Long-term CO_2 exchange and biomass measurements in a spruce-hemlock stand near Howland, Maine, supporting regional-scale studies and ecosystem manipulation experiments

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Abstract

Objectives. We seek to understand the biological and environmental controls of CO_2 and energy exchange between a coniferous forest and the atmosphere. Our goal for this work is to help reduce scientific uncertainty about the effects of atmosphere-ecosystem exchanges of mass, momentum, and energy on climate, with an emphasis on the carbon cycle.

Location. These studies will take place at the Howland Integrated Forest Study site located in central Maine, USA (45.20° N, 68.74° W).

Hypotheses/Questions. In this work we are exploring the relationships between CO_2 exchange and underlying environmental and ecological factors. We are addressing the following research questions:

- What are the most important factors regulating CO_2 exchange in a northern coniferous ecosystem that operate on the long time scales most relevant to climate issues (years to decades)?
- How do short-term effects of climatic variability and extreme events affect net exchange of CO_2 in this ecosystem?
- How can tower flux data be used to scale up from point measurements to regional and continental scale carbon balances?
- Over what temporal scale do estimates of soil respiration and tree growth best relate to tower-based measurements of NEE?

Approach. Carbon dioxide, water vapor, heat, and momentum fluxes is being measured by the eddy covariance technique using a 3-axis sonic anemometer and a closed-path gas analyzer. Soil respiration is being measured by vented, non-steady state, dynamic manual and automated chambers. Manual chambers are distributed extensively throughout the landscape and sampled weekly, whereas automated chamber are near the tower base and make half-hourly flux measurements..

Deliverables. The proposed studies will improve understanding of the role of terrestrial ecosystems in regional cycles of energy and mass exchange by, 1) identifying environmental and biological factors that affect photosynthetic and respiratory processes, 2) serving as "controls" for 2 large-scale ecosystem manipulation experiments (DOE/TCP-funded research to experimentally examine the impact of anthropogenic nitrogen addition on ecosystem C exchange and DOE-funded support to examine the effect of a low impact (shelterwood) harvest on forest C exchange), and 3) contributing data and analysis to regional-level syntheses of the carbon cycle (COBRA-ME project and other synthesis efforts). Expected deliverables include quality controlled meteorological and flux data sets and scientific manuscripts describing ecosystem control of regional C exchange and the impact of experimental treatments on forest C sequestration. We will also contribute data and expertise to several on-going synthesis efforts.