An aerial photograph of a vast, snow-covered landscape. The snow is uneven, with numerous small mounds and depressions. Sparse, low-lying vegetation, likely shrubs or small trees, is scattered across the terrain. Long, soft shadows are cast across the snow, suggesting a low sun position. The overall scene is bright and wintry.

NGEE-Arctic research activities on snow redistribution processes and impacts

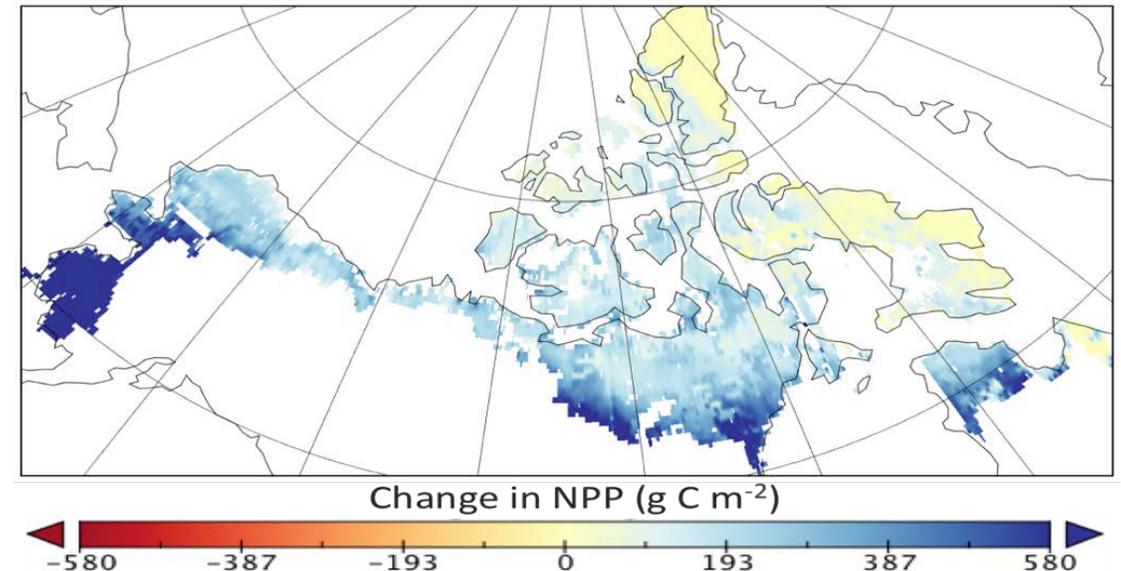
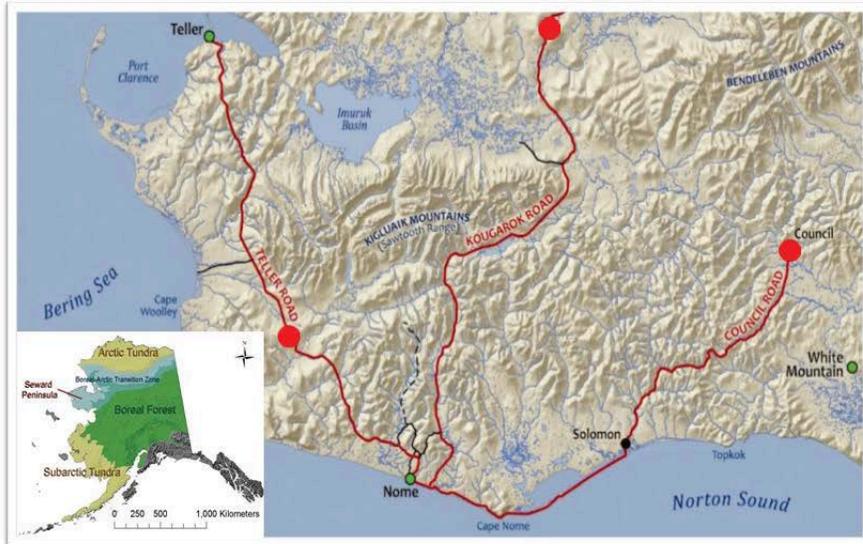
Cathy Wilson

July 8, 2019 SnowEx-ABOVE planning meeting

NGEE Arctic

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.

