

J.Daabeck*, R.Bonifacio, V.Karhila, F.Ii, S.Lamy-Thépaut, A.Jørgensen
European Centre for Medium-Range Weather Forecasts

1. INTRODUCTION

Metview is the ECMWF meteorological visualisation and computation software. It has now matured into a highly adaptable, modular package, under the ultimate aim of providing "meteorological desktop publishing" (DTP) capacities to the operational and research meteorologist. The computational capacity of Metview rests on an easy to learn, high-level macro language particularly adapted to meteorological data.

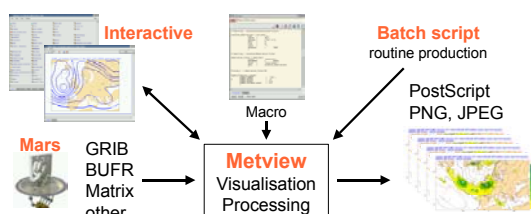


Figure 1 - Metview Overview

Metview has been recently ported to Linux, therefore widening considerably its potential user base by offering much increased performance from a substantially reduced investment.

Metview can be operated in two modes:

- As a meteorological desktop plotting package thanks to its WYSIWYG visualisation (it can be used for routine production of meteorological charts in an operational environment);
- As a powerful meteorological data processing software thanks to its macro language.

Metview has a modular architecture and was conceived as a fully distributed system, its modules being able to run on different machines. ECMWF software for data access (MARS), Böttger (2001), and graphics (MAGICS), O'Sullivan (1998/1999), provide its underlying data handling and plotting capacity.

Metview was designed for the UNIX environment and is highly portable within the UNIX world. At ECMWF, Metview was used mainly on SGI systems and now being rolled out on Linux PCs and IBM servers, following the porting of its latest version. Elsewhere it is installed and operational also on SUN, HP and Alpha-based workstations. The choice of a Linux platform widens considerably its potential for deployment by being able to run on comparatively very low cost hardware including a laptop.

Metview was developed under a cooperative project

between ECMWF and INPE/CPTEC, Brazil, with assistance from Météo-France.

2. RECENT EVOLUTION OF METVIEW

Since its first release, Metview went through a number of operational versions, all of which were structurally similar, Daabeck (2001). Over the last few years, Metview underwent its first major structural revision that lead to its version 3.

The basic principles of Metview remain the same: *Everything in Metview is an icon* and the operating principle: *Every Metview task is a sequence of actions on icons*. Icons represent each and every file and directory inside the Metview workspace, Bonifacio (1999/2000). A number of data types are recognised (GRIB, BUFR, some NetCDF, ASCII data columns and matrices) and assigned a particular icon.

Externally, Metview presents a new user interface thoroughly redesigned to give priority to user customisation ability.

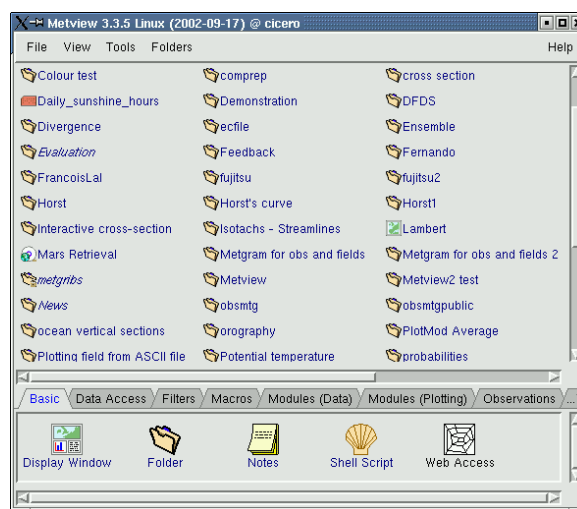


Figure 2 - Metview Main User Interface

The greatest changes took place in the visualisation tool, which was completely rewritten from scratch, with a wide range of features being introduced:

- Arbitrary layout of different plots in the same window based on a graphical interactive Layout editor;

* Corresponding author address: J. Daabeck, ECMWF, Shinfield Park, Reading, Berkshire RG2 9AX, UK; e-mail: jens.daabeck@ecmwf.int

- Data plotting is view based - a view is a plotting perspective, which controls the type of plot (e.g. geographical map, cross-section, etc.) and the plot characteristics (geographical projection, cross-section transect coordinates, among many others). Which plot to obtain from a given data unit is determined by the view specified;
- Drag and drop updating of data, plotting attributes and type of plot (e.g. 2D fields to cross-section, data permitting);
- Browsing and animating a stack of fields, including synchronised animation of individual plots;
- Fully flexible geography manipulation tool including on-the-fly projection changes and windowing.

In spite of the revisions and re-structuring, the new version is backwards compatible, so that older icons and macro programs can be used.

Internally, extensive rewriting, streamlining and simplification of the code took place that will make Metview easier to extend and maintain.

Metview was always available for most UNIX platform flavours. A major and now favoured platform was reached when Metview was ported to Linux.

