Using GRIB Tools

Computer User Training Course 2018

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Contents

ecCodes command line tools – basic concepts

- The ecCodes tools are a set of command line programs for interactive and batch processing of GRIB data
- Provide ready and tested solutions to the most common processing of GRIB data
- Their use will avoid the need to write new code and thus speed up your work
  - Consider using ecCodes tools instead of writing your own program
- The tools are provided with a common set of options so that it is quick to apply the same options to different tools
- Use of the tools is recommended whenever possible!

GRIB Tools – basics

All tools use a common syntax

grib_<tool> [options] grib_file [grib_file] … [output_grib]

There are tools to

- count the messages in a GRIB file
  - grib_count
- inspect the content of and compare GRIB files
  - grib_ls, grib_dump, grib_get, grib_get_data, grib_compare
- copy some messages
  - grib_copy
- change the content of a GRIB message
  - grib_set, grib_filter
- convert a GRIB file to netCDF format
  - grib_to_netcdf

Getting help

- **UNIX ‘man’-style pages are available for each tool by running the tool without any options or input file**

```
> grib_dump
NAME    grib_dump

DESCRIPTION
        Dump the content of a grib file in different formats.

USAGE
        grib_dump [options] grib_file grib_file ...

OPTIONS
        -O      Octet mode. WMO documentation style dump.
        -D      Debug mode.
        -d      Print all data values.
…
```

Generic ecCodes tools

- There is a tool for getting information about the ecCodes installation
  - codes_info
- There is a tool for counting GRIB or BUFR messages
  - codes_count
- There is a tool to split an input file (GRIB, BUFR etc) into chunks of roughly the same size
  - codes_split_file

codes_info – information about ecCodes installation

The generic codes_info tool gives basic information about the ecCodes package being used

- ecCodes Version
- Path to definition files: ECCODES_DEFINITION_PATH
- Path to sample files: ECCODES_SAMPLES_PATH

```
> codes_info
ecCodes Version 2.6.0

Default definition files path is used:
   /usr/local/apps/eccodes/2.6.0/GNU/5.3.0/share/eccodes/definitions
Definition files path can be changed setting ECCODES_DEFINITION_PATH environment variable

Default SAMPLES path is used:
   /usr/local/apps/eccodes/2.6.0/GNU/5.3.0/share/eccodes/samples
SAMPLES path can be changed setting ECCODES_SAMPLES_PATH environment variable
```

ecCodes documentation

- **The ecCodes documentation and support pages are available at**

  https://software.ecmwf.int/wiki/display/ECC/ecCodes+Home

- **The GRIB Tools are documented at**

  https://software.ecmwf.int/wiki/display/ECC/GRIB+tools

  Includes some examples of how to use the tools

- **The ecCodes software can be downloaded from**

  https://software.ecmwf.int/wiki/display/ECC/Releases

ecCodes keys and parameters for GRIB – THE Reference

- Parameters in GRIB
  - GRIB Parameter Database - http://apps.ecmwf.int/codes/grib/param-db

- ecCodes GRIB keys - http://apps.ecmwf.int/codes/grib/
  - GRIB Edition 1 - http://apps.ecmwf.int/codes/grib/format/grib1/
  - GRIB Edition 2 - http://apps.ecmwf.int/codes/grib/format/grib2/
  - GRIB Edition Independent - http://apps.ecmwf.int/codes/grib/format/edition-independent/

