

Magics++, The next generation of ECMWF's meteorological graphics library

Stephan Siemen

Since 1984 the MAGICS (Meteorological Application Graphics Integrated Colour System) graphics library has been at the heart of the plotting of weather maps at the ECMCF, its Member States and other weather services around the world. Alone at the European weather centre every day hundreds of maps are produced and printed for the MetOps room and further thousands of plots are produced for the ECMWF web page. This last number is steadily growing.

MAGICS is not only used directly through its Fortran interface, but it is also used to produce graphics inside ECMWF's Metview and *Météo-France's* Synergie.

Why redesign MAGICS?

MAGICS source code has been developed over the past 20 year which brings with it a large legacy. To take advantage of recent developments in software engineering and clean the code of the legacy the decision was made to rewrite MAGICS. As MAGICS was first designed, techniques such as the internet, object-oriented programming and user interactivity were not thought of. The next generation of MAGICS, called Magics++ to avoid confusion, will make use of these new technologies.

MAGICS was originally designed to provide paper printouts of weather maps, but over the last years the majority of plots are produced for the web. An example of how times have changed can be seen in how the text is formatted. MAGICS has a quite complicated and very restricted way of defining special fonts and characters, while Magics++ will use HTML style to format text to make it more flexible and usable.

With Intel's IA-64 and AMD64 appearing as new platforms, MAGICS was in need of a major overhaul, because the 64bit pointers of these platforms were incompatible with the design of MAGICS. The new design is independent of the size of pointers.

Magics++ will also have a new installation procedure which makes it easier to install than the *imake* based installation of MAGICS. The *configure* tool used, is widely used for many software packages on Unix systems.

Even though the design of MAGICS is changing, the Fortran interface used by many programs will be maintained to be as backwards compatible as possible with the old MAGICS. Small changes are necessary (e.g. default coastline colour changed from yellow to black) and newer interactive features may not be used through the Fortran interface.

The new architecture

Magics++ is programmed in C++ in a strict object-oriented way, whereby the objects are defined in a meteorological sense. These objects are defined in XML and the source code and documentation are generated through scripts from these definitions. This allows a focus on the design of Magics++ and not on the implementation of code. Through this system it is also easier to extend Magics++.

To have run-time information, such as descriptions of observational symbols, also in XML files has the advantage that they can be changed without a recompilation of the library itself.

In the last workshop it was presented that the algorithms developed by Hiroshi Akima (*ACM Transactions on Mathematical Sciences*) will be used for contouring. The algorithms were chosen because of their flexibility and their support of gridded and scattered data. INPE/CPTEC (Brazil) has successfully implemented the algorithms in C++.

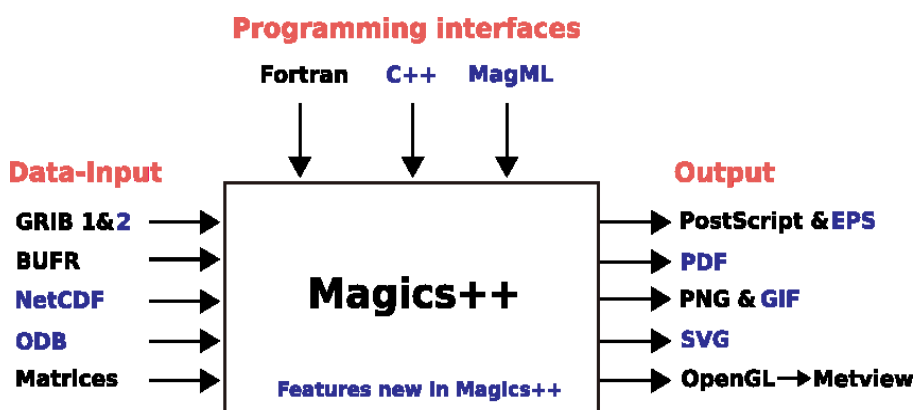


Fig. 1 Magics++ as the user will see it. Features new to Magics++ are in blue.

