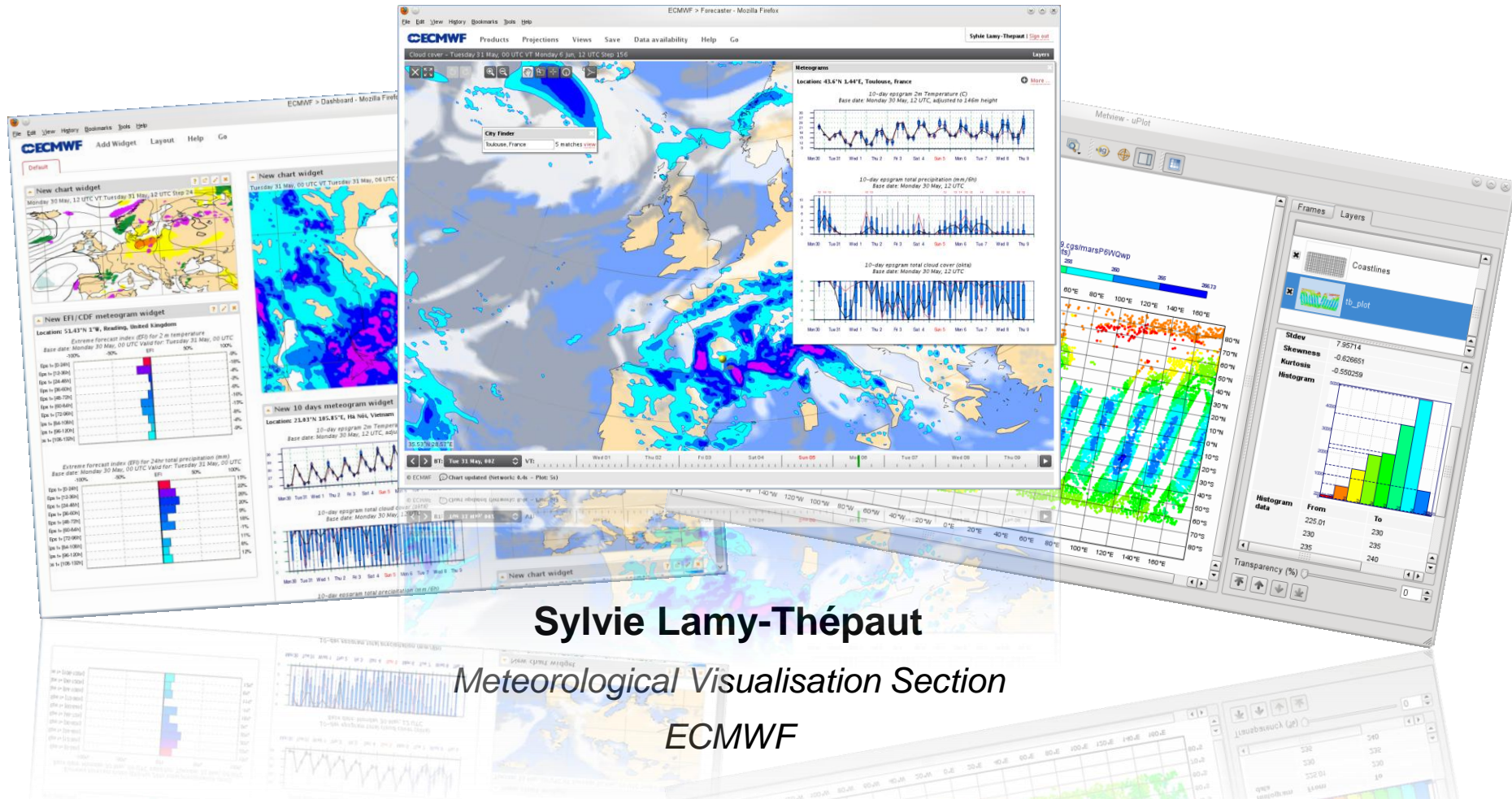


ecCharts and Metview 4 2 new visualisation systems at ECMWF

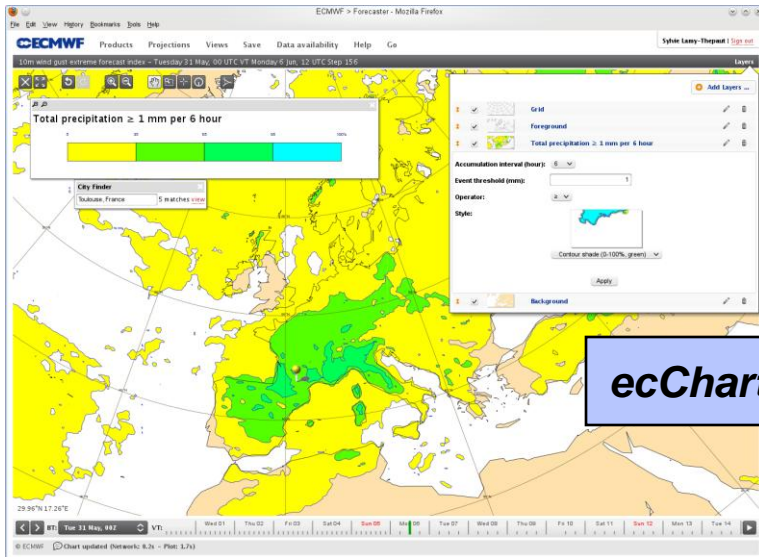


Sylvie Lamy-Thépaut

Meteorological Visualisation Section

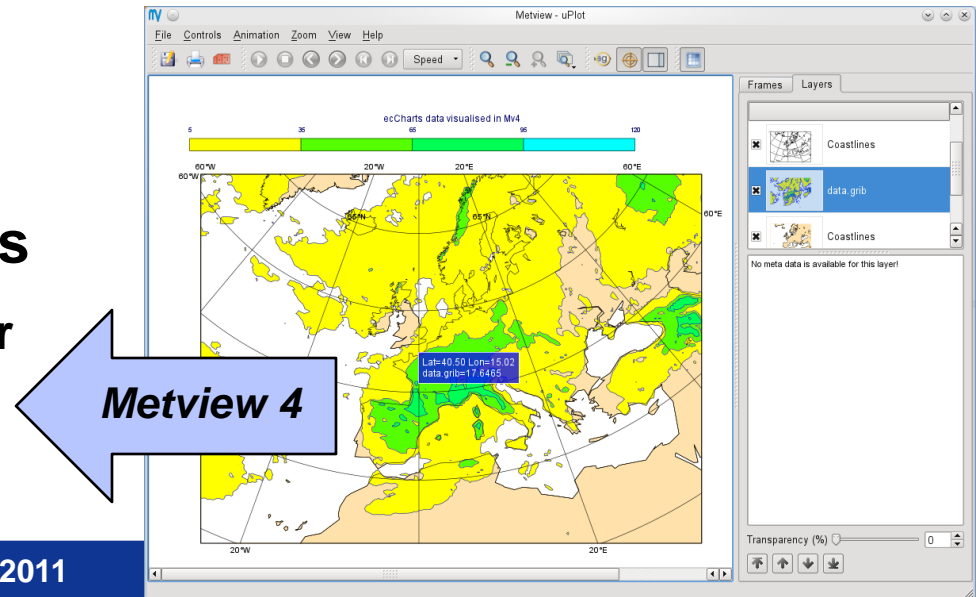
ECMWF

ecCharts and Metview 4



- **Web application**
 - Response Time, Monitoring
- **Dedicated to forecasters**
 - Simplicity of the User Interface, High availability
- **WMS server**

- **Desktop application**
 - Qt toolkit
- **Dedicated to researchers**
 - Macro language, examiner tools
- **WMS client**



ecCharts and Metview 4 : What do they share?

