

**Agroecosystems: Effects of changes in climate, carbon dioxide, and
ozone over the central United States**

PI: Tracy Twine, University of Minnesota (collaborative with Leakey at UIUC)

OBJECTIVES

Future effects of climate change on ecosystem goods and services in the Midwest will be dominated by the response of soybean, maize and wheat agriculture. We will reduce scientific uncertainty about how projected climate change will affect the functioning of agroecosystems in terms of regional energy, water, and carbon budgets. Because agroecosystems cover nearly 40% of the global land surface, results will have direct relevance to national and global environmental issues.

HYPOTHESES

The Midwest is projected to be warmer and wetter in the future, with possible increased frequency of extreme events. We hypothesize that (1) the combination of changes in temperature and precipitation means and variability, and increases in [CO₂] and [O₃] will lead to significant changes in regional energy, carbon, and water budgets, and (2) changes in agroecosystem functioning vary by crop type and location, such that some agroecosystems might benefit from global climate change, while others might suffer.

LOCATION

The proposed study will examine the major agroecosystems of the Midwest (maize, soybean, winter wheat, spring wheat).

METHODS

We will use a well-tested dynamic global vegetation model (DGVM), Agro-IBIS, that simulates the functioning of major U.S. agroecosystems to (1) evaluate the response of corn and soybean to recent trends in climate using measurements from AmeriFlux sites and free-air concentration enrichment (FACE) experiments, (2) evaluate simulated response to elevated [CO₂] and [O₃] with observations, (3) Quantify how changes in climate means and variability will affect regional energy, carbon, and water budgets of U.S. agroecosystems through Agro-IBIS simulations with synthetic climate datasets, and (4) Examine the cumulative response of agroecosystems to the concomitant changes in climate, climate variability, and elevated [CO₂] and [O₃]. Metrics evaluated include net primary productivity, biomass, canopy structure, evapotranspiration, soil temperature and moisture, runoff, and streamflow.

EXPECTED DELIVERABLES

(1) Quantification of the response of regional energy, water, and carbon budgets to projected climate change through explicit representation of agroecosystems within a DGVM; (2) Characterization of the distinct physical and physiological responses of maize, soybean, and wheat to spatially and temporally varying scenarios of environmental drivers, which will inform development of DGVMs as components of coupled climate-carbon modeling systems; (3) Expansion of a DGVM to estimate the impact of elevated [O₃] on ecosystem function; (4) Unique validation of DGVM capability to estimate altered ecosystem function in response to elevated [CO₂], [O₃] and reduced rainfall by comparison with empirical data from FACE experiments on soybean, maize and wheat.