Ensemble prediction at Météo-France: a progress report

L. Descamps, C. Labadie, A. Joly, E. Bazile, J. Nicolau
Groupe d'étude de l'Atmosphère Météorologique (GAME), Météo-France et CNRS,
42 avenue G. Coriolis, F-31057 Toulouse cedex 1, France
Corresponding author: alain.joly@meteo.fr

1. Changes to the operational system

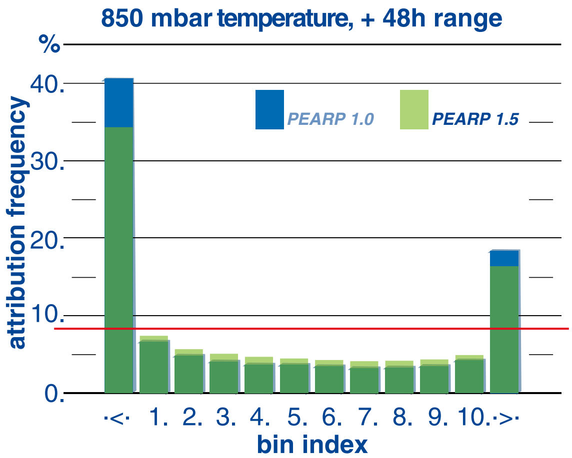


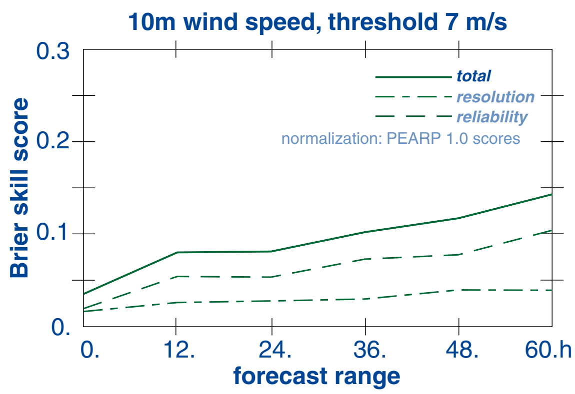
Figure 1: *Rank histogram contrasting the operational ensemble forecast of 2007 (labelled PEARP 1.0) with the version that went into operations at the end of january 2008 (labelled PEARP 1.5). The parameter is 850 mbar temperature at 48 h range. The histograms result from a one month validation period.*

Météo-France runs operationally since 2004 an ensemble forecast based on its global model Arpege, developed within the forecast department by J. Nicolau. It is called *PEARP*, french acronym for *Arpege ensemble forecast*. The ensemble has 10 members, it runs once per day following the 18UTC production assimilation. It is initialized with singular vector perturbations computed over the Northern Atlantic and Europe with an optimization time of 12 h. The model was unperturbed and exactly identical to its deterministic version. This ensemble was primarily meant to provide possible alternative scenarios in situations favourable to rapid storm development.

As the interest for producing actual probabilistic forecasts raises, it has been decided to hand the future evolution of the ensemble forecasting tool to the research department, while the forecast department would concentrate on developing methodologies and probabilistic products from both PEARP at short range and the ECMWF EPS at longer range. On 28 january 2008, a first step of evolution within the new organization has been completed. A new version, termed *PEARP 1.5* has been declared operational.

It includes the following changes. *(a):* although ensemble size is still 10, the horizontal resolution of the base PEARP model has been uncoupled from that of the deterministic version and fixed at T358 with the geometric factor C of the Schmidt-Courtier-Geleyn transform at $C = 2.4$. However, the vertical resolution continues to follow that of the other Arpege-Aladin models (changing from 41 to 60 levels), except that the mesosphere is removed. As a result, a control member has been added. It was planned to expand ensemble size later in 2008. Although indeed 10 further forecasts are performed in our experimental framework, the operations departments have other priorities and were no able to include these extra members in the operational suite. *(b):* further singular vectors are computed in all parts of the globe, although at low resolution (T44). The most significant change to the initialization, however, is the inclusion of some form of breeding. Indeed, initialization now includes the 24 h evolved perturbations from the previous run, combined to the singular vectors. *(c):* furthermore, the final anomalies added to the analysis are scaled to an amplitude sized using error variances derived from the 4D-Var assimilation cycle. *(d):* the complete

Figure 2: *Brier skill score of the event* 10 m wind speed faster than 7 ms^{-1} *as a function of the forecast range. The reference used for normalizing the score is the operational ensemble (PEARP 1.0). Also shown is the decomposition of the Brier score into its reliability and resolution components.*



