ECMWF Feature article

COMPUTING

Metview 4 – ECMWF's latest generation meteorological workstation

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Version 4 builds on the flexible and proven modular structure of previous versions of the Metview meteorological workstation. The system continues to offer an interactive user interface for users to combine and process data from various sources with visual definitions to generate complex meteorological plots. Besides the interactive user interface, Metview offers a very powerful batch system through its macro programming language. An article in the previous *ECMWF Newsletter* (No. 125, Autumn 2010, 30–32) described the Macro language changes for version 4 in more detail.

This article provides an overview of the new features of Metview 4, along with the main differences from Metview 3 from the user's point of view.

Information about how to run Metview 4 is given in Box A.

Motivation for Metview 4

Thanks to its service-oriented architecture, Metview's functionality is divided into separate modules which work together, but can be upgraded individually.

Metview makes use of a number of external packages to process and visualise data. In recent years some of these libraries have been replaced, for example GRIBEX with GRIB_API and MAGICS 6 with Magics++. Metview has undergone some changes to cater for this. Other, more general, third-party libraries such as Motif have ceased development and are in urgent need of replacements. Consequently Motif is being replaced incrementally within Metview by Qt.

Metview 4's use of GRIB_API throughout provides full compatibility with GRIB editions 1 and 2. In addition the support for data in NetCDF format, especially conforming to the CF convention, has been improved. Through the use of Magics++ for the visualisation and a new framework for user interfaces, Metview now provides more interactive functionality within its Display Window. Together with other improvements, Metview can now be built as a 64-bit application, handle larger data sets and provide more user interactivity.

How to run Metview 4   **A**

At ECMWF, version 4 is available internally on Linux workstations and clusters, and on the Ecgate server, by using the command metview4. We recommend that external users who run Metview 3 also install Metview 4 in parallel until they are happy that the new version can replace their current Metview installation.

New Display Window

The main visible change for interactive users of Metview is the newly designed display module, called uPlot (Figure 1). The module has been re-written to take advantage of Magics++ for its plots. Its toolbars can be removed or detached and docked elsewhere on the window. Also its panes can be resized. These settings are remembered each time you close a Display Window.

By default the new control area is on the right of the Display Window. This area is subdivided into tabs and allows the user to easily browse the data and alter the plot.

All the plots are listed in the Frames tab; this panel allows users to step through all the plots. Pressing the left and right cursor keys also moves between plots. Each column provides a piece of meta-data about the fields (queried through keys) – clicking on the column headings sorts the frames. The keys can be grouped into a user-configurable 'key profile', and multiple profiles can be set up.

Beside the Frames tab is the Layers tab (Figure 2), providing a quick way to toggle plot layers on or off. The Layers tab can also be used to alter the transparency of any layer, although when the plot is saved, not all graphics file formats support transparency. A user should imagine looking down through the layers, with the top layer closest to their eye.

The magnifying glass provides a way for an analyst to examine small numbers and symbols. On its left-hand side the control adjusts the magnification scale. The glass can be resized and moved with the mouse. Various options are available to zoom the display and a user can select a previous view in the zoom history.

