ORNL's Terrestrial Ecosystem Science Scientific Focus Area -2014

Paul J. Hanson (hansonpj@ornl.gov) - Oak Ridge National Laboratory (PI), Daniel M. Ricciuto, ORNL; Peter E. Thornton, ORNL; Project Participants.

The TES SFA combines experimental and observational research and process-level modeling in an iterative exchange among (1) hypothesis development from model simulations, (2) the execution of observations and experiments to characterize multi-factor environmental responses of ecosystems and the organisms they contain, and (3) the use of empirical results to parameterize and evaluate ecological models. This continuous research loop allows us to better understand and predict the global terrestrial ecosystem forcing of the earth's climate, and to assess vulnerability of terrestrial ecological systems to projected changes in climate and atmospheric composition. The research is focused on how terrestrial ecosystems affect atmospheric CO_2 and other greenhouse gases and how the ecosystem processes responsible for these effects interact with climate and with anthropogenic forcing factors.

Overarching science questions include: (1) How will interactions among the physical climate, biogeochemical cycles, ecological processes, fossil fuel emissions and land use evolve and influence one another over decades and centuries, (2) How do terrestrial ecosystem processes, interactions and feedbacks control the magnitude and rate of change of greenhouse gases, and (3) How will the magnitude and rate of atmospheric and climatic change alter the structure and function of terrestrial ecosystems and their capacity to provide goods and services to society?

Unique experiments such as the Spruce and Peatland Responses Under Climatic and Environmental Change (SPRUCE) experiment are conducted to quantify biogeochemical responses to environmental and atmospheric change and to improve model-based predictions of the effects of atmospheric and climatic change on ecosystems' function, composition and feedbacks to the atmosphere and climate. SPRUCE will execute a transient belowground warming treatment sequence in 2014 to be followed by whole-ecosystem warming in 2015.

Additional process research and landscape-scale, carbon-cycle observations in understudied ecosystems also serve to provide data for the improvement of mechanistic representations of ecosystem processes within terrestrial carbon (C) cycle and Earth-system models. TES SFA research informs and improves terrestrial land surface and biogeochemistry models, with a particular emphasis on migration of knowledge into the Community Land Model (CLM4) component of the Community Earth System Model (CESM). Integration among experiments, models and observations advances the predictive skill of climate system models through improved fidelity of process representation in their land surface biophysics and biogeochemistry components; and generates and tests new hypotheses which address critical uncertainties in the terrestrial ecosystem components of climate system prediction.