Geophysical Research Abstracts, Vol. 7, 05864, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05864

Combined Parameter and State estimation in the Sacramento Soil Moisture Accounting (SAC-SMA) model using Parallel Computing

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While considerable progress has been made in the development and application of automated calibration methods for nonlinear watershed models, many of these approaches treat the underlying uncertainty in the input-output representation of the model as being primarily due to uncertainty in the parameter estimates. However, uncertainties in the modeling procedure stem not only from uncertainties in the parameter estimates, but also from measurement errors associated with the system input (forcing) and output, and from model structural inadequacies. In this paper, we combine the strengths of the parameter search efficiency of the Shuffled Complex Evolution Metropolis (SCEM-UA) algorithm, with the power and computational efficiency of the Ensemble Kalman Filter to provide a better treatment of input, output, parameter and model structural uncertainties in the Sacramento Soil Moisture Accounting (SAC-SMA) model. To solve the resulting high-dimensional and computational intensive parameter and state estimation problem, we used a distributed computer system using multiple processors connected in parallel. Results demonstrate that improved SAC-SMA streamflow forecasts are obtained when explicitly and properly accounting for input, output, model structural and parameter uncertainty. Moreover, the application of parallel computing results in a considerable time savings compared to traditional serial computations and therefore provides an ideal means to generate ensemble streamflow forecasts.