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Effects of Vegetation on Subsurface-Surface-Atmosphere interactions

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The aim of this project is to investigate the effect of vegetation on the coupling between groundwater, surface energy fluxes, and the atmospheric boundary layer. Literature demonstrates that conditions at the land surface can affect water table dynamics and development of the atmospheric boundary layer. Leaf Area Index (LAI) in particular is shown to have an important effect on land surface processes such as interception, albedo, evaporation, and transpiration. In this work, we perform a sensitivity analysis on a range of LAI values within a real catchment to investigate the role of vegetation on transition zones of strongest coupling between water table and energy fluxes at the land surface on one hand, and between water table dynamics and the atmospheric boundary layer on the other hand.

In the first phase of this work, integrated groundwater-surface water simulations using the coupled model ParFlow-CLM are performed for different LAI values. These will be based on ranges obtained from observations for specific vegetation types within the real catchment. The subsurface-surface simulations are used to obtain the equilibrium soil moisture field given a specific set of atmospheric forcing conditions. Furthermore, results are analyzed to investigate LAI effects on the hydrologic and energy balance at the land surface, and how this affects the regions and times of strongest feedbacks between energy fluxes and water table depth. In the second phase, the equilibrium soil moisture field obtained from ParFlow-CLM will be used to initialize a second set of sensitivity analysis simulations using the fully coupled subsurface-surface-atmospheric model ParFlow-CLM-COSMO. Results will help draw conclusions on which regions within a watershed exhibit stronger vegetation effects on the two-way feedbacks between water table and atmospheric boundary layer on both diurnal and seasonal timescales.