

Considering Alaska Landscapes; science questions, places, and people

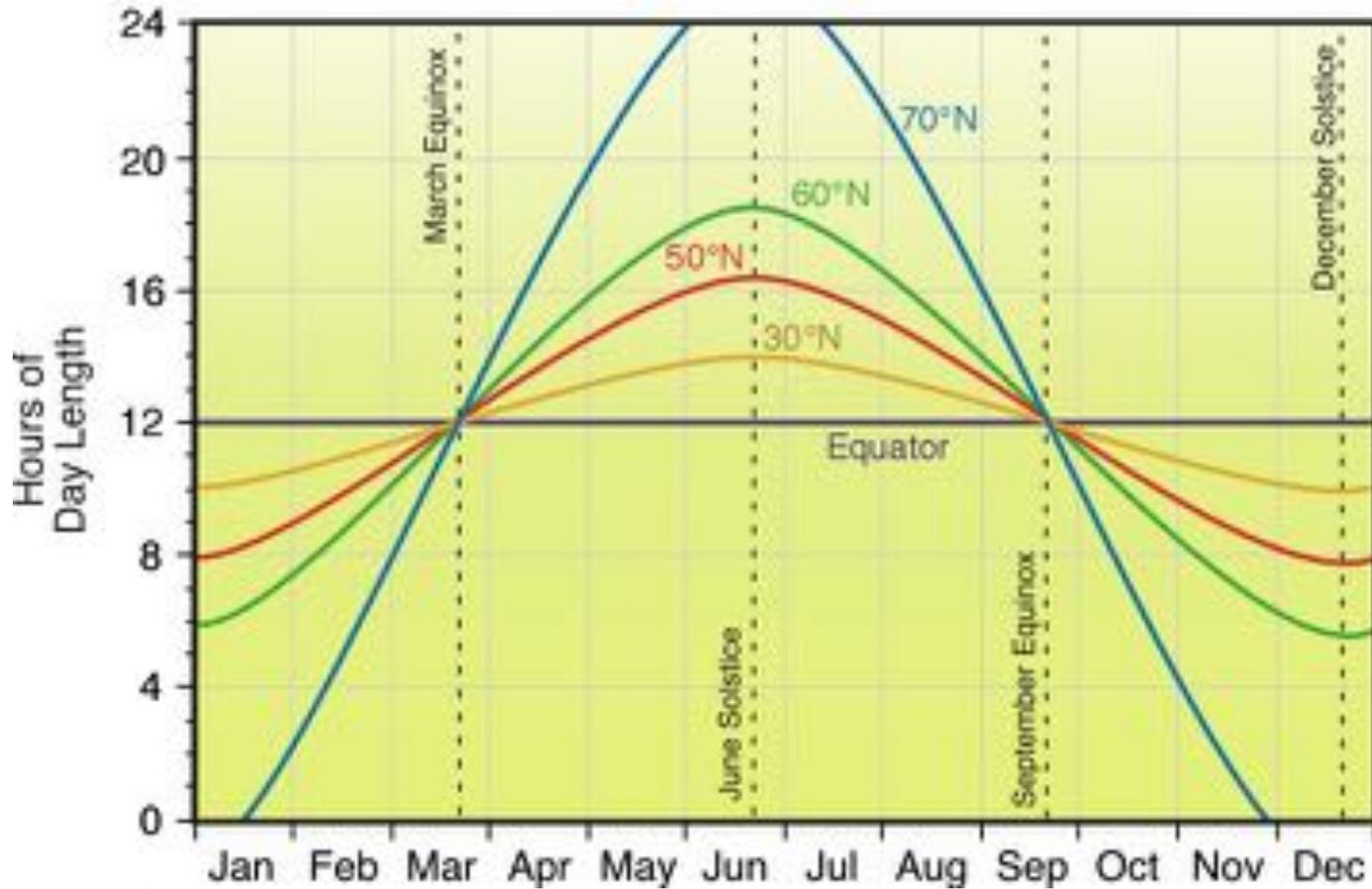
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What's special about high latitudes?



