Soil depths respond differently to *in situ* warming

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Over half of global soil organic carbon (SOC) is stored in subsurface soils (>30 cm), but little is known about the vulnerability of this deep SOC to climate change. Most soil warming experiments have only warmed surface soils, so the temperature sensitivity of deeper SOC and its potential to generate a positive feedback to climate change is undetermined. We are currently investigating how SOC down to 1 m deep responds to experimental *in situ* soil warming (+4°C). Our field site is a coniferous forest in the foothills of the Sierra Nevada in California, USA. Our objectives are to understand (1) the dynamics of soil respiration at different depths, (2) how +4°C warming affects CO_2 production from different depths, and (3) how the temperature sensitivity of soil respiration differs by depth.

Warming began in October 2013, and we have successfully warmed 1 m of the soil profile to 4°C (±0.5) above ambient temperatures at each depth and maintained this warming throughout different seasons. We have taken monthly surface CO_2 flux measurements and monthly gas samples from stainless steel tubes at 15, 30, 50, 70, and 90 cm depths. We used Fick's law of diffusion and experimentally derived site-specific diffusion parameters to model CO_2 production from different depths. Warming significantly increased CO_2 production from all depths. Using the data from both treatments, we were able to estimate temperature sensitivity. Two indices of relative apparent temperature sensitivity (Q_{10} and E_a) indicate that the deeper soil is more temperature sensitive than the surface soil. However, no depths are sensitive to temperature at low soil moisture (VWC>0.25). Apparent temperature sensitivity is greatest during the winter, when soil moisture is high, which also suggests we are measuring a heterotrophic response. Despite the sensitivity of deep soil carbon to warming, only 11 to 13% of soil CO_2 production occurs below 30 cm even though 37% of all soil organic carbon is stored below 30 cm. The amount of carbon produced per gram soil is least in this deep soil implying deep soil C is overall less available to microbes overall. This study is one of the first to test whole-profile SOC responses to warming and shows that deep soil carbon is equally vulnerable to climate change in these upland mineral soils.

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