DEVELOPMENT OF PROBABILISTIC FORECASTING AT METEO-FRANCE

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1. INTRODUCTION

It has always been clear to all meteorologists, even if not explicitely recognized, that weather forecasting is in essence probabilistic. The interest, if not the necessity, of qualifying the uncertainty of the weather forecasts has been stated over and over again in the litterature for 40 years and more. However, for years the dominant trend among forecasters has rather been towards determinism, at least in the way of expressing the forecasts. Only implicitly, mainly through different phrasings, has the (subjective) estimate of the forecast probability been conveyed to the user.

Now, after years of ambitious work to improve deterministic forecast production and extend it well into the medium range, it has become clear that this approach was approaching its limits, at least until a new major breakthrough is made in NWP. Hence the new impetus given to probabilistic approaches, and in particular to the development of Ensemble Prediction Systems, most noticeably at ECMWF and at NCEP Washington, but also in other centres. However, while these EPS systems were progressing towards acceptable performance levels, one cannot say that the procedures in operational forecast production were following the way towards probabilism at a similar pace.

At Meteo-France, there is now a widespread interest for the development of probabilistic forecasting, and a plan has been designed for a real introduction of probabilistic thinking into the operational production. Considering that the scientific understanding is more advanced for the medium range than for the short range, through the development of ensemble prediction systems (although it is rather an empirical form of understanding), we decided to concentrate our action, at least initially, on the medium range, with the ECMWF EPS. The plan is then two fold: on one hand, to develop an automatic production for professional users, on the other hand, to add probabilistic information into the production by forecasters.

Finally, to help with the definition of the information which could be provided to the general public, Meteo-France has ordered a preliminary market survey, some results of which are presented in the last section of this paper

2. AUTOMATIC PRODUCTION

Meteo-France intends to develop a commercial offer based on the probability of weather events from the ECMWF EPS. The products will be proposed to professional users, who should be able to derive a real benefit from using these probabilities in their decision making.

There are several requirements that this offer must folloz. The first one is that the definition of the events should be tailored to the needs of the users, which implies that the production system should be flexible enough to cater for a large variety of events.

A second requirement is that the products should be « as good as possible », i.e., any forecast bias should be removed, and, most importantly, the probabilities should be reliable.

A further requirement is that the users will need to know what to expect in terms of quality, i.e. sharpness of the predicted probabilities. Professional users should not be given products without an indication of their

expected quality. Probably the best information to be provided in that respect are the ROC curves, as they are closely related to decision making.

Very often, there are worries among meteorologists that the probabilities of events derived from the EPS might be difficult to understand and to use outside the meteorological world. From our first experience, these worries do not seem to be justified. We explained these probabilities to the management staff of a major professional newspaper in agriculture. It did not take long before they came to the crucial question : "how good are these probabilities?", and they had no particular difficulty to understand non trivial verifications techniques such as reliability diagrams.

What they found difficult to achieve however, was to define precisely the weather events whose occurrence was to be predicted. It appears that this can be quite a complex issue for sophisticated users with many types of applications.

3. PRODUCTION BY FORECASTERS

The first question to address is: what is the aspect of medium range probabilistic forecasting on which forecasters can provide the best added value compared to direct model output? There is little or no objective evidence available to answer that question, but, from the experiences of various met services since ensemble prediction has started, it does seem that forecasters can contribute a lot to the estimation of forecast confidence.

The task of the forecasters will therefore be the following: in addition to the description of the most likely forecast evolution, to provide an estimation of a confidence index for that forecast. The range covered will be from day 3 to day 7 (i.e. day 4 to day 8 model range), and obviously the confidence index may vary with forecast range, depending on the situation.

The confidence index will be produced by the Central Forecast division in Toulouse. It will be included in the technical medium range guidance delivered to all forecast offices, and it will then be up to the regional centres (and to a specialised division in Paris for the national media) to convey the information to the end users in a usable form.

The confidence index will be based essentially on the tubing of the ECMWF EPS (cf. contributions from F. Atger and T. Desponts at this Workshop).

4. A MARKET SURVEY

Something essential to be decided is then the way to express this confidence index. This question, or similar ones, have been asked over and over again since the EPS started, without much insight given into what the answer should be. Météo-France therefore decided to tackle it, at least for a start, through a market survey conducted by a company specialised in marketing, completely outside the meteorological world.

The request to that company was essentially to help us answer the question : *« how should we express confidence information for the general public ? »* It was not to answer a question which I think is voiced far too often, which is : « will the public understand ? », because the answer to that question is known from the start : some of them will understand, and others will not, in the same way as some people use weather forecasts in a sensible way, and others don't.

The survey was conducted by open discussions with panels of 10 to 15 people (professional or semi-professional users of weather forecasts were excluded from the panels). Staff from Météo-France had helped to formulate the questions, but were not present at the disussions.

Examples of expressions proposed to the panel are listed below : (to be added at the end of a traditional bulletin : Mainly cloudy, temperature close to normal, etc...)

Confidence :

Forecast confidence : high

Forecast confidence : limited

Forecast confidence (from 1 to 5) : 5

Very likely evolution

Doubtful forecast evolution

etc...

Alternatives :

Other possible evolution : much colder temperature

Evolution to be excluded : return to cold conditions

We cannot make a day 7 forecast today

During the panel discussions, initially there were a few negative reactions to the inclusion of confidence information in the forecast ("the weather will be fine, unless it rains"...), but none at the end of the session : a confidence index was actually perceived as a valuable addition to the forecast.

On the other hand, most people would not easily understand that a 'precise' forecast can have a low confidence. So it is very important that the phrasing account for that: as a simple example, do not say "temperature 12 degrees" if the confidence is low, but say: "temperature between 10 and 14".

Then, most people grasped very quickly the fact that a forecast with high confidence « must » be correct. Too many cases of poor forecast with high confidence would soon ruin any interest from the public.

More detailed reactions are given below.

- Reactions to various confidence index formulations :

number between 1 and 5	mainly positive reactions
text only	not so well understood, carries a negative image

use phrases (e.g. the evolution is highly likely)	very negative reactions and poor understanding

- « we cannot make a day 7 forecasttoday »

  reasonably well accepted as long it does not happen to often

- Alternative scenarios

mention other possible evolution(s)	reactions mainly negative («cover-up »)
mention evolutions which can be excluded	reactions positive or very positive

Overall, beyond the few negative initial reactions, the general perception was of ***increased commitment and honesty*** on the side of the met service.

Another point to be noticed is that the interest for confidence information expressed by the participants was not so much for them personnally, but rather in the way of saying that this information should be interesting for such and such categories of users. There is not that much demand from the so-called general public as such, at least not at the moment. Clearly the best way to go is to develop probabilistic products and services for professional and semi-professional users first. They are the ones who are really interested.