

Metview BUFR Tutorial



Meteorological Visualisation Section
Operations Department
ECMWF

05/03/2015



This tutorial was tested with Metview version 4.3.0
and some features might not work for previous versions.

© Copyright 2015
European Centre for Medium-Range Weather Forecasts
Shinfield Park, Reading, RG2 9AX, United Kingdom

Literary and scientific copyrights belong to ECMWF and are reserved in all countries.

The information within this publication is given in good faith and considered to be true, but ECMWF accepts no liability for error, omission and for loss or damage arising from its use.

Table of Contents

Part 1 - BUFR Basics.....	5
Part 2 - The BUFR Icon.....	7
Part 3 - Direct Visualisation.....	10
Part 4 - The Obs Filter Icon.....	12
Part 5 - Advanced Filtering with Obs Filter.....	20

PREPARATIONS

Before you start the tutorial you need to execute the following preparatory steps:

1. Start **Metview 4** with your local command. At the ECMWF you can do it by typing the following command in a terminal window:

```
metview4 -slog &
```

The optional `-slog` switch will enable Metview to print detailed logging information to the standard output.

2. Copy the directory containing the tutorial icons (both exercises and solutions) into your Metview environment. At the ECMWF you need to type the following command in a terminal window to do this:

```
cp -R /home/graphics/cgx//tutorials/bufr_tutorial ~/metview
```

Otherwise you can download this directory from the Metview website (<http://software.ecmwf.int/metview>) and copy it into your `~/metview` directory.

In your main Metview folder now you should find a 'buf_r_tutorial' folder.

PART 1 - BUFR BASICS

What is BUFR?

BUFR (Binary Universal Form for Representation of meteorological data) is a WMO standard for transmitting and storing observed meteorological data. BUFR is flexible. It can be used to store very different data, ranging from traditional SYNOP and TEMP observations to modern satellite and radar observations.

The Structure of BUFR

A BUFR file itself is simply a concatenation of individual (binary) BUFR messages. Each message has **header sections** containing metadata (e.g. type, subtype, date and time) and a section containing one or more observations in a coded format. Data stored in BUFR messages are identified by **data descriptors**. Data descriptors are keys to the BUFR data. To access any data values from BUFR messages we need to know the data descriptor of the data type.

BUFR is a **Table Driven Code Form**. This code form is based on the idea that part of the metadata, including the values used for coding, is stored in external table files.

Details about the BUFR format and the tables can be found in the WMO references available at the following URL: <http://www.wmo.int/pages/prog/www/WMOCodes.html>.

Wikipedia also provides useful information about BUFR:

<http://en.wikipedia.org/wiki/BUFR>

Templates

Templates define rules for storing certain type of data in a BUFR message. In this way the content and structure of BUFR data products can be standardised. The WMO has released a number of BUFR templates for surface and upper air observational data. The BUFR files used in this tutorial are based on these WMO templates.

PrepBUFR

BUFR is so flexible that it is possible to encode BUFR tables in BUFR format. NCEP (National Centers for Environmental Prediction, USA) creates BUFR files, called **PrepBUFR** files, where BUFR messages containing meteorological data are preceded by BUFR messages that contain BUFR table entries. These tables are required to decode the data

part and can be encoded with standard data descriptors. This method avoids all table related errors in decoding, but it requires extra software functionality.

About the Metview interface

ECMWF developed a software package called BUFRDC written in FORTRAN to handle BUFR data. This package provides a low level interface for BUFR data. Metview has an internal **C++ wrapper**, with a high level of abstraction, around the basic BUFRDC library. As a result, Metview is able to provide several tools to handle BUFR data on a high abstraction level. With Metview we can easily examine, extract and plot BUFR data and do computations with it.

Metview provides support for **PrepBUFR** files as well.

PART 2 - THE BUFR ICON

In this exercise we will learn about the *BUFR* icon and see how to examine its content.

The BUFR Icon

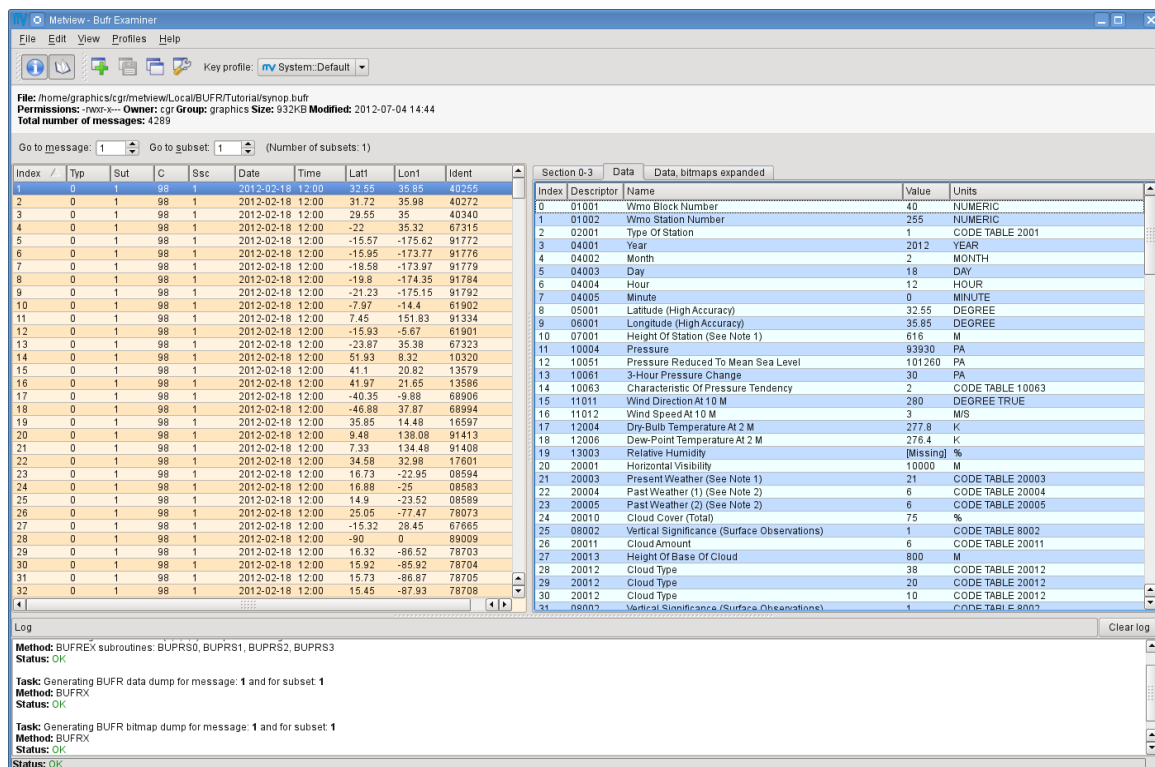
Open folder 'obs_filter' inside your 'buftr_tutorial' folder (double-click or right-click, **edit**). Here you will find a BUFR file called 'synop.buftr'. Metview automatically assigns this *BUFR* icon to BUFR files:



We will see what data is stored in this file in the next step.