- **Metview 4 and ecCharts are both services oriented.**
 - Data access, compute service and visualisation
- **They use the same graphical kernel: Magics++**
 - The plots have the same look and feel
 - They share the concepts of visual definitions or styles
- **They both implement a powerful cache system.**
 - A complex visualisation is always the result of some basic data access/computation/visualisation. Every stage is cached.
 - Metview 4 uses his own one
 - ecCharts uses Memcached

ecCharts and Metview 4 : What is different?

● The End-User

- A forecaster for ecCharts
- A Researcher for Metview 4

● The Dataset

- Metview 4 can potentially display any data in any style
- ecCharts can only display ECMWF latest forecast in predefined styles

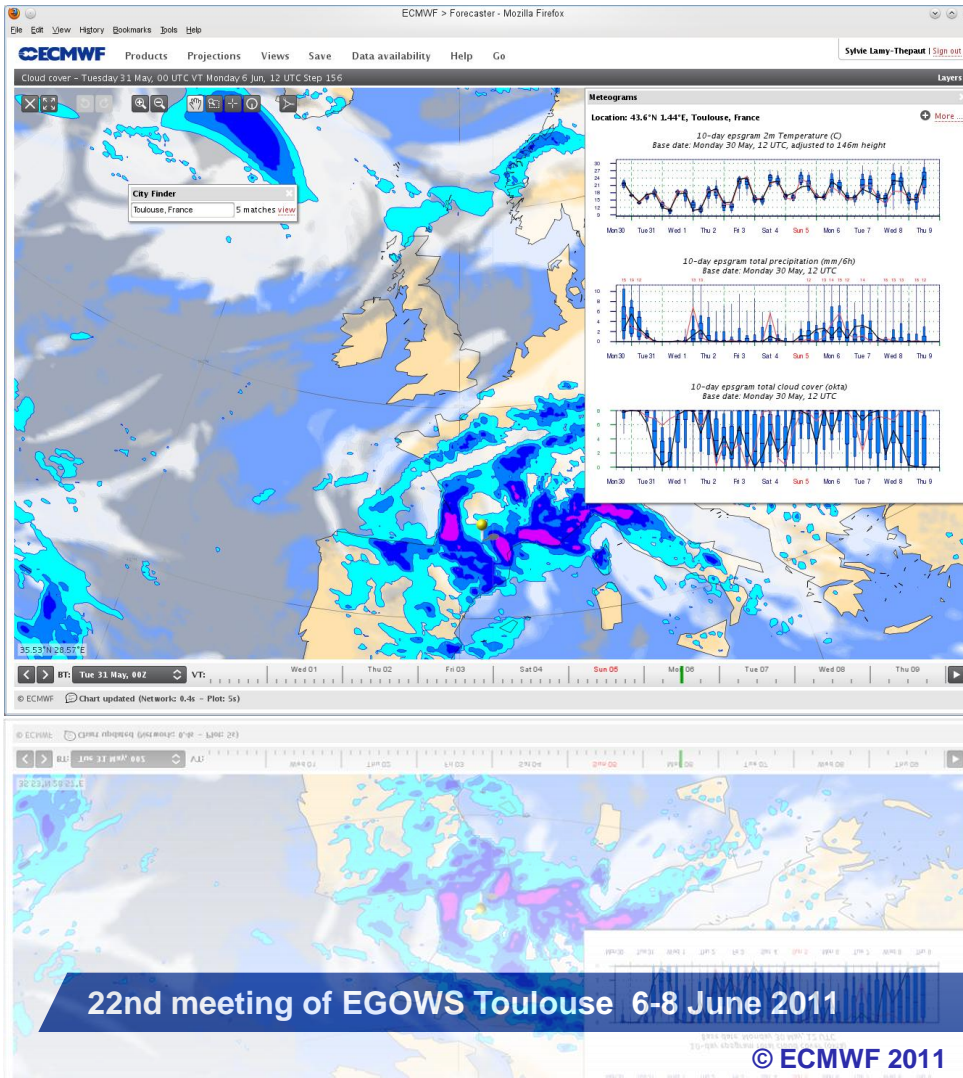
● The technology

- Metview 4 uses a classic workstation environment
- ecCharts is a Web Application

● The level of operation

- ecCharts is highly available 24/7

ecCharts requirements:

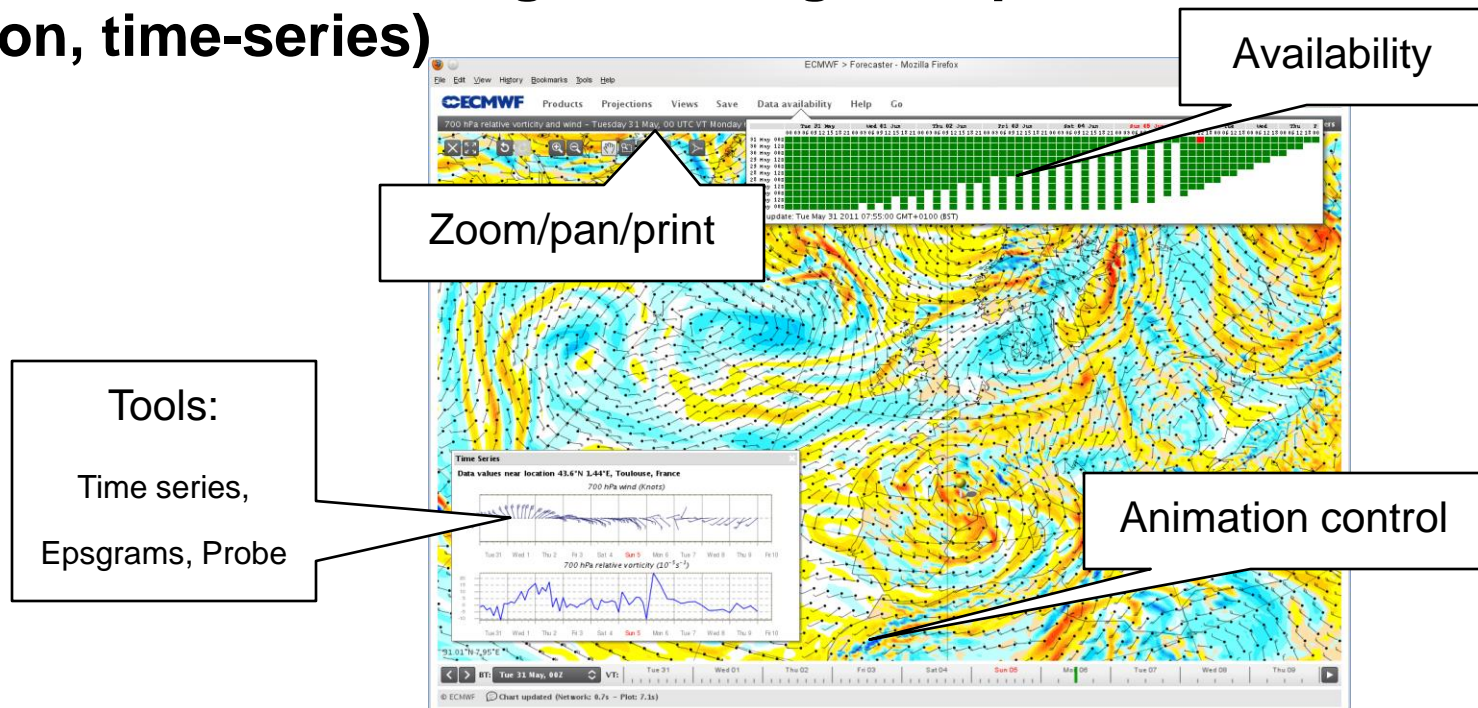


- Simple User Interface
- Few tools to examine the data
- Few options to customise user environment
- High availability
- Monitoring
- Response time

