SUBSURFACE-LANDSURFACE-ATMOSPHERIC FEEDBACKS UNDER A RANGE OF CLIMATE CONDITIONS

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There is a strong body of evidence which demonstrates that subsurface-surface-atmospheric feedbacks play a particularly significant role in wet-to-dry climate transition zones around the world. On the watershed scale, previous studies show that these feedbacks are strongest within transitional zones around saturated river valley regions. The aim of this project is to study effects of climate on the coupling strength between water table dynamics and energy fluxes at the land surface.
Using series of simulations performed with the variably saturate groundwater model ParFlow coupled to the Common Land Model (PF.CLM) for real watersheds from different climatic regions (semi-arid, wet, and temperate), zones and times of strong subsurface-surface coupling within the watersheds are extracted. For each watershed, the model is run repeatedly for a number of years until the water and energy balances converge and the system reaches dynamic equilibrium. This allows the model to develop its natural hydrologic state given the set of atmospheric conditions for each region. We compare the seasonal dependence as well as changes in location and extent of transition zones of strongest coupling between water table depth and land surface energy fluxes for these different climatic regions. The numerical experiments are part of an emerging virtual laboratory that will be utilized to develop and test data assimilation and scaling algorithms in a different study. In future work, results from these simulations will also be used in fully coupled subsurface-landsurface-atmospheric simulations of the watersheds to study effects of climate conditions on rainfall persistence, the two-way feedback between water table depth and atmospheric boundary layer depth, and changes in coupling strength around rainfall events. Such comparisons are important because they improve our understanding of the transfer of energy and mass between different components of the hydrologic cycle, which in turn forms a basis of transferability of the subsurface-atmospheric connection between other watersheds in different climatic regions.