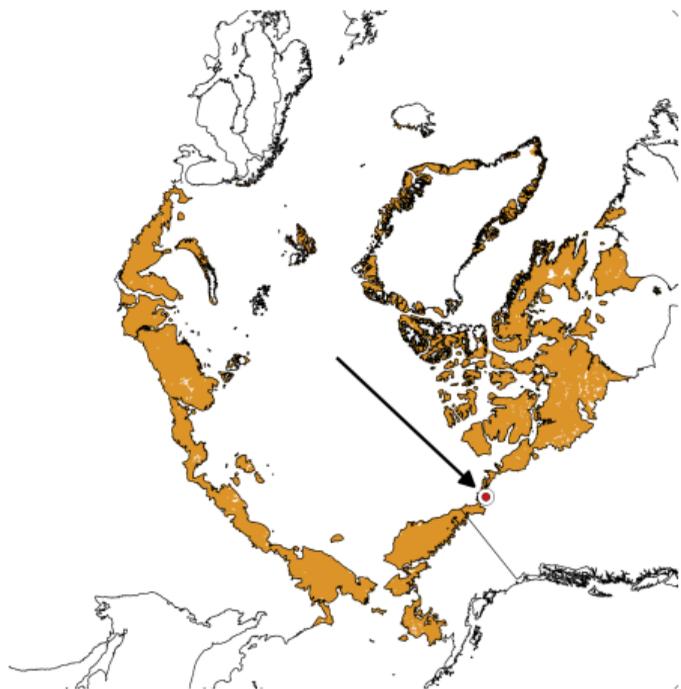


# Soil temperature and thaw depth differences associated with tundra vegetation types at Trail Valley Creek, NWT, Canada

Inge Grünberg, Sofia Antonova, William L. Cable, Stephan Lange, Julia Boike

EGU General Assembly, 2019/04/08



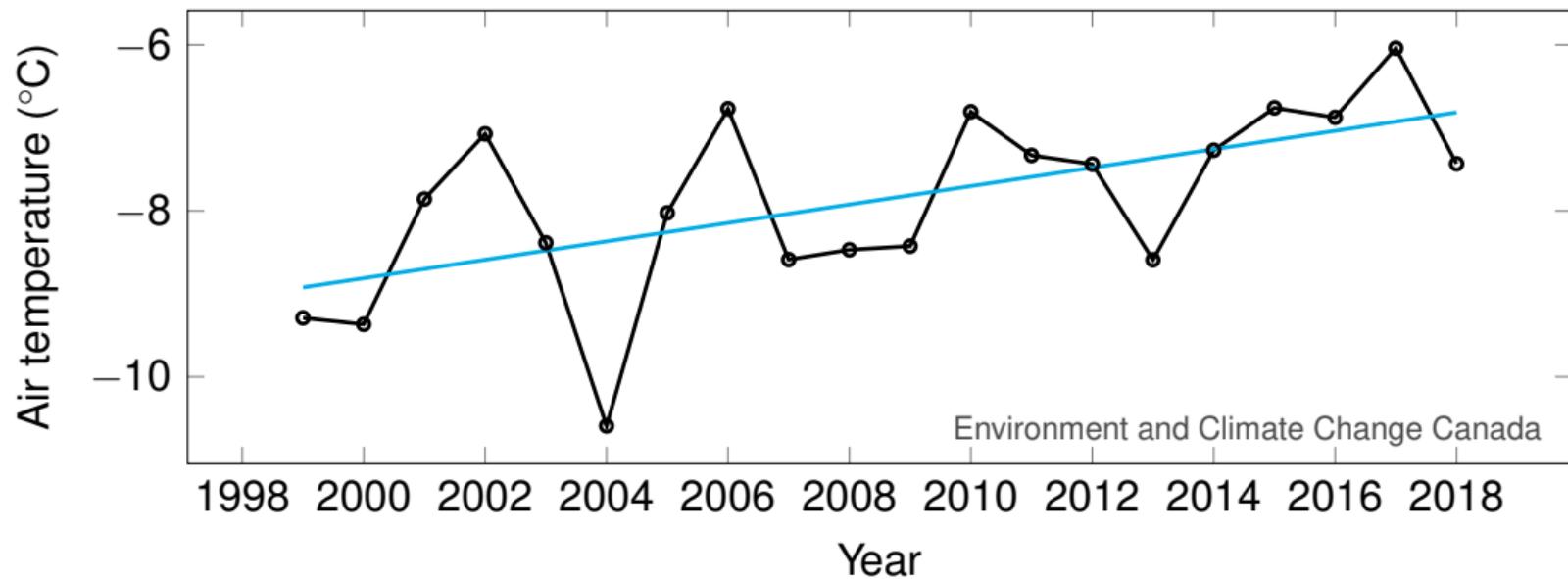
Data from Walker et al. (2005)

## Trail Valley Creek

- ▶ 68.74 °N, 133.50 °E
- ▶ North-West Canada
- ▶ Low Arctic, tree line
- ▶ Annual temperature:  $-7.9^{\circ}\text{C}$
- ▶ Active layer depth:  
25 cm to 100 cm
- ▶ Permafrost depth:  
100 m to 150 m

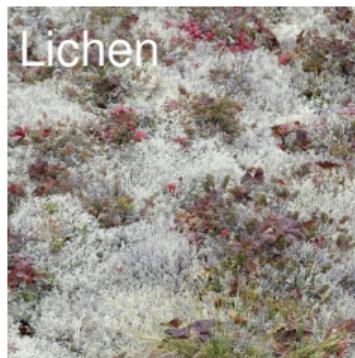
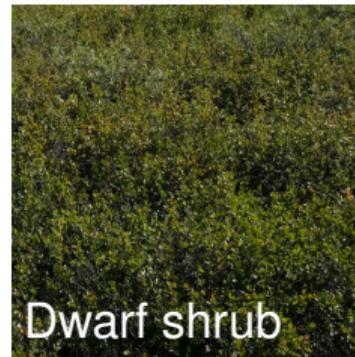
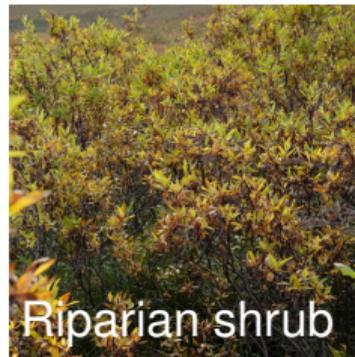
Marsh et al. (2008)

