The role of precipitation in hydrological model uncertainty

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Rainfall-runoff models produce outputs which differ from observations due to uncertainties in process description, process parametrization, uncertainties in observations and changing spatio-temporal variability of input and state variables. Traditionally, attention has been focused mostly on process parameters to quantify runoff uncertainty using e.g. GLUE.

Here we have focused on the role of precipitation uncertainty relating to discharge. For this purpose, we used an inverse model approach. We generated time series of daily precipitation with high spatial resolution using a modified version of Random Mixing and the Shannon-Whittaker interpolation to improve simulated runoff using the SHETRAN (physically-based) and HBV (conceptual) models, both spatially distributed for various sub-catchments of the Neckar River in Germany. HBV was initially calibrated using interpolated precipitation, while SHETRAN uses pre-defined parameters. The modelling goal was to find a spatio-temporal series of precipitation which improved the predicted runoff, under the constraints that the precipitation values be the same at the measurement locations and share their spatial variability with the observations at a given step. Care was taken to select subsequent days for improvement such that the previously improved step considered the effect of the previous steps.

We asked the questions: i) does improving precipitation inputs for one sub-catchment bring runoff improvement for the others? ii) Can the improved precipitation using SHETRAN be used for HBV and still get runoff improvements as compared to the interpolated precipitation and vice versa?

Results showed that overall runoff errors were reduced by 40 to 50% for all sub-catchments. For the peaks, a reduction of 70 to 90% was observed. As compared with the interpolated fields, new fields showed similar overall distribution but different details at finer spatial scales. Swapping improved precipitations between SHETRAN and HBV showed improvement as compared with the discharge from interpolated precipitation.