Title: Water and Hysteretic Controls on Soil Carbon Biogeochemistry

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Project Abstract:

Soil organic carbon (SOC) persistence is unpredictable under extreme wetting and drying conditions, because carbon protection mechanisms are not clearly understood or well represented in models, in which the sensitivity of SOC decomposition to soil moisture is typically modeled as bell-shaped curves that relate the maximum decomposition rate to soil water content. These curves assume a linear relationship between moisture and respiration without factoring in hysteresis effects during drying and wetting that occur because different pore size domains drain in a different order than they are filled. Thus, at the same water content, the matric potential is different during draining vs. wetting events. As a result, models based on static assumptions of how soil respiration is related to soil moisture will exhibit more limited responses than real-world processes.

We are developing a process-rich understanding of how SOC physical protection under varying antecedent moisture conditions (i.e., drought, flood, or field-moist conditions) can improve the predictive power of models at a variety of scales. Our numerical experiments have strong hysteresis effect in all simulations using mechanistic approaches. Our laboratory experiments significant divergence in carbon quality and respiration drying and wetting, with rewetting soils exhibiting levels of soil respiration and soluble SOC compared to the same moisture level. The soluble fraction of rewet increased abundance of aromatic groups and decreased aliphatic hydrocarbons, compared to drying soils. Our demonstrate the need to further refine the hysteresis individual SOC pools in models, to accurately capture C under the influence of water.

Experiments are currently underway to investigate how of drought influences SOC bioavailability; and (b) destabilization by pore saturation vs. increased ionic strength increases biological decomposition of SOC. We hypothesize that chemical changes due to drying are relatively static and the duration of drought will not significantly influence the chemical profile of SOC; but there will be greater differentiation with respect to the microbial community, since a longer drought duration gives the microbial community time to adapt or acclimate to the drought conditions.