The Arctic-Boreal Vulnerability Experiment 2018

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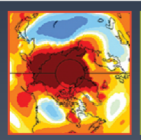
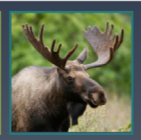
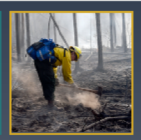


ABoVE

ARCTIC BOREAL VULNERABILITY EXPERIMENT

Vulnerability and Resilience Framework

CAUSES OF CHANGE

Many factors from the local, to regional, to global scales drive changes to ecosystems. Examples include: natural disturbances such as fires and insects; and increasing temperature and CO_2.

CHANGES TO ECOSYSTEMS

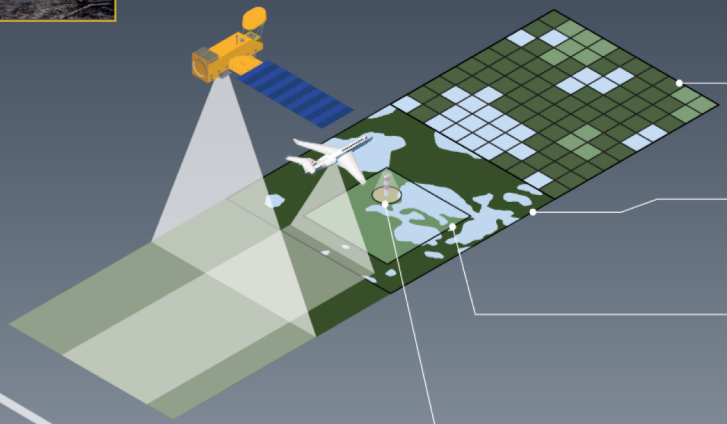
Ecosystem structure and function are impacted by drivers that are both external (e.g., climate, invasive sprecies) and internal (e.g., fire, animal disease, mining, infrastructure).

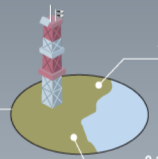
ECOSYSTEM SERVICES

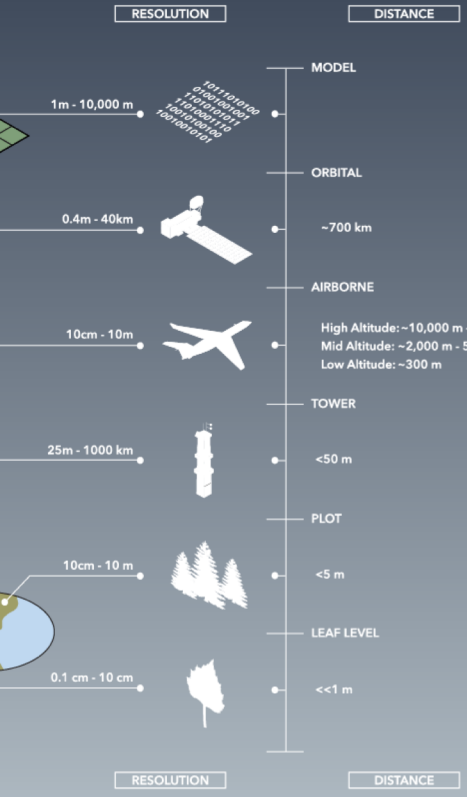
Ecosystem services are the benefits and value that people derive from the environment that sustains us. Examples include: food and freshwater production and indigenous wildlife harvest.

SOCIAL SYSTEMS

People respond to these changes in many ways. Individuals and households may change their behavior, for example relying more heavily on store-bought food than subsistence hunting.







Scaling Observations from Leaf to Orbit

AIRCRAFT, SCIENCE AND ABoVE

NASA's Arctic-Boreal Vulnerability Experiment (ABoVE) campaign used aircraft to measure landscape-scale changes in vulnerable arctic-boreal ecosystems that satellites and ground instruments alone could not.

National Aeronautics and Space Administration

HOW MIGHT EARTH BEHAVE IN A WARMER WORLD?

Rapidly evolving landscapes like the arctic-boreal ecosystems of Alaska and western Canada provide real-time examples of how seasonally frozen landscapes adjust to a changing climate. ABoVE aircraft used their unique perspective to help us understand the regional-scale changes in topography, vegetation and more that satellites and ground instruments can't see.

