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Title: Ngee Arctic LANL Overview

Author(s): Bennett, Katrina Eleanor
Rowland, Joel C.
Wullschleger, Stan D.
Iversen, Colleen M.

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NGEE Arctic

Next-Generation Ecosystem Experiments

NGEE Arctic LANL Overview

Katrina Bennett
LANL Institutional Lead
Science Question 5 Co-Lead

March 3, 2022



Introduction

NGEE Arctic (2012-Present)

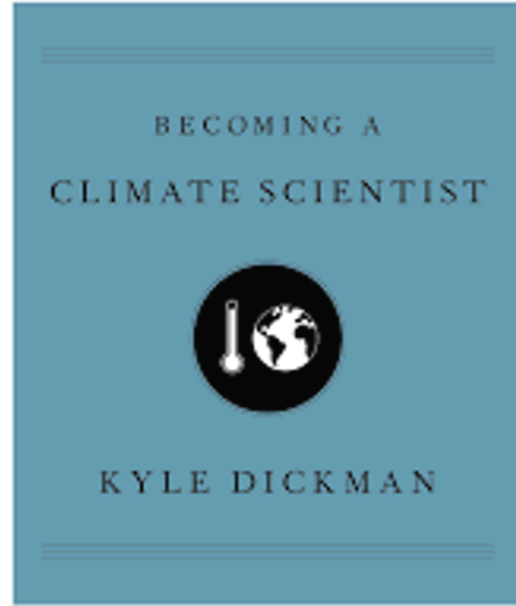
Deliver a process-rich ecosystem model, extending from bedrock to the top of the vegetative canopy/atmospheric interface, in which the evolution of Arctic ecosystems in a changing climate can be modeled at the scale of a high-resolution Earth System Model (ESM) grid cell.



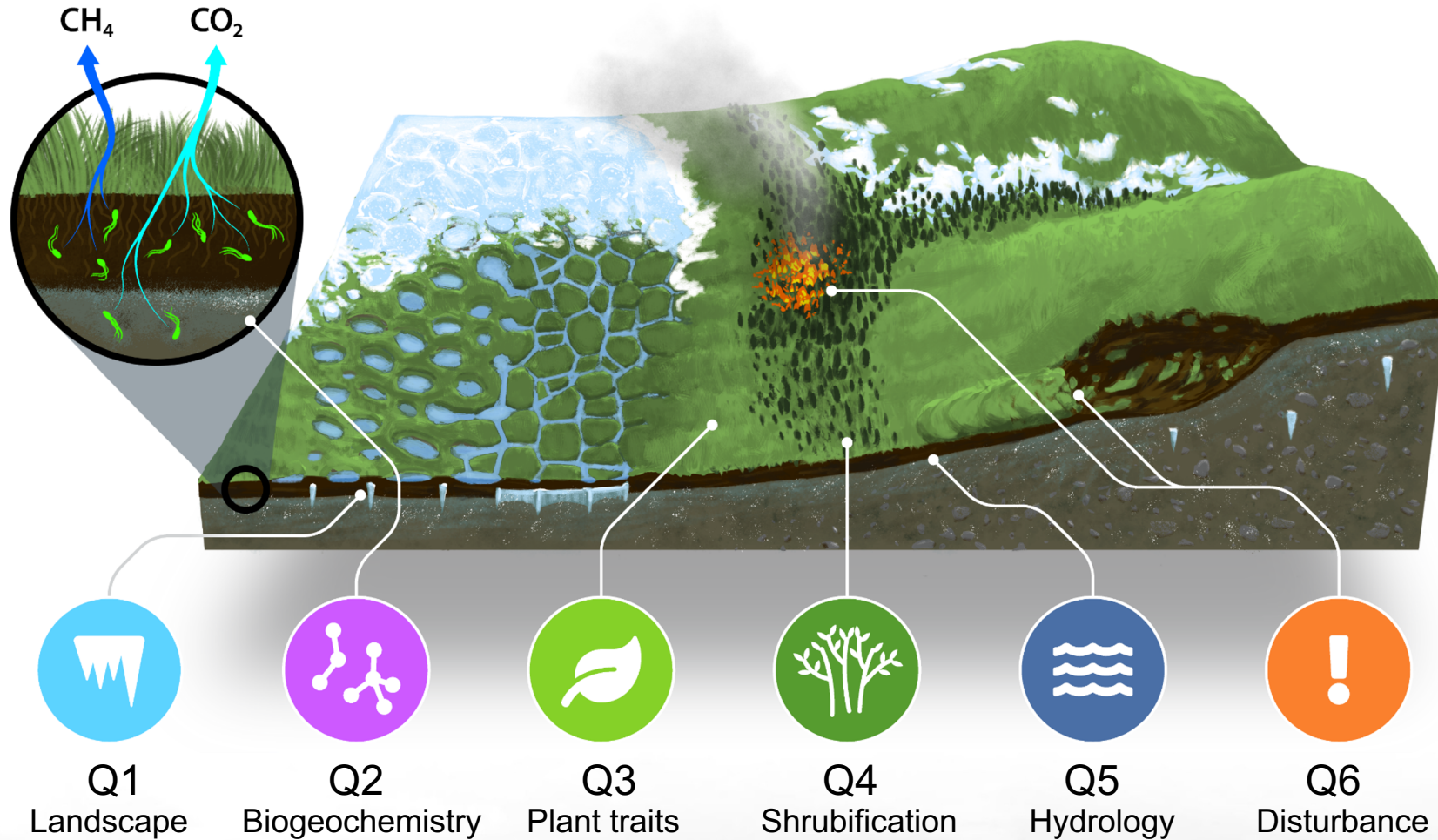
Society and Broader Scientific Involvement



Cathy Wilson: USPA President
Bob Bolton: USPA Co-Chair, DEI
Members DEI Committee
Christian Andresen, Julian Dann,
Mara Nutt, and Shannon Dillard



NGEE Arctic Phase 3 (2020-2024)

