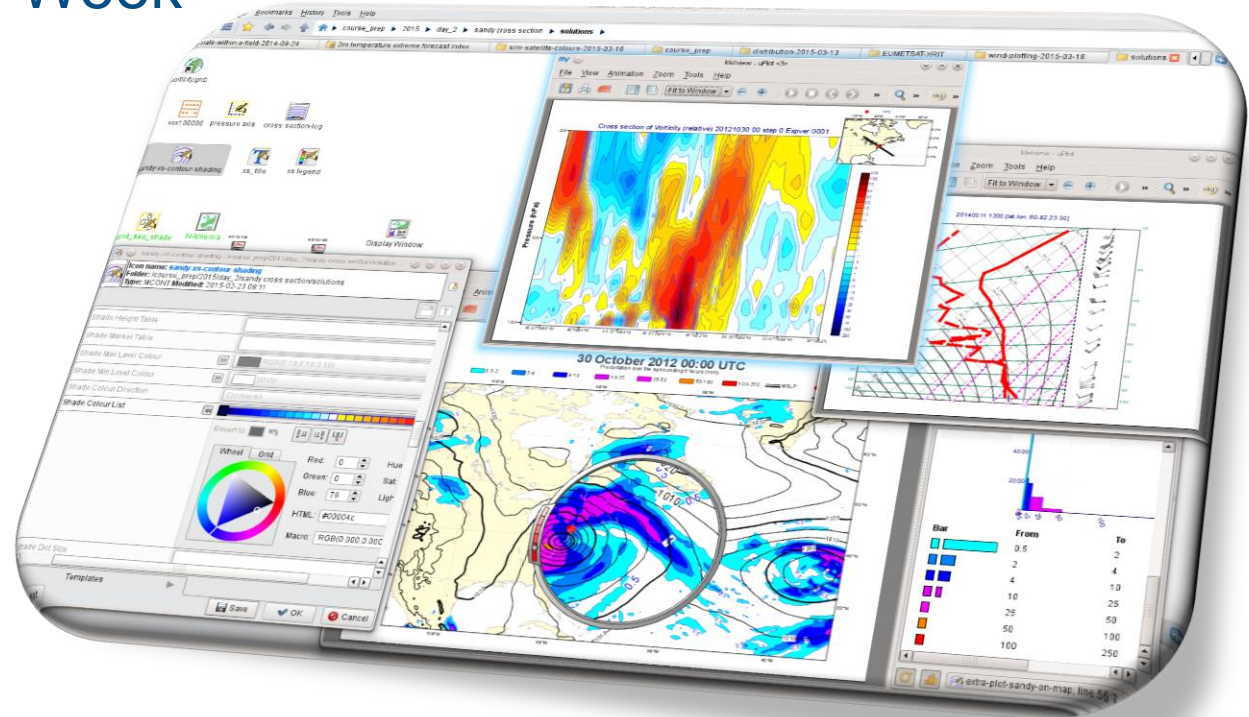


Data Analysis and Visualisation with Metview

ECMWF Visualisation Week

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Development Section, ECMWF



What is Metview?

- Workstation software for researchers and operational analysts
 - Runs on UNIX, from laptops to supercomputers (now includes Mac OS X)
- Retrieve/manipulate/visualise/examine meteorological data
- Drag & drop user interface / powerful scripting language

Built on core ECMWF technologies:
MARS, GRIB_API, Magics, ODB, Emoslib

- Handles GRIB, BUFR, NetCDF, ODB, Geopoints, CSV, ASCII
- Can access MARS, either locally or through the Web API
- Open Source under Apache Licence 2.0
- Metview is a co-operation project with INPE (Brazil)

The image displays the Metview software interface. The top window shows a weather map of Europe with various data layers overlaid, including a color-coded temperature field and a circular inset showing a detailed view of a specific location. Below the map is a file browser window showing a directory structure with folders like 'Tests' and 'Vapor', and files such as 'Average Data', 'Cartesian View', 'Coastlines_notext', and several 'Contouring' files. At the bottom, a terminal window shows a script being executed, which retrieves data and performs calculations. The script output shows the covariance and correlation values for two data fields, f1 and f2.

```
6 # retrieve some data
7
8 f1 = retrieve (date : -1, levels : 1000, grid : [1.5, 1.5])
9 f2 = retrieve (date : -2, levels : 1000, grid : [1.5, 1.5])
10
11
12 # perform some calculations for comparison
13
14 cv_f1f2 = covar_a (f1, f2)
15 cv_f1f1 = covar_a (f1, f1)
16 cv_f2f2 = covar_a (f2, f2)
17 var_f1 = var_a (f1)
18 var_f2 = var_a (f2)
19
20 corr_manual = cv_f1f2 / (sqrt(cv_f1f1) * sqrt(cv_f2f2))
21 corr_manual2 = cv_f1f2 / (sqrt(var_f1) * sqrt(var_f2))
22 corr_builtin = corr_a (f1, f2)
23
```

covar of f1 and f2 = 615250.382118
corr_manual = 0.870234693771
corr_manual2 = 0.870234693771
corr_builtin = 0.870234693771

Program finished (OK) - 611 ms [Finished at 11:18:47]

