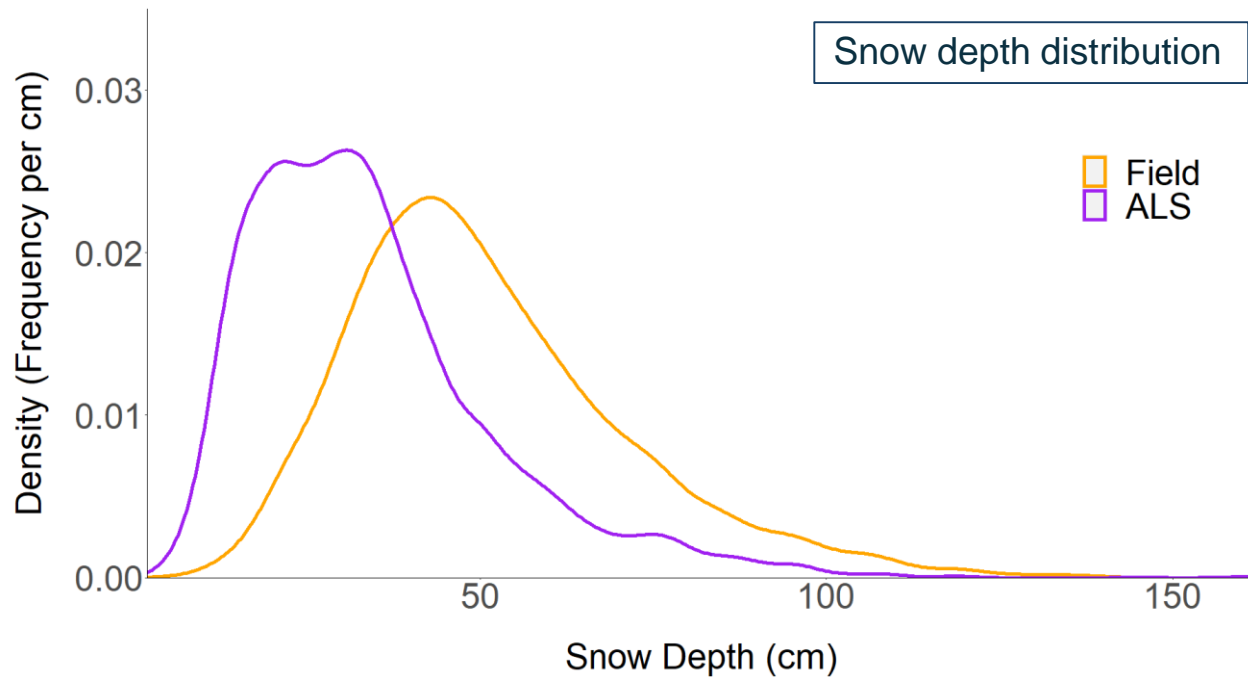


Snow accumulation patterns from 2023 Airborne Laser Scanning (ALS) data in Trail Valley Creek, Western Canadian Arctic

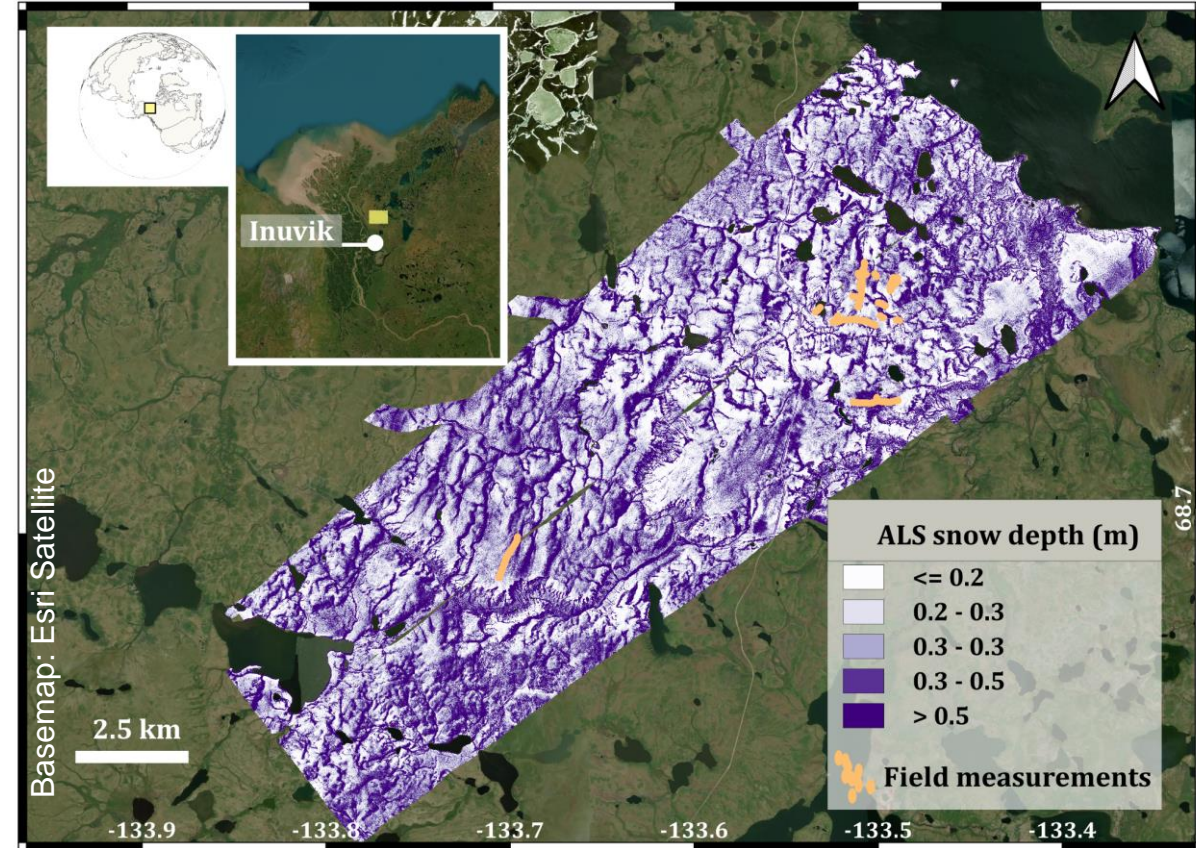
Daniela Hollenbach Borges^{1,2}, Inge Grünberg¹, Jennika Hammar¹, Nick Rutter³, Thomas Krumpen¹, Julia Boike^{1,2}



- Topography and vegetation are the main drivers of spatial variation of snow ([Pohl and Marsh, 2006](#))
- Deep snow packs can lead to warmer ground surface temperatures and facilitate permafrost thawing ([Callaghan et al., 2011](#); [Zhang, 2005](#)).



