



Theme 2: Monitoring permafrost change

Theme 2 Co-leads

Trevor Lantz, University of Victoria

Antoni Lewkowicz, University of Ottawa

Objective: Use monitoring to reveal and quantify permafrost change in Canada and understand its varying rates and expressions at the land surface.

Theme 2: Monitoring permafrost change

Sub-theme objectives

1. To measure or infer permafrost change using geophysical methods, remote sensing and traditional and local knowledge so that spatial patterns and temporal trends can be discerned.
2. To synthesise and reconcile results from differing modes of permafrost monitoring so that they can support local decision making as well as coherent national synthesis



Today's Presentation



1. Overview of Research in Theme 2

All of the project researchers are at the AGM. Check out their talks and posters and find them at coffee breaks.

2. Plans for Synthesis in Theme 2

Allison Plourde (MSc1):

Measuring Surface Displacement using Winter SAR

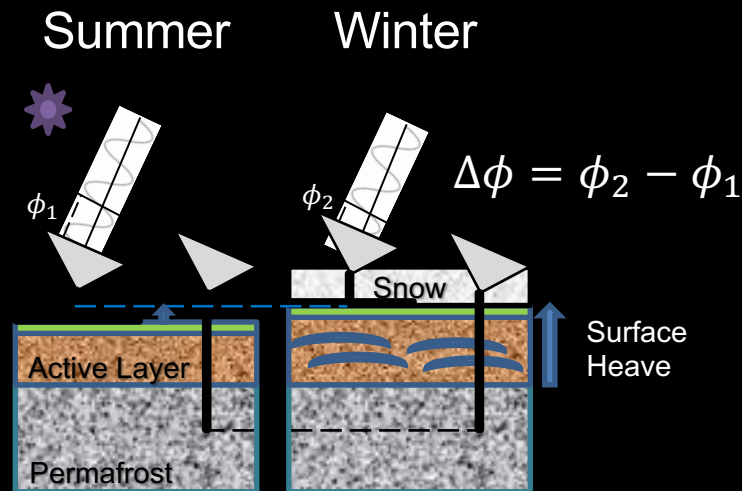


Objectives

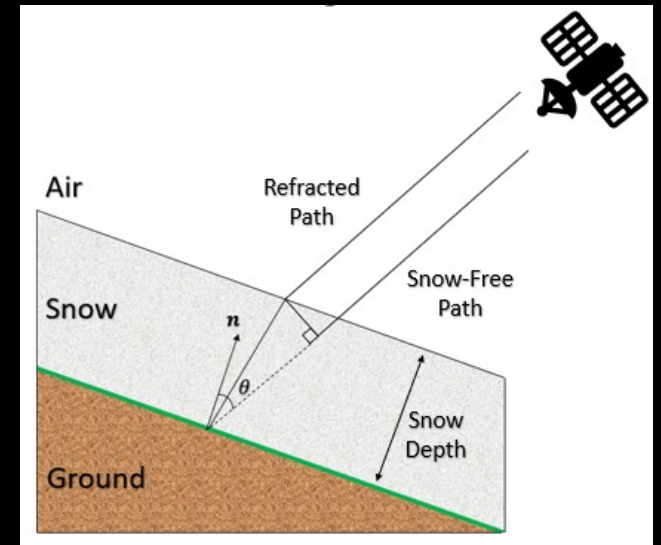
1. Measure surface displacement and snow water equivalent change calculated using in-situ data and InSAR phase change data.
2. Examine the spatial variability of both snow distribution and surface displacement

Theory

Interferometric Synthetic Aperture Radar (InSAR) measures the phase change of the radar signal between acquisitions.