ecCharts - User Interface

The end-user of ecCharts is a forecaster

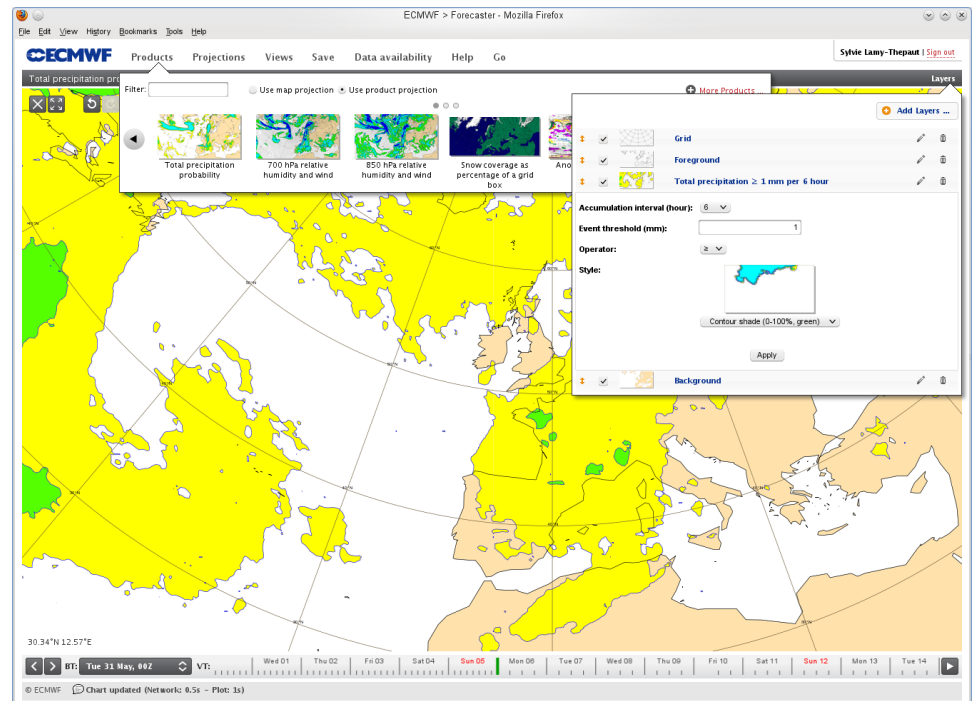
- He needs a fast and easy to use user-interface to access ECMWF forecast.
- He needs few tools to navigate through the products (animation, time-series)



ecCharts - User Interface

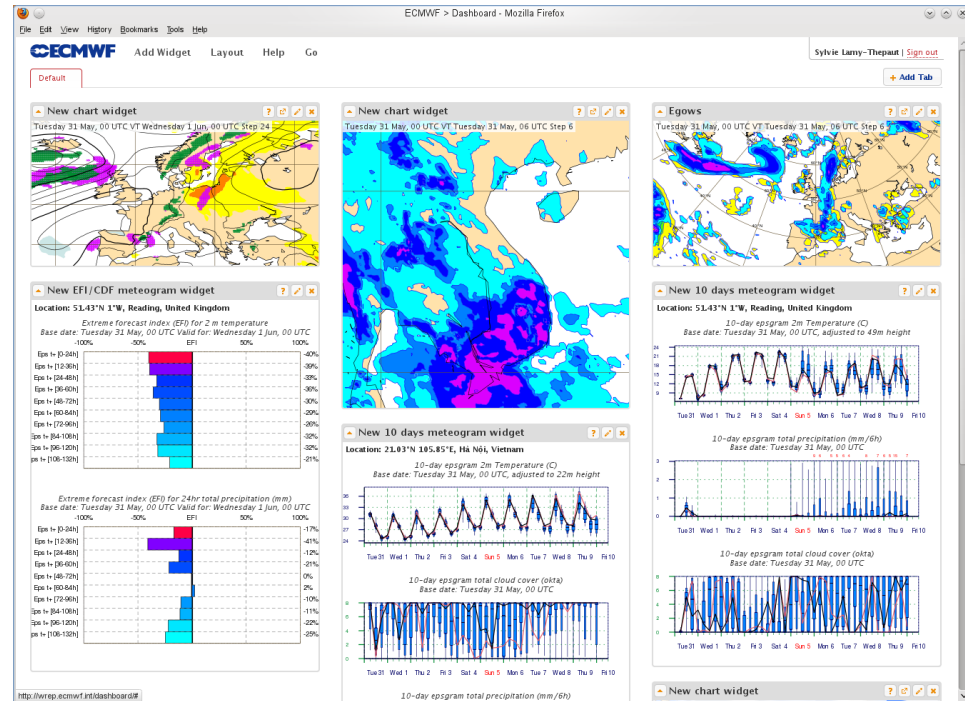
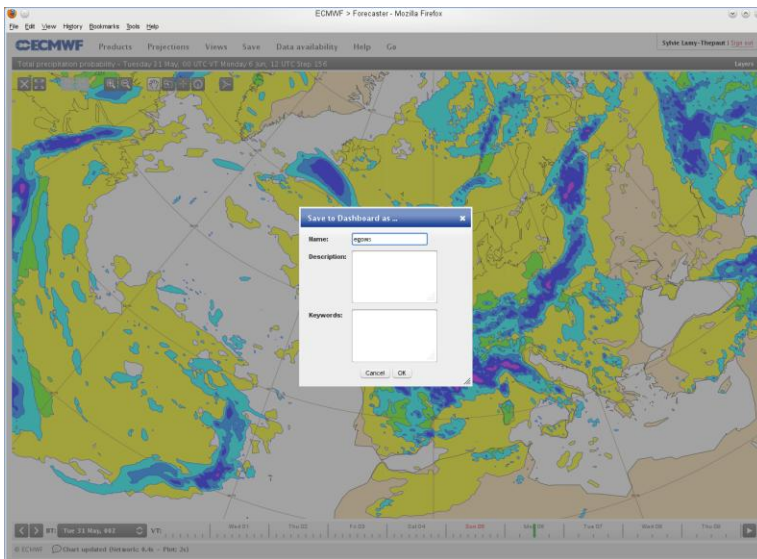
ecCharts offers a set of predefined products but also a way to create and save some tailored ones

- A product is a set of layers.
- A layer is the visual representation of a meteorological parameter.
- A layer offers a set of styles.
- A layer can offer basic computation on the parameter.



ecCharts - User Interface

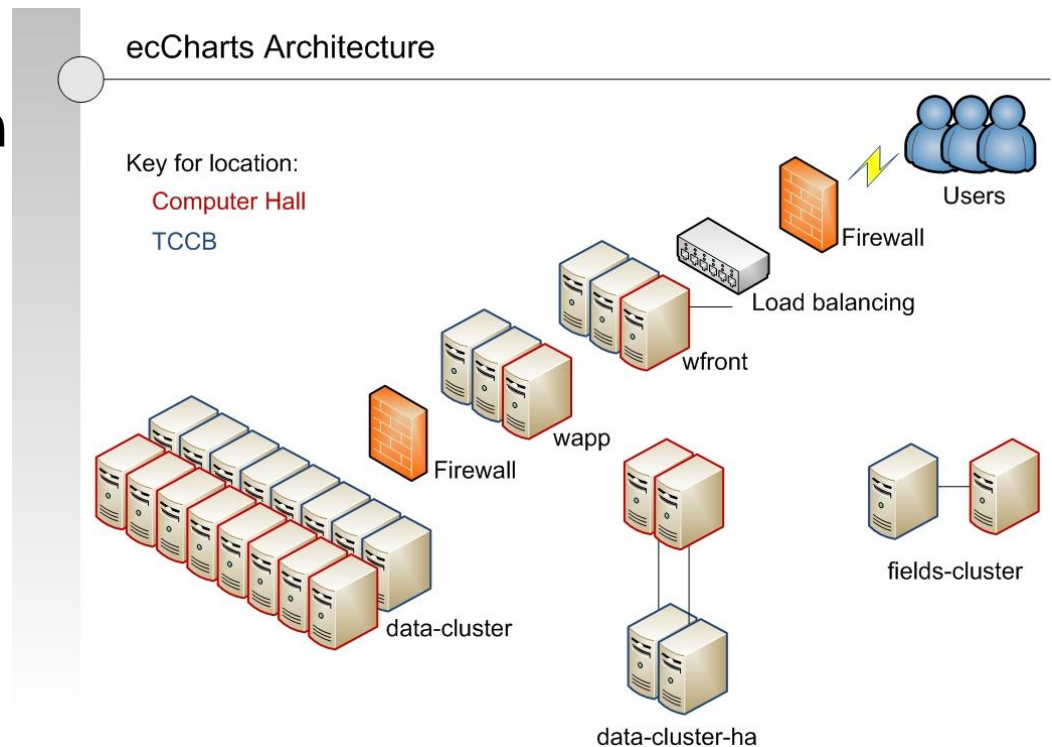
- A user can create and save his own product
- A user can export products to his dashboard.