The BUFR Examiner

Right-click on your 'synop.buftr' *BUFR* icon and select **examine** from the icon menu. This will start the **BUFR examiner** application.



File: /home/graphics/cgr/metviewLocal/BUFR/Tutorial/synop.buftr
 Permissions: -rwxr-x--- Owner: cgr Group: graphics Size: 932KB Modified: 2012-07-04 14:44
 Total number of messages: 4289

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

Index	Typ	Sut	C	Ssc	Date	Time	Lat1	Lon1	Ident
1	0	1	98	1	2012-02-18	12:00	37.55	35.98	40345
2	0	1	98	1	2012-02-18	12:00	31.72	35.98	40372
3	0	1	98	1	2012-02-18	12:00	29.55	35	40340
4	0	1	98	1	2012-02-18	12:00	-22	35.32	67315
5	0	1	98	1	2012-02-18	12:00	-15.57	-175.62	91772
6	0	1	98	1	2012-02-18	12:00	-15.95	-173.77	91776
7	0	1	98	1	2012-02-18	12:00	-18.58	-173.97	91779
8	0	1	98	1	2012-02-18	12:00	-19.8	-174.35	91784
9	0	1	98	1	2012-02-18	12:00	-21.23	-175.15	91792
10	0	1	98	1	2012-02-18	12:00	-7.97	-14.4	61902
11	0	1	98	1	2012-02-18	12:00	7.45	151.83	91334
12	0	1	98	1	2012-02-18	12:00	-15.93	-5.57	61901
13	0	1	98	1	2012-02-18	12:00	-23.87	35.98	67323
14	0	1	98	1	2012-02-18	12:00	51.93	8.32	10320
15	0	1	98	1	2012-02-18	12:00	41.1	20.82	13579
16	0	1	98	1	2012-02-18	12:00	41.97	21.65	13586
17	0	1	98	1	2012-02-18	12:00	-40.35	-9.89	68906
18	0	1	98	1	2012-02-18	12:00	-46.88	37.87	68994
19	0	1	98	1	2012-02-18	12:00	35.85	14.48	16597
20	0	1	98	1	2012-02-18	12:00	9.48	138.08	91413
21	0	1	98	1	2012-02-18	12:00	7.33	134.48	91408
22	0	1	98	1	2012-02-18	12:00	34.58	32.98	17601
23	0	1	98	1	2012-02-18	12:00	16.73	-22.95	08594
24	0	1	98	1	2012-02-18	12:00	16.88	-25	08583
25	0	1	98	1	2012-02-18	12:00	14.9	-23.52	08589
26	0	1	98	1	2012-02-18	12:00	25.05	-77.47	78073
27	0	1	98	1	2012-02-18	12:00	-15.32	28.45	67665
28	0	1	98	1	2012-02-18	12:00	-90	0	89009
29	0	1	98	1	2012-02-18	12:00	16.32	-86.52	78703
30	0	1	98	1	2012-02-18	12:00	15.92	-85.92	78704
31	0	1	98	1	2012-02-18	12:00	15.73	-86.87	78705
32	0	1	98	1	2012-02-18	12:00	15.45	-87.93	78708

Section 0-3 Data Data, bitmaps expanded

Index	Descriptor	Name	Value	Units
0	01001	Wmo Block Number	40	NUMERIC
1	01002	Wmo Station Number	255	NUMERIC
2	02001	Type or Station	1	CODE TABLE 2001
3	04001	Year	2012	YEAR
4	04002	Month	2	MONTH
5	04003	Day	18	DAY
6	04004	Hour	12	HOUR
7	04005	Minute	0	MINUTE
8	05001	Latitude (High Accuracy)	32.55	DEGREE
9	06001	Longitude (High Accuracy)	35.85	DEGREE
10	07001	Height Of Station (See Note 1)	616	M
11	10004	Pressure	93930	PA
12	10051	Pressure Reduced To Mean Sea Level	101260	PA
13	10061	3-Hour Pressure Change	30	PA
14	10063	Characteristic Of Pressure Tendency	2	CODE TABLE 10063
15	11011	Wind Direction At 10 M	280	DEGREE TRUE
16	11012	Wind Speed At 10 M	3	M/S
17	12004	Dry-Bulb Temperature At 2 M	277.8	K
18	12006	Dew-Point Temperature At 2 M	276.4	K
19	13003	Relative Humidity	[Missing]	%
20	20001	Horizontal Visibility	10000	M
21	20003	Present Weather (See Note 1)	21	CODE TABLE 20003
22	20004	Past Weather (1) (See Note 2)	6	CODE TABLE 20004
23	20005	Past Weather (2) (See Note 2)	6	CODE TABLE 20005
24	20010	Cloud Cover (Total)	75	%
25	08002	Vertical Significance (Surface Observations)	1	CODE TABLE 8002
26	20011	Cloud Amount	6	CODE TABLE 20011
27	20013	Height Of Base Of Cloud	800	M
28	20012	Cloud Type	38	CODE TABLE 20012
29	20012	Cloud Type	20	CODE TABLE 20012
30	20012	Cloud Type	10	CODE TABLE 20012
31	08002	Vertical Significance (Surface Observations)	1	CODE TABLE 8002

Log

Method: BUFR EX subroutines: BUPRS0, BUPRS1, BUPRS2, BUPRS3
 Status: OK

Task: Generating BUFR data dump for message: 1 and for subset 1
 Method: BUFR EX
 Status: OK

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

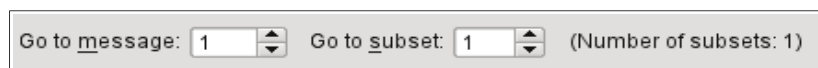
The examiner's interface is split into four main areas:

- The **information panel** is located at the top and displays the name, size and permissions of the file being examined. The total number of messages is displayed as well.