# Air temperature trend

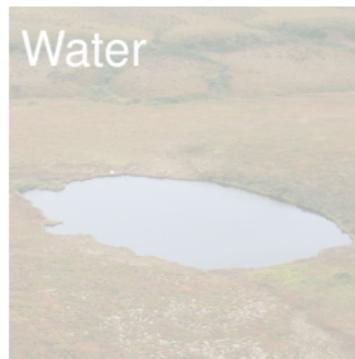
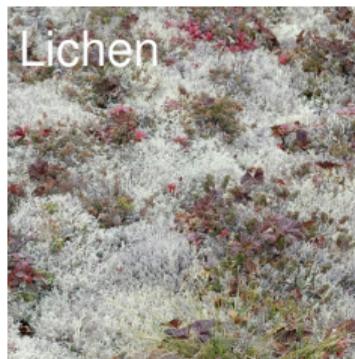
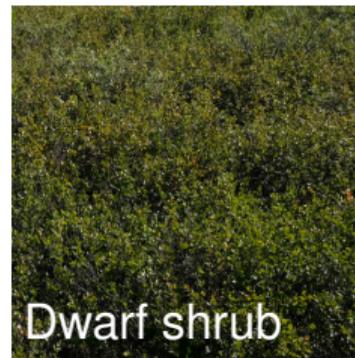
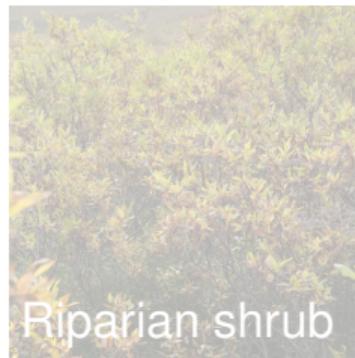
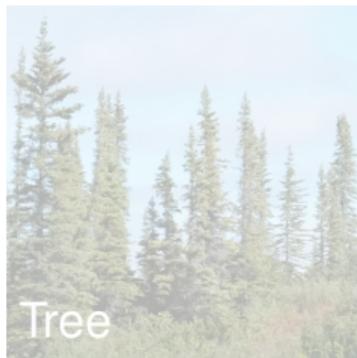


- ▶ Trend of the annual mean temperature:  $1.1\text{ }^{\circ}\text{C}/\text{decade}$
- ▶ Strongest trend in May:  $2.8\text{ }^{\circ}\text{C}/\text{decade}$

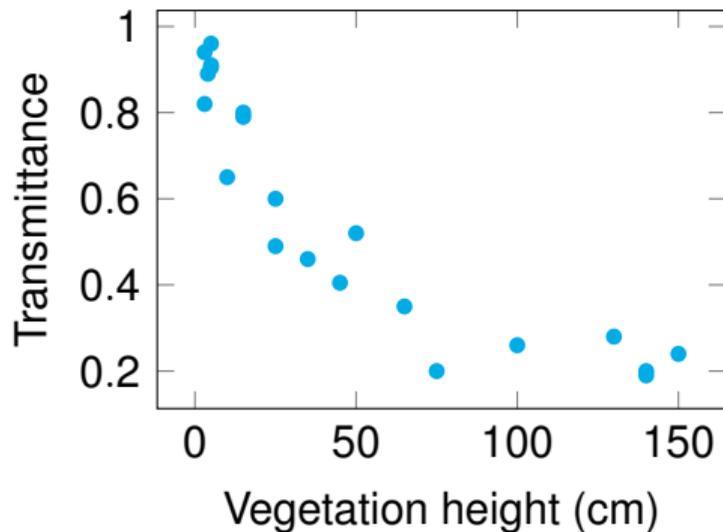
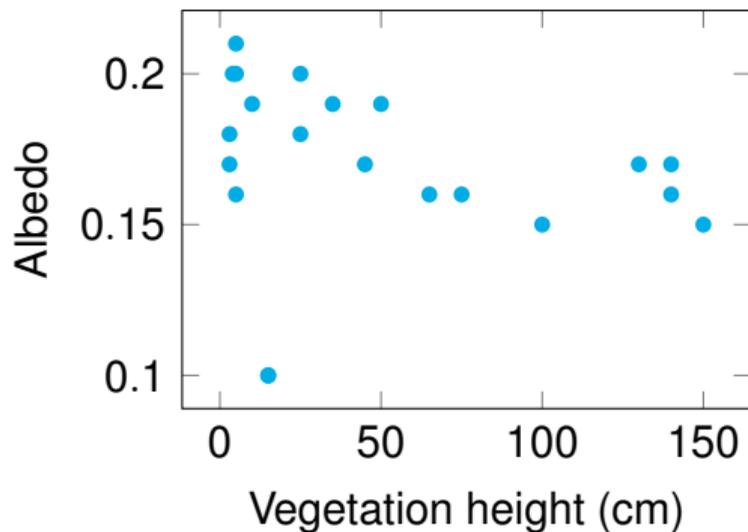
# Vegetation types



