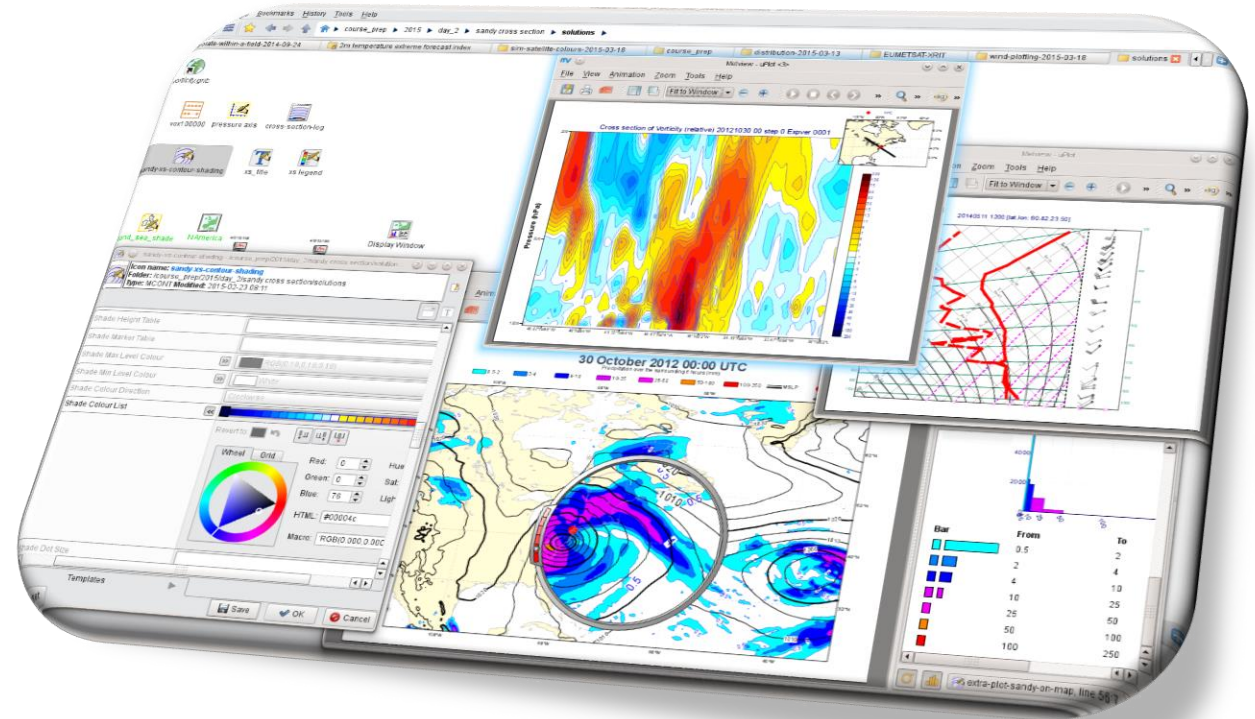


Metview Introduction

ECMWF

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What is Metview?

- Workstation software for researchers and operational analysts
 - Runs on UNIX, from laptops to supercomputers (also being tested on Mac OS X)
- Retrieve/manipulate/visualise/examine meteorological data
- Can access MARS, either locally or through the Web API
- Open Source under Apache Licence 2.0
- Installed on ECMWF machines (module avail metview)
- Available via binary installations (RPM, DEB) and on conda
- Metview is a co-operation project with INPE (Brazil)



EUROPEAN CENTRE FOR MEDIUM-RANGE WEATHER FORECASTS



The screenshot displays the Metview software interface. At the top, a weather map shows a low-pressure system over the North Atlantic. Below the map is a file explorer window showing a directory structure with folders like 'Tests' and 'Vapor'. A code editor window shows the following code:

```
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 calculation
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
21 corr_manual2 = cv_f1f2
22 corr_builtin = corr_a (cv_f1f2)
23
```

The bottom right window shows a plot of a cross-section view with wind speed and geopotential height. The plot includes a color scale for wind speed and a red line indicating the cross-section path. The plot title is 'mv_plot_area_view'.

Built on top of ECMWF software packages

Metview

Data decoding

Regridding

Plotting

Data Access

ecCodes
(GRIB,
BUFR)

ODB_API

Other
(NetCDF,
Geopoints
, CSV)

MIR

Magics

MARS

CDS

Files

WMS

URL

Using Metview (1)

- 1. User interface driven via *icons*
 - Provides a subset of Metview's functionality

The screenshot displays the Metview software interface. The main window, titled "radiance_map - /tutorials/odb_seminar_2017 - Metview", shows a file browser with a "Bookmarks" panel on the left and a central area containing several icons: "AMSUA.odb", "tb_plot", "amsua.mv", "symbol_fixed", "coast_dark", "Legend", and "title".

Two configuration dialog boxes are overlaid on the interface:

- Data for XSection_pressure_levels**:
 - Icon name: Data for XSection_pressure_levels
 - Folder: /Tests/CrossSection
 - Type: RETRIEVE Modified: 2019-07-25 10:29
 - Parameters:
 - Dataset: [empty]
 - Class: Operations
 - Type: FC
 - Stream: DA
 - Expver: 1
 - Repres: Spherical Harmonics
 - Reportype: OFF
 - Levtype: Pressure Levels
 - Levelist: 1000/850/500/300/100/10/1
 - Param: T
 - Date: -1
- symbol_fixe**:
 - Icon name: symbol_fixe
 - Folder: /tutorials/odb_seminar_2017
 - Type: MSYMB Modified: 2019-07-25 10:29
 - Parameters:
 - Symbol Advanced Table Max Level Colour: Red
 - Symbol Advanced Table Min Level Colour: Blue
 - Symbol Advanced Table Colour Direction: Clockwise

Using Metview (2)

- 2. Scripting (run from UI or command line)
 - Can do everything from icons, plus lots more
 - Macro language or Python interface – Python interface gives access to all Macro functions, and will gain more features and allows you to combine with other Python libraries and to work in Jupyter and other environment

```
File Edit View Insert Program Settings Help
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 on
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,
```

- ✓ The Macro Language
 - Macro syntax
 - Macro Data Types
- ✓ List of Operators and Fun...
 - Information Functions
 - The nil Operand
 - Number Functions
 - String Functions
 - Date Functions
 - List Functions
 - Vector Functions
 - **Fieldset Functions**
 - Geopoints Functions
 - NetCDF Functions

Note that the following lines are equivalent, although the first is more effi

```
z = corr_a ( x, y )
z = covar_a ( x, y ) / ( sqrt(var_a(x)) * sqrt(var_a(y)) )
```

```
fieldset coslat ( fieldset )
```

For each field in the input fieldset, this function creates a field where each

```
fieldset covar ( fieldset,fieldset )
```

Computes the covariance of two fieldsets. With n fields in the input fieldset, the ith value of the resulting field, the formula can be written :

$$z_i = \frac{1}{n} \sum_{k=1}^n x_i^k y_i^k - \frac{1}{n} \sum_{k=1}^n x_i^k \sum_{k=1}^n y_i^k$$

Note that the following lines are equivalent:

```
z = covar(x,y)
z = covar(x,y) - mean(x)*mean(y)
```

... in either input fieldset will result in a missing value in the c

```
fieldset covar_a ( fieldset,fieldset )
fieldset covar_a ( fieldset,fieldset,list )
```

... computes the covariance of two fieldsets over a weighted area. The area of the whole field will be used in the calculation. The result is a nu

```
( fieldset )
```

```
t2m_fc48 = mv.read('t2m_fc48.grib')
synop = mv.read('t2m_obs.bufr')

# filter just the 2m temperature from the obs data
synop_t2m = mv.obsfilter(
    output      = "geopoints",
    parameter   = "airTemperatureAt2M",
    data        = synop)

# compute the difference
diff = t2m_fc48 - synop_t2m
```

Using Metview (3)

- 3. Can generate code from icons

The image shows a composite screenshot of the Metview software interface. On the left is the main workspace with a file browser and icons for 'obs.bufr', 't2m', 'Python Script.py', 'land_sea_shade', and 'coloured_symbols'. A blue arrow points from the 'coloured_symbols' icon to a Python script editor window. The script editor shows a line of code: `view = mv.geoview (`. A second blue arrow points from the 'coloured_symbols' icon to a 'coloured_symbols - /Demos/General - Metview' dialog box. This dialog box contains the following information:

- Icon name: coloured_symbols
- Folder: /Demos/General
- Type: MSYMB Modified: 2018-10-27 12:49

Below this information are several configuration options:

- Symbol Advanced Table Max Level Colour: Red
- Symbol Advanced Table Min Level Colour: Blue
- Symbol Advanced Table Colour Direction: Clockwise

At the bottom of the dialog are 'Reset', 'Save', 'OK', and 'Cancel' buttons. The background of the dialog shows a color wheel and RGB/HTML/Macro color selection options.

Now please do exercise Part 1 - Intro

Metview + GRIB

- Plot
- Examine
- Filter, regrid, masking
- Maths, Boolean
- Specialised:
 - Cross section
 - Thermodynamics
 - Gradient
 - Vertical integration
 - Model to pressure lev
 - Etc

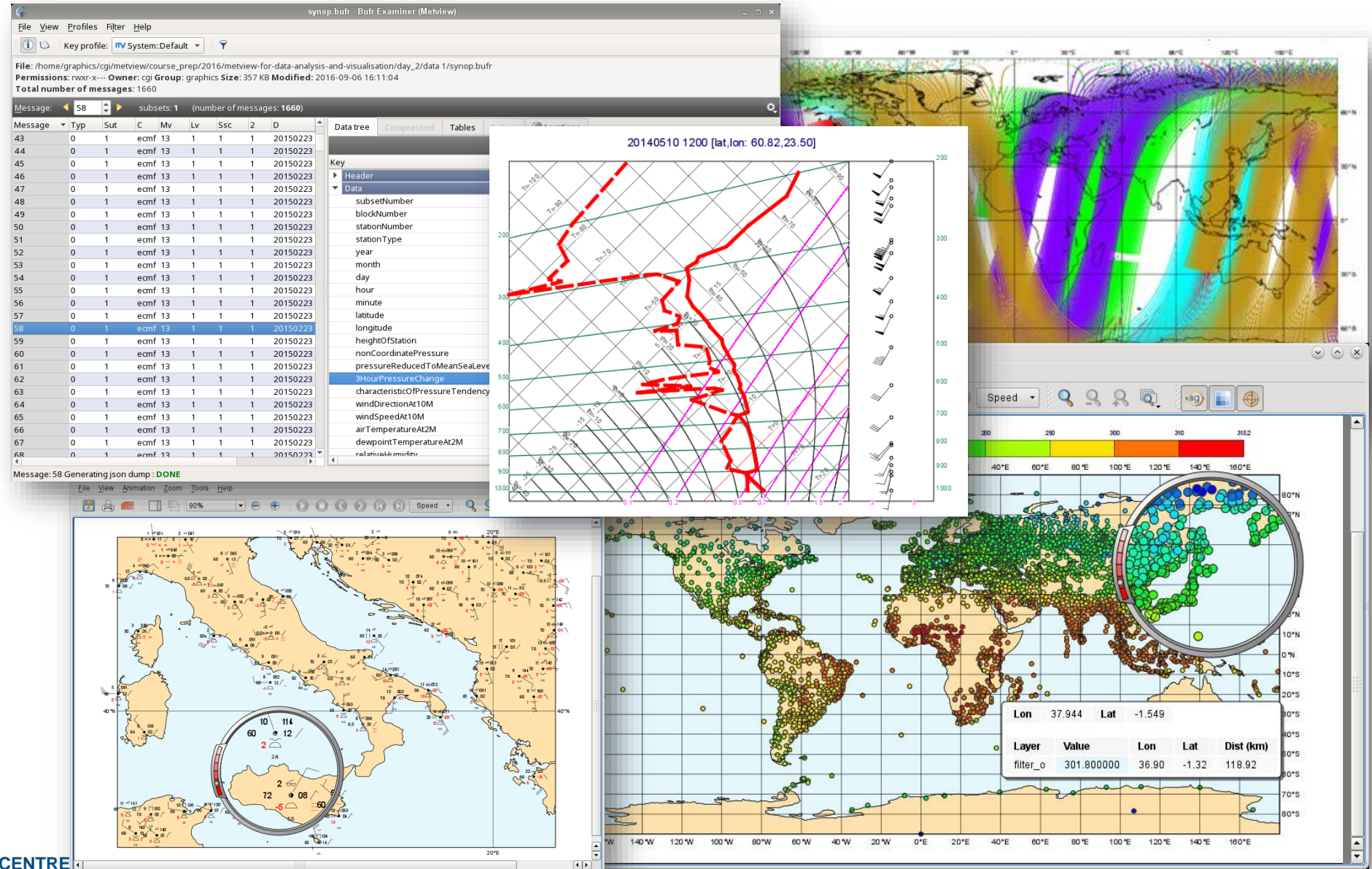
The image displays several screenshots from the Metview software interface:

- Two side-by-side maps of Europe showing the U component of wind on Sunday 22 February 2015 at 12 UTC. The maps use a color scale from blue (negative) to red (positive).
- A large vertical cross-section plot on the right showing a color-coded vertical profile of a meteorological variable, with a color bar at the top ranging from 0.4 to 4.1211.
- A central window titled '20140512 1200 step 0 [0.00,0.00] saturation over water' showing a cross-section with a red line and a grid.
- A window titled 'statistics - /home/graphics/cgi/metview/Tests/Macros/statistics' containing a script for data retrieval and calculation. The script defines variables f1 and f2, performs covariance and variance calculations, and outputs correlation coefficients. The output shows: corr_manual = 0.876684930973, corr_manual2 = 0.876684930973, and corr_builtin = 0.876684930973.
- A window titled 'Metview - uPlot' showing a map of Europe with a color scale for temperature on Thursday 24 April 2014 at 12 UTC.
- A window titled 'Histogram (for data in visible area)' showing a bar chart with a color scale from -37.9446 to 10.
- A window titled 'Tree Text' showing a list of sections and their properties, such as sectionLength, numberOfVerticalCoordinate, and resolutionOfComponentFlag.

