Data Part 1

Download

Download the icons for this session from the link below. Create a sub-directory called `training` inside your Metview home directory, `$HOME/metview`, and save the .tar.gz file there. Then, from Metview, navigate to this folder and right-click on the tar.gz icon; choose **Extract** to uncompress the files into their folder. Work from there. The main instructions are written for participants of the Data analysis and visualisation using Metview training course at ECMWF. Any files to be copied from the file system will also be downloadable from this page.

File	Modified
ZIP Archive data 1.tar.gz	Sep 08, 2016 by Iain Russell
File ztuv.grb	Sep 08, 2016 by Iain Russell

Download All

Getting Data into Metview

Copying files and creating links

By default, Metview can only see files under the `$HOME/metview` directory. You can select a different home directory for Metview (`-u` option on the Metview startup command line), but you can also copy files into this directory (or a sub-directory of it) or create links to external data files - this can be useful if you have large data files which would exceed the quota in your home directory.

One way is to do this from a shell command line (`ln` command), but Metview can also create these links for you.

Right-click an empty spot in the Metview desktop and choose **Create New… Link to File** and type /home/ectrain/trx/mv_data/ztuv.grb into the **File name** box (or navigate there and select the file with the mouse). Note that the text label under the new icon is in italics, and there is an arrow in the bottom-left corner - these indicate that this is a link; if you hover the mouse cursor over the icon, the link details will be shown in the status bar. The padlock in the bottom-right corner tells us that this file is read-only. This file contains analysis and 1, 2, 3, 4 and 5-day forecasts for geopotential, temperature and wind at various pressure levels – **visualise** it to see for yourself.

You can create links to individual files or complete folders. This facility can be used to share folders between users.

Retrieving data from MARS

Metview has the ability to retrieve data directly from the ECMWF MARS archive (or indeed any other MARS archive installed outside ECMWF). Metview can also retrieve data from certain data sets without much special setup using the MARS Web API.

Create a new *Mars Retrieval* icon. Edit it and set only the following:

Grid	1.5/1.5

This ensures that the data is transformed onto a regular 1.5 degree grid. Much of Metview's functionality relies on GRIB data being on a grid (regular or quasi-regular) and not stored as spherical harmonics.

If you look at the other parameters in the icon editor, you will see that by default, it will retrieve analysis data (**Type** = An) of geopotential (**Param** = Z) on six pressure levels **(Levelist** = 1000/850/700/500/400/300) for yesterday (**Date** = -1).

Save the icon, then **visualise** it. The data should be retrieved, then visualised. From the titles of the different fields in the plot you can confirm that it is the correct data.

We will see in Processing Data how we can manipulate the data returned from MARS.

Icon Feedback

The *Mars Retrieval* icon gives us the opportunity to explore another feature of Metview. The colour of an icon's text label tells us which state it is in:

Black	No operation executed since last save (default)
Orange	Operation in progress, e.g. waiting for data retrieval from database
Green	Operation successfully executed, data may be cached for some icons
Red	Operation failed, e.g. due to invalid input parameters

The icon should currently be green, meaning that if you visualise it (or perform any other action on it), the data will not be retrieved again - the cached copy will be used instead. There are two ways to un-cache the data:

1. edit the icon and change at least one parameter (in this case, the cached data will no longer match the retrieval request, so it is deleted)
2. right-click on the icon and select **Clear result**

Use the second technique, then **execute** the icon and observe as the colour of its name changes.

Icon Output

By now you should have generated some log message, probably when you performed the MARS retrieval. Each icon has its own text output which can be viewed by selecting **Log** from the icon's right-click menu. This is only enabled when there is output for that icon, and is reset when the icon's contents change. Have a look at the log messages for the *Mars Retrieval icon* (ensure that you have retrieved data first).

You can view a complete history of output from all icons by selecting **Log** from the **Tools** menu in any **Metview desktop**.

For an even more detailed output, you can start Metview on the command line with the '-slog' option - this will write lots of information to your terminal window. This information can be useful when reporting a problem to the Metview team! '`metview -h`' gives a list of all useful command line options and environment variables.

Downloading files from URLs

Metview's *Download* module provides the means to download a file from an arbitrary URL.

Create a new *Download* icon, edit it and set:

Url	http://download.ecmwf.org/test-data/metview/gallery/2m_temperature.grib

Visualise the icon to retrieve the file and plot it. If there was a problem with the URL then look at the icon's log messages.