The Display Window also has, among other features, animation controls, an anti-aliasing option for smoothing the plots, the ability to send a plot to a printer or file (multiple output formats may be generated in one go), and a button to create a macro that will automatically re-create the plot.
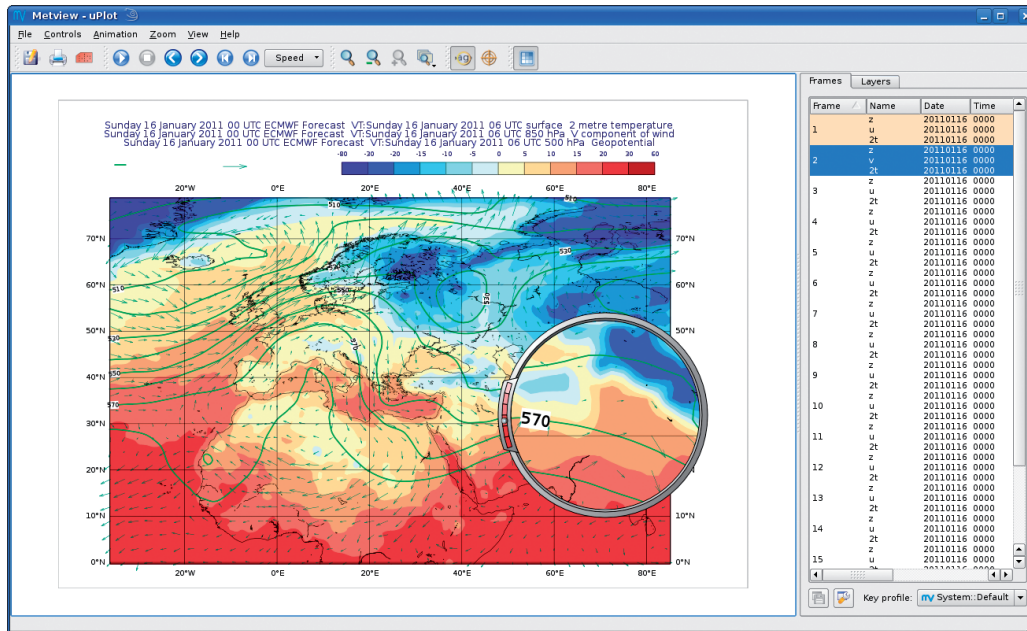

Figure 1 The new visualisation module of Metview 4. Icons on the top let the user interact with the display, while the menu on the right enables browsing through frames and layers.
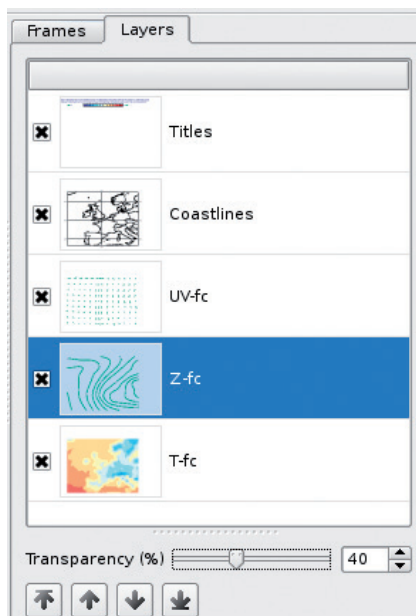

Figure 2 The Layers tab allows the user to reorder the plot layers (either using the buttons or by dragging and dropping) and set the transparency of each.

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Data examiners

To allow analysts and researchers to examine meteorological data, Metview 4 provides new, more powerful, data examiners. In addition to the existing NetCDF and geopoints examiners, new tools for inspecting GRIB and BUFR data are available. To examine a GRIB file, right-click on its icon and select 'examine' from the context menu. The GRIB examiner will appear, as illustrated in Figure 3.

The left-hand pane contains a list of all the messages (fields) in the GRIB file; when one is selected, the meta-data on the right-hand-side is updated for that message. A number of options allow different ways of viewing the meta-data.

By clicking on the column headings in the messages pane the messages can be sorted. The columns represent GRIB_API keys, and can be configured using the buttons at the top, or from the Profiles menu - see Figure 4. Multiple key profiles can be set up and shared with the Display Window.

Internally, Metview's GRIB examiner uses both the grib_dump command and GRIB_API's programming interface to display the meta-data – the log window at the bottom will convey any error or warning messages to the user.

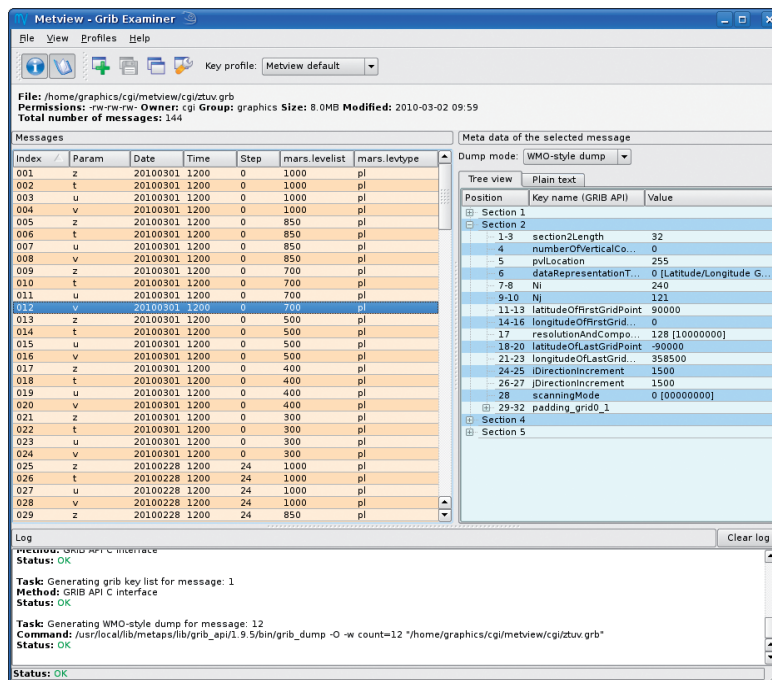The BUFR examiner follows a similar design to the GRIB examiner and is shown in Figure 5.

