Geophysical Research Abstracts, Vol. 7, 05639, 2005
SRef-ID: 1607-7962/gra/EGU05-A-05639

Incorporating variable bed friction into the Titan2D geophysical mass-flow model using a GIS layer

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Titan2D models an incompressible Coulomb continuum; it is a depth-averaged, thin-layer, granular-flow code. The conservation equations for mass and momentum are solved with a Coulomb-type constitutive model. The computation uses 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. Hence smaller data sets can be computed on PCs while larger data sets take advantage of the multiprocessing capabilities of Titan. Two essential property parameters of the flowing mass are needed for the model: a bed friction angle and an internal friction angle. The choice of a single appropriate bed friction value for model simulations of natural avalanches is difficult, especially when erosion of the substrate is involved. This problem is compounded when the application involves solutions for terrains with greatly different surface properties. The 1963 rock avalanches at Llittle Tahoma Peak (Mount Rainier), Washington illustrate this problem. Here the avalanches passed over the Emmons Glacier for the upper half of their extent but rode over stream gravels and glacial outwash for the lower part of their run out. The avalanches also passed over bedrock and forested soils. Intuitively the basal friction for each of these terrains should be different making the selection of a representative value very difficult. Titan2D simulations at Little Tahoma Peak using a single bed friction could not adequately match velocity, pile height and run out for the actual avalanches; friction angles for flow over ice were too low and conversely, friction angles corresponding to flow over stream gravel were too large. The ability to assign specific friction angles that are suitable for geographically distinct areas is extremely useful in this case. Based on the surface materials in the area, geographically

different values of basal friction based on a surface characterization were designated through a GIS interface. The simulations using such local friction properties appear to obtain better correspondence of the simulations to the actual avalanches.