MEETINGS

Planning the Next Generation of Arctic Ecosystem Experiments

Climate Change Experiments in High-Latitude Ecosystems; Fairbanks, Alaska, 13–14 October 2010

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A 2-day climate change workshop was held at the International Arctic Research Center, University of Alaska Fairbanks. The workshop, sponsored by Biological and Environmental Research, Office of Science, U.S. Department of Energy (DOE), was attended by 45 subject matter experts from universities, DOE national laboratories, and other federal and nongovernmental organizations. The workshop sought to engage the Arctic science community in planning for a proposed Next-Generation Ecosystem Experiments (NGEE-Arctic) project in Alaska (http://ngee.ornl.gov/).

The goal of this activity is to provide data, theory, and models to improve representations of high-latitude terrestrial processes in Earth system models. In particular, there is a need to better understand the processes by which warming may drive increased plant productivity and atmospheric carbon uptake and storage in biomass and soils, as well as those processes that may drive an increase in the release of methane (CH_4) and carbon dioxide (CO_2) through microbial decomposition of soil carbon stored in thawing permafrost. This understanding is required to quantify the important feedback mechanisms that define the role of terrestrial processes in regional and global climate.

Speakers and participants worked through a series of thematic questions that included the following: What are the greatest uncertainties and sensitivities in current generation Arctic ecosystem models and Earth system models? What are observations and experiments telling scientists about changes in rates and magnitudes of processes and responses, the relative importance of terrestrial processes, and the role of heterogeneity across scales in space and time? What are the strengths and limitations of current observations and experiments, and how can those limitations be overcome?

Participants recommended experiments and observations to elucidate mechanisms underlying greenhouse gas fluxes from warming permafrost, changing hydrology, shifting distribution of vegetation, and large-scale geomorphic dynamics. Research to address the vulnerability of Arctic ecosystems to global change should be designed to characterize chemical, physical, and biological processes in sufficient detail so that current representations in coupled land-atmosphere models can be improved and new mechanisms can be identified and quantified for future inclusion in regional and global climate models. Discussions highlighted the considerable degree of system complexity likely to be encountered in high-latitude ecosystems and the need to describe interactions and feedbacks among permafrost, snow, soil water, vegetation, microbial communities, and atmospheric processes.

Participants also emphasized that new experiments and observations must be designed to account for landscape dynamics, because disturbances like fire, subsidence, and thermokarst can be expected to exert a dominant control on biogeochemical, hydrologic, and ecosystem processes and thus shape how these events are ultimately represented in Earth system models. A science and implementation plan is being developed by a multidisciplinary team of scientists from across DOE national laboratories and strategic university partners. The plan will describe how integration of surface and subsurface science (e.g., genomics to geophysics) can help quantify the response of physical, ecological, and biogeochemical processes to atmospheric and climatic change.

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