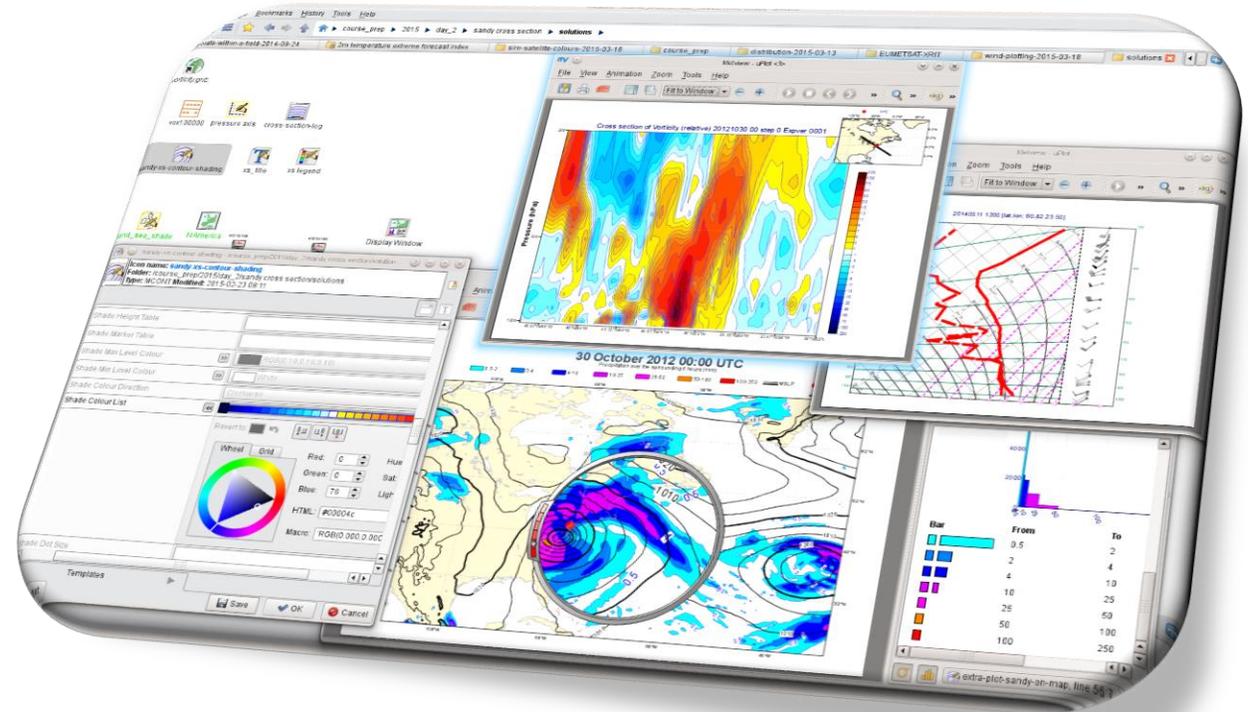


Metview 5.0 and Beyond, to its Pythonic Future

MOS 2017, ECMWF

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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, ecCodes, Magics, ODB, Emoslib
(future: MIR)

- 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. At the top, a weather map shows a forecast for Friday 21 October 2011 00 UTC, with a color-coded temperature scale and a circular inset showing a zoomed-in view of a specific location. Below the map is a file browser window titled 'Metview - Desktop' showing a directory structure with folders like 'Tests', 'Vapor', and 'solutions'. A table of file properties is visible, including 'Icon name: ERA5-ens-z500', 'Folder: Workshops/UERRA 2016', and 'Type: RETRIEVE Modified: 2016-11-16 16:06'. At the bottom, a script execution window shows a series of commands and their output, including data retrieval and correlation calculations. The output shows the covariance of f1 and f2 as 615250.382118, and manual and builtin correlation coefficients as 0.870234693771. The status bar at the bottom indicates 'Program finished (OK) : 611 ms [Finished at 11:18:47]' and 'L:19, C:1'.

Using Metview

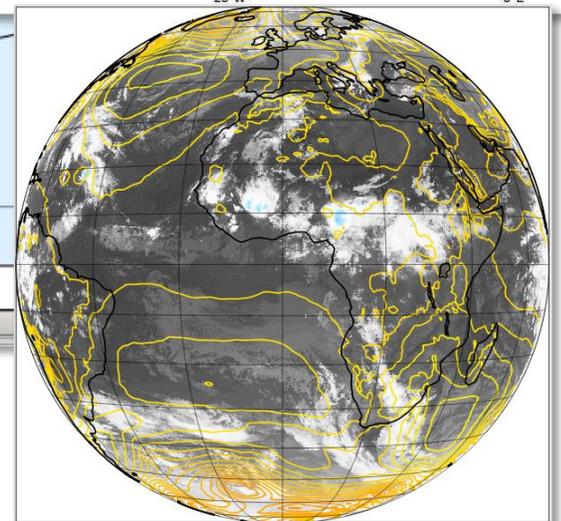
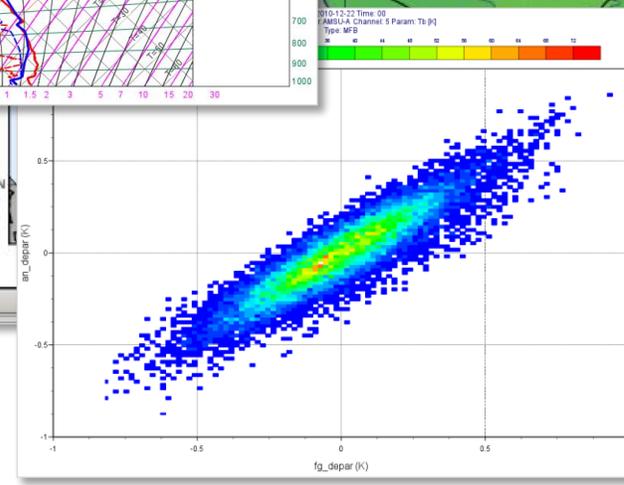
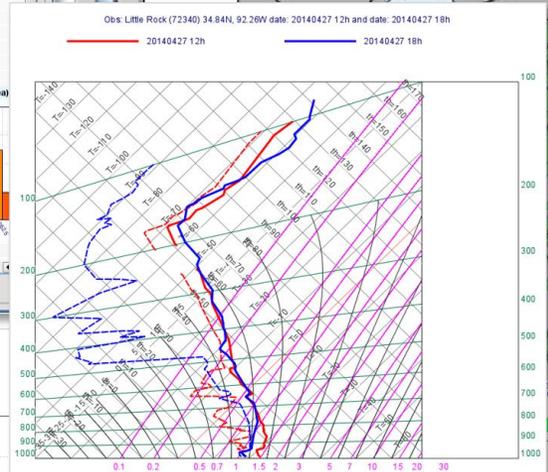
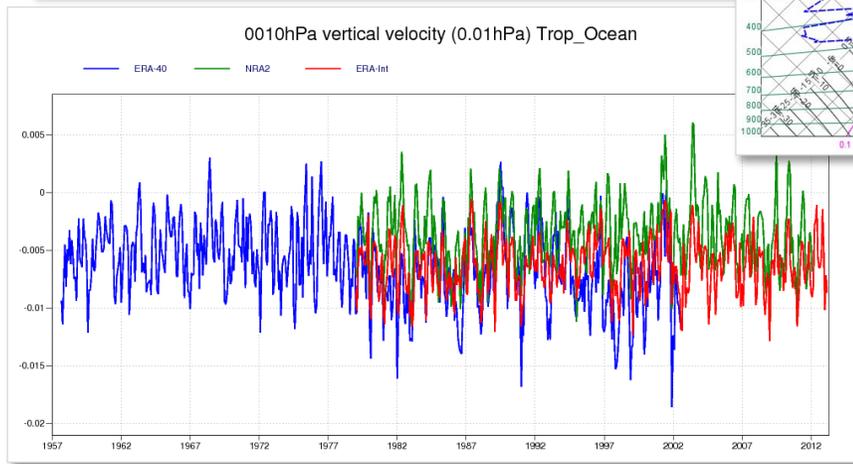
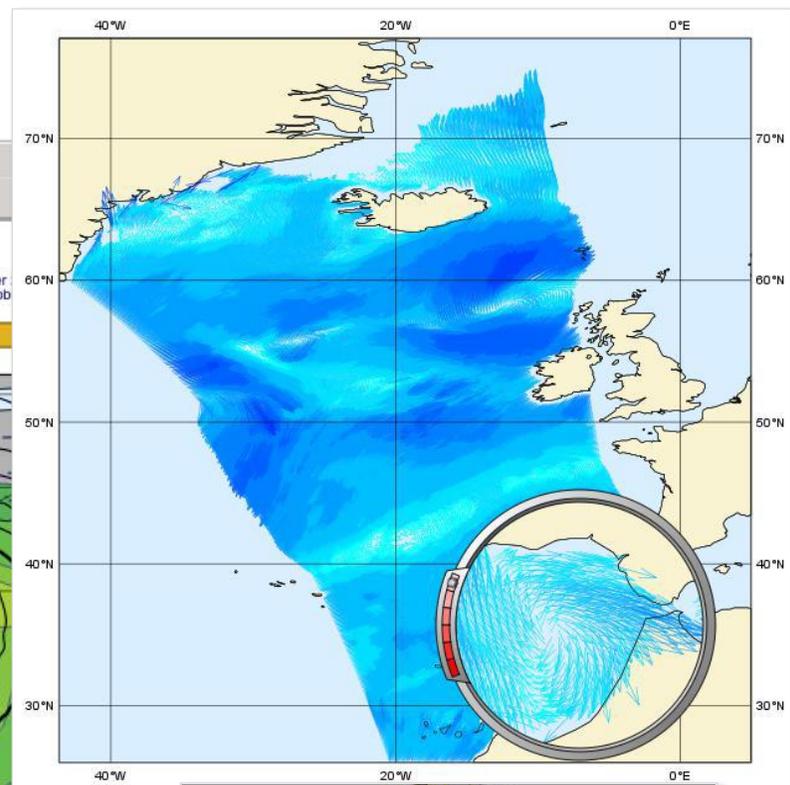
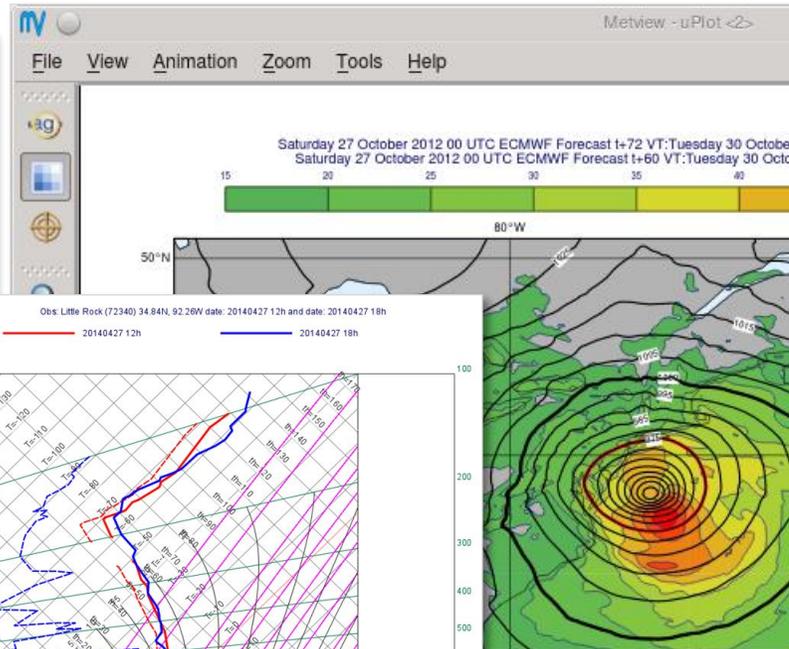
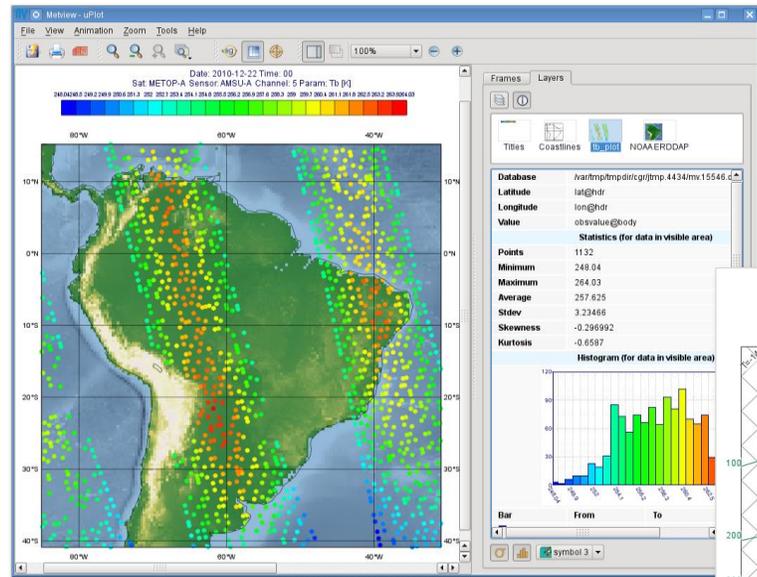
- Icon-based user interface
 - interactive investigation of data
 - icons represent data, settings and processes
 - icons can be chained together – output from one is input to another
- Powerful Macro scripting language
 - more serious computations
 - batch or interactive usage

