Four Years of Warming the Whole Soil Profile in a Conifer Forest: LBNL TES SFA

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Soils contain three times as much carbon as the Earth’s atmosphere, with approximately half of the total soil carbon stocks in subsoil horizons. The storage of carbon as soil organic carbon, and its exchange with the atmosphere through decomposition, is critical to the maintenance of Earth’s climate. However, the impact of warming on decomposition throughout the whole soil profile is a major source of uncertainty in climate projections. Here, we present the results from four years of the first in situ, replicated, whole soil warming experiment. The experiment is located at the University of California Blodgett Experimental Forest in a mixed coniferous forest in the foothills of the Sierra Nevada mountains in California at 1370 m above sea level. Three replicate pairs of 3 m in diameter, warmed and un-warmed plots were constructed in 2013 and heating began in October 2014. Vertical heating cables maintain a +4°C warming above the ambient plots temperatures down to 1 m depth. Soil surface fluxes have been measured monthly and total annual soil respiration is 34-37% greater in warmed plots than control plots with an average monthly Q10 temperature response of 2.4. Monthly sampling of CO2 concentrations throughout the soil profile, along with soil profile diffusion flux modeling, reveals that soil CO2 production in the deep soil increased by a similar amount. Sampling of soil pore water using lysimeters at 20 and 70 cm shows a significant increase in total organic carbon concentrations in the warmed plots at both depths. Together, the results from soil CO2 flux measurements and soil pore water sampling indicate greater decomposition of soil organic carbon under 4°C warming and a similar degree of vulnerability of deep soil and surface soil organic carbon to loss. Warming of the whole soil profile reveals a much larger response than currently predicted by other in situ soil warming experiments that only warm the soil profile and thus fail to account for the impact of soil warming on deep soil carbon losses.