Next-Generation Ecosystem Experiments – NGEE Arctic

Quarterly Report
September 30, 2012

A progress report submitted to

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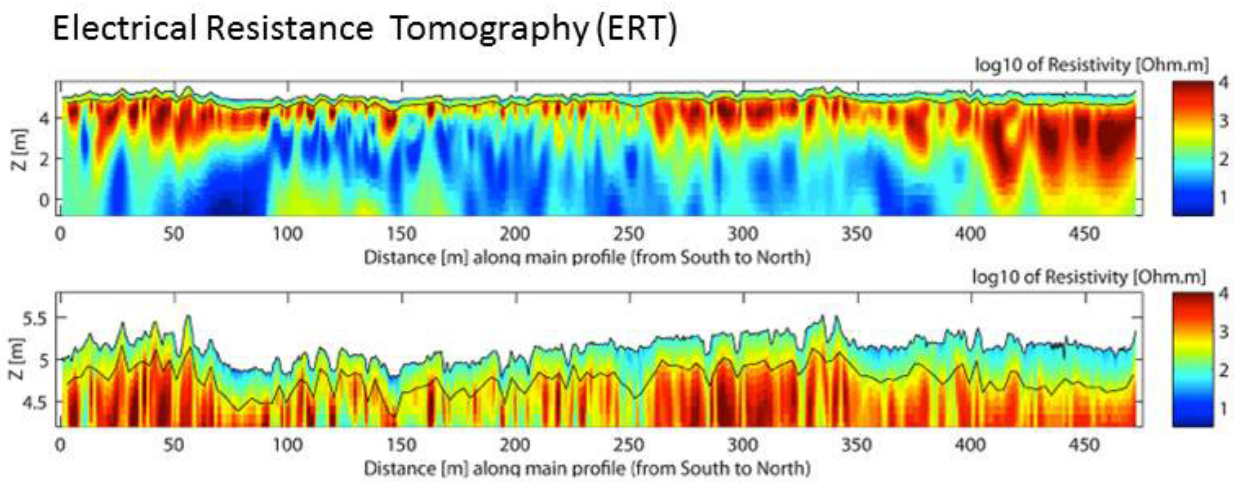
Geophysical Techniques Used to Examine Subsurface Features in Permafrost

Scientists from the Lawrence Berkeley National Laboratory (LBNL), led by senior scientist Susan Hubbard, are using remote sensing and surface geophysical data to characterize the spatial variability and relationships between land surface and subsurface properties in an Alaska Coastal Plain ecosystem. Together with researchers from the Los Alamos and Oak Ridge National Laboratory, University of Alaska Fairbanks, and University of Texas El Paso, Hubbard and her team collected a suite of measurements within a polygon-dominated region of the Barrow Environmental Observatory (BEO). Joint consideration of the datasets revealed the utility of LiDAR and geophysical methods for identifying critical terrestrial ecosystem properties and zonation that can be used to parameterize numerical models. The study, now accepted for publication in the journal Hydrogeology, shows the potential of combining LiDAR and surface geophysical measurements to quantify land surface, active layer and permafrost characteristics as well as the spatial zonation within and the linkages between these ecosystem compartments – all of which are important for quantifying terrestrial ecosystem evolution and feedbacks to climate.

Citation: Hubbard S.S., C. Gangodagamage, B. Dafflon, H. Wainwright, J. Peterson, A. Gusmeroli, C. Ulrich, Y. Wu, C. Wilson, J. Rowland, C. Tweedie and S.D Wullschleger (2012). Quantifying and relating subsurface and land-surface variability in permafrost environments using surface geophysical and LiDAR datasets. Hydrogeology (in press).



Geophysical techniques were used to access thaw depth and possible ice wedge location along a 450 meter transect on the Barrow Environmental Observatory (BEO).