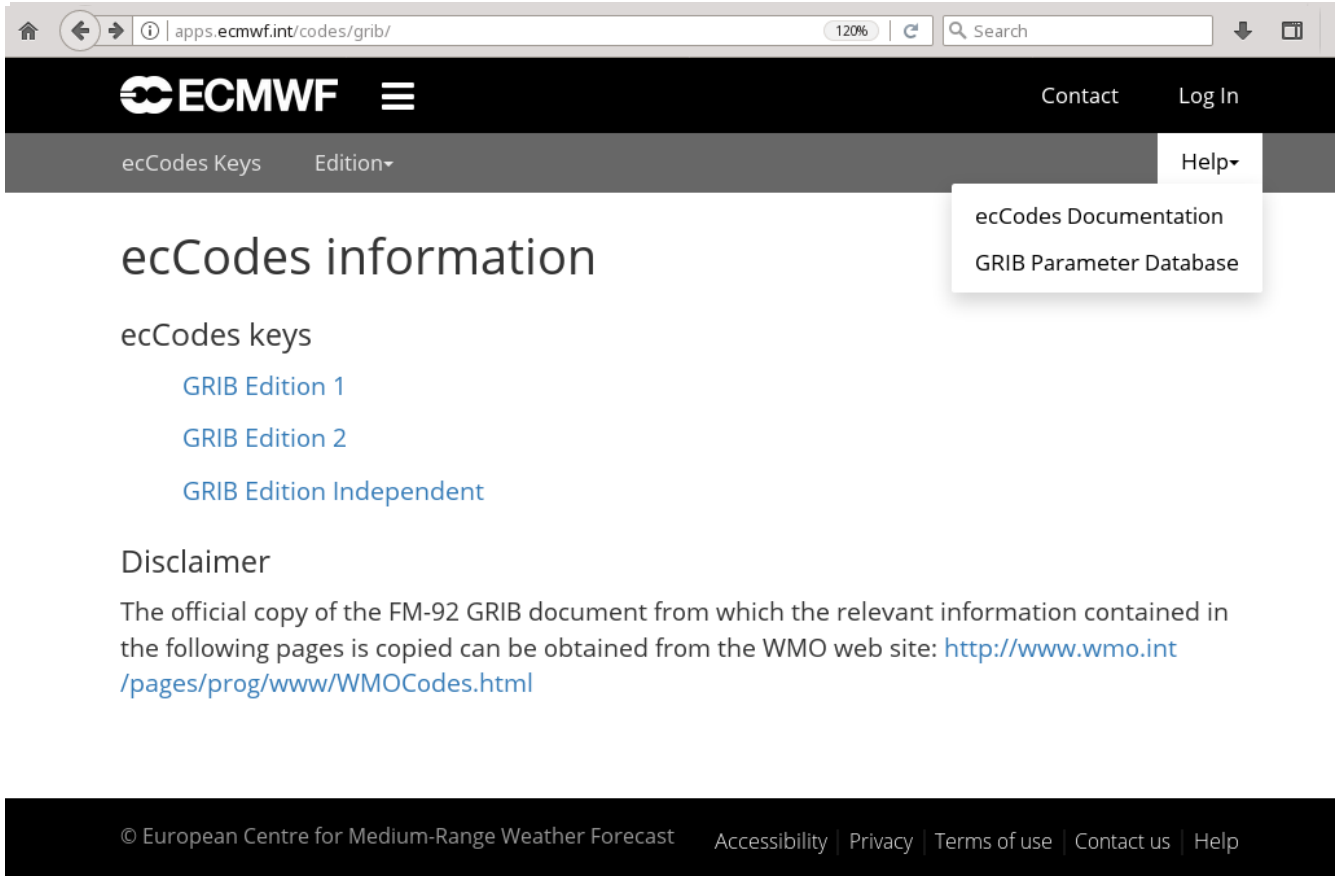
Disclaimer

The official copy of the FM-92 GRIB document from which the relevant information contained in above pages is derived can be obtained from the WMO web site: http://www.wmo.int/pages/prog/www/WMOCodes.html

