Geophysical Research Abstracts
Vol. 21, EGU2019-4010, 2019
EGU General Assembly 2019
© Author(s) 2019. CC Attribution 4.0 license.

Mineral weathering diversifies the response of soil carbon and microbial dynamics to warming

Sebastian Doetterl (1,2), Asmeret Asefaw Berhe (3), Peter Finke (4), Jennifer Harden (5,6)

(1) Terrestrial Ecosystems, Environmental Systems Science, ETH Zurich, Zürich, Switzerland (sdoetterl@usys.ethz.ch), (2) Institute of Geography, Augsburg University, Augsburg, Germany, (3) Life and Environmental Sciences, University of California at Merced, Merced, United States, (4) Department of Environment, Ghent University, Gent, Belgium, (5) Soil Biogeochemistry Research group, US Geological Survey, Menlo Park, United States, (6) School of Earth, Energy & Environmental Sciences, Stanford University, Stanford, United States

Quantifying soil carbon dynamics is of utmost relevance in the context of global change because soils play an important role in land-atmosphere gas exchange. Our current understanding of both present and future carbon dynamics is limited because we fail to accurately represent soil processes across temporal and spatial scales, partly because of the paucity of data on the relative importance and hierarchical relationships between microbial, geochemical and climatic controls.

Using observations from a 3000 ka soil chronosequence, we show how soil carbon dynamics are driven by the relationship between short-term biotic responses and long-term mineral weathering. We linked temperature sensitivity of heterotrophic respiration to biogeochemical soil properties through their relationship with microbial activity and community composition. In a final step, we tested if the dependencies of soil organic carbon dynamics on mineral properties can be translated into a model framework and help to improve SOC modeling on decadal to millennial timescales using a version of the soil weathering model SoilGen including the functionality of the multi-pool C turnover model RothC.

We found that soil mineralogy, in particular changes in mineral reactivity and resulting nutrient availability, impacts the response of heterotrophic soil respiration to warming by altering carbon inputs, carbon stabilization, microbial community composition and extracellular enzyme activity. We demonstrate that biogeochemical alteration of the soil matrix (and not short-term warming) controls the composition of microbial communities and strategies to metabolize nutrients. More specifically, weathering first increases and then reduces nutrient availability and retention, as well as the potential of soils to stabilize carbon. We conclude that there is a great benefit of including geochemical rate modifiers in SOC models that can help to explain the varying importance of biotic and abiotic soil components along weathering and geochemical sequences.