Details at a Glance

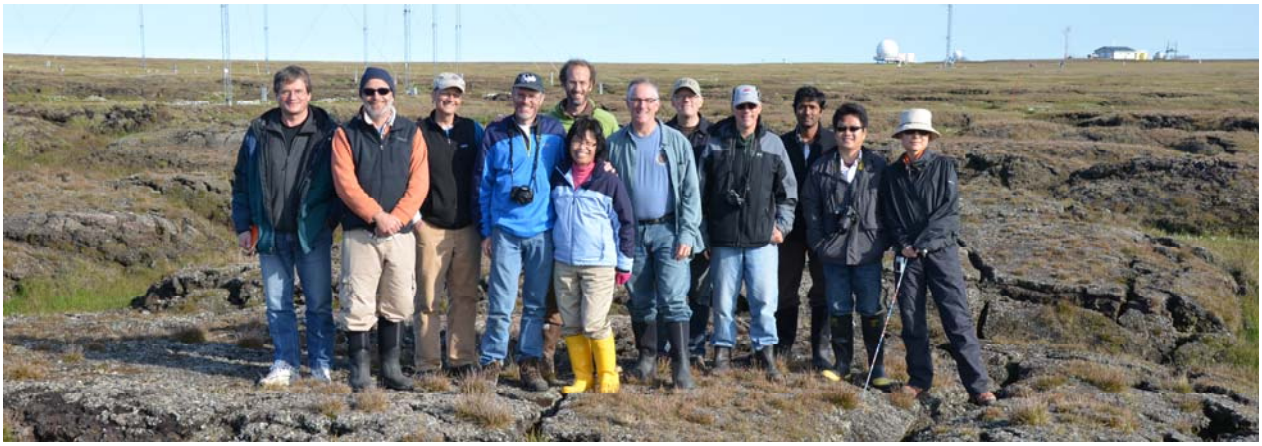
Activities during the July 1 to September 30, 2012 quarter include:

- NGEE Arctic modelers and BER/ORNL managers travel to Alaska
- September was a busy month for the NGEE Arctic in Barrow
- Monitoring freeze-thaw transitions in Arctic soils using the complex resistivity method
- Scientists submit abstracts to AGU meeting
- Vegetation composition documented for low- and high-centered polygons on the BEO

Progress and Accomplishments

Modelers and managers gain improved appreciation for climate feedbacks through trip to Alaska:

Last year a dozen participants in the NGEE Arctic project gained first-hand knowledge of arctic and sub-arctic ecosystems through a trip to Alaska. A similar effort this year (August 7-15, 2012) focused on taking modelers involved in the NGEE Arctic project on a tour of Alaska from Nome and Council on the Seward Peninsula north across the Brooks Range to Barrow, Alaska. It was felt that modelers have a tremendous challenge to develop computer models for ecosystems that they may not have seen. This trip addressed that deficiency for six of our process- to climate-scale modelers. Modelers were joined by Sharlene Weatherwax, Gary Geernaert, and Mike Kuperberg from the DOE, Office of Science, Biological and Environmental Research (BER) and Martin Keller, Associate Laboratory Director from ORNL. The group benefitted from seeing vegetation transition zones at the northern edge of the boreal forest and permafrost-dominated ecosystems of the North Slope. While in Barrow the team also toured facilities associated with the DOE-sponsored Atmospheric Radiation Measurement (ARM) project (see appendix).



NGEE Arctic modelers and BER managers pose for a group picture standing atop a degraded polygon in Barrow, Alaska. Pictured (left to right) Vladimir Romanovsky, Martin Keller, Stan Wullschleger, Peter Thornton, Sharlene Weatherwax, Charlie Koven, Mike Kuperberg, Scott Painter, Gary Geernaert, Jitendra Kumar, Chonggang Xu, and Haruko Wainwright. Photo courtesy of Larry Hinzman.

September was a busy month for NGEE Arctic team in Barrow:

The NGEE Arctic team was busy throughout the summer with vegetation surveys, harvests, soil and water sampling, CO_2 and methane measurements, and other activities from across our national laboratory and university partners. September, in particular, was busy with the installation of an eddy covariance system. Dave Billesbach, University of Nebraska, working closely with Margaret Torn (LBNL), post-doc Melanie Hahn, and Ph.D. student Naama Yaseef were able to identify a suitable location for deployment of an instrument package on the Barrow Environmental Observatory (BEO). The 4-meter, tripod-mounted tower is equipped with a Li-7500 open-path CO_2 and H_2O analyzer and Li-7700 methane analyzer. The system is equipped with data transmission capabilities making nearly real-time data acquisition possible. The eddy covariance system is currently operating and producing usable data despite difficult "shoulder

season" weather conditions (e.g., rain, fog, sleet, and snow). The eddy covariance team will meet in the near future to determine how long the main instruments can be safely deployed and to plan for their take-down and shipping to the University of Nebraska for routine maintenance and re-calibration. All instruments are powered from a 120 volt GFI outlet. Service for this and other instruments in the NGEE Arctic project will be upgraded in the spring. In addition, the footprint analysis presented in the June 30, 2012 Quarterly Report has been recalculated for the installed tower height. The footprint indicates that the tower instruments sense a mixture of wet (low) and dry (high) areas on the tundra.