ecCharts - Architecture

ecCharts is highly available

- The products/layers/styles definitions are stored in a mongodb database
- Everything is replicated
- Systems are located in different parts of the building, attached to different network routers and different power sources



ecCharts - Monitoring

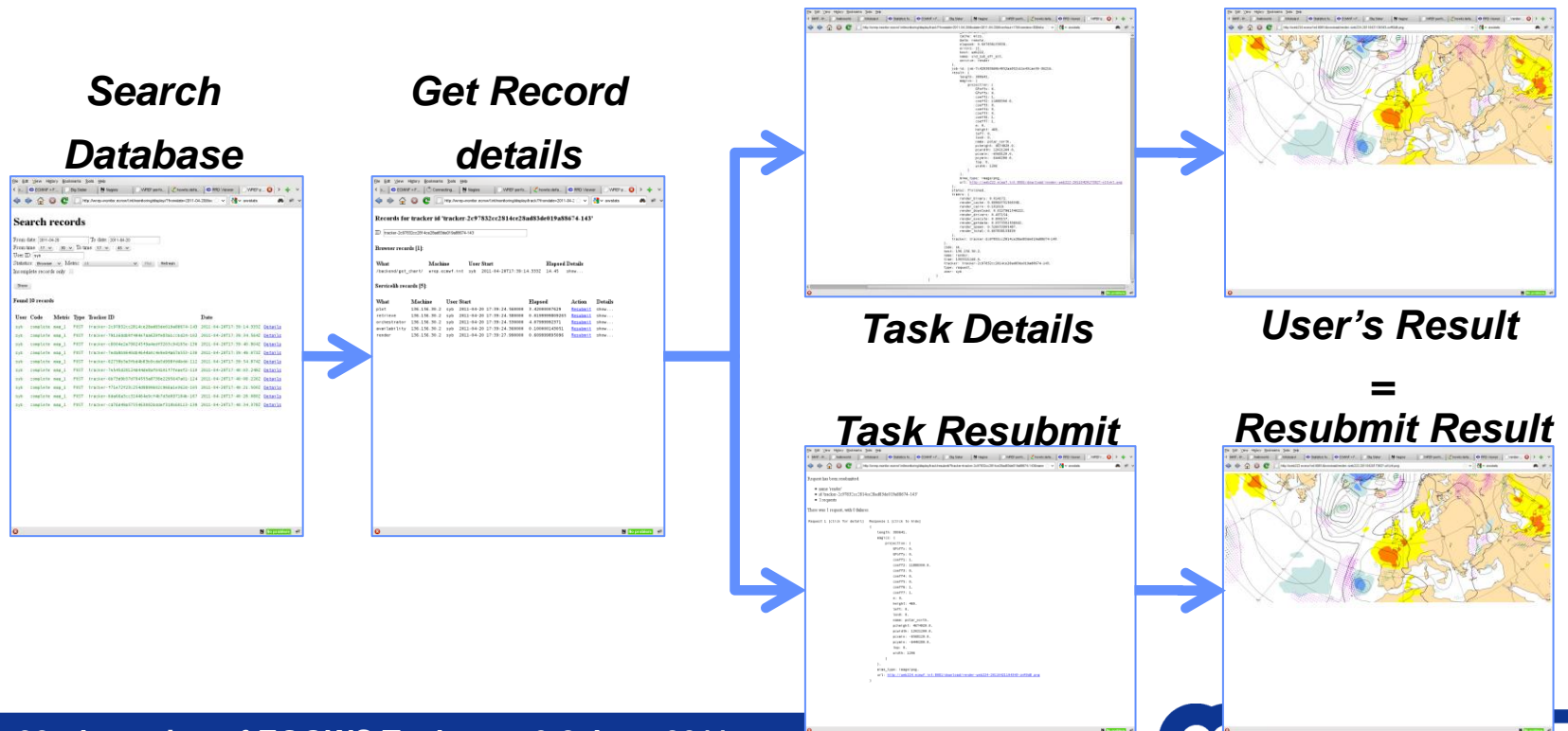
The End-User is behind a browser somewhere !

- To understand what is going on, a powerful monitoring system had to be developed
- Log every ecCharts user request:
 - Record every request to our web service.
 - Record data collected within users' web browsers:
 - We can query the monitoring database for any request.
 - We can re-run requests to check the results.
 - Process request data into statistics in RRDs (Round Robin Databases).
 - Continuously in near real-time (10 minutes).
 - Web application to visualise the statistical data.

ecCharts's Monitoring

We can get insight into end-user experience!

- **Web Interface to browse the database for requests**
 - Examine user's result
 - Resubmit



ecCharts's Monitoring

name	elapsed	plot	render	retrieve	compute
gusts_prob_data	9.54	0.71	0.49	4.96	6.58
2t_percentile	7.61	0.73	0.67	3.20	2.99
tp_percentile	7.47	0.59	0.41	1.59	5.51
wind_prob_data	6.04	0.69	0.68	3.18	1.47
tp_proba_interval	5.96	0.69	0.56	1.65	3.75
wind_percentile	5.84	0.93	0.50	1.06	3.35
700w	4.89	3.76	1.09	0.05	
500vorticity	4.30	3.04	1.21	0.05	
700vorticity	4.25	2.99	1.21	0.05	
300vorticity	3.92	2.71	1.15	0.06	
lcc	3.85	2.58	1.21	0.08	
snow_cover	3.62	1.03	0.37	0.17	4.23
700divergence	3.47	2.44	0.96	0.09	
hcc	3.25	2.36	0.87	0.05	
mcc	3.25	2.33	0.89	0.05	
2tprob	2.91	0.53	0.50	0.69	1.16
10m_fg_interval	2.83	1.27	0.59	0.18	0.75
rh925	2.64	1.85	0.73	0.05	
swh_percentile	2.63	0.51	0.54	0.41	1.13
mwp_percentile	2.60	0.47	0.47	0.39	1.17
wind_speed	2.39	1.78	0.54	0.07	
det_orography	2.30	0.91	0.47	0.18	0.77
850ws	2.25	1.64	0.53	0.07	
925ws	2.23	1.57	0.53	0.14	
swh_prob_data	2.19	0.40	0.56	0.48	0.66
700ws	2.13	1.43	0.62	0.07	
mwp_prob_data	2.09	0.46	0.47	0.39	0.71

