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Sensitivity of hydrological fluxes and states to groundwater representation in continental scale simulations over Europe.

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This study explores the influence of groundwater representation on soil moisture, evapotranspiration, total water storage, water table depth and groundwater recharge/discharge through the comparison of multi-model simulations using the stand-alone Community Land Model (CLM3.5) and the ParFlow hydrologic model. ParFlow simulates three-dimensional variably saturated groundwater flow solving Richards equation and overland flow with a two-dimensional kinematic wave approximation, whereas CLM3.5 applies a simple approach to simulate groundwater recharge and discharge processes via the connection of bottom soil layer and an unconfined aquifer. Over Europe with a lateral resolution of 3km, both models were driven with the COSMO-REA6 reanalysis dataset for the time period from 1997 to 2006 at an hourly time step using the same datasets for the static input variables (such as topography, vegetation and soil properties). Evaluation against independent observations including satellite-derived and in-situ soil moisture, evapotranspiration, and total water storage datasets show that both models capture the interannual and seasonal variations well at the regional scale, however ParFlow performs better in simulating surface soil moisture in comparison with in-situ data. Moreover, juxtaposition of both models shows that simulations of water fluxes and sates in both space and time are sensitive to the differences in groundwater representation in the model. For example, simulations with ParFlow have overall wetter soil moisture than CLM, particularly in humid and cold regions and driest soil moisture in the arid and semi-arid regions. Seasonally, ParFlow simulates wetter soil moisture in winter and driest in summer than CLM model. This study helps to understand and quantify uncertainties in groundwater related processes in hydrologic simulations and resulting implications for water resources assessment at regional to continental scales.