Geophysical Research Abstracts,
Vol. 10, EGU2008-A-08529, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-08529
EGU General Assembly 2008

Bayesian Treatment of Forcing Error Using Adaptive Markov Chain Monte Carlo Sampling

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There is increasing consensus in the hydrologic literature that an appropriate framework for streamflow forecasting and simulation should include explicit recognition of forcing, parameter and model structural error. The contributions of this paper are twofold. First, we present a novel Markov Chain Monte Carlo (MCMC) sampler, entitled DiffeRential Evolution Adaptive Metropolis (DREAM) that is especially designed to efficiently estimate the posterior probability density function of parameters in complex, high-dimensional sampling problems. This MCMC scheme adaptively updates the scale and orientation of the proposal distribution during sampling, and maintains detailed balance and ergodicity. Second, we demonstrate how DREAM can be used to better treat forcing data error during watershed model calibration using a 5-parameter rainfall - runoff model with streamflow data from two different catchments. Explicit treatment of input error during rainfall - runoff model calibration not only results in prediction uncertainty bounds that are more appropriate, but also alters the posterior distribution of the model parameters. This has significant implications for regionalization studies.