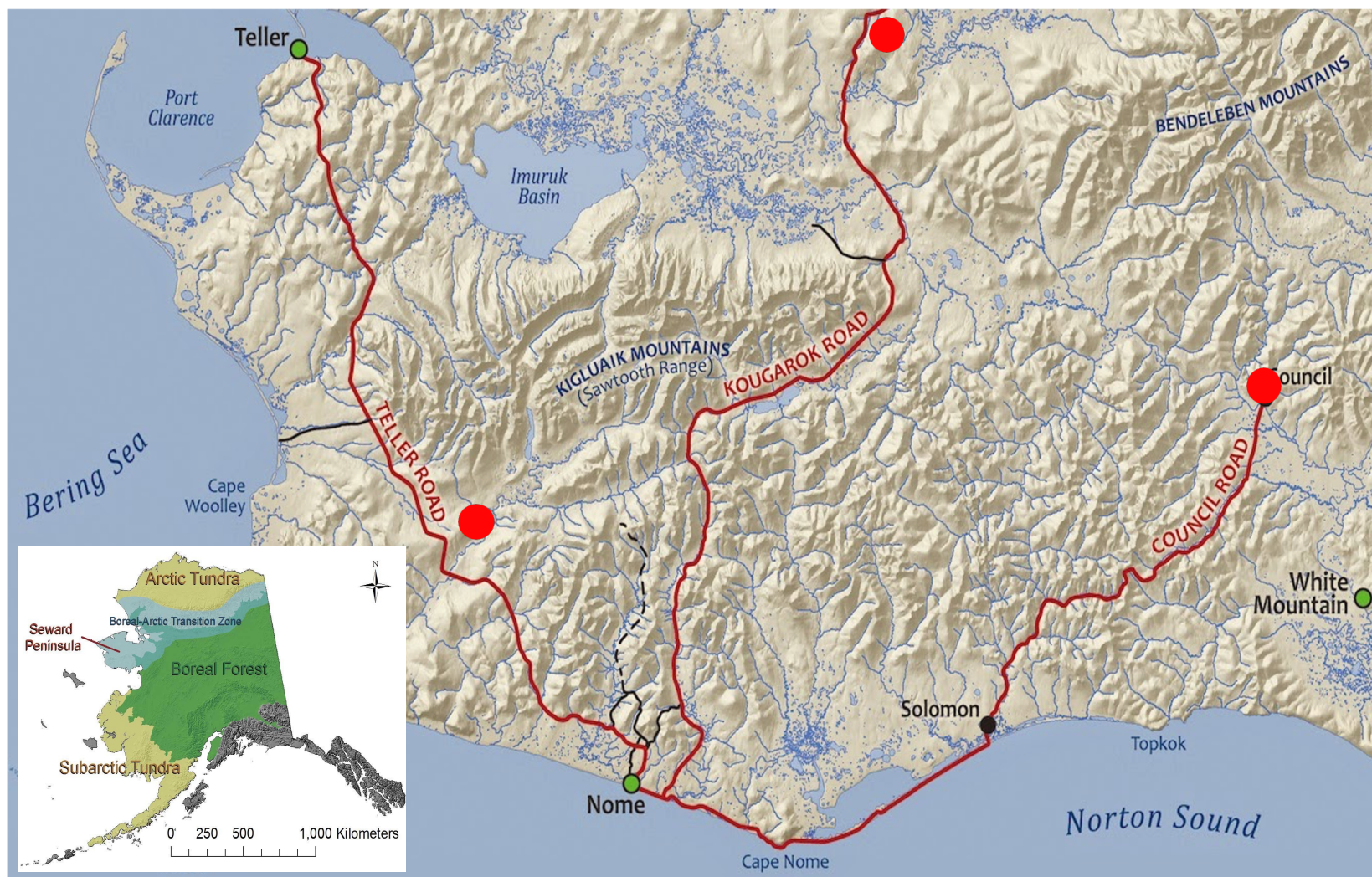


South-north gradient of topography, permafrost, vegetation, and hydrology

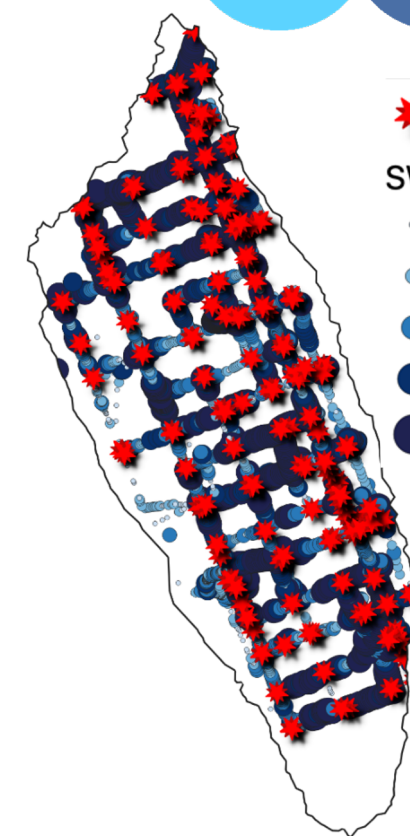
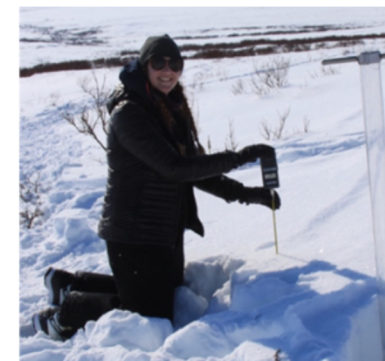
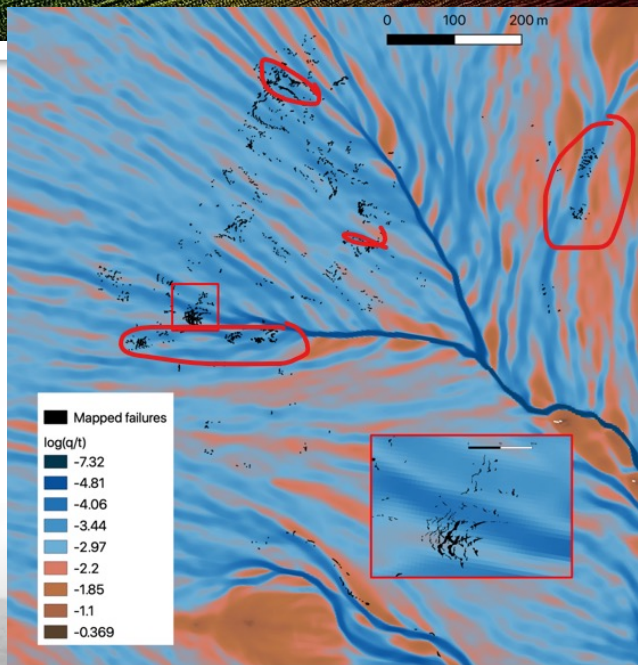
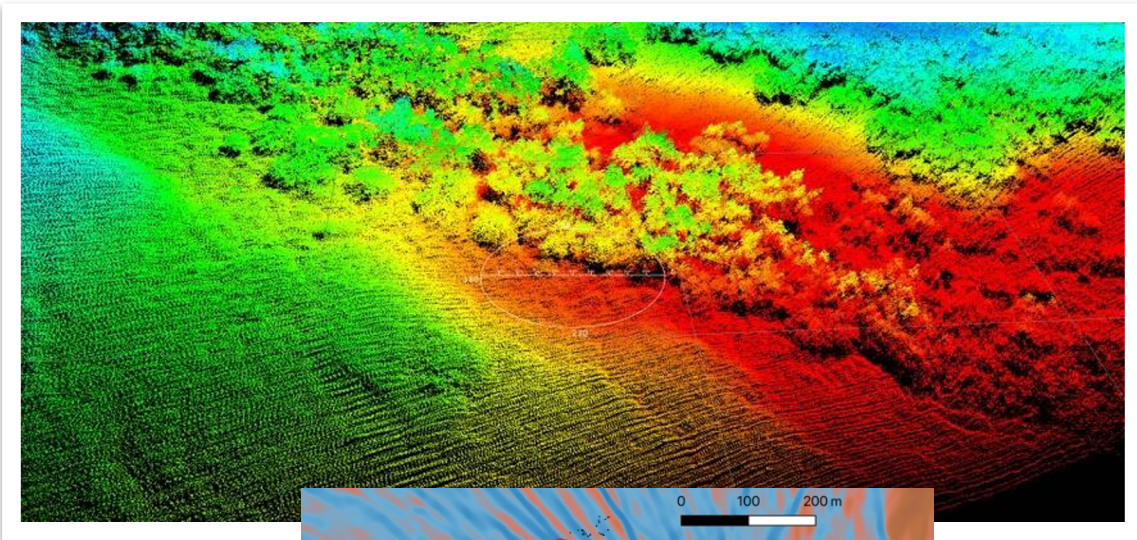
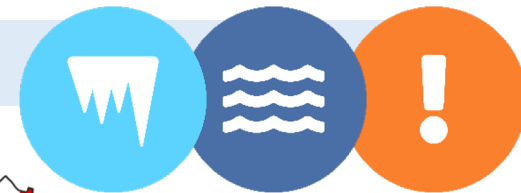
LANL works across multiple NGEA Arctic science questions:

- Q1. How does the structure and organization of the landscape control permafrost evolution and associated carbon and nutrient fluxes in a changing climate?
- Q5. Where, when, and why will the Arctic become wetter or drier, and what are the implications for climate forcing? (LANL co-lead)
- Q6. What controls the vulnerability of Arctic ecosystems to disturbance, and how do disturbances alter the structure and function of these ecosystems? (LANL co-lead)

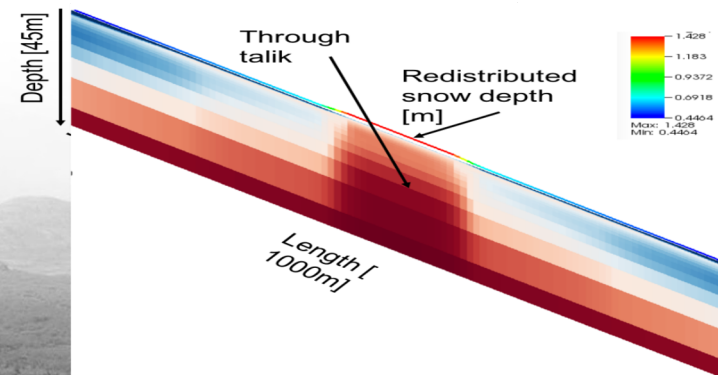
NGEE Arctic Field Sites (Seward Peninsula)



LANL Research Summary Q1, Q5, Q6



- ★ SWE Samples
- SWE at Snow Depth
- 15 - 20
- 20 - 30
- 30 - 40
- 40 - 50
- 50.0 - 120.0



