Linking Snowmelt and Nitrogen Cycling to Vegetation Community Dynamics along a Hillslope Transect

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Changes in the hydrologic cycle, particularly early snowmelt or reduced snowpack are hypothesized to disrupt coupled plant-microbial behavior, possibly due to the temporal discontinuity between microbial nutrient release and vegetation greening around the snowmelt period. The objective of this work is to quantify the influence of variations in snowmelt timing and snowpack depth on nitrogen fluxes and plant phenology along a lower montane hillslope site in the East River catchment, Crested Butte, CO. In particular, this study compares the process couplings and mechanisms that guide nitrogen fluxes and plant behavior for an average hydrologic year (e.g., 2016), a deep snowpack (e.g., 2017) or an unusually sparse and early melting snowpack year (e.g., 2018) as observed at the East River site. For this purpose, a hillslope-to-floodplain transect model has been developed using *ecosys* - a comprehensive plant ecosystem model that can account for surface energy exchange, microbial metabolism, vegetation phenology/physiology, as well as vertical and lateral hydrologic and biogeochemical fluxes.

Ecosys results demonstrate distinct spatial and temporal signatures of hydrological and biogeochemical fluxes along the hillslope transect. In particular, observed and simulated nitrate concentration is highest around the midslope position following snowmelt. Ecosys simulations further show that an earlier but lower nitrate concentration is obtained in low snow years (i.e., 2018) as compared to high snow years (i.e., 2017) due to alterations to the under-snow nutrient buffer. Simulated results indicate that water and nutrient deficit in surface soils in low snow years adversely impacts forb production and favors deep rooting shrubs. Overall, these findings demonstrate the significant spatial and temporal connection between snowmelt-associated nutrient release and vegetation community along the hillslope.