Change in Shrub NPP
2100 - 2010

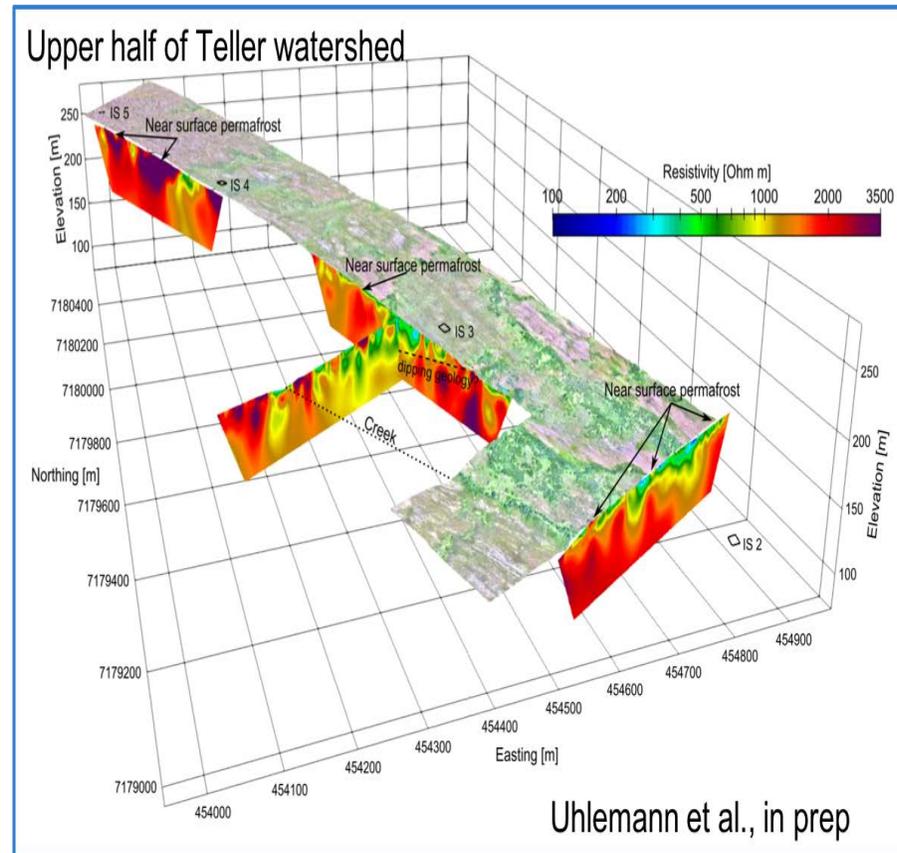


NGEE-Arctic Snow Research

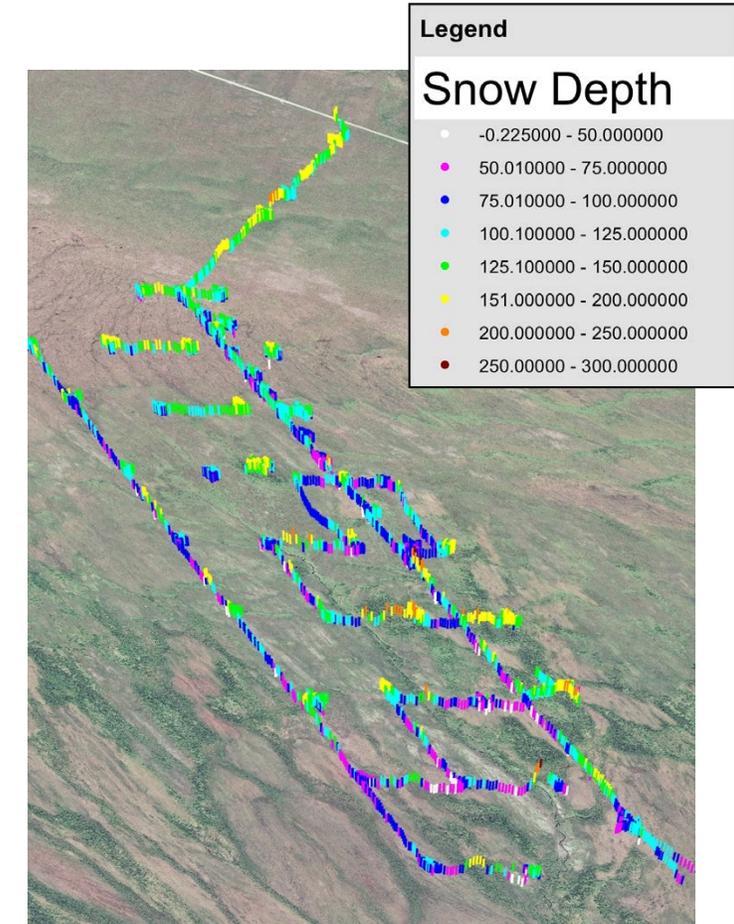
We are collecting, analyzing and modeling data that demonstrates the role of tall shrub patches in deep snow trapping, permafrost thaw and changes in watershed hydrology

Objectives

- Develop “physics informed” snow redistribution model for Earth System Land Models.
- Understand interactions between snow, topography, vegetation, permafrost and hydrology.
- Predict how interactions will change with climate.



Teller geophysical survey data showing talik under tall shrub patches



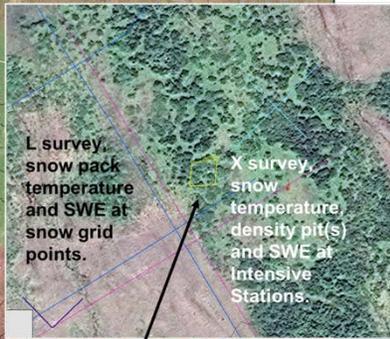
2018 Teller snow depth

Intensive snow survey at two watersheds with different topography, climate and ecology

Seward Peninsula



Teller Site (Mile 27)



L survey, snow pack temperature and SWE at snow grid points.

X survey, snow temperature, density pit(s) and SWE at Intensive Stations.

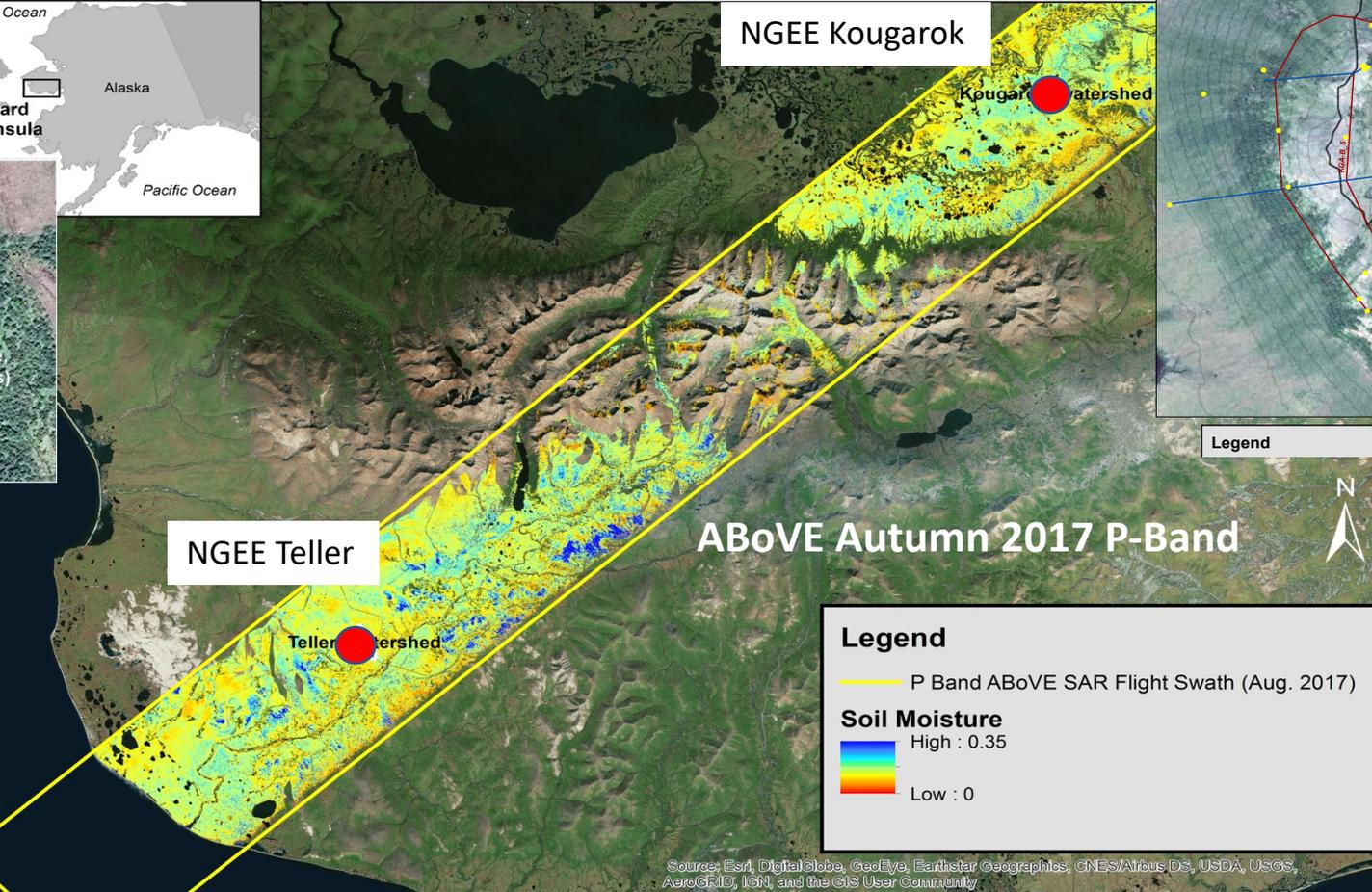
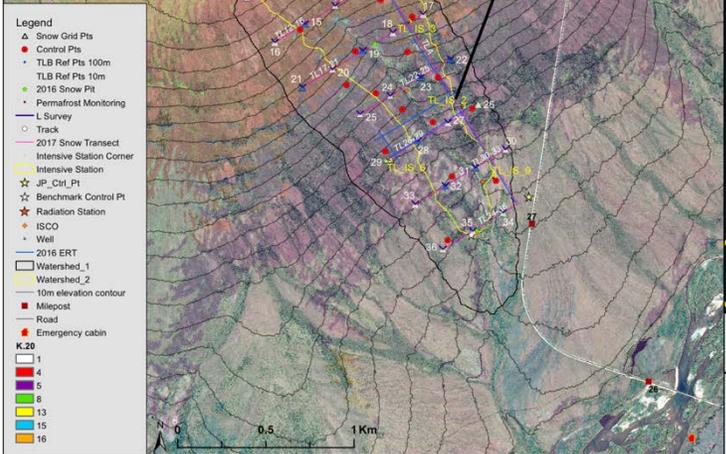
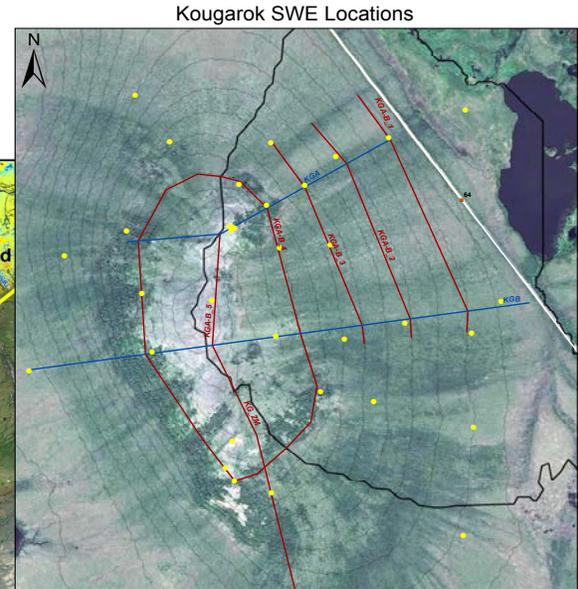
NGEE Kougarak