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- What is the snow depth difference among ALS and field measurements?
- What is the snow depth distribution across topography and vegetation?

Snow depth

- 4615 field measurements (26 - 31 March 2023)
- ALS measurements - same points (2 April 2023)

Topography

- Classified based on summer ALS 2023 data and the geomorphons approach ([Jasiewicz and Stepinski, 2013](#)).

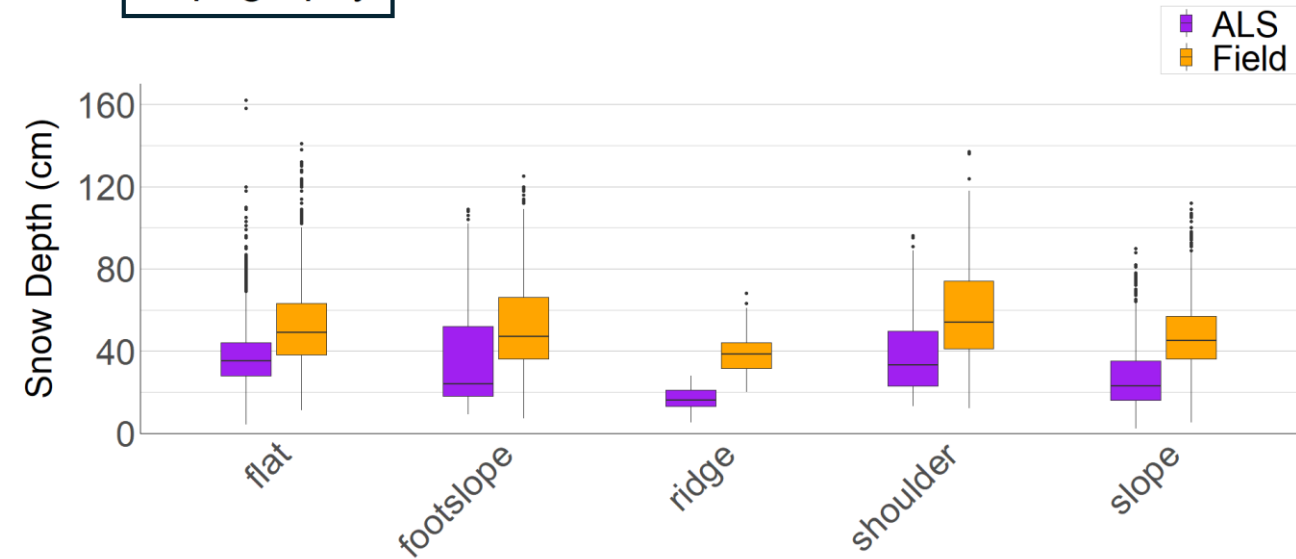
Vegetation

- Classified using ground data, airborne photography and full-waveform summer ALS data.

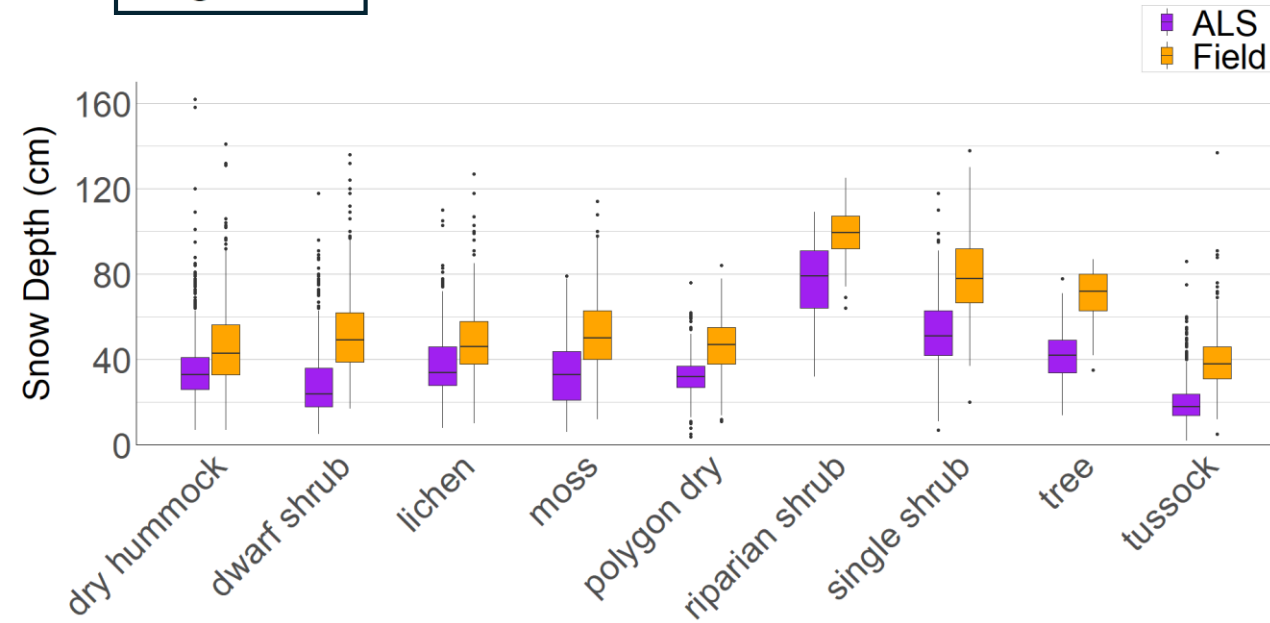
Key findings

- Field measurements tend to be higher than ALS snow depths (median differences: 10 to 30 cm).
- Ridges have the shallowest snow depths; shoulder and footslopes the highest.
- Snow packs are deepest in tallest vegetation areas, such as shrubs and trees.

