

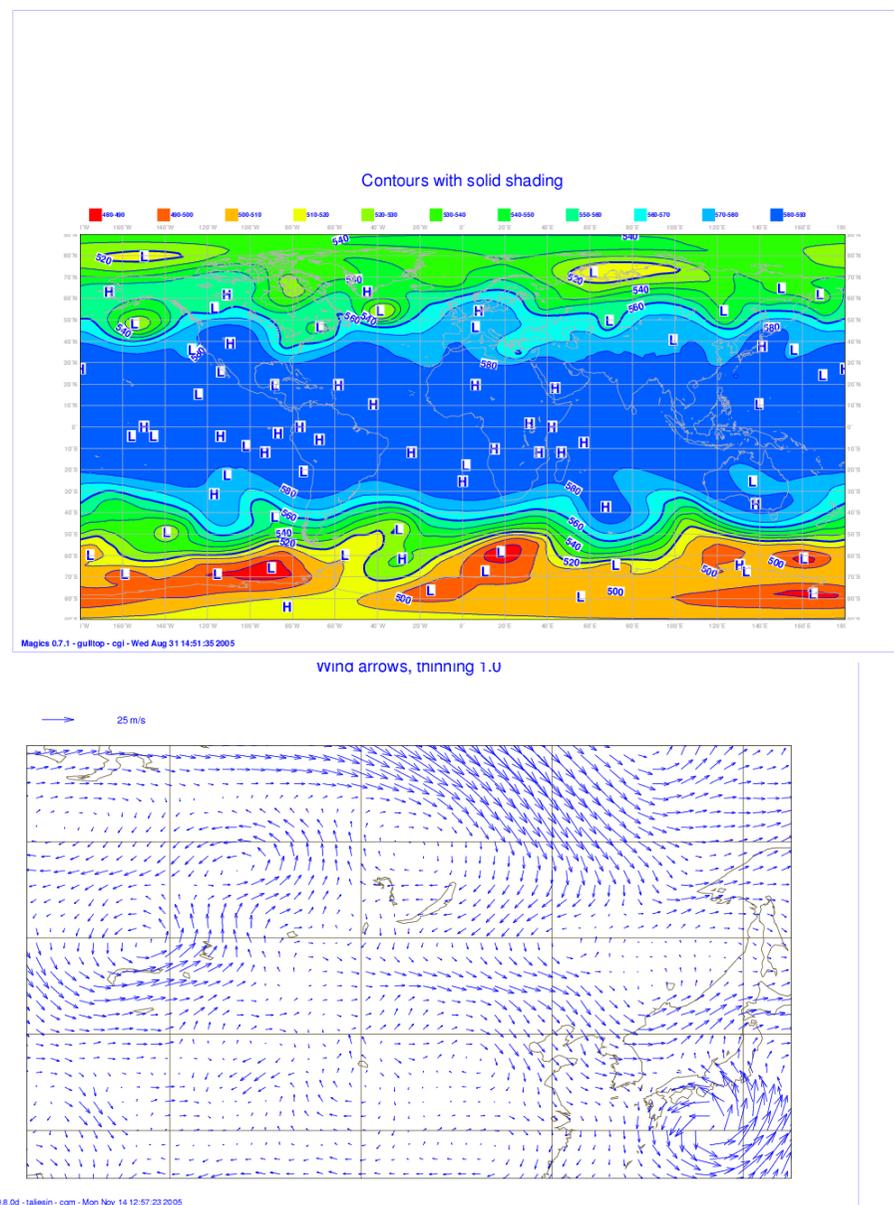
Magics++

The next generation of ECMWF's
meteorological graphics library

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MAGICS 6.x

- **Meteorological Applications Graphics Integrated Colour System**
- **In operational use since 1984**
- **Used by Member States and many other weather services**
- **Used in *Metview* and *Synergie***
- **Hundreds of plots are produced daily for MetOps**
- **Thousands of plots for the Web with growing demand**