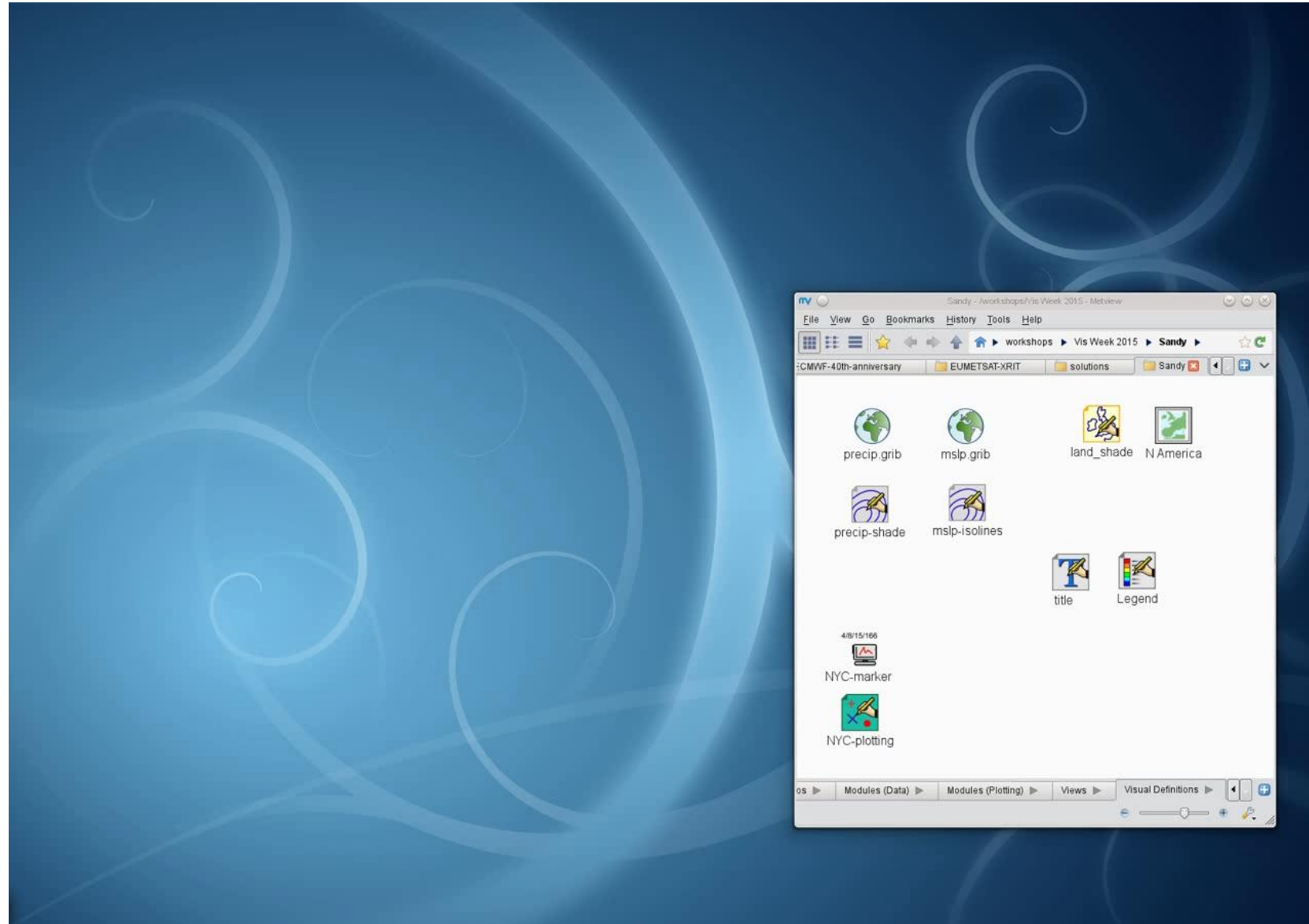
Using Metview

- Icon-based user interface
 - interactive investigation of data
 - icons represent data, settings and processes
 - icons can be chained together – output from one is input to another
- Powerful Macro scripting language
 - more serious computations
 - batch or interactive usage

