S2T3

Physical controls on microbial carbon cycling in soils

Vanessa Bailey

Pacific Northwest National Laboratory, Richland, Washington, USA

Abstract

Soil structure, soil water, and soil microbiology interlink to regulate the soil carbon cycle; carbon cycle feedbacks to the Earth system result from the destabilization of soil carbon. Destabilization includes processes that occur along a spectrum through which carbon shifts from a “protected” state to an “available” state where it can be mineralized by microbes to gaseous or soluble forms that are then lost from the soil. The physical structure of soil – aggregates and pores – partially govern these shifts. For example, soil pores comprise the habitat for soil microbes, the flow paths for resource transport in the aqueous phase, and pore water is the reagent within which biogeochemical transformations occur. We combine advanced techniques for molecular characterization of soil carbon with tomography and sequencing to reveal where in the soil matrix carbon persists, and in what forms. We have found little evidence for chemical recalcitrance as a carbon protection mechanism. We have imposed extreme water cycles, from drought through flood, and found that moisture history is a strong control on the forms of carbon in soil, where they are located, and how they contribute to CO2 emitted through heterotrophic respiration. Yet, we find these patterns are expressed differently in different soils and we hypothesize that water and soil structure may explain some of these differences. By considering different physical, chemical, and biological controls as processes that contribute to soil C destabilization, we can inform more accurate and robust predictions of soil C cycling in a changing environment.