- The **message list** occupies the left hand side. Here a set of metadata keys taken from BUFR sections 0-3 is displayed for each message. By hovering the cursor in the column headings the description and section of the given metadata key is displayed in the tooltip. Any column can be used to sort the **message list** by clicking on that column's heading.
- By clicking on a message in the **message list** the contents of the selected message are displayed in the **data dump panel** on the right hand side. Here a set of tabs is available:
 - Section 0-3: displays the metadata stored in BUFR sections 0,1,2 and 3.
 - Data: displays the decoded data items.
 - Data, bitmaps expanded.
- The **log panel** at the bottom shows the log messages generated during the decoding of the BUFR messages. This panel can be hidden or shown by the **View log** toggle button in the toolbar:



The examiner features two spin boxes just above the **message list** to directly navigate to a given message or message subset (if there are any) in the BUFR file:

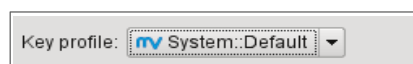


Both the data message list and the data dump panels are searchable. Just press `Ctrl+F` or select **Edit** → **Find** from the menubar to launch the **search panel**.



Key Profile Management

The metadata keys appearing in the **message list** form a “key profile”. There can be any number of key profiles defined, which then can be loaded from the **Key profile** combo box in the toolbar.



By default the **BUFR examiner** uses a key profile called “System::Default”. This is a read-only profile and users cannot change it. Therefore, to fully customise key profiles it is advised to create custom key profiles. The easiest way to do this is to duplicate an existing profile.

Now click on the **Duplicate key profile** button in the toolbar:

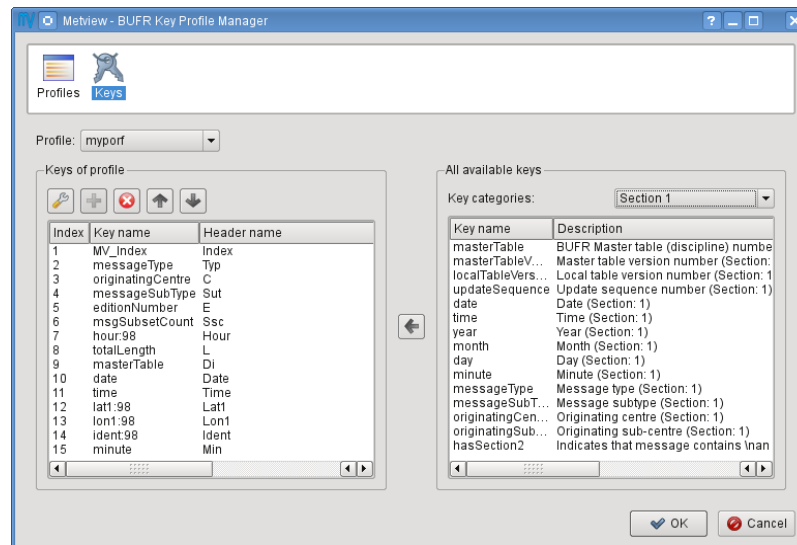


A dialog will pop up requesting for the name for the duplicate. Once you have specified the name and clicked **Ok** the examiner will load your newly created profile automatically. Here you have the following editing choices:

- Change the order of the meta-data keys by simply dragging and dropping a given column heading into a new position.
- Right-click on a column heading and select an action from the context menu.
- Add a new metadata key by dragging any of the items from the **Section 0-3** tab in the right hand side into the **message list**.
- Start up the **Key profile manager** by clicking on this button in the toolbar:



The **Key profile manager** offers full customisation for key profiles.

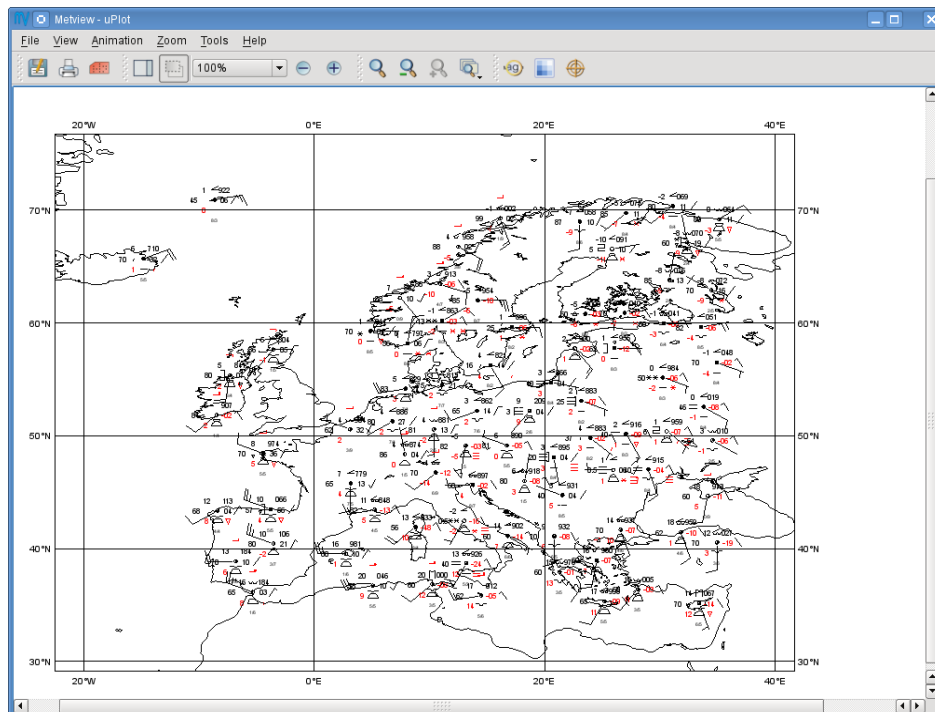


PART 3 - DIRECT VISUALISATION

Metview is able to plot certain BUFR data directly, mainly some WMO conventional observation types including SYNOP and TEMP. We will see how it is working by visualising the SYNOP observations from the BUFR file we examined in the previous chapter. We will work in folder 'obs_filter' again.

