LBNL Terrestrial Ecosystem Science SFA - Mysteries of the deep: Impact of warming on microbiology and carbon cycling in deep soils.

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In LBNL's Terrestrial Ecosystem Science SFA on soil carbon cycling, we conduct basic research on soil carbon turnover, storage, and loss. Our goal is to improve process-level understanding of biogeochemical dynamics and develop next-generation predictive capacity in global models of soils' role in ecosystem-climate interactions. Recent research demonstrates that environmental and biological controls are as important as soil organic matter (SOM) structure for SOM dynamics. To improve predictions of SOM response to climate change, this SFA aims to integrate this emerging understanding into soil carbon models by conducting strategically designed experiments and using observations to test and develop new model structures and parameters.

Soils store about 1,300–1,600 Pg organic carbon in the top meter. Despite their low carbon density, subsoil horizons contain more than half of global soil organic carbon, however while C turnover at depth is proposed to be slower than surface C, the vulnerability of deep soil carbon under future climate scenarios is yet to be understood. Microorganisms are responsible for both decomposition and formation of soil organic matter (SOM). The responses of microorganisms —changes in community composition, activity, gene expression, and physiology— determines how an environmental change will alter soil carbon and nutrient cycling. In this project, we aim to understand how long term warming impacts microbial community composition and decomposition of SOM in deep soils. To this end we established a soil warming experiment at the Blodgett Forest Research Station, located in the foothills of the Sierra Nevada, CA. The treatment warms the soil +4°C above ambient to >1 m depth while maintaining the natural temperature depth gradient. Samples across the soil profile were collected prior to the onset of warming and subsequently at six month intervals. Microbial community changes were analyzed via 16S rRNA gene sequencing and changes in microbial decomposition potential were assed via extracellular enzyme activity measurements for β-glucosidase (BG), cellobiohydrolase (CBH), N-acetyl-β-D-glucosaminidase (NAG) and acid phosphatase (AP). Additionally lab incubations with ^{13}C isotopologs of glucose and pyruvate were carried out to assess whether changes in microbial carbon use efficiency (CUE) occurred in response to warming. Although the activity of all enzymes declined with depth, when adjusted for mass of soil C total hydrolytic enzyme activity (CBH + BG + NAG) was similar across depths. NAG actitivity that also releases organic N, was higher than cellulose hydrolyzing enzymes (CBH, BG) in surface soils. While microbial composition and diversity varied significantly through the soil profile, with increases in bacteria with oligotrophic growth strategies with depth. Over the first six months soil warming did not significantly impact microbial composition and diversity; however incubations with ^{13}C-labelled substrates demonstrated a 2-3 fold increase in respiration due to warming. Metabolic modeling is being carried out to determine whether microbial CUE profiles correspond to microbial composition across the soil profile if CUE varies in response to warming.