Dynamical Error Model applied to Hydrological Ensemble Forecasts

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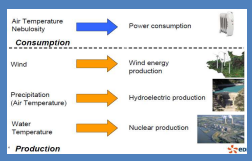
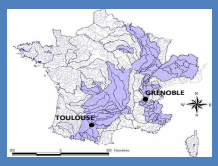
Forecasts at EDF-DTG (French producer of energy)

At EDF, hydro-meteorological forecasts have started in the 50's for reservoir inflow management and activities have increased up today for:

- short to medium range discharge forecast (from D until D+6)
- reservoir inflow and the snowmelt forecast
- drought forecast
- water temperature forecast
- sediment transport forecast



The river Arc at Bramans, the 29th of may 2008

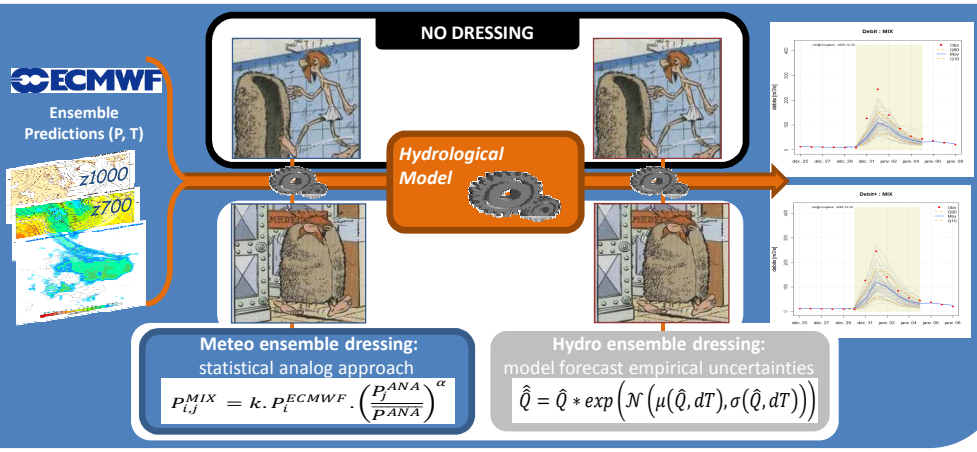


Hydro-meteorological forecasts are necessary to ensure safety, security of installations, respect of regulatory requirements and the optimise water resources (*Desaint et al., 2008*).

Towards an Ensemble Prediction System…

In order to better communicate forecasts to end-users, and more particularly their incertitude, forecasters expertise is more and more focused on discharge ensemble predictions. To do so, an ensemble forecast method was developed in 2010 and is now used at EDF-DTG. Its principal issue is to let the forecasters expertise and modify on the meteorological and hydrological forecasts. A "mix" method, which consists in combining the ECMWF skill with the reliability of the analog approach *(Le Lay et al., 2010)*, have been developed.

One of the incertitude source comes from hydrological modelling. A discharge post treatment is a necessary condition in order to cope with the under-dispersion of the hydrologic probabilistic forecasts.



Hydro ensemble dressing used in EDF-DTG

(Empirical Model)

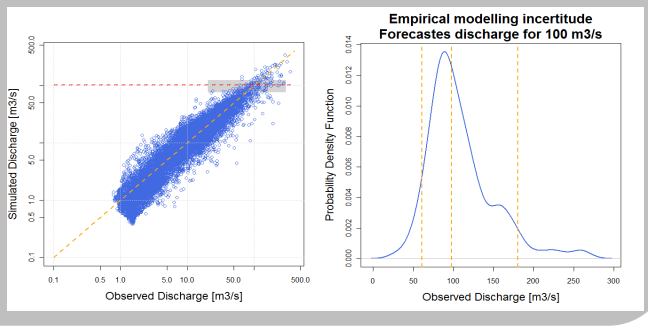
Hydro ensemble dressing used in EDF-DTG is based on a statistical modelling of the empirical error. It compares observed to forecasted discharges according to a quantile sub-sampling of the forecasted discharges, with a focus for the extremes (a 2% width for the 0-10% and 90-100% quantiles and a 8% width for the 10-90% quantiles) for each lead times.