GRIB keys

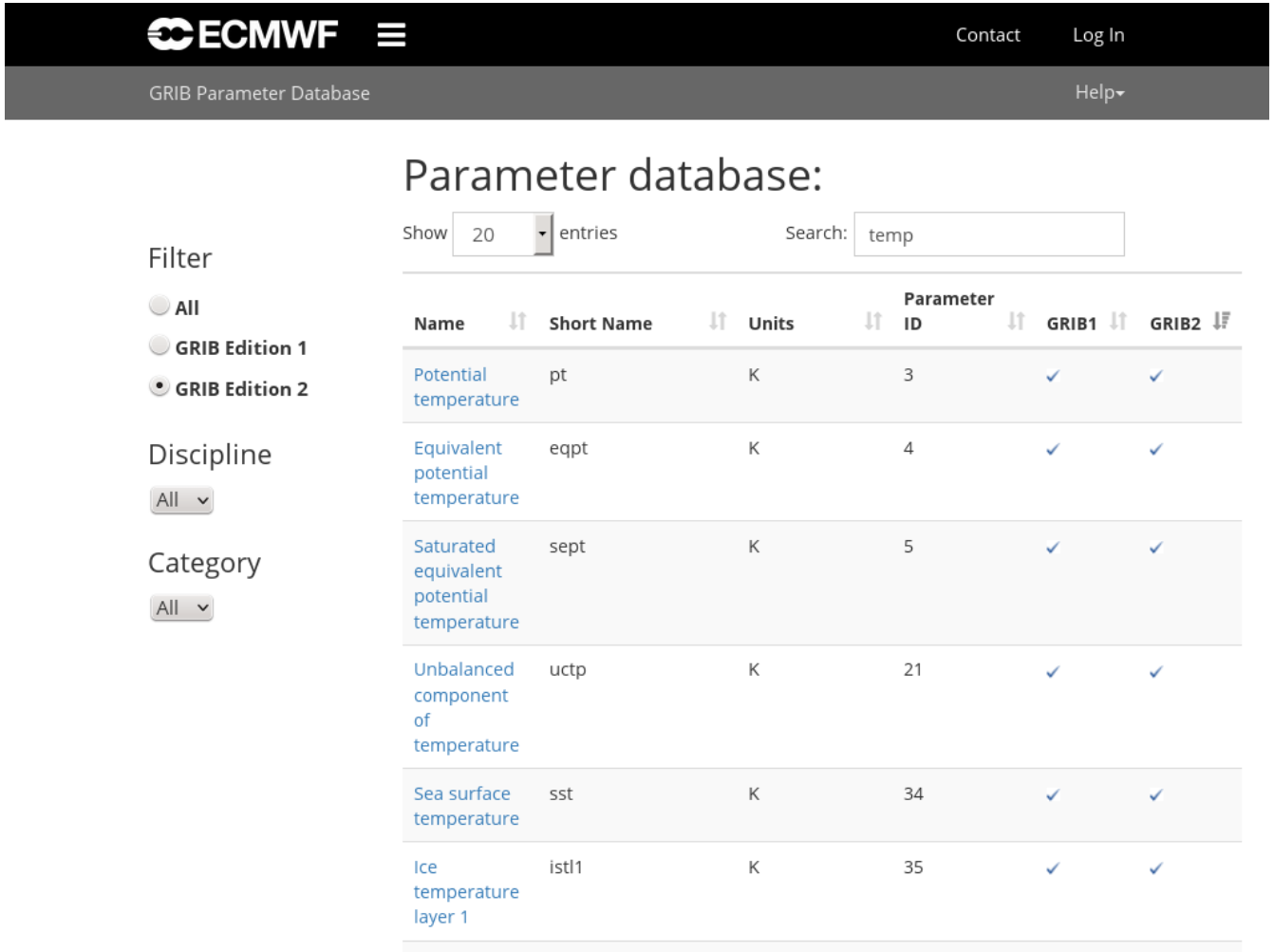
- **For definitions of edition independent keys, GRIB1 or GRIB2 keys see http://apps.ecmwf.int/codes/grib/**

- **Usage of edition independent keys should be preferred**



The parameter database

- The parameter database stores information about the GRIB 1 and GRIB 2 encoding of all parameters recognised by ecCodes



- The database is accessible via a web interface at: http://apps.ecmwf.int/codes/grib/param-db

grib_count – count GRIB messages

- **Counts (very quickly) the number of GRIB messages (only) in a list of files**
- **Syntax**

```
grib_count grib_file1 [grib_file2 …]
```

(takes wildcards)

grib_dump – dump content of GRIB files

- **Use grib_dump to dump the content of a file containing one or more GRIB messages**
- **Various output formats are supported**
  - **Octet mode provides a WMO documentation style dump**
  - **Debug mode prints all keys available in the GRIB file**
  - **Octet and Debug modes cannot be used together**
  - **Octet content can also be printed in hexadecimal format**
- **Options also exist to print key aliases and key type information**
- **Output to JSON (JavaScript Object Notation)**
  - **Easy to process**

grib_dump – usage

```
grib_dump [options] grib_file grib_file …
```

Basic options

`-O`	Octet mode (WMO documentation style)
`-D`	Debug mode
`-a`	Print key alias information
`-t`	Print key type information
`-H`	Octet content in Hexadecimal
`-D`	Debug mode
`-w key[:{s|i|d}]{=|!=}value,…`	Where clause
`-j`	JSON output
`-V`	Print ecCodes Version

