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Improving the Terrain-Based Parameter for the Assessment of Snow Redistribution in the Col du Lac Blanc Area and Comparisons with TLS Snow Depth Data

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Wind and the associated snow drift are dominating factors determining the snow distribution and accumulation in alpine areas, resulting in a high spatial variability of snow depth that is difficult to evaluate and quantify. The terrain-based parameter Sx characterizes the degree of shelter or exposure of a grid point provided by the upwind terrain, without the computational complexity of numerical wind field models. The parameter has shown to qualitatively predict snow redistribution with good reproduction of spatial patterns, but has failed to quantitatively describe the snow redistribution, and correlations with measured snow heights were poor.

The objective of our research was to a) identify the sources of poor correlations between predicted and measured snow re-distribution and b) improve the parameters ability to qualitatively and quantitatively describe snow redistribution in our research area, the Col du Lac Blanc in the French Alps. The area is at an elevation of 2700 m and particularly suited for our study due to its constant wind direction and the availability of data from a meteorological station. Our work focused on areas with terrain edges of approximately 10 m height, and we worked with 1-2 m resolution digital terrain and snow surface data.

We first compared the results of the terrain-based parameter calculations to measured snow-depths, obtained by high-accuracy terrestrial laser scan measurements. The results were similar to previous studies: The parameter was able to reproduce observed patterns in snow distribution, but regression analyses showed poor correlations between terrain-based parameter and measured snow-depths.

We demonstrate how the correlations between measured and calculated snow heights improve if the parameter is calculated based on a snow surface model instead of a digital terrain model. We show how changing the parameter's search distance and how raster re-sampling and raster smoothing improve the results. To improve the parameter's quantitative abilities, we modified the parameter, based on the comparisons with TLS data and the terrain and wind conditions specific to the research site. The modification is in a linear form $f(x) = a * Sx$, where a is a newly introduced parameter; f(x) yields the estimates for the snow height. We found that the parameter depends on the time period between the compared snow surfaces and the intensity of drifting snow events, which are linked to wind velocities. At the Col du Lac Blanc test side, blowing snow flux is recorded with snow particle counters (SPC). Snow flux is the number of drifting snow particles per time and area. Hence, the SPC provide data about the duration and intensity of drifting snow events, two important factors not accounted for by the terrain parameter Sx. We analyse how the SPC snow flux data can be used to estimate the magnitude of the new variable parameter a.

We could improve the parameters' correlations with measured snow heights and its ability to quantitatively describe snow distribution in the Col du Lac Blanc area. We believe that our work is also a prerequisite to further improve the parameter's ability to describe snow redistribution.