3. NEW FEATURES IN METVIEW 3

3.1 Layout Editor

According to its Meteorological DTP character, users can arrange their plots in any layout they wish - layout design takes place in an interactive graphical layout editor.

This graphical layout editor simulates a sheet of paper (in European standard A-proportions by default, but users can choose any arbitrary size), which can be subdivided at will into layout frames; arbitrary re-sizing

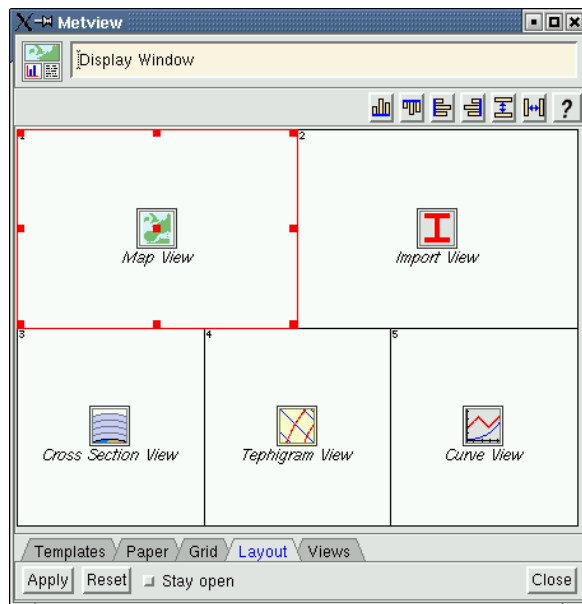


Figure 3 - Graphical Layout Editor with View Icons inserted

and positioning of these frames is available in order to achieve complex layouts with only a few mouse clicks.

Once the layout is designed, users specify which type of plot will be produced in each frame, by supplying appropriate view icons. A finished layout is saved as a display window icon, which when visualised (with a simple mouse click) originates a display window on screen ready for data to be provided and plotted.

3.2 The Display Window

Visualisation is achieved by plain drag and drop of data and visual definition (e.g. a contour specification) icons.

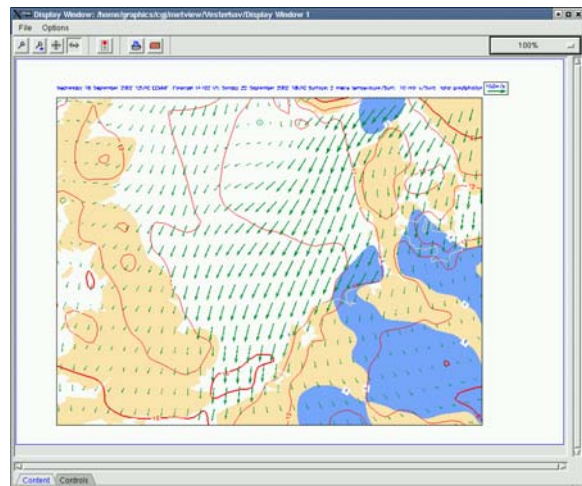


Figure 4 - Display Window

Some data units to be visualised allow different plots to be prepared - e.g. a multi-level, multi-forecast step set of fields can be visualised as a stack of geographical plots or a number of cross sections or vertical profiles. In this case, to quickly change from one plot type to another simply drop a different view icon in the display window, e.g. drop a cross-section icon to change from the current plot to a cross-section plot (or updating to a different cross-section).

3.3 Geography Tool

The display window allows users to change the geographical characteristics of their plots on the fly - through a simple mouse click-right a geography tool is launched which is specific to the plot where clicked. This tool has different flavours depending on the view used for the plot - in the map flavour projection and sub-area can be changed, in the cross section (vertical profile) flavour only transect (point/area) coordinates can be changed; all flavours have a zoom facility to help in selection over small regions.

3.4 Contents handling

Visualisations may involve many different data units and visual definitions. In order to provide users with full

control over the visualisation, the Display Window provides access to its component icons (data, views, visual definitions) through the Contents drawer.

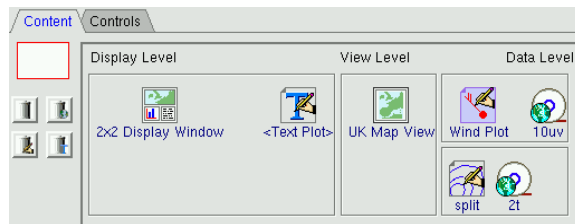


Figure 5 - Contents Drawer in Display Window

The Contents drawer is an interactive representation of the visualisation structure which:

- Provides the user with a schematic display showing all the icons involved, their relative role and their positioning within the visualisation layout;
- Allows the user to modify interactively the icons that make up the visualisation, add new icons to the visualisation and replace or remove existing ones.

In a word, the Contents drawer offers users a very fine degree of control over the visualisation process. Indeed some modifications to a visualisation may only be possible to do via the contents drawer.