…

grib_dump – examples

```
> grib_dump file.grib1
***** FILE: file.grib1
#==============   MESSAGE 1 ( length=3280398 )             ==============
GRIB {
  editionNumber = 1;
  table2Version = 128;
  # European Center for Medium-Range Weather Forecasts (grib1/0.table)
  centre = 98;
  generatingProcessIdentifier = 139;
  # Geopotential  (m**2 s**-2)  (grib1/2.98.128.table)
  indicatorOfParameter = 129;
  # Isobaric level pressure in hectoPascals  (hPa)  (grib1/3.table)
  indicatorOfTypeOfLevel = 100;
  level = 1000;
  # Forecast product valid at reference time + P1  (P1>0)  (grib1/5.table)
  timeRangeIndicator = 0;
  # Unknown code table entry (grib1/0.ecmf.table)
  subCentre = 0;
  paramId = 129;
  #-READ ONLY- units = m**2 s**-2;
  #-READ ONLY- nameECMF = Geopotential;
  #-READ ONLY- name = Geopotential;
  decimalScaleFactor = 0;
  dataDate = 20110223;
  dataTime = 1200; …
```

grib_dump – examples

```
> grib_dump -O file.grib1
***** FILE: file.grib1
#==============   MESSAGE 1 ( length=3280398 )             ==============
1-4       identifier = GRIB
5-7       totalLength = 3280398
8         editionNumber = 1
=================   SECTION_1 ( length=52, padding=0    ======================
1-3       section1Length = 52
4         table2Version = 128
5         centre = 98 [European Centre for Medium-Range Weather Forecasts (grib1/0.table) ]
6         generatingProcessIdentifier = 145
7         gridDefinition = 255
8         section1Flags = 128 [10000000]
9         indicatorOfParameter = 129 [Geopotential  (m**2 s**-2)  (grib1/2.98.128.table) ]
10        indicatorOfTypeOfLevel = 100 [Isobaric level pressure in hectoPascals(hPa)
                                                    (grib1/local/ecmf/3.table , grib1/3.table) ]
11-12     level = 1000
13        yearOfCentury = 16
14        month = 2
15        day = 27
16        hour = 12
17        minute = 0
18        unitOfTimeRange = 1 [Hour (grib1/4.table) ]
19        P1 = 0 …
```

grib_dump – examples

```
> grib_dump -OtaH  file.grib1
***** FILE: file.grib1
#==============   MESSAGE 1 ( length=3280398 )             ==============
1-4       ascii identifier = GRIB ( 0x47 0x52 0x49 0x42 )
5-7       g1_message_length totalLength = 3280398 ( 0x32 0x0E 0x0E )
8         unsigned editionNumber = 1 ( 0x01 ) [ls.edition]
======================   SECTION_1 ( length=52, padding=0 )    ======================
1-3       section_length section1Length = 52 ( 0x00 0x00 0x34 )
4         unsigned table2Version = 128 ( 0x80 ) [gribTablesVersionNo]
5         codetable centre = 98 ( 0x62 ) [European Center for Medium-Range Weather
             Forecasts (grib1/0.table) ] [identificationOfOriginatingGeneratingCentre, originatingCentre,
                                                                          ls.centre, centreForTable2]
6         unsigned generatingProcessIdentifier = 139 ( 0x8B ) [generatingProcessIdentificationNumber, process]
7         unsigned gridDefinition = 255 ( 0xFF )
8         codeflag section1Flags = 128 [10000000] ( 0x80 )
9         codetable indicatorOfParameter = 129 ( 0x81 ) [Geopotential  (m**2 s**-2) (grib1/2.98.128.table) ]
10        codetable indicatorOfTypeOfLevel = 100 ( 0x64 ) [Isobaric level pressure in hectoPascals  (hPa)
                                                          (grib1/3.table) ] [levelType, mars.levtype]
11-12     unsigned level = 1000 ( 0x03 0xE8 ) [vertical.topLevel, vertical.bottomLevel, ls.level, lev,
                                                                                mars.levelist]
13        unsigned yearOfCentury = 11 ( 0x0B )
14        unsigned month = 2 ( 0x02 )
15        unsigned day = 23 ( 0x17 )
16        unsigned hour = 12 ( 0x0C )
17        unsigned minute = 0 ( 0x00 ). . .
```

