Variability of Snow Depth Distributions in a Forested Mountain Basin from UAV-Lidar Remote Sensing

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ABSTRACT

In complex terrain with heterogeneous vegetation, multiscale snow processes lead to large variability in snowpack distributions. Statistical representations of the snowpack are critical from many snowmelt modelling schemes but quantifying process-dependent variability across a complex basin in a comprehensive and consistent manner is challenging with traditional methods. The extent of snow surveys are limited by accessibility and labour limitations and forest cover frustrates most remote sensing approaches of snow depth. Lidar systems deployed on UAVs provide a means to resolve sub-canopy snow depth at centimeter accuracy, even in dense forests. This work seeks to demonstrate unique opportunities for UAV-lidar to quantify the variability in snow depth distributions at a research basin scale subjected to differences in accumulation, redistribution, interception, and ablation processes. To support this a sequence of UAV-lidar scans of Fortress Mountain Research Basin in the Canadian Rockies were taken in field campaigns in winter/spring 2019-2021. The results demonstrate differences in snow depth distribution as functions of multiscale controls on snow redistribution and ablation processes; these range from a dependency of tree wells to tree height during accumulation periods to differences in snow-vegetation interactions with slope and aspect during ablation periods. UAV-lidar observations provide unprecedented details on the spatial variability of snowpack's in complex terrain and forest cover as they accumulate and ablate that will be critical to developing understanding and improving snow modelling at all scales.

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