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Alaska is getting wetter. That's bad news for permafrost and the climate

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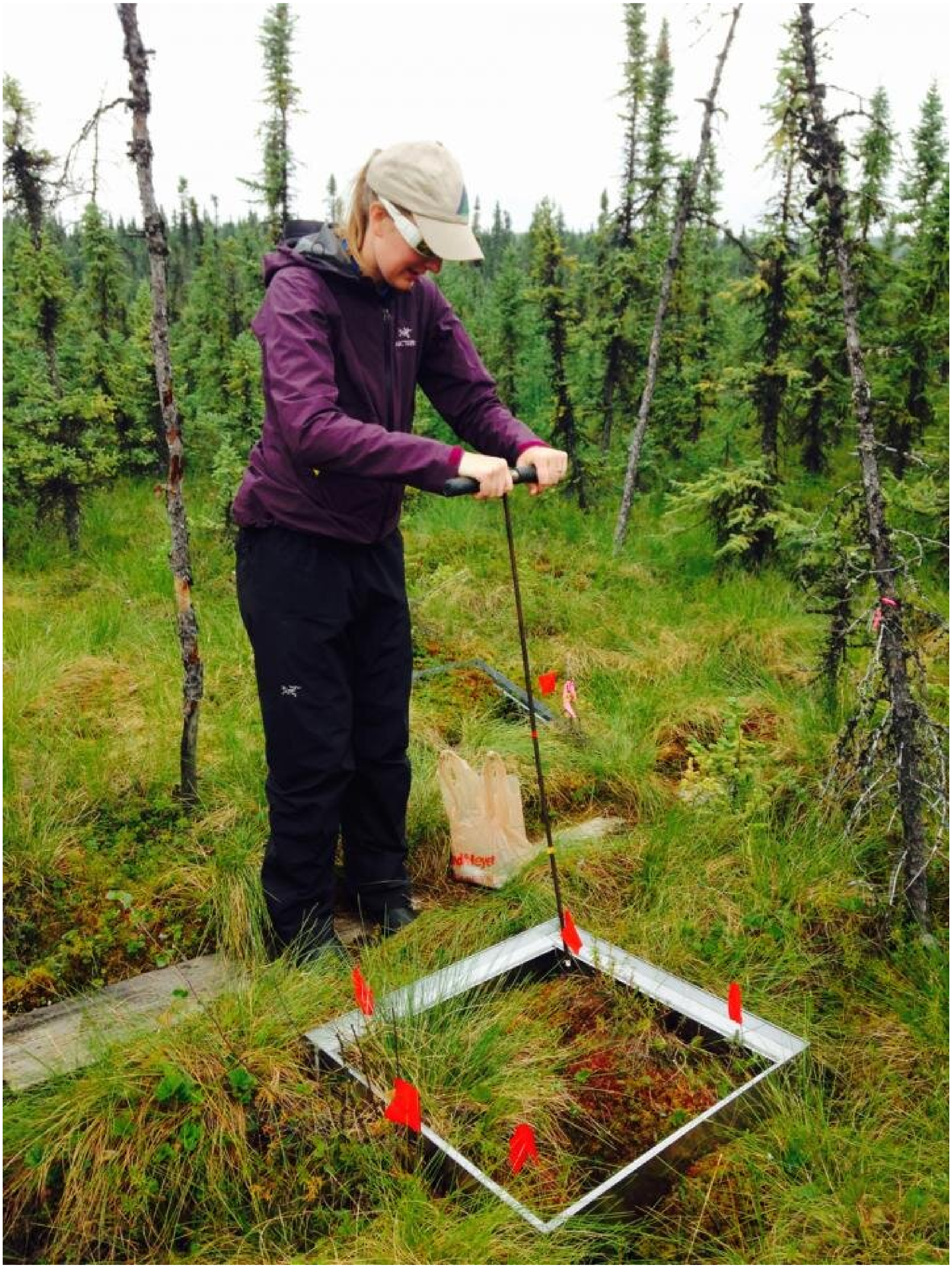

Postdoctoral fellow Catherine Dielemen associated with Merritt Turetsky's research group uses a frost probe to determine the location of surface permafrost beneath the ground surface in interior Alaska. Credit: Merritt Turetsky

Alaska is getting wetter. A new study spells out what that means for the permafrost that underlies about 85% of the state, and the consequences for Earth's global climate.

