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Spatiotemporal Snow Surface Roughness across Multiple Resolutions

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Abstract. To support refinement in hydrological and climate models assessing snow melt, this research employed measurement of random roughness and fractal analysis in estimating snow surface roughness across two scales. Accurate assessments of snowmelt timing are critical in mountainous regions; however, most hydrological and climate models ignore the variability of the snow surface roughness which nonetheless affects the sensible and latent heat fluxes in snow-dominated systems. We used data collected during the NASA Cold Land Processes Experiment of 2002 and 2003: 100 manual measurements from photographs of snow roughness boards at resolution of about 1 mm over a length of 1 m, and 100 airborne LiDAR pixel measurements of the snow surface at a 1.5 m resolution across a 1 km^2 grid. Roughly half of the measurements were collected in sub-alpine coniferous forest and half in wind-exposed alpine terrain. We examined temporal variability with the finer resolution snow board data and spatial variability and scaling using both datasets. Results illustrated that large scale snow surface roughness across the study site were consistent over time. Individual board data in forested area were consistent over time, while alpine board data varied up to two orders of magnitude. Fractal analysis showed snow surface roughness did scale, with different processes affecting forest and alpine measurements. Ongoing research aims to further investigate climatic effects through the directionality of roughness characteristics based on modeled wind characteristics and time since last snowfall.