Kougarak Watershed

NGEE Teller

Teller Watershed

ABOVE Autumn 2017 P-Band

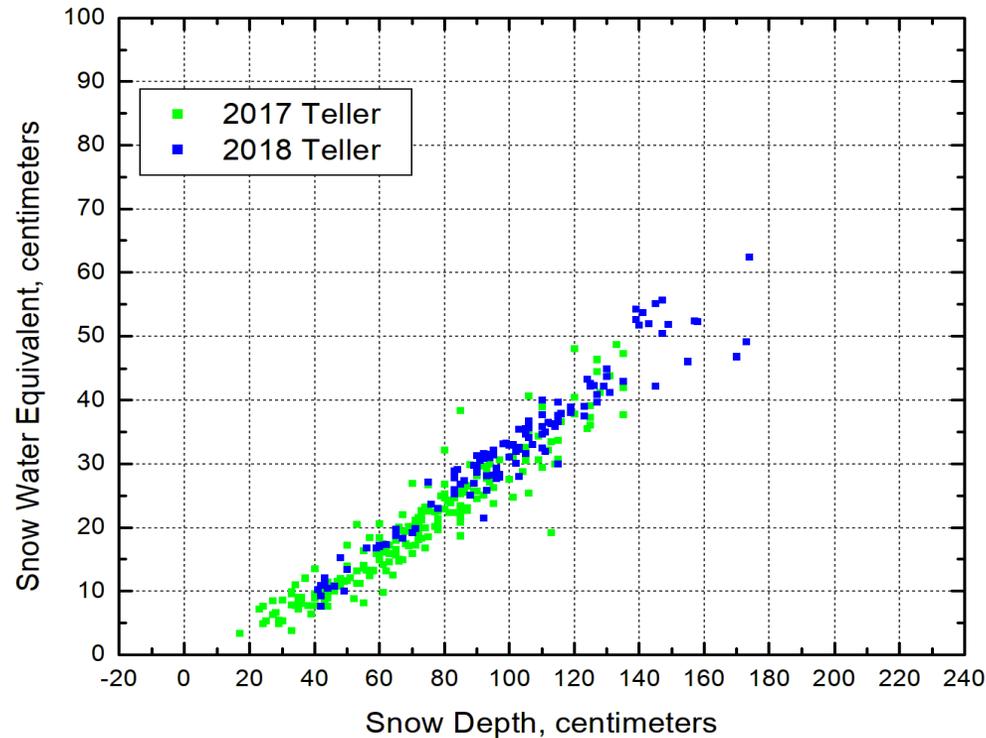


Source: Esri, DigitalGlobe, GeoEye, Earthstar Geographics, CNES/Airbus DS, USDA, USGS, AeroGRID, IGN, and the GIS User Community

Data includes tens of depth vs density, hundreds of SWE and snowpack temperature, thousands of depths over multiple years



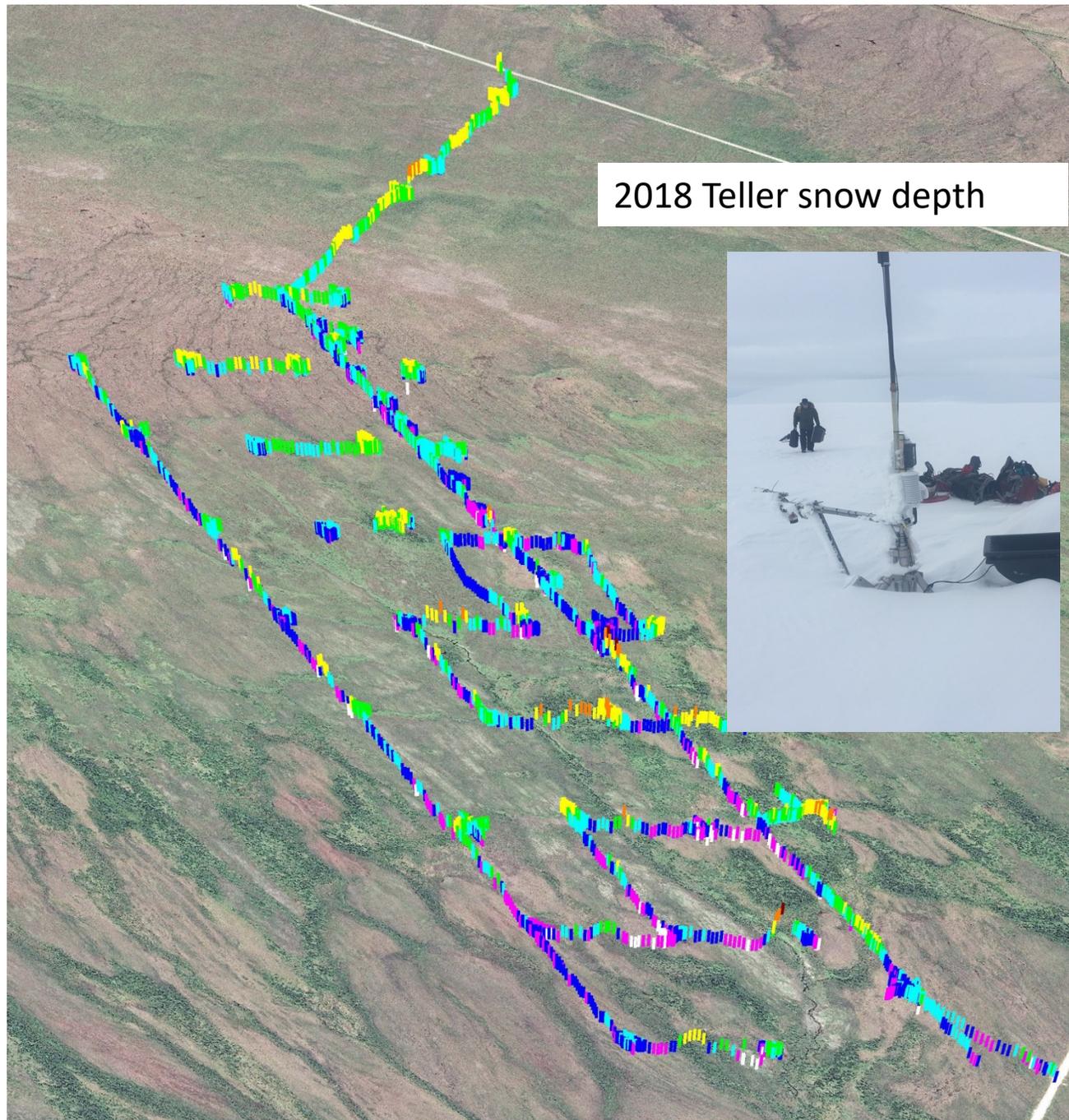
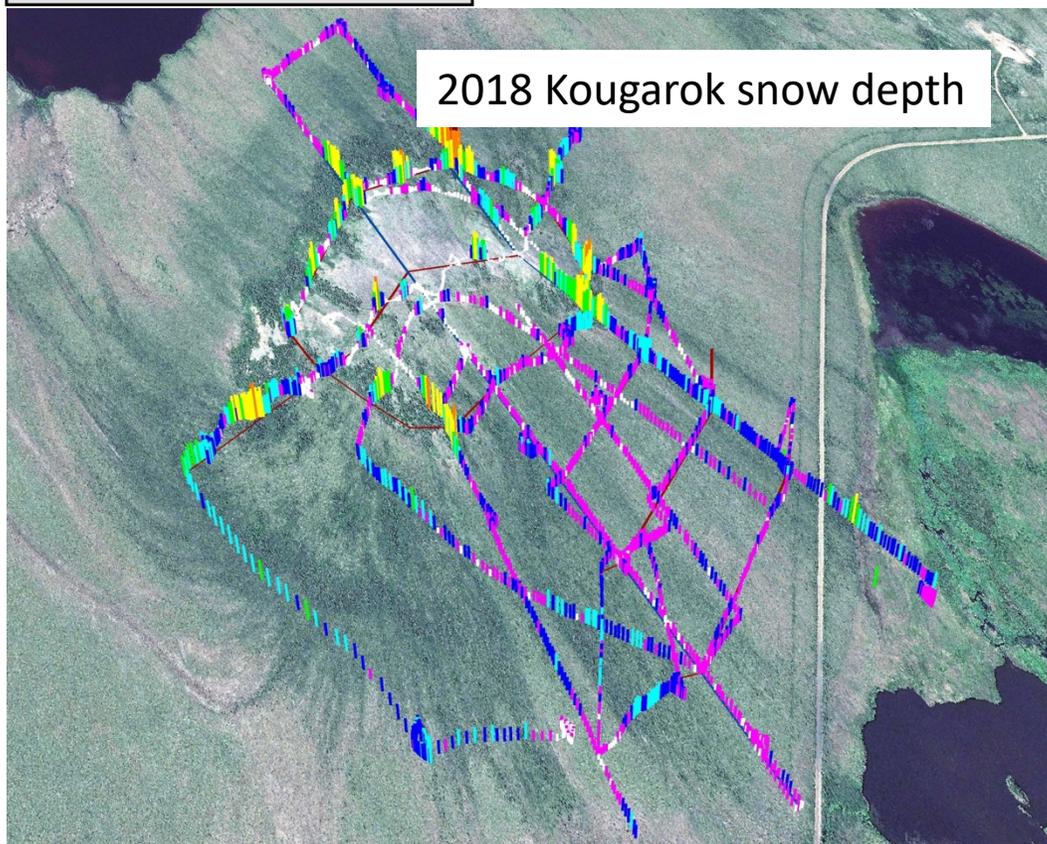
Snow Water Equivalent