The study, published today in Nature Publishing Group journal *Climate and Atmospheric Science*, is the first to compare how rainfall is affecting permafrost thaw across time, space, and a variety of ecosystems. It shows that increased summer rainfall is degrading permafrost across the state.

As Siberia remains in the headlines for record-setting heat waves and wildfires, Alaska is experiencing the rainiest five years in its century-long meteorological record. Extreme weather on both ends of the spectrum—hot and dry versus cool and wet—are driven by an aspect of climate change called Arctic amplification. As the earth warms, temperatures in the Arctic rise faster than the global average.

While the physical basis of Arctic amplification is well understood, it is less known how it will affect the permafrost that underlies about a quarter of the Northern Hemisphere, including most of Alaska. Permafrost locks about twice the carbon that is currently in the atmosphere into long-term storage and supports Northern infrastructure like roads and buildings; so understanding how a changing climate will affect it is crucial for both people living in the Arctic and those in lower latitudes.

"In our research area the winter has lost almost three weeks to summer," says study lead author and Fairbanks resident Thomas A. Douglas, who is a scientist with the U.S. Army Cold Regions Research and Engineering Laboratory. "This, along with more rainstorms, means far more wet precipitation is falling every summer."

Over the course of five years, the research team took 2750 measurements of how far below the land's surface permafrost had thawed by the end of summer across a wide range of environments near Fairbanks, Alaska. The five-year period included two summers with average precipitation, one that was a little drier than usual, and the top and third wettest summers on record. Differences in annual rainfall were clearly imprinted in the amount of permafrost thaw.

More rainfall led to deeper thaw across all sites. After the wettest summer in 2014, permafrost didn't freeze back to previous levels even after subsequent summers were drier. Wetlands and disturbed sites, like trail crossings and clearings, showed the most thaw. Tussock tundra, with its deep soils and covering of tufted grasses, has been found to provide the most ecosystem protection of permafrost. While permafrost was frozen closest to the surface in tussock tundra, it experienced the greatest relative increase in the depth of thaw in response to rainfall, possibly because water could pool on the flat surface. Forests, especially spruce forests with thick sphagnum moss layers, were the most resistant to permafrost thaw. Charlie Koven, an Earth system modeler with the Lawrence Berkeley National Laboratory, used the field measurements to build a heat balance model that allowed the team to better understand how rain was driving heat down into the permafrost ground.

The study demonstrates how land cover types govern relationships between summer rainfall and permafrost thaw. As Alaska becomes warmer and wetter, vegetation cover is projected to change and wildfires will disturb larger swathes of the landscape. Those conditions may lead to a feedback loop between more permafrost thaw and wetter summers.

In the meantime, rainfall—and the research—continue. Douglas says, "I was just at one of our field sites and you need hip waders to get to areas that used to be dry or only ankle deep with water. It is extremely wet out there. So far this year we have almost double the precipitation of a typical year."

"This study adds to the growing body of knowledge about how extreme weather—ranging from heat spells to intense summer rains—can disrupt foundational aspects of Arctic ecosystems," says Merritt Turetsky, Director of the University of Colorado Boulder's Institute of Arctic and Alpine Research (INSTAAR) and a coauthor of the study. "These changes are not occurring gradually over decades or lifetimes; we are watching them occur over mere months to years."

More information: Thomas A. Douglas et al, Increased rainfall stimulates permafrost thaw across a variety of Interior Alaskan boreal ecosystems, *npj Climate and Atmospheric Science* (2020). DOI: 10.1038/s41612-020-0130-4

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