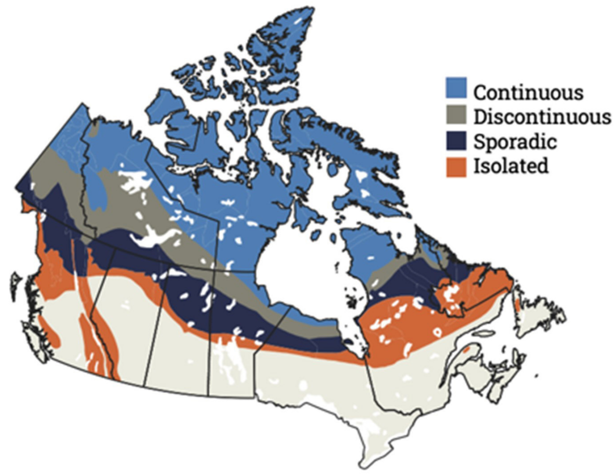
Establishing a Canadian database of geoelectrical surveys of permafrost.

Teddi Herring, Antoni G. Lewkowicz, University of Ottawa

Keywords: Geophysics, electrical resistivity tomography, database, monitoring, climate change.

Study locations: Canada-wide



The main outcome of this project is a database of electrical resistivity tomography (ERT) surveys of permafrost in Canada. These geophysical surveys are often used to characterize permafrost extent and conditions, but until now there has been no framework for data sharing. We created the Canadian Permafrost Electrical Resistivity (CPERS) database to archive surveys in a standardized way. The database enables researchers, practitioners, and community members to easily share and access data, improving our collective understanding of permafrost conditions and how they are changing over time.

Research summary

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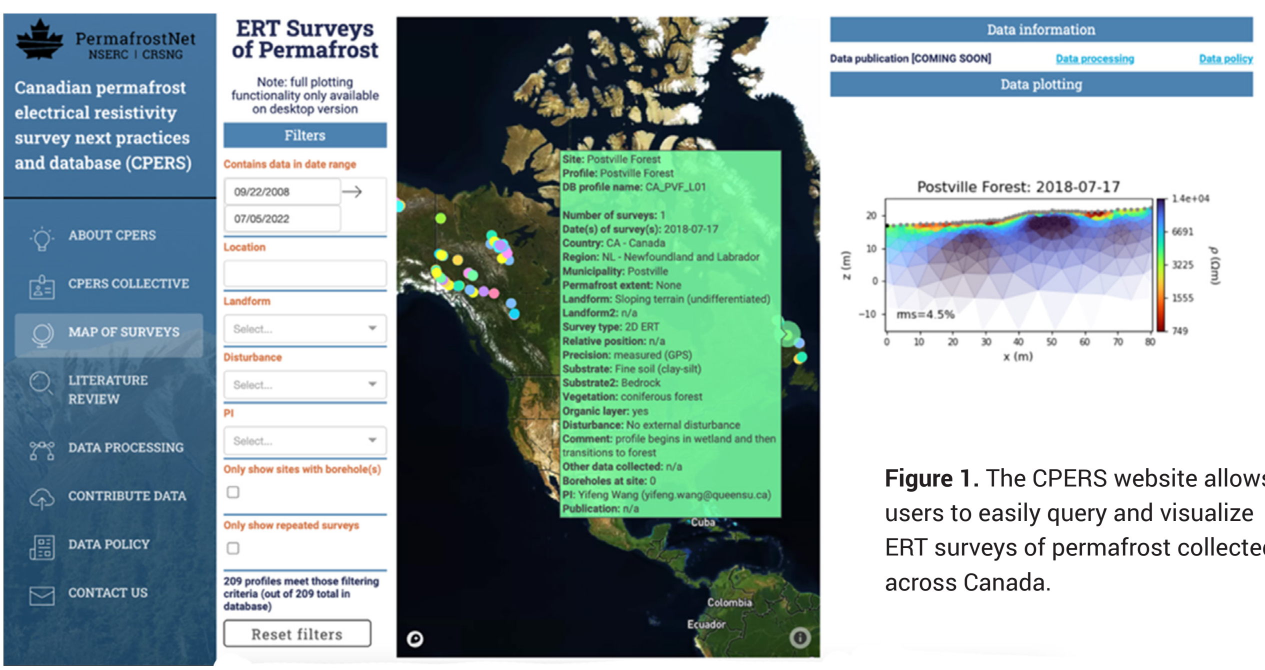

Figure 1. The CPERS website allows users to easily query and visualize ERT surveys of permafrost collected across Canada.