Phase due to seasonal surface heave



Phase due to snow accumulation

Allison Plourde: Project Updates

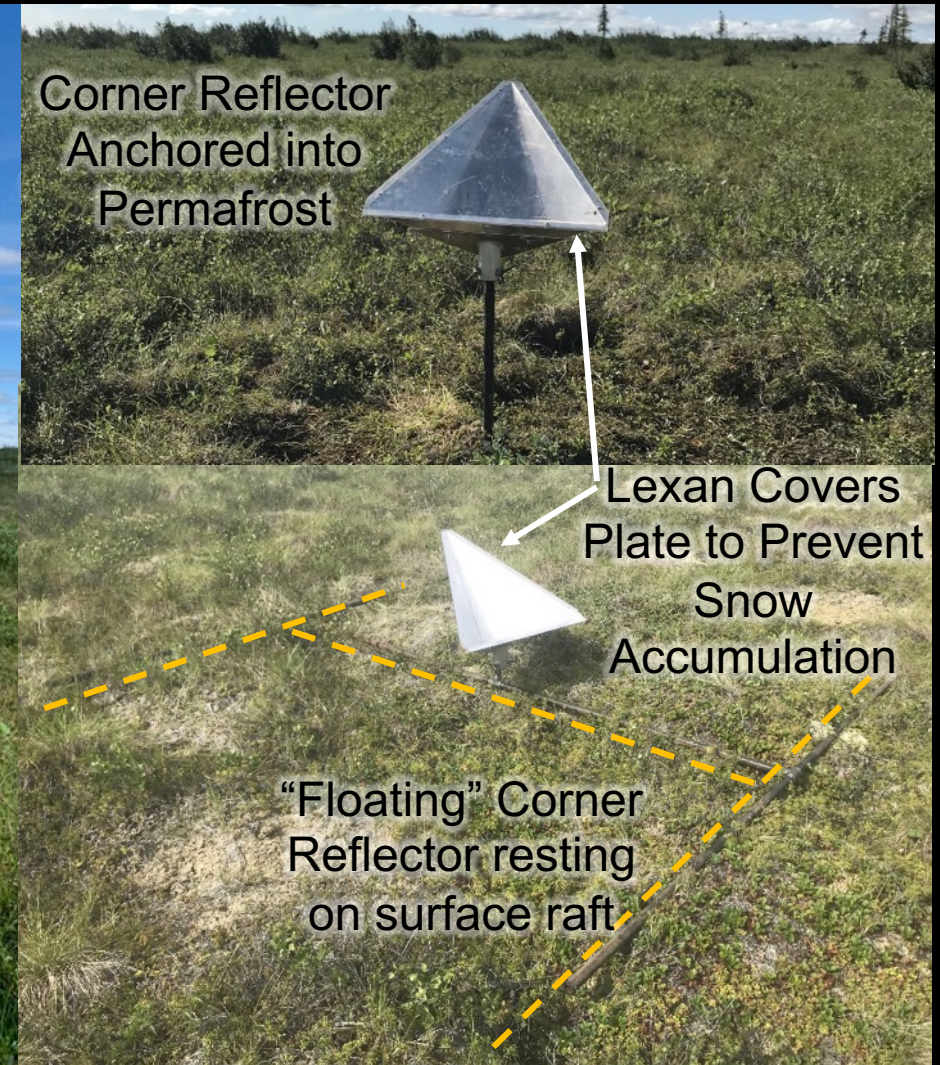
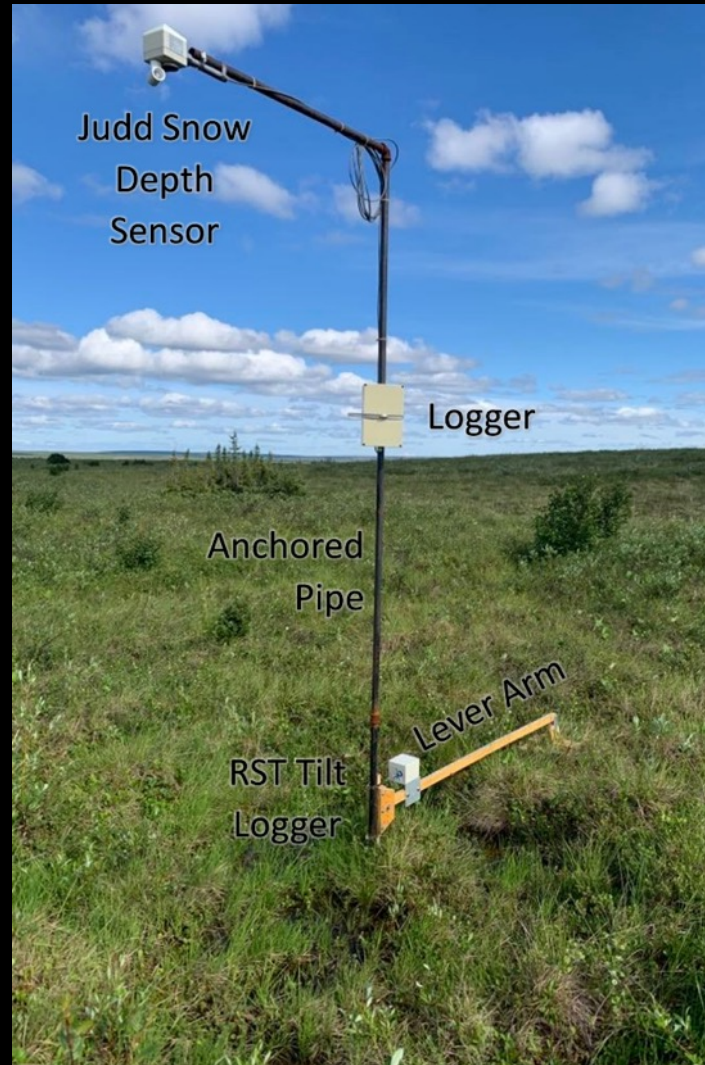
Detailed Presentation - Wednesday AM

