EGU22-1233
https://doi.org/10.5194/egusphere-egu22-1233
EGU General Assembly 2022

Climate history dictates microbial metabolic response to drought stress: from semi-arid soils to tropical forest precipitation gradients

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The frequency and intensity of environmental fluctuations play an important role in shaping microbial community composition, trait-distribution, and adaptive capacity. We hypothesize here that a communities' climate history dictates it's metabolic response to future perturbation under a changing climate. Such a response is significant as changes in microbial metabolism can, in turn, feedback onto metabolite exudation, the chemical structure of necromass, and the formation and stability of soil organic matter. Here we use laboratory and field experiments to examine the metabolic pathways invoked under osmotic and matric stress within semi-arid and tropical soils. For example, using non-destructive, synchrotron-based Fourier-transform infrared spectromicroscopy we profiled the stress response of phylogenetically similar bacteria isolated from soils with contrasting climate histories subjected to both matric and osmotic stress. We note a strong carbohydrate-based, metabolic response of tropical microbes that is entirely absent in semi-arid organisms. At the field scale, we use metagenomic sequencing and metabolite analysis to demonstrate how four different sites established across a 1 m precipitation gradient from the Caribbean coast to the interior of Panama respond to a 50 % reduction in throughfall. The precipitation gradient permits the development of distinct communities at each site that show clearly divergent response to imposed hydrological perturbation. Our contribution here will discuss how communities adapted to different precipitation regimes respond metabolically to drought conditions, and how these change feedback onto the structure and stability of soil organic matter.