Bayesian uncertainty estimation and multi-response calibration in rainfall-runoff modelling: the case of the Haute-Mentue catchment (Switzerland)

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The Haute-Mentue catchment, located in the western part of Switzerland, represents the experimental basin of the HYDRAM Laboratory at the Swiss Federal Institute of Technology in Lausanne. The field data collected over more than 20 years served beyond the experimental hydrology as input for different hydrological conceptual or physically based models. In order to estimate models parameters and to take into account uncertainty associated with estimated parameters and model output, a Bayesian approach for multi-response calibration has been developed via Monte Carlo Markov Chains techniques and a Gibbs within Metropolis algorithm. Previous field acquired knowledge (i.e. soil storage saturation deficit, stream water silica and calcium concentrations) has been used to constrain parameterization of the classical and of a modified versions of TOPMODEL. Multi-calibration led to a trade-off behaviour of the efficiencies of the simulated responses. The total modelling uncertainty of the new introduced responses was considerably reduced at the expense of a slight increase in the total uncertainty of the simulated discharges. Nevertheless, the multi-response calibration methodology showed that internal variable and other additional information could contribute to better identify the posterior distributions of the hydrological model parameters and to better assess the model output uncertainty.