Topography



Vegetation

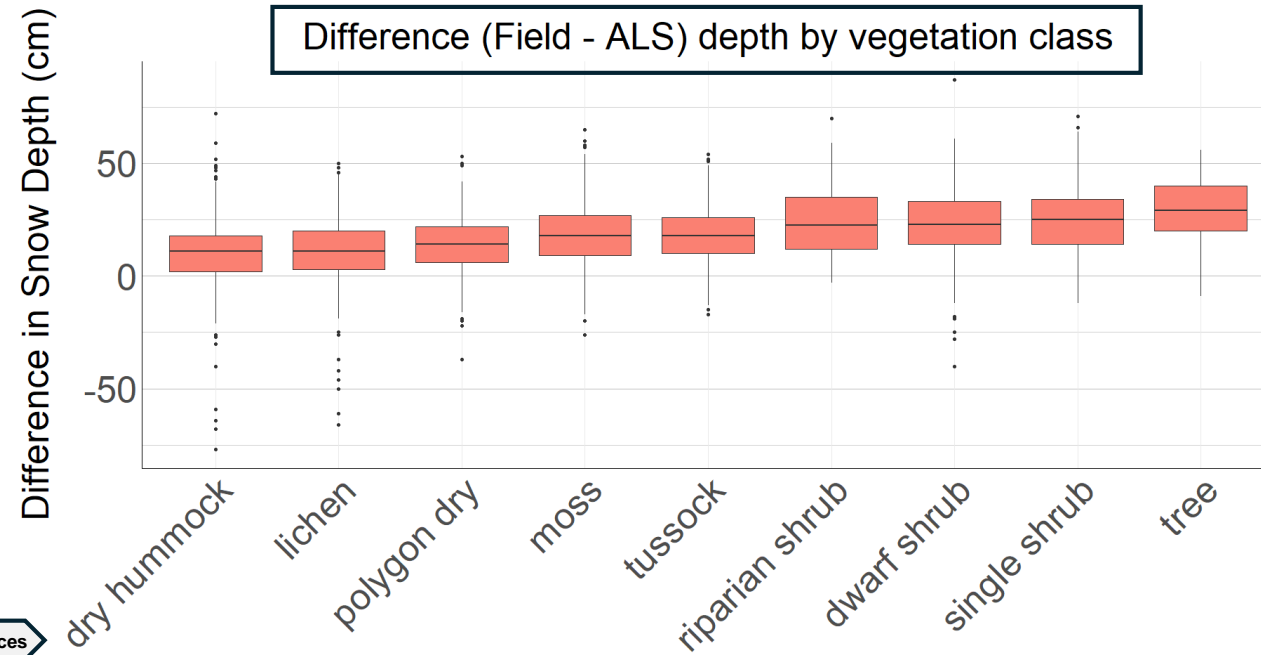
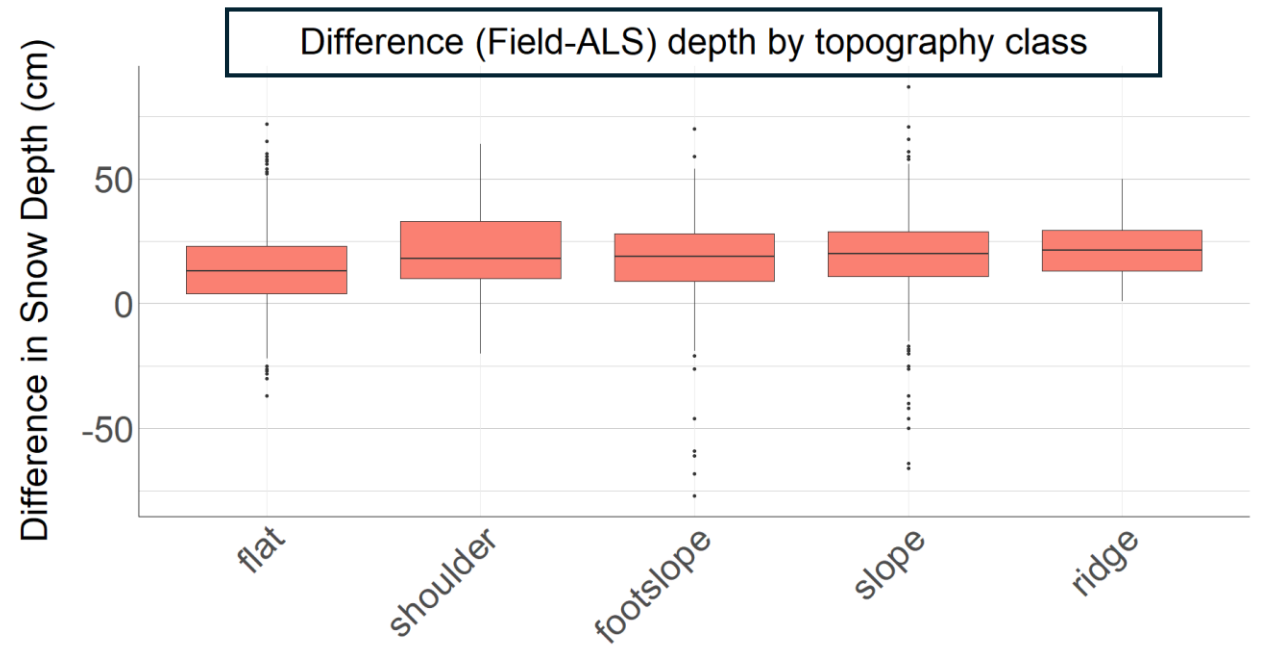


Field measurements

- Magnaprobe: Snow depth field measurements with depth accuracy of 5 cm and spatial accuracy of $\pm 5\text{m}$ ([Sturm and Holmgren, 2018](#)), used for validation of ALS snow depth map.
- Data from [Nick Rutter](#) (Northumbria University) and [Branden Walker](#) (Wilfrid Laurier University).

• Field measurements higher than the ALS snow depths (median differences varying from 10 to 30 cm depending on class).

