

Metview – Training Course



The screenshot displays the Metview Desktop environment. At the top, a menu bar includes File, Edit, View, Go, Bookmarks, History, Tools, and Help. Below it is a file explorer showing a directory structure with folders like 'Tests' and 'Vapor', and various data files. On the left, a window titled 'Metview - s0104' shows a map of Europe with a circular region highlighted and labeled '40°E'. Below the map is a table with columns for 'Index', 'Param', 'Date', 'Time', 'Step', 'Level', and 'Longitude'. The 'statistics' window on the right contains 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] | L: 14, C: 27

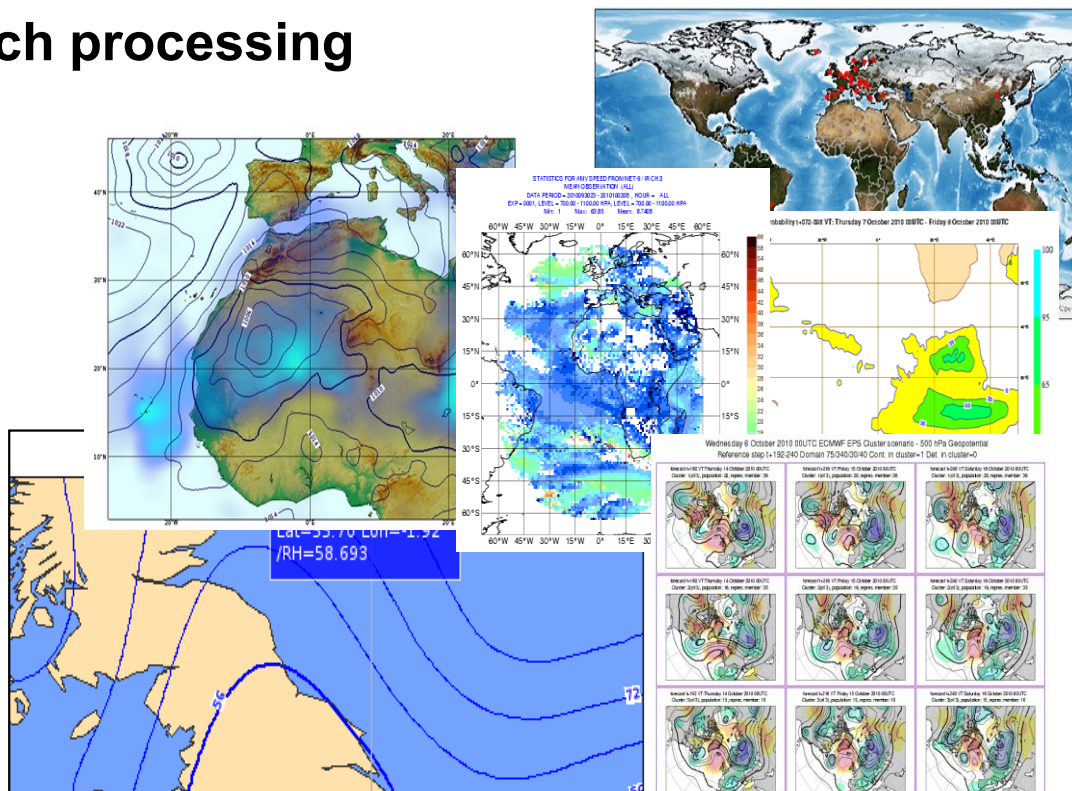
Fernando Ii, Iain Russell, Sándor Kertész

Development Section - ECMWF



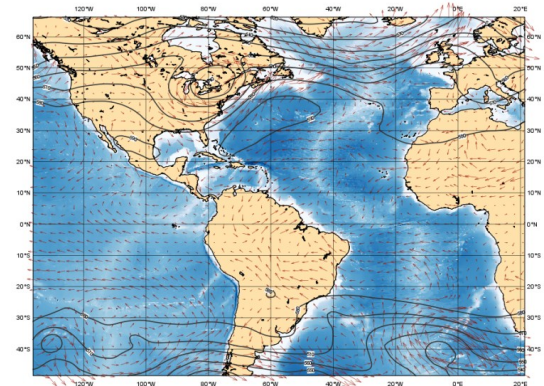
Outline

- ▶ Introduction
- ▶ Interactive usage
- ▶ Macro language & batch processing



Metview: meteorological workstation

- ▶ Retrieve/manipulate/visualise meteorological data
- ▶ Working environment for operational and research meteorologists
- ▶ Allows analysts and researchers to easily build products interactively and run them in batch mode



Built on core ECMWF technologies:

MARS, GRIB_API, Magics, ODB, Emoslib

- ▶ Open Source under Apache Licence 2.0
 - ▶ *Increased interest from research community*
- ▶ Metview is a co-operation project with INPE (Brazil)

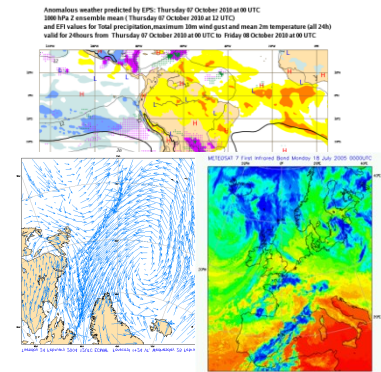


Metview history

- ▶ 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 prototype in 1991
- ▶ First operational version in 1993
- ▶ OpenGL graphics introduced in 1998
- ▶ New user interface in 2000
- ▶ Magics++ and Qt introduced in 2010
- ▶ New Qt Desktop introduced in 2014

INPE

Metview 1.0

Metview 2.0

Metview 3.0

Metview 4.0

Metview 4.5

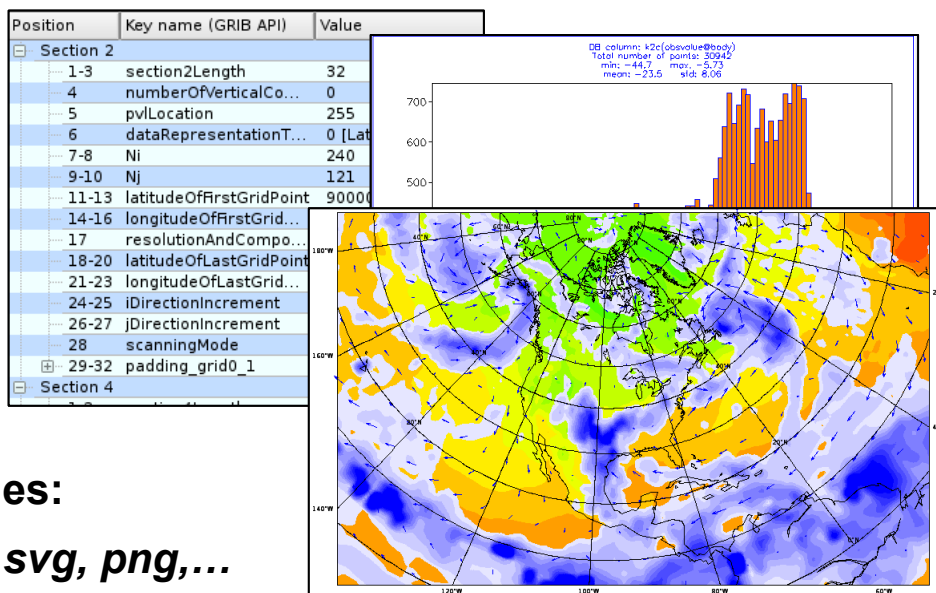
What can Metview do?

► Data:

- Access
- Examine
- Manipulate
- Plot / Overlay

- Generate graphics files:

ps, eps, kml, svg, png,...



- Can be run interactively or in batch

- Runs self-contained standalone

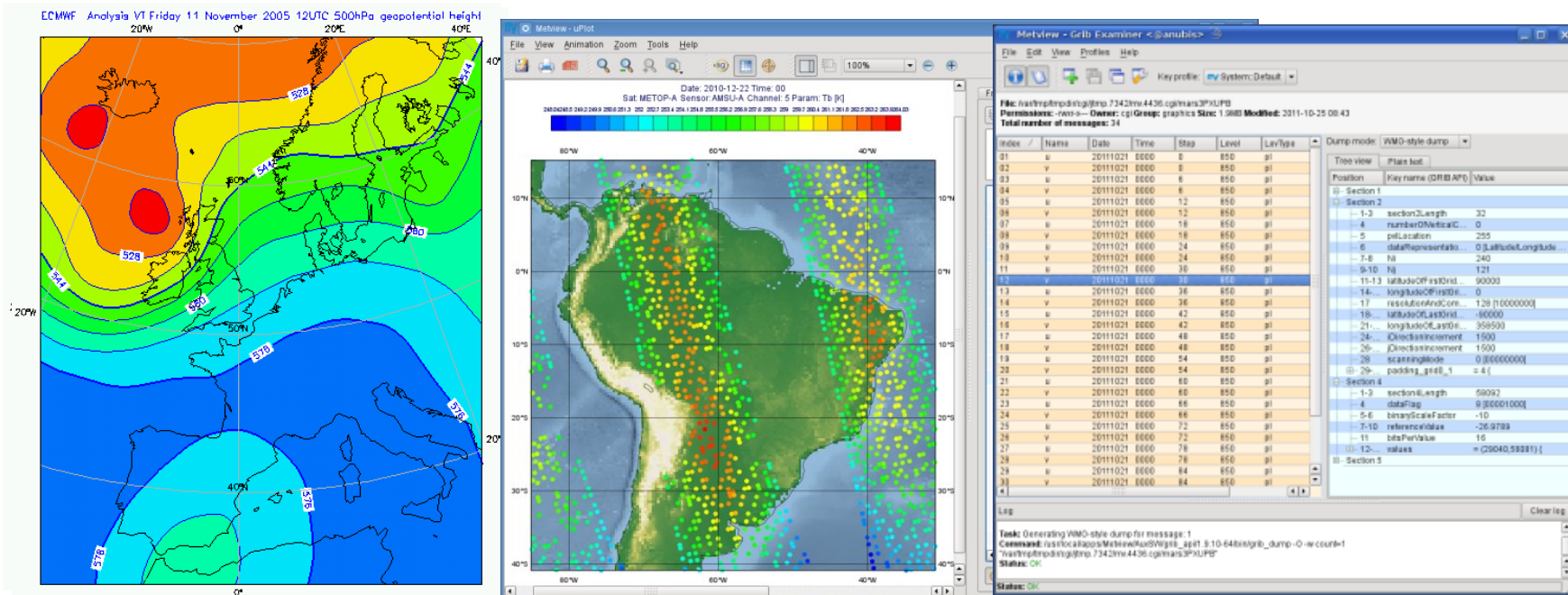
- From laptops to supercomputers

- No special data servers required (but easily connected to MARS or local databases)

Main features

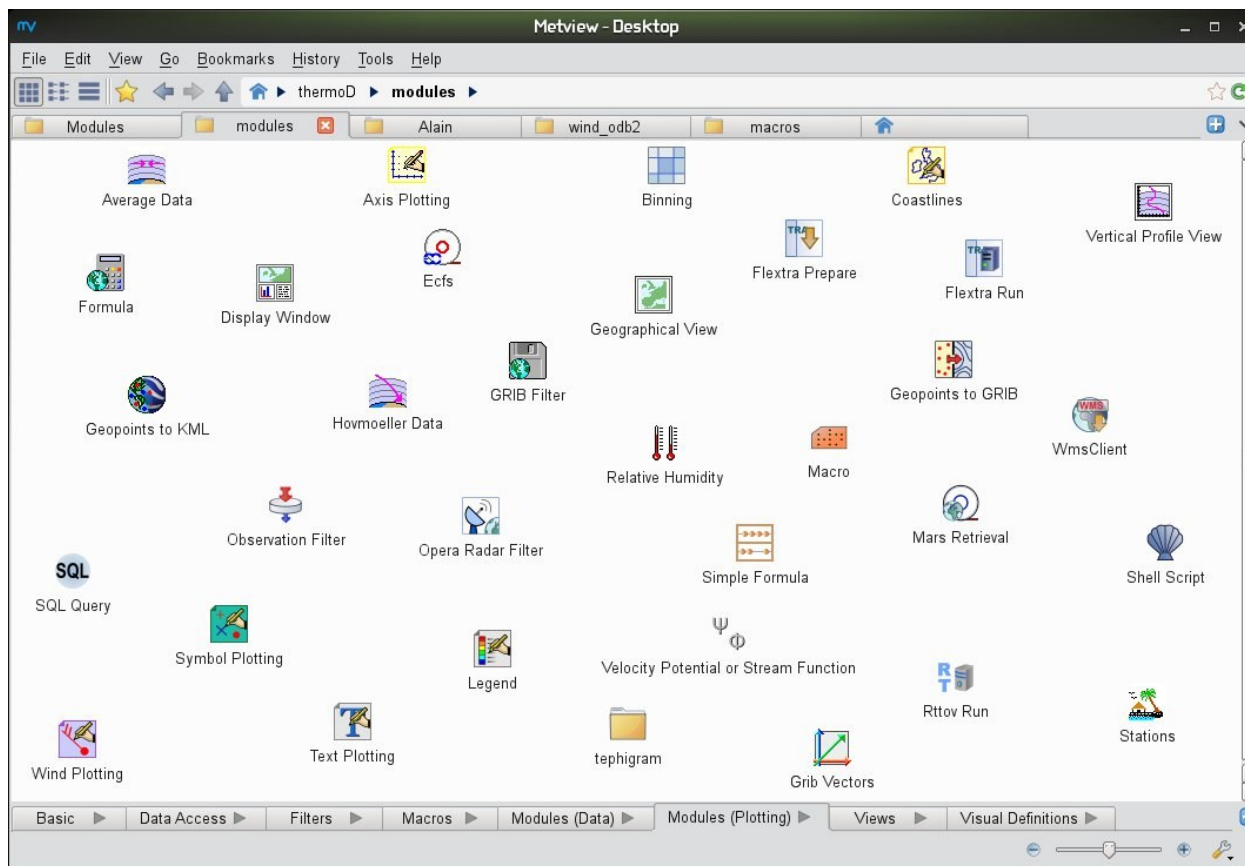
1) Data handling

- ▶ Supports a variety of data types (meteorological and non-meteorological)
- ▶ Rich set of modules and functions for data manipulation