Source: UAF



Source: Physicalgeography.net

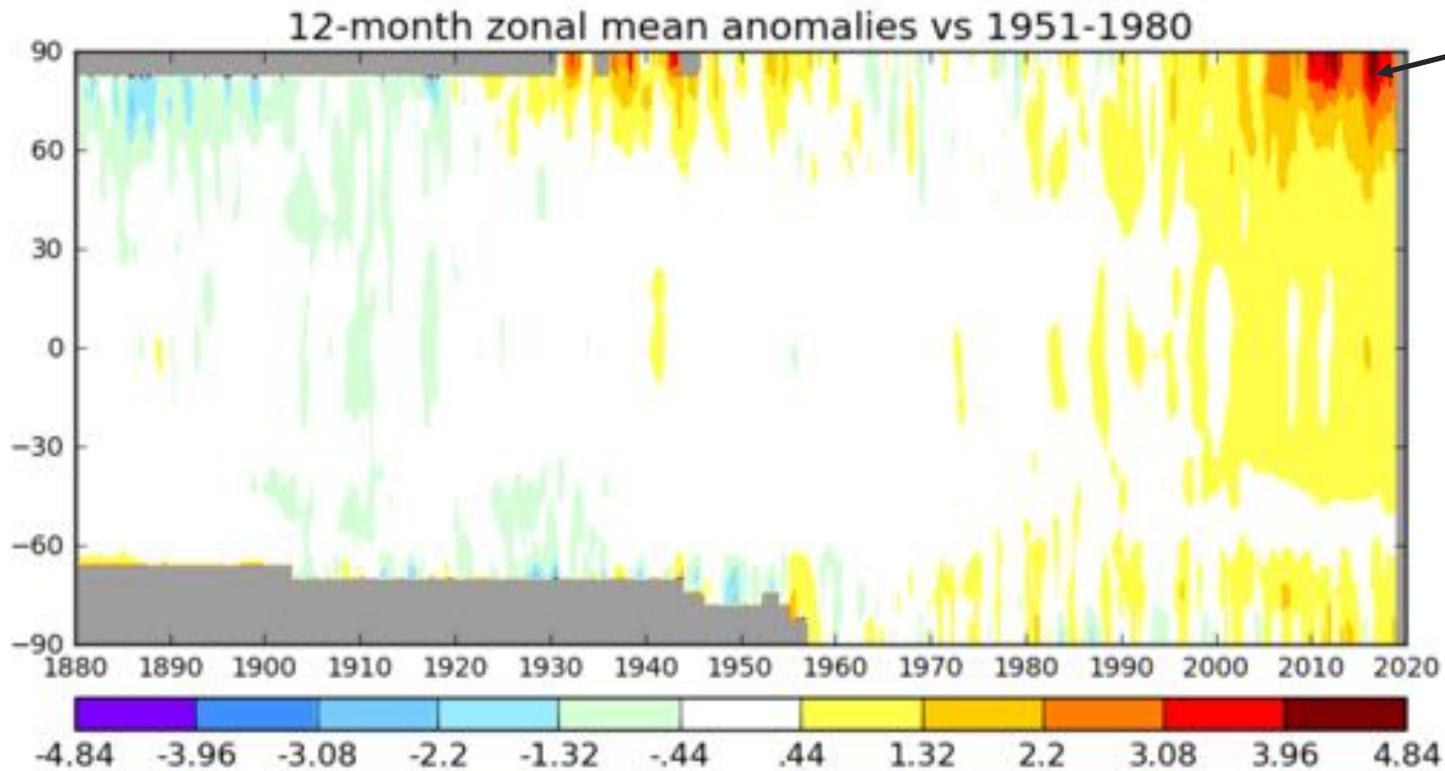
What's special II

Sparse People,
Sparse Observations



Source: NASA

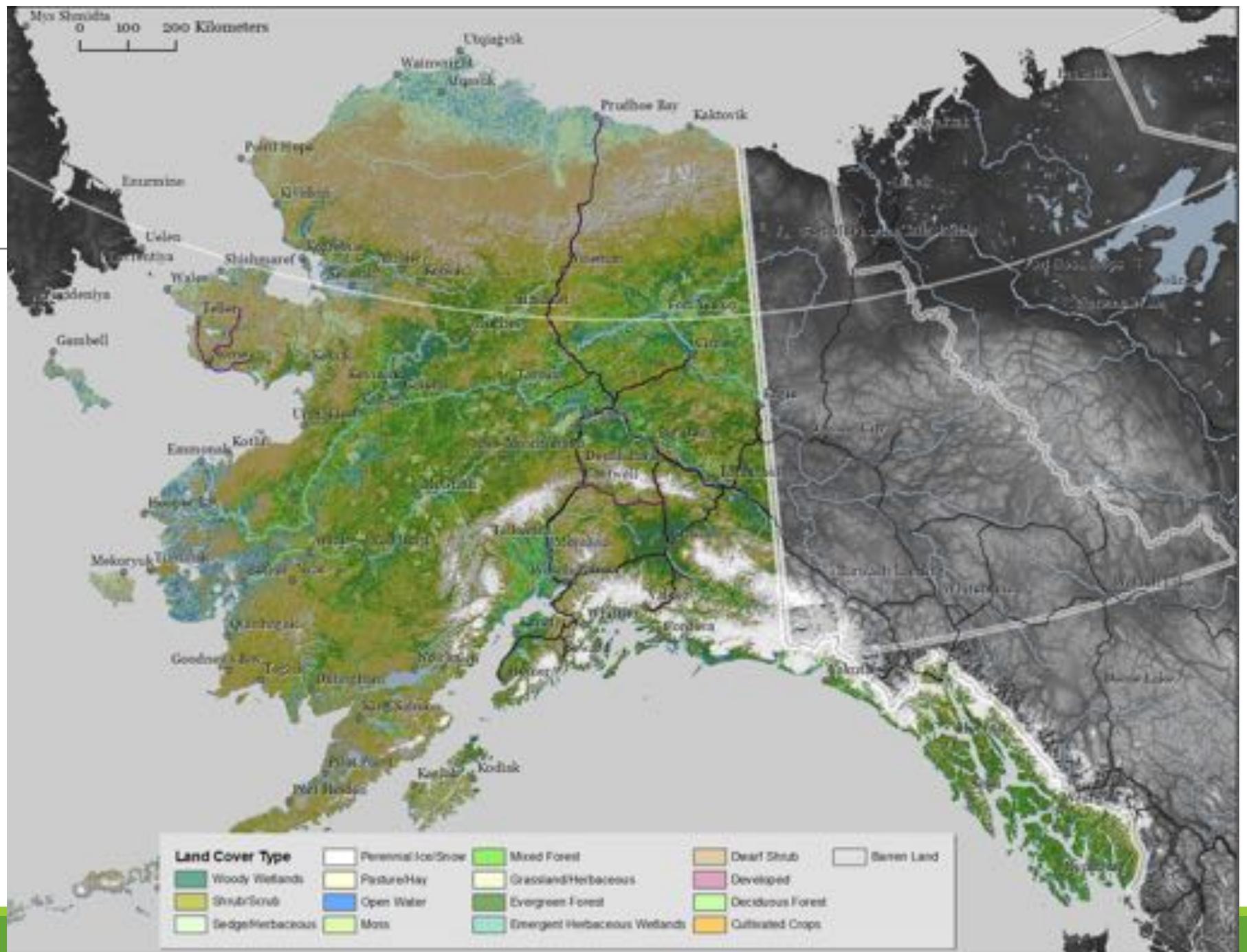
What's Special III



Arctic Amplification

Source:
GISS Surface Temperature Analysis (v4)

