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Merging a Terrain-Based Parameter and Snow Particle Counter Data for the Assessment of Snow Redistribution in the Col du Lac Blanc Area

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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. It does not, however, provide a quantitative estimate of changes in snow depths.

The objective of our research was to introduce a new parameter to quantify changes in snow depths 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 consistently bi-modal wind directions. Our work focused on two pronounced, approximately 10 m high terrain breaks, and we worked with 1 m resolution digital snow surface models (DSM). The DSM and measured changes in snow depths were obtained with high-accuracy terrestrial laser scan (TLS) measurements.

First we calculated the terrain-based parameter Sx on a digital snow surface model and correlated Sx with measured changes in snow-depths (ΔSH). Results showed that ΔSH can be approximated by $\Delta SH_{estimated} = \alpha * Sx$, where α is a newly introduced parameter. The parameter α has shown to be linked to the amount of snow deposited influenced by blowing snow flux.

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 α.

To simulate the development of the snow surface in dependency of Sx, SPC flux and time, we apply a simple cellular automata system. The system consists of raster cells that develop through discrete time steps according to a set of rules. The rules are based on the states of neighboring cells. Our model assumes snow transport in dependency of Sx gradients between neighboring cells. The cells evolve based on difference quotients between neighbouring cells.

Our analyses and results are steps towards using the terrain-based parameter Sx, coupled with SPC data, to quantitatively estimate changes in snow depths, using high raster resolutions of 1 m.