NASA TE ST meeting
Sept 2019

Leadership Group
Goetz, Miller,
Griffith, Margolis,
Falkowski

Special thanks to
++ WG Leads ++

and all who
contributed results
about
"*What we're Learning*"
from
Phase I projects

ABoVE

Arctic-Boreal Vulnerability Experiment

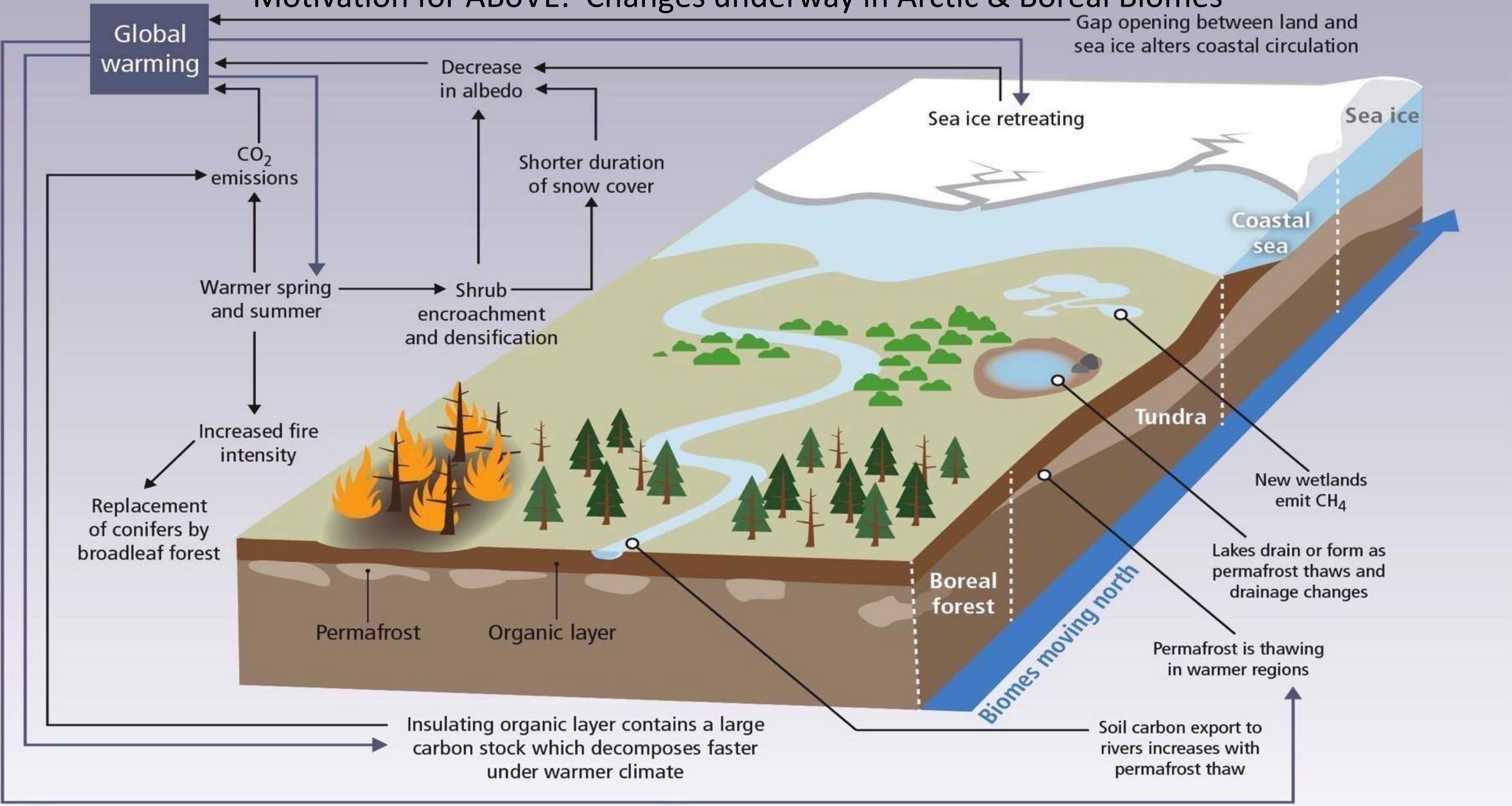
above.nasa.gov

ABoVE is a large-scale NASA-led study of environmental change in Arctic & boreal regions and the implications for ecological systems and society

Our overarching Science Question is

How vulnerable or resilient are ecosystems and society to environmental change in the Arctic and boreal region of North America (over the next few decades)?