grib_dump – examples

```
> grib_dump -D  file.grib1
***** FILE: file.grib1
#==============   MESSAGE 1 ( length=9358 )
  :
======> section GRIB (9358,9358,0)
   0-0 constant ieeeFloats = 0
   ======> section section_0 (0,0,0)
      ----> label empty
   <===== section section_0
   0-4 ascii identifier = GRIB
   4-7 g1_message_length totalLength = 9358
   7-8 unsigned editionNumber = 1 [ls.edition]
   ======> section section_1 (52,52,0)
      :
      36-36 g1date dataDate = 20110223 [mars.date, time.dataDate]
      36-36 evaluate year = 2011
      36-36 time dataTime = 1200 [mars.time]
      36-36 julian_day julianDay = 2.45562e+06
      36-36 codetable stepUnits = 1 [Hour (stepUnits.table) ]
      36-36 concept stepType = instant
      36-36 g1step_range stepRange = 0 [time.stepRange]
      36-36 long_vector startStep = 0
      36-36 long_vector endStep = 0 [stepInHours, mars.step]
      36-36 mars_param marsParam = 129.128 [mars.param]
      36-36 validity_date validityDate = 20110223
      36-36 validity_time validityTime = 1200
    ...
```

In debug mode computed keys are shown

ls.<key> , mars.<key> and time.<key> denote keys in namespaces

ecCodes – namespaces

namespace	keys
ls	centre, shortName, level etc. used by the grib_ls tool
parameter	paramId, shortName, units etc. which relate to the meteorological parameter
statistics	maximum, minimum, average, standard deviation etc. related to the statistics of the data values
time	forecast date, validity date, steps etc. describing the forecast runs
geography	bounding box of the grid, number of points along a parallel etc. describing the grid geometry
vertical	type of the level, list of coefficients of the vertical coordinate etc. describing the levels and layers
mars	class, stream, type etc. used to describe the content of MARS (ECMWF's Meteorological Archival and Retrieval System)

Particularly useful with **`grib_ls`**

Practical

- Work in your $SCRATCH

```
cd $SCRATCH
```

- Make a copy of the practicals directory in your $SCRATCH

```
tar -xvf /home/ectrain/trx/ecCodes/grib_tools.tar
```

- This will create a directory in your $SCRATCH containing the GRIB data files for all the practicals
- There is a sub-directory for each practical:

```
ls $SCRATCH/grib_tools

grib_compare  grib_copy   grib_dump   grib_get  grib_ls

grib_set  . . .
```

Practical: using grib_dump

- Familiarise yourself with the web documentation by exploring the different keys available for type GRIB1 and type GRIB2 messages
  - Identify some keys common to both GRIB1 and GRIB2

- Experiment with using the different grib_dump options (`-O`, `-a` and `-t`). Inspect the GRIB message in the files file1.grib1 and file1.grib2 and identify:
  - the GRIB edition used to encode the messages
  - the (MARS)parameter ID, date, time, forecast step and the grid geometry

- What are the maximum, minimum and average values of the fields?

grib_ls – list the content of GRIB files

- **Use grib_ls to list the content of GRIB files**
- **Without options grib_ls prints a default list of keys**
  - **The default list printed is different for GRIB 1 and GRIB 2**
- **Options exist to specify the set of keys to print or to print keys in addition to the default set**
- **Output can be ordered**
  - **e.g. order by ascending or descending step**
- **grib_ls does not fail if a key is not found**
- **grib_ls can also be used to find the grid point(s) nearest to a specified latitude-longitude and print the value of the field at that point(s)**
  - **Modes available to obtain one or four nearest grid points**

grib_ls – usage

```
grib_ls [options] grib_file grib file …
```

Options

`-p key[:{s|i|d}],…`	Keys to print
`-P key[:{s|i|d}],…`	Additional keys to print
`-w key[:{s|i|d}]{=|!=}value,…`	Where clause
`-B “key asc, key desc…”`	Order by: “step asc, centre desc”
`-n namespace`	Print all the keys belonging to namespace (ls, parameter, statistics, geography, time, mars, vertical)
`-i index`	Data value corresponding to given index is printed
`-m`	Print MARS keys (short for –n mars)
`-W width`	Minimum column width (default 10)
…	