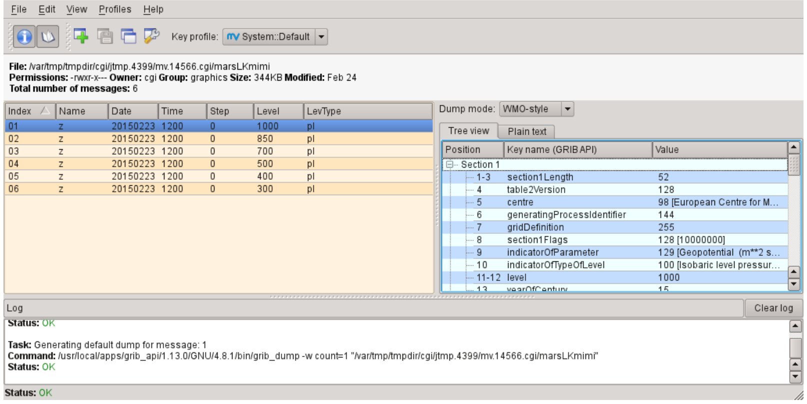
Saving results to disk

The data files cached by these icons will be removed when the current Metview session is terminated. To store a permanent copy, right-click on the icon and select **Save result**. Try this with either your *Mars Retrieval* or your *Download* icon.

Field Data in GRIB Files

ECMWF's model output fields are stored in GRIB format, so that is where much of Metview's functionality lies. The following sections will introduce some of the data inspection facilities available.

Examining GRIB Meta-data



File: /var/tmp/tmpdir/cgi/jtmp.4399/mv.14566.cgi/marsLKmimi
Permissions: -rwxr-x--- **Owner:** cgi **Group:** graphics **Size:** 344KB **Modified:** Feb 24
Total number of messages: 6

Index	Name	Date	Time	Step	Level	LevType
01	z	20150223	1200	0	1000	pl
02	z	20150223	1200	0	850	pl
03	z	20150223	1200	0	700	pl
04	z	20150223	1200	0	500	pl
05	z	20150223	1200	0	400	pl
06	z	20150223	1200	0	300	pl

Position	Key name (GRIB API)	Value
Section 1		
1-3	section1Length	52
4	table2Version	128
5	centre	98 [European Centre for M…
6	generatingProcessIdentifier	144
7	gridDefinition	255
8	section1Flags	128 [10000000]
9	indicatorOfParameter	129 [Geopotential (m**2 s…
10	indicatorOfTypeOfLevel	100 [Isobaric level pressur…
11-12	level	1000
13	yearOfCentury	15

```
Status: OK

Task: Generating default dump for message: 1
Command: /usr/local/apps/grib_api/1.13.0/GNU/4.8.1/bin/grib_dump -w count=1 "/var/tmp/tmpdir/cgi/jtmp.4399/mv.14566.cgi/marsLKmimi"
Status: OK
```

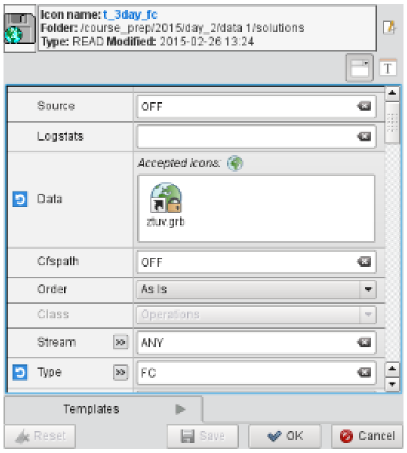
Status: OK

Right-click and **Examine** the *Mars Retrieval* icon (if for some reason the retrieval did not work, or you do not have access to MARS, then use *ztuv.grb* instead).

GRIB file. In this case we have 6 fields (messages) in the file, each represented by a row in the message list on the left-hand side. The right-hand side shows detailed meta-information for the selected message, presented in a number of different ways (try changing between **Tree view** and **Plain text**; try different **Dump modes**). You can sort the fields by clicking on the different column headers. The GRIB Examiner can be customised – see the extra tasks for this chapter, as this is an advanced topic.

Filtering GRIB Data

Metview provides powerful data filtering capabilities. Let's take our *ztuv.grb* file and extract the forecast and analysis data separately from it.



