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OVERVIEW OF METEOROLOGICAL WORKSTATION DEVELOPMENT IN EUROPE

J.Daabeck *
European Centre for Medium-Range Weather Forecasts

1. INTRODUCTION

Initially many European national meteorological services started their own workstation projects according to available resources, eg SYNERGIE, HORACE, DIANA, whereas METVIEW at ECMWF and more recently the NinJo project in Germany have had participation from several partners.

Fifteen years ago the European working Group on Operational Work Stations (EGOWS) meetings were initiated to encourage cooperation with meteorological workstation projects and have since become a yearly forum for exchanging information on European meteorological workstation developments. EGOWS has been hosted in turn by the European Meteorological Services.

Some of the European meteorological workstation projects have been presented at ECMWF workshops and at AMS. The ECMWF Workshops on Meteorological Operational Systems are held every second year in Reading, UK, where many of these projects from Europe and elsewhere have been presented.

Below follows an overview of some of the major European meteorological workstation development projects.

2. EUROPEAN DEVELOPMENTS

The pioneering European meteorological workstation development started in Finland in 1987 on a microVAX II/GPX, Karhila and Kukkonen (1988). The meteorological workstation was demonstrated at the first EGOWS meeting in Oslo in 1990.

Thereafter Météo-France was the first to start their SYNERGIE meteorological workstation development, followed by ECMWF with Metview. SYNERGIE was aimed at becoming a tool for the forecaster whereas Metview was mainly targeted at research scientists. Some years later, UK started the development of HORACE. Recently came the NinJo development in Germany supported by other partners. SYNERGIE, HORACE and NinJo have been full-featured large-scale projects (eg 100+ man years) whereas other meteorological services had smaller scale projects (eg team size of 2 - 4) such as Metview at ECMWF and HAWK from Hungary. Some countries developed applications with even smaller teams, e.g. DIANA in Norway, MAVIS from Austria and XCHARTS, Hamilton (1999), from Ireland. Other countries developed specialized applications e.g. the GridEditor and TAFeditor, Kilpinen and Sarkanen (2003), from Finland. Some of the remaining countries are using commercial systems, e.g. the Netherlands, Czech and Romania, Cordoneanu (2003). Most services now also have an automatic map production in place for the web.

3. METVIEW (ECMWF)

Metview, Daabeck et al (2003), Karhila (2003), is the ECMWF's meteorological data visualisation and processing tool. By virtue of its design and extensive range of features, Metview can act as a complete working environment for the operational and research meteorologist by providing powerful data management, visualisation and processing tools. It can be seen as a meteorological desktop plotting package thanks to its WYSIWYG visualisation, but it is also powerful meteorological data processing software thanks to its macro language, and can be used for routine production of meteorological charts in an operational environment. Metview is based on ECMWF software for data access (MARS) and graphics (MAGICS), Lamy-Thépeaut (2003). MAGICS is currently being redesigned and migrated from Fortran to C++. These applications were in routine use at the time of Metview development and provide its underlying data retrieval/handling and plotting capability. Metview's user interface is based on MOTIF and the X Windows system. Metview was designed for the UNIX environment and is highly portable within the UNIX world.

At ECMWF, Metview is used on Linux desktops and IBM server systems, but elsewhere it has been installed and performs operational work also on SGI, SUN and HP (UX and Alpha) workstations. Metview has a modular architecture and was conceived as a fully distributed system, its modules being able to run on different machines. Metview was developed as part of a co-operative project between ECMWF and INPE/CPTEC, Brazil, with assistance from Météo-France.

The development of Metview started in 1991 and the first release became available to internal ECMWF users in December 1993. Metview was released to ECMWF Member States in October 1995. It is now used in most Members States, plus Brazil, Australia and New Zealand.

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

4. NINJO (GERMANY, DENMARK, SWITZERLAND AND CANADA)

One of the largest and recent meteorological workstation development projects is NinJo, Eymann (2003), implemented entirely in Java. The project started 5 years ago and version 1.0 should be released early 2005 with further versions to follow later in the year. The main contributor is DWD (Offenbach and Potsdam) with GMGO (German Military Geophysical Office in Traben-Trarbach), DMI (Danish Meteorological Institue), MétéoSuisse and the Canadian Meteorological Service as partners.