grib_ls – examples

Use `-p` option to specify a list of keys to be printed:

```
> grib_ls file.grib2
file.grib2
edition centre date     … gridType   …  typeOfLevel   level    shortName  packingType
2       ecmf   20110226 … reduced_gg …  isobaricInhPa  1000    q          grid_simple
2       ecmf   20110226 … reduced_gg …  isobaricInhPa  850     q          grid_simple
2       ecmf   20110226 … reduced_gg …  isobaricInhPa  700     q          grid_simple
2       ecmf   20110226 … reduced_gg …  isobaricInhPa  500     q          grid_simple
4 of 4 grib messages in file1.grib2

4 of 4 total grib messages in 1 files
```

```
> grib_ls -p centre:i,dataDate,shortName,paramId,typeOfLevel,level file.grib2
file.grib2
Centre     dataDate     shortName    paramId      typeOfLevel    level
98         20110226     q            133          isobaricInhPa  1000
98         20110226     q            133          isobaricInhPa  850
98         20110226     q            133          isobaricInhPa  700
98         20110226     q            133          isobaricInhPa  500
4 of 4 grib messages in file.grib1

4 of 4 total grib messages in 1 files
```

grib_ls – examples

- **When a key is not present in the GRIB file, it returns “not found” for this key**

```
> grib_ls -p my_key  file.grib1

file.grib1
my_key
not found

> echo $?

0
```

exit code returned = 0

- **Similar behaviour to grib_get (see later)**
  - **grib_ls is better for interactive use**
  - **use grib_get within scripts**

Using the ‘where’ option

- **The ‘where option’ `-w` can be used with all GRIB Tools**
- **Constraints are of the form key=value or key!=value**

```
-w key[:{s|i|d}]=value, key[:{s|i|d}]!=value
```

- **Messages are processed only if they match ALL key/value constraints**
- **Values separated by / represent “OR” condition**

```
> grib_ls -w levelType=pl file.grib1
...
> grib_ls -w step!=6,level=700/850 file.grib1
...
> grib_ls -w count=3 file.grib1
```

Practical: using grib_ls

- **Use grib_ls to inspect the files msl.grib1 and msl.grib2**
  - **Which keys does grib_ls show by default for the two files ?**
  - **What fields do they contain ?**
- **Use grib_ls to print the MARS keys**
- **Use grib_ls with other namespaces**
- **Use grib_ls to order the output by descending step**
- **Use grib_ls to print the centre, dataDate, stepRange, levelType, shortName and paramId for both files**
  - **Experiment with both –P and –p options and 'key:i', 'key:s'**

Finding nearest grid points with grib_ls

- **The value(s) of a GRIB field close to the point of a Latitude/Longitude can be found with grib_ls**

```
grib_ls –l Latitude,Longitude[,MODE,file] grib_file
```

MODE **Can take the values**

4	**Print values at the 4 nearest grid points (default)**
1	**Print value at the closest grid point**

file	**Specifies a GRIB file to use as a mask** **The closest *land* point (with mask ≥ 0.5) is printed**

- **GRIB files specified must contain grid point data**

Practical: using grib_ls –l

- **The file msl.grib1 contains the mean sea-level pressure from the ENS control forecast at 6-hourly time steps for the first 24 hours on a N100 regular Gaussian grid**
- **Find the value of the MSLP at the grid point nearest to ECMWF (Lat 51.42°N, Lon 0.95° W) at each forecast step**
  - **What is the lat-lon value of the grid point nearest to ECMWF ?**
  - **How far is the chosen grid point from ECMWF ?**
- **Change the command used to output only the forecast step and the MSLP value at the nearest grid point**
- **Change the command to output the MSLP values at the four grid points nearest to ECMWF**
- **Use the file lsm.grib1 to provide a land-sea mask**
  - **Are all four nearest grid points land points (mask ≥ 0.5) ?**

CodesUI

- **CodesUI** is a standalone, UNIX-based graphical user interface built on ecCodes to handle GRIB (and BUFR) data to
  - Inspect the overall structure of GRIB files
  - Examine data and metadata of the individual messages
- CodesUI shares its codebase with the Metview code examiners. It was packaged as a standalone software application with the minimum possible dependencies requiring only ecCodes and Qt5 for installation.
- Can be started up from the command line. E.g. on ecgate use

```
codes_ui -g [grib_file_1 grib_file_2 …]
```

CodesUI is currently still a beta version!

