Submitted Abstract

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Abstract

Topography and total roughness of the terrain, which is composed of surface roughness (approximately 1 m-scale) and terrain roughness (approximately 5-10 m-scale), influence the distribution of snow as well as snowpack properties. Down woody debris such as logs, stumps, branches or root plates as well as rocks and other obstacles in the terrain cause surface roughness. These features disturb the snowpack and can influence avalanche formation by creating an inhomogeneous and noncontinuous snow stratigraphy and by anchoring the snowpack. The uneven distribution/redistribution of snow due to wind will promote inhomogeneous snow depths and snow stratigraphy, which can disrupt the continuity of a potential weak layer or sliding surface. Roughness elements distributed along the fall line can therefore help anchoring the snowpack to the ground as a snow supporting structure. By accounting for the roughness in the direction of the fall line of the terrain, it might be possible to further refine the delineation of potential avalanche release areas.

We present a newly developed automated directional roughness algorithm using a point cloud surface model (PCSM). The algorithm defines a roughness score for each point contained in the PCSM by approaching obstacles from different rotational directions (0°-180°). The algorithm attempts to separate the terrain, similar to a point cloud terrain model (PCTM, which is compiled from the rotational direction investigation), from the roughness of the PCSM. The roughness of the terrain is quantified by using the differences between the PCSM and the PCTM. The slope of the smoothed terrain is approximated as a byproduct of the rotational directional roughness calculation and can be used to investigate the capability for roughness to act as snow supporting structures.

We applied our algorithm to an area with a wind-disturbed forest with many stumps, root plates and logs laying on and above the ground providing surface roughness and calculated the roughness along the automatically detected fall line. Additionally, the direction of the maximum and minimum roughness can be extracted. The PCSM of the study area was derived from UAV-based structure-from-motion photogrammetry. With our tool, we can now investigate how the height, distribution and orientation of down woody debris affect the protective effect of a disturbed forest with regards to potential avalanche release areas. In general, directional roughness can be computed in any direction with this algorithm, be it the terrain fall line or wind direction, which has implications for quantifying the effect of surface roughness on snow distribution/redistribution.