Error Model

$$\varepsilon_i = ln\left(\frac{Q_i}{\hat{Q}_i}\right) \longrightarrow (\mu,\sigma)$$

Inspired by *Montanari & Brath, 2004*
Schaefli et al., 2007

BUT: for a same discharge, RR modelling do not depend only on discharge, but also on processes
(recession, water level rising…)



Improvement proposed: post-treatment

Error modeling based on the searching of analog scenario

Distance Criterion:

$$D = \left(Q_j^{Prev} - Q_j^{Archive}\right)^2 + \left(Q_{j-1}^{Prev} - Q_{j-1}^{Archive}\right)^2$$

Forecast Evaluation:

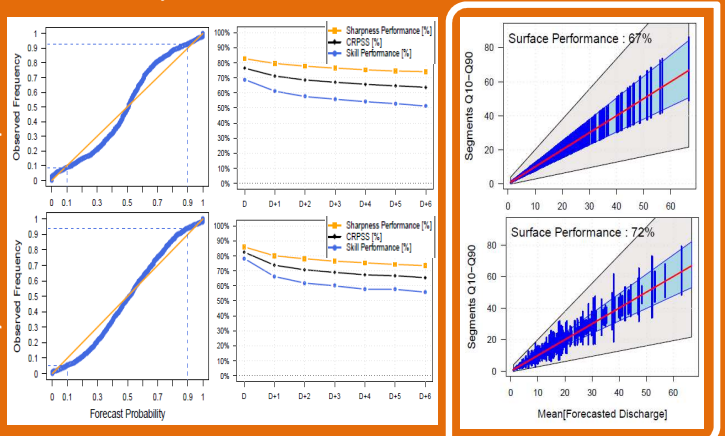
predictions based from 2005-2008 ensemble forecasts

Reliability

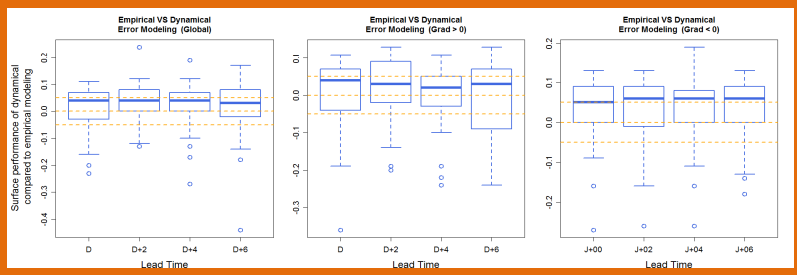
CRPSS

Sharpness Score

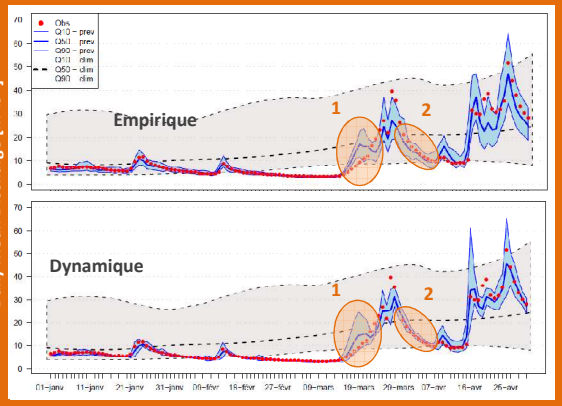
Compared to climatologic ensemble forecast



Synthesis: *based on 21 catchments*



Example:



Improvements:

- the dressing is wider during the flood rise (1)
- forecasts are sharper during recessions period and droughts (2)

Perspectives

After the comparison of empirical and dynamical dressing, different ways of research are planned:

1. The implementation of the algorithm for the real forecast,
2. The tests of others distance criteria for seeking the analog members.

Références

Desaint et al., 2008. *La Prévision Hydrométéorologique Opérationnelle : L'Expérience d'Electricité de France*, Colloque SHF-191e, CST-« Prévisions Hydrométéorologiques ».
Le Lay et al., 2010. *Operational use of ensemble hydro-meteorological at EDF (French producer of energy)*, European Geosciences Union, 3-8 April 2011.
Montanari & Brath, 2004. *A Stochastic approach for Assessing the Uncertainty of Rainfall-Runoff Simulations*, Water Resour. Res, vol. 40, W01106.
Schaefli et al., 2007. *Quantifying Hydrological Modelling Errors through a Mixture of Normal Distributions*, Journal of Hydrology, 332, 303-315.