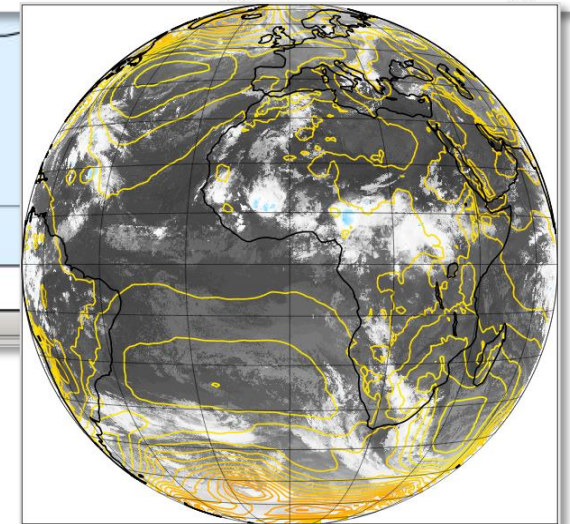
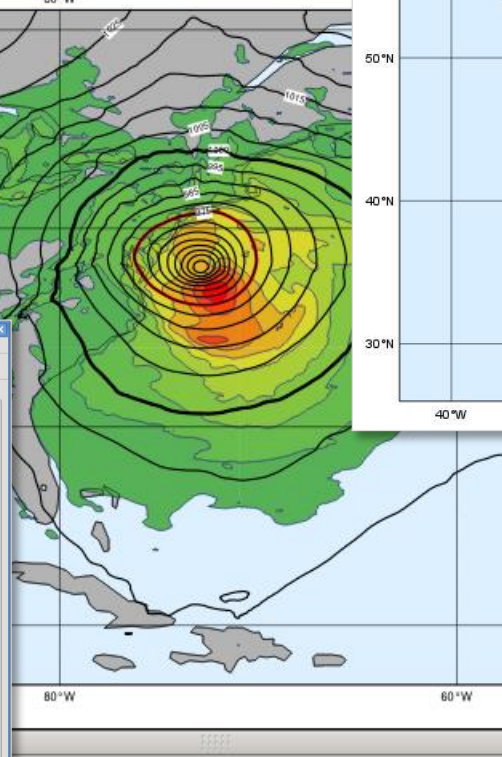
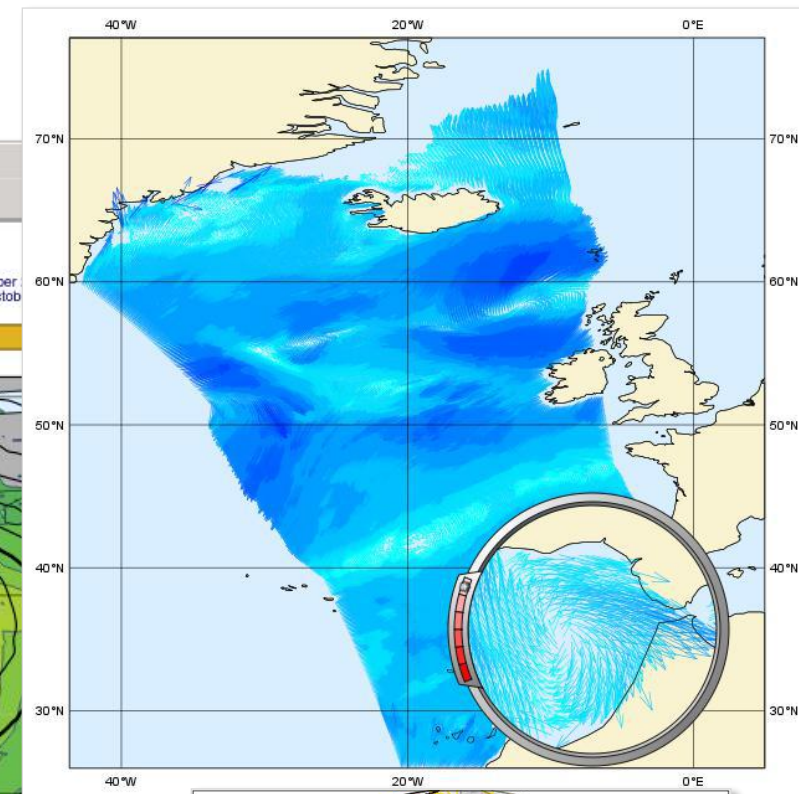
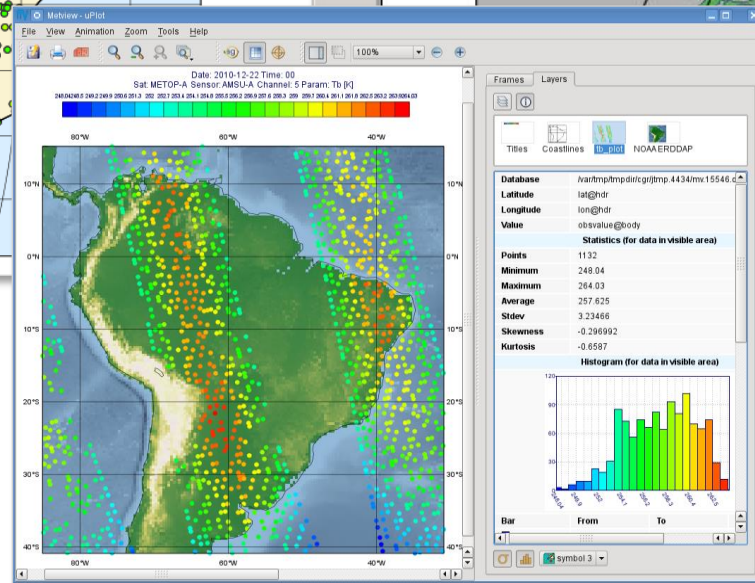
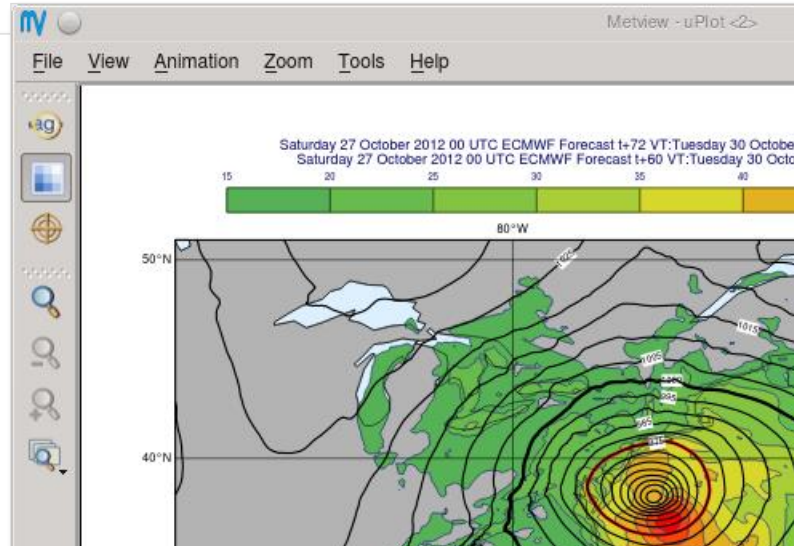
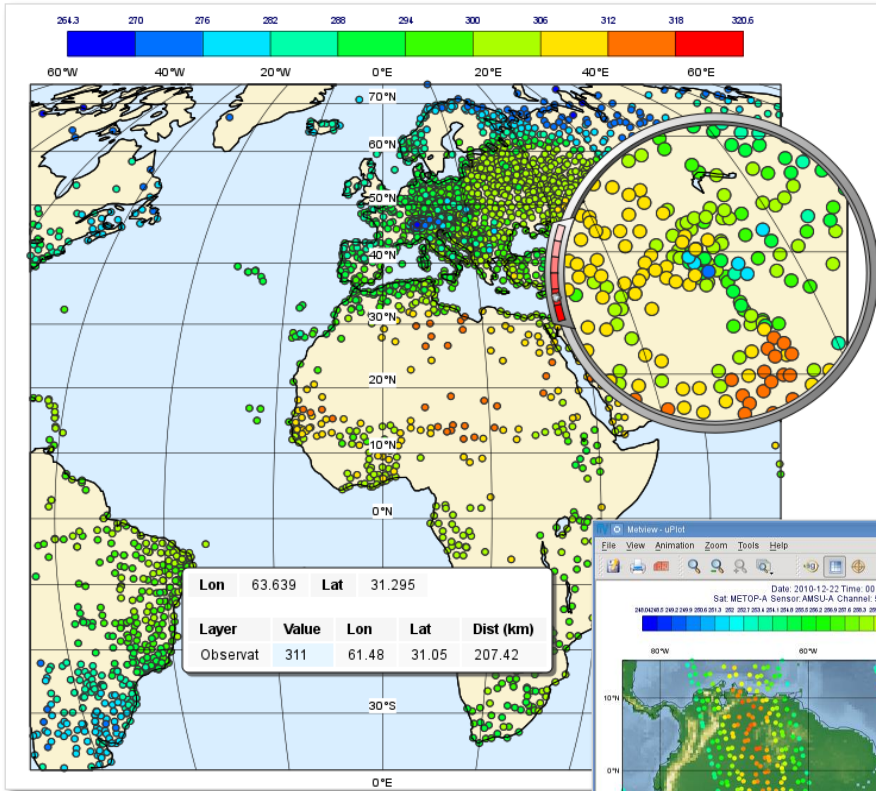
The screenshot displays the Metview software interface. At the top, there is a menu bar with options: File, View, Go, Bookmarks, History, Tools, Help. Below the menu bar is a breadcrumb navigation path: course_prep > 2015 > day_4 > ensemble forecast > solutions. The main workspace shows a file explorer with various icons representing data files and processes, such as fc_latest_oper.grib, fc_oper.grib, title_oper, wgust_shade, wgust_spread_shade, prob_shade, fc_ens.grib, spag_ens.grib, ens_mean.mv, ens_spread.mv, and ens_prob.mv. A context menu is open over the spag_ens.grib icon, listing actions like Visualise (Ctrl+I), Examine (Ctrl+M), Save result (Ctrl+S), Clear result, Duplicate (Ctrl+D), Copy (Ctrl+C), Cut (Ctrl+X), Rename (F2), Move to wastebasket (Del), Send, and Archive as... Below the file explorer is a toolbar with icons for Axis Plotting, Binning, Coastlines, Contouring, Graph Plotting, Legend, and Obs. In the center, a data table is visible with columns: Index, Name, Date, Time, Step, Le/, LevType. The table contains data for indices 001 to 025. To the right, a tree view shows a hierarchy of sections and key names (GRIB API) with their corresponding values. At the bottom, a macro editor window is open, showing a script with the following content:

```
181 v = retrieve(  
182     date      : -1,  
183     param     : "v",  
184     level     : 700,  
185     area      : area_xx,  
186     grid      : [1.5,1.5]  
187 )  
188  
189 # Compute the gradient of Q  
190 q = gradientb(q)  
191  
192 # Extract the area we are calculating  
193 q = read ( area : area_xx, data : q)  
194  
195 # Compute the advection of Q  
196 a = q[1]*u + q[2]*v  
197 a = -a * (10 ^ 8) # units will be 10e-8 (kg/kg)/sec  
198  
199 # Plot positive advection in blue, negative in red  
200 contour_common = (  
201     contour_level_selection_type : "interval",  
202     contour_interval             : 3,  
203     contour_label                 : "on",  
204     contour_label_height         : 0.25,  
205 )
```

