Growth rings and xylem anatomy of Alaskan tundra shrubs under experimental warming and snow fence treatment (Toolik Lake)

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The goal of our study is to explore growth response of arctic shrubs to both ongoing and predicted temperature and snow depth increase in tundra ecosystem. Using both dendrochronological methods and quantitative wood anatomy we investigated shrubs' annual growth rings applied to plants growing under control and experimental treatments in Toolik Lake, Northern Alaska. Specifically we evaluated the effects of a 21 year experimental warming (due to open top chambers, OTC's) and snow depth increases (in the inter-

Biogenic silica accumulation varies across plant functional type in Arctic tussock tundra

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The importance of a dynamic biological silica (SiO_2) cycle in terrestrial landscapes has recently been emphasized, but the majority of terrestrial Si research has thus far focused on agricultural and forested ecosystems. Knowledge of terrestrial silica cycling in the Arctic is severely lacking and our understanding of how climate change will impact the Arctic silica cycle is limited. Here we quantify biogenic silica (BSi) accumulation in above and belowground portions of tussock tundra vegetation and elucidate how silica storage shifts across plant functional type. We quantified BSi accumulation in three moist acidic tundra (MAT) sites (Coldfoot, Toolik, Sagwon) spanning a 300 km latitudinal

Flowpath of snowmelt water in an ice-covered arctic lake

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At springtime, the melting snow on the landscape enables high discharge enriched in dissolved organic carbon (DOC) into ice-covered lakes. However, empirical studies tracking this inflow during the spring melt are rare, and the fate of its solutes remains uncertain. The extent to which the snowmelt loading spreads, mixes vertical, and is retained is important for metabolism within the lake. Our goal was to characterize these transport processes in Toolik Lake, Alaska, during spring 2013, 2014, and 2015. We traced the path of inflowing meltwaters by combining the use of high resolution time series data for conductance, temperature, and fluorescence with daily profiles on cross lake transects. Fluorescence signal was largely due to DOC, so we used it as a tracer to quantify DOC spreading and retention in the lake. Water samples were collected and analyzed to determine DOC concentration. We also measured ambient meteorology, stream dcol.hdr

Modeling the growth of

Implications of shrub expansion on soil carbon sequestration

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Implications of shrub expansion on soil carbon sequestration and permafrost stability, greenness, plant cover and productivity, is a critical driver of both the carbon and the surface energy budget of terrestrial ecosystems. While some parts of the rapidly warming Arctic have experienced greening, others are undergoing browning, and it not clear how the observed changes in plant productivity and composition will affect annual carbon fluxes, soils carbon storage, and the rate of permafrost thaw. We used soil surveys along gradients of increasing shrub density in the Toolik area to quantify current relationships between shrub cover, soil carbon stocks and active layer depth.

Our surveys show that areas dominated by shrub tundra have higher carbon stocks, with more microbially-processed organic material as indicated by lower C:N ratios, shorter alkane chain length and stable nitrogen isotope ratios. Laboratory soil incubation experiments further reveal a low priming potential in moist acidic tussock tundra soil, indicating that increasing shrub litter inputs are unlikely to result in large losses of existing soil carbon. The soil surveys further demonstrate very clearly that areas with higher shrub density have shallower active layers. Together, our data highlights the need to more comprehensive datasets on shrub expansion (as well as browning) and that shrub expansion should be considered in projections of permafrost degradation.

Ecotypic differences in the phenology of the tundra species

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Locally adapted populations (ecotypes) of *Eriophorum vaginatum* have been identified across the distribution of *E. vaginatum* using measures of biomass, physiology, and survival in reciprocal transplant experiments. However, little is

Resilience of plant communities to changes in climate and fire regime: palaeoecological insights from arctic peatlands in Alaska

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High-latitude ecosystems have experienced higher-amplitude climate warming than other parts of the globe in recent decades, and are projected to continue to warm in the future, with consequences for vegetation communities, peat accumulation rates and carbon cycling (Yu 2012; Kuhry et al., 2013). Specifically, tundra vegetation communities are increasing in terms of cover and height, and fires are becoming more frequent (Myers-Smith et al., 2013). These processes restrict the growth of other plant species by limiting light availability and increasing the frequency and intensity of fire regime. Most of the data concerning the response of plant communities (species, biomass phenology) to recent warming is based on current observational studies, with comparatively little research focusing on centennial to millennial scale changes. In addition, there are limitations in our understanding of fire regime dynamics and in particular of the tolerance of tundra plant species to increased fire frequencies. Therefore, studies that focus on long-term vegetation dynamics under varying environmental conditions are indispensable to our understanding of the contemporary changes in vegetation and the most likely long-term response to future climatic changes.
In this palaeoecological study, we use the fossil record (plant macroremains, testate amoebae, macro- and microcharcoal, carbon accumulation) and ^{210}Pb (for the last ~150 years) and AMS ^{14}C measurements to determine the response of arctic plant communities to past climate warming in northern Alaska.
Specificall aims of our palaeoecological studies are: i) to reconstruct local and regional vegetation changes during the last millennium; ii) to evaluate the influence of changes in climate and autogenous succession in the development of arctic plant communities; iii) to explore fire regime dynamics and vegetation feedback on fire activity; and iv) to determine shifts in carbon accumulativion