Since NinJo is a joint project, it has been very important to have a clear, open and expandable software architecture. NinJo has to be independent from hardware and operating systems, because the organisations involved rely on different IT-infrastructures. Special attention has been paid to generic frameworks that allow independent implementation of applications.

NinJo 2D visualisation is 99% pure Java and hence platform independent (1% optional OpenGL renderer). The default renderer of the NinJo graphics API is Java2D. Java2D line rendering is slower than the NinJo OpenGL renderer but overall Java2D currently remains the best choice for 2D because of straightforward image handling, easy processing of complex polygons and good font support.

5. SYNERGIE (FRANCE)

SYNERGIE, Voidrot et al (1999), is efficient and user-friendly software dedicated to the forecasters with easy and powerful access to all meteorological data. It gives full interactive access to data, supports interactive production of bulletins, significant weather charts and meteorological objects production (ANASYG/ PRESYG). SYNERGIE is available on PC Linux and Sun Solaris in standalone and server/client configurations.

Météo-France started the development of SYNERGIE in 1990 and every French forecaster has been trained on SYNERGIE since 1994. A new release is made available once a year including new developments. SYNERGIE is used at more than twenty sites outside France.

SYNERGIE accepts data types such as alphanumerical data, analysis and forecast maps, numerical weather production model output, satellite images, radar images and lightning impacts. Data visualisation includes surface data (plotting), NWP fields, wave model output, satellite images and products, radar images from mosaïc or single radar, metgrams of observed or forecast parameters, observed or forecast upper air soundings, T4 and BUFR products and alphanumerical messages. Interaction functionality includes clever zooming, panning and overlaying with any data type, cross section (vertical and time), metgram, trajectories, animation, synchronisation of parallel loops, watch mode and print or save to file.

Production applications are available to create and issue alphanumerical bulletins, analysis maps, significant weather charts (SIGWX) (general, aviation) and maps dedicated for media (press, TV). Utility applications include unit converter and compute tools, creation and replay of interface automated scripts (macro system), own data extraction from the database, creation and replay of archived meteorological situation, and batch mode for plotter management or web server provision.

6. HORACE (UK)

HORACE, Radford (2001), is an easy-to-use, robust and flexible computer graphics system designed by the Met Office for professional meteorologists. It visualises all types of meteorological information and enables users to create analysis and forecast charts in order to distribute the most effective forecast products. The HORACE project started in 1993.

With its friendly, graphical interface, HORACE is easy to set up and learn. Simple keyboard commands and mouse clicks enable users to gather observations, text and numerical fields, combine them as required, and produce tailor-made outputs for different requirements.

HORACE frees forecasters from unproductive tasks. It enables them to focus their expertise on the manipulation of inputs and the creation of the most effective products. By simplifying the process of data acquisition, visualisation, manipulation and dissemination, it gives professionals more time to use their expertise and deliver products that are more effective, professional and reliable.

HORACE has been developed with forecasters in mind from the start - they have been involved in what gets done and how it gets done, so that HORACE does exactly what the forecaster working in an operational environment requires.

As a result of this 'forecaster design', emphasis has been given to the two tasks that forecasters carry out most often - analysing current observations (creating analysis charts) and forecasting future weather (creating forecasting charts).

Two unique applications have been developed for these two major tasks: on-screen analysis (OSA) and on-screen field modification (OSFM).

7. DIANA (NORWAY)

The DIANA (DIgital ANAlysis) operational workstation at met.no is their system for visualisation and editing, Martinsen and Christoffersen (2003). It can visualise data such as fields, satellite and radar pictures, surface observations and soundings; it can also edit scalar fields and draw fronts and significant weather symbols.

Other programs are connected to DIANA, and use DIANA to visualise their results including Modfly (an aviation forecast tool), Tseries (showing time series), Qed (point forecast editing) and Veps (verification presentation system). All these tools are built on a Linux platform using C++, OpenGL and Trolltech Qt technologies.

There are three regional centres in Norway and one of the reasons for developing DIANA was to better coordinate forecast production for these three areas. DIANA has made it possible for the three regions to coordinate the analysis process and consequently deliver a coherent end user product.