The screenshot displays the Metview software interface. At the top, there is a menu bar (File, View, Go, Bookmarks, History, Tools, Help) and a breadcrumb trail (course_prep > 2015 > day_4 > ensemble forecast > solutions). Below this is a file explorer showing various data files with icons representing different types of data or processes. A context menu is open over the 'spag_ens.grib' file, listing actions such as Visualise, Examine, Save result, Duplicate, Copy, Cut, Rename, Move to wastebasket, Send, and Archive as... A data table is visible, showing columns for Index, Name, Date, Time, Step, Le/, and LevType. A macro editor window is open, displaying a script with the following content:

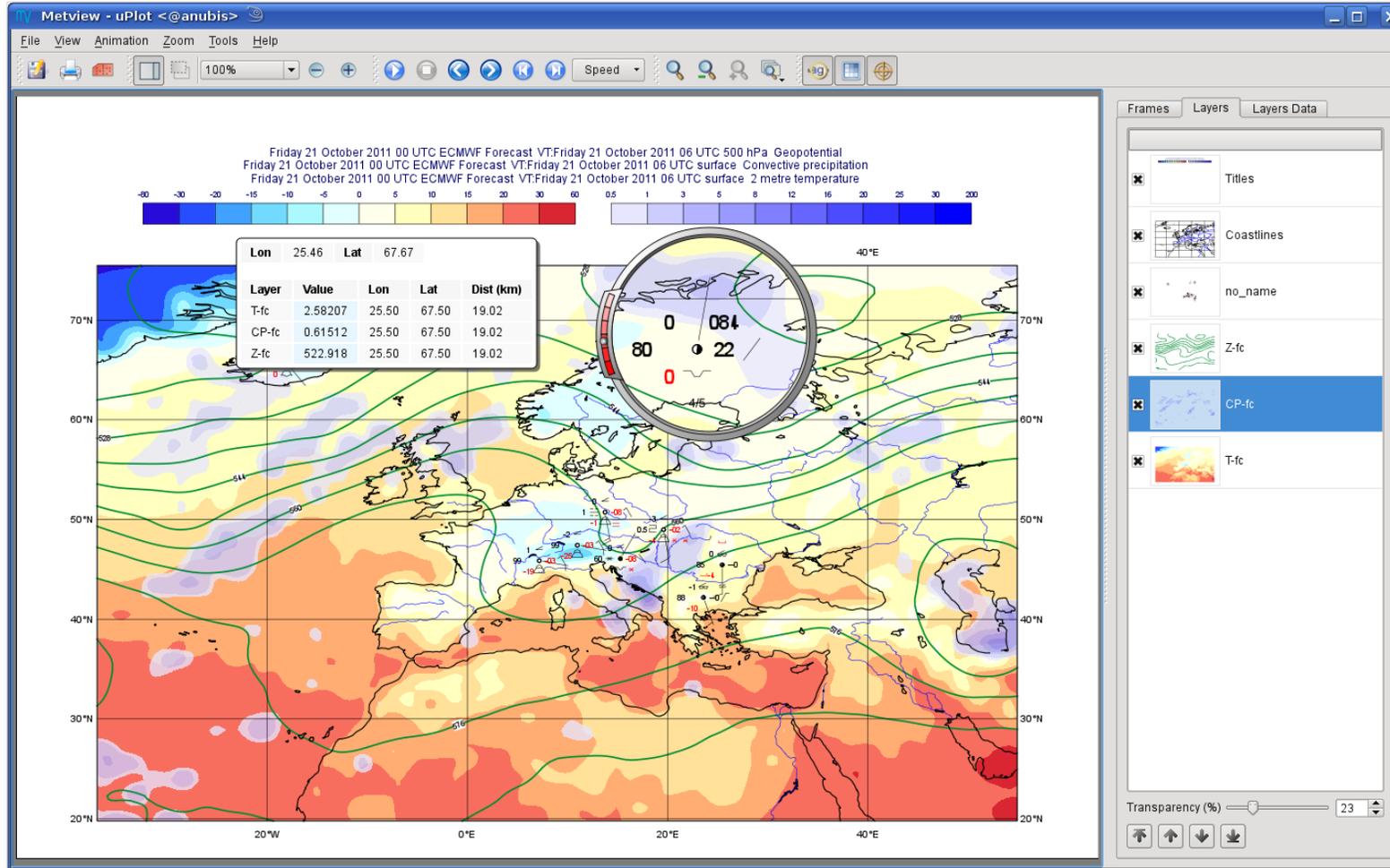
```
181 v = retrieve(  
182     date      : -1,  
183     param     : "v",  
184     level     : 700,  
185     area      : area_xx,  
186     grid      : [1.5,1.5]  
187 )  
188  
189 # Compute the gradient of Q  
190 q = gradientb(q)  
191  
192 # Extract the area we are calculating  
193 q = read ( 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 )
```

At the bottom of the interface, there is a toolbar with icons for various data processing and visualization tasks, including Axis Plotting, Binning, Coastlines, Contouring, Graph Plotting, Legend, and Obs.

