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Climate Change Experiments in Arctic Ecosystems: Scientific Strategy and Design Criteria

Stan D. Wullschleger, Larry D. Hinzman, A. David McGuire, Steve F. Oberbauer, Walter C. Oechel, Richard J. Norby, Edward A.G. Schuur, Herman H. Shugart, Peter E. Thornton, John E. Walsh, and Cathy J. Wilson

Arctic and subarctic ecosystems are sensitive to changes in climate. These are among the largest and coldest of all ecosystems and are perceived by many as especially vulnerable to environmental change. Warming, in particular, is expected to be greatest in northern latitudes with potentially significant consequences for tundra, taiga, and peat lands. Observational evidence suggests that warming is already affecting physical and ecological processes in high-latitude ecosystems. Models predict that permafrost degradation and the northward expansion of shrubs into tundra represent important feedbacks on climate. Manipulative experiments can help understand the vulnerability of ecosystems to climate warming. Previous attempts to manipulate the environment of ecosystems in arctic and subarctic regions have focused on warming plant and soils, but treatments have been limited to small scales and modest increases in temperature. Manipulating the environment at larger scales and exposing ecosystems to higher temperatures for longer periods of time will be required to fully describe the physical, chemical, and biological mechanisms that govern land-atmosphere interactions. A variety of logistical and engineering challenges must be overcome and new approaches developed before we can address the questions being asked of the scientific community especially as we continue to move toward large-scale and long-term experiments.

In light of the many uncertainties that surround the response of high-latitude ecosystems to global climate change, it is important that the scientific community consider how manipulative experiments can address and resolve ecosystem impacts and feedbacks to climate. A workshop sponsored by the Department of Energy, Office of Science was recently held at the University of Alaska, Fairbanks. The goal of the workshop was to highlight conclusions from observational and modeling studies about the response of arctic and subarctic ecosystems to a changing climate. Participants were asked how experiments could best be designed to address issues related to plant and ecosystem dynamics, permafrost degradation, carbon and methane emissions, landscape processes, and the many land-atmosphere feedbacks that are likely to arise as a result of global warming. Recommendations that address the scientific strategy and design criteria of future large-scale, long-term climate change experiments in Arctic ecosystems were contributed. This information will be summarized and evaluated in the context of existing and emerging efforts to better understand high-latitude ecosystems to climate warming.

Contact: Stan Wullschleger (wullschlegsd@ornl.gov)