ECMWF New Users Metview Tutorial

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Date: 06-Mar-2014 08:43
URL: https://software.ecmwf.int/wiki/display/METV/ECMWF+New+Users+Metview+Tutorial

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1 Preparation

These exercises demonstrate some basic functionality of Metview, showing how to retrieve data from MARS, examine the data's structure, compute the differences between different data sets and visualise them.

First start Metview; at ECMWF, the command to use is `metview_dev` for this tutorial (see Metview at ECMWF (https://software.ecmwf.int/wiki/display/METV/Metview+at+ECMWF) for details of Metview versions; on ecgate, the command is `metview4_dev`). You should see the main Metview *desktop* which looks something like **Figure 1** (except that the tabbed area at the bottom will not be open).

In Metview, all operations can be performed via *icons*. Most icons are available in the tabbed *drawers* at the bottom of the Metview desktop.

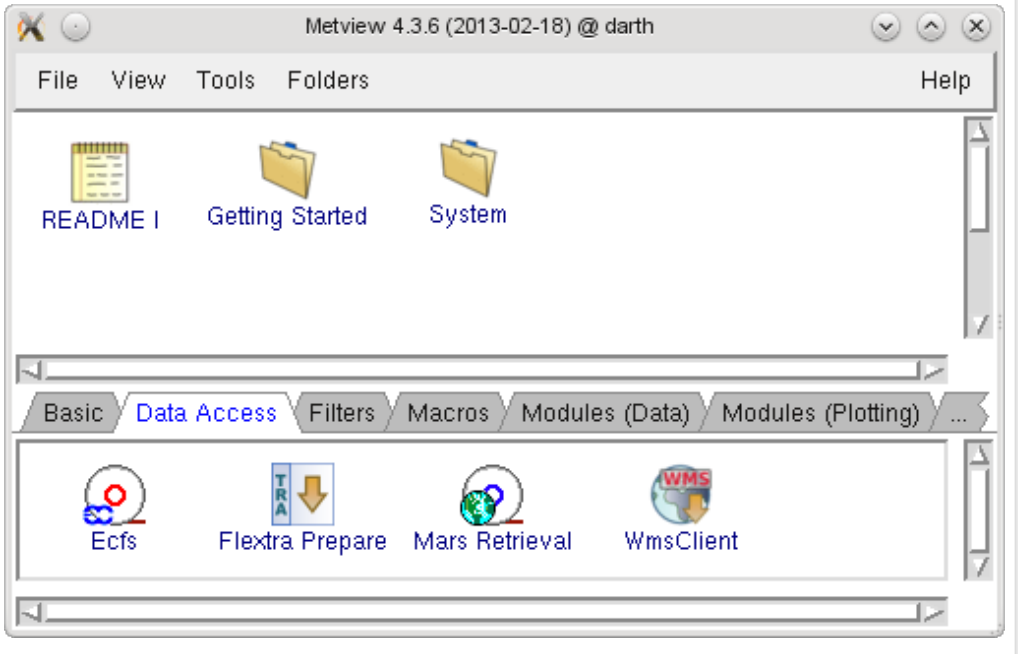
You will create some icons yourself, but some are supplied for you - please download the following file:

Download

solutions.tar.gz
Alternatively, if at ECMWF then you can copy it like this from the command line:
`cp /scratch/graphics/cgi/solutions.tar.gz $HOME/metview`

and save it in your `$HOME/metview` directory. You should see it appear on your main Metview desktop, from where you can right-click on it, then choose **execute** to extract the files. You should now (after a few seconds) see a *solutions* folder which contains the solutions and also some additional icons required by these exercises. You should work in the main Metview desktop, not the *solutions* folder.

Figure 1 - the Metview desktop



2 Exercise 1: forecast - analysis difference

This exercise shows how to retrieve GRIB data from MARS, examine its structure, compute the differences between fields and visualise the data in various ways.