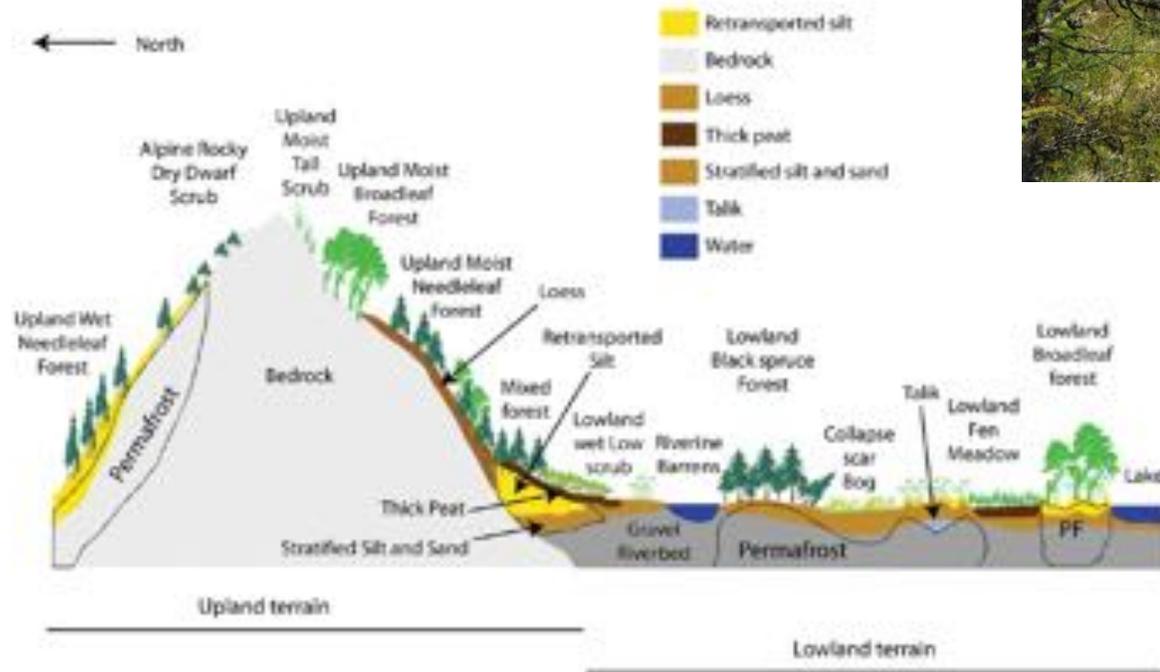
Land Cover



Arctic Landscapes



Boreal Forest



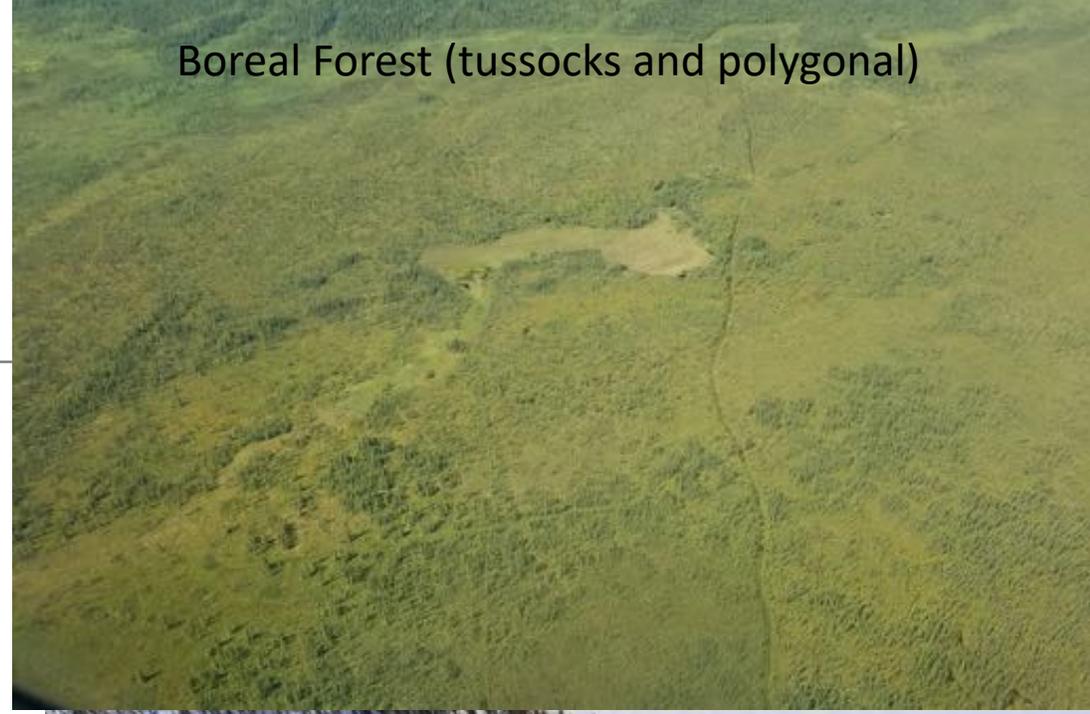
Elementa: Science of the Anthropocene • 2: 000032 • doi: 10.12952/journal.elementa.000032

Douglas et al, 2014; Jorgenson et al. 2010

Arctic Tundra (polygonal)



Boreal Forest (tussocks and polygonal)