Eddy covariance system recently installed on the Barrow Environmental Observatory (BEO) for use in model evaluation.

Two teams from LANL (Cathy Wilson, Brent Newman, and Marvin Gard) and ORNL (David Graham, Liyuan Liang, and Tommy Phelps) were also in Barrow during the month of September for sampling surface and groundwater. These teams had previously installed a number of water sampling devices (i.e., diffusion cell and drive point piezometers, and rhizons) across our NGEE Arctic field plots. Chemical measurements will include pH, alkalinity, conductivity, redox potential, total organic carbon, dissolved oxygen, and major and minor cations and anions. The

stable isotopes of water will also be monitored at all locations except the diffusion samplers. A subset of locations will be sampled for dissolved methane & methane isotopes, Fe+2/Fe+3, and ammonium. These parameters should facilitate a thorough comparative assessment of the different approaches when combined with information regarding ease of use and stability over the winter period.

Garrett Altmann (LANL) collects a "grab sample" from one of the many water-filled troughs on the NGEE Arctic field plots.

Joel Rowland and Garrett Altmann returned to Barrow in late September install devices that will help characterize the geomechanical properties of the different polygons we are studying as part of the NGEE Arctic project. A series of sliding tubes (white PVC) rise and fall with changes in surface topography thus providing an indication of changes in the geomechanical properties of soils throughout the season. Such data will be used to parameterize models and interpret field observations.

Joel Rowland is shown drilling holes for pipes that will support indicators of shrink and swell properties for permafrost soils.

Organized oral session on plant functional types proposed for 2013 ESA meeting:

Dynamic vegetation models used at regional to global scales simulate natural vegetation distribution and terrestrial carbon, water, and energy exchange in response to climate, soil, disturbance, and their many interactions. These models rely on the concept of plant functional types (PFT) to reduce the complexity of species diversity to a few key plant types. The challenge likely to be encountered in moving forward with modeling vegetation dynamics, however, lies in evaluating the trade-offs between simplicity in our classification of PTFs, while capturing sufficient complexity in describing differences among PFTs for major ecosystem properties and processes. In this organized oral session, speakers will discuss how PFTs have been represented in regional and global models and if and how vegetation dynamics can be improved in the future. Speakers will be encouraged to take a broad perspective on these topics, while recognizing that our goal is to target representation of PFTs in advanced high-resolution land models of Arctic terrestrial ecosystems. Such ecosystems are critically important, yet poorly represented in current global dynamic vegetation models. Thus, this session will focus on new model formulations of PFTs for high-latitude ecosystems and the field measurements and remote imagery that are required to support the development (e.g., parameterization and validation) of these next-generation models. Speakers will highlight how PFTs have historically been characterized, the sources of data used to represent PFTs in early models, and trade-offs associated with various classification schemes. Knowledge gaps will be identified. Subsequent speakers will build upon this information and discuss how the improved availability of plant functional trait data can potentially enable a more realistic and empirically-based representation of terrestrial vegetation in Earth Systems Models. One speaker will present their perspectives for how belowground processes can be incorporated into PFTs by highlighting the inclusion of important root traits (e.g., phenology, turnover) into predictive models. Furthermore, the possibilities to incorporate genetic diversity and adaptive plasticity within PFTs through probabilistic representation of key processes will be discussed. Speakers will emphasize the value of including basic ecological principles in advanced models of climate. Progress in these areas and the incorporation of new approaches to define PFTs will be of interest to many members of the ESA including taxonomists, ecologists, physiologists, statisticians, computer scientists, and other disciplines.

Photosynthetic characterization of plant functional types from tundra ecosystems:

An important goal of Earth System Models (ESMs) is to improve understanding and projection of future global change. In order to do this these models must accurately represent the carbon fluxes associated with the terrestrial carbon cycle. Photosynthetic CO_2 uptake is well described by the Farquhar et al. biochemical model of photosynthesis, and most ESMs use a derivation of this model. One of the key parameters required for this model is an estimate of the maximum rate of carboxylation by the enzyme Rubisco. In ESMs the parameter is usually fixed for a given

plant functional type (PFT) and often estimated from the empirical relationship between leaf N content and the rate of Rubisco carboxylation. However, uncertainty in this parameter has been shown to account for significant variation in model estimation of gross primary production, particularly in the Arctic. As part of the NGEE Arctic project, Alistair Rogers at Brookhaven National Laboratory is working to improve the representation of leaf gas exchange for key Arctic plant species. He has measured the response of photosynthesis (A) to internal CO_2 concentration (ci) in two sedges (*Carex aquatilis*, *Eriophorum angustifolium*), a grass (*Dupontia fisheri*) and a forb (*Petasites frigidus*) growing on the Barrow Environmental Observatory, Barrow, AK. Early analyses indicate that values of Rubisco carboxylation (normalized to 25oC) currently used to represent Arctic PFTs are approximately half of the values we measured in these species in July, 2012, on the coastal tundra in Barrow. Alistair and his team hypothesize that these plants have a greater fraction of leaf N invested in Rubisco than is assumed by the models. These results have important implications for the carbon balance of Arctic terrestrial ecosystems and suggest that physiological characterization of a more extensive list of plant species is required.