Figure 3 The GRIB examiner in Metview 4 offers a powerful way to inspect data.
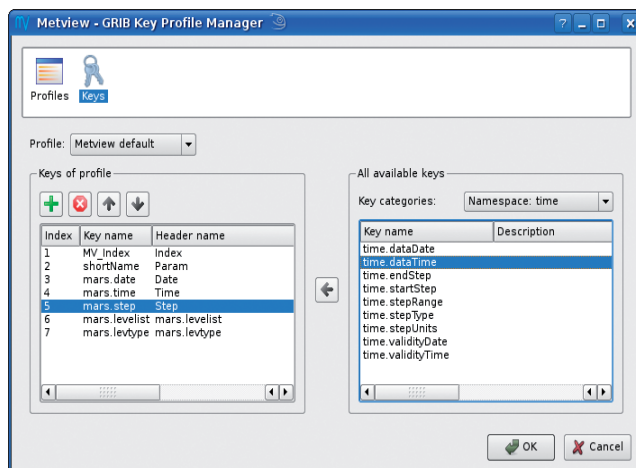Meta-data can be displayed in many user-configurable ways from an intuitive interface.

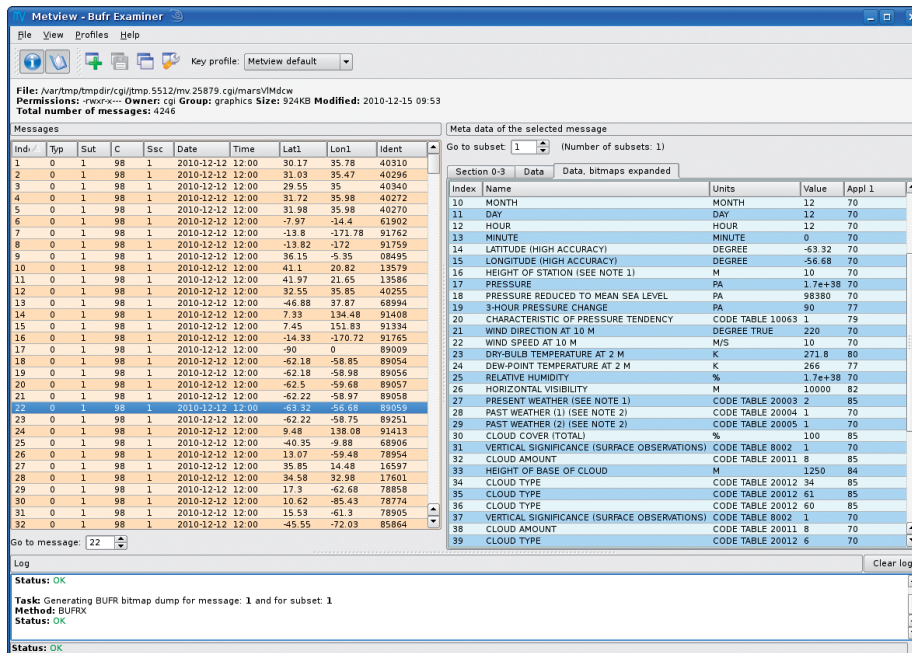**Figure 4** The GRIB examiner can be configured to show different user-defined selections of keys.

Figure 5 The BUFR examiner has a similar look and feel to the GRIB examiner, providing an easy and powerful way to inspect BUFR data.

