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Subsurface Carbon Inventories, Transformations and Fluxes Across Gradients in Elevation and Moisture Within an Alpine Watershed

Kate Maher[1*], Matthew J. Winnick[1], Hsiao-Tieh Hsu[1], Sami L. Chen[1], Yuchen Liu[2], Jennifer L. Druhan[2], Corey R. Lawrence[3], and Kenneth H. Williams[4]

[1]Department of Earth System Science, Stanford University, Stanford, California
[2]Department of Geology, University of Illinois at Urbana-Champaign, Urbana, Illinois
[3]U.S. Geological Survey, Denver, Colorado
[4]Lawrence Berkeley National Laboratory, Berkeley, California

Contact: kmaher@stanford.edu

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The interface extending from the top of the soil layer to the bottom of the water table is characterized by dynamic couplings among vegetation, the movement of water and an array of subsurface biogeochemical processes. This complex interface also contains the largest reservoir of terrestrial carbon (C), one that is highly sensitive to shifts in climate, vegetation, and the resulting hydrologic regimes. Within the LBNL SFA East River, CO watershed study site, we are studying belowground respiration and carbon fluxes and their dependence on *(1)* the timescales and length scales of moisture variability and *(2)* molecular-level changes in organic matter compositions due to differing plant inputs and climatic drivers. We are further developing modeling approaches that capture the dynamic response to external forcings (*i.e.*, soil moisture dynamics and plant communities).

We have characterized two microcatchment study sites at different elevations and life zones (2950 and 3500 m; upper montane and upper subalpine, respectively) using depth- resolved soil moisture and temperature sensors, soil gas wells and lysimeters paired with repeat surveys of soil CO_2 fluxes, above ground biomass and belowground soil carbon distributions. Using a combination of Fourier transform infrared spectroscopy (FT-IR) and bulk carbon X-ray absorption spectroscopy (XAS), we find substantial variability in organic carbon functional group abundances between sites at different elevations. Soils at lower elevation are predominantly composed of polysaccharides, while soils at higher elevation have more complex distributions, including substantial portions of carbonyl, phenolic or aromatic carbon. Soil CO_2 respiration rates also show complex seasonal patterns across sites, with the majority of CO_2 production in the shallow (ca. <40 cm) soil. Peaks in CO_2 production follow precipitation events, with larger pulses of CO_2 production associated with larger rainfall events. However, the relationship between CO_2 production and soil moisture appears complex and highly variable due to the combined effects of both autotrophic and microbial respiration. Incubation experiments utilizing multiple rewetting events also show a complex dependence on soil moisture. A model framework that captures the transition between active and dormant biomass can explain the incubation experiments and will be examined as a tool for partitioning the net belowground fluxes. Collectively, carbon inputs and speciation and their coupling to soil moisture provide fundamental constraints on subsurface respiration dynamics and their potential response to environmental variability.