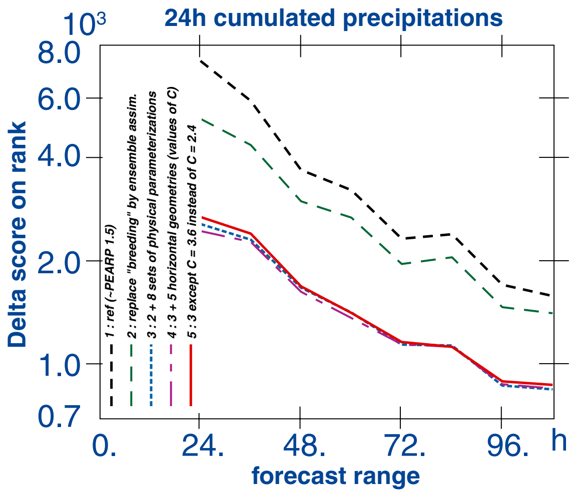


Figure 3: *A result from the PEARP 2009 preparatory experiment: the so-called "Δ" score of 24 h accumulated precipitations as a function of the forecast range (see Candille and Talagrand, 2005). This score measures the departure of the rank histogram from flatness. It has been derived from a series of experiment covering one month. Experiment definitions are recalled in the figure itself. Both the use of ensemble assimilation realizations and multiple parameterization sets bring key improvement to the probabilistic forecast of the parameter. All experiments are performed with 21 members.*

TIGGE requirements for output have been implemented, coupling files for the Hungarian Met Service limited area Aladin ensemble forecast are produced.

Figures 1 and 2 summarize the one month (05/01/2007 to 05/02/2007) evaluation period of this new version. The main goal of these changes was to turn *PEARP* into a true global ensemble forecast system as part of Météo-France contribution to the *TIGGE* project. However, the introduction of the semi-breeding especially, improved dispersion and resolution over the area of main interest.

2. Preparing the 2009 version

Preparations for turning *PEARP* into a more state-of-the-art ensemble prediction system that is both global and mesoscale over North-Atlantic and Europe are under way. One important innovation that has been introduced in our operational system in 2008 is a 6-members 3D-Var FGAT ensemble assimilation running parallel to the main 4D-Var Arpege assimilation cycle (Berre *et al.*, 2007). One goal of this assimilation ensemble with perturbed observations is to feed the 4D-Var with error statistics of the day. But another, equally important goal, is to provide better initial conditions for ensemble forecasting. Replacing the semi-breeding with perturbations from the assimilation ensemble is one primary feature of the 2009 changes. Another one is to include some kind of model error. One source will be to use several sets of physical parameterizations. According to another one month test period (march 2008, figures 3 and 4), these two aspects are able to bring very significant improvements, in particular with the probabilistic forecast of "actual weather" parameters (rainfall, near-surface state). Playing with the horizontal resolution (by changing the geometric factor C) is also considered: this can also improve the mesoscale aspects of the forecast. Finally, the ensemble size should be significantly enlarged up to between 30 and 40 members.

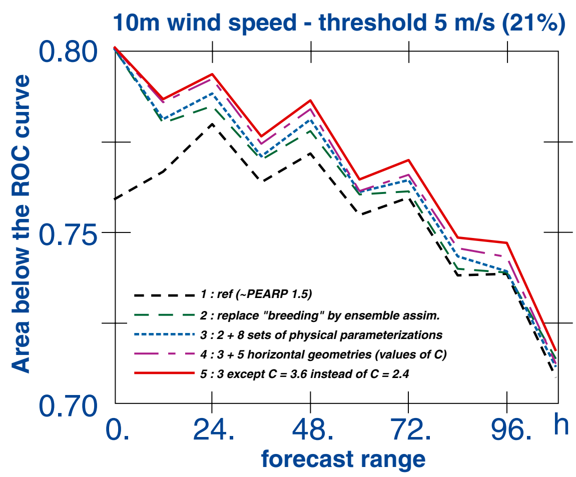


Figure 4: *Same as fig. 3 except that the score is now the area below the ROC curve, the parameter is the 10 m wind speed and the result is tied to the specific event that this speed is larger than 5 ms^{-1}. The frequency of that event is 0.21.*

Reference

Berre, L., O. Pannekoucke, G. Desroziers, S.E. Ştefănescu, B. Chapnik and L. Raynaud, 2007: A variational assimilation ensemble and the spatial filtering of its error covariances: increase of sample size by local spatial averaging. *Proceedings of the ECMWF workshop on flow-dependent aspects of data assimilation*, 11-13 June 2007, 151-168.

Candille, G. and O. Talagrand, 2005: Evaluation of probabilistic prediction systems for a scalar variable. *Quart. J. Roy. Meteor. Soc.*, **131**, 2131–2150.