Legend

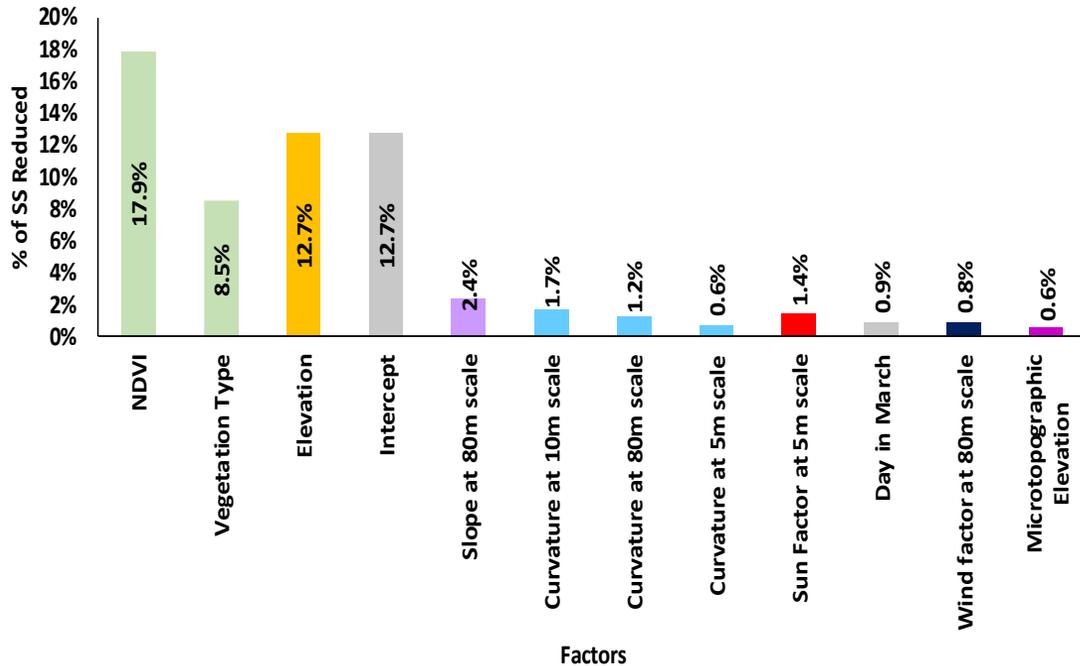
Snow Depth

- 0.225000 - 50.000000
- 50.010000 - 75.000000
- 75.010000 - 100.000000
- 100.100000 - 125.000000
- 125.100000 - 150.000000
- 151.000000 - 200.000000
- 200.000000 - 250.000000
- 250.000000 - 300.000000

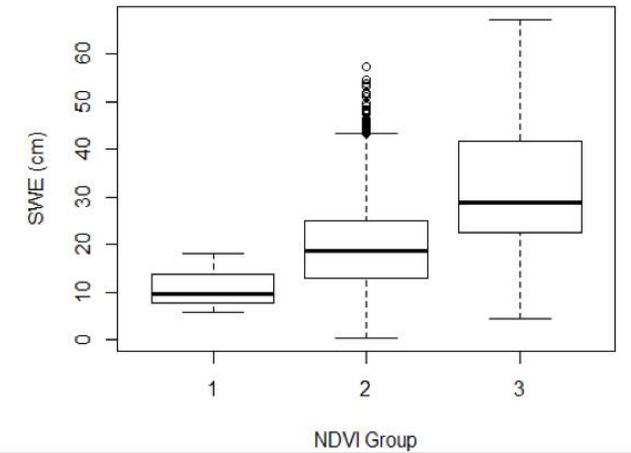
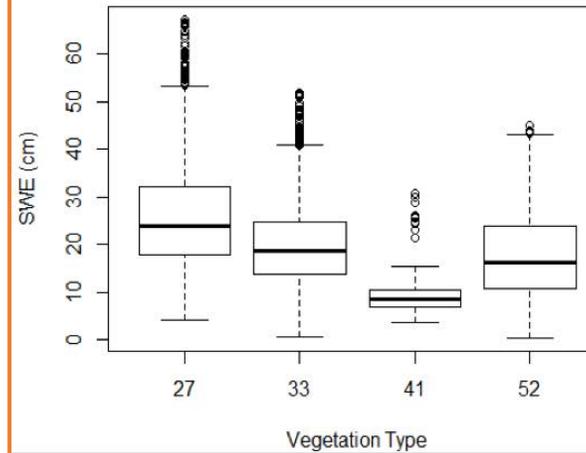
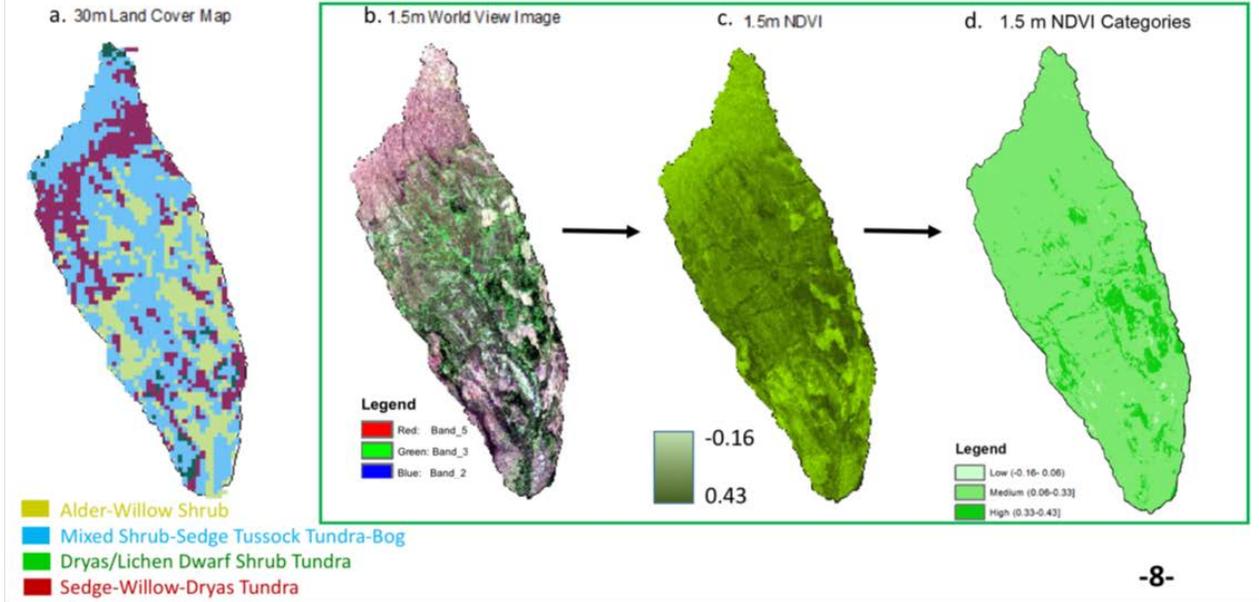