IM1

Inundation
dynamics



IM2

Hillslope
hydrology



IM3

Snow-vegetation-
terrain interaction



IM4

Representation of
tundra vegetation



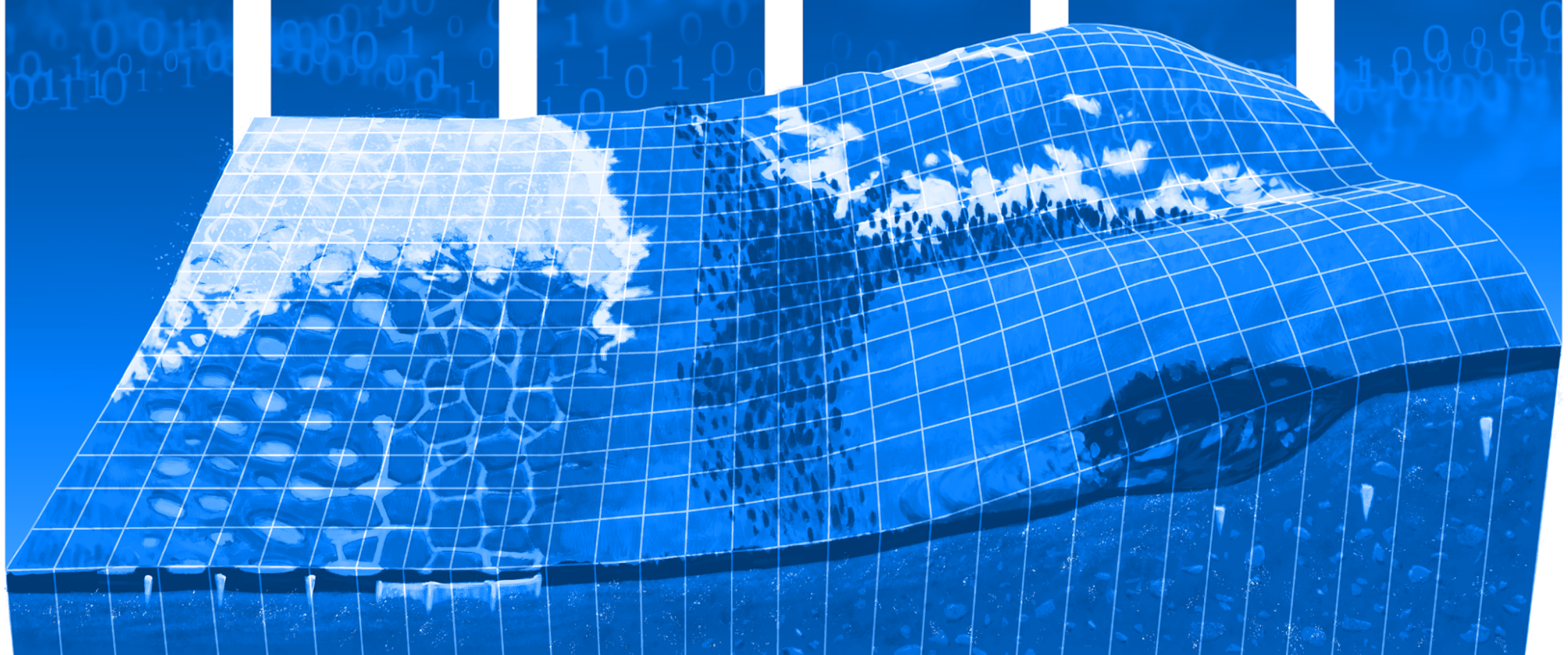
IM5

Vegetation
dynamics

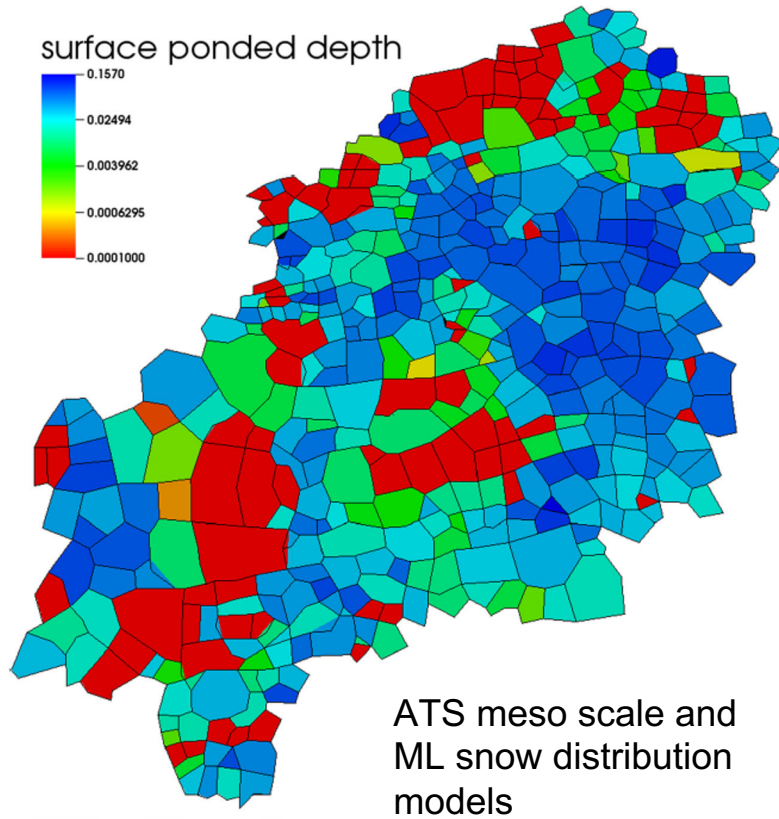


IM6

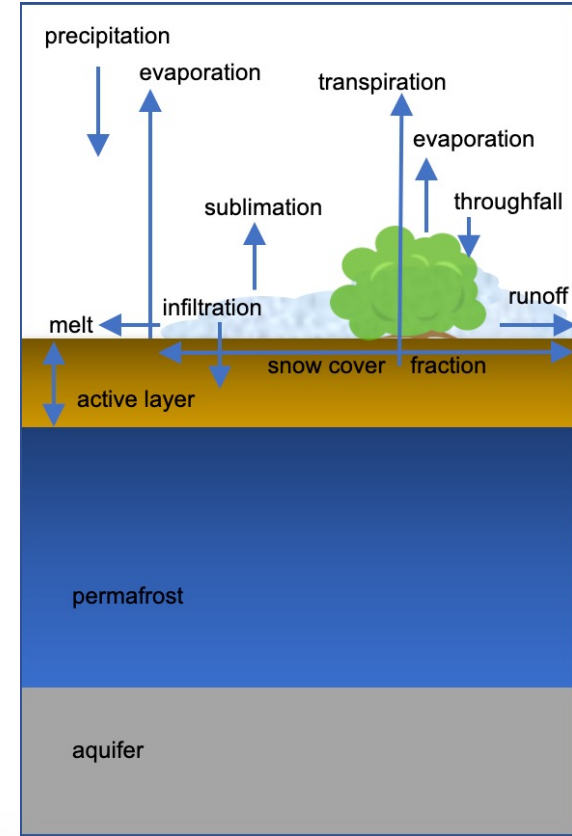
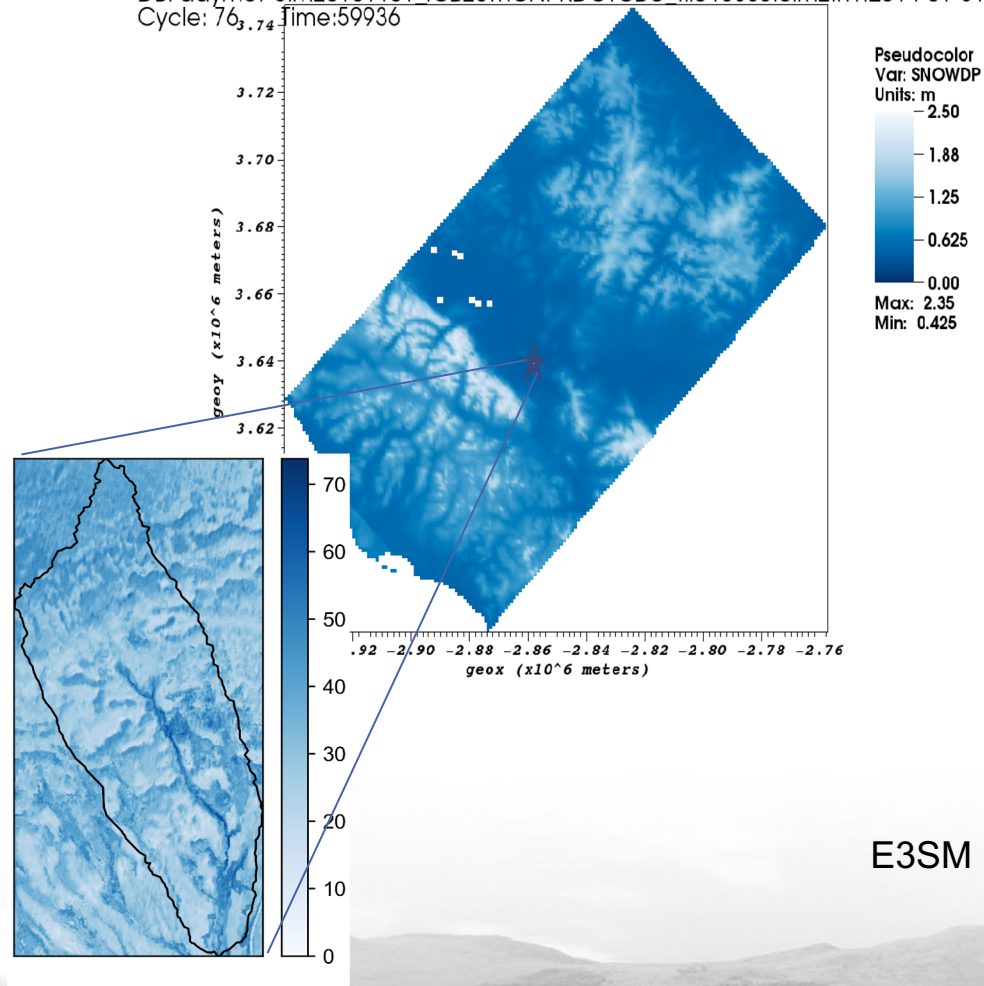
Soil
biogeochemistry



Integrated modeling: Improved representation of fractional inundated area, hillslope hydrology, and snow distribution



DB: daymet-elm20181101_ICB20TRCNPRDCTCBC_file13868.clm2.h1.2014-01-01-00000
Cycle: 76_{3.74} time:59936



