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Forecasting Skills of a Multi-Model Approach with Variational Data Assimilation of Remote Sensing Data in the Upper Main Basin

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Ensemble forecasting has been increasingly applied in flow forecasting systems to provide users a better understanding of forecast uncertainty and consequently to take better-informed decisions. In order to produce ensemble forecasts, probabilistic numerical weather predictions (NWP) are commonly forced into a deterministic hydrological model to generate streamflow ensembles. The approach aims at the representation of meteorological uncertainty and neglects uncertainty of the hydrological sub-system. A complementary approach is the use of a probabilistic model pool in combination with a data assimilation technique to represent the uncertainty of historical data and the hydrological model.

We present the assessment of the forecasting skills of a multi-model approach in combination with a simultaneous data assimilation of multiple observations using a 4Dvar method. The model pool is based on the variation of the spatial discretization of a conceptual HBV rainfall-runoff model and different parameter sets with an equivalent calibration. The approach enables the assimilation of streamflow data and remote sensing products for snow coverage, snow water equivalent and soil moisture to provide a set of initial conditions for the forecast. In comparison to the standard implementation of an Ensemble Kalman Filter, structural and parametric uncertainty is represented in the model pool and therefore does not propagate out of the system over time.

The framework is applied to the Upper Main basin in Germany. It is a data-dense environment with well-calibrated rainfall-runoff models. We present the model performance and address the ability of the model pool to represent model uncertainty over a historical period. The lead time performance of the model is assessed for perfect forecasts, i.e. by forcing the model with observed data, remote sensing products from the H-SAF project and several deterministic and probabilistic NWP. The assessment of lead-time performance demonstrates the added value both of the assimilation techniques and the use of a model pool over the use of a single deterministic model.