Next-Generation Ecosystem Experiments – NGEE Arctic

Quarterly Report
September 30, 2010

A progress report submitted to

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Department of Energy, Office of Science, Biological and Environmental Research

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Reducing Climate Model Uncertainties Serves as NGEE Motivation

Arctic and sub-arctic terrestrial ecosystems contain more than one-third of the world's organic carbon, approximately 1650 Pg C, most of which resides in frozen soil or permafrost. This region of the world is undergoing rapid environmental changes including higher mean annual air temperatures and reduced snow cover; increased runoff from higher precipitation and permafrost thaw; greater CO_2 and CH_4 emissions associated with a deepening of the active layer; and longer snow-free period and growing season. Moreover, the spatial distribution of boreal and tundra vegetation types has started to shift with large consequences for snow depth, snow cover, surface energy fluxes, and regional albedo. In combination, these changes imply a potentially strong positive feedback to increased climate warming through increased greenhouse gas fluxes to the atmosphere, decreased albedo, and changes in local and regional hydrology.

Earth system models must represent the most significant drivers and feedback mechanisms that underlie climate predictions. Current climate models make reasonable hindcast predictions of the evolution of atmospheric CO_2 and associated climate changes, but results from different models diverge as future forcings are imposed. There remain uncertainty, poorly quantified sensitivities, and lack of process representation for the mechanisms that control the climate system at regional to global scales.

We have taken initial steps to identify current uncertainties, sensitivities, and lack of process representation in ecosystem and climate models. The list, far from complete, includes:

- Geophysical dynamics and thermal characteristics of permafrost and the active layer, including interactions with local and regional hydrology, and snow depth and cover,
- Flux dynamics of CO_2, CH_4, and biogenic volatile organic compounds (BVOCs) from thawing permafrost as a function of rising temperature, soil moisture, biogeochemistry, plant composition and productivity of vegetation, and local and regional hydrology,
- Carbon and nitrogen biogeochemistry and interactions with warming and CO_2 fertilization that determine NPP, vegetation dynamics, and GHG emissions, and
- Vegetation dynamics (e.g., shrub invasion) in response to warming and CO_2 fertilization and consequences to albedo and surface energy balance.

Several NGEE activities are planned in the coming quarter to better understand the source of these uncertainties and to characterize the mechanisms that would need to be included in models for improved process representation.

Details at a Glance

Activities during the July 1 to September 30 quarter include:

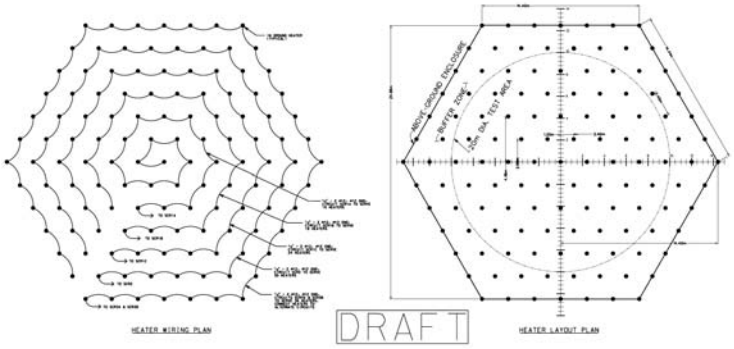
- Technical staff from the U.S. Army Cold Regions Research and Engineering Laboratory (CRREL) and the Barrow Arctic Science Consortium (BASC) traveled to ORNL in early August. The two-day visit focused on the technical aspects of the prototyping activities at Fairbanks and Barrow, Alaska.

- Site preparation, ploy layout, and geophysical characterization of soils at the CRREL Permafrost Research Station in Fairbanks are underway.
- LANL initiates model simulations of above- and below-ground warming designs.
- Agenda and participants list finalized for the October 13-14, 2010 climate change workshop to be held at the University of Alaska, Fairbanks.
- AGU Abstracts submitted for December 13-17, 2010 meeting in San Francisco.
- NGEE web site now on-line

Progress and Accomplishments

Engineering diagrams completed:

ORNL engineers have completed all electrical and electronic drawings and diagrams for the soil warming prototype. These include plot layout, wiring, instrumentation for control of deep-soil temperature and performance monitoring. A full set of plans have been distributed to colleagues at Fairbanks and Barrow, plus several of the diagrams have been distributed to ORNL F&O staff and outside companies for development of data acquisition and communication and control systems for the two prototypes.



