Long-term response by the carbon budget of a mid-latitude deciduous forest to ecological processes, climate variations, and air pollutants

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Mid-latitude forests are thought to be an important sink of CO_2. Understanding the factors that control CO_2 uptake by forests is critical to making predictions of future atmospheric CO_2 concentrations. The measurements at Harvard Forest are the longest continuous record of carbon exchange and air pollutant concentrations in a forest environment. A principal focus of this proposal is to document and understand the long-term carbon balance of a typical Northeastern mixed-deciduous forest, including all time scales from instantaneous response to environmental forcing, to seasonal and annual/interannual effects of intrinsic ecosystem processes and climatic variations, to decadal trends due to succession, and land-use change..

The research will be based at the Harvard Forest in Petersham, Massachusetts.

We hypothesize that carbon cycling at the Harvard Forest is controlled by instantaneous response to environmental forcing factors (temperature, light, moisture) and that these responses are modulated on longer time scales by climatic variation, cumulative nitrogen deposition, legacies of prior land use, disturbance events, and shifts associated with forest growth and succession.

We will continue long-term flux measurements at Harvard Forest complemented by integrated interdisciplinary research, as needed to quantify key mechanisms and responses. Included are *forest inventories*, *ecosystem studies*, *environmental observations*, and baseline data for *atmospheric concentrations of important species*. Data analyses and modeling activities will focus on identifying the physical and ecological causes for interannual variation and long-term trends in carbon sequestration at Harvard Forest. Long-term records of nitrogen deposition and ozone fluxes will be utilized to test for chronic and cumulative effects on the forest. Comparisons to forest inventory measurements and tree ring chronologies will be used to establish regional and historical context to the present-day observations.

The expected outcome of this research is a quantification of long term variability and trends in carbon cycling by a typical mixed deciduous forest. We will identify the key factors and mechanisms responsible for variability. Key deliverables from the research are: (1)Time series of fluxes of CO_2, H_2O and energy, trace-gas concentrations, meteorology, and biometric measurements; (2) Analyses of forest carbon budget from atmospheric and biometric methods