THE PRESENTATION OF ECMWF NUMERICAL PRODUCTS TO MEMBER STATES

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1. Introduction

The lecture the "General description and organisation of ECMWF's planned forecasting system" (on page 311, hereinafter referred to as A) described the basic operational process by which ECMWF plans to produce numerical medium-range forecast products on a daily basis. The present lecture discusses the actual presentation and availability of the numerical products to Member States, covering such aspects as the possible meteorological value of the results and how this might influence the range and format of products offered, ECMWF's planned operational schedule, and tentative suggestions regarding the arrangements for request of products by Member States. These questions are of considerable importance and interest, as the primary day-to-day impact of ECMWF on Member States will be the provision each day of a "Medium-range" forecast (i.e. for the period 4-10 days).

The present paper concentrates on the description of the situation, and range and format of products that may be offered. The aspects of communication of these products to Member States, the logical and functional handling of the products in Member States, and the various possible ways of using them and applications to which they may be put are covered in the lectures by D. Söderman. "Technical facilities required for handling communications between ECMWF and Member States" on page 389 and "Use of ECMWF products from a logical, functional and meteorological point of view" on page 381.

2. Meteorological considerations

To have meteorological value, the deviation of a prediction from the true evolution must certainly be less that that of climatology. The measure of the deviation in this context is not the simple verification techniques so often used such as root mean square error, skill score etc., but whether or

not some real predictability value exists in the forecast at some scale or another (probably the largest scale in the case of medium-range forecasting).

Current thinking on these matters suggest that the predictability is strongly related to the scale of the weather system; in general, predictability for weather systems of the scale 10-100 km is less than a few hours - for systems of scale 1000 km it is 1-2 days, and for the largest planetary waves it may be of the order of a week or two. These predictability limits are also more or less equivalent to the lifetimes of these systems (although, some particular small-scale systems such as hurricanes do have relatively long lifetimes). The influence of this factor on the general design of the forecasting system was stressed in A, in that it implies, a priori, that for medium-range forecast, the global domain and the largest scales must be considered, as well as atmospheric processes which have an effect on this time scale. In terms of numerical prediction this also evidently means that obtaining an accurate detailed prediction in the medium range is very much more difficult than for the short range. This is because the physical limit of the deterministic predictability of the smaller scale synoptic disturbances is only a few days, and in the case of a medium range prediction of, say, 10 days, this limit is exceeded. These scales of motion cannot be realistically determined, but only predicted in a statistical sense. Thus, in practice, at the later stages of the forecast, there would be some confidence in the prediction of large-scale areas of activity (e.g. areas of cyclogenesis, cyclone tracks) but not the details of the small scale systems within these areas. Nonetheless, even the small scale systems will be correct in a statistical sense - that is such systems will have the correct space and time scales, and structure, but are not necessarily correct in timing or position. The implications of this in terms of presentation and use of medium-range forecasts are considerable, and the question arises as to how best the meteorological valuable content of the forecasts may be represented. What is immediately clear is

that the results for the medium range timescale (say, for more than 5 days) must not be used in the same way as short range forecasts, for example, looking at values and details in relatively small local areas. ECMWF has begun some preliminary study on how such forecasts can be presented, in a way which would be consistent with the expected characteristics of the results after 5 days, and to display the meteorologically valuable information in an immediately useful way with less risk of mis-interpretation. The ideas being explored at the moment are how to bring out the largest scale flow patterns, which it is believed have the greatest predictability and, for example, ways of representing areas of cyclogenesis and cyclone tracks.

Another approach could be to consider what is of importance to be able to do, and the way in which the results of medium-range forecasting could be applied. For example, it would be of great interest if changes of type could be indicated (e.g. anticyclonic to cyclonic, mild southwesterly to cold northerly). For forecasting this sort of event, the necessary meteorological information for given periods could be represented using space- and time-mean charts.

In summary, it is stressed that there is a considerable difference in the way in which the medium-range forecast products have to be interpreted and used to that of short-range products.

