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Estimation and impact assessment of input and parameter uncertainty in predicting groundwater flow with a fully distributed model

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Transient numerical groundwater flow models have been used to understand and forecast groundwater flow systems under anthropogenic and climatic effects, but the reliability of the predictions is strongly influenced by different sources of uncertainty. Hence, researchers in hydrological sciences are developing and applying methods for uncertainty quantification. Nevertheless, spatially distributed flow models pose significant challenges for parameter and spatially distributed input estimation and uncertainty quantification. In this study, we present a general and flexible approach for input and parameter estimation and uncertainty analysis of groundwater models. The proposed approach combines a fully distributed groundwater flow model (MODFLOW) with the DiffeRential Evolution Adaptive Metropolis (DREAM) algorithm. To avoid over-parameterization, the uncertainty of the spatially distributed model input has been represented by multipliers. The posterior distributions of these multipliers and the regular model parameters were estimated using DREAM. The proposed methodology has been applied in an overexploited aquifer in Bangladesh where groundwater pumping and recharge data are highly uncertain. The results confirm that input uncertainty does have a considerable effect on the model predictions and parameter distributions. Additionally, our approach also provides a new way to optimize the spatially distributed recharge and pumping data along with the parameter values under uncertain input conditions. It can be concluded from our approach that considering model input uncertainty along with parameter uncertainty is important for obtaining realistic model predictions and a correct estimation of the uncertainty bounds.