Calibration and uncertainty analysis of integrated surface-subsurface model using iterative ensemble smoother for regional scale surface water-groundwater interaction modeling

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Abstract

Surface water-groundwater interaction (SWGI) is an important hydrological process that influences both the quantity and quality of water resources. However, regional scale SWGI model calibration and uncertainty analysis have been a challenge because integrated models inherently carry a vast number of parameters, modeling assumptions, and inputs, potentially leaving little time and budget to explore questions related to model performance and forecasting. In this study, we have proposed the application of iterative ensemble smoother (IES) for uncertainty analysis and calibration of the widely used integrated surface-subsurface model, SWAT-MODFLOW. SWAT-MODFLOW integrates Soil and Water Assessment Tool (SWAT) and a three-dimensional finite difference model (MODFLOW). The model was calibrated using a parameter estimation tool (PEST). The major advantage of the employed IES is that the number of model runs required for the calibration of an ensemble is independent of the number of adjustable parameters. The pilot point approach was followed to calibrate the aquifer parameters, namely hydraulic conductivity, specific storage, and specific yield. The parameter estimation process for the SWAT model focused primarily on surface-related parameters. The uncertainties both in the streamflow and groundwater level were assessed. The work presented provides valuable insights for future endeavors in coupled surface-subsurface modeling, data collection, model development, and informed decision-making.

Keywords : SWAT-MODFLOW, iterative ensemble smoother, uncertainty analysis, PEST

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