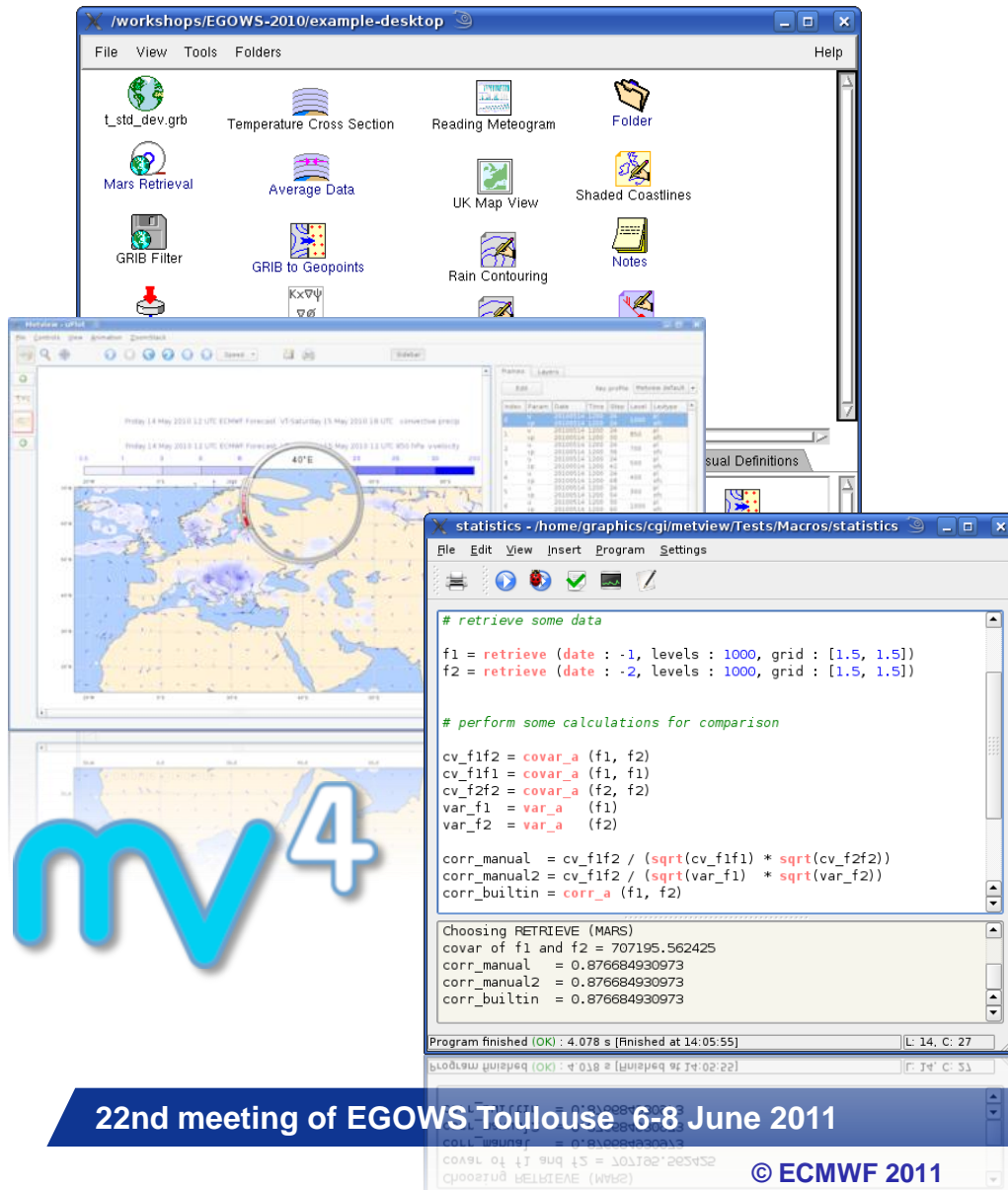
ecCharts - usability and response-time

- From <http://www.useit.com/papers/responsetime.html>, Miller 1968; Card et al. 1991:
 - 0.1 second is about the limit for having the user feel that the system is reacting instantaneously
 - 1 second is about the limit for the user's flow of thought to stay uninterrupted
 - 10 seconds is about the limit for keeping the user's attention focused on the dialogue
 - >10s and users will want to perform other tasks while waiting for the computer to finish
- ecCharts “get_chart” are nominally in the range 1s to 10s.
- ecCharts “animation” is nominally in the range 10s – 60s.

ecCharts - usability and response-time

- **Response time is a challenge!**
 - ecCharts is using high resolution data
 - ecCharts is plotting tailored products that have to be produced from data on-demand
 - ecCharts data changes progressively with every forecast cycle
 - ecCharts caches every data retrieval, every calculation result, every plot and every image rendered

Metview 4 requirements



The image displays the Metview 4 software interface. At the top, a file explorer window shows various data files and tools like 'Temperature Cross Section', 'Reading Meteogram', and 'UK Map View'. Below it, a map window shows a geographical map with a circular region highlighted. In the foreground, a statistics window displays 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]

mv4

- Flexible visualisation
- Nice outputs for external publications
- Full control of the visualisation
- Powerful computation facilities
- Tools to examine the data contents
- Overlay data from different sources (external databases or local files)

Metview 4 - User Interface

Full control of the visualisation

The screenshot displays the Metview 4 user interface with several key components highlighted by callouts:

- Print/export:** A callout points to the printer and export icons in the software's toolbar.
- Zoom stack:** A callout points to the zoom controls (magnifying glass and zoom in/out buttons) in the toolbar.
- Animation:** A callout points to the animation controls (play, stop, and frame advance buttons) in the toolbar.
- Layer management:** A callout points to the 'Frames' panel on the right, which lists visualization layers such as 'Titles', 'Coastlines', 'get_rain_line 37:7', 'T-fc', and 'Coastlines'.

The central visualization shows a map of Europe with a color-coded temperature forecast. The map includes a latitude/longitude grid and a color scale legend at the top. The legend shows values from 0.5 to 60, with colors ranging from blue (cooler) to red (warmer). The map data is labeled as 'Monday 23 May 2011 00' and 'Monday 23 May 2011 12'.

On the left, a 'Metview' configuration window is open, showing settings for 'Contour Shade Colour Method' (set to 'List'), 'Contour Shade Max Level Colour' (blue), 'Contour Shade Min Level Colour' (red), 'Contour Shade Colour Direction' (set to 'Anti Clockwise'), and 'Contour Shade Colour List' (a multi-color palette). Other options include 'Contour Shade Label Blanking' (On) and 'Contour Method' (Automatic).

6-8 June 2011

Metview 4 - Macro language

- Powerful high-level meteorologically oriented script language
- All Metview tasks can be written or saved as macro
- The Macro editor has been rewritten to ease the creation and debug of macros.

The screenshot shows a window titled "nearest_gridpoint_info_test" with a menu bar (File, Edit, View, Insert, Program, Settings, Help) and a toolbar. The main area contains a script with the following code:

```

1 data = retrieve (date : -2, parameter: 'T', grid : [1.5,1.5], area:[-20, -20, 60, 60])
2
3
4 #data = (data > 0) # test for nil values
5 #data = bitmap (data, 1)
6
7 listdef = nearest_gridpoint_info (data, 52.345, 1.2)
8
9 loop ngp in listdef
10  if (ngp = nil) then
11    print('it is nil')
12  else
13    print ("Value      : ", type(ngp.value) " " ngp.value)
14    print ("Latitude  : ", ngp.Lati
15    print ("Longitude : ", ngp.long
16  end if
17 end loop
18
19
20 listvals = nearest_gridpoint (data, 52
21
22 print (listvals)
23

```

A context menu is open over line 13, showing options: Undo (Ctrl+Z), Redo (Ctrl+Shift+Z), Cut, Copy, Paste, Delete, Select All, and Insert Unicode control character.

