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

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For the LBNL's Terrestrial Ecosystem Science SFA on soil carbon cycling, we are conducting research on the role of microbes in soil carbon turnover, storage, and loss—the impacts of climate change on these processes. We are focusing on deep soils because despite their low carbon density, subsoil horizons contain more than half of global soil organic carbon (out of 1,300–1,600 Pg organic carbon in the top meter). Moreover, the C turnover at depth is proposed to be slower than surface C, yet 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 of α- and β-glucosidase, cellobiohydrolase, N-acetyl-β-D-glucosaminidase and acid phosphatase. 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, we detected higher enzyme activities in response to heat treatment at each depth. Below the organic soil horizons, 20-60 cm showed the strongest enzyme activity response to the heating treatment. While microbial composition and diversity varied significantly through the soil profile, with increases in bacteria with oligotrophic growth strategies with depth. Over 18 month period however incubations with ^{13}C-labelled substrates demonstrated a 2-3 times 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.