Icon name: t_3day_fc
Folder: /course_prep/2015/day_2/data 1/solutions
Type: READ **Modified:** 2015-02-26 13:24

Source	OFF
Logstats	
Data	ztuv.grb
Cfspath	OFF
Order	As Is
Class	Operations
Stream	ANY
Type	FC

Create a new *GRIB Filter* icon. This time we'll rename it from within the icon editor (just to show an alternative way to rename an icon). Edit the icon, and notice the button to the right of the information panel; click it and change the name of the icon to *t_3day_fc* - we will use this icon to extract only the 3-day forecast data for temperature.

First, we specify the input data. Drag the *ztuv.grb* icon into the **Data** field of the editor. This is an *icon field* – an area where you can drop other icons. Now set the following parameters to extract just the 3-day (72-hour) temperature forecast:

Type	FC or Forecast
Param	T or Temperature
Step	72

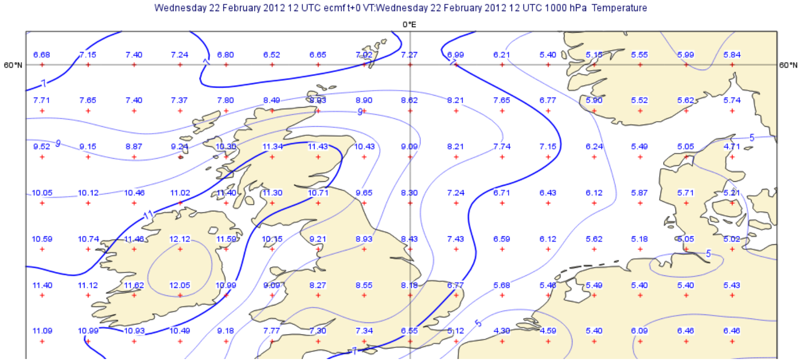
Visualise this icon and verify that it returns only the data we expect.

Now create a new *GRIB Filter* icon, rename it *t_an* and use it to extract only the temperature analysis data:

Type	AN or Analysis
Param	T or Temperature

It is quite often the case that GRIB data comes as several fields in the same file, and using the *GRIB Filter* icon is an easy way to extract just the fields you want without making copies of the file. This icon also has some parameters to perform some post-processing on the data, which we will cover in Processing Data.

Plotting Grid Values

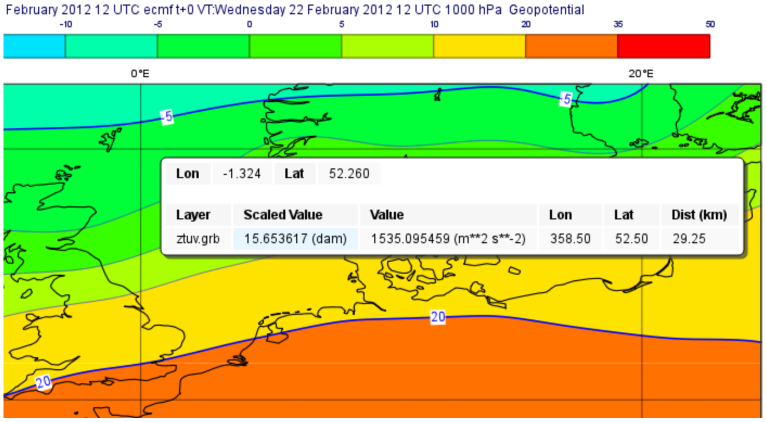


We will now plot the actual grid values. Create a new *Contour* icon and rename it *grid_10x10*. Edit it and find the set of parameters close to the bottom of the editor which control the plotting of grid values. Activate grid value plotting, set it to plot **both** values and markers, and set the lat/lon frequency each to 10. Visualise a scalar field (temperature or geopotential) from *ztuv.grb* and apply the new visdef icon to it - you will see every 10th grid point plotted. If you wish, you can also deactivate the isolines by setting **Conotur** to Off.

If you zoom into smaller areas, you may want to see every grid point - duplicate *grid_10x10* and call it *grid_1x1*. Set the lat/lon frequency to 1 - one fast way to do this is to click on the **blue 'revert' button** next to the parameter. This button does two things: it indicates that a parameter has been altered from its default, and it restores the parameter to its default when clicked.

Note that plotting every grid point value for a global plot of a high-resolution field can be slow; it also results in an unreadable plot, so it is not recommended!

