

Abstract: The interactive effects of elevated temperature and CO₂ applied under field conditions on a soybean ecosystem

PI: Carl J Bernacchi, University of Illinois

Co investigators: Bruce A. Kimball, USDA-ARS

Donald R. Ort, University of Illinois & USDA-ARS

Evan H. DeLucia, University of Illinois

Objectives

Continual increases of atmospheric CO₂ concentrations coupled with rising temperatures will alter terrestrial ecosystem functioning and primary productivity. Our objective of this proposed research is to address underlying physiological responses and consequent alterations of ecosystem carbon cycling and climate system feedbacks of soybean, a dominant species in the largest ecosystem in the Midwestern US, to growth in elevated CO₂ and increased temperature under open-air conditions.

Hypotheses

We hypothesize that: (1) Higher temperatures will result in a decrease in gross primary productivity (GPP), an initial increase in plant (R_d) and soil (R_s) respiration, and, together these two responses will substantially lower net primary productivity (NPP). Over time, a decrease in the labile pool of C in the soil will result in lower heterotrophic soil respiration (R_h). (2) The combined increase in [CO₂] with temperature will result in higher GPP as well as higher R_d and R_s than all other treatments, although the increase in GPP will offset higher R_a and R_s and lead to increases in NPP. Given a large pool of carbon in the form of plant residues, R_h will remain higher in this combination treatment.

Location

This study will take place at the Soybean Free Air gas Concentration Enrichment (SoyFACE) experiment in Champaign, IL.

Methods

We are installing infrared heater arrays over soybean in the control and elevated CO₂ plots at SoyFACE which will be fully operational for the 2009 growing season. We will experimentally manipulate soybean growth and development according to the mid to upper predictions of CO₂ (585 $\mu\text{mol m}^{-2} \text{s}^{-1}$) and temperature (ambient + 3.5 °C) for midway through this century by the IPCC. Support is requested for two graduate students to measure responses of physiology, including development, biomass accumulation, photosynthesis, respiration, and water use, as well as various components of the annual carbon cycle, including R_s and soil organic C. Plant development, biomass accumulation, diurnal *in situ* photosynthesis and R_d will be collected in regular intervals throughout the growing season. Leaf biochemical and biophysical properties as related to photosynthesis will be determined in time intervals similar to the *in situ* photosynthesis measurements. We will monitor soil moisture, R_s and canopy evapotranspiration. The measurements will allow for determination of mechanistic responses of photosynthesis to the CO₂ by temperature interaction.

Outcomes

The research focuses on the globally relevant topic of plant and ecosystem responses to combined climate and atmospheric change under field conditions. We will train two PhD students and several undergraduate students within the proposed project. The data collected will lead to peer review journal publications, conference proceedings, and seminars, as well as provide a unique dataset for model parameterization and validation of other NICCR funded projects.