Geophysical Research Abstracts
Vol. 14, EGU2012-12108-1, 2012
EGU General Assembly 2012

Efficient Auto-Calibration of Computationally Intensive Hydrologic Models by Running the Model on Short Data Periods

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Sophisticated hydrologic models may require very long run times to simulate for medium-sized and long data periods. With such models in hand, activities like automatic calibration, parameter space exploration, and uncertainty analysis become very computationally intensive as these models are required to repeatedly run hundreds or thousands of times. This study proposes a strategy to improve the computational efficiency of these activities by utilizing a secondary model in conjunction with the original model which works on a medium-sized or long calibration data period. The secondary model is basically the same as the original model but running on a relatively short data period which is a portion of the calibration data period. Certain relationships can be identified to relate the performance of the model on the entire calibration period with the performance of the secondary model on the short data period. Upon establishing such a relationship, the performance of the model for a given parameter set over the entire calibration period can be probabilistically predicted after running the model with the same parameter set over the short data period.

The appeal of this strategy is demonstrated in a SWAT hydrologic model automatic calibration case study. A SWAT2000 model of the Cannonsville reservoir watershed in New York, the United States, with 14 parameters is calibrated over a 6-year period. Kriging is used to establish the relationship between the modelling performances for the entire calibration and short periods. Covariance Matrix Adaptation-Evolution Strategy (CMA-ES) is used as the optimizing engine to explore the parameter space during calibration. Numerical results show that the proposed strategy can significantly reduce the computational budget required in automatic calibration practices. Importantly, these efficiency gains are achievable with a minimum level of sacrifice of accuracy. Results also show that through this strategy the parameter space can be efficiently explored and unpromising regions in the parameter space can be reliably identified and disregarded in the course of calibration.