III. WORKSHOP REPORT

1. Introduction

The Eighth Workshop on Meteorological Operational Systems was held at ECMWF 12-16 November 2001.

The objective of the workshop was to review the state of the art of meteorological operational systems and address future trends in the use of medium-range forecast products, data management and meteorological visualisations on workstations. The workshop was organised under the following main subjects:

Use and interpretation of medium-range forecast guidance

Over the two years since the last workshop the ECMWF forecasting system had been developed substantially. Significant improvements in the performance had resulted from the introduction of a 12-hour data window in 4D-Var, more and better use of satellite data, in particular the microwave radiances from AMSU-A, and model resolution increases.

In November 2000, the Centre increased the resolution of its global atmospheric model from T319 to T511. This is roughly equivalent to a reduction from 60 km to 40 km grid size. The resolution of the data assimilation minimisation was changed from T63 to T159. On the same date, the model resolution of the Ensemble Prediction System (EPS) was increased to T255. In accordance with the Centre's long-term strategy, a second run of the EPS based on 00 UTC data was introduced in spring 2001 as an initial test system in support of severe weather prediction.

Operational centres presented their approaches to medium-range weather forecasting and reported on their experiences with the recent enhancement to the forecasting system. The issue of forecasting extreme weather events in the medium range was addressed and discussed in a working group.

Operational data management systems

Access to the ECMWF information system and the data archive will be based to an increasing extent on web technology. The Centre had recently embarked on a project called Web MARS, which will give direct access to the MARS archive to all internal and Member States and Co-operating States users, using web technology. In addition, the browsing facilities of the archives will also provide the user interface for customers of the Centre's Data Services. Issues of how to harness the benefits of web technology to provide user orientated access to information systems and data were addressed in this session and discussed further in a working group.

Meteorological visualisation applications

At this workshop, the Linux systems which, combined with low cost hardware, had become attractive platforms were the focus. Meteorological visualisation applications, which had become available for Linux were presented. The network-based use of meteorological visualisation applications was also shown. Experience with software development tools for Linux was discussed in a working group. Also the choice of graphics cards and graphics libraries was addressed.

The reports from the working groups are summarised in this section of the proceedings while the papers from the presentations are given in Section IV.

2. Report of the working group on the use and interpretation of forecast guidance

- There is now a wide agreement that the quality of ensemble products can be usefully subjected to calibration / post-processing in a way similar to other NWP products. Methods demonstrated during the workshop include Kalman filters, perfect prognostic techniques, combinations of sub-grid scale variability with dynamical (ensemble) grid-point probabilities, Talagrand diagrams corrections, use of past error statistics or stratification according to large scale patterns.
- It has been recognised that calibration of ensembles poses new specific problems compared to the calibration of deterministic forecasts. Products have to be verified in the context of their use. There is no generic calibration process that can address all users needs - for example, most methods presented were general in their scope and therefore only poorly performed in the case of severe weather events. Specific strategies for addressing such events are needed but will be subject to sampling problems due to the small size of samples on which to calibrate.

