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Modeling the spatial variability of snow instability with the snow cover model SNOWPACK

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Snow stratigraphy – key information for avalanche forecasting – can be obtained using numerical snow cover models driven by meteorological data. Simulations are typically performed for the locations of automatic weather station or for virtual slopes of varying aspect. However, it is unclear to which extent these simulations can represent the snowpack properties in the surrounding terrain, in particular snow instability, which is known to vary in space. To address this issue, we implemented two newly developed snow instability criteria in SNOWPACK relating to failure initiation and crack propagation, two fundamental processes for dry-snow slab avalanche release. Snow cover simulations were performed for the Steintälli field site above Davos (Eastern Swiss Alps), where snowpack data from several field campaigns are available. In each campaign, about 150 vertical snow penetration resistance profiles were sampled with the snow micro-penetrometer (SMP). For each profile, SMP and SNOWPACK- based instability criteria were compared. In addition, we carried out SNOWPACK simulations for multiple aspects and slope angles, allowing to obtain statistical distributions of the snow instability at the basin scale. Comparing the modeled to the observed distributions of snow instability suggests that it is feasible to obtain an adequate spatial representation of snow instability without high resolution distributed modeling. Hence, for the purpose of regional avalanche forecasting, simulations for a selection of virtual slopes seems sufficient to assess the influence of basic terrain features such as aspect and elevation.