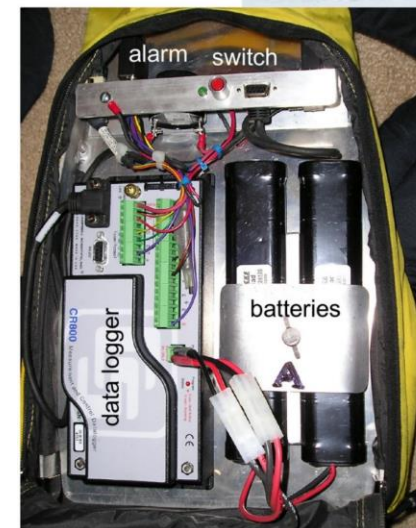
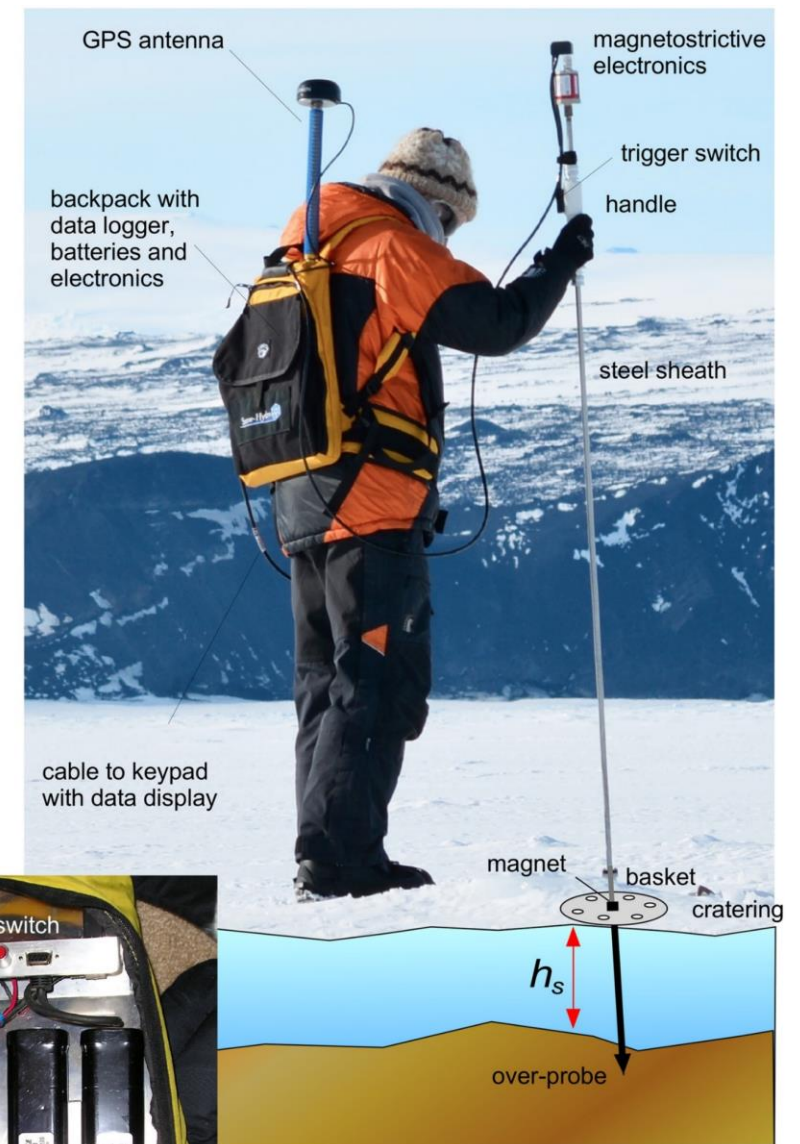
• This difference (Field minus ALS) tends to be higher among higher vegetation types, such as shrubs and trees.



Field measurements

- Snow depth (h_s) is measured vertically from the floating basket to the tip of the probe (ideally the ground), as described by [Sturm and Holmgren \(2018\)](#).

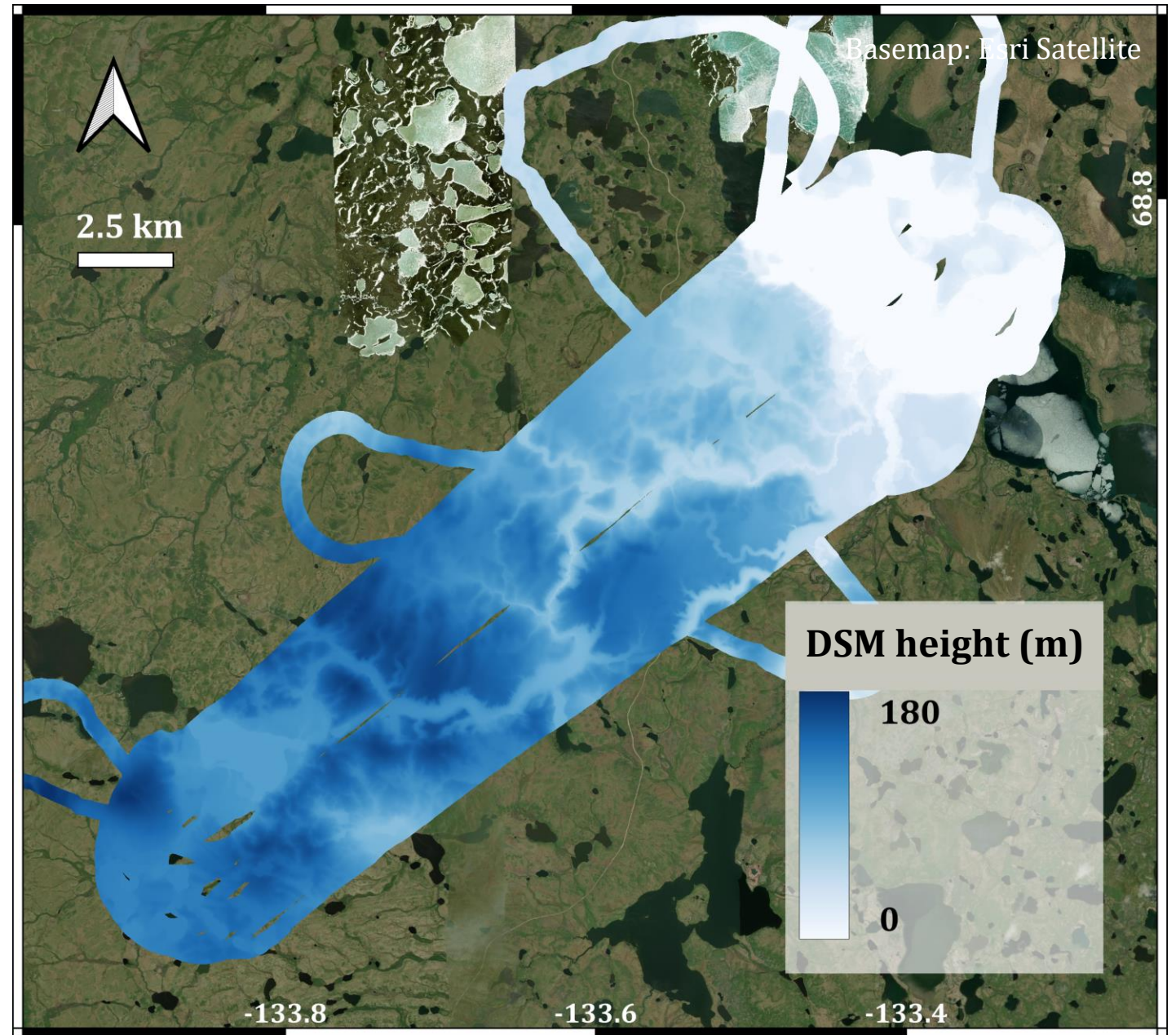
Date	Measurements
26.03.2023	1327
28.03.2023	2122
29.03.2023	586
30.03.2023	300
31.03.2023	280
Total	4615