Vegetation height is the most important landscape factor affecting snow redistribution

NDVI better distinguished tall shrubs than veg map



Vegetation



27: Alder-Willow Shrub

33: Mixed Shrub-Sedge Tussock Tundra-Bog

41: Dryas/Lichen Dwarf Shrub Tundra

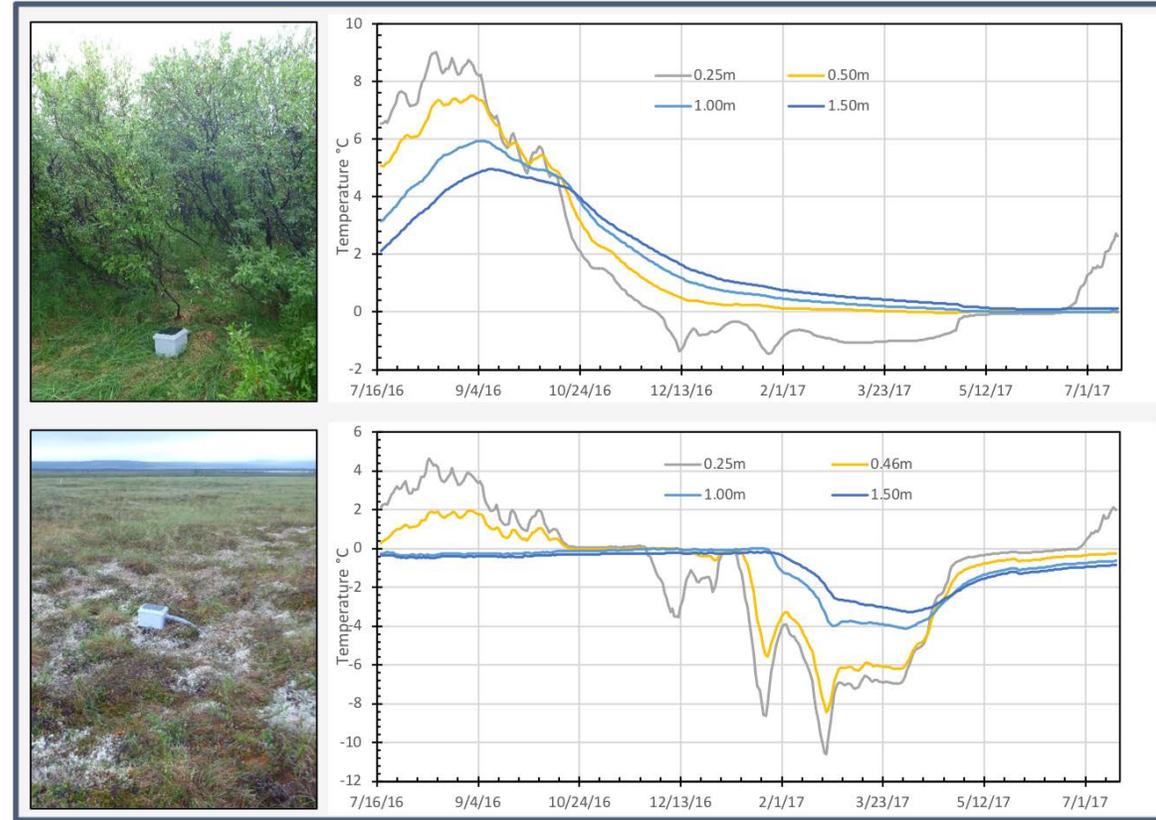
52: Sedge-Willow-Dryas Tundra

1: NDVI in (-0.16, 0.06]