Completed:

- ✓ Surface displacement measured from inclinometer
- ✓ Snow depth measured from ultra-sonic range finder
- ✓ InSAR measurements of surface displacement from Corner Reflectors (results are independent of snow accumulation)

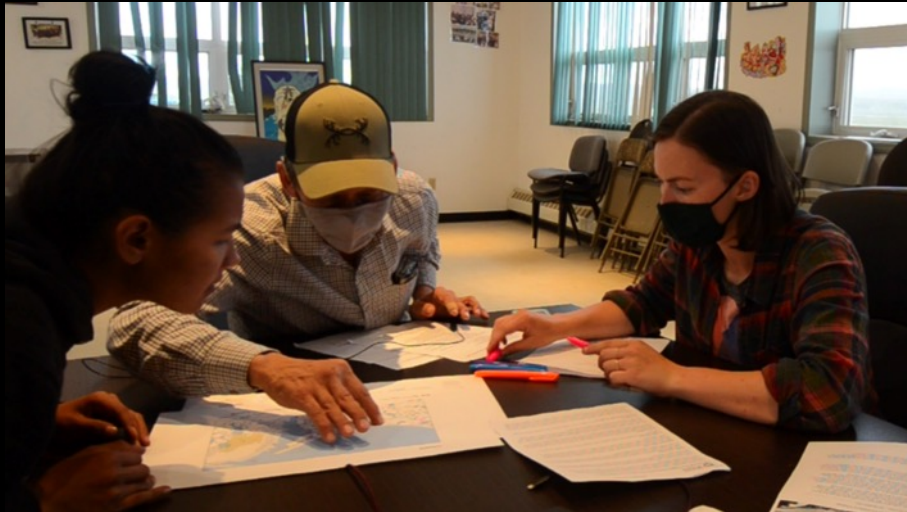
In Progress:

- ... InSAR measurements of surface displacement over the whole region accounting for snow accumulation
- ... InSAR snow water equivalent estimation



Emma Street (T2-PhD2)

Exploring Traditional Knowledge of Permafrost in the Gwich'in Settlement Area and Inuvialuit Settlement Region.



