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Towards a high resolution, integrated hydrology model of North America: Diagnosis of feedbacks between groundwater and land energy fluxes at continental scales.

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Recent studies demonstrate feedbacks between groundwater dynamics, overland flow, land surface and vegetation processes, and atmospheric boundary layer development that significantly affect local and regional climate across a range of climatic conditions. Furthermore, the type and distribution of vegetation cover alters land–atmosphere water and energy fluxes, as well as runoff generation and overland flow processes. These interactions can result in significant feedbacks on local and regional climate. In mountainous regions, recent research has shown that spatial and temporal variability in annual evapotranspiration, and thus water budgets, is strongly dependent on lateral groundwater flow; however, the full effects of these feedbacks across varied terrain (e.g. from plains to mountains) are not well understood. Here, we present a high-resolution, integrated hydrology model that covers much of continental North America and encompasses the Mississippi and Colorado watersheds. The model is run in a fully-transient manner at hourly temporal resolution incorporating fully-coupled land energy states and fluxes with integrated surface and subsurface hydrology. Connections are seen between hydrologic variables (such as water table depth) and land energy fluxes (such as latent heat) and spatial and temporal scaling is shown to span many orders of magnitude. Model results suggest that partitioning of plant transpiration to bare soil evaporation is a function of water table depth and later groundwater flow. Using these transient simulations as a proof of concept, we present a vision for future integrated simulation capabilities.