E3SM Land Model

NGEE Arctic at LANL and beyond... the numbers

>140 NGEЕ Arctic team members

Current LANL team is 25 members

263 publications with >1,750 co-authors

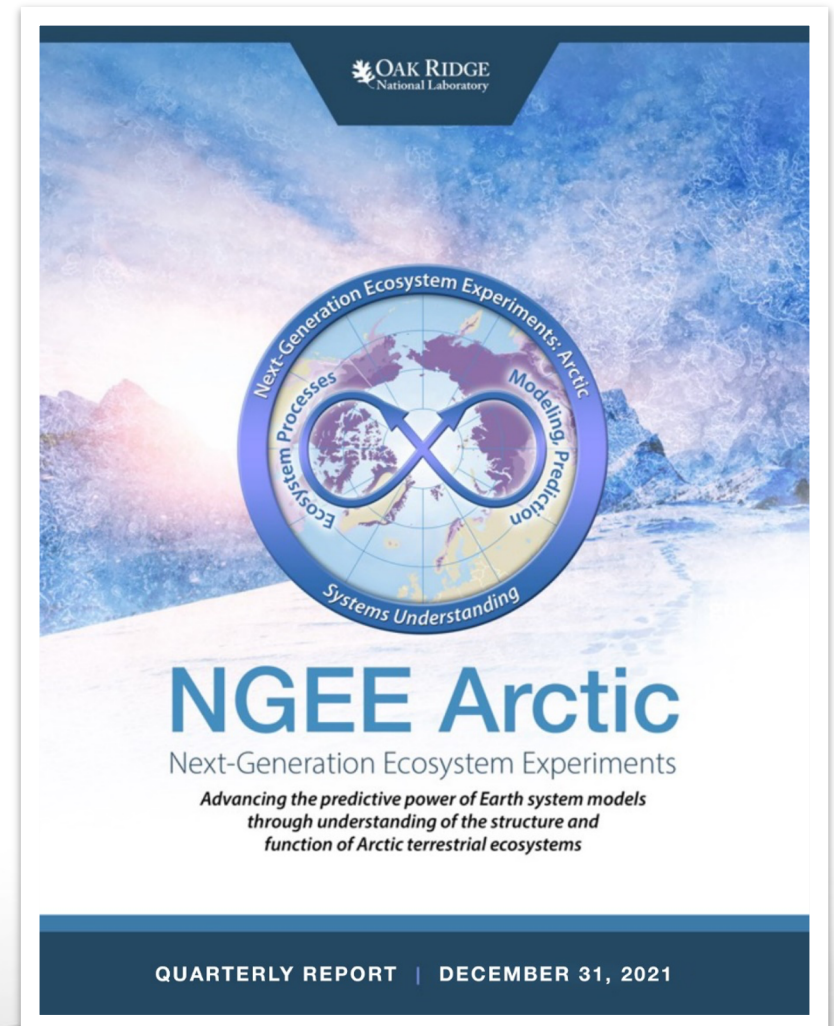
Cited >10,740 in 85 journals

207 data/metadata @ NGEЕ Arctic portal

129 public datasets @ NGEЕ Arctic portal

267 unique dataset downloads in 2021

7,534 sessions @ NGEЕ Arctic website 2021



The Next-Generation Ecosystem Experiments (NGEE Arctic) project is supported by the Office of Biological and Environmental Research in the DOE Office of Science.

We also thank the following Native Corporations for allowing us to conduct our research on the traditional homelands of the Inupiat people.

UIC Science – Mary’s Igloo Native Corporation –
Council Native Corporation – Sitnasuak Native Corporation

Katrina E. Bennett
kbennett@lanl.gov

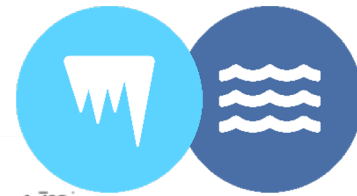
Extra Slides



Instruments (Seward Peninsula)



Data-model integration shows shift to deep groundwater pathways



OBJECTIVE

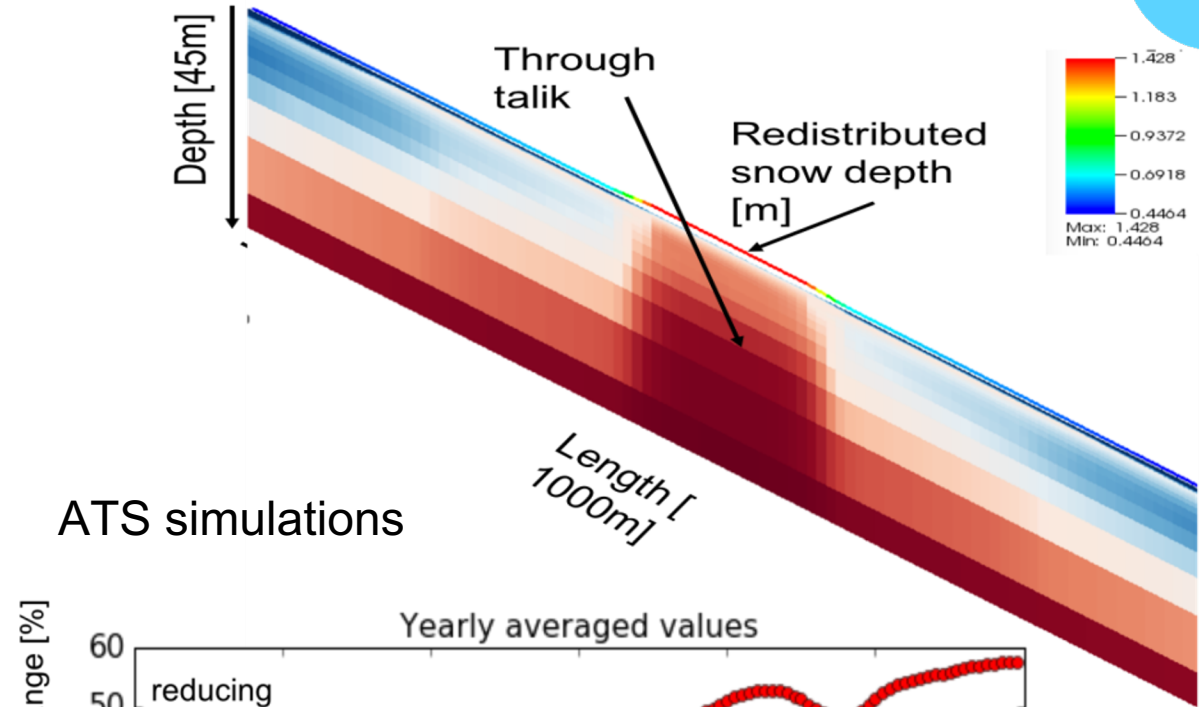
Explore how variation of key processes and parameters in space and time interact with permafrost distribution and evolution.

