2019 Toolik Field Station All Scientists Meeting Poster Abstracts

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Toolik Field Station Mission:

To support research and education that creates a greater understanding of the Arctic and its relationship to the global environment.

Purpose of the All Scientists Meeting:

The goal of the meeting is to share scientific findings, promote collaboration, and gather future science support requirements

Seasonal thaw depth and soil C and N inventories in graminoid tundra in the vicinity of Toolik Field Station, AK

Claudia I. Czimczik*, S.A. Pedron, S.R. Holden, X. Xu, J.C. Walker, T.K. Nguyen, J.M. Welker, E.S. Klein, C.A. Masiello, X. Gao

czimczik@uci.edu
University of California, Irvine

Northern circumpolar permafrost soils contain vast amounts of organic carbon (1,035±150 Pg C in the top 3 m) that may become vulnerable to microbial decomposition as climate warms and permafrost thaws. Major uncertainties remain regarding the timing and magnitude of the permafrost C feedback to climate change.

Here, we investigated active layer dynamics and soil organic matter properties in moist acidic tussock tundra near Toolik Field Station to understand the vulnerability of soil carbon stocks in this common type of graminoid tundra to climate change. We monitored the timing, magnitude, and variability of active layer thaw and compared our measurements to observations made by the Circumpolar Active Layer Monitoring Network (CALM) and Long-Term Ecological Research (LTER) networks. We also collected soil cores and used elemental and isotopic analyses to quantify the amounts and composition of soil organic matter in the active layer and underlying surface permafrost.

We found that the active layer is fully developed by mid-July. The active layer depth is 46±15 cm (mean±SD), with a range of 20-80 cm, and has not changed significantly during the past 25 years. Moist acidic tussock tundra contains 91 kg C m

Arctic Lake Water Isotopes Track Climatological Phenomena

William Daniels*

wcdaniels@geo.umass.edu
University of Massachusetts

The hydrogen and oxygen isotopes of water (D/H and $^{18}O/^{16}O$) are excellent tracers of the hydrologic cycle. They are commonly employed to study paleoclimatology, moisture sources, groundwater and surface water flowpaths, and ecophysiological processes. At Toolik Field Station (TFS), they can potentially be used as a tracer of both persistent meteorological changes, interannual changes in moisture availability (i.e. precipitation-evaporation), physical limnology, and other aspects of the arctic hydrology.

Here we begin to explore the fundamental patterns and changes in hydrology at TFS using the water isotopes of lakewater samples. We analyzed 712 archived samples from the Arctic Long-Term Ecological Research Program for D/H and $^{18}O/^{16}O$ using a Picarro Cavity Ring-down Spectrometer at the University of Massachusetts Amherst. We compare open versus closed-basin lakes, and epilimnion versus hypolimnion waters from a suite of LTER lake sites over their sampling histories (Toolik Lake, Lake N1, Lake E5, and Lake Fog 2).

Climate sensitivity of

Snowmelt hydrology of the Upper Kuparuk River

Kelsey Dean*, Svetlana Stuefer

kdean6@alaska.edu
University of Alaska Fairbanks

The Fourth National Climate Assessment Report (2018) indicate that Alaska has been warming at a rate two times greater than the global average with the Arctic continuing to be experiencing higher rates of warming. Changes to air

Toolik Field Station GIS: Flying into the Future

Randy Fulweber*, Jason Stuckey*, Jorge Noguera

rafulweber@alaska.edu
University of Alaska Fairbanks

In response to research requests for high resolution spatial and temporal data products, the Toolik Field Station GIS Program has developed and continues to enhance our Unmanned Aerial System (UAS) platforms, sensors, and services. Our dual-camera commercial-grade UAV is capable of flying in temperatures down to -20C, allowing us to fly during cold shoulder seasons and capture images of snow conditions and snow events of interest to researchers and management. Our research-grade multispectral camera can record high-resolution (>3cm/pixel) images in the blue, green, red, red edge, and near-IR wavelengths improving the data products (e.g. NDVI maps of research areas) we can provide Toolik scientists. Our second camera can record very-high resolution (sub-centimeter/pixel) images in the red, green, blue wavelengths which we can process to create 3D models of research features (e.g. thermo-erosional features, river banks, shrub patches, elevation models) at a level of detail previously available only via expensive and time-consuming LiDAR systems. We are excited at the prospects these new tools and data products offer Toolik researchers.