Now please do exercise Part 2 - GRIB

Metview + BUFR

- Plot
- Examine
- Filter
- Extract values
- Convert to Geopoints
- Thermodynamics



Metview + Geopoints CSV & ASCII

- Geopoints – geo-located values
- Plot
- Examine
- Filter
- Maths, Boolean
- Geo functions
- Convert between GRIB, BUFR and Geopoints
- Can also read CSV

CSV (and similar)

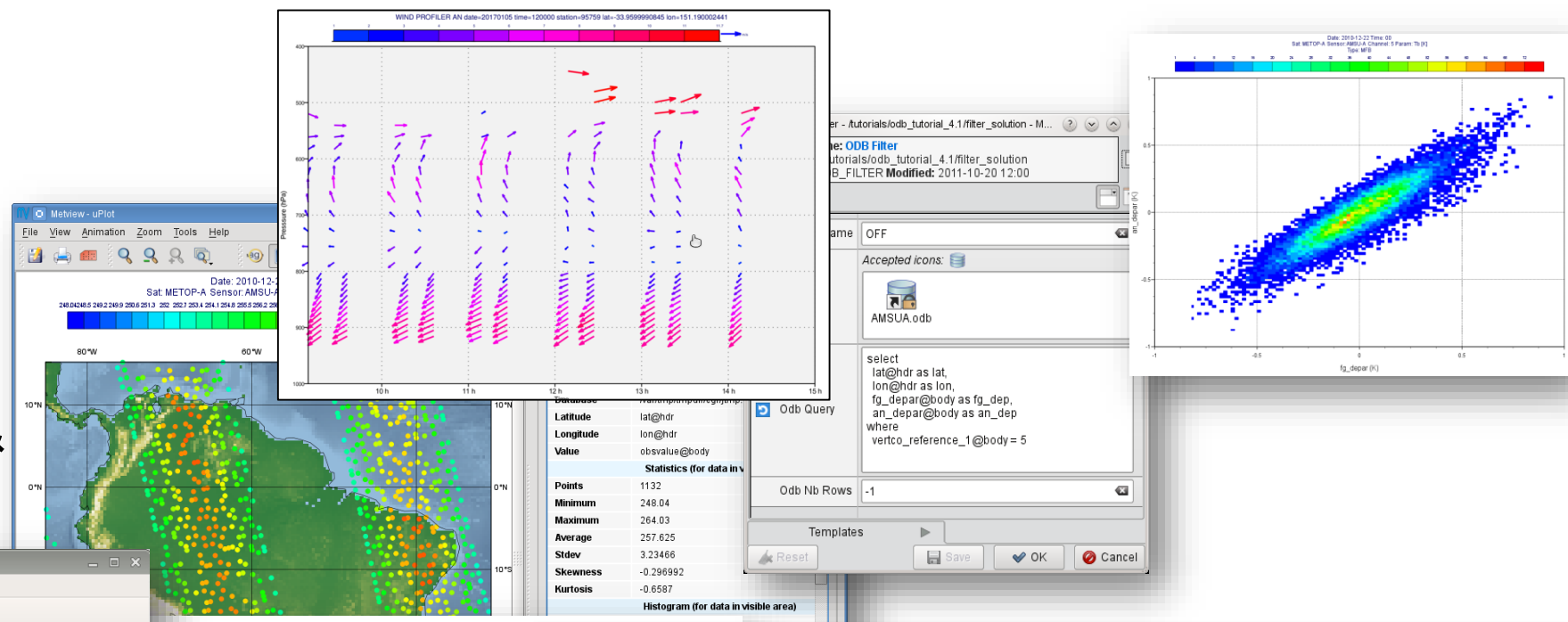
1	degrees_lat	degrees_lon	fg_depar
2	43.37942	-15.32557	7.7474003900818
3	37.25943	-22.93482	-1.9798161031505
4	30.94732	-42.5021	10.609738886033
5	43.94829	-76.45218	-3.3929916442406
6	28.94935	-89.62981	7.1024207535072
7	77233	-93.30165	4.5346224539512
10768	-119.4183	3.6048699999283	
96311	-113.71029	-2.5591580715308	
06225	-144.48569	2.0515008637495	
38039	-179.80404	16.225524892237	
70696	-174.86691	8.5849734979496	
.90788	-0.50169	5.1074401690909	

Index	latitude	longitude	level	date	time	value
1	69.6523	18.9057	0	20150126	1000	276.45
2	63.4882	10.8795	0	20150126	1000	275.25
3	63.5657	10.694	0	20150126	1000	276.25
4	61.2928	5.0443	0	20150126	1000	276.85
5	61.122	9.063	0	20150126	1000	265.35
6	60.7002	10.8695	0	20150126	1000	270.15
7	60.7733	10.8055	0	20150126	1000	270.45
8	61.455	10.1857	0	20150126	1000	267.55
9	58.7605	5.6505	0	20150126	1000	277.45
10	58.34	8.5225	0	20150126	1000	275.95
11	59.6193	10.215	0	20150126	1000	275.45
6	90	0	1000	20150220	1200	251.568
7	90	1.5	1000	20150220	1200	251.568
8	90	3	1000	20150220	1200	251.568
9	90	4.5	1000	20150220	1200	251.568
10	90	6	1000	20150220	1200	251.568
11	90	7.5	1000	20150220	1200	251.568
12	90	9	1000	20150220	1200	251.568
13	90	10.5	1000	20150220	1200	251.568
14	90	12	1000	20150220	1200	251.568
15	90	13.5	1000	20150220	1200	251.568

Now please do exercise Part 3 - BUFR

Metview + ODB

- Plot
- Examine
- Filter
- Convert to Geopoints & pandas

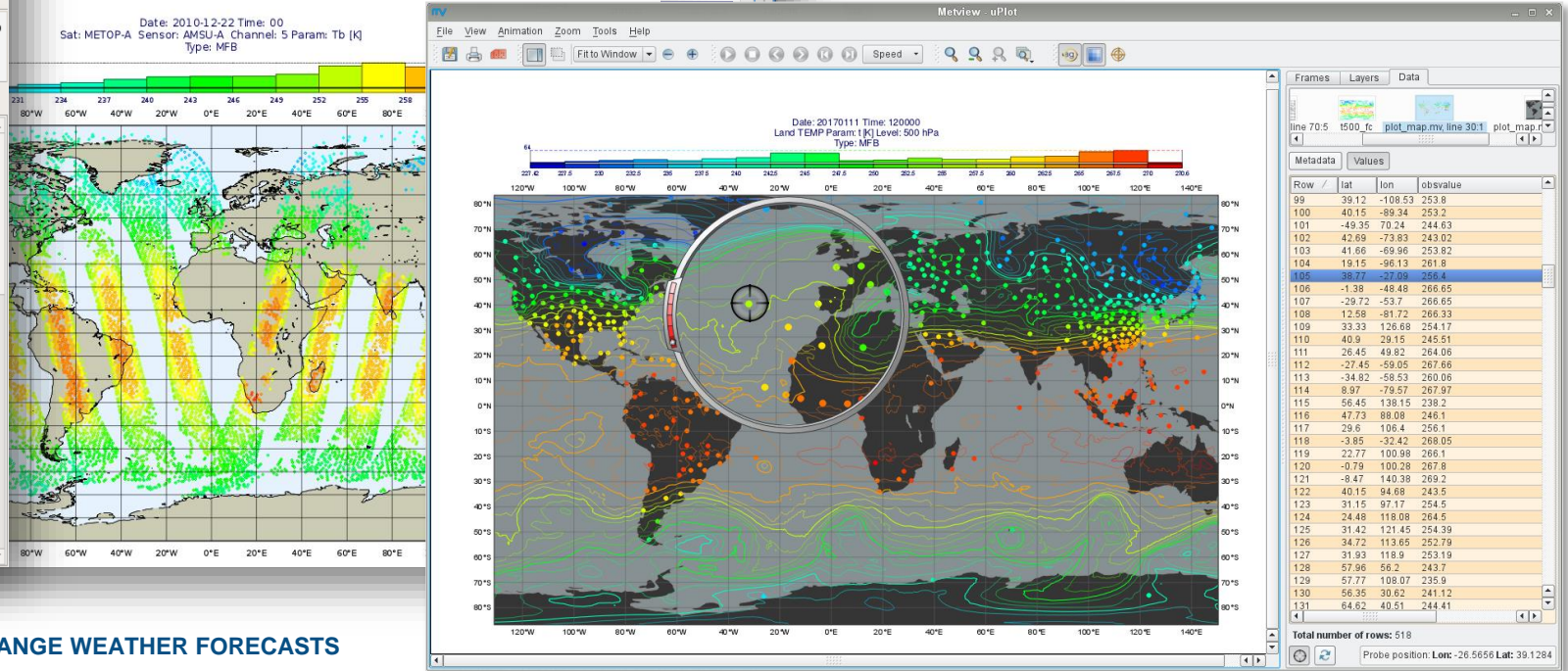


Metview - ODB Examiner

File View Settings Help

File: /home/graphics/cgi/metview/course_prep/2016/metview-for-data-analysis-and-visualisation/day_3/data_2/AMSUA odb
Symmlink target: /scratch/graphics/cgr/odb_data/AMSUA.odb
Permissions: rw-r--r-- Owner: cgr Group: graphics Size: 17 MB Modified: 2017-01-06 09:20:58

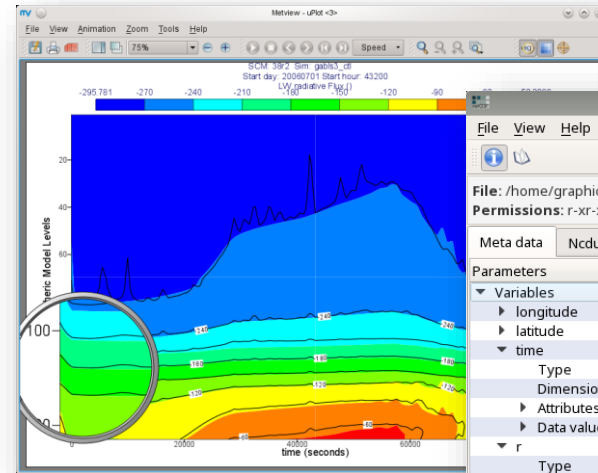
Name	Type	Constant	Min	Max	Table
an_depar@body	float	n	-3.47203	3.95354	body
an_sens_obs@body	float	y	0	0	body
andate@desc	int	y	20101222	20101222	desc
antime@desc	int	y	0	0	desc
biascorr@body	float	n	-0.739071	4.33658	body
biasctrl@body	float	n	-0.737179	4.35366	body
bufitype@hdr	int	y	3	3	hdr
class@desc	string	y	N/A	N/A	desc
codetype@hdr	int	y	210	210	hdr
datastream@sat	int	n	0	1	sat
date@hdr	int	n	20101221	20101222	hdr
datum_anflag@body	bitfield	n	N/A	N/A	body
datum_event1@body	bitfield	y	N/A	N/A	body
datum_rdbflag@body	bitfield	y	N/A	N/A	body
datum_status@body	bitfield	n	N/A	N/A	body
entryno@body	int	n	3	14	body
expver@desc	string	y	N/A	N/A	desc
fc_sens_obs@body	float	y	0	0	body
fg_depar@body	float	n	-3.34557	3.28031	body
fg_error@errstat	float	n	0.0603554	3.8495	errstat
final@update_1	float	n	-2.14748e+09	-2.14748e+09	update_1



