THE DEVELOPMENT OF COMPUTER AIDED FORECASTING AT FMI

Juha Kilpinen
Finnish Meteorological Institute (FMI)
Helsinki, Finland

Summary: The construction of final forecast products has been highly manual at Finnish Meteorological Institute (FMI). This paper gives the highlights of the plan concerning development of computer aided forecasting at FMI.

The purpose of our work is to make the construction of end products more effective and to increase forecast skill. Interactive computer graphics to control the large forecast set is an essential element of the system.

This development began at FMI last year together with other Nordic meteorological institutes. During this co-operation the production of Terminal Aerodrome Forecasts (TAF) was automated. These systems will be in operational phase rather soon.

Also other forecast products (forecasts for general public and for special customers, worded forecast, graphical forecasts, etc.) will be produced automatically. Such forecasts are automated first which have a form of table. The worded and graphical forecasts will be automated later. The time schedule of the development work is 1994-1997.

1. INTRODUCTION

Computer technology has been applied extensively at Finnish Meteorological Institute (FMI) in processing of meteorological data. The massive observational data amounts have been processed and analysed for numerical models and the model output data has been post processed and visualised with computer graphics. Most of the end products have been created manually without direct computer processing. This is the weakest and most ineffective part of the whole forecasting process.

Graphical end products can be rather easily made from model output data as well as exclusive animation for television. Good quality multilanguage worded forecasts can also be produced from model data (e.g. *Verret,* 1993). The basic idea in the automation development is that forecaster must be able to control all relevant meteorological data. To control the relevant data the forecaster must have a graphical editor with advanced tools.

The first step in this development work was so called NORTAF project in which four Nordic meteorological institutes developed methods and software for automated production of TAF's (Terminal Aerodrome Forecast).

The general idea of the future system will be the same as in the NORTAF system. All essential parameters for TAF's are derived from model output with statistical and other interpretation methods and the parameters are represented in a forecast matrix (*Kilpinen,* 1993). A 1-dimensional numerical model plays an important role in interpretation of planetary boundary layer (*Gollvik and Olsson,* 1993). Fig. 1 shows the schematic structure of NORTAF system. A suggestion for TAF is then made from the forecast matrix ac-

cording to the WMO rules. The duty forecaster has the final decision and he or she can change the final forecast. Both the guidance and final forecasts are also verified by the system.

Object oriented programming methods will be applied as largely as it is possible and necessary.

The time schedule of the development work is 1994-1997 so that NORTAF part should be operational by the end 1994.

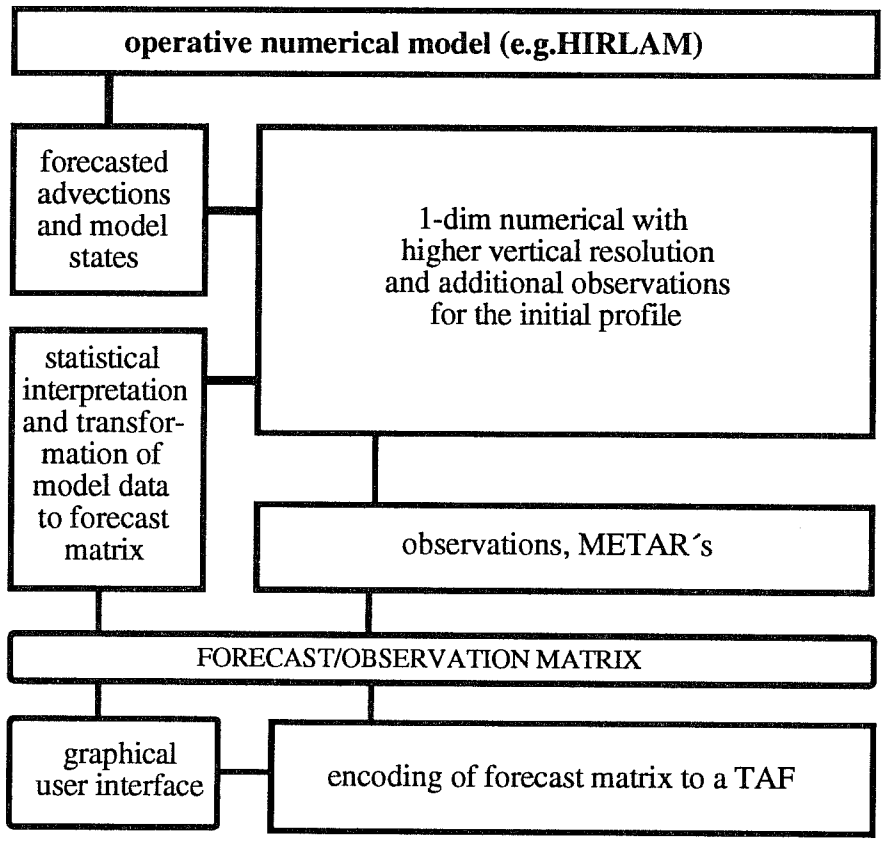

Fig. 1 The schematic structure of an operative NORTAF system.

2. FORECAST MATRIX

Forecast matrix includes only the data that is necessary for making forecasts. The data may be both in grid point and station based form with time interval 1-3 hours for first 1-2 days and with 6-12 hour interval beyond that.

