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Bayesian estimation of parameters in a regional hydrological model

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Abstract. This study evaluates the applicability of the distributed, process-oriented Ecomag model for prediction of daily streamflow in ungauged basins. The Ecomag model is applied as a regional model to nine catchments in the NOPEX area, using Bayesian statistics to estimate the posterior distribution of the model parameters conditioned on the observed streamflow. The distribution is calculated by Markov Chain Monte Carlo (MCMC) analysis. The Bayesian method requires formulation of a likelihood function for the parameters and three alternative formulations are used. The first is a subjectively chosen objective function that describes the goodness of fit between the simulated and observed streamflow, as defined in the GLUE framework. The second and third formulations are more statistically correct likelihood models that describe the simulation errors. The full statistical likelihood model describes the simulation errors as an AR(1) process, whereas the simple model excludes the auto-regressive part. The statistical parameters depend on the catchments and the hydrological processes and the statistical and the hydrological parameters are estimated simultaneously. The results show that the simple likelihood model gives the most robust parameter estimates. The simulation error may be explained to a large extent by the catchment characteristics and climatic conditions, so it is possible to transfer knowledge about them to ungauged catchments. The statistical models for the simulation errors indicate that structural errors in the model are more important than parameter uncertainties.

Keywords: regional hydrological model, model uncertainty, Bayesian analysis, Markov Chain Monte Carlo analysis

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