CRREL and BASC travel to ORNL:

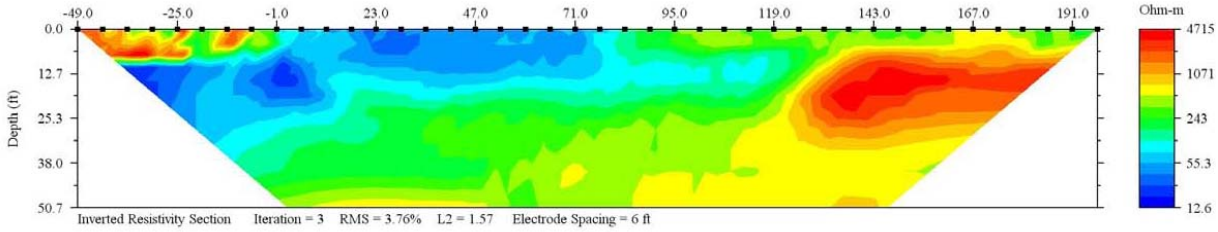
A two-day meeting was held August 2-3, 2010 at ORNL with the goal of helping CRREL and BASC support staff better understand the scope of work required for the construction and field evaluation of the below-ground warming prototypes at Fairbanks and Barrow, Alaska. Joe Hilderbrand and Lewis Brower from BASC and Tommie Hall and Mark Beede from CRREL joined Jeff Riggs, Chris Tavino, and others from ORNL to discuss plot layout, heater installation, wiring diagrams, PID/SCR diagrams, power monitoring, and performance evaluation. Site visits were arranged so staff could view current prototyping activities at ORNL including the earlier 3-m open-top chamber prototype and the 12-m prototype envisioned for use in the SPRUCE project. The full agenda for this meeting can be found in the Appendix.

CRREL completes NEPA and begins prototype installation:

A location for prototype activities within U.S. Army Permafrost Experiment Station was identified by Jon Zufelt and Anna Wagner (CRREL) and Wullschleger. This site was a previously disturbed area that now consists of second-growth trees and shrubs. Vegetation consists mainly of birch and spruce trees with additional willows and brush. The 30 x 30m plot was cleared of trees and brush with the slash chipped and piled for disposal. Clearing operations were completed on September 24, 2010.

Geophysical characterization of site conducted at Fairbanks:

Surface geophysical methods are used to map permafrost over limited areas and to determine changes in permafrost extent and thickness over time. Electrical resistivity tomography is one method that is commonly used to measure and map soil in order to infer areas of permafrost. Resistivity data were collected at the Fairbanks site with an AGI Supersting R8/IP multi-channel switch resistivity meter and passive cables on September 28-29, 2010. Two 2-D lines were collected to characterize the plot with both passing through the center of the proposed plot.



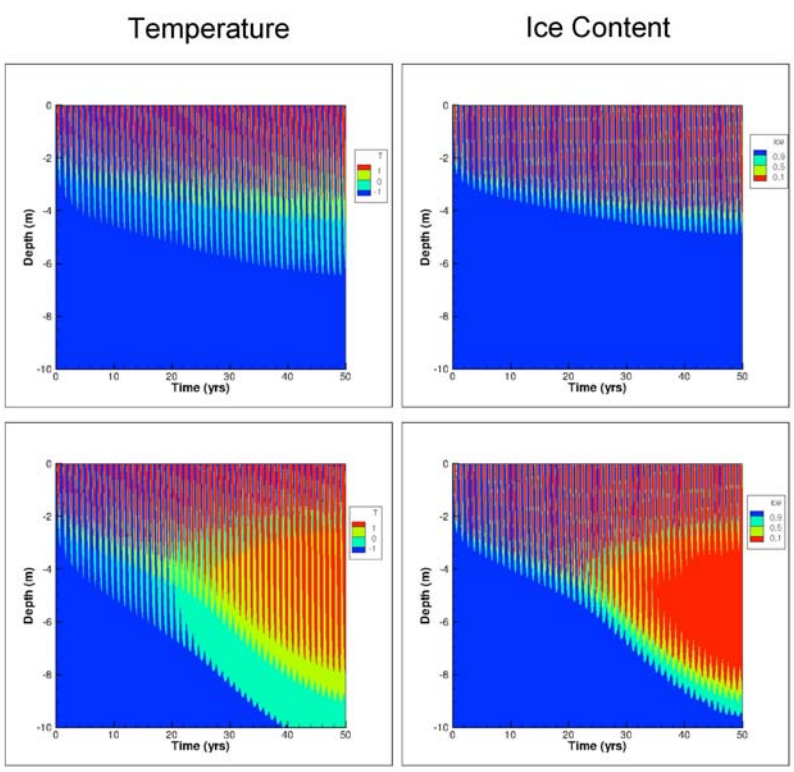
Plot characterization using geophysical approaches revealed that permafrost is found through-out the study area. Consistent with the discontinuous nature of permafrost at this southern location in Alaska, the permafrost is sporadic and occurs mostly at depths below 2 to 6 m within the cleared plot. Permafrost-rich areas can be seen at shallow depths (in red) with the site generally showing characteristics of low-moisture, warm permafrost.