3.5 Applications

Applications in Metview 3 work in a more consistent or unified way from those of the previous version. Some applications in Metview 2 returned a mix of data and visualisation info, e.g. a cross-section would return the data plus axis details and formatting.

In Metview 3 there is now a separation of roles - the new applications return only data and nothing else. All plotting detail is taken care of by the visual definitions and the view.

This also means that the output of an application can be saved. This output may be saved as a GRIB file, when the application returns fields or a geopotents file when it returns irregularly spaced data. For other types of output, such as cross section data, the format chosen for output is NetCDF.

3.6 Macro Language

The Metview macro language is designed to perform data manipulation and plotting from within the Metview system environment. A language is the best "user interface" to describe very complex sequences of actions, particularly if the flow of action is conditional. It also provides a common means to express the mathematical formulae used when performing data manipulations and provides an easy, powerful and comprehensive way for a researcher to manipulate and display meteorological data. It extends the use of Metview into an operational environment as it enables a user to write complex scripts that may be run with any desired periodicity.

Macro has been extended with the macro

equivalents of the new features - there are revised commands for the new plot layout, display window, new output devices. Some functions have been added and a new capacity arose from the fact that now applications return data. Whereas before only the result of a cross-section could be visualised, now the output of a cross-section application can be used as a set of fields and used as input into suitable functions which take recognised NetCDF structures as input - this allows easy computation of climatological or ensemble averages, variances, etc, of cross-section data.

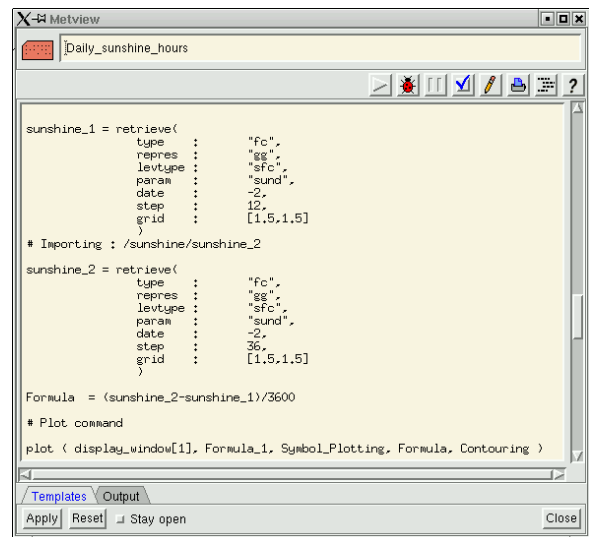


Figure 6 - Metview Macro Editor

3.7 Variety of output devices

So far we focused mainly on the on-screen display of Metview 3. Metview implements what is known as output devices - these are simply the media in which the visualisation is produced. The following output devices are available:

- Screen - visualisation is displayed on screen in the display window tool;
- PostScript / printer - visualisation output to a PostScript file or printer;
- JPEG/PNG - visualisation output to one of these two graphics formats.

3.8 The Import view

For publication purposes, it is sometimes useful to place side by side results generated by Metview with those from a non-Metview source. Provided the "external" item is in PostScript/JPEG/PNG formats, this is done using an Import view, instead of the usual data handling/plotting views (such as Map, Cross-Section, etc.).

3.9 The Text view

As a further aid to user plot publication needs, we incorporated a Text view. This view accepts text (e.g. as

provided by a plain ASCII file) formatted by means of MAGIC string instructions (for font, style and size specification).

This allows users to incorporate their own text elements into a plot, e.g. a detailed explanatory legend; it is meant to bridge the gap between the plot-only capacities of a visualisation package and the professional publishing standards of conventional DTP packages.

3.10 Help/Documentation

Documentation for Metview 3 is an integral part of the installation package. Users can use the Help menu to launch Netscape with the appropriate volume/section of the manual.

For printing purposes the documentation is also available as PDF files; these are prepared with full hyperlink facilities, allowing users to navigate through the document.

4. FUTURE PERSPECTIVES

At the moment Metview has matured and stabilised and this means it is time to start improving on it again.

There is a continuing routine effort to incorporate new data handling abilities in Metview - new projections and geographical representations, new meteorological data fields. Though these efforts are routine and not visible in terms of new user interface details, they are nonetheless one of the main basis for the continuing usage of Metview - making the processing and visualisation of large and complex data sets as easy and simplified as possible. This brings new data sets closer to operational usage by forecasters and liberates valuable "brain time" to the researcher.

A further addition to the desktop publishing dimension of Metview is a straight-to-HTML visualisation output. Users will be able to specify an HTML output device for their visualisation - this means the visualisation will be output to an HTML file which obeys some user (or institution) defined template. This is useful to upload visualisation products to a web page, a process that can be automated if incorporated into a macro program. This simplifies enormously the work from data archive to dissemination channel.

5. CONCLUSION

The Metview project will continue at ECMWF and the software will be developed further. Metview is expected to keep expanding its capabilities to meet the ever-increasing demands from its user base while at the same time widening its hardware basis according to developments in the computer software and hardware industry.

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