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Soil temperature and thaw depth differences associated with tundra vegetation types at Trail Valley Creek, NWT, Canada

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Climate, vegetation, and permafrost are coupled through various positive and negative feedback loops in the Arctic and Subarctic. Many of these feedback mechanisms are still poorly quantified, in particular with respect to vegetation density or biomass. For instance, climate warming facilitates shrub densification and range expansion. The shrub canopies in-turn shade the ground surface during the summer, keeping permafrost cooler, while during the winter the canopies trap more snow, insulating the surface and keeping the ground (and permafrost) warmer. We investigated the feedback of vegetation change on permafrost conditions and local climate at the Trail Valley Creek study site, near tree-line, in Northwest Canada (133.50°W, 68.74°N). In particular, we quantified the effect of vegetation on the soil surface temperature and thaw depth through shading in summer and through snow collection in winter. We combine local field measurements of vegetation, climate, and permafrost with spatially resolved data from repeated aerial surveys of high resolution imagery and laser scanning. Our results show that winter ground surface temperatures below tall shrubs are on average 2°C warmer than below lichen tundra due to the snow layer being twice as deep. However, delayed spring onset and soil shading in summer result in shallower thaw depths below tall shrubs (47cm on average) as compared to lichen tundra (61cm on average). Our results highlight the complex interactions between vegetation and permafrost involving snow, the surface energy budget and soil properties.