Geophysical Research Abstracts,
Vol. 10, EGU2008-A-01048, 2008
SRef-ID: 1607-7962/gra/EGU2008-A-01048
EGU General Assembly 2008

Two-phase debris flow modeling

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Debris flows have different flow forms depending on water and solid concentration, particle size distribution and the topography of the flow path. Numerical models are available and work well in simulating the dynamics within a single flow regime. However due to restrictive assumptions they often fail to describe the transition between different regimes. In our project, we relax assumptions on the particle distribution and propose an extended depth-averaged two-phase model. By taking into account internal phase diffusion and vertical particle motion, we are able to model sedimentation and resuspension processes. We realize the model by looking at an extended set of system variables, given by mass, depth-averaged concentration, depth-averaged velocity and vertical centre-of-mass. Considering the vertical centre-of-mass provides information on the current state of vertical mixing. The derivation of the model equations and a comparison to the well-known Iverson model is presented in detail and some 1D numerical computations are discussed with respect to the underlying physics. The whole project has been motivated by analyzing recent data from real scale events in the Illgraben (Kanton Wallis, Switzerland). In a final step, we show that there exists good qualitative agreement between the numerical model and the full scale experiments.