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Microstructural insights into the compressive failure of snow based on a peridynamic framework

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Highly-porous cohesive granular materials such as snow possess complex modes of failure. Apart from classical failure modes, they show microstructural failure and fragmentation associated with densification within a local, narrow zone. Therefore cracks may form and propagate even under compressive load ('anticracks','compaction bands'). Such failure modes are of importance in a range of geophysical contexts. For instance, they may control the release of snow slab avalanches and influence fracturing of porous rock formations. In the snow context, specific failure mechanisms of the ice matrix and their interplay with the microstructure geometry of snow are still poorly understood. Recently, X-ray computed tomography images have provided insights into snow microstructure and capability of directly simulating its elastic response by the finite element method (FEM). However, apart from thermodynamically driven healing processes the inelastic post-peak behaviour of the microstructure is controlled by localized damage, large deformations and internal contacts. As a result of the well-known limitations of FEM to capture these processes we use Peridynamics (PD) as a non-local continuum method to approach the problem. Due to its formulation, (micro)cracks and damage are emergent features of the problem solution that do not need to be known or located in advance. Furthermore, the Lagrangian character of the governing equations makes the method suitable for simulating large deformations. In this contribution we perform confined uniaxial compression simulations of snow microstructures within a peridynamic framework. Computed tomography images of snow specimen serve as a simulation data base. The obtained results show a novel insight into local failure of snow and allow a better comprehension of the underlying failure mechanisms. This study contributes to improve non-local macroscopic constitutive models for snow for future applications.