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Timescales of soil carbon cycling across latitudes

Alison Hoyt (1,2), Jeffrey Beem-Miller (1), Carlos Sierra (1), Shane Stoner (1), Bernhard Ahrens (1), Qing Zhu (2), William Riley (2), Corey Lawrence (3), Grey Monroe (4), and Susan Trumbore (1)

(1) Max Planck Institute for Biogeochemistry, Jena, Germany, (2) Lawrence Berkeley National Laboratory, Berkeley, CA, USA, (3) US Geological Survey, Denver, CO, USA, (4) Colorado State University, Fort Collins, CO, USA

Although soils are a globally important carbon reservoir, there are large uncertainties in the decadal response of this carbon to a changing climate. Here we explore the dynamics of carbon respired from soils, which is rapidly cycling and likely to be most vulnerable to environmental change on decadal timescales. We synthesize heterotrophic respiration data from incubation studies, which measure the radiocarbon content of the respired CO_2. These measurements are an indicator of the age of carbon leaving the system and correspondingly, the transit time of carbon in soils. The compiled dataset spans a complete latitudinal gradient, from the arctic to the tropics, allowing us to evaluate the extent to which temperature and moisture drive differences in the age of respired carbon. Across sites, the transit time for CO_2 respired from shallow soils ranges from two years to a decade. We also find respired ^{14}C concentrations are closer to the atmosphere at warmer sites, indicating faster transit times with increasing mean annual temperature. Finally, we present ways in which this dataset can be used to constrain rates of active carbon cycling in global models, since models are increasingly providing predictions of the age of respired carbon. To demonstrate this approach, we compare our dataset against the COMISSION model and the E3SM land model (ELM-ECA). A better understanding of the age of respired carbon globally will improve our ability to predict the response of actively cycled soil C to disturbance on decadal timescales.