Cursor Data

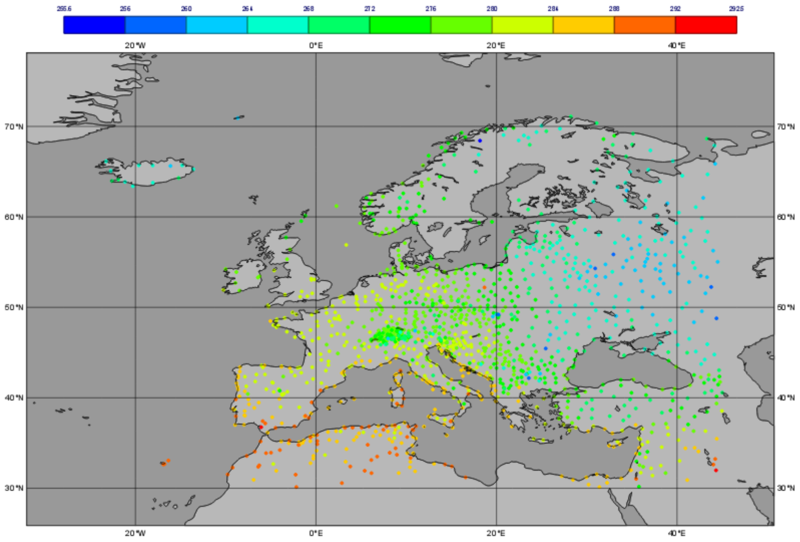

February 2012 12 UTC ecmf t+0 VT:Wednesday 22 February 2012 12 UTC 1000 hPa Geopotential
-10
-5
0
5
10
20
35
50
0°E
20°E
5
5
20
20

Lon	-1.324	Lat	52.260

Layer	Scaled Value	Value	Lon	Lat	Dist (km)
ztuv.grb	15.653617 (dam)	1535.095459 (m**2 s**-2)	358.50	52.50	29.25

As already seen in A Simple Visualisation, the Cursor Data can also be used to inspect grid point values. Activate it and check it against the plotted values!

Scattered Data in Geopoints files



Format overview

Geopoints is the ASCII format used by Metview to handle spatially irregular data (e.g. observations). There are a number of variations on the format, but the default one is a 6-column layout. The columns do not have to be aligned, but there must be at least one whitespace character between each entry.

This example shows a geopoints file containing dry bulb temperature at 2m (PARAMETER = 12004).

```
#GEO
PARAMETER = 12004
lat         long     level  date        time     value
#DATA
36.15       -5.35      0   19970810     1200     300.9
34.58       32.98      0   19970810     1200     301.6
41.97       21.65      0   19970810     1200     299.4
45.03        7.73      0   19970810     1200     294
45.67        9.7       0   19970810     1200     302.2
44.43        9.93      0   19970810     1200     293.4
```

If you have observation data which you wish to import into Metview, Geopoints is probably the best format because:

1. it is easy to write data into this format
2. Metview has lots of functions to manipulate data in this format

Variants of the format allow 2-dimensional variables to be stored (e.g. U/V or speed/direction wind components), and another variant stores only lat, lon and value for a more compact file.

Examining geopoints

Examine the supplied *geopoints.gpt* icon to confirm the contents of the file. The columns are sortable. You may wish to open the file in an external text editor to see exactly what it looks like.

Visualising geopoints

Visualise the icon. The visdef used for geopoints is *Symbol Plotting*, and its default behaviour is to plot the actual numbers on the map. This can become cluttered, and text rendering can be slow. Create a new *Symbol Plotting* icon and set the following parameters:

Legend	On
Symbol Type	Marker
Symbol Table Mode	Advanced
Symbol Advanced Table Max Level Colour	Red
Symbol Advanced Table Min Level Colour	Blue
Symbol Advanced Table Max Colour Direction	Clockwise

Rename the icon to *symb_auto* and drop it into the **Display Window** to see the points coloured according to their value.

Computing some statistics in Macro

First, we will print some information about our geopoints data. Create a new *Macro* icon, type this code and run it:

```
gp = read('geopoints.gpt')
print('Num points: ', count(gp))
print('Min value: ', minvalue(gp))
print('Max value: ', maxvalue(gp))
```

Perform a simple data manipulation and return the result to Metview's user interface:

```
return gp*100
```

Save the macro and see its result by right-clicking on its icon and choosing **examine** or **visualise**. We could also have put a `write()` command into the macro to write the result to a geopoints file.

Finding geopoints points within 100km of a given location

As a more complex example, we will combine two functions in order to find the locations of the points within a certain distance of a given location. We will use the same geopoints file as before.