Objectives

1. Document Gwich'in and Inuvialuit Traditional Knowledge of permafrost thaw
2. Map permafrost change in Inuvialuit and Gwich'in communities
3. Work with communities on community-identified projects



Emma Street: Project Updates

Poster Presentation: Tuesday 4:00

Completed:

- ✓ Interview data collection for this project was completed in October, 2023
- ✓ 110 interviews were held among the eight communities of the Gwich'in Settlement Area and Inuvialuit Settlement Region (Paulatuk, Fort McPherson, Inuvik, Sachs Harbour, Ulukhaktok, Aklavik, Tuktoyaktuk, Tsiigehtchic)

In Progress:

- ... Transcription and analysis are currently underway stage
- ... Meeting with project partners (IGC, GRRB, HTC's, and RRCs) to shape the next phase of the project



Pete Castillo (T2-MSc2)

Distribution of Polygonal Terrain and Patterned Ponding in the NWT

Poster Presentation: Tuesday 4:00



Objectives

1. Identify the climate and terrain factors associated with the distribution of polygonal terrain in the NWT.
2. Use random forests to model the sensitivity of ice wedge pond development.

Stage: Parameterizing random forest models and acquiring broad-scale data to use in the model.



Nick Brown (T2-Special Mission)

Evaluation of temperature-derived metrics for monitoring permafrost change



Objectives

1. Review existing thermally-derived metrics used to describe permafrost change and identify possible novel metrics.
2. Evaluate how well these metrics reflect surface displacement and sensible and latent heat gain in permafrost using simulated observations.
3. Investigate how permafrost change can be visualized and communicated using these metrics at multiple scales from single depths to coarser levels of aggregation.