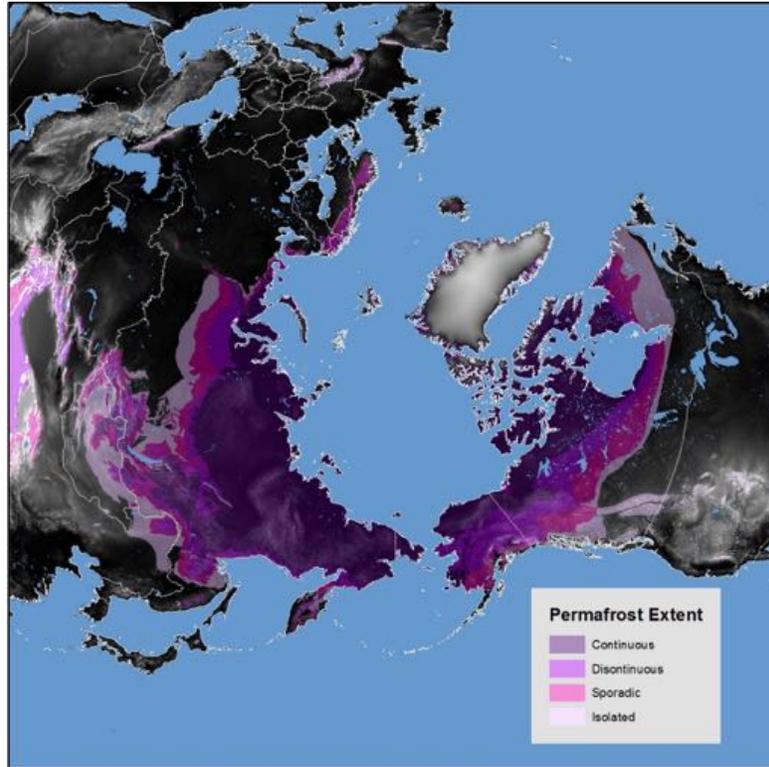
Landscape and
Snow Differences



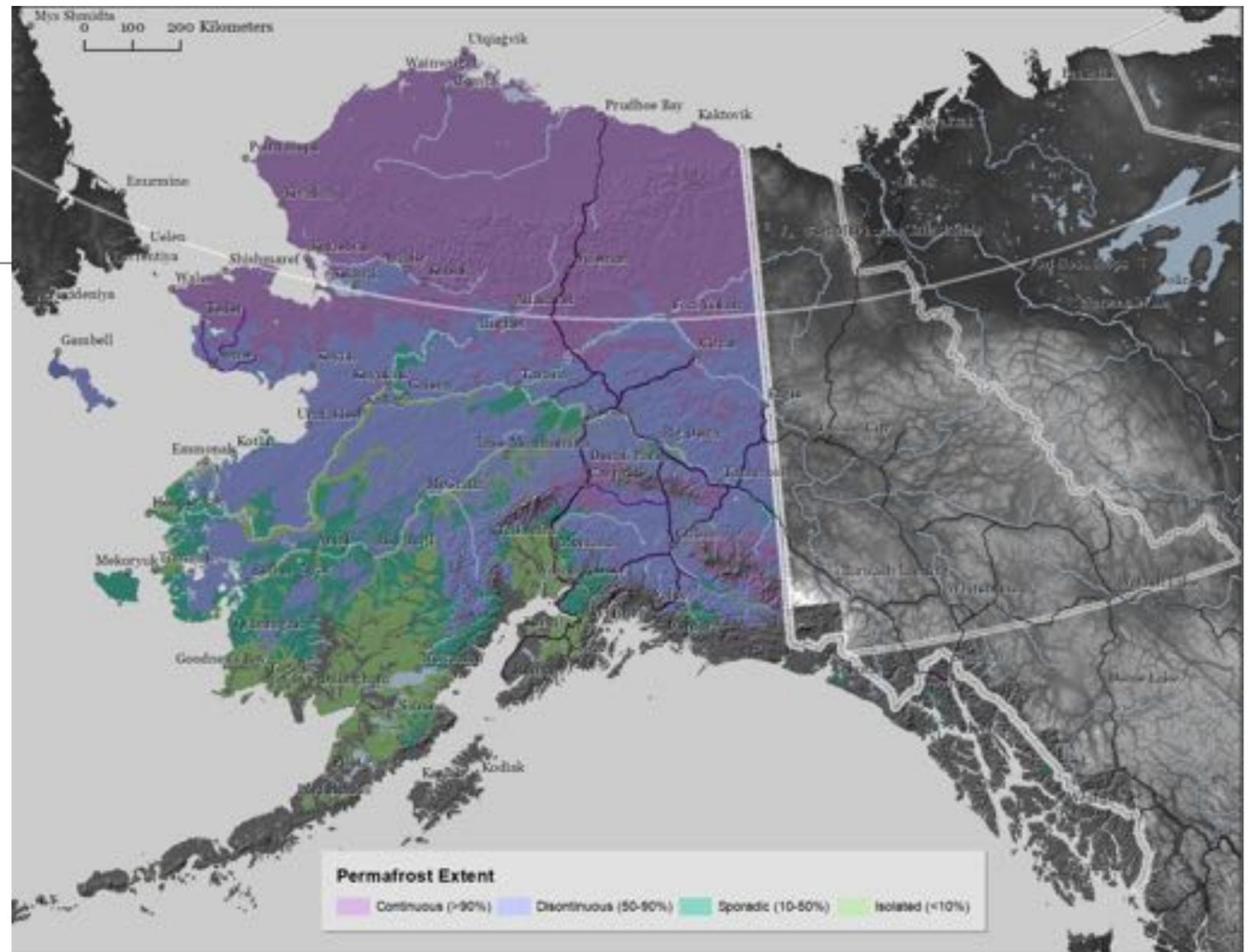
Permafrost Landscapes (Boreal)



Permafrost



Brown et al. 1998



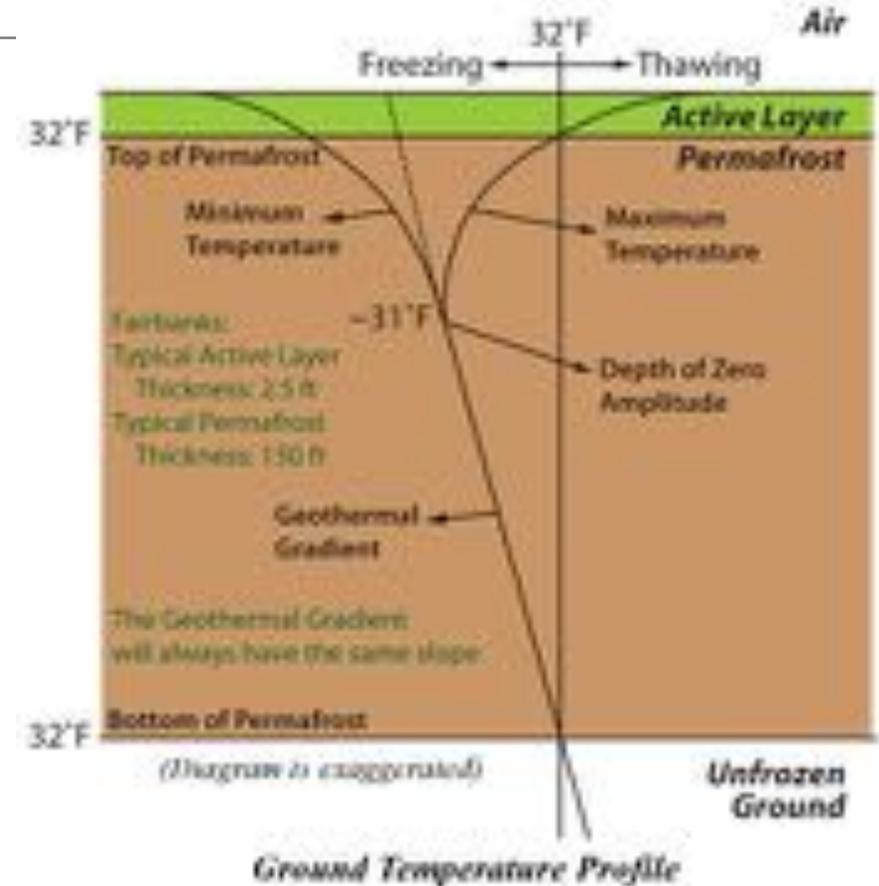
Jorgenson et al. 2008

Cryosphere: Permafrost

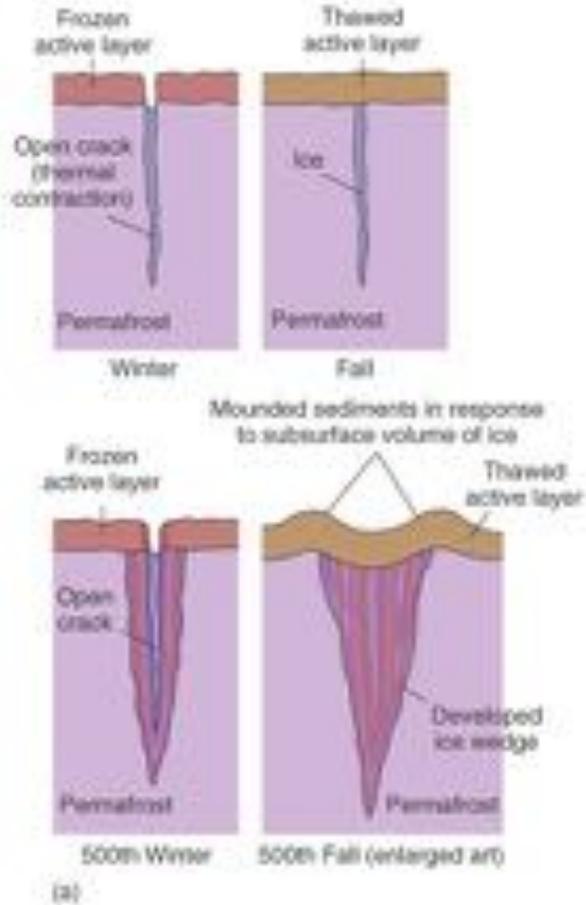
Soil or Rock Frozen for 2+ years.

