WEAK LAYER SPATIAL VARIABILITY
Weak-Layer Spatial Variability as a Possible Trigger of Slab Tensile Failure

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The evaluation of the location of slab tensile failure represents an important concern for the evaluation of the extent of avalanche release zones and hence hazard assessment.

In this study, a mechanically-based statistical model of the slab-weak layer system accounting for weak-layer spatial variability, stress redistributions by elasticity of the slab and the slab possible tensile failure is simulated using a stochastic finite element method. Two types of avalanche releases are distinguished in the simulations: (1) full slope releases, for which the entire simulated slope is released and the heterogeneity is not sufficient to trigger a tensile failure within the slab; (2) partial slope releases, for which tensile failure occurs within the slab due to the heterogeneity so that only a part of the slope is released.

We present the proportion of these two release types as a function of the different model parameters obtained from finite element simulations.

One of the main outcomes is that, for slab tensile strength higher than the average cohesion of the weak layer, all the releases appear to be full-slope, justifying the major influence of topographical and morphological features such as rocks, trees, slope curvature, ridge and heterogeneous snow cover often claimed in the literature.

WEAK LAYERS IDENTIFICATION
A Relative Difference Approach to Detect Potential Weak Layers Within a Snow Profile

F. Monti, J. Schweizer

Reducing the subjectivity of stability evaluation derived from snow profiles and increasing the spatial and temporal resolution of snow stratigraphy information are among the current possibilities to improve avalanche forecasting.

In the last few years, several semi-quantitative methods (e.g. the threshold sum approach) have been developed to more objectively evaluate snow profiles.

On the other hand, numerical modelling, for example, with the 1-D snow cover model SNOWPACK has the potential to supply snow cover stratigraphy information even in periods and from locations where manual observation are impossible.

We propose a revised threshold sum approach (TSA) for snow profile interpretation. The considered snow cover properties are the same as with the TSA (i.e. grain size, type, hardness, depth, difference in grain size and hardness). Each variable was transformed in a dimensionless quantity and standardized within the single snow profile. Hence, relative differences and values were used to identify the location of layers which have a higher probability than others to be potential weak layers.

This relative threshold sum approach (RTA) was preliminarily tested on a dataset of 107 manually recorded snow profiles, which were collected at skier-triggered avalanches.

The characteristics of potential weak layers detected by RTA and TSA in simulated snow stratigraphy profiles were then compared with the characteristics of the failure layers found with compression tests in 83 manual profiles. Overall, the RTA was capable of detecting potential weak layers in manual as well as simulated snow profiles. Combined with the skier stability index it provides an estimate of stability.

THERMAL ENERGY IN SNOW AVALANCHES

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Avalanches can exhibit many different flow regimes from powder clouds to slush flows. Flow regimes are largely controlled by the properties of the snow released and entrained along the path. Recent investigations showed the temperature of the moving snow to be one of the most important factors controlling the mobility of the flow. The temperature of an avalanche is determined by the temperature of the released and entrained snow but also increases by frictional and collisional processes with time.

The aim of this study is to investigate the thermal balance of an avalanche. Infrared thermography technology was used to assess the surface temperature before, during and just after the avalanche with a high spatial resolution.

Manually measured snow temperature profiles along the avalanche track and in the deposition area allowed quantifying the temperature of the eroded snow layers. This data set allows to calculate the thermal balance, from release to deposition, of an avalanche and to discuss the magnitudes of different sources of thermal energy in snow avalanches.

AVALANCHE DANGER SCENARIOS
Identification of Avalanche Danger Scenarios frequently used in Avalanche Bulletins based on the European Avalanche Danger Scale and the Bavarian Matrix

M. Valt, F. Berbenni

The avalanche forecaster should describe and represent, unambiguously and clearly to users, the avalanche danger through the bulletin. The EAWS Bavarian matrix, adopted in 2005, is a valuable support to the forecaster to determine avalanche hazard scenarios and to define, objectively, the level of danger. In recent years, its systematic use allowed us to verify the existence of intermediate hazard scenarios and their frequency for level 2-moderate and 3-considerable and to represent them in the bulletins, on a trial basis, by means of an icon.

The collection of data relating to the frequency of intermediate situations shows that it is important to explicitly provide users with the information relating to the "weight" of the avalanche danger within each single scale degree.

WET SNOW AVALANCHES
Wet Snow Avalanche Activity in the Swiss Alps – Trend Analysis for Mid-Winter Season

C. Pielmeier, F., C. Marty, T. Stucki

During the winter 2011-2012 the Alps experienced repeated periods with high activity of wet snow and full-depth glide avalanches during mid-winter season (December to February).

Damage to infrastructure, but also fatalities, were the consequence.

Looking back 5 years, there was at least one intense and widespread wet snow and full-depth glide avalanche period in four out of five midwinter seasons. To study the long-term trend, changes in wet snow and full-depth glide avalanche activity during mid-winter season were analyzed from 1952 to 2013, based on long-term observation stations.

Robust time series analyses showed a positive trend in number and proportion of wet snow and full-depth glide avalanche records. The trend coincides with the trend in increasing air temperature in Switzerland.

A break in the data series is shown that originates probably from a major revision of the snow and avalanche recording system in 2002. For the 50 year period before the revision, the proportion of wet snow avalanches increased by 0.4% per year. With the anticipated increasing temperatures in the European Alps, the positive trend in wet snow avalanche activity will most likely continue, which requires adaptations in risk management.

GLIDE-SNOW AVALANCHES
The Influence of Weather on Glide-Snow Avalanches

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During the winter 2011-2012 the

Swiss Alps experienced high glide-snow activity. The danger of glide-snow avalanches combined with large snow depths posed a challenge to the local authorities. Glide-snow avalanches are difficult to predict and hard to control.
Weather, snowpack, soil and terrain are known to influence snow gliding. So far, however, no clear relationship between these variables and glide-snow activity could be established.
Many research results report that a wet basal layer is paramount for the formation of glide-snow avalanches.
Based on observations, the assumption is made that different processes favor the production of this basal layer and thus the triggering of snow gliding in winter and in spring.
In winter the snowpack is usually cold and dry, in spring it's warm and wet.
Thus, there are different processes causing water at the snow-soil boundary. In order to shed some light into these two different periods, glide-snow activity was monitored at a well-known glide-snow avalanche site, the Dorfberg above Davos, Switzerland during the winter seasons 2008-2009 and 2011-2012 using time-lapse photography.
Glide-snow avalanche activity was compared to weather parameters of a nearby weather station.
We used univariate and multivariate statistical methods to explore the data.
Results verify different processes in winter and spring. Most important weather parameters in winter are maximal air temperature, the 5-day sum of new snow and incoming shortwave radiation.
In spring, parameters as snow surface temperature, minimal air temperature, difference in air temperature to the day before and relative humidity seem most important.
The difference in important parameters for winter and spring periods indicate different sources of the thin water layer at the snow-soil interface and therefore different underlying processes that lead to snow gliding.

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