New Approaches for Estimating Snow Surface Roughness

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Abstract. In cold climates, the snow surface is often the interface between the atmosphere and the earth. Changes in this surface can have important effects on the hydrologic process, but it is difficult to characterize and model these changes. The roughness of a surface influences atmospheric turbulence, and surface roughness length (Z_0) is used to understand the flow of water, temperature, and moisture over a surface. Z_0 is a critical variable for estimating latent and sensible fluxes at the surface, but most land surface models treat Z_0 simply as a function of land cover and do not address the variability of this value due to changing snow surfaces. This is due in large part to the difficulty and cost of obtaining estimates of Z_0. This research compares methods for estimating Z_0 and tests the viability of approaches that do not rely on expensive wind tower instrumentation. The anemometric method, relying on field observations of wind turbulence, is compared geometric methods using algorithms relating aerodynamic parameters to measures of surface morphometry. In order to allow for geometric roughness calculations, the snow surface was scanned with a terrestrial laser scanning system, and these results were validated using the more standard anemometric approach. Snow surface roughness is a complicated metric and improvements to methods for estimating Z_0 would aid researchers and modelers working on this subject.