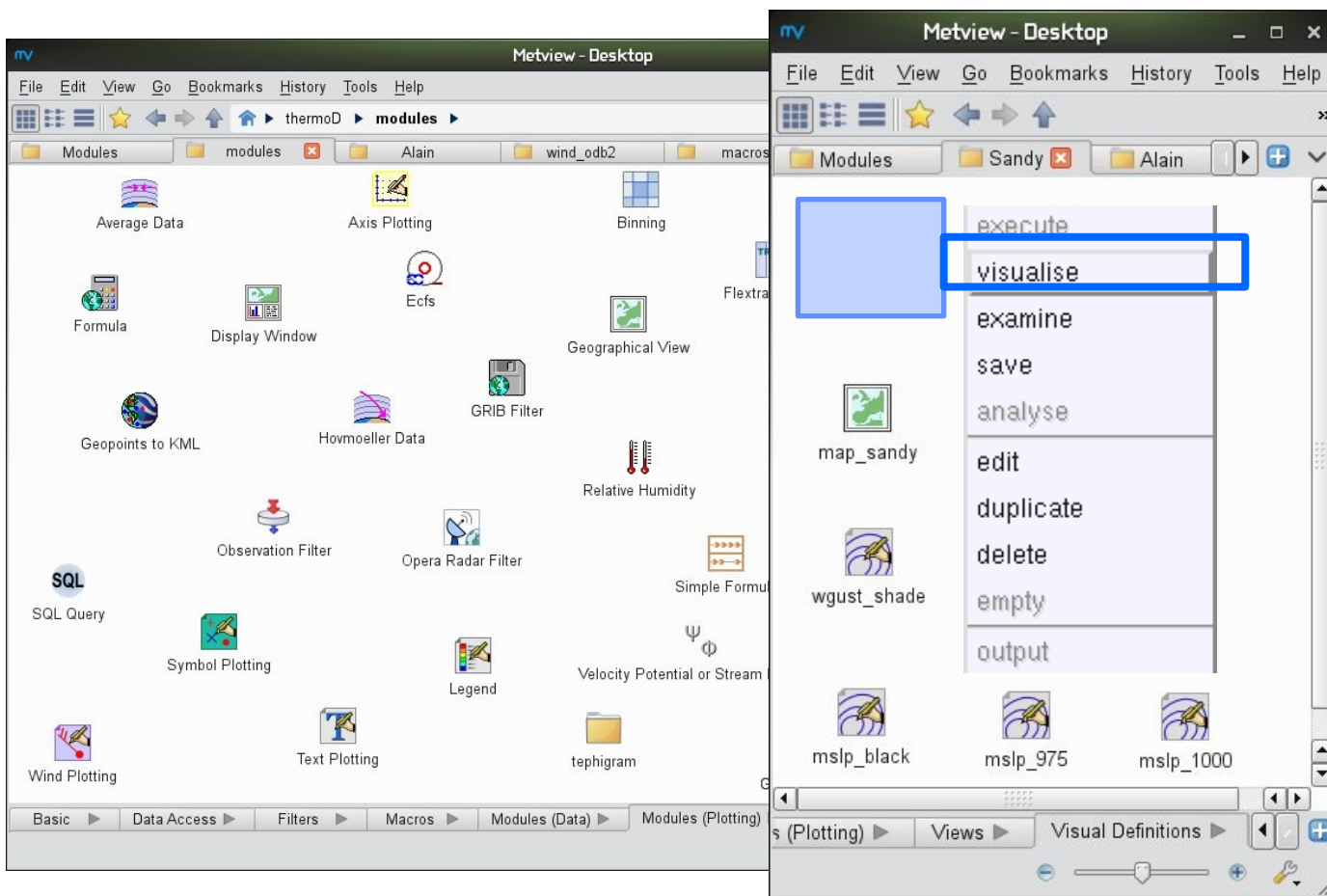
Main features

2) Icon-based interface



Main features

3) Drag and Drop support



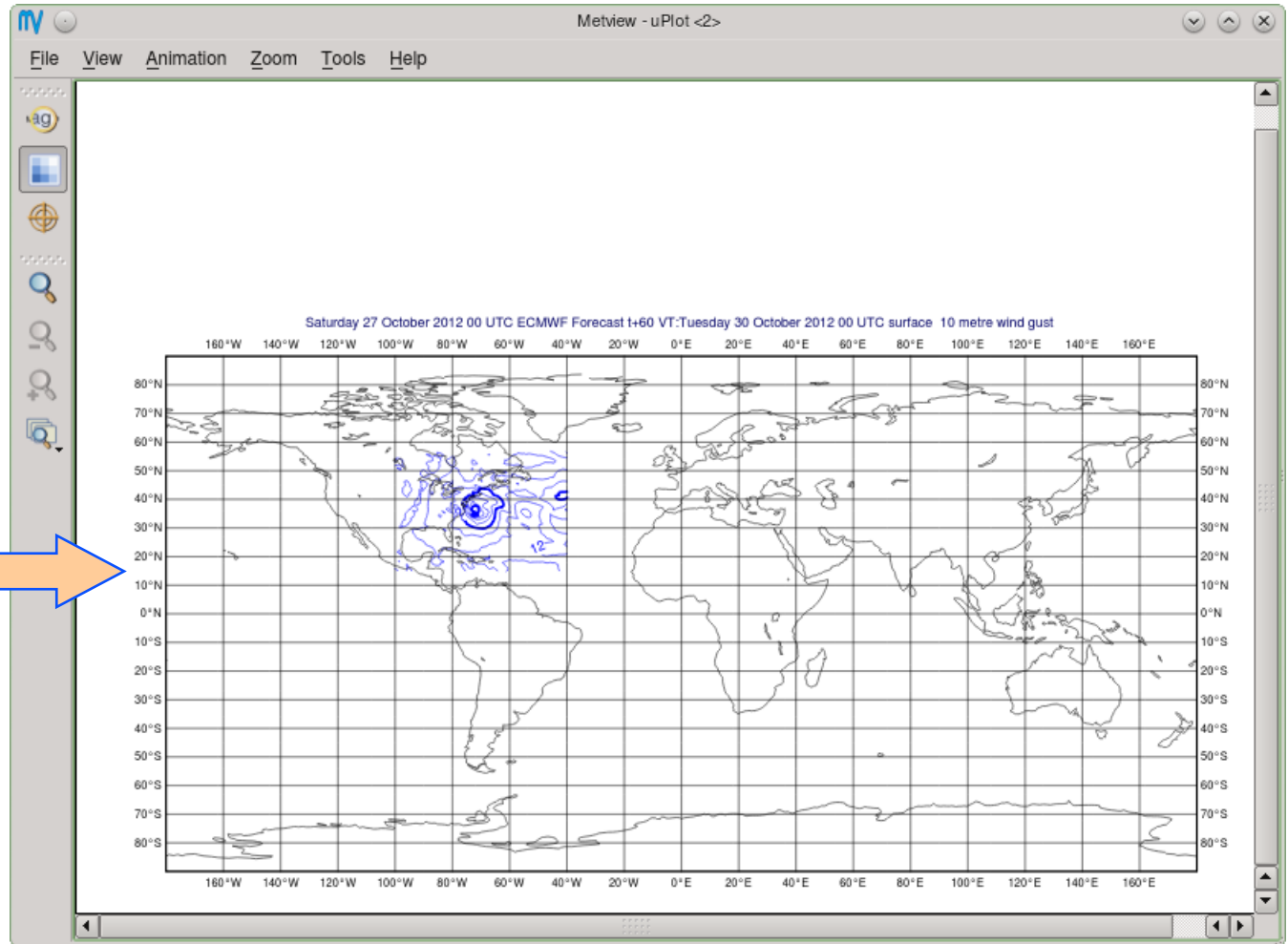
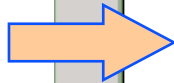
Visualisation

GRIB file



wgust.grib

- execute
- visualise**
- examine
- save
- analyse
- edit
- duplicate
- delete
- empty
- output

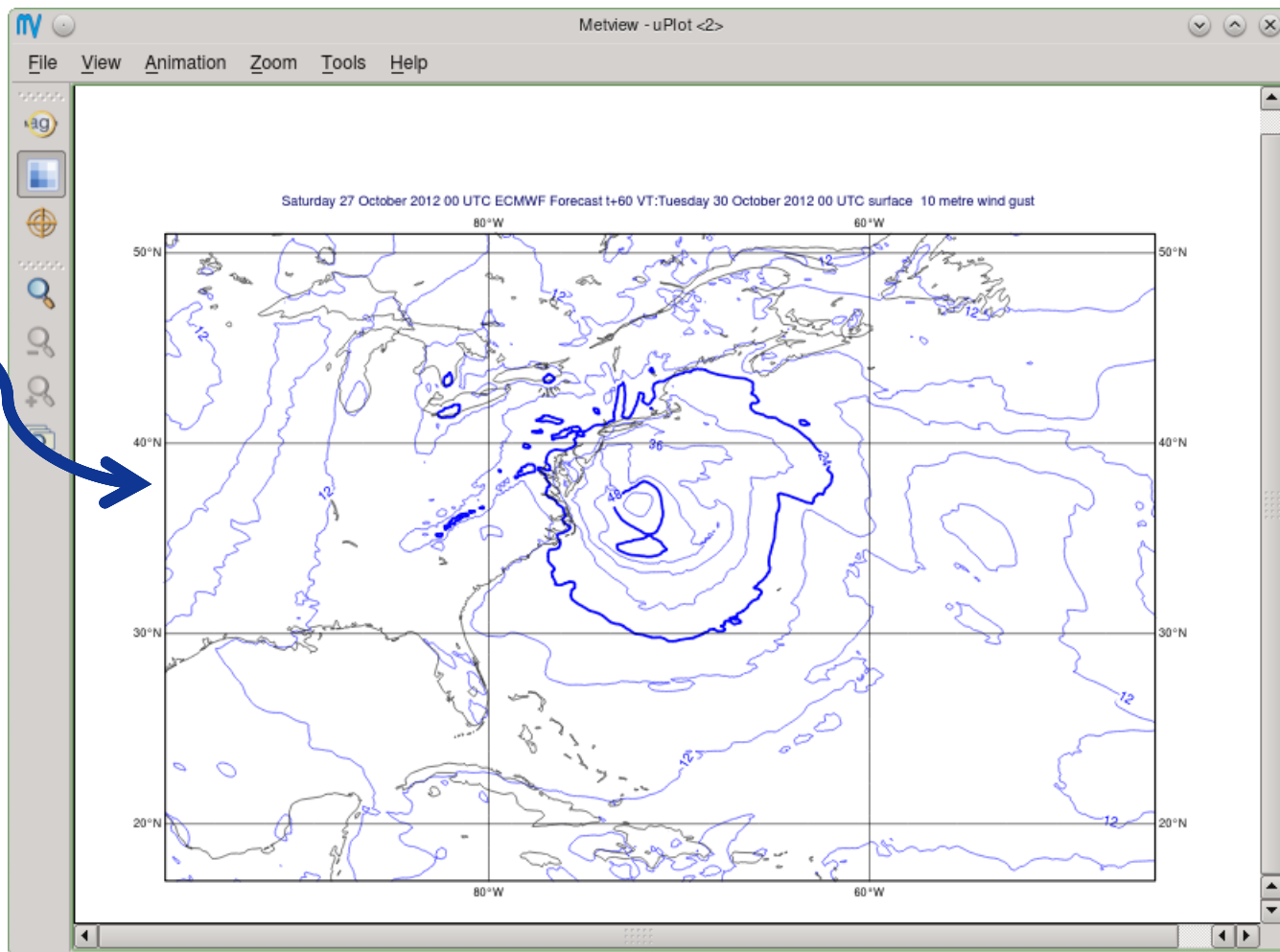
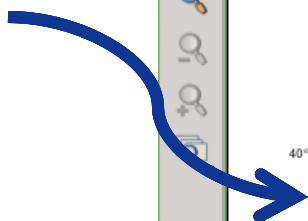