- The usefulness of processing model climate distributions for the interpretation of the products has been demonstrated, and it is therefore recommended that medium range NWP centres keep updated records of such information.
- Concerns have been expressed on the tension that is likely to exist on model developments as a result of the post-processing strategies demanding stable historical records of model forecasts.
- Both to address severe weather events and to adapt more quickly to model changes, research is needed to develop methods of calibration that keep training periods to a minimum while keeping statistical significance.
- Whether or not the calibration should be performed centrally by the NWP centres or locally by the users was debated, but it was concluded that the absence of generic calibration methods meant local calibration was probably the best option. However as for other NWP products, there is a responsibility for NWP centres to inform the users of the sources of errors (incorrect spread, deterministic model errors, representativity problems) that require corrective action from their side.
- Passionate debates between "probabilistic" and "deterministic" supporters have now left room for more pragmatic discussions about how to better adapt the medium range products to our users. Although stochastic estimates of uncertainty are now widely recognised to be a crucial component of any forecast system, it is also recognized that some users demand a categorical formulation of the forecast. It has traditionally been the role of the forecaster to adapt the forecast to his own estimate of the users needs, a task that is now greatly simplified thanks to better formulations of the model uncertainty and of cost/loss models of economic value.
- It has been mentioned that probabilistic products now meet categories of commercial users with a very advanced knowledge of stochastic models of decision making (insurance, hydrology, etc...). Adequate training of meteorologists who will be in contact with such users is an issue.
- Successful attempts have been made to generate EPS products in a form that can bring the information across in a simple format. NCEP spaghetti diagrams and predictability maps, ECMWF EPSgrams and Extreme Forecast Indices are among those. They demonstrate the need not only to educate the users, but also to adapt the products to their level of education and/or professional background.
- Limitations of the value models due to their crude representation of social aspects of the decision making processes have been underlined.
- Confidence indices have been discussed in several presentations, but their verification usually shows that they only have poor resolution in their present form. Although they should ideally be associated with specific aspects of the forecast like local temperature of precipitation, they are easy to understand by the public only if they broadly cover the uncertainty of the weather scenario. More refined definitions and verification of the indices (e.g. using perfect model or other references) will however be needed to improve the resolution of this product.

3. Report of the working group on operational data management systems

The working group discussions focussed on three major issues:

(i) Providing end users with data and products

- The group noted a trend to move to more IP based transmissions. There are some limitations when handling large numbers of small transactions.
- Issues of dissemination of very large amounts of data were addressed. Problems will arise from substantial increases in satellite observations. Technical solutions will be available but at a price.
- More information is provided on the web, including weather forecasts and products. The users need to be informed about the quality and weaknesses of on-line forecasts and products.

(ii) Tailoring products to match client needs

- The web technology has led to an explosion in the number of potential customers. Everyone must now be considered as a potential client.
- Issues of production cost in terms of computer and human resources were addressed. What is the real price of making a product and how much is a customer in the end prepared to pay for a forecast?

(iii) Move to simplicity

- Customers want simple products to help them in their decision making process. Products need to be understandable by the non-specialist, i.e. the customer has to be provided with a high level of value added products.
- A web based product service provides the facilities and the means to offer the customer the tailored products, meteograms with local forecasts are an example.

4. Report of the working group on meteorological visualisation applications

Summary of presentations

General applications in use:

- Synergie, developed at Météo-France, has a two-year development cycle with one release per year and is used by 1000 users at 42 sites for visualisation and production.
- The new version of Metview includes meteorological desktop publishing features and also runs on Linux. MAGICS is a subroutine library for plotting meteorological data in many different ways. Both systems were developed at ECMWF.

General applications in development:

- CGS is a 2D/3D Java based comprehensive visualisation and production system planned for 2004 by DWD, CGGO, MeteoSwiss and DMI.
- A classification was presented of the processes from raw data to end-product in preparation for the next generation forecaster production system, Concorde, to be developed by Météo-France and MetOffice by 2006/7.

Specialised applications:

- Experience with the use of the FMI Grid editor was outlined. The GUI development has been more difficult than the development of the visualisation. Forecasters have to be trained to do their work in a different way and then can add value to model output at least in some parameters.
- The TIPS application for display and processing of tropical cyclone information, from the Hong Kong Observatory, was presented.
- VisAD is a Java infrastructure for environmental software and is being implemented by collaborating institutions around the World.

Meteorological visualisation techniques:

- IBM Thomas J. Watson Research Center presented a classification and examples of meteorological visualisation. In addition techniques were demonstrated to locate data and to find compromises between data amount and access time, data fidelity and interactivity for web-based 3D visualisations.
- Initial evaluation in USA shows that the use of 3D visualisation does have a potential value in operational forecast offices.
- Advanced techniques for unsteady flow visualisation using animated flow textures on dense numerical grids, developed at the Swiss Centre for Scientific Computing, were presented.