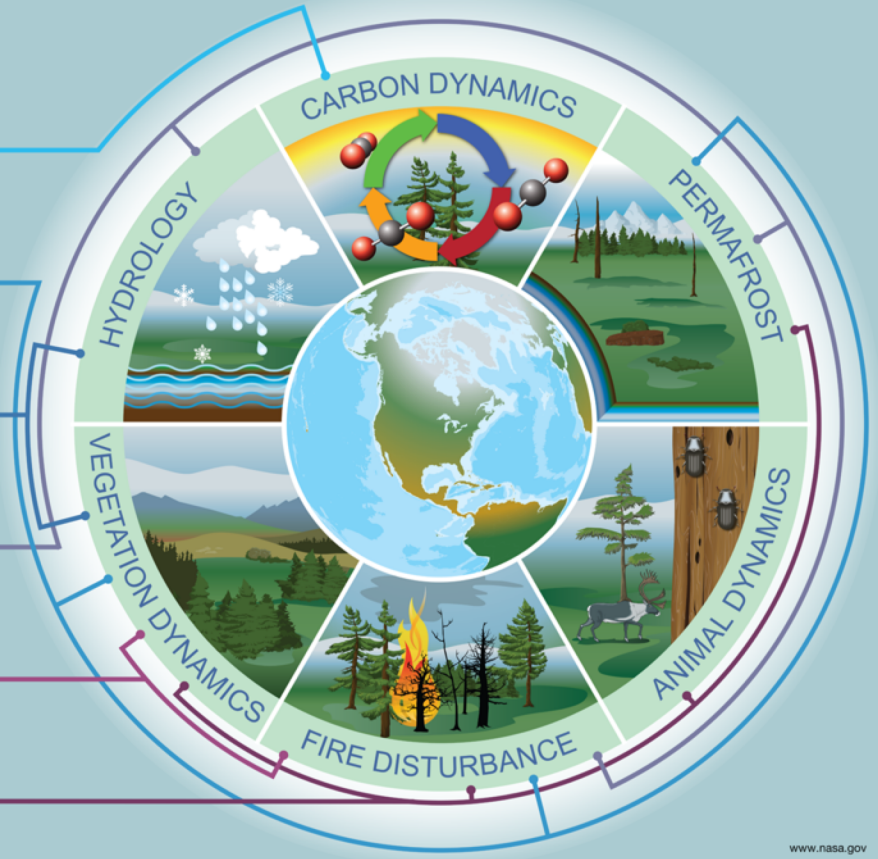
Here are three things we wouldn't know without ABoVE aircraft data:

- **WILDFIRES ARE CHANGING THE ARCTIC-BOREAL LANDSCAPE:** Measurements aboard the G-III showed where wildfire had thawed permafrost, creating rougher, wetter terrain. This change could have local to global implications, including changes in the distribution and growth of local plant species to the regional acceleration of carbon dioxide (CO_2) and methane (CH_4) released into the atmosphere.

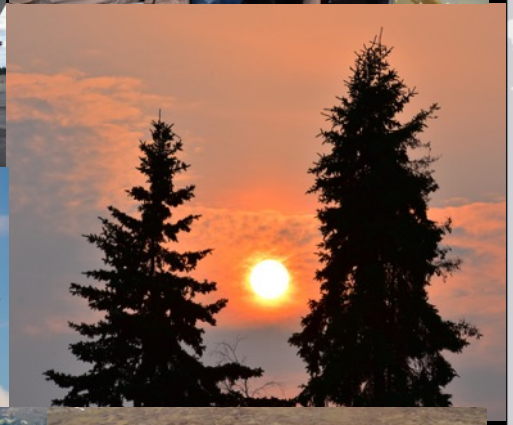
- **WE'RE LEARNING WHAT "GREEN" MEANS:** Changes in NDVI, a measurement of vegetation greeness, indicate how ecosystems respond to changing environmental conditions. Data collected aboard the B-200 are teaching us how to better interpret NDVI in tundra and boreal ecosystems where high NDVI values could mean high concentrations of either moss or vascular plants. This distinction could have wide-ranging consequences for everything from water and carbon fluxes to future fire disturbances.