Data formats

Magics++ is one of the first users of ECMWF's new *GribAPI* library and so not only supports GRIB version 1 but also version 2. NetCDF is now also supported with its own action routine PNETCDF.

New in Magics++ is the general support for retrieving data from databases and plotting it directly in Magics++. In particular ECMWF's ODB (*Observational DataBase*) is supported to retrieve data and plot it directly in Magics++. This is especially challenging because of the large amounts of data involved.

Programming interfaces

Until now MAGICS has been only usable through its Fortran interface. This will change with Magics++. Beside the procedural Fortran interface (now also usable with C), a new object-oriented interface can be used by C++ or MagML. The latter is a descriptive language based on XML.

The object-oriented interfaces are not intended for direct use, because their objects are based on the internal structure of Magics++, and are therefore hard to program without knowledge about it. The usage of these interfaces will be more through Metview (C++) and web services (ECMWF's *plot-on-demand*).

Output formats

In addition to the output formats of MAGICS (PS, JPEG, PNG), Magics++ will support EPS (Encapsulated PostScript), PDF, GIF and SVG. Magics++ allows the definition of multiple output formats one a time, which saves computational time, because tasks are only run once.

As SVG was discussed in detail in the last workshop it was hoped that by the time of this workshop this format would be better supported in browsers. Unfortunately this has not happened. Especially in text sizes and support of interactivity there are major differences between browsers. Should SVG support not improve, it would be possible to change the SVG output to another XML based format if necessary (e.g. Microsoft XAML).

Future benefits for Metview

Many new features of Magics++ will naturally also benefit Metview. Metview will be able to take greater advantage of Magics++ as soon a new plotting module is written, because both use the same programming language, C++. The new plot module should have improved quality of text and import of graphics. The interactivity should be improved, by allowing the toggling of contour labels, HiLo and shading. Resolutions of contours and coastlines will be changeable interactively.

The way ahead

Magics++ has already been used at ECMWF for the ERA40 catalogue and is being tested for the *plot-on-demand* project. In November 2005 version 1.0 will be released internally in ECMWF. A version on *ecgate* for Member States will follow soon. A release of an external version is planned for the second half of 2006.

After the internal release of Magics++ the work will continue on the integration of Magics++ into Metview.

The progress and documentation of Magics++ can be seen on its webpage at:
<http://www.ecmwf.int/publications/manuals/magics>

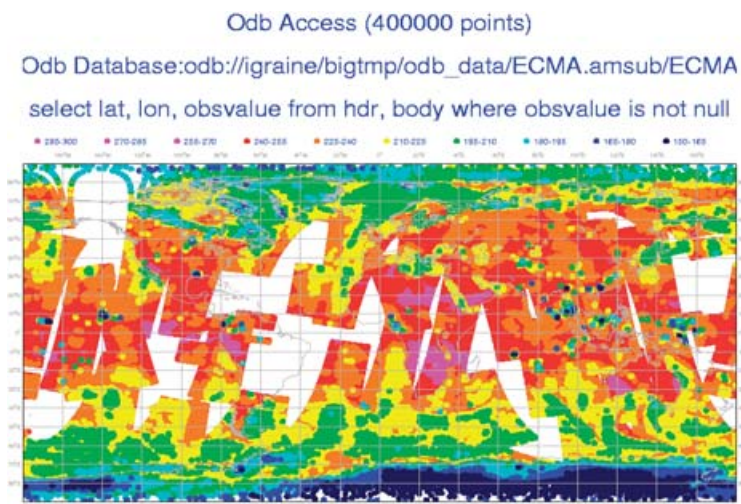


Fig. 2 Magics++ and ODB. The title shows details of the request.