The output window at the bottom shows the following results:

```

Latitude : 52.5
Longitude : 1.5
Value : number 235.678
Latitude : 52.5
Longitude : 1.5
Value : number 225.204
Latitude : 52.5
Longitude : 1.5
[278.739990234, 268.864257812, 258.63835144, 243.814880371, 235.677734375, 225.203552246]

```

The status bar at the bottom indicates "Program finished (OK) : 1.171 s [Finished at 13:45:56]" and "L: 13, C: 63".

Metview 4 – Data Examiners

- **Essential tools to inspect data, e.g. to check:**
 - contents, structure
 - headers
 - errors or inconsistencies
- **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)**

Metview 4 – Data Examiners

Metview - Grib Examiner

File View Profiles Help

Key profile: Metview default

File: /var/tmp/tmpdir/cgs/jtmp.10980/mv.23494.cgs/marsK1tAVE
 Permissions: -rwxr-xr-x Owner: cgs Group: graphics Size: 1.2MB Modified: 2011-06-02 14:06
 Total number of messages: 21

Messages

Index	Param	Date	Time	Step	mars.levelist	mars.levtype
01	z			0	500	pl
02	z			12	500	pl
03	z			24	500	pl
04	z			36	500	pl
05	z	20110601	1200	48	500	pl
06	z	20110601	1200	60	500	pl
07	z	20110601	1200	72	500	pl
08	z	20110601	1200	84	500	pl
09	z	20110601	1200	96	500	pl
10	z	20110601	1200	108	500	pl
11	z	20110601	1200			
12	z	20110601	1200			
13	z	20110601	1200			
14	z	20110601	1200			
15	z	20110601	1200			
16	z	20110601	1200			
17	z	20110601	1200			
18	z	20110601	1200			
19	z	20110601	1200			
20	z	20110601	1200			
21	z	20110601	1200			

Meta data of the selected message

Dump mode: Namespace dump

GRIB API Namespace: Default

Key name (GRIB API)	Value
GRIBEXSection1Problem	0
GRIBEditionNumber	?
Ni	240
Nj	121
P1	
P2	
PL Present	

File View Profiles Help

Key profile: Metview default

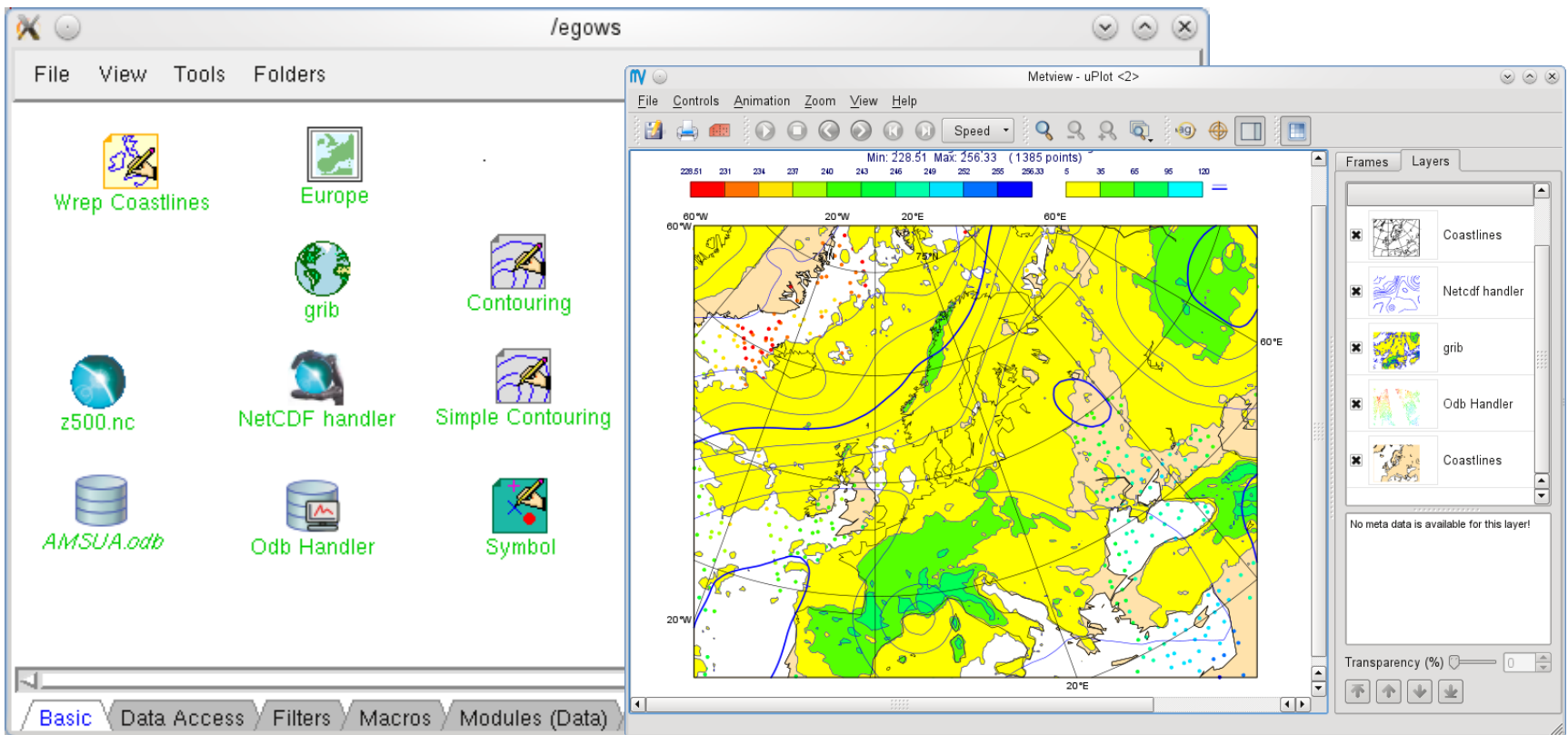
File: /home/graphics/cgs/metview/egows/AMSUA.odb
 Symlink target: /scratch/graphics/cgr/odb_data/AMSUA.odb
 Permissions: lrwxrwxrwx Owner: cgs Group: graphics Size: 0B Modified: 2011-06-02 14:06
 Total number of messages: 140