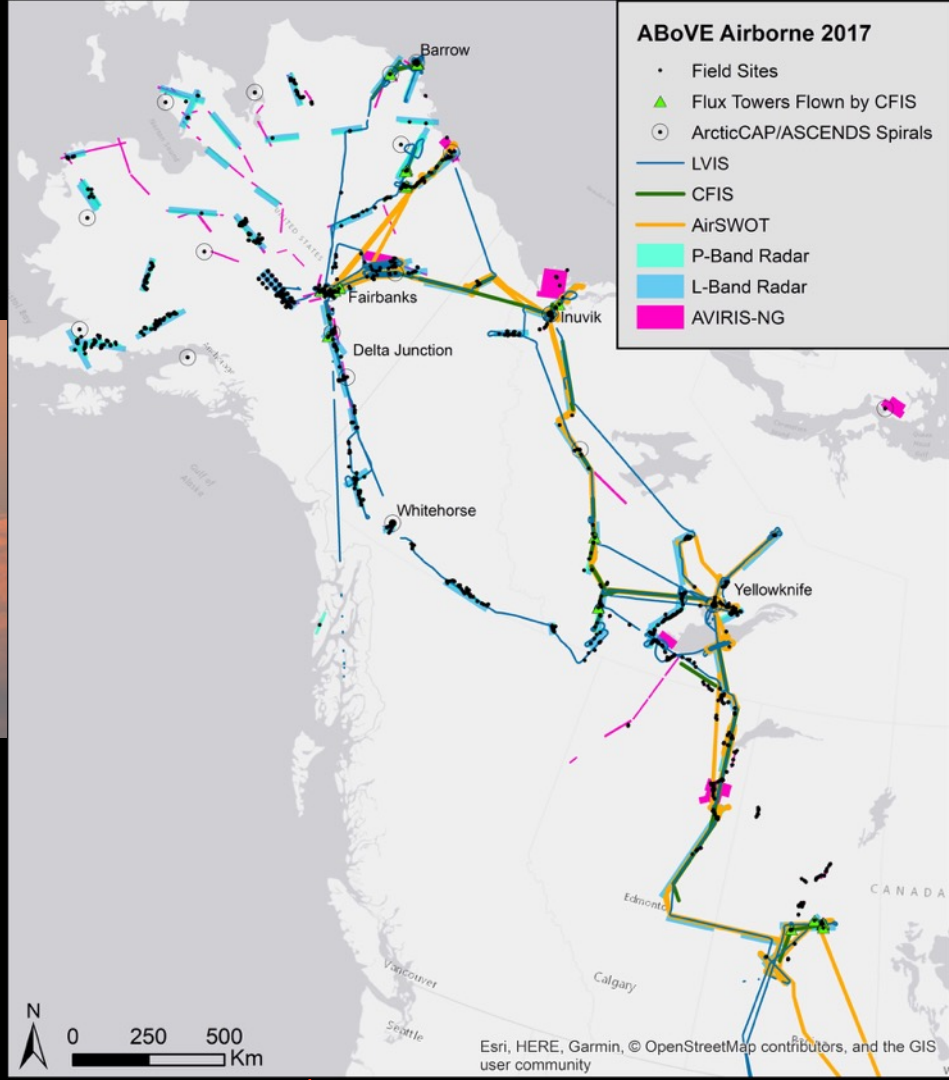
- **AIRCRAFT CAN HELP US DETERMINE CO_2 AND CH_4 FLUXES ON LARGE AND SMALL SCALES:** Instruments aboard the DC-8 and Mooney observed increases in CH_4 from bacterial respiration and decreases in CO_2 from plant photosynthesis near the surface of the Earth. The DC-8 also detected large-scale boundary condition concentrations of the two gases above the Arctic Ocean. Large changes in CO_2 and CH_4 impact on how our planet regulates temperature.

PLATFORM	SENSORS
DC-8	• AVOCET • Picarro • DACOM/DLH • CO_2 Sounder • ACES
G-III	• L-Band SAR • P-Band SAR
B-200	• LVIS • AirSWOT • AVIRIS
Mooney	• ATM-C
DHC6	• CFIS • NEON AOP
UAV	• SFM