New Macro Editor

Analysts and researchers can leverage even more power out of Metview by using its macro scripting language. The new Macro Editor provides all the functionality of the previous one and more, and is much more user-friendly. One of the most powerful features of Metview's Macro Editor has been the ability to drop Metview icons into it, automatically generating the equivalent macro code. This facility has been retained, along with the ability to run macros directly from the editor.

This Macro Editor behaves more intuitively than the previous version with regards to copy & paste, and has an 'undo' feature. It also gives the user control over the use of tabs and spaces, and by default automatically indents text by the same amount as on the previous line (see the Settings menu). Line numbers can be displayed down the left-hand side and the Macro code is syntax highlighted (Figure 6). Some basic functionality is provided for interactive help: a list of available macro functions is provided, a set of pre-prepared skeleton code templates is available and 'icon functions' such as `pcont()` have a special help dialogue which lists the available parameters and values. The Macro Editor extends its power to the editing of MagML (the XML interface to Magics++) files, shell scripts and plain text files.

ODB Visualisation

Metview's interface to ECMWF's Observational DataBase (ODB) has been redesigned and now enables users to examine, filter, plot and process ODB data within the Metview environment. These actions are available both in the interactive user interface and in the Macro language.

The contents of ODB data can be inspected via the ODB examiner, which is the latest development of the new data examiners. Users can write and perform ODB/SQL queries and visualise the resulting data using the *ODB Manager* icon. This icon provides a quick and easy way to generate maps with symbol and wind plotting out of the ODB data. Both symbol and wind plotting in Metview 4 now benefit from the improved functionalities of Magics++: the most important novelty is that the colour palette can be automatically generated for the plots, just like it has been available for the *Contouring* icon. This feature makes ODB plot generation much easier.

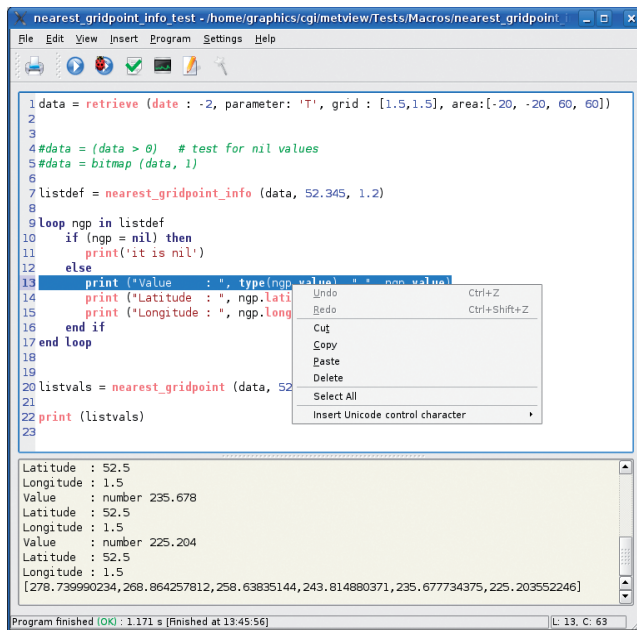ODB data can be overlaid with any other data types in Metview as shown in Figure 7.

