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Effective calibration and uncertainty assessment of integrated distributed hydrological models

R. S. Blasone (1), H. Madsen (2) and D. Rosbjerg (1)

(1) Institute of Environment & Resources, Technical University of Denmark, Kgs. Lyngby, Denmark, (2) DHI Water & Environment, Hørsholm, Denmark (rsb@er.dtu.dk / Phone: +45 45251452)

The complexity of distributed and integrated hydrological models makes the processes of calibration and uncertainty assessment more challenging than for simpler lumped, conceptual types of models. The main reasons for this are: (i) the larger number of parameters to calibrate, (ii) the inclusion of observations of several hydrological variables, often measured at multiple locations, and (iii) the larger computational demands.

Among the different procedures proposed in hydrology, the Generalized Likelihood Uncertainty Estimation (GLUE) methodology has been widely employed in calibration and uncertainty assessment problems, despite its high computational requirements and the subjectivity involved in many parts of the process. By using a Markov Chain Monte Carlo (MCMC) method as parameter sampler the effectiveness and efficiency of the GLUE procedure can be improved. In fact, more realistic estimates of the posterior distributions of parameters and model outputs are obtained when the high probability density region of the parameter space is efficiently searched.

This study illustrates the application of an adaptive MCMC method, the Shuffled Complex Evolution Metropolis (SCEM-UA) algorithm in conjunction with GLUE to an integrated, spatially distributed hydrological model. The hydrology of a Danish watershed, the Karup catchment, is modeled using the MIKE SHE modeling system. The huge dimensionality of the calibration problem is reduced by an initial parameterization and sensitivity analysis, in order to calibrate only the most sensitive model parameters. The different types of measurements (multi-variable and multi-site data) are aggregated into a single objective function through a distance scale transforma-

tion, which allows balancing the impact of the groundwater levels and runoff data in the calibration process. Time and space validation of the uncertainty on the simulated responses is conducted.