The Cryosphere Discussions

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Comment on "Dynamic crack propagation in weak snowpack layers: Insights from high-resolution, high-speed photography" by Bergfeld et al.

Edward Bair (Referee)

Referee comment on "Dynamic crack propagation in weak snowpack layers: Insights from high-resolution, high-speed photography" by Bastian Bergfeld et al., The Cryosphere Discuss., https://doi.org/10.5194/tc-2020-360-RC2, 2021

In "Dynamic crack propagation in weak snowpack layers: Insights from high-resolution, high-speed photography" by Bergfeld et al., fracture in Propagation Saw Tests (PSTs) is examined using a new high-speed/resolution camera combined with digital image correlation for particle tracking. I enjoyed reviewing this article as it contains high-speed measurements and analysis of fracture at the PST scale that improves resolution of acceleration and other derivative measures that were too noisy using older equipment. The strain measurements in the weak layer and the collapse wavelength measurement are notable. The methods employed are sound and varied, e.g. three different techniques were employed for crack speed estimates.

Most of my critiques are minor and are included as an annotated manuscript. My major critique is that no attempt is made to link these measurements to slope scale avalanches or practical use, which should be overarching goals. Since its inception, the PST has been used to study fracture in snow, however we know that, as with any small-scale stability test that involves isolated blocks of snow, it is contrived and not fully representative of the avalanche process. Recent work (e.g. Gaume et al., 2019) suggests that the PST can effectively represent collapse waves in low angle terrain, but that the exaggerated bending is not representative of slope scale failure. For example, slab fracture in the PST begins at the top of the snowpack, while the simulated crowns in Gaume et al. (2019) open from the bottom. Crack speeds measured in avalanches (Hamre et al., 2014) are several times faster than 21-30 m/sec values measured in the PSTs here. Thus, I suggest further discussion on the motivation and utility of these high speed PST measurements towards understanding the avalanche process. Why are we still doing PSTs and carefully studying them? Slope angles of the PSTs are not provided, but should be. Judging from the vegetation in the background, it looks like they were conducted on nearly flat slopes. Thus, some discussion of the slower collapse wave measured on flat ground versus the faster shear fractures on steep slopes is advised. As discussed by others (Rosendahl and Weißgraeber, 2020; van Herwijnen et al., 2016), the specific fracture energies reported here are comparable to the tensile fracture of solid ice, meaning that either: 1) there is something wrong with the elastic modulus and fracture energy measurements; or 2) there is a lot of energy being dissipated during the collapse process. I suggest at least mentioning these issues with the reported values.

The data statement does not comply with The Cryosphere's stated policy. I also found numerous grammatical errors, particularly with respect to use of verb tense and subject agreement, e.g. from the abstract "The high frame rates allowed time derivatives to obtain velocity and acceleration fields." I did not highlight or correct all of these errors and suggest the use of an English language service.

NB 2/11/2021

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Please also note the supplement to this comment:
https://tc.copernicus.org/preprints/tc-2020-360/tc-2020-360-RC2-supplement.pdf