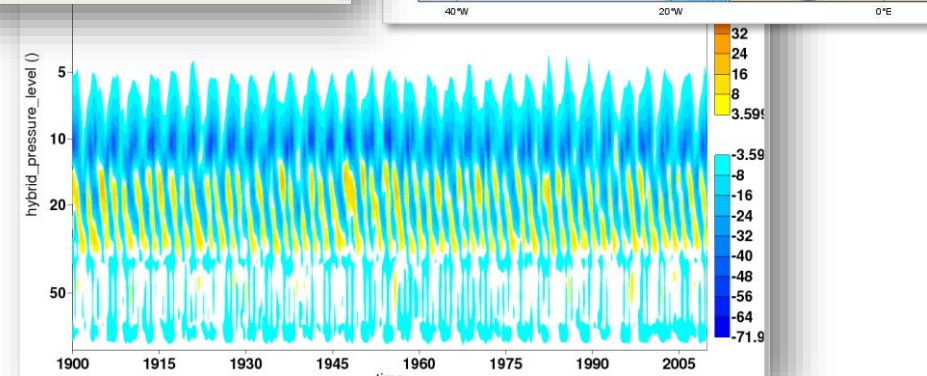
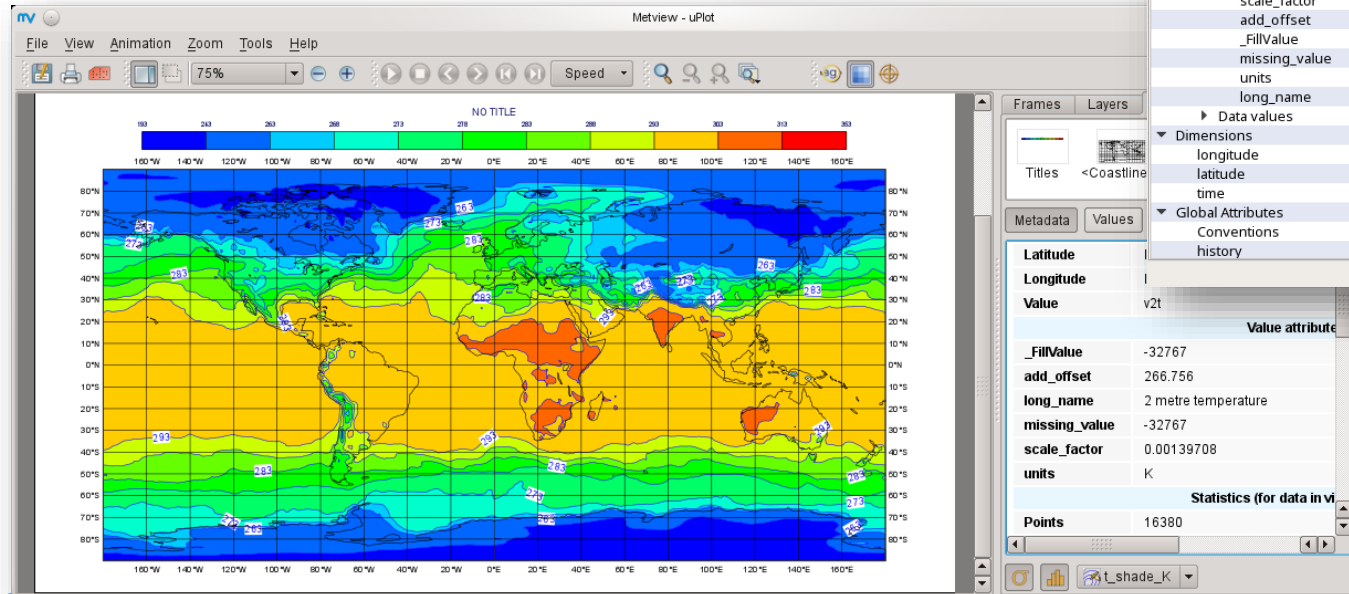
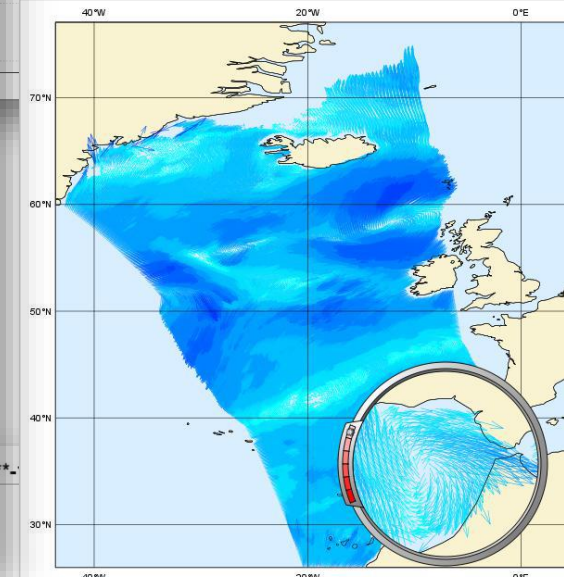
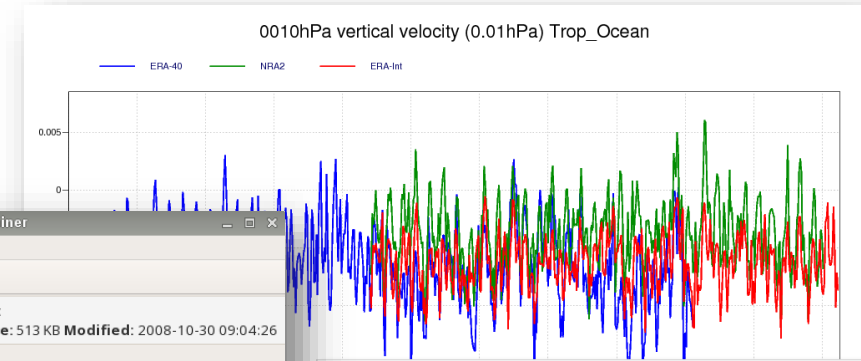
Now please do exercise Part 4 - ODB

Metview + NetCDF

- Plot
- Examine
- Maths, Boolean



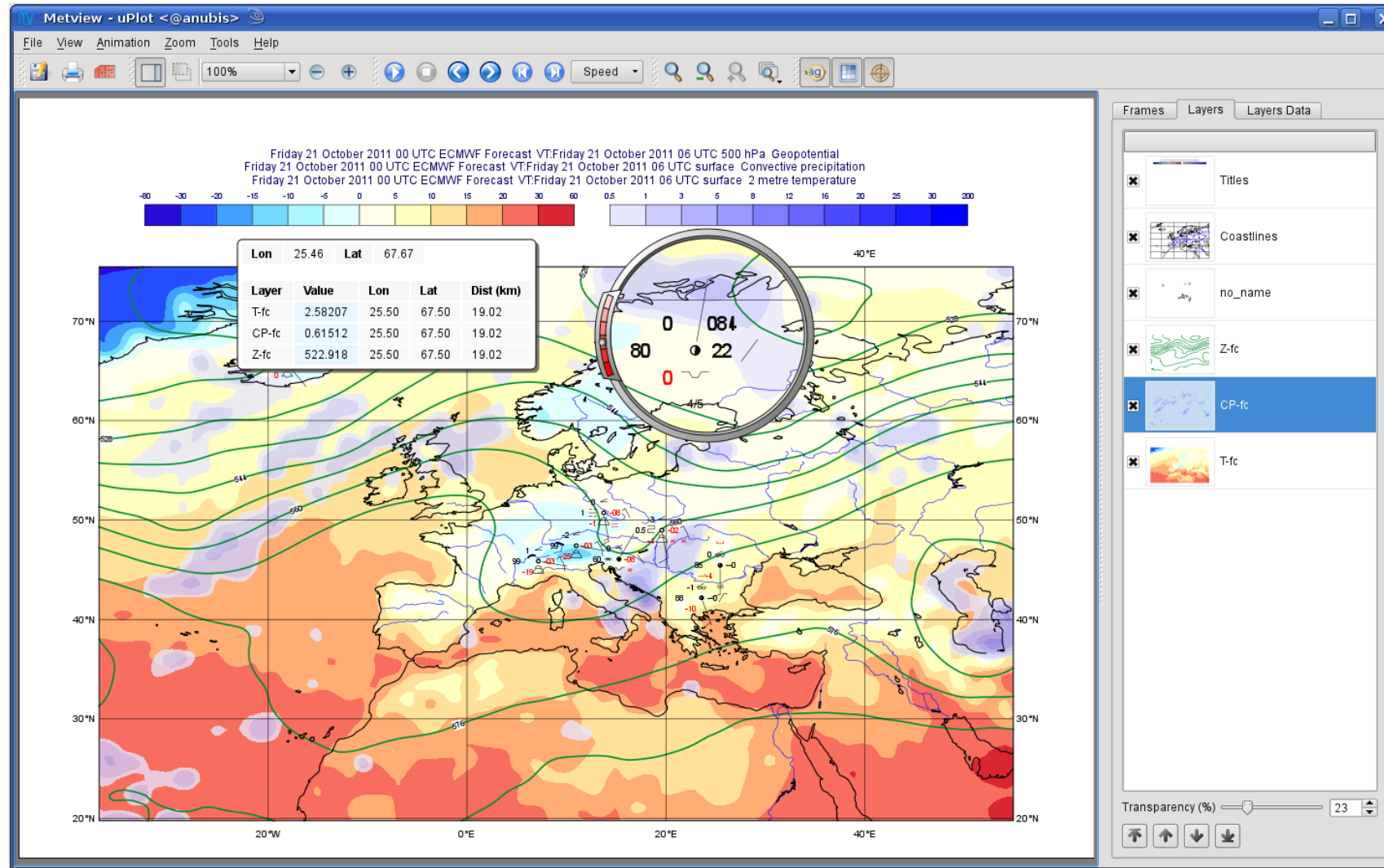
Parameters	Values
File	/home/graphics/cgi/metview/Tests/uplot/rh850.nc
Permissions	r-xr-x--- Owner: cgi Group: graphics Size: 513 KB Modified: 2008-10-30 09:04:26
Meta data	Ncdump
Variables	
▶ longitude	
▶ latitude	
▼ time	
Type	nlong (int)
Dimensions	(time)
Attributes	
Data values	
▼ r	
Type	short
Dimensions	(time, latitude, longitude)
Attributes	
scale_factor	0.0016890305022737
add_offset	52.1403569442292
_FillValue	-32767s
missing_value	-32767s
units	%
long_name	Relative humidity
Data values	
Dimensions	
longitude	720
latitude	361
time	1
Global Attributes	
Conventions	CF-1.0
history	2005-05-10 12:55:35 GMT by mars2netcdf-0.92