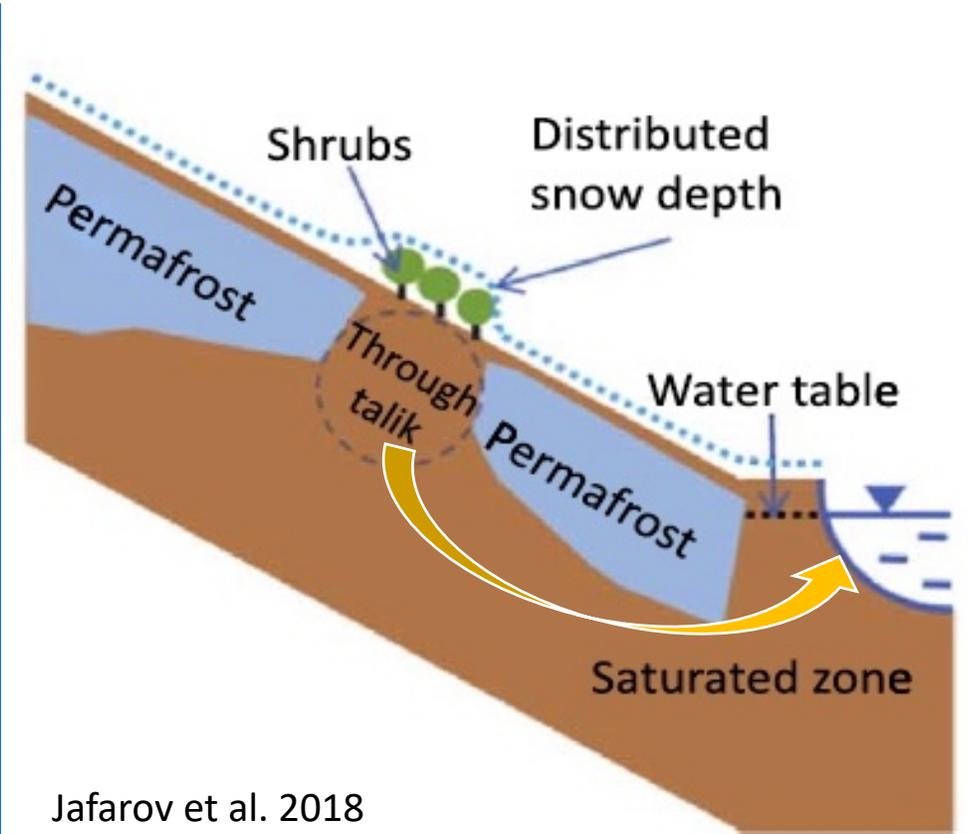
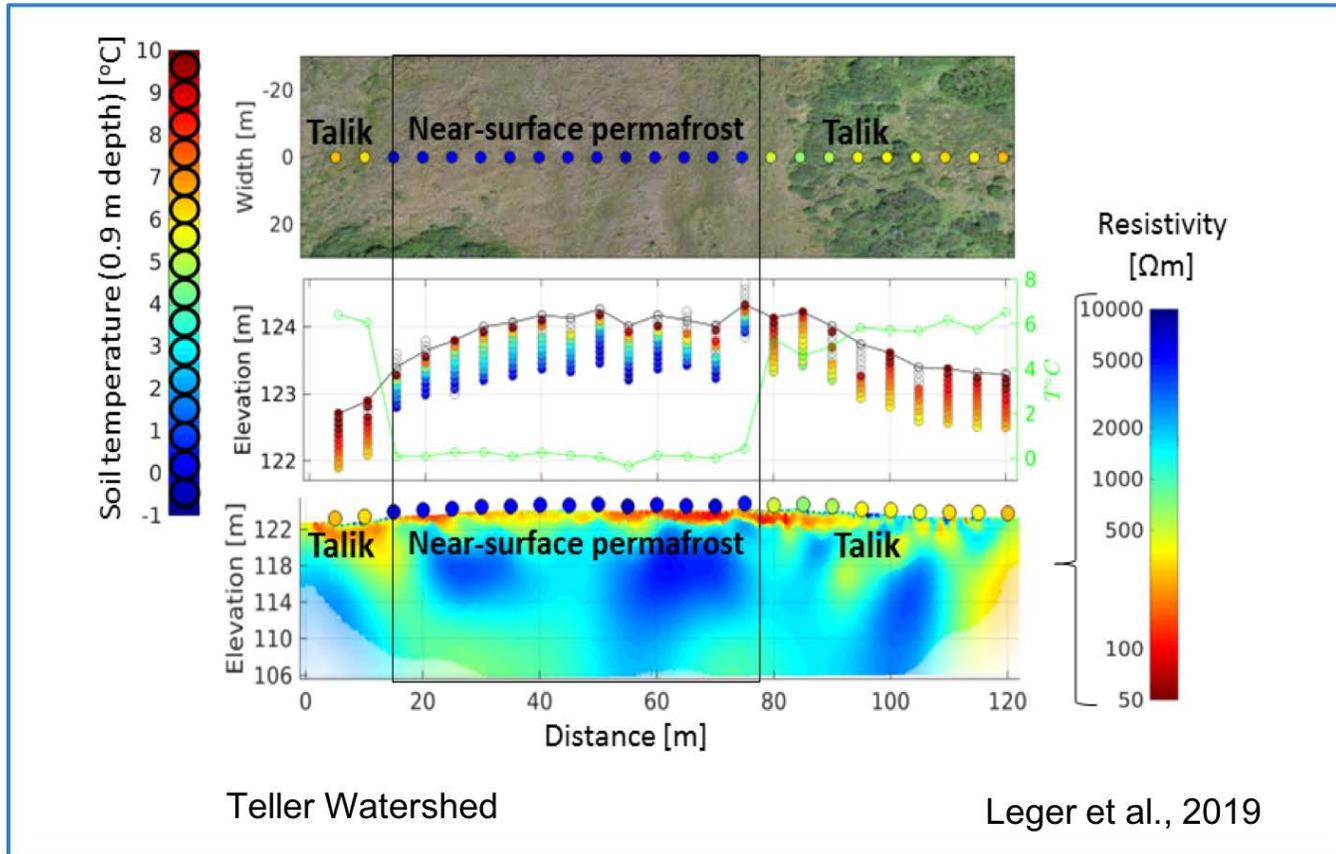
2: NDVI in (0.06, 0.33]

3: NDVI in (0.33, 0.43], tall shrubs

Tall shrubs patches with deep snow have warmer Winter (and Summer) ground temperatures

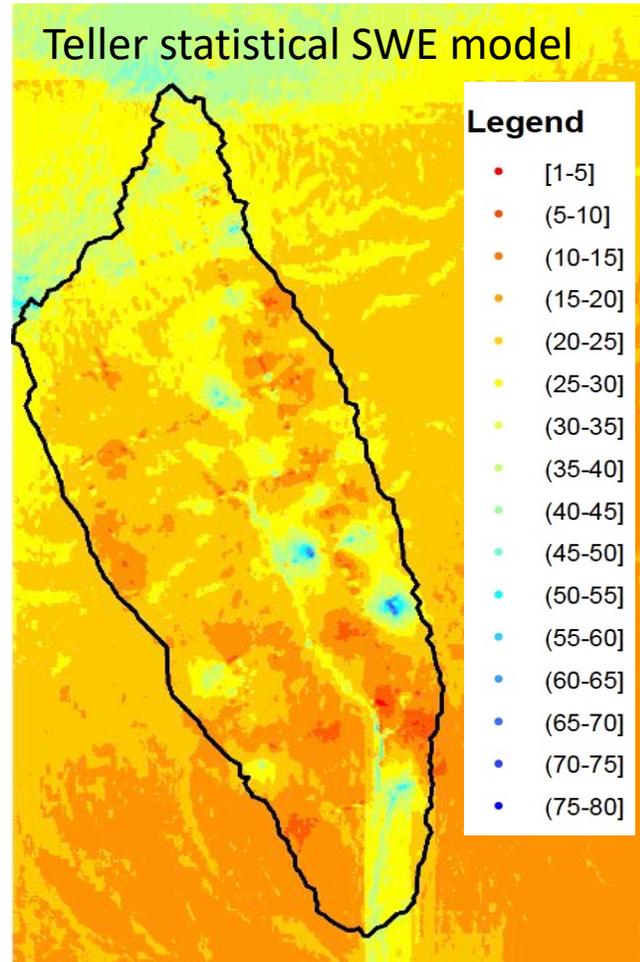


The ATS hillslope permafrost-hydrology model (informed by NGE data) showed that deep snow in tall shrub patches can drive “rapid” through-talik formation and increase baseflow

