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ABSTRACT TITLE: LBNL Terrestrial Ecosystem Science SFA: Controls on Belowground Carbon Cycling

ABSTRACT: We conduct basic research with a focus on soil carbon cycling and its role in terrestrial biogeochemistry and climate feedbacks. We are addressing gaps in process-level understanding and data to improve ecosystem models of ecosystem-climate feedbacks and sequestration. Using a combination of field and laboratory experiments, natural abundance $^{13}$C and isotopically labeled substrates, advanced imaging, and microbial ecology, we are currently studying:

- Decomposition and stabilization of aboveground and belowground plant inputs. (1) Blodgett Forest. In 2001, we placed $^{13}$C/$^{15}$N-labeled roots and needles in Sierra Nevada soils. We are using the final 10-year collection to investigate the influence of litter type, soil depth, and microbial community on decomposition rates, pathways, and compound-specific stabilization. (2) EBIS-AmeriFlux. We are assessing soil density fractionations and quantifying $^{14}$C-based turnover times of soil organic matter and $^{14}$C-labelled leaves and roots at four AmeriFlux sites, as part of the multi-Lab Enriched Biosphere Isotope Study.

- Physical and microbial processes of black carbon degradation.

- Mechanisms of long-term soil organic matter stabilization. We are working to bridge from molecular mechanisms of carbon stabilization to multi-scale biogeochemical models, integrating experimental data and numerical simulation methods to improve terrestrial models based on new understandings of organic matter dynamics.

Example of a current project on: The effect of soil warming and soil depth on microbial decomposition of biochar, wood, and bulk soil organic carbon in contrasting temperate and tropical soils. We conducted an incubation study using soils from a moist tropical forest in Puerto Rico (PR) and a Mediterranean grassland in California (CA), collected from surface and deep horizons. We added ground $^{13}$C-labeled biochar (or the wood from which it was derived) to these soils and incubated them at ambient and ambient +6°C temperatures (at field gravimetric moisture) for one year. There were distinct microbial communities in the four soil types according to 16S rRNA gene analysis. Wood decomposed approximately 35 times faster than did char, based on $^{13}$CO$_2$ evolution from the soils. Amendments in the surface decomposed faster than those in deeper soil at ambient temperature, and in forest faster than in grassland soil. Both substrates had Q$_{10}$<2, which was less than the temperature response of native SOC. Wood increased decomposition losses of the native soil organic carbon by ~30% in the grassland and slightly less in forest soil. Biochar had only a slight priming effect but stimulated Actinobacteria in the grassland soil, and α-Proteobacteria, Actinobacteria, and Acidobacteria in the tropical soil. Biochar addition was associated with a decline in cellulose and hemicellulose degrading enzyme activity in grassland soils. Based on $^{13}$C analysis of soil density fractions, more biochar than wood was found physically protected fractions, and in the clay-rich deeper Tabonuco soil. Together, these results show that decomposition of these slow-cycling organic inputs is not sensitive to warming but is influenced by soil characteristics that vary with location and soil depth, independent of the type of material being decomposed.