Alistair Rogers (BNL) demonstrates the use of a LiCOR portable photosynthesis system to climate modeler Peter Thornton (ORNL). The instrument provides valuable information on parameters use in climate models to estimate rates of carbon flu.

<u>Monitoring of freeze-thaw transitions in Arctic soils using the complex resistivity method</u>:

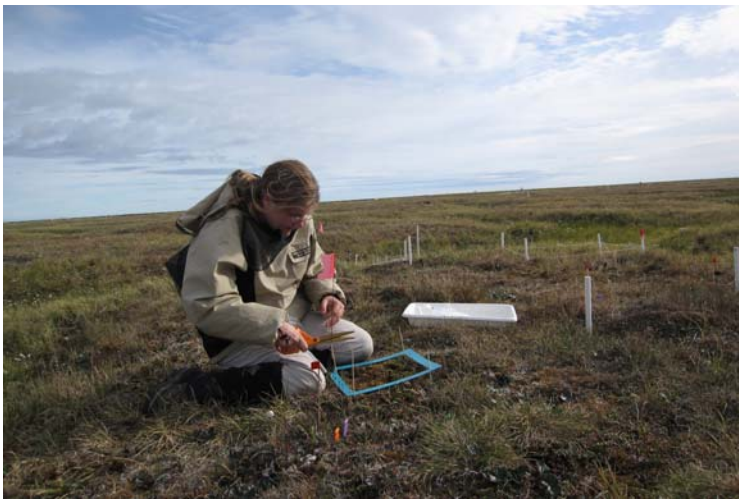
An ability to monitor freeze-thaw transitions is critical to developing a predictive understanding of biogeochemical dynamics in high-latitude environments. Surface-based geophysical methods offer an avenue to improve the quantification of freeze-thaw transitions in high resolution and over landscape scales. Scientists from LBNL using permafrost cores taken from the Barrow Environmental Observatory (BEO) outside Barrow, Alaska conducted laboratory column experiments to explore the potential of the complex resistivity method for monitoring the freeze-thaw transitions in permafrost soils. Freeze-thaw transitions were induced in temperature-controlled environments and complex resistivity measurements were collected regularly. Over two orders of magnitude changes of resistivity were observed during freeze-thaw transition and electrical polarization signals were found to be exclusively related to the unfrozen water in the soil matrix, suggesting that these geophysical attributes can be used for quantification of the freeze-thaw processes. Spectral electrical responses and fitted parameters contained additional information about the freeze-thaw transition affected by the soil grain size distribution. Specifically, a shift of the observed spectral response to lower frequency was observed during

isothermal thawing process, which we interpret to be due to sequential thawing, first from fine then to coarse particles within the soil matrix. This study demonstrates the potential of the complex resistivity method for remote monitoring of freeze-thaw transitions and indicates the potential of the method for monitoring the transitions, which control critical biogeochemical processes, over large tundra areas and in a non-invasive manner. This study also indicates opportunities for linking larger scale electrical geophysical observations to pore scale properties and processes that occur during freeze-thaw transitions.

Citation: Y. Wu, S. S. Hubbard, C. Ulrich and S.D. Wullschleger. 2012. Remote monitoring of freeze-thaw transitions in Arctic soils using the complex resistivity method. Vadose Zone Journal (in press).

NGEE Arctic ecologists and modelers travel to Council, Alaska:

Scientists Rich Norby, Victoria Sloan, and Dan Hayes all traveled to the Seward Peninsula in late-August. This trip was to compare soils and vegetation found along the southern edge of the tundra to that studied by the NGEE Arctic team much farther north in Barrow, Alaska. Dan is an ecosystem modeler and together with colleagues at the University of Alaska Fairbank, this team is interested in learning more about what controls the distribution of plants across the landscape and then how best to represent those controls in dynamic vegetation models. Victoria has spent the summer in Barrow conducting extensive soil and vegetation surveys across a gradient of ice-rich polygons. Those data will be analyzed this fall and discussions will focus on the incorporation of important aspects of this research into models.