2.1 Retrieving the analysis data

To perform a MARS retrieval in Metview, click the Data Access tab at the bottom of the Metview desktop to open it, and drag the *Mars Retrieval* icon onto your Metview desktop; this will create a copy of the icon for you to customise. Rename the new icon to *temperature_analysis* by clicking on its name. Edit your icon (right-click & **edit**, see **Figure 2**) and set the following parameters:

Param	T	Note: sets the desired meteorological parameter to Temperature
Date	-3	Note: sets the analysis base time to 3 days ago
Grid	1.0/1.0	Note: interpolates the result onto a 1.0-degree grid

You must press the *Return* key after typing each value.

To save these settings, click the Apply button at the bottom-left of the icon editor.

2.2 Inspecting the analysis data

Perform the data retrieval by choosing **execute** from the icon's context menu. The icon name should turn orange whilst the retrieval takes place, then green to indicate success (if the name turns red, then the retrieval failed and you should look in the output log, available from the **output** entry in the context menu). The data is now cached locally. To see what was retrieved, right-click **examine** the icon. This brings up Metview's GRIB Examiner tool (**Figure 3**). Here we can see that we retrieved six vertical levels of data; this is as expected if we look at the **Levelist** parameter in the icon editor.

The GRIB Examiner allows in-depth examination of GRIB files with many ways to customise the information. We will not cover these facilities in this introduction.

Now **visualise** the data, again using the icon's context menu. You will see a map plot with the default contouring style in the Display Window (**Figure 4**). The *zoom* controls in the toolbar give control over the area selection.

To plot the data with shaded colours, go to the Visual Definitions drawer (if this drawer is not visible, you may have to either expand your Metview desktop window to the right, or else click on the dots which appear to the right of the last visible drawer). Drop the *Contouring* icon onto your Metview desktop, rename it *shade* and **edit** it, providing these parameters:

Legend	On	
Contour Shade	On	
Contour Shade Method	Area Fill	
Contour Shade Max Level Colour	Red	Note: to select a colour, click the small triangle next to the parameter name to reveal the colour selection dialog
Contour Shade Min Level Colour	Blue	
Contour Shade Colour Direction	Clockwise	

Save the icon settings (Apply) and drop this into the Display Window (re-visualise the data if you have closed the Display Window). The result should resemble **Figure 5**. Metview's *Contouring* icon provides much flexibility in choosing how to display gridded fields; this tutorial uses only simple colour schemes.

The fields can be visualised using different *views*. These can be defined by a set of icons such as *Geographical View* and *Cross Section View*. In the *solutions* folder are 2 pre-prepared view icons for you to try. Visualise the *polar_stereo_europe* icon and drop your data icon into the resulting Display Window. If you edit this view icon, you will see how to define a geographical view. Now close the Display Window and visualise your data in the same way with the the *cross_section_example* view. This icon defines a geographical line along which a cross section of the data is computed (remember that the data consists of a number of vertical levels). You can also drop your *shade* icon into the plot (**Figure 6**).

The Display Window provides a number of facilities for further inspection of the data (e.g. magnifier, point values, histogram) , not covered here.

2.3 Retrieving the forecast data

Create a copy of your *temperature_analysis* icon (right-click, **duplicate**) and rename the copy to *temperature_forecast*. Edit this icon and set the following parameters:

Type	FC
Param	T
Date	-5
Step	48
Grid	1.0/1.0

The analysis data was valid for 3 days ago; this new icon retrieves a 48-hour forecast data generated 5 days ago, so it is also valid for 3 days ago. You don't need to separately **execute** and **visualise** the icon - if you **visualise** it, the data will automatically be retrieved first. The plot title will verify that this data is valid for the same date and time as the analysis data. It also contains the same set of vertical levels.

2.4 Compute the forecast-analysis difference

Create a new *Simple Formula* icon by taking a copy from the Macros icon drawer. Rename the copy to *fc_an_diff*. Edit the icon, ensure that the first tab is selected (F+G) and that the operator is minus (-). Drop your *temperature_forecast* icon into the **Parameter 1** box, and drop *temperature_analysis* into the **Parameter 2 box**. Save the icon and **visualise** it. The difference will be computed and the result plotted. Note that all 6 fields in each data icon are used in the computation - the result is a set of 6 fields. The *solutions* folder contains two *Contouring* icons which can be used to show the differences: select both *pos_shade* and *neg_shade* with the mouse and drop them both together into the Display Window (see **Figure 7**). It is also possible to drop them one at a time, but they do not accumulate - one will replace the other.