Staging of materials and supplies at Fairbanks and Barrow nearly complete:

CRREL and BASC both took delivery of approximately 10,000 lbs. of heater casings, deep-soil heaters, temperature-measuring instruments, and data control and acquisition systems throughout August and September. Shipping was arranged through ORNL and Global Associates, a service-provider for shipments to Alaska. Fifty-six crates containing 260 heater casings and deep-soil heaters left ORNL in mid-August and arrived Fairbanks and Barrow in mid-September. No problems were noted. These materials and associated supplies are now on-site and scheduled for installation at Fairbanks in October. Installation in Barrow is pending until NEPA issues are resolved.

LANL models subsurface heating:

Numerical simulations of subsurface changes in temperature and ice content due to soil warming are providing support to the engineering design of NGEE experiments in several ways. First, simulations are estimating evolution of likely subsurface response to a gradual warming of the atmosphere by several ^{o}C. Climate warming scenarios of +4°C and +8°C above ambient have been simulated. These simulations take into account daily to seasonal and long-term variations in surface temperature. Initial simulations indicate that +4°C warming (upper two panels) will deepen the active layer significantly, to a few meters depth, over a period of several years, while +8°C (lower two panels) may induce talik formation at a depth of a few meters, that is, a thawed layer that persists year-round. A permanently thawed talik layer would allow production of CO_2 and CH_4 during the winter months. The specific details will depend on soil properties and soil moisture levels. Testing of our numerical model against data from a site in Interior Alaska was successful, both for soil temperature prediction and for soil gas (CO_2 and CH_4) evolution. We are now collecting data from other sites, including Fairbanks and Barrow, for further model testing. Among our initial results, a schedule of heater power *versus* time has been estimated by combining an optimization algorithm to the subsurface dynamics model ARCHY. The power schedule is in reasonable agreement with original thermal calculations using the ORNL HEATING model. Another use of our model is to predict interactions between heater configuration and permafrost degradation, hydrology and soil deformation due to thawing. Several enhancements in the ARCHY model are underway; these include a better snow cover model, soil mechanics to capture slumping and heaving in response to thawing and freezing, and coupling of vegetation to the subsurface dynamics.



Numerical models help simulate potential NGEE air-warming chambers:

The LANL atmospheric model HIGRAD is being used to simulate strategies for above-ground heating in open-top chambers (OTCs) in support of NGEE. In particular, HIGRAD has been employed to simulate the fine-scale (i.e., ~0.1 m) turbulent flows within and around OTCs of various configurations using topography and vegetation characteristic of Arctic tussock and shrub ecosystems. Furthermore, HIGRAD simulations have been used to explore the coupled effects of these turbulent flow fields with various temperature control strategies such as forced air heating and infrared (IR) lamps. These simulations allow for an assessment of the exchange of heat and mass between the chamber and its evolving environment for a wide range of design scenarios.

The HIGRAD simulations indicate that for enclosures of relatively large diameter (i.e., 12–20 m) and with elevated temperatures, thermal energy losses due to turbulent mixing may be greater, and more significant heterogeneities in temperature would exist, within high-sided (5 m) chambers than within low-sided (0.5 m) chambers. The results also demonstrate that while forced air heating allows for greater control of the airflow within a chamber (e.g., to match the ambient winds), and may reduce turbulent mixing between the OTC and winds aloft, it is still uncertain whether forced air heating alone will be able to warm large-diameter enclosures uniformly. In this regard, HIGRAD simulations that employ a combination of forced air and IR heating in chambers of 12 m and 20 m diameter exhibit more uniform and comparable plant and air temperatures than those seen in simulations that employ forced air or IR heating alone, and more uniform air temperatures than those seen in simulations that employ IR heating alone.

Additional simulations are required to examine the dependence of heating strategies on chamber diameter, along with an assessment of the positive and negative impacts associated with each design strategy. Further simulations are also required to explore a larger parameter space of regimes relevant to NGEE (e.g., daytime, nighttime, weak winds, strong winds). These results demonstrate that HIGRAD is a uniquely valuable tool for NGEE, not only for design purposes, but also for the ongoing interpretation of data collected during NGEE, as well as for posing and exploring science questions and hypotheses relevant to climate change science within the context of NGEE.

