Poster #21-73

Vegetation and Soil Biogeochemistry Feedbacks as Impacted by Snowmelt Regime and Landscape Topography

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BER Program: SBR
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In recent years, decreasing snowpack and early snowmelt have been observed with increasing frequency in the mountainous west. 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 determine the mechanisms underlying feedbacks between hydrologic and biogeochemical fluxes, microbial metabolism and vegetation phenology/physiology. We particularly focus on comparing these process couplings for an average hydrologic year (e.g., 2016) to variations due to a deep snow pack (as observed in 2017) or an unusually sparse and early melting snowpack (as observed in 2018).

Remote sensing and machine learning using training data from lower montane ecosystem hillslope transects was employed to classify vegetation and to quantify distributions of functional types (shrubs, forbs, grass) and multiple representatives of these functional groups were selected for simulations using the *ecosys* land-atmosphere model. Autonomous *in situ* measurements of seasonal temperature and water availability through the soil and subsurface demonstrated contrasting insulating effects of snow cover on soil temperature regimes and feedbacks between surface soil temperature and soil water movement under snow, with consequences for nitrogen retention following snowmelt. *Ecosys* simulation results demonstrate distinct spatial signatures of hydrological and biogeochemical fluxes along the hillslope transect, with greater evapotranspiration rates and higher soil water storage in the floodplain as compared to upslope regions. Consistent with observations, simulated water and nitrogen fluxes are higher around the backslope region following snowmelt. Model simulations indicate that nitrogen runoff after snowmelt impacts vegetation community structure, resulting in islands of fertility around the backslope. Soil depth, and topographic features such as slope and curvature are currently being investigated as key factors defining vegetation distributions and phenology.

Ecosys simulations also show that an earlier, and larger, soil water nitrate concentration occurs with advanced snowmelt due to atmospheric warming and that differences in snowpack depth alterthe under-snow nutrient buffer, particularly ammonium concentrations. In both scenarios of simulated early snowmelt and decreased snowpack, slrrub dominance was observed at the site. These results clearly indicate a temporal connection between snowmelt-associated nutrient release and shrubification at the hillslope site.