Epigenetic adaptation during maturation in Arctic white spruce

Zachery Halem*, Me*m

Seedling recruitment and clonal expansion of willows may contribute to tall shrub thickets in retrogressive thaw slumps (RTS) in the Alaskan Low Arctic

Diane C, Huebner*, Vladimir Douhovnikoff, Diana E. Wolf

dchuebner@alaska.edu
University of Alaska Fairbanks

Thermal erosion of ice-rich permafrost soils (thermokarst) is likely to increase in frequency as the Arctic warms. Retrogressive thaw slumps (RTS) are large depressions of exposed mineral soil on hillslopes caused by permafrost thaw and mass soil wasting. Within a decade of disturbance, RTS in the Toolik Lake area

individuals through increased seedling recruitment post-disturbance, or of fewer recruits and survivors that expanded clonally following disturbance. We compared eight microsatellite loci of two populations, including ramets (aboveground branches) excavated and used as clonal controls: 141 ramets from a RTS aged within 20-30 years since disturbance, and 82 ramets from undisturbed (control) tundra. Ramets were sampled on the same hillslope in 18 x

between ramets (intermediate), and 0.25 m between ramets (fine), to understand RTS effects on willow recruitment and expansion. We identified 121 genotypes, including 10 clones, in the RTS and 66 genotypes and 7 clones in the control, with higher Ht in the RTS than control: 0.626 and 0.524, respectively. Expected clonal diversity and percent distinguishable were higher in the RTS than control: 0.997 and 0.86 versus 0.994 and 0.81, respectively. Spatial analysis found three times more broadly-spaced clones in the RTS than control, at an average distance between ramets of 4.4 (1.9) and 1.2 (0.4) m, respectively. Broadly-spaced clones were located 7-16 m downslope in the RTS versus 4 m apart at the same altitude in the control. Our results suggest 1) seedling recruitment may be higher in RTS-disturbed tundra; 2) conditions for clonal expansion may be better in RTS than undisturbed tundra; and 3) RTS may alter the bud bank by separation and translocation of clonal fragments.

Evaluation of permafrost degradation after the Anaktuvuk River Fire using L-band SAR data

Go Iwahana*
giwahana@alaska.edu

University of Alaska Fairbanks

In the Arctic terrestrial regions, climate warming and surface disturbance will alter ground heat balance and induce permafrost degradation. Thermokarst is the process that deforms original landforms due to the thawing of ice-rich permafrost or the melting of massive ice. Thermokarst development is often observed as ground deferential subsidence in the Arctic region after natural or anthropogenic surface disturbances like wildfires and various land-use changes, which impacts local human life and infrastructure. We investigated thermokarst development triggered by a tundra wildfire in Alaska (Anaktuvuk River Fire in 2002) underlain by ice-rich permafrost using both optical and L-band microwave remote sensing as well as in situ fieldwork measurements and observations. GAMMA software was used to generate interferograms from Lv1.1 data of ALOS-PALSAR and Lv1.1 data of ALOS-2/PALSAR-2 by the differential SAR interferometry (DInSAR) technique. Digital surface models (ArcticDEM) were used to simulate and remove topographic fringe. Assuming ground displacement occurred only vertically, the line of sight change was converted to vertical displacement using the incidence angle. Significantly large amounts of subsidence (up to 6.2 cm/year spatial average) were measured by the DInSAR within burned areas relative to unburned nearby in the first three years after the fire. Post-fire interferograms were decorrelated along fire boundaries where rapid surface roughness changes due to lateral erosion can be expected and clearly separated subsiding burned areas from stable areas of intact environment. Inside the burned areas there are some gradual changes in phase values while there are relatively uniform phase values in unburned areas. Despite the topography of the studied area being flat or showing only gentle slopes, the magnitude of subsidence depended on slope angles. Operation period of ALOS2 covered from 8th to 11th years after the fire. The spatial variation of thermokarst subsidence measured during this period shows a markedly different pattern from the period just after the fire (1st to 3rd years). The distribution shift was thought to be reflected from variations in depths to bedrock, active layer thickness, and relative location to burned areas. Observations from high-resolution optical images and field surveys supported the DInSAR measurements of thermokarst subsidence.

