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Effects of data assimilation on different fluxes of a fully coupled land surface/subsurface model

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We test the improvement of flux predictions with data assimilation (DA) in a coupled land surface/subsurface model. We present results of DA experiments in an idealized testcase with an extent of 1km x 5km x 50m. Our model considers multiple heterogeneous soil units, different plant functional types and a sophisticated topographical design chosen to induce lateral flow and rivers at specific areas. We use TSMP-PDAF to couple the land-surface model CLM and the subsurface/surface flow model ParFlow with the DA framework PDAF. We use a Localized Ensemble Kalman Filter (LEnKF) with an ensemble of 93 members. We consider uncertainty in the atmosphere, soil properties and initial conditions by different atmospheric forcings, distinct heterogeneous soil parameter distributions and an individual spinup for each ensemble member. The ensemble, which has a horizontal grid resolution of 40m, is updated with virtual measurements from a high resolution (10m) reference model.
In the scope of this work, we address the impact of updating different state variables (soil moisture and pressure head) on groundwater recharge, lateral subsurface flow, surface runoff, and evapotranspiration. While surface runoff and evapotranspiration directly depend on pressure head and soil moisture, subsurface flow depends on pressure head gradients. For groundwater recharge, our estimate depends on groundwater storage changes (which can directly be enforced by the updates during DA) as well as subsurface flow. To investigate if DA can directly improve these fluxes, we run multiple experiments with different observation frequencies and localization radii. Further, we investigate if there are improvements in the fluxes during open loop forecasting periods subsequent to DA.