Motivation for ABoVE: Changes underway in Arctic & Boreal Biomes

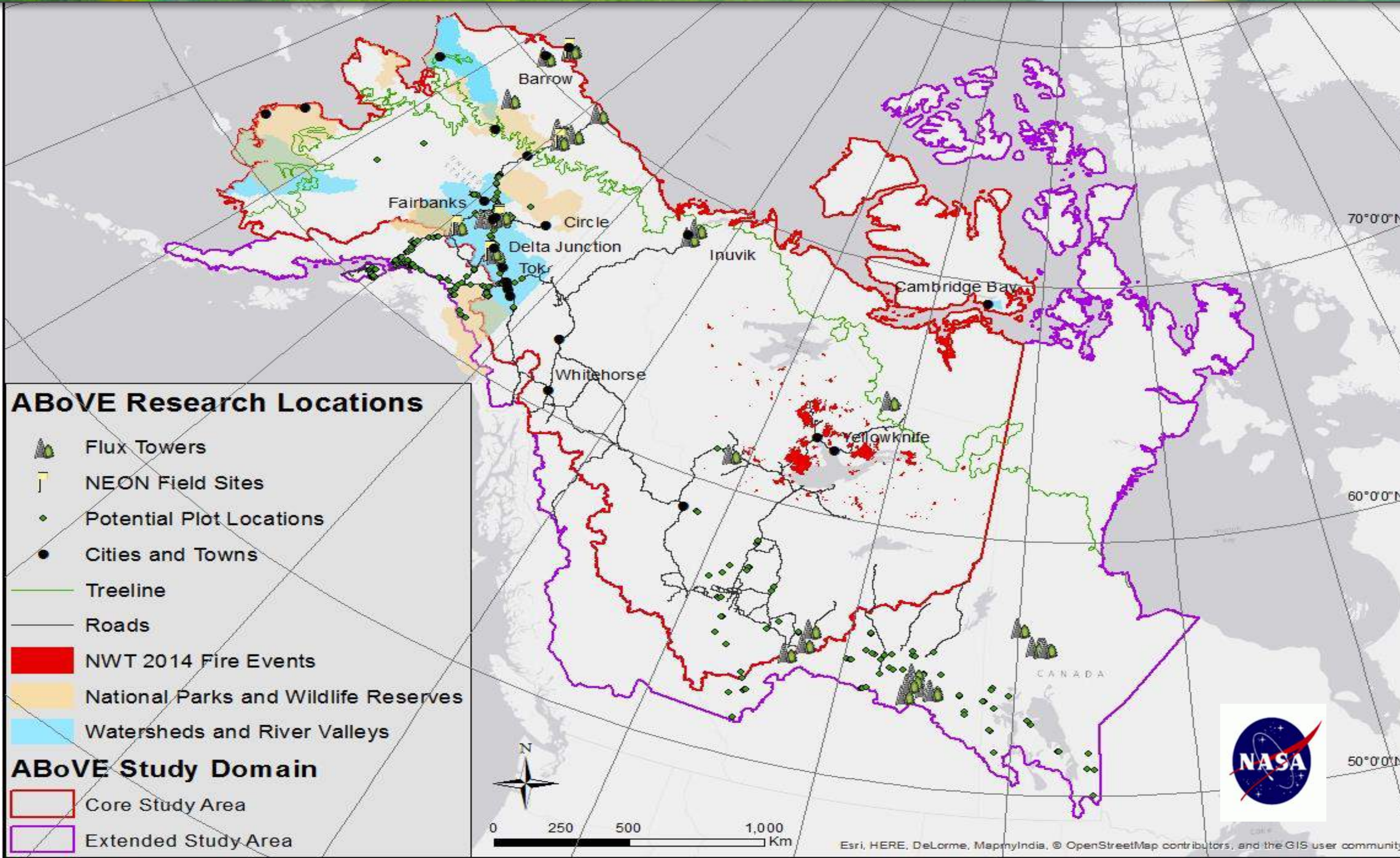


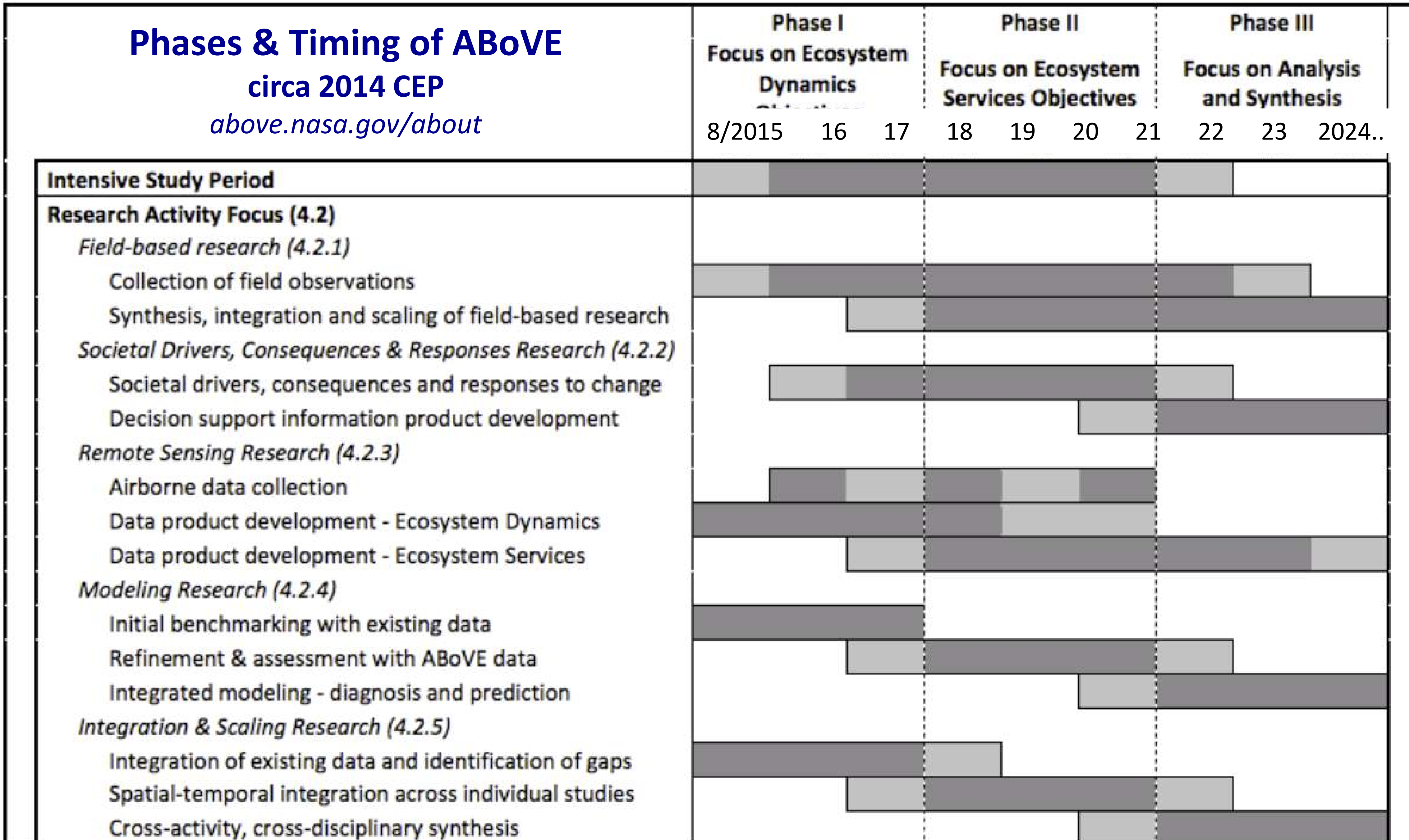
The ABoVE Scoping Study was initiated in 2008

IPCC AR5, WG2, Chap.4

Arctic-Boreal Vulnerability Experiment

Spatial domain & core site locations




Phases & Timing of ABoVE
circa 2014 CEP
above.nasa.gov/about
Phase I
Focus on Ecosystem
Dynamics
Phase II
Focus on Ecosystem
Services Objectives
Phase III
Focus on Analysis
and Synthesis
8/2015
16
17
18
19
20
21
22
23
2024..
Intensive Study Period
Research Activity Focus (4.2)
Field-based research (4.2.1)
Collection of field observations
Synthesis, integration and scaling of field-based research
Societal Drivers, Consequences & Responses Research (4.2.2)
Societal drivers, consequences and responses to change
Decision support information product development
Remote Sensing Research (4.2.3)
Airborne data collection
Data product development - Ecosystem Dynamics
Data product development - Ecosystem Services
Modeling Research (4.2.4)
Initial benchmarking with existing data
Refinement & assessment with ABoVE data
Integrated modeling - diagnosis and prediction
Integration & Scaling Research (4.2.5)
Integration of existing data and identification of gaps
Spatial-temporal integration across individual studies
Cross-activity, cross-disciplinary synthesis

ABoVE Science Team

Currently 86 NASA funded projects

(66 ABoVE + 20 other NASA projects)

21 affiliated projects

(other agencies, incl Canadian)

As of this week..

90 Project Leads

714 ST members

1317 “participants”

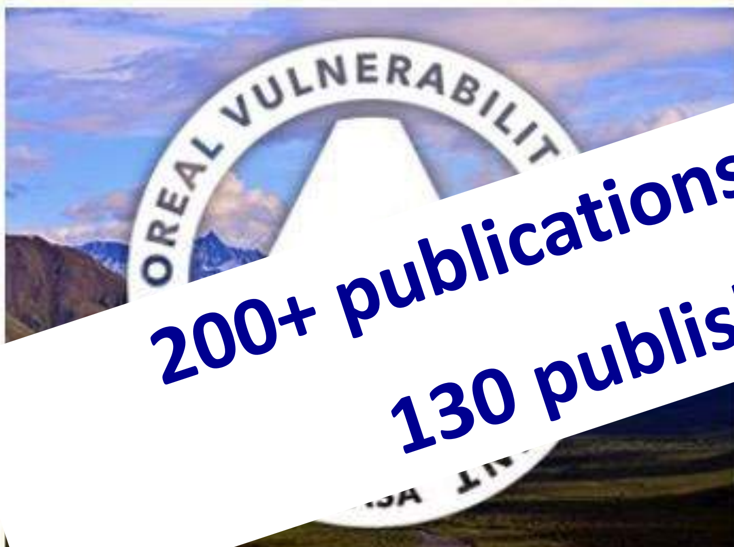
ASTM5, May 2019, La Jolla

Environmental Research Letters

Resiliency and Vulnerability of Arctic and Boreal Ecosystems to Environmental Change: Advances and Outcomes of AB… Arctic Boreal Vulnerability Experiment)

200+ publications reported by 107 projects

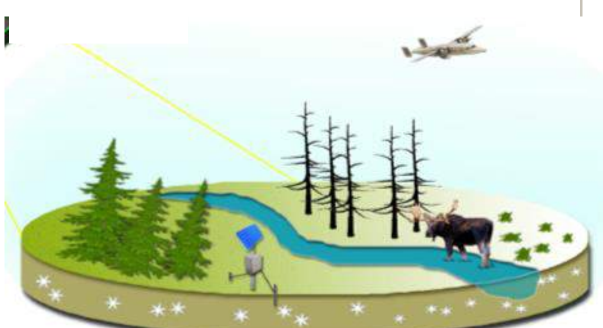
130 published data sets to date



http://iopscience.iop.org/journal/1748-9326/page/ABoVE

25 contributed papers thus far.
Several more in press / in review

…ersity
…, NASA Goddard Space Flight Center
…mane, Harvard University
Joshua Fisher, NASA / Caltech Jet Propulsion Laboratory
Peter Griffith, NASA Goddard Space Flight Center
Mike Goulden, University of California at Irvine
John Kimball, University of Montana
Tatiana Loboda, University of Maryland
Michelle Mack, Northern Arizona University
Charles Miller, NASA / Caltech Jet Propulsion Laboratory
Sue Natali, Woods Hole Research Center
Christopher Neigh, NASA Goddard Space Flight Center
Brendan Rogers, Woods Hole Research Center
Merrit Turetsky, University of Guelph
Jennifer Watts, University of Montana