850 hPa Temperature Differences
19th February 2004 : 5-day Forecast minus Analysis

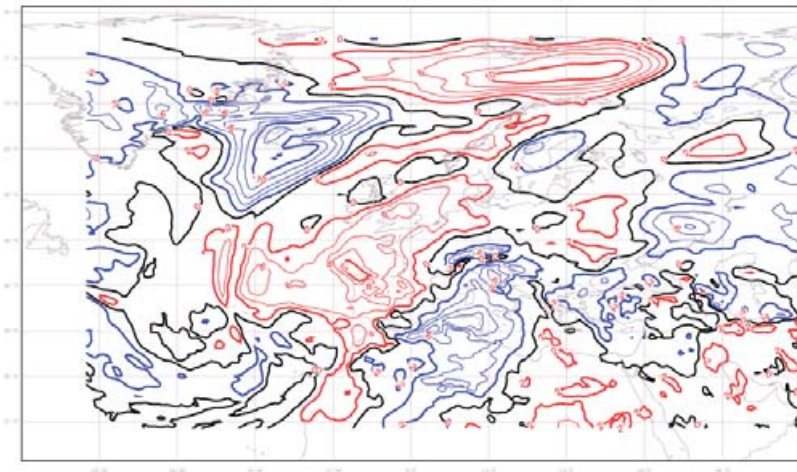


Fig. 3 Split contour of difference field.

Contours with solid shading

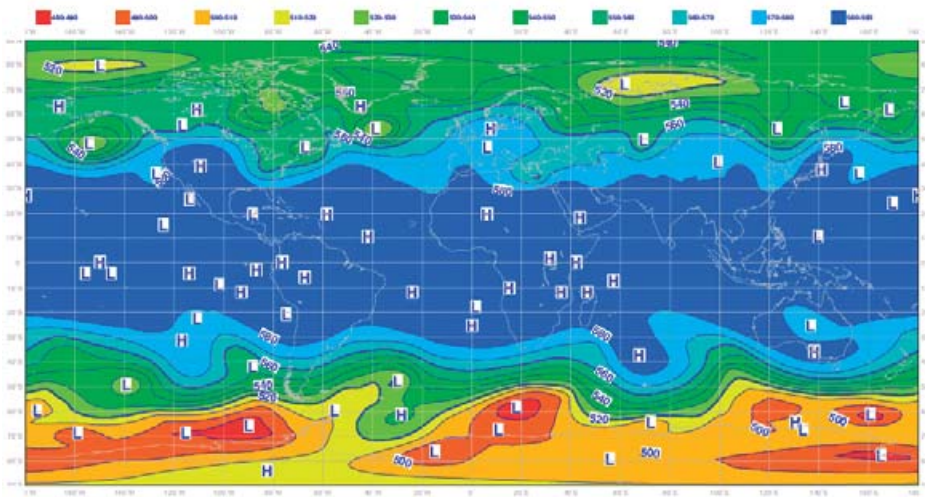


Fig. 4 Solid shading with Magics++.

Wind arrows, thinning 1.0

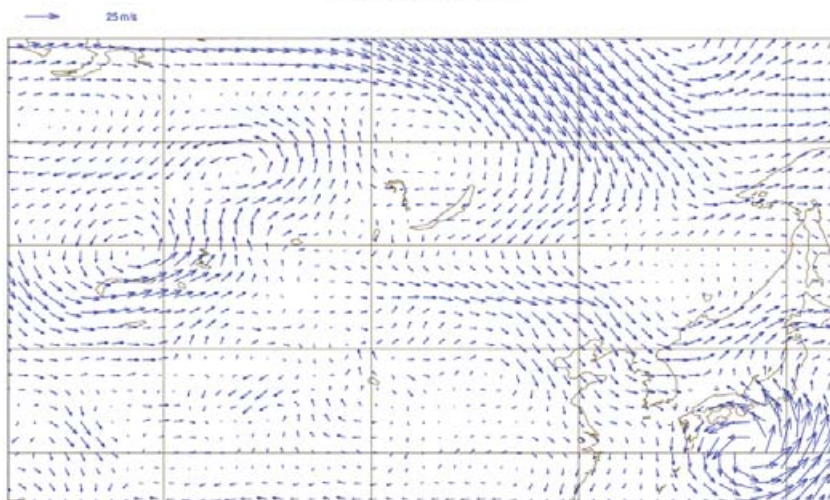


Fig. 5 Wind field plotting with Magics++.