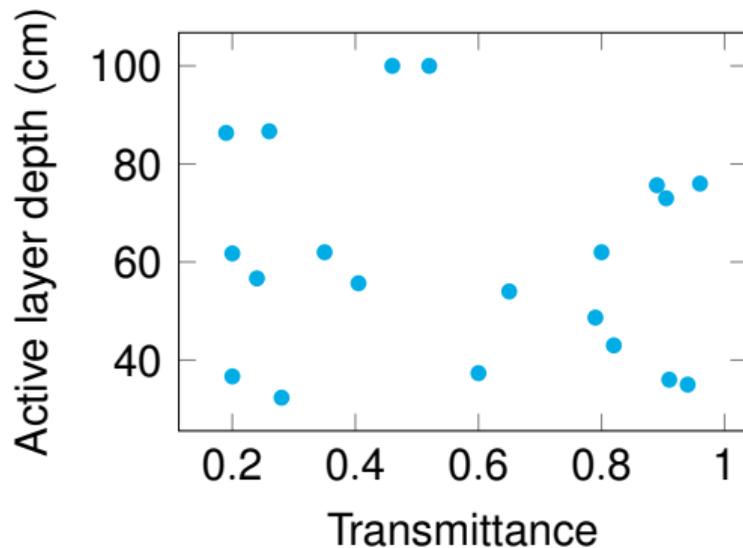
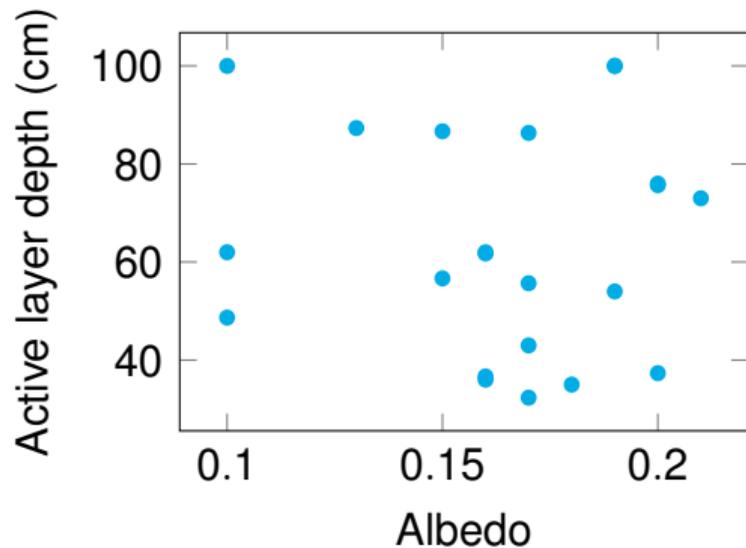
# Vegetation types



# Vegetation – radiation relationship



- ▶ Lowest albedo at water logged conditions
- ▶ Tall vegetation shades the soil and reduces the albedo