Arctic LTER: The role of biogeochemical and community openness in governing response to climate change and disturbance

Frances Iannucci*, Ed Rastetter, Breck Bowden, Phaedra Budy, Anne Giblin, Laura Gough, George Kling

fiannucc@gmail.com
University of Vermont

The Arctic is rapidly warming. Responses to warming involve acceleration of processes common to all ecosystems (e.g., plant community changes) and changes to processes unique to the Arctic (e.g., loss of permafrost). Our objectives are to use the concepts of biogeochemical and community "openness" and "connectivity" to understand the responses of Arctic ecosystems to climate change and disturbance. "Biogeochemical openness" relates to ecosystems dependence on external sources of nutrients and organic carbon versus nutrients recycled internally and organic carbon fixed locally by photosynthesis. "Community openness" relates to the effect of organism movement in and out of

describes the nature and strength of interactions among ecosystem components and the resultant propagation of ecological signals across the landscape. Components of the Arctic landscape differ widely in biogeochemical and community openness. We will compare key ecosystems of the Arctic to determine how their degree of openness governs their responses to climate change and acute disturbance such as fire and surface slumping associated with permafrost thaw. We will also determine how the responses to climate change and disturbance are mediated by landscape connectivity and the movement of nutrients, carbon, and organisms across Arctic landscapes, and how that movement is facilitated or impeded by the degree of openness of the ecosystems.

Photofate of Tetrabromobisphenol A in Waters Under Natural and Simulated Sunlight

Jill Kerrigan*, Yu-Ping Chin

jfkerr@udel.edu
University of Delaware

The discontinued use of polybrominated diphenyl ethers as flame retardants in consumer products has led to its replacement by other brominated compounds, such as tetrabromobiphenol A (TBBPA). TBBPA is extensively used across the globe and its detection in remote regions (e.g. Arctic inhabitants, wildlife, and vegetation) strongly suggests their potential to be globally transported. As such,

Characterization of Spatial Heterogeneity of Temperatures in a Tundra River Using Thermal Infrared Imagery

Tyler King

Does vegetation, warming and substrate availability effect decomposability of SOM?

Mari Könönen

Living a double life: Communication dynamics on and off the station

Victoria McDermott*

vmmcdermott@alaska.edu
University of Alaska Fairbanks

Remote field stations pose unique situations for both staff and researchers often being isolated, confined and extreme environment for weeks to months on end. Generally, remote field stations are far removed from society and people struggle to communicate with those outside of the field camp. The present study sought to uncover the lived experiences of both staff and researchers at Toolik Field Station to understand how remote field station life impacts communication on and off the station. Through 20 interviews of a variety of field camp members, the

from deployment, the extended period away from family and friends can impact

study further explored the

communication was impacted through the use of shifts during a peak summer research season. Finally, the researcher present potential strategies for improving the reintegration coping strategies among staff and scientists.

Who has access: Mapping the impact of Toolik Field Station job postings

Victoria McDermott*

vmmcdermott@alaska.edu
University of Alaska Fairbanks

Diversity is a driving force in many companies to expand their job search pool and potential for attracting a variety of talented candidates. Currently, there is a lack of diversity within the sciences and especially within remote field stations impacting the current culture and climate. Many field stations are questioning how to increase diversity among staff, researchers and research projects in order to increase their organizational diversity. The present study used network analysis theory to map Toolik Field Station as an organization to better understand the reach of their current job posting system. Findings suggest that Toolik Field station is utilizing different platforms than other Arctic remote field stations and missing some of the strong communication hubs that interest target populations. Furthermore, findings suggest that there are a few strong ties that connect the remote field station community not being utilized by Toolik. Overall, there is a lack of cohesion in recruitment methods online for remote field stations that may be impacting their access to target and potential populations.