Nick Brown: Project Updates

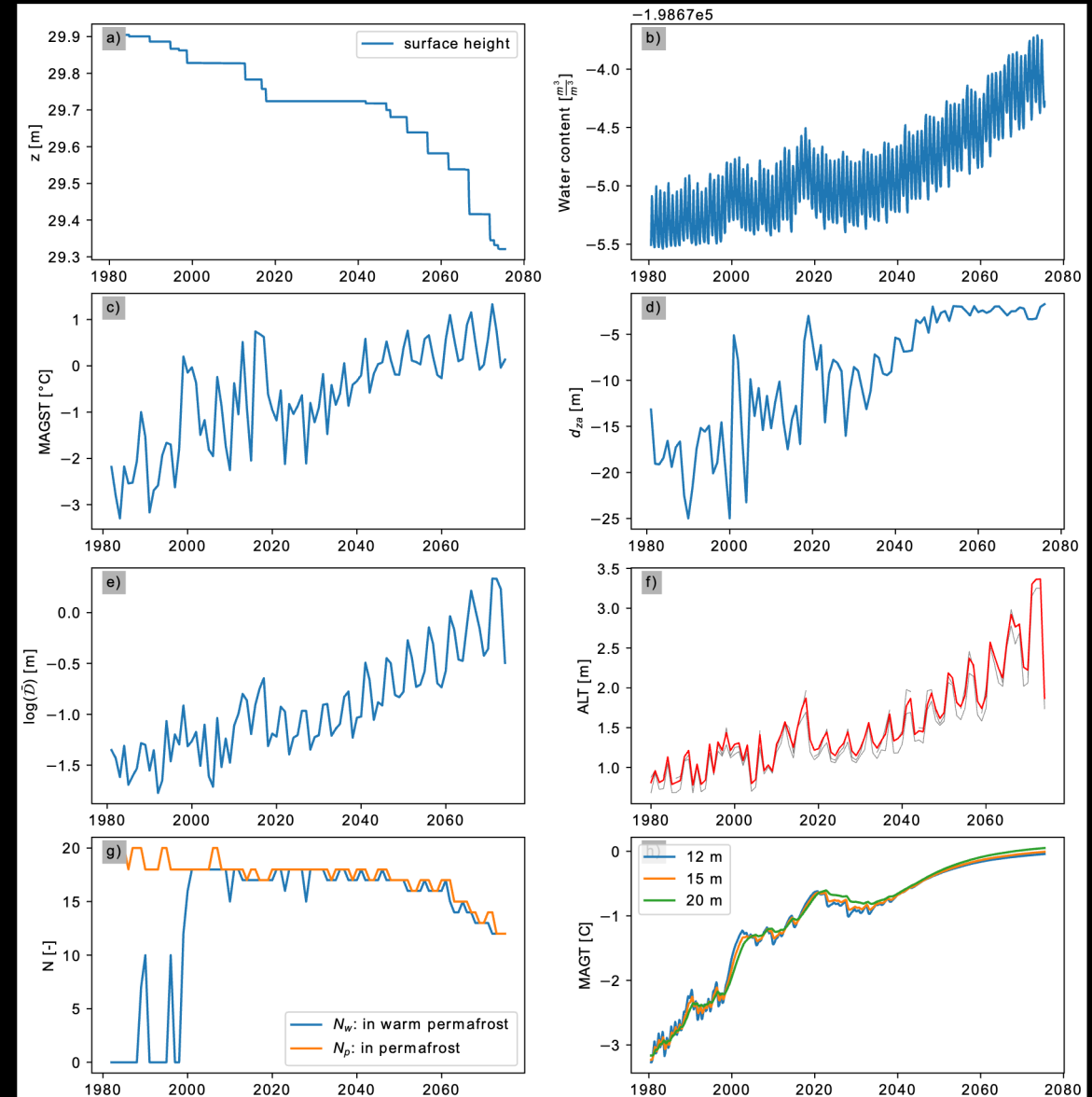
Poster Presentation: Tuesday 4:00

Completed:

- ✓ Write code to calculate metrics
- ✓ Simulation framework: 100 years of warming tracking excess ice and surface displacement

Next steps:

1. Run additional simulations to capture variability in soil conditions and meteorology.
2. Develop methodology to assess correlation of metrics with variables of interest.
3. Develop methods for aggregation:
 - a. Single-sensor metrics to borehole metrics.
 - b. Time series to single-value trends or rates.
4. Incorporate metrics into tsp python package to facilitate re-use.



Olivia Meier-Legault (T2-M3)

Interpreting ground temperature and subsidence for better quantifying permafrost change