Now please do exercise Part 5 - NetCDF

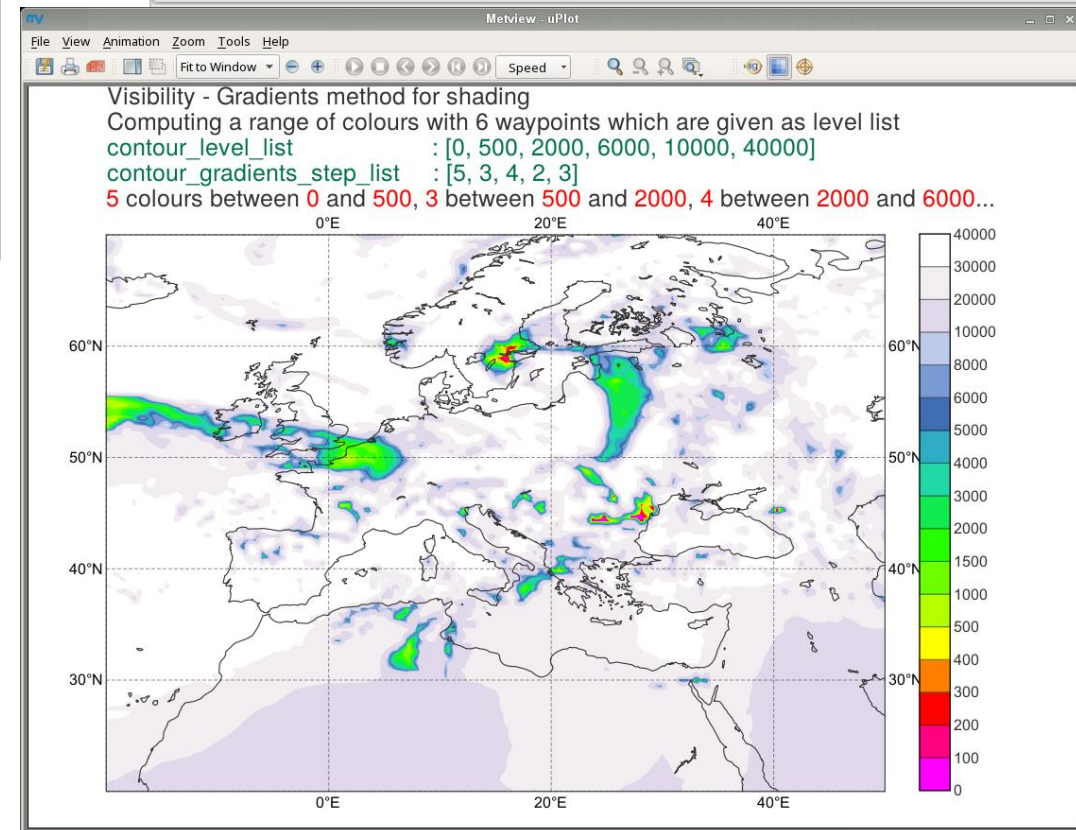
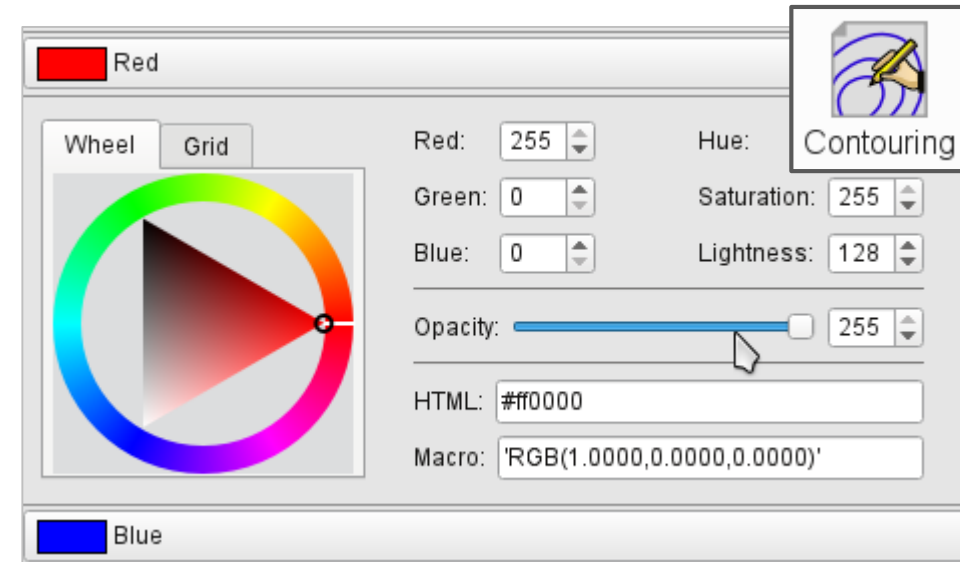
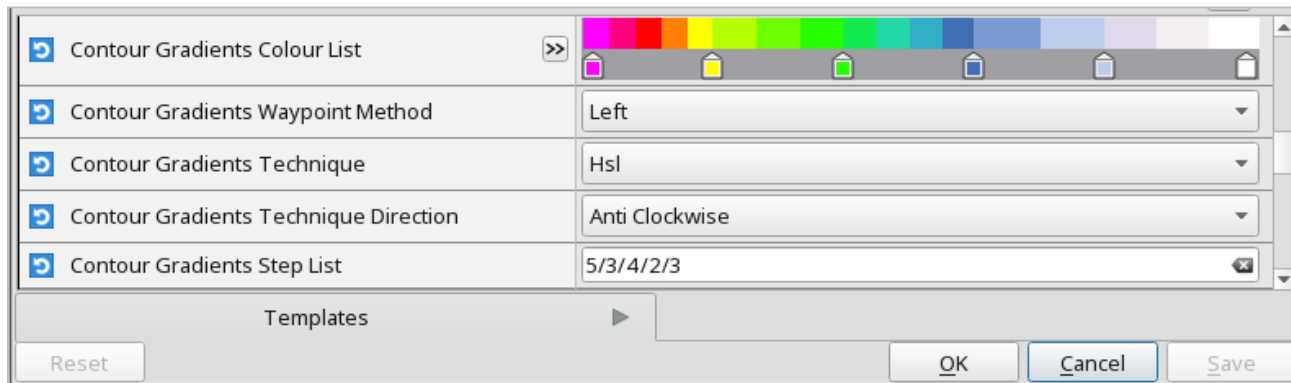
What we didn't cover

Visualisation - Overlay



Contouring schemes

- Plenty of options for complete customisation of palettes



Contouring schemes



- A set of pre-defined palettes is also available
 - But you still have to supply the mapping between values and colours

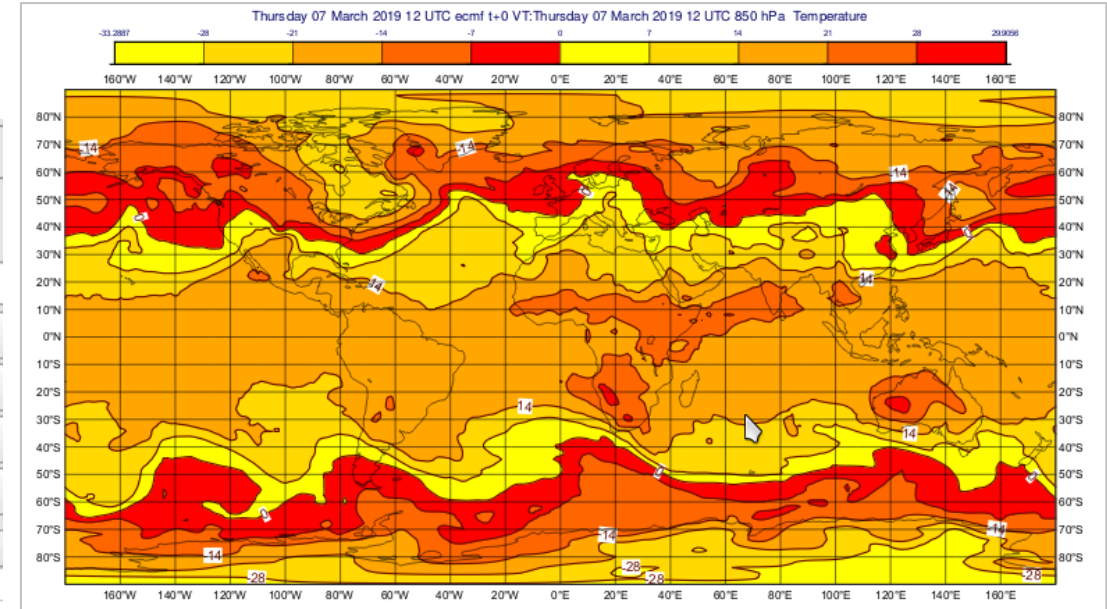
Contour Shade Palette Name: eccharts_yellow_red_5

Clear all filters

Name: ANY
Origin: ANY
Colour: ANY
Count: ANY
Parameter: ANY

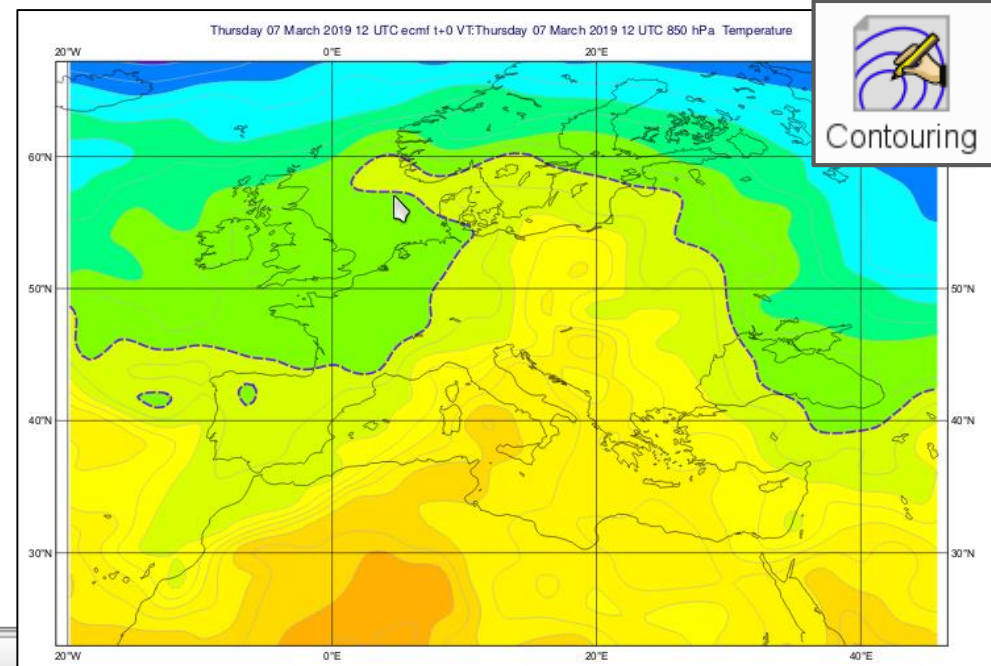
Palette	Name
	eccharts_white_transparent_12
	eccharts_yellow_blue_14
	eccharts_yellow_blue_dark_9
	eccharts_yellow_darkred_13
	eccharts_yellow_navy_8
	eccharts_yellow_purple_6
	eccharts_yellow_red_5
	eccharts_yellow_red_9
	m_alt_rainbow2_10
	m_alt_rainbow2_11

Contour Shade Palette Policy: Cycle



Contouring schemes

- Can select from pre-defined styles
 - the styles come from ecCharts
 - everything is done for you
 - or choose “Contour Automatic Setting = ECMWF” – style will be chosen based on meta-data



Contour Automatic Setting

Style Name

Contour Style Name

sh_all_fm48t56i4_ct_wh

tempera

Matching styles

- sh_all_fm48t56i4
- sh_all_fm48t56i4_ct_wh**
- sh_all_fm50t58i2
- sh_all_fm52t48i4
- sh_all_fm52t48i4_light
- sh_all_fm64t52i4
- sh_all_fm80t56i4_v2
- sh_anomaly_rb_m20t20
- sh_blured_fm1t1lst
- sh_efi2t_fm1t1lst

Style sh_all_fm48t56i4_ct_wh

Img

Method Method : Area fill & grey contours Level range : -48 to 56 Interval : 2 Thickness : 1 Colour : All colours Used for temperature

