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Characteristics of dynamic crack propagation in a weak snowpack layer over its entire life cycle

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For a slab avalanche to release, a weak layer buried below a cohesive snow slab is required, and the system of weak layer and slab must support crack propagation over large distances. This process, called "dynamic crack propagation", is highly relevant for avalanche release, and computational models are nowadays able to model crack propagation over increasingly larger scales. Field measurements on dynamic crack propagation are however very scarce, although these are required to validate models. We therefore performed a series of flat field PST experiments up to ten meters long over a period of 10 weeks. During this time, PST results evolved from crack arrest to full propagation and back to crack arrest – reflecting the life cycle of the weak layer. All PST experiments were analyzed using digital image correlation to derive high-resolution displacement fields to compute dynamic crack propagation metrics, including crack length and speed as well as touchdown distance, the distance from the crack tip to the trailing point where the slab comes into contact with the substratum. Comparing the displacement fields during sawing to a mechanical model, we estimated the effective elastic modulus of slab and weak layer as well as the specific fracture energy of the weak layer. Our results show how dynamic crack propagation characteristics change over the life cycle of a weak layer and how these measures relate to snowpack properties such as load and effective elastic modulus of the slab. We found that crack speed was highest for PSTs resulting in full propagation and that the touchdown length increased with increasing elastic modulus of the slab. Our dataset provides unique insight into the dynamics of crack propagation, and provides valuable data to validate models used to study sustained crack propagation.