Neutron scattering proposal submitted for beam time at SNS/HFIR:

In late-August, Alex Johs and others (Graham, Liang, and Wullschleger) submitted a proposal for beam time in response to a solicitation from the ORNL Neutron Scattering Science Office. The proposal focused on the use of neutrons to better characterize ice distribution, water movement, and the physical process of cryoturbation in thawing permafrost soil. Cryoturbation or mixing of soil layers due to repeated freeze-thaw processes is a major soil forming process in arctic regions. It may contribute to long-term storage of C in soils of northern latitudes. If beam time is granted, the laboratory-scale investigation would be conducted either at the Spallation Neutron Source (SNS) or the High Flux Isotope Reactor (HFIR) at ORNL and take advantage of integration across several areas of our subsurface science area. The call for proposals is included in the Appendix.

Interactions with other Agencies, Universities, and National Laboratories

Brookhaven National Laboratory – SDW traveled to BNL on July 16, 2010 to discuss NGEE and to exchange ideas on below-ground prototype design and deployment with Alistair Rogers, Keith Lewin, John Nagy, and others. Guidance from DOE/BER for the BNL scope of work in FY11 was received and ORNL will precede interactions with Rogers and Lewin accordingly.

Los Alamos National Laboratory – SDW also traveled to LANL on July 20-21, 2010 to discuss NGEE with Cathy Wilson, Rodman Linn, Bryan Travis, and Phil Cunningham, and others. A seminar was given and discussions were conducted over a two-day period. During this time a number of activities were discussed and task timelines developed. These included simulations of below- and above-ground concepts for ecosystem warming, plans for model improvement, and then publications. LANL staff have been especially pro-active in looking for opportunities to translate their simulations and resulting ideas to publications.

SDW will travel to Lawrence Berkeley National laboratory (LBNL) in late November to discuss NGEE activities with Susan Hubbard, Margaret Torn, and others. NGEE activities for the coming year will require expertise in geophysical characterization. LANL has unique capabilities in this area (as does CRREL) and will be engaged to the extent interested. Additional expertise will be explored for land-atmosphere interactions and use of isotopes to better understand and couple field results to models.

A seminar series has been initiated to bring university scientists to ORNL for NGEE-relevant presentations and discussions. In September, Gareth Phoenix, the University of Sheffield (http://www.sheffield.ac.uk/aps/staff/acadstaff/phoenix.html) visited (Host Colleen Iversen) and presented an interesting seminar entitled "Arctic ecosystems: impacts of extreme winter warming events and how to measure roots from satellites". His abstract is in the Appendix. In November, Michael Weintraub (http://www.eeescience.utoledo.edu/Faculty/weintraub/ESELab.htm) from the University of Toledo will visit and engage staff from across the laboratory in discussions regarding the role of microbes in nitrogen availability and interactions between biogeochemical cycles and responses of vegetation to warming in Arctic landscapes.

Publications, Presentations, and Posters

Publications:

Hayes, D.J., Hinzman, L.D., McGuire, A.D., Norby, R.J., Thornton, P.E., Walsh, J.E., Wilson, C.J., and Wullschleger, S.D. (2010) Ecosystem experiments to quantify biogeophysical interactions in a warming Arctic. This article is a deliverable from the UAF workshop and is being prepared as a feature article for *EOS*. *EOS* is a weekly science-based newsletter published by the American Geophysical Union (AGU) and is distributed to 50,000 members.

Presentations:

Wullschleger SD. Next-generation climate change experiments in the Arctic: What are our power options? Presented July 15, 2010 at Oak Ridge National laboratory, Oak Ridge, TN.

Wullschleger SD. Next-generation ecosystem experiments (NGEE): Science and engineering for climate change research in the Arctic. Presented July 16, 2010 at Brookhaven National Laboratory, Upton, NY.

Wullschleger SD. Next-generation ecosystem experiments in the Arctic tundra. Presented July 21, 2010 at Los Alamos National Laboratory, Los Alamos, NM.

Wullschleger, S.D. Next-generation ecosystem experiments: Science Planning. Presented July 27, 2010 at Oak Ridge National Laboratory, Oak Ridge, TN.

Wullschleger, S.D. The Alaska Prototype – Parts 1, 2 and 3. Presented August 3, 2010 at Oak Ridge National Laboratory, Oak Ridge, TN.

Wullschleger, S.D. Land-atmosphere interactions due to permafrost warming in the Alaska tundra. Presented August 19, 2010 at Oak Ridge National laboratory for Rear Admiral David Titley, U.S. Navy Task Force Climate Change.