Working Groups are the Core of ABoVE Science Efforts

above.nasa.gov

ABoVE Working Groups

-- **ABoVE WG Telecon Email List:** above_wg_telecon@cce.nasa.gov
-- **Join a WG**: click "join" to send email with your name/affiliation to web support
-- **ABoVE Projects - Measurements - WG Members Summary Excel Report** >>
-- **Ad Hoc Working Groups** >>

Working Group >> description	Email List	Members	Join	Measurements of WG Projects (excel)
Hydrology & Permafrost >>	above_wg_hydrology@cce.nasa.gov	Members >>	join	excel
Vegetation Dynamics >>	above_wg_vegdynamics@cce.nasa.gov	Members >>	join	excel
Fire Disturbance >>	above_wg_fire@cce.nasa.gov	Members >>	join	excel
Carbon Dynamics >>	above_wg_carbon@cce.nasa.gov	Members >>	join	excel
Wildlife & Ecosystem Services >>	above_wg_wildlife@cce.nasa.gov	Members >>	join	excel
Modeling Framework & Comparisons >>	above_wg_modeling@cce.nasa.gov	Members >>	join	N/A
Airborne Science >>	above_wg_airborne@cce.nasa.gov	Members >>	join	excel

Arctic-Boreal Vulnerability Experiment

Hydrology & Permafrost >>	above_wg_hydrology@cce.nasa.gov	Members >>	join	excel
Vegetation Dynamics >>	above_wg_vegdynamics@cce.nasa.gov	Members >>	join	excel
Fire Disturbance >>	above_wg_fire@cce.nasa.gov	Members >>	join	excel
Carbon Dynamics >>	above_wg_carbon@cce.nasa.gov	Members >>	join	excel
Wildlife & Ecosystem Services >>	above_wg_wildlife@cce.nasa.gov	Members >>	join	excel
Modeling Framework & Comparisons >>	above_wg_modeling@cce.nasa.gov	Members >>	join	N/A
Airborne Science >>	above_wg_airborne@cce.nasa.gov	Members >>	join	excel
Airborne Ops	above_airborne_ops@cce.nasa.gov	Members >>	join	N/A
Core Variables & Standards >>	above_wg_corevar@cce.nasa.gov	Members >>	join	N/A
Geospatial Products & Standards >>	above_wg_geospatial@cce.nasa.gov	Members >>	join	N/A
Digital Elevation Models	above_wg_dem@cce.nasa.gov	Members >>	join	N/A
Collaborations and Engagement >>	above_wg_stakeholder@cce.nasa.gov	Members >>	join	N/A
Student and Citizen Science >>	above_wg_globe@cce.nasa.gov	Members >>	join	N/A
Communications >>	above_wg_comm@cce.nasa.gov	Members >>	join	N/A

Core WGs

Other standing WGs

Ad Hoc Working Groups

Working Group	Email List	Members	Join
GMAO Weather Email List	gmao_wx@cce.nasa.gov	Members >>	join
Airborne Data	above_wg_airborne_data@cce.nasa.gov	Members >>	join
CalVal Data Synthesis	above_wg_calval@cce.nasa.gov	Members >>	join
Radar Aboveground Woody Biomass	above_wg_radar_biomass@cce.nasa.gov	Members >>	join
Radar Active Layer-Deep Soil Moisture	above_wg_radar_alt@cce.nasa.gov	Members >>	join
Radar Wetlands and Surface Soil Moisture	above_wg_radar_wetlands@cce.nasa.gov	Members >>	join
Radarsat	above_wg_radarsat@cce.nasa.gov	Members >>	join
Spectral Imaging	above_wg_spectral@cce.nasa.gov	Members >>	join

Phase 1 ABoVE WG Coordination & Synthesis Activities

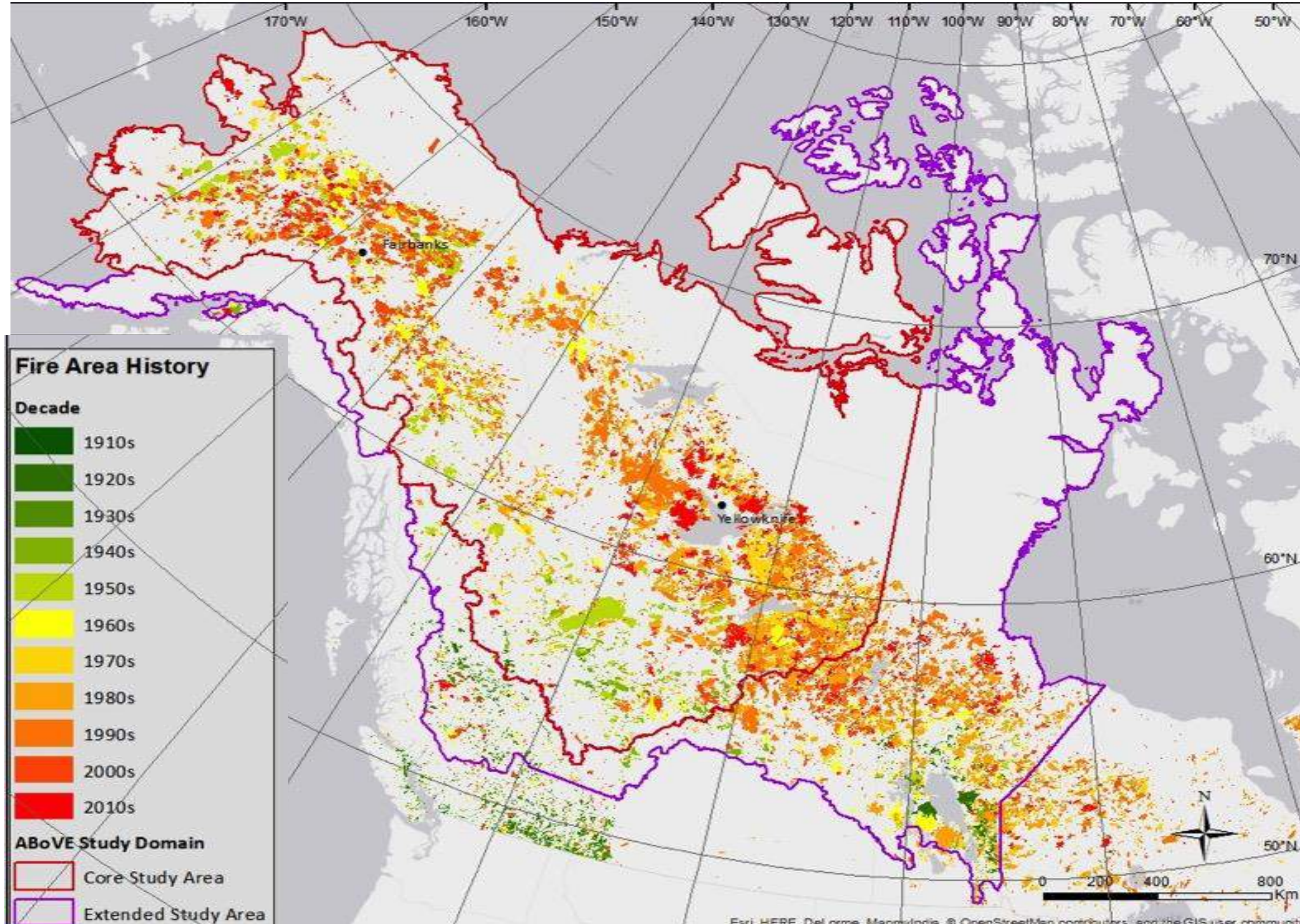
Fire Disturbance:
Wildfire soil carbon combustion synthesis
Post-fire forest regrowth composition & trajectories (***with Veg Dynamics WG***)

Vegetation Dynamics:
Succession/recovery following disturbances (***with Fire WG***)
Forest greening/browning including role of climate & insects in forest decline
Tundra greening/browning including shrub expansion & densification