[Sturm and Holmgren, 2018](#)

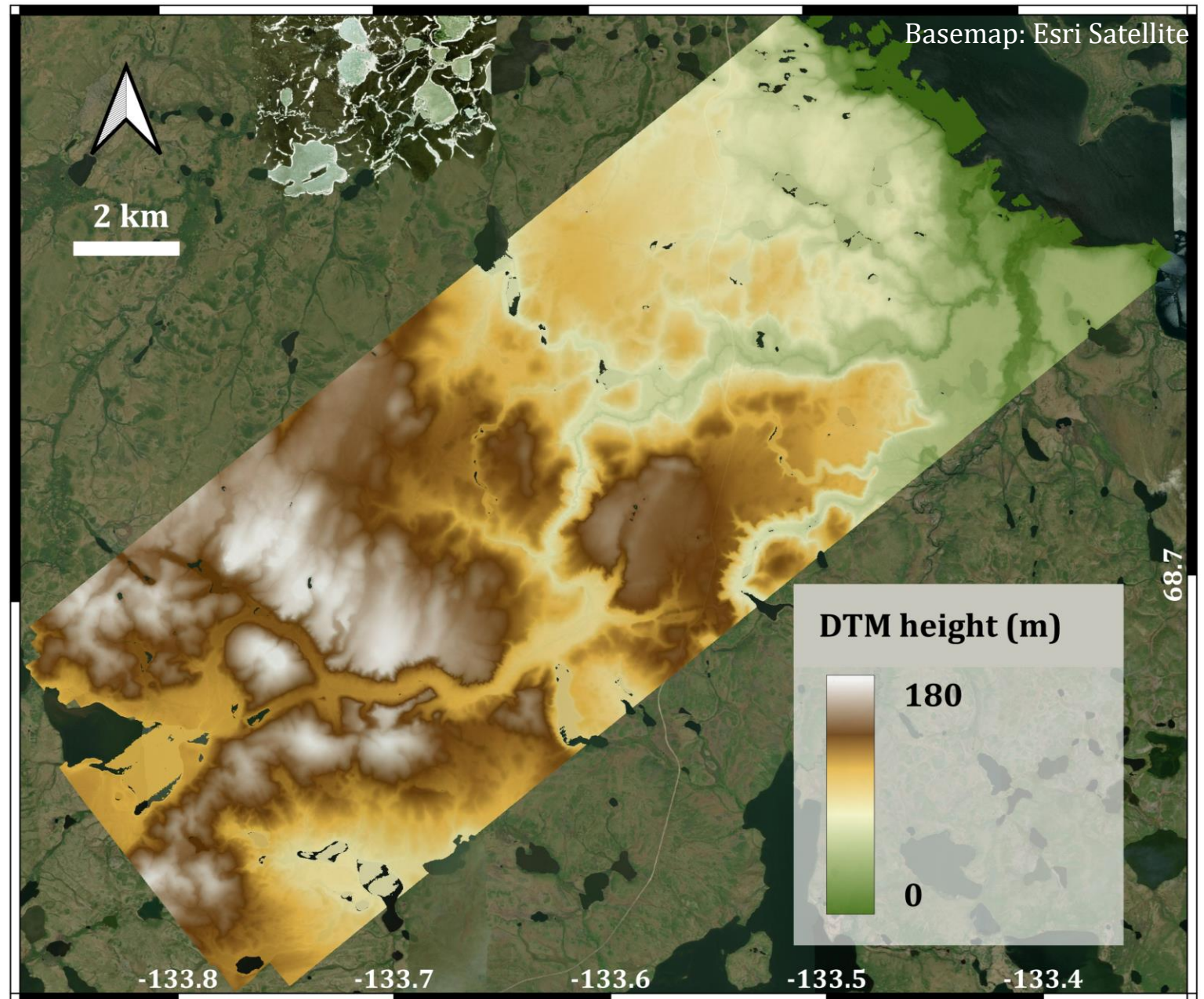
DSM

- Snow-covered digital surface model from winter ALS 2023 ([Krumpfen et al., 2023](#))
- Survey: 02 April 2023
- 170 km² of total covered area
- Resolution: 1 m/pixel