Drag and Drop

Map view



map_sandy

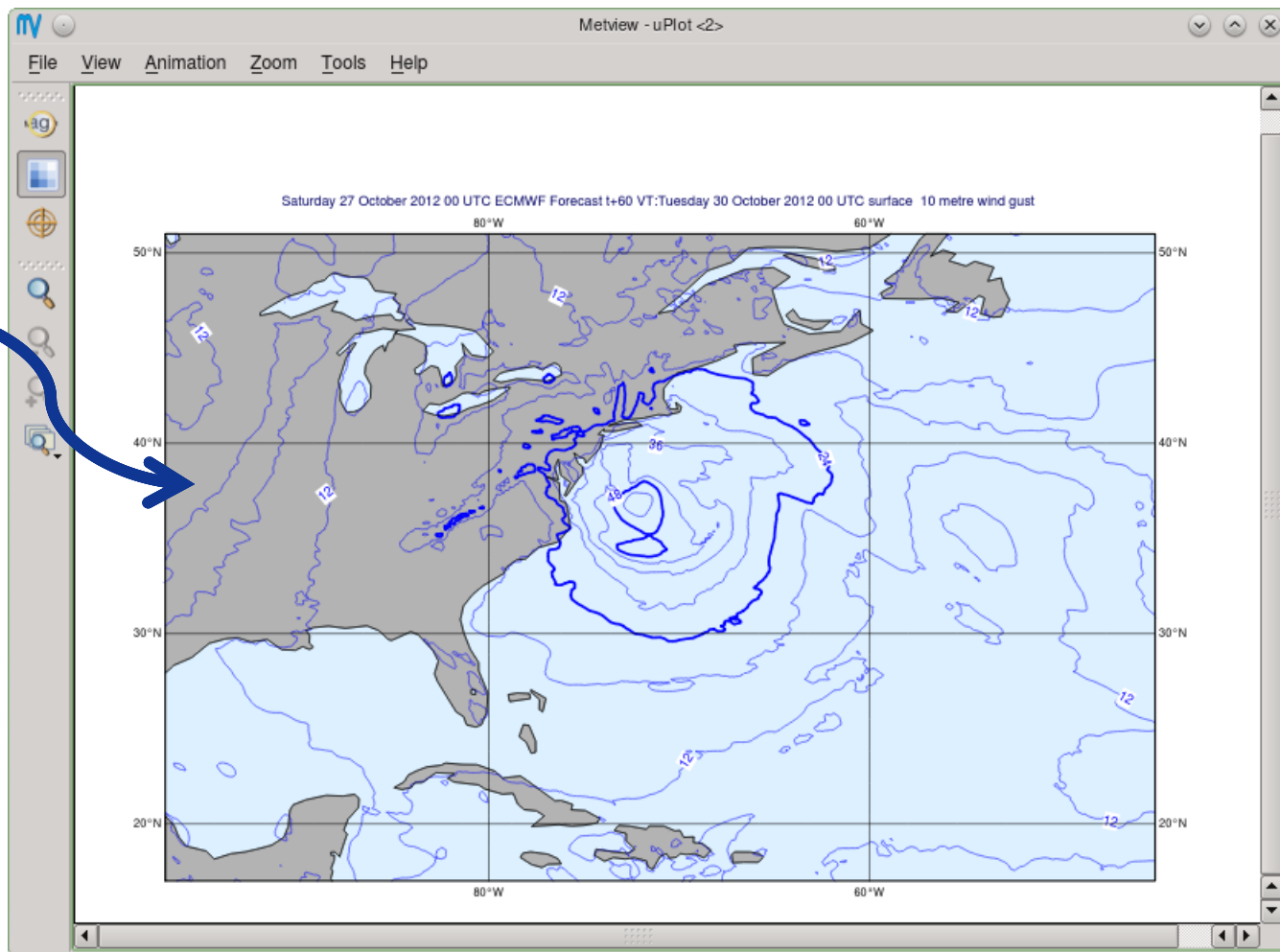


Drag and Drop

Coastlines



coast_grey_light

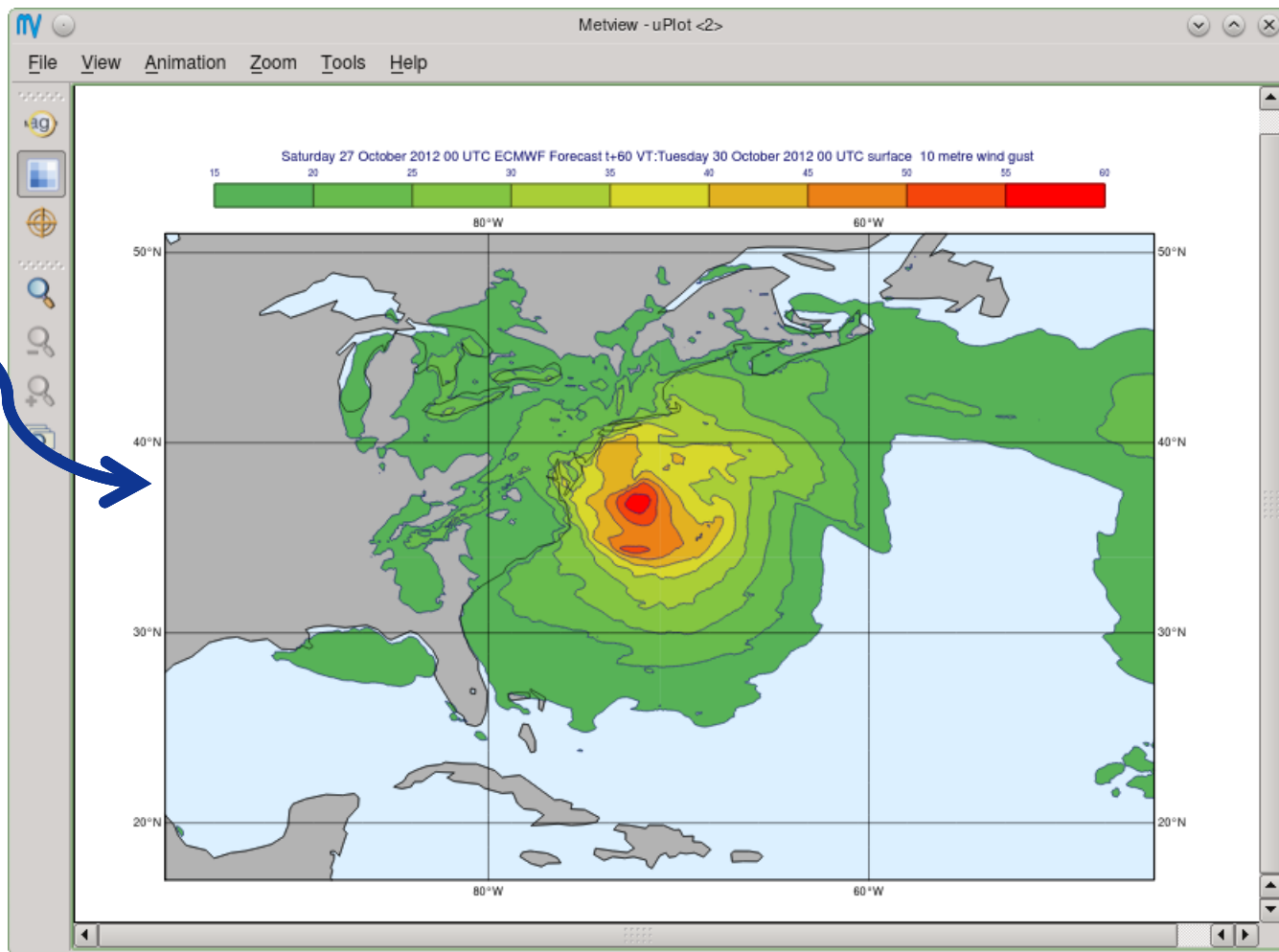


Drag and Drop

Contour shading



wgust_shade



Drag and Drop - Overlay

Overlay works for all the data types!

MSLP (GRIB)



mstp.grib



mstp_black

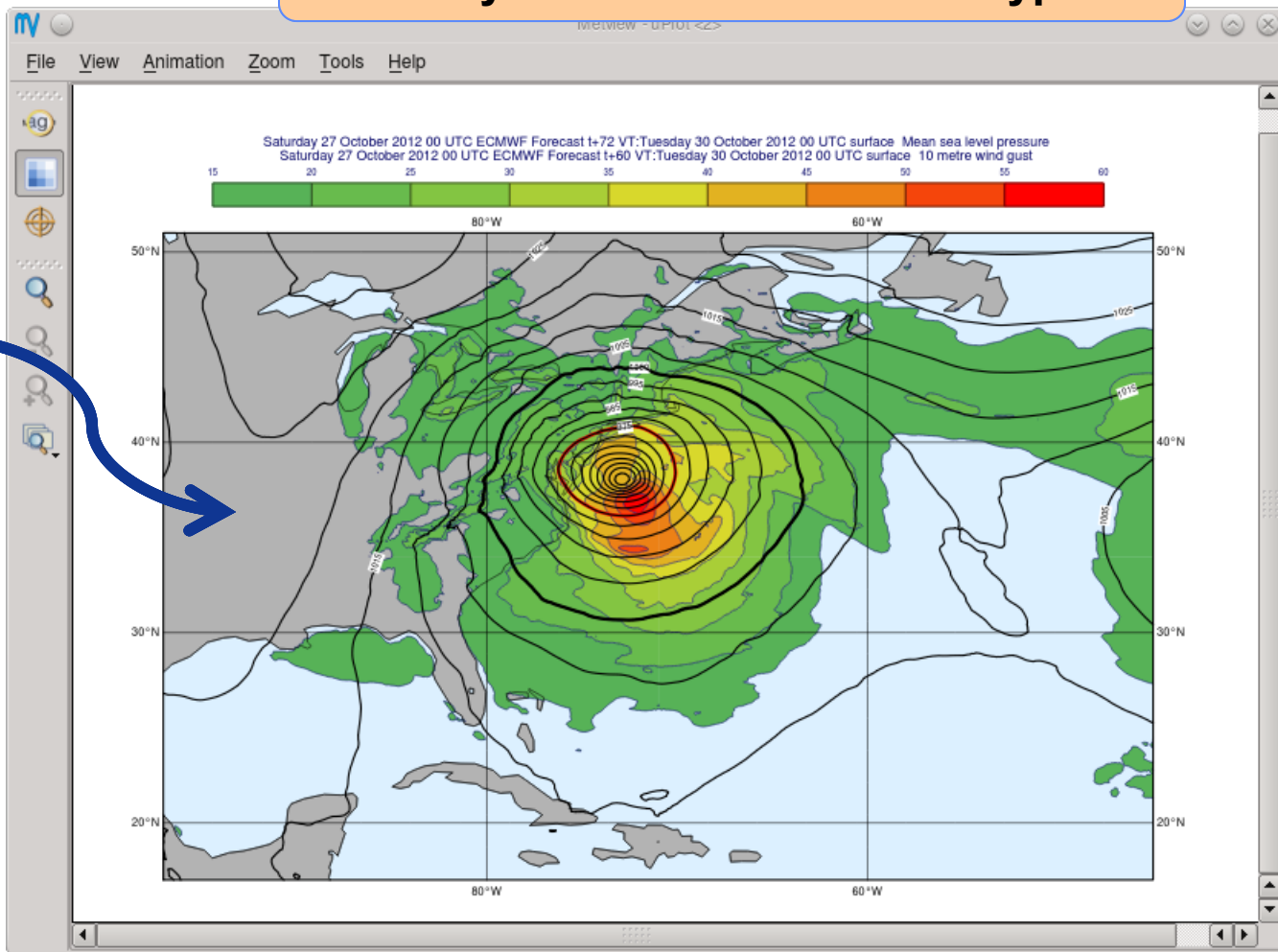


mstp_975



mstp_1000

Contouring



Main features

4) Macro language

- ▶ Powerful meteorologically oriented language
- ▶ Simple script language + modern computer language
- ▶ Extensive list of functions
- ▶ Interfaces with Fortran/C/C++ code
- ▶ Outputs:
 - ▶ Derived data
 - ▶ Interactive plotting window
 - ▶ Multiple plots
- ▶ Customised editor
- ▶ Run in batch or interactive modes

```
# Read a grib file
temp = read ( "/home/graphics/temp.grb" )

# Re-scaling field
if threshold > 0 then
    temp = temp - 273.5
    a = integrate ( temp )
end if

# Compute the gradient
q = gradientb ( temp )

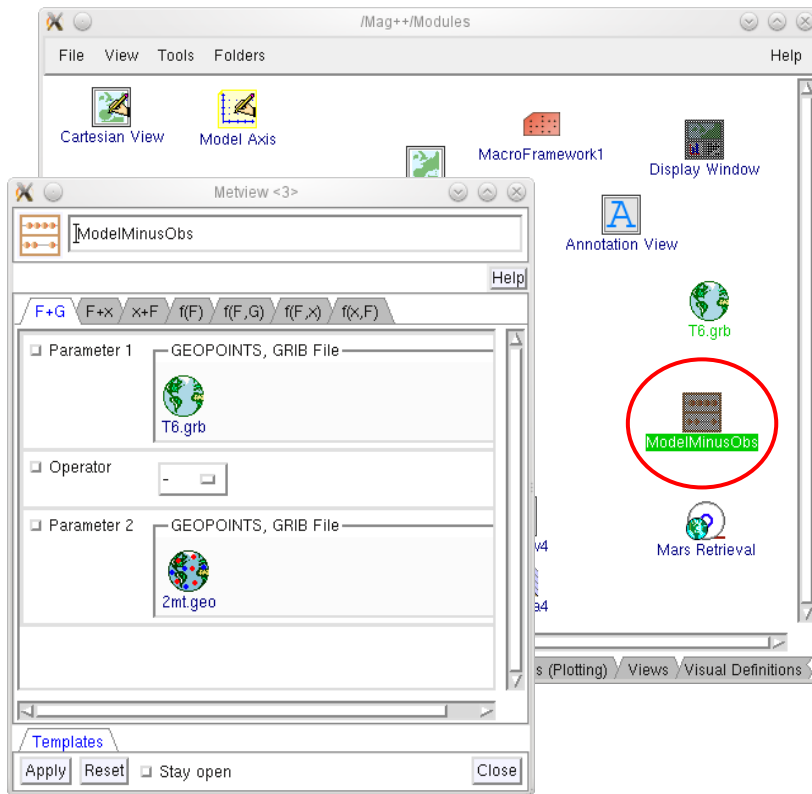
# Save field
write ( "/home/graphics/gradient.grb" , q )

# Plot field
plot ( [ps,svg], q )
```