Plotting

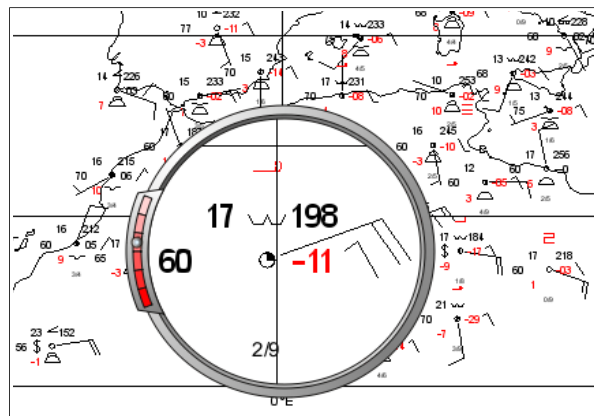
Right-click and **visualise** the 'synop.buf' *BUFR* icon. This will bring up the Metview **Display Window** using the default visualisation assigned to observation plotting.



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. However, the individual numbers and symbols are probably still too small to see. To overcome this difficulty you need to launch the **Magnifier** by clicking on the magnifier icon in the toolbar and navigate it to your area of interest in the plot.



The magnifier has an adjustable power control on the left hand side and by using it the station data can be blown up to the desired size.



Remarks

- If you directly visualise a BUFR file containing no conventional observations an empty plot will be generated.

Customising the Plot

To customise which values to include (or exclude) from a plot, we use the *Observation Plotting* icon.

PART 4 - THE OBS FILTER ICON

In this exercise we will learn about the *Obs Filter* icon.



The *Obs Filter* icon was designed to extract 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.

Obs Filter generates a BUFR, CSV or **geopoints** file as a result. Geopoints is Metview's custom ASCII format to store scattered geo-referenced data. The main advantage of using the geopoints output is that it can be directly plotted in Metview and there is a great variety of functions and operations available for it in Metview Macro.

The Exercise

As a demonstration of the *Obs Filter* icon we will extract the 2 metre temperature SYNOP observations from the same BUFR file we worked with in the previous chapters. We will generate a geopoints file on output and visualise it.

The Data Structure

First, we will look into the file to see its data structure. Open folder 'obs_filter' inside your 'bufr_tutorial' folder. Right-click **examine** the 'synop.bufr' *BUFR* icon and go to the **Data** tab on the right hand side.

Here you can see that one message contains observations only for a given station, so there is only one 2 metre temperature value per message. This means that our filter will be very simple: we only need to specify our parameter descriptor without any other filter options.

Index	Descriptor	Name	Value	Units
0	01001	Wmo Block Number	40	NUMERIC
1	01002	Wmo Station Number	255	NUMERIC
2	02001	Type Of Station	1	CODE TABLE 2
3	04001	Year	2012	YEAR
4	04002	Month	2	MONTH
5	04003	Day	18	DAY
6	04004	Hour	12	HOUR
7	04005	Minute	0	MINUTE
8	05001	Latitude (High Accuracy)	32.55	DEGREE
9	06001	Longitude (High Accuracy)	35.85	DEGREE
10	07001	Height Of Station (See Note 1)	616	M
11	10004	Pressure	93930	PA
12	10051	Pressure Reduced To Mean Sea Level	101260	PA
13	10061	3-Hour Pressure Change	30	PA
14	10063	Characteristic Of Pressure Tendency	2	CODE TABLE 1
15	11011	Wind Direction At 10 M	280	DEGREE TRUE
16	11012	Wind Speed At 10 M	3	M/S

The Obs Filter Icon

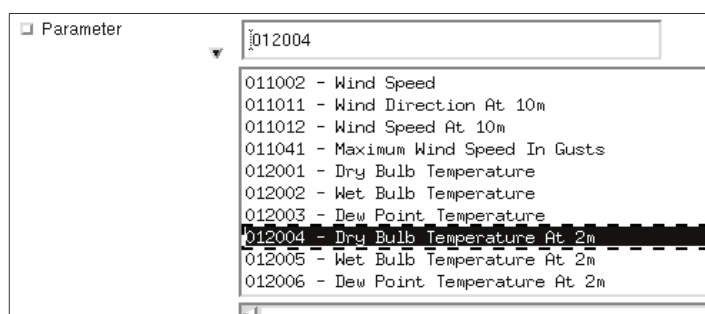
Create a new *Observation Filter* icon (you can find it in the **Filters** icon drawer) by dragging it into your folder and rename it 't2_filter'.

First, open its editor and drop your 'synop.bufr' icon into the **Data** field. This specifies the BUFR file for which the filtering will be applied. Then edit the following parameters as it is shown below:

Output	Geographical Points
Parameter	012004

Here we selected the geopoints output format and specified the BUFR descriptor of the 2 metre temperature. You might wonder how we could figure out the descriptor value (012004). Well, you do not have to be a BUFR expert to do it since Metview offers various ways to find out information about descriptors:

- Just click on the triangle-shaped button next to **Parameter** in the interface. It will bring up a list of BUFR parameter descriptors together with their names. Here you need to look for item “Dry Bulb Temperature At 2m”. You can see that its descriptor is 012004.

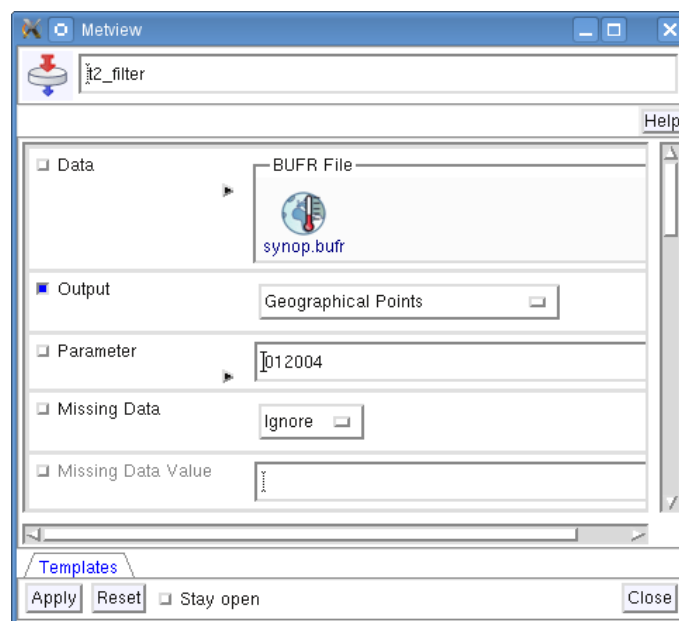


Please note that this list contains only a small subset of all the possible BUFR parameter descriptors, so Metview offers an alternative way to find information about descriptors.

