

Poster #217

Advancing Integrated Hydrologic Modeling at the Continental Scale

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The first high-resolution integrated hydrologic model the continental US was developed for Use Case 3 of the Interoperable Design of Extreme-scale Application Software (IDEAS) project. This model covers 6.3 million km² at 1 km² spatial resolution, and incorporates dynamic interactions from the groundwater to the land surface using ParFlow-CLM. We employ this platform to simulate transient behavior based on historical meteorological forcings for several scenarios. Predevelopment simulations were used to evaluate the partitioning between evaporation and transpiration. Results demonstrate a novel connection between lateral groundwater flow and terrestrial water budgets. This work reconciles systematic differences between global observations and global land surface models. Additionally, predevelopment model outputs demonstrate that groundwater surface water exchanges systematically bias Budyko relationships between runoff and evapotranspiration in predictable ways. Building from the predevelopment scenario, we incorporate groundwater depletions that have occurred over the last century. Comparisons between depleted and predevelopment groundwater configurations demonstrate how large scale storage losses have fundamentally altered system dynamics. Next this anthropogenic signal will be compared to systematic warming in additional scenarios that reflect several levels of projected warming.

We are also working to expand the domain from coast-to-coast and increase the spatial resolution to 250 m². Lack of consistent subsurface data is one of the primary limitations of continental scale simulations. To facilitate this expansion, we developed the first US aquifer map including information on aquifer thicknesses and spatial distribution of alluvial aquifer systems and consolidated aquifers. Using this map, we have tested subsurface parameterizations and sensitivities in the high plains and central valley.

Through the collaboration with IDEAS, Use Case 3 has also explored improving the productivity of developers and scientists who work with ParFlow. In particular, ParFlow developers have updated several tools and practices based on best practice methodologies promoted through IDEAS and demonstrated in the Extreme-scale Scientific Software Development Kit (xSDK) exemplar package, Alquimia. These updates include, moving source code management to a public Git repository on the GitHub site, and leveraging tools there for issue tracking and continuous integration (e.g., Travis CI). In addition, a Software Productivity and Sustainability Plan was developed for ParFlow, which describes the development team's approach to software engineering methodologies that ensure a sustainable high-quality capability for the community. Finally, the team is exploring the componentization and interface design of its Land Model in order to release it to the community as a domain component in the xSDK.