Geophysical Research Abstracts
Vol. 14, EGU2012-1897, 2012
EGU General Assembly 2012

Development and comparison of Bayesian modularization method in uncertainty assessment of hydrological models

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Abstract:With respect to model calibration, parameter estimation and analysis of uncertainty sources, different approaches have been used in hydrological models. Bayesian method is one of the most widely used methods for uncertainty assessment of hydrological models, which incorporates different sources of information into a single analysis through Bayesian theorem. However, none of these applications can well treat the uncertainty in extreme flows of hydrological models' simulations. This study proposes a Bayesian modularization method approach in uncertainty assessment of conceptual hydrological models by considering the extreme flows. It includes a comprehensive comparison and evaluation of uncertainty assessments by a new Bayesian modularization method approach and traditional Bayesian models using the Metropolis Hasting (MH) algorithm with the daily hydrological model WASMOD. Three likelihood functions are used in combination with traditional Bayesian: the AR (1) plus Normal and time period independent model (Model 1), the AR (1) plus Normal and time period dependent model (Model 2) and the AR (1) plus multi-normal model (Model 3). The results reveal that (1) the simulations derived from Bayesian modularization method are more accurate with the highest Nash-Sutcliffe efficiency value, and (2) the Bayesian modularization method performs best in uncertainty estimates of entire flows and in terms of the application and computational efficiency. The study thus introduces a new approach for reducing the extreme flow's effect on the discharge uncertainty assessment of hydrological models via Bayesian.

Keywords: extreme flow, uncertainty assessment, Bayesian modularization, hydrological model, WASMOD