28*th* IUGG Conference on Mathematical Geophysics, June 7-11, 2010, Pisa, Italy
Session 1: Geophysical fluid dynamics I - Volcanoes

A two-phase, depth-averaged model for geophysical mass flows in the TITAN code framework

Gustavo Cordoba[1,2], Bruce E. Pitman[1], Michael F. Sheridan[1]

[1] *University at Buffalo, Buffalo, USA*
[2] *Universidad de Nariño, Nariño, Colombia*

Keywords: *two-phase flow; modelling; TITAN; depth-averaged; mud-flow*

Particle-laden surface flows are extremely dangerous natural phenomena, especially near urban and suburban areas. Tools for portraying their evolution in time, flow dynamics and run out distance are helpful in forecasting the consequences of potentially hazardous events, development of hazard and risk maps, and design of management policies in areas of potential natural disasters. One example, the TITAN2D code (Patra et al. 2005) that was developed to simulate granular flows in volcanic landscapes, is widely used in hazard assessment (see Murcia et al., 2010). Many of these models and the companion computer codes strictly apply only to dry granular flows like rock avalanches and volcanic block-and-ash flows. Because the presence of an interstitial fluid strongly modifies the dynamics of a flow, we developed a new, more general, two-phase model that is valid for flows that contain a broad range of water and solid mixtures, such as debris flows and mud flows. This model is based on balance laws for mass and momentum for each phase. The granular material is assumed to obey a Coulomb constitutive relation, and the fluid is assumed to be inviscid. The Darcy-Weisbach formulation is used to account for bed friction, and a phenomenological drag coefficient mediates the momentum exchange between phases. These equations are depth averaged, resulting in a system of 6 partial differential equations. The resulting equations correspond to the Savage and Hutter model in the limit of no fluid, and to the typical shallow water solutions (see Ortiz, 2005) for pure water. We implement the two-phase model within the familiar TITAN2D framework. The model has been tested on artificial topographic channels as well as on some volcano landscapes.

[1] Murcia, H.F., Sheridan, M.F., Macìas, J.L. and Cortès, G.P., 2010, TITAN2D simulations of pyroclastic flows at Cerro Machìn Volcano, Colombia: Hazard implications, Journal of South American Earth Sciences, 29(2): 161-170.
[2] Patra, A.K., Bauer, A.C., Nichita, C., Pitman, E. B., Sheridan, M.F, and Bursik, M.I, Rupp, B., Weber, A., Stinton, A.J., Namikawa, L.M., and Renschler, C.S., 2005, Parallel adaptive simulation of dry avalanches over natural terrain. Journal of Volcanology and Geothermal Research, 139(1-2):1-21.
[3] Ortiz, P., Shallow water problems. in Zienkiewicz, O.C., Taylor, R.L., and Nithiarasu, P., The finite element method for fluid dynamics, 2005, Elsevier, 6th Edition, 400 pp.