The `distance()` function returns a new geopoints variable based on its input geopoints, where each point's value has been replaced by the distance of that point from the given location. The description of this function follows:

```
geopoints distance ( geopoints,number,number )
geopoints distance ( geopoints,list )
```

> Returns geopoints with the value of each point being the distance in metres from the given geographical location. The location may be specified by supplying either two numbers (latitude and longitude respectively) or a 2-element list containing latitude and longitude in that order. The location should be specified in degrees.

Choose a location and use this function to compute the distances of the data points from it. Assign the result to a variable called `distances` and return it to the user interface to examine the numbers. The distances are in metres.

Now we will see a boolean operator in action. The expression `distances < 100000` (one hundred thousand) will return a new geopoints variable where, for each point, if the input value was less than 100000, the resulting value will be 1; otherwise the resulting value will be zero. So the resulting geopoints will have a collection of ones and zeros. Confirm that this is the case.

The `filter()` function, from the documentation:

```
geopoints filter ( geopoints,geopoints )
```

> A filter function to extract a subset of its geopoints input using a second geopoints as criteria. The two input geopoints must have the same number of values. The resulting output geopoints contains the values of the first geopoints where the value of the second geopoints is non-zero. It is usefully employed in conjunction with the comparison operators :
>
> ```
> freeze = filter(temperature,temperature < 273.15)
> ```

The variable `freeze` will contain a subset of temperature where the value is below 273.15.

Use this in combination with what you have already done to produce a geopoints variable consisting only of the points within 100km of your chosen location. Plot the result to confirm it.

Saving geopoints data

Geopoints variables can be saved to disk using the `write()` command:

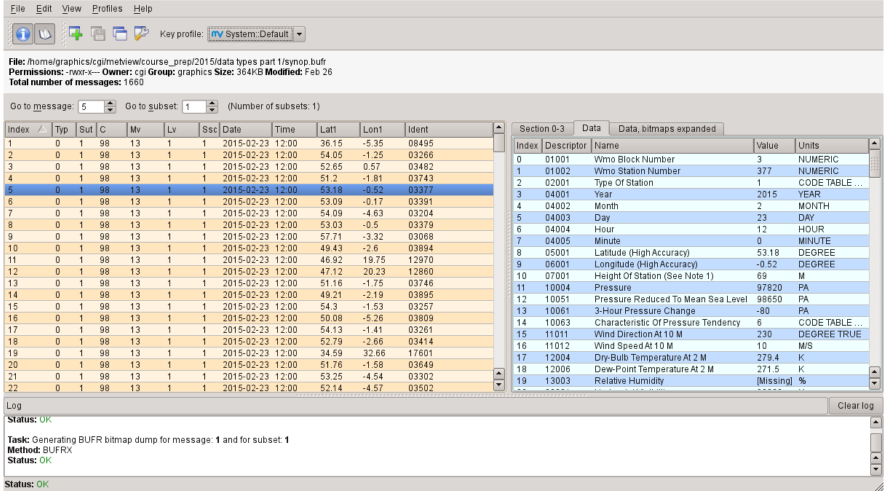
```
write('my_computed_data.gpt', points)
```

It is also possible to convert between geopoints and GRIB format - this will be covered in Processing Data.

Observation Data in BUFR files

Much observation data is received in BUFR format. BUFR is a complex format, capable of storing almost anything; BUFR files can vary widely, but there are some conventions which can help software to interpret them. We will have a brief overview of Metview's BUFR-handling capabilities here; for more information, see the dedicated tutorial on the Tutorials page.

Examining BUFR Meta-data



File: /home/graphics/cgi/metview/course_prep/2015/data types part 1/synop.bufr
Permissions: -rwxr-x--- **Owner:** cgi **Group:** graphics **Size:** 364KB **Modified:** Feb 26
Total number of messages: 1660

Go to message: 5 Go to subset: 1 (Number of subsets: 1)