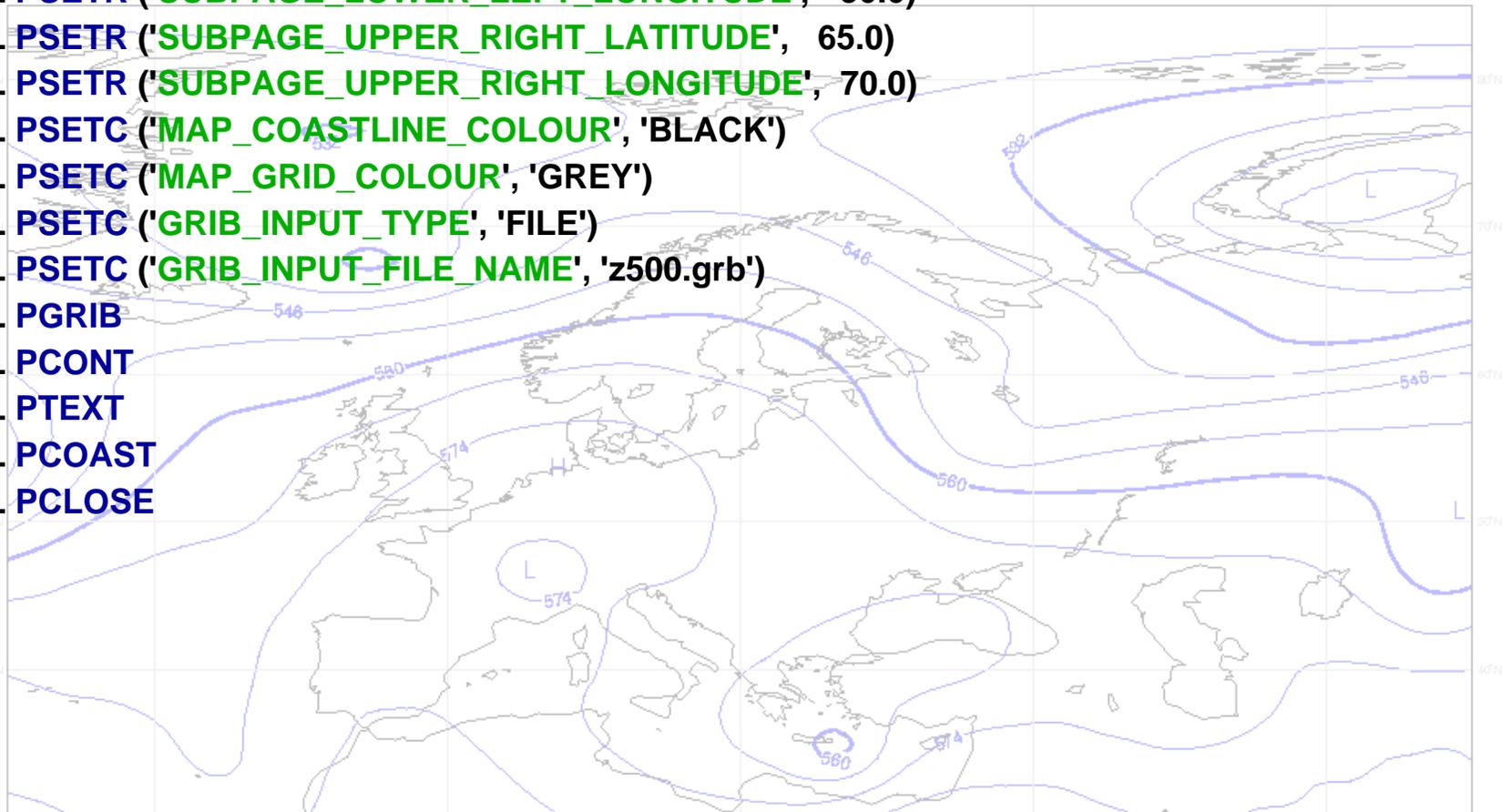
Why redesign MAGICS?

- **20 years of code history/legacy**
- **Take advantage of recent developments in software engineering**
- **Work practice changing: from paper to web usage (e.g. formatting text)**
- **New architecture allows more interactivity for users with Metview and formats such as SVG**
- **GNU *configure* simplifies installation and allows shared libraries to be built**
- **MAGICS 6.x way of handling pointers is not working on IA64/AMD64 bit platforms**

