DYNAMIC MODELLING OF DENSE SNOW AVALANCHE RUNOUT

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ABSTRACT: Human experience with snow avalanches has motivated pursuits to determine the physics underlying the motion of flowing snow. Of particular practical concern is the behavior of extreme avalanche runout, with important implications for infrastructure defense and hazard mapping in mountainous terrain. Both probabilistic extreme runout analyses, based on terrain parameters and statistical methods, and dynamic models, using a variety of flow laws, have been introduced and refined with varying success. The current investigation employs a numerical solution of the hydrodynamic equations for unsteady, open channel hydraulics using quasi-two-dimensional formulations of continuity and momentum conservation. In contrast to a fixed-grid (Eulerian) coordinate system as employed in most preceding models, a moving (Lagrangian) reference frame, following the flow downslope, is adopted. This is believed to be more appropriate given the unsteady nature of avalanche flow. Due to the uncertainty surrounding the dynamics of basal snow entrainment, and the certain physical importance of this process in the upper reaches of the avalanche path, the model uses the middle of the avalanche track as the starting point for the numerical simulation. Below this point, entrainment and other resistive terms are presumed negligible compared to basal friction, which becomes the dominant parameter influencing the runout distance. An empirical upper limit envelope for maximum avalanche speed, as a function of total vertical fall of the path, provides an initial velocity for the flowing mass. The initial volume or mass of the flow is prescribed based on the area of the starting zone and an initial slab thickness. The flow mass is divided into discrete, deformable blocks that maintain constant volume. Under passive internal pressure, the flow advances downslope to rest.

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