- The alternative way is inspecting the BUFR data in the **BUFR examiner** since it displays all the relevant information we need to know. Now examine your 'synop.bufr' *BUFR* icon (right-click **examine**) and select the **Data** tab on the right hand side. Here you need to scroll down a bit to find parameter “Dry-Bulb Temperature At 2m”. It comes as no surprise that the descriptor is the same as we found in the list in the icon editor (12004, the leading zero in this case can be omitted).

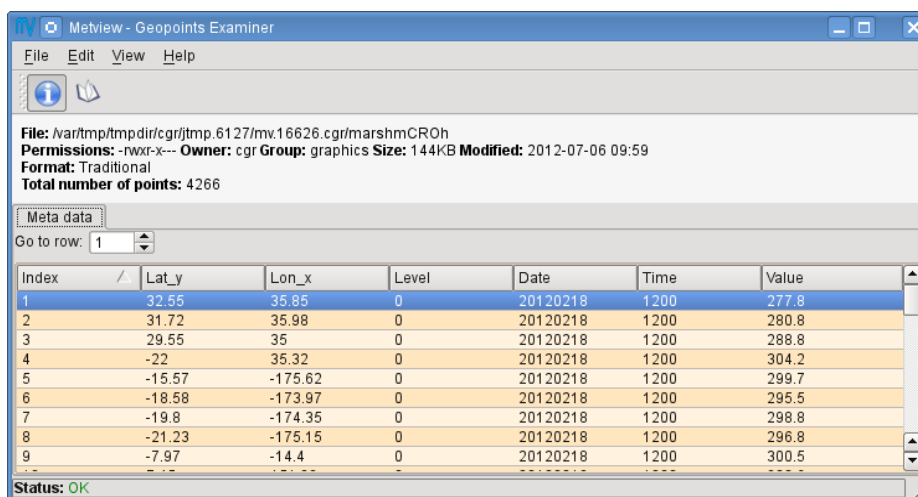
Index	Descriptor	Name	Value	Units
13	10061	3-Hour Pressure Change	30	PA
14	10063	Characteristic Of Pressure Tendency	2	CODE TABLE 1006
15	11011	Wind Direction At 10 M	280	DEGREE TRUE
16	11012	Wind Speed At 10 M	3	M/S
17	12004	Dry-Bulb Temperature At 2 M	277.8	K
18	12006	Dew-Point Temperature At 2 M	276.4	K
19	13003	Relative Humidity	[Missing]	%
20	20001	Horizontal Visibility	10000	M

Having finished the modifications your icon editor should look like this:



Running the Filter

Save your *Obs Filter* icon (**Apply**) then right-click and **execute** to run the filter. Within a few seconds the icon should turn green indicating that the operation was successful and the results have been cached. Now your icon behaves exactly like a *Geopoints* icon. Right-click **examine** to look at its content (the **Geopoints examiner** will be started up). You can see that for each BUFR message the geographical position, the date, the time and the observed value for 2 metre temperature were extracted.



Index	Lat_y	Lon_x	Level	Date	Time	Value
1	32.55	35.85	0	20120218	1200	277.8
2	31.72	35.98	0	20120218	1200	280.8
3	29.55	35	0	20120218	1200	288.8
4	-22	35.32	0	20120218	1200	304.2
5	-15.57	-175.62	0	20120218	1200	299.7
6	-18.58	-173.97	0	20120218	1200	295.5
7	-19.8	-174.35	0	20120218	1200	298.8
8	-21.23	-175.15	0	20120218	1200	296.8
9	-7.97	-14.4	0	20120218	1200	300.5

Save a Copy of the Extracted Data

Now close the **Geopoints examiner**. Right-click and **save** the icon to get a local copy of the file. A **File Save** dialog will appear with a **Selection** box at the bottom where you can

specify the output file name. Type here 't2.gpt' and click **Ok**. After a few seconds a *Geopoints File* icon with the selected name will appear in your folder.

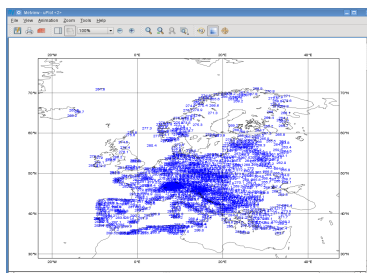


This icon now stores your extracted data. You can check its content by right-click and **examine** or **edit**.

Please note that saving the results into a file is not essential for using BUFR data in Metview but allows you to have a local copy of the results for later processing inside or outside Metview. The rest of this chapter will work directly with the 't2_filter' *Obs Filter* icon and not the saved copy of the data.

Visualising the Extracted Geopoints Data

Right-click and **visualise** the 't2_filter' *Obs Filter* icon to plot the extracted data. This will bring up the Metview **Display Window** using the default visualisation assigned to symbol plotting. By default the data values are plotted on the map (it might be different for you if you have already changed your default *Symbol Plotting* settings). After zooming into the area containing the data you should see something like this.



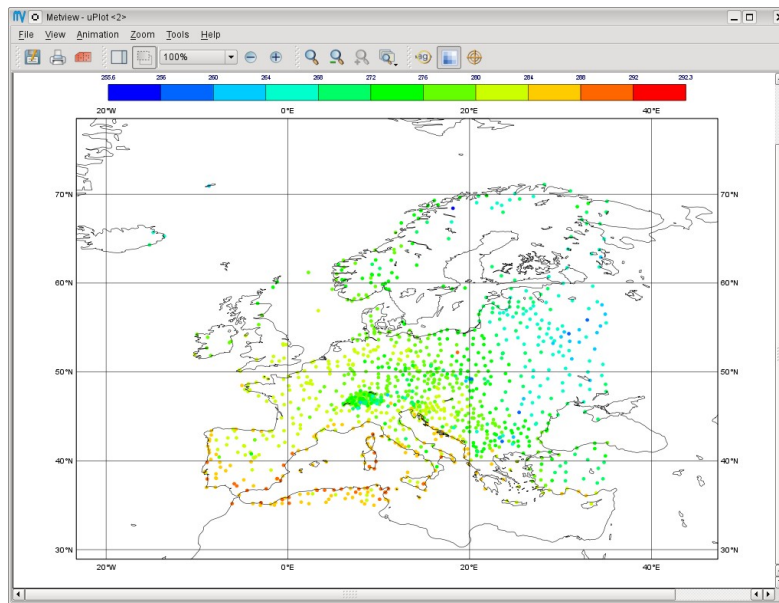
Unfortunately this plot is not very readable so we will enhance it by using markers instead of numbers and change the colour, as well. Let's create a new *Symbol Plotting* icon (it can be found in the **Visual Definitions** icon drawer, you may need to scroll the drawers to the right).