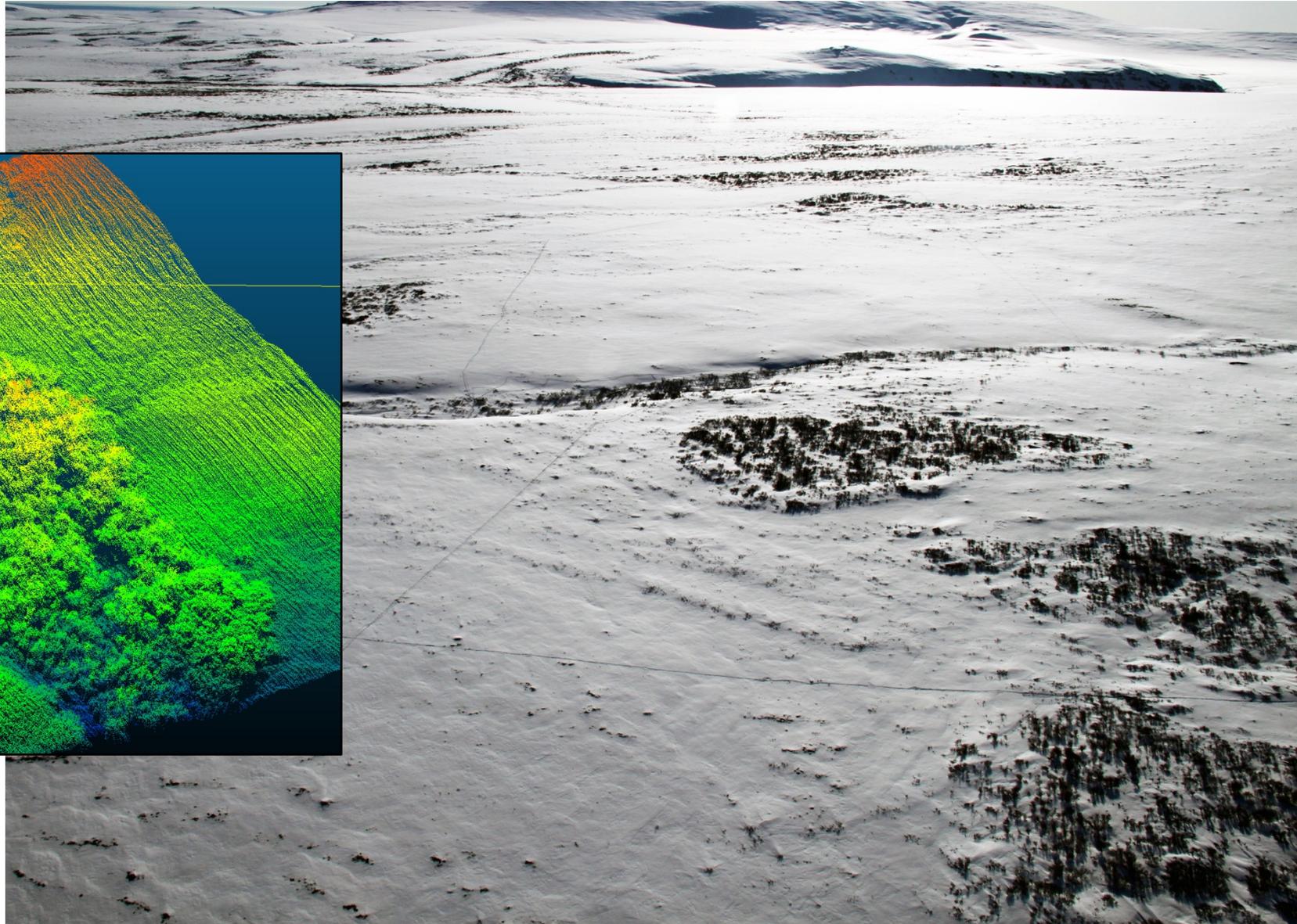
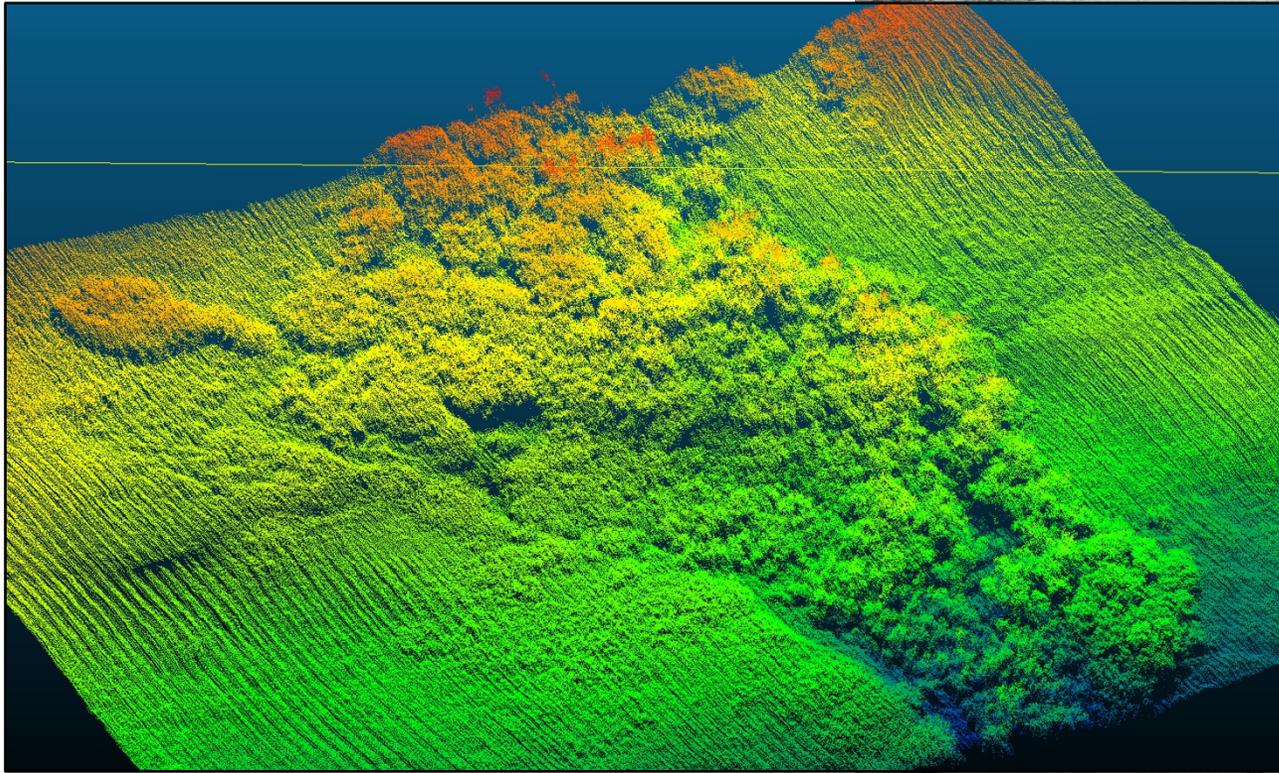


Greening may drive increased Winter baseflow

Next Steps: Develop **dynamic snow model** for ELM that accounts for topography, vegetation and weather



