

## Poster #1-65

### Steady State Gradients versus Microbe-Mineral Modeling Predict Different Temperature Responses of Upland Soils: Model Evaluation in the LBNL TES SFA

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BER Program: TES

Project: LBNL TES SFA

Modelers and empiricists often use spatial data to characterize soil organic carbon (SOC) stock responses to warming and to test climate predictions in the absence of long-term warming measurements. This “space-for-time” approach assumes that the decadal-scale warming responses of SOC stock are similar to the steady-state relationship between temperature and SOC stocks at spatially distributed sites. This assumption, however, is poorly tested. Using a process-rich soil model, we found that while different ways of representing temperature-response can give equally good predictions of steady-state SOC stocks, the transient response of SOC stocks to warming differs greatly.

We developed four variants of a reaction-network-based model of soil organic matter and microbes (ReSOM) using measured SOC stocks from a large latitudinal transect. Each model featured different assumptions about the temperature sensitivity of microbial activity and mineral sorption. All model versions made similar SOC stock predictions at steady state but predicted transient warming responses that differed in the sign and magnitude of change. We compared these different predictions for SOC stock to the latitudinal dataset and a large meta-analysis of observed warming impacts. Models that did well and that did poorly at matching the warming response of SOC stock were indistinguishable when compared to steady state observations; in other words matching the steady state temperature gradient data did not mean that the model could produce consistent or accurate predictions of change under temperature changes. We also found that for the largest SOC pool, the mineral-associated SOC, direct temperature sensitivity was not required to cause large changes in stock due to the connection with DOC. Specifically, even in cases where mineral-SOC (i.e., sorption kinetics) was not directly affected by temperature, the model predicted a large change in SOC stock due to the warming effect on decomposition rates of the aqueous (i.e., desorbed) SOC. Mineral-associated C changed by  $-0.3$  to  $+0.09$  kg C m<sup>-2</sup> K<sup>-1</sup> yr<sup>-1</sup> when only microbial activity is temperature sensitive due to interactions between the mineral-surface and the dissolved monomer C that is vulnerable to microbial consumption. In conclusion, steady state and “space-for-time” observations may be inadequate for constraining or evaluating a models’ ability to predict the response of soil carbon cycling to rapid environmental change. Both microbial and mineral mechanisms affect these dynamics.