THE USAGE OF GRAPHICAL PRODUCTS IN ECMWF'S METEOROLOGICAL OPERATIONS - PRESENT AND FUTURE PLANS

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Introduction

The enormous amount of information produced by an analysis and ten-day forecast cycle every day needs to be monitored, assessed and studied in some detail in order to assure the quality of the products disseminated to Member States and to detect shortcomings (incidental and systematic) in the forecasting system. This task can only be performed by the limited number of staff available if graphical tools are provided that give fast and efficient access in a suitable resolution to the fields and quantities to be inspected. A high standard of graphical products has been reached at ECMWF but new techniques will also be needed to solve some of the remaining problems.

1. Operational monitoring

1.1 Monitoring of meteorological input data

1.1.1 Density and amount of data and the time of receipt are presently monitored using data coverage maps for 4 six-hour time windows per day, i.e. around 18z, 00z, 06z and 12z. Eight different types of data are represented with symbols used to define data types and, in the case of TEMP and PILOT observations, the parts received are tropospheric/stratospheric. For more detailed investigations, this display could be split up for several layers of the atmosphere and could also include a summary of quality, e.g. flags represented by colour on the graphical screen.

1.1.2 Data visualisation has to be performed in an efficient way in case of quality defects in data-sparse areas. This can be done in alphanumeric form and, for TEMPS, in the form of a Tephigram. For surface observations, a symbolic representation (synop observation plot) would be very helpful and should be implemented in the near future.

1.1.3 Data statistics are presently available in alphanumeric form; diagrams would be an advantage.

1.2 Analysis monitoring

Display of analysed fields with plotted observations is still the best way to ascertain that the analysis is accepting or rejecting and using the data in the right way. Again, the symbolic representation of surface observations needs to be introduced and new ways are being investigated to facilitate this important task of the analyst. Progress is expected here from the flexible use of a colour graphics terminal, where three-dimensional representation, use of colours for analysis flags, and fast access will be essential.

1.3 Forecast monitoring

1.3.1 Height and temperature fields are mostly displayed in the form of contour lines and so are fields of humidity, vertical velocity, vorticity and divergence. The latter fields are either derived from, or in a close connection to, the mass and wind field and, therefore, they have to be checked in conjunction with mass and wind fields. Different linestyles and thicknesses can be used to show about two different fields and coastlines on one map - a rather serious limitation considering the range of available parameters at 15 levels in different possible combinations. It is hoped that the use of colour and a quick-access graphical terminal will be a key to a more comprehensive regular monitoring, where a large number of fields (5 parameters at 15 timesteps for the first stage) can be prestored and displayed almost instantaneously in a choice of combinations.

1.3.2 Wind fields

Presently, the horizontal wind is displayed using arrows or WMO-wind flags. The representation in form of arrows, whose length indicates the speed, has some shortcomings since large variations in the total wind speed occur and the scaling usually leads to large areas where the arrows shrink to mere points in order to avoid overlapping arrows in zones of strong wind. From these representations, it is also quite difficult to detect areas of diffluence and confluence, which can be seen better in stream line representation.

Some thought should also be given to the representation of three-dimensional flow, where new ideas are becoming available (see Nassif and Silvester, 1980).

1.3.3 Cloudiness, as forecast by the model in the form of "pseudo-satellite pictures" is given in a raster representation. Recent experiments in a colour pseudo-3D-representation, indicating cloud-top height in an animated loop, seem to prove that a deeper insight in atmospheric processes can be gained from using advanced graphical techniques.

1.3.4 Cross sections through the atmosphere are revealing the vertical structure of systems in analyses and forecasts. An extension to three-dimensional histograms can be envisaged, together with skewed plots to show 3-D "cubes" of air.

2. Non-Real-Time Evaluation

2.1 Case studies of interesting forecast events are being carried out in a way similar to the operational monitoring, but with more in-depth studies. A more flexible system capable of resolving more detail is required for this purpose. Diagnostic diagrams of physical processes are added to the standard displays.

2.2 Verification studies

2.2.1 Objective verification of fields is carried out on a routine basis and time-height diagrams of correlation coefficients, RMS-errors or standard deviation together with plots showing the useful time-range of forecast are produced. Histograms are used to depict mean and systematic errors of the forecasting model.

2.2.2 Subjective verification and forecast intercomparisons give an insight into the phenomenological behaviour of the model, and typical ways of handling synoptic features (lows, highs, frontal structures, etc.) can be compared in analyses and forecasts. At present, this task requires a substantial amount of paper handling, and display methods have been developed to facilitate these evaluations. (Example, Meteorological Operations Room.) The implementation of a meteorological work station using a fast graphical terminal, including the possibility of animated sequences,will make this work quicker and more efficient.

2.3 Interpretation of forecasts

As an experimental guideline for local forecasting, time series of weather parameters as predicted by the model, interpolated to specific sites,are given in the form of "Meteograms". They give an impression of the evolution of characteristic weather parameters, such as surface temperature, wind, cloudiness and precipitation over the first seven days of the forecast.

References

Nassif, N. and Silvester, P.P. (1980): Graphic representation of three-component vector fields. Computer aided design, Vol. 12, number 6, November 1980.