www.nasa.gov




ABoVE Airborne 2017
Field Sites
Flux Towers Flown by CFIS
ArcticCAP/ASCENDS Spirals
LVIS
CFIS
AirSWOT
P-Band Radar
L-Band Radar
AVIRIS-NG
Barrow
Fairbanks
Inuvik
Delta Junction
Whitehorse
Yellowknife
Edmonton
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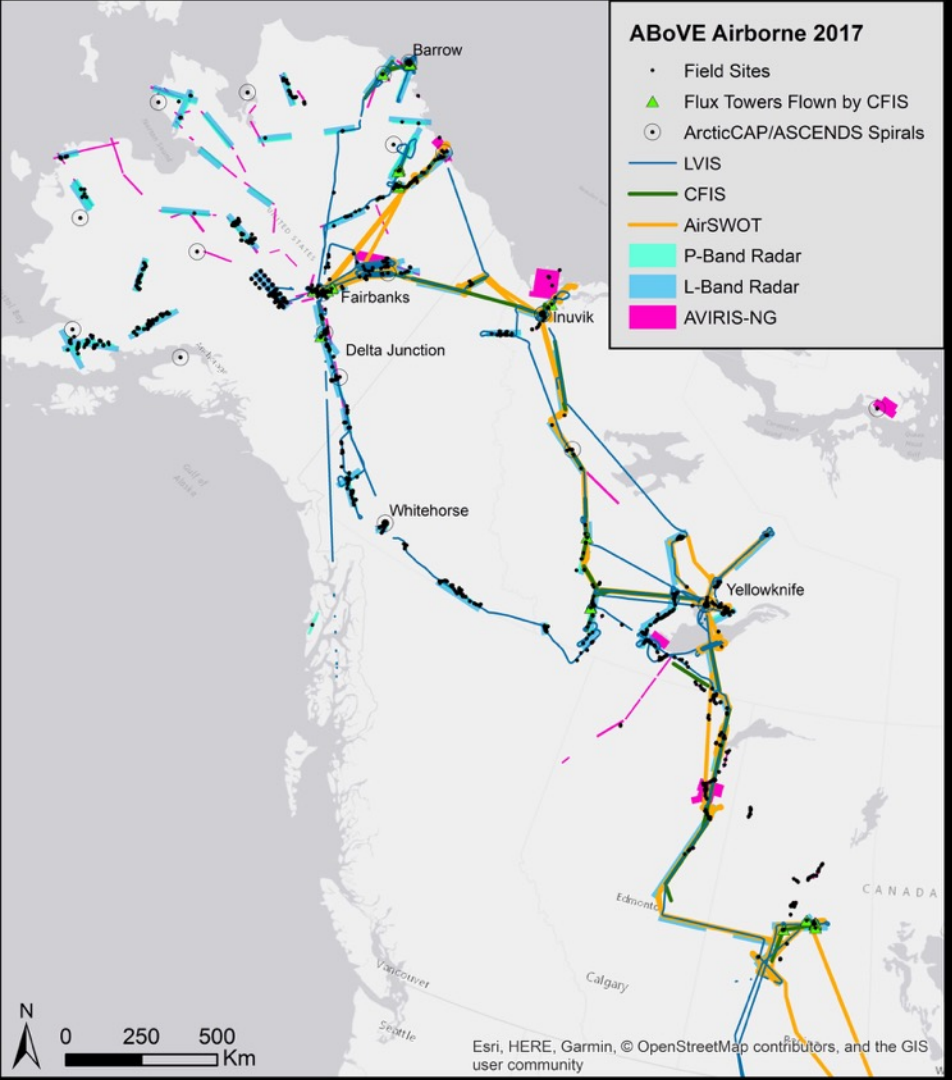
