Forecast confidence index derived from the Ensemble Prediction System

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Based on a fixed classifier of meteorological weather patterns, post-processing of the Ensemble Prediction System allows to produce a confidence index for the predictability of the forecast and also a guidance on weather parameters in probabilistic terms. The usefulness of the confidence index as a skill of forecast is proven by the correlation between good forecasts and high index values. The fixed classifier is also used to cluster the ensemble members providing several possible scenarios.

1. Confidence index

The effective skill of weather forecasts is an important statement allowing to specify the confidence on a single deterministic forecast, or to help to distinguish in advance between *good* and *bad* forecasts. The Ensemble Prediction System (EPS) is a the well-suited method to use since it is designed to capture the range of uncertainty within its range of solutions at any time. One procedure consists in deriving probabilities of occurrence of meteorological events (such as the probability of rainfall) from the EPS. However most of the products issued to the public contain several weather parameters, usually presented in a deterministic form, which have to be qualified as a whole (fig.1). We propose to assess the forecast with a confidence index. In this contribution an objective confidence index based on the Ensemble Prediction System (EPS) is presented.

(← indices de confiance, max. 100)

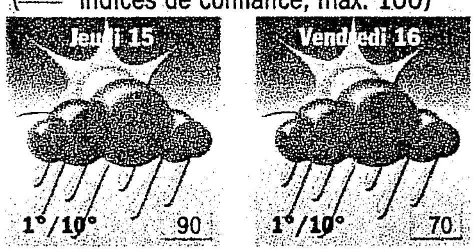

Fig.1 Graphical forecast issued in a newspaper, it contains a deterministic forecast with a confidence index (box bottom right)

The basic idea is to use the dispersion of the members of the EPS at each time-step and to produce automatically an index. Assuming that a large dispersion means that several solutions are possible (i.e confidence is low for a selected solution), at the reverse a small dispersion corresponds to a good reliable forecast. We have worked with the fixed classifier of typical situations containing the fields Z500 hPa and T850 hPa[1]. At each time-step the dispersion of the ensemble members on the classifier is measured using the entropy. This value is then converted linearly to a confidence index ranging from 0 to 10 (10 is good confidence).

The quality of a confidence index is verified by checking the relation between the rate of good control forecasts and the confidence index (fig.2). Obviously there is a good relationship between the confidence index and the quality of the control forecasts, but of course the verification is done on upper air meteorological fields and the conclusions may not be directly pertinent to forecasts of local weather parameters (temperature, clouds, precipitation, etc.). Nevertheless, the confidence index is objectively derived and can be used as a guidance for estimating the uncertainty. The forecasters are then asked to modify the confidence index according to the forecasted probabilities of local weather parameters.

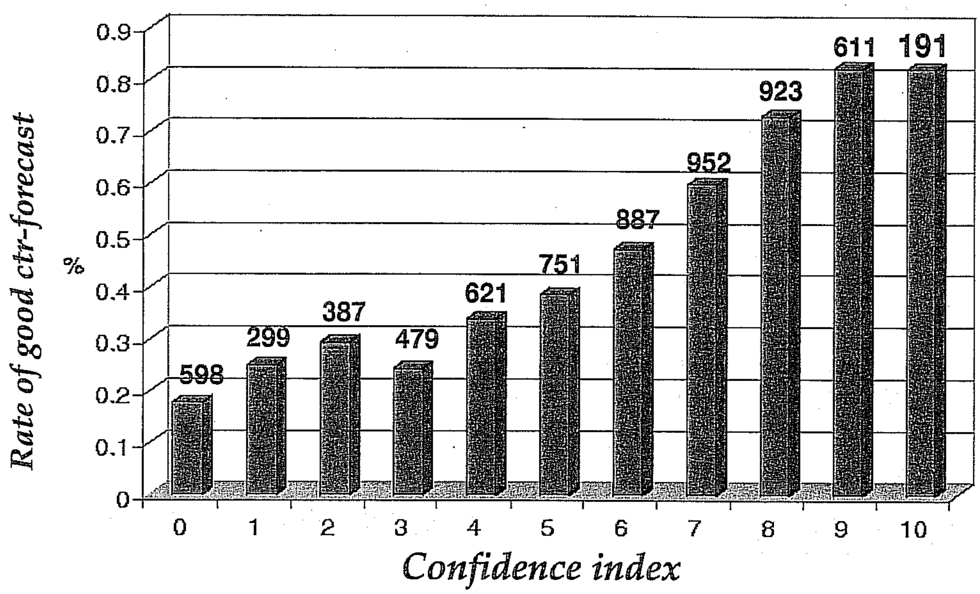

Fig.2. Control forecast quality versus confidence index, D+4 to D+10, period Jan. 97 to Sept. 99, verification on T850hPa and Z500hPa.

