EGU21-12259
https://doi.org/10.5194/egusphere-egu21-12259
EGU General Assembly 2021

A random forest model to assess snow instability from simulated snow stratigraphy

Stephanie Mayer, Alec van Herwijnen, and Jürg Schweizer
WSL Institute for Snow and Avalanche Research SLF, Switzerland

Numerical snow cover models enable simulating present or future snow stratigraphy based on 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. Several instability metrics describing the mechanical processes of avalanche release have been implemented into the detailed snow cover model SNOWPACK. However, there exists no readily available method that combines these metrics to predict snow instability.

To overcome this issue, we compared a comprehensive dataset of almost 600 manual snow profiles with SNOWPACK simulations. The manual profiles were observed in the region of Davos over 17 different winter seasons and include a Rutschblock stability test as well as a local assessment of avalanche danger. To simulate snow stratigraphy at the locations of the manual profiles, we interpolated meteorological input data from a network of automatic weather stations. For each simulated profile, we manually determined the layer corresponding to the weakest layer indicated by the Rutschblock test in the corresponding observed snow profile. We then used the subgroups of the most unstable and the most stable profiles to train a random forest (RF) classification model on the observed stability described by a binary target variable (unstable vs. stable).

As potential explanatory variables, we considered all implemented stability indices calculated for the manually picked weak layers in the simulated profiles as well as further weak layer and slab properties (e.g. weak layer grain size or slab density). After selecting the six most decisive features and tuning the hyper-parameters of the RF, the model was able to distinguish between unstable and stable profiles with a five-fold cross-validated accuracy of 88%.

Our RF model provides the probability of instability (POI) for any simulated snow layer given the features of this layer and the overlying slab. Applying the RF model to each layer of a complete snow profile thus enables the detection of the most unstable layers by considering the local maxima of the POI among all layers of the profile. To analyze the evolution of snow instability over a complete winter season, the RF model can provide the daily maximal POI values for a time series of snow profiles. By comparing this series of POI values with observed avalanche activity, the RF model can be validated.

The resulting statistical model is an important step towards exploiting numerical snow cover models for snow instability assessment.