USE OF ECMWF PRODUCTS FROM A LOGICAL, FUNCTIONAL AND METEOROLOGICAL POINT OF VIEW

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1. Introduction

Forecasts in the time-scale of 4 - 10 days are evidently of great potential value for the agriculture and construction industries with smaller benefits in the areas of transport and energy. The Centre's medium-range forecasts should indeed have a beneficial effect in these sectors, but this will only be possible if the meteorological services in Member States are scientifically and technically prepared to use the products of the Centre in an appropriate way.

2. Available products

According to present plans, analyses and forecasts of geopotential height, temperature, wind and relative humidity are likely to be available on a number of standard pressure levels (see 5.2 of " The Presentation of ECMWF Numerical Products to Member States",page .There will also be forecasts of the vertical velocity as well as of many surface parameters (pressure, temperature, wind, relative humidity, accumulated precipitation, fluxes of heat and moisture, etc.). The forecasts will be produced for every 6 hours, up to 240 hours ahead and the total number of different products is of the order of 3000. These products will be made available both on a global 1.5^{o} x 1.5^{o} latitude-longitude grid and a polar-stereographic grid for the major part of the northern hemisphere. The availability of such a range and format of products should satisfy most requirements, although it should be kept in mind that the forecasts are only produced once a day, with a relatively late cut-off time and with no back-up facilities in case of computer problems.

3. Some basic considerations related to use of ECMWF products

3.1 General

ECMWF products will be made available to users in Member States in a coded grid point form, and it is expected that normally this data will be converted locally into pictorial form for manual inspection and interpretation. An alternative approach is to use the forecasts as input to various local forecasting schemes (e.g. dynamical statistical methods); this approach is described in 4.

3.2 Expected quality of ECMWF forecasts

Relatively few experiments with the analysis scheme and ECMWF forecasting model have so far been performed. However, it is apparent that both the analysis scheme and model in their present form perform reasonably well and produce meteorologically consistent results. It is not as yet possible to give a realistic quantitative estimate of the accuracy of the forecasts. Suffice to say that the results so far obtained compare favourably with any forecasts at present available, and there is worthwhile predictability and information in the predictions up to at least 6 or 7 days, even in the preliminary experiments.

3.3 Technical limitations related to ECMWF product dissemination

Producing the great range of forecast results for users in Member States in the variety of formats and over the many areas required, needs considerable computational resources. However, the ECMWF computer system will be able to cope with the anticipated requests. In the initial period the main technical limitation will be caused by the capacity

of some of the telecommunication circuits between ECMWF and Member States. Some of the circuits have only a capacity of 50bps [1], and thus to transmit a product field of 1000 grid points (with three digits to represent a grid point value, and allowing for overheads), would take 6 or 7 minutes. Only 50 products at the most could be taken during the course of the complete six-hour forecast period, and in this case, the recipient might have to select carefully products of particular value to him. Also on low speed circuits the error control is less reliable and automatic handling of results at the user end may be more difficult. With the medium speed circuits (2400 bps), to transmit a typical product field will take only a few seconds, and thus for users having medium speed connections with the Centre there is no practical constraint regarding the number of products that can be taken.

4. Possible ways of using ECMWF products

The following ways of using ECMWF products can easily be identified :

(i) Conversion from digital to pictorial form, manual examination, interpretation and forecasting;

(ii) Input of short-range forecasts into national analyses schemes (in order to improve first guess);

(iii) Input of boundary values into national limited area models;

(iv) Input into local forecasting schemes (e.g. by statistical methods);

(v) Use in special applications, such as ship routing, forecasting long-range transport of air pollutants, etc.

1) bits per second

These five possibilities are considered in more detail below.

4.1 Conversion from digital to pictorial form

The conversion from digital to pictorial form will be the obvious procedure in many cases, as the ECMWF products can then be handled, examined and interpreted by experienced meteorologists using a conventional approach. A careful selection of products to be converted into pictorial form must be made, firstly to prevent overloading of the conversion equipment and, secondly of the users of the products, who are not likely to be capable of handling more than some 20 - 40 maps in the period available. This implies, in view of the considerable number of products that could be taken, that new approaches for the pictorial representation of the meteorologically valuable information in a compact form must be investigated, such as time mean maps (particularly for the second half of the forecasting period), cyclone tracks,etc.
The conversion from pictorial to digital form requires suitable hardware and software, with off-line plotters or alternatively mini-computer controlled on-line (electrostatic) plotters.

4.2 Input into national analysis schemes

The ECMWF analysis and data assimilation schemes are planned to be global and will use all available data in a systematic way. The forecasts will also be for the global domain with 6,12,18,...hour forecasts using 12 GMT of the current day as initial data. It is therefore possible (using simple interpolation if the grid is not identical) to extract from ECMWF's forecasts first guess

fields required for any national analysis schemes. Taking account of the global coverage, the use of all available data in the Centre's analysis and the late cut-off time, and the subsequently good qualities of the Centre's short-range forecasts, there could be significant beneficial effect on the national analysis.

4.3 Input of boundaries

It would be straightforward to extract boundary values for any national limited area forecasting model. There is, however, the restriction that the forecasts will be available only once per day and with a 6 hour interval between the forecast fields. This is not likely to cause significant problems in most cases.

4.4 Input into local forecasting schemes

The Centre's forecast, having a relatively high resolution in space and time, could well be used for input into national statistical forecasting schemes - particularly as all common predictors used in such schemes are available from the ECMWF system. In the beginning, however, very little will be known about the behaviour of ECMWF's forecasting model, and a period of 1 - 2 years will be required before the statistical relationships appropriate to the Centre's model have been evolved. Much research and development work must be done in this area, particularly in relation to use of dynamical medium range forecasts in such a context, as local statistical forecasting has not been widely extended to a time scale of 4 - 10 days.

4.5 Special applications

The large range of analysed and forecast parameters available from ECMWF can evidently be used in a variety of other applications. Typical applications are : ship-routeing (requiring surface wind and possibly also temperature forecasts with a high horizontal and time resolution up to 7 - 10 days) and the forecasting of the long-range transport of air pollutants (requiring upper air winds up to 7 - 10 days, as in the case of nuclear bomb experiments). Many other examples can be foreseen and study is required in this area.

5. Foreseen cooperation between the Centre and the Member States in relation to the Centre's operational forecasts

There will clearly be a considerable interest both in the Centre and within the national meteorological services of the Member States to evaluate, both subjectively and objectively, the quality of ECMWF products. This will certainly require exchange of a significant amount of information by correspondence and at special meetings, but this aspect will not be dealt with in the present lecture.

The following gives examples of evaluation tasks that need to be undertaken either jointly or by the Centre or one or several Member States :

(i) objective evaluation of the behaviour of the forecasting model (large scale energetics and objective verification scores; comparison with similar quantities derived from the products of NMC Washington, or other available medium range forecasts)

(ii) synoptic evaluation of model results (independently and in comparison with corresponding forecasts produced by NMC Washington and major European centres)

(iii) operational objective verification over relatively small areas (Western Europe, North America etc.; both for ECMWF products and other available forecasts)

(iv) verification by national centres of derived products from local forecasting schemes (using as input both ECMWF and other available forecasts) and assessing and comparing the predictions of the local weather.

Cooperation of this sort in the evaluation of the Centre's products is vital for the success of the Centre. The evaluation will naturally require the devotion of some effort and that the appropriate resources are available in the Member States (and in the Centre). Similar resources,in connection with the evaluation, will naturally also be required for Member States to use efficiently the products of the Centre.