3. The start of operations at ECMWF

The timetable for the implementation of regular operations at ECMWF is as follows :

Operational trials commence	third quarter, 1979
Operational forecasting, Phase 1	fourth quarter, 1979
Operational forecasting, Phase 2	second quarter, 1980

The first operational model is under development within ECMWF on the basis described in A. This model and also all the many supporting taks must be cast into operational form, and a complete system is planned for completion in the summer of 1979. There will then follow various phases of operational forecasting :

Phase 1 - forecasts prepared 2-5 days per week;

Phase 2 - forecasts prepared 7 days per week

The main reasons for this phased implementation of the forecasting system is to enable errors in the system to be perceived and corrected, and also to allow the Centre and users in Member States to gain experience in interpretation and use of the forecast results, and possibly to develop improved methods of presentation as indicated in paragraph 2 above, before the forecasts become available on a routine basis 7 days a week.

4. The planned daily operational timetable

Another factor of relevance in the availability of ECMWF analyses and forecasts to Member States is the time at which these products come to hand. The present plan is that ECMWF's daily operational cycle will begin at 20Z with the re-analysis of the 18Z data for the previous day, and then the analyses for 00Z, 06Z, 12Z, 18Z for the current day. Analyses for these main hours will be available to users at roughly 22Z and the forecast will then proceed at the rate of one forecast day in about 45 minutes. On this basis the forecast of H+24 would normally be available at just before 23Z, the forecast for 10 days at about 05 or 06Z. After the appropriate processing on the CYBER 175, the results should be available for dissemination to Member States 10-15 minutes after production on the CRAY-1.

In accordance with these principles the range of products theoretically available is summarised in Table 1.

Table 1 - Products theoretically available from ECMWF's forecasting system

Three-dimensional parameters		Two-dimensional parameters	Verifying times (D= current day)
Parameters	Standard pressure levels		
. Wind or wind-components	1000	.Surface pressure	Analyses 18Z, D-1
. Geopotential height	850	.Surface temperature	00Z, D
. Relative humidity	700	.Surface wind	06Z, D
. Temperature	500	.Surface relative humidity	12Z, D
. Vertical velocity	400	.Accumulated precipitation	Forecasts
	300	.Surface fluxes of heat,moisture	18Z, D to
	250	.Surface radiative fluxes	12Z, D + 10
	200		at 6 hourly
	150		intervals
	100		
	70		
	50		

The three-dimensional fields are originally produced by the forecasting system on sigma-surfaces but as explained in A(3.5) are transformed to a number of standard pressure levels.

The products will basically be available in grid point form on two standard grids, a latitude/longitude grid (probably $1\frac{1}{2}^{o}$ x $1\frac{1}{2}^{o}$ or multiples thereof) or a polar stereographic grid covering the northern hemisphere of resolution 150 km at 60^{o}N. These resolutions have been chosen to be as close as possible to the resolution expected to be used in the Centre's first operational model.

5. Range and format of products offered to Member States

5.1 Details of the range and format of products

ECMWF's products will basically only be available to Member States in a grid-point format in the first period of operations, being transmitted over the telecommunications network in coded form. However, it is hoped relatively soon to add to the basic range of grid point products some other products of the type indicated in 2 presenting the meaningful meteorological information in a descriptive way, to help in interpretation and use of the forecast. The form of these products will also be digitally oriented.

In offering products to Member States, ECMWF intends to follow certain general principles :

i. The basic form of the presentation of the products (i.e. the vertical and horizontal resolution, and the range of parameters themselves) will be kept constant and independent as far as possible of the internal model parameters and model structure. The model itself is likely to be modified fairly frequently regarding such aspects as horizontal and vertical resolution, but following this principle the actual products will not in general change. This does imply that interpolation procedures must be applied to transform the model format into the format presented to users (see A(3.5)).

ii. Only basic model parameters will be offered, and the user himself must compute such parameters as vorticity, dewpoint, instability, indices etc. However, where the derivation of parameters will be critically affected by the interpolations involved in (i) above, or is intrinsic to the model itself (e.g. vertical velocity) this principle will not be applied.