Main features

5) Strong synergy between Icons & Macros

- ▶ Every icon can be translated into a Macro command

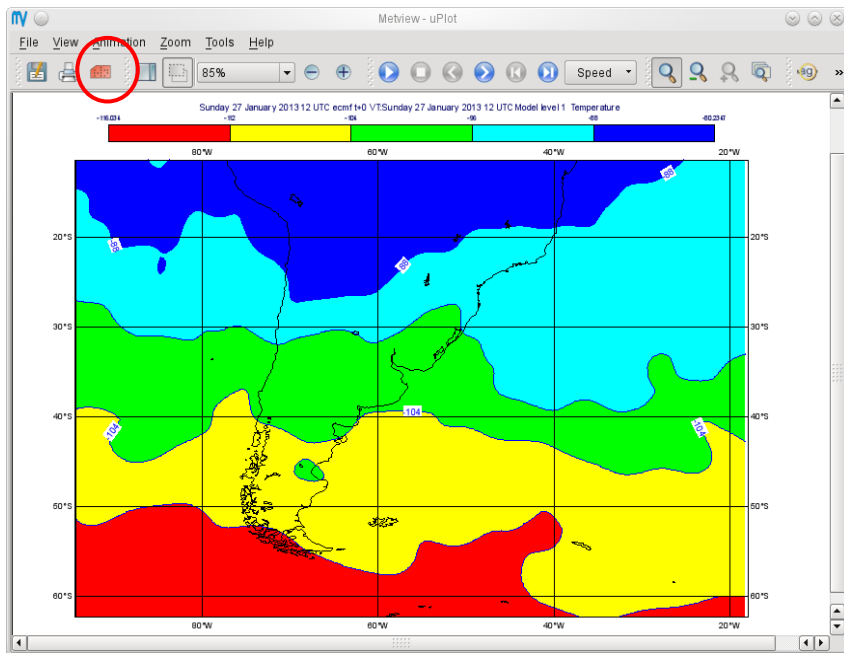


```
Macro* - /home/graphics/cgk/metview/Mag++/Modules/Macro
File Edit View Insert Program Settings Help
#Metview Macro
# Read grib model field
temp = read("/home/graphics/T6.grb")
# Read geopoints observations
obs = read("/scratch/2mt.geo")
# Compute model - observations
gpt = temp - obs
File loaded L: 10, C: 1
```

Main features

5) Strong synergy between Icons & Macros

- ▶ Plots can be translated into a Macro program



File Edit View Insert Program Settings Help

```
# Metview Macro

# Importing T91_grb
temp = read ( "/home/graphics/cgk/T91.grb" )

cont4 = mcont(
  LEGEND                      : "ON",
  CONTOUR_LEVEL_SELECTION_TYPE : "INTERVAL",
  CONTOUR_LABEL_TEXT          : "",
  CONTOUR_SHADE                : "ON",
  CONTOUR_SHADE_METHOD        : "AREA_FILL"
)

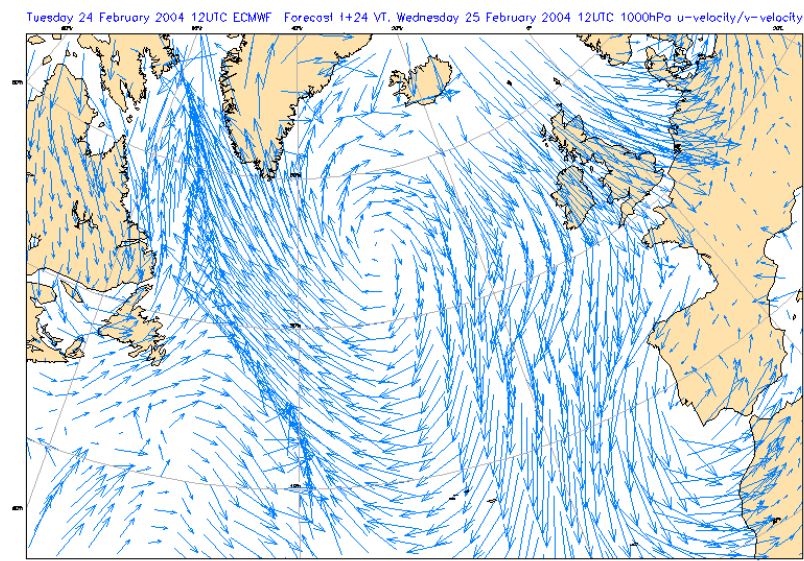
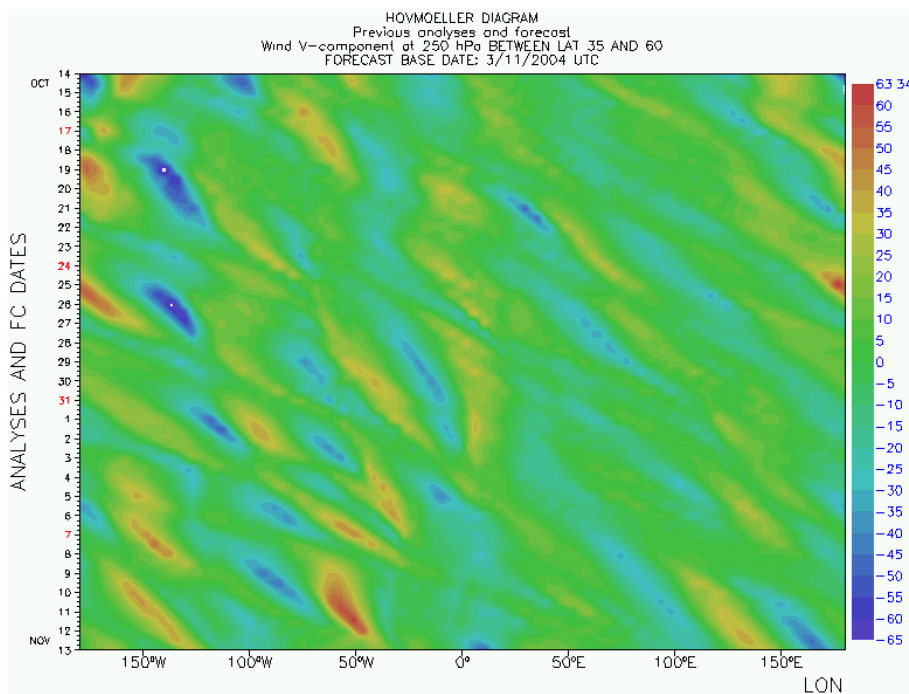
# Plot command
plot ( temp, cont4 )
```

File saved L: 16, C: 1

Main features

6) Can produce a variety of meteorological charts

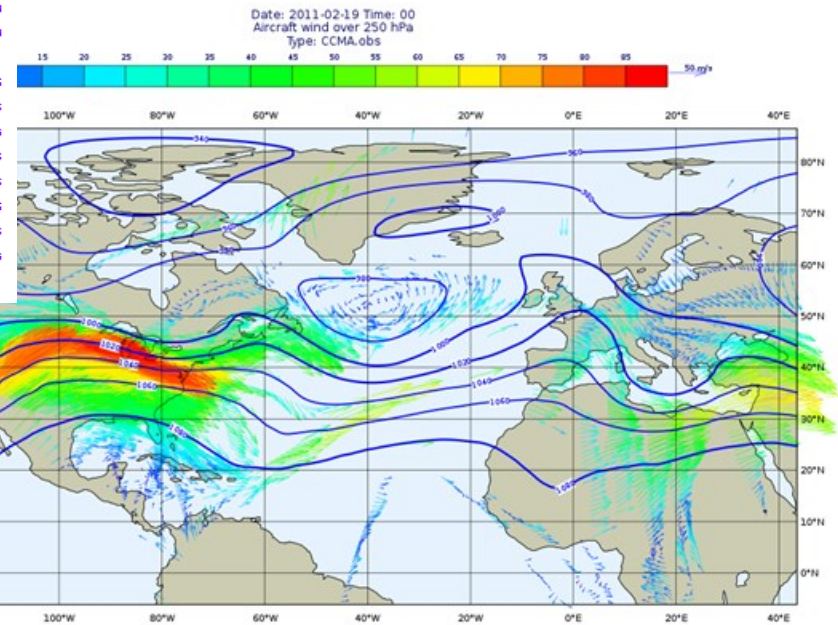
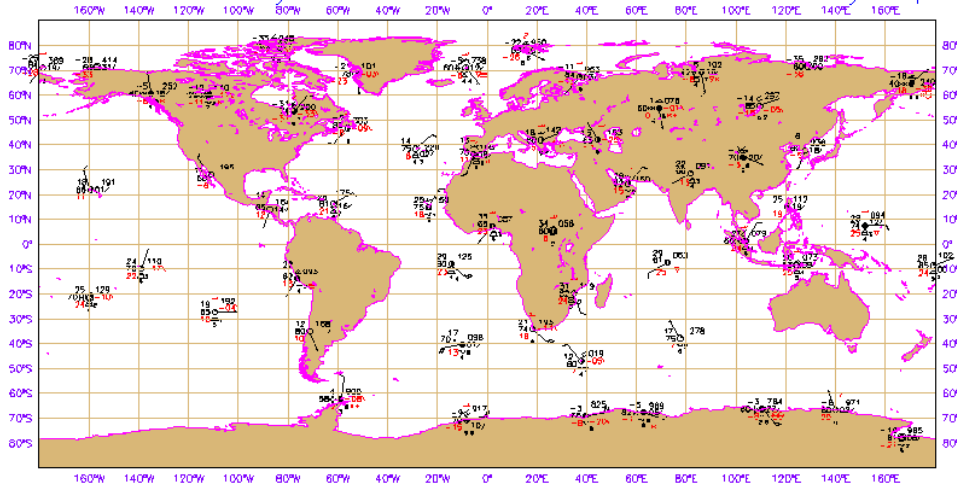
- ▶ Rich set of visualisation attributes



Main features

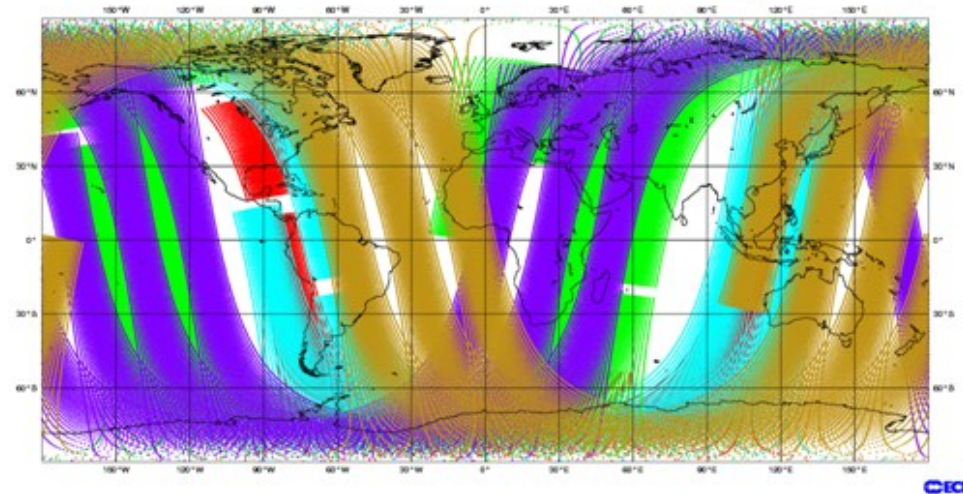
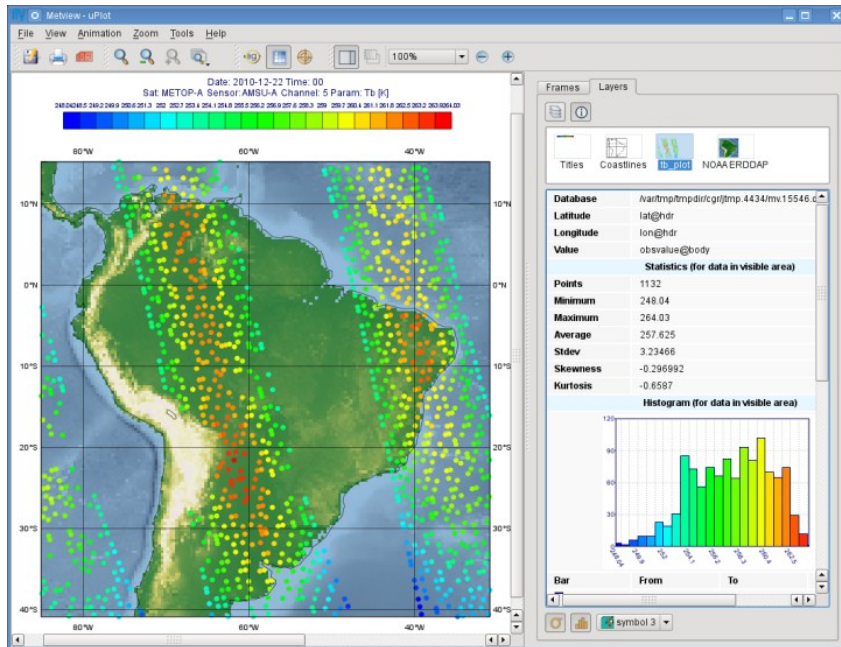
6) Can produce a variety of meteorological charts

