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Examining the moisture and temperature sensitivity of soil organic matter decomposition in shallow and deep temperate forest soils

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Temperature and moisture are primary environmental drivers of soil organic matter (SOM) decomposition, but in temperate coniferous forests, the response of SOM decomposition to changes in soil climate remains poorly understood. This is most often a consequence of difficulties in separating heterotrophic and autotrophic components of soil respiration in the field, of teasing apart co-varying temperature and moisture regimes, and of disturbance effects associated with laboratory incubations. The objectives of this research were to determine the influence of soil moisture on heterotrophic soil respiration in shallow and deep soil microcosms and to determine the effect of soil moisture on the temperature sensitivity of soil respiration. Minimally disturbed soil cores from shallow (0-25 cm) and deep (25-50 cm) soil layers were extracted from a 20 year old red spruce stand and were then transferred to a climate chamber where they were incubated for 3 months under constant or diurnal temperature regimes. Soil microcosm triplicates were subjected to a range of dry to saturated water contents. Temperature, moisture, and CO_2 surface flux were assessed daily for all soils and continuously on a subset of the microcosms. The results from this study indicate that shallow soils dominate the contribution to surface flux (90%) and respond more predictably to moisture than deep soils. An optimum moisture range of 0.15 to 0.60 water-filled pore space was observed for microbial SOM decomposition in shallow cores. Short-term changes in fluxes following rewetting events were observed, consistent with both CO_2 mass transport out of the soil profile and a short-term stimulation of microbial respiration. Steady state moisture flux responses indicated temperature was the main determinant of flux magnitudes, and that temperature sensitivity was relatively constant across moisture, temperature cycle and depth. This suggests that for soil moisture conditions experienced by many northern forest soils, flux-temperature relationships alone may provide reasonable estimates of heterotrophic respiration.