Satellite-based rainfall datasets and autocalibration techniques' effects on SWAT+ flow prediction

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Abstract

Accurate flow prediction is a primary goal of hydrological modeling studies, which can be affected by the use of varying rainfall datasets, autocalibration methods, and performance indices. The combined effect of three rainfall datasets — Fifth generation of European ReAnalysis (ERA-5), Gridded meteorological data (gridMET), Global Precipitation Measurement Integrated Multi-satellitE Retrievals (GPM IMERG) — and three autocalibration techniques — Dynamically Dimensioned Search (DDS), Generalized Likelihood Uncertainty Estimation (GLUE), Latin Hypercube Sampling (LHS) — on SWAT+ river flow prediction was measured using three evaluation metrics — Nash Sutcliffe Efficiency (NSE), Kling Gupta Efficiency (KGE) and coefficient of determination (R^2) — for two watersheds in North Carolina (Cape Fear, Tar Pamlico) using the Soil Water Assessment Tool Plus (SWAT+) model. Five parameters in the SWAT+ model, cn2, revap_co, flo_min, revap_min, and awc, were found to be significantly sensitive under all combinations for both watersheds. Simulated flow varied more with the change in rainfall than the calibration technique used. We discovered that GPM IMERG gave the best results of the rainfall datasets, followed by ERA-5 and gridMET. We observed that the NSE score is more sensitive to different combinations of rainfall datasets and calibration techniques than the KGE scores. SWAT+ underperformed in the prediction of base flow for the groundwater-driven watershed. Overall, we recommend using the GPM IMERG rainfall dataset with the GLUE optimization technique and KGE performance index for optimal flow simulations. The results from this study will help hydrological modelers choose an optimal combination of rainfall dataset, autocalibration technique, and performance index depending on watershed characteristics.

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