

# Metview 4 – ECMWF's next generation meteorological workstation



The screenshot displays a desktop environment with several windows. The main window is a file explorer showing icons for 't\_std\_dev.grb', 'Temperature Cross Section', 'Reading Meteogram', 'Folder', 'Mars Retrieval', 'Average Data', 'UK Map View', 'Shaded Coastlines', 'Rain Contouring', 'Notes', 'Temperature Contouring', and 'Wind Barbs'. A window titled 'statistics' is open, showing the following code and output:

```
# retrieve some data
f1 = retrieve (date : -1, levels : 1000, grid : [1.5, 1.5])
f2 = retrieve (date : -2, levels : 1000, grid : [1.5, 1.5])

# perform some calculations for comparison
cv_f1f2 = covar_a (f1, f2)
cv_f1f1 = covar_a (f1, f1)
cv_f2f2 = covar_a (f2, f2)
var_f1 = var_a (f1)
var_f2 = var_a (f2)

corr_manual = cv_f1f2 / (sqrt(cv_f1f1) * sqrt(cv_f2f2))
corr_manual2 = cv_f1f2 / (sqrt(var_f1) * sqrt(var_f2))
corr_builtin = corr_a (f1, f2)

Choosing RETRIEVE (MARS)
covar of f1 and f2 = 707195.562425
corr_manual = 0.876684930973
corr_manual2 = 0.876684930973
corr_builtin = 0.876684930973
```

Program finished (OK) : 4.078 s [finished at 14:05:55]

Iain Russell

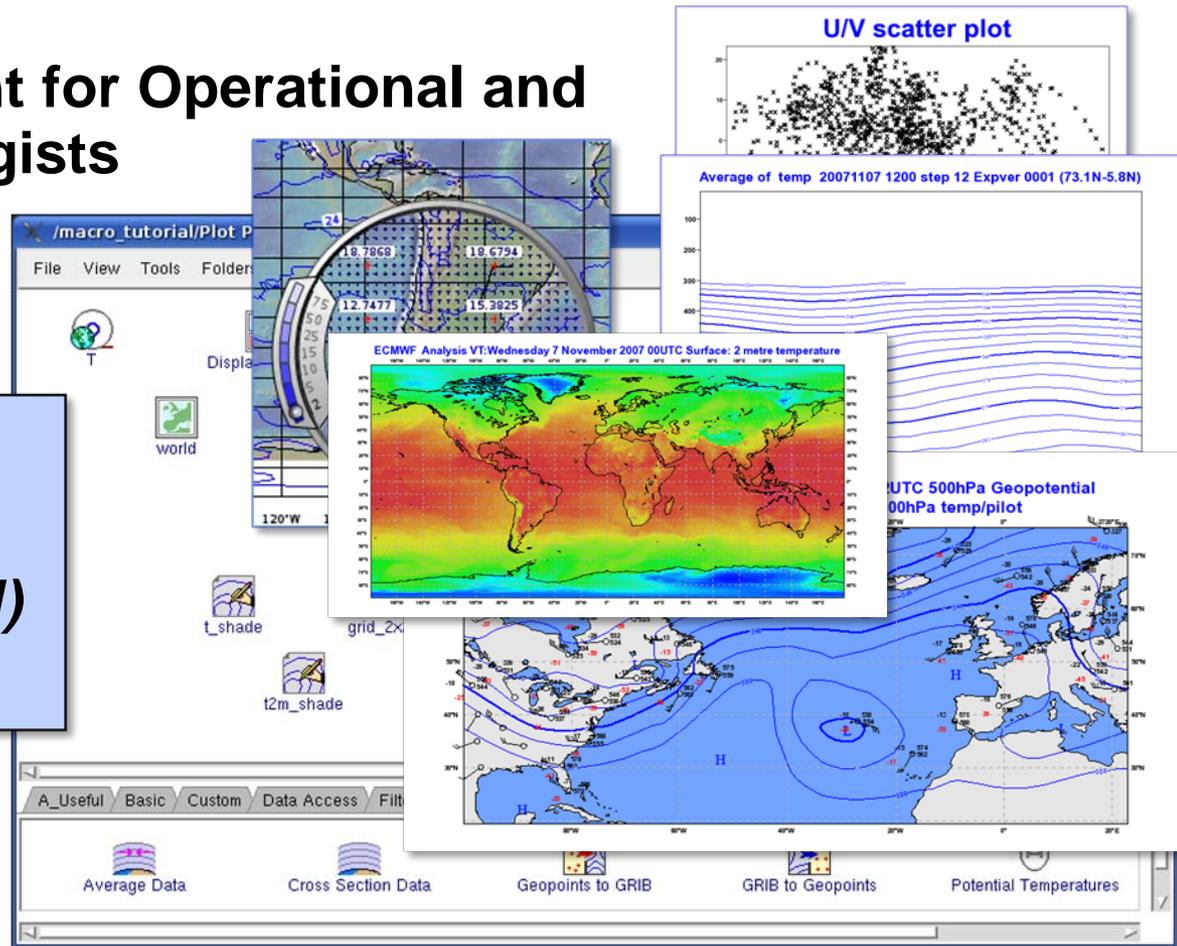
Graphics Section  
ECMWF

# What is Metview? (1)

- Working environment for Operational and Research Meteorologists
- Runs on UNIX

Co-operative project:

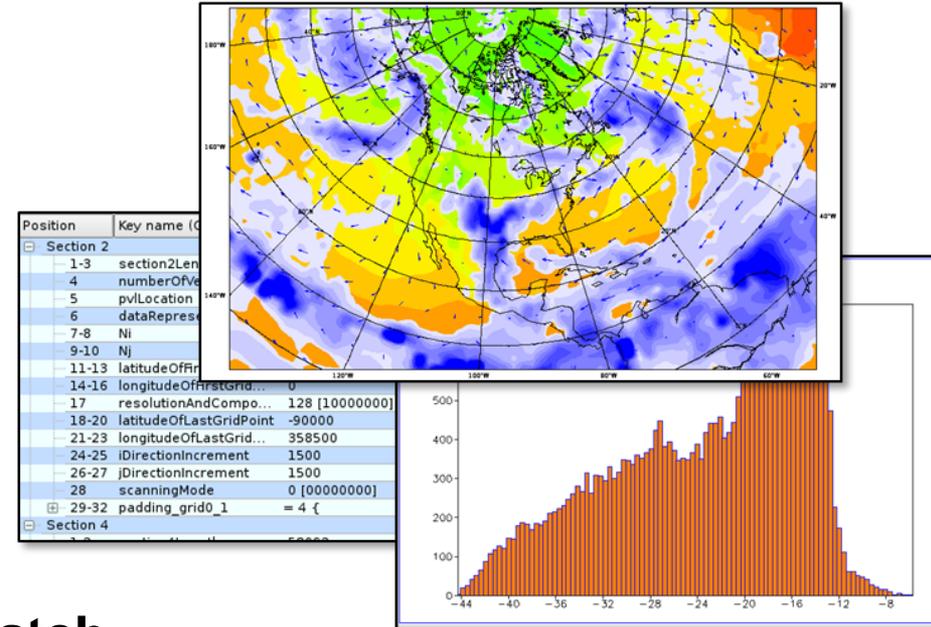
- *ECMWF*
- *INPE/CPTEC (Brazil)*
- *Météo-France*



# What is Metview? (2)

- **Data:**

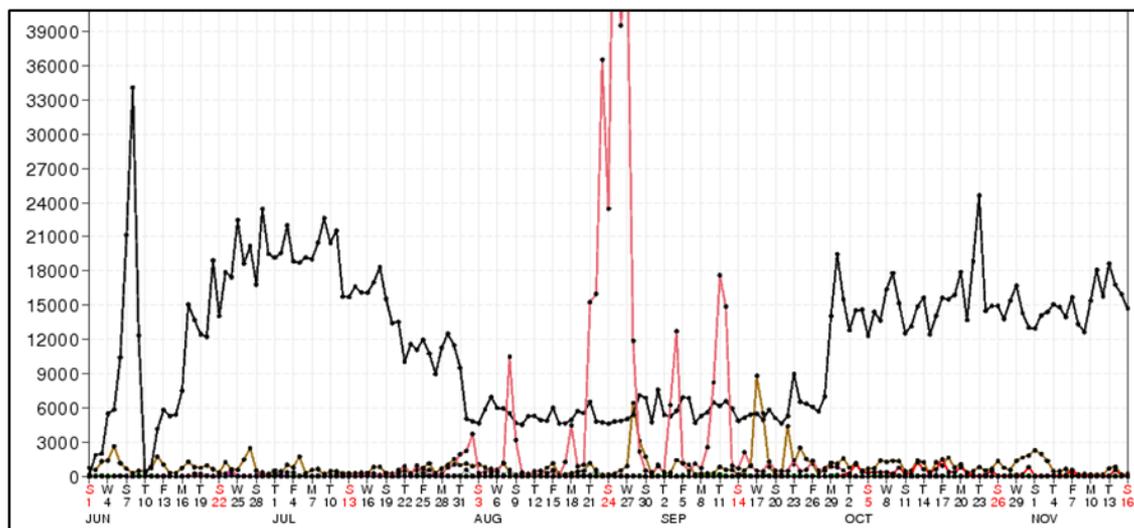
- Retrieve
- Examine
- Manipulate
- Plot / Overlay



- Can be run interactively or in batch
- Works with data archives and with local data files
- Can be installed and run standalone on a desktop or laptop
  - No data servers required
- At ECMWF we install Metview on central servers

# Who uses Metview?

- Used internally at ECMWF by researchers and operational analysts
- Member States (local installations and remotely on our ecgate server)
- Other national weather services
- Commercial customers



# Metview history (summary)

- **Announced at first EGOWS in June 1990 (Oslo)**

## Metview

*There are plans to develop a general and unique system for the visualization of meteorological data at ECMWF which should serve the scientist and the operational analyst alike. The Metview concept will provide a standard framework within which applications relating to the retrieval, processing and visualization of meteorological data can be implemented, and will enable both Operations and research*