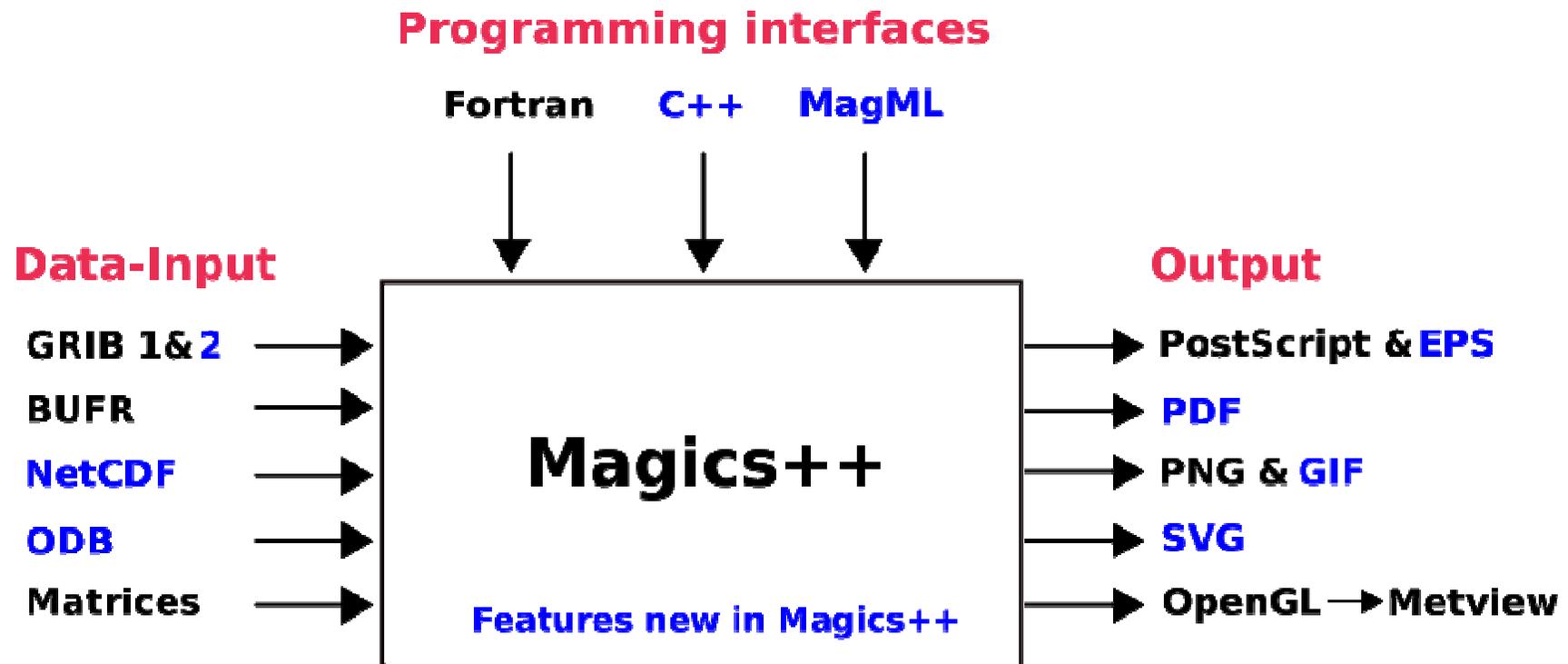
But ensure backwards compatibility!

Compatibility – Fortran example

```
CALL POPEN
CALL PSETR ('SUBPAGE_LOWER_LEFT_LATITUDE', 30.0)
CALL PSETR ('SUBPAGE_LOWER_LEFT_LONGITUDE', -30.0)
CALL PSETR ('SUBPAGE_UPPER_RIGHT_LATITUDE', 65.0)
CALL PSETR ('SUBPAGE_UPPER_RIGHT_LONGITUDE', 70.0)
CALL PSETC ('MAP_COASTLINE_COLOUR', 'BLACK')
CALL PSETC ('MAP_GRID_COLOUR', 'GREY')
CALL PSETC ('GRIB_INPUT_TYPE', 'FILE')
CALL PSETC ('GRIB_INPUT_FILE_NAME', 'z500.grb')
CALL PGRIB
CALL PCONT
CALL PTEXT
CALL PCOAST
CALL PCLOSE
END
```



Magics++ - how the user sees it



The new architecture (1)

- **Object-oriented architecture, where objects have a meteorological meaning (e.g. *EPSgram*)**
- **Magics++ objects are defined in XML so that code and documentation are produced automatically**
- **Standard C++ features such as the *STL* and well-known design patterns make Magics++ more portable and easier to optimise**
- **More user control over the resolution of contouring and coastlines**
- **Allows clearer warning and error messages**

The new architecture (2)

- Easier to implement a new data format or add a driver
- XML based formats for descriptions of titles and symbols is convenient and allows users to change these without recompiling the library

MAGICS 6.x:

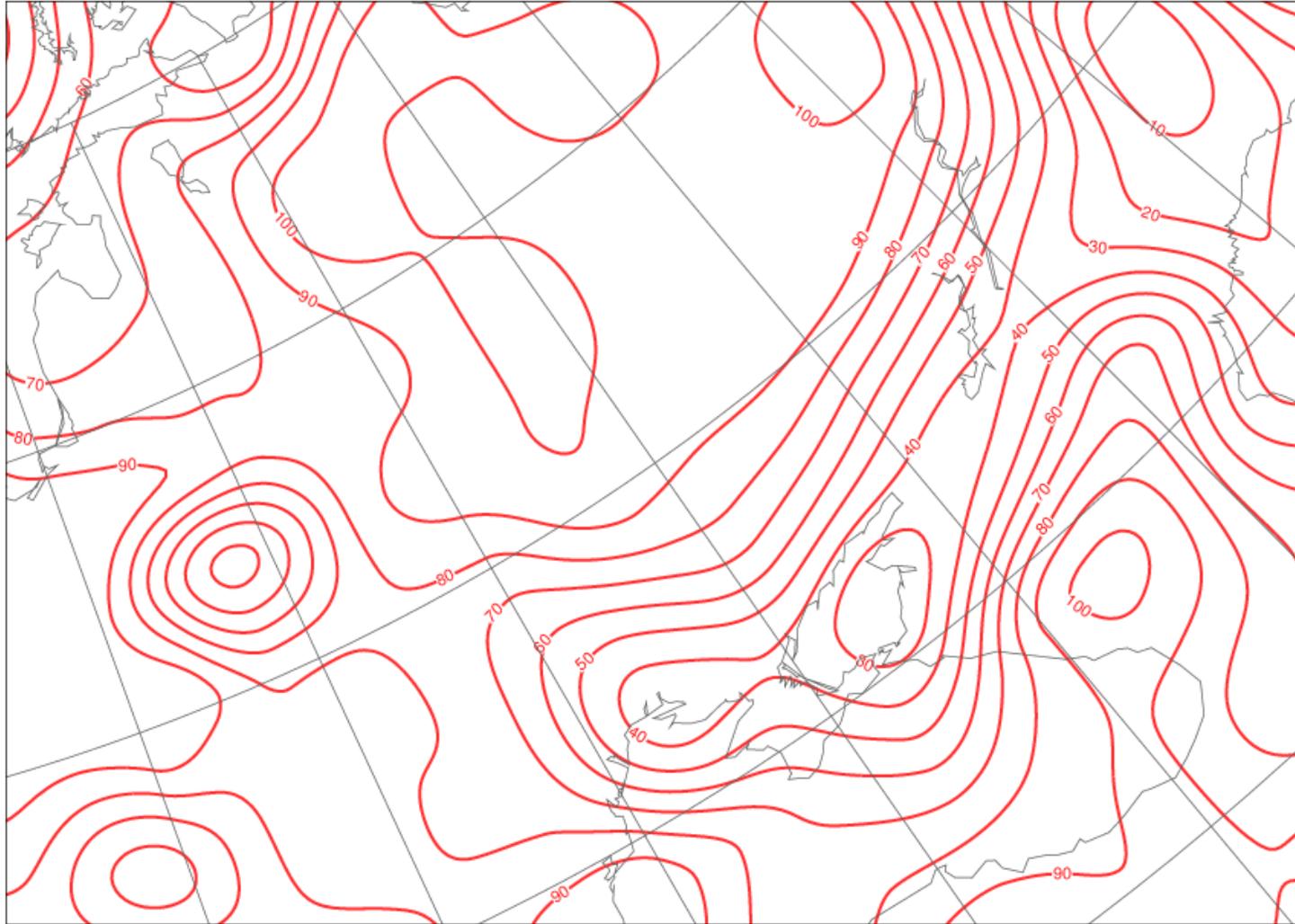
3 & pot temp & potential temperature & 1.0 & 0.0 & K & deg k & 5.0 & 0 & 0 & & PT &

Magics++: <centre code='98'>
 <table code='128'>
 ...
 <param code='3'
 short_title='pot temp'
 long_title='potential temperature'
 scaling='1.0' offset='-0.0'
 original_unit='K' derived_unit='deg k'
 vector1='0' vector2='0'
 contour_interval='5.0' />
 ...

Contouring - Akima

- **Successful implementation of Akima algorithms, as presented at last Workshop**
- **Algorithms developed by Hiroshi Akima - documented in the ACM Transactions on Mathematical Software**
- **INPE/CPTEC (Brazil) has been implementing a C++ version**
- **Algorithms handle gridded and scattered data**
- **Speed and accuracy are configurable by the user, although Magics++ will always choose sensible automatic values by default**

Akima Contouring; Relative Humidity, 850hPa; 1st March 2005.



