Thaw dynamics of a rapidly degrading isolated permafrost plateau in south-central Alaska

Joel Eklof[1], Mark Waldrop[2], Benjamin Jones[3], and Rebecca Neumann[1]

[1]University of Washington
[2]US Geological Survey
[3]University of Alaska, Fairbanks

November 26, 2022

Abstract

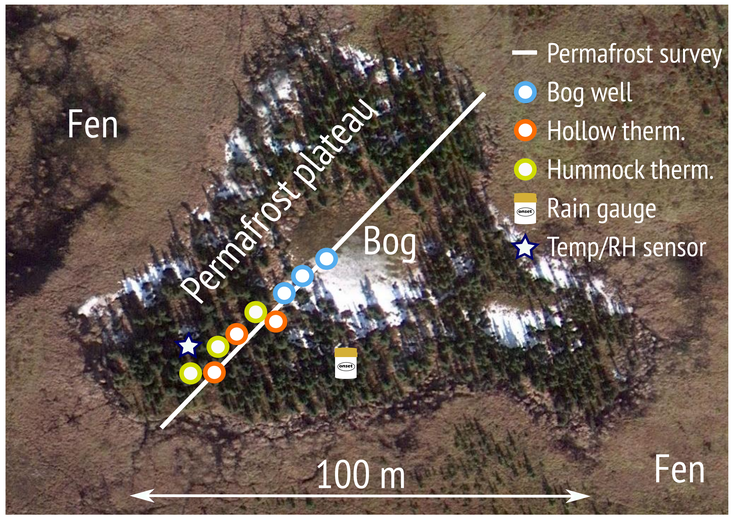
Northern high latitudes are projected to get warmer and wetter in the future which will affect rates of permafrost thaw and the mechanisms by which thaw occurs. To better understand these changing thaw dynamics, we instrumented an isolated permafrost plateau in south-central Alaska with climate conditions that currently mirror those expected in more northern permafrost regions in the future. Using preliminary 2019 measurements of temperature from the soil surface into permafrost, depth to frost table, water level, groundwater temperature, and meteorological variables, we tracked soil and permafrost warming throughout the season, and identified how environmental factors, such as water table elevation, microtopography, and warm rain events, affected rates of warming and thaw. Additionally, we present the extent of permafrost degradation since the last observations at this site in 2015. Permafrost thaw and resultant landscape change has a net warming effect on the climate. Understanding of the environmental factors that lead to thaw and rates at which permafrost will thaw under future climate conditions will allow for better preparation, modeling, and policy making for the future.

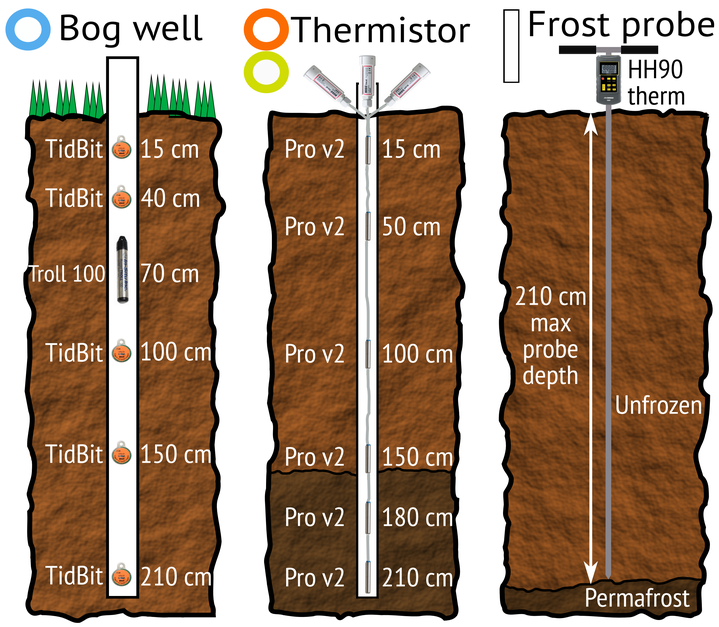
Thaw dynamics of a rapidly degrading isolated permafrost plateau in south-central Alaska