Messages

Ssc	Date	Time	Lat1	Lon1	Ident
1	2005-02-13	12:00	54.18	7.9	10015
1	2005-02-13	12:00	55.02	8.42	10020
1	2005-02-13	12:00	55.86	8.94	10035
1	2005-02-13	12:00	56.70	9.46	10050
1	2005-02-13	12:00	57.54	9.98	10113
1	2005-02-13	12:00	58.38	10.50	10170
1	2005-02-13	12:00	59.22	11.02	10227
1	2005-02-13	12:00	60.06	11.54	10284
1	2005-02-13	12:00	60.90	12.06	10341
1	2005-02-13	12:00	61.74	12.58	10398
1	2005-02-13	12:00	62.58	13.10	10455
1	2005-02-13	12:00	63.42	13.62	10512
1	2005-02-13	12:00	64.26	14.14	10569
1	2005-02-13	12:00	65.10	14.66	10626
1	2005-02-13	12:00	65.94	15.18	10683
1	2005-02-13	12:00	66.78	15.70	10740
1	2005-02-13	12:00	67.62	16.22	10797
1	2005-02-13	12:00	68.46	16.74	10854
1	2005-02-13	12:00	69.30	17.26	10911
1	2005-02-13	12:00	70.14	17.78	10968
1	2005-02-13	12:00	70.98	18.30	11025
1	2005-02-13	12:00	71.82	18.82	11082
1	2005-02-13	12:00	72.66	19.34	11139
1	2005-02-13	12:00	73.50	19.86	11196
1	2005-02-13	12:00	74.34	20.38	11253
1	2005-02-13	12:00	75.18	20.90	11310
1	2005-02-13	12:00	76.02	21.42	11367
1	2005-02-13	12:00	76.86	21.94	11424
1	2005-02-13	12:00	77.70	22.46	11481
1	2005-02-13	12:00	78.54	22.98	11538
1	2005-02-13	12:00	79.38	23.50	11595
1	2005-02-13	12:00	80.22	24.02	11652
1	2005-02-13	12:00	81.06	24.54	11709
1	2005-02-13	12:00	81.90	25.06	11766
1	2005-02-13	12:00	82.74	25.58	11823
1	2005-02-13	12:00	83.58	26.10	11880
1	2005-02-13	12:00	84.42	26.62	11937
1	2005-02-13	12:00	85.26	27.14	11994
1	2005-02-13	12:00	86.10	27.66	12051
1	2005-02-13	12:00	86.94	28.18	12108
1	2005-02-13	12:00	87.78	28.70	12165
1	2005-02-13	12:00	88.62	29.22	12222
1	2005-02-13	12:00	89.46	29.74	12279
1	2005-02-13	12:00	90.30	30.26	12336
1	2005-02-13	12:00	91.14	30.78	12393
1	2005-02-13	12:00	91.98	31.30	12450
1	2005-02-13	12:00	92.82	31.82	12507
1	2005-02-13	12:00	93.66	32.34	12564
1	2005-02-13	12:00	94.50	32.86	12621
1	2005-02-13	12:00	95.34	33.38	12678
1	2005-02-13	12:00	96.18	33.90	12735
1	2005-02-13	12:00	97.02	34.42	12792
1	2005-02-13	12:00	97.86	34.94	12849
1	2005-02-13	12:00	98.70	35.46	12906
1	2005-02-13	12:00	99.54	35.98	12963
1	2005-02-13	12:00	100.38	36.50	13020
1	2005-02-13	12:00	101.22	37.02	13077
1	2005-02-13	12:00	102.06	37.54	13134
1	2005-02-13	12:00	102.90	38.06	13191
1	2005-02-13	12:00	103.74	38.58	13248
1	2005-02-13	12:00	104.58	39.10	13305
1	2005-02-13	12:00	105.42	39.62	13362
1	2005-02-13	12:00	106.26	40.14	13419
1	2005-02-13	12:00	107.10	40.66	13476
1	2005-02-13	12:00	107.94	41.18	13533
1	2005-02-13	12:00	108.78	41.70	13590
1	2005-02-13	12:00	109.62	42.22	13647
1	2005-02-13	12:00	110.46	42.74	13704
1	2005-02-13	12:00	111.30	43.26	13761
1	2005-02-13	12:00	112.14	43.78	13818
1	2005-02-13	12:00	112.98	44.30	13875
1	2005-02-13	12:00	113.82	44.82	13932
1	2005-02-13	12:00	114.66	45.34	13989
1	2005-02-13	12:00	115.50	45.86	14046
1	2005-02-13	12:00	116.34	46.38	14103
1	2005-02-13	12:00	117.18	46.90	14160
1	2005-02-13	12:00	118.02	47.42	14217
1	2005-02-13	12:00	118.86	47.94	14274
1	2005-02-13	12:00	119.70	48.46	14331
1	2005-02-13	12:00	120.54	48.98	14388
1	2005-02-13	12:00	121.38	49.50	14445
1	2005-02-13	12:00	122.22	50.02	14502
1	2005-02-13	12:00	123.06	50.54	14559
1	2005-02-13	12:00	123.90	51.06	14616
1	2005-02-13	12:00	124.74	51.58	14673
1	2005-02-13	12:00	125.58	52.10	14730
1	2005-02-13	12:00	126.42	52.62	14787
1	2005-02-13	12:00	127.26	53.14	14844
1	2005-02-13	12:00	128.10	53.66	14901
1	2005-02-13	12:00	128.94	54.18	14958
1	2005-02-13	12:00	129.78	54.70	15015
1	2005-02-13	12:00	130.62	55.22	15072
1	2005-02-13	12:00	131.46	55.74	15129
1	2005-02-13	12:00	132.30	56.26	15186
1	2005-02-13	12:00	133.14	56.78	15243
1	2005-02-13	12:00	133.98	57.30	15300
1	2005-02-13	12:00	134.82	57.82	15357
1	2005-02-13	12:00	135.66	58.34	15414
1	2005-02-13	12:00	136.50	58.86	15471
1	2005-02-13	12:00	137.34	59.38	15528
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1	2005-02-13	12:00	139.02	60.42	15642
1	2005-02-13	12:00	139.86	60.94	15699
1	2005-02-13	12:00	140.70	61.46	15756
1	2005-02-13	12:00	141.54	61.98	15813
1	2005-02-13	12:00	142.38	62.50	15870
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1	2005-02-13	12:00	145.74	64.58	16098
1	2005-02-13	12:00	146.58	65.10	16155
1	2005-02-13	12:00	147.42	65.62	16212
1	2005-02-13	12:00	148.26	66.14	16269
1	2005-02-13	12:00	149.10	66.66	16326
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1	2005-02-13	12:00	154.14	69.78	16668
1	2005-02-13	12:00	154.98	70.30	16725
1	2005-02-13	12:00	155.82	70.82	16782
1	2005-02-13	12:00	156.66	71.34	16839
1	2005-02-13	12:00	157.50	71.86	16896
1	2005-02-13	12:00	158.34	72.38	16953
1	2005-02-13	12:00	159.18	72.90	17010
1	2005-02-13	12:00	160.02	73.42	17067
1	2005-02-13	12:00	160.86	73.94	17124
1	2005-02-13	12:00	161.70	74.46	17181
1	2005-02-13	12:00	162.54	74.98	17238
1	2005-02-13	12:00	163.38	75.50	17295
1	2005-02-13	12:00	164.22	76.02	17352
1	2005-02-13	12:00	165.06	76.54	17409
1	2005-02-13	12:00	165.90	77.06	17466
1	2005-02-13	12:00	166.74	77.58	17523
1	2005-02-13	12:00	167.58	78.10	17580
1	2005-02-13	12:00	168.42	78.62	17637
1	2005-02-13	12:00	169.26	79.14	17694
1	2005-02-13	12:00	170.10	79.66	17751
1	2005-02-13	12:00	170.94	80.18	17808
1	2005-02-13	12:00	171.78	80.70	17865
1	2005-02-13	12:00	172.62	81.22	17922
1	2005-02-13	12:00	173.46	81.74	17979
1	2005-02-13	12:00	174.30	82.26	18036
1	2005-02-13	12:00	175.14	82.78	18093
1	2005-02-13	12:00	175.98	83.30	18150
1	2005-02-13	12:00	176.82	83.82	18207
1	2005-02-13	12:00	177.66	84.34	18264
1	2005-02-13	12:00	178.50	84.86	18321
1	2005-02-13	12:00	179.34	85.38	18378
1	2005-02-13	12:00	180.18	85.90	18435
1	2005-02-13	12:00	181.02	86.42	18492
1	2005-02-13	12:00	181.86	86.94	18549
1	2005-02-13	12:00	182.70	87.46	18606
1	2005-02-13	12:00	183.54	87.98	18663
1	2005-02-13	12:00	184.38	88.50	18720
1	2005-02-13	12:00	185.22	89.02	18777
1	2005-02-13	12:00	186.06	89.54</	