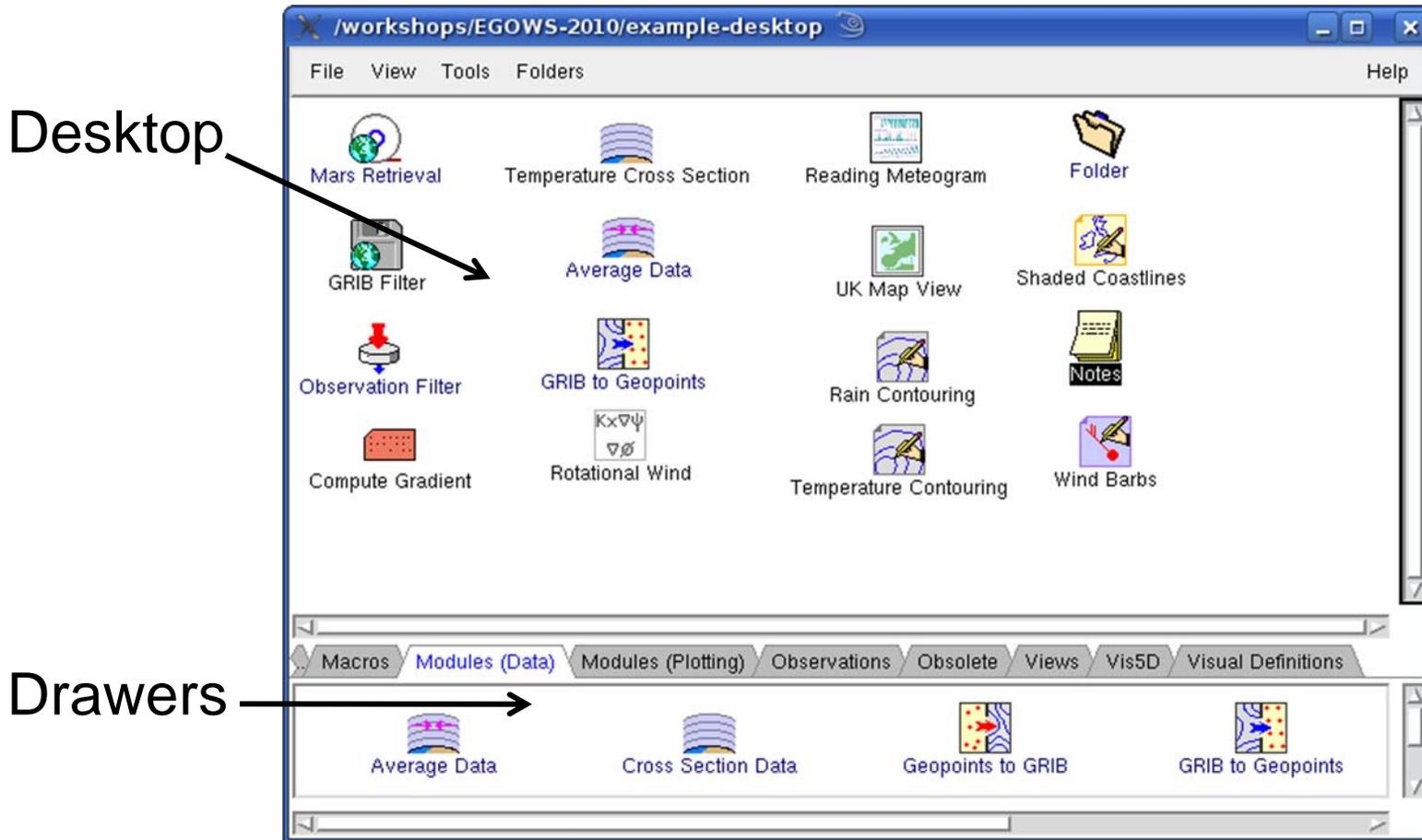
- **First operational version (Metview 1.0) in 1993**
- **OpenGL graphics introduced in 1998 (Metview 2.0)**
- **New user interface (Metview 3.0) in 2000**

# Metview today

- **Metview 3.11.5 is the latest export version (September 2009)**
  - Most subsequent updates have been quite small
  - Biggest updates are to use a new version of GRIB API
  
- **Main focus is on developing Metview 4**
  - Written in C++ (inherits code from Metview 3)
  - Changing from Motif/OpenGL to Qt
  - Using Magics++ instead of MAGICS 6 for plotting
    - Extends the power of Magics to interactive usage
    - To cope with increasing data volume
    - Enables 64-bit version
  - Built-in OGC client – retrieval and plotting / overlay
  - Uses *autotools* for building and installation – ready for RPM

# Metview concepts – the desktop

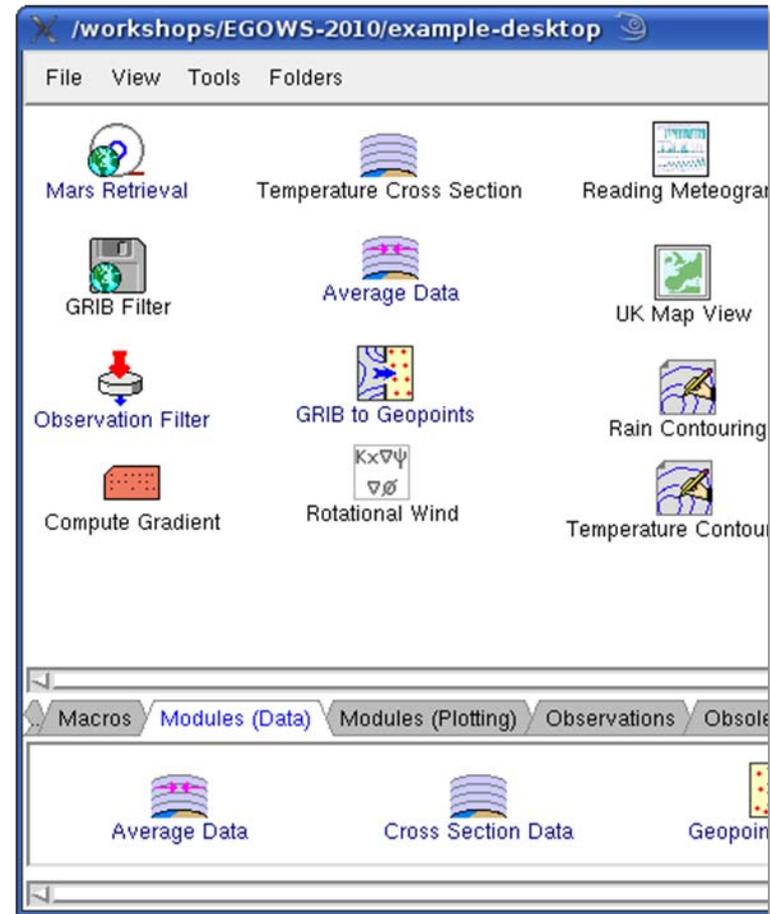
- The Metview desktop is like a file manager



# Metview concepts – icons

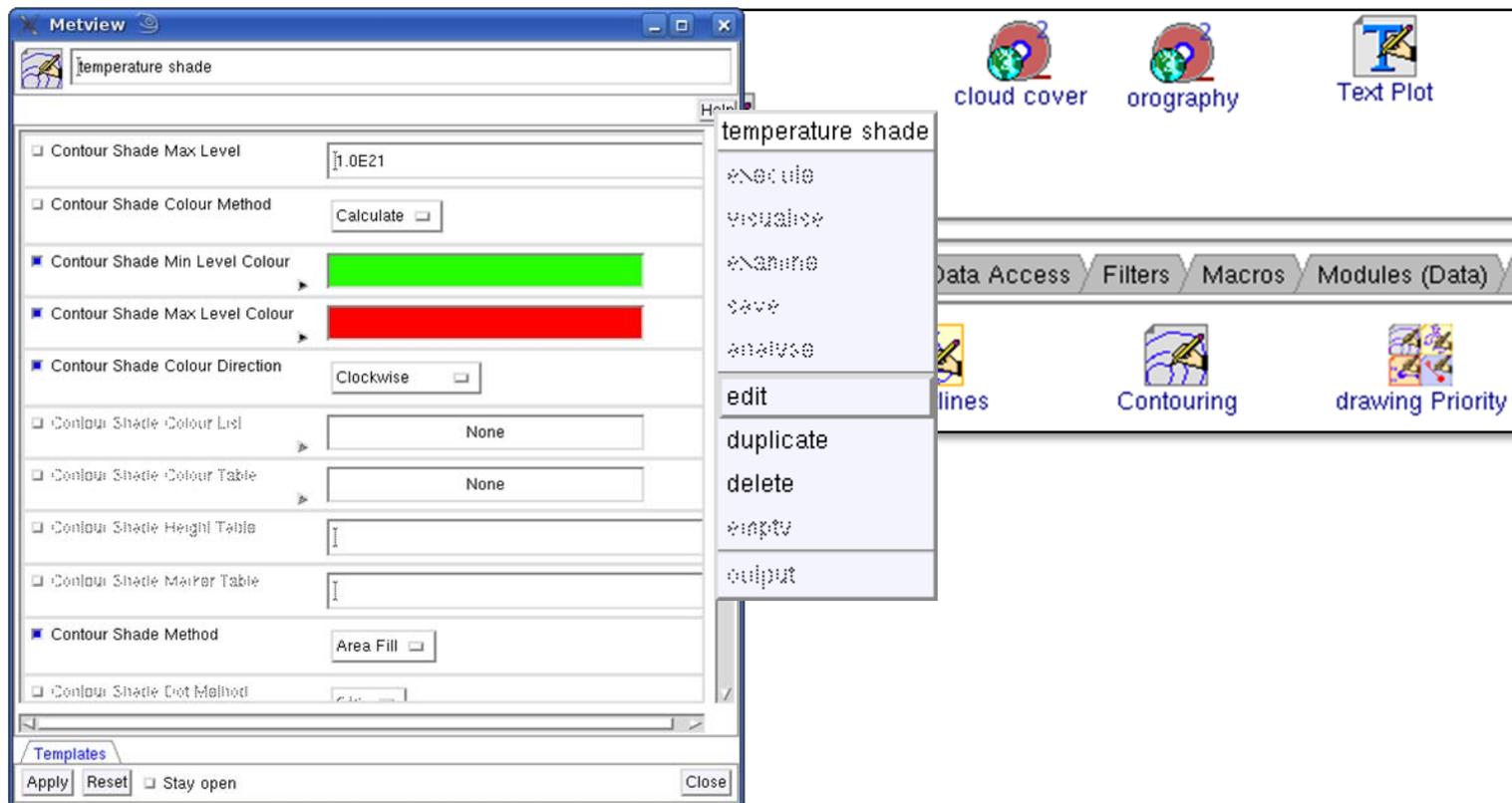
- **Icons represent everything:**

- **Data files (e.g. GRIB, BUFR, netCDF)**
- **Data retrieval directives (e.g. MARS access, WMS request)**
- **Data manipulation directives (e.g. cross sections, arithmetic computations)**
- **Visualisation attributes (e.g. contouring parameters, map areas)**
- **Macros, MagML**
- **(Other files)**