Obs: Sunday 3 March 2002 12UTC Surf:synop



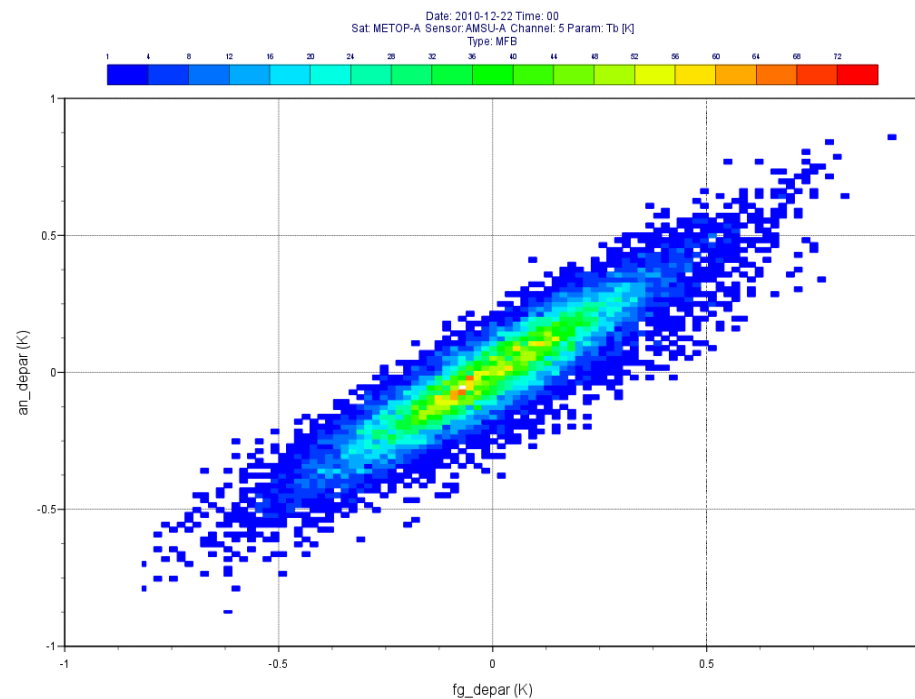
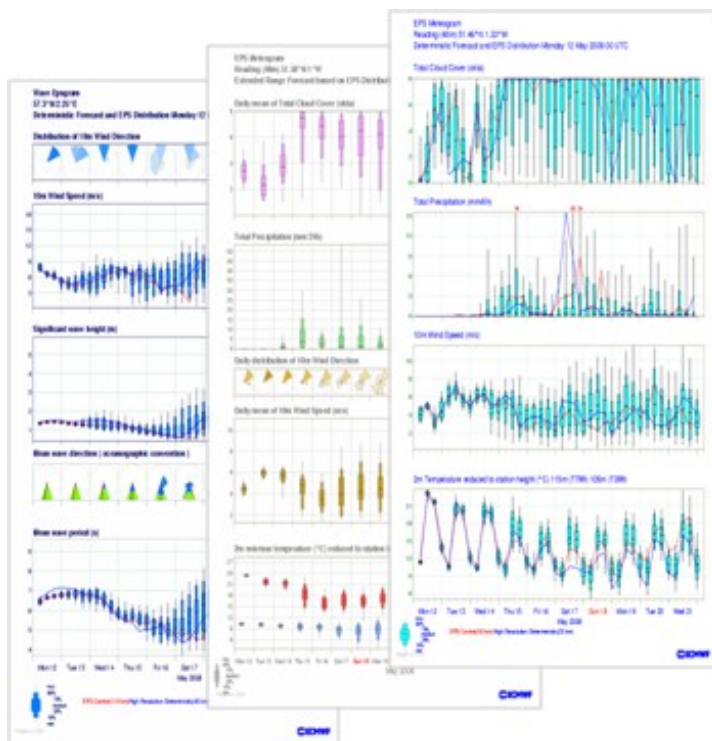
Main features

6) Can produce a variety of meteorological charts



Main features

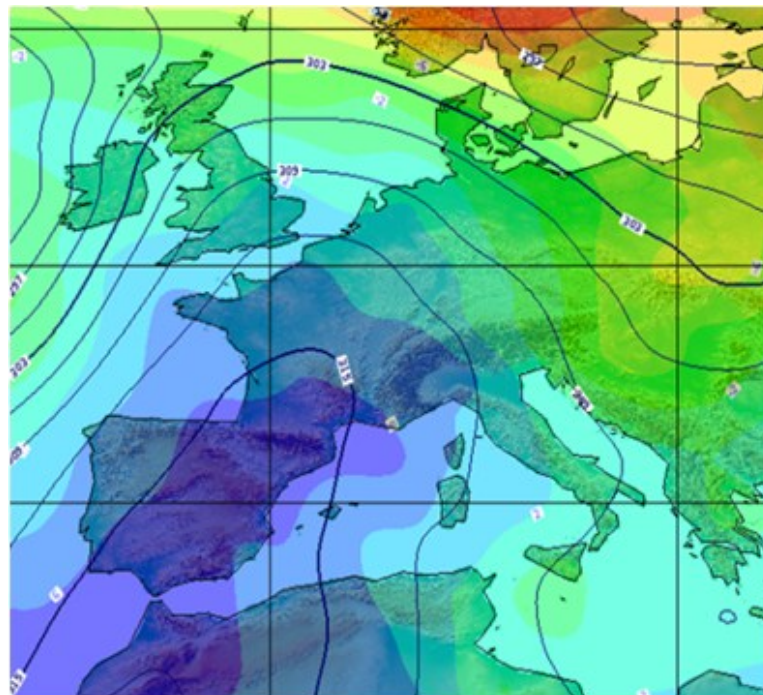
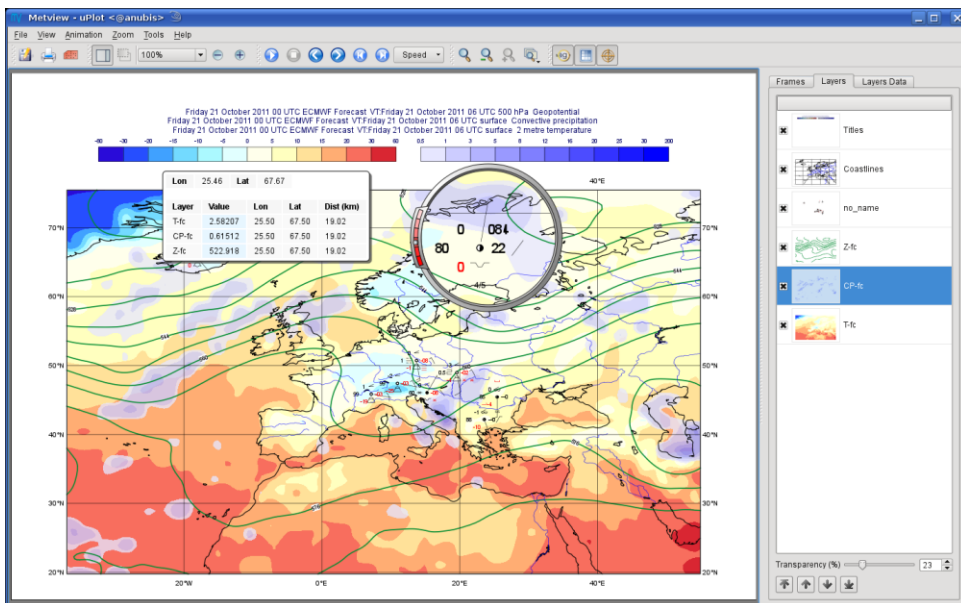
6) Can produce a variety of meteorological charts



Main features

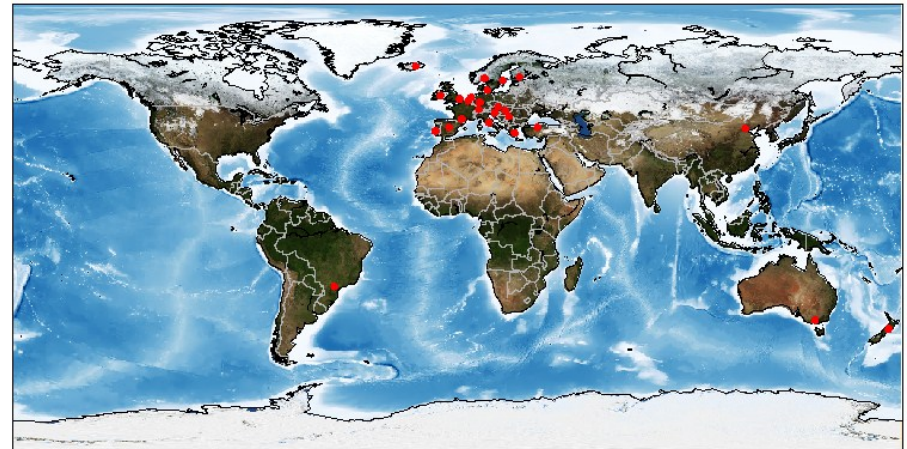
6) Can produce a variety of meteorological charts

- Easy to overlay different data sets



Who uses Metview?

- ▶ Used internally at ECMWF by researchers and operational analysts
 - ▶ To assess the quality of Observations/Forecast
 - ▶ To develop new (graphical) products
 - ▶ For general research activities
- ▶ Member States (local installations and remotely on our *ecgate* server)
- ▶ Other national weather services and Universities
- ▶ Commercial customers of ECMWF products



For more information ...

email us:

🖱 **Metview:** metview@ecmwf.int

visit our web pages:

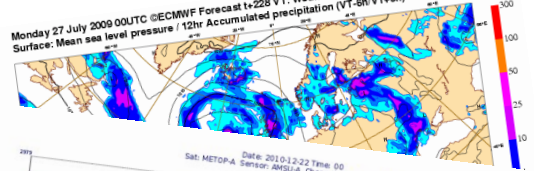
🖱 <https://software.ecmwf.int/metview>

➤ **Download**

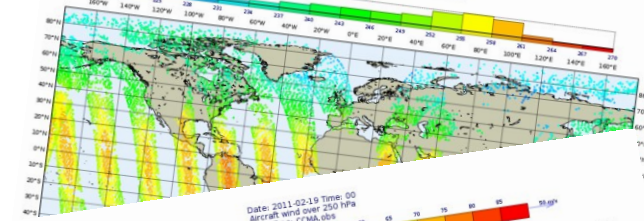
➤ **Documentation and tutorials available**

➤ **Metview articles in recent ECMWF newsletters**

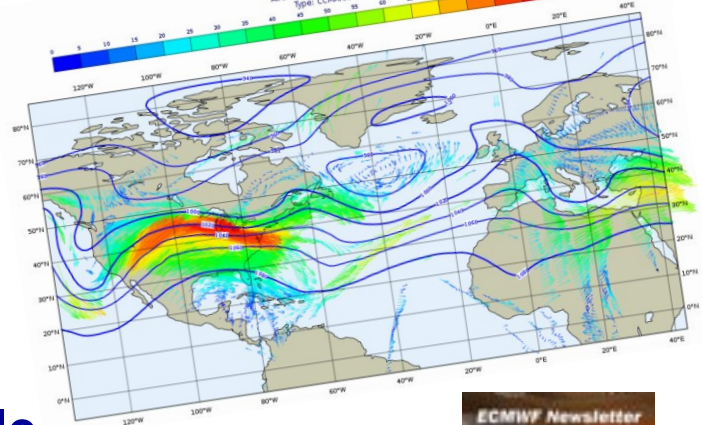
Monday 27 July 2009 00UTC ©ECMWF Forecast t+228 VT: Wednesday 5 August 2009 12UTC
Surface: Mean sea level pressure / 12hr Accumulated precipitation (VT-6h/VT+6h)



Sat: METOP-A Date: 2011-02-22 Time: 00
Sensor: AMSU-A Channel: 5 Param: Tb [K]
Type: MFB



Date: 2011-02-19 Time: 00
Aircraft wind over 200 hPa
Type: CMAA_obs



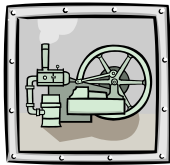
Metview Tutorial: Interactive Usage

- ▶ **Part 1: Introduction**
- ▶ Part 2: Visualising your Data
- ▶ Part 3: Data
- ▶ Part 4: Visual Definitions, Views and Layouts
- ▶ Part 5: Visualisers, Drops, Overlay and Icons
- ▶ Part 6: Data Overlay, Metview Applications and Tools

Metview Principles

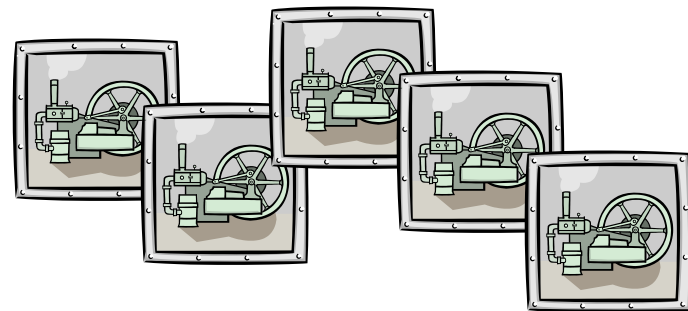
- **First Metview Principle:**

“Everything in Metview is an Icon”



- **Second Metview Principle:**

“Every Metview Task is a sequence of actions on icons”



