

Investigating the dynamics that reshape permafrost environments

June 25 2022



Taking measurements at the Barrow Environmental Observatory, 330 miles north of the Arctic Circle for the Next-Generation Ecosystem Experiment (NGEE-Arctic). The project seeks to improve climate model predictions by studying Arctic terrestrial ecosystems. Credit: Roy Kaltschmidt, Lawrence Berkeley National Laboratory

When permafrost thaws, water can flow more quickly through the ground, creating a complex subsurface flow system. Researchers at the Barrow Environmental Observatory in Alaska gained insight into this process by taking daily measurements of the electrical resistivity of the ground. The results show that vegetation and the snowpack that accumulates on the vegetation in winter control the temperatures of the ground and the flow of water in the ground. Where snow accumulates, ground temperatures stay warmer and water and energy from snowmelt and rain can flow through the ground quickly. Where the snowpack is thin, ground temperatures are colder, preventing the flow of water.

Highlighting the link between above- and belowground properties and processes in the Arctic will help improve scientists' predictions of how the Arctic relates to broader climate change. The results also show that Arctic systems are changing rapidly, and that [permafrost](#) at the research team's study site could disappear within the next decade. Changes in [snowpack](#) distribution and rainfall patterns could accelerate this process.

Climate change is causing rapid changes in Arctic ecosystems, but scientists have not collected enough data needed to unravel complex subsurface processes associated with these changes. Using geophysical and in situ sensing, researchers closed an observational gap associated with thermohydrological dynamics in discontinuous permafrost systems.

Researchers collected data over more than two years of monitoring and were able to uncover the effects of vegetation, topography, and snow thickness distribution on subsurface thermohydrological properties and processes. Large snow accumulation near tall shrubs insulates the ground and allows for rapid and downward heat [flow](#), whereas thinner snowpack above low graminoid grasses and sedges results in surficial freezing and prevents [water](#) from infiltrating the subsurface.

Analyzing short-term disturbances such as snowmelt or [heavy rainfall](#),

the research team found that lateral flow could be a driving factor in the formation of a talik, a subsurface layer in permafrost that remains unfrozen year-round. Interannual measurements indicate that deep permafrost temperatures increased by about 0.2 degrees centigrade over two years.

The results of this study, which suggest that snow-vegetation-subsurface processes are tightly coupled, will improve predictions of Arctic feedback to climate change, including how subsurface thermohydrology influences carbon dioxide and methane fluxes.

The study is published in the *Geophysical Research Letters*.

More information: S. Uhlemann et al, Geophysical Monitoring Shows that Spatial Heterogeneity in Thermohydrological Dynamics Reshapes a Transitional Permafrost System, *Geophysical Research Letters* (2021).
[DOI: 10.1029/2020GL091149](https://doi.org/10.1029/2020GL091149)

Provided by US Department of Energy

Citation: Investigating the dynamics that reshape permafrost environments (2022, June 25) retrieved 24 May 2024 from <https://phys.org/news/2022-06-dynamics-reshape-permafrost-environments.html>

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