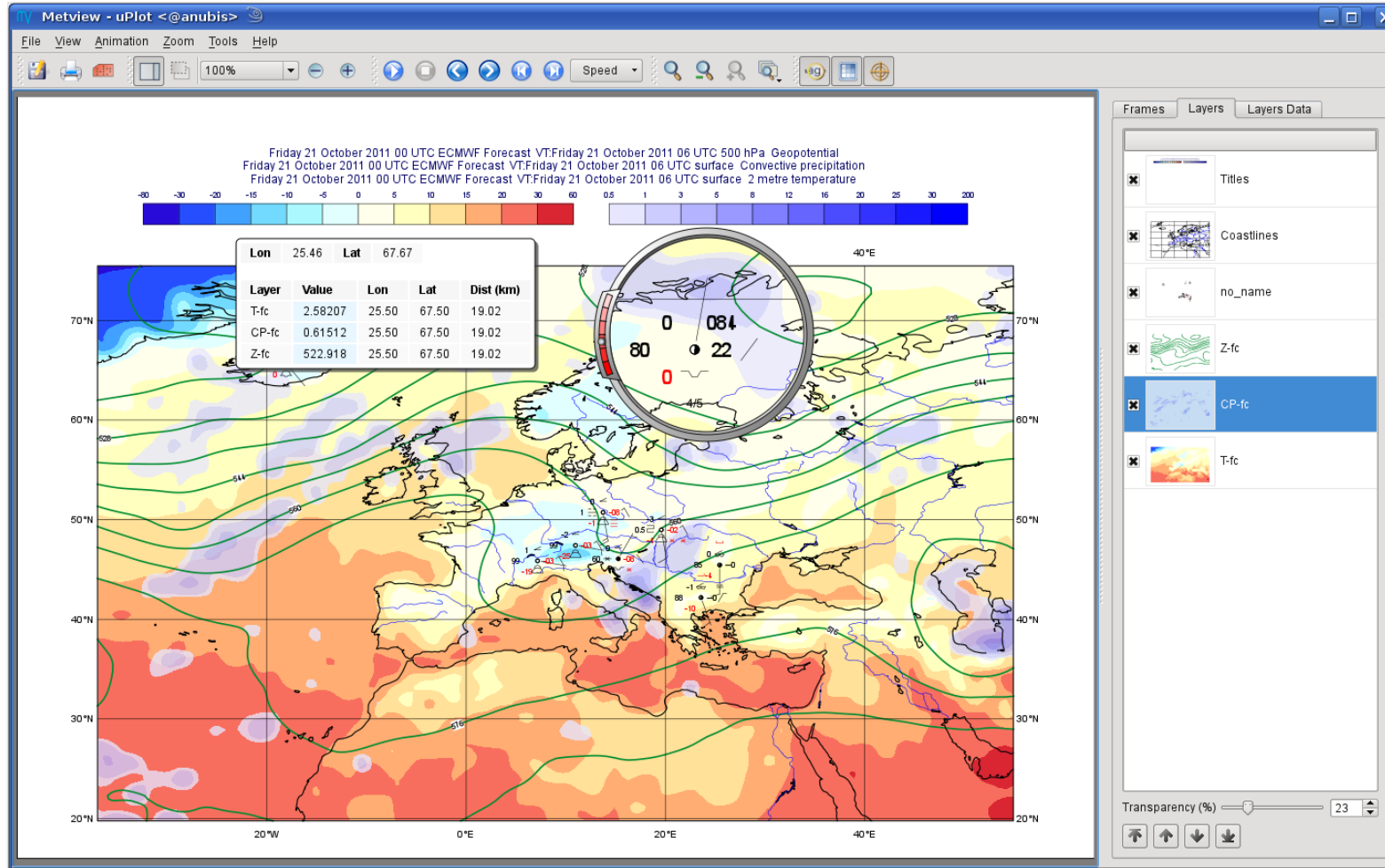
Metview In Action



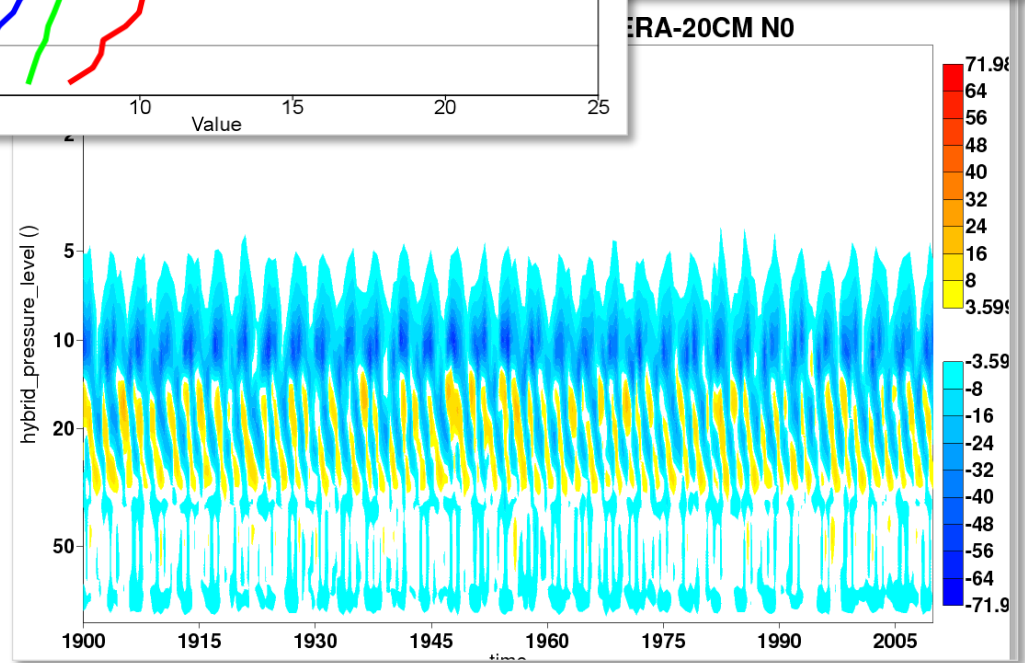
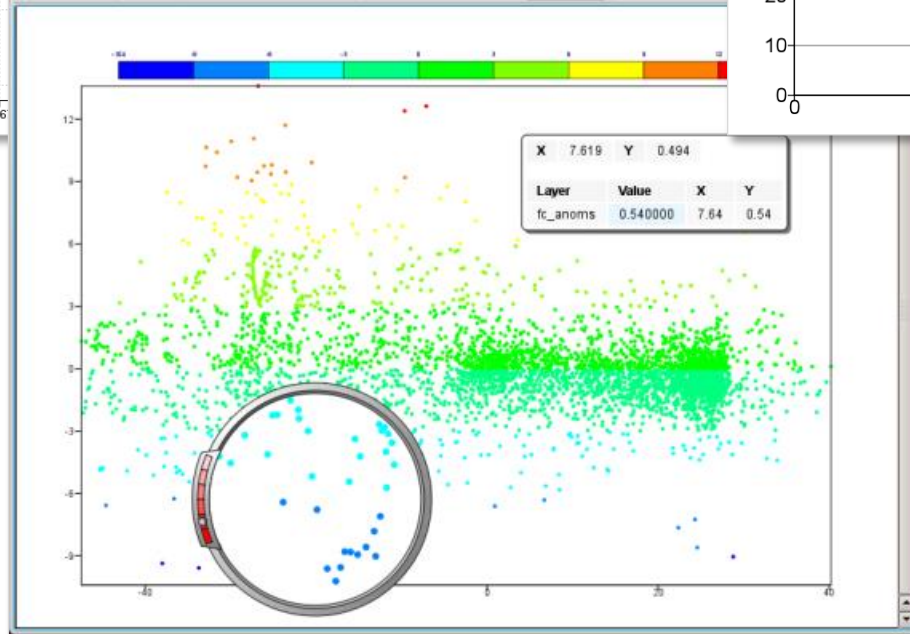