2.5 Automating the whole procedure

Ensure that the difference fieldset is visualised with the contouring applied. To generate a Metview Macro script from this plot, click the **Generate Macro** button (also available from the **File** menu). A new Macro script will be generated - have a look at it to confirm that it contains code to retrieve all the data, compute the difference and plot the result. Run the macro to obtain the plot, either by using the Run button from the Macro Editor, or by selecting **visualise** from the icon's context menu). By default, the macro is written so that it will produce an interactive plot window; it will generate a PostScript file if it is run with the **execute** command, or if it is run from the command line:

```
metview -b <macro-name>
```

Metview Macro is a rich, powerful scripting language designed for the high-level manipulation and plotting of meteorological data. For examples of the available functions, see List of Operators and Functions (https://software.ecmwf.int/wiki/display/METV/List+of+Operators+and+Functions). The code generated automatically above is intended as a starting point only - usually at least some editing will be required in order to make the code more streamlined for your needs.

Figure 2 - the Mars Retrieval icon editor

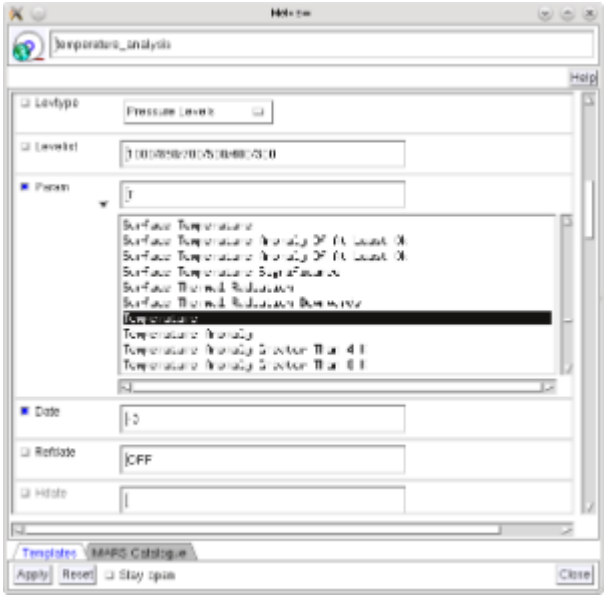


Figure 3 - the GRIB Examiner

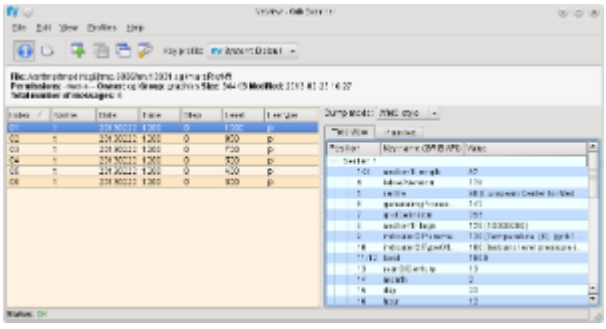


Figure 4 - a default map plot

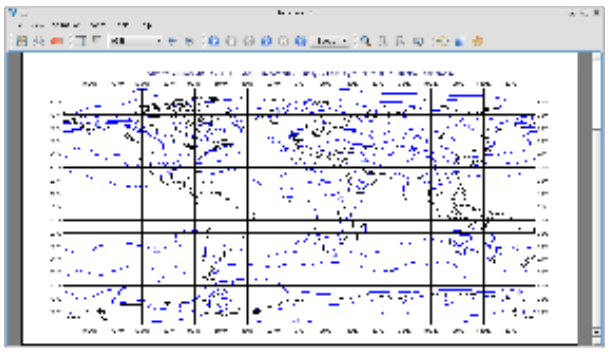


Figure 5 - map plot with shaded contours

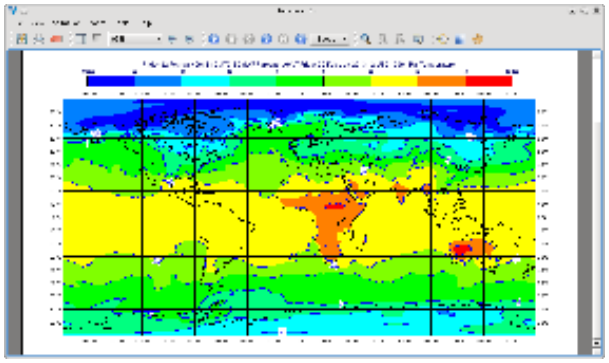


Figure 6 - cross section plot of data

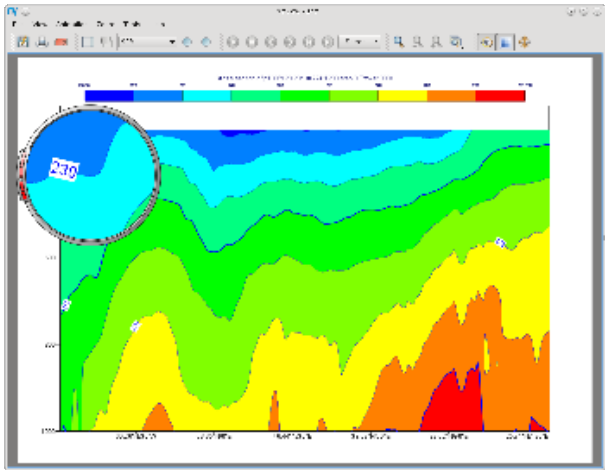
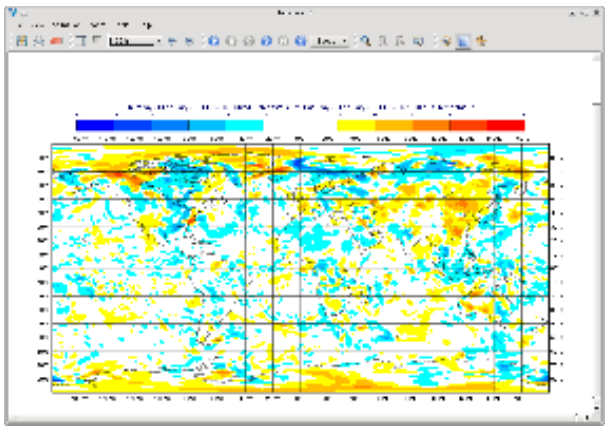


