Poster #1-3

Digging Deeper: Exometabolomics Reveals Biogeochemical Hotspots with Depth and by Vegetation Type in Arctic Tundra Soils

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With the Arctic warming twice as fast as the rest of the planet, permafrost thaw is increasing both in depth and duration, resulting in increased microbial decomposition of carbon- rich organic matter and the subsequent release of greenhouse gases. Reliably predicting the magnitude of this feedback to the climate system and modeling where and when these carbon- losses are most likely to occur across the landscape requires detailed knowledge of the chemical composition, or decomposability, of soil organic matter—in particular, the water-soluble fraction most available to microbial communities, low molecular weight (LMW) dissolved organic matter (DOM). This soil "exometabolome" represents an information-rich chemical signal of biological activity that is critical to understanding the underlying mechanisms of carbon storage and release in Arctic systems. Due to analytical challenges however (i.e. isolation, detection, quantitation), relatively little is known about how this complex mixture of small molecules varies with soil depth or how it may be influenced by vegetation. We have established a sensitive, high-throughput, and robust workflow from sample collection to analyte annotation, to characterize LMW DOM from soil water samples obtained from polygonal tundra soils near Barrow, Alaska on the Barrow Environmental Observatory (BEO). Soil water extractions were obtained along the length of the organic horizon beneath areas where aboveground vegetation was primarily either *Carex aquatilis* or *Eriophorum angustifolium*, two species commonly found in polygonal tundra systems and of interest to the NGEE-Arctic vegetation team. In evaluating the exometabolomics platform, the median limit of detection was 0.20 ng/mL with linearity over at least two orders of magnitude ($R2 > 0.98$) and reasonable reproducibility (< 15 %) between biological replicates. Untargeted exometabolomic profiling revealed thousands of features present in these soils and showed both positively- and negatively-correlated quantitative trends with depth and between vegetation types. Hundreds of features matched to freely-available, online databases and classes of compounds detected ranged from plant- and microbial metabolites to organic acids, sugars, lipids, and small peptides. Interestingly, although each core represented a single soil horizon (organic) and had similar moisture contents, signature osmolytes that have been linked to desiccation stress were found to accumulate beneath the *Eriophorum* cores, demonstrating the ability of the technique to detect discrete hotspots of biological activity. The optimized approach is sensitive and robust and has enabled a quantitative description of LMW DOM across space in Arctic soils. These data will be leveraged in mechanistic models of microbial decomposition helping to reduce uncertainty in our predictions of how Arctic landscapes will respond under a warmer climate in the future.