Estimating Rutschblock Stability from Snowmicropen Measurements

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Stability prediction from SnowMicroPen (SMP) profiles would support avalanche forecasting operations, since stability information could be gathered more quickly than with standard tests, thereby allowing sampling at higher resolution and over larger spatial scales. In previous studies, the snow properties derived from the SMP have been related to observed snow properties at Rutschblock and compression test failure planes. The goal of this study is to show to what extent Rutschblock stability can be derived from SMP measurements. Our analysis is based on measurements at 36 different sites, which each included a Rutschblock test, a manual profile, and up to 8 adjacent SMP measurements, for a total of 262 SMP profiles. A recently improved SMP analysis procedure is used to estimate the microstructural and mechanical properties of manually defined weak layers and slab layers. SMP signal quality control and different noise treatment methods are taken into consideration in the analysis. The best and most robust predictor of Rutschblock score is the weak layer compressive strength. In combination with the SMP-estimated density of the slab layer, the cross-validated total accuracy of predicting Rutschblock stability classes is 85% over the entire data set, and 88% when signals with obvious signal dampening (11% of the dataset) are removed. The effect of SMP data quality on the analysis is quantified. The analysis is robust to trends and offsets in the absolute SMP force, which is a frequent signal error but is sensitive to dampened or disturbed SMP force micro variance. Our sensitivity analysis shows that SMP data quality has a significant influence on classification results. It also shows that the best predictor of instability, the weak layer micro-scale compressive strength, is robust to the choice of SMP signal noise removal method.