Rename it 'symbol' then edit it, by setting 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 Colour Direction	Clockwise
Symbol Advanced Table Marker List	15
Symbol Advanced Table Height List	0.2

Now drop this icon into the plot to see the effect of the changes.



We used the **Symbol Table Mode** in our icon and set it to ‘Advanced’ which enabled us to automatically define intervals with a separate maker type, colour and size. These settings work in a similar way as in the *Contouring* icon.

Our palette was automatically generated from a colour wheel by interpolating in the clockwise direction between **Symbol Advanced Table Min Level Colour** and **Symbol Advanced Table Max Level Colour**.



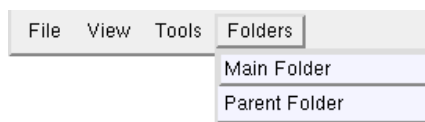
The identifiers of the available symbol markers are summarised in the table below. Please note that the rendering speed of the markers can be significantly different and using a simpler symbol (in terms of rendering) can greatly reduce the plotting time. For example, the usage of marker 3 (plus sign) can result in much faster plot generation than that of marker 15 (filled circle).

0	□	14	⊠
1	○	15	●
2	△	16	✖
3	+	17	◆
4	×	18	■
5	◇	19	▲
6	▽	20	▼
7	⊠	21	⊙
8	⊠	22	⊙
9	⊠	23	⊙
10	⊠	24	⊙
11	⊠	25	⊙
12	⊠	26	●
13	⊠	27	●
		28	●

Changing the Default Symbol Plotting Icon (optional)

Since the visual change is so useful (and the rendering process is much faster, as well) we will now make the settings of our ‘symbol’ icon the defaults for symbol plotting in Metview.

- Open your main Metview folder (select item ‘Main Folder’ from the **Folders** menu in the menu bar of the **Metview Desktop**)



- Open the subfolder called ‘System’ and then subfolder ‘Defaults’.
- Do one of the following: edit the *Symbol Plotting* icon in the ‘Defaults’ folder to specify your new settings or else delete it and copy your ‘symbol’ icon into this folder then rename it ‘Symbol Plotting’

For information: To delete an icon, right-click, **delete**; to move an icon between folders, drag it with the left mouse button; to copy an icon between folders, drag it with the middle mouse button.

- Save your changes and visualise your *Obs Filter* icon again - your new default symbol plotting attributes are automatically applied.

Now close your ‘Defaults’ folder.

Fixing the Symbol Plotting Intervals

Now zoom in and out of different areas. What happens to the palette - does it stay constant? The default behaviour is to create 10 interval levels *within the range of data actually plotted*. As the area changes, so does the range of values being plotted.

Let’s create a palette which will not be altered when we change the area. Copy your ‘symbol’ icon (either right-click + **duplicate**, or drag with the middle mouse button), and rename the copy ‘symbol_fixed’ by clicking on its title. Edit the icon and make the following changes:

Symbol Advanced Table Selection Type	Interval
Symbol Advanced Table Min Value	255
Symbol Advanced Table Max Value	295
Symbol Advanced Table Interval	5

Now when you apply this icon you will see that the palette is fixed wherever you zoom.

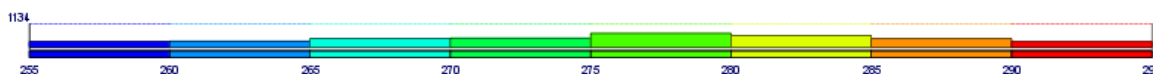
Having a Histogram in the Legend

So far we have used the default legend settings, which resulted in a continuous legend. Now we will change our legend so that it could display a histogram showing the data distribution across the data intervals used in the symbol plotting.

Let's create a new *Legend* icon (it can be found in the **Visual Definitions** icon drawer).



Edit it, by setting **Legend Display Type** to Histogram. Now drop the icon into the plot to see how the legend has been changed: it now contains an additional area holding the histogram.



Metadata and Statistics

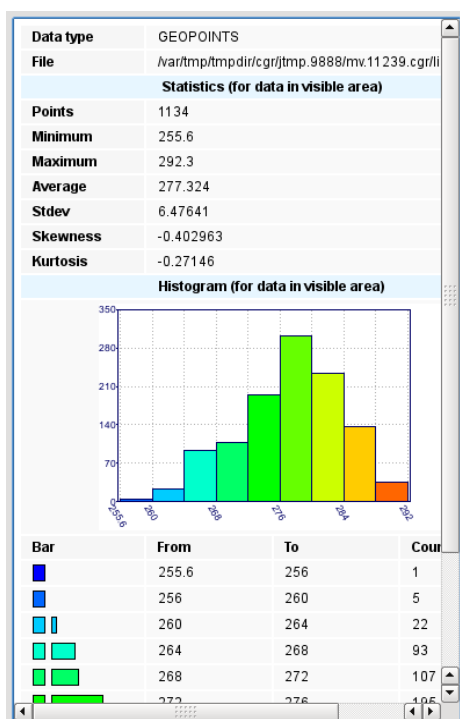
There is sidebar in the **Display Window's** right hand side. If it is not visible just click on the **Show sidebar** toggle button in the toolbar:



Now click on the 't2_filter' layer in the **Layers** tab in the sidebar. If you change the view by clicking on the **View meta-data** toggle button



you will see the statistics and histogram associated with the visualised data.