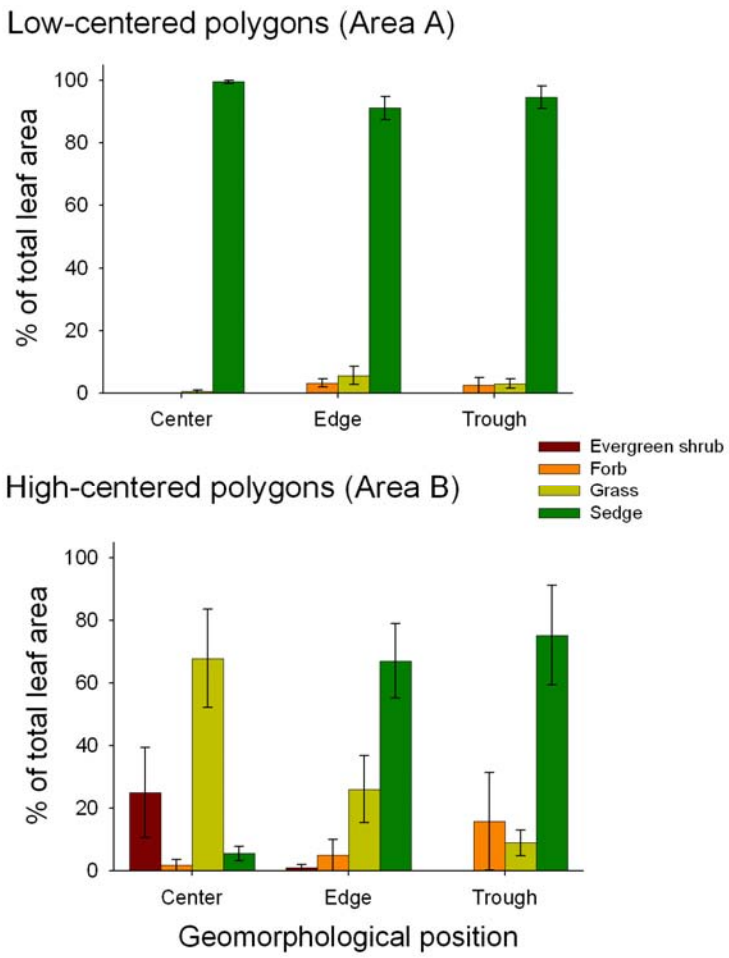


Victoria Sloan (ORNL) surveys vegetation present in centers, edges, and troughs of ice-rich polygons in Barrow, Alaska.

Vegetation composition documented for low- and high-centered polygons:

The Arctic Coastal Plain is comprised of a heterogeneous mix of thaw lakes, drained thaw lake basins, and interstitial tundra. Because of the ice-rich nature of tundra in these high-latitude ecosystems, polygons are a distinguishing feature of the landscape. Low- and high-centered

polygons (e.g., patterned ground) occur throughout the region with each having distinct surface and soil water characteristics. The NGEE Arctic team is working to understand how various properties and processes vary across different polygons and the geomorphological positions designated centers, edges, and troughs. In the case of vegetation composition survey data collected throughout the field season by Victoria Sloan (ORNL) is beginning to highlight the interaction that takes place between plant dynamics and these geomorphological positions. Note that in low-centered polygons the centers, edges, and troughs are all typically moist and thus favor growth of sedges. By comparison, the centers of high-centered polygons are much drier and tend to be colonized by evergreen shrubs and grasses. This distribution of vegetation is obvious in the field and likely reflects a requirement of vegetation of soil and surface water. It also has implications for soil carbon, biogeochemistry, fluxes of CO_2 and methane, albedo, etc. These datasets have been collected for similar geomorphological positions and will be analyzed soon.



Vegetation composition for centers, edges, and troughs of low- and high-centered polygons on the Barrow Environmental Observatory (BEO). Data provided courtesy Victoria Sloan.