Index	Typ	Sut	C	Mv	Lv	Ssc	Date	Time	Lat1	Lon1	Ident
1	0	1	98	13	1	1	2015-02-23	12:00	36.15	-5.35	08495
2	0	1	98	13	1	1	2015-02-23	12:00	54.05	-1.25	03266
3	0	1	98	13	1	1	2015-02-23	12:00	52.65	0.57	03482
4	0	1	98	13	1	1	2015-02-23	12:00	51.2	-1.81	03743
5	0	1	98	13	1	1	2015-02-23	12:00	53.18	-0.52	03377
6	0	1	98	13	1	1	2015-02-23	12:00	53.09	-0.17	03391
7	0	1	98	13	1	1	2015-02-23	12:00	54.09	-4.63	03204
8	0	1	98	13	1	1	2015-02-23	12:00	53.03	-0.5	03379
9	0	1	98	13	1	1	2015-02-23	12:00	57.71	-3.32	03068
10	0	1	98	13	1	1	2015-02-23	12:00	49.43	-2.6	03894
11	0	1	98	13	1	1	2015-02-23	12:00	46.92	19.75	12970
12	0	1	98	13	1	1	2015-02-23	12:00	47.12	20.23	12860
13	0	1	98	13	1	1	2015-02-23	12:00	51.16	-1.75	03746
14	0	1	98	13	1	1	2015-02-23	12:00	49.21	-2.19	03895
15	0	1	98	13	1	1	2015-02-23	12:00	54.3	-1.53	03257
16	0	1	98	13	1	1	2015-02-23	12:00	50.08	-5.26	03809
17	0	1	98	13	1	1	2015-02-23	12:00	54.13	-1.41	03261
18	0	1	98	13	1	1	2015-02-23	12:00	52.79	-2.66	03414
19	0	1	98	13	1	1	2015-02-23	12:00	34.59	32.66	17601
20	0	1	98	13	1	1	2015-02-23	12:00	51.76	-1.58	03649
21	0	1	98	13	1	1	2015-02-23	12:00	53.25	-4.54	03302
22	0	1	98	13	1	1	2015-02-23	12:00	52.14	-4.57	03502

Index	Descriptor	Name	Value	Units
0	01001	Wmo Block Number	3	NUMERIC
1	01002	Wmo Station Number	377	NUMERIC
2	02001	Type Of Station	1	CODE TABLE ...
3	04001	Year	2015	YEAR
4	04002	Month	2	MONTH
5	04003	Day	23	DAY
6	04004	Hour	12	HOUR
7	04005	Minute	0	MINUTE
8	05001	Latitude (High Accuracy)	53.18	DEGREE
9	06001	Longitude (High Accuracy)	-0.52	DEGREE
10	07001	Height Of Station (See Note 1)	69	M
11	10004	Pressure	97820	PA
12	10051	Pressure Reduced To Mean Sea Level	98650	PA
13	10061	3-Hour Pressure Change	-80	PA
14	10063	Characteristic Of Pressure Tendency	6	CODE TABLE ...
15	11011	Wind Direction At 10 M	230	DEGREE TRUE
16	11012	Wind Speed At 10 M	10	M/S
17	12004	Dry-Bulb Temperature At 2 M	279.4	K
18	12006	Dew-Point Temperature At 2 M	271.5	K
19	13003	Relative Humidity	[Missing]	%

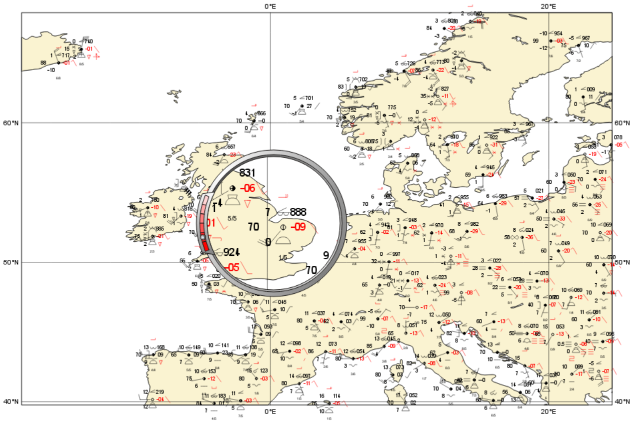
```
Status: OK

Task: Generating BUFR bitmap dump for message: 1 and for subset: 1
Method: BUFRX
Status: OK
```

Status: OK

Right-click on the supplied *synop.bufr* BUFR icon and select **examine** from the icon menu. This will start the BUFR examiner application. The right-hand panel displays data for the message selected in the left-hand panel. This can be an easy way to find the correct descriptor for a given parameter such as Relative Humidity.

