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A field study on failure of storm snow slab avalanches

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Storm snow often avalanches before crystals metamorphose into faceted or rounded shapes, which typically occurs within a few days. We call such crystals nonpersistent, to distinguish them from snow crystals that persist within the snowpack for weeks or even months. Nonpersistent crystals can form weak layers or interfaces that are common sources of failure for avalanches. The anticrack fracture model emphasizes collapse and predicts that triggering is almost independent of slope angle, but this prediction has only been tested on persistent weak layers. In this study, dozens of stability tests show that both nonpersistent and persistent crystals collapse during failure, and that slope angle does not affect triggering (although slope angle determines whether collapse leads to an avalanche). Our findings suggest that avalanches in storm snow and persistent weak layers share the same failure mechanism described by the anticrack model, with collapse during fracture. Manual hardness measurements and near-infrared measurements of grain size sometimes show thin weak layers of softer and larger crystals in storm snow, but often show failures at interfaces marked by softer layers above and harder layers below. We suggest collapse often occurs in crystals at the bottom of the slab. Planar crystals such as sectored plates are often found at failures, suggesting they are especially prone to collapse.