Submitted Abstract

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Abstract

Numerical snow cover models allow simulating snow stratigraphy using meteorological input data from automatic weather stations, numerical weather prediction or climate models. To assess avalanche danger for short-term forecasts or with respect to long-term trends induced by a warming climate, modeled snow stratigraphy has to be interpreted in terms of mechanical instability. While instability indices describing the mechanical processes of dry-snow avalanche release have been implemented into snow cover models, there exists no readily applicable method that combines these metrics to predict snow instability.

We developed a novel, machine-learning based method to assess snow instability from snow stratigraphy simulated with SNOWPACK. Employing a data set of observed and corresponding simulated snow profiles, we trained and validated a random forest (RF) classification model based on observed snow instability. To develop the model, we manually compared 742 observed snow profiles with their simulated counterparts, which included selecting a simulated layer corresponding to the observed rutschblock failure layer. We used the observed stability test result and an estimate of the local avalanche danger to construct a binary target variable (stable vs. unstable). The final RF classifier aggregates six explanatory variables describing the weak layer and the overlying slab into the output probability of instability (Punstable). Our model can be applied to every layer of a simulated snow profile, which offers the possibility of detecting the weakest layer and assessing its degree of instability with one single index, the maximum of Punstable. We then simulated future snow stratigraphy using downscaled climate scenarios in the region of Davos, Switzerland and applied our RF model to comprehensively assess changes in snow instability due to climate change.