<u>NGEE Arctic scientists submit abstracts to AGU meeting</u>:

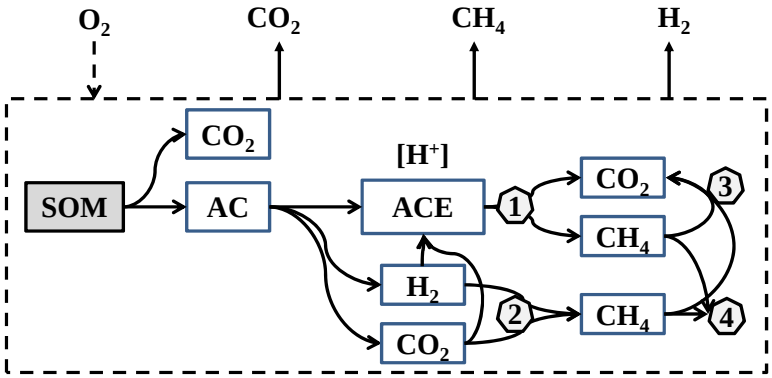
Enthusiasm in the NGEE Arctic project was especially obvious this quarter as members of the team submitted more than 30 abstracts for the upcoming American Geophysical Union (AGU)

meeting. The abstracts captured status reports in all areas of interest to the project including geophysics, biogeochemistry, vegetation dynamics, and hydrology. Abstracts reflected a good integration of scientific topics across partners in the project and between scientists working in the field and laboratory and ecosystem and climate modelers. The AGU meeting is to be held December 3-7, 2012 in San Francisco.

AGU FALL MEETING
San Francisco | 3–7 December 2012

Simulating carbon cycle dynamics from incubated permafrost soils:

An incubation experiment has been conducted by ORNL scientists to examine the production and consumption of CO_2 and CH_4 in soils of top layer, active layer, and permafrost layer under various moisture and temperature conditions. The experiment uses cores extracted from Alaskan permafrost soils. The incubation results confirm the productions of hydrogen gas and acetic acid and soil pH drop, and three key mechanisms for production and consumption of CH_4: methanogenesis from acetic acid, methanogenesis from hydrogen and carbon dioxide, and aerobic CH_4 oxidation. These mechanisms were incorporated into a subroutine program which was then combined with decomposition subroutines in the Community Land Model (CLM4) to evaluate the performance of these mechanisms in simulating CO_2 and CH_4 production and consumption from incubated permafrost soils. Two guilds of methanogens and one group of methanotroph were simulated for their growth, death, and functions on CH_4 production and consumption. The simulation results confirm that microbial mechanisms are critically important in reconstructing the observed changes in CO_2 and CH_4 concentrations. There are large variations in CO_2 and CH_4 production and consumption among soil layers. The accumulation of acetic acid causes soil pH drop, which in turn exerts a substantial effect on CO_2 and CH_4 dynamics. The moisture and temperature have significant effects on microbial mechanisms and further on CO_2 and CH_4 production and consumption. Sensitivity analysis confirms the importance of acetic acid's direct effects and indirect effects through pH feedback on CO_2 and CH_4 production and consumption. This study, soon to submitted for publication, suggests that microbial mechanisms are critical for land-atmosphere interaction and it is urgent to incorporate these mechanisms into the Earth system models to evaluate the role of microbe on the global carbon feedbacks to the climate system.



AC: available carbon; ACE: acetate acid; the numbers indicate microbe groups; 1 indicates acetate acid-based methanogens; 2 indicates H_2-based methanogens; 3 indicates aerobic methanotrophys; 4 indicates anaerobic oxidation of methane

UMIAQ files expanded North Slope Borough (NSB) permit on behalf of NGEE Arctic team:

Karl Newyear, UMIAQ Chief Scientist, worked with Stan Wullschleger (ORNL) to finalize an expanded land use permit for project-related research on the Barrow Environmental Observatory (BEO) in Barrow, Alaska. An original permit was completed in February, 2012 and covered research activities related to biogeochemical and geophysical characterization of ice-wedge polygons and collection of water and gas samples. The new permit will continue to cover these activities, but will also allow NGEE Arctic researchers to further instrument intensive study sites with tripod-mounted data loggers for collection of above- and below-ground data and establish eddy covariance capabilities for measuring CO_2 and CH_4 flux at a location central to their experiment. The permit covers an expanded set of low-impact measurements on a series of satellite sites (i.e., thaw lakes and drained thaw lake basins) on the BEO. All of these activities will be important as the NGEE Arctic team continues to gather data in support of climate models.

Post-doctoral associates bring unique expertise to NGEE Arctic project:

Santonu Goswami joins ORNL as a post-doctoral research associate. Santonu received his PhD in Environmental Science and Engineering at the University of Texas at El Paso. He studied with Drs. Craig Tweedie and John Gamon on a large ecosystem manipulation study in Barrow, Alaska. His research focused the impacts of changing soil moisture on the optical properties of the arctic tundra using a robotic cart system. His dissertation research has significant implications for interpreting satellite imagery and monitoring the productivity of arctic ecosystems as they respond to climate change. While at ORNL, Santonu will be responsible for collection and interpretation of remote imagery associated with a new Early Career Award project recently awarded to Dan Hayes by the Department of Energy, Office of Biological and Environmental Research. Santonu will also help with aspects of the NGEE Arctic project especially those that relate to the use of satellite imagery in modeling terrestrial processes in the Arctic.