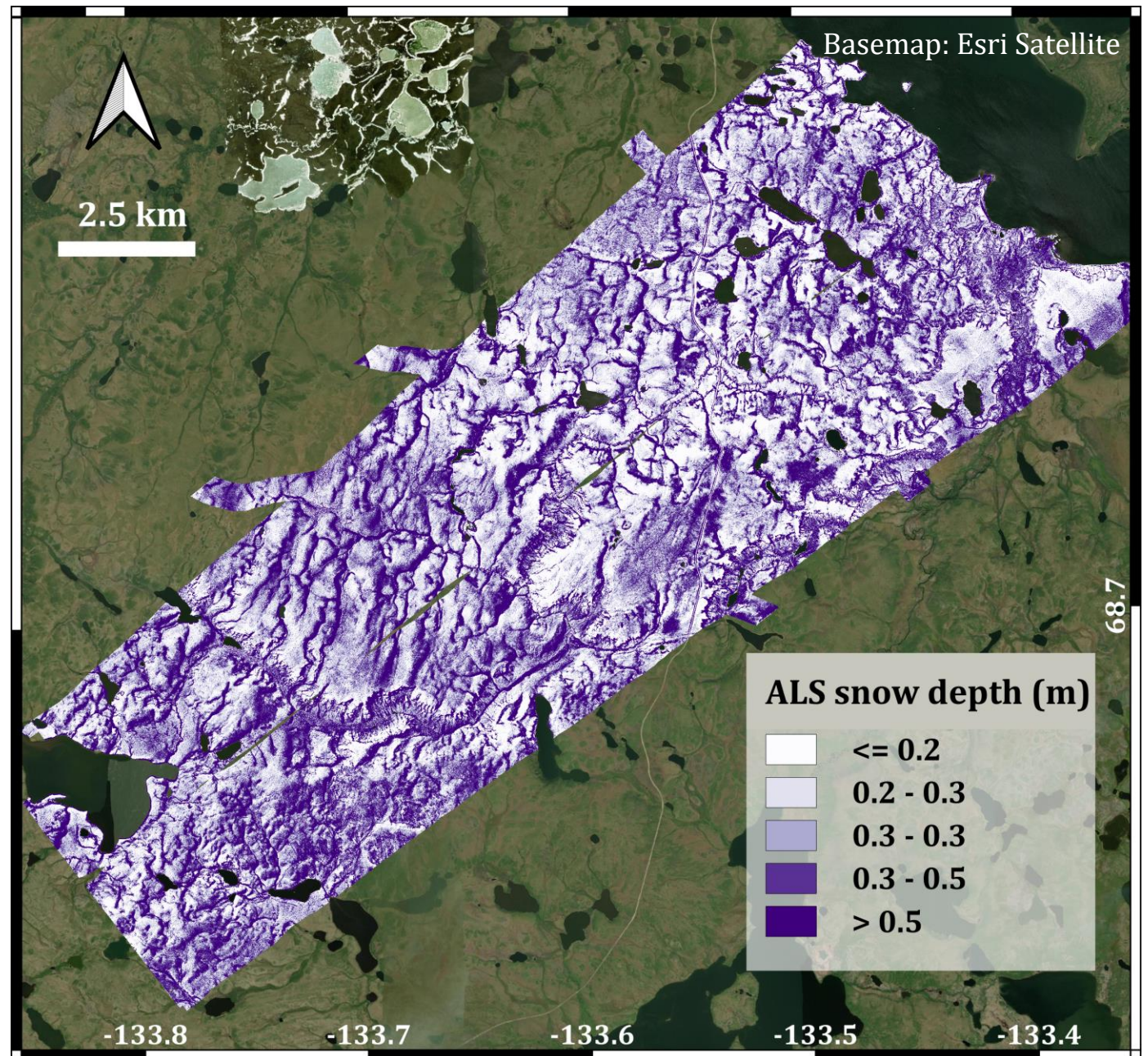
DTM

- Snow-free digital terrain model from full-waveform summer ALS 2023 ([Perma-X, 2023](#))
- Survey: 10 July 2023
- Resolution: 1 m/pixel



