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Snow cover stability patterns in the Eastern European Alps

C. Mitterer and J. Schweizer

WSL Institute for Snow and Avalanche Research SLF Davos, Switzerland (mitterer@slf.ch)

Information on snowpack instability is highly relevant when assessing avalanche danger. However, manual snowpack observations including stability tests are usually sparse – in time and space, and their results are spatially variable. The amount of variation depends on the scale of investigation. To find distinct patterns of instability at a supra-regional scale we derived stability information from manual snow profile data collected in parts of the Eastern European Alps and analyzed it. The data consisted of over 1600 snow profiles recorded in Bavaria (Germany), South Tyrol (Italy), Tyrol (Austria) and Grisons (Switzerland) during the winters of 2005/2006 (N = 976) and 2006/2007 (N = 676). Due to differences in recording standards it was not possible to classify the profiles in regard to stability using well established stability interpretations. Therefore, a new stability index was developed based on the structural instability index. This stability index is solely based on manual snowpack data such as grain type, grain size, hand hardness and layer depth. Threshold values for the new stability index were determined using a training data set consisting of 477 snow profiles for which both the structural instability index and a manual stability interpretation were available. Persistent weak layers within the snowpack, i.e. faceted crystals, depth hoar and surface hoar, were nearly always present. The new stability index detected general instabilities such as a weak basal snowpack layers which generally form during cold and dry periods early in the winter season. Storm snow instabilities which typically persist for only a few days were not well detected with the new stability index. Profiles were analyzed in two-week intervals and stability patterns were identified visually. This interval was chosen based on the numbers of profiles which were available for a given time interval. A shorter interval would have resulted in an undersized number of profiles. On average about 96 profiles with a mean spacing of 8 km were needed per time interval for adequate coverage of the area under investigation. However, due to the large observation interval of two weeks, the sample occasionally contained very different snowpack conditions so that spatial patterns may have become blurred. The snowpack stability patterns were compared with weather data as well as with avalanche danger forecasts from various avalanche warning services. No clear patterns were identified in regard to the predominant snow climate. For example, the common perception that the snowpack in the inner alpine regions is generally weaker was not supported by our results. Nevertheless, distinct patterns for some regions were found such as generally rather weak snowpack stability in the southern part of the investigated area. Furthermore other regions showed clear patterns towards either a rather stable or a rather unstable snowpack, particularly in early and mid season. Towards spring, variation increased and no clear patterns were found. Before further investigation with future data a consistent recording standard for all four regions needs to be established. In particular, it would be essential to always complete a snow profile observation with a well established stability test. This would also allow a data exchange across borders between the various warning services.