Figure 6 The new Macro Editor gives users powerful code editing facilities, allowing faster development cycles.
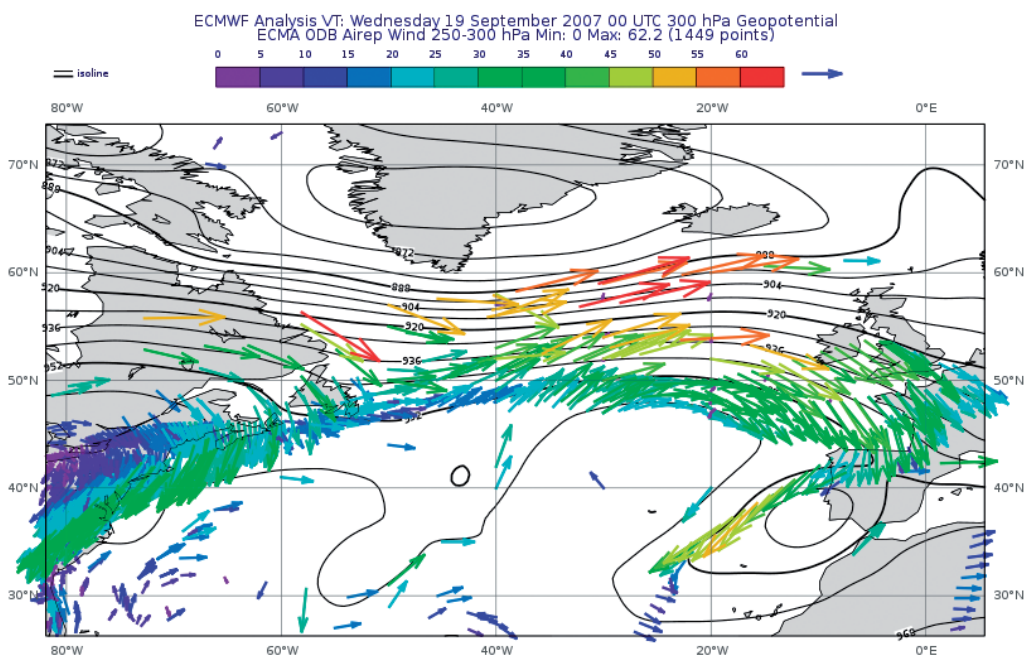

Figure 7 Wind data from an ODB overlaid with isolines of geopotential from GRIB data.

Support for OGC web services

The Open Geospatial Consortium (OGC) defines a number of standards for serving and retrieving geospatial data over the web. One of these is the Web Map Service (WMS), which focuses on geographical maps. This server-oriented concept fits neatly into Metview's architecture and so a WMS client was developed for Metview 4. This allows users to overlay Metview charts with maps provided by other organisations. Figure 8 shows snapshots of how these WMS layers can be queried and how they look overlaid in the Display Window.

Work on Metview's OGC clients is still ongoing and ECMWF's Graphics Section is actively involved in the work of the MetOcean Domain Working Group of the OGC to promote the use of OGC standards within meteorology.
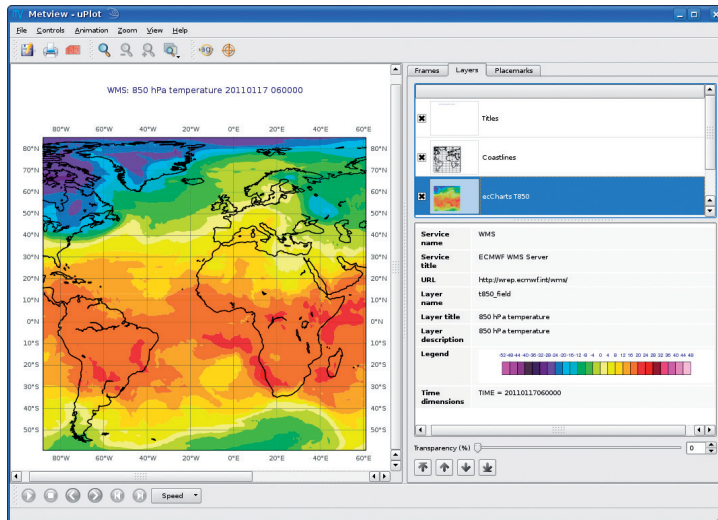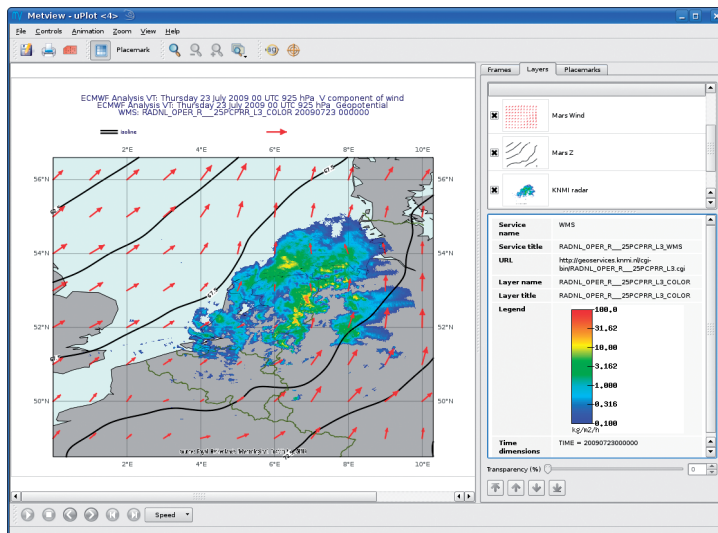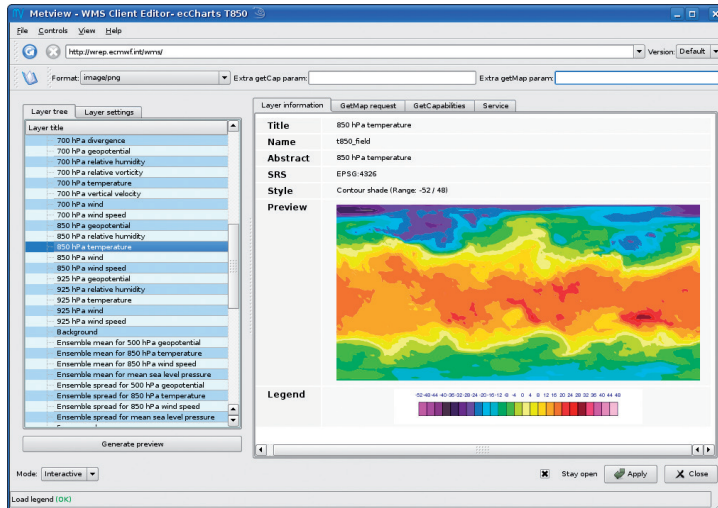
Figure 8 Interface to select layers provided by a WMS server, in this case ECMWF's ecCharts (left), and the resulting plot (top right). A further example shows radar data from KNMI's WMS server overlaid with forecast data from ECMWF's MARS archive (bottom right).