Vegetation succession, carbon accumulation and hydrological change in sub-Arctic peatlands (Abisko, N. Sweden)

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We present results from a multiproxy study on the hydrological, ecological and carbon accumulation dynamics of two sub-Arctic peatlands in Abisko, Sweden. High-resolution analyses of plant macrofossils, testate amoebae, pollen, mineral content, bulk density, and carbon and nitrogen were undertaken. The peat records were dated using tephrochronology, ^{14}C and ^{210}Pb. Local plant succession and hydrological changes in peatlands were synchronous with climatic shifts, although autogenous plant succession towards ombrotrophic

Development of polygon mires/ice-wedge polygon: examples from Lena River Delta (N Russia)

Mapping tundra vegetation communities near Toolik Field Station at 1-meter resolution

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High-resolution mapping of vegetation community distribution enables accurate

Soil and plant Hg dynamics at Toolik Field Station

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Introduction: Atmospheric mercury (Hg) can be transported over long distances to remote regions such as the Arctic where it can then deposit and cause

40±0.2 ug kg-1). Mass calculations show that Hg mass in the upper 40 cm of the soil profile (200-500 g ha-1) was primarily stored in mineral soil layers (over 90%). Hg mass showed substantial spatial variability, particularly along an upland-wetland gradient where wetland Hg pools were much lower due to an absence of mineral soil layer. Methyl-

Investigating greenhouse gas fluxes from tundra soils during freeze and thaw cycles using GC-MS flux chambers

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Arctic tundra soils represent significant carbon stores that release greenhouse gases such as methane (CH_4) and carbon dioxide (CO_2) particularly during thawing periods. As the atmospheric lifetime and radiative forcing of each of these species differs, it is important to understand the mechanisms by which carbon release may preferentially be in favour of one species over the other. In situ observations of CH_4 and CO_2 concentrations were hence undertaken within and above the soils at the Toolik Field Station over a 2-year period. Field observations showed both net oxidation of CH_4

Assessing seedling recruitment in retrogressive thaw slumps in the Alaskan Low Arctic

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Thermal erosion of permafrost soils is implicated in post-disturbance shifts from moist acidic tussock tundra (MAT) to shrub tundra in the Alaskan Low Arctic. Tall birch and willow shrub thickets (> 0.5 m) are observed in stabilized retrogressive

Greenhouse gas (CO_2, CH_4 & N_2O) feedbacks are regulated by phenological changes in herbivore-vegetation interactions in Alaskan coastal tundra

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Comparison of soil-surface temperatures with satellite trends of increasing phytomass in Northern Alaska

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Multiple studies are revealing evidenc 0.24 0 0 0.24 90.48007 605.0

Arctic Landscape Conservation Cooperative Research Overview

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Since 2009, the Arctic Landscape Conservation Cooperative (LCC) has supported over 60 projects, with a focus on describing and forecasting arctic ecosystem change. Recent and ongoing research from projects will be highlighted, including an Alaskan Arctic-wide long term monitoring network (http://arcticlcc.org/projects/teon/), an Arctic Coastal Plain Tundra

Arctic Tundra Soils: A Microbial Feast That Shrubs Will Cease

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Rapid climate warming may already be driving enhanced decomposition of the vast stocks of carbon in Arctic tundra soils. However, stimulated decomposition

Circulation and Respiration in Ice-Covered Arctic Lakes

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Arctic lakes are ice-covered 9 months of the year. During at least part of this time, the sediments heat the overlying water. Sediment respiration increases specific conductivity, depletes oxygen, and produces greenhouse gases (GHG). Whether anoxia forms and whether the greenhouse gases are sequestered at depth depends on processes inducing circulation and upward fluxes. Similarly, whether the GHG are released at ice off depends on the extent of vertical mixing at that time. Using time series meteorological data and biogeochemical arrays with temperature, specific conductivity, and optical oxygen sensors in 5 lakes ranging from 1 to 150 ha, we illustrate the connections between meteorological forcing and within lake processes including gravity currents resulting from increased density just above the sediment water interface and internal waves including those induced by winds acting on the surface of the ice and at ice off. We found that CO_2 production was well predicted by the initial rate of oxygen drawdown near the bottom at ice on and that the upward density flux depended on lake size, with values initially high in all lakes but near molecular in lakes of a few hectares in size by mid-winter. Both CO_2 production and within lake vertical fluxes were independent of the rate of cooling in fall and subsequent within lake temperatures under the ice. Anoxia formed near the sediments in all 5 lakes with the concentration of CH_4 dependent, in part, on lake size and depth. Inflowing snowmelt waters flowed under the ice with some mixing with underlying lake water. The loading of DOC and CH_4 depended on the rate of snowmelt. Twenty to fifty percent of the greenhouse gases produced under the ice remained in the lakes by the time thermal stratification was established in summer despite considerable mixing at the time of ice off. These observations and analysis lay a framework for understanding the links between within lake hydrodynamics, within year variability, and the fraction of greenhouse gases produced over the winter which evade at ice off.