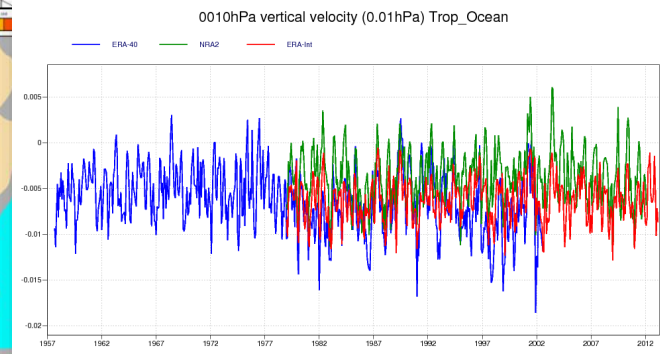
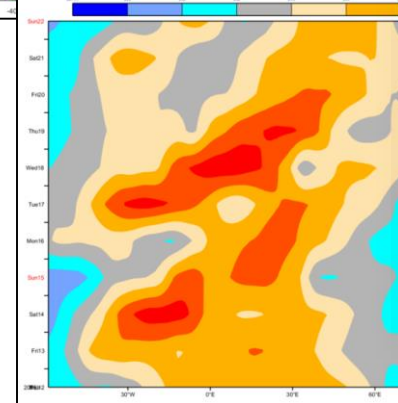
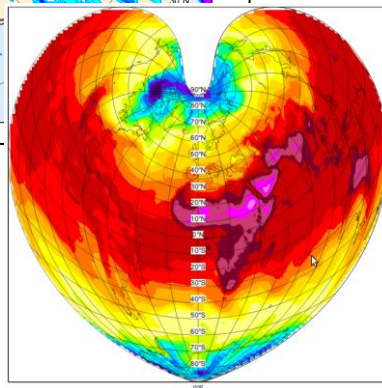
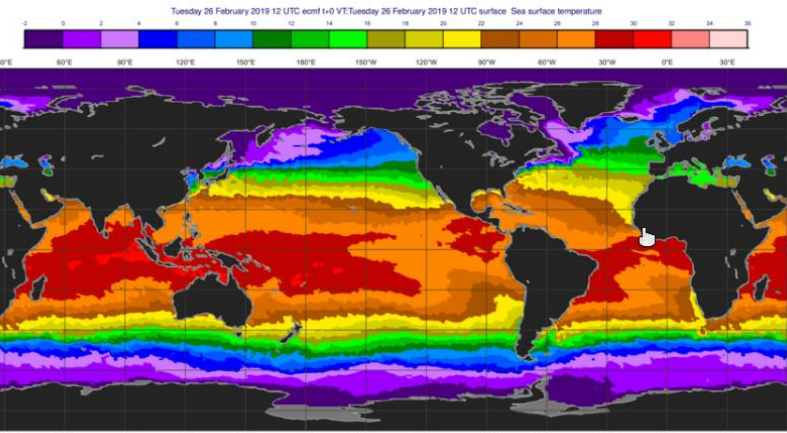
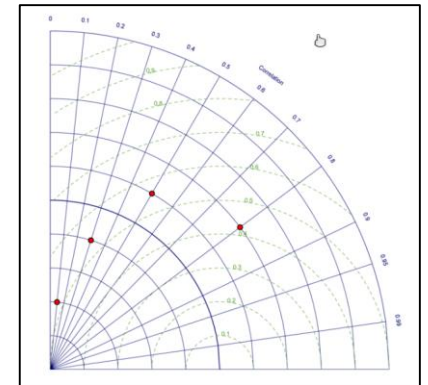
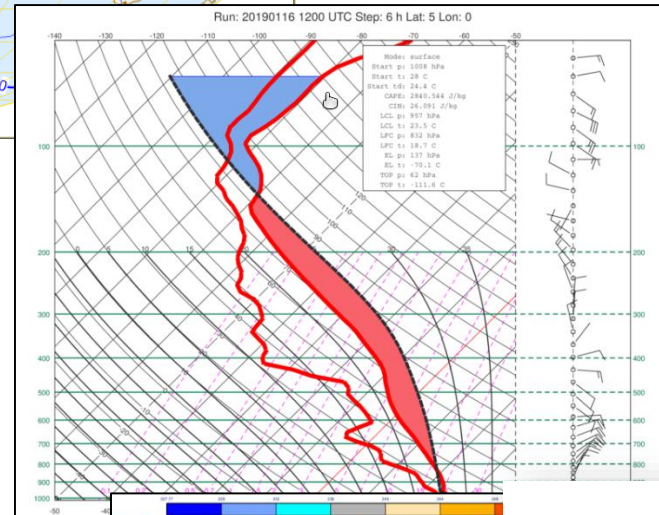
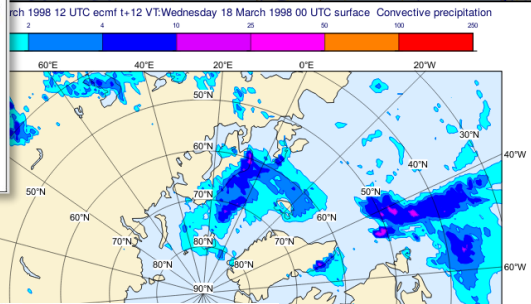
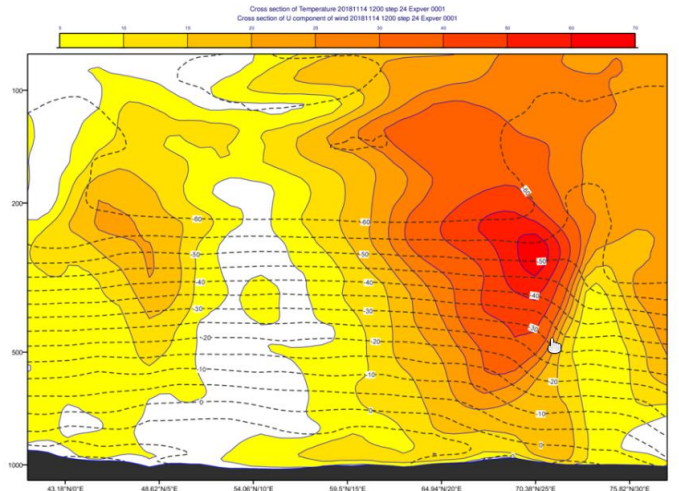
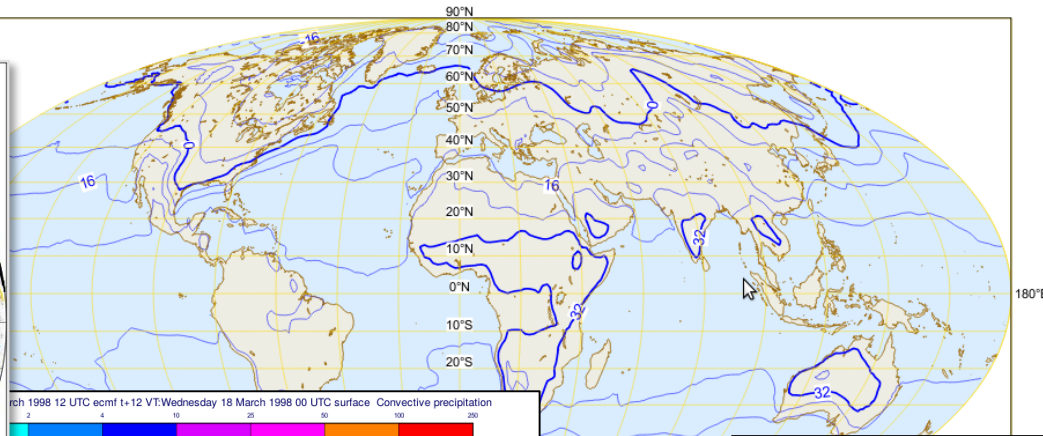
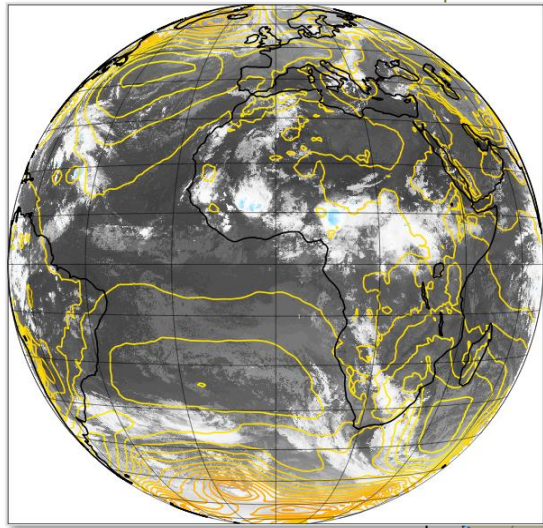
Layers 2t, mn2t, mx2t, 2t_dewpoint

Keywords temperature, T2m, rainbow

Colours blue, magenta

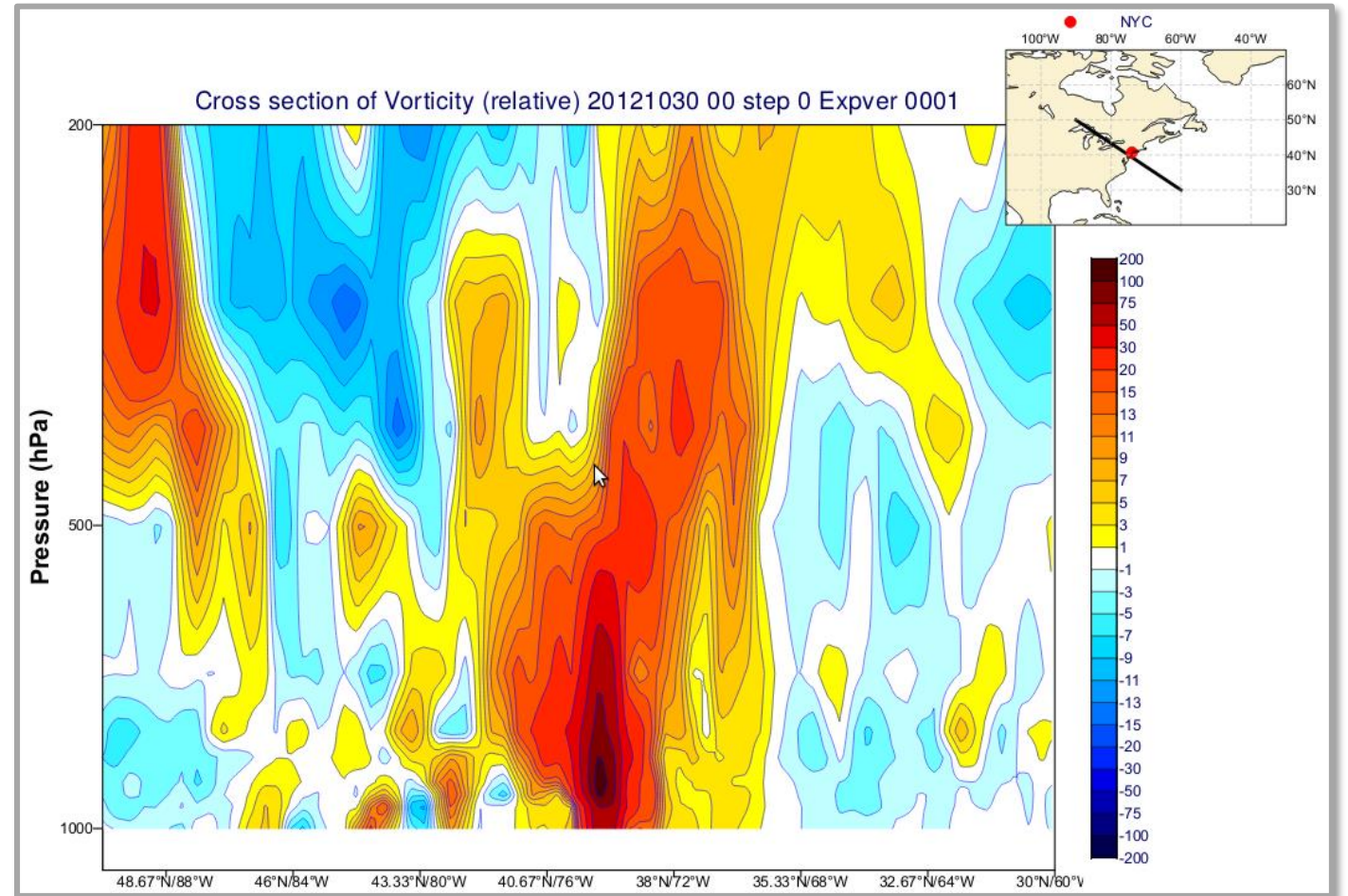
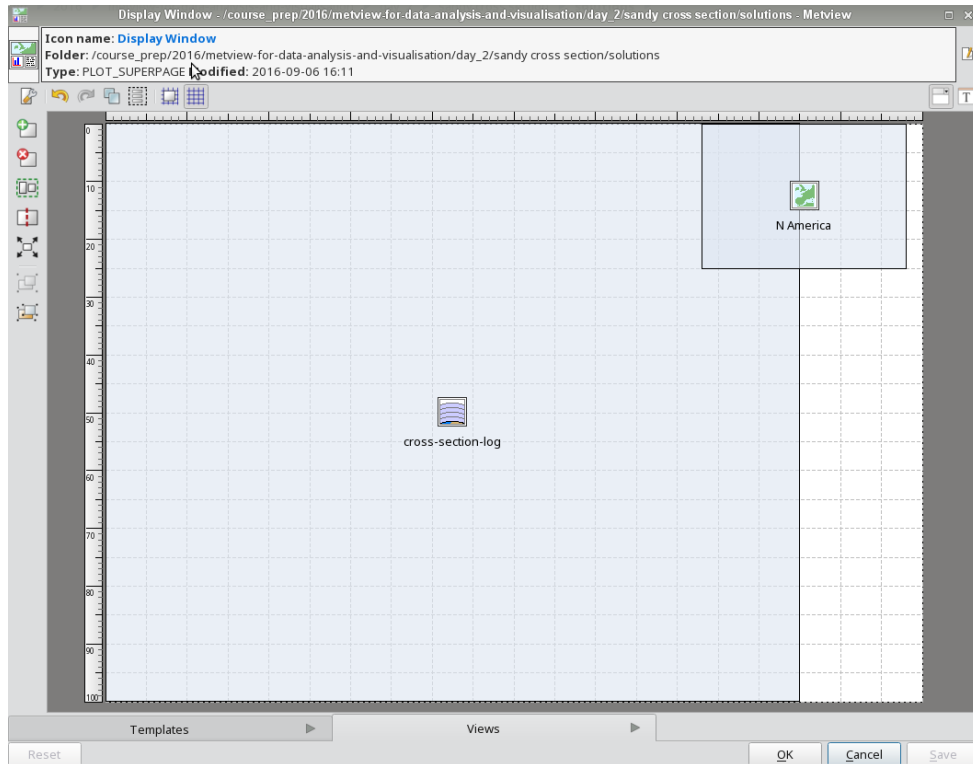
Views

Tuesday 05 March 2019 12 UTC ecmf t+0 VT: Tuesday 05 March 2019 12 UTC 1000 hPa Temperature



