Geophysical Research Abstracts
Vol. 14, EGU2012-9308, 2012
EGU General Assembly 2012

Multi-step optimization scheme for XinAnJiang model parameters based on their time scale dependent sensitivities

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The objective of this study is to develop a multi-step optimization scheme for XinAnJiang (XAJ) model parameters taking into account their time scale dependent sensitivities. The XAJ model is the most popular rainfall-runoff model in China, and also widely used all over the world. In this study, a modified XAJ model with fifteen parameters is used.

Understanding the sensitivities is undoubtedly crucial for parameter optimization, even for manual calibration by trial and error. The time scale dependent nature of the sensitivities should be considered in the hydrological modeling practice. A global sensitivity analysis technique proposed by Morris(1991) is used to analyze their sensitivity at time scale of year, month and day. At annual scale, the parameters for input data adjustment are most sensitive. At daily scale, the parameters concerning to runoff component separation and runoff concentration are sensitive. And the parameters relating to runoff generation are less sensitive at all three temporal scales. Also strong interactions between the parameters are observed at all three temporal scales.

Based on the result of global sensitivity analysis, model parameters are classified into three groups, and a multi-step optimization scheme is designed to optimize them group by group by using SCEM-UA, a global optimization algorithm. Starting from a set of commonly used parameter values, the parameters in one group are optimized in a single step and used in the following steps. In order to test its performance, the optimization scheme is applied to a proxy basin. It is shown that this scheme converge to the true parameter values under ideal condition. For actual practice, this multi-step optimization scheme applied to one basin in China and one basin in the United States. The optimization converged and the optimized parameter sets for the XAJ model give reasonable simulation results for both basins.