# Metview concepts – icon editors

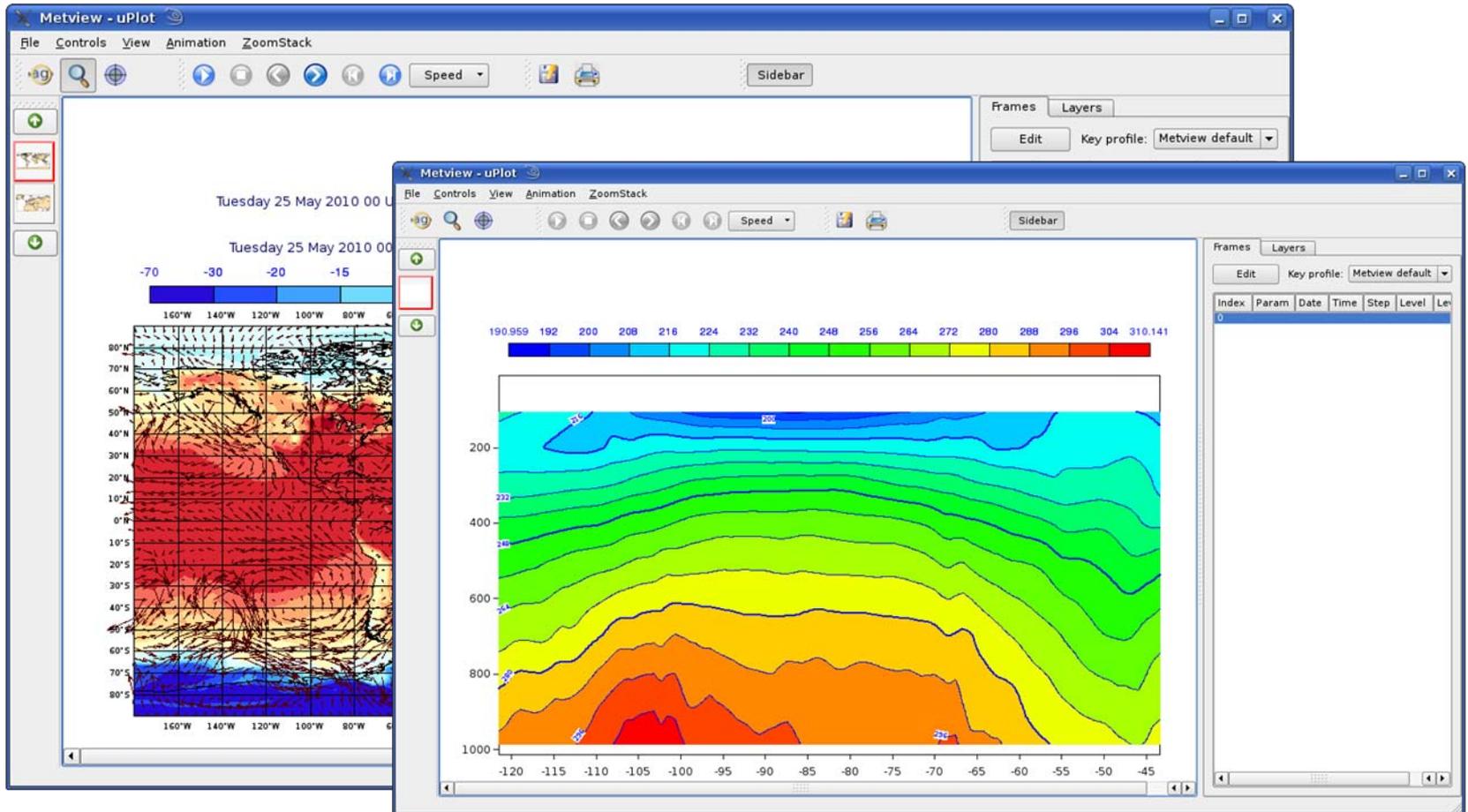
- Create a new icon (or use a supplied template)
- Edit the attributes and save before using (optional)





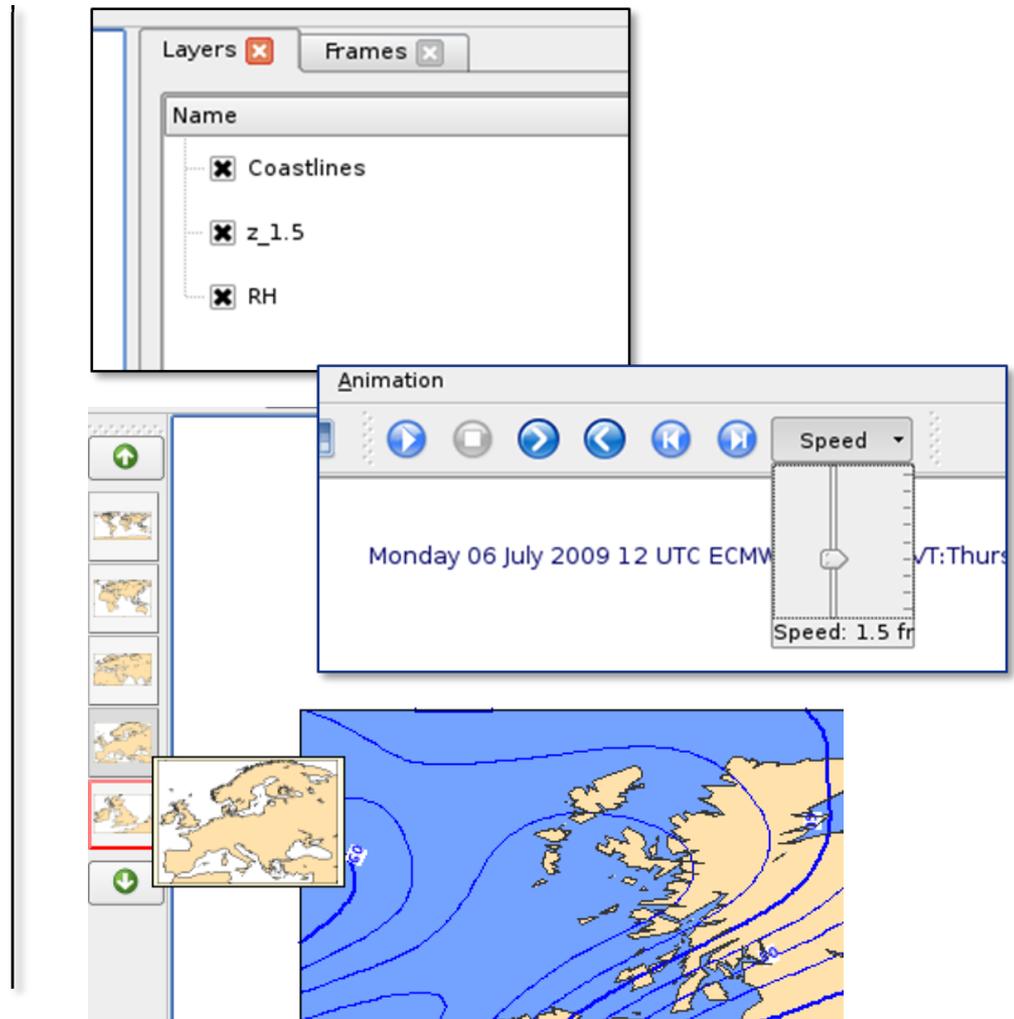
# uPlot – the Magics++ interactive plot window

- Interactive, drag & drop, zoomable plots with overlay



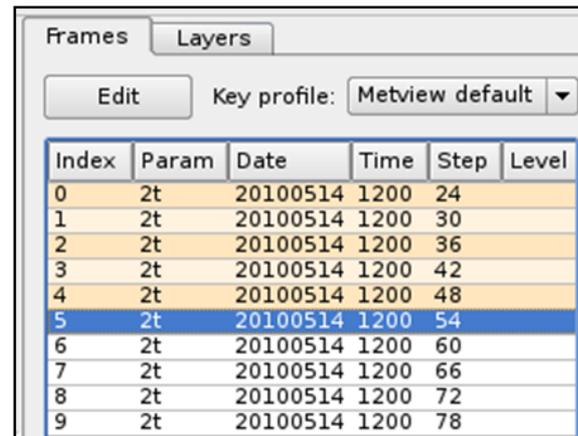
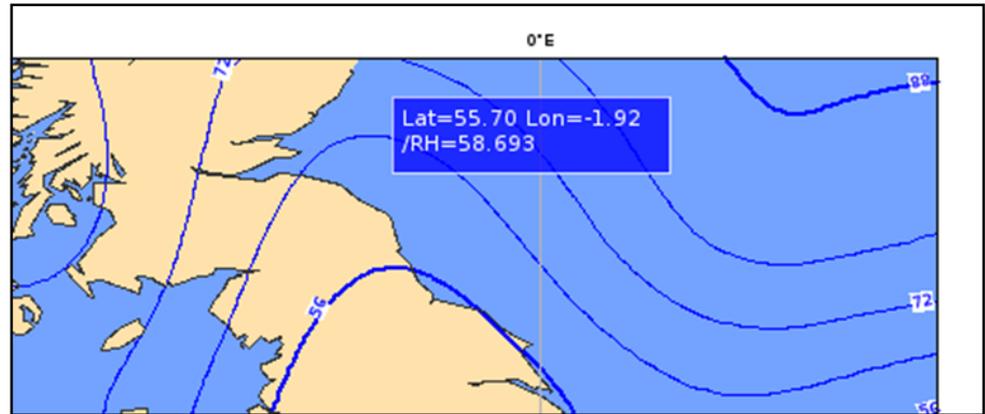
# Current uPlot features (1)

- **Layers control – toggle and reorder**
- **Zoom history stack and animation controls in dockable toolbars**



## Current uPlot features (2)

- **Cursor data – follows cursor as it moves**
- **Frames control – with user configurable and sortable columns**



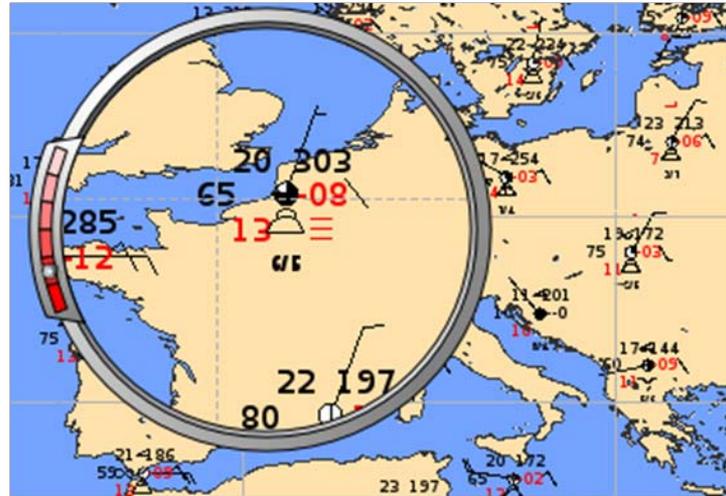
The screenshot shows a software interface with a 'Frames' tab selected. Below the tab is an 'Edit' button and a 'Key profile:' dropdown menu set to 'Metview default'. The main area contains a table with the following data:

