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The benefits of satellite soil moisture data in parameter estimation and uncertainty reduction of a distributed rainfall-runoff model

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The rapid development of remotely sensed techniques leads to a number of available hydrological data that can be used for hydrological modelling, among which, remotely sensed soil moisture data play an important role. Recent studies have paid attentions to assimilating the catchment-averaged or sub-catchment-averaged values of remotely sensed soil moisture products into hydrological models or using them as added constraints for model parameter calibrations. However, the benefits of satellite soil moisture data in hydrological modelling have not been fully identified, especially for distributed hydrological models. Here we evaluate the benefits of remotely sensed soil moisture in multi-objective parameter estimation and uncertainty reduction of a distributed model by addressing two research questions (i) Calibration against satellite soil moisture data influences which parameters of the distributed model; (ii) How the weights of objective on optimizing gridded soil moisture influence the parameters and model simulations. A multi-objective Bayesian calibration method is used to calibrate the daily DEM-based distributed rainfall-runoff model (DDRM) against streamflow data at catchment outlet and gridded SMAP soil moisture data in Qujiang catchment of China. Different weights of objectives on optimizing streamflow and soil moisture simulations are set to see the influences. Results indicate that multi-objective calibrations have improved parameter estimation and reduced uncertainty in model parameters and model simulations. Four parameters of the distributed models that are related to soil moisture simulations are significantly identified when calibrating with satellite data. Streamflow simulations are more likely to be affected by weights of objectives than soil moisture simulation. This study provides insights into the benefits of satellite soil moisture data in distributed hydrological model calibrations.