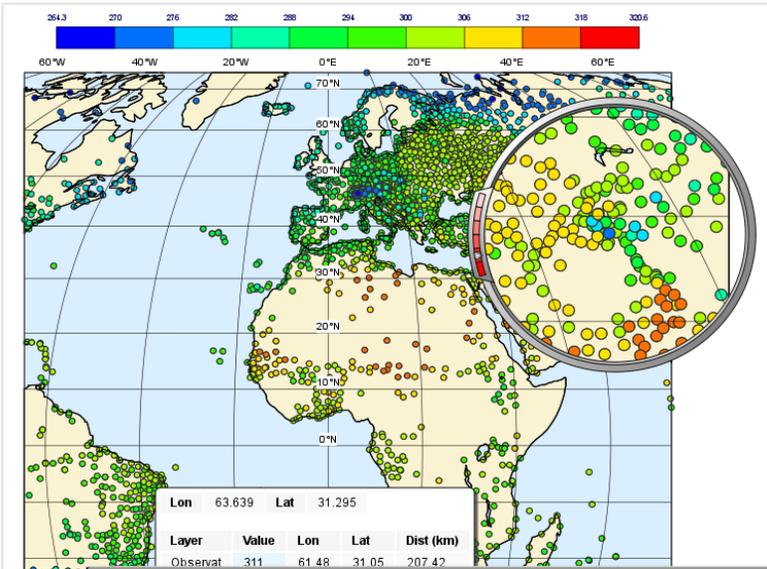
Visualisation



Visualisation - Overlay



Interactive Data Inspection



File Edit View Profiles Help

Key profile: **nv System: Default**

File: /home/graphics/cgi/metview/Demos/New Desktop/obs-for-tephi.bufr
 Permissions: rwxr-x-- Owner: cgi Group: graphics Size: 755 KB Modified: 2014-05-14 09:27:09
 Total number of messages: 746

Go to message: 16 Go to subset: 1 (Number of subsets: 1)

Index	Typ	Sut	C	Mv	Lv	Ssc	Date	Time	Lat1	Lon1	Ident
1	2	96	98	13	1	1	2014-05-11	12:00	46.91	18.04	12935
2	2	96	98	13	1	1	2014-05-11	12:00	47.18	7.42	06632
3	2	96	98	13	1	1	2014-05-11	12:00	46.81	6.95	06610
4	2	96	98	13	1	1	2014-05-11	12:00	47.69	8.61999	06620
5	2	96	98	13	1	1	2014-05-11	12:00	43.43	5.23	07650
6	2	96	98	13	1	1	2014-05-11	12:00	34.11	-94.29	74752
7	2	96	98	13	1	1	2014-05-11	12:00	40.18	-104.73	74533
8	2	96	98	13	1	1	2014-05-11	12:00	65.5	-144.68	70197
9	2	96	98	13	1	1	2014-05-11	12:00	30.09	-96.78	72246
10	2	95	98	13	1	1	2014-05-11	12:00	65.5	-144.68	70197
11	2	96	98	13	1	1	2014-05-11	12:00	42.9	-101.69	74437

Index	Descriptor	Name	Value	Units
6	04004	Hour	12	HOUR
7	04005	Minute	0	MINUTE
8	05002	Latitude (Coarse Accuracy)	40.3	DEGREE
9	06002	Longitude (Coarse Accuracy)	-3.3	DEGREE
10	07001	Height of Station (See Note 1)	588	M
11	02003	Type Of Measuring Equipment Used	6	CODE TABLE ...
12	02101	Type Of Antenna	4	CODE TABLE ...
13	02106	3-Db Beamwidth	6	DEGREE
14	02121	Mean Frequency	1.29e+09	Hz
15	26001	Rango Gate Length	75	M

File View Animation Zoom Tools Help

Fit to Window

Date: 20170111 Time: 120000
 Land TEMP Param: t [K] Level: 500 hPa
 Type: MFB

Row	lat	lon	obsvalue
99	39.12	-108.53	253.8
100	40.15	-89.34	253.2
101	-49.35	70.24	244.63
102	42.69	-73.83	243.02
103	41.66	-69.96	253.82
104	19.15	-96.13	261.8
105	38.77	-27.09	256.4
106	-1.38	-48.48	266.65
107	-29.72	-53.7	266.65
108	12.58	-81.72	266.33
109	33.33	126.68	254.17
110	40.9	29.15	245.51
111	26.45	49.82	264.06
112	-27.45	-59.05	267.66
113	-34.82	-58.53	260.06
114	8.97	-79.57	267.97
115	56.45	138.15	238.2
116	47.73	88.08	246.1
117	29.6	106.4	256.1
118	-3.85	-32.42	268.05
119	22.77	100.98	266.1
120	-0.79	100.28	267.8
121	-8.47	140.38	269.2
122	40.15	94.68	243.5
123	31.15	97.17	254.5
124	24.48	118.08	264.5
125	31.42	121.45	254.39
126	34.72	113.65	252.79
127	31.93	118.9	253.19
128	57.96	56.2	243.7
129	57.77	108.07	235.9
130	56.35	30.62	241.12
131	64.62	40.51	244.41

Total number of rows: 518

Probe position: Lon: -26.5656 Lat: 39.1284

File View Animation Zoom Tools Help

100%

Sunday 26 February 2017 12 UTC cont to 0 VTSunday 26 February 2017 12 UTC 1000 hPa Temperature

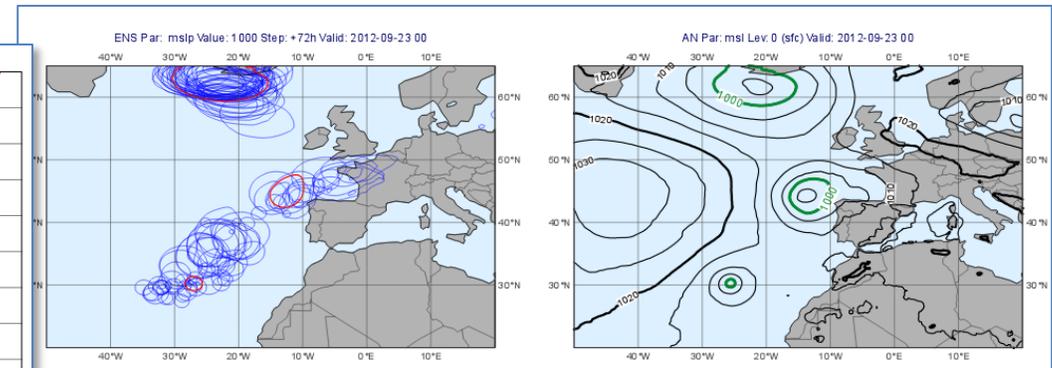
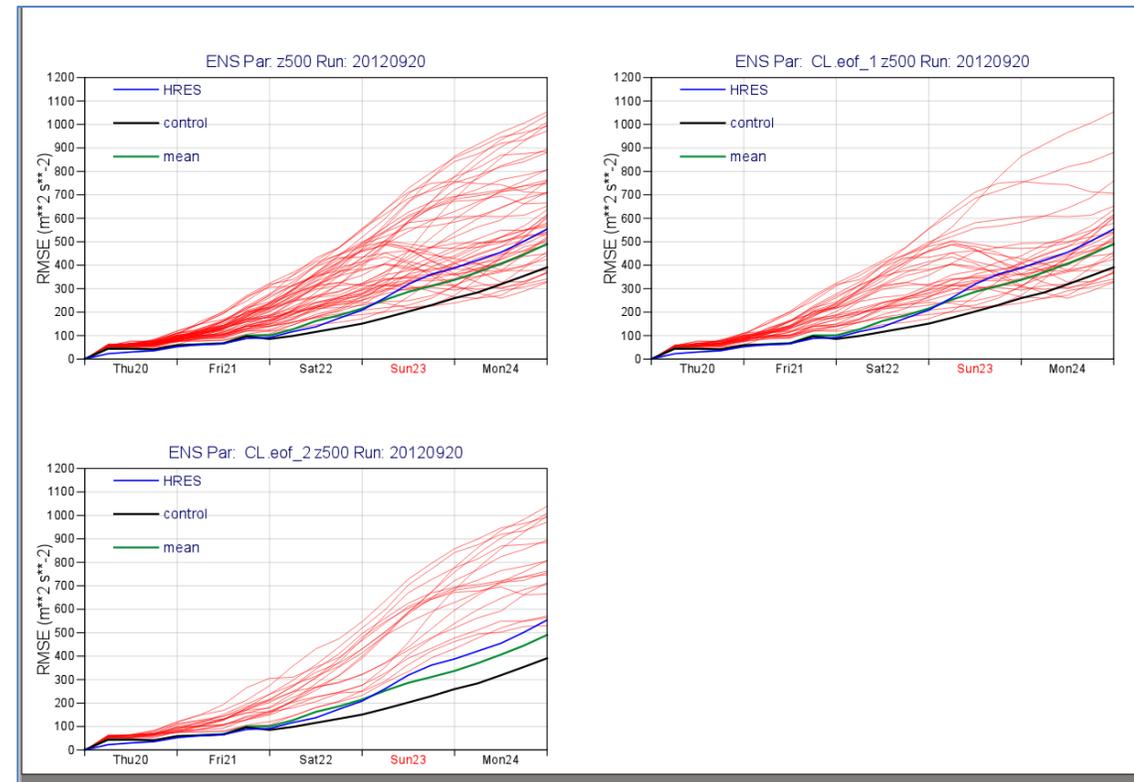
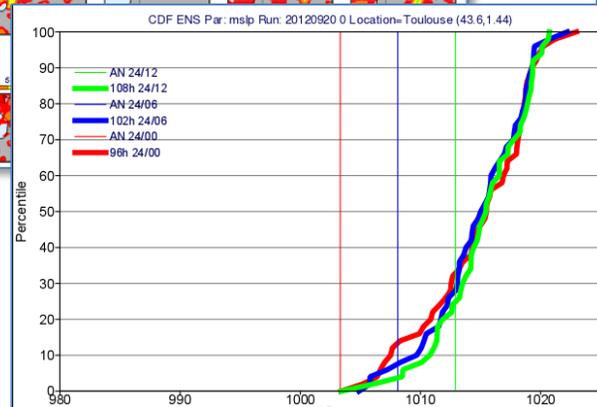
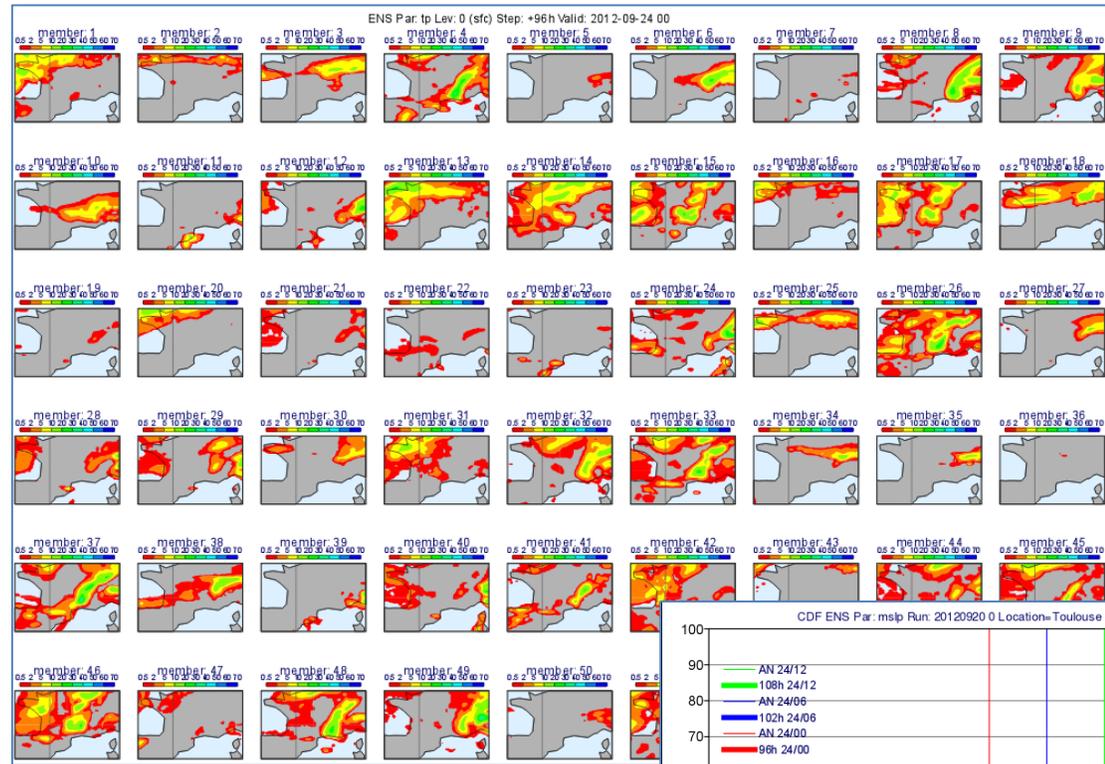
Layer	Scaled Value	Value	Lon	Lat	Dist (km)
loc	10.128818 (C)	283.288818 (K)	353.61	54.66	0.51

