

**Effects of Multiple Changes in Climate and Atmospheric Composition on Terrestrial Ecosystem Structure and Functioning in the Southeastern United States:  
A Regional Synthesis with Data-Model Assimilation**

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**Project Summary**

Terrestrial ecosystems in the southeastern United States (SE US) have experienced a complex set of climatic changes, increased atmospheric composition, and land-use and land-cover change. Little is known about how these alterations have affected the structure and functioning of terrestrial ecosystems in the SE US. **The overall goal of this proposal is to quantify effects of climate variability and change, increased atmospheric CO<sub>2</sub> and tropospheric O<sub>3</sub>, with changing patterns of land use and land cover on structure and functioning of terrestrial SE US ecosystems.** Here we propose to synthesize and advance mechanistic understanding of ecological structure (LAI and biomass) and functioning (carbon and water cycling) at a regional scale with an emphasis on the factors that control gross primary production (GPP), net primary production (NPP), evapotranspiration and water yield. Our study will be organized by two linked questions: 1) How have ecosystem structure and functioning changed in the SE US in the past 100 years? and 2) What are the relative roles of multiple stressors of climate and atmospheric composition in affecting the changes in carbon pools and fluxes, and water fluxes at the regional scale?

The two research questions will be addressed through synthesis activities by using a combination of process-based ecosystem modeling, satellite-based observations, field studies and Forest Inventory Analysis (FIA) data. Specifically, we will (1) extrapolate the daily and monthly temperature and precipitation data from about 1200 weather stations in this region to 1 km spatial resolution from 1901 to present; (2) collect and analyze the historical climate extremes including El Niño/Southern Oscillation (ENSO) data, especially with emphases on the Gulf states; (3) reconstruct the tropospheric O<sub>3</sub> data of this region with 1 km spatial resolution from 1901 to present; (4) improve the land-cover change data sets by including spatial distribution of plantations with age information; (5) calibrate the Dynamic Land Ecosystem Model (DLEM) and the Terrestrial Ecosystem Model (TEM) using the FACE and AmeriFlux sites in this region including the Duke FACE (Free Air CO<sub>2</sub> Enrichment) site and the recently established eddy flux site on the eastern coastal plain of North Carolina; (6) conduct multi-simulations with single and combined stressors in climate and atmospheric composition to examine their impacts on ecological structure (LAI, forest age structure, biomass) and functioning (carbon and water cycling), and (7) uncertainty analysis associated with input data, spatial resolution, parameter sensitivity and model assumptions.

This proposed research emphasizes the Focus Area 4 to carry out synthesis research with a spatial scale of entire Southeast region. The products of this research will be made available to the larger scientific community via the web.