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Very Old and Very New Soil Organic Carbon in the Arctic is Equally Sensitive to Warming: ^{14}C Evidence in the NGEE Arctic Project

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The Arctic is expected to shift from a sink to a source of atmospheric CO_2 this century due to climate-induced increases in soil carbon mineralization. The magnitude of this effect remains uncertain, however, largely because temperature sensitivities of organic matter decomposition and the distribution of these temperature sensitivities across soil carbon pools are not well understood. We used a novel analytical method with natural abundance radiocarbon (^{14}C) to evaluate temperature sensitivities across soil carbon pools. With soils from Utqiaġvik (formerly Barrow), Alaska, we used an incubation experiment to evaluate soil carbon age and decomposability, disentangle the effects of temperature and substrate depletion on carbon mineralization, and compare temperature sensitivities of fast-cycling and slow-cycling carbon. Old, historically stable carbon was shown to be vulnerable to decomposition under warming. Using radiocarbon to differentiate between slow-cycling and fast-cycling carbon, temperature sensitivity was found to be invariant among pools, with a Q_{10} of ~2 irrespective of native decomposition rate. These findings imply that mechanisms other than chemical recalcitrance mediate the effect of warming on soil carbon mineralization. This work also informs land models of arctic biogeochemistry, showing that carbon age or pool turnover time does not constrain the temperature sensitivity. Even very old yedoma or buried carbon in the Arctic may be vulnerable to rapid decomposition upon thaw or warming.