IMPROVING SURFACE AND SUBSURFACE HYDROLOGIC PROCESSES WITHIN THE COMMUNITY LAND SURFACE MODEL (CLM): COUPLING PFLOTRAN AND CLM

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Numerous studies have shown a positive soil moisture-rainfall feedback through observational data, as well as, modeling studies. Spatial variability of topography, soils, and vegetation play a significant role in determining the response of land surface states (soil moisture) and fluxes (runoff, evapotranspirtiaon); but their explicit accounting within Land Surface Models (LSMs) is computationally expensive. Additionally, anthropogenic climate change is altering the hydrologic cycle at global and regional scales. Characterizing the sensitivity of groundwater recharge is critical for understanding the effects of climate change on water resources. In order to explicitly represent lateral redistribution of soil moisture and unified treatment of the unsaturated-saturated zone in the subsurface within the CLM, we propose coupling PFLOTRAN and CLM.

PFLOTRAN is a parallel multiphase-multicomponent subsurface reactive flow and transport code for modeling subsurface processes and has been developed under a DOE SciDAC-2 project. PFLOTRAN is written in Fortran 90 using a modular, object-oriented approach. PFLOTRAN utilizes fully implicit time-stepping and is built on top of the Portable, Extensible Toolkit for Scientific Computation (PETSc). The PFLOTRAN model is capable of simulating fluid flow through porous media with fluid phases of air, water, and supercritical CO2. PFLOTRAN has been successfully employed on up t o 204,000 cores on Jaguar, the massively parallel Cray XT4/XT5 at ORNL, for problems composed of up to 2 billion degrees of freedom.

In this work, we present a strategy of coupling the massively parallel subsurface groundwater code, PFLOTRAN, and CLM. A tightly coupled surface water component is added t o the PFLOTRAN model, resulting in an integrated surface--subsurface model. Representation of topography i n structured grid models suffer from two shortcomings: presence of inactive cells within the mesh; and disconnected vadose zone of neighboring cells, due to stair-step representation of the surface elevation. In order to overcome the above shortcomings, we have implemented unstructured grid capability within the PFLOTRAN model that enables simulatingland surface/subsurface processes at length scales of kilometers, while maintaining reasonable mesh sizes.Few preliminary results obtained from the coupled model are presented.