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Coupling the Community Land Model 5.0 with the Parallel Data Assimilation Framework

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Land surface models are important tools to improve our understanding of interacting ecosystem processes, but their predictions are associated with uncertainties related to model forcings, parameters and process simplifications. As high-quality observations become more and more available, they can be used to constrain the uncertainty of land surface model predictions. In this study, we use data assimilation for the fusion of data into the Community Land Model 5.0 (CLM5). CLM5 simulates a broad variety of important land surface processes including moisture and energy partitioning, surface runoff, subsurface runoff, photosynthesis and carbon and nitrogen storage in vegetation and soil. Here, we focus on water movement in soils and related soil hydraulic parameters and assimilate in-situ soil moisture data into CLM5 to improve the estimate of model states and soil hydraulic parameters. To do this, we have coupled the Parallel Data Assimilation Framework (PDAF) with CLM5. This coupling is based on the online variant of PDAF, i.e., data assimilation occurs during simulation runtime in the main memory and not via input/output files. Online coupling requires modification of the model source code, but we aim to keep the modifications to the CLM5 code minimal so that maintenance of the ongoing CLM5 developments remains straightforward. To this end, our approach reuses the existing CLM5 ensemble mode with only necessary adjustments to connect the PDAF parallel communicators. Furthermore, we developed the coupling in the framework of the Terrestrial System Modeling Platform (TSMP). TSMP is a highly modular modeling system for the fully integrated soil-vegetation-atmosphere system. To illustrate the potential of this coupling, we use the ensemble Kalman Filter to perform simultaneous state and parameter updates in a forest headwater catchment.