Improving Parameter Estimation in a Land Surface Model by Using GRACE Water Storage Data

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Several recent studies have shown the significance of representing shallow groundwater in land surface hydrologic simulations. However, optimal methods for parameter estimation in order to realistically simulate water table depth have received little attention. Most models assume globally-constant parameters due to the lack of data and suitable methodology for calibrating groundwater parameters. The recent availability of GRACE water storage data provides a unique opportunity to constrain model simulations of terrestrial water storage. Our previous work has demonstrated that baseflow can be used to constrain water table depth simulation in land surface models. In this study, we simultaneously incorporate both GRACE and baseflow for parameter estimation in land surface models, and demonstrate the advantages gained from this approach using a Monte Carlo simulation framework. The optimal parameter set estimated using the Shuffled Complex Evolution algorithm is validated successfully in Illinois. For other regions without groundwater data, the multi-objective calibration strategy demonstrated here can be used to enhance parameter estimation and to improve water table depth simulations in land surface models. In current and future work, the calibrated land surface model will be applied to the entire U.S. to study the impact of groundwater on the time scales of land hydrologic memory.