Magics 0.8.0d - gulltop - cgi - Mon Nov 14 15:48:42 2005

Data formats

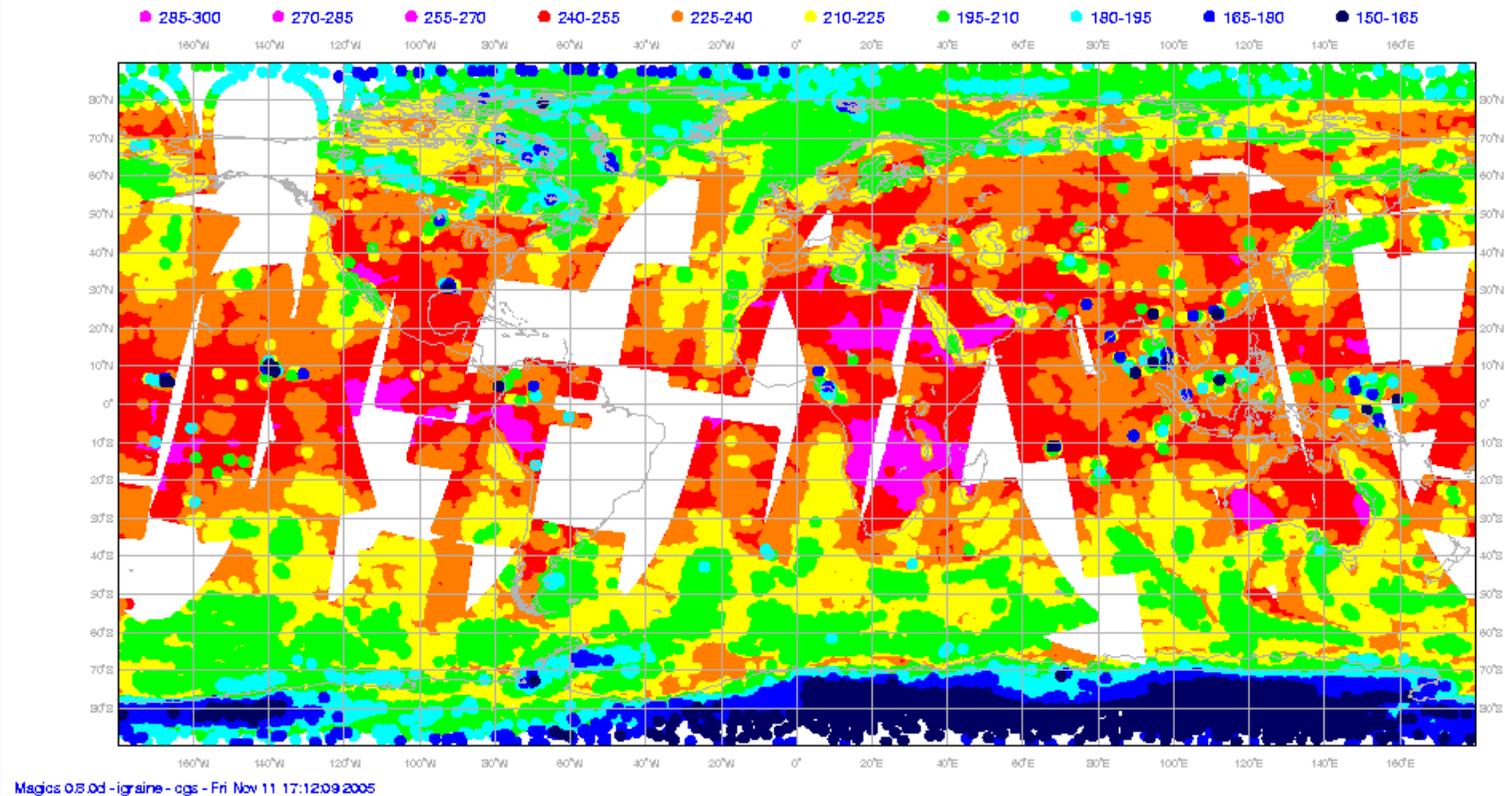
- **Grib versions 1 & 2 are supported through new ECMWF GribAPI library**
- **NetCDF support added**
- **Observations no longer only read from BUFR**
- **Magics++ supports the retrieval of data through ECMWF's *Observational DataBase* (ODB)**
- **ODB request can be sent from Magics++ and instantly plotted**
- **The high data volume of the ODB is challenging, especially for interactive usage**
- **Magics++ can easily be extended to access other databases**

Magics++ and ODB example

Odb Access (400000 points)

Odb Database:odb://igraine/bigtmp/odb_data/ECMA.amsub/ECMA

select lat, lon, obsvalue from hdr, body where obsvalue is not null



Programming Interfaces

- **Definitions of Magics++ plots can be written in Fortran, C/C++ and MagML (XML)**
- **Procedural (Fortran/C) and object-oriented (C++, MagML)**
- **The simple API for Fortran with its *parameter* concept stays – with a few default values changed**
- **Aim is to plot meteorological data as simply as possible with meaningful automatic scaling and title**