Wullschleger, S.D. Role of experiments in reducing uncertainty in regional and global climate models. Presented September 9, 2010 to the BESD Leadership Team. Oak Ridge national Laboratory, Oak Ridge, TN.

Wullschleger, S.D. Data needs of the next-generation ecosystem warming experiment in Alaska. Presented September 28, 2010 to the CDIAC advisory board, oak Ridge National laboratory, Oak Ridge, TN.

Wullschleger, S.D. Climate change experiments in the Arctic (NGEE). Presents September 28, 2010 at the Oak Ridge IFRC All Hands Meeting, Oak ridge national laboratory, Oak Ridge, TN.

Wullschleger, S.D. Science and modeling needs that drive manipulative experiments in the Arctic tundra. Presented at the First Annual Science Advisory Board (SAB) meeting, Climate Change Science Institute, Oak Ridge National laboratory, September 29, 2010.

Posters:

Wullschleger, S.D., Wilson, C.J., and Rogers A. Next-Generation Ecosystem Experiments (NGEE): Site Selection for Prototype Evaluation. Presented at the First Annual Science Advisory Board (SAB) meeting, Climate Change Science Institute, Oak Ridge National Laboratory, September 29, 2010.

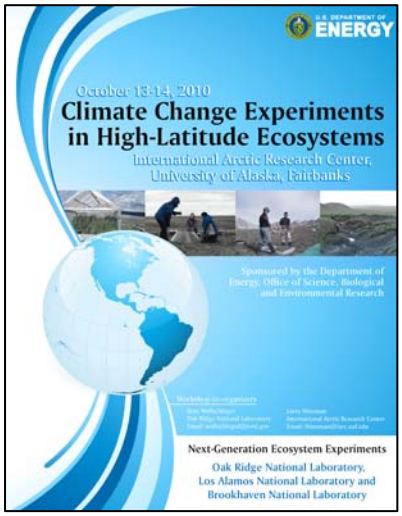
Abstracts:

Wagner, A., Zufelt, J., and Wullschleger, S.D. (2010) Ecosystem warming prototype deployed at the Fairbanks Permafrost Research Station. Submitted to AGU, San Francisco, CA, December 13-17, 2010.

Wullschleger, S.D., Hinzman, L.D., McGuire, A.D., Oberbauer, S.F., Oechel, W.C., Norby, R.J., Schuur, E.A.G., Shugart, H.H., Thornton, P.E., Walsh, J.E., Wilson, C.J. (2010) Climate change experiments in Arctic ecosystems: Scientific strategy and design criteria. Submitted to AGU, San Francisco, CA, December 13-17, 2010.

Upcoming meetings:

Climate Change Experiments in High-Latitude Ecosystems. October 13-14, 2010, International Arctic Research Center, University of Alaska, Fairbanks. This workshop, co-organized by ORNL and IARC, will involve 45 scientists, and address observations and models and what they tell us about the response of the Arctic to a changing climate. Participants will be asked to discuss how experiments can best be designed to address issues related to ecosystem response, permafrost degradation, and other feedbacks likely to arise as a result of global warming and CO_2 fertilization. This information will be summarized for an *EOS* article highlighting how experiments can reduce uncertainties and improve process representation in climate models. A draft will be distributed at the workshop, with submission in early November.



Understanding circumpolar ecosystems in a changing world: Outcomes of the International Polar Year. November 3-6, 2010, University of Alberta Conference Centre, Edmonton, Alberta, Canada. SDW will attend this workshop.

American Geophysical Union (AGU) Fall Meeting. December 13-17, 2010, Moscone Center, San Francisco, CA. SDW will attend this meeting. He and collaborators have submitted two abstracts that highlight NGEE-related activities.

