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Modeling debris flows using the Titan2D toolkit

D. Kumar(1), A. Patra(1), L. Le(2), E. B. Pitman(1,2), M.F. Sheridan(3) and M. Bursik(3)

[1]Department of Mechanical & Aerospace Engineering, University at Buffalo, Buffalo, NY, USA

[2]Department of Mathematics, University at Buffalo, Buffalo, NY, USA

[3]Department of Geology, University at Buffalo, Buffalo, NY, USA

We report here on recent work to extend the computational simulation capabilities of Titan2D[1] to include a two phase model of debris flows developed by Le and Pitman[2]. Titan2D simulates the motion of an incompressible continuum using depth-averaging and a Coulomb type constitutive model. The conservation equations for mass and momentum are solved using a parallel, adaptive mesh, Godunov scheme. Adaptive gridding dynamically concentrates computing power in regions of special interest; mesh refinement and coarsening key on the perimeter of the moving avalanche and other areas where sharp solution features develop. Parallel computing allows the use of large grids to compute realistic flows. Integration with a geographical information systems enables the computation of flows over natural terrain.

The Pitman-Le approach models debris flows as two-phase continua with an explicit drag force term accounting for the interaction between phases. Earlier models[3] used simpler mixture theory type approaches to model the fluid behavior. We compare results from two phase and single phase models for both smaller laboratory scale flows and larger flows on natural terrain, where we match our predictions against observations of historical flows. Preliminary results for simple flows indicate that the use of a two phase model in the simulations predicts higher velocities while producing similar spreading. This observation, if sustained in more complex natural flows, could explain the discrepancy between flow velocities predicted by single phase models and field estimates of flow velocities[4].

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