Title: **Water and Hysteretic Controls on Soil Carbon Biogeochemistry**

Kaizad Patel,[1] Jianqiu Zheng,[1] Sarah Fansler,[1] Ben Bond-Lamberty,[1,2] Vanessa Bailey[1]*

[1]Biological Sciences Division, Pacific Northwest National Laboratory, Richland, WA;
[2]Joint Global Change Research Institute, Pacific Northwest National Laboratory, College Park, MD

Contact: (vanessa.bailey@pnnl.gov)

Project Lead Principal Investigator (PI): Vanessa Bailey

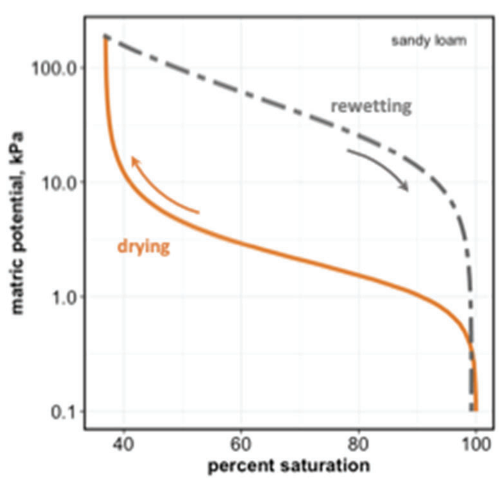
BER Program: TES

Project: PNNL TES Project

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 shown a strong hysteresis effect in all simulations using empirical and mechanistic approaches. Our laboratory experiments have shown significant divergence in carbon quality and respiration rate during drying and wetting , with rewetting soils exhibiting increased levels of soil respiration and soluble SOC compared to drying soils at the same moisture level. The soluble fraction of rewet soils also had increased abundance of aromatic groups and decreased abundance of aliphatic hydrocarbons, compared to drying soils. Our results demonstrate the need to further refine the hysteresis effect on individual SOC pools in models, to accurately capture C dynamics under the influence of water.



Experiments are currently underway to investigate how (a) duration 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.