Snow Depth is an Integration of the Ground and Snow Surfaces

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Abstract. Snow depth is the most easily comprehendible and measurable point snowpack property, yet illustrates the greatest spatial variability. Manually snow depth measurements can be performed using a ruler inserted into the snow. These measurements have recently been supplemented by LiDAR (Light Detection And Ranging) data estimated by differencing snow-off (summer or fall) from snow-on (winter) aerial surveys – the snow depth is a difference between the ground surface and the snow surface. These high spatial resolution data allow the question: are the spatial properties of the snow surface decoupled from the ground surface?

Three datasets were used to examine the temporal and spatial variations between this potential decoupling. For changes in time, two parallel 50-m long transects of snow depth at a 1-m interval have been measured biweekly or monthly for 2 years in a small meadow adjacent to the Natural Resources Conservation Service's Joe Wright SNOTEL station near Cameron Pass, Colorado. This has enabled the investigation of temporal changes in the degree of correspondence between spatial ground and snow depth patterns. For changes in two-dimensional space, LiDAR and point snow depth measurements from the NASA Cold Land Process Experiment for March-April 2003 at Walton Creek near Rabbit Ears Pass, Colorado were analyzed. Each ground, snow surface, and snow depth dataset was detrended yielding a linear or planar best fit slope of zero. The spatial structure of the three datasets was compared for each site using roughness indices and fractal analysis – fractal dimension and correlation length. Temporally, the patterns were similar. Decoupled behaviour between ground surface and snow aurface was identified by the large difference at certain spatial and temporal scales.