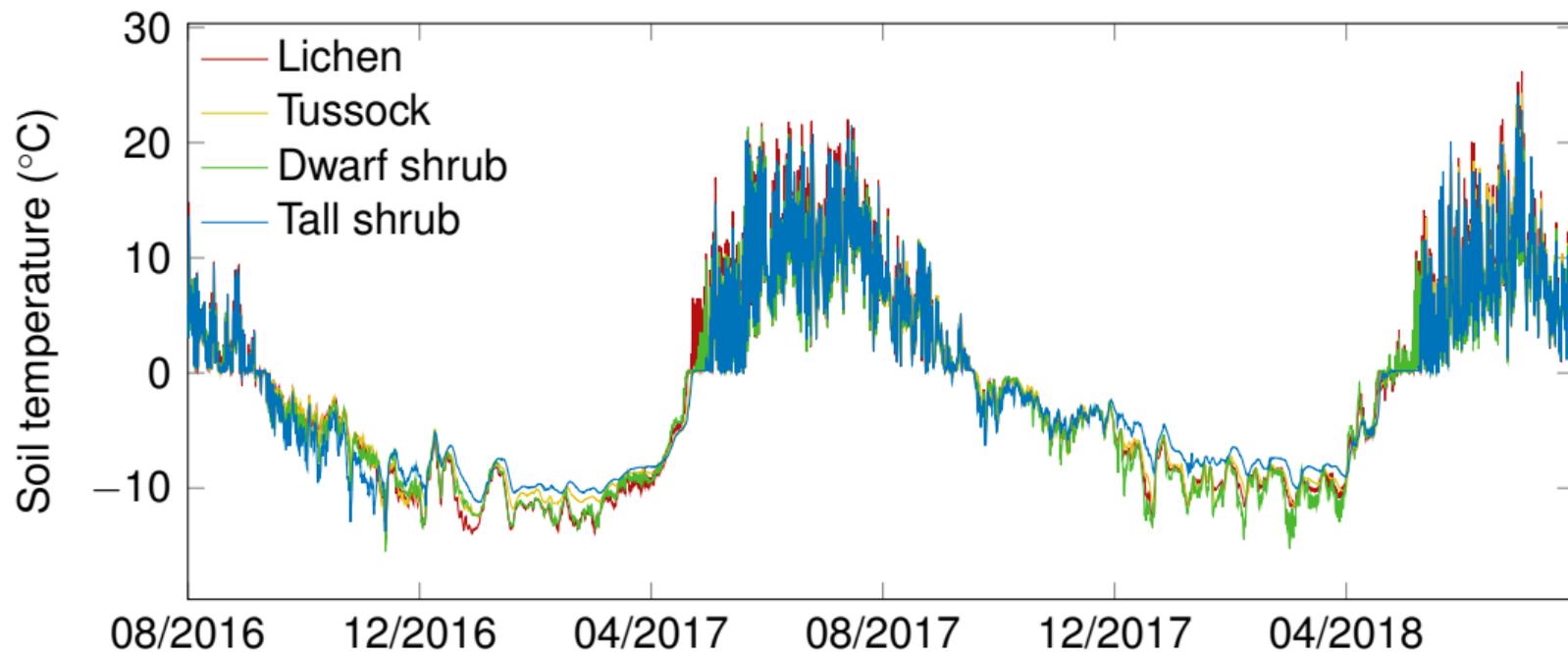


▶ Apparently no connection

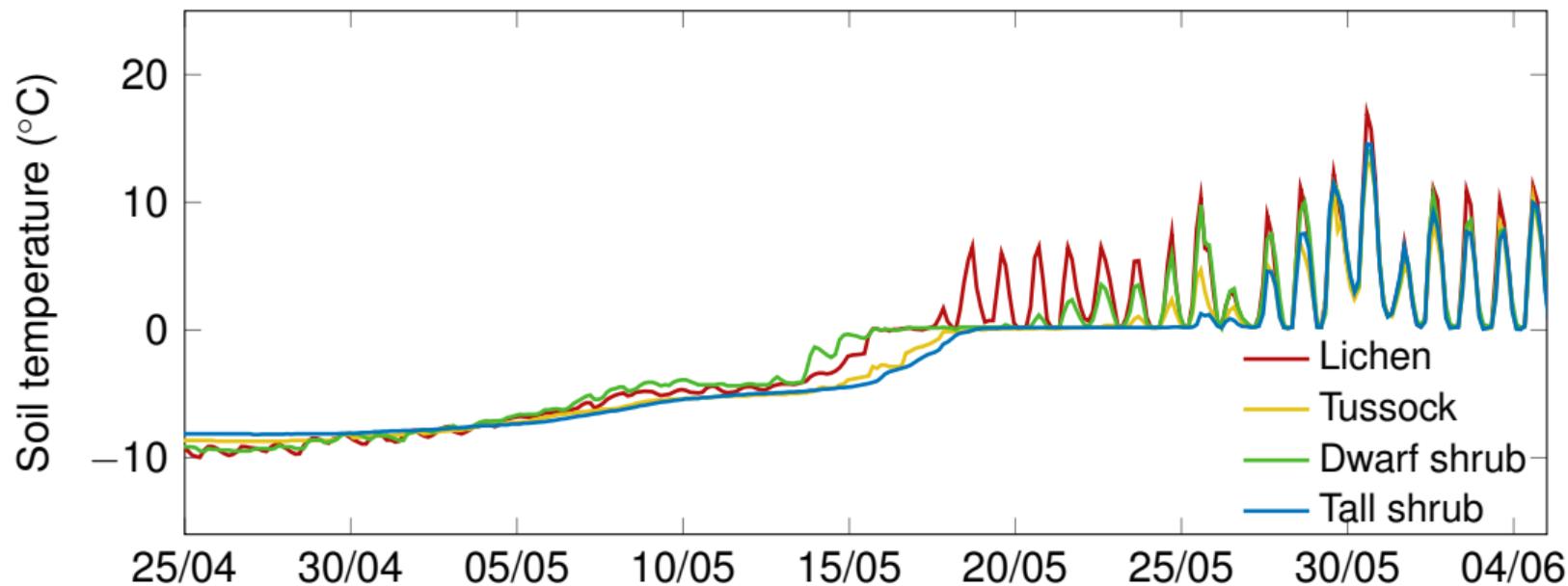


- ▶ 68 iButton temperature sensors just below the soil/lichen/moss surface
- ▶ Below different vegetation within a 600 m radius
- ▶ August 2016 to August 2018
- ▶ Snow depth measurements April 2017, active layer depth August 2018

