

Abstract

Project Title: Parsing the mechanisms that drive soil decomposition responses to climate change: a test of the substrate depletion and microbial acclimation hypotheses.

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The response of soil decomposition to experimental warming has been studied for over a decade, yet our ability to predict long-term soil responses to climate change remains inadequate. This is primarily due to a limited understanding of the mechanisms driving the observed responses to experimental warming. This is also because most experiments have induced a single step-change in temperature, and have not investigated the interactions of warming with altered precipitation. Our objective is to improve our mechanistic understanding of decomposition responses to climate warming and altered precipitation patterns.

We will test two hypotheses to explain the long-term responses of decomposition to soil warming observed in previous experiments. (1) The substrate depletion hypothesis posits that soil warming stimulates decomposition rates, which decreases the amount of bioavailable C through time, assuming inputs remain constant. (2) The microbial acclimation hypothesis posits that microbial communities acclimate to warming through time, and alter the temperature sensitivity of microbial processes. Both mechanisms could produce similar long-term respiration responses to a single step-change in temperature, and thus cannot be tested by re-evaluating data collected in previous experiments.

We propose to conduct this research in the recently initiated Boston Area Climate Experiment (BACE) in Waltham, MA. This experiment exposes a typical New England 'Old Field' to a warming gradient within three levels of precipitation.

To address the substrate depletion hypothesis, we will apply a novel approach that will be very sensitive to treatment effects on soil organic matter quality. We will use pyrolysis-molecular beam mass spectrometry to quantitatively evaluate the chemical composition of soil organic matter. We will also measure soil enzyme activities, which are sensitive indicators of changes in soil quality. The microbial acclimation hypothesis will be tested by measuring several microbial responses that are independent of soil organic matter quality. These assays will measure the temperature sensitivity of (1) bacterial and fungal growth rates, (2) multiple substrate induced respiration (SIR) rates, and (3) soil enzyme activities. While the absolute rates of each of these microbial processes can be affected by altered soil organic matter bioavailability, altered temperature sensitivity of these processes would indicate microbial acclimation to the experimental treatments.

This proposed research will add great value to the already funded BACE experiment. Expected deliverables include: new data on soil and microbial responses to altered temperature and precipitation, data sharing with related DOE projects, web dissemination of results, and peer-reviewed publications and scientific presentations.