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Taking action

Data is essential for characterizing permafrost environments and making informed decisions about mitigating and adapting to permafrost thaw. If you would like to contribute data to the CPERS database or learn more about the project, please visit https://data.permafrostnet.ca/cpers/.

Connections to other projects

This project is directly relevant to

1 Theme 1 (characterization of permafrost) and 2 Theme 2 (monitoring of permafrost change).

Partners, team members and support

We gratefully acknowledge Robert Way, Yifeng Wang, Alexandre Chiasson, Joseph Young, and Duane Froese for their data contributions, as well as the data collectors and field assistants, who are too numerous to list here. We thank Nick Brown for the IT support, Etienne Godin for assisting with the Nordicana D data publication, and the Digital Research Alliance of Canada for the digital resources. Greg Oldenborger, Fabrice Calmels, and Anne-Marie Leblanc provided guidance on this project. We thank members of the International Permafrost Association action group "Towards an International Database of Geoelectrical Surveys on Permafrost (IDGSP)" who collectively developed the metadata form and database structure used for this project.

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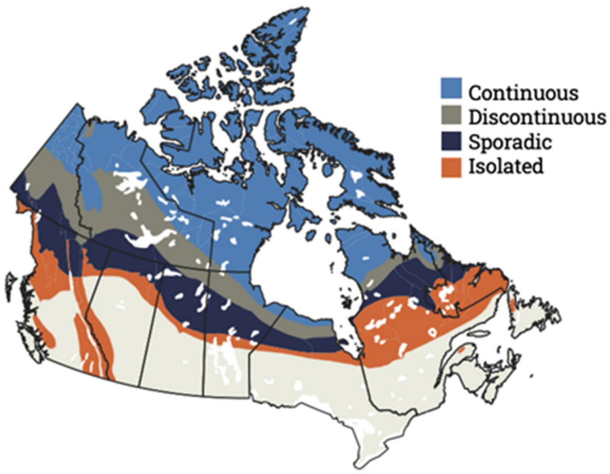
Mapping and understanding how ice conditions change in thermokarst lakes over multiple decades.

Teddi Herring, Antoni G. Lewkowicz, University of Ottawa

Study locations: Old Crow Flats, northern Yukon.

Keywords: Geophysics, electrical resistivity tomography, database, monitoring, climate change.

This research produces maps from a machine-learning algorithm that shows where the ice in shallow lakes is frozen to the bed (bedfast ice) and where it is not (floating ice). The differences in ice conditions impact the stability or thaw of permafrost. The maps can be generated going back 30 years and reveal how fast and where changes are happening. Having such maps helps us understand why changes in environments such as the Old Crow Flats occur and predict how they might continue in the future. The maps can inform local knowledge holders and scientists on how observations at differing locations may be related.



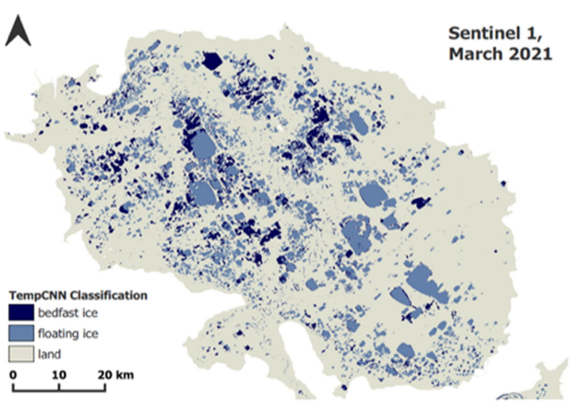


Figure 1 shows a map produced from a machine learning algorithm using a Synthetic Aperture Radar (SAR) image taken by the Sentinel 1 satellite in March 2021. The algorithm has classified the surface as either land, floating ice or bedfast ice. Maps have been produced from 1993 to 2021 and the machine learning algorithm can be applied in other permafrost regions.

