Thermal Transport by Rain: A Mechanism for Warming and Thawing Frozen Soil

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BER Program: TES **Project**: University Project **Project 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. These measurements indicate substantial degradation of permafrost over the past four years. Notably, collected data show rapid thaw of frozen soil within the permafrost plateau during a large rain event, providing clear evidence of the ability of rain to advect thermal energy into soils. Previous work in more northern latitudes has linked rain with soil warming within thermokarst bogs (Neumann et al.
2019) — data from this recent study identifies rain within a currently warm and wet climate as a mechanism for thawing frozen soils. This result indicates, but does not prove, that thermal transport by rain could be an important mechanisms for thawing permafrost. Capturing and correctly accounting for dynamic biosphere-atmosphere interactions and feedbacks, such as those involved with permafrost thaw, requires Earth system modeling. However, current Earth system land models, like the Energy Exascale Earth System Model Land Model (ELM), do not include transport of heat into soil from rain. Results from this and the previous study have motivated current efforts to incorporate advective heat transport within ELM, to improve its predictive capability.

References:

Neumann, R. B., Moorberg, C. J., Lundquist, J. D., Turner, J. C., Waldrop, M. P., McFarland, J. W., Euskirchen, E. S., Edgar, C. W. and Turetsky, M. R.: Warming Effects of Spring Rainfall Increase Methane Emissions From Thawing Permafrost, Geophysical Research Letters, 46, 1393–1401, doi:10.1029/2018GL081274, 2019.