Metadata	Values
Scaled units	deg c
Date	20170226
Time	1200
Step	0
Level	1000
Level type	pl
Grid type	reduced_gg
Gaussian number	1280
Octahedral	yes
Dx	MISSION
Points	121
Minimum	8.19913
Maximum	11.3808
Average	9.69732
Stdev	0.974081
Skewness	0.171858
Kurtosis	-1.22154

WEATHER FORECASTS

Metview and ensemble data

- Many ways to process and visualise ENS data



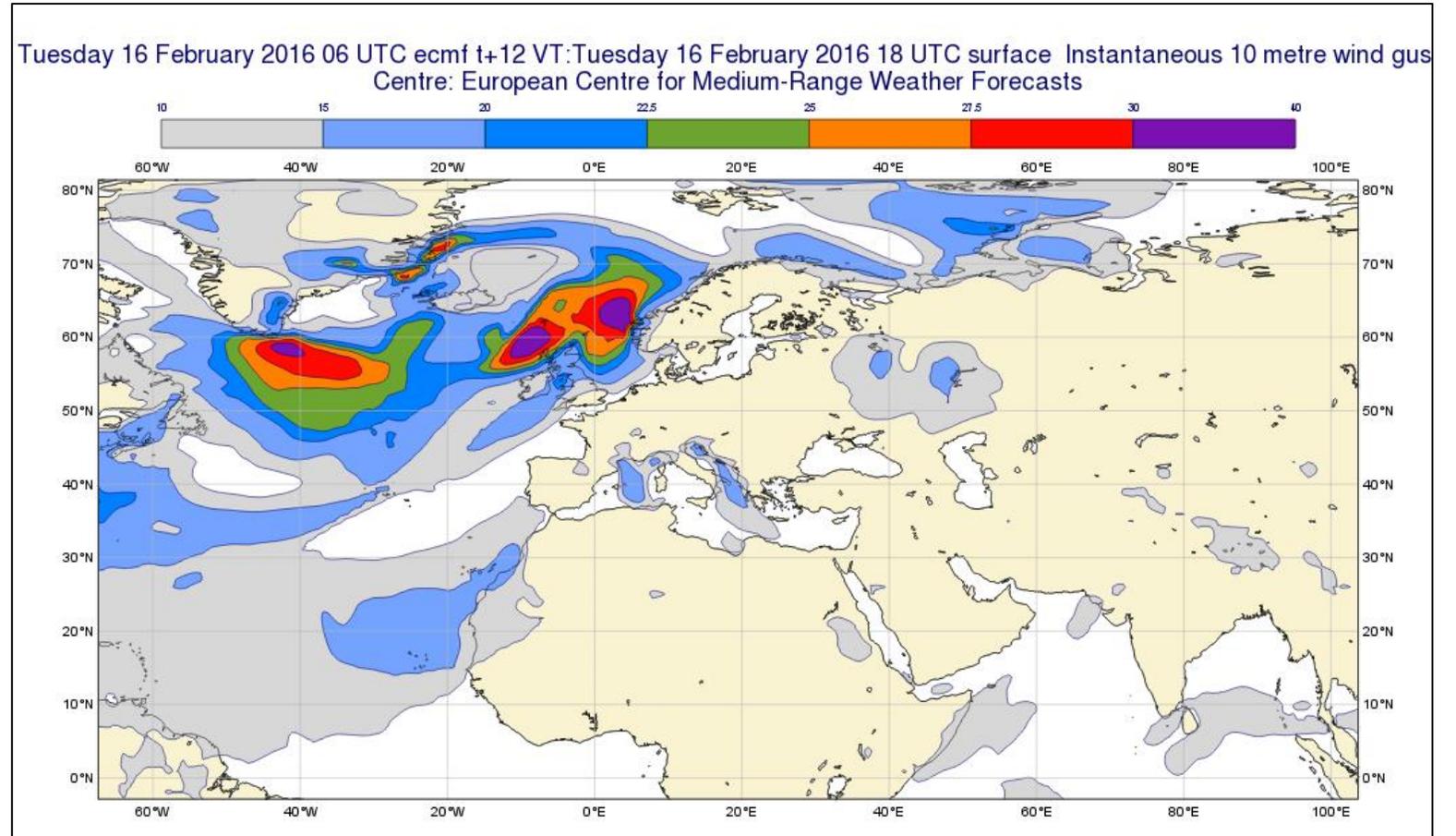
Stamp, RMSE plumes, CDF and spaghetti plots

Metview and ensemble data

- Ensemble mean:

```
data = retrieve (...)
```

```
ens_mean = mean(data)
```

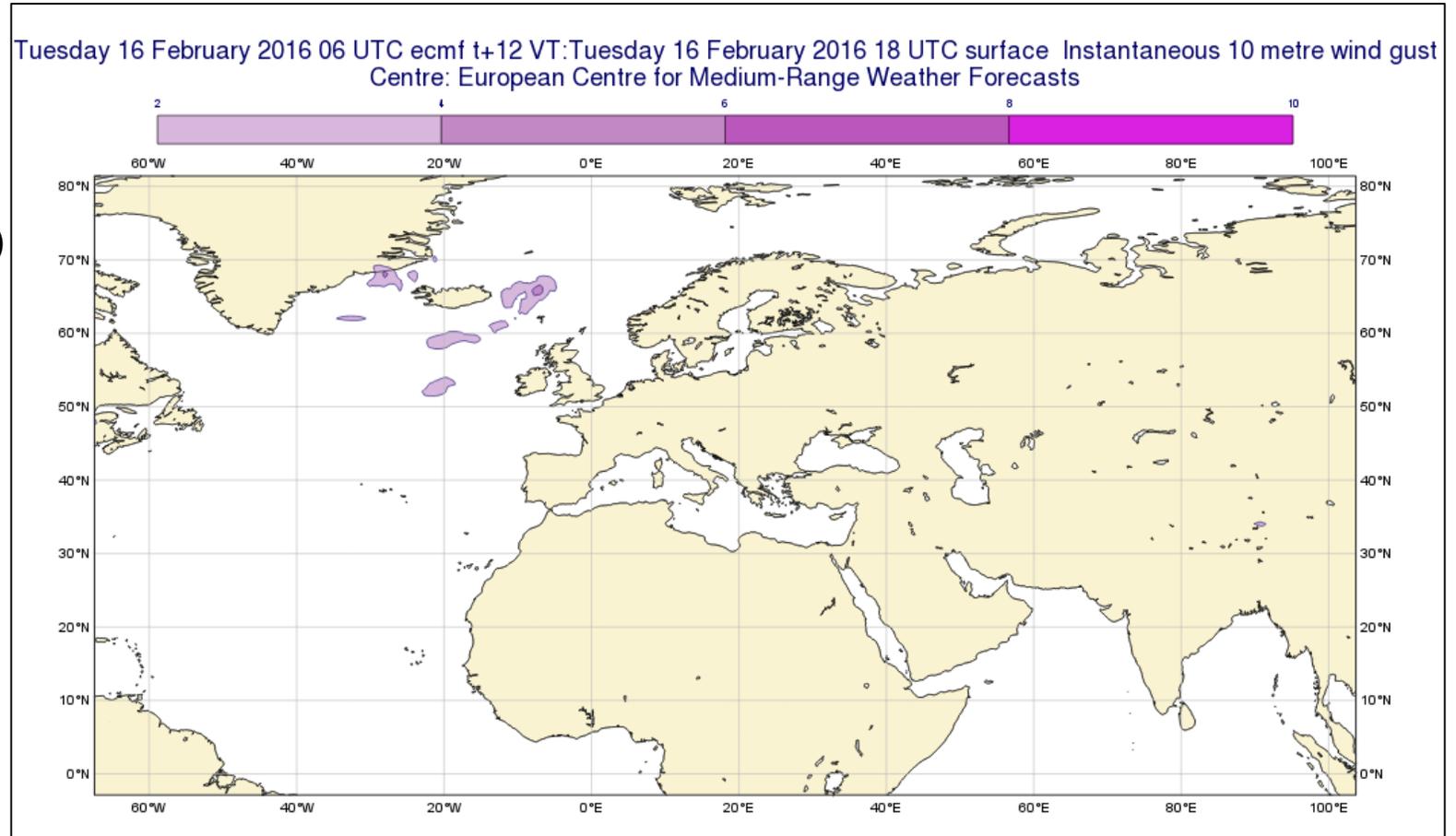


Metview and ensemble data

- Ensemble spread:

```
data = retrieve (...)
```

```
ens_spread = stdev(data)
```