NEW SCIENCE

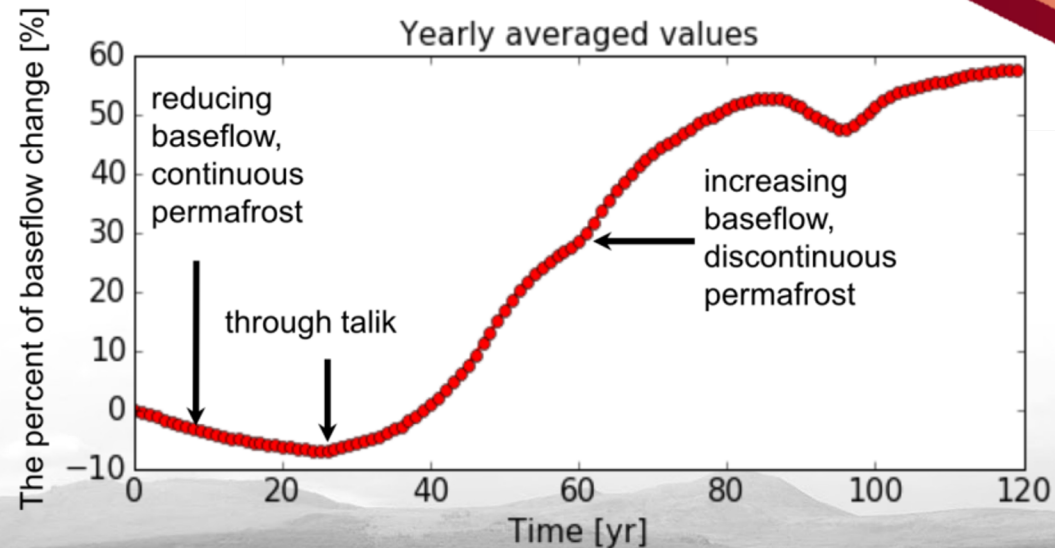
First simulations of 2-D surface/subsurface interactions and key controls on permafrost evolution in a hilly landscape.

SIGNIFICANCE

New understanding of how changes in vegetation structure and patterns of winter precipitation and temperature will drive permafrost evolution. Simulations will enable snow parameterization for ELM.



ATS simulations



Discontinuous permafrost allowed 60% increase in baseflow

Diagnosing controls on sources and lateral water fluxes



OBJECTIVE

Determine how permafrost and landscape structure influence lateral hydrologic pathways and residence times.

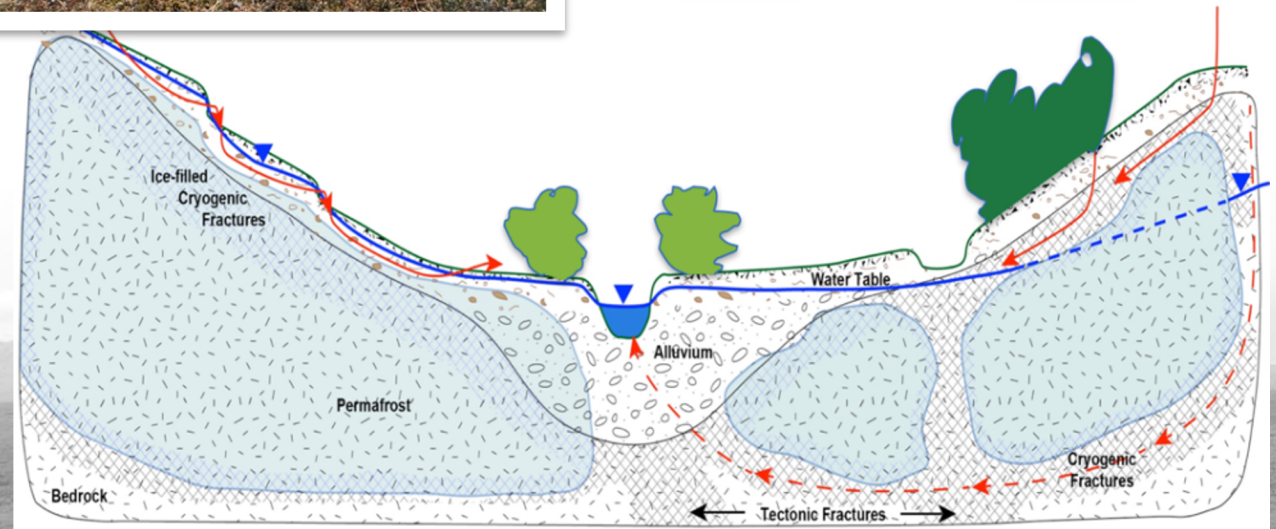
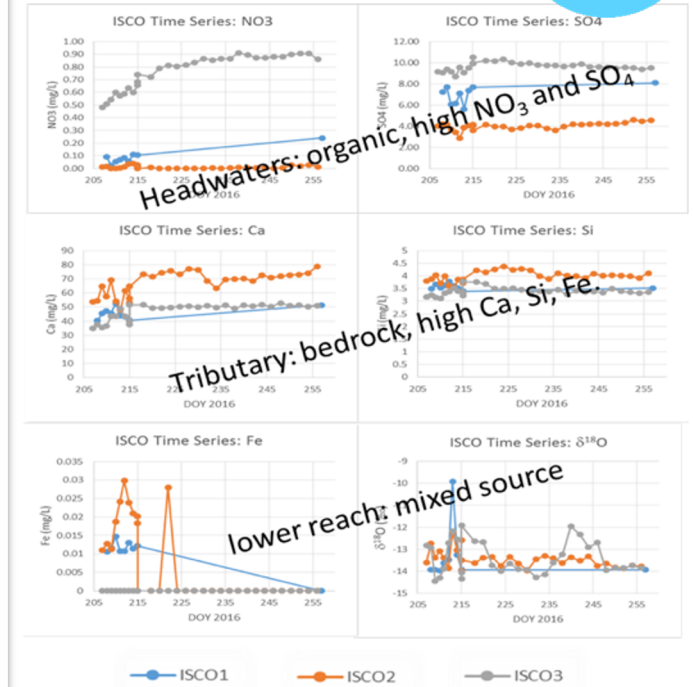
NEW SCIENCE

Combining Airborne NASA ABoVE SAR soil moisture, ground based geophysics and soil and stream geochemistry data to map hydrologic processes and pathways.

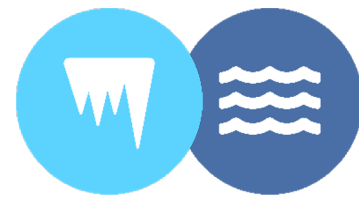
SIGNIFICANCE

Benchmark data to inform fine scale to watershed scale models;

Apply data and models to assess role of shallow and deep lateral fluxes in permafrost landscapes for parameterized incorporation in ELM.



