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Assimilation of remotely sensed soil moisture into the Community Land Model for improving hydrologic predictions over Europe

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Accurate and reliable hydrologic simulations are important for many applications, such as water resources management, future water availability projections and predictions of extreme events. However, the accuracy of water balance estimates is limited by the lack of observations at large scales and the uncertainties of model simulations due to errors in model structure and inputs (e.g. hydrologic parameters and atmospheric forcings). In this study, we used a joint model parameter calibration and data assimilation approach to improve continental-scale hydrologic estimates of soil moisture, surface runoff, discharge and total water storage. The assimilation experiment was conducted over a time period from 2000 – 2014 with the Community Land Model, version 3.5 (CLM3.5) integrated with the Parallel Data Assimilation Framework (PDAF) in the Terrestrial System Modeling Platform (TerrSysMP-PDAF) at a spatial resolution of approximately 3km over Europe. The model was forced with the high-resolution reanalysis COSMO-REA6 from Hans-Ertel Centre for Weather Research (HErZ). Using this modeling framework, the coarse-resolution remotely sensed ESA CCI soil moisture (SM) daily data were first downscaled to the model resolution and then assimilated into TerrSysMP-PDAF. The impact of remotely sensed soil moisture data on improving continental-scale hydrologic estimates was analyzed through comparisons with independent observations including ESA CCI-SM, E-RUN runoff, GRDC river discharge and total water storage from GRACE satellite. Cross-validation with independent CCI-SM observations show that estimates of soil moisture improved, particularly in the summer and autumn seasons. The assimilation experiment also showed overall improvements in runoff particularly during peak runoff. The results demonstrate the potential of assimilating satellite soil moisture observations to improve high-resolution hydrologic model simulations at the continental scale, which is useful for water resources assessment and monitoring.