Poster #21-72

Hillslope to Watershed Subsurface Hydrologic and Biogeochemical Exchanges with the Atmosphere and River

Tetsu Tokunaga[1*], Bhavna Arora[1], Jiamin Wan[1], Adi Lavy[2], Erica Siirila-Woodburn[1], Boris Faybishenko[1], A. Phuong Tran[1], Wendy Brown[3], Joseph Rungee[4], Markus Bill[1], John Christensen[1], Mark Conrad[1], Jillian F. Banfield[2], and Kenneth H. Williams[1]

[1]Lawrence Berkeley National Laboratory, Berkeley, CA
[2]University of California, Berkeley, Berkeley, CA
[3]Rocky Mountain Biological Laboratory, Gothic, CO
[4]University of California, Merced, Merced, CA

Contact: tktokunaga@lbl.gov

Studies focused on a lower montane hillslope draining into the East River, Colorado are providing insights into depth-distributed subsurface water flow and biogeochemical transformations, and their coupling to the atmosphere and river. Surface and subsurface measurements of aqueous and gas phase compositions, pressures, and temperatures are being obtained within a 200 m long transect sampled down to 10 m below the soil surface at four stations. Hydraulic potential measurements show seasonally dependent recharge and evapotranspiration influences within the upper 2 m, underlain by baseflow through the fractured Mancos Shale.

Understanding of mountainous watershed subsurface cycling of C and other elements is emerging through quantifying depth-, location-, and season-resolved inventories and fluxes of carbon and nutrients, including OC, IC, C/N, δ^{13}C, ^{14}C, SOM speciation, isotopic analyses as well as respiration rates from laboratory-simulated field conditions. Soil to bedrock chemical composition and mineralogy reveal weathering fronts and weathering contributions to C and metals cycling. Microbially-mediated biogeochemical processes impact large-scale exports from the watershed. Genome resolved metagenomes coupled with metatranscriptomes allow exploration into how the microbial community interacts with these cycles and are employed to study the metabolism of microbial communities at three subsystems within the watershed: the hillslope transect, meander- associated floodplain, and grassland hillslopes.

22-year simulations of evapotranspiration using semi-analytical formulas and the Community Land Model indicate that 55% of the watershed averaged annual precipitation is lost due to evapotranspiration, and 75% of which occurs from May to September. Partitioning of ET indicates that transpiration, soil evaporation, and canopy evaporation account for ~50%, 32%, and 18% of total ET. ET is greater at the middle elevation of ~3000 m, where both air temperature and LAI are largest, and smaller along the river valley and at high elevations. Primary controls on water, carbon, and nitrogen fluxes along the hillslope are being investigated with 2-D (x-z) models. An integrated groundwater-surface water model of the East River basin is being used to obtain upper boundary conditions for the models. Historical meteorological data are being used to simulate representative wet and dry years with early and late snowpack melt, to understand impacts of antecedent conditions during extreme weather years. Simulation results indicate significant heterogeneity in hydrologic and biogeochemical fluxes. Water and nitrogen fluxes are higher around footslope regions following snowmelt. Analyses of geochemical data indicate the importance of dilution from snowmelt infiltration in upslope regions and the prominence of iron and nitrate reduction in footslopes.