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Snow accumulation patterns from 2023 Airborne Laser Scanning data in Trail Valley Creek, Western Canadian Arctic

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Snow cover plays a pivotal role in the Arctic's climate, hydrology, and ecology, making the understanding of its deposition and accumulation dynamics crucial. Snow depth and its duration can directly influence soil temperature: the insulating properties of snow increase with greater snow depth, which prevents soil temperatures from declining in winter. Trail Valley Creek, NWT, Canada, is located at the northern boundary of the tundra-taiga transition zone, approximately 45 km north of Inuvik, and is underlain by continuous permafrost. The region's rapid warming points to a trend of vegetation changes such as shrub expansion northwards into the tundra.

Topography and vegetation cover are the main drivers of spatial variation of snow depth across different landscapes, while wind significantly influences snow redistribution. This reallocation causes snow to accumulate preferably in terrain features such as valleys and leeward sides of ridges, and taller vegetation, as their height and intricate structure can favour snow trapping. Understanding the relationships among snow distribution, topography features, and vegetation types is vital, though it is often limited by the scarcity of high-resolution data with broad spatial cover.

To investigate the spatial snow distribution in Trail Valley Creek, we analyzed how snow depth varies according to different topography classes and slope aspects, as well as the region's different vegetation classes and heights.

For this purpose, we explored records from Aerial Laser Scanning (ALS) collected during both winter and summer of 2023, covering an area of over 170 km^2. We generated a high-resolution Digital Elevation Model (DEM) from the winter snow-covered surface (2023-04-02), a Digital Terrain Model (DTM) from the summer snow-free terrain (2023-07-10), and by combining both, created a 1-m resolution snow depth map of the area. Additionally, we used 3129 Magnaprobe ground-based snow depth measurements for validation (2023-03-26 to 2023-03-29).

For the topography analysis, we classified the slope aspects, and subdivided the terrain into 10 geomorphological classes using the geomorphons approach. This method calculates terrain

forms, such as plateaus, slopes, ridges and valleys, and their associated geometry using a machine vision approach. To analyze the role of vegetation cover, we used a 13-class map that categorizes land-cover features and vegetation types, such as graminoids, shrubs and trees, and vegetation height rasters, derived from the ALS summer data.

Snow is the main driver of the hydrological system in Trail Valley Creek, and the outcomes of this study will provide insights in the important interplay between vegetation, snow depth and terrain characteristics in a permafrost landscape.