Research summary

Lake ice changes in response to climate change. Many shallow Arctic lakes and ponds freeze to bed in the winter months, maintaining the underlying permafrost. As climate changes, fewer lakes are expected to develop bedfast ice, and this can accelerate permafrost thaw. To understand this, we need to know where the ice is bedfast, where it floats, and how these patterns change over time. This research has developed a method for making such maps based on satellite radar images. It produced maps for the Old Crow Flats from 1993 to 2021 that aligned well with field measurements and the Canadian Lake Ice Model. The maps show that the area covered by bedfast ice has increased over the 29 years, which is tentatively attributed to the catastrophic drainage of some lakes, lowered water levels, and a reduction in snowfall in the region.

Taking action

The next step for these findings that researchers could follow up on is the simulation of the development of lowland thermokarst. Accurate maps of bedfast ice and lake extent allow for the tracking of lake drainages and early identification of catastrophic drainages and thermokarst events and processes, which scientists can use to predict future changes and also for the local community to employ mitigation and adaptation measures.

Connections to other projects

4 This project links to theme 4 projects also being conducted in Old Crow Flats by Danielle Chiasson, looking at permafrost recovery in drained lakes and ponds, and Nicole Corbiere, looking at mercury and methylmercury concentrations in drained basin complexes in Old Crow Flats, Yukon, Canada.

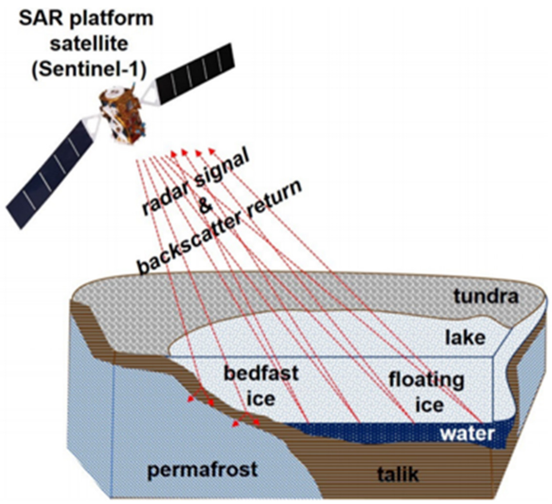


Figure 2 shows the components of tundra and lake landscapes and how a Synthetic Aperture Radar (SAR) satellite can detect the difference between land, floating ice and bedfast ice.

Regional synthesis

This work provides a strong baseline for future thermokarst lake ice dynamics analysis in the Old Crow Flats and beyond, as thermokarst lowlands cover approximately 20% of the northern permafrost regions and contain significant stores of soil organic carbon. Documenting transitions between bedfast and floating ice is crucial to understanding permafrost dynamics beneath shallow lakes and drained lake basins, with potential impacts on methane ebullition and the regional carbon balance, in addition to affecting the livelihood of the local community (e.g. fishing, trapping, travelling).

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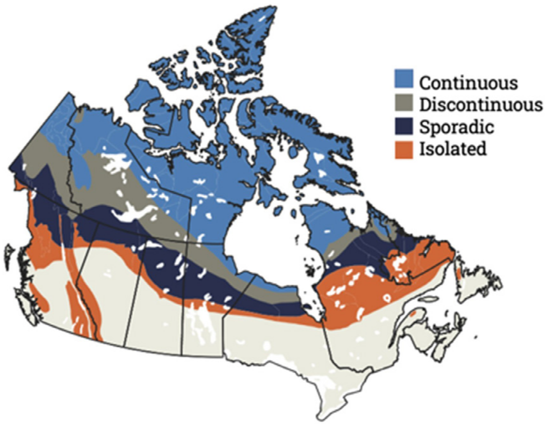

