Soil Warming and Carbon-Cycle Feedbacks to the Climate System

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We propose to investigate how soil warming affects key processes associated with carbon storage in plants and soils of mid-latitude forest ecosystems.

For this work, we will use ongoing (15 years) and newly established (4 years) soil-warming manipulations at the Harvard Forest in Petersham, Massachusetts.

Three primary questions organize our research: 1) How much soil organic carbon will be lost to the atmosphere as CO_2 from a mid-latitude forest in response to a 5º C warming? 2) Can soil warming change ecosystem N distribution and thereby change the capacity of forests to store C? 3) How will climate change influence the capacity of mid-latitude forests to store C?

To answer these questions, we will continue to use our two soil-warming installations (one with 5 x 5 m heated plots, another with a 30 x 30 m heated plot (mega-plot), both with appropriate controls) at the Harvard Forest to study effects of soil warming on the carbon budget of a forest ecosystem. Question 1 will be explored through a set of CO_2 flux measurements (and microbial community measurements funded separately by DOE) made on the control and heated plots of the original soil warming experiment and on the new mega-plots at the Harvard Forest. We will use the results of a completed factorial trenching and warming experiment (and a new "physiological girdling" experiment funded by NSF) to separate the microbial and root respiration components of soil respiration. Question 2 will be addressed through a set of measurements of nitrogen mineralization and plant growth in the new mega-plots. Question 3 will be pursued using an extant process-based ecosystem model, our Terrestrial Ecosystem Model (TEM), which has been improved by incorporating insights from our soil-warming studies as well as insights from the eddy flux studies at the Harvard Forest.

This research is designed to advance our understanding of the consequences of human impacts on the global carbon cycle, especially how climate change affects the carbon cycle feedbacks from land ecosystems to the climate system. We will document our research in four peer-reviewed papers – 1) fifteen-year summary of soil responses to warming (target, *Ecolgical Monongraphs*); 2) warming and forest ecosystem feedbacks to the climate system (target, *Nature*); 3) soil warming and shifts in plant community composition with implications for carbon storage (target, *Ecology Letters*); 4) partitioning soil respiration between roots and microbes using a "physiological girdling" technique (target, *Plant and Soil*).