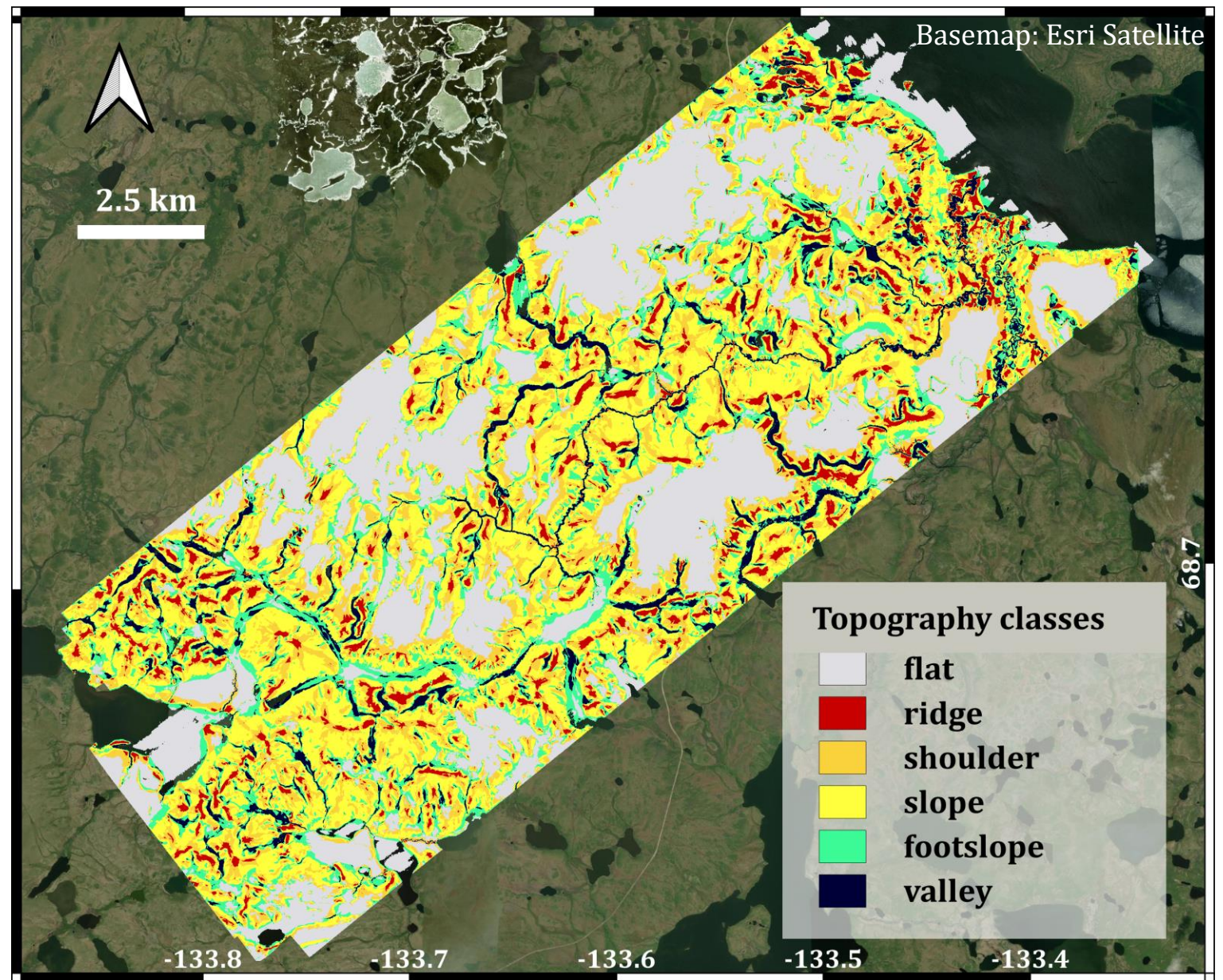
Snow depth

- Snow depth = DSM - DTM
- 140 km² of snow depth data
- Resolution: 1 m/pixel



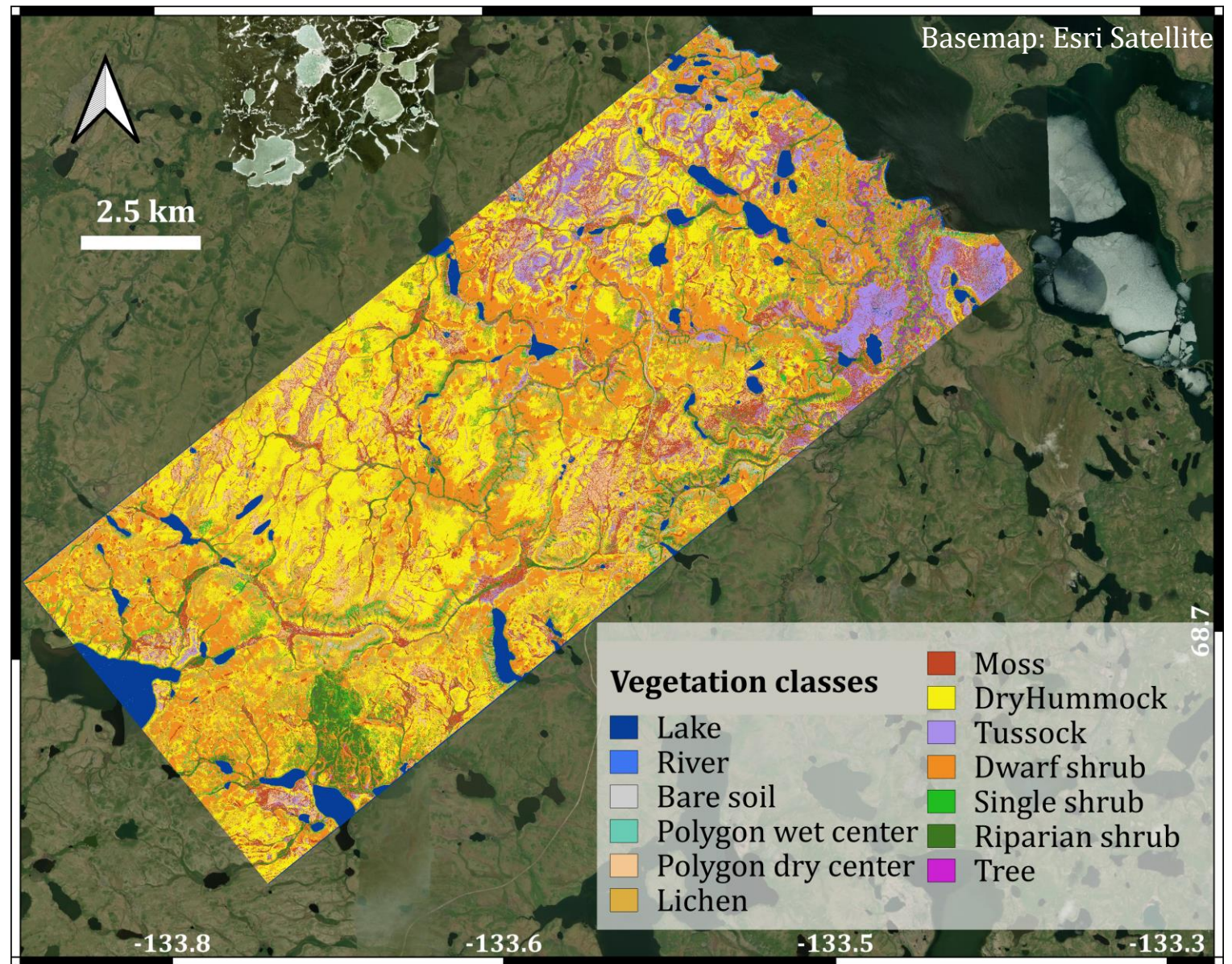
Topography

- Snow-free digital terrain model's terrain forms classified using the geomorphons approach ([Jasiewicz and Stepinski, 2013](#))
- Slope threshold = 2 degrees
- Resolution: 1 m/pixel



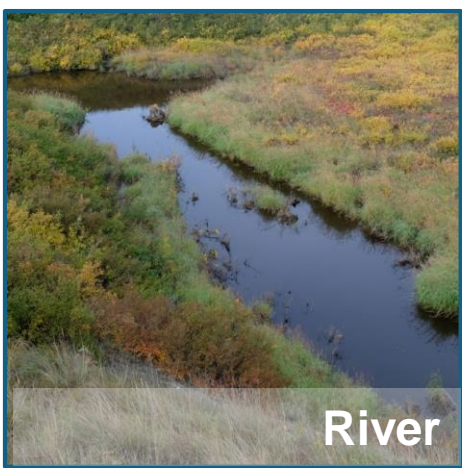
Vegetation

- Vegetation classified using ground data, airborne photography and full-waveform summer (snow-free) ([Lange et al., 2021](#)).
- Resolution: 1 m/pixel





