Microbial environmental feedbacks and the evolution of soil organic matter

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The vast majority of Earth's organic matter is stored in soil. The products of microbial metabolism as well as dead microbes (necromass), along with residues from plants and other organisms at different stages of decomposition, constitute a large fraction of that soil organic matter (SOM). The ability of microbes to modify and degrade SOM depends on physicochemical characteristics of the soil, affecting SOM stability and persistence.

While the contributions of microbes to the decomposition and loss of SOM have been intensively studied, their role in maintaining terrestrial SOM is poorly understood.

Specifically, how fungi, bacteria, and archaea participate in SOM production, its interaction with minerals, and the formation of soil aggregates remains a significant gap in our understanding of the terrestrial carbon cycle. Herein, we employ field and laboratory experiments to further understand the role of microbial communities in stabilizing SOM under drought and fluctuating wet-dry cycles in clay-rich tropical soils. We begin by identifying traits characteristic of the single cell physiological response to drought stress through real-time and non-destructive Fourier-transform infrared spectroscopy at the Advanced Light Source at LBNL. This dataset serves as a baseline for the interpretation of molecular data generated across several different scales in complexity, beginning with simple community responses to drought within an abstraction of the soil environment. We scale up through a mesocosm experiment with intact soil cores collected from Isla Buena Vista, a kaolinite rich soil within a tropical rainforest, which also serves as the location of a long-term drying experiment (termed *Parched.Panama*), that serves as the final experimental scale. We use a combination of metagenomic sequencing and metabolomic profiling to examine how traits expressed within the laboratory and field experiments feedback on to the composition of soil organic matter. These three interacting scales will be used to parameterize and benchmark a mechanistic model coupling above- and belowground processes (the *ecosys* model), to predict the fate of SOM on longer time scales.

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