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Soil development in a warming Arctic and its role for the terrestrial carbon cycle

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Climate warming is transforming the Arctic at an unprecedented rate. Barren and sparsely vegetated landscapes are undergoing "greening," and the Arctic biosphere is transitioning into a new state of functionality. This substantially alters the storage and flux of carbon in and out of Arctic soils. Soil development and the accompanying geochemical alterations are generally considered less important for these changes because they occur over centuries. However, this perception is likely incorrect for many Arctic regions, given the drastically increased availability of heat and water, as well as the large amounts of primary minerals in the physically pre-processed parent material from which future soils will develop.

In my talk, I will demonstrate how soil development across larger gradients contributes substantially to changes in plant and microbial functioning and community composition. Importantly, the response of Arctic soils to warming is heterogeneous across space and is governed by the geochemistry of the parent material. We observe a pronounced decoupling between above- and belowground plant biomass inputs and the actual mineral-associated carbon storage potential of soils. Furthermore, fossil (petrogenic) carbon constitutes a significant portion of C stocks and fluxes in many vegetated regions. This complicates assessments of C turnover and challenges the stability and origin paradigms of "old" C in Arctic soil systems.

The development of Arctic soils will not cease with the loss of organic matter and the disappearance of permafrost over large areas. As climatic boundary conditions shift, we conclude that weathering and soil development may become primary controls for future plant communities and C storage in Arctic soils over the coming centuries.