# Top soil temperature

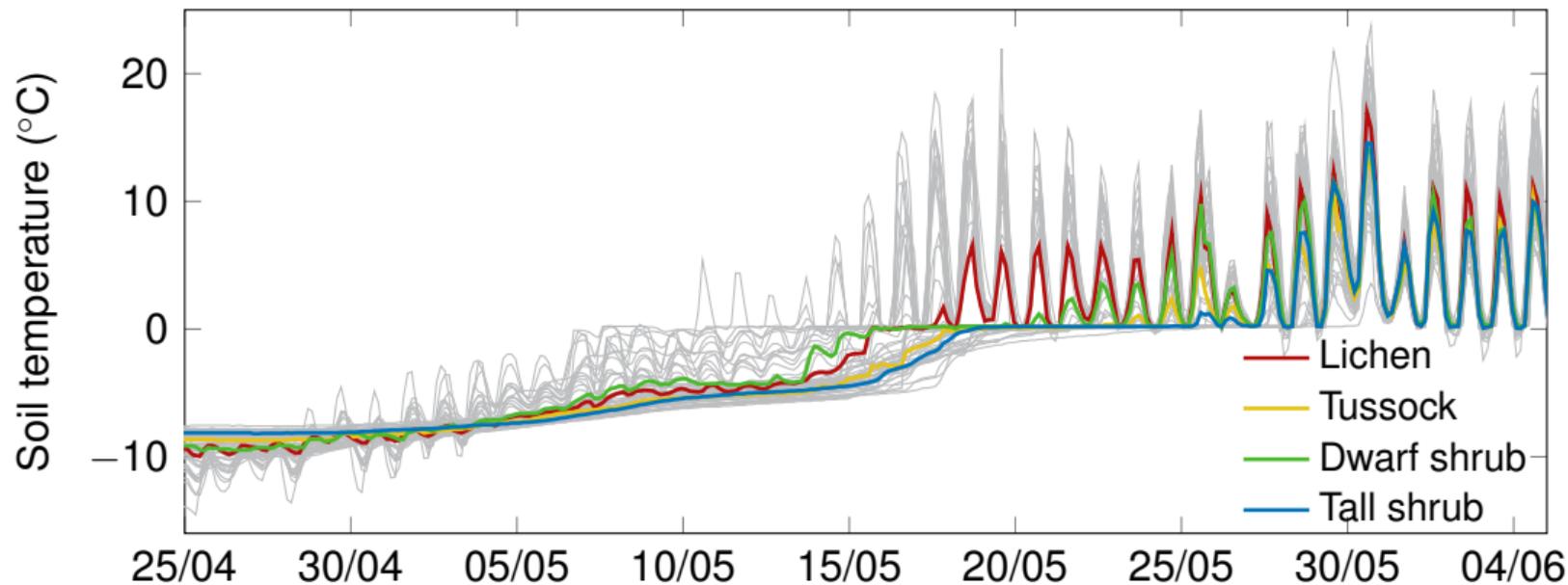


# Top soil temperature and snow



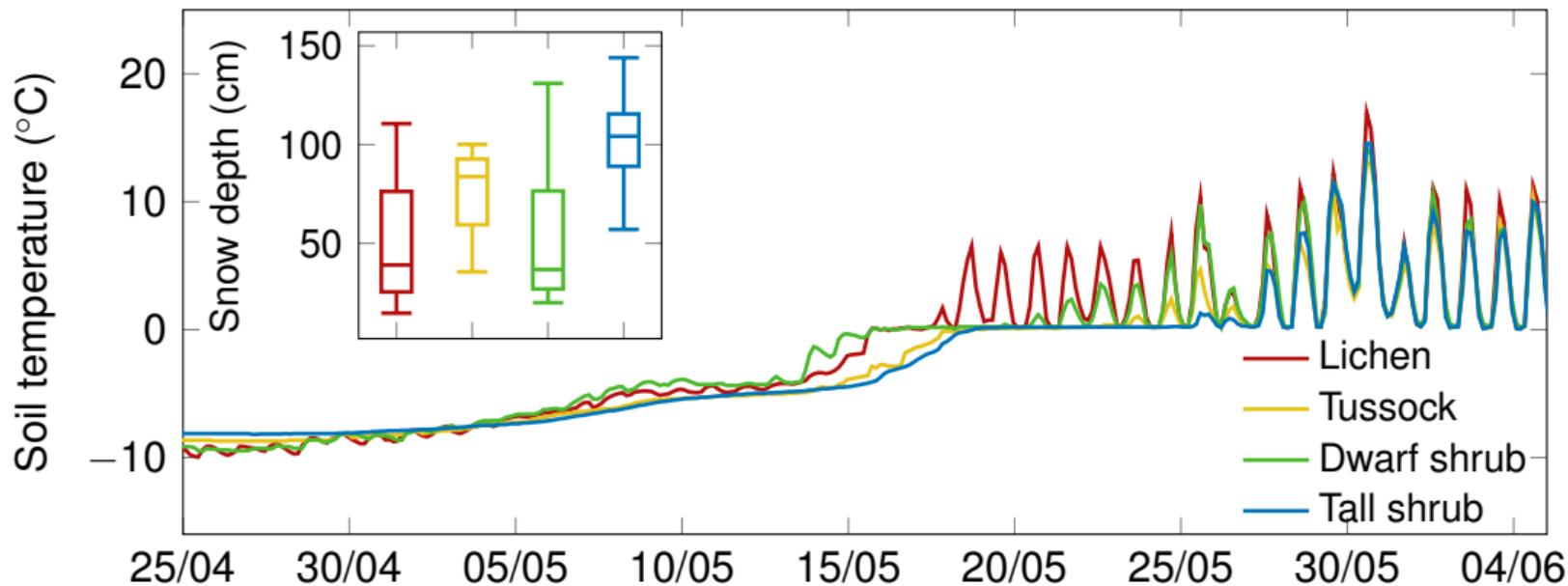
- ▶ Tall shrubs trap snow: warm soil in winter and cold top soil in spring
- ▶ Lichen and dwarf shrub tundra are similar in winter

# Top soil temperature and snow



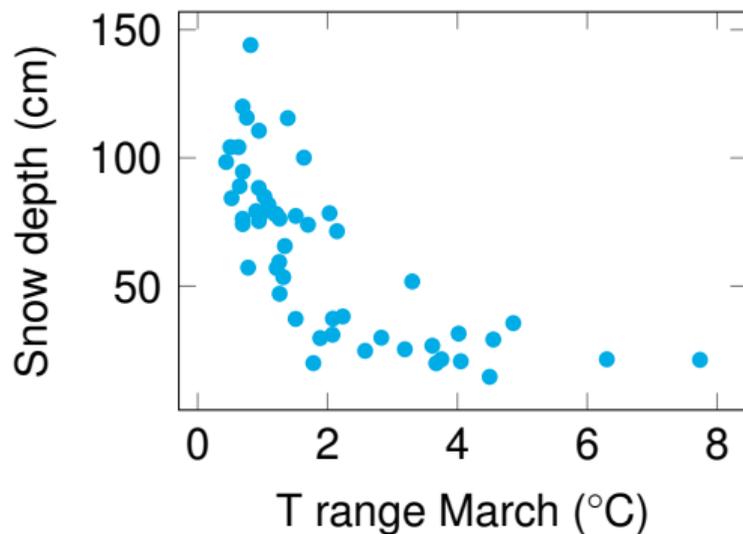
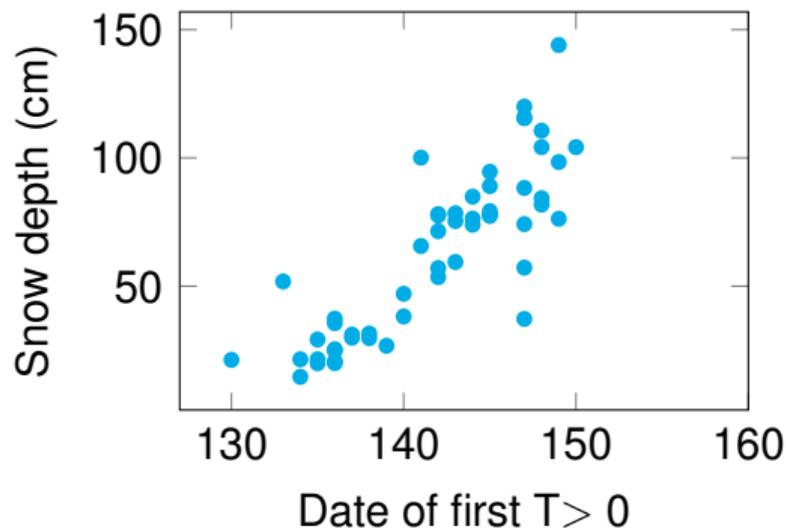
- ▶ Tall shrubs trap snow: warm soil in winter and cold top soil in spring
- ▶ Lichen and dwarf shrub tundra are similar in winter

# Top soil temperature and snow



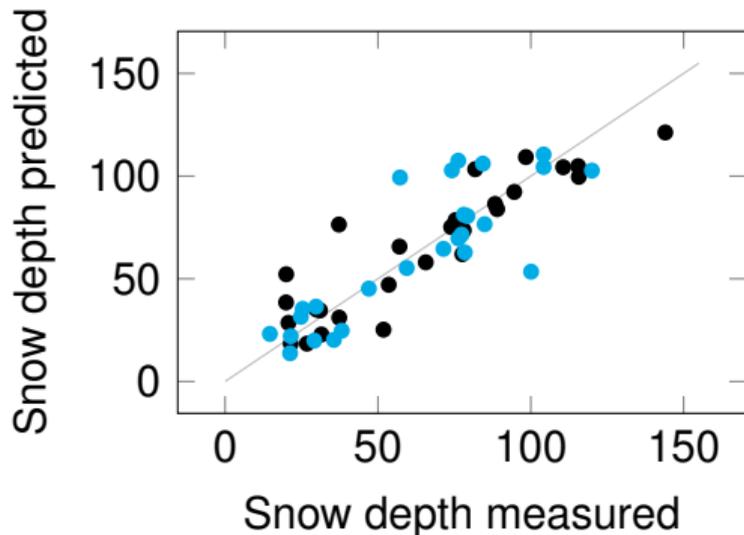
- ▶ Tall shrubs trap snow: warm soil in winter and cold top soil in spring
- ▶ Lichen and dwarf shrub tundra are similar in winter