Figure 7 - difference plot with two contour icons



3 Exercise 2: forecast - observation difference

This exercise builds on Exercise 1, but uses observation data in BUFR format instead of analysis fields.

3.1 Retrieving the observation data

Create a new *Mars Retrieval* icon and rename it to *obs*. Edit it and set the following parameters in order to retrieve BUFR observation data from 3 days ago:

Type	OB
Repres	Bufr
Date	-3

Retrieve the data and **examine** it. Metview's BUFR Examiner displays the contents of the BUFR data (**Figure 8**). Each message contains many measurements. If you **visualise** the data, you will see a standard display of synoptic observations. **Figure 9** shows this, using the *shaded_coastlines* icon from the *solutions* folder (this plot has also been zoomed to show a smaller area).

3.2 Extracting the 2 metre temperature

Create a new *Observation Filter* icon from the Filters icon drawer, and rename it to *filter_obs_t2m*. With this icon we will extract just the 2m temperature into Metview's custom ASCII format for scattered geographical data - *geopoints*. Set these parameters:

Data	Drop your *obs* icon here
Output	Geographical Points
Parameter	012004

Note that 012004 is the code for 'Dry bulb temperature at 2m'. If you **examine** this icon now, you will see the result: a table of geo-located temperature values. When you **visualise** the data, you will see that the actual values are plotted as text on the screen; we can do better than this. From the *solutions* folder, drop the *coloured_markers* icon into the Display Window. The *shaded_coastlines* icon may also help make the points easier to see (**Figure 10**).