Carbon Dynamics:
Changes in seasonal amplitude of CO_2 concentrations
CH_4 data/knowledge gaps; Aquatic carbon fluxes
Partitioning net ecosystem exchange components
CO_2 flux syntheses / C Flux measurements in permafrost ecosystems (***with Hydrology/Permafrost WG & Permafrost C Network***)

Hydrology / Permafrost:
Active Layer Distribution - synthesize & assess active layer depths (***with SAR WGs***)
Freeze-thaw dynamics and timing (***with C Dynamics WG***)
Lake trends – comparison of methods & long-term trends in lake area, and drivers
Snow properties – crosscutting synthesis activity ***with Wildlife WG***

Fire Disturbance

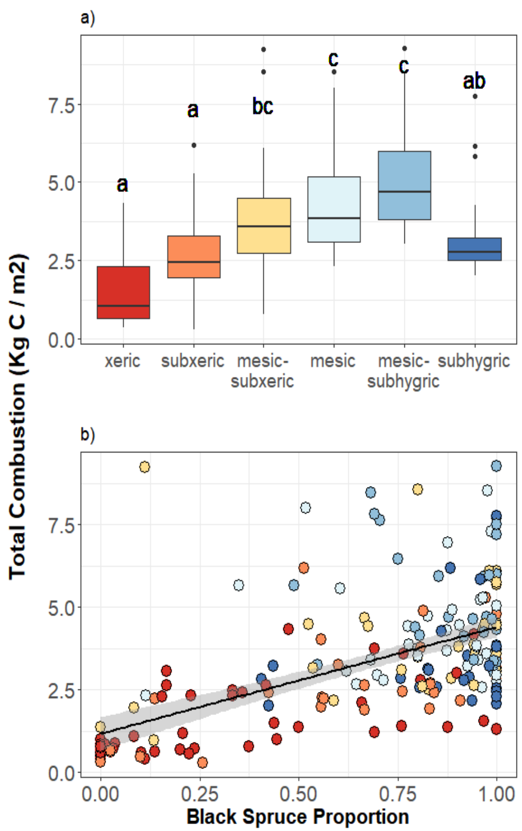


Cross-scale controls on carbon emissions from boreal mega-fires

Walker et al. 2018 GCB

Increasing fire severity and the loss of legacy carbon from forest and tundra ecosystems of northwestern North America

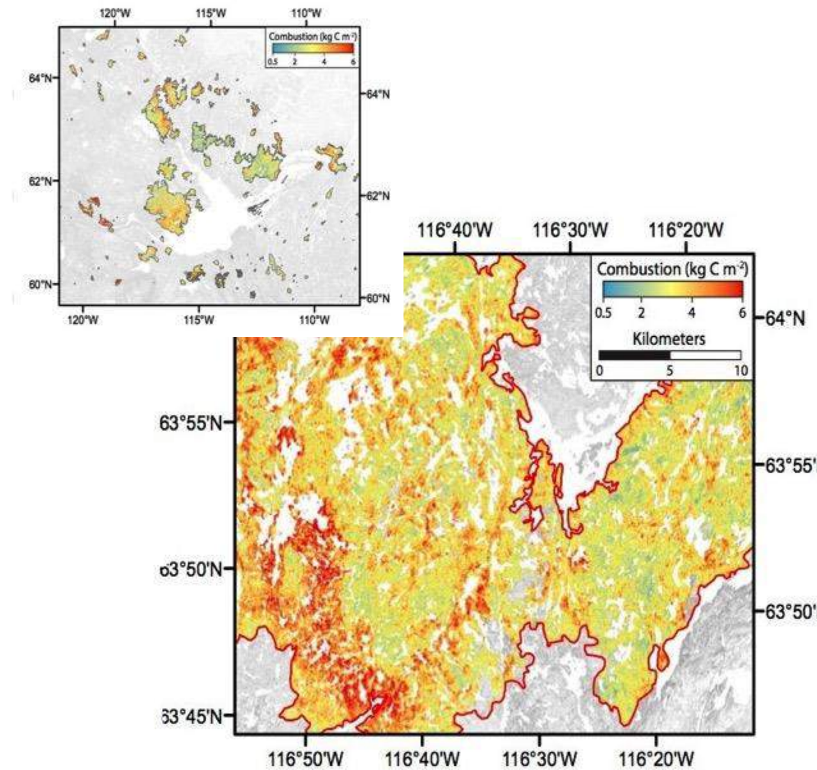
Field data



Combustion emissions increased with topographic wetness and increased with the proportion of black spruce

Full Model: moisture category, elevation, stand age, latitude, proportion of black spruce, and pre-fire tree biomass

Remote Sensing extrapolation



Full Model *informed by field data:* topographic wetness index, terrain ruggedness, dNBR, relative change in tree cover, percent black spruce, and percent sand in the top 15 cm of soil.

Total 2014 emissions from NWT mega-fires: 94.3 Tg C from 2.85 Mha burned area

Canadian Boreal forests store 10-47 Tg C yr-1 in annual net ecosystem production (Pan et al. 2011, Bradshaw and Warkentin 2015).

***The 2014 fire year in the Northwest Territories offset carbon uptake across all Canadian boreal forests*.**

Increasing wildfires threaten the historic carbon sink of boreal forest soils

Walker, et al. 2019 *Nature*

IARPC Terrestrial Ecosystems Collaboration Team Meeting
this Friday 2:00 ET

Science Question

Could the intensification of wildfire disturbance shift the carbon balance of boreal forests from a net C sink to a net C source across consecutive fires?

Analysis

Soil radiocarbon dating was used to asses... carbon that escaped burning in pre... ('legacy carbon') combusted ... fire year.

Findings

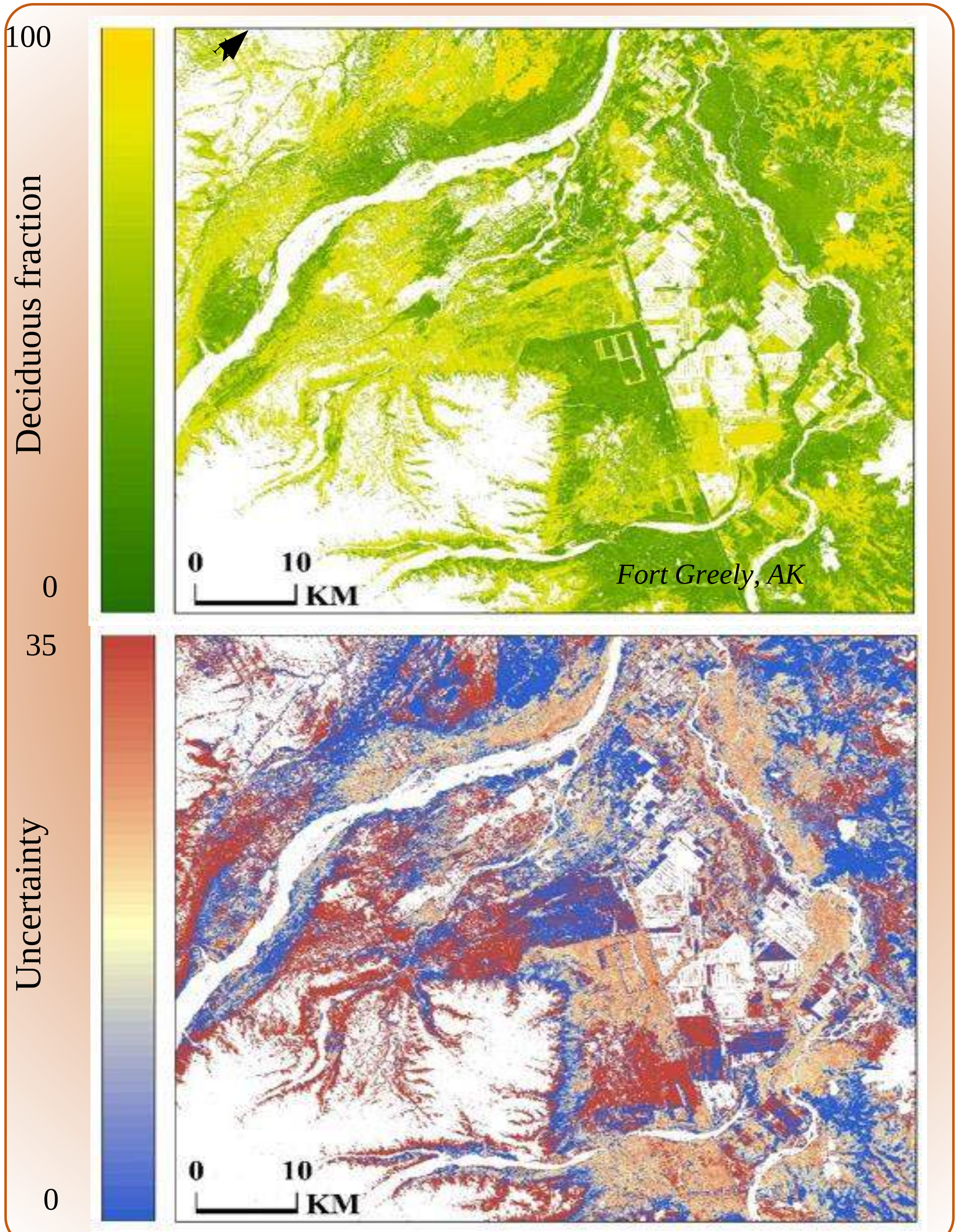
> Fores... ...oung (<60 years) at the time of fi... ...erable to shifting into a new domain o... ...cycling, but older stands remained C sinks.