2. Alternative scenario

The fixed classifier is also used to cluster the ensemble members at any timestep within the 144 typical situations. The four most populated units of the classifier are presented to the forecasters at every time step (fig.3). By displaying the patterns most likely to occur, such a presentation helps the forecaster to choose a scenario. As another benefit of the taking alternatives into account is eventually to reveal different confidence for different weather elements.

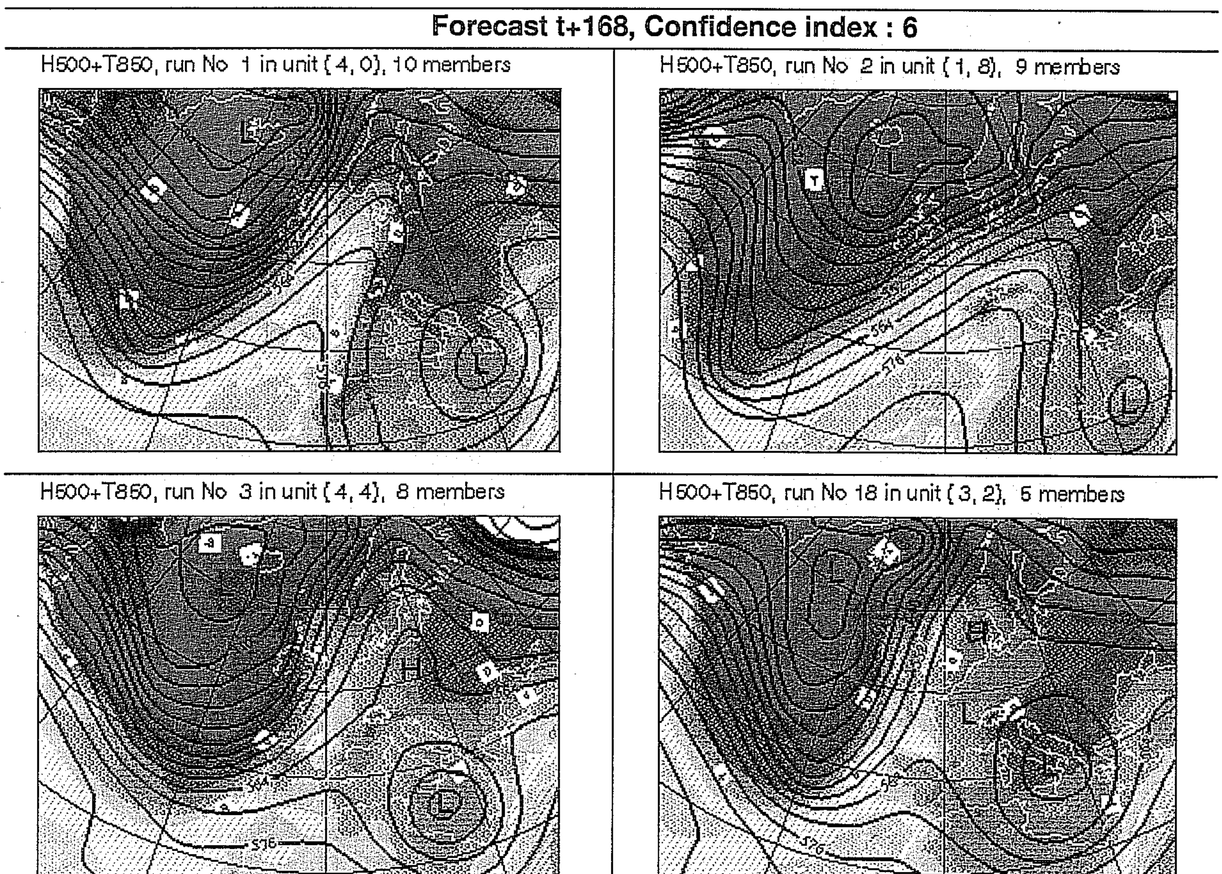

Fig.3 Four situations most populated by EPS members at D+7, geopotential heights at 500hPa are in black, temperature anomalies at 850hPa are presented in colour.