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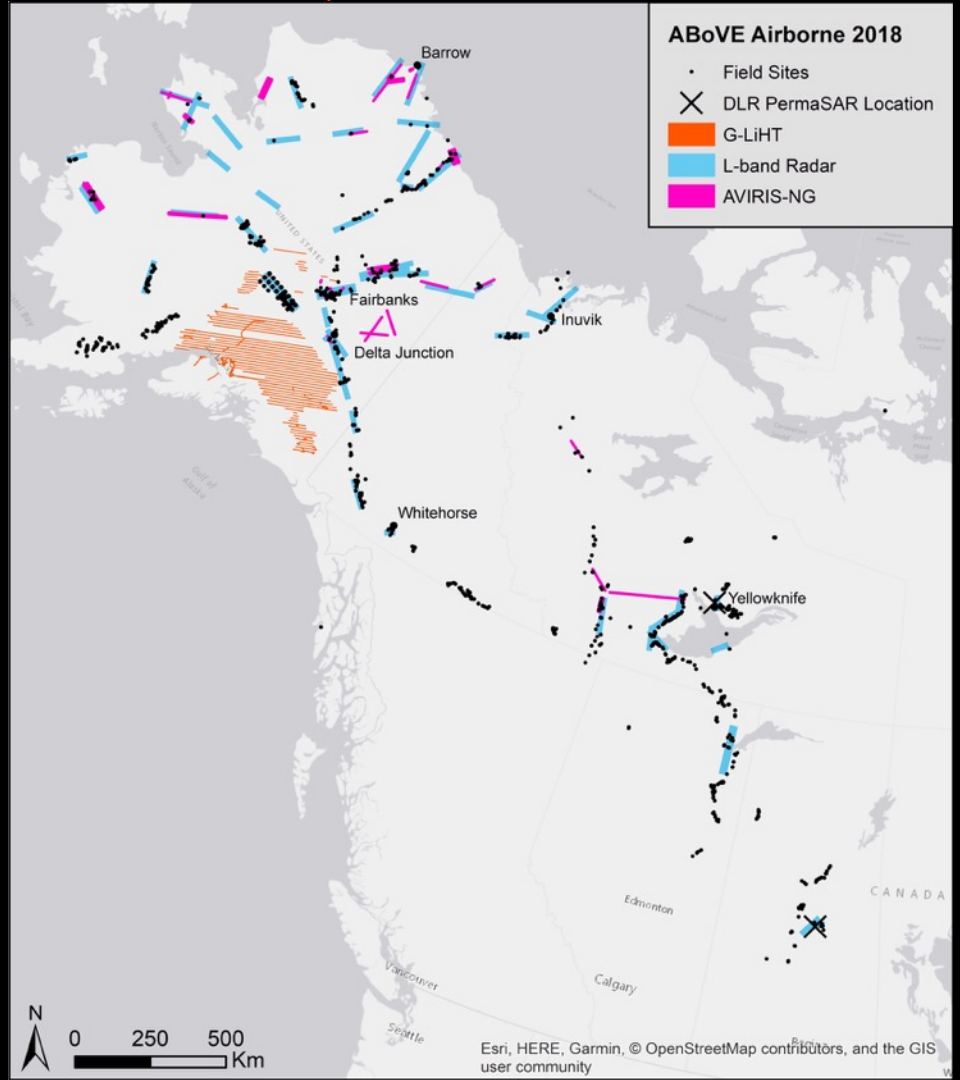
ABoVE Airborne 2018
Field Sites
DLR PermaSAR Location
G-LiHT
L-band Radar
AVIRIS-NG
Barrow
Fairbanks
Inuvik
Delta Junction
Whitehorse
Yellowknife
Edmonton
Vancouver
Calgary
Seattle
CANADA
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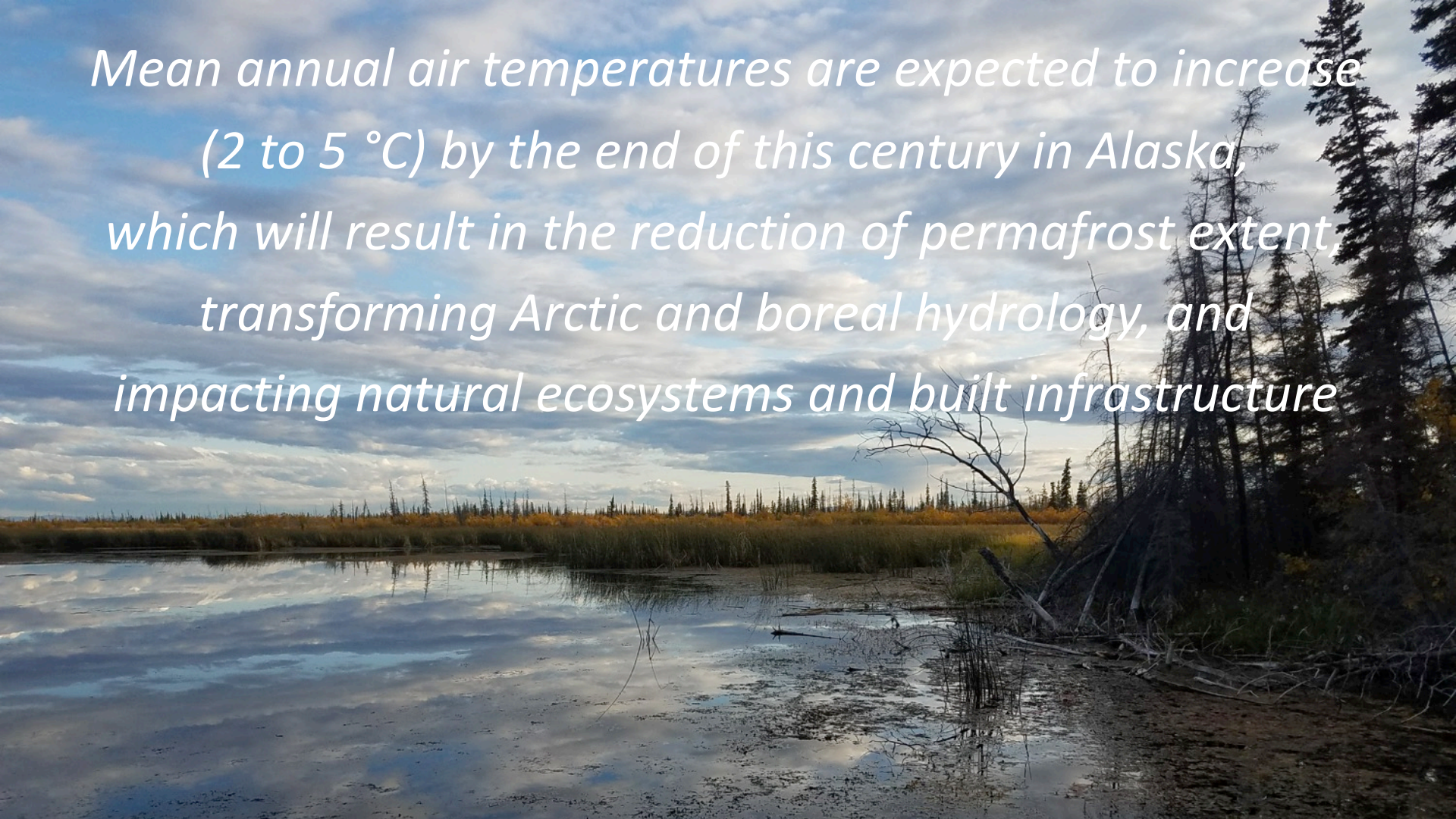
Motivating Question:

What processes control changes in the distribution of Alaska's surface waters and permafrost and what are the impact of these changes?

Core Participants:

Neal J Pastick (SGT & UMN), M. Torre Jorgenson (Alaska Ecoscience), Scott Goetz (NAU), Helene Genet (UAF), David McGuire (UAF), Bruce Wylie (USGS), Burke Minsley (USGS), and others


Mean annual air temperatures are expected to increase (2 to 5 °C) by the end of this century in Alaska, which will result in the reduction of permafrost extent, transforming Arctic and boreal hydrology, and impacting natural ecosystems and built infrastructure

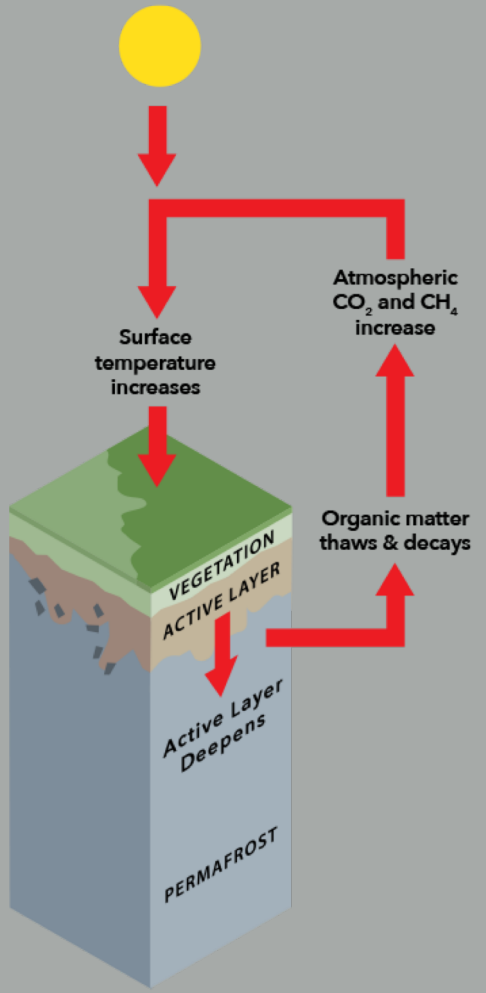
Drunken Forest Collapse

Time-lapse documentation of spruce trees collapsing in a thermal erosion gully near Erickson Creek, Interior Alaska, 2016-2017

By Torre Jorgenson, Alaska Ecoscience

A Permafrost Hydrology Study Supported by
NASA's Arctic-Boreal Vulnerability Experiement

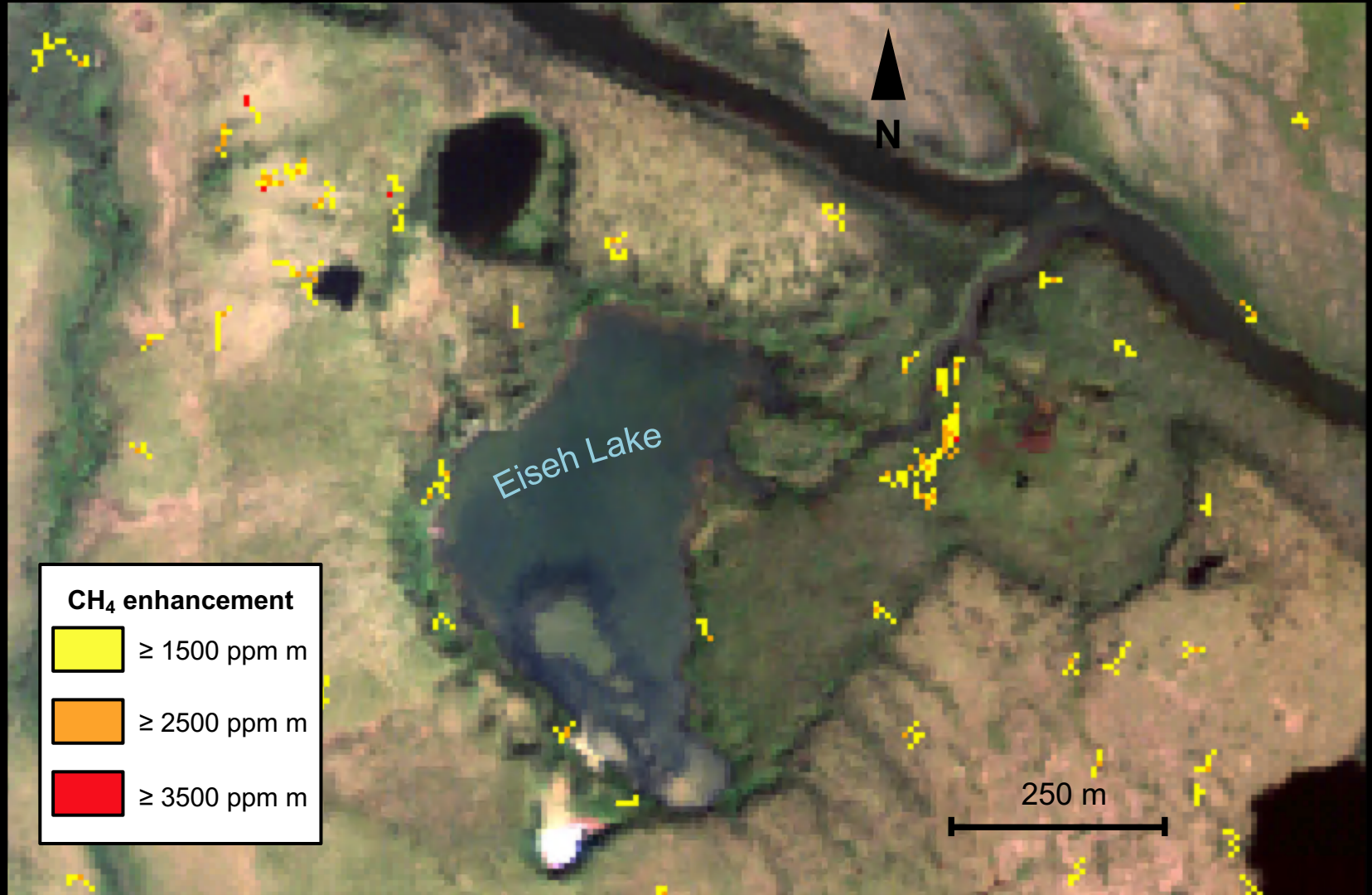
Impacts and feedbacks to local, regional, and global systems