Data held in latitude/longitude format will be available over the entire globe, and basically "rectangular" subsets of these data can be selected. (By "rectangular" in this context is meant a rectangular array of points bounded by meridians in the N/S direction and lines of latitude in the E/W direction). Within the rectangular bounds there is the possibility of effectively selecting differently shaped areas by use of a bit map option in the ECMWF grid code. Data can be taken at the basic $1\frac{1}{2}^{o}$ resolution and multiples thereof.

For data on the polar stererographic grid only areas in the Northern Hemisphere will be available and only one grid orientation is possible - likely to be with the Greenwich meridian as true north/south and a point at the north pole. Rectangular subsets of the polar stereographic grid can be selected, with the axes of the rectangle respectively perpendicular and parallel to the Greenwich Meridian.

5.2 Comments on the available range of products

The analyses produced by the ECMWF system are likely to be of interest bearing in mind the specialised analysis techniques employed, the late cut-off time before the analysis is carried out and the global coverage of the analyses. However, these analyses, as for the forecasts for days 1 and 2 in particular, will only be available some hours later (see 4) than the equivalent analyses and forecasts produced by Member States.

For the later stages of the forecast, 7-10 days, it will be appreciated, in view of the comments in 2, that it is not appropriate to use the products at a fine geographical or time resolution as features with a geographical scale less than 24 hours will not be determinstic. As an

extension of this idea, some parameters will not be available at all levels or for all times if they are not meteorologically significant (e.g. relative humidity above 300 mb).

The possibility has sometimes been raised of making products available on a global basis in spectral form. However, there are various technical and operational complications in transmitting data in this form to users in Member States, significant computer processing is needed to utilise them at the user end, and an entire global (or hemispheric) field has to be taken.

Thus, ECMWF does not formally plan to offer products in spectral format in the first phase, although spectral representations of analysis and forecasts data will be available in real time in the post-processing data base (A (3.5)).

6. Communication and liaison between ECMWF and Member States, and specificaiton of Member States' requirements for ECMWF products

As a result of a series of questions issued during the course of work of the Advisory Committee* on matters related to communications between ECMWF and Member States, a first estimate was formed of the range of products and domain of coverage required by users in Member States. However, requirements need to be more exactly specified for the start of operations and thus next year, Member States will be asked to specify closely their operational needs for ECMWF's products (i.e. which parameters, which resolution and projection, domain of coverage, forecast times). In this selection, attention should be paid to the meteorological considerations raised in various parts of this lecture. The use of the

products by Member States, and variety of products required is naturally expected to change quite often, especially in the first few months of operation. Therefore, it will be easy to change the requirements at a day or two's notice and all that will be necessary is a letter or telex from the Member State stating the revised selection of products.

Member States might possibly wish to use ECMWF's products for back-up in case its own forecast fails or cannot be run because of computer difficulties, for example. In these circumstances, provided notification was received prior to the start of that day's operational run, it would not be difficult to make an alternative specified range of products available.

In the first stages of operations, Member States will just be able to receive for a given operational run, the products which are specified at the time of the forecast. In the first year or two of operations there will be no automatic request system to obtain additional products (or to suppress products) on particular occasions, for example, a one-off special need, or in an unusual meteorological situation. It is planned to implement this facility later.

There are several other aspects to liaison and communication and liaison between the Centre and Member States. For example as described in A, there will be a human monitor on duty during the ECMWF operational cycle, and he will make an assessment in real-time of the quality of the forecast being produced. In an extreme case, it may be decided that the forecast is totally unrealistic and non-meteorological (perhaps resulting from an undetected computer error), and in this case, distribution of the forecast might be totally suppressed.

More likely is the circumstance that the human monitor has reason to be suspicious of the forecast for various reasons (e.g. in the case of extreme or unusual developments when a great deal of input data are missing). In this case the human monitor would wish to send to users an appropriate real-time warning. At another level (not in real-time) there will be a need to exchange information between ECMWF and Member States regarding short and long term assessments of ECMWF products.

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* An Advisory Committee established by the Council of ECMWF to consider the technical aspects of the telecommunications network taking ECMWF and Member States.