Belowground responses to 20 years of plant species removal in moist acidic tundra

Samantha Miller*, Xanthe J. Walker, Haley Dunleavy, Julia Stuart, Michelle C. Mack, M. Syndonia Bret-

NEON Aquatics at Toolik Field Station

Partitioning of emerging contaminants to Arctic dissolved organic matter

Lauren O'Connor*, Jill Kerrigan, Yu-Ping Chin

oconnorl@udel.edu
University of Delaware

Anthropogenic organic pollutants have been commonly detected in the Arctic, and include new classes of brominated flame retardants (BFRs) and current use pesticides (CUPs). In this study, we focus on the environmental fate of chlorpyrifos (CUP) and tetrabromobisphenol A (TBBPA), which is a flame retardant). These chemicals are produced and used at lower latitudes and

Predictability of variable arctic soil hydraulic and thermal properties, and implications of such variability on future thaw

Michael O'Connor*, Kindra D. Nicholaides, M. Bayani Cardenas, Bethany T. Neilson, Ahmad Jan, Ethan T. Coon, George W. Kling

mtoconnor12@gmail.com
University of Texas, Austin

Global climate change is driving rapid increases in arctic temperatures and the thawing of shallow permafrost. The amount of anticipated permafrost thaw has uncertainty because of the limited observations of hydraulic and thermal

The National Ecological Observatory Network's Flora Data Collection at Toolik Field Station

Post-fire response to nutrient addition

Adrian Rocha*, Ian Klupar

arocha1@nd.edu
Notre Dame

Characterized by low-temperatures and severe nutrient limitation, the arctic responds readily to environmental changes such as warming. Thus, climate change has the potential to influence important ecosystem processes such as nutrient cycling and wildfire activity in these regions. Predicted annual temperature increases are expected to stimulate nutrient cycling through accelerated plant-soil interactions and increase wildfire activity through a warmer, drier regional climate. However, the role wildfire plays in arctic nutrient cycling is unclear. It is believed that wildfire will increase nutrient availability shortly following such events so one might expect post-wildfire tundra to be less nutrient limited. However, given the severe nutrient limitation of arctic tundra, we hypothesize that burned tundra will still respond to nutrient addition. In this study, nitrogen and phosphorus were added to severely burned and unburned arctic tundra for 3 years to capture vegetation response. Nutrient addition of the severely burned site occurred during the ninth, tenth and eleventh year of post-fire recovery at the Anaktuvuk River burn scar in northern Alaska. The addition of nitrogen, phosphorus and nitrogen plus phosphorus resulted in varying degrees of species composition, canopy structure, and ANPP in both tundra types. Yet, the response was generally stronger in burned tundra, suggesting a nutrient limited environment even after fire. As such, both wildfire occurrence and wildfire history have the potential to impact tundra ecosystem behavior in novel ways that are only beginning to be understood.

Nutritional Landscapes: Observations, Experiments, and Models Yield Insights to the Arctic Caribou System in Alaska

Jeff M. Welker*, H.A. Becker, T.W. Bentzen, T. Brinkman, K. Elder, K.C. Kelsey, G. Kofinas, S. Leorna, K.B. Lynöe, A.J. Leffler, G.E. Liston, S.H. Pedersen, J. Richert, J.O. Sexton, D. Spalinger, R.W. Vachon

jmwelker@alaska.edu
University of Alaska Anchorage

Terrestrial Arctic systems are the result of complex interactions between climate, vegetation, herbivores, and humans that must be studied together to fully understand their functional traits today and in the future. While low temperatures and short-growing seasons limit plant growth, enough plant biomass exists to support herds of migratory caribou, which Native Alaskans depend on for their livelihood. Any changes in the base of the food web (vegetation and soils) have cascading consequences for primary (herbivores) and secondary (humans) consumers and their interactions. Today, the Arctic system is in the midst of transformational climate change resulting in new vegetation assemblages, changes in the nutritive value of plant tissues, and ultimately the diets of migratory caribou and the humans that depend on them. This project examines the nutritional landscape of the Central Arctic Caribou Herd as a unifying concept in Arctic System Ecology. This project describes the nutritional landscape as

NEON Assignable Assets Program - Putting NEON Assets to Use for the Research Community

Rommel Zulueta*, Gregory D. Wirth, Mike SanClements

rzulueta@battelleecology.org
NEON

The National Ecological Observatory Network (NEON) is a long-term ecological observatory focused on collecting and providing open, continental-scale data that characterize and quantify complex and rapidly changing ecological patterns and processes. As part of the broader Observatory design, specific components of