Press Releases and News Clips

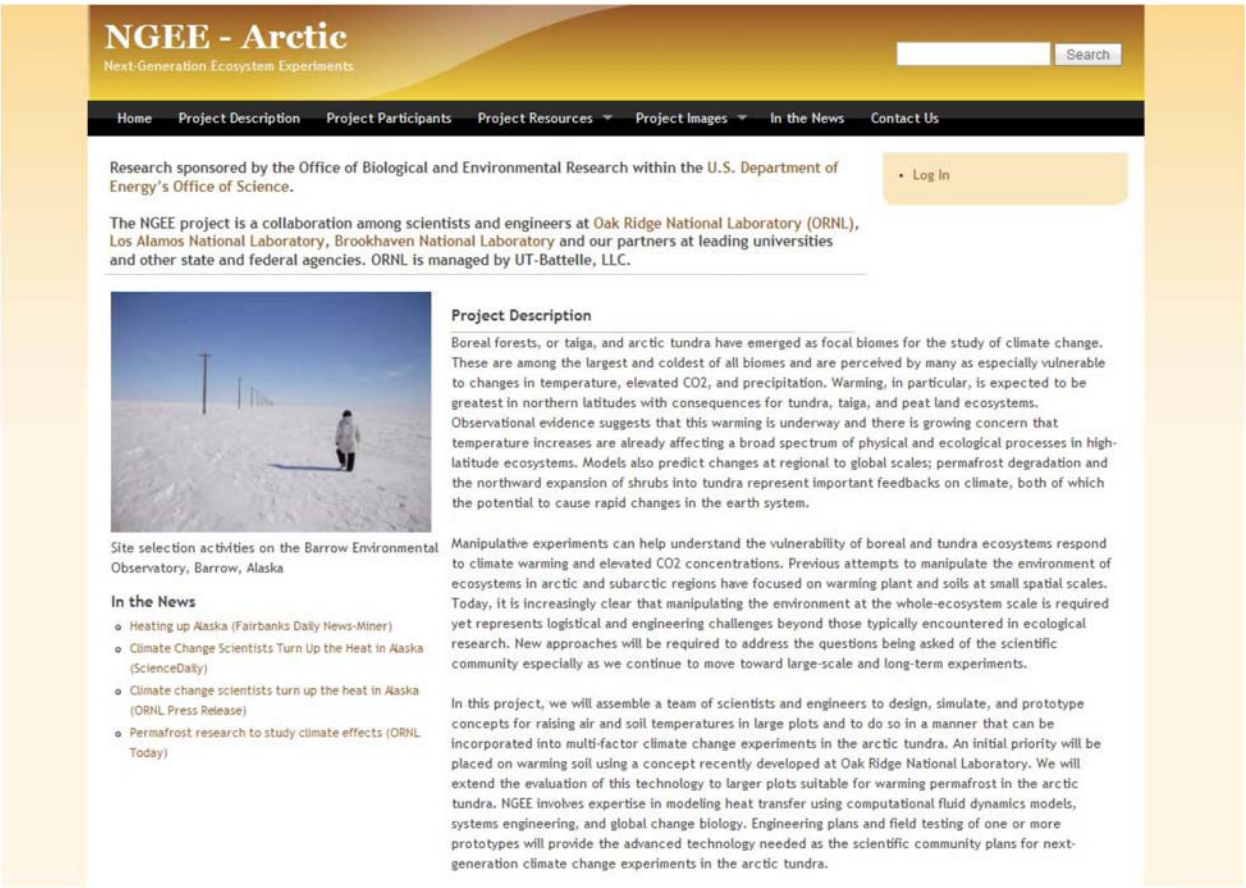
DOE Pulse
http://www.ornl.gov/info/news/pulse/no317/profile.shtml

DOE Pulse
http://www.ornl.gov/info/news/pulse/no316/story4.shtml

ScienceDaily
http://www.sciencedaily.com/releases/2010/06/100625185432.htm

ORNL Today
http://www.ornl.gov/info/press_releases/get_press_release.cfm?ReleaseNumber=mr20100625-00

NGEE has web site: http://ngee.ornl.gov/



NGEE - Arctic

Next-Generation Ecosystem Experiments

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Research sponsored by the Office of Biological and Environmental Research within the U.S. Department of Energy's Office of Science.

The NGEE project is a collaboration among scientists and engineers at Oak Ridge National Laboratory (ORNL), Los Alamos National Laboratory, Brookhaven National Laboratory and our partners at leading universities and other state and federal agencies. ORNL is managed by UT-Battelle, LLC.

- Log In

Site selection activities on the Barrow Environmental Observatory, Barrow, Alaska

In the News

- Heating up Alaska (Fairbanks Daily News-Miner)
- Climate Change Scientists Turn Up the Heat in Alaska (ScienceDaily)
- Climate change scientists turn up the heat in Alaska (ORNL Press Release)
- Permafrost research to study climate effects (ORNL Today)

Project Description

Boreal forests, or taiga, and arctic tundra have emerged as focal biomes for the study of climate change. These are among the largest and coldest of all biomes and are perceived by many as especially vulnerable to changes in temperature, elevated CO2, and precipitation. Warming, in particular, is expected to be greatest in northern latitudes with consequences for tundra, taiga, and peat land ecosystems. Observational evidence suggests that this warming is underway and there is growing concern that temperature increases are already affecting a broad spectrum of physical and ecological processes in high-latitude ecosystems. Models also predict changes at regional to global scales; permafrost degradation and the northward expansion of shrubs into tundra represent important feedbacks on climate, both of which the potential to cause rapid changes in the earth system.

