Comparison of *in situ* Snow Depth Measurements and Impacts on Validation of Unpiloted Aerial System Lidar over a Mixed-Use Temperate Forest Landscape: A Case Study in Durham, New Hampshire, United States

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ABSTRACT

The accuracy of snow depth measurements depends on the measuring device and the conditions of the site and snowpack in which it is being used. This research informs practices to consider when validating unpiloted aerial system (UAS) lidar-derived snow depth measurements in shallow snowpacks. We conducted three snow depth sampling campaigns from December 2020 to March 2021 that included three transects from an open field to coniferous, mixed, and deciduous forest plots at Thompson Farm in Durham, NH. Snow depth was measured using a magnaprobe, a snow tube, field cameras, and UAS-lidar. Depth measurements were compared by measurement technique and land type. Impacts of the leaf litter on snow depth measurements were also quantified.

The open field snow depths (16.6 cm ± 0.5) were consistently deeper than the forested area depths (13 cm ± 0.5). Over the three sampling campaigns, there was nearly a 20% difference between the magnaprobe (15 cm) and snow tube (12.7 cm) average snow depths, with a greater difference in the forest than the field. This was likely due to the tube encountering woody debris and the magnaprobe over-probing through the leaf litter and possibly into the soil; over-probing was mitigated by creating a new cross-like shaped tip to limit probing into the litter layer, which yielded snow depth more consistent with snow tube measurements. The snow depth measurements estimated from visual inspection of snow stake photos routinely taken by the field cameras had approximately 1 cm precision. The results indicate that in shallow snowpacks, snow depth estimates are significantly different among instruments and those difference vary by land use and local surface conditions (i.e. vegetation height, leaf litter, and woody debris).

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