Two Layers:

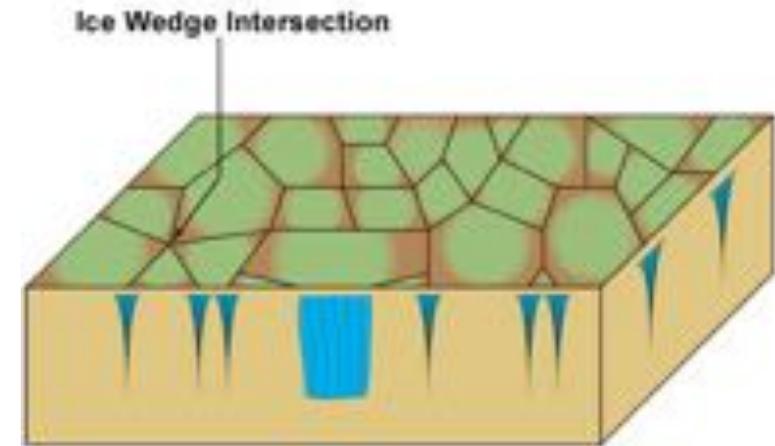
- Active Layer (thaws and re-freezes from the top)
- Permafrost (stays frozen)



Ice Wedges

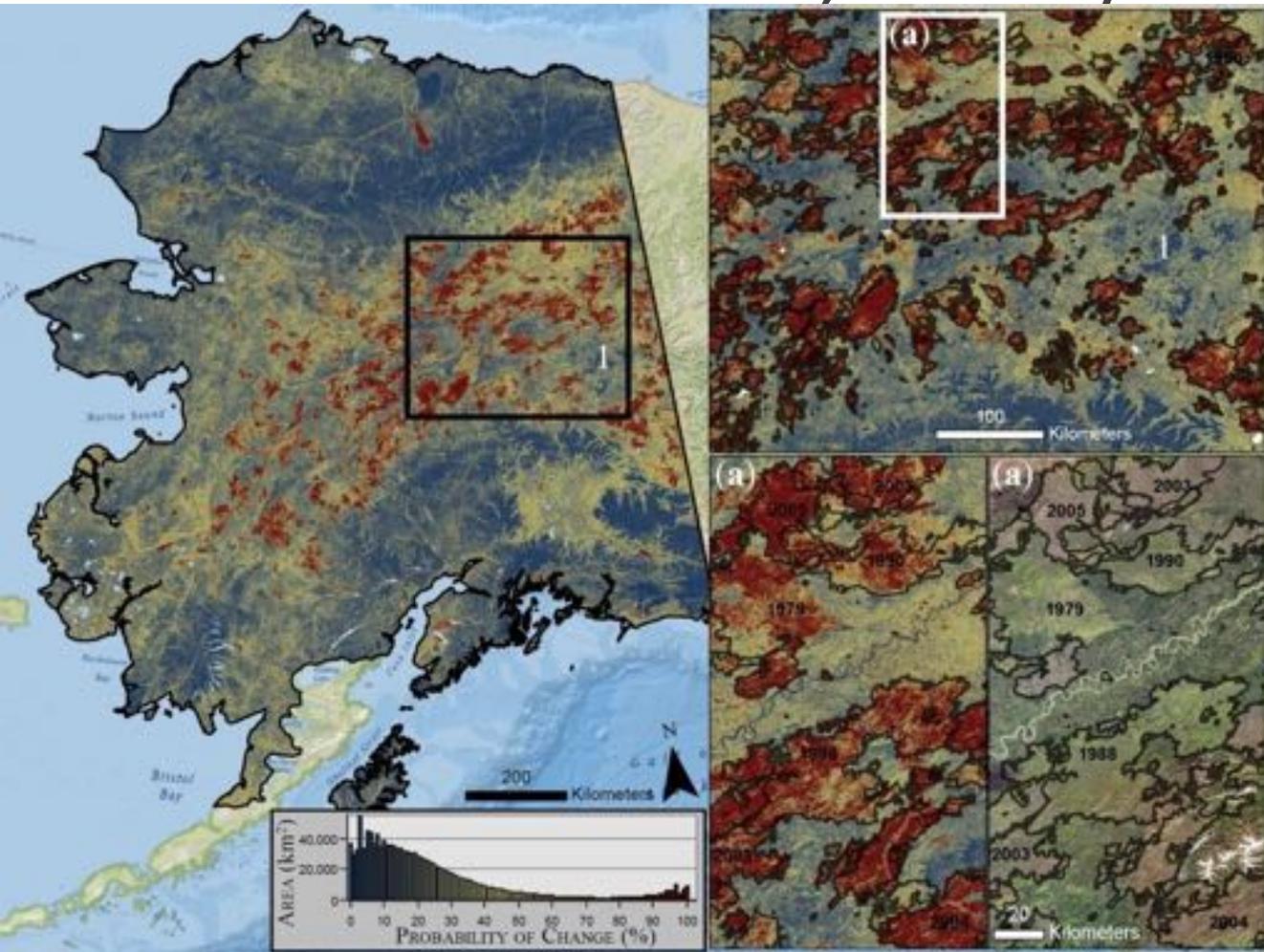


(b)