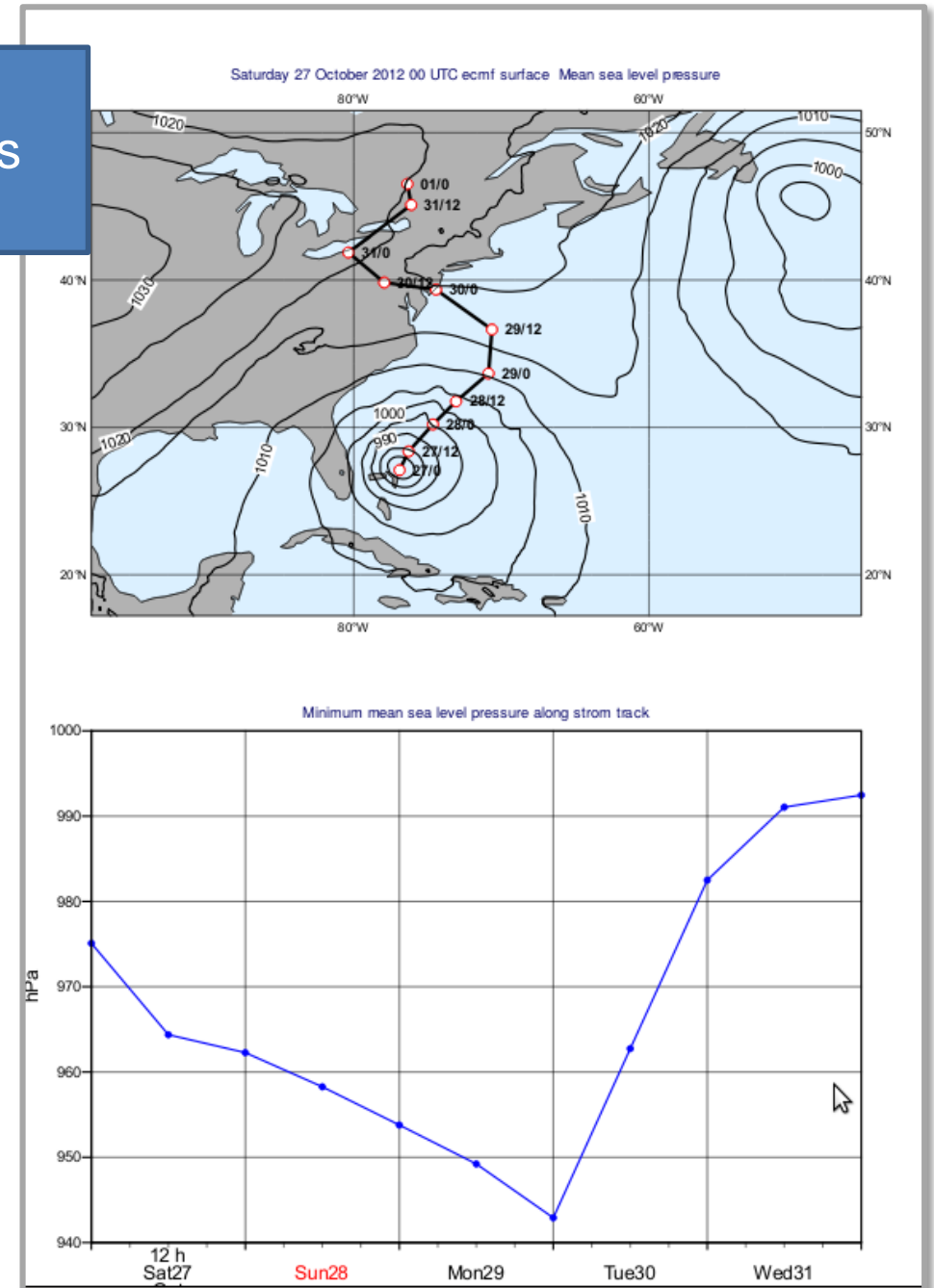
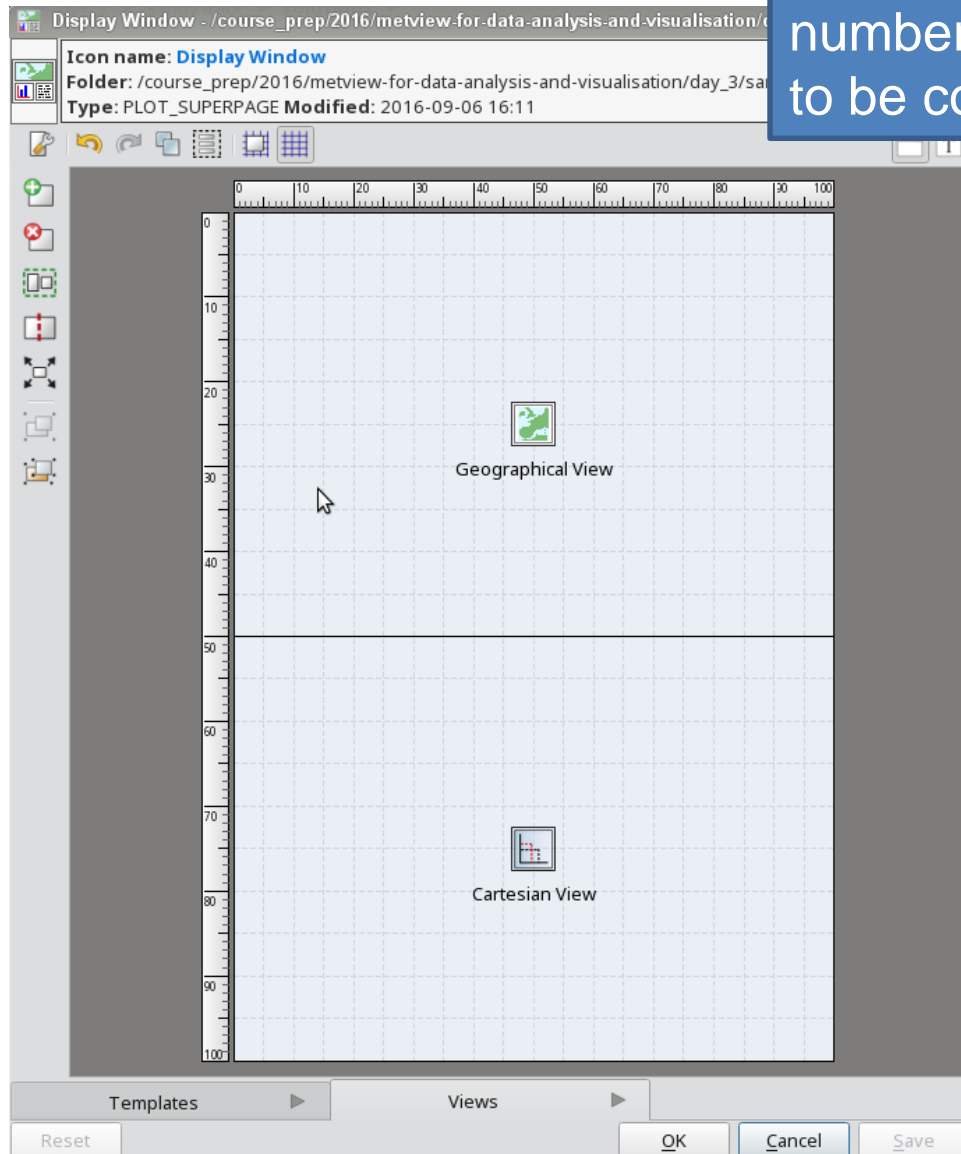
Visualisation - Layout

Layout editor allows any number of different views to be combined



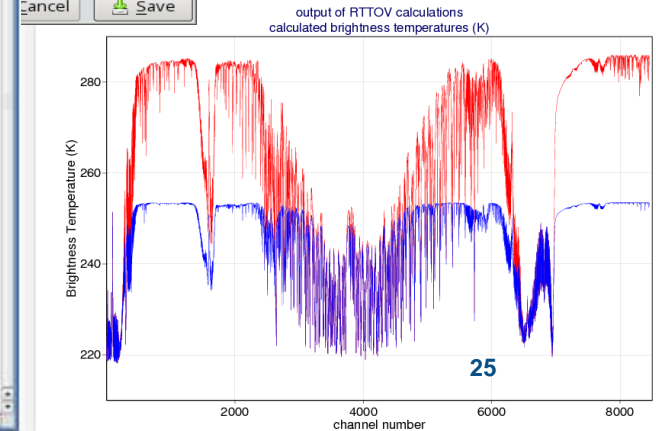
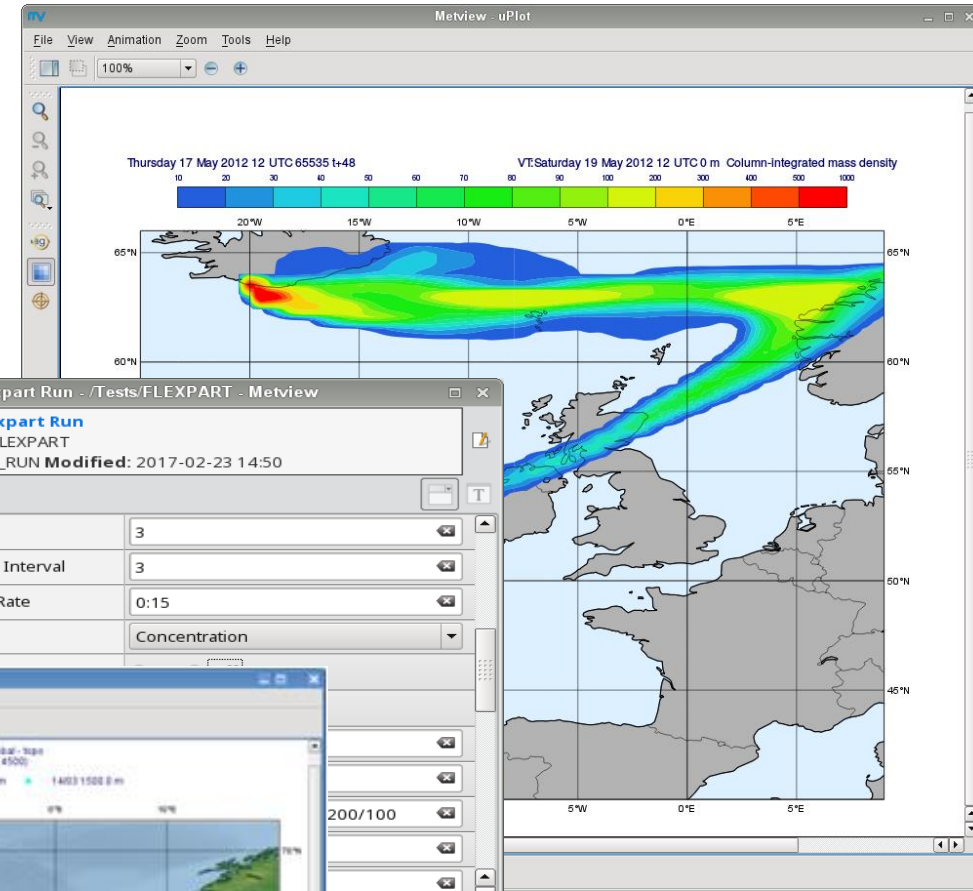
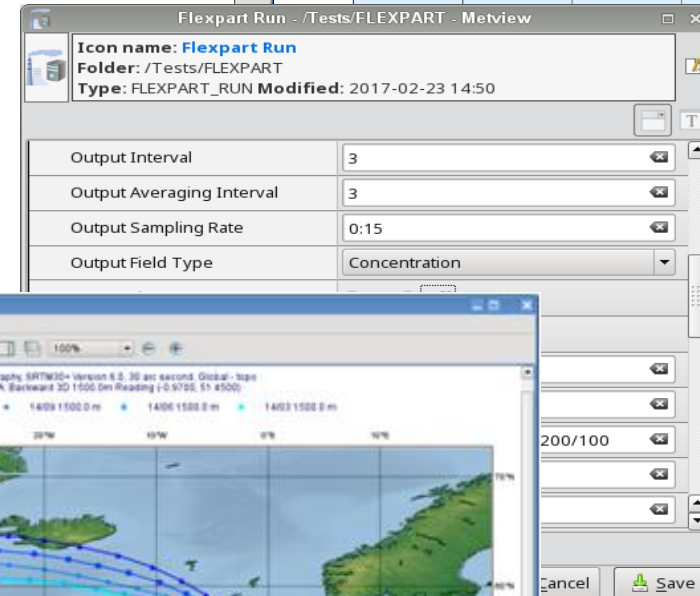
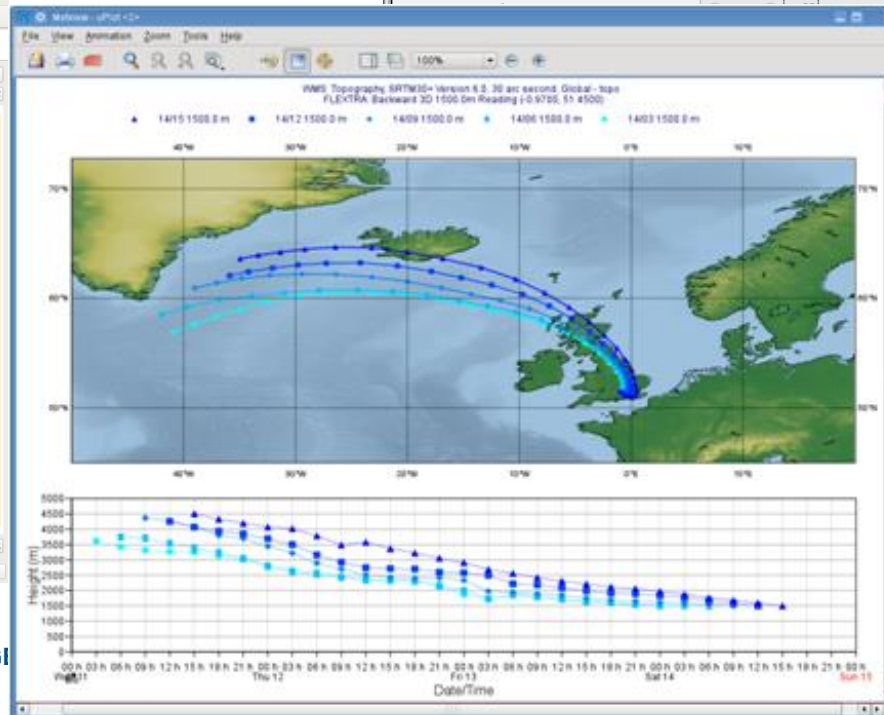
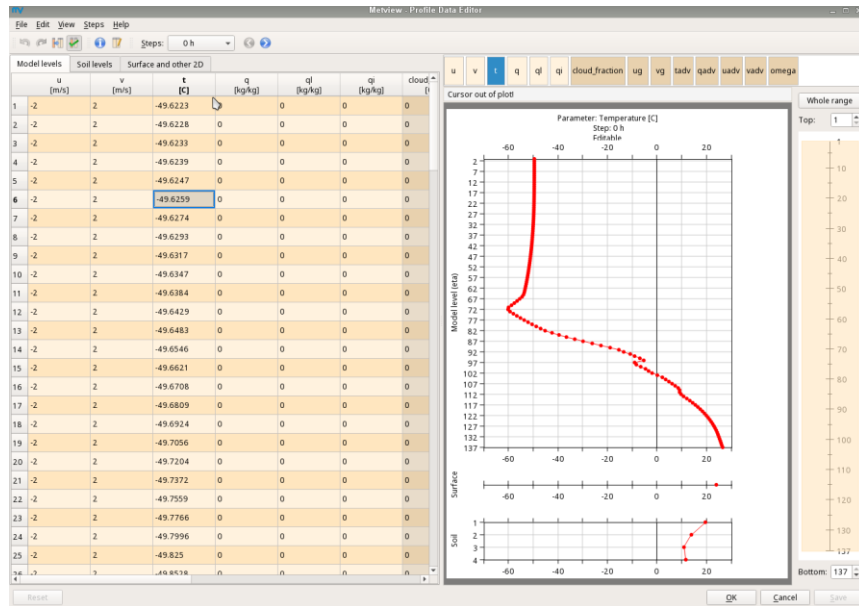
Visualisation - Layout