Interactions with other Agencies, Universities, and National Laboratories

NOAA, ATDD, July 25, 2012. Oak Ridge, TN.

Publications, Presentations, and Posters

Publications:

McCarthy H.R., Y. Luo and S.D.Wullschleger. 2012. Integrating empirical-modeling approaches to improve understanding of terrestrial ecology processes. New Phytologist 195: 523-525.

Hubbard S.S., C. Gangodagamage, B. Dafflon, H. Wainwright, J. Peterson, A. Gusmeroli, C. Ulrich, Y. Wu, C. Wilson, J. Rowland, C. Tweedie and S.D Wullschleger. 2012. Quantifying and relating subsurface and land-surface variability in permafrost environments using surface geophysical and LiDAR datasets. Hydrogeology (in press).

Wu Y., S.S. Hubbard, C. Ulrich and S.D. Wullschleger. 2012. Remote monitoring of freeze-thaw transitions in Arctic soils using the complex resistivity method. Vadose Zone Journal (in press).

Xu X.F., Elias D.A., Graham D.E., Phelps T.J, Carroll S.L., Thornton P.E. 2012. Simulating CO_2 and CH_4 production and consumption from incubated permafrost soils. Journal of Geophysical Research-Biogeosciences (in review).

Gangodagamage C., J.C. Rowland, C. Wilson, S. Hubbard, S. Brumby, H. Wainwright, G. Altmann, A. Liljedahl, C. Tweedie, S. D. Wullschleger. 2012. Predicting active layer thickness using statistical learning from remotely sensed high resolution data. Geophysical Research Letters (internal review).

Neslihan T., M.S. Torn, S.S. Hubbard, L. Smith, E. Brodie, and J. Jansson. 2012. Microbial composition and generation of trace gases vary across different arctic polygon features. Journal TBD (internal review).

Presentations:

Romanovsky, V.E. 2012. Permafrost in Alaska. Lecture at the IARC Summer School, July 17 2012, UAF, Fairbanks.

Wullschleger, S.D. 2012. Improved Climate Prediction through Process-Rich Understanding of Arctic Terrestrial Ecosystems. NOAA ATDD Seminar Series, Oak Ridge, TN. July 25, 2012.

Romanovsky, V.E., S.S. Marchenko, and G. Grosse. 2012. Observations and Modeling of Changes in Permafrost, Invited Oral presentation at the Toolik Lake Research Station Strategic Planning Workshop, August 2-4, 2012, Portland, OR.

Wullschleger, S.D. 2012. Next-Generation Ecosystem Experiments: Progress and Plans. Barrow Arctic Research Center, Barrow, AK. August 12, 2012.

Gusmeroli, A. Ground-based geophysics: Applications on snow, glaciers, permafrost and freshwater ice in Alaska. International Arctic Research Center Seminar Series, Frozen Signals, University of Alaska, Fairbanks, AK. August 14, 2012.

Wainwright, H. 2012. Multiscale Bayesian fusion approach using geophysical and remote sensing data for characterizing Arctic tundra hydrogeochemical properties. International Arctic Research Center Seminar Series, Frozen Signals, University of Alaska, Fairbanks, AK. August 14, 2012.

Rogers, A. 2012. Next Generation Ecosystem Experiments – Arctic. Annual Research Meeting of the DOE Office of Science Graduate Fellowship Program. Brookhaven National Laboratory. July 30, 2012.

Rogers, A. 2012. Improving Representation of the Arctic in Earth System Models. New York University Graduate School of Journalism, Science Health Environmental Reporting Program. Brookhaven National Laboratory. September 27, 2012.

Workshops Attended: None.

Posters: None.

Upcoming Meetings:

Research Coordination Network, Vulnerability of Permafrost Carbon, San Francisco, CA. December 2, 2012.

