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Discontinuous permafrost dynamics - simulating effects from spatially varying snow cover and soil moisture on permafrost thaw in 2D

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Discontinuous and sporadic permafrost is found at the climatic margin of the permafrost regions. Local factors such as topography, hydrology and soils influence the impact of the air temperature on the ground temperature distribution in these areas. We present a study in which the influence of snow and soil moisture spatial distributions on permafrost is investigated using a model of coupled surface energy balance, snow distribution, and subsurface water and energy transport. We hypothesize that (1) discontinuous permafrost in palsa peatlands is created and maintained by spatial variability in snow cover and soil moisture induced by local topography, and that (2) as the ground temperature varies across the landscape, lateral heat fluxes will impact thaw rates of permafrost when air temperatures and snow cover thickness increase.

Our modeling experiments are driven by meteorological and ground thermal data from northern Sweden, where permafrost in palsas has been monitored since 2005. The configuration of the simulated domain is inspired by observed topography and sediment stratigraphy at the same site.

We hope that this study will give new insights for how we can best conceptualize and model permafrost dynamics in the discontinuous and sporadic permafrost areas. Today's models for permafrost either simulate only vertical heat fluxes and can be applied for larger regions, or fluxes in 2D (such as in this experiment) or 3D but only for limited scenarios due to computational limitations. With this experiment we hope to achieve a better understanding of the main processes that drive the formation of discontinuous/sporadic permafrost, which can be helpful for understanding permafrost formation and degradation on larger scales.