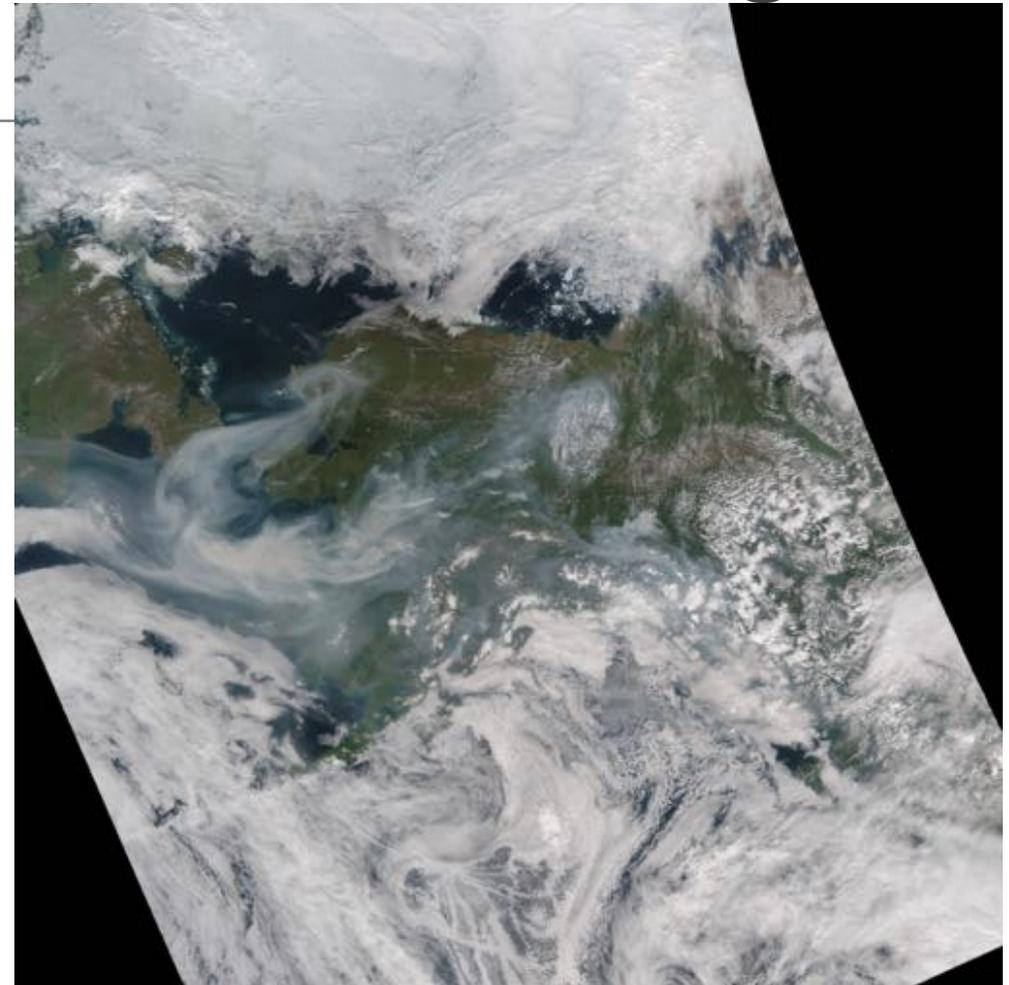


CRREL

Disturbances; Ecosystem Science Linkages

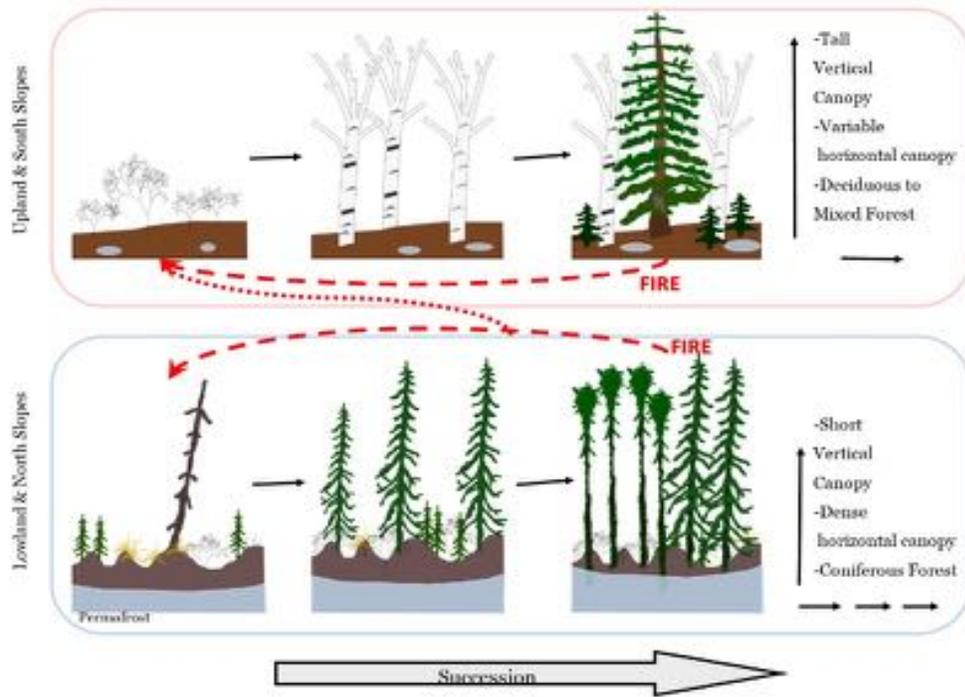


Pastick et al. 2018



SNPP True Color 9 July 2019

Successional Pathways



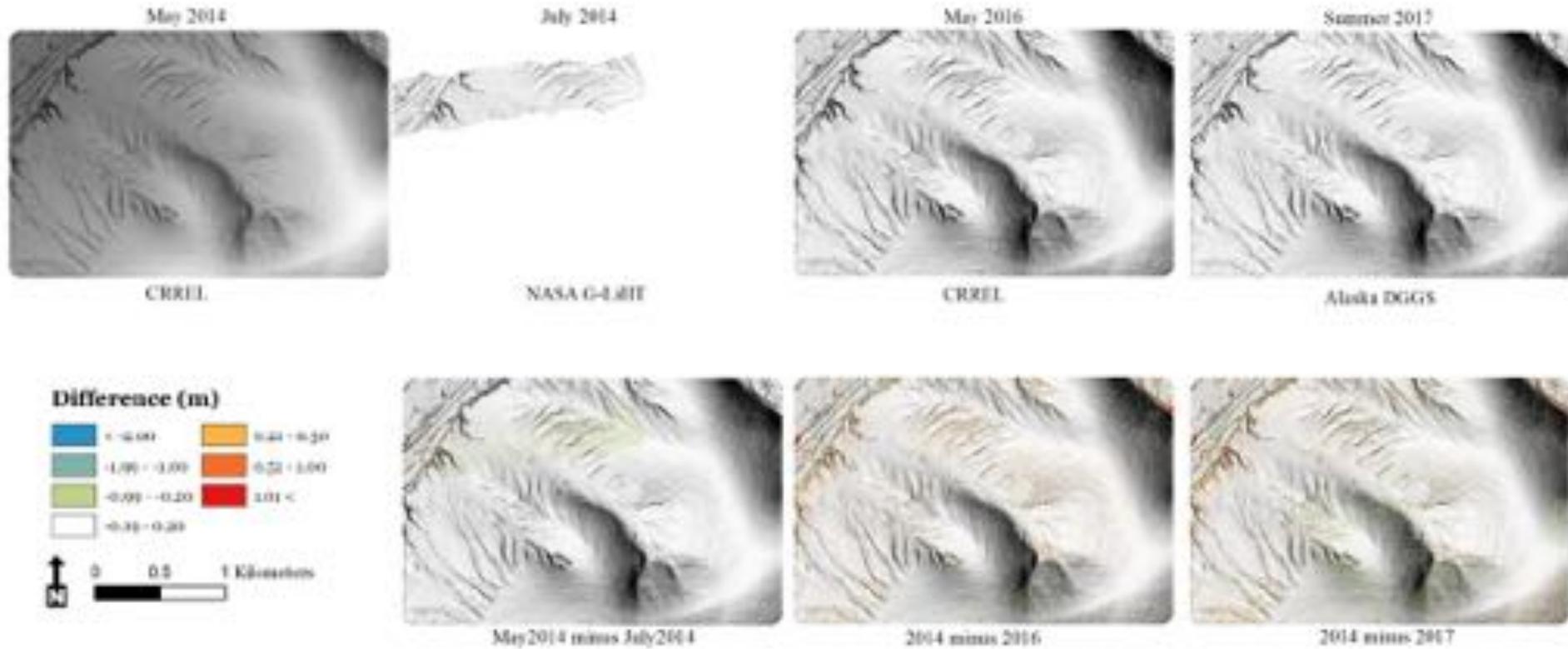
Bark Beetles



Thermokarst



Thermokarst



Snow

Isolated Efforts (long and short term)

Ground truth efforts done by potential partners:

CRREL (Hiemstra, Douglas, Vas)

University of Alaska Fairbanks

(Sturm, Arp, Jones, Liljedahl, Stuefer)