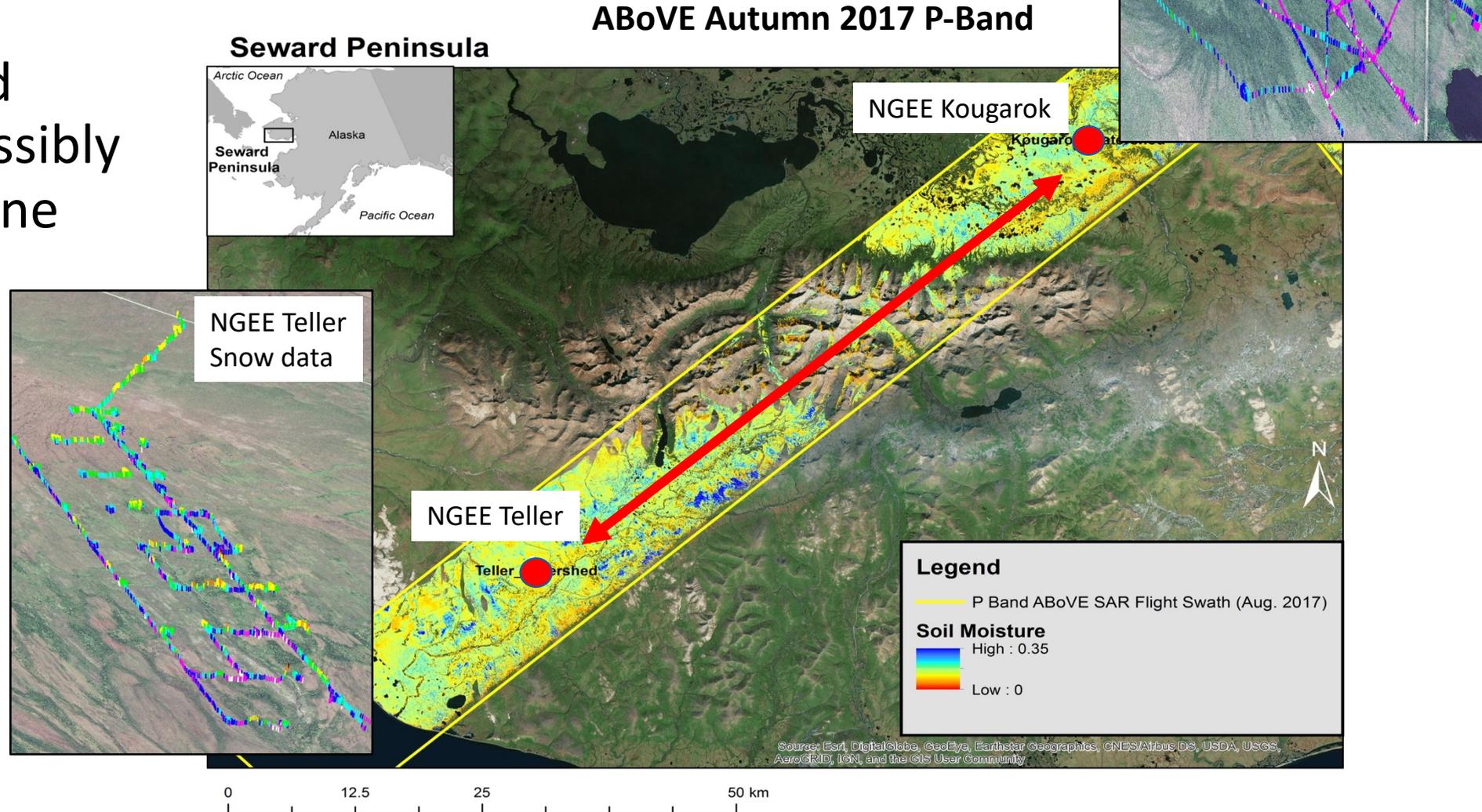
Inform snow model with shrub patch size, structure, density data



NGEE-SnowEX-ABOVE Opportunity

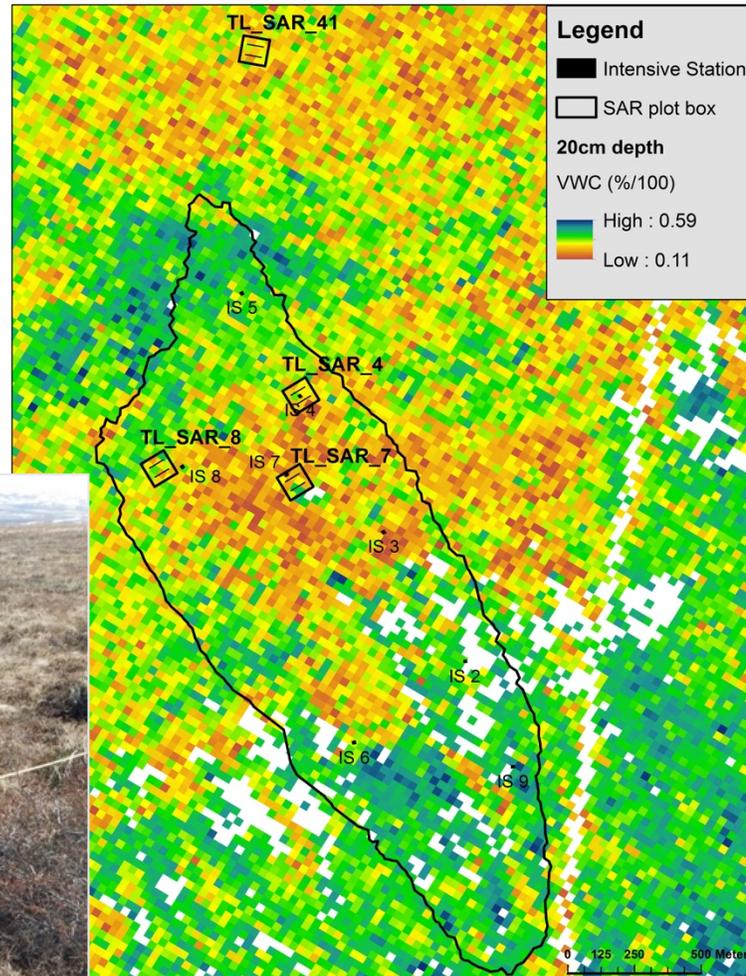
Bridge data gap between Teller and Kougarak sites, possibly along the L-Band line

Additional LANL collaboration with new NOAA-AK Alaska snowmelt runoff project

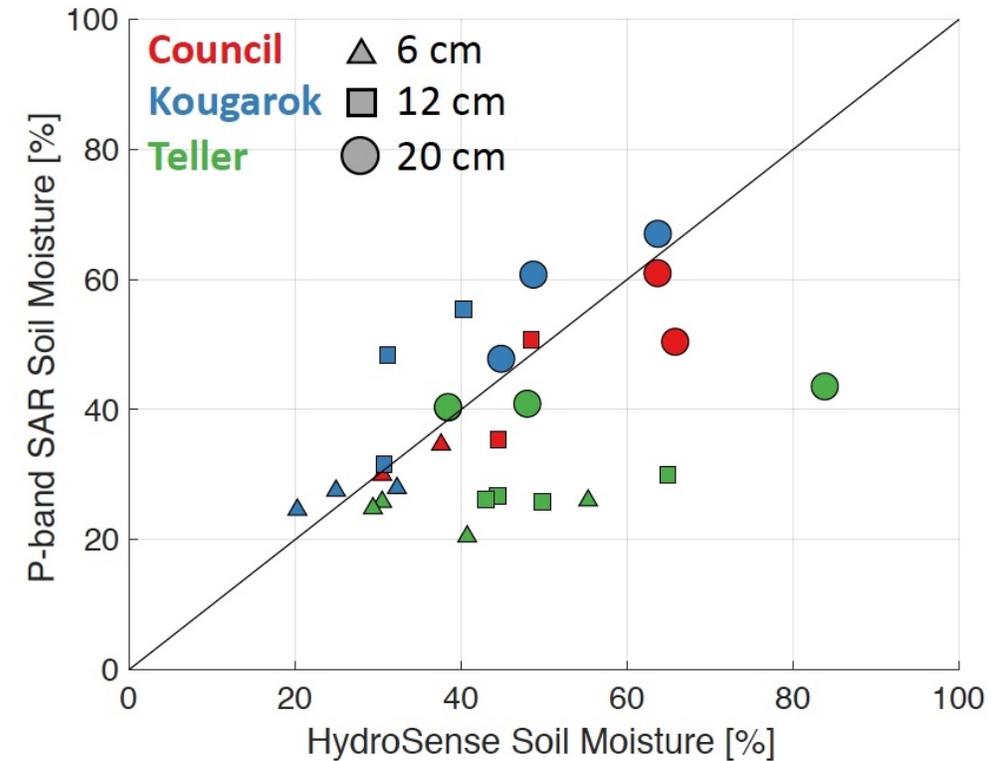


Build on NGEE-ABoVE Soil Moisture Collaboration

NGEE Arctic researchers measured in-situ soil moisture and ALT at Seward Peninsula during ABoVE 2017 P-band surveys, and in Barrow during 2017 L-Band surveys.



HydroSense: calibration eqn. from Laura B.-C.
P-band SAR : calibration eqn. from Laura B.-C.



Extend snow redistribution model to the Seward Peninsula using “ecosystem-type” framework, and evaluate its use for sub-grid properties in ELM