3.3 Retrieving the forecast data

Create a new *Mars Retrieval* icon, rename it to *t2m_forecast,* and set these parameters:

Type	FC
Levtype	Surface
Param	2t
Date	-5
Step	48
Grid	1.0/1.0

The retrieved data is the 48-hour forecast made 5 days ago for 2-metre temperature.

3.4 Computing the forecast-observation difference

This is just the same as in Exercise 1, using a *Simple Formula* icon; create a new one and rename it to *fc_obs_diff*. Drop *t2m_forecast* into the **Parameter 1** box, and *filter_obs_t2m* into the **Parameter 2** box. Visualise the result - you will see that the result of a field minus a scattered geopoints data set is another geopoints data set. For each geopoint location, the interpolated value from the field was extracted before performing the computation. From the *solutions* folder, drop both the *diff_symb_hot* and the *diff_symb_cold* icons together into the plot in order to get a more graphical representation of the result.

3.5 Overlaying data in the same plot

To plot the forecast field together with the observation differences, do the following. Visualise *t2m_forecast* and drop the *shade* icon into the plot. Now drop *fc_obs_diff* into the plot, followed by (or with) *diff_symb_hot* and *diff_symb_cold*. The observation differences don't stand out well against the strongly coloured field, so drop *shade_light* into the plot to obtain something like **Figure 11**.

Figure 8 - the BUFR Examiner

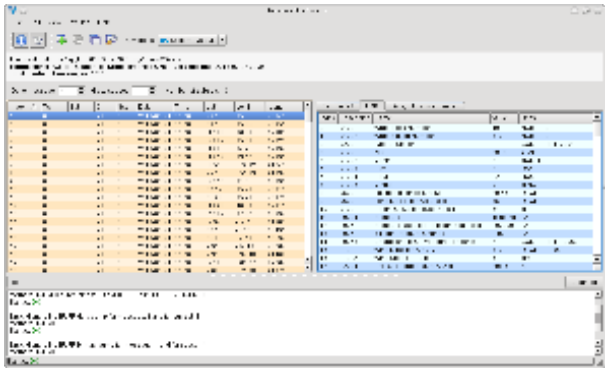


Figure 9 - synoptic observation plotting

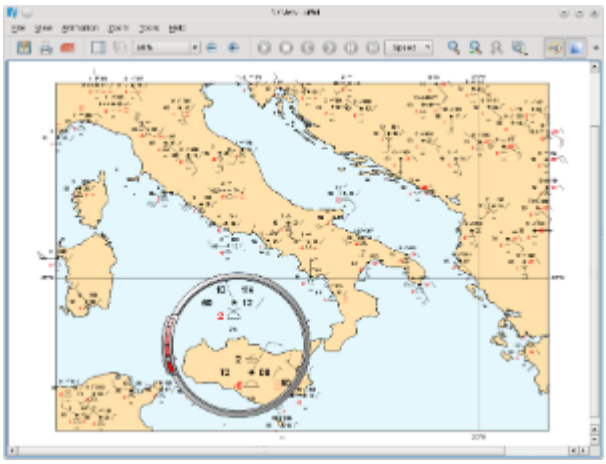


Figure 10 - 2m temperature observations

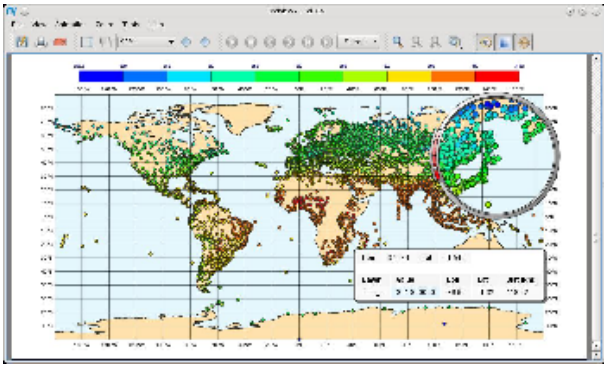


Figure 11 - temperature forecast field with obs-forecast differences overlaid