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Wavelet based error correction and predictive uncertainty of a hydrological forecasting system

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River discharge predictions most often show errors with scaling properties of unknown source and statistical structure that degrade the quality of forecasts. This is especially true for lead-time ranges greater then a few days. Since the European Flood Alert System (EFAS) provides discharge forecasts up to ten days ahead, it is necessary to take these scaling properties into consideration. For example the range of scales for the error that occurs at the spring time will be caused by long lasting snowmelt processes, and is by far larger then the error, that appears during the summer period and is caused by convective rain fields of short duration. The wavelet decomposition is an excellent way to provide the detailed model error at different levels in order to estimate the (unobserved) state variables more precisely. A Vector-AutoRegressive model with eXogenous input (VARX) is fitted for the different levels of wavelet decomposition simultaneously and after predicting the next time steps ahead for each scale, a reconstruction formula is applied to transform the predictions in the wavelet domain back to the original time domain.

The Bayesian Uncertainty Processor (BUP) developed by Krzysztofowicz is an efficient method to estimate the full predictive uncertainty, which is derived by integrating the hydrological model uncertainty and the meteorological input uncertainty. A hydrological uncertainty processor has been applied to the error corrected discharge series at first in order to derive the predictive conditional distribution under the hypothesis that there is no input uncertainty. The uncertainty of the forecasted meteorological input forcing the hydrological model is derived from the combination of deterministic weather forecasts and ensemble predictions systems (EPS) and the Input Processor maps this input uncertainty into the output uncertainty under the hypothesis that there is no hydrological uncertainty. The main objective of this Bayesian forecasting system is to get an estimate of the conditional probability distribution of the future observed quantity (i.e. the discharge in the next days) given the available sample of model predictions by integrating optimally the hydrological and the input uncertainty.

At the moment this integrated system of error correction and predictive uncertainty estimation has been tested and set up for operational use at some stations in Central Europe only, but will be extended to the EFAS domain within the near future.