# Top soil temperature and snow



- ▶ Date of snow melt is strongly related to snow depth
- ▶ Top soil temperatures in March and April are related to snow depth

- ▶ Snow depth  $\sim$  End date of thawing + T range March + T range April

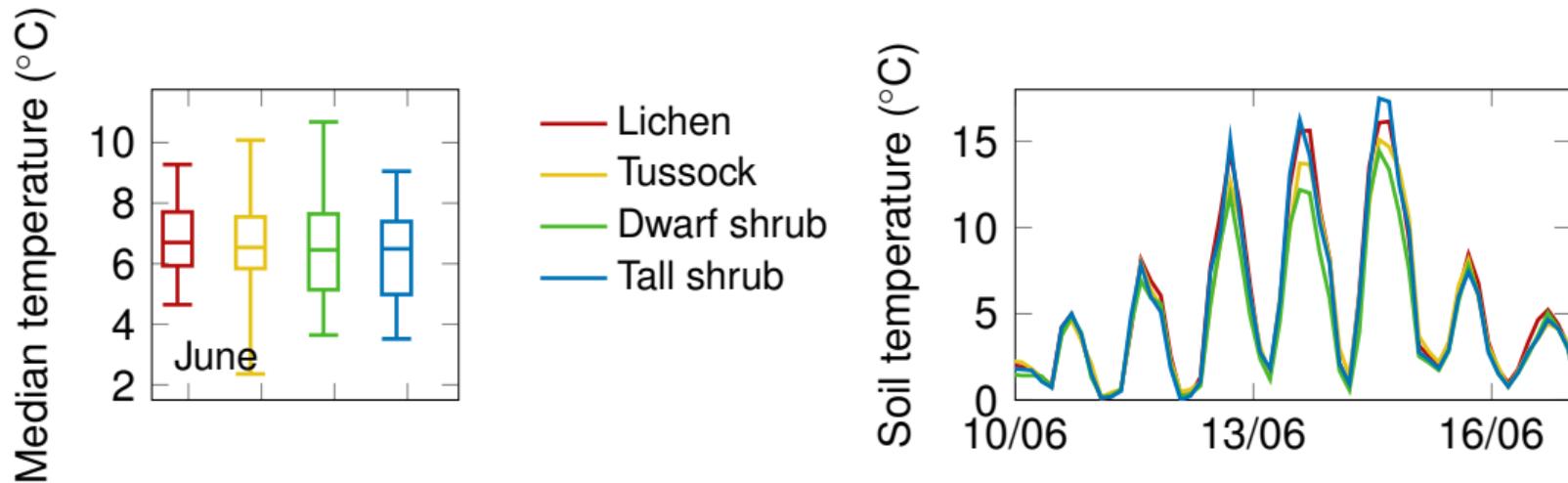


- Calibration data
- Validation data

$$R^2 = 0.82, 0.72$$

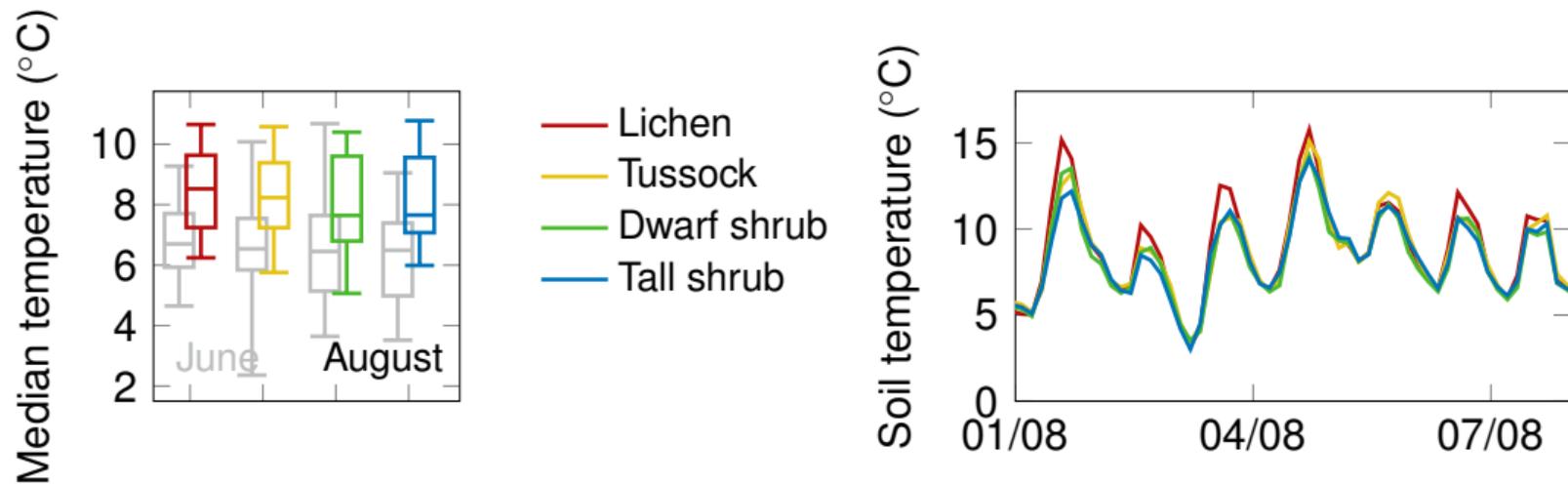
Mean absolute error: 11.3 cm, 12.5 cm

# Top soil temperature and active layer



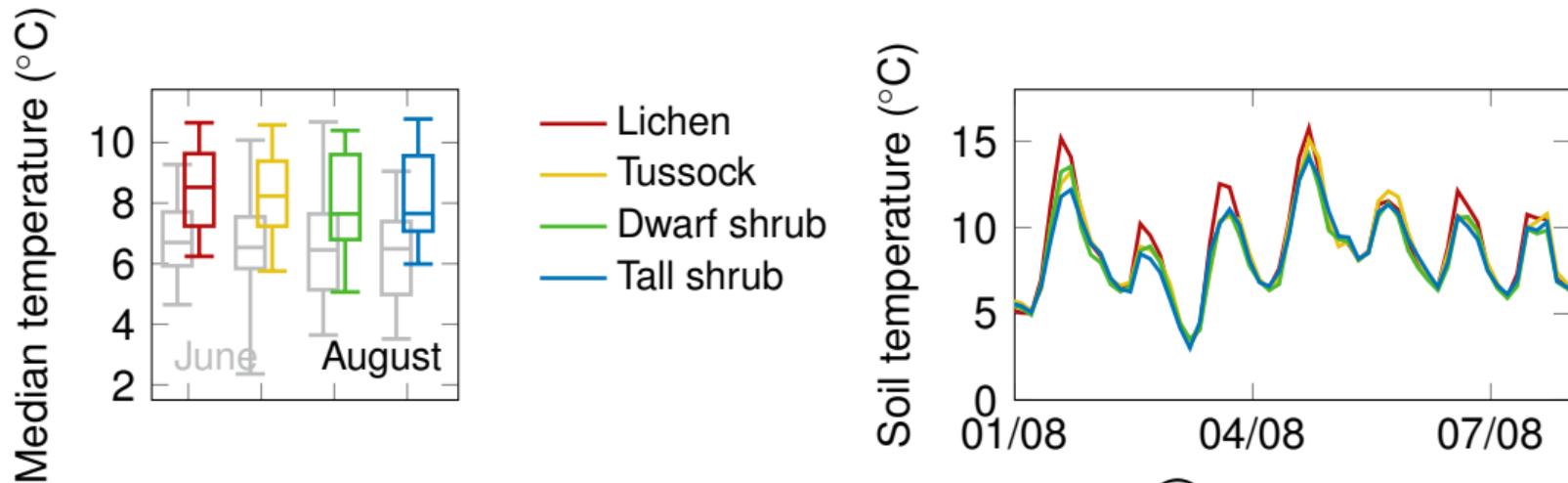
