PROJECT ABSTRACT

Past, present & future rates of terrestrial CO_2 flux in North-Eastern Forests: the role of ecophysiological responses, land-use history & disturbance legacies

P.I./institution: Professor Paul R. Moorcroft, Harvard University

The purpose of this research is to understand the past, present and future biogeochemical functioning of New England ecosystems under current and future climate regimes and disturbance regimes. In doing so, this project directly addresses three of goals of the North American Carbon Plan: (1) reconciling independent methods of closing the carbon budget, (2) developing models that synthesize observations at principal study sites, and (3) developing conceptual frameworks to apply study site results to the regional scale.

The research will be conducted using data collected Harvard Forest, Massachusetts and forest inventory data collected across the New England region.

We will develop a constrained regional ecosystem model to (i) quantify the contribution of environmental forcing (climate and rising CO_2 levels), land-use history and disturbance history to past and current regional patterns of CO_2 fluxes within New England and (ii), predict the state of the carbon cycle over the next hundred years under a range of future climate and disturbance scenarios.

A diverse set of observations, spanning timescales ranging from hours to centuries, will be used to constrain a process-based ecosystem model, the Ecosystem Demography model (ED), at the Harvard Forest eddy-flux tower site. This will be achieved by simultaneously fitting the model to the 13-year CO_2 flux dataset and accompanying estimates of soil respiration, stand structure, stand composition, above-ground biomass growth, above-ground biomass mortality collected at Harvard Forest over the past 65 years. We will then test the performance of the constrained model by performing simulations for the New England region, comparing ED's predictions of CO_2 fluxes, forest structure and forest dynamics to corresponding estimates of these quantities within the region. The results of the simulations will then be analyzed to assess the relative contributions of environmental forcing, land-use history and disturbance history during the past 250 years. The endpoints of these simulations will then be used as initial conditions for a series of model runs exploring the future state of the New England carbon cycle over the remainder of the century under a series of climate and disturbance scenarios.

Deliverables include a spatial dataset of disturbance history for the New England Region, datasets of the contribution of land use history, environmental forcing and disturbance history to the state of the carbon cycle for the New England region from 1750-present, and peer-reviewed publications describing the analysis of past, present and future state of the carbon cycle in New England.