C1

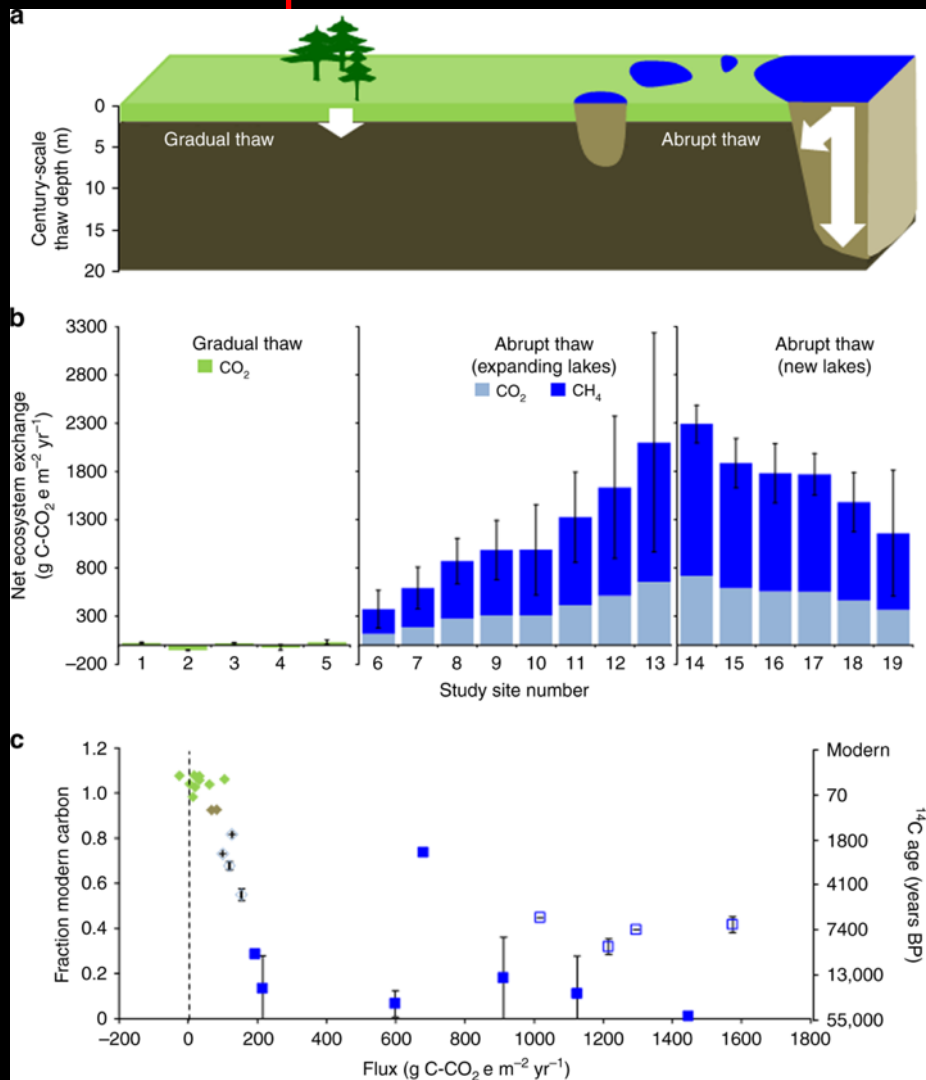
methane lake flare video clip

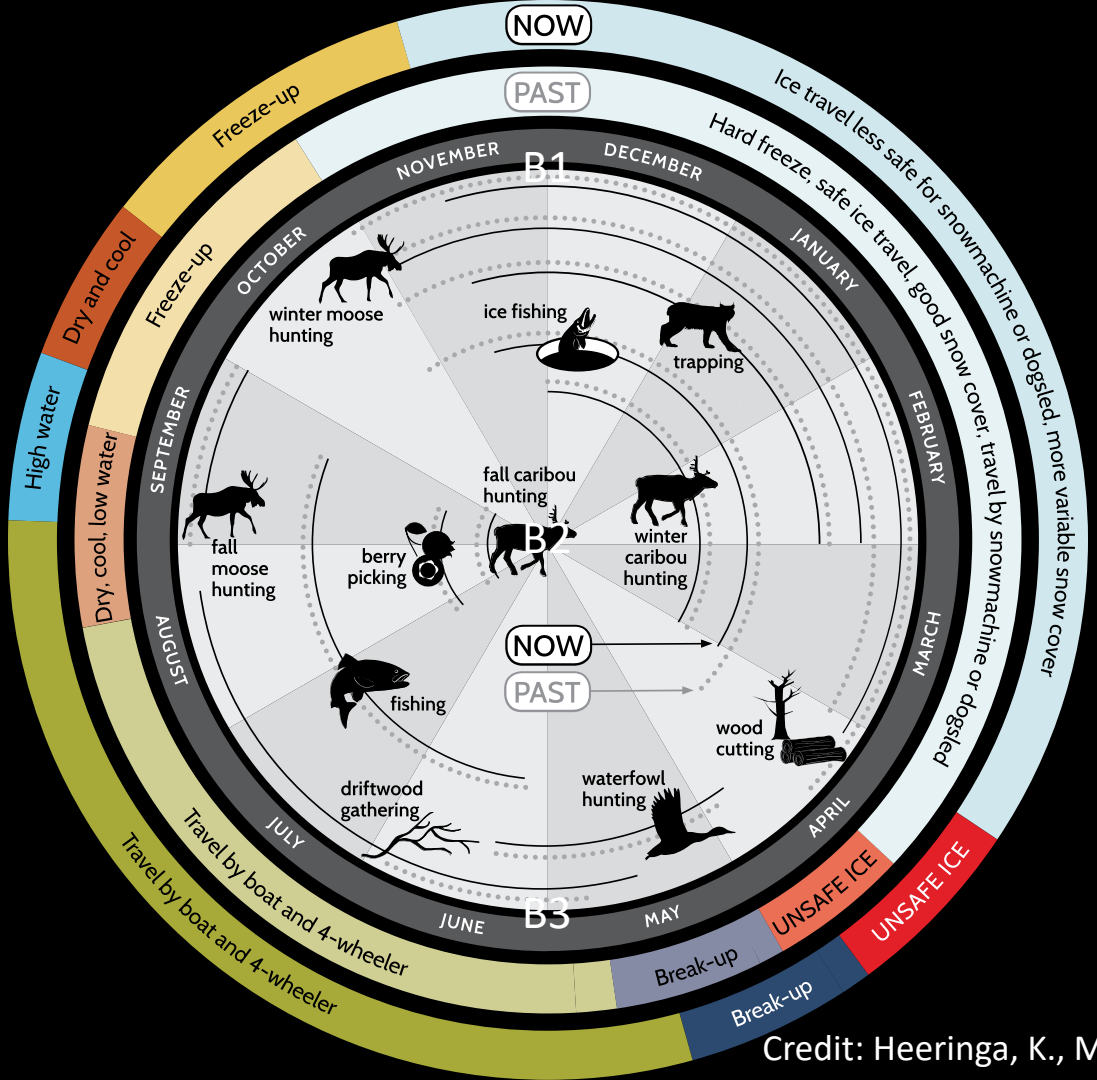
C2


N
Eiseh Lake
CH4 enhancement
≥ 1500 ppm m
≥ 2500 ppm m
≥ 3500 ppm m
250 m

Abrupt thaw accelerates mobilization of deeply frozen, ancient carbon, increasing 14C-depleted permafrost soil carbon emissions by ~125–190% compared to gradual thaw alone. *These findings demonstrate the need to incorporate abrupt thaw processes in earth system models for more comprehensive projection of the PCF this century.*

21st-century modeled permafrost carbon emissions accelerated by abrupt thaw beneath lakes
Katey Walter-Anthony et al. Nature Communications 2018





Credit: Heeringa, K., MacFarland, H., & Rosner, C

Miki Collins
Lake Minchumina, Alaska
April 24

“Mushing from shore onto the spring ice, then out on the ice of the lake. Travel on the lake is still good by dog team, although the dogs need to go through water flooding the edge of the ice getting on/off the pack ice. Usually at this point the surface is hard and free of snow and slush, but this year found a layer of thin ice overlying watery slush sitting on the pack ice, making it slow and a little unpleasant for the dogs. Can be challenging and occasionally dangerous.”

This change affects travel, and is observed seasonally. It has a moderate effect on safety.

http://mapventure.org/environmental-impacts-access/

Joe Turner
Nulato, Alaska
June 22

“Fire in Nulato during hot, dry summer. Very poor air quality. It shut down all travel during fire. I couldn't go on ATV trails because of fallen trees (lots of trees fell).”

This change affects village travel. I see this happen every few years. It has a moderate effect on safety.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