- ▶ June temperatures are similar for all types

# Top soil temperature and active layer

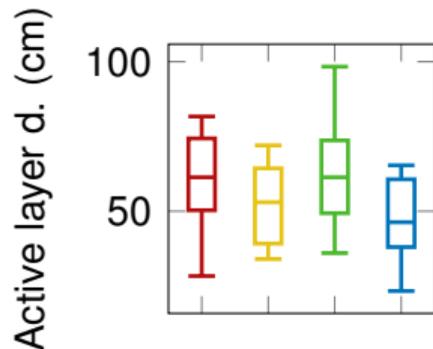


- ▶ June temperatures are similar for all types
- ▶ August temperatures are cooler below shrubs

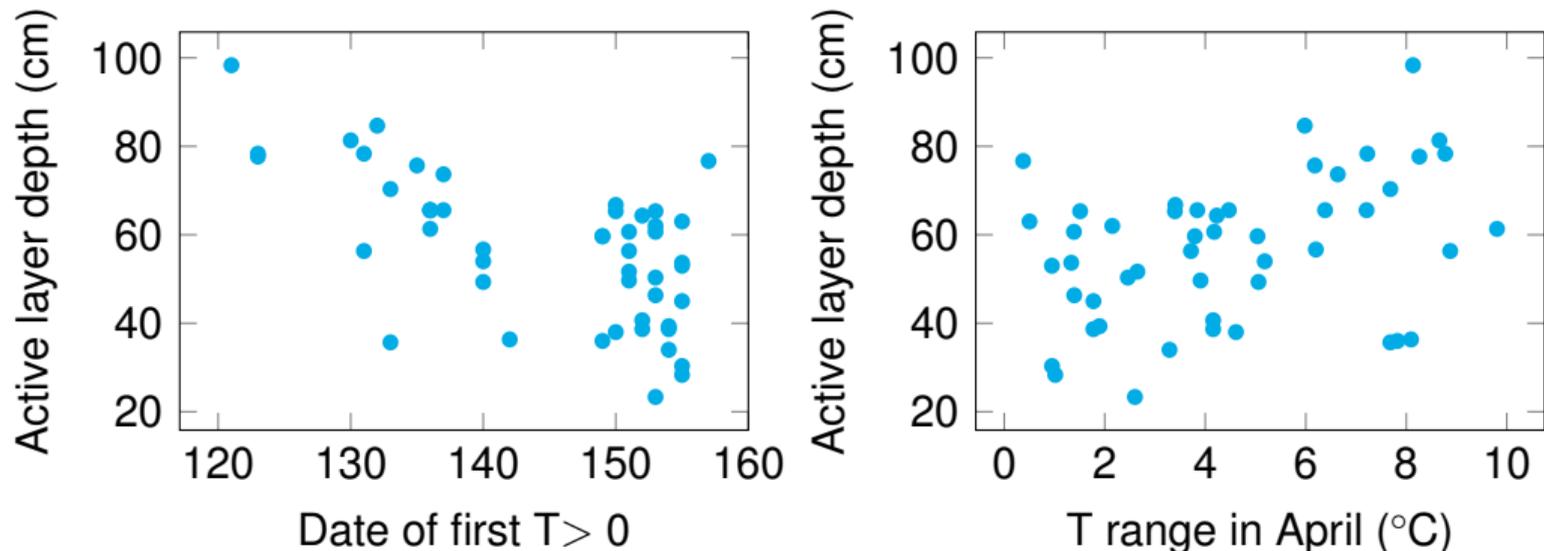
# Top soil temperature and active layer



- ▶ June temperatures are similar for all types
- ▶ August temperatures are cooler below shrubs
- ▶ Tall shrubs reduce the active layer depth