ECMWF data is the basic source of information beyond 2 days and HIRLAM model for the two first days. All other models are also optional for the system. The matrix should include at least surface pressure, 2 metre temperature, 10 metre wind, cloudiness (and possibly cloud types), weather phenomena and locations of fronts. Also minimum and maximum temperature and ground temperature are required as well as gust speed. For some special purposes derived variables like wind chill factor may be included to the matrix.

Verification is based on the data of forecast matrix and no additional information is needed. Some verification measures should also be included to the matrix. Verification measures are essential in bringing the influence of forecasts spread to at least worded forecasts and meteograms.

The default values for forecast matrix are derived from numerical models directly or through interpretation system. The utilisation of other models than ECMWF or HIRLAM is not so easy because the number of output variables of these models is more limited. Modern interpretation methods require model output from upper pressure levels representing free atmosphere as well as from model levels near surface.

The interpretation system applies both traditional methods like Perfect Prognosis (PP) and Model Output Statistics (MOS) as well as modern up dateable methods Kalman filtering (*Persson*, 1991; *Kilpinen,* 1992) and neural networks.

Fig. 2 represents the structure of an automated production system.

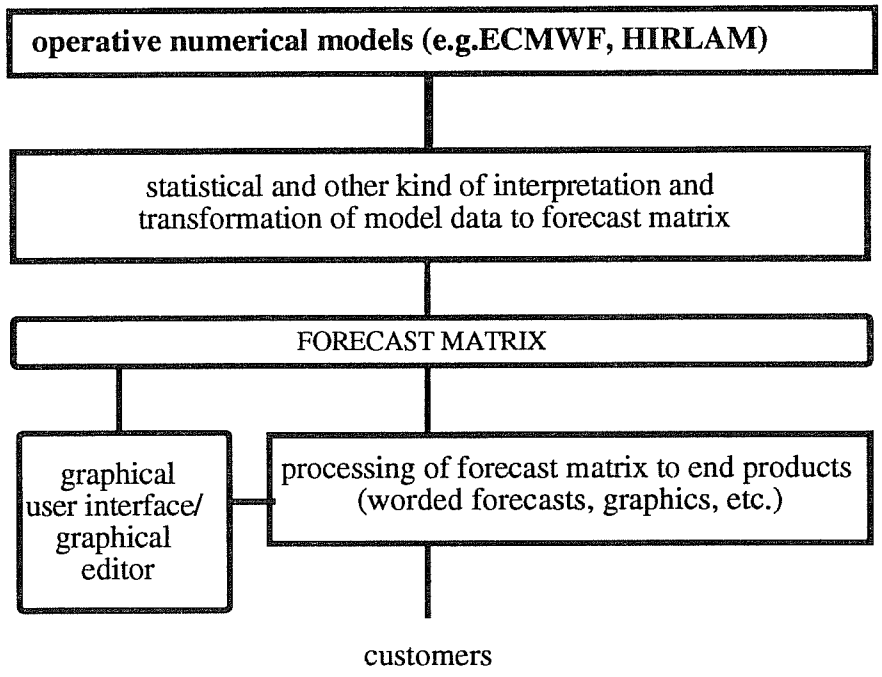

Fig. 2 The schematic structure of a system for automated preparation of end products.

3. GRAPHICAL EDITOR

The forecaster needs a graphical editor for controlling the data in the forecast matrix and to see the changes he or she has made. The editor is the fundamental part of the automated forecast production if one requires that the final decision remains on the forecaster. No real rationalisation is created if the tools for changing the variables in matrix are not good. The user should be able to change everything just by clicking with mouse.

Graphical editor is a functional extension of graphical meteorological workstation and it applies same graphical tools for visualising the data matrix. The matrix should be separated from other operational data and there should be an option that local (regional) offices have their own portion of the common matrix.

4. TOOLS FOR PREPARATION OF END PRODUCTS

Worded forecasts will be prepared directly from forecast matrix. The forecasts are changed through changing the matrix not through changing concepts. Most worded forecasts should be made both in Finnish and Swedish language because these are the two official languages in Finland. Some foreign languages like English are also important.

Graphical tools for making end products can be both commercial or in house software of the meteorological workstation.

The tools should be integrated more or less closely to graphical editor because it is important that the user can see how the changes in matrix change worded and graphical end products.

5. REFERENCES

Gollvik, S., and E. Olsson, 1993: NORTAF: Computer Generated Aerodrome Forecasts. 5th International Conference on Aviation Weather Systems,. Vienna, Virginia, AMS, 335-338.

Kilpinen J.,1992: The Application of Kalman Filter in Statistical Interpretation of Numerical Weather Forecasts. 12th Conference on Probability and Statistics in the Atmospheric Sciences, Toronto, Ont., Canada, AMS, 11-16.

Kilpinen J. 1993: The Combination of forecasts in an Automated Aviation Weather forecasting System. Fifth International Conference on Aviation Weather Systems., Vienna, Virginia, AMS, 339-340.

Persson, A. 1991: Kalmanfiltering - A new approach to adaptive statistical interpretation of numerical meteorological forecasts. Lectures and papers presented at the WMO training workshop on the interpretation of NWP products in terms of local weather phenomena and their verification, Wageningen, The Netherlands, 29 July-9 August 1991. Programme on short- and medium-range weather prediction research report series no. 34. XX-27 - XX-32.

Verret, R., G. Babin, D. Vigneux, R. Parent, and J Marcoux, 1993: SCRIBE: An Interactive System for Composition of Meteorological Forecasts. Pre-prints of 13th Conference on Weather Analysis and Forecasting, Vienna, Virginia, AMS, 213-216.