Joel Eklof (U. Wash) @EklofJoel , Mark Waldrop (USGS), Ben Jones (UAF), and Rebecca Neumann (U. Wash) @BeccaNeum

Introduction

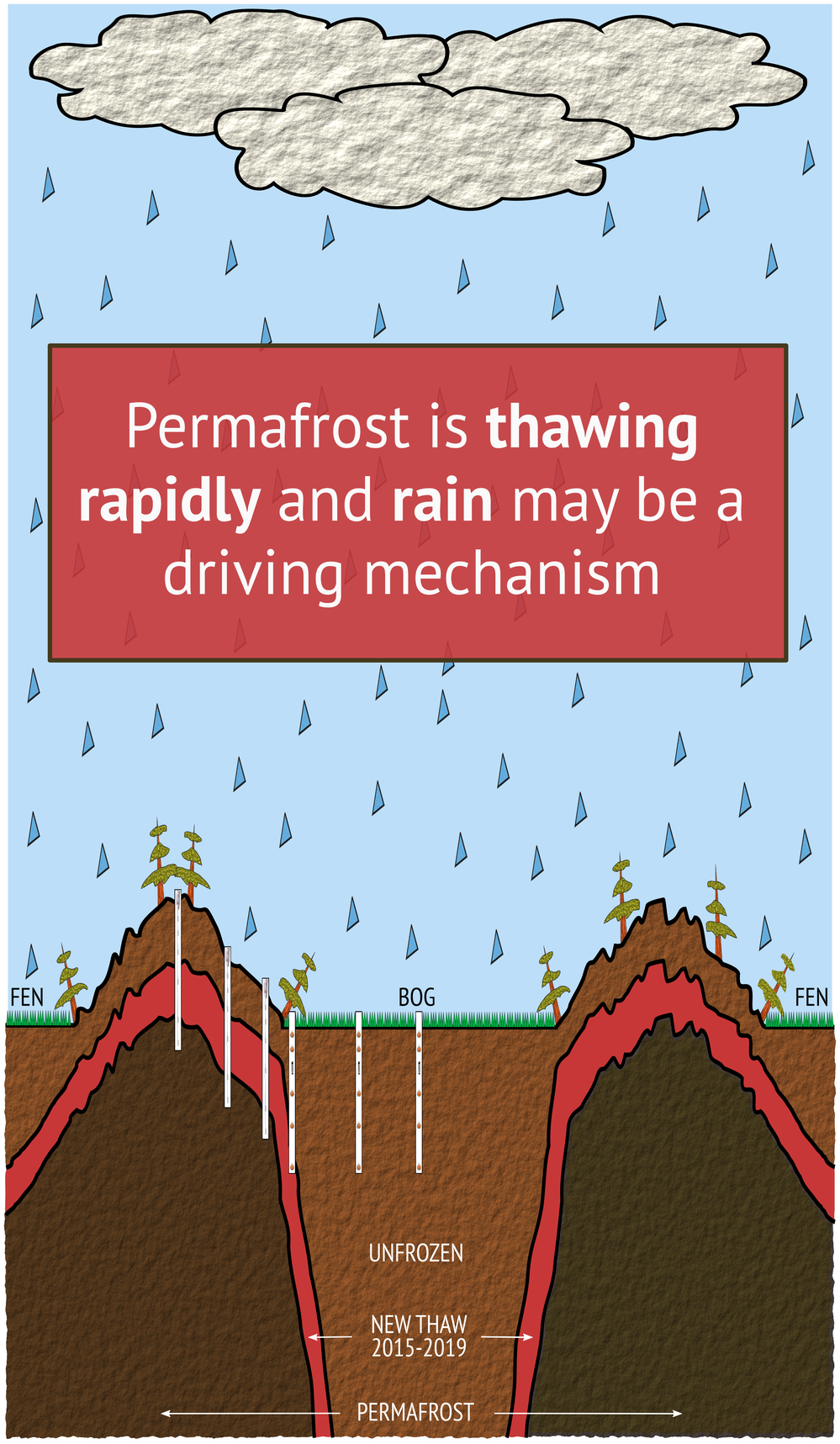
Northern high latitudes are expected to get warmer and wetter in the future. To better understand how permafrost landscape thermal regimes will change, we instrumented a discontinuous permafrost site currently experiencing these climate conditions.



