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# Snow instability evaluation in skier-triggered snow slab avalanches: combining failure initiation and crack propagation

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Dry-snow slab avalanches start with a local failure in a weak snowpack layer buried below cohesive snow slab layers. If the size of the failed zone exceeds a critical size, rapid crack propagation occurs possibly followed by slab release if the slope is steep enough. The probability of skier-triggering a slab avalanche is generally characterized by classical stability indices that do not account for crack propagation. In this study, we propose a new model to evaluate the conditions for the onset of crack propagation in skier-triggered slab avalanches. For a given weak layer, the critical crack length characterizing crack propagation propensity was compared to the size of the area where the skier-induced stress exceeds the shear strength of the weak layer. The ratio between both length scales yields a stability criterion combining the processes of failure initiation and crack propagation. The critical crack length was calculated from a recently developed model based on numerical simulations. The skier-induced stress was computed from analytical solutions and finite element simulations to account for slab layering. A detailed sensitivity analysis was performed for simplified snow profiles to characterize the influence of snowpack properties and slab layering on crack propagation propensity. Finally, we applied our approach for manually observed snow profiles and compared our results to rutschblock stability tests.