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Microstructure-based finite element modeling of snow failure envelope

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The mechanical behaviour of snow under combined shear and compression is determinant in snow slab avalanche release and is tied to the microstructure. In this contribution, the failure envelope of snow is reproduced numerically using the snow microstructure captured by micro-tomography and the mechanical properties of ice. We use finite-element simulations to compute the stress distribution in the ice matrix with a simple constitutive elastic material for ice. We also assume that brittle failure only occurs at bonds pre-determined with a geometrical grain segmentation algorithm. This approach expedites the simulations and enables to compute mechanical simulations on large and representative microtomographic images. Uniform kinematic boundary conditions combining normal and shear deformation were considered. The model was used to reproduce the failure envelopes of numerous snow samples spanning seasonal alpine snow types and densities. This work thus provides a new insight into the impact of snow physical properties on failure initiation mechanisms in slab avalanche releases.