DIANA has made the meteorologists' analysis and monitoring more efficient and more precise. All available information is utilised as a basis for weather analysis and monitoring. The development has been done in close cooperation with forecasters, resulting in an intuitive and user-friendly system i.e. offering both conventional mouse interfaces and keyboard shortcuts.

8. HAWK (HUNGARY)

The HAWK-2 (Hungarian Advanced Weather WorKstation) system is a visualisation system developed at HMS for Linux and HP-UX platforms, written mainly in C and C++, Kertész et al (2004). HMS started development in 1999 based on a former workstation system and it has been operational since 2000. HAWK-2 can visualise deterministic and ensemble model outputs, satellite and radar images, surface observations, cloud-camera images, lightnings, upper air soundings and wind profiler data using various display modes. Developments of the last two years include a meteogram display mode, 3D visualisation of gridded data, foreign language support, interactive trajectory and transport model calculations, and also front editing. Much effort has been put into an automated product generation system, and has been concluded recently.

They plan to create a completely new system HAWK-3 based on the experiences gained from HAWK-2 that is now also used in Belgium. Features will include support for various input formats including netCDF and GRIB, automatic product generation mode, extensive comparison and verification capabilities, and an integrated graphical forecast editor. The development will be for Linux in C++ sources using Trolltech Qt for GUI, internationalisation, OpenGL for 3D graphics, MySQL and ORACLE interface for meteorological data.

9. MAVIS (AUSTRIA)

MAVIS (Met Austria VISualisation) is a visualisation system developed at the Austrian Meteorological Service. It runs on SUN workstations as well as on Linux PCs. It is written mainly in C and C++, small parts are also written in Fortran. MAVIS is used to visualise such data as model fields, satellite and radar images, surface observations and soundings. Furthermore with MAVIS fronts are drawn and significant weather symbols can be edited. Within MAVIS a map of the whole world including meteorological observations and geographical information such as orography, rivers and main cities are available.

One important tool in MAVIS is the nowcasting system. The Austrian nowcasting system is based mainly on satellite quantities, Csekits et al. (2001). It consists of the following products (available for every satellite image): A manual diagnosis of the satellite imagery, an automatic analysis of the satellite imagery, automatic detection of convective cells, forecasts of cloud features for the next 2hrs, linear extrapolation of surface weather reports for the next 120 minutes and finally a precipitation analysis tool as well as the 2hr forecast of precipitation areas, Csekits et al. (2002).

In the SATREP (SATellite REPort, available on http://www.knmi.nl/satrep) - an analysis of satellite imagery in terms of conceptual models - ECMWF model parameters as well NWP parameters from DWD and ALADIN model are available. A comparison of the three models can be done leading to the decision of which model seems to be the best for a certain synoptic feature or region. This information is very important for the forecasters.

The detection and propagation of convective cells is an important aim in nowcasting. A pattern recognition method, based on software of the company GEPARD, has been developed at the Austrian Meteorological Service, Csekits et al. (2000), and is used operationally by the weather forecast staff. This tool gives the forecaster a quick overview about size, cloud top temperature, location, development, activity and displacement of convective cells for the next thirty minutes.

Forecasts of cloud features for the next 2 hours are provided as an overlay for each IR image, based on AMVs (Atmospheric Motion Vector). Motion in the atmosphere can be derived from satellite images by the tracking of clouds and other atmospheric components, e.g. water vapour patterns and ozone patterns in cloud free areas. The product derived from tracking the atmospheric motions with the help of satellite imagery is called Atmospheric Motion Vector. With the help of the AMVs, surface weather reports can also be extrapolated for the coming 120 minutes, supporting the weather forecast staff in issuing warnings against severe weather events such as snow and hail for certain locations.

Within the precipitation analysis tool the actual observed precipitation events are received from one-hourly reports at weather stations, from measurements of automatic stations every ten minutes, from lightning reports and radar information. The output of this nowcasting tool provides information about convective and frontal precipitation, the areas of precipitation within fronts or convective features, and the extrapolated movement of the precipitation events for the next two hours.

10. CONCLUSION

The initial idea with EGOWS was to encourage cooperation with meteorological workstation projects but in practice this only happened with METVIEW and recently with NinJo. However, many of the European meteorological services have built up an expertise in this evolving area and have rapidly been able to take advantage of the fast advances in software and hardware.

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