Layout editor allows any number of different views to be combined to be combined



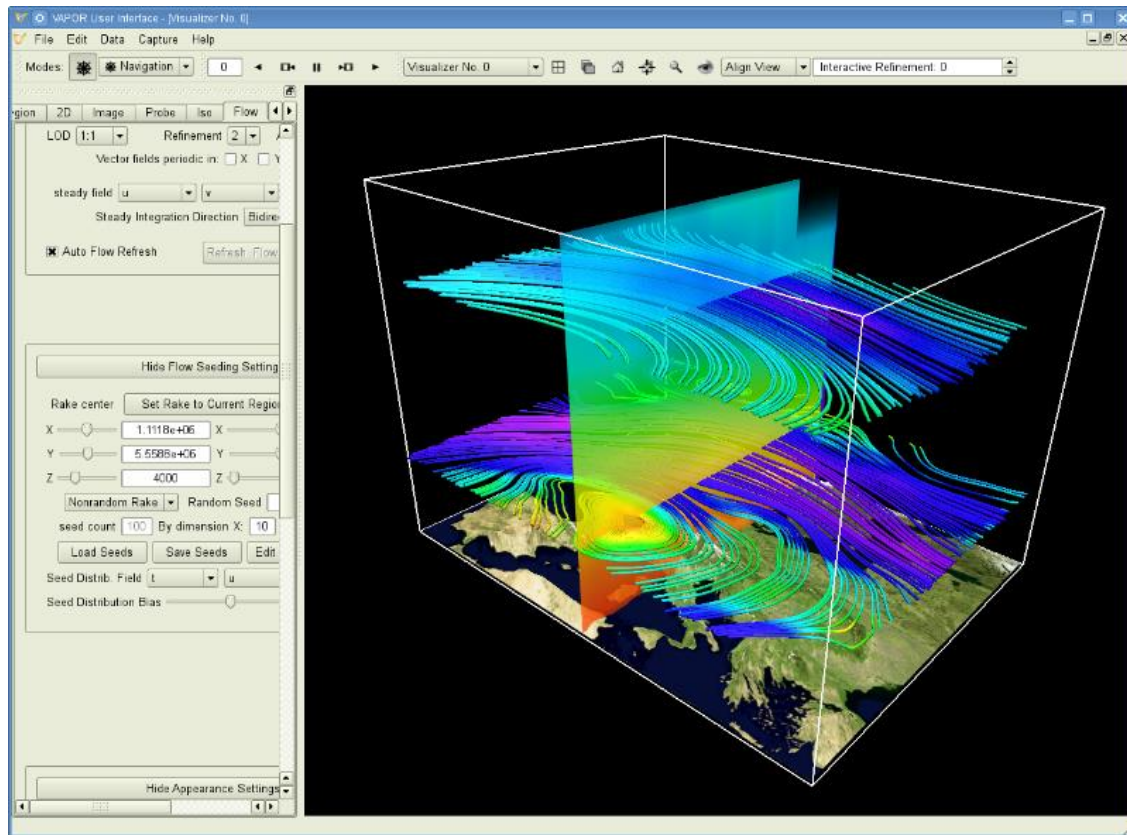
Running models

- Metview is able to prepare data for, run, and plot output from:
- FLEXTRA (trajectory)
- FLEXPART (particle dispersion)
- SCM (Single Column Model)
- RTTOV (Satellite)

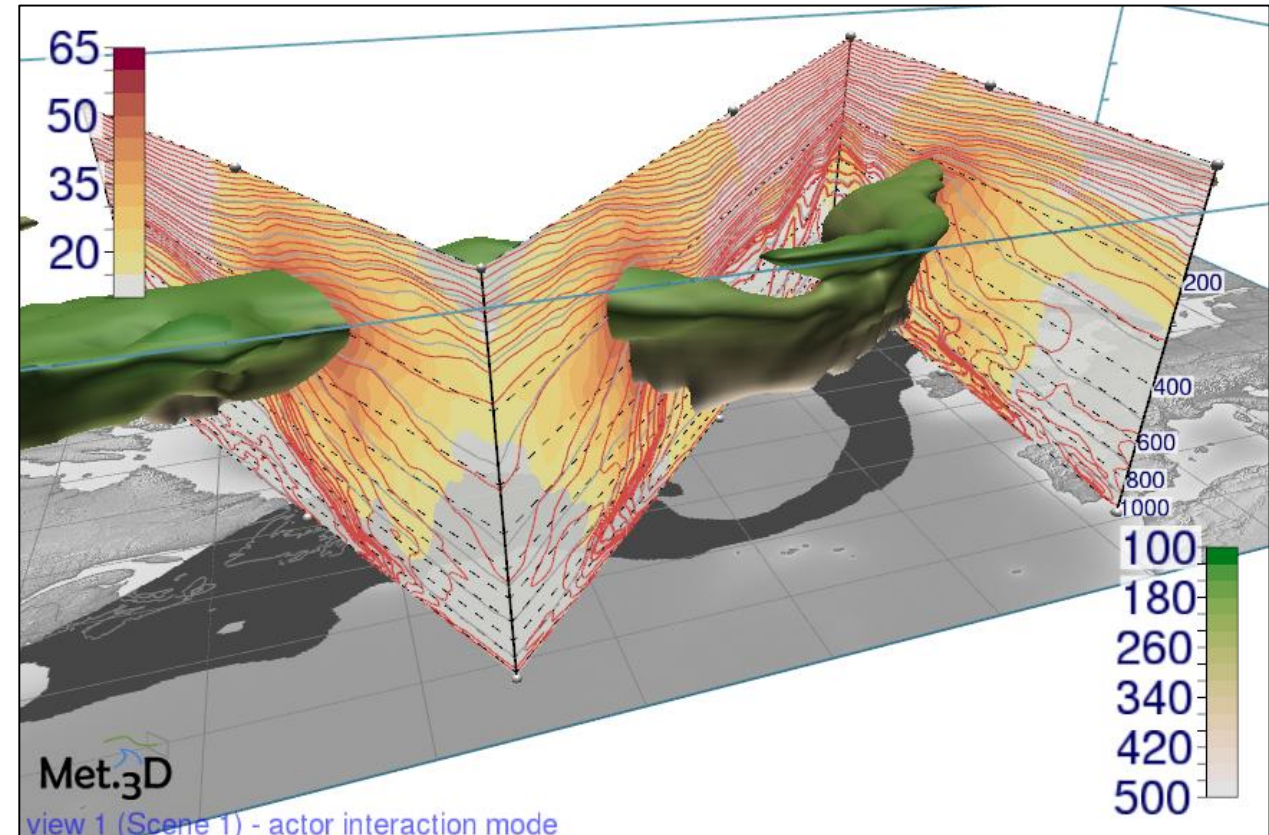


3D

- Metview can prepare data for, and launch:
- VAPOR, Met.3D



Imagery produced by VAPOR



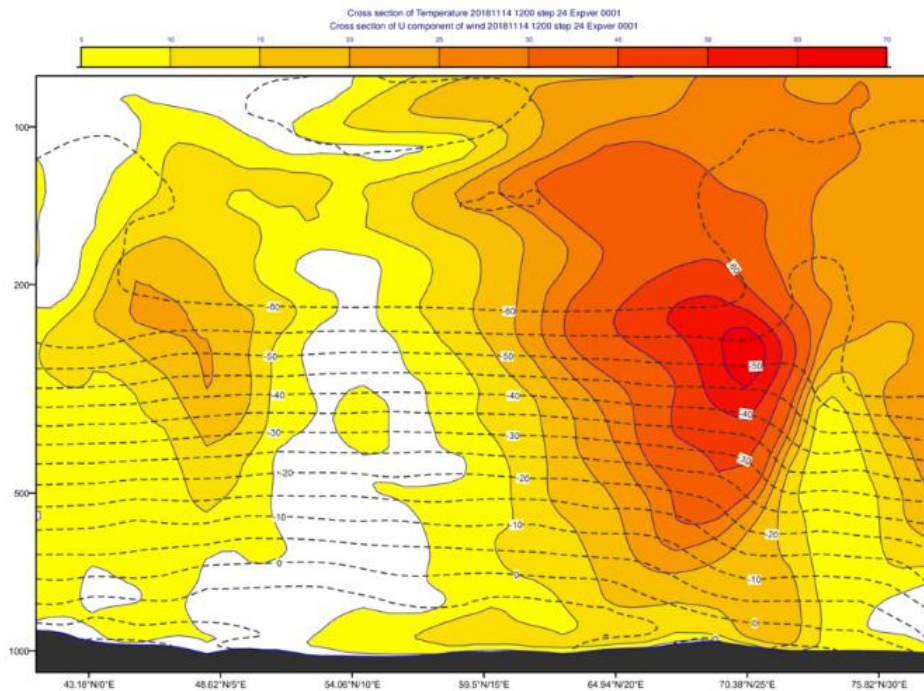
Imagery produced by Met.3D (met3d.wavestoweather.de)

Examples

- See the Gallery for Macro and Python examples

Cross Section with Orography Example

Created by Sandor Kertesz, last modified on Feb 21, 2019



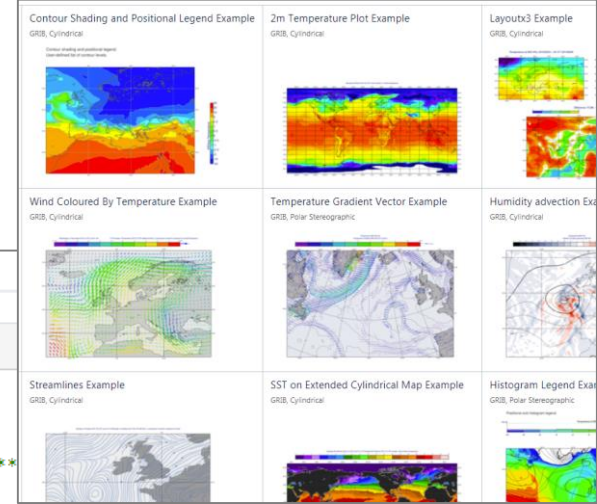
Download source and data
cross_section_orog.tar.gz