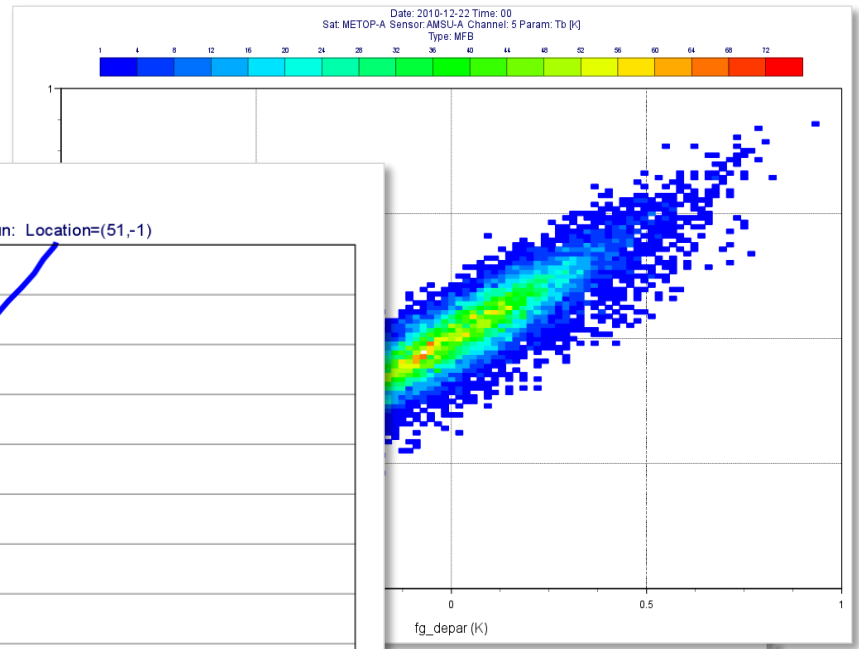
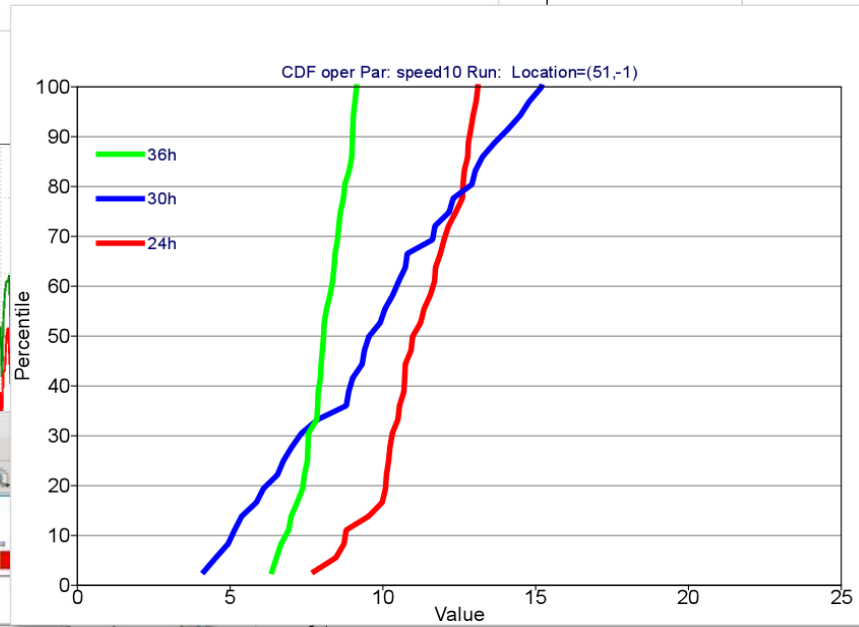
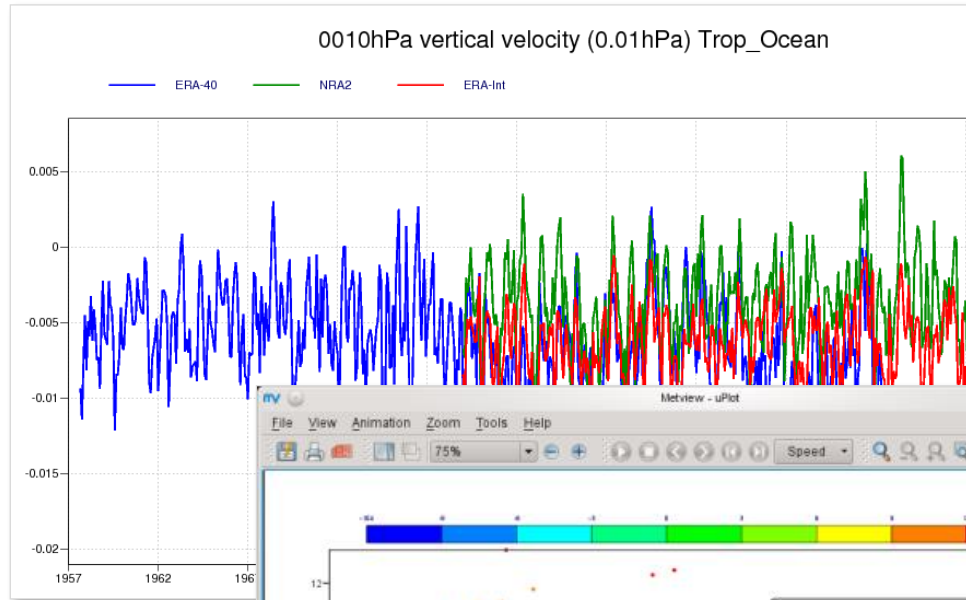
Visualisation - Maps