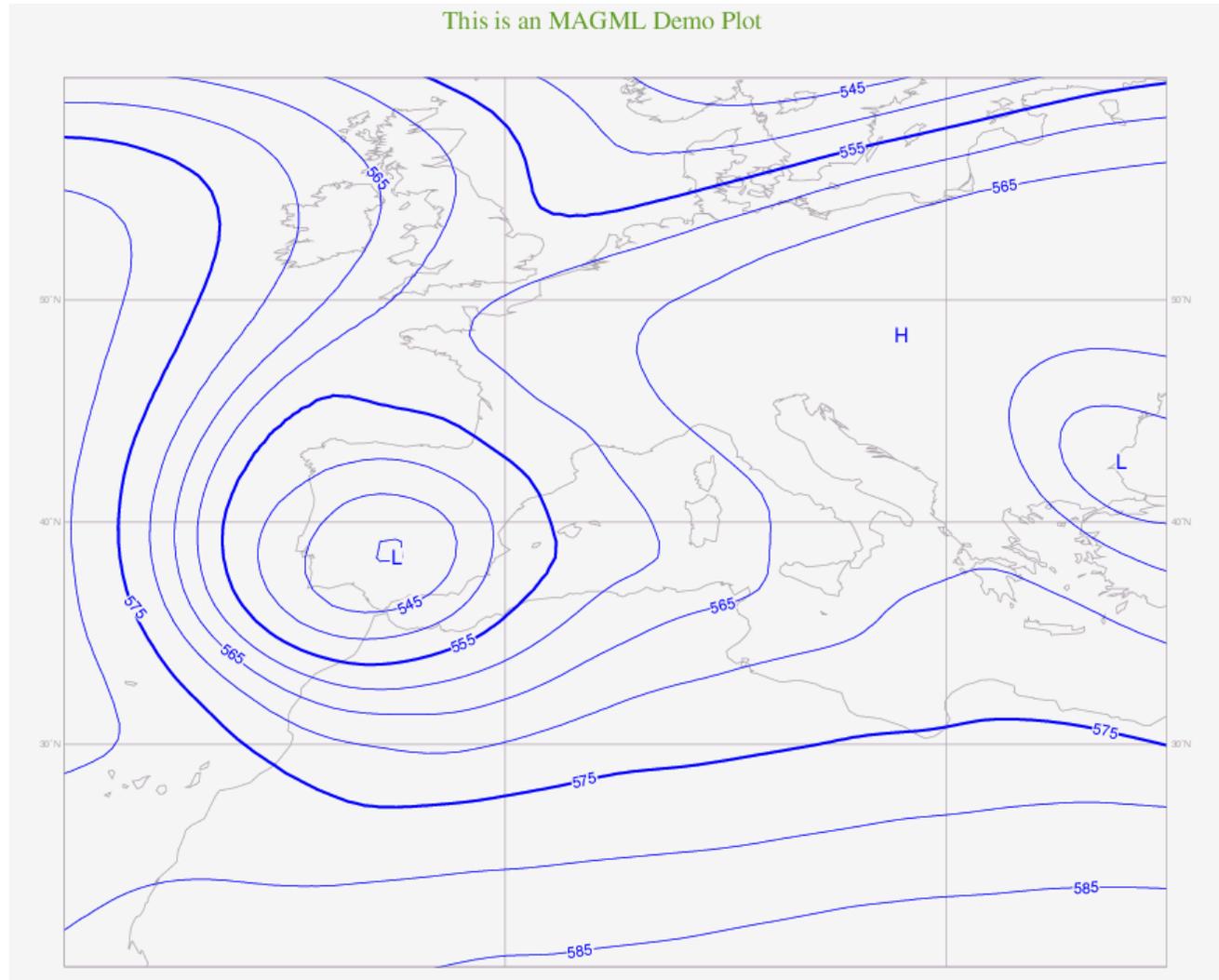
MagML

- XML based format to describe Magics++ plots
- Descriptive, not procedural
- No need for (re-)compilation
- *MagML_Interpreter* program processes a MagML file
- Interpreter can be easily called in user code
- Description is very different from Fortran API – more closely reflecting the internal structure of Magics++
- Can be integrated into more complex XML request descriptions → see “plot on demand” demo

