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Soil Respiration Across Scales

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Soil respiration fluxes play a fundamental role in the terrestrial carbon cycle. Nevertheless, representing the processes that drive soil respiration in models remains an outstanding challenge due to an array of spatially- and temporally-dependent sensitivities to environmental drivers. In particular, the interactions between these drivers, such as plant phenology, temperature, and soil moisture remain largely uncharacterized. Another outstanding challenge is in partitioning between the heterotrophic and autotrophic components of respiration. To address these challenges, we have conducted incubation studies of soil respiration, characterized soil carbon stocks using spectroscopy and radiocarbon, and measured soil respiration rates in a subalpine meadow within the East River watershed, Gothic, CO over the 2016, 2017, and 2018 growing seasons. Laboratory incubations studies with variable soil moisture were used to test a moisture-dependent model framework for microbial respiration that captures the transition between dormant and active states. When the model is run using field measurements of soil moisture and soil carbon, the model successfully matches deep late season CO_2 profiles. To further constrain the parameters of this modeling framework, we are now extracting RNA/DNA ratios as a function of time to monitor the timescale of transition between active and dormant states. To quantify total soil respiration and understand how microbial processes translate to plot-scale measurements, we quantified depth- resolved net CO_2 production rates using observations of soil pCO_2 and surface efflux rates to drive a 1-D diffusion-reaction model. These rates were then compared to sensor monitoring data of soil moisture and temperature and to the MODIS satellite-derived enhanced vegetation index (EVI) as a proxy of plant phenology. A comparison of MODIS EVI across the field site between years demonstrated that when rain events occurred late in the growing season, as vegetation is senescing, soil respiration is significantly less response to increased soil moisture. Future work will examine the extent to which the plant response is further mediating the microbial response, potentially due to a reduction in exudate input. We also observe significant fluxes of CO_2 from the deep subsurface (> 165 cm) in the late growing season that likely persist under snowpack. Collectively, our results suggest that *(1)* plant phenology regulates the response of soil respiration rates to pulse wetting events and *(2)* deep subsurface carbon fluxes may constitute a significant portion of integrated annual surface CO_2 fluxes. Both processes will need to be adequately reflected on model representations to fully capture the response of ecosystems to a more variable water cycle.