Using Airborne Lidar to Assess the Variability and Scaling of Snow Depth Retrievals from Satellite-Based Altimeters

G.A. Sexstone and S.R. Fassnacht
Watershed Science Program, Colorado State University

Abstract. Characterizing the spatial variability of the snowpack within mountainous terrain is challenging due to the complex heterogeneity of snow and limited resolution of available snowpack measurements. Satellite-based altimeters provide excellent opportunity to provide the fine resolution snow depth retrievals needed within complex terrain. To understand the variability of snow depth associated with the extent and spacing of NASA (Ice, Cloud, and land Elevation Satellite) ICESat lidar altimeter retrievals, this research assesses the sub-scale and local scale variability of snow depth across the NASA Cold Land Processes Experiment (CLPX) study area in northern Colorado. We assess the sub-pixel variability of ICESat footprints using airborne lidar derived snow depth fields collected during CLPX. Binary regression trees were used to determine how wind, vegetation, and topographic variables are driving the sub-pixel variability of snow depth. Additionally, methods for upscaling along-track snow depth retrievals to the surrounding local scale were evaluated. Preliminary results from the Fraser Alpine (FA) Intensive Study Area (ISA) show that considerable variability of snow depth occurs within the extent of an ICESat footprint. The mean and coefficient of variation of snow depth within sub-alpine forested footprints was greater than those of footprints over alpine terrain. Binary regression trees show that canopy height, northness, and curvature are the main drivers of sub-pixel variability within the sub-alpine footprints, while elevation explained the majority of the variability within the alpine footprints. The patterns of variability observed here are similar to previous studies assessing this dataset, suggesting the sub-pixel information may resolve the variability required to accurately upscale to surrounding areas.