MagML example (1) – the code

```
<magics>
  <page format='a4' orientation = 'landscape' >
    <subpage>
      <mapview>
        <cylindrical>
          <corners min_longitude='-20' min_latitude='20' max_longitude='30' max_latitude='60' />
        </cylindrical>
      </mapview>
      <coastlines>
        <coast>
          <colour> grey </colour>
        </coast>
      </coastlines>
      <layer>
        <grib path = '/path_to_data/z500.grb' />
        <contour/>
      </layer>
      <text font ='Times-Roman' >This is an MAGML Demo Plot
        <colour> avocado </colour>
      </text>
    </subpage>
  </page>
</magics>
```

MagML example (2) - the output

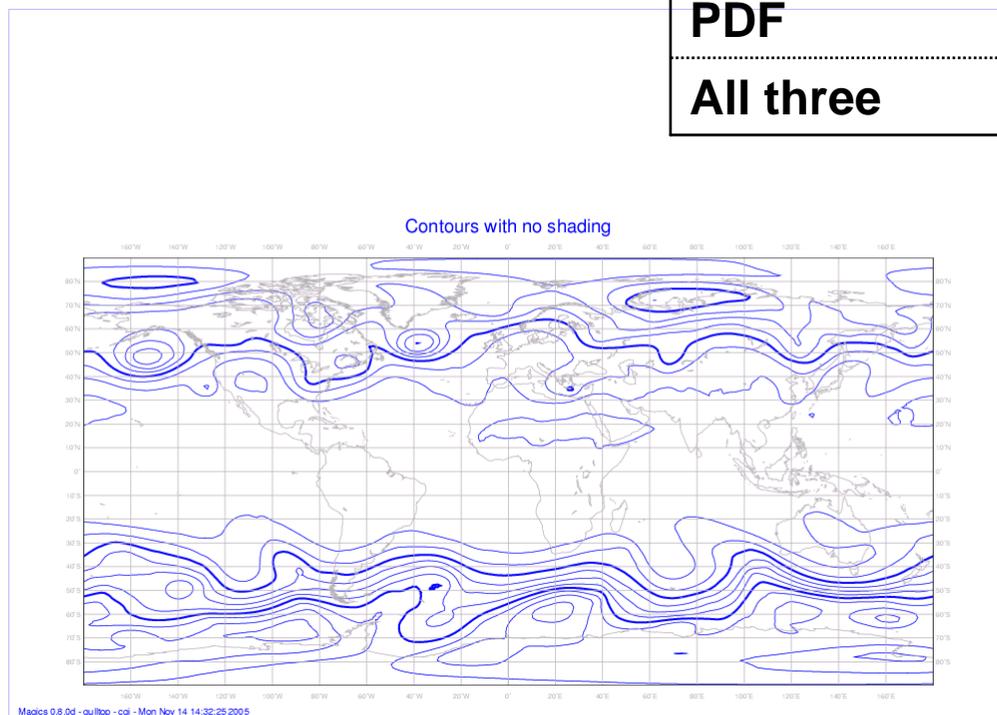


Output formats

- In a single run **Magics++** can produce multiple output formats to save computing time (calculations are only performed once)
- New object-oriented architecture allows easy implementing of new output drivers
- PostScript driver extended to output PDF and EPS
- **Magics++** uses *GD* to produce GIF, PNG and JPEG (much faster than with *ImageMagick's convert*)
- GIFs can be animated

Multiple output formats - example

	MAGICS 6.10 +convert	Magics++
PostScript	0.51	0.46
GIF	1.58	0.50
PDF	1.39	0.88
All three	2.46	1.12



Output formats - SVG

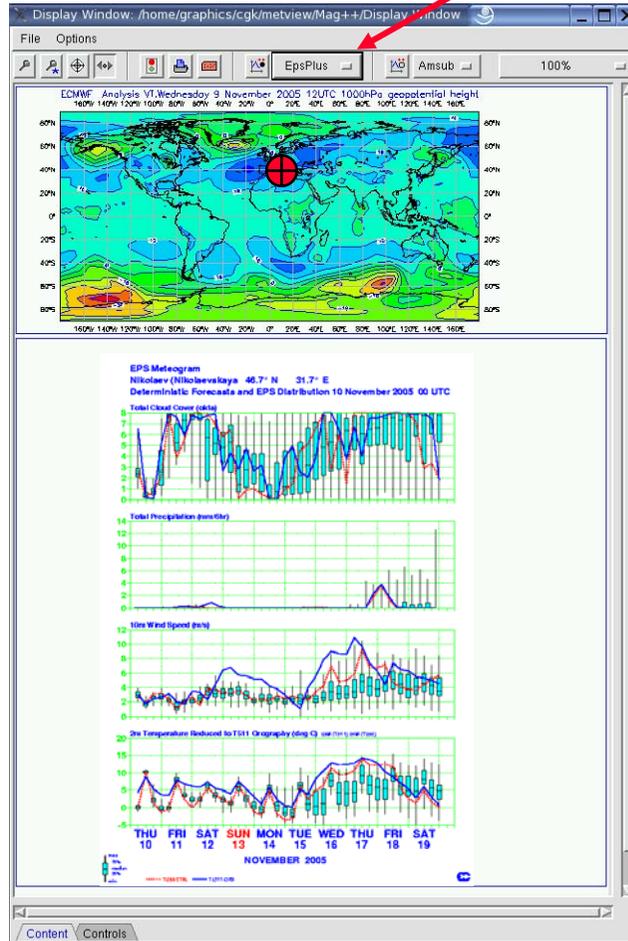
- **SVG is an XML based vector graphics format for the web**
- **Supports interaction with user to enable navigation through a plot**
- **Problem is the support of SVG in web browsers (differences in scripting and font sizes)**
- **The hope of the last workshop that SVG would be much better supported by now has not materialised**
- **Driver can easily be adapted to support any other future XML based vector graphics format (e.g. MS WVG/Avalon)**