Index	Param	Date	Time	Step	Level
0	2t	20100514	1200	24	
1	2t	20100514	1200	30	
2	2t	20100514	1200	36	
3	2t	20100514	1200	42	
4	2t	20100514	1200	48	
5	2t	20100514	1200	54	
6	2t	20100514	1200	60	
7	2t	20100514	1200	66	
8	2t	20100514	1200	72	
9	2t	20100514	1200	78	

# Current uPlot features (3)

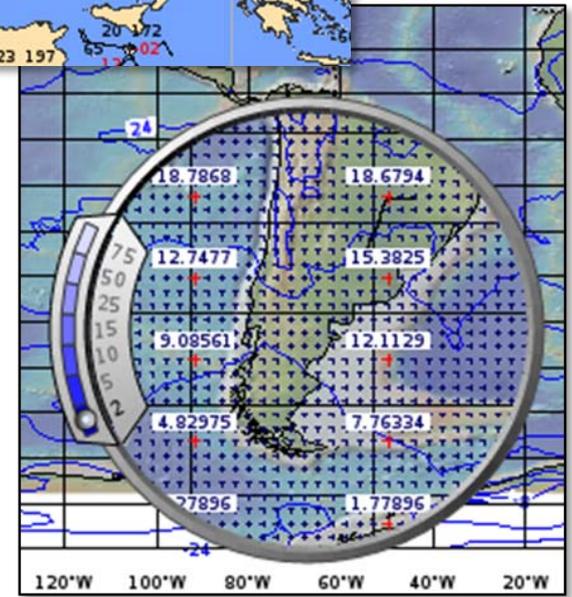
- **Magnifying glass**

- For reading numbers and small symbols



- **Data mode**

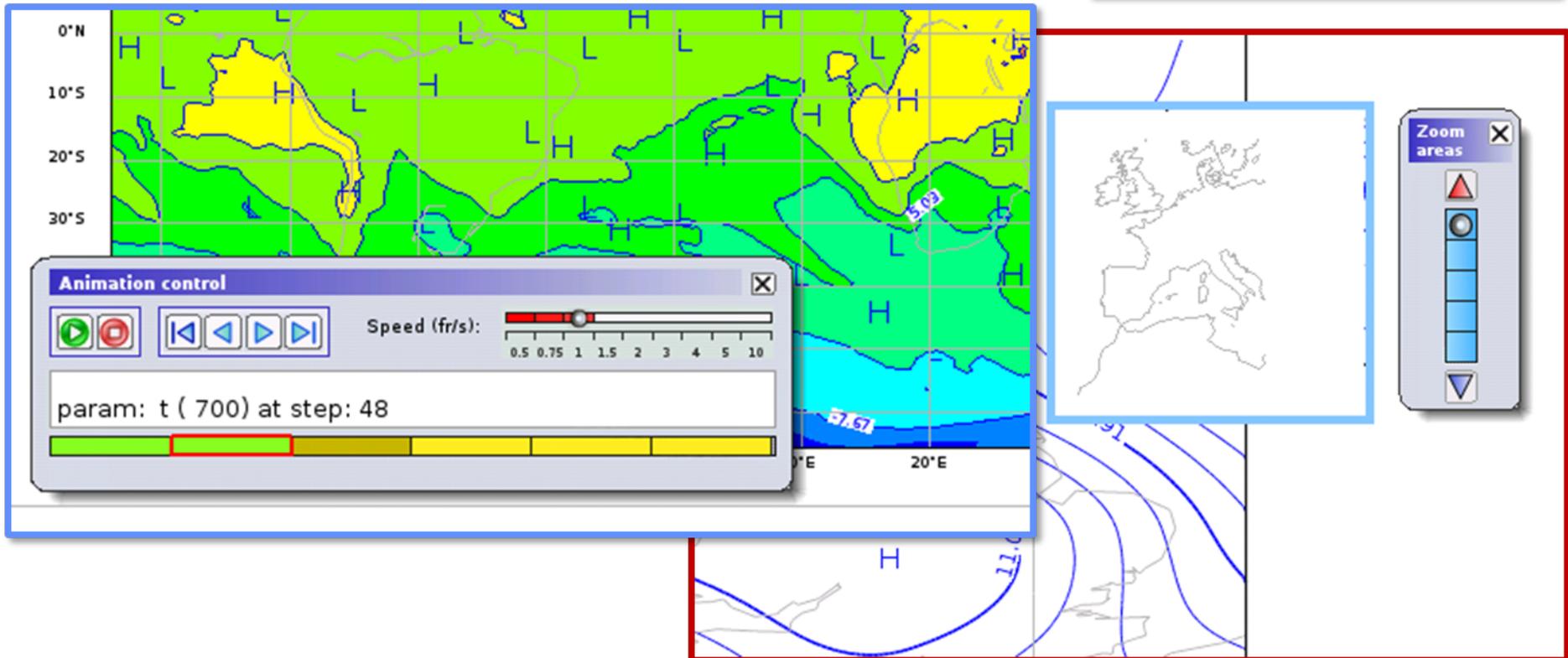
- For examining data values



# Development of uPlot (1)

- **Stage 1 – Motif GUI with OpenGL plotting and controls**

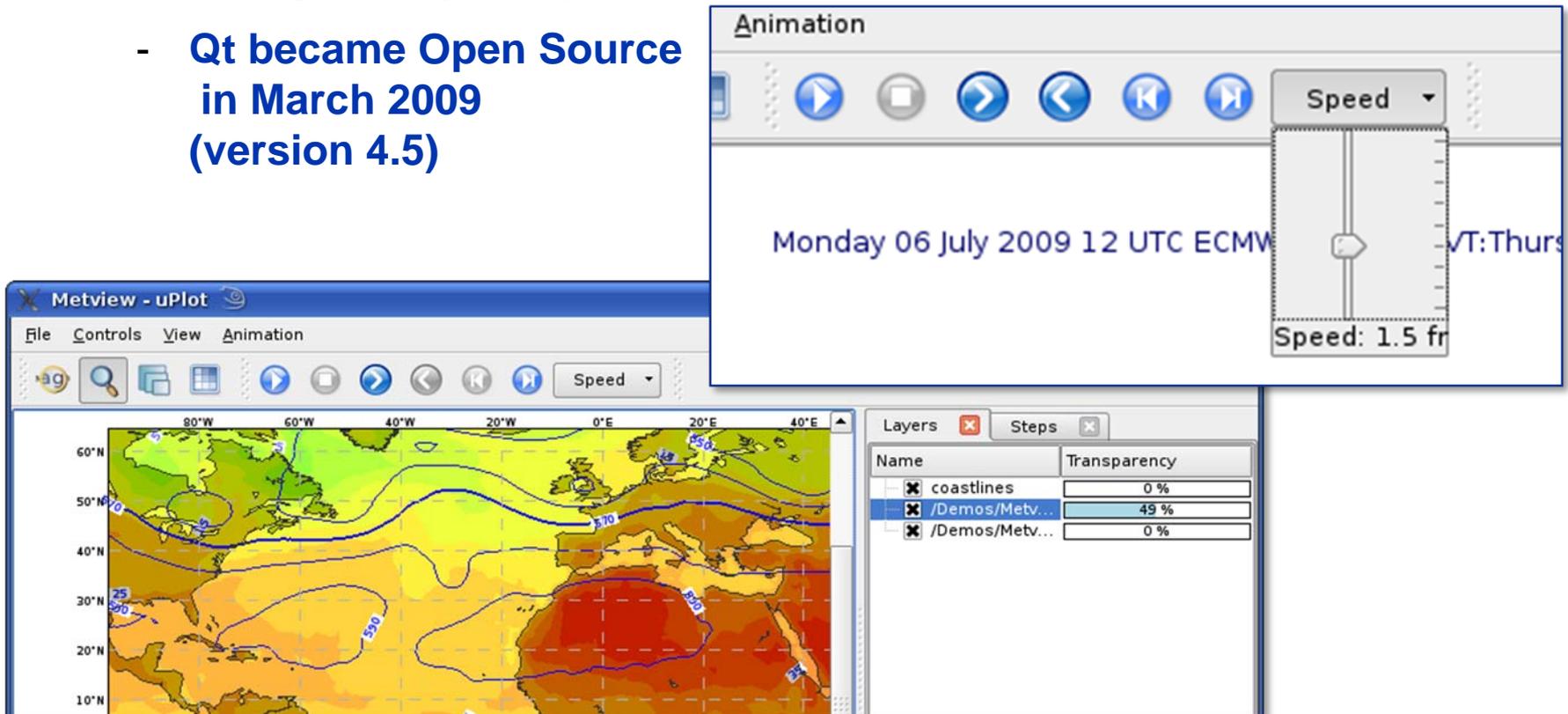
- **First version released December 2007**



