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Influence of sampling strategies on estimation of hydrological models uncertainty

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A lot of attention in the hydrologic literature has been given to model uncertainty analysis. However quantification of the parameter uncertainty is still remains a key challenge in hydrology. In this study we are testing six different methods namely, Monte Carlo (MC) simulation, generalized likelihood uncertainty estimation (GLUE, Beven and Binly, 1992), Markov Chain Monte Carlo (MCMC), shuffled complex evolution Metropolis algorithm (SCEM-UA, Vrugt, 2003), differential evolution adaptive metropolis (DREAM, Vrugt et al., 2008) and adaptive cluster covering (ACCO, Solomatine, 1999).

GLUE is a widely known variation of Monte Carlo method using an empirical form of likelihood formulation. MCMC simulation is a widely adopted approach to estimate the posterior probability distribution function of the parameters that appropriately samples the high-probability-density region of the parameter space. DREAM runs multiple chains simultaneously for global exploration of parameter space and automatically tunes the scale and orientation of the proposal distribution during the evolution to the posterior distribution. ACCO is a randomized search algorithm that is used in this study in the function as an efficient sampler. All these methods have different sampling strategies, and all experiments were run till convergence in the model output statistics was observed.

We applied these methods to estimate uncertainty of streamflow simulation using conceptual hydrological model HBV with real-world observed streamflow data. Bagmati catchment in Nepal is considered. The results are compared with respect to the shape of the posterior distribution of parameters, uncertainty of model outputs and computation time.

It is found that comparison of the results is not straightforward at all, and the main reason for this is seen in the differences in sampling strategies used. It is suggested to perform more studies into this issue since in uncertainty propagation studies it is commonly assumed that the choice of sampling strategies should not be influencing the results too much if enough runs are made till some sort of convergence is observed - but our experiments show that this is not necessarily the case.