> Some 0.35 M ha of young forests shifted into a new domain of C cycling in the NWT of Canada, emitting 8.6 Tg C

Significance

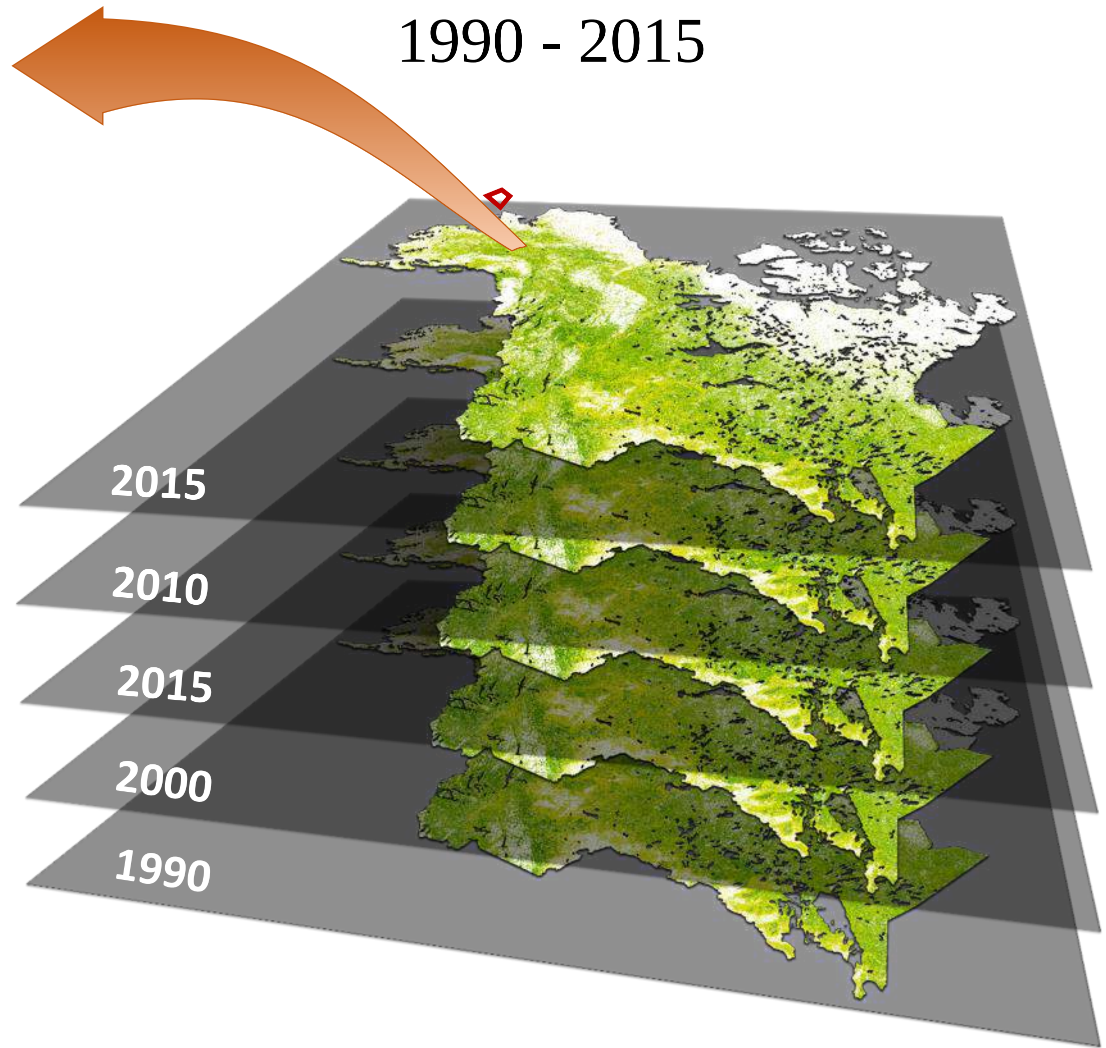
As both the total area burned and the frequency of bore... increased areas of forest transitioning from net C uptak... The impacts of increasing fire frequency on forests cros... to be incorporated into models addressing boreal forest...

Vegetation Dynamics



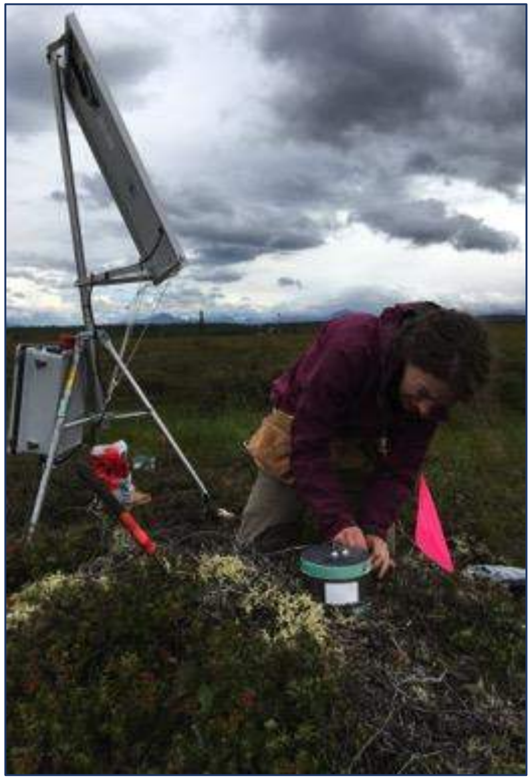
N = 5,000

Deciduous Fraction Maps
1990 - 2015



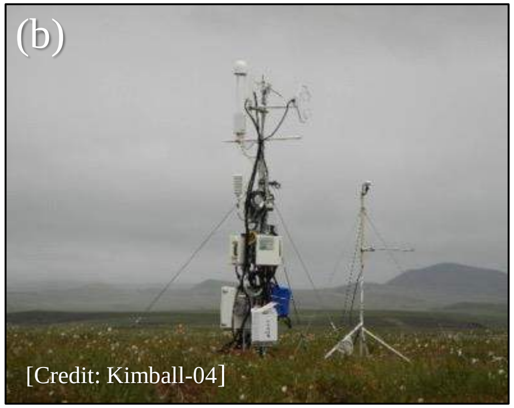
Carbon Dynamics

Lake chemistry monitoring system
(Striegl)



