Submitted Abstract

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Abstract

In Switzerland extreme value statistics is used to define snow fracture heights for practical avalanche dynamics calculations. The method relates measured three-day snow depth increase to return period at representative snow observation stations. The fracture heights are then modified to include terrain effects (primarily steepness), elevation and snow drift. The procedure is an integral part of avalanche hazard mitigation in Switzerland, especially since it allows engineers to study 30Y, 100Y and 300Y avalanche scenarios using a consistent and observation-based method.

The important role of snow entrainment in avalanche dynamics calculations is well known. Not only can entrainment change the mass balance of a specific event, it also influences the overall avalanche flow regime (e.g. powder or wet). Advanced avalanche dynamics models consider entrainment, including the temperature and moisture content of the entrained snow. Flow rheology is made temperature and moisture dependent, including fluidization and lubrication processes which lead to different avalanche flow regimes. The problem remains, however, of how to consistently define the snowcover disposition, temperature and moisture content in complex terrain, for different climatic regions as input for simulations.

In this paper we determine the snow entrainment heights using extreme value statistics. Similar to the case of fracture heights, the entrainment heights are related to measured three-day snowfall amounts. The procedure uses the same representative snow observation stations and therefore can be integrated easily into existing calculation methods. Snow heights are altered to include elevation and temperature gradients. However, the effects of snow drift are only included in the determination of fracture heights. We apply the method to several recent avalanches where the mass balance has been captured with aerial drones. Because the events are recent, we have reliable temperature estimates. Although the method appears to be applicable for the 30Y avalanches we investigate, we express our concerns regarding extreme events where snowcover distribution and temperature might vary strongly from the proposed procedure. Finally, we discuss how the method could be improved and expanded to investigate climate change scenarios on future avalanche activity.