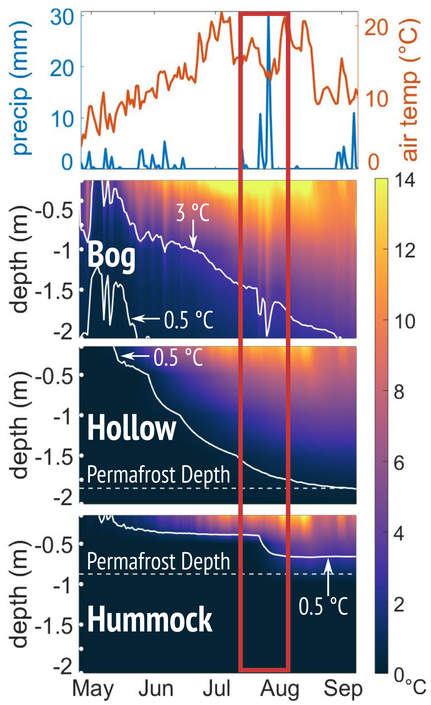


Motivation

Spring/summer rain events rapidly warm boreal wetland soils to deep depths by advecting thermal energy (Neumann et al. 2019, Geophys. Res. 46:1393). We hypothesized that this mechanism also warms seasonally frozen boreal plateau soils and accelerates permafrost thaw.



Advective Heat Transfer by Rain



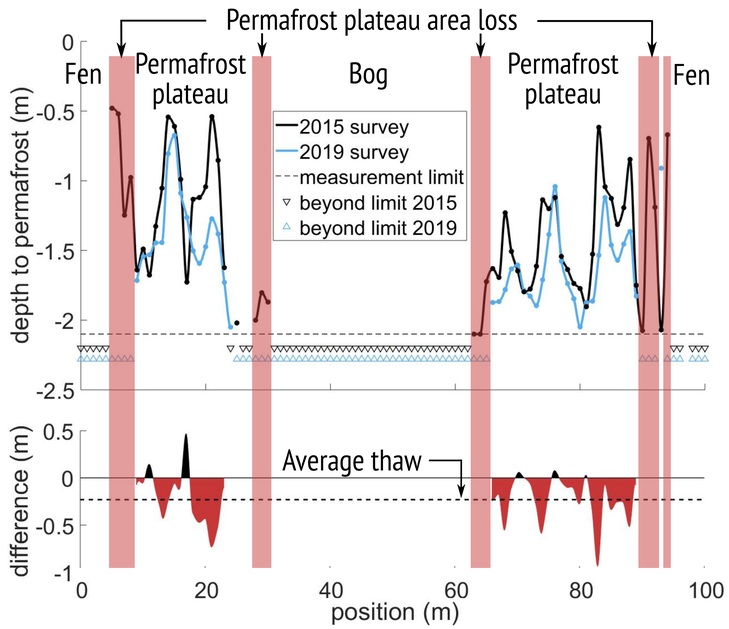
During a warm July rain event...

Significant warming to >2 m in bog

Minimal additional warming in plateau hollows

Rapid warming/thaw in plateau hummocks to permafrost table

Permafrost Change 2015-2019



Between Sept. 2015 and Sept. 2019...

26% reduction of measureable permafrost plateau extent (~14 lateral meters)

0.23 meter increase in average depth to permafrost (~0.06 meters per year)