Assessing the Spatial Distribution of Snow Depth in Open and Forested Environments by UAV Lidar

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ABSTRACT

Spatial distribution of the snow depth in two agro-forested sites and one coniferous site in eastern Canada was analyzed for topographic and vegetation effects on snow accumulation. Spatially distributed snow depth retrievals were obtained by Unmanned Aerial Vehicle Light Detection and Ranging (UAV lidar) measurements in 2019 and 2020. Lidar-derived snow depths showed distinct patterns of snow accumulation and erosion in open areas/fields versus adjacent forested areas across all sites. Omnidirectional semi-variogram analysis of snow depths showed the existence of a scale break distance less than 10 m in the forested area at all three sites whereas open areas showed scale invariance or comparatively larger scale break distances (i.e., 18 m). To investigate the effect of vegetation and topographic variables on the spatial variability of the snow depth, random forest models were employed. Our results showed that including wind-related forest edge effects improved the model accuracy by more than 50% in agro-forested sites whereas incorporating canopy characteristics improved the model accuracy by more than 60% in the coniferous site. This implies the importance of including and better representing these processes in process-based models for accurate estimates of snowpack dynamics. As well, within agro-forested sites, it is rather the underlying topography and/or the wind-redistribution of snow along forest edges that govern the snow depth variability, while within the coniferous environment, it is the forest structure variability. The findings of this study could be applied/extrapolated to similar landscapes in the region and any similar environment that addresses the relevant processes.

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