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Effects of temporal and spatial resolution of calibration data on integrated hydrologic water quality model identification

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Hydrological water quality modeling is increasingly used for investigating runoff and nutrient transport processes as well as watershed management but it is mostly unclear how data availablity determins model identification. In this study, the HYPE (HYdrological Predictions for the Environment) model, which is a process-based, semi-distributed hydrological water quality model, was applied in two different mesoscale catchments (Selke (463 km2) and Weida (99 km2)) located in central Germany to simulate discharge and inorganic nitrogen (IN) transport. PEST and DREAM(ZS) were combined with the HYPE model to conduct parameter calibration and uncertainty analysis. Split-sample test was used for model calibration (1994-1999) and validation (1999-2004). IN concentration and daily IN load were found to be highly correlated with discharge, indicating that IN leaching is mainly controlled by runoff. Both dynamics and balances of water and IN load were well captured with NSE greater than 0.83 during validation period. Multi-objective calibration (calibrating hydrological and water quality parameters simultaneously) was found to outperform step-wise calibration in terms of model robustness.
Multi-site calibration was able to improve model performance at internal sites, decrease parameter posterior uncertainty and prediction uncertainty. Nitrogen-process parameters calibrated using continuous daily averages of nitrate-N concentration observations produced better and more robust simulations of IN concentration and load, lower posterior parameter uncertainty and IN concentration prediction uncertainty compared to the calibration against uncontinuous biweekly nitrate-N concentration measurements. Both PEST and DREAM(ZS) are efficient in parameter calibration. However, DREAM(ZS) is more sound in terms of parameter identification and uncertainty analysis than PEST because of its capability to evolve parameter posterior distributions and estimate prediction uncertainty based on global search and Bayesian inference schemes.