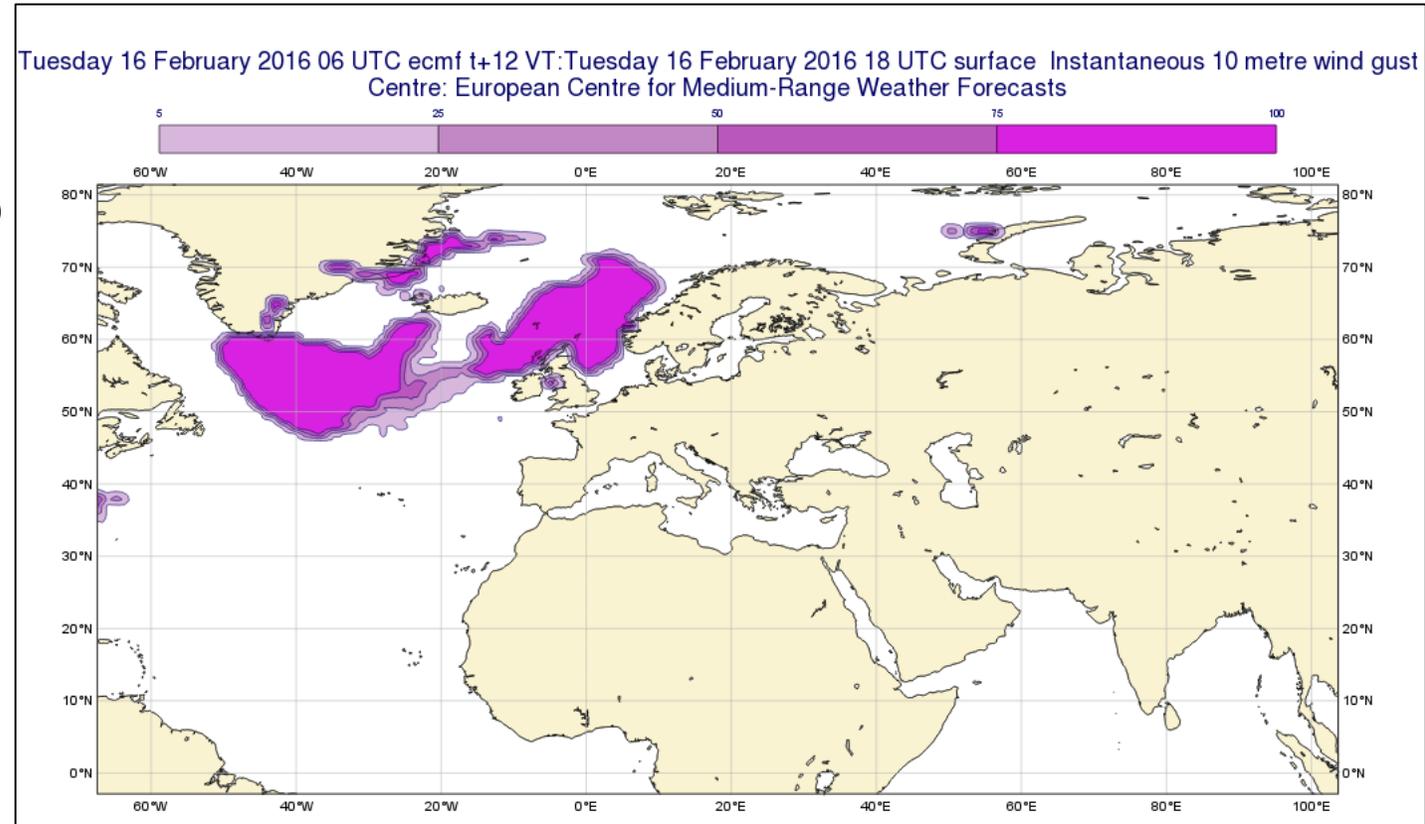


Metview and ensemble data

- Ensemble probability:

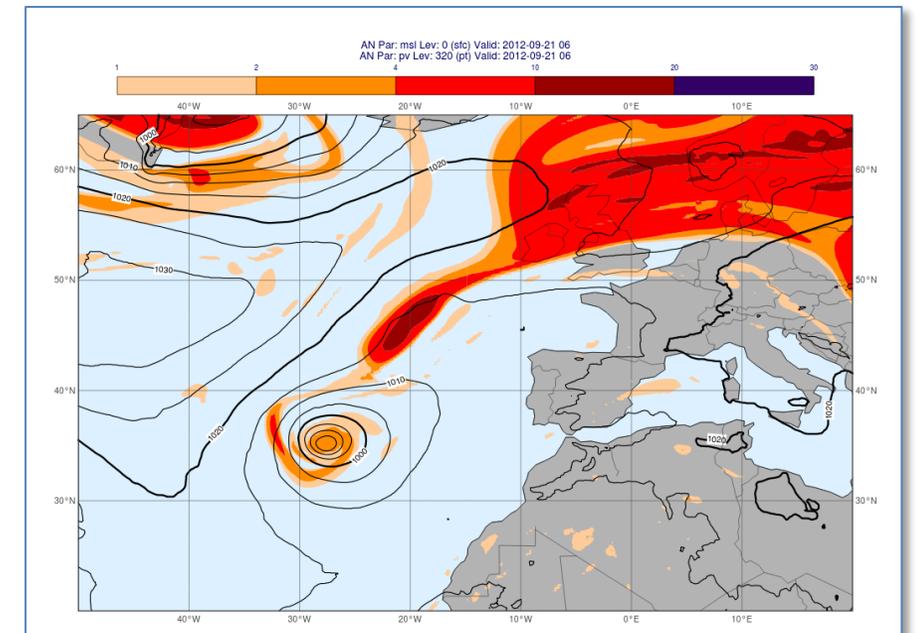
```
data = retrieve (...)
```

```
ens_prob = mean(data>22)*100)
```



Metview 5

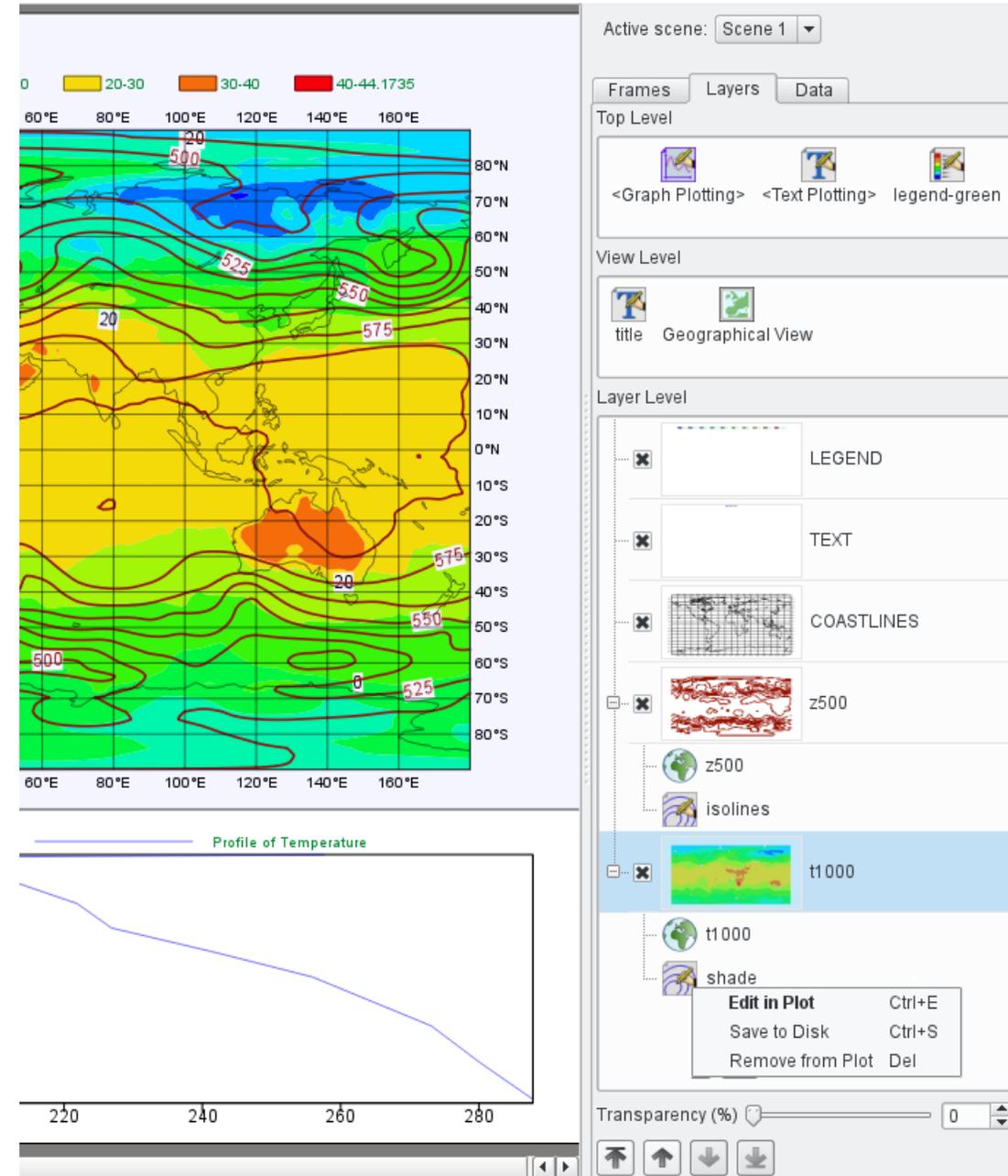
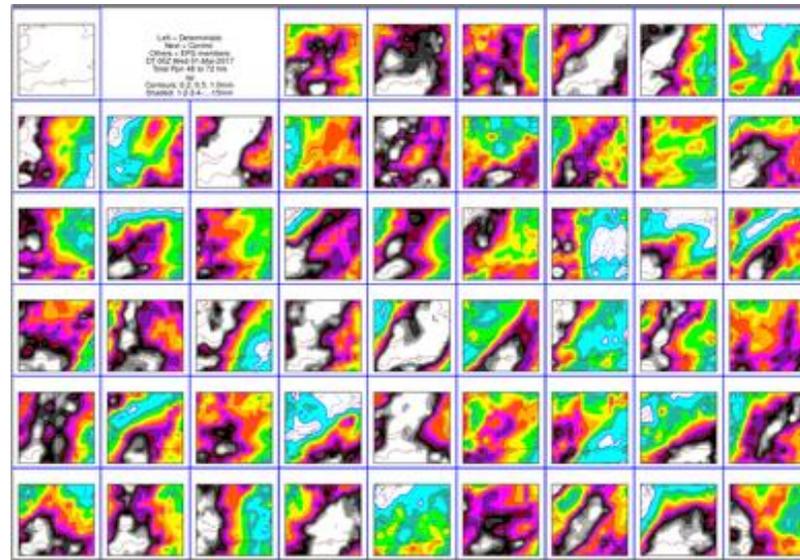
- Expected in the coming months
- First major version number update since 2010
- We plan to update the major version number more often
 - Users should not be worried by it!
- Metview 4 to 5 transition should involve no work for the majority of users



