Poster #1-2

Representing Organo-Mineral Associations in Soil Carbon Models: Implications for Carbon Storage and Vulnerability (LBNL TES SFA)

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Observed patterns of soil organic carbon (SOC) content across geochemical regimes are signatures of process and provide opportunities to understand the underlying decomposition and stabilization mechanisms that can guide their representation in models. The type of sorption equation used in SOC decomposition models has large implications for SOC stocks and cycling. Here we compared different bulk model formulations of SOC sorption to mineral surfaces, motivated by the myriad of underlying organo-mineral associations, and used laboratory and field incubations to inform model parameters. We explored linear, Langmuir, and Sips adsorption models, where the latter emerges from heterogeneous compositions of substrate and surface components. We show the effect of model representations on predicted trends of SOC as a function of mineralogy and discuss the role of soil C saturation on emergent patterns. Specifically, our results highlight that the response of mineral-associated organic C (MOC) to changes in plant C inputs depends greatly on the C saturation deficit of the soil and thus, the representation of organo-mineral associations in models can lead to nonlinear steady-state responses in MOC. We also find that, consistent with field experiments, the trend in MOC with mineralogy is linear, but, interestingly, the slope depends on the degree of C saturation. We contend that this latter finding is an important consideration for field studies that did not find a universal slope and interpreted this as an inability of mineralogy to explain observed patterns. Our results also suggest that warming affects this slope, with higher temperatures causing a decrease in the amount of MOC for a given saturation capacity and C input rate. This means that more C inputs will be needed to keep the same amount of MOC at higher temperatures. Using field and global data, we infer a MOC saturation capacity for different soil types, which is essential for parameterizing process-based SOC models globally. Organo-mineral interactions play a key role in governing soil C stabilization and long-term storage, and thus, improving their representation for inclusion in Earth system models is crucial for understanding and predicting feedbacks under global change.