# Development of uPlot (2)

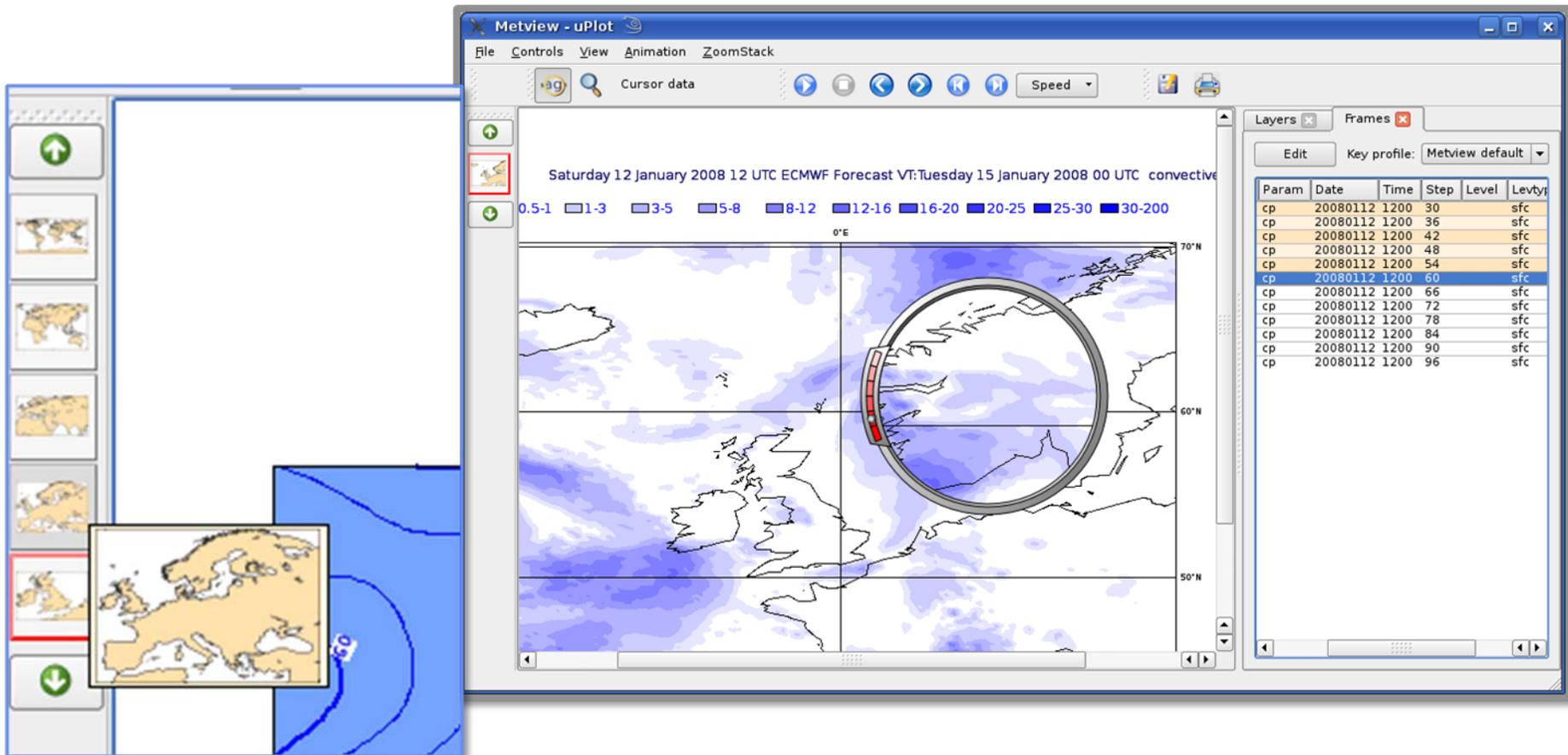
- **Stage 2 – Qt GUI with OpenGL plotting**

- **First prototype May 2009**
- **Qt became Open Source in March 2009 (version 4.5)**



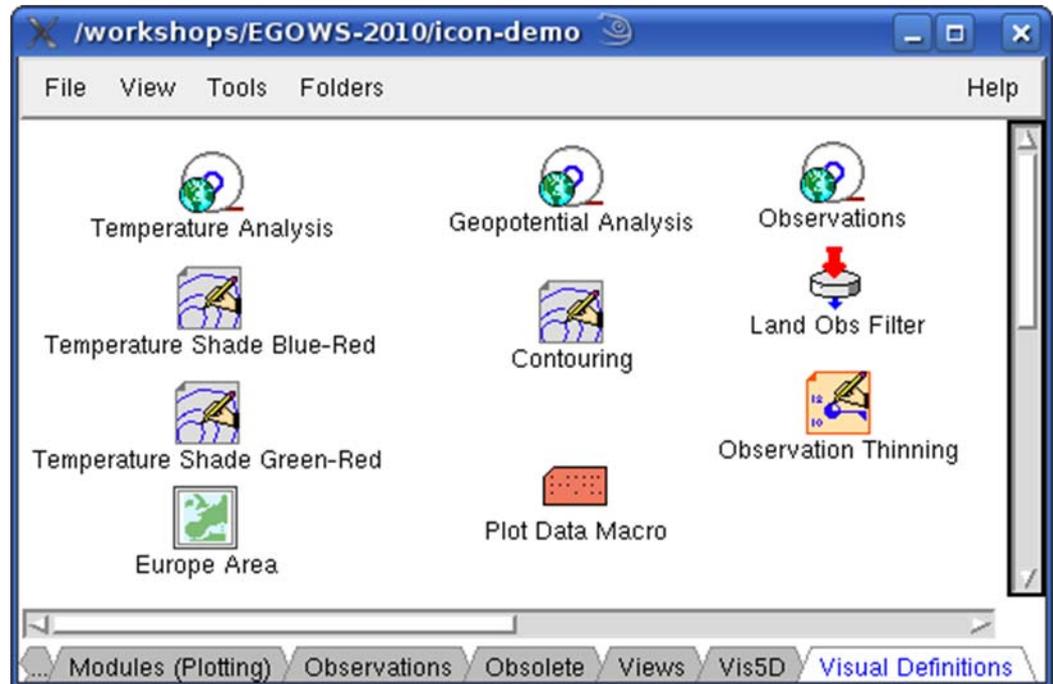
# Development of uPlot (3)

- Stage 3 – Qt GUI with Qt plotting
  - First release May 2010



# Metview concepts – icons to macros

- **Analyst: “I can generate my nice plot using icons I’ve customised – it was easy, but now I want to generate this plot every morning!”**
- **Metview guru: “Aha! You can turn your icons into Macro code in a few seconds – then you can generate your plot automatically!”**



# Macro Editor – icon dropping

The image shows a software interface for editing macros. On the left is a module palette with the following items:

- Temperature Analysis (with a globe icon)
- Temperature Shade Blue-Red (with a pencil and map icon)
- Temperature Shade Green-Red (with a pencil and map icon)
- Europe Area (with a map icon)

On the right is a code editor window titled "Plot Data Macro\* - /home/graphics/cgi/metview/workshops/EGOWS-2010/icon-demo". The code in the editor is as follows:

```
File Edit View Insert Program Settings

# Importing : /workshops/EGOWS-2010/icon-demo/Temperature Analysis
temperature_analysis = retrieve(
  levelist : 1000,
  param   : "t",
  date    : -3,
  grid    : [1.5,1.5]
)

# Importing : /workshops/EGOWS-2010/icon-demo/Temperature Shade Green-Red
temperature_shade_green_2d_red = pcont(
  legend      : "on",
  contour     : "off",
  contour_level_selection_type : "level_list",
  contour_level_list : [-100,-20,-10,0,5,10,15,20,25,30,35,40,50,100],
  contour_shade : "on",
  contour_shade_min_level_colour : "yellowish_green",
  contour_shade_max_level_colour : "red",
  contour_shade_colour_direction : "clockwise",
  contour_shade_method : "area_fill",
  contour_label : "off",
  contour_hilo : "off"
)

plot (temperature_analysis, temperature_shade_green_2d_red)
```

At the bottom of the interface, there is a status bar with "File saved" on the left and "L: 26, C: 1" on the right.

# Metview macros

- All Metview tasks can be written or saved as macros, and run in batch mode (or interactively)
- Generate code from icons, or write complex functions yourself using the extensible high-level meteorologically-oriented Macro language

- Resulting output could be:

- Derived data (e.g. GRIB, netCDF, ASCII)
- Plots (e.g. PDF, PNG, KML, PostScript)

```
function geostrophic_wind(sp_geopot:fieldset)

  # Compute gradients with respect to lon and sin(lat)
  grad_sp=spectral_gradient(sp_geopot)

  # Interpolate into a grid, omit the polar regions
  grad = read(data : grad_sp, grid : [1.5,1.5], area :

  # Weighting with R*cos(lat) to get the gradient in x
  grad_weight = 6380000 * coslat(grad[1])
  for i=1 to count(grad) do
    grad[i] = grad[i] / grad_weight
  end for

  # Compute the coriolis parameter
  omega = 2 * 3.14 / 86400.
  coriolis = 2 * omega * sinlat(grad[1])
end function
```

# Macro Editor – Metview 3 to 4

- Rewrite of macro editor – was Motif, is now Qt

The screenshot displays the Metview macro editor interface, which has been rewritten from Motif to Qt. The main window shows a code editor with the following code:

```
data = retrieve (date : -2, parameter: 'T', grid : [1.5,1.5], area:[-20, -20, 60, 60])

#data = (data > 0) # test for nil values
#data = bitmap (data, 1)

listdef = nearest_gridpoint_info (data, 52.345, 1.2)

loop ngp in listdef
  if (ngp = nil) then
    print('it is nil')
  else
    print ("Value      : ", type(ngp.value), ngp.value)
    print ("Latitude   : ", ngp.latitude)
    print ("Longitude  : ", ngp.longitude)
  end if
end loop

listvals = nearest_gridpoint (data, 52.345, 1.2)

print (listvals)
```

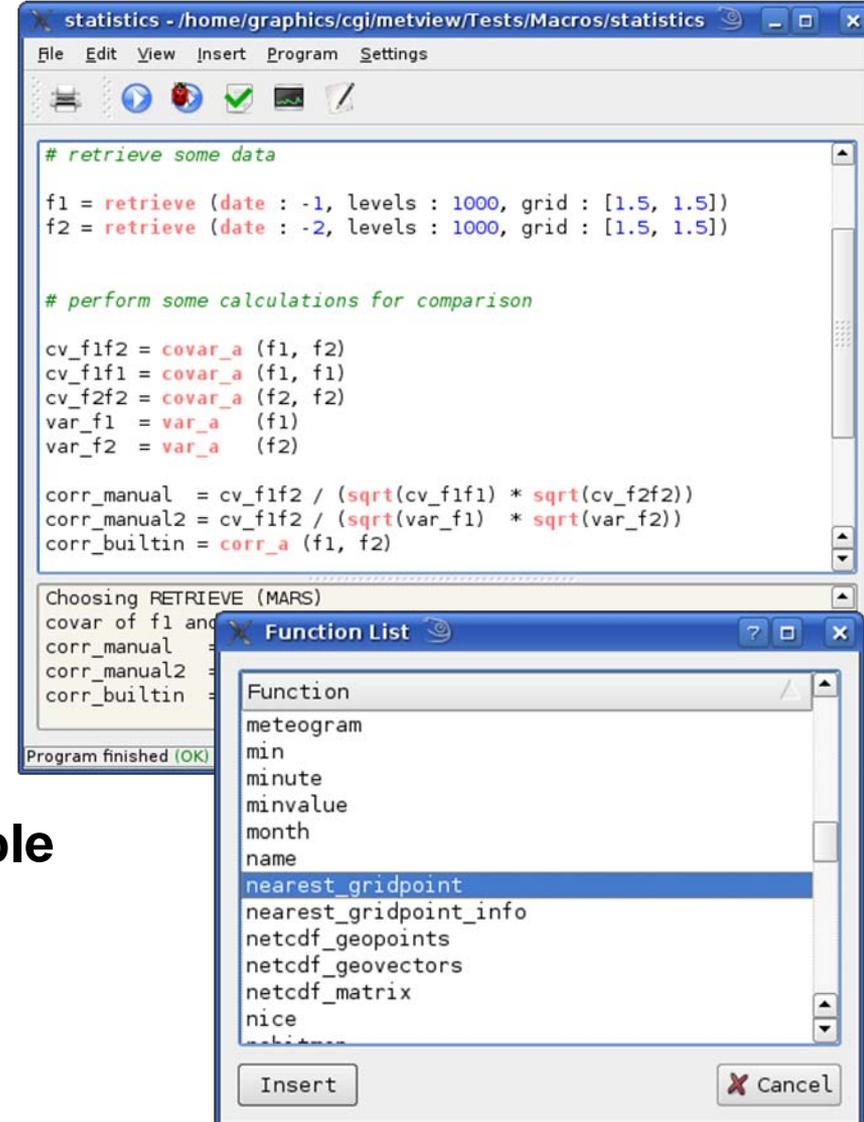
The output window shows the following results:

```
Longitude : 1.5
Value     : number240.361
Latitude  : 52.5
Longitude : 1.5
Value     : number227.847
Latitude  : 52.5
Longitude : 1.5
[281.337890625,272.131835938,261.74877]
I
```