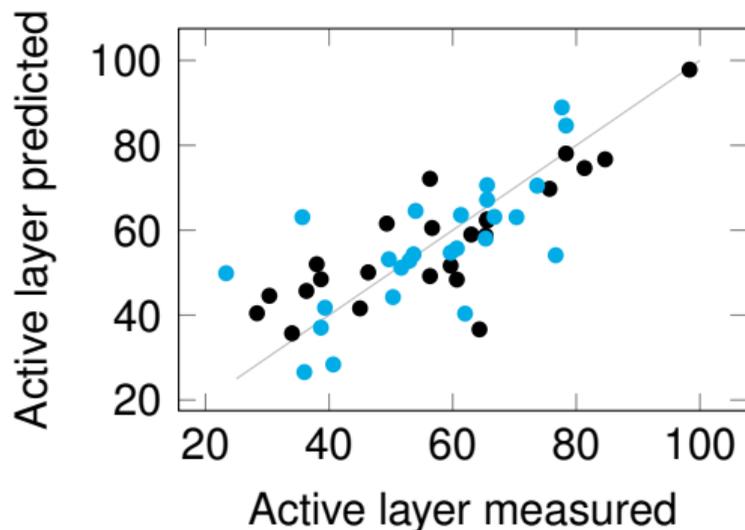
# Top soil temperature and active layer



- ▶ Snow melt date influences end of season active layer depth
- ▶ Weak relationship with the range of temperatures in April

# Statistical model for active layer depth

- ▶ Active layer depth  $\sim$  End date of thawing + Median T January + T range May



● Calibration data

● Validation data

$R^2 = 0.68, 0.49$

Mean absolute error: 8.1 cm, 8.1 cm

- ▶ Uncertainty due to irregular soil surface
- ▶ Top soil temperatures indicate the spatial snow depth variability
- ▶ Top soil temperatures after snow melt have no connection with active layer development
- ▶ Vegetation has an influence but cannot be used as main indicator

# Thank you — Questions?



**HELMHOLTZ**

RESEARCH FOR GRAND CHALLENGES

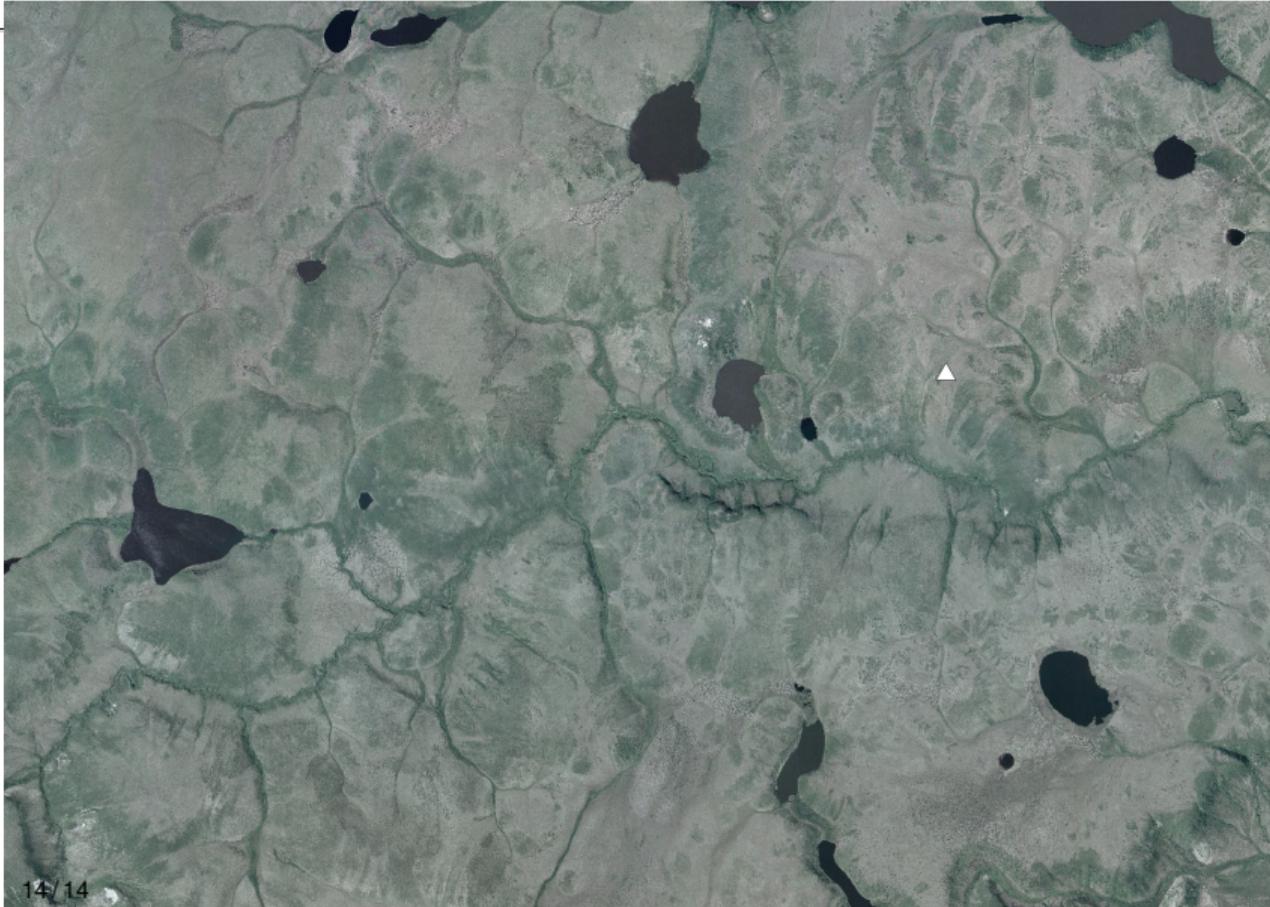


Marsh, P., et al. (2008), *Snowmelt Processes and Runoff at the Arctic Treeline: Ten Years of MAGS Research*, 97–123, Springer Berlin Heidelberg, Berlin, Heidelberg.

Walker, D. A., et al. (2005), *Journal of Vegetation Science*, 16(3): 267–282.

- ▶ Published LiDAR dataset of 2016:
  - ▶ Mean and maximum vegetation height
  - ▶ DTM: slope, aspect, roughness, topographic index, topographic position index
- ▶ Canadian aerial imagery
- ▶ Resolution 10 m
- ▶ 87% accuracy at validation data set
- ▶ User and producer accuracy of all classes  $>75\%$

# Vegetation map of Trail Valley Creek



# Vegetation map of Trail Valley Creek