Inspecting the Data Values

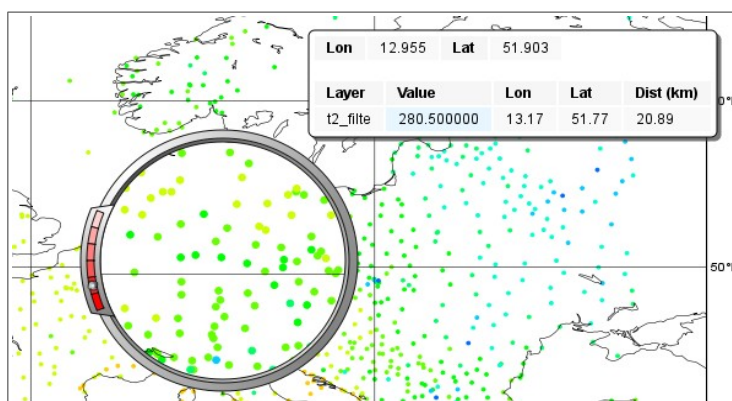
Data values at the cursor position can be inspected with the **Cursor Data Tool**, which can be activated by pressing on the gun-sight icon in the toolbar of the **Display Window**. The **Cursor Data Tool** displays the co-ordinates of the current cursor position and the information for the nearest data point to this position.



You may find it hard to use the **Cursor Data Tool** since it is complicated to properly position the cursor in data dense regions in the plot. To overcome this difficulty you need to launch the **Magnifier** by pressing on the magnifier icon in the toolbar and navigate it to your area of interest in the plot.



Now if you move the cursor inside the magnifying glass it is significantly easier to distinguish the individual data points since you navigate the cursor inside a close-up region.



Changing the Title

No automatic title is generated for geopoints files. To add a title to the plot we need a **Text Plotting** icon (it can be found in the **Visual Definitions** icon drawer). This time you do not need to create a new icon since there is one called 'title' already prepared for you. Edit this icon to see how the title is constructed. Then simply drag it into the **Display Window** and see how your title has been changed.

PART 5 - ADVANCED FILTERING WITH OBS FILTER

In this chapter we will see further examples of the capabilities of the *Obs Filter* icon. We will work in folder 'obs_filter' again.

Height and Area Filter (SYNOP)

In this exercise we will extract the 2 metre temperature values for stations located above 1000 m in the Alpine region. We will work again with the same SYNOP BUFR file as in the previous chapters ('synop.bufr') whose data structure we are already familiar with.

First, duplicate 't2_filter' *Obs Filter* icon and rename the duplicate 't2_level_filter' and edit the newly created icon. You should see the following settings defining the input, the output and the parameter to be extracted:

Data	synop.bufr
Output	Geographical Points
Parameter	012004

Now we will define a level filter:

Level	Descriptor Range
Level Descriptor	007001
First Level	500
Second Level	5000

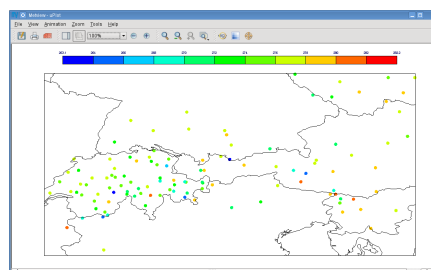
Here we set **Level** to 'Descriptor Range' indicating that we would define the level type with a descriptor and we would filter a level range. We set the level type to Height of Station by using its descriptor (007001) and defined a level range between 500 and 5000 m.

The last step is to define the area filter:

Location Filter	Area
Area	44/4/50/16

Note that the area definition is S/W/N/E; the question mark button beside the **Area** parameter launches an interactive area selection tool.

Now, save your icon (**Apply**) then right-click and **visualise** (this action will implicitly execute the filter). After zooming into the area containing the data and customizing the plot you should see something like this.



Value Filter (SYNOP)

In this exercise we will extract the 2 metre temperature values that are greater than a predefined value (285 K). We will work again with BUFR file 'synop.bufr'.

First, duplicate 't2_filter' *Obs Filter* icon and rename the duplicate 't2_value_filter' and edit the newly created icon. You should see the following settings defining the input, the output and the parameter to be extracted:

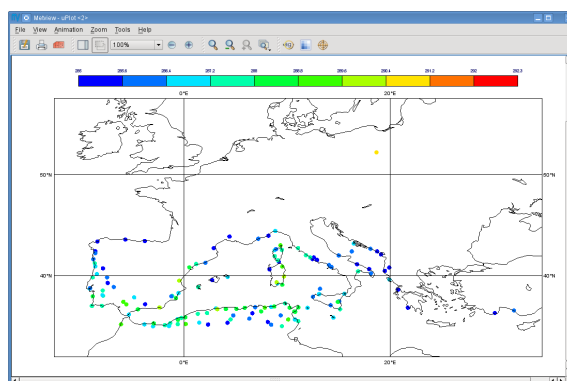
Data	synop.bufr
Output	Geographical Points
Parameter	012004

In the next step we will define a value filter:

Custom Filter	Filter by Range
Custom Parameter	012004
Custom Values	285/320

Here we set **Custom Filter** to 'Filter by Range' indicating that we want to extract only those observations where the value of a specified custom parameter lies within a prescribed range. We set the **Custom Parameter** to 2 metre temperature by using its descriptor (012004) and defined a range between 285 and 320 K.

Now save your icon (**Apply**) then right-click and **visualise**. After zooming into the area containing the data and customizing the plot you should see something like this.



Height and Date Filter (Aircraft)

In this exercise we will extract the temperature values from aircraft observations above 10000 m taken within a specific time period. We will work with BUFR file 'aircraft.bufr'.

First, we will look into the file to see its data structure. Right-click **examine** the 'aircraft.bufr' *BUFR* icon and go to the **Data** tab on the right hand side. Here you can see that each message

contains data only for one flight at a given height and date, so the data structure is somewhat similar to what we have for SYNOP.