Lake



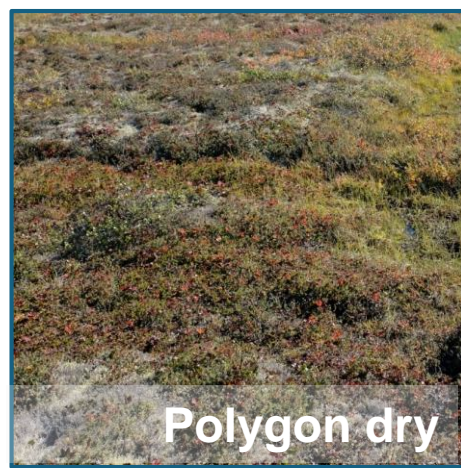
River



Baresoil



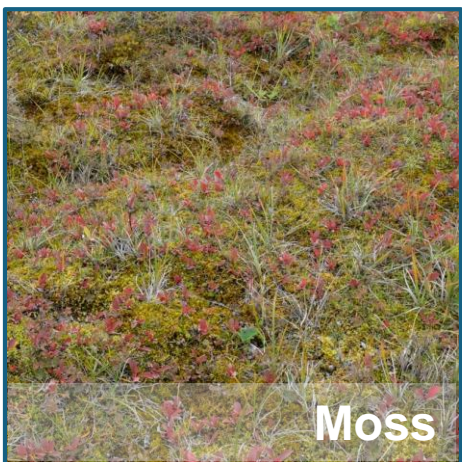
Polygon wet



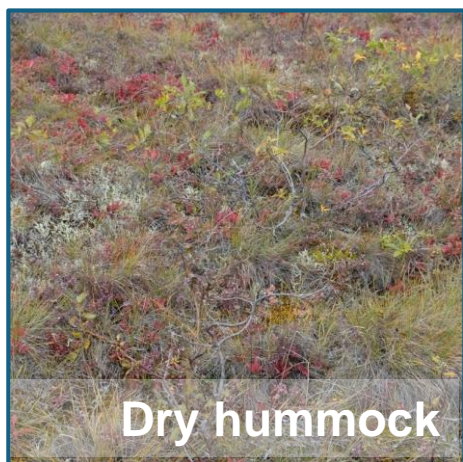
Polygon dry



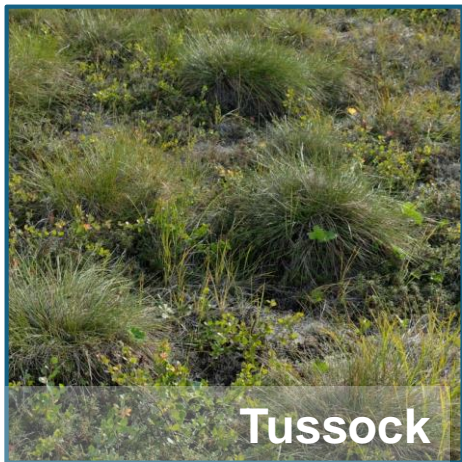
Lichen



Moss



Dry hummock



Tussock



Dwarf shrub

Images: [Inge Grünberg](#)



Single shrub



Riparian shrub



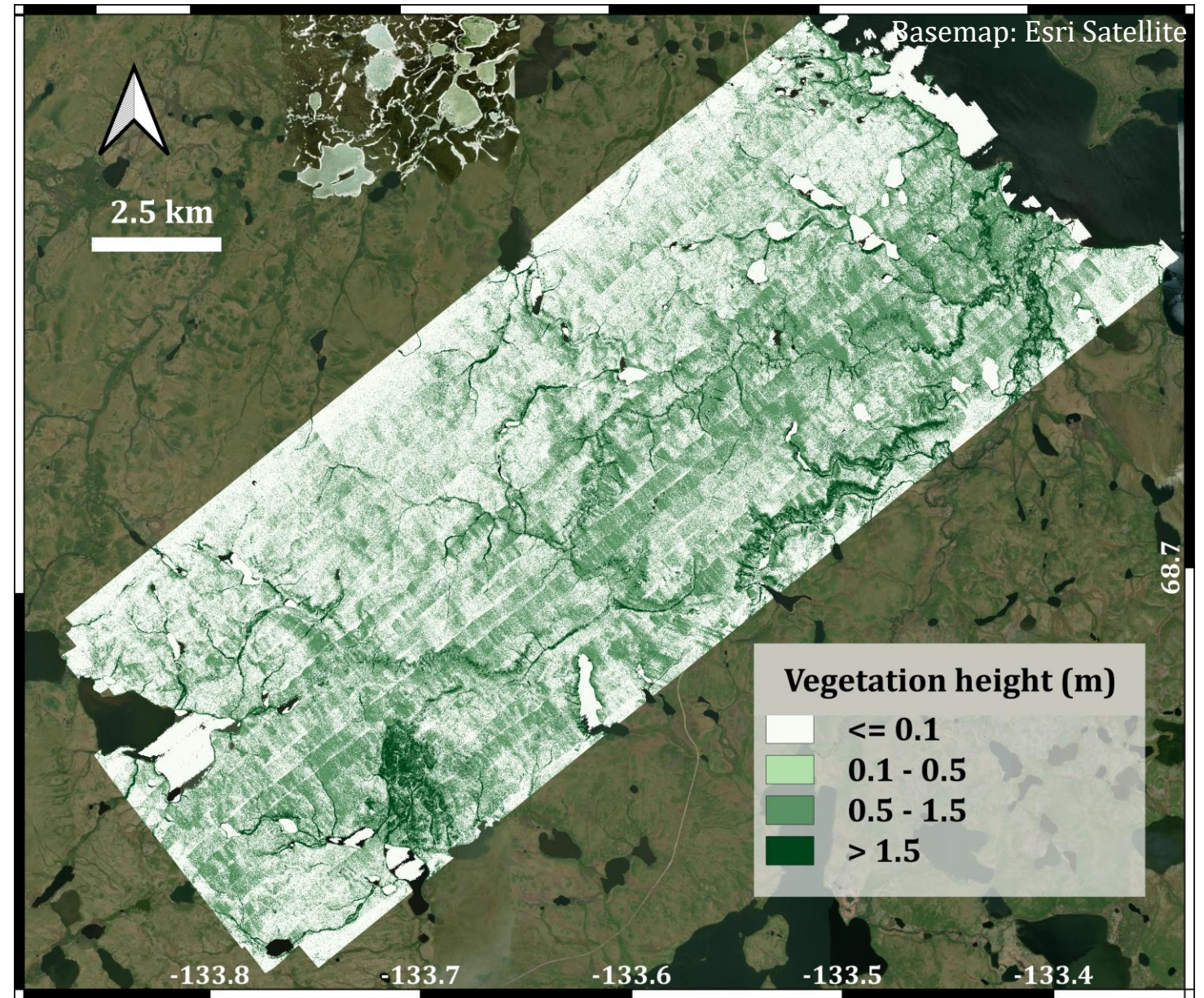
Tree

[home](#) [results](#) [field data](#) [DSM](#) [DTM](#) [snow depth](#)

[topography](#) [veg map](#) [veg images](#) [veg height](#) [references](#)

Vegetation height

- Maximum vegetation height classified using full-waveform summer (snow-free) ALS 2023 data ([Perma-X, 2023](#))
- Resolution: 1 m/pixel



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