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Modeling uncertainty in observed precipitation using a meta-Gaussian model and conditional simulation

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In recent years modeling uncertainty in environmental models has been acknowledged as an important topic among both modelers and decision makers using models operationally. In hydrological modeling much attention has been focused on parameter uncertainty, and less attention on the uncertainty of in-data, calibration data (e.g. discharge) and model structure. This work forms part of a larger ongoing project where the main objective of the project is to assimilate uncertainty in in-data, parameters and discharge in order to estimate a predictive distribution for discharge. For assimilating these uncertainties a particle filter is being used.

The work presented here will focus on modelling the uncertainty in observed daily-accumulated precipitation. This is done by using a meta-Gaussian model and conditional simulation for generating precipitation ensembles. These ensembles can be used as forcing for the hydrological model to generate samples of state parameters that can be fed into the particle filter by some suitable sampling regime.

In order to model precipitation spatial dependency need to be taken into account. Here we chose to use the meta-Gaussian model due to its flexibility and easy estimation of the dependence structure. The model allows for any continuous marginal distribution for each individual variable (in this case, each rain gauge station), and by transforming the marginal distributions into Gaussian distributions, the joint distribution is multivariate normal. This allows the dependence structure to be modeled by the covariance or correlation. The conditional simulation is then performed on the transformed data by using kriging. By inverting the simulated data and the correlation structure, precipitation realizations and dependencies are obtained between the original variables. This model is referred to as Gaussian copulas in other branches.

One major issue which arises from working with daily precipitation data is the handling zero values. Precipiation has a mixed distribution between discrete values of point mass zero and continuous positive values. But zero values cannot be transformed into a continuous Gaussian distribution, which is required by the meta-Gaussian model. In order to overcome this problem, the zero values are simulated in the transformed Gaussian space using Gibbs sampling.

The spatial dependency of precipitation is dependent of the local meteorological regime (weather type). Thus a k-means classification of the precipitation is performed prior to using the meta-Gaussian model in order to try and capture the meteorological regime. The meta-Gaussian model is then used with data from each classification class. A comparison is then made to assess if results are improved using k-means classifications.

The results from the model will be evaluated for selected catchments in the Trøndelag area in the middle of Norway.