Metview Desktop

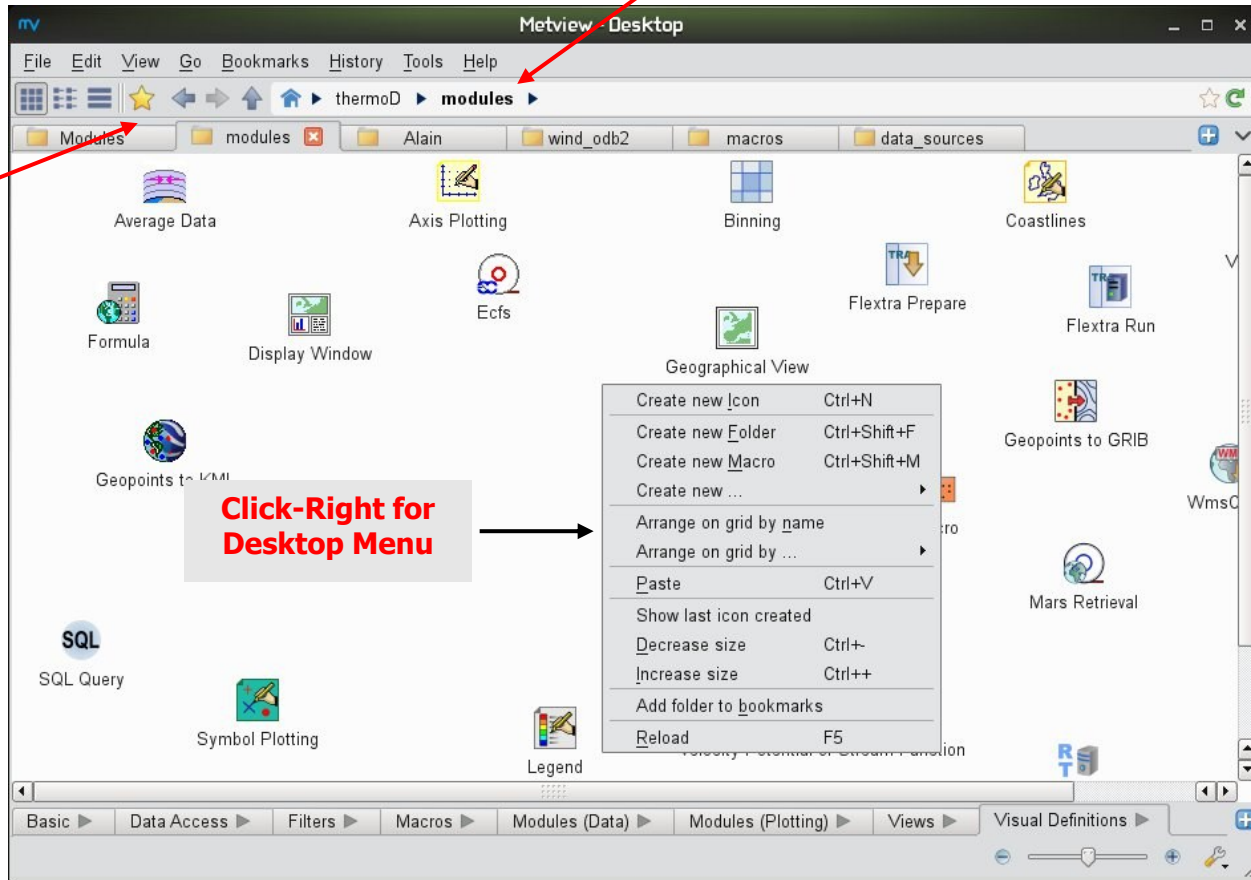
New user interface in beta test!

Navigation

View styles

Bookmarks

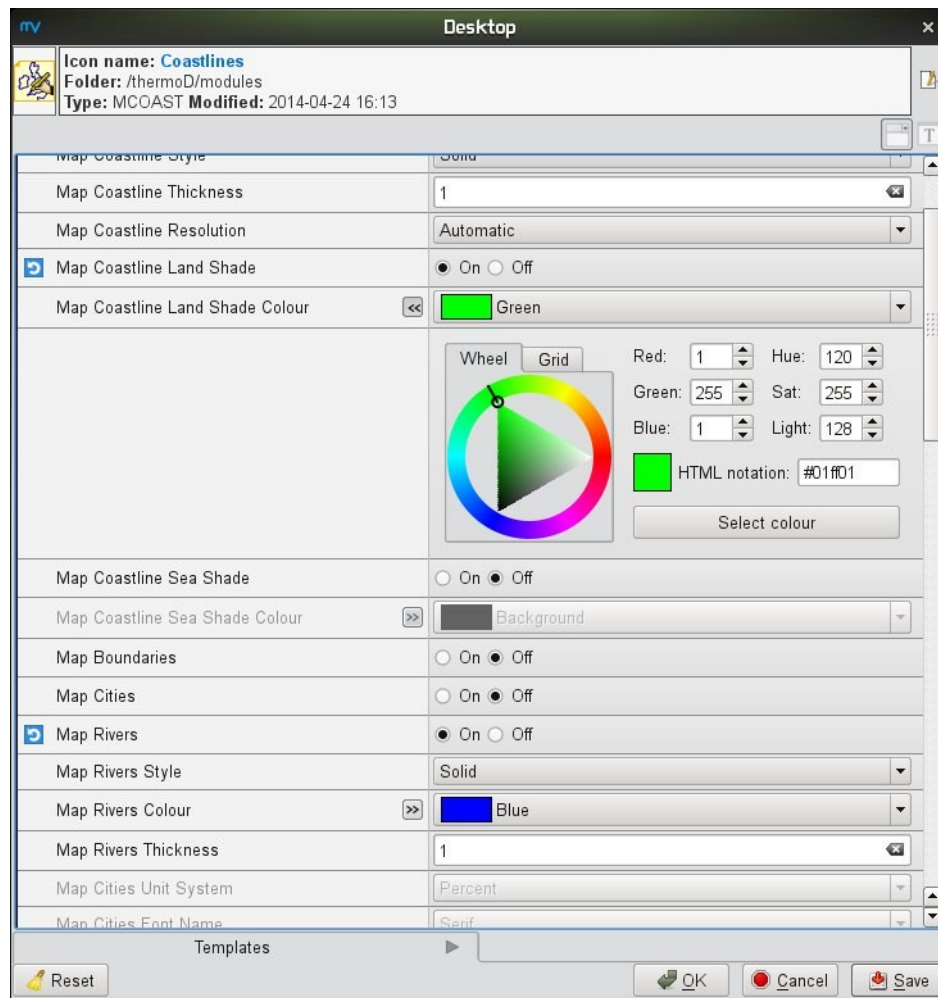
Icon Drawers



Click-Right for Desktop Menu

Icon size

Icon Standard Editor



Input area →

Save/Exit area →

← Input element:
Alphanumeric Field

← Input element:
Colour Menu

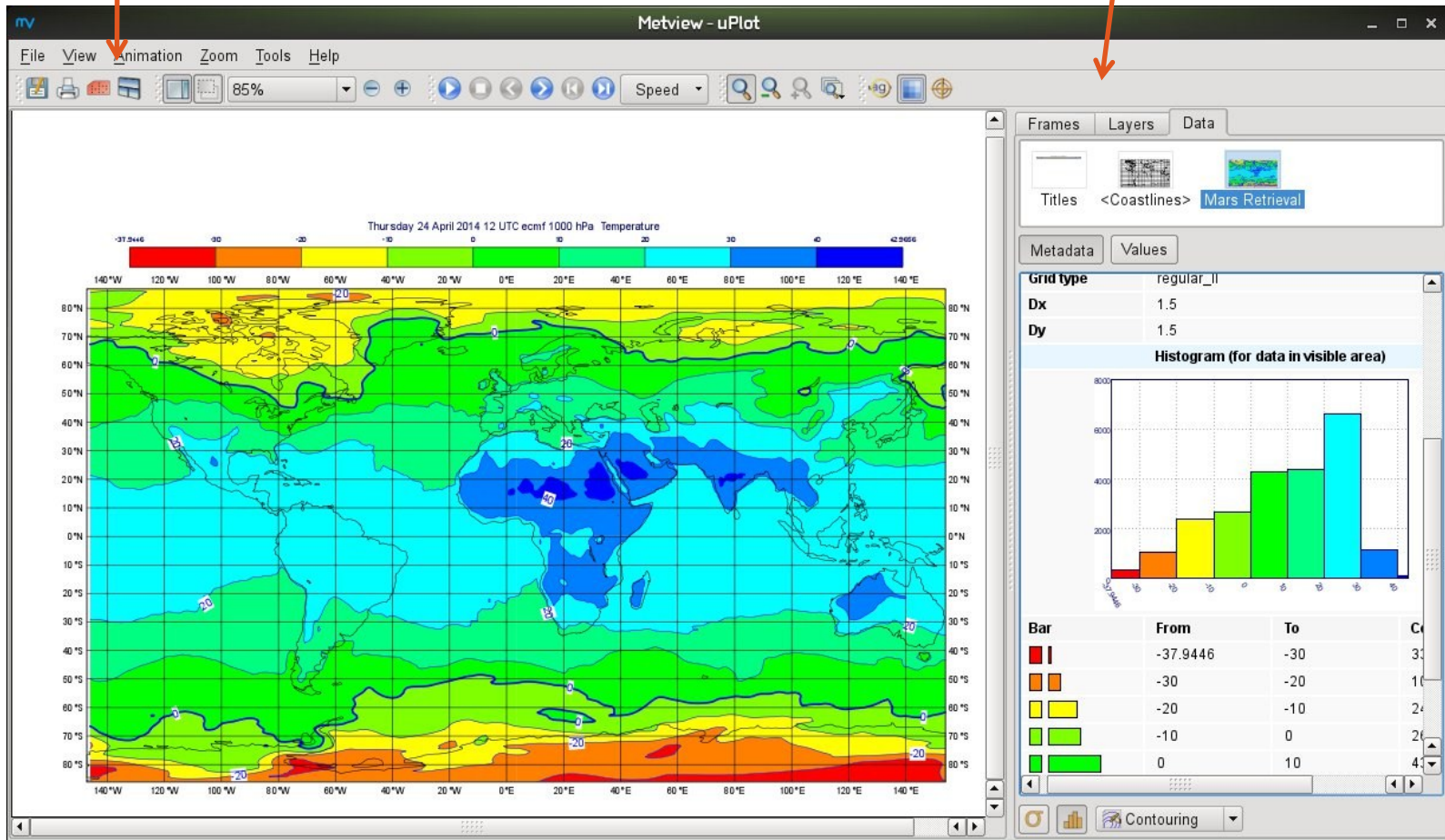
← Input element:
Toggle option

← Input element:
Option Menu

Display Window

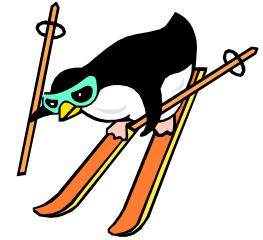
Controls

Metadata



Desktop Behaviour (1)

mv⁴



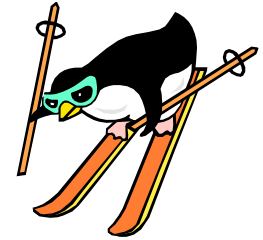
▶ KDE settings relevant to Metview:

1) Change the window behaviour

- ▶ KDE menu (icon at bottom-left)
- ▶ System Settings
- ▶ Window behaviour
- ▶ Window behaviour
- ▶ Set *Focus stealing prevention level* to “None”
- ▶ Set *Policy* to “Focus Follows Mouse”
- ▶ Disable *Click raises active window*
- ▶ Apply and close the dialog

Desktop Behaviour (2)

mv⁴



2) Change the desktop behaviour

- ▶ KDE menu (icon at bottom-left)
- ▶ System Settings
- ▶ Desktop
- ▶ Screen Edges
- ▶ Disable the settings
 - ▶ *Maximise windows by dragging...*
 - ▶ *Tile windows by dragging....*
- ▶ Apply and close the dialog

Starting Metview



- ▶ To start Metview, please type the following command from an *xterm*:

metview_dev -desktop &

- ▶ Please minimise the *xterm* but do not close it

Metview Tutorial: Interactive Usage

- ▶ Please do Part 1 of the Tutorial

Part 1 – Additional Notes

- ▶ **Metview scans its open folders for new files every 8 seconds**
- ▶ **‘View | Reload’ forces an immediate rescan (F5)**
- ▶ **Deleted icons go into the Wastebasket – right-click, Empty to finally delete icons from there**
- ▶ **Navigation breadcrumbs**
- ▶ **Display Window resizing control in the Toolbar**

Metview Tutorial: Interactive Usage

- ▶ Part 1: Introduction
- ▶ **Part 2: Visualising your Data**
- ▶ Part 3: Data
- ▶ Part 4: Visual Definitions, Views and Layouts
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- ▶ Part 6: Data Overlay, Metview Applications and Tools

