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Weak snow layer detection based on relative differences in snow properties between layers

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Snow stratigraphy information plays a prominent role in avalanche forecasting. Therefore, it is important how both manually collected and simulated snow profiles are interpreted in regard to snow stability. In the last few years several semi-quantitative methods have been developed to reduce the subjectivity of stability evaluation derived from snow profiles. One of them is the threshold sum approach (TSA), which identifies structural discontinuities related to mechanical stability within snow profiles by analyzing snow layers (i.e. grain size, type, hardness) and their interface properties (i.e. depth, difference in grain size and hardness). The threshold values identifying the structural properties were defined statistically and are optimized for the data sets they were based on.
Since this approach relies entirely on absolute thresholds, problems arise, if properties (e.g. grain size estimation) are collected in a different way. Even though guidelines for collecting snow profiles are internationally defined, slight differences between observers of different avalanche services exist. The same problem arises when using this approach for simulated snow profiles.
We propose a revised threshold sum approach for snow profile interpretation. Instead of using absolute values, we applied relative differences and values to the snow profiles, e.g. it was not considered how soft a snow layer is, but rather how soft it was compared to the weighted average value of the profile. This method allows the detection of potential weak layers within a snow profile but does not give an absolute estimation of their weakness. In other words, we give a probability that a particular layer is a weak layer.
We tested this relative threshold approach (RTA) on a data set consisting of 128 manually recorded snow profiles, which were collected near the fracture line of or on slopes adjacent to skier-triggered avalanches. Results are encouraging since the RTA detected the weak layers related to the avalanches observed in the field as potential weak layers with a higher probability than the other layers of the profiles.
This approach has the advantage to be independent from the subjectivity of the measurements (e.g. grain size estimation) – provided a variable is measured consistently within a profile – and can directly be applied to simulated profiles. A further step includes testing the RTA on simulated profiles and comparing the potential weak layers with failure layers identified in manually observed profiles completed with stability tests.