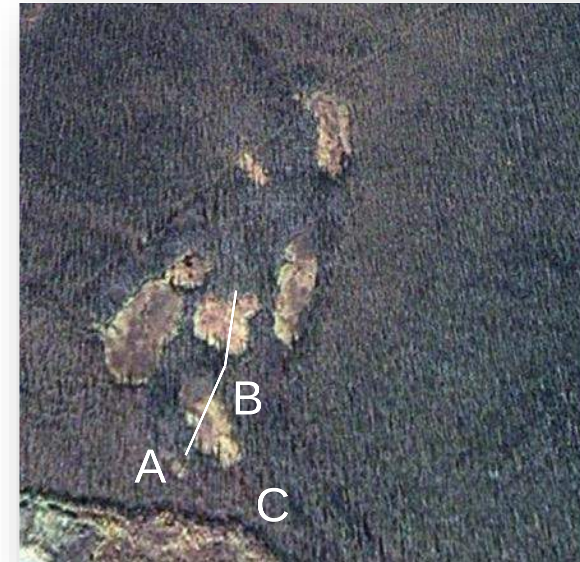
Soil respiration, temp. and moisture system
(Natali)

Lake CO_2 & CH_4 concentrations



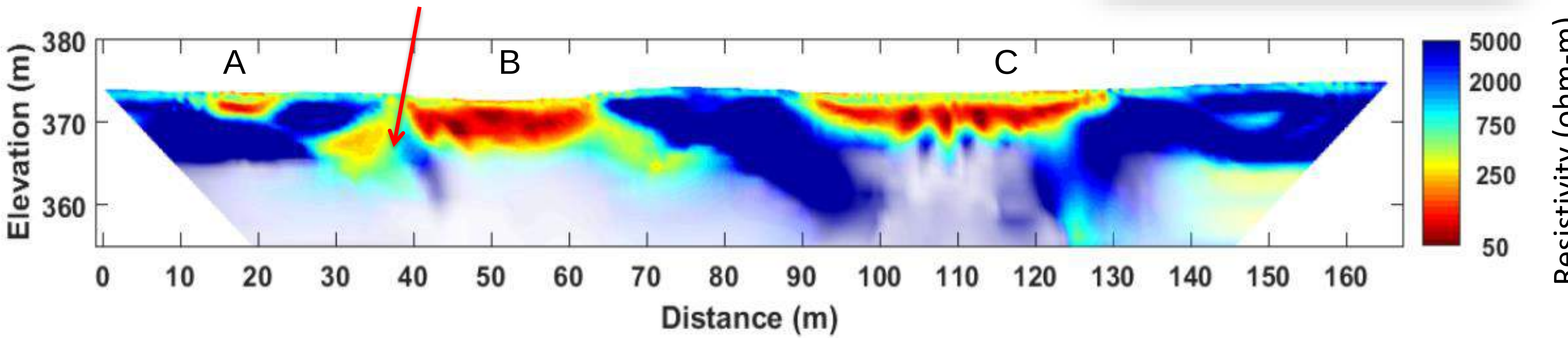
Student measures organic layer
depth at Nome Creek (Natali)

Hydrology & Permafrost Dynamics



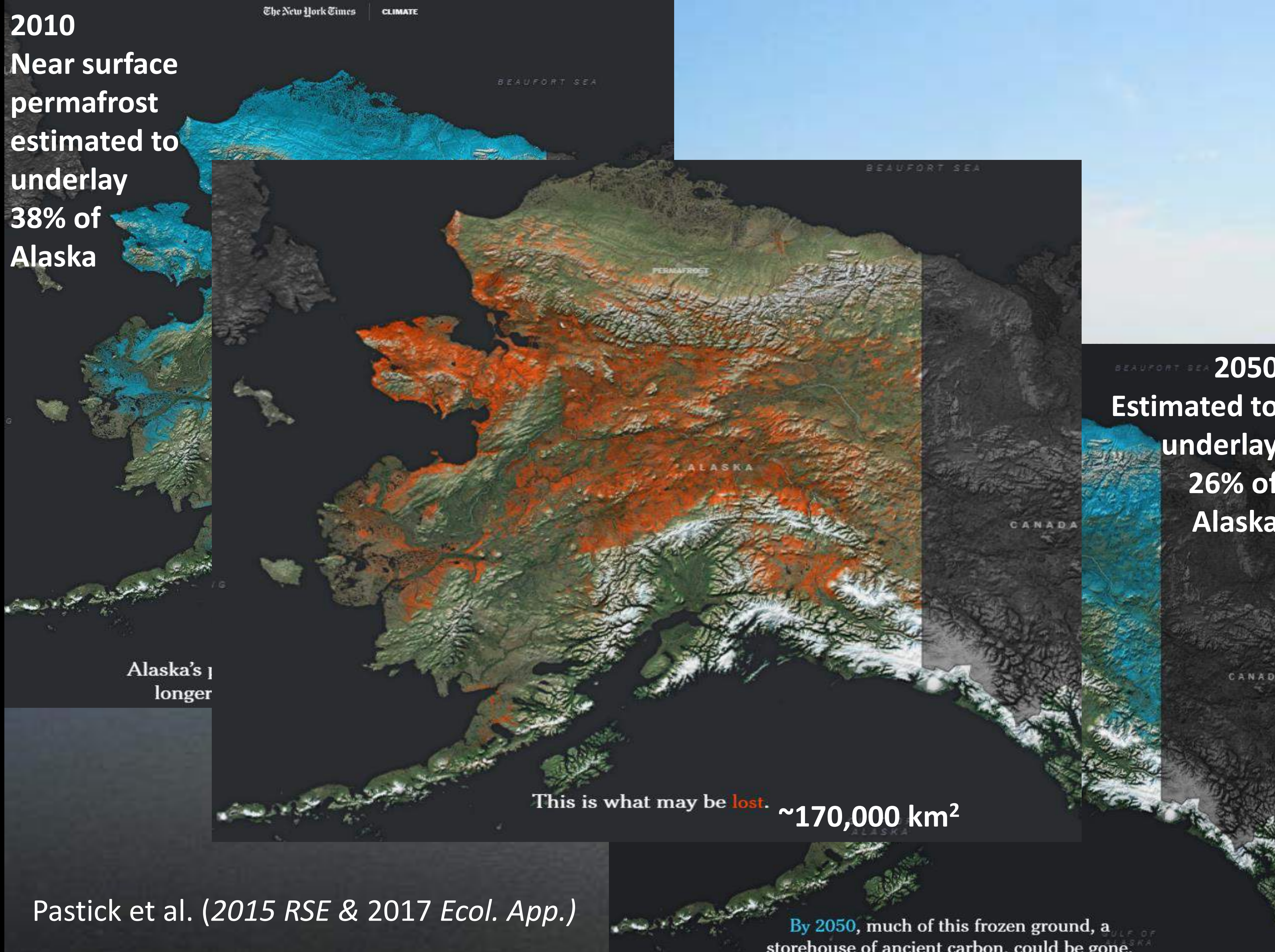
Electrical Resistivity Tomography (ERT)

Thawed at depth, potentially leading to future thermokarst and coalescing bogs?



Minsley, Striegl et al. ABoVE ongoing active field measurements

2010
Near surface permafrost estimated to underlay 38% of Alaska



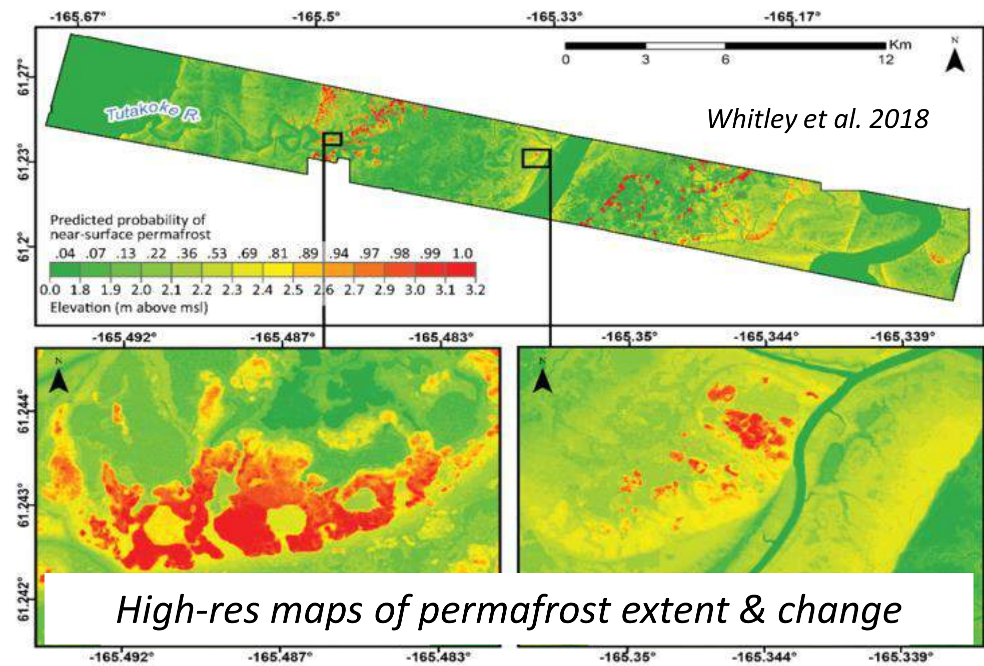
2050
Estimated to underlay 26% of Alaska

