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Impact of variability in measured and simulated tundra snowpack properties on heat transfer metrics

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Tundra snowpack properties are highly heterogenous over a variety of spatial scales and evolve over the course of the winter. Variations in snowpack properties such as snow density and microstructure control the transfer of heat through the snowpack. Thermal properties of the snowpack impact the subnivean environment; snow insulates the underlying soil, allowing films of liquid water to remain unfrozen, enabling biological processes to take place. In this study, field measurements from four field campaigns across two different winters (March and November 2018, January and March 2019) are used to capture and constrain the spatial variability of the snowpack. These include 1050 spatially distributed Snow MicroPenetrometer (SMP) profiles throughout the Trail Valley Creek catchment in the Northwest Territories, Canada. Bespoke coefficients for tundra snowpacks were calculated (based on the work of King et al., 2020) to convert raw SMP force measurements to densities. This allowed density changes of vertical profiles to be assessed and spatial variability in the thickness and properties of three snowpack layers (wind slab, indurated hoar and depth hoar) to be quantified. 105 needleprobe measurements from 37 snowpits were used to contrast the density and thermal conductivity of snowpack layers, as well as thermal conductivities estimated from recalibrated SMP density profiles. These in-situ measurements will be compared to 1-D simulations of snowpack properties from the Community Land Model (PTCLM 5.0) over the two winter seasons. The impact of snowpack layering on snow heat transfer metrics will be investigated using both 2-layer (wind slab: depth hoar) and 3-layer (wind slab: indurated hoar: depth hoar) snowpack configurations. The spatial variability of heat transfer metrics across the Trail Valley Creek catchment will also be considered.