Model for avalanches in three spatial dimensions: comparison of theory to experiments

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Abstract

A three-dimensional theory is derived to describe the temporal behavior of gravity currents of cohesionless granular media, in an attempt to model the motion of dense, flow-type snow avalanches, ice and rock slides. A Mohr-Coulomb yield criterion is assumed to describe the constitutive behavior of the material, and the basal bed friction is described similarly by a Coulomb type of friction. A drag term is included in order to model the occurrence of flow regimes where boundary drag becomes non-negligible. Data from laboratory simulations are compared to a series of numerical studies based on the aforementioned theory. A nondimensional, depth and width averaged form of the theory is considered. A Lagrangian finite difference scheme is then applied to numerically model some limiting cases of the governing equations. Two different numerical models are developed, tested and compared to experimental values. The results indicate that the model can account for flow transitions by inclusion of the drag term when the initial inclination angle is large enough to affect boundary drag. Furthermore, the temporal and spatial evolution of the granulate and final runout position can be predicted to values well within the experimental error.