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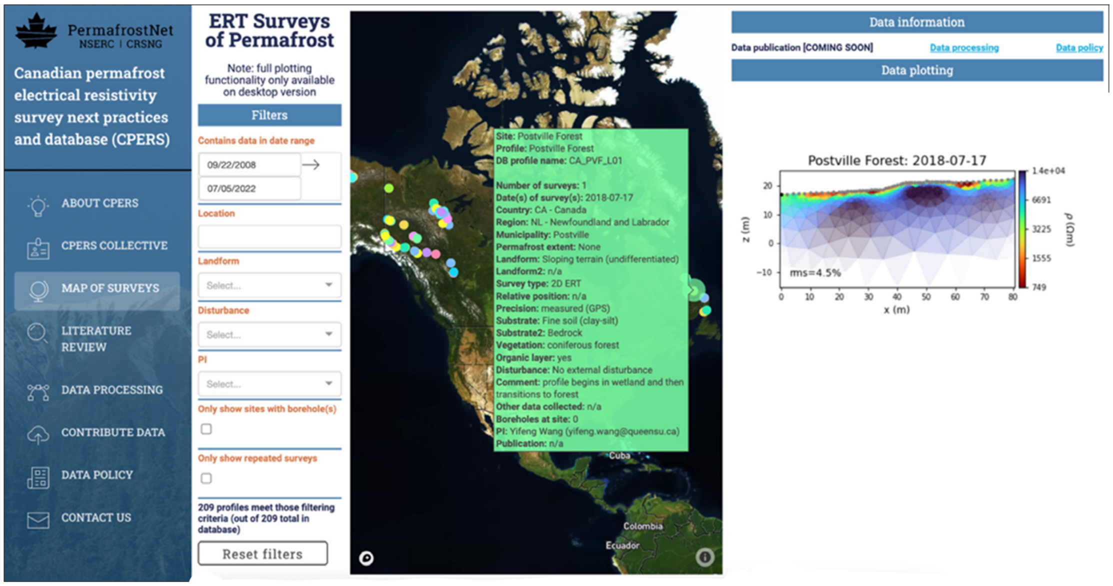

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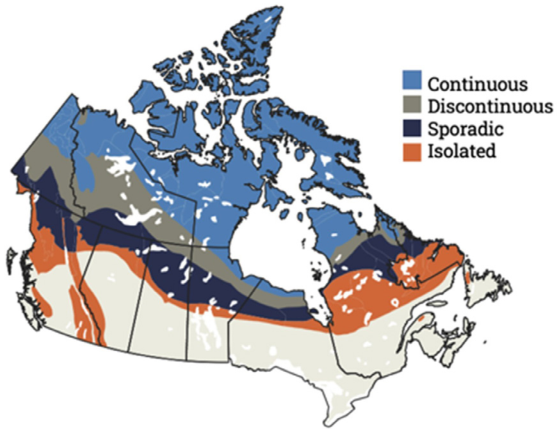

Maria Shaposhnikova[1], Claude Duguay[1] and Pascale Roy-Léveillée[2].
1. University of Waterloo 2. Université Laval

Study locations: Old Crow Flats, northern Yukon.

Keywords: Lake ice, thermokarst lake, lake drainage, satellite, remote sensing, machine learning, neural network.

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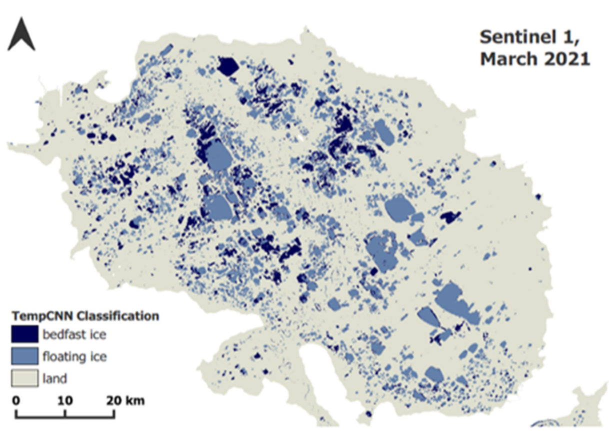

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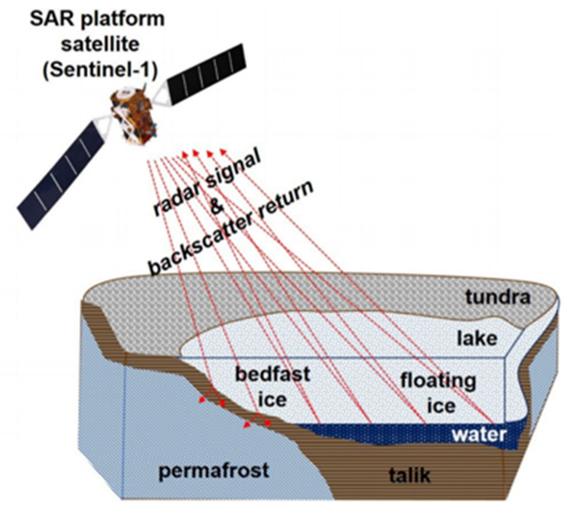

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