Metview 5 – new features

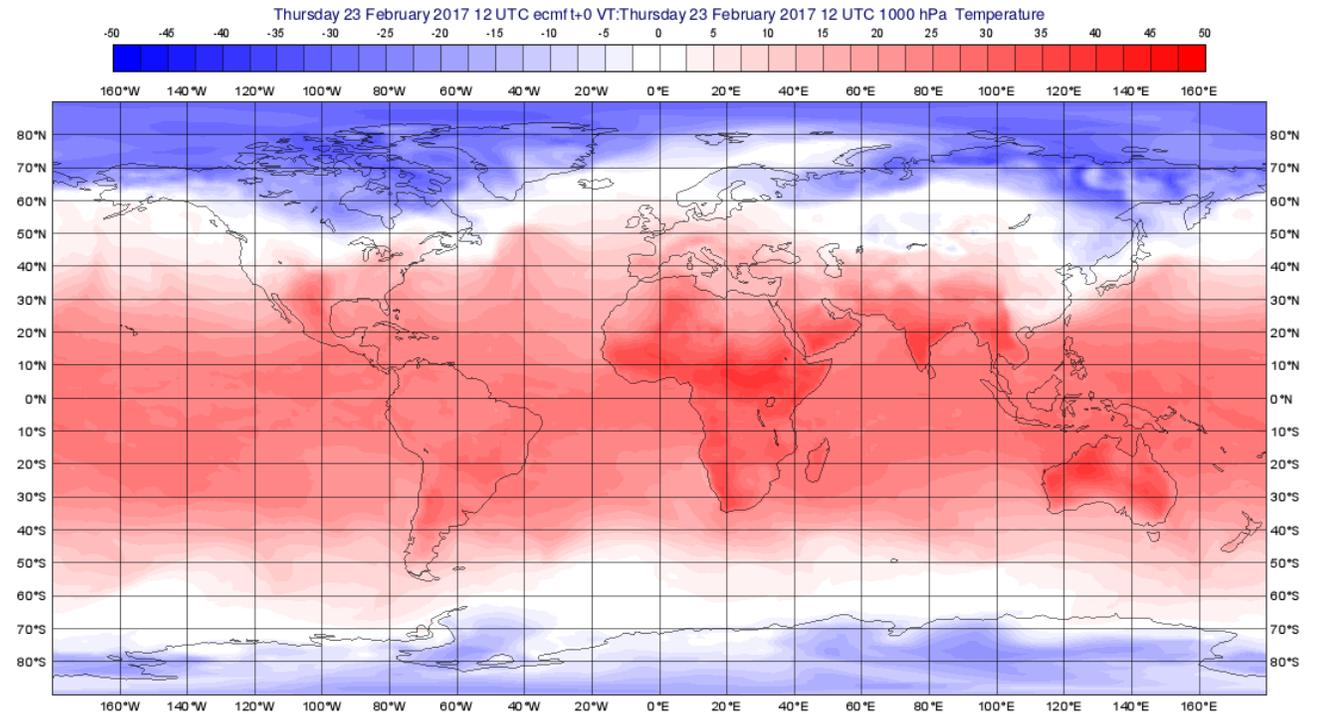
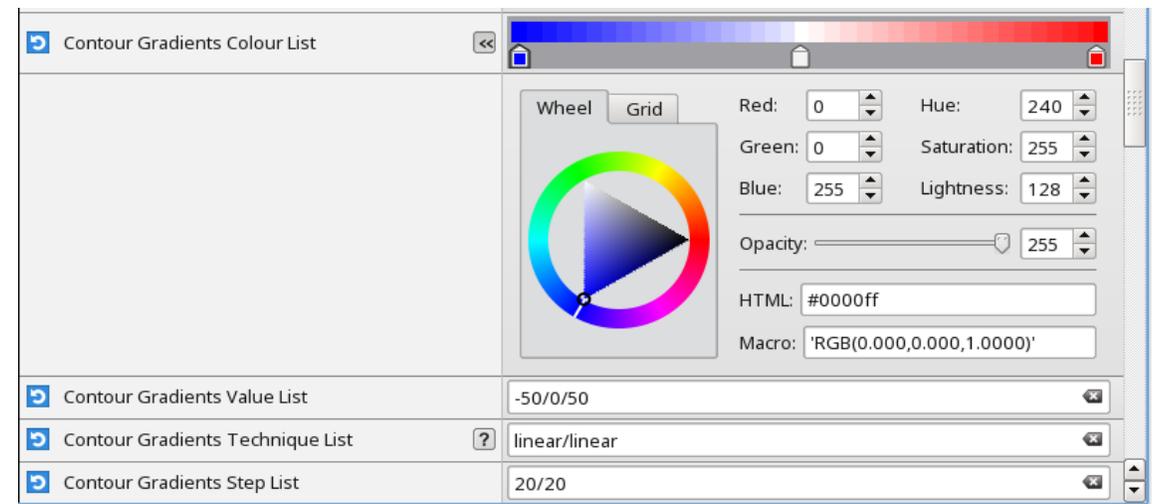
- Layer Management

- Possible to make changes to the plot “inline” in the plot window
- Can drop visual definition icons onto a particular data layer
- Can drop icons at different ‘levels’ of the plot hierarchy, e.g. to apply contouring to all maps in a stamp plot



