Modeling solid-fluid transitions in snow avalanches using the Material Point Method

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ABSTRACT

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 simulated the dynamics of propagating anticracks reported in snow fracture experiments [1] as well as the propagation and reflection of localized compaction bands [2]. Finally, we simulated the release and flow of slab avalanches at the slope scale triggered either artificially (bombing) or accidentally (remote triggering). Our unified model represents a significant step forward as it allows simulating the entire avalanche process, from failure initiation to crack propagation and solid-fluid phase transitions in snow, which is of paramount importance to mitigate and forecast snow avalanches as well as gravitational hazards in general.

REFERENCES

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