CodesUI: The user interface

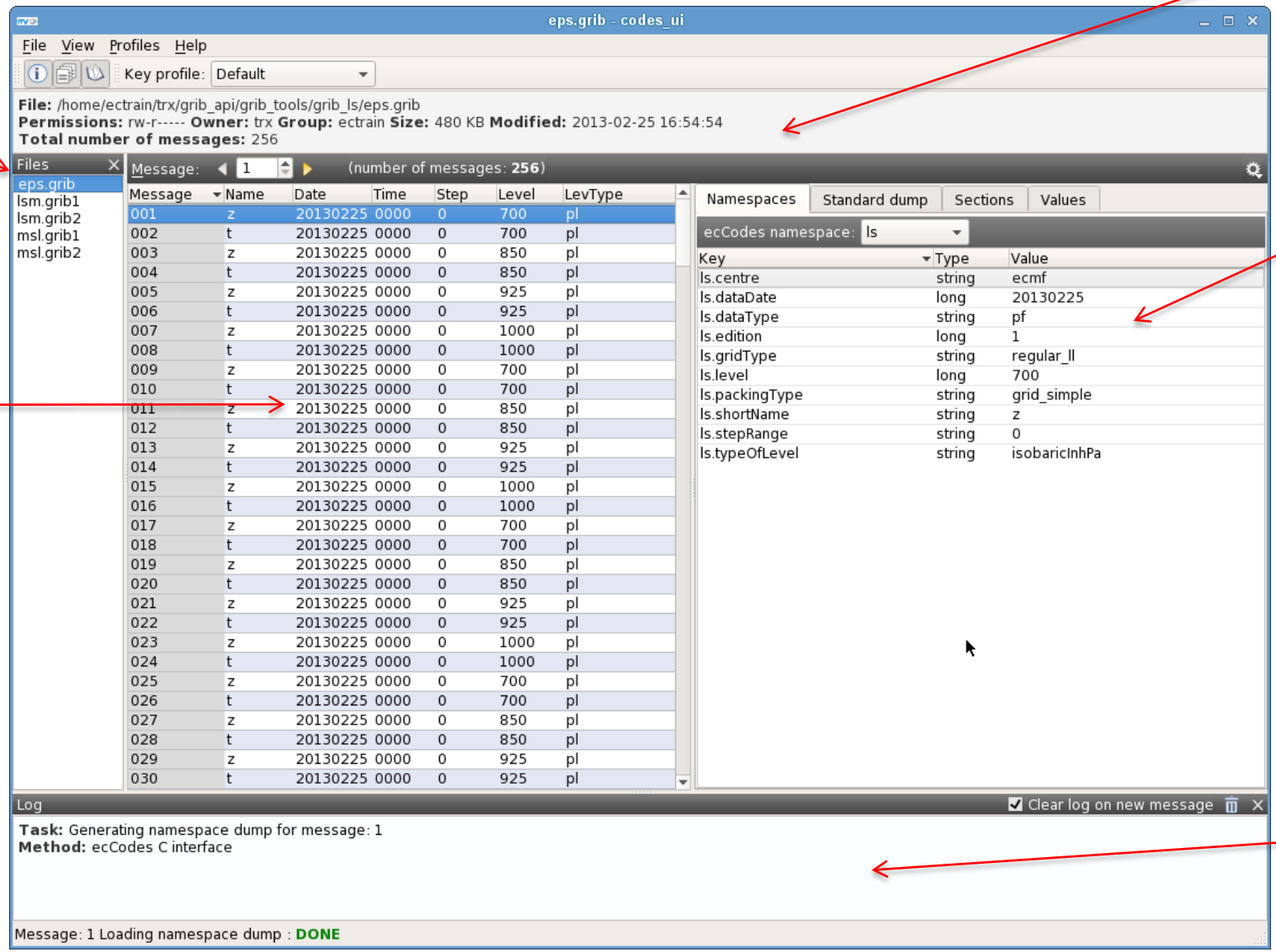
File information

File list

Message list (with user defined GRIB key selection)

Message content panel (grib_dump)

Log



CodsUI: Managing GRIB keys