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Automatic high-resolution mapping and classification of avalanche terrain regarding potential release, triggering and run-out zones

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Terrain characteristics are one of the main factors contributing to avalanche formation as well as affecting the runout. Hence, terrain assessment is crucial for planning and decision making when travelling in the backcountry. So far, terrain is mainly interpreted manually from topographic maps or by observations in the field. Recent support for interpreting avalanche terrain is given by slope angle layers derived from digital elevation models or the Avalanche Terrain Exposure Scale (ATES) for classifying avalanche terrain manually. While digital elevation models and numerical simulations are used as standard for mapping avalanche hazard threatening settlements and key infrastructure, this is hardly the case when planning tours in the backcountry. Thus, our scope was to classify and map terrain of maximum size class 3 avalanches, which typically threaten backcountry recreationists. We present a new methodology for a high-resolution automatic classification of the avalanche terrain specifically for recreational backcountry travel by taking into account: a) potential avalanche release areas, b) remote triggering of avalanches, c) possible runout zones of max. size 3 avalanches.

Potential release areas were specified by computing a density estimate based on terrain characteristics of observed avalanche starting zones in the Davos region. The potential of remote triggering was estimated with a least-cost path analyses depending on the triggering distance from remotely triggered avalanches. Avalanche runout zones were performed with the avalanche simulation model RAMMS::EXTENDED. Combining all these methods and out of many simulations a classified avalanche terrain map for the entire Swiss Alps and the Jura was created characterizing potential release areas and runout zones. A validation of 870 accidental avalanches in the backcountry of Switzerland shows that only 2% of the mapped avalanche perimeters do not overlap with the simulations. The distribution of the terrain characteristics within both the release areas of the training dataset and the validation data was almost identical. Thus, the extrapolation from the calculated density estimate to the whole of Switzerland is feasible and appropriate. The created map assists the interpretation of avalanche terrain for travelling in the backcountry considering release areas and runout zones. Although the focus is on Switzerland, the methods can also be applied to other mountain areas worldwide.