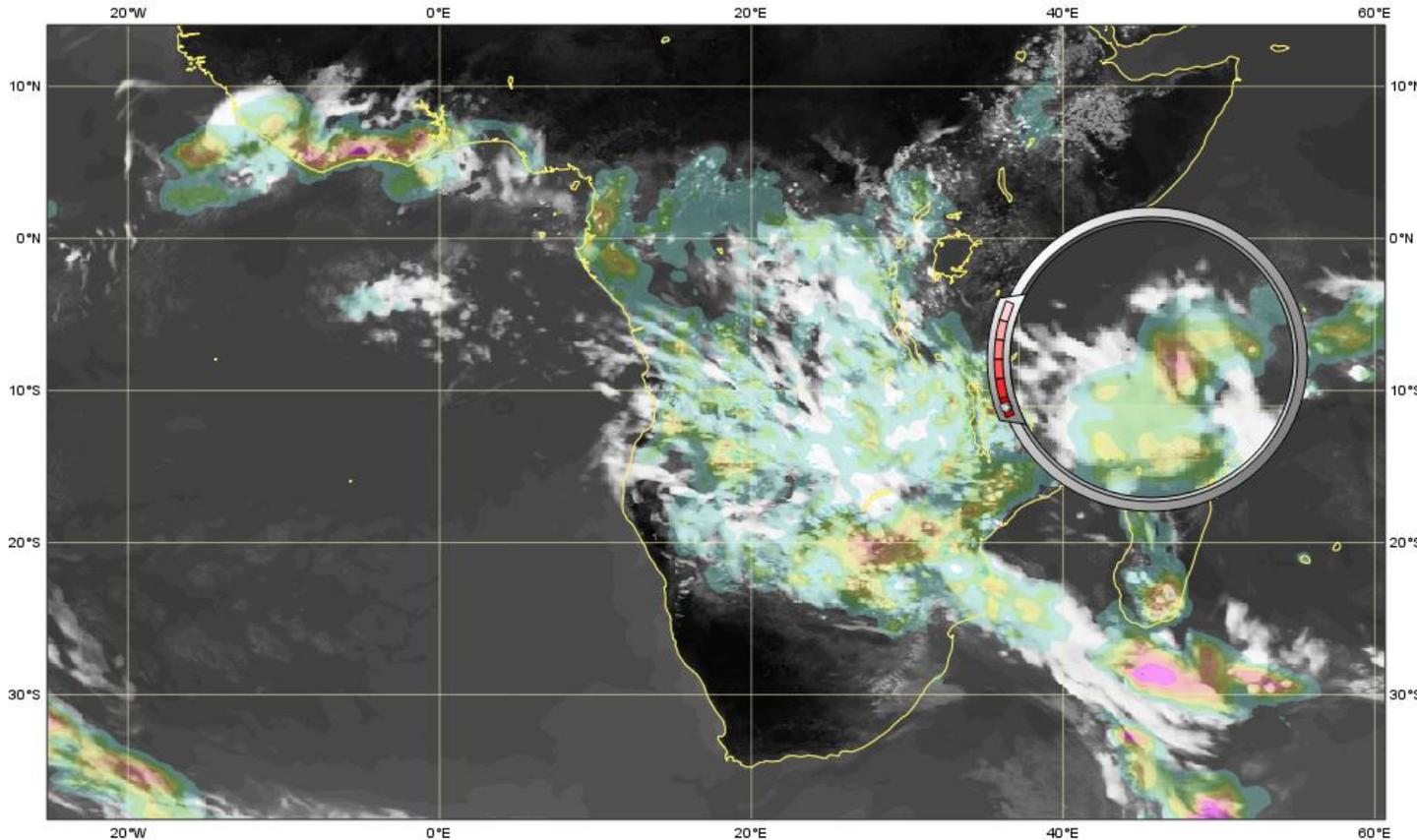
Metview 5 – new features

- Colour gradients
 - More sophisticated colour gradient definition
 - Can use a single Contouring icon where multiple icons were needed in the past
 - Takes advantage of new developments in Magics



Metview 5 – new features

- Improved support for transparency
 - Can now have transparent colours and gradients in the interactive plot window



RGBA(0.76,0.03,0.03,0.19)

Wheel Grid

Red: 194 Hue: 0

Green: 7 Saturation: 236

Blue: 7 Lightness: 101

Opacity: 48

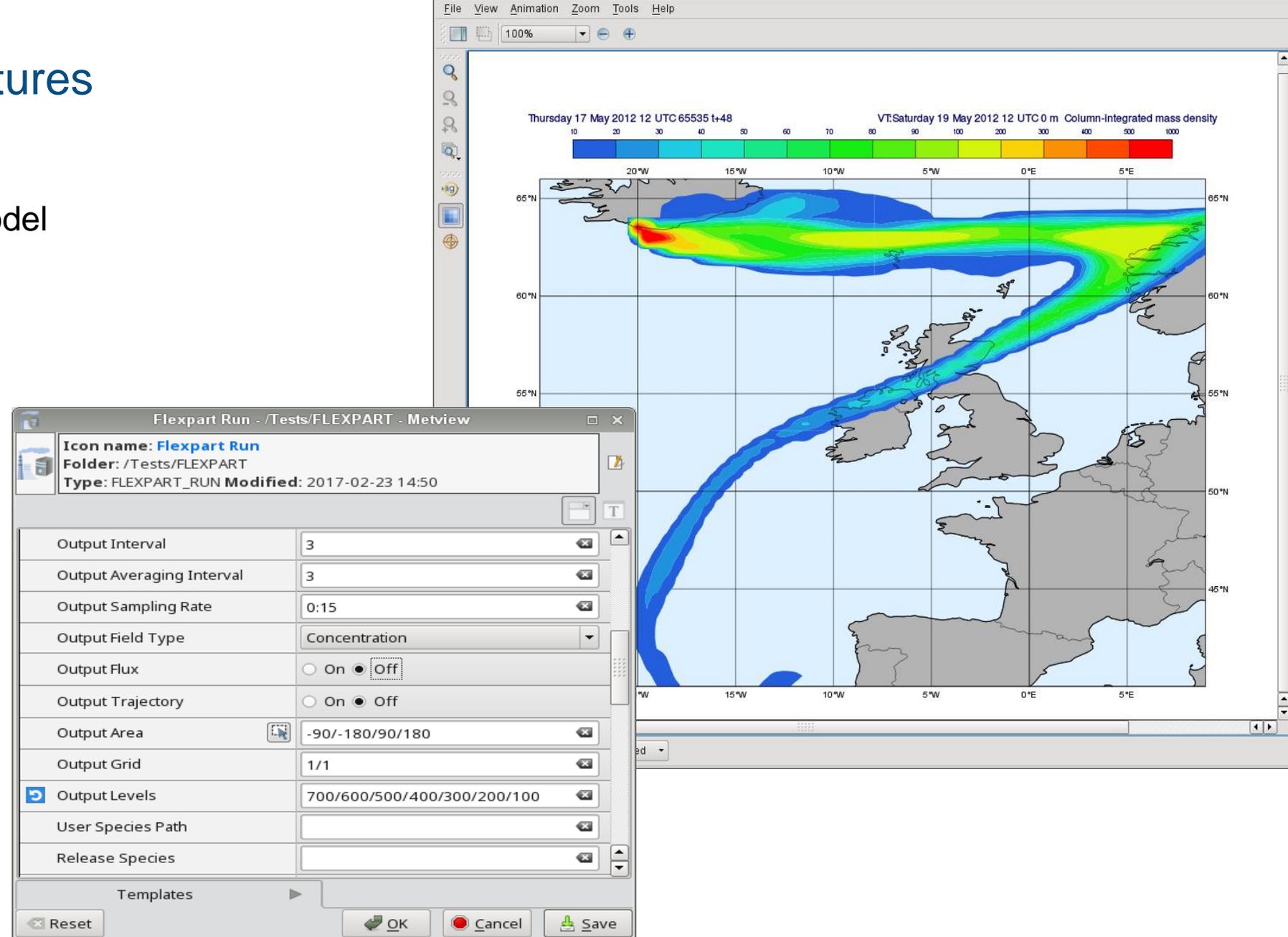
HTML: #c20707

Macro: RGBA(0.760,0.030,0.0300,0.188)

Simulated satellite (b&w) plus probability of total precipitation > 5mm (semi-transparent colours)

Metview 5 – new features

- FLEXPART
 - particle dispersion model
- Metview can
 - prepare input data
 - run FLEXPART
 - process and visualise the output

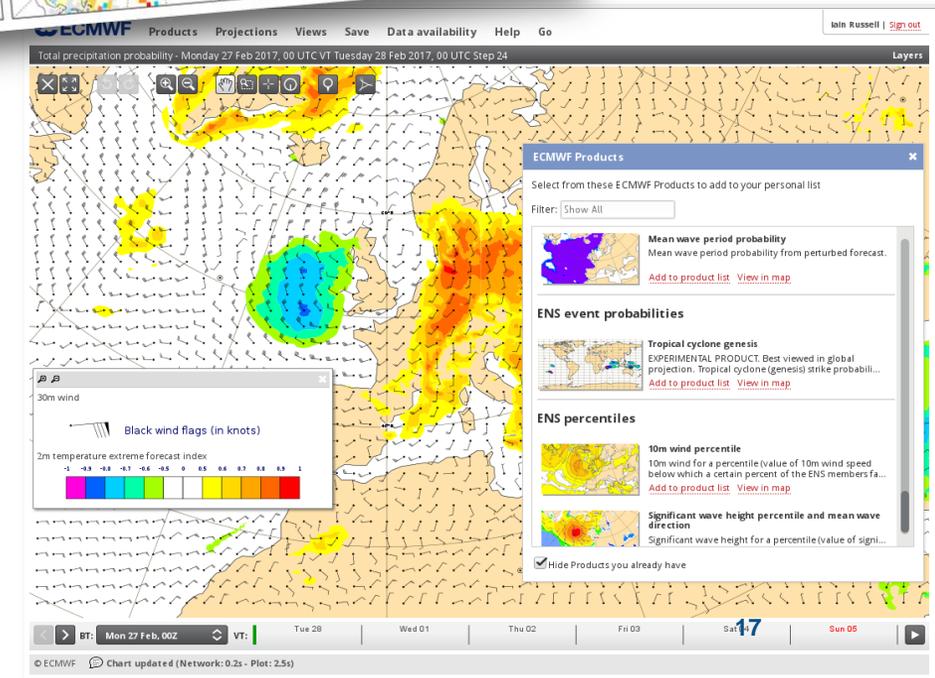
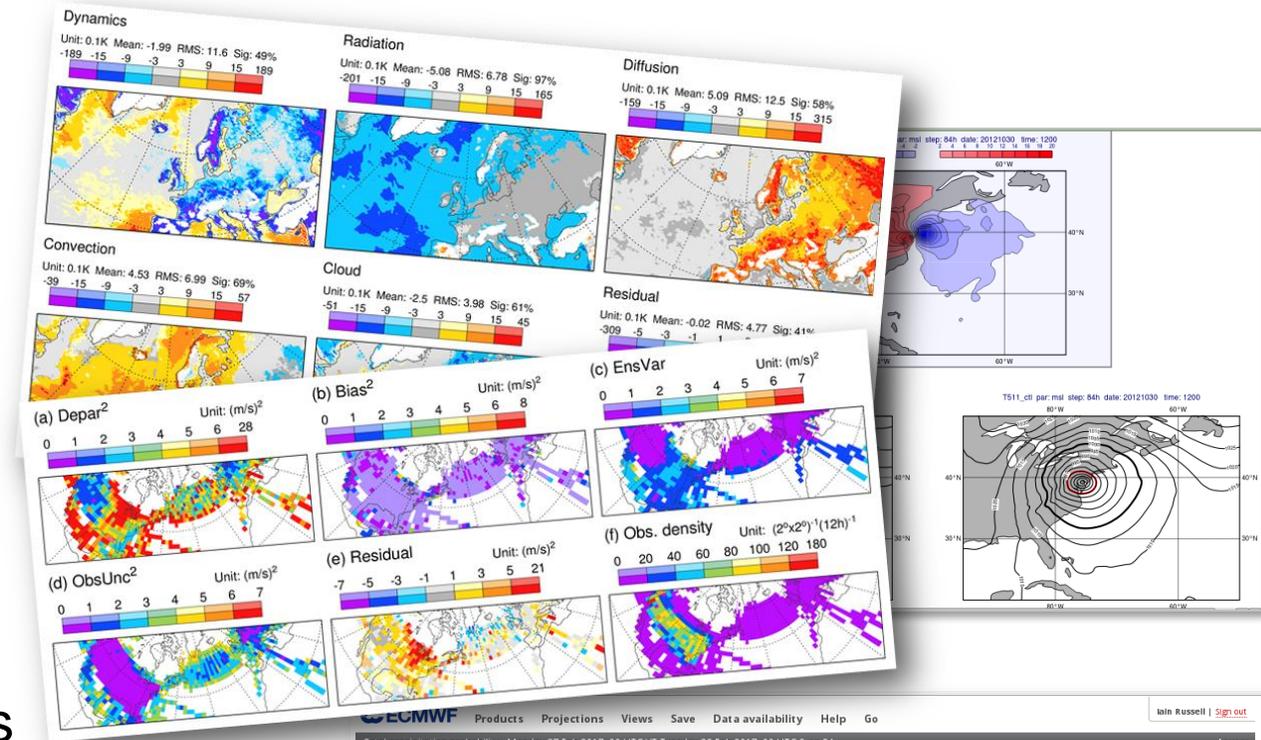