Visualisation - Overlay



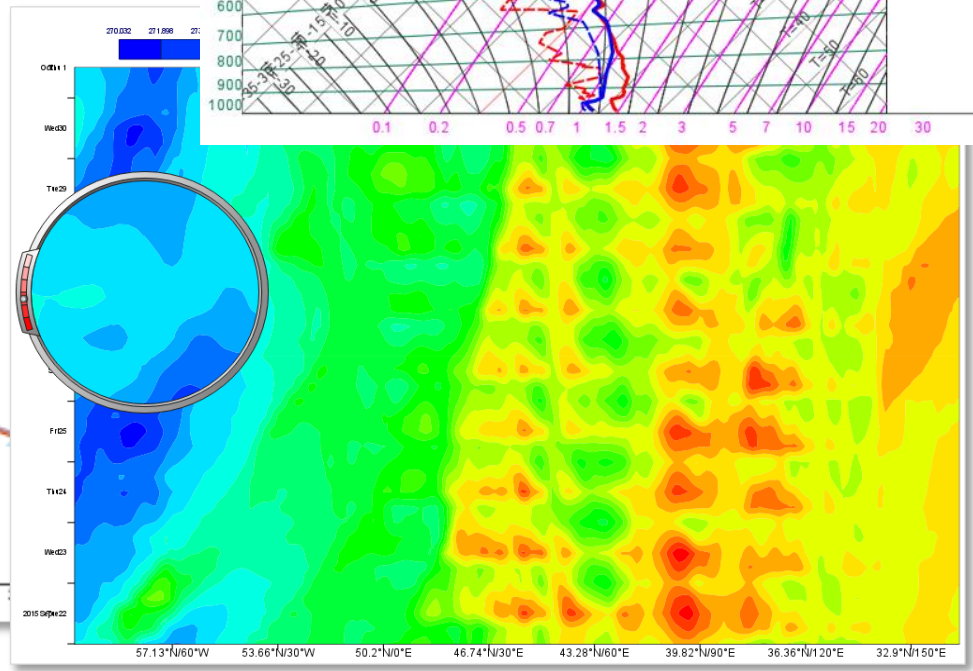
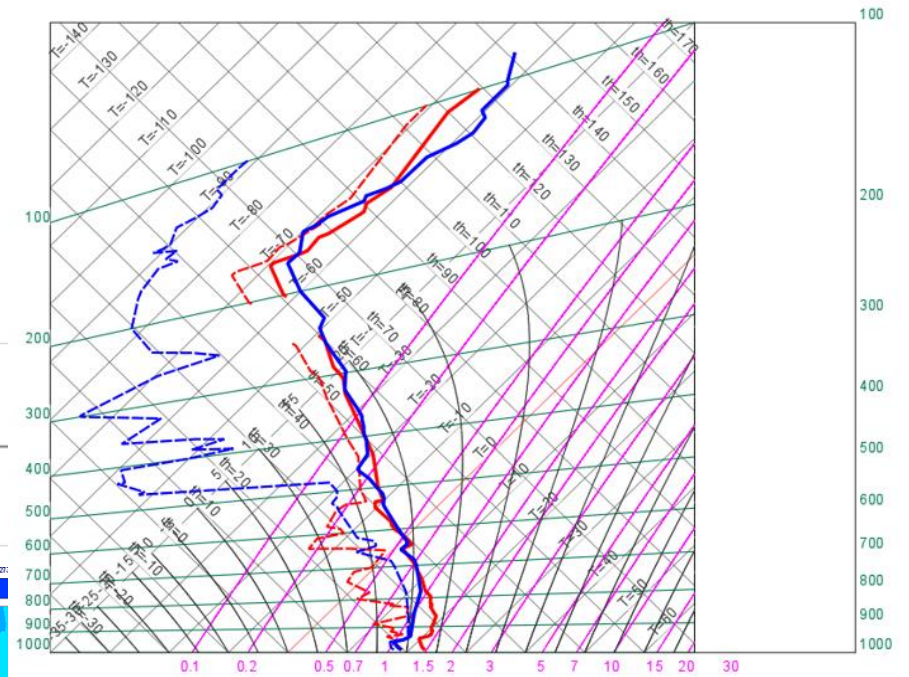
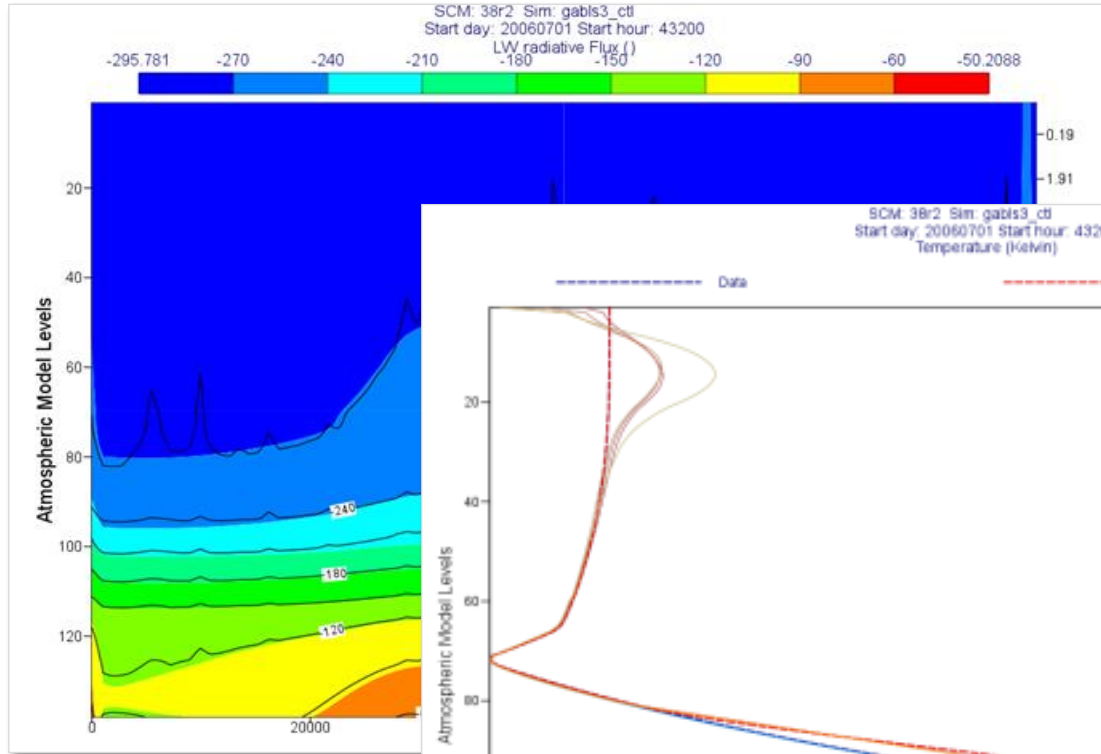
Visualisation - Graphs



Visualisation – Particular for Geo/Atmospheric Sciences

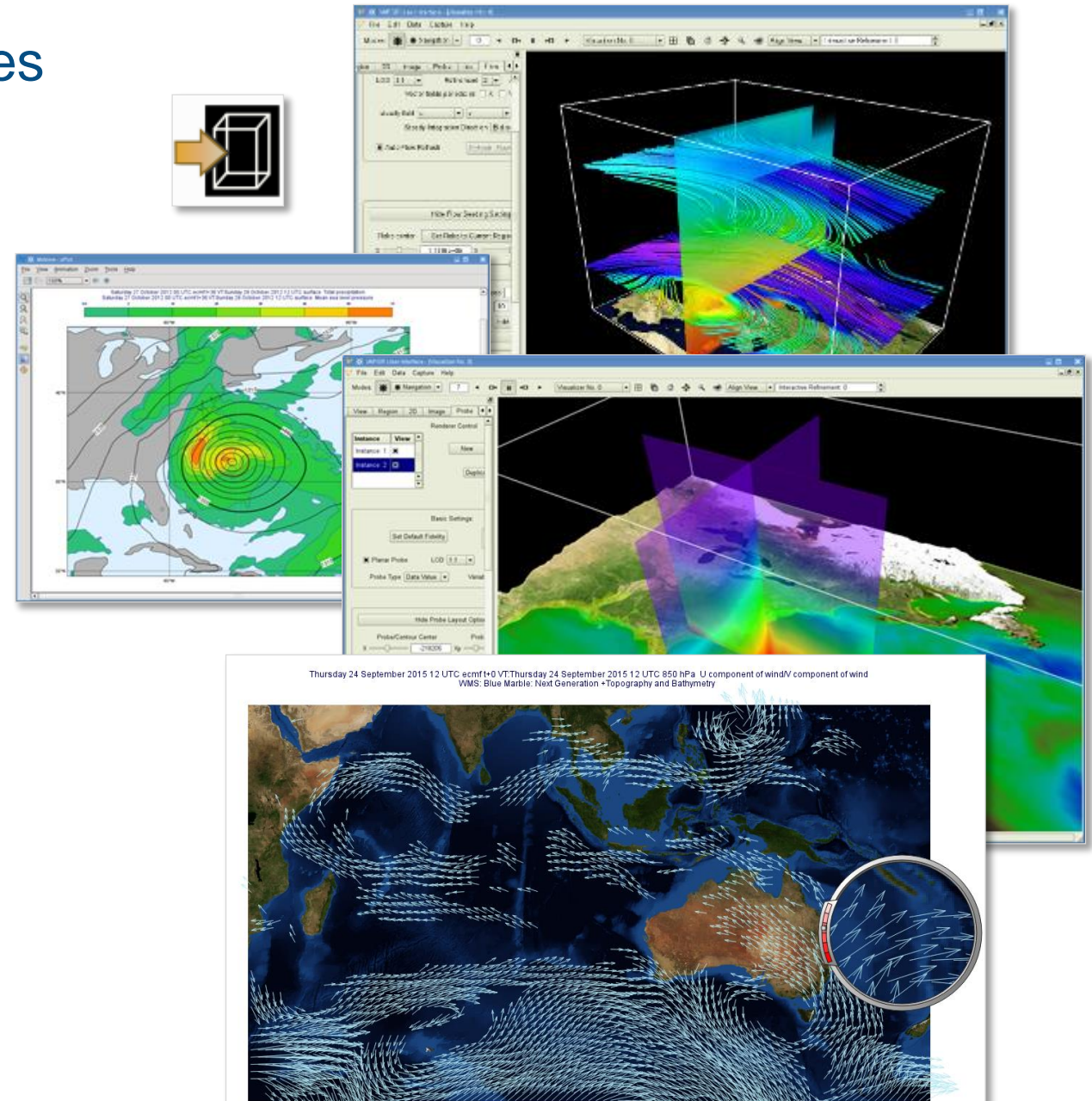
Obs: Little Rock (72340) 34.84N, 92.26W date: 20140427 12h and date: 20140427 18h