University of Alaska Anchorage (Pedersen)

Colorado State University (Liston)

NOAA River Forecast Office (Cherry)

National Park Service (Kirchner)

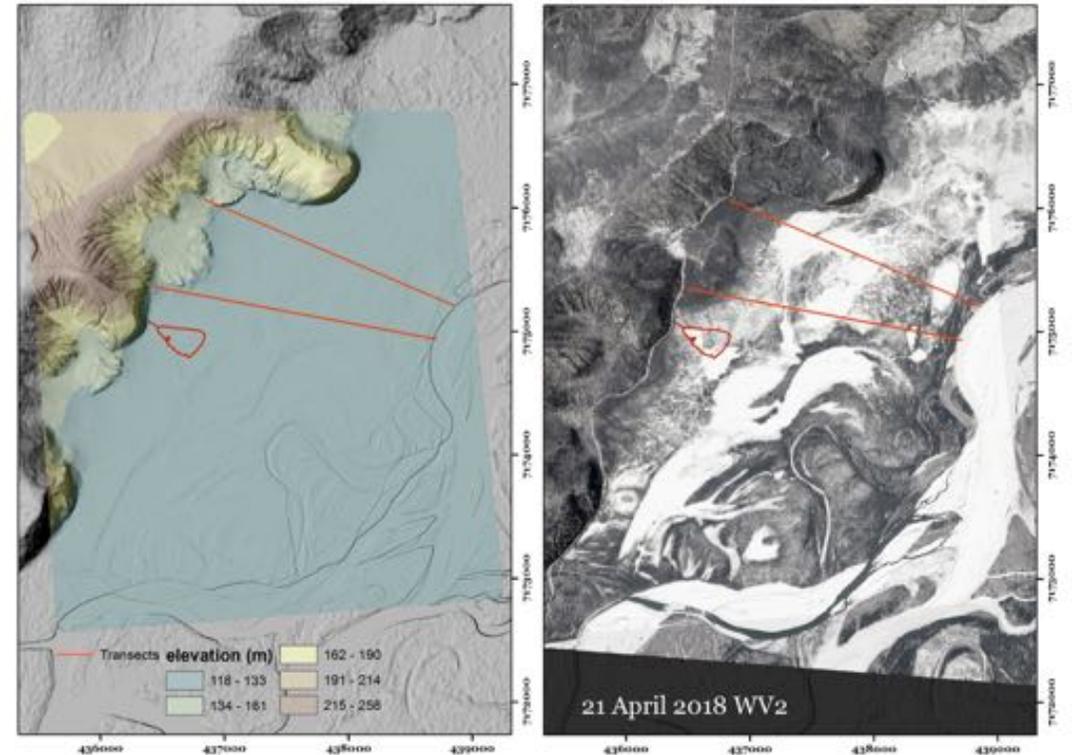
USGS (Urban, Toohey, and Littell)

DOE (Wilson, Bennett)

NEON

USFWS

BLM



Apex Site and Transects
(2015-present)

SnowEx Science Plan's Overarching Question:

What is the distribution of snow-water equivalent (SWE), and the snow energy balance, in different canopy types and densities, and terrain?

Science Traceability Matrix:

What are the patterns of snow accumulation and melt in boreal vs. temperate forests, and what is the resulting hydrologic partitioning of snowmelt in these areas?

Linking Snow, Land Cover, and Permafrost

How well do *snow depth* retrieval methods (e.g., lidar, InSAR, SfM) work where “bare earth” surfaces change? Snow-free surface elevations can vary cms to dms in one season and over years. Some shrub canopies become prostrate with cold temperatures and areas with severe surface roughness (e.g., tussocks) are common. What errors do these challenges create? Do snow depth estimates in more mature forest stands have higher errors due to low density ground-canopy components (mosses, lichens, grasses, and prostrate shrubs) becoming compressed with snow? The moss/lichen and snow boundary can be indeterminate. How do variations in measuring its position impact SWE estimates? How well do methods that integrate multiple types of data with process-based models help to fill in observational gaps?

How do canopy succession and disturbance impact ground conditions, snow properties, and our ability to estimate SWE in boreal and Arctic landscapes? How do vertical and horizontal canopy structures impact surface energy, thaw depth, snow properties (e.g., depth, density, moisture, grain type and size, conductivity), and snowmelt? How abundant are void spaces between the snow and ground surfaces, and what are their impacts on remote sensing of boreal and tundra snow? How persistent are voids, and in what landscapes are they most abundant?

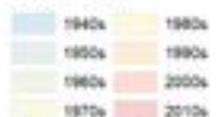
How do we quantify the interactions among snow arrival, timing, and conditions; and canopy snow retention and reaction to snow cover (flexible vs. rigid; snow retention in canopy); albedo and energy balance over a season and during melt?

How do vegetation and snow cover processes impact the “zero curtain” or freeze-thaw status of the surface layer and active layer transitions over seasonal time scales? How does this impact snow remote sensing?

