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Ensemble Kalman Filter Data Assimilation for the ParFlow Hydrologic Model

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Research in hydrometeorology has demonstrated repeatedly that atmospheric models benefit from detailed formulations of the land surface, and that energy and moisture fluxes between the land surface and atmosphere are coupled strongly not only with atmospheric conditions, but also with subsurface hydrology—particularly soil moisture distribution. Improving the representation of hydrologic processes should lead to better predictive skill in a fully-coupled weather forecasting model, and the hydrologic model itself can be improved by incorporating observed data values. For this work, we apply the Ensemble Kalman Filter functionality included in the Data Assimilation Assimilation Research Testbed (DART), a collection of data assimilation tools maintained at the National Center for Atmospheric Research, to the ParFlow hydrologic model—the hydrologic component of the TerrSysMP fully coupled hydrologic – land surface – atmospheric model system. This generalized data assimilation tool allows observations of variables in the hydrologic component of the system to be incorporated into the overall error covariance matrix thus guiding the development of quantities that define the model state. Single dimension column tests, two-dimensional hillslope tests, and a three-dimensional drainage and dry-out test were performed with the ParFlow-DART system to evaluate the effects of assimilating pressure head, soil moisture, and outflow observations on the development of the model through time. The success of these tests will allow the ParFlow-DART system to be developed into a complete data assimilation package for the TerrSysMP fully-coupled modeling system.