIB {
# Meteorological products  (grib2/tables/16/0.0.table)
 discipline = 0;  editionNumber = 2;
# Offenbach  (RSMC)  (grib2/centre.table)    centre = 78;  subCentre = 255;
# Start of forecast  (grib2/tables/16/1.2.table)    significanceOfReferenceTime = 1;
dataDate = 20160114;
 dataTime = 0;
dateTime = 201601140000;
 # Uncertainties in ensembles of regional reanalysis project test  (UERRA)  (grib2/tables/16/1.3.table)    productionStatusOfProcessedData = 9;
 # Forecast products  (grib2/tables/16/1.4.table , grib2/tables/local/edzw/1/1.4.table)    typeOfProcessedData = 1;
....
stepUnits = 1;
forecastTime = 3;
stepRange = 3;
# Specified height level above ground  (m)  (grib2/tables/16/4.5.table , grib2/tables/local/edzw/1/4.5.table)    typeOfFirstFixedSurface = 103;
 #-READ ONLY- unitsOfFirstFixedSurface = m;
 #-READ ONLY- nameOfFirstFixedSurface = Specified height level above ground ;
scaleFactorOfFirstFixedSurface = 0;
scaledValueOfFirstFixedSurface = 2;
 # Missing (grib2/tables/16/4.5.table , grib2/tables/local/edzw/1/4.5.table)    typeOfSecondFixedSurface = 255;
#-READ ONLY- unitsOfSecondFixedSurface = unknown;
#-READ ONLY- nameOfSecondFixedSurface = Missing;  scaleFactorOfSecondFixedSurface = MISSING;  scaledValueOfSecondFixedSurface = MISSING;
level = 2;
.....
shortName = RELHUM_2M;
.....
 #-READ ONLY- maximum = 100;
#-READ ONLY- minimum = 6.71332;
#-READ ONLY- average = 75.0553;
#-READ ONLY- numberOfMissing = 0;
#-READ ONLY- standardDeviation = 16.3698;
#-READ ONLY- skewness = -1.11381;
#-READ ONLY- kurtosis = 1.27099;
#-READ ONLY- isConstant = 0;
#-READ ONLY- getNumberOfValues = 174688;}
```

Additional statistics

TOOLS grib_get/grib_set

Get keys or set key-value-pairs:

grib_get –p key[:s,l,d] in.grib
grib_set –s key1=val1,key2=val2 in.grib out.grib

Get: *Minimum, maximum, average of values*

grib_get –p shortName,min,max,avg in.grib

Set: *GRIB2 format*

grib_set –s edition=2 in.grib1 out.grib2 ■ May NOT work! Use grib_filter!

Set : *Celsius instead of Kelvin (Bias)*

grib_set –s offsetValuesBy=-273.15 TK.grib TC.grib

Set : *Scale with factor*

grib_set –s scaleValuesBy=0.968 X.grib Y.grib

Copy messages with grib-copy

grib_copy [options] grib_file output_grib_file

Example 1: *Extraction of desired fields (here: Temperature)*

grib_copy –wshortName=T input.grib T.grib

Example 2: *Split one file into its messages (one file per shortName)*

grib_copy input.grib [shortName].grb