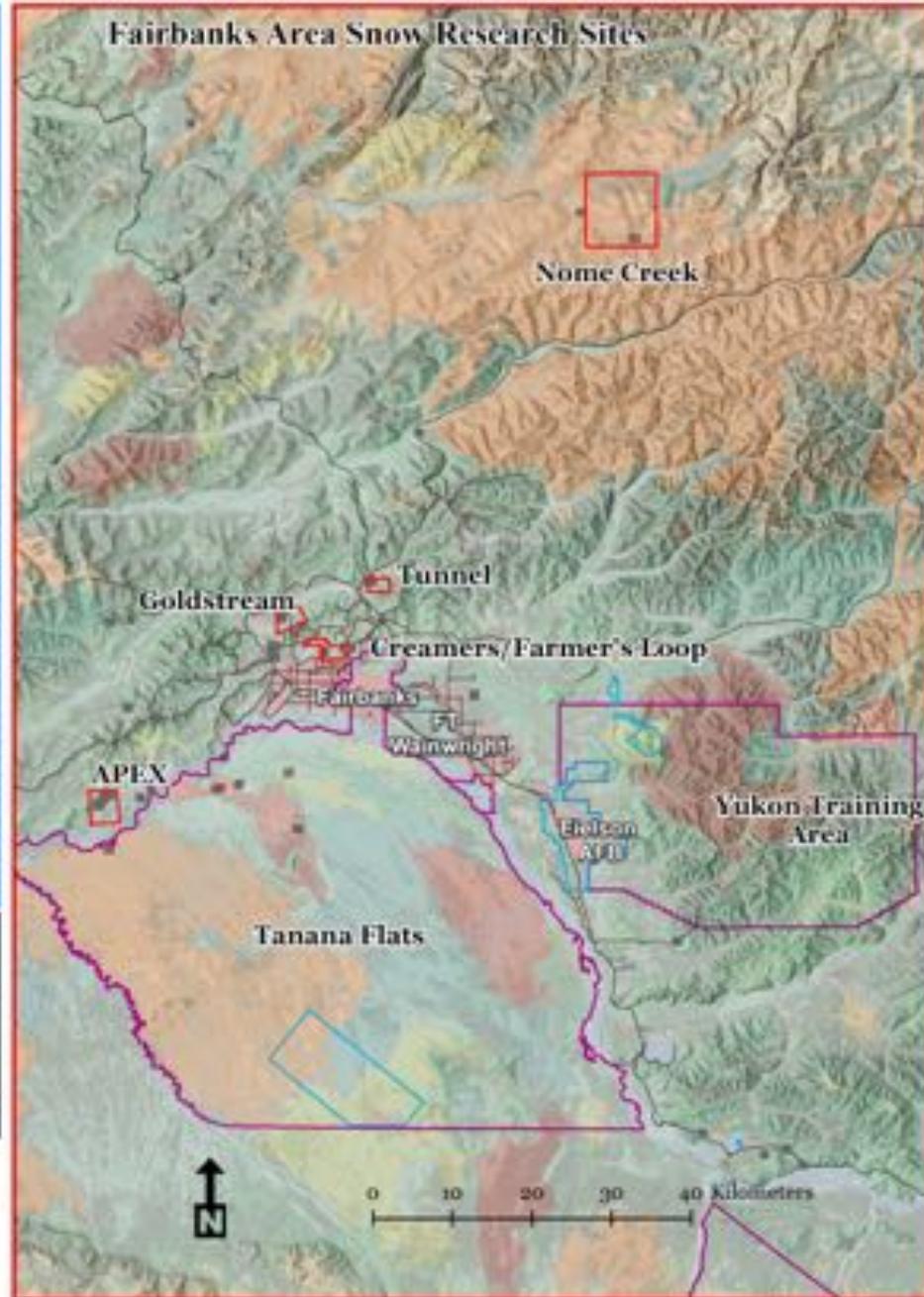


■ ABOVE Ground Locations

Fire Year



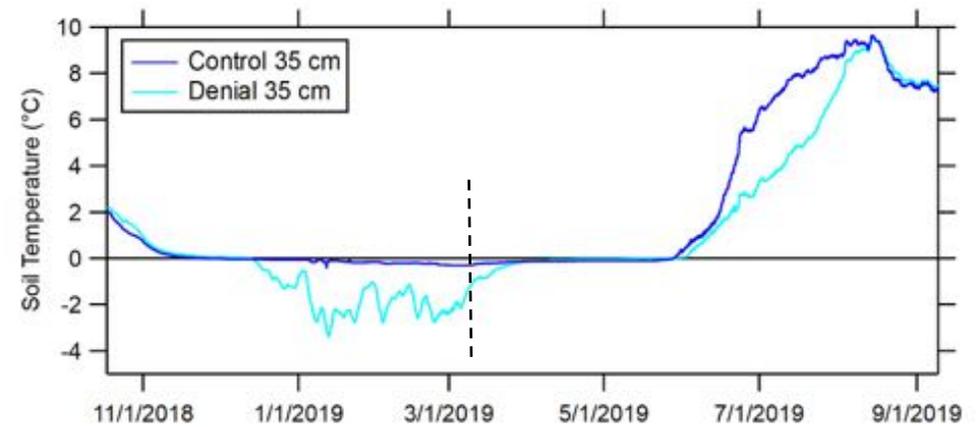
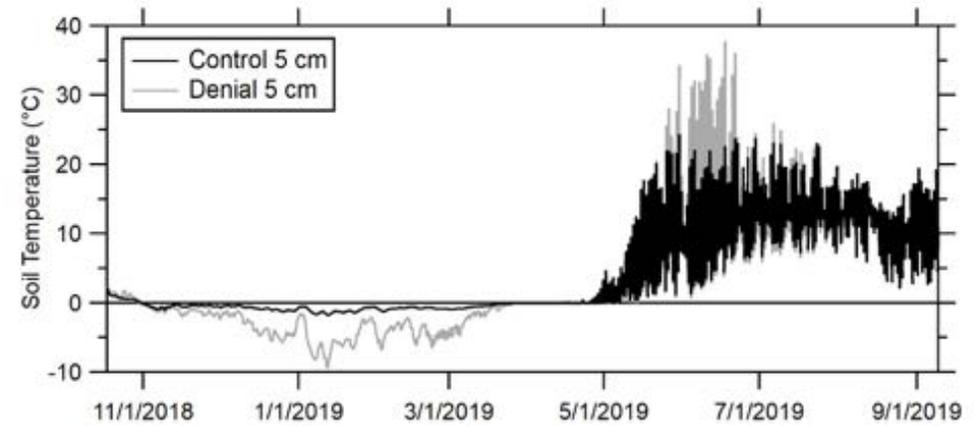
NALCMS Land Cover



Datasets

Site (Figure 3)	Permafrost	Meteorological	Snow	Aerial lidar	Stereo imagery (s=snow; ns = no snow)
Nome Creek (upland)	N/A	Temp, RH, WSpd, WDir	Daily Depths; March Campaign 2015-2019	2010	2018s/ns 2019s
Tunnel (upland)	Geophysics, Drill Logs	Temp, RH, WSpd, WDir, Ground Temp.	Daily Depths, SWE; March Campaign 2013-2019	2014, 2016, 2017	2018s/ns 2019s
APEX (upland and lowland)	Geophysics, Drill Logs	Temp, RH, WSpd, WDir, Ground Temp	March Campaign 2015-2019	2016	2018s/ns 2019s
Yukon Training Area (upland and lowland)	Mapped	Temp, RH, WSpd, WDir, Ground Temp	N/A	2018	2019s
Goldstream (lowland)	Geophysics,	N/A	March Campaign 2016-2019	2016, 2017	N/A
Creamers/Farmers Loop (lowland)	Geophysics, Drill Logs	Temp, RH, WSpd, WDir, Ground Temp	Daily Depths; March Campaign 2013-2019	2014 2016 2017	2018s/ns 2019s
Tanana Flats Training Area (lowland)	Geophysics, Mapped	N/A	N/A	2016* 2019	2019s

2018-2019 Snow Denial Experiment



Shovel Creek Fire

- 9000 Ha
- Started 21 June 2019



28 June 2019



Alaska Snow Links

Most recognize snow as important feature and have desperately little information about it (it's desired, but largely ignored)

Alaska Federal Land Managers (NPS, FWS, BLM; largest federal land holdings, 61% of state)

Alaska-Pacific River Forecast Center (NOAA-NWS)

Natural Resources Conservation Service Alaska (USDA-NRCS)

Alaska Climate Adaptation Science Center; Alaska Science Center (USGS)

National Ecological Observing Network (NSF-NEON)

US Army, US Air Force (Alaska Training Ranges)

US Army Corps of Engineers (Alaska District)

UAF (strong snow research for decades, research stations)

Alaska Division of Geological and Geophysical Surveys (DGGS)

- Citizen Snow Science Observations

Industry (1002 area, ANWR)