Metview 5 – Changes and Removals

- Remove all Motif code (pre-2015 user interface gone)
- Change (improve) netCDF handling in Macro
 - E.g. handle **time** variables properly, automatically apply **scaling factors**, understand **missing values**, etc.
- Harmonise the output drivers (e.g. font sizes and line widths in PDF, PNG, SVG, PostScript and on-screen)
 - Actually coming with Magics 3.0

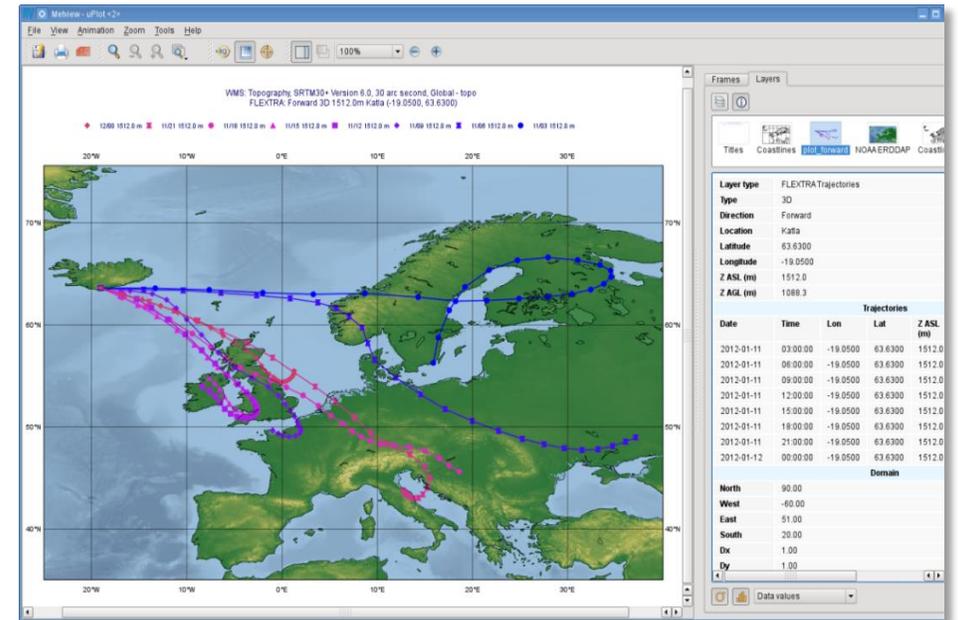
25 years of Metview so far

- Serving users of ECMWF data since...
 - 1990 **Announced at EGOWS (Oslo)**
 - 1991 **First prototype (INPE)**
 - 1993 **Metview 1.0**
 - 1998 **Metview 2.0**
 - 2000 **Metview 3.0**
 - 2010 **Metview 4.0**
 - 2017 **Metview 5.0**
- Used daily by many analysts and researchers
 - also by commercial users of our data
- Some large developments, e.g. the Diagnostics Toolbox, OpenIFS workshops, are based on top of Metview
- ecCharts is based on Metview's architecture and takes it onto the web



Metview's Trajectory (Beyond Metview 5)

- Continue to develop Metview, providing a high-level interface to ECMWF packages
 - In-house software gives us full control for scalability and research
- Bring Metview forward and allow more interoperability with other packages
- Therefore...



Metview + Python (1)



```
import metview
```

- Project to design and prototype a Python interface to Metview
- Should provide an environment where ECMWF libraries can work seamlessly together, and with the Python eco-system in general
- Better unify the Python-based interfaces at ECMWF where we currently have different solutions (e.g. verification)
- Bring in the expertise of an external company to help with this design phase
 - Greater knowledge of the wider Python community
 - Helps us during another very busy year

Metview + Python (2)



- Requirements to be based on existing Metview functionality, plus input from users (and non-users)
- Should be able to interact with the Copernicus Climate Data Store Toolbox (in development)
- Use existing solutions where possible (e.g. for multi-dimensional data arrays, data models)
- Ensure the new framework can smoothly interact with existing high-level packages



Metview Availability

• The Metview Virtual Machine

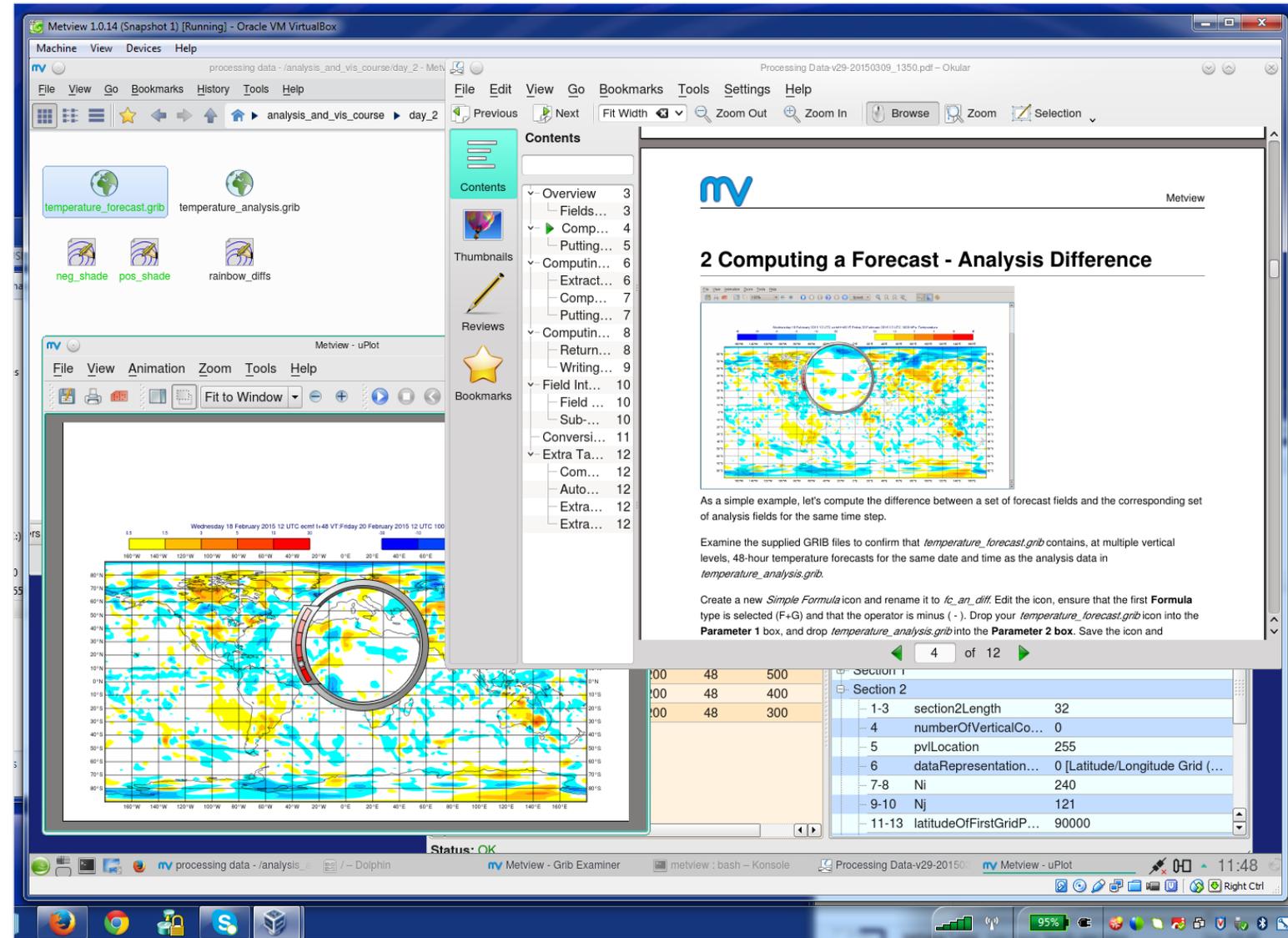
- Comes with Metview and other ECMWF software pre-installed
- Contains the latest Metview training course material

• Available on ecgate (just type 'metview')

• Alternatively:

- Install from binaries
- Build from source
- Build from bundle

• Thanks to the Ubuntu community for incorporating Metview into its default distribution



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
- **Coming soon – e-Learning material**

- **See us at the exhibition this afternoon!**

Questions?