Macro Python

Cross Section with Orography Example

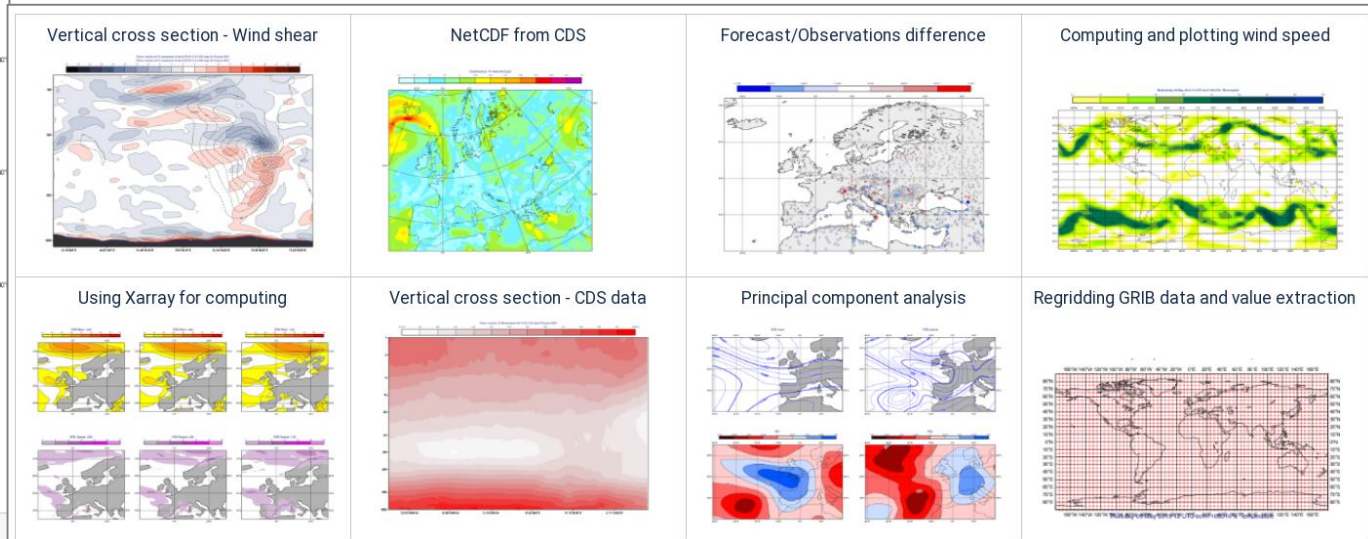
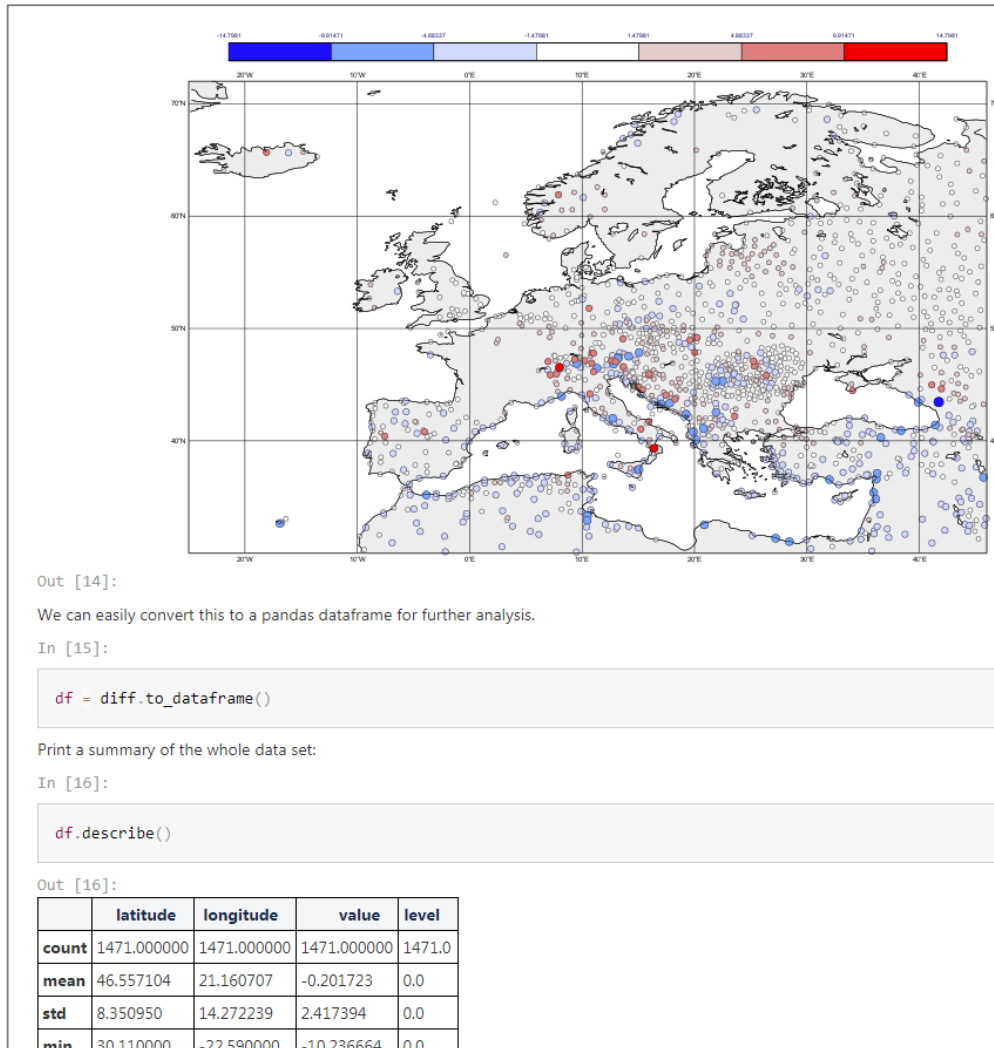
#Metview Macro

```
# ***** LICENSE START *****  
#  
# Copyright 2019 ECMWF. This software is distributed under the terms  
# of the Apache License version 2.0. In applying this license, ECMWF does not  
# waive the privileges and immunities granted to it by virtue of its status as  
# an Intergovernmental Organization or submit itself to any jurisdiction.  
#  
# ***** LICENSE END *****  
#  
# read grib file - contains model level data  
fs = read(source : "fc_ml.grib")  
  
# read temperature and scale it to C  
t = read(data : fs, param : "t")  
t = t - 273.16  
  
# read wind components and compute speed  
u = read(data : fs, param : "u")  
v = read(data : fs, param : "v")  
sp = sqrt(u*u + v*v)  
  
# read log of surface pressure  
lnsp = read(data : fs, param : "lnsp")  
  
# define cross section line  
line = [41,-2,78,32]  
  
# define shading for wind speed  
sp_cont = mcont(legend : "on",  
                contour_automatics_settings : "style_name",  
                contour_style_name : "sh_red_f5t701st")
```



Examples


- See the Jupyter Notebooks for more Python



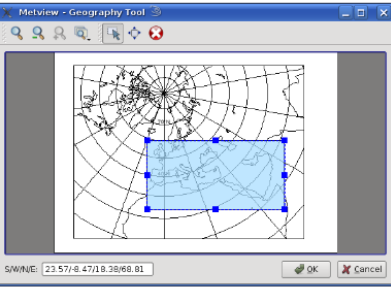
Tutorials

- Lots of material online including longer tutorials


Now we want to set the area used in the view. Although we can interactively zoom into smaller areas in the **Display Window**, we can use exactly the same one again and again. Set the **Map Area Definition** to **Corners** and click on the **Geography Tool** button.



This tool helps you define a region.

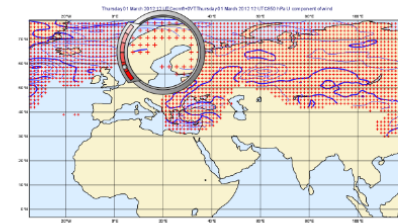


Use the **Zoom** tools to enlarge the European area and use the **Area** tool to select a region over Europe. Click **Ok** to save the selection in the **Geographical View** editor. Click **Apply** in the **Geographical View** editor to save everything. Plot your data in this view to confirm the selection.



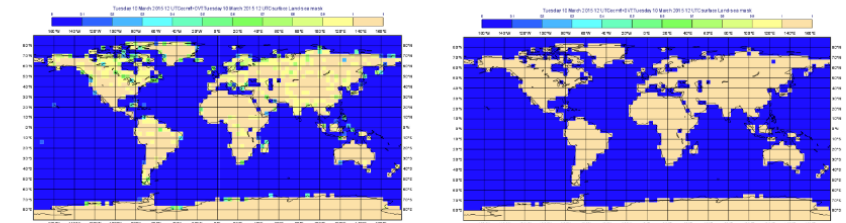
- A Quick Tour of Metview
- Data analysis and visualisation using Metview
- A Simple Visualisation
- Customising Your Plot
- Case Study: Plotting Hurricane S...
- Data Part 1
- Processing Data
- Analysis Views
- Layout in Metview
- Case Study: Cross Section of Sa...
- Data Part 2
- Handling Time in Metview
- Graph Plotting in Metview
- Case study: Plotting the Track o...
- Working with graphical output
- Organising Macros
- Missing Values and Masks
- Optimising Your Workflow
- Customising Your Plot Title
- Case study: Ensemble Forecast
- Running Metview in Batch Mode
- Working with Folders and Icons
- Exploring Metview

Overview



Fields and observations can often contain missing values - it can be important to understand the implications of the missing values. Using a mask of missing values can enable Metview to perform computations on a specific subset of points.

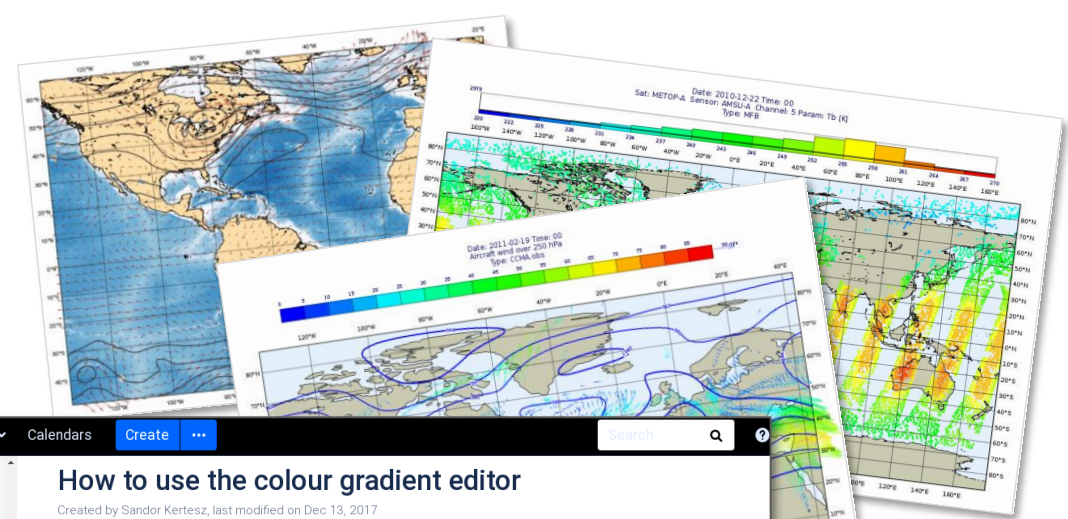
Computing the mean surface temperature over land



As an example, we will use a land-sea mask field as the basis of performing a computation on only the land points, excluding sea points. Visualise the supplied `land_sea_mask.grib` icon using the `grid_shade` icon. This `Contouring` icon is set up to shade the land points. To help illustrate what's going on, we've chosen low-resolution fields - this one is 4x4 degrees. The value of the field is between 0 and 1 on points which are close to both sea and land. Before we can use this field as a mask, we must do a computation on whether they count as land or sea! Let's say that a value of 0.5 or more is land.

For more information...

- Ask for help:
 - Software.Support@ecmwf.int
- Visit our web pages:
 - <http://confluence.ecmwf.int/metview>



How to use the colour gradient editor
Created by Sandor Kertesz, last modified on Dec 13, 2017

Colour gradients offer an easy way to define stunning colour schemes for contour plotting. The idea behind the colour gradients is that we just define a few waypoints representing certain colours then the colours between the waypoints are automatically generated with a given interpolation method and resolution.

Enable gradient shading

To enable the colour gradient mode in the **Contouring** icon we need to use contour shading and set the **Contouring Colour Method** to "Gradients". This is how it looks in the **Contouring** icon editor:

<input checked="" type="checkbox"/> Contour Shade	<input type="radio"/> On <input checked="" type="radio"/> Off
Contour Shade Technique	Polygon Shading
<input checked="" type="checkbox"/> Contour Shade Colour Method	Gradients
<input checked="" type="checkbox"/> Contour Shade Method	Area Fill

Having set this we need to scroll further down in the icon editor to find the gradient settings. This is what we can see as default:

<input checked="" type="checkbox"/> Contour Gradients Colour List	
Contour Gradients Waypoint Method	Both
Contour Gradients Technique	Rgb
Contour Gradients Technique Direction	Clockwise
Contour Gradients Step List	10

Start editing

To edit **Contour Gradients Colour List** open its helper by clicking on the << button:

Questions?