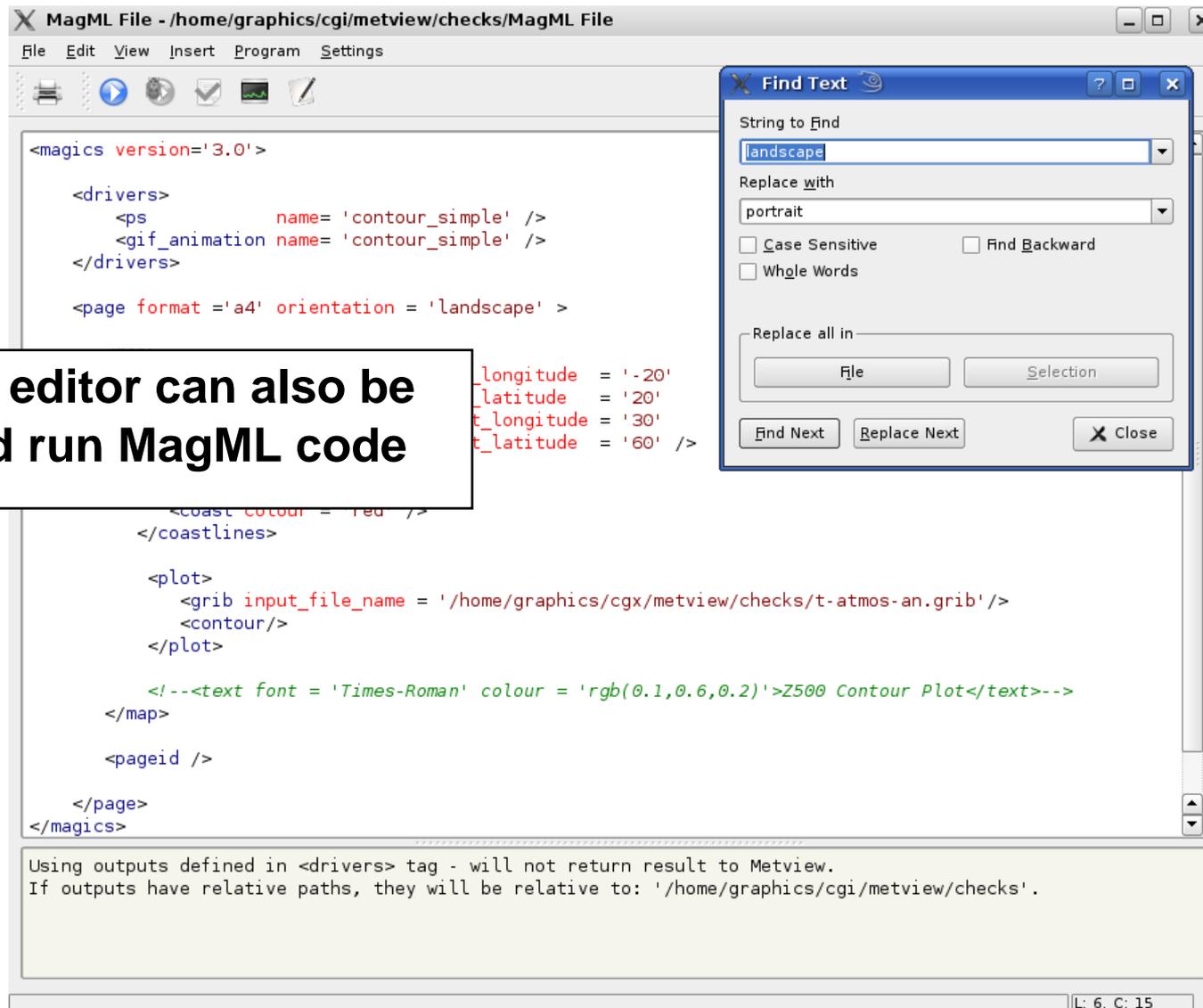
The interface includes a menu bar (File, Edit, View, Insert, Program, Settings), a toolbar with icons for print, run, stop, and save, and a status bar at the bottom indicating "Program finished (OK) : 1.649 s [Finished at 14:09:02] L: 14, C: 1". A context menu is visible over the code editor, showing options like Undo, Redo, Cut, Copy, Paste, Delete, Select All, and Insert Unicode control character.

# Macro Editor – new features

- Transition to Qt toolkit enabled many improvements:
- Syntax highlighting
- ‘Proper’ copy & paste, undo, ...
- Printing
- Can incorporate ‘insert function’ tool from built-in list of available macro functions (done), plus online help (still to do)
- Qt text widgets much more capable of handling large amounts of output



# Macro Editor – MagML editing



The screenshot shows a window titled "MagML File - /home/graphics/cgi/metview/checks/MagML File". The window contains XML code for a MagML macro. A "Find Text" dialog box is open on the right, with "landscape" in the "String to find" field and "portrait" in the "Replace with" field. The dialog also has checkboxes for "Case Sensitive", "Find Backward", and "Whole Words", and buttons for "File", "Selection", "Find Next", "Replace Next", and "Close".

```
<magics version='3.0'>
  <drivers>
    <ps          name= 'contour_simple' />
    <gif_animation name= 'contour_simple' />
  </drivers>

  <page format = 'a4' orientation = 'landscape' >

    <coast colour = 'red' />
  </coastlines>

  <plot>
    <grib input_file_name = '/home/graphics/cgx/metview/checks/t-atmos-an.grib' />
    <contour />
  </plot>

  <!--<text font = 'Times-Roman' colour = 'rgb(0.1,0.6,0.2)'>Z500 Contour Plot</text-->
</map>

<pageid />

</page>
</magics>
```

Using outputs defined in <drivers> tag - will not return result to Metview.  
If outputs have relative paths, they will be relative to: '/home/graphics/cgi/metview/checks'.

- The new macro editor can also be used to edit and run MagML code

# Metview tools – data examiners

- **We produce many many data files here every day**
- **Metview also produces data files and allows users to modify their headers**
- **Analysts often want to examine a data file to check for errors or inconsistencies in its header, for example**
- **Also useful to compare files produced in different centres**
- **Various data types have a built-in examiner in Metview (e.g. GRIB, BUFR, ODB, netCDF)**
- **Allow examination of the meta-data and structure**

# Metview GRIB examiner

- The GRIB examiner lists the messages on the left and gives meta-data for the selected message on the right

The screenshot shows the Metview GRIB Examiner interface. On the left, a table lists messages with columns for Index, Date, Time, Step, and Param. On the right, a detailed view of a selected message is shown, including a table of metadata fields and their values.

Index	Date	Time	Step	Param
019	20100301	1200	0	u
020	20100301	1200	0	v
021	20100301	1200	0	z
022	20100301	1200	0	t
023	20100301	1200	0	u
024	20100301	1200	0	v
025	20100228	1200	24	z
026	20100228	1200	24	t
032	20100228	1200	24	v
033	20100228	1200	24	z
034	20100228	1200	24	t
035	20100228	1200	24	u
036	20100228	1200	24	v
037	20100228	1200	24	z
038	20100228	1200	24	t
039	20100228	1200	24	u
040	20100228	1200	24	v
041	20100228	1200	24	z
042	20100228	1200	24	t

Position	Key name (GRIB API)	Value
Section 1		
Section 2		
1-3	section2Length	32
4	numberOfVerticalCoordinateValues	0
5	pvLocation	255
6	dataRepresentationType	0 [Latitude/Longitude G
7-8	Ni	240
9-10	Nj	121
11-13	latitudeOfFirstGridPoint	90000
14-16	longitudeOfFirstGridPoint	0
24-25	iDirectionIncrement	1500
26-27	jDirectionIncrement	1500
28	scanningMode	0 [00000000]
29-32	padding_grid0_1	= 4 {
Section 4		
Section 5		