Moisture content effects of Normalized Difference Vegetation Index and photosynthesis rates in four low Arctic moss communities

Jeremy May

Tundra fire disturbance homogonizes belowground food web

A Pan-Ar

Monitoring phenology of Alaska tundra communities using the Mobile Instrumented Sensor Platform (MISP) system

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Understanding and monitoring environmental factors that influence phenology is important to understanding how climate change will alter Arctic plant communities. Here we detail yearly and intra-seasonal phenological shifts of vegetation communities in Toolik Lake, Imnaviat Creek, Atqasuk, and Barrow, Alaska. Monitoring was conducted on a 50m transect at each of the four study sites using the Mobile Instrumented Sensor Platform (MISP) system, with each transect traversing multiple community types. Normalized Difference Vegetation Index (NDVI) was measured using a mounted GreenSeeker system (Trimble

Survival of white spruce (   ) seedlings in subarctic Alaska under changing climate

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Alpine treelines in Alaska have advanced for the past 50 years in response to the recent climate warming. However, further increases in temperatures may cause treeline species drought stress and increase susceptibility to insect outbreaks and fire. Complex factors such as soil conditions and plant species composition also impact the survival of seedlings, which are essential to sustain boreal forests. Our goals were to assess 1) what environmental factors affect survival of treeline species, *Picea glauca* (white spruce) seedlings, 2) whether survival is different in season, and 3) if there are special or temporal effects on survival of the seedlings. We studied the survival strategies of spruce seedlings along an altitudinal gradient at 6 sites, consisting of tundra, forest, or transitional ecotone in Denali National Park and one forest site in Fairbanks, AK. In May 2012, four-month old seedlings were planted with or without naturally occurring plants to compare the presence or absence of the interspecific interaction. Summer temperatures were increased by one small greenhouse per site. After each summer growing seasons (June - August) and each winter times (September - May), survival rates were recorded, and the final survival was recorded at the end of the summer in 2014. Survival differed depending on treatments and

NEON Aquatic Sampling and Infrastructure at Domain 18

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The National Ecological Observatory Network (NEON) is a national-scale research platform designed to assess the effects of climate change, land-use change, and invasive species on ecosystem structure and function across 20 ecoclimatic domains from Alaska to Puerto Rico. NEON's aquatic program is comprised of a suite of instrument and observational data collected at 24 wadeable streams, 7 lakes, and 3 large rivers, including biogeochemistry, hydrology, site morphology, and biology. Domain 18 aquatic sampling began at Oksrukuyik Creek and Toolik Lake during summer 2016. Initial sampling included collection of water and sediment chemistry samples, aquatic microbes, periphyton and phytoplankton, aquatic plants, macroinvertebrates, and zooplankton. Fish sampling will be initiated in 2017, as will construction of groundwater wells and sensor infrastructure, which will include continuously monitoring water quality sensors at both the stream and lake sites. Data collected

Closing the winter gap in permafrost carbon emissions: A passive, quasi-continuous $14CO_2$ sampler

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Over millennia, Artic soils have accumulated vast stocks of organic carbon in permafrost. A major concern today is

Winter processes drive Arctic terrestrial carbon and water dynamics

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Our long-term studies in the Low and High Arctic provide a comparative framework to understand and quantify how winter snow traits have carry-over effects on biogeochemical and ecohydrologic processes such as plant mineral nutrition, plant water sources, CH_4 and CO_2 e

Shifts in Phenology due to Climate Change: Physiological Plasticity in an Arctic Hibernator

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Shifts in the timing of seasonal events are among the most commonly reported responses of vertebrates to climate change. However, the mechanistic underpinnings of phenological shifts in hibernators are unclear and the potential for sex-dependent responses has not been examined. Here, we describe sex-dependent plasticity in the hibernation physiology of arctic ground squirrels in response to late spring snowstorms, which may be increasing under climate change. Female and non-reproductive male arctic ground squirrels responded to the >1month delay in snow melt by either extending hibernation or re-entering hibernation following several days of 'post-hibernation' euthermia. Reproductive males, in contrast, were not plastic and did not re-enter hibernation, presumably because high testosterone associated with seasonal gonadal recrudescence prevents torpor. Our results suggest that climate-driven delays in spring combined with differences in sex-dependent plasticity could lead to a seasonal mismatch between the sexes.

Shrub expansion, peat formation, and carbon sequestration in Arctic tundra on the North Slope of Alaska

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