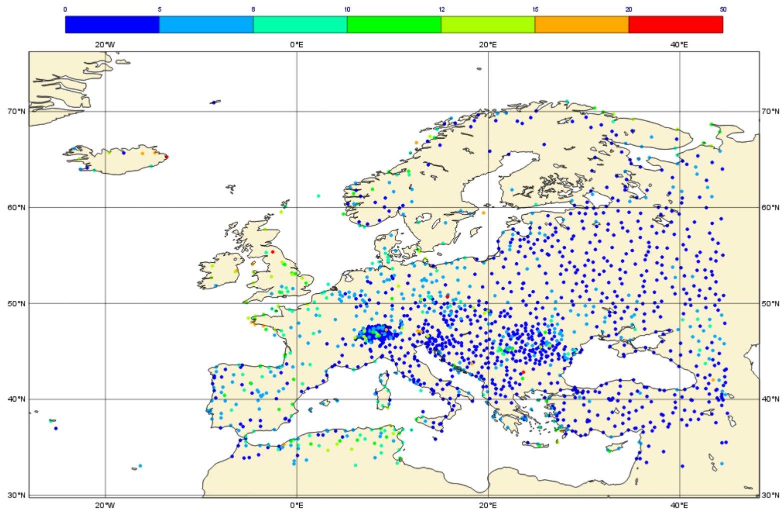
Plotting BUFR Data



Metview is able to plot certain BUFR data directly, mainly some WMO conventional observation types including SYNOP and TEMP.

Right-click and **visualise** the *synop.bufr* BUFR icon. This will bring up the **Display Window** using the default visualisation assigned to observation plotting. What we see here is a spatially thinned set of SYNOP observations plotted on the map by using the official WMO-style. If you zoom into a smaller area you will see more observations but the thinning is still kept so that the plot should not seem cluttered.

Filtering Observation Data



BUFR files can contain a lot of information, but we often want to extract just one or two parameters.

The *Observation Filter* icon extracts a single scalar or vector value from each message in a BUFR file. It is able to perform filtering according to message type, date, time, level, area, location and custom descriptors. Examine the BUFR file and find the descriptor for wind speed at 10m (look in the blue right-hand panel) - make a note of it.

Create a new *Observation Filter* icon, rename it to *wind_speed* and edit it. Drop the BUFR icon into the **Data** field and set the following to extract the wind speed values in geopoints format:

Output	Geographical Points
Parameter	11012

Visualise the icon - the filtering will take place, then the result is plotted using the default Symbol Plotting definition, which is to plot the data as numbers. Drop your *symb_auto* icon into the **Display Window** for a nicer plot.

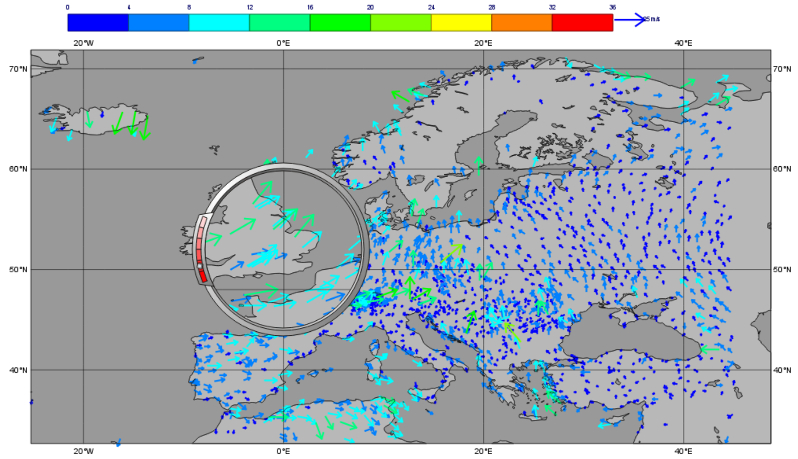
Notice that there is a point which claims a wind speed of 80m/s! Reliability can be a big issue with observational data, and this point claims winds of 288km/h! We can filter out data that we consider unrealistic - add the following parameters to your *wind_speed* icon:

Custom Filter	Filter By Range
Custom Parameter	11012
Custom Values	0/50

This ensures that we only extract points whose wind speed is between 0 and 50 (m/s). Having a smaller range of values also allows the automatic colour range to spread more evenly through the data. There is still a point with a large value, which you can also filter out if desired.

Notice that the values in the colour scale change as you zoom in and out of different areas - *this is computed according to the data currently visible*. Try the supplied icon *symb_wind_speed_fixed*, which has a fixed value/colour mapping.

Extracting vector values from BUFR



We can extract the wind direction too, and plot the wind as arrows (or flags).

