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Simulating snow instability in complex terrain

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Numerical snow cover models are increasingly used in operational avalanche forecasting. While these models can provide snow stratigraphy and some snow instability information, their full potential is not yet exploited in forecasting. We investigated, how well the snow cover model Alpine3D simulated spatial and temporal variations in snow instability. Therefore, simulations were performed in highly varying complex terrain for the winter season 2016-2017 in the region of Davos, Switzerland for an area of about 21 km x 21 km. Alpine3D was forced with data from several automatic weather stations within the region, which were interpolated to a resolution of 100 m. To reproduce observed spatial variability, we scaled precipitation input with snow height measurements derived with airborne laser scanning. For comparison, we also simulated the snowpack without scaling. The simulation with scaling precipitation showed significantly higher spatial variability in modeled snow instability than the simulation without scaling. However, when information was aggregated to aspect and elevation dependent information for the whole region, as it is done for operational forecasting, this variability vanished and scaling precipitation seems unnecessary. At the beginning of the season and towards the end, snow instability depended on aspect, while in the winter months December to March, differences between different aspects were small. The simulations with scaling precipitation revealed a strong influence of snow depth on snow instability, although the various snow instability criteria provided inconsistent results. Simulated profiles, which were classified as rather favourable were rated as rather unstable and vice versa. A comparison to traditional snow profiles shows that snow stratigraphy was reproduced well, but assessing snow instability from stratigraphy alone is not feasible.