20140427 12h 20140427 18h



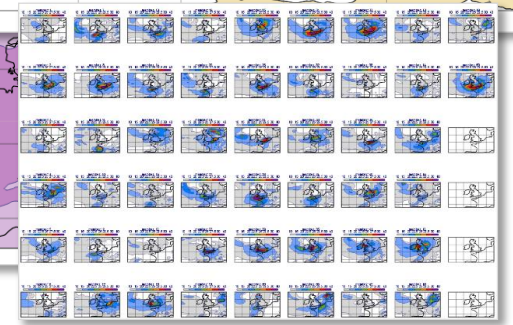
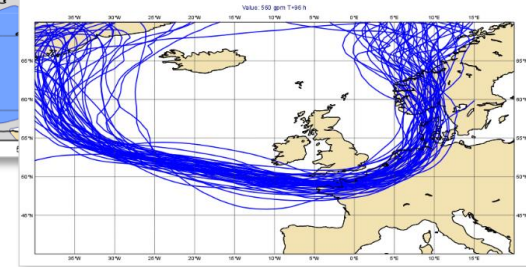
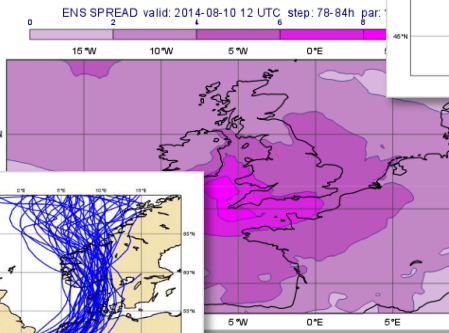
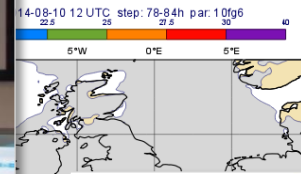
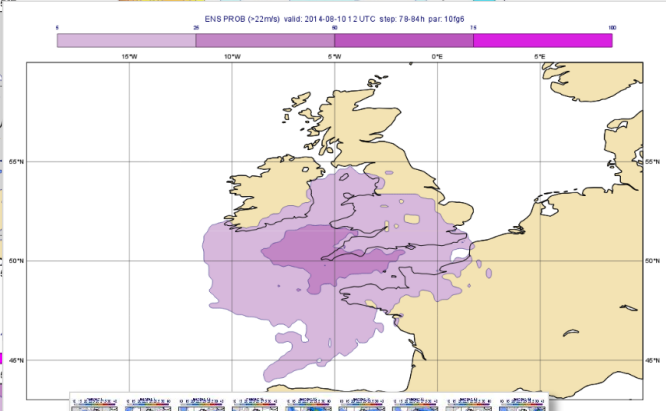
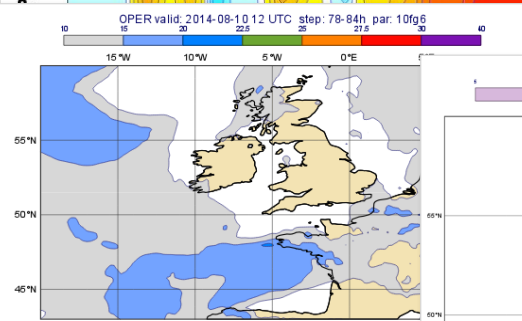
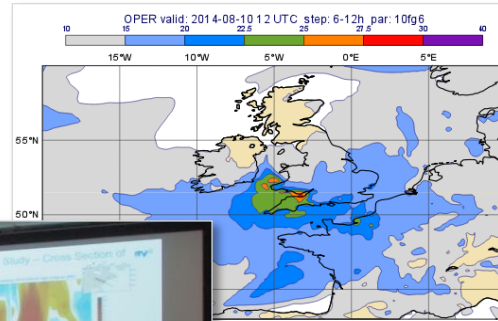
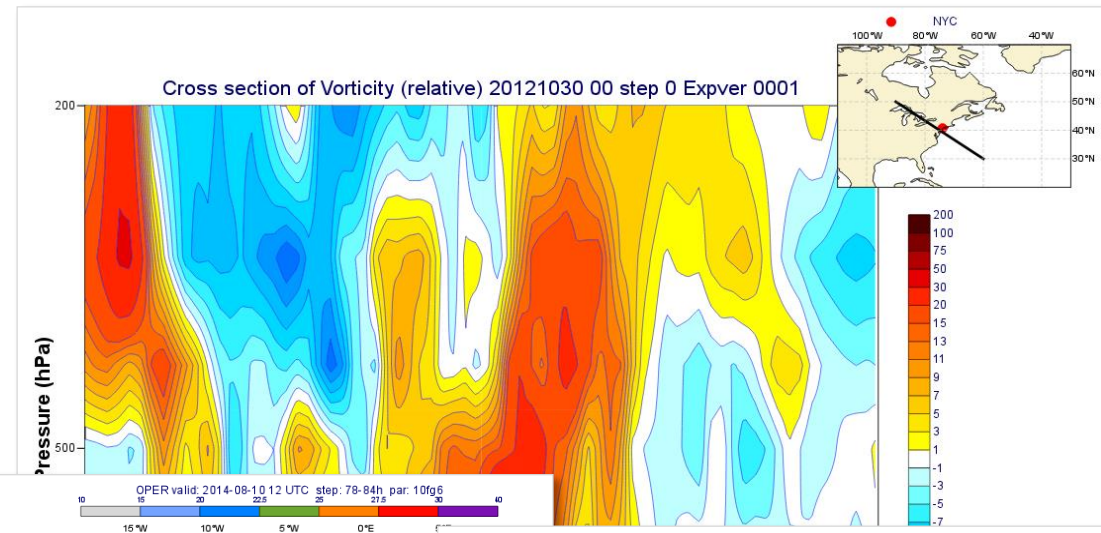
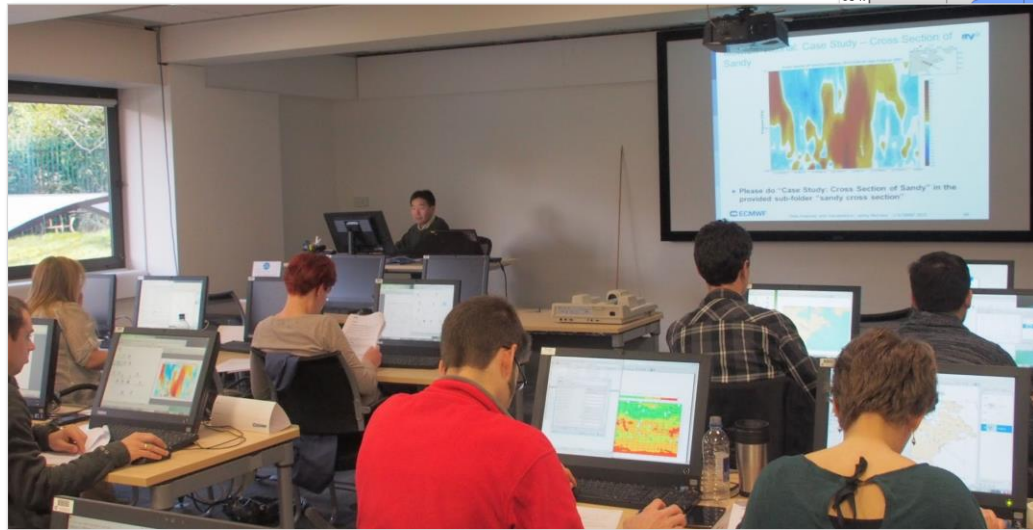
Visualisation Using External Packages