Manipulative experiments can help understand the vulnerability of boreal and tundra ecosystems respond to climate warming and elevated CO2 concentrations. Previous attempts to manipulate the environment of ecosystems in arctic and subarctic regions have focused on warming plant and soils at small spatial scales. Today, it is increasingly clear that manipulating the environment at the whole-ecosystem scale is required yet represents logistical and engineering challenges beyond those typically encountered in ecological research. New approaches will be required to address the questions being asked of the scientific community especially as we continue to move toward large-scale and long-term experiments.

In this project, we will assemble a team of scientists and engineers to design, simulate, and prototype concepts for raising air and soil temperatures in large plots and to do so in a manner that can be incorporated into multi-factor climate change experiments in the arctic tundra. An initial priority will be placed on warming soil using a concept recently developed at Oak Ridge National Laboratory. We will extend the evaluation of this technology to larger plots suitable for warming permafrost in the arctic tundra. NGEE involves expertise in modeling heat transfer using computational fluid dynamics models, systems engineering, and global change biology. Engineering plans and field testing of one or more prototypes will provide the advanced technology needed as the scientific community plans for next-generation climate change experiments in the arctic tundra.

Appendix

Oak Ridge National Laboratory

Barrow Arctic Science Consortium (BASC)
Cold Regions Research and Engineering Laboratory (CRREL)

Agenda

Tuesday, August 3, 2010

8:30am	Check-in at ORNL Visitor Center

Building 1505, Room 189 (Ocoee Conference Room)

9:00am	Project Overview – Stan Wullschleger
10:00am	Plot Layout – Stan Wullschleger Heater Installation – Stan Wullschleger
10:30am	Heater Wiring Diagrams – Chris Tavino PID/SCR Diagrams – Chris Tavino Power Monitoring – Chris Tavino and Jeff Riggs Performance Monitoring – Jeff Riggs
Noon	Lunch at ORNL Cafeteria
1:15pm	Tour of ORNL Computational Science Facilities
1:30pm	Tour of EVEREST

Building 1520, Room 304 (Green River Conference Room)

2:15pm	Prototype Tour (LDRD and 0800) – Paul Hanson
4:30pm	Close-out Discussions and Questions
5:00pm	Adjourn

Gareth Phoenix, Ph.D.
The University of Sheffield
Department of Animal and Plant Sciences

Friday, September 3, 2010
10:00 A.M.
Bldg. 1520, Beech River Conference Room (Room 202)

Contact: Colleen Iversen, 241-3961

Arctic ecosystems: impacts of extreme winter warming events and how to measure roots from satellites

The Arctic is warming more than most other regions of the globe. The potential for considerable feedback to global climate from release of its vast stores of carbon, along with changes in energy and water balance is of major concern. However, while much research to date has focused on Arctic ecosystem responses to summer warming, the impacts of winter warming have been largely ignored – a major oversight given that the Arctic is predicted to warm more in the winter than summer. One of the most impressive of winter climate change phenomena are extreme winter warming events, where temperatures rapidly rise to above $0^{o}C$, causing snow melt at landscape scales and warming of ecosystems before rapid return of ambient extreme winter cold. Here I will report findings from the first field simulation of extreme winter warming events that show considerable damage to Arctic shrub species, and declines in biomass and productivity. I will also show support for the simulation study seen in the impacts of a recent real winter warming event that occurred in north-west Scandinavia showing damage at large scales.

AGU Abstract

Ecosystem Warming Prototype Deployed at the Fairbanks Permafrost Research Station

Anna Wagner, Jon Zufelt, and Stan D. Wullschleger
U.S. Army, Cold Regions Research and Engineering laboratory
Oak Ridge National Laboratory

Controlled experiments in terrestrial ecosystems are necessary to understand how changes in climate may affect the interactions among physical, chemical, and biological parameters. Advanced approaches to above and below ground warming will improve our understanding of the biotic and abiotic processes that govern plant and soil response to climatic change in terrestrial ecosystems. A prototype concept for raising soil temperatures in large outdoor plots has been developed at Oak Ridge National Laboratory. The performance of this design has been field-tested in 3-m diameter plots in a temperate deciduous forest and also numerically simulated for experimental plots ranging from 3 to 20 m in diameter. The goal of the present study is to determine if the prototype system can be used to increase the temperature of permafrost soils in arctic and sub-arctic climates. Two sites in Alaska have been selected (Fairbanks and Barrow) for installation and testing of 20-meter diameter plots beginning in the fall of 2010. Fairbanks has a continental climate, with a mean annual air temperature of -3.3^{o}C, mean annual precipitation of 287 mm, and relatively warm (-1 to -2 ^{o}C) permafrost temperatures. Barrow is located within the Alaskan Arctic coastal plain and has a mean annual air temperature of -12.6^{o}C, mean annual precipitation of 124 mm, and colder (-8 to -12 ^{o}C) permafrost temperatures. This presentation focuses on the study site located at the U.S. Army Cold Regions Research and Engineering Laboratory Permafrost Experiment Station, Fairbanks.