Example 3: *Convert multi-GRIB-fields to single fields*

grib_copy multi.grib2 single.grib2

Compare 2 GRIB files

grib_compare [options] grib_file1 grib_file2

Filter a GRIB file according to given rules (*special syntax for rules file!)*

grib_filter [options] rules_file grib_file

WMO/ECCODES
GRIB(2) definition

Summary / FAQ / Links

GRIB1 vs GRIB2

Short summary of major differences with „solutions“

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- **Different definition of „level“ for layers in GRIB1 and GRIB2**
  - ➔ Use *"topLevel"* and *"bottomLevel"* instead
- **Depth below ground in cm (GRIB1) or m (GRIB2)**
  - ➔ Use ***level:d, topLevel:d, bottomLevel:d*** or coded keys ***scaledValueOfFirstFixedSurface/scaleFactorOfFirstFixedSurface*** to show correct values when using grib_ls or grib_get
- In GRIB2 **W_SO** and **W_SO_ICE** are coded as **layers**
- **New vertical coordinate: generalVertical(Layer)**
  - ➔ No vertical coordinate parameters any more but GRIB2 3D height fields (HHL)
- **Longitudes and latitudes in „milli“- (GRIB1) or „micro degrees“ (GRIB2)**
  - ➔ Use the independent keys ***".....InDegrees"***
- **GRIB2: Range of longitudes only from 0 - 360 Degrees! No negative values.**
- **Special case "constant data"**

(isConstant=1, numberOfBits=0, only reference value, no data)

FAQ – See also ECMWF FAQ

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FAQ	ANSWER

Useful Links

Deutscher Wetterdienst
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WMO

Manual on Codes (Volume I.2, Part B)
http://www.wmo.int/pages/prog/www/WMOCodes/ManualonCodes.html
Extracted GRIB2 Templates and Tables / Common code tables
http://www.wmo.int/pages/prog/www/WMOCodes/WMO306_vI2/LatestVERSION/LatestVERSION.html

ECCODES / ECMWF

EcCodes HOME: https://confluence.ecmwf.int/display/ECC/ecCodes+Home
ECMWF parameter database: https://apps.ecmwf.int/codes/grib/param-db/

ECCODES / DWD

DWD eccodes definition files: https://opendata.dwd.de/weather/lib/grib

COSMO

GRIB documentation page
http://www.cosmo-model.org/content/model/documentation/grib/default.htm

ICON

ICON documentation
https://code.mpimet.mpg.de/projects/iconpublic/wiki/Documentation

THANKS FOR YOUR ATTENTION

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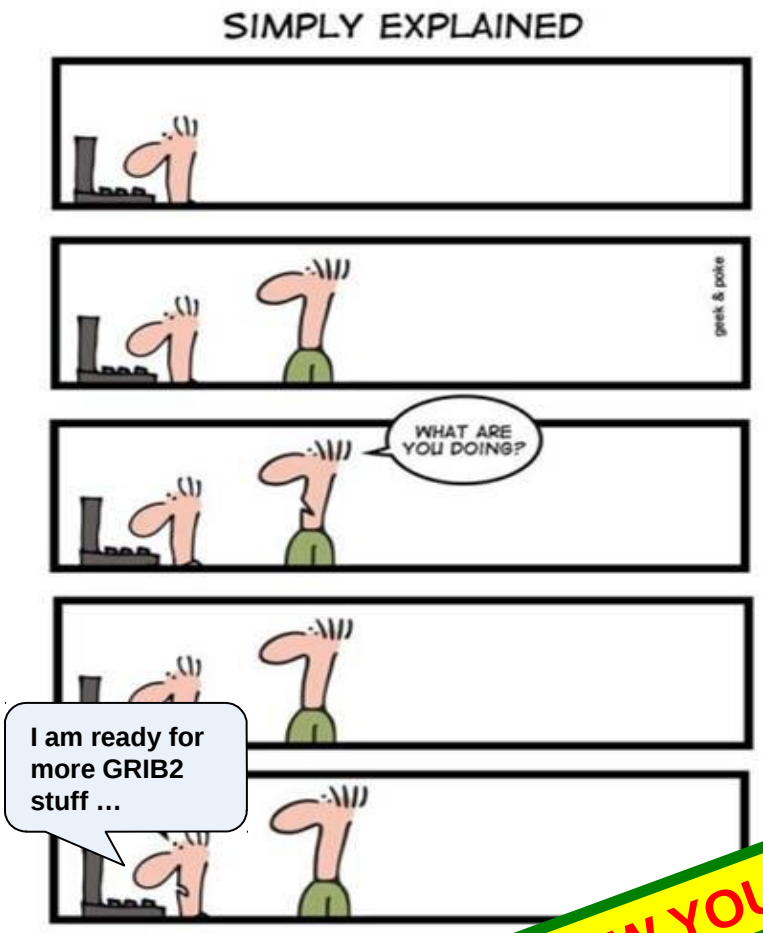

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GRIB2 and EcCodes

for

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