Submitted Abstract

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Abstract

Snow- and landslides pose a significant threat to settlements in avalanche-prone areas, where protective measures are widely used to improve safety. Simulations of the flow of avalanches against obstructions is essential for the design of catching and deflecting dams as well as other protective measures in run-out zones. Hazard zoning below protective measures and, in general, for avalanche paths with complex terrain geometry also requires advanced simulations of snow-avalanche dynamics . We present an efficient implementation of an incompressible granular-flow rheology for computational fluid dynamics (i.e. OpenFOAM), based on recent advances in the theory of μ(I) granular rheologies. Model parameters have been calibrated with observations from eight large Icelandic avalanches. Our simulations reproduce observed shapes of avalanche deposits in the run-out zones and available radar measurements of avalanche velocities. Observed and estimated values for avalanche volume and release depth in starting areas serve as initial conditions for our simulations. Several studied examples involve flow paths with complicated geometries, including deep gullies and ridges that split the simulated avalanche in the run-out zone, which indirectly provides constraints on the simulated flow dynamics.

Our approach represents an important improvement with respect to existing, depth-averaged models for snow-avalanche flow in complicated terrain geometries as it is able to simulate the full three-dimensional flow at impact with obstacles such as catching and deflecting dams and braking mounds. Our simulations are able to recreate the formation and time-dependent development of hydraulic jumps. Thus, splashing is formed at impact with obstacles as well as granular wedges behind the upstream face of dams or mounds alongside many other flow features expected in such complex granular flows. We will present several simulations of avalanche flows against protective dams in Iceland.