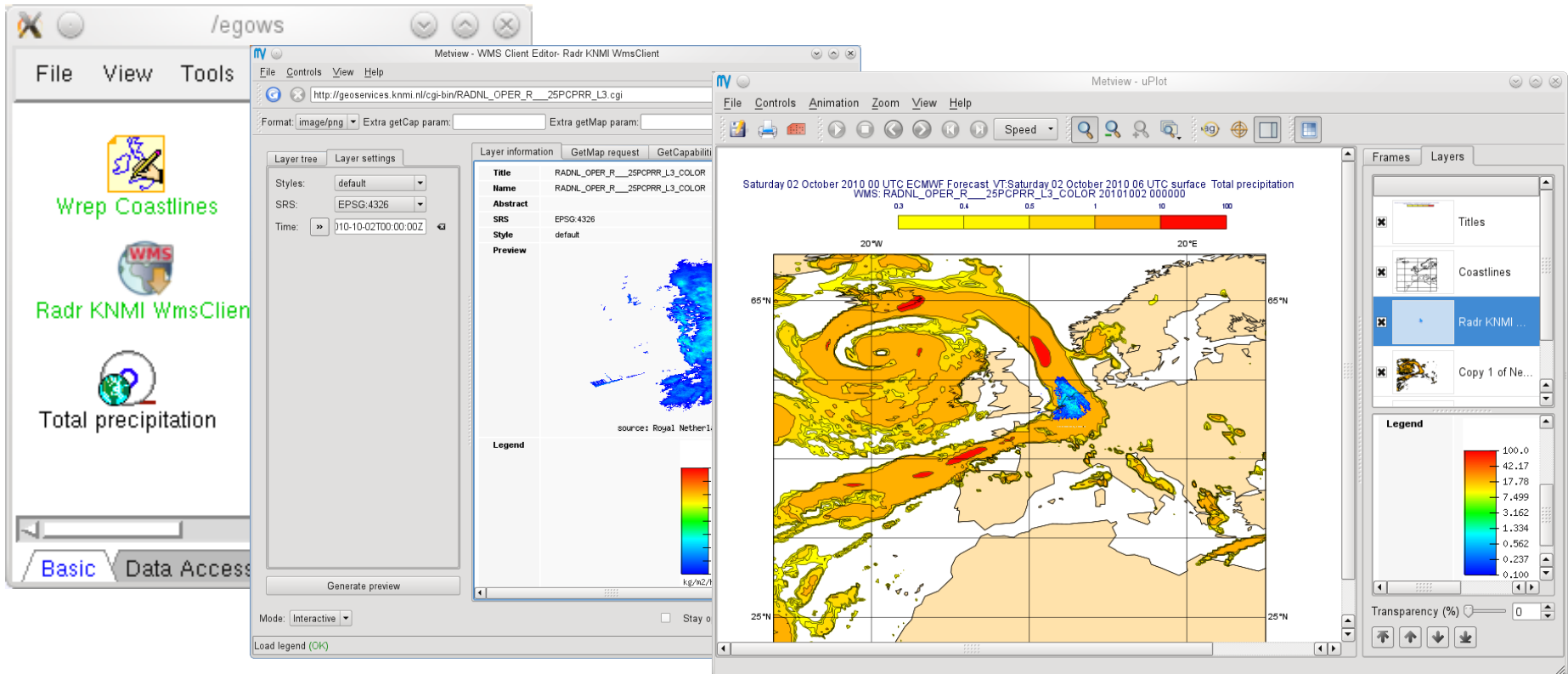
Metview 4 – WMS Client

Metview has always been able to overlay data coming from different sources

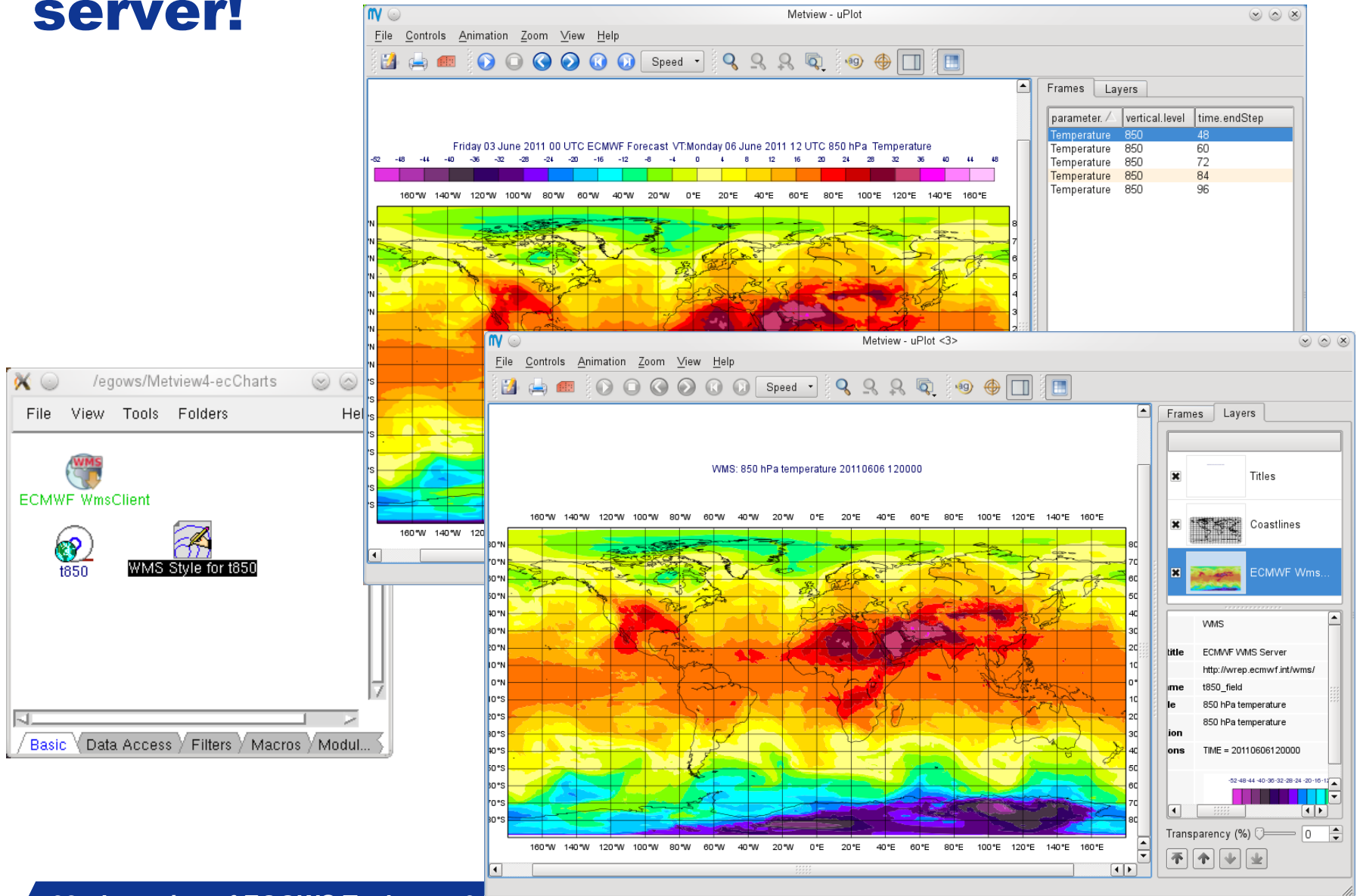


Metview 4 : WMS Client

- The getCapabilities function allows the creation of the icon editor.
- The getMap function allows the retrieval of the map for overlay in a Metview visualisation window.



Metview 4 WMS client of ecCharts WMS server!



Metview 4 - ecCharts : Chicken or egg?

- **ecCharts developers need Metview to design new products and new visualisation styles**
 - Export Icons to the ecCharts setup.
- **Metview users want to access ECMWF forecasts with the same simplicity as ecCharts**
 - Easier access to current forecast
 - Import Styles to Metview
 - More Interaction on visualisation in Metview such as panning
- **But, They are definitely cooperative tools !**

Metview 4 – ecCharts - Conclusion

- We are very happy with the developments
 - We took advantage of our new softwares GRIB API and Magics++
- We have very good user feedback
 - We have a lot of new exciting features to implement
- We have good foundation for the next years!
 - We have a good “Synergie” between all Magics based systems.