Poster Presentation: Tuesday 4:00

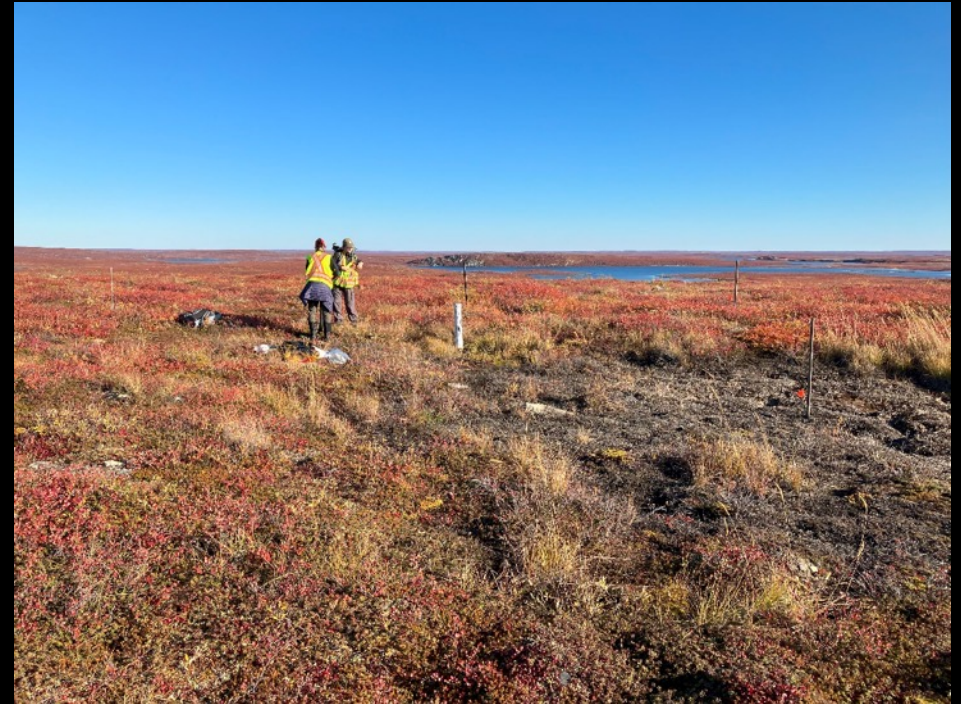


Objective

- Quantify permafrost thaw and temperature change in Canada using borehole temperature data

Methods:

- Using a dense and wide spatial coverage of borehole data, calculate monitoring metrics and thaw metrics for each borehole
- Summarize changes per borehole and compare across all



Stage: Currently in the process of acquiring data and developing workflow for borehole analysis

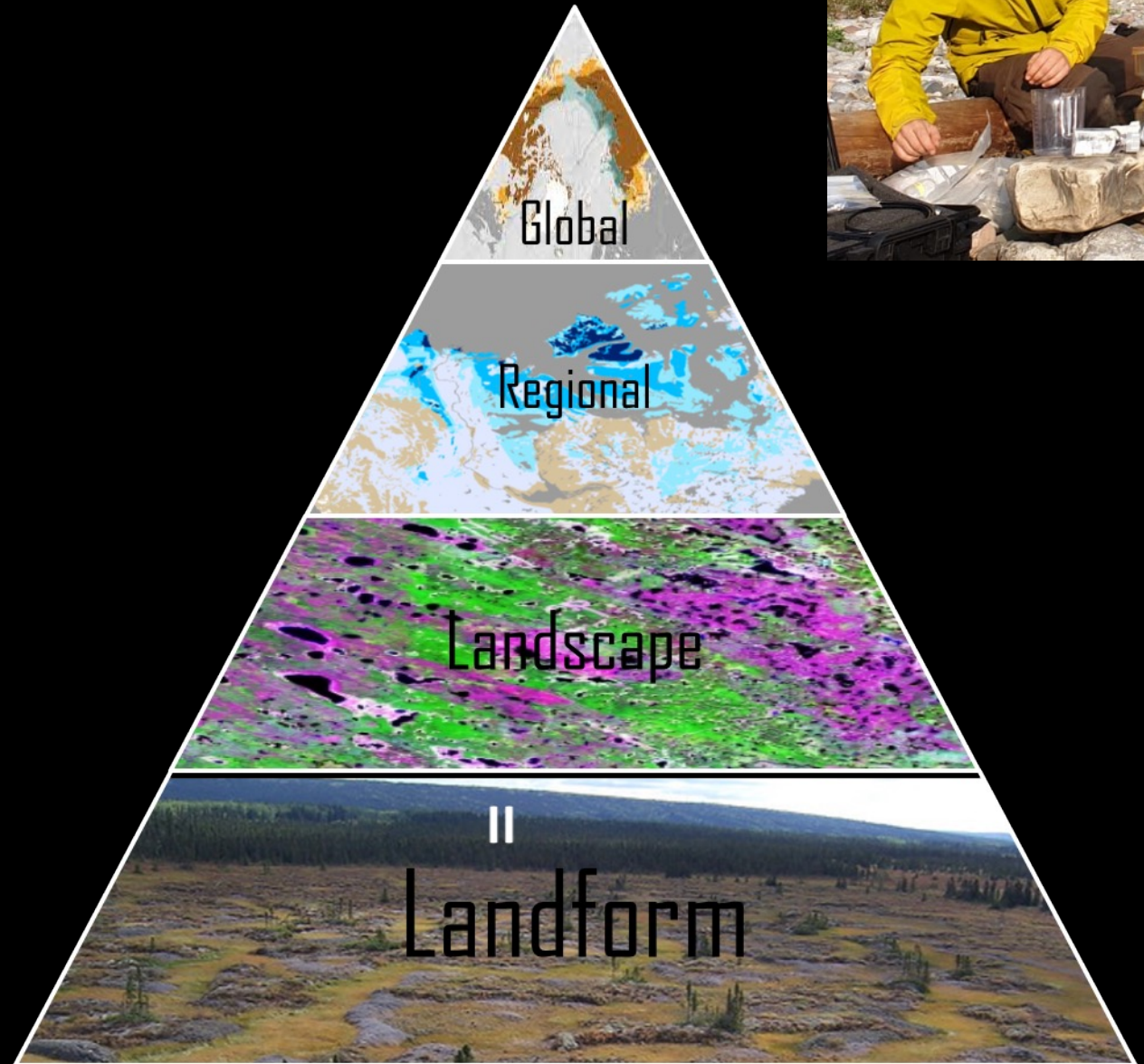
Niek Speetjens (PDF)

