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Unified modeling of the release and flow of snow avalanches using the material point method

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Snow slab avalanches start with the failure of a weak snow layer buried below a cohesive snow slab. After failure, the very porous character of the weak layer leads to its volumetric collapse and thus closing of crack faces due to the weight of the overlaying slab. This complex process, generally referred to as anticrack, explains why avalanches can be remotely triggered from flat terrain. On the basis of a new elastoplasticity model for porous cohesive materials and the Material Point Method, we accurately reproduce the dynamics of anticracks observed in snow fracture experiments as well as the subsequent detachment of the slab and the flow of the avalanche. In particular, we performed 3D slope scale simulations of both the release and flow of slab avalanches triggered either directly or remotely. Our simulations naturally reproduce snow granulation, erosion and deposition processes. Our unified model represents a significant step forward as it allows simulating solid-fluid phase transitions in geomaterials which is of paramount importance to mitigate and forecast gravitational hazards.