~170,000 km^2

Pastick et al. (*2015 RSE* & 2017 *Ecol. App.)*

Wildlife, Knowledge Co-production, Ecosystem Services

Thawing permafrost



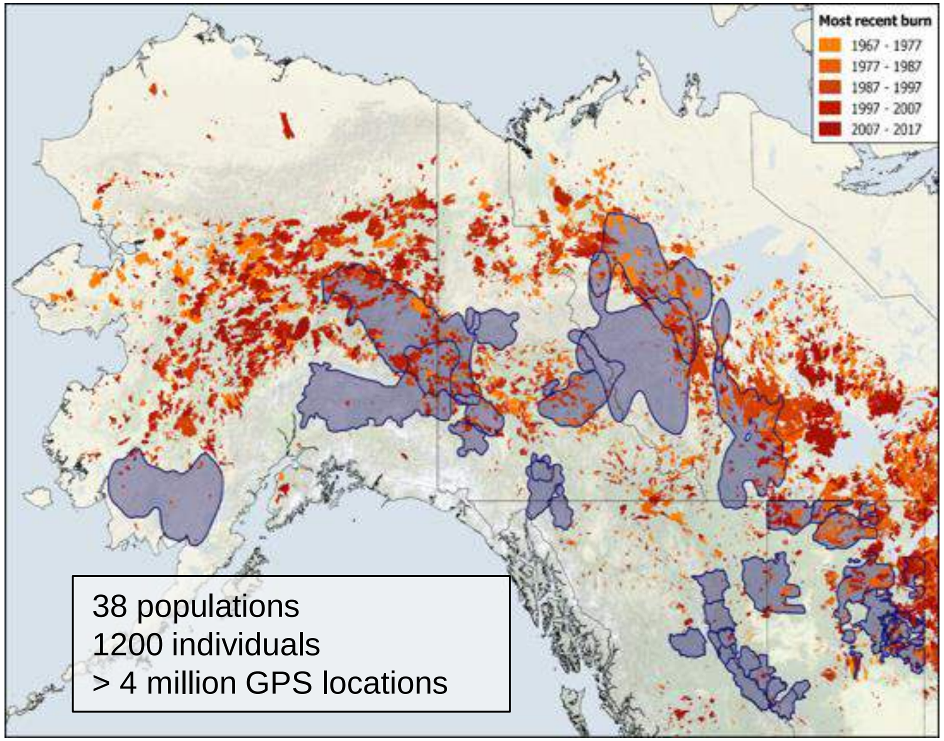
Socio-ecological implications of change: Yukon Delta, Alaska (Brinkman & Frost projects)

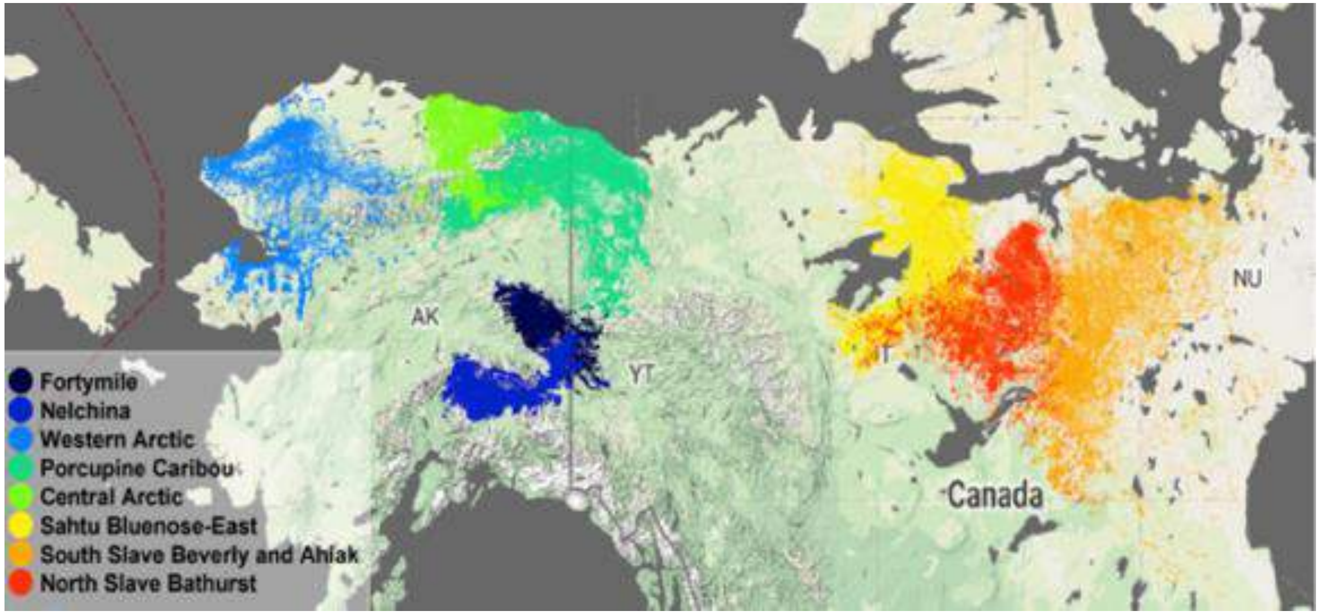
Effects of Interacting Disturbances on Caribou Habitat and Population Dynamics

