

ABSTRACT

Decadal-Scale Measurements of Decadal-Cycling Forest Soil Carbon

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Objectives: Among the largest uncertainties for understanding biospheric responses to global change are decadal-scale changes in soil carbon stocks. Hence, our objectives are: (1) to test estimates of the sizes and mean residence times (MRTs) of soil C pools by remeasuring the ^{14}C of soil C fractions first measured a decade ago; (2) to test estimates of soil C pools susceptible to increased rates of decomposition in a new soil warming experiment; (3) to estimate decadal trends in the relative contributions to soil CO_2 efflux from root respiration and heterotrophic decomposition; (4) to compare our empirical estimates of pool sizes and MRTs with default values in common soil C models.

Location: Harvard Forest, central Massachusetts.

Hypotheses: (1) A multi-pool model of soil C dynamics, parameterized with our 1996 results, can predict the radiocarbon content soil C fractions and CO_2 efflux one decade later. (2) Soil warming will stimulate decomposition of rapidly cycling soil C (MRTs <10 years), causing a predictable increase in soil CO_2 efflux, but warming-induced stimulation of decomposition of older soil C will generate insufficient CO_2 to be detectable by standard flux measurements. (3) Increased decomposition of litter layer carbon, which has elevated ^{14}C relative to root respiration, occurs in warm and wet summers.

Approaches: We will measure soil ^{14}C fractionated by size and density, $^{14}\text{CO}_2$ efflux, and radiocarbon signatures of autotrophic and heterotrophic respiration at the study sites we established in the mid 1990s and in a new soil warming experiment. Annual estimates of soil CO_2 efflux at the base of the AmeriFlux eddy covariance tower will be improved by autochamber measurements. The CASA and CENTURY model parameters for soil C stocks and MRTs will be compared with the estimates of our empirical model constrained by radiocarbon measurements.

Intended accomplishments: This proposal responds to focus 3, utilizing measurements of contemporary fluxes of soil carbon to improve constraints on models used for predicting decadal-scale responses of the terrestrial biosphere to climate change. Data on key biological processes for understanding potential changes in soil C stocks will be posted on public websites within a year of measurement. Our quantitative understanding of current fluxes of soil C and constraints on model parameterizations of soil C dynamics will be improved. While directly applicable to the forested northeastern USA, our research will demonstrate globally applicable principals of constraining multi-pool soil C models with radiocarbon-based estimates of pools and mean residence times.