Arctic soil carbon: does permafrost carbon matter for future climate feedbacks?

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Recent trends of increased global temperatures are amplified in the Arctic, where the soil contains twice as much carbon as is currently in today's atmosphere. This enhanced Arctic warming is projected to thaw permafrost and to increase microbial activity and may release large quantities of soil carbon to the atmosphere. To examine soil carbon dynamics, we studied the in situ microbial carbon usage in mineral and organic soils from a dozen locations in Svalbard, the Canadian high Arctic and various locations in Alaska. We measured the natural abundance radiocarbon in microbial biomarkers of the viable microbial community as phospholipid fatty acids (PLFA) and the radiocarbon content of the bulk soil organic carbon. The premise of this technique is that membranes of the viable microbial community take on the isotopic value of the carbon the microbes are eating. Our results indicate that at all sites, the amount of soil carbon dramatically decreases with depth while the radiocarbon age of the soil organic carbon increases with depth. We also found that the abundance of microbes decreased exponentially with depth at all sites. This means that most of the microbes inhabited the upper 10s of centimetres of the soil profile and there were far fewer microbes at depth. Additionally, we found that regardless of the soil profile studied, the microbes preferentially used younger carbon than the soil organic carbon, which suggests that only a fraction of the soil organic carbon pool is accessible and not all permafrost carbon will be vulnerable to microbial degradation. Collectively, these results indicate the largest fluxes of carbon from microbes will be from the surface soils that contain the most and youngest carbon. Additionally, as the Arctic warmed and subsequently greens, the pool of young surface carbon will continue to increase thereby minimizing the release of remineralized deep, old carbon.