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Patterns of snow instability within a small basin

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The amount of horizontal variation seen among snow properties is anticipated to control the avalanche release probability by either hindering extensive crack propagation or facilitating localized failure initiation.

At a certain location and time snow instability is understood as the interaction of snow mechanical properties. With a lately developed method mechanical properties measured with the snow micro-penetrometer (SMP) including snow density, effective modulus, strength and specific fracture energy are combined to model the failure initiation and the crack propagation propensity. As this method offers fast enough data acquisition we are for the first time able to cover a small 400 m $\times$ 400 m basin with 150 objective measurements of the failure initiation and the crack propagation propensity.

Field data from the Steintälli Basin above Davos collected during the winter seasons between 2011 and 2013 contain different situations with respect to snow instability. We used potential drivers of snow instability such as snow depth, elevation, aspect and slope angle and selected the best fitting trend model of those drivers. The experimental semi-variogram based on the residuals of the trend model was fitted to recover the range as a measure of auto-correlation. By external drift kriging spatial predictions were eventually computed to map the distribution of snow instability in the Steintälli basin. Locations where we observed signs of instability during our field campaigns agreed well with the interpolation results between SMP measurements. Moreover, our results indicate that the distributions of both, the failure initiation and the crack propagation propensity, influence basin scale snow instability. Our sets of drivers of snow instability differed and could partly be explained by the meteorological conditions prevailing during the accumulation period and the processes shaping the snowpack afterwards. The range was in some cases related to the auto-correlation length of the underlying terrain. Measuring spatial variations of snow instability is key to understand the variable nature of avalanche formation related processes and is a requirement to verify three dimensional snow cover model predictions in the near future.