Snow, topography and vegetation interact to drive permafrost conditions



OBJECTIVE

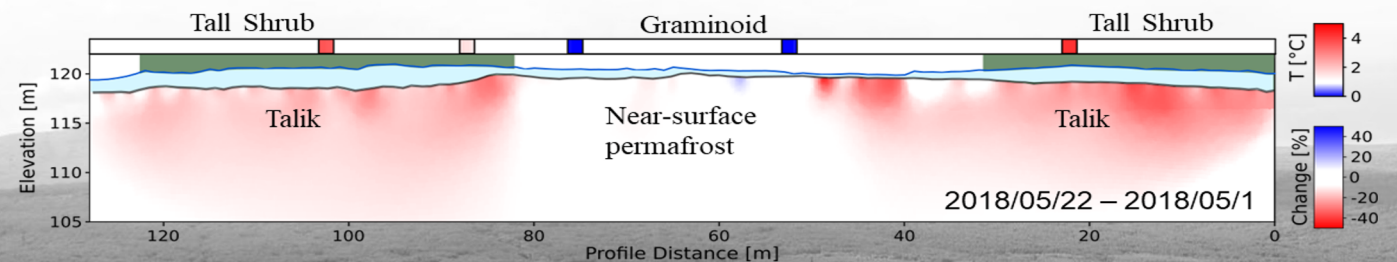
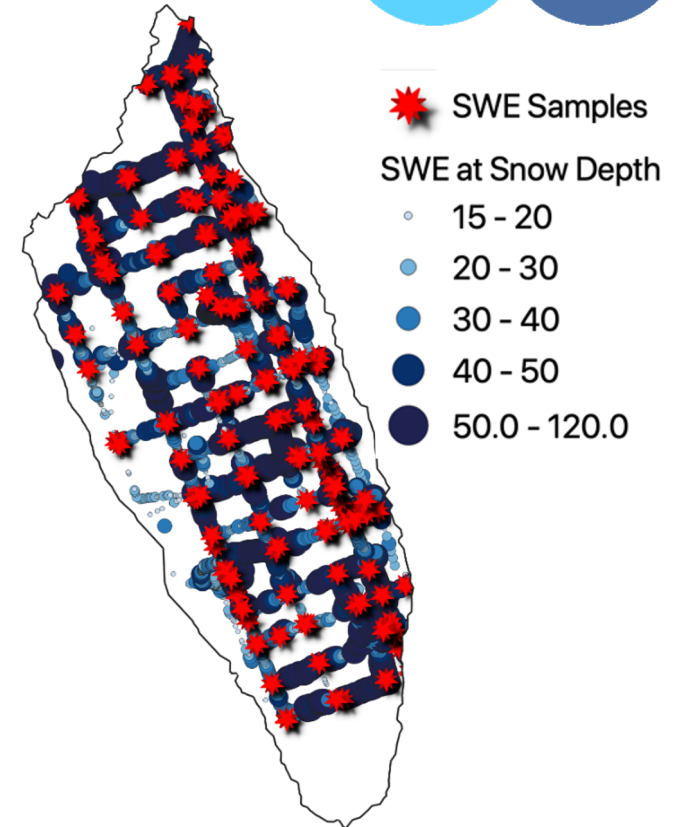
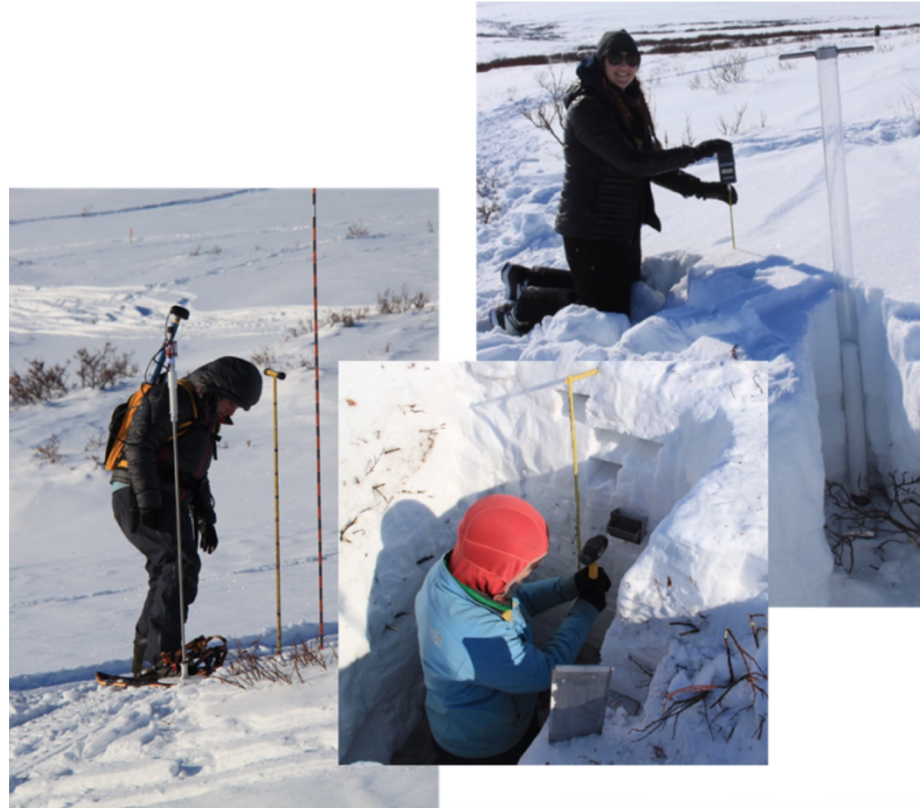
Develop comprehensive, high resolution, model-driven snow data set to quantify snow-landscape interactions and evolution.

NEW SCIENCE

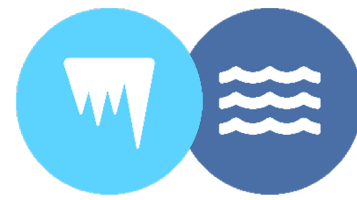
Combines high resolution watershed scale multi-platform measurements: vegetation and geophysics surveys, *in-situ* and geophysics-based snow depth & density, UAS snow elevation.

SIGNIFICANCE

Benchmark data for watershed scale models to inform ELM.



Quantifying spatial controls on ecosystem function through UAS acquisitions, temperature sensors, and ecotype mapping