For example in the case displayed in figure 3, the four most frequent situations of the ensemble show three main features: the presence of a ridge associated with warm air over the west and centre of Europe, south-westerly winds blowing on the west part of Europe, and an active low over Italy. All the features lead to a small risk of precipitation over Switzerland, but a uncertainty in winds and temperatures which have to be expressed either in words for the general public or terms of probabilities for professional customers.

3. Event probabilities

Events are defined here as, for example, rainfall (24-hour total) > 10 mm, wind gusts > 45 km/h or relative sunshine between 25% and 60%, at given stations. The probabilities of occurrence of local weather event are produced by combining the frequency of occupation by EPS members on the units of the classifier and the statistically derived probabilities of the event for each unit. The statistics correlating the weather elements to the units was made for the period 1981 to 1997.

A verification was made for every parameter at different swiss locations. The results in terms of long term climate Brier skill score are positive up to day +10, with the exception of rare events such as rainfall (24-hour total) > 50mm or wind gusts > 75 km/h. Although this technique gives useful information (better than climatology) up to day +10, it doesn't provide risky forecasts because the deviation from climatology is rather small.

Figure 4 shows a verification of rainfall (24-hour total) greater than 0.1 mm. While on the reliability plot the verification points are on the 45 degree line indicating a good reliability, the forecast distribution is centred on the climatological frequency and relatively flat with respect to the ideal U-curvature (lack of resolution).

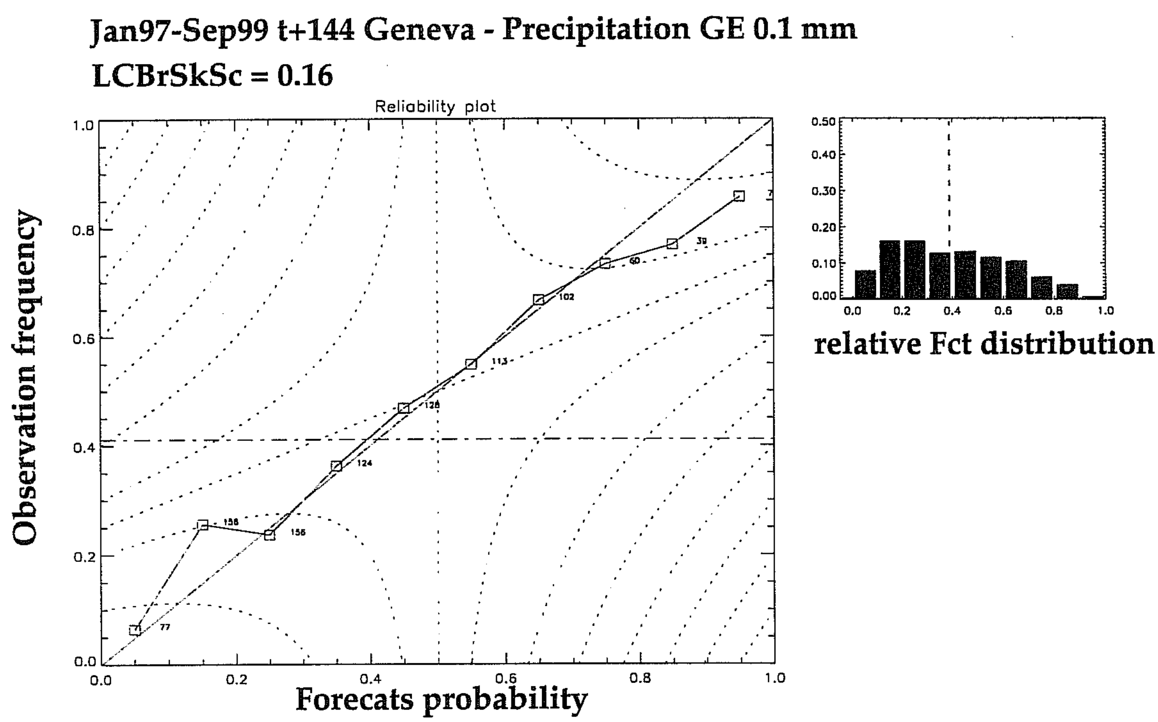

Fig.4 Reliability plot and relative forecast distribution.

Reference:

[1] P. Eckert, D. Cattani, J. Ambühl, 1996, Classification of Ensemble Forecasts by Means of an artificial Neural Network. Meteorol Appl. 3, 169-178.