A Permafrost Terrain Types Framework for Canada

Presentation: Tuesday 1:30

Objectives

1. Develop a conceptual model for permafrost terrain type classification in Canada
2. Deploy the model in one or more case studies



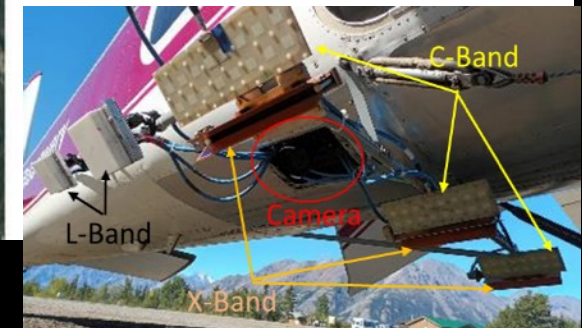
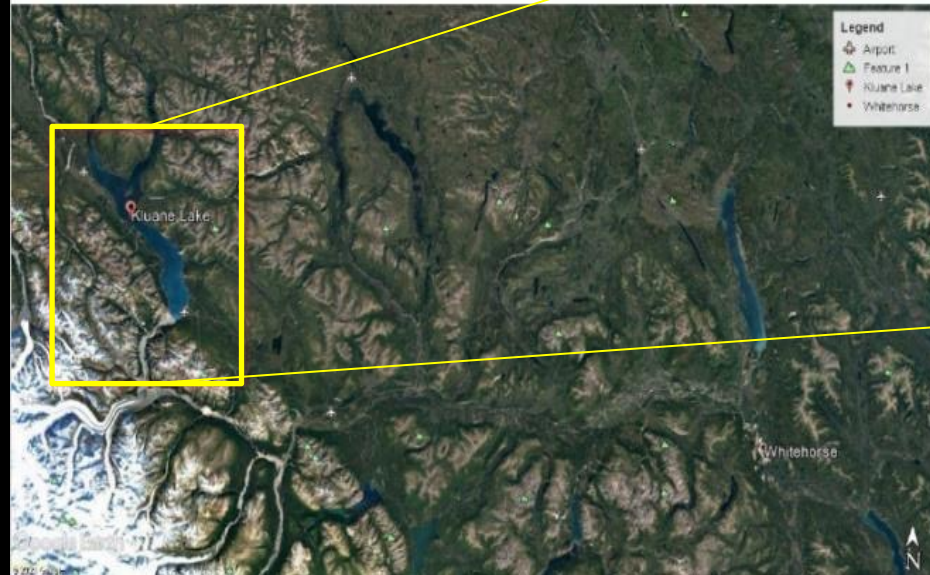
Usman Iqbal (PhD4)

Linear Infrastructure and Permafrost Monitoring



Objectives

1. Measure surface displacement using airborne photogrammetric driven DEMs
2. Measure surface displacement with Interferometric SAR (InSAR) timeseries analysis.