- Metview already has an interface to VAPOR 3D (NCAR)
- Metview converts ECMWF forecast data to format required by VAPOR, then starts up VAPOR with that data
- Could interface to other software – for instance Met.3D (TUM) !
- WMS client built into Metview – map image generated on a server somewhere



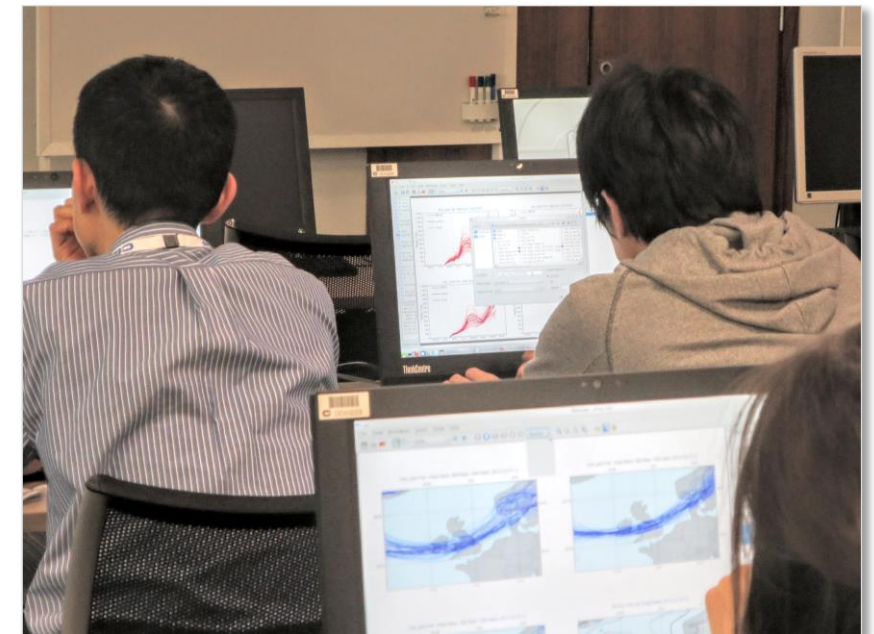
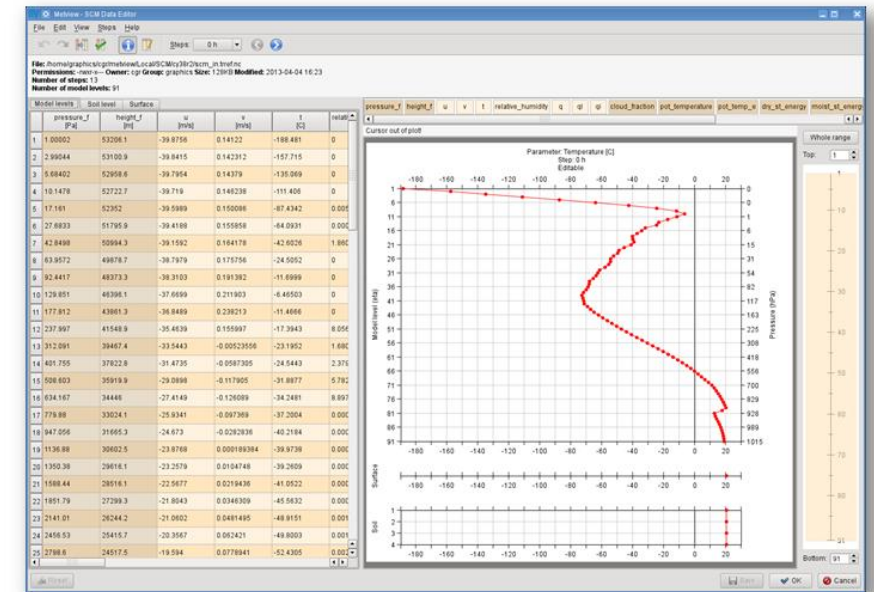
Training Material

- Metview training course in 2015 was completely re-written
- Greater emphasis on case studies
- Section on ensemble data
- Available for download
- Contained in virtual machine



Metview in Research Training 2015

- Used in the “Parameterisation of diabatic and subgrid processes” training course at ECMWF (May 2015)
 - Metview used to run the Single Column Model
 - Custom profile editor created within Metview
- Used in OpenIFS User Meeting at ECMWF (June 2015)
 - Reduced version of IFS
 - For training and academic research
 - Lots of Metview macros were pre-prepared so that students could focus on the science



The Metview Virtual Machine

- Comes with Metview and other ECMWF software pre-installed
- Contains the latest Metview training course material

The screenshot displays the Metview 1.0.14 virtual machine environment. The main window shows a training course slide titled "2 Computing a Forecast - Analysis Difference". The slide content includes:

2 Computing a Forecast - Analysis Difference

As a simple example, let's compute the difference between a set of forecast fields and the corresponding set of analysis fields for the same time step.

Examine the supplied GRIB files to confirm that *temperature_forecast.grib* contains, at multiple vertical levels, 48-hour temperature forecasts for the same date and time as the analysis data in *temperature_analysis.grib*.

Create a new *Simple Formula* icon and rename it to *fc_an_diff*. Edit the icon, ensure that the first **Formula** type is selected (F+G) and that the operator is minus (-). Drop your *temperature_forecast.grib* icon into the **Parameter 1** box, and drop *temperature_analysis.grib* into the **Parameter 2** box. Save the icon and

The uPlot window shows a map of Europe with a color scale for temperature differences. The scale ranges from -10 to 10, with yellow representing positive differences and blue representing negative differences. A circular region of interest is highlighted on the map.

Section 1	Section 2
1-3	section2Length 32
4	numberOfVerticalCo... 0
5	pvlLocation 255
6	dataRepresentation... 0 [Latitude/Longitude Grid (...]
7-8	Ni 240
9-10	Nj 121
11-13	latitudeOfFirstGridP... 90000

For more information...

- Email us:
 - metview@ecmwf.int
- Visit our web pages:
 - <http://software.ecmwf.int/metview>
- Download (Metview source, binaries, virtual machine)
- Documentation and tutorials available
- Metview articles in ECMWF newsletters

- More Metview at Visualisation Week
 - Fernando's talk on Thursday: "20 years of success for Metview's modular architecture"

Questions?

