Geophysical Research Abstracts
Vol. 15, EGU2013-10946, 2013
EGU General Assembly 2013

Real-time hydrological probability forecasting improved with ensemble dressing, a case study of the river Meuse

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Hydrological forecasts are affected by inherent uncertainties. These originate from multiple sources including atmospheric forcing, hydrological model schematisation and its parameters, and observations used in the forecasting process. It is increasingly common for forecasting agencies to make explicit estimates of these uncertainties and thus produce probabilistic forecasts. However, streamflow forecasts are often produced using ensemble forcing predictions without additional hydrological post-processing. As a result, the streamflow ensembles can be under-dispersive or overconfident because the estimated predictive distribution does not include hydrological uncertainties.

Under the assumption that the meteorological forecast ensemble is unbiased, “ensemble dressing” constitutes a promising method for estimating combined forcing and hydrological uncertainties. Hydrological uncertainties are estimated from the joint distribution of streamflow simulations and observations, whereby simulations are produced using observed meteorological forcings. Each of the predicted streamflow ensemble members is then dressed using these estimates of hydrological uncertainties. From the dressed ensembles, the combined predictive uncertainty distribution, i.e. the probability forecast is determined.

The present paper describes a study for river Meuse where ensemble dressing is applied. Hydrological uncertainties are characterised using Quantile Regression. Streamflow ensembles are produced by routing the 16 member COSMO LEPS ensemble of precipitation and temperature through a conceptual rainfall-runoff and a one-dimensional hydrodynamic model (HBV and Sobek, respectively). The ensemble members are used to create conditional estimates of hydrological uncertainty. The posterior predictive distribution is produced by averaging probability distributions of each of the dressed ensemble members.

From a two year record of hindcasts , a number of verification metrics are determined. These include correlation coefficient, relative mean error, the Brier skill score, the continuous ranked probability skill score, and the relative operating characteristic score. Results show that forecast quality increases when moving from raw to dressed ensembles, both in the Type-I and the Type-II sense.