

Designing Forest Warming Experiments and Other Interacting Factors

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Abstract

1. Statement of Objectives) The Department of Energy (DOE) had contributed greatly to our understanding of how terrestrial ecosystems may respond to the direct effect of increased atmospheric CO₂ concentrations through a suite of the Free Air CO₂ Enrichment (FACE) experiments. Following on this success is a broad interest in developing a second generation of experiments to consider the effect of the potential increased air temperature on ecosystem function. Efforts to design and plan these warming experiments are frustrated by subtle questions, both with respect to the technical complications of achieving a controlled warming of the free-air column, and with respect to scientific issues of corresponding changes to the humidity regime (e.g. relative humidity and vapor pressure deficit). This proposal seeks support to examine the key technological issues related to straight warming experiments and jointly controlled warming-humidity experiments.

2. Science Questions) The project will evaluate a range of technologies for releasing heat (and moisture), related power needs, heat source geometries, and the resulting structure of the modified space-time field of air temperature, relative humidity and vapor-pressure deficit. The project will also examine the impact of the temperature changes on the stability of the local atmosphere and its concomitant effects on the turbulent transport characteristics.

3. Location) The simulations will be conducted at Duke University and will focus on the Duke FACE site and two other canopy types, as defined through a discussion with DOE representatives.

4. Methods) The project consists of a set of simulated experiments using a state-of-the-art numerical model of turbulent flow and transport in plant canopies. This Large Eddy Simulation (LES) code was developed through DOE support to the PI and has been used extensively at the Duke forest.

5. Deliverables) In the last month of this one-year project, a workshop will be held at Duke University, with 20 participants invited (travel support provided by this project) to collaborate on designing warming experiments in light of the technical issues illuminated by the numerical experiments proposed here. One primary product of the workshop will be a joint publication that outlines specific ideas and methods for next-generation climate change experiments. The workshop proposed here will be co-organized with ORNL scientists Stan Wullschleger and Rich Norby.