Figure 9 A contour definition icon from Metview 3 and Metview 4.

Other changes since Metview 3

One of the aims of Metview 4 is to utilise the new plotting features of Magics++. This requires many icons to be updated, specifically the visual definition icons such as *Contouring* and *Coastlines*. To avoid interfering with Metview 3's existing icons, Metview 4 defines a new set. These icons look the same as the old ones, but have some different parameters available. Metview 3's icons continue to work as normal (with some possible changes in behaviour), but they will appear slightly greyed out. Figure 9 shows this difference.

Metview 4 will not allow the direct creation of new instances of the 'old' icons, but the new ones can be found in the desktop drawers and in the New Icon desktop menu. From the point of view of macros, these icons have different icon-function names with the 'p' prefix replaced with an 'm'; instead of `pcoast()` we have `mcoast()` etc.

Although old icons will still work in Metview 4, users may wish to convert some of them to the new formats in order to use the new parameters available; this can be done with the icon editors. As an example, suppose there is a *Contouring* icon from Metview 3 which a user wishes to convert into a Metview 4 *Contouring* icon. In Metview 4, a new contour icon should first be created and opened for edit. The old icon is now dropped into the icon editor and the parameters that are valid in the new icon will be transferred; clicking the *Apply* button will save the new icon.

With the aim of allowing Metview 3 and Metview 4 to be run side-by-side, Metview 4 now stores the system settings in a new folder. Everything which was previously stored in the `~/metview/Metview` folder is now stored in `~/metview/System`. This includes default icons, icon templates, the contents of icon drawers and Metview's preferences. These will be initially set to the new defaults, so any user-created icon drawers or defaults set up in Metview 3 will not automatically be available (although old icons can still be copied across to the new folders).

Future developments

Metview 4 is still under active development. Layout options and overlay controls are being improved, making complex plots easier to produce. Also enhanced interactivity within icon editors will make Metview an even more powerful tool for data query.

Work is also in progress to make more use of the macro language's built-in vector data type. Many macro functions, for example `gridvals()`, currently return a long list of numbers; the `list` is a very useful general-purpose structure for storing elements of any type, but the `vector` is optimised for sets of numbers and the performance difference can be very significant. Metview 4 will introduce a much richer set of functionality for the `vector` data type, and functions which currently return a long `list` of numbers will now return a `vector`. Because the access of `list` and `vector` elements is identical, users should not have to change any code in order to take advantage of this.

User feedback is important for improving Metview, and users are encouraged to send their suggestions by e-mail to metview@ecmwf.int.