Log

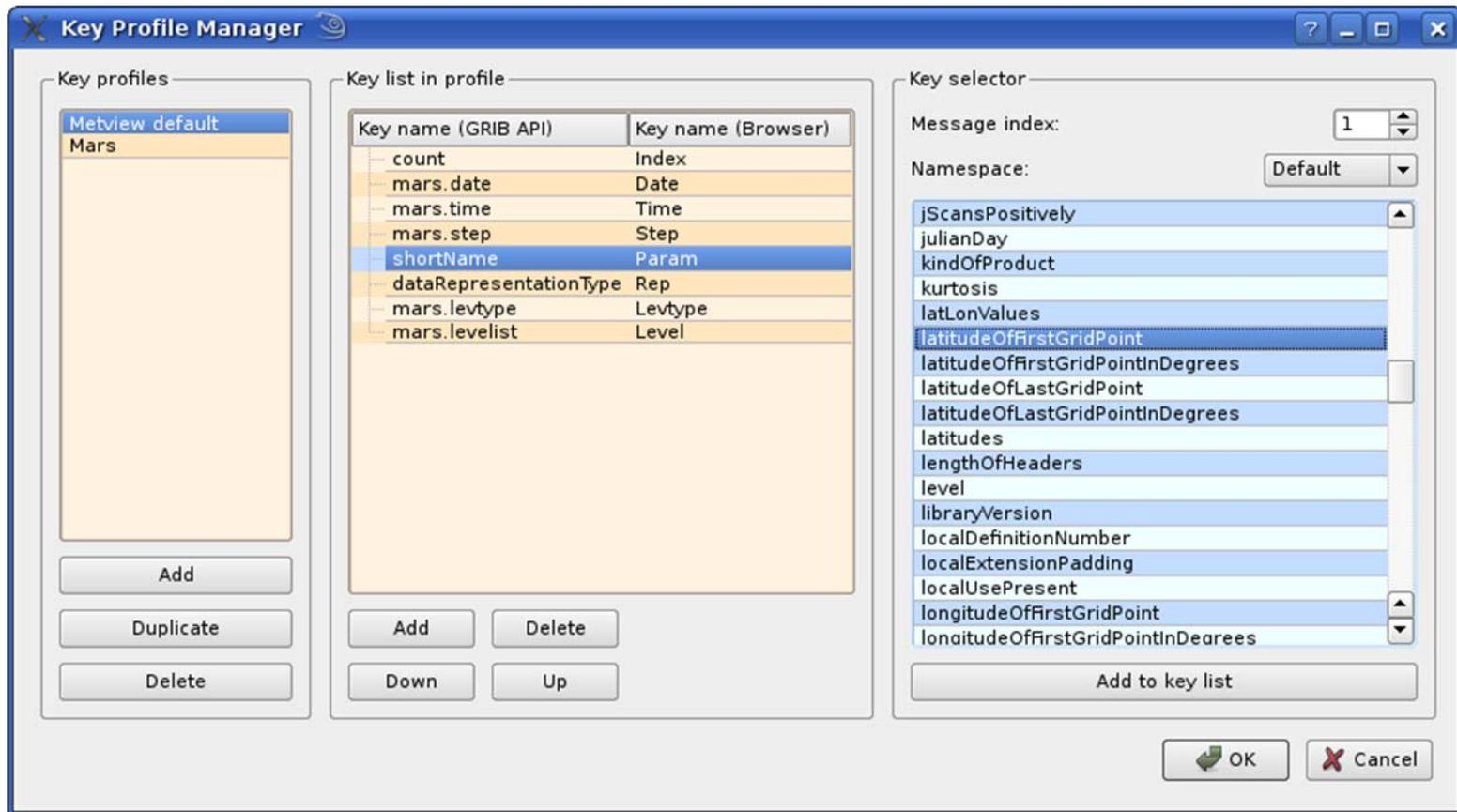
Status: OK

Task: Generating WMO-style dump for message: 31  
Command: /usr/local/lib/metaps/lib/grib\_api/1.8.4/bin/grib\_dump -O -w count=31 "/home/graphics/cgi/metview/cgi/ztuv.grb"  
Status: OK

Task: Generating default dump for message: 31  
Command: /usr/local/lib/metaps/lib/grib\_api/1.8.4/bin/grib\_dump -w count=31 "/home/graphics/cgi/metview/cgi/ztuv.grb"  
Status: OK

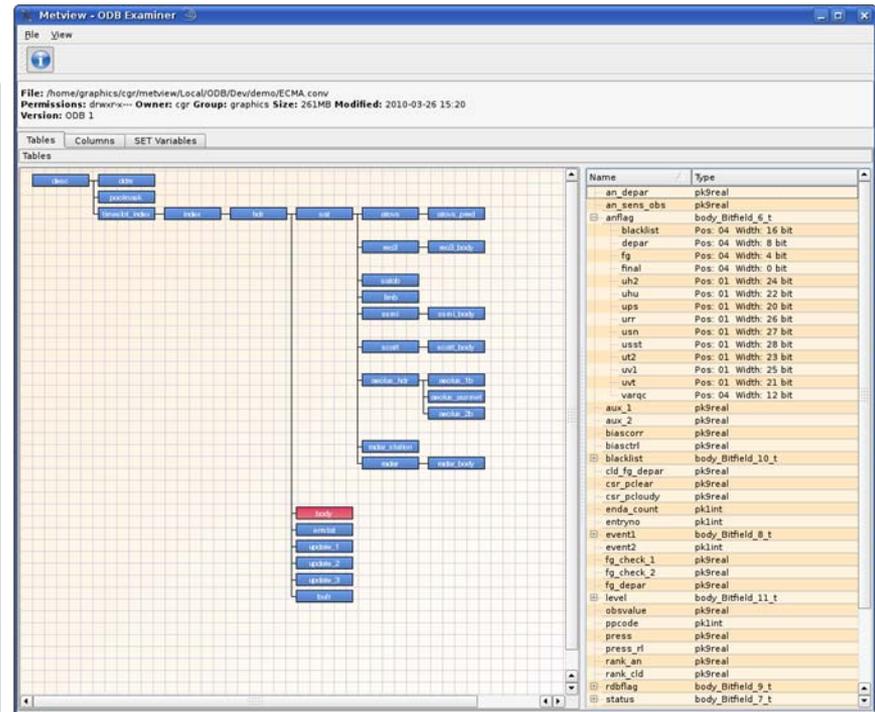
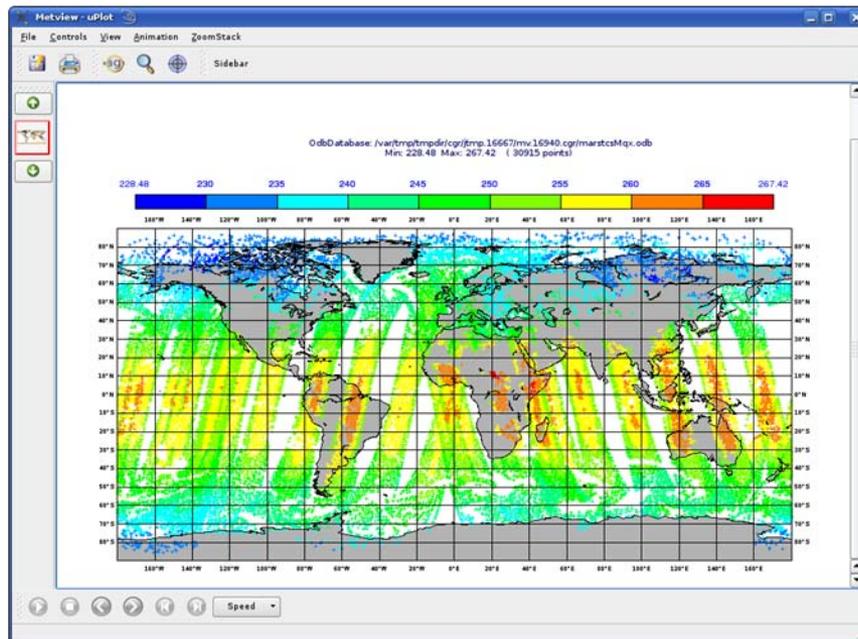
# Metview GRIB examiner

- The columns on the left-hand side are sortable and user definable

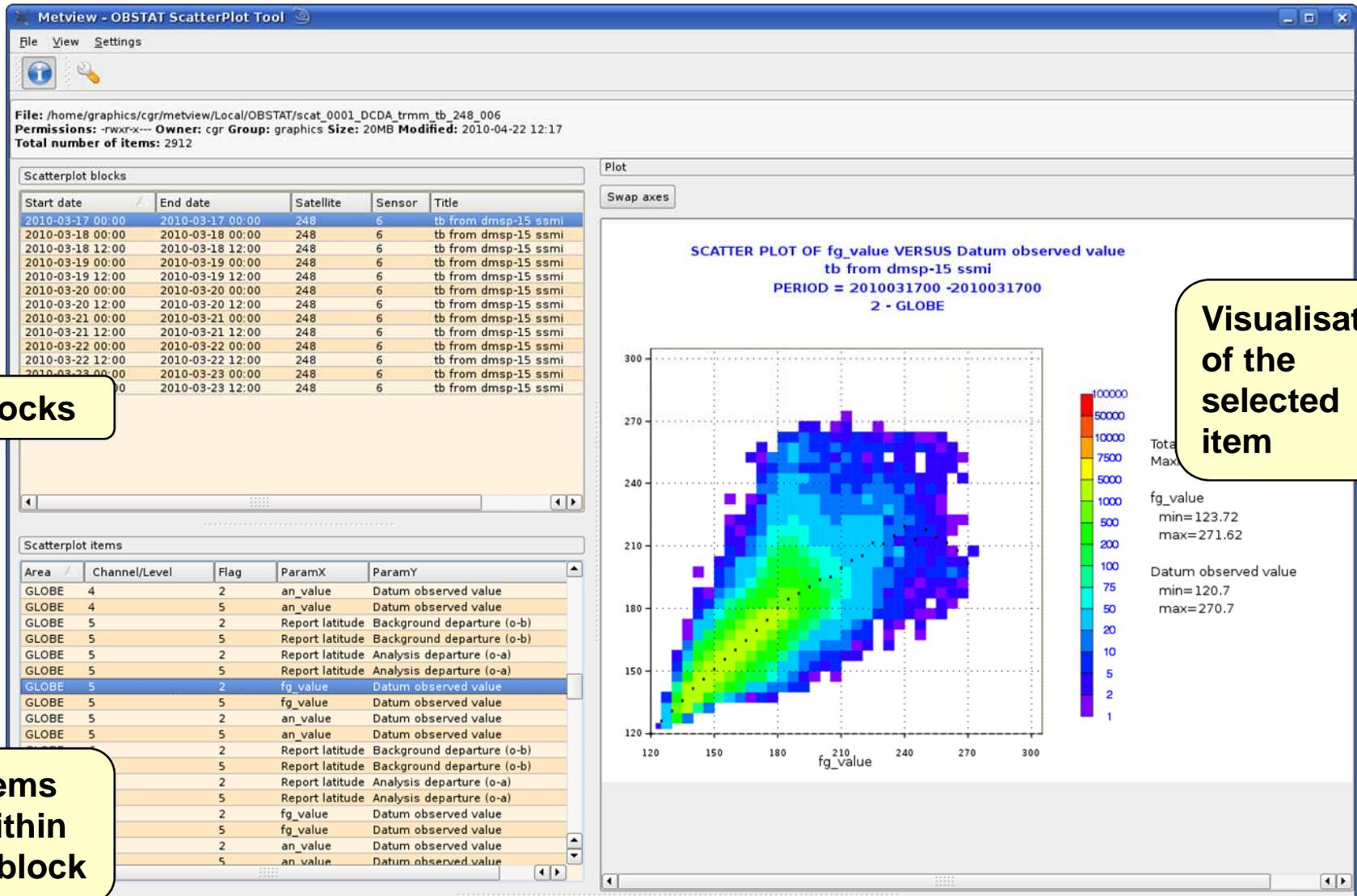


# Metview and Observation Monitoring

- To replace existing tools and create new ones with Metview 4
- Interact with ODB (Observation DataBase)
  - Retrieve, query/filter, examine, plot, overlay