OBJECTIVE

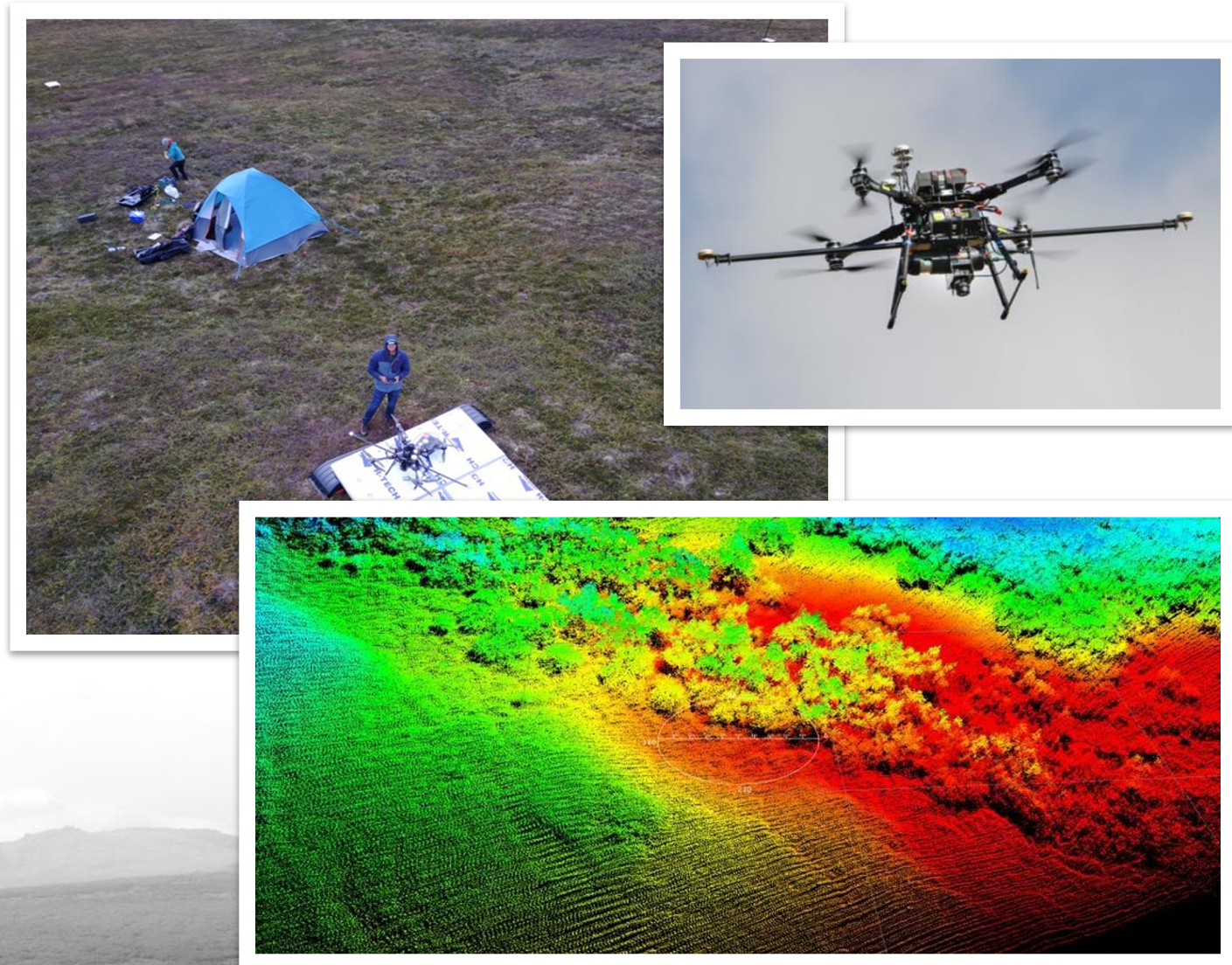
Create high resolution maps of physical and ecosystem patterns and processes using UAS technology.

NEW SCIENCE

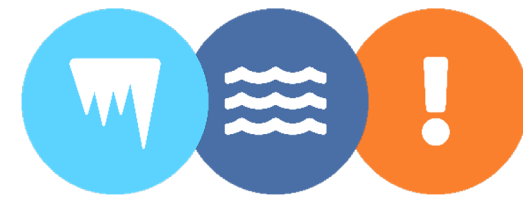
Deployed multiple UAS platforms including cameras, spectrometers, gas analyzers and Lidar. Achieved high resolution spatial data, including 400 point / m² ground elevation and plant structure data.

SIGNIFICANCE

Explore how landscape structure at different scales interacts/co-varies with physical and ecosystem processes to inform models.



Quantifying the rates, patterns and controls of rapid erosion and catastrophic landscape change



OBJECTIVE

Quantify how permafrost and hydrological changes will alter sediment and carbon fluxes from watershed and alter the stability of landscape.

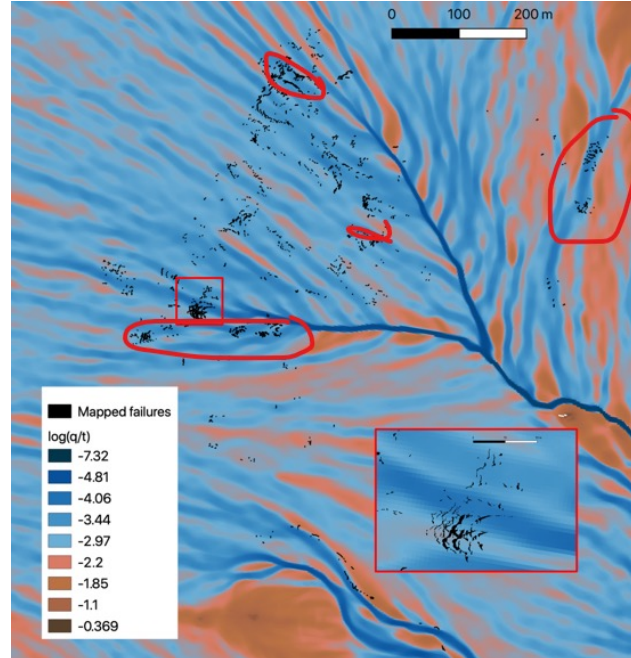
NEW SCIENCE

Use of multi-scale observations from subsurface to satellites to quantify how hillslope and watershed structure control the vulnerability and resilience of the Arctic to catastrophic change

SIGNIFICANCE

Link hillslopes processes to rivers and stream and develop predictive models to quantify rapid change and erosion

Map of theoretical hillslope stability and actual failures



Catastrophic failures destabilizing hills and accelerating erosion



Rapid thaw and erosion adding sediment and nutrients to streams

Community Outreach

the **SOUND** of **SCIENCE** PODCAST

The Unseen World of Climate Change

OAK RIDGE National Laboratory

Clear Skies Ahead

AMS

Conversations about Careers in Meteorology and Beyond

Global Institute for Water Security USASK presents

Breakthroughs in Water Security

Distinguished Lecture Series

10 Lecture 4: *Moving toward the next generation of Arctic land models*

14

All lectures will be held virtually at 10:00 am CST (UTC-6)

Register at water.usask.ca/dls

Cathy J. Wilson
Los Alamos National Laboratory

Cathy Wilson is a Senior Scientist at Los Alamos National Laboratory. She is a national observational and computational hydrologist and geomorphologist who aims to improve the understanding of climate change impacts and feedbacks through better representation of Arctic processes in Earth System Models.

GLOBAL WATER FUTURES

UNIVERSITY OF SASKATCHEWAN School of Environment and Sustainability

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Strait Science Series Lectures

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International Arctic Research Center

IARC SALON

A discussion with Joanna Young, Bob Bolton and Syndonia Bret-Harte

<https://ual-iarc.org/events/iarc-salons/>

November 18 @ noon

THE CHANGING CULTURE OF FIELD WORK