Data visualisation

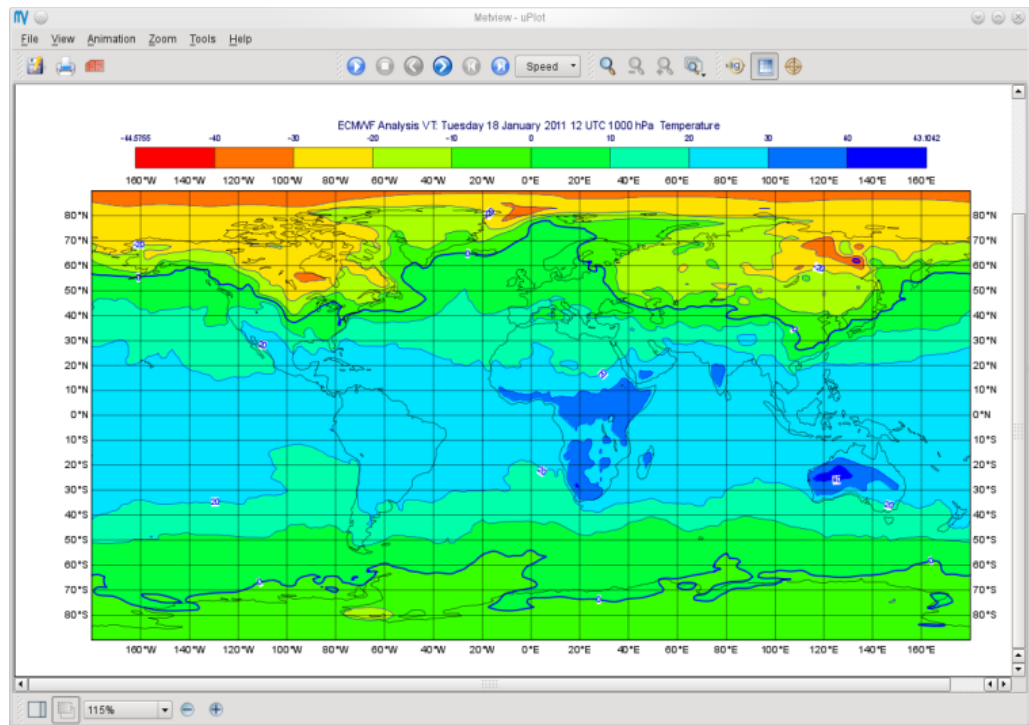
► Modifying visual definition

- Contouring

- Legend

- Title

► Inspect data values



Metview Tutorial: Interactive Usage

- ▶ If you have not already done so at the end of Part 1:
 - ▶ get the rest of the icons and data we will need:
 - ▶ ensure that you have created the folder called 'course', because this is where the files will be copied!
 - ▶ from a terminal command line:

```
~trx/mv_data/get_data
```

- ▶ Please do Part 2 of the Tutorial

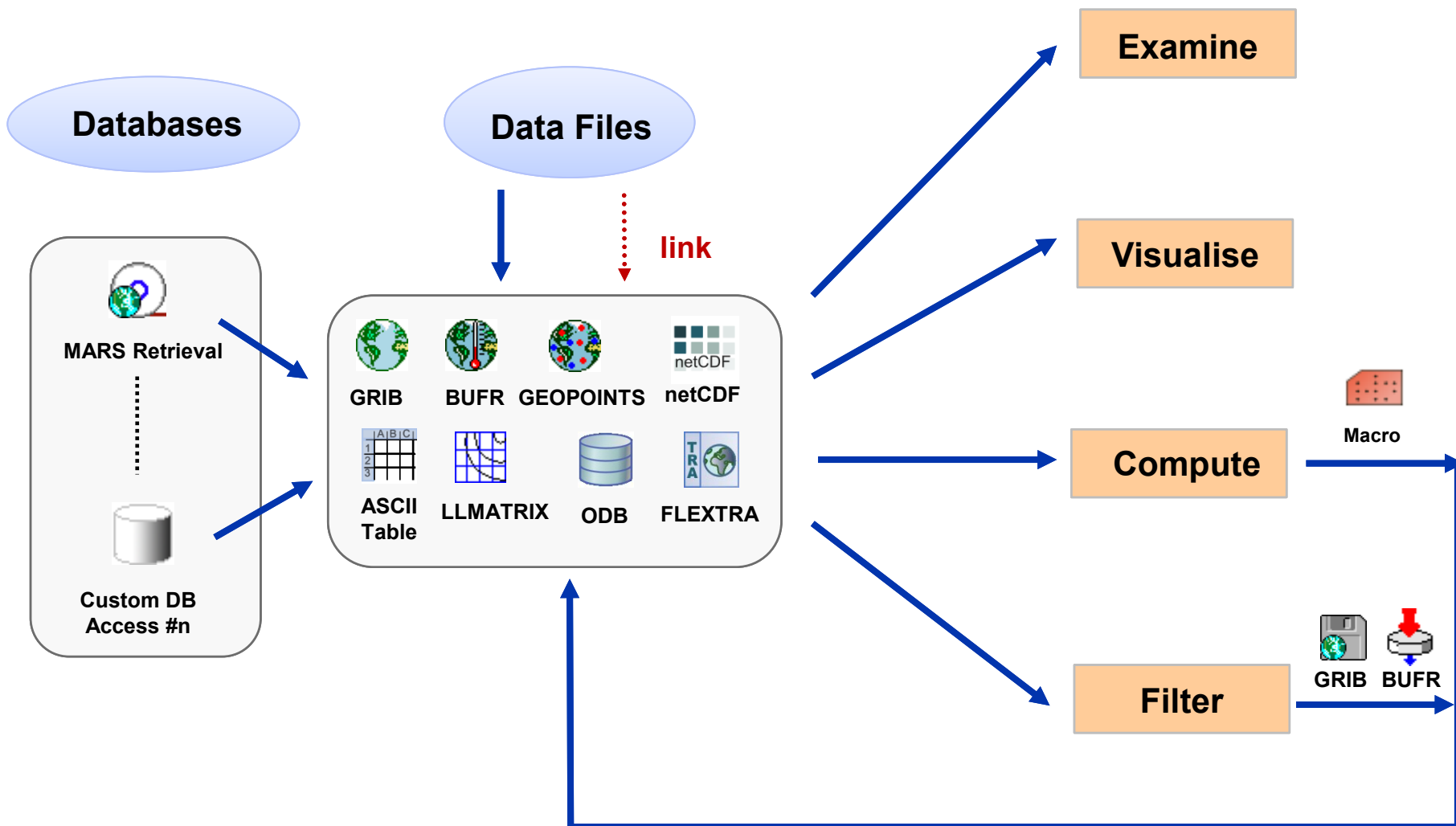
Part 2 – Additional Notes

- ▶ **Contouring often has automatic unit conversion – can be deactivated in the *Contour* icon**
- ▶ **Cursor data – shows both scaled and non-scaled values**
- ▶ **Layer meta-data reflects the selected area**

Metview Tutorial: Interactive Usage

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Data handling in Metview



Metview Tutorial: Interactive Usage

- ▶ Please do Part 3 of the Tutorial

Part 3 – Additional Notes (1)

- ▶ What data is stored in MARS?
 - ▶ WebMars catalogue: <http://www.ecmwf.int/en/forecasts/datasets>
- ▶ MARS **language syntax**
 - ▶ List of values: 0/12/24/36/48
 - ▶ Range of values: 0/TO/48/BY/12
- ▶ MARS **date format**
 - ▶ Specific dates, e.g. 20090303
 - ▶ Relative dates, e.g. -1 (yesterday)

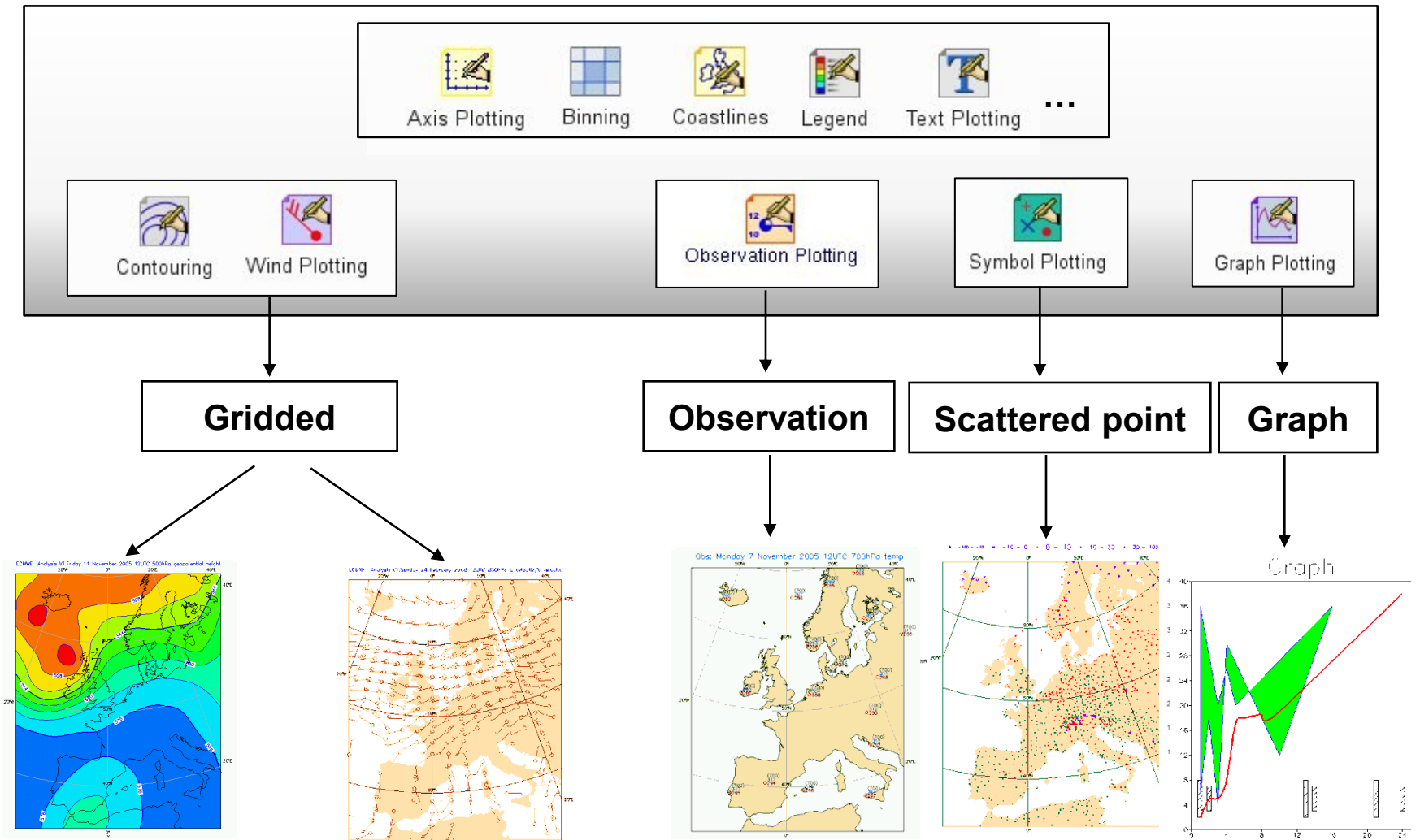
Part 3 – Additional Notes (2)

- ▶ Use action **save** from the icon menu to get a local copy of data files
- ▶ If an icon goes red, then check the message log (Ctrl-L)
- ▶ Icons can be input to other icons, thus forming a chain
- ▶ GRIB computations (e.g. via the Simple Formula icon) yield derived fields. **GRIB scaling** is **off** by default for these fields in the Contouring icon!

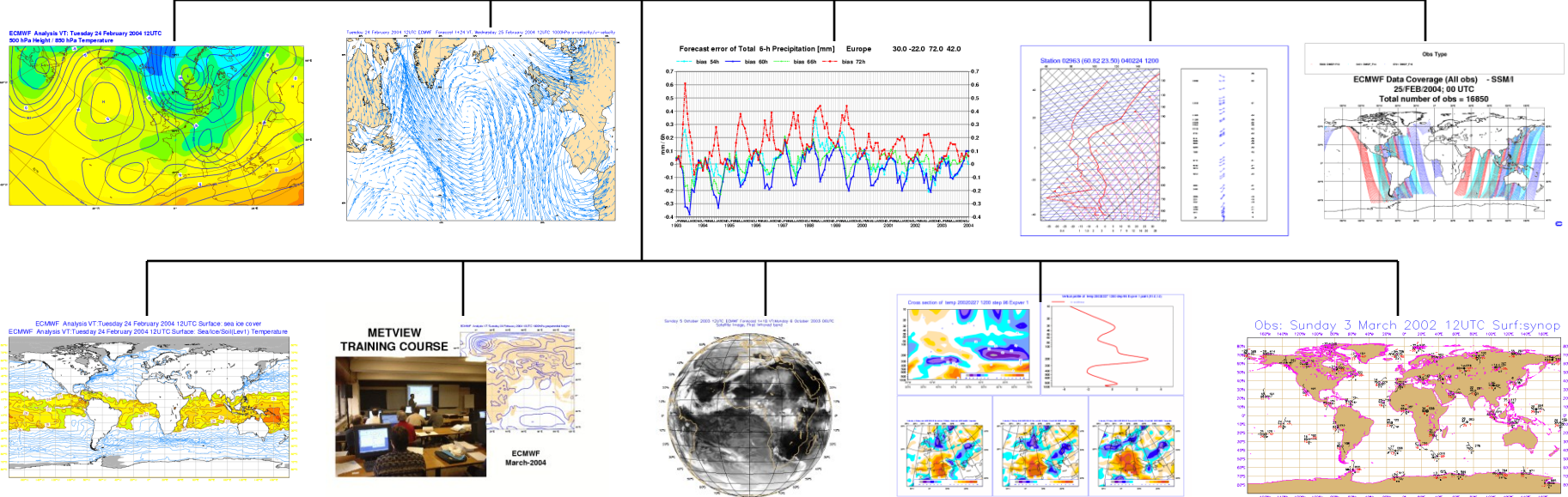
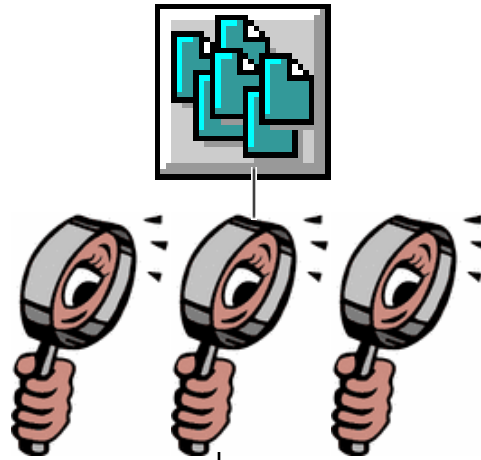
Metview Tutorial: Interactive Usage

