IDEAS Use Case I: Improved process representation in watershed models across scales through software interoperability and productivity

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The need to understand and predict climate impacts and feedbacks on terrestrial ecosystems is driving an increased interest in models that represent and couple all relevant processes. But even as field and laboratory campaigns rise to the challenge of collecting diverse and heterogeneous datasets that can inform and constrain these models, questions remain about process representation and implementation. In this presentation, we summarize three activities we have performed to address different aspects of these questions in support of modeling efforts of Berkeley Lab's Watershed Function Scientific Focus Area at the East River watershed, Colorado. In particular, we (1) pursue code interoperability as an efficient means to add existing capabilities to codes that lack them (2) explore variable mesh resolution and refinement approaches to improve model accuracy in regions of interest, and (3) use model intercomparison to benchmark capabilities and build confidence in model results.

Code Interoperability. As our models become more elaborate and move toward multiscale representations, we need the ability to combine different computational processes and algorithms in a sensible and interoperable fashion. For example, we use Alquimia, an interoperable interface designed to provide biogeochemical processes to flow/transport models, to add biogeochemical capabilities to surface-subsurface codes ATS/Amanzi and Parflow. Current work focuses on the use of the new capabilities in the simulation biogeochemical transformations along a hillslope of the East River watershed.

Adaptive Mesh Refinement (AMR). AMR is a numerical technique for adjusting the resolution of computational grids near important features to enable more accurate calculations locally, and to reduce the computational burden of large domains. We have developed a surface-subsurface solver based on the kinematic wave and Richards equations using an AMR formulation. This approach may be particularly useful in accurately capturing water fluxes that develop in localized areas of the simulation domain.

Benchmarking. The community is increasingly turning to model intercomparison studies where multiple codes solve the same problem to expose and understand differences in results. While recent model intercomparisons in integrated hydrology have utilized simple geometries and small domains, we take a step further by tackling the complex and highly characterized topography associated with a meandering reach of the East River. Specifically, we compare three integrated hydrology codes ParFlow, Amanzi/ATS and the AMR-based code described above, which solve variably saturated subsurface flow using Richards equation coupled to surface water flow.