Index	Descriptor	Name	Value	Units
5	04004	Hour	13	HOUR
6	04005	Minute	39	MINUTE
7	05001	Latitude (High Accuracy)	41.95	DEGREE
8	06001	Longitude (High Accuracy)	11.6	DEGREE
9	08004	Phase Of Aircraft Flight	5	CODE TABLE 80
10	07002	Height Or Altitude	5760	M
11	12001	Temperature/Dry-Bulb Temperature	253.8	K
12	11001	Wind Direction	307	DEGREE TRUE
13	11002	Wind Speed	15	M/S

Now create a new *Obs Filter* icon and rename it 'aircraft_filter'. First, we need to specify the input, the output and the parameter to be extracted (we have already seen in the previous chapter how to do it):

Data	aircraft.bufr
Output	Geographical Points
Parameter	012001

In the next step we will define a level filter:

Level	Descriptor Range
Level Descriptor	007002
First Level	10000
Second Level	20000

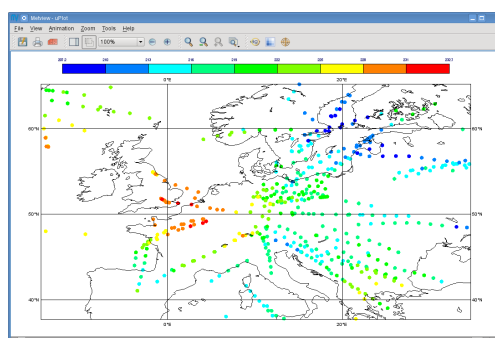
Here we set **Level** to 'Descriptor Range' indicating that we want to define the level type with a descriptor and filter a level range. We set the level type to Height by using its descriptor (007002) and defined a level range between 10000 and 20000 m.

The last step is to define the date filter:

Time	14
Resolution in Mins	30

With these settings we selected only the observations taken between 13:30 and 14:30 UTC on any given day (we could have used the **Date** parameter to specify the day as well).

Save your icon (**Apply**) then right-click and **visualise** (this action will implicitly execute the filter). After zooming into the area containing the data and applying a proper *Symbol Plotting* icon you should see something like this.



Pressure Level Filter (TEMP)

In this exercise we will extract the dewpoint temperature values at 850 hPa from TEMP observations. We will work with BUFR file 'temp.buf'.r

First, we will look into the file to see its data structure. Right-click **examine** the 'temp.buf'.r BUFR icon and go to the **Data** tab on the right hand side. Here you can see that a message contains all the data for a given station and for each pressure level (descriptor 07004) the same type of data is repeated throughout the message.

Index	Descriptor	Name	Value	Units
27	07004	Pressure	101700	PA
28	08001	Vertical Sounding Significance	4	FLAG TABLE 8001
29	10003	Geopotential	370	M**2/S**2
30	12001	Temperature/Dry-Bulb Temperature	281.4	K
31	12003	Dew-Point Temperature	275.4	K
32	11001	Wind Direction	[Missing]	DEGREE TRUE
33	11002	Wind Speed	[Missing]	M/S
34	07004	Pressure	100000	PA
35	08001	Vertical Sounding Significance	32	FLAG TABLE 8001
36	10003	Geopotential	1770	M**2/S**2
37	12001	Temperature/Dry-Bulb Temperature	280.2	K

Now create a new *Obs Filter* icon and rename it 'temp_filter'. First, we need to specify the input, the output and the parameter to be extracted:

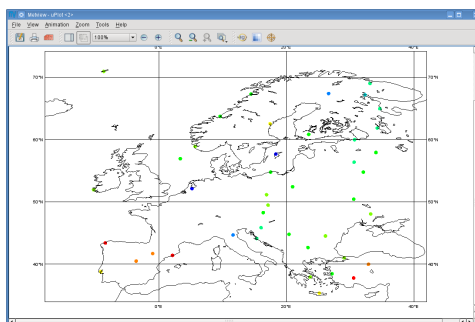
Data	temp.buf'.r
Output	Geographical Points
Parameter	012003

In the next step we will define a level filter:

Level	Single Level
First Level	850

Here we set **Level** to 'Single Level' indicating that we want to use a pressure level and set the value to 850 hPa.

Save your icon (**Apply**) then right-click and **visualise** (this action will implicitly execute the filter). After zooming into the area containing you should see something like this.



Remarks:

- For the level specification we could have used the coordinate descriptor again by setting **Level** to 'Descriptor Value', **Level Descriptor** to Pressure (007004) and **First Level** to 85000 (Pa).

Channel Filter (Satellite)

In this exercise we will extract the brightness temperature values for a given channel from AMSU-A radiances. We will work with BUFR file 'amsua.buftr'.

First, we will look into the file to see its data structure. Right-click **examine** the 'amsua.buftr' **BUFR** icon and go to the **Data** tab on the right hand side. Here you can see that a message contains all the channels for a given pixel and for each channel (descriptor 02150) the same type of data is repeated throughout the message.

Index	Descriptor	Name	Value	Units
37	02150	Tovs/Atovs/Avhrr Instrumentation Channel Number	28	CODE TAB
38	25076	Log-10 Of (Temperature-Radiance Central Wavenumber) For Atovs	1.89976	LOG (1/M)
39	25077	Bandwidth Correction Coefficient 1 For Atovs	0	NUMERIC
40	25078	Bandwidth Correction Coefficient 2 For Atovs	1	NUMERIC
41	33032	Channel Quality Flags For Atovs	1.57286e+06	FLAG TABL
42	12063	Brightness Temperature	243.45	K
43	02150	Tovs/Atovs/Avhrr Instrumentation Channel Number	29	CODE TAB
44	25076	Log-10 Of (Temperature-Radiance Central Wavenumber) For Atovs	2.02011	LOG (1/M)
45	25077	Bandwidth Correction Coefficient 1 For Atovs	0	NUMERIC
46	25078	Bandwidth Correction Coefficient 2 For Atovs	1	NUMERIC
47	33032	Channel Quality Flags For Atovs	1.57286e+06	FLAG TABL
48	12063	Brightness Temperature	244.4	K

Now create a new *Obs Filter* icon and rename it 'amusa_filter'. First, we need to specify the input, the output and the parameter to be extracted:

Data	amsua.buftr
Output	Geographical Points
Parameter	012063

In the next step we will define a channel filter:

Level	Descriptor value
Level Descriptor	002150
First Level	30

Here we set **Level** to 'Descriptor Value' indicating that we want to define the level type with a descriptor and filter a certain level (channel in this case). We set the level type to Tovs/Atovs/Avhrr Channel Number by using its descriptor (002150) and set the channel 30.

Save your icon (**Apply**) then right-click and **visualise** (this action will implicitly execute the filter). After zooming into the area containing the data and customising the plot you should see something like this.