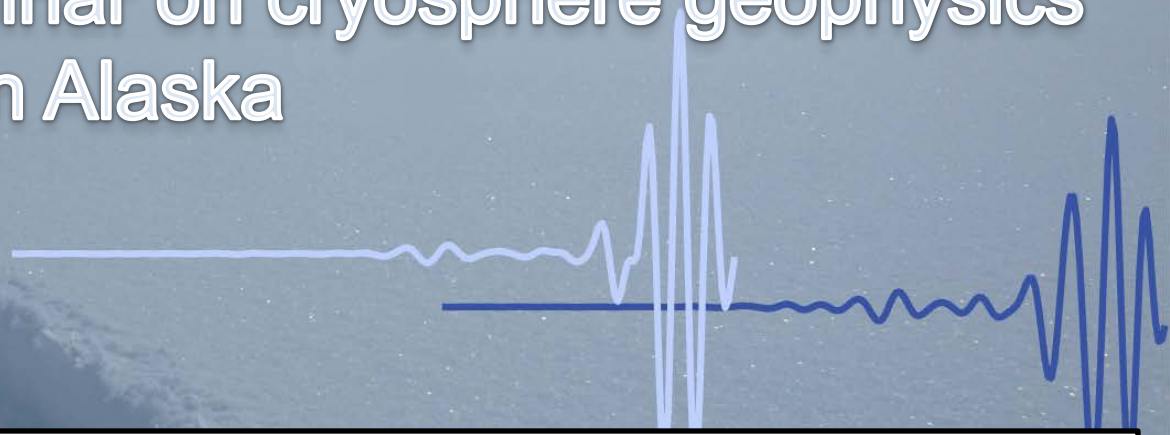
Press Releases and News Clips

Another Kind of Rush in Alaska
http://www.arm.gov/news/facility/post/18942

Appendix

Frozen signals

A 3 speakers seminar on cryosphere geophysics and applications in Alaska



Tuesday, August 14, 1.30 pm, IARC 401

Dr. Alessio Gusmeroli (University of Alaska Fairbanks)

Overview. Case studies on glaciers, snow, permafrost and freshwater ice.

Dr. Lin Liu (Stanford University)

Mapping active layer with space-borne and ground-based radar.

Dr. Haruko Wainwright (Lawrence Berkeley National Laboratory)

Multiscale Bayesian approaches for Arctic Tundra characterization.

contact alessio@iarc.uaf.edu for more information

IARC Seminar

Tuesday, August 14th, 1.30 to 2.30 pm

FROZEN SIGNALS. A 3 speakers seminar on cryosphere geophysics and applications in Alaska

By Alessio Gusmeroli, Lin Liu and Haruko Wainwright.

Documenting the present state of snow, ice, and permafrost in Alaska through observations is a crucial component for predicting and adapting to the dramatic changes in the cryosphere expected in the next 30 years. In this seminar we will present recent geophysical research on Alaska snow, ice and permafrost. The seminar will be divided in three parts:

PART 1 - Alessio Gusmeroli- 1.30 – 1.45 pm. *Ground-based geophysics: Applications on snow, glaciers, permafrost and freshwater ice in Alaska.*

PART 2 - Lin Liu- 1.45 – 2 pm. *Mapping active layer with space-borne and ground-based radar.*

PART 3 - Haruko Wainwright – 2 pm -2.15 pm. *Multiscale Bayesian fusion approach using geophysical and remote sensing data for characterizing Arctic Tundra hydrogeochemical properties.*

Dr. Alessio Gusmeroli is a Postdoctoral Fellow at the International Arctic Research Center, University of Alaska Fairbanks. Alessio received a Ph.D. in Physical Geography from Swansea University in the UK in 2010 and moved to Alaska shortly after that. Since then he has been involved in a number of geophysical expeditions targeted to understanding processes and changes on the Greenland and Antarctic ice sheets, Alaska glaciers, freshwater ice and permafrost in Alaska. alessio@iarc.uaf.edu

Dr. Lin Liu is a Postdoctoral Fellow at the Department of Geophysics in Stanford University, California. Lin received his Ph.D. in Geophysics from the University of Colorado in 2011. His research focuses on monitoring changes in the polar areas using space-borne and field-based geophysical methods. He also studies the interaction between the solid earth, the atmosphere, ocean and cryosphere. liulin523@gmail.com

Dr. Haruko Wainwright is a Postdoctoral Fellow at the Division of Earth Sciences of the Lawrence Berkeley National Laboratory in Berkeley, California. Haruko received a Ph.D. in Nuclear Engineering at the University of California, Berkeley in 2010. Her research interests are geostatistics, hydrogeophysics and hydrogeology. Her work on Alaska permafrost focuses on the use of multi scale Bayesian approaches in the Next-Generation Ecosystem Experiments (NGEE Arctic) project to characterize the Arctic Tundra at the Barrow site in Alaska. hmwainwright@lbl.gov