Future benefits for Metview

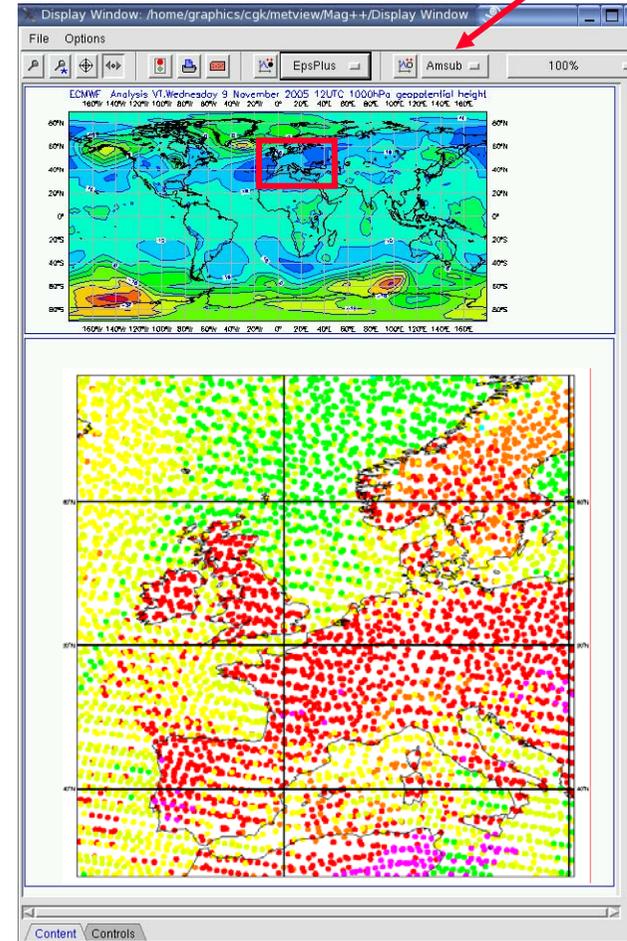
- **Magics++ and Metview will both use C++**
- **More input and output formats**
- **More interactivity for users**
 - toggle contour labels, shading, HiLo
 - change quality of contours/coastlines
- **Better display through the new OpenGL driver**
 - higher quality text
 - improved import of graphics
- **Generate MagML for plot-on-demand (web)**

Magics++ in Metview

Point selection



Area selection



Lessons learned

- **Using XML for the description of objects and configuration has made Magics++ very flexible and stable**
- **Choice of *STL* container can affect the performance a lot**
- **C++ *exceptions* are not working with Fortran inside static libraries**
- **Converting from *ClearCase* to *Perforce* for version control was a big improvement**
- **Limit the number of third-party dependencies**
- **Benefit of automated test suite with HTML output (various platforms / ECMWF SMS)**

The way ahead (1)

- **Magics++ was already used for the ERA-40 catalogue ('PNETCDF') and is being tested at ECMWF for web requests through MagML**
- **Nov. 2005: Internal release of Magics++ 1.0 in ECMWF**
- **Version on *ecgate*, to test for Member States, follows shortly**
- **Followed by external webpage**

<http://www.ecmwf.int/publications/manuals/magics>

The way ahead

- **Implementing further interactive features in SVG output**
- **Release of external version second half 2006**
- **Integrate Magics++ into Metview and extend Metview to take advantage of new features (i.e. interactivity)**
- **Consider using GIS data in Magics++ (see Working Group)**

Overview