- ▶ Part 1: Introduction
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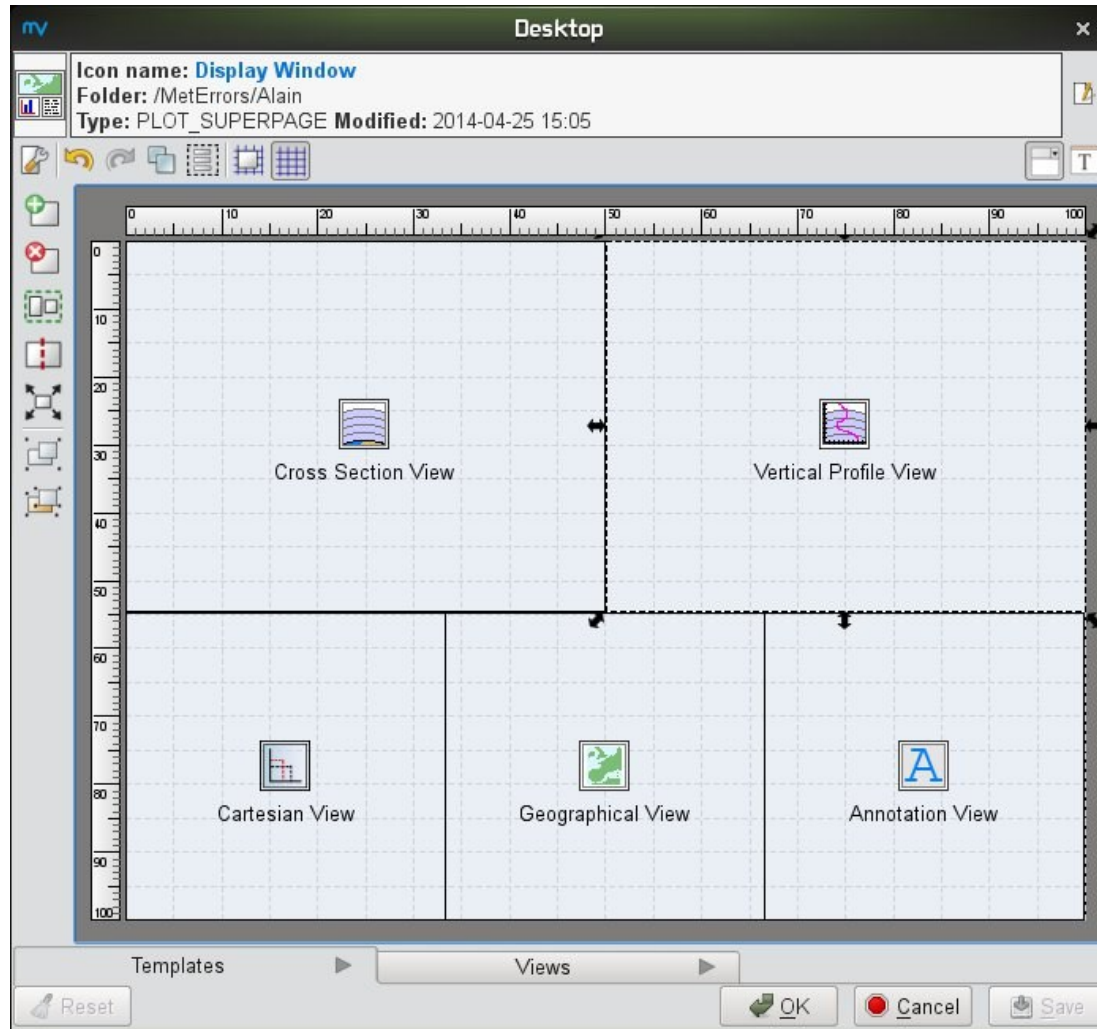
Visual Definition (*visdef*)



The VIEW concept



Display Window icon – layout editor



Metview Tutorial: Interactive Usage

- ▶ Please do Part 4 of the Tutorial

Part 4 – Additional Notes

- ▶ Put frequently used icons into their own drawer
- ▶ Dot/hatch shading can be used to ‘mimic’ transparency in postscript
- ▶ Many options are common to all views (position, ...)
- ▶ Difference between icon drawers and template drawers

Metview Tutorial: Interactive Usage

- ▶ Part 1: Introduction
- ▶ Part 2: Visualising your Data
- ▶ Part 3: Data
- ▶ Part 4: Visual Definitions, Views and Layouts
- ▶ **Part 5: Visualisers, Drops, Overlay and Icons**
- ▶ Part 6: Data Overlay, Metview Applications and Tools

Icon Drop Rules

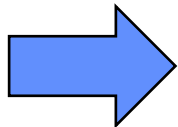
- ▶ Icon drop is easy but can be ambiguous because...
 - ▶ Should I drop *data* and *visdef* together, or in sequence?
 - ▶ How do I apply multiple *visdef* icons?
 - ▶ ...jointly drop them, or in sequence?
 - ▶ *How do I contour overlaid fields?*
- ▶ Luckily Metview has some intelligence → use the Icon Drop Rules

Data Overlay

- ▶ Multi-data visualisations, e.g. T+Z,...
 - ▶ When are different data overlaid in the same plot?
- ▶ Default data overlay rules
- ▶ Need more control? – Use the [Data Overlay Control](#)

Visualisers

- ▶ **GRIB is ‘easy’ to plot**
 - ▶ **Standardised meta-data – geographic coordinates, resolution, etc**
- ▶ **Some other formats (e.g. netCDF) are more versatile and can contain matrices, scattered points, multiple variables, etc**
 - ▶ **users need to tell Metview what to plot**



visualiser icons

Metview Tutorial: Interactive Usage

- ▶ Please do Part 5 of the Tutorial

Part 5 – Additional Notes

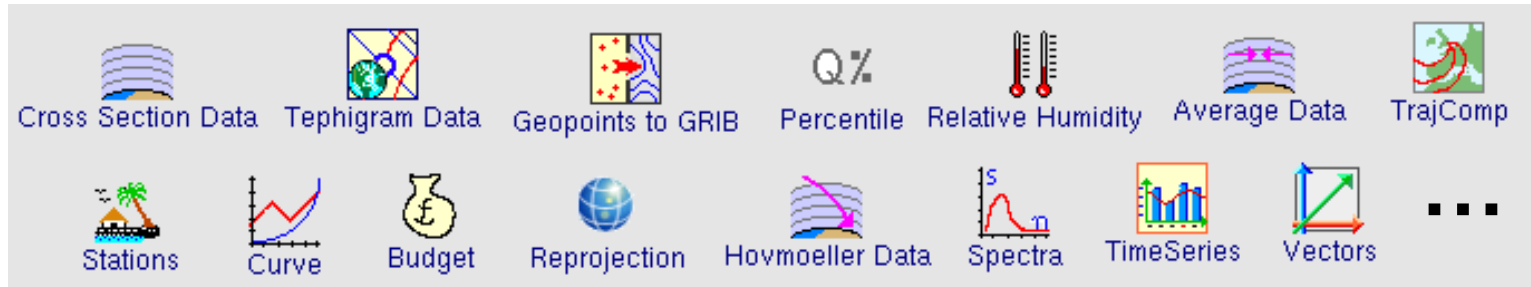
- ▶ **Note the different plot types available in the Visualiser icons**
 - ▶ Allow a range of ways to interpret and plot data, e.g. geographic, x/y, matrices, vector pairs, ...

Metview Tutorial: Interactive Usage

- ▶ Part 1: Introduction
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- ▶ Part 5: Visualisers, Drops, Overlay and Icons
- ▶ **Part 6: Metview Applications and Tools**

Metview Applications

► Large set of applications:



► Create intermediate data → input to another application

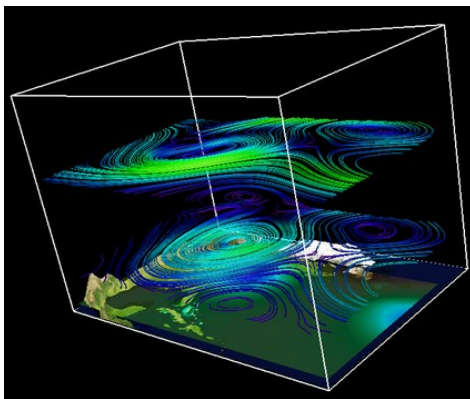
► No application for your needs?

► Write a Metview Macro

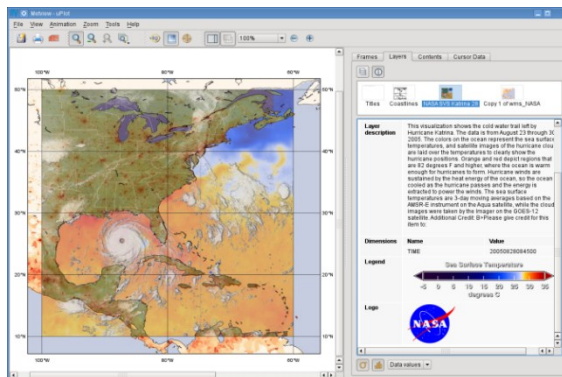
Metview Applications: Tutorials

► Many tutorials available, including:

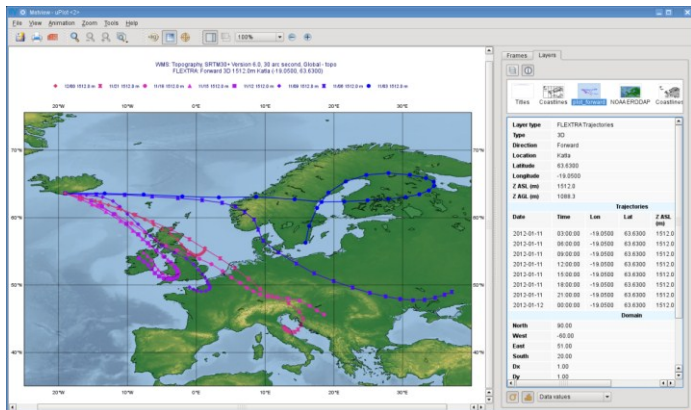
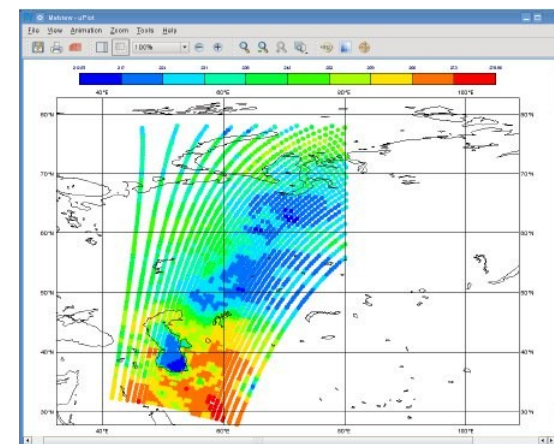
VAPOR



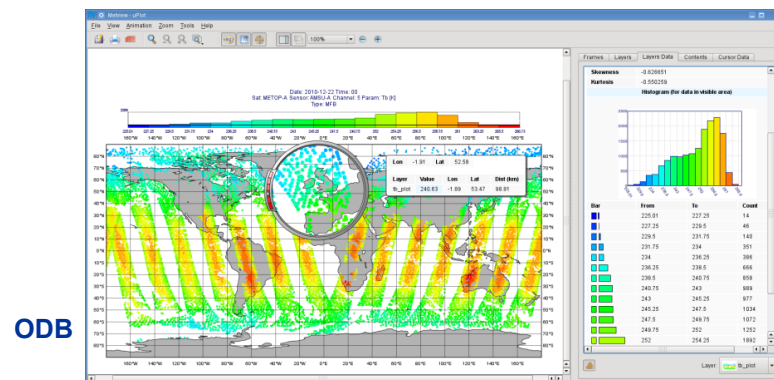
WMS



BUFR



FLEXTA



ODB

<https://software.ecmwf.int/metview>

Metview Tools

mv⁴



- ▶ **Mail** - exchange icons by email
- ▶ **Archive** - convert a group of icons into an archive
- ▶ **Monitor** – to monitor and control tasks
 - ▶ Check the progress of long tasks
 - ▶ Abort a misbehaving Metview process
- ▶ **Station** – search Station Database
 - ▶ Access Metview database of 10,000 WMO stations

Metview Tutorial: Interactive Usage

- ▶ Please do Part 6 of the Tutorial

Part 6 – Additional Notes

- ▶ Ways to bookmark folders
- ▶ View modes
- ▶ Icon size control
- ▶ Metview recognises many vector field pairs automatically, e.g. U/V, 10U/10V
- ▶ Other fields can be paired by using the *GRIB_VECTORS* icon