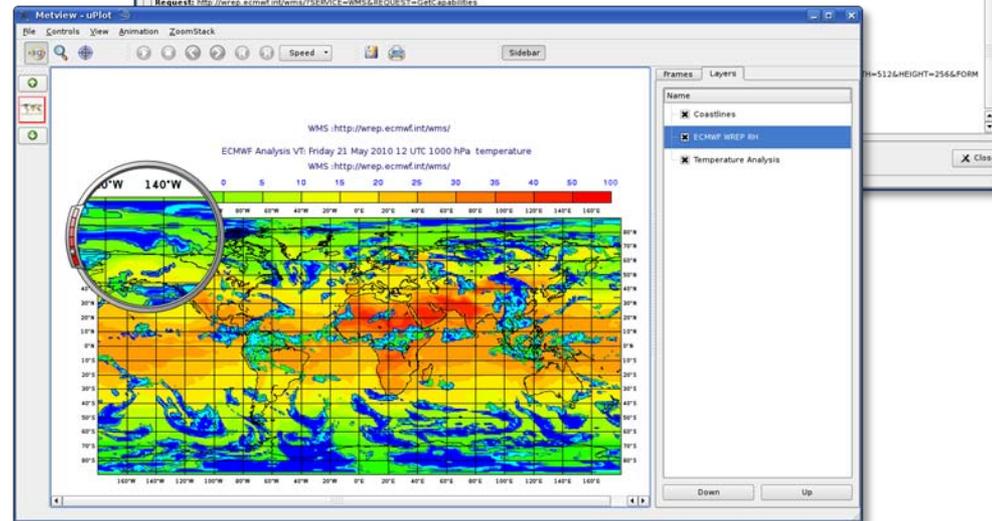
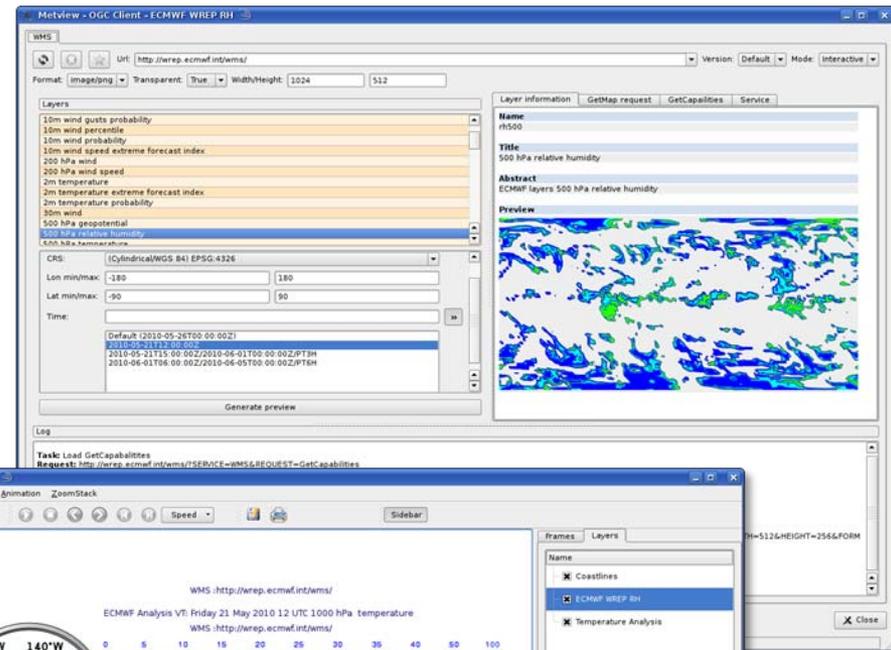
# OBSTAT (ECMWF) Scatterplot Examiner



# Metview as an OGC client

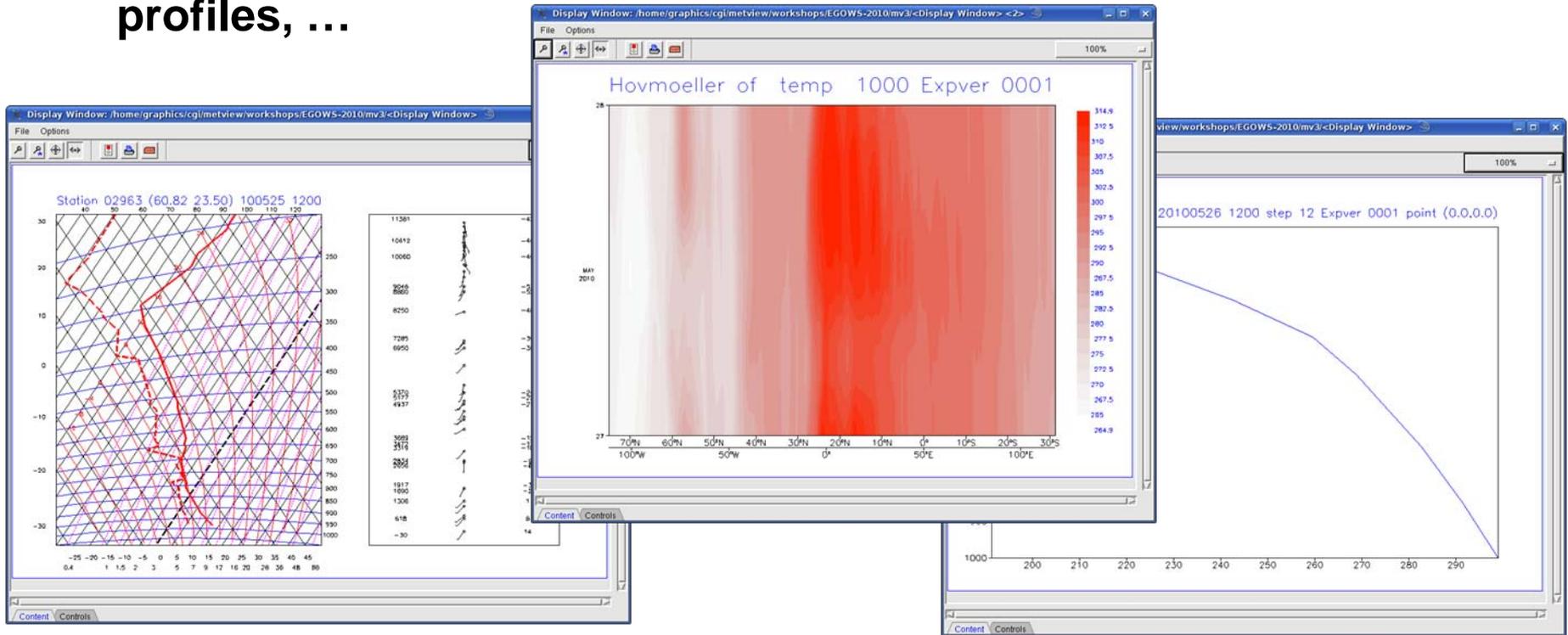


- **Metview 4 has an OGC client**
- **Fits neatly into Metview's architecture**
- **Enter the server address**
  - Selectable layers, etc are presented in the interface
  - Preview the layer/style
  - Advanced request editing possible
  - Save your choice
  - Drop into a Metview plot window to visualise or overlay with other data



# Other Metview tools

- Metview 3 has many tools that have not yet been carried over to Metview 4
- Examples include tephigrams, Hovmöller diagrams, vertical profiles, ...



# Our experiences of using Qt



- **Motif served us well in the past, but Metview has benefited greatly from using Qt**
- **MUCH easier to work with than Motif**
- **Encourages more development of tools**
- **Good books, training and online help available**
- **In our implementation, graphics performance better than software OpenGL, but not quite as good as hardware OpenGL (obviously depends on particular implementations!)**
- **Graphics more consistent over a network than OpenGL (this was an important reason behind the decision to move to Qt)**
  - **More independent of graphics hardware than OpenGL**
- **Qt is being frequently improved**

# Metview 4 – the future



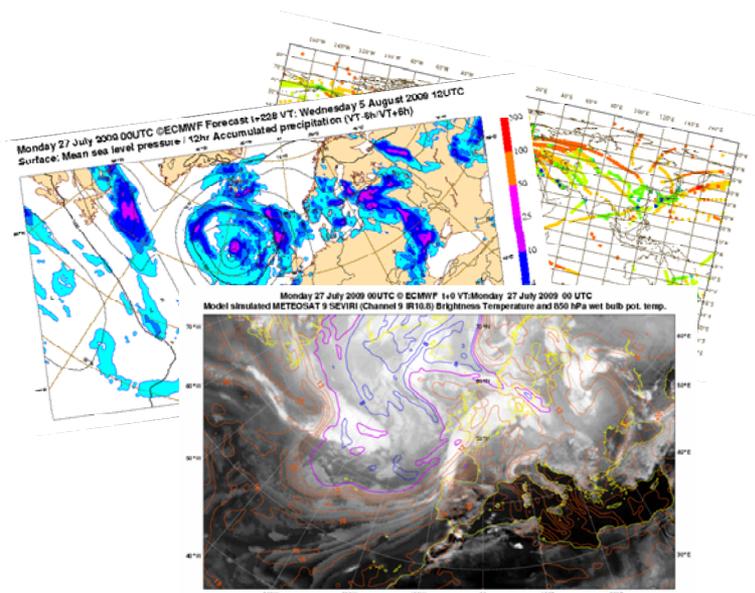
- **Replace all Motif code with Qt**
- **Revisit all modules – some will be reintroduced as they are, some will be re-written, some will be removed**
- **Continue to add clients for more web services (WCS, WFS)**
- **Development of more specific tools (satellite data manipulation)**
- **Further support for formats from the GIS world (shape, geotiff)**
- **Extension of batch/macro capabilities (e.g. Python interface?)**
- **Release plans**
  - **June 2010: internal release candidate**
  - **September 2010: first external release**
  - **Updates will add new features (more frequently than Metview 3)**

# For more information ...

email us:

 **Metview:**      [metview@ecmwf.int](mailto:metview@ecmwf.int)

 **Magics:**      [magics@ecmwf.int](mailto:magics@ecmwf.int)



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