Biogeochemical Responses to Seasonal Snowmelt-Driven Hyporheic Disturbances in an Upland Catchment

MICHAEL J. WILKINS[1,2], CASEY M. SAUP[1], AUDREY H. SAWYER[1], AMELIA NELSON[1], SAVANNAH BRYANT[1], JOHN N. CHRISTENSEN[3], AND KENNETH H. WILLIAMS[3]

[1]School of Earth Sciences, Ohio State University, Columbus, OH, USA. wilkins.231@osu.edu, saup.4@osu.edu, sawyer.143@osu.edu, nelson.1464@osu.edu, bryant.1694@osu.edu

[2]Department of Microbiology, Ohio State University, Columbus, OH, USA.

[3]Lawrence Berkeley National Laboratory, Berkeley, CA, USA. jnchristensen@lbl.gov, khwilliams@lbl.gov

Upland rivers host exceptionally strong linkages between the terrestrial and aquatic elemental cycles, with organic carbon and other solutes (e.g., metals) exported from hillslopes to river channels along seasonally variable flow paths. Snowmelt in western US watersheds can drive the transfer of significant quantities of dissolved organic carbon (DOC) from the catchment to the river. Once in the river channel, carbon may be processed in the riverbed where converging river water (RW) and groundwater (GW) can generate favorable environments for microorganisms and lead to the formation of reactive hyporheic “hot spots”. Here we quantified the extent of RW-GW mixing in the riverbed at the East River, near Crested Butte, CO using continuous monitoring depth-resolved temperature probes and strontium isotopic measurements ($^{87}Sr/^{86}Sr$ ratios). Data revealed a greater influence of down-welling river water under high discharge conditions that contrasted with more groundwater-influenced pore water chemistry in the riverbed under base flow. While greater carbon transfer into the river channel was observed under high flow conditions, shifts in RW-GW mixing patterns resulted in direct changes in carbon chemistry in riverbed pore fluids. The intrusion of oxic river water and ‘young’ DOC into the riverbed under higher flow conditions also stimulated higher rates of microbial aerobic respiration that were coupled with increases in microbial taxonomic diversity through the riverbed. Conversely, beta-dispersion anlayses revealed more vertical stratification in microbial communities under low-flow regimes. Together, these data reveal dynamic changes in riverbed biogeochemistry linked to seasonal hydrology. Climate-change linked shifts in snowmelt dynamics in upland catchments will therefore impact solute processing in riverbed ecosystems.