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Comparison of ensemble post-processing approaches, based on empirical and dynamical error modelisation of rainfall-runoff model forecasts

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In the context of a national energy company (EDF : Electricité de France), hydro-meteorological forecasts are necessary to ensure safety and security of installations, meet environmental standards and improve water ressources management and decision making. Hydrological ensemble forecasts allow a better representation of meteorological and hydrological forecasts uncertainties and improve human expertise of hydrological forecasts, which is essential to synthesize available informations, coming from different meteorological and hydrological models and human experience. An operational hydrological ensemble forecasting chain has been developed at EDF since 2008 and is being used since 2010 on more than 30 watersheds in France. This ensemble forecasting chain is characterized ensemble pre-processing (rainfall and temperature) and post-processing (streamflow), where a large human expertise is solicited.

The aim of this paper is to compare 2 hydrological ensemble post-processing methods developed at EDF in order improve ensemble forecasts reliability (similar to Monatanari &Brath, 2004; Schaefli et al., 2007). The aim of the post-processing methods is to dress hydrological ensemble forecasts with hydrological model uncertainties, based on perfect forecasts. The first method (called empirical approach) is based on a statistical modelisation of empirical error of perfect forecasts, by streamflow sub-samples of quantile class and lead-time. The second method (called dynamical approach) is based on streamflow sub-samples of quantile class and streamflow variation, and lead-time. On a set of 20 watersheds used for operational forecasts, results show that both approaches are necessary to ensure a good post-processing of hydrological ensemble, allowing a good improvement of reliability, skill and sharpness of ensemble forecasts. The comparison of the empirical and dynamical approaches shows the limits of the empirical approach which is not able to take into account hydrological dynamic and processes, i. e. sample heterogeneity. For a same streamflow range corresponds different processes such as rising limbs or recession, where uncertainties are different. The dynamical approach improves reliability, skills and sharpness of forecasts and globally reduces confidence intervals width. When compared in details, the dynamical approach allows a noticeable reduction of confidence intervals during recessions where uncertainty is relatively lower and a slight increase of confidence intervals during rising limbs or snowmelt where uncertainty is greater. The dynamic approach, validated by forecaster's experience that considered the empirical approach not discriminative enough, improved forecaster's confidence and communication of uncertainties.

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