The experiment station was established in 1945 and consists of 135 acres of ice-rich permafrost soils generally present to a depth of 60 m with an active layer that varies from 55 to 85 cm in undisturbed areas. The site has a smooth, gentle slope to the west, providing good surface drainage except at the lowest elevations where saturated conditions can exist. Soils consist of tan silt and wind blown loess near the surface and grey silt at depths below 1.4 m. Permafrost moisture contents range from 26 to 41 percent by mass for the frozen silts which makes this relatively low moisture content permafrost. Vegetation is typical of the Alaskan Interior-subarctic taiga forest with white spruce (*Picea glauca* [Moench] Voss), and black spruce (*P. mariana* [Mill] B.S.P) interspersed with lowbush cranberry (*Vaccinium oxycoccos* L.) and Labrador tea (*Ledum groenlandicum* Oeder). Feather moss and sphagnum moss are present in the understory. The experimental plot is a hexagonal shaped area (29 by 25 m) where vegetation had previously been removed but has regrown over the last 40-50 years. Soil warming is accomplished by 127 vertically-installed low-energy heating elements installed at spacing of 2.4 m and to a depth of 4 m. Only the lower 1-m is heated to a setpoint +4 C above ambient. The heated area includes a buffer zone resulting in a test area with a diameter of 20 m. This proof-of-concept study will result in improvements to experimental design and thermal modeling ground-truth data as the scientific community plans for possible next-generation climate change experiments in terrestrial permafrost ecosystems.

AGU Abstract

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.

Call for Proposals

Neutron Scattering Science – Oak Ridge National Laboratory

Due August 25, 2010

Proposals for beam time at Oak Ridge National Laboratory's High Flux Isotope Reactor (HFIR) and Spallation Neutron Source (SNS) will be accepted via the web-based proposal system until 11:59 p.m. eastern time, Wednesday, August 25, 2010. This call is for experiments anticipated to run from January through May 2011.

Information and instructions

To learn more about submitting a proposal for beam time, go to http://neutrons.ornl.gov/users/proposals.shtml or directly to the proposal system at www.ornl.gov/sci/iums/ipts/. Previously submitted proposals may be used as the basis for new proposals. All proposals will be reviewed for feasibility, safety, and the potential for high-impact science. Before beginning approved experiments, users must complete access and training requirements and ensure that the appropriate user agreements are in place.

Available instruments for general users

The ORNL Neutron Sciences web site, neutrons.ornl.gov, provides specific information about each of these instruments.

HFIR

- HB-1 Polarized Triple-Axis Spectrometer
- HB-1A Fixed-Incident-Energy Triple-Axis Spectrometer
- HB-2A Neutron Powder Diffractometer
- HB-2B Neutron Residual Stress Mapping Facility*
- HB-3 Triple-Axis Spectrometer
- HB-3A Four-Circle Diffractometer
- CG-1D Neutron Imaging Prototype Station*
- CG-2 General-Purpose SANS
- CG-3 Bio-SANS
- CG-4C Cold Neutron Triple-Axis Spectrometer*

SNS

- BL-2 Backscattering Spectrometer (BASIS)
- BL-3 Spallation Neutrons and Pressure Diffractometer (SNAP)
- BL-4A Magnetism Reflectometer (MR)
- BL-4B Liquids Reflectometer (LR)
- BL-5 Cold Neutron Chopper Spectrometer (CNCS)
- BL-6 Extended Q-Range SANS (EQ-SANS)
- BL-7 Engineering Materials Diffractometer (VULCAN)
- BL-11A Powder Diffractometer (POWGEN)
- BL-12 Single Crystal Diffractometer (TOPAZ)
- BL-15 Neutron Spin Echo Spectrometer (NSE)*
- BL-17 Fine-Resolution Fermi Chopper Spectrometer (SEQUOIA)
- BL-18 Wide Angular-Range Chopper Spectrometer (ARCS)

**Instruments with limited availability for general users*

For more information:

Neutron Scattering Science User Office, neutronusers@ornl.gov or (865) 574-4600.

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