Make a copy of your *wind_speed* filter icon and call it *wind_speed_and_direction*. Find out which descriptor provides wind direction, then change the following parameters in your new filter icon:

Output	Geographical Polar Vectors
Parameter	11012/?????

where ????? is replaced by the wind direction descriptor number.

When you visualise the icon, you will see numbers as before, but if you drop a newly created *Wind Plotting* icon into the **Display Window** you will see wind arrows. Try the supplied *coloured_wind_arrows* icon too. Try changing it to plot wind flags instead of arrows.

You may wish to customise a *Coastlines* icon to provide a darker background for the plot.

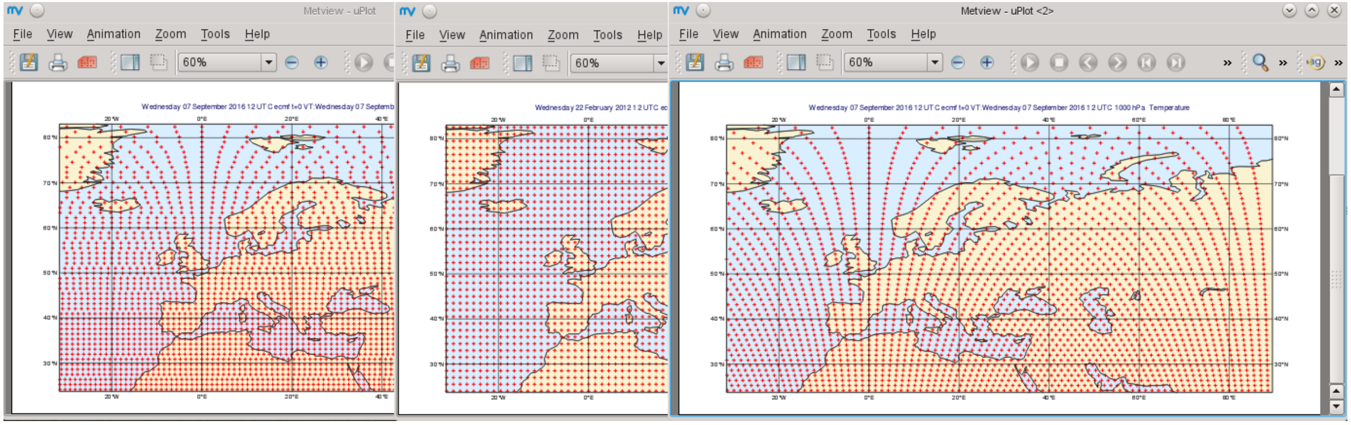
Extra Tasks

Write a macro to plot the wind arrows from BUFR

Use the icons you created to filter and plot the wind arrows from BUFR data to write a macro which produces the same plot. Extract the 'magic numbers' such as the filtering threshold and the wind parameter descriptors into variables at the top of the macro, and use these variables in the macro rather than the raw numbers.

Investigate different grids

GRIB fields are often not as simple as regular lat/lon! ECMWF also produces data in "reduced Gaussian grids", two of which are included in your folder. Visualise them with your *grid_1x1* icon to see how the points are spaced around the globe. Use both a cylindrical and a polar stereographic projection to look at them (*Geographic View* icon).


Metview - uPlot
File View Animation Zoom Tools Help
60%
Wednesday 07 September 2016 12 UTC ecmf t+0 VT:Wednesday 07 Septemb
Wednesday 22 February 2012 12 UTC ec
Metview - uPlot <2>
Wednesday 07 September 2016 12 UTC ecmf t+0 VT:Wednesday 07 September 2016 12 UTC 1000 hPa Temperature
20°W
0°E
20°E
40°E
60°E
80°E
80°N
70°N
60°N
50°N
40°N
30°N

Try the search facilities in the data examiners

Examine the GRIB file and the BUFR file; press CTRL-F to initiate the search. Look carefully at the options!

Create your own GRIB Examiner key profile

When you examine a GRIB file, a list of 'keys' is used to display the GRIB messages - one key per column. These columns are configurable - a 'key profile' is a set of keys, and you can create as many of them as you want. It can be very useful to have different key profiles for different tasks. From the user interface in the GRIB Examiner, create a new key profile; starting either from scratch, or else from a duplicate of the default profile. Note that the **Display Window** also operates on the same principles, and you can share key profiles between the two.

Observation filtering

Extract 2m temperature values below the freezing point from *synop.bufr*.

Hints:

- use geopoints output
- use custom filter
- temperature values are given in K