Usman Iqbal : Project Updates

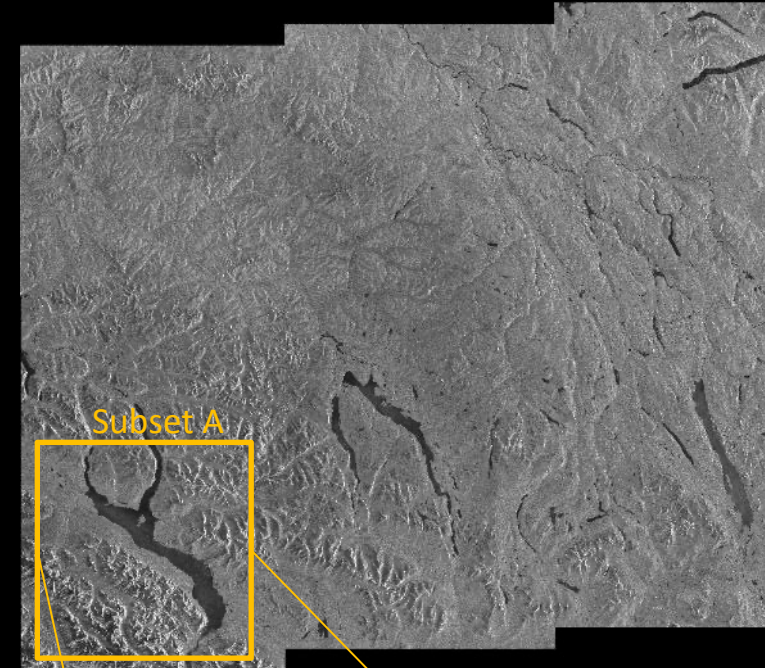
Poster Presentation: Tuesday 4:00

Completed:

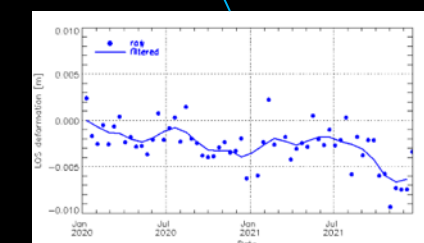
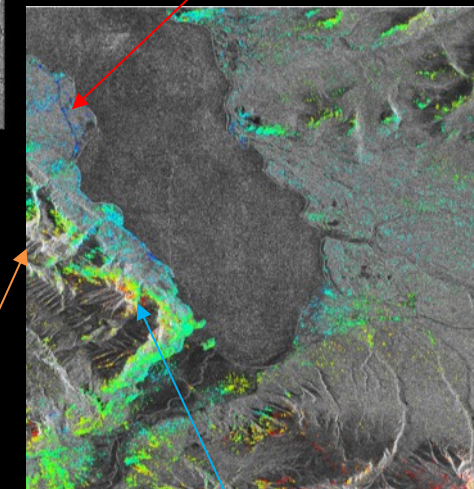
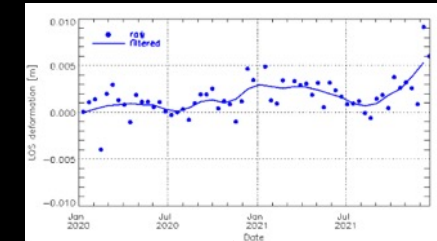
- ✓ Airborne SAR and Optical Data Collection (90%)
- ✓ Photogrammetric DEM based deformation analysis chain
- ✓ Extraction of motion refinement parameters from optical photogrammetry block adjustment
- ✓ Spaceborne InSAR timeseries analysis chain

In Progress:

- ... Airborne Repeat Pass Interferometry chain
- ... Incorporation of Motion refinements estimates for enhanced interferometric outputs
- ... Refinement of Photogrammetry and Spaceborne InSAR results



LOS Deformation



Research in Theme 2



The diversity of research approaches in theme 2 mirrors the diversity of methods for monitoring.

Synthesis in theme 2 will focus on assembling a short review monitoring modalities.

Questions