Climatic Drivers of Arctic Barrenground Caribou Migration During Spring

Boelman et al. "Animals on the Move" project

animals on the move

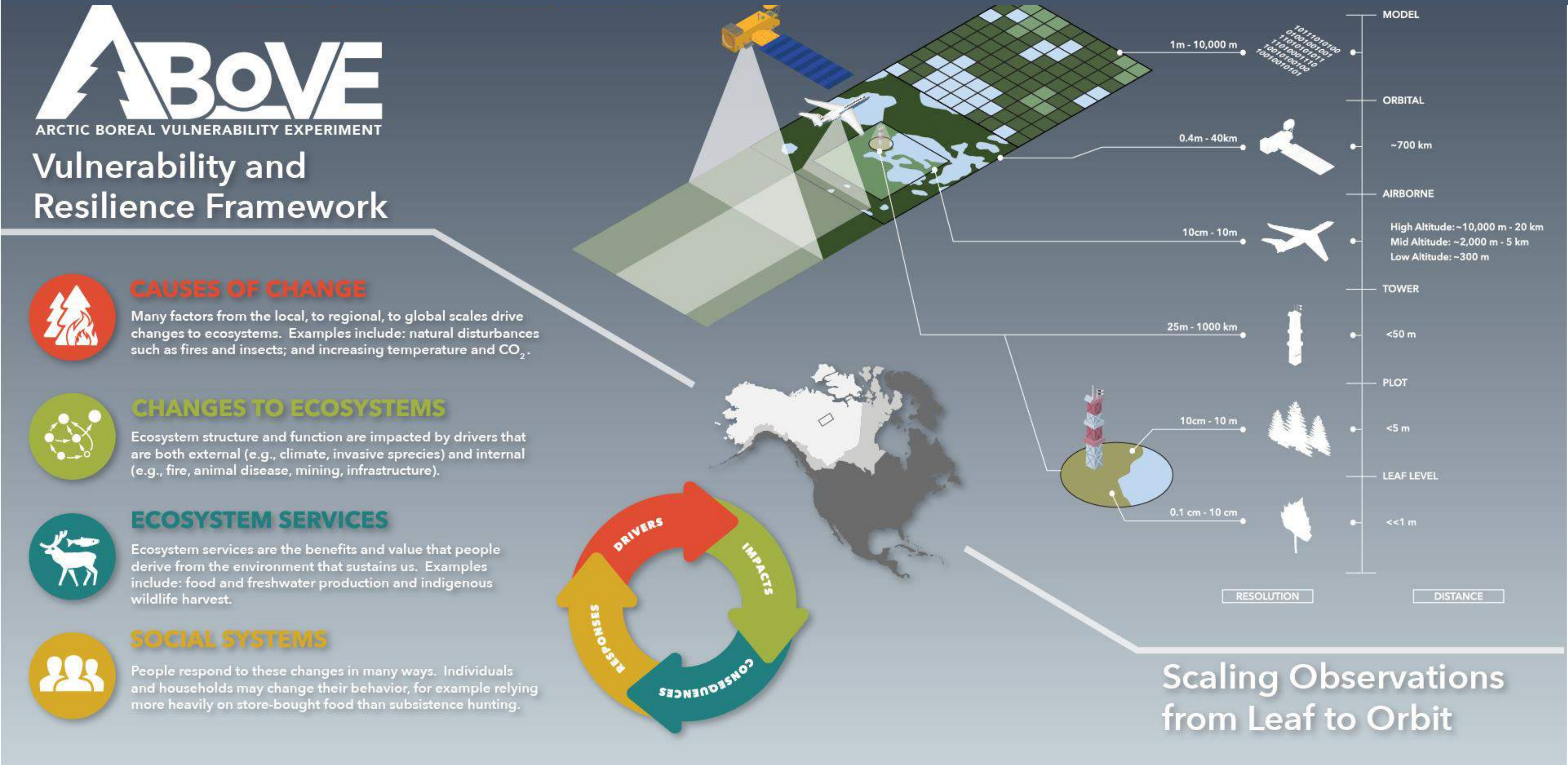




(above) Modeling drivers of *Barrenground* herds using tracking data during Spring migration.

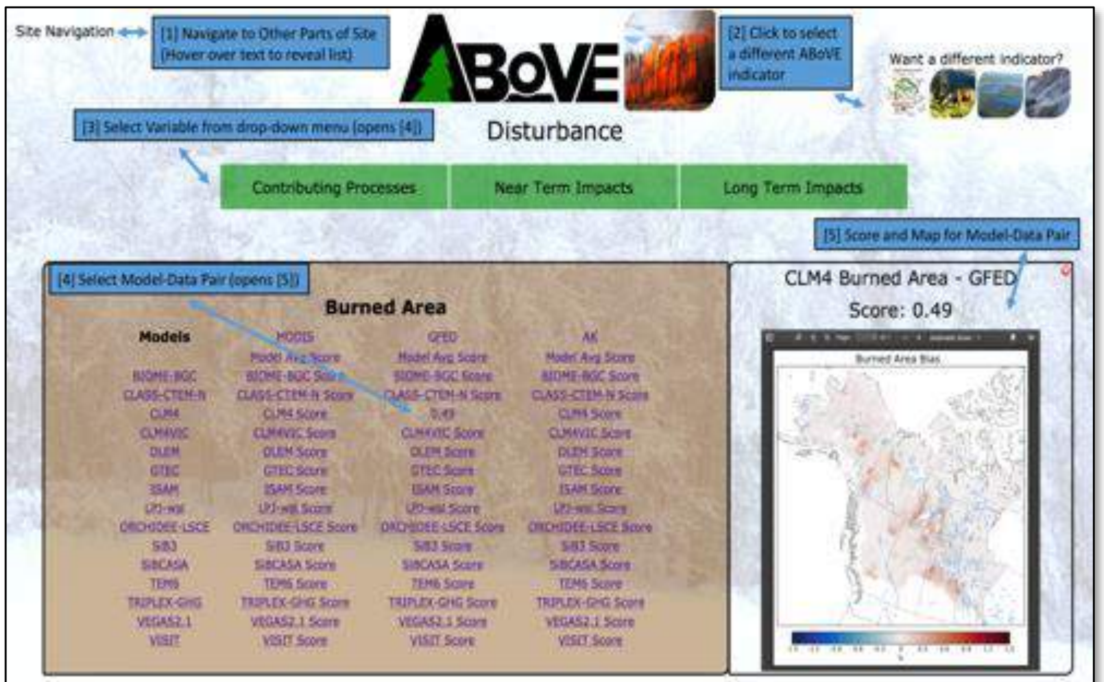
(left) *Woodland* herd ranges are impacted by fire and predator utilization of gas exploration cut lines

ABoVE is ultimately about coordinating & facilitating transdisciplinary science in a resiliency / vulnerability framework..



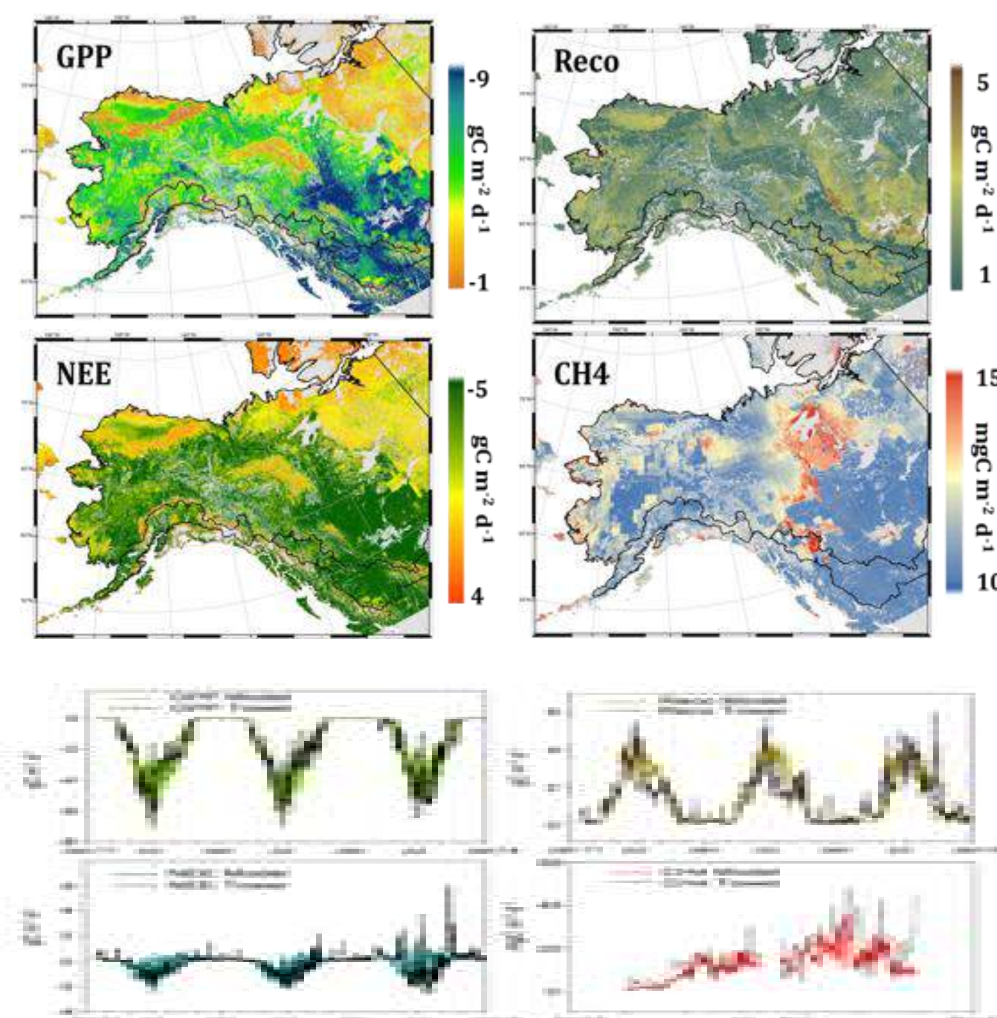
..and Capturing Vulnerability / Resiliency in Models

Model-Data Integration Framework



Fisher et al. 2018.
Missing pieces to modeling the Arctic-Boreal puzzle. *Environmental Research Letters*,
ABoVE Focus Collection

Model Development & Results



PLANNING, DATA MANAGEMENT AND DISCOVERY WORKFLOW