Geophysical Research Abstracts
Vol. 15, EGU2013-12370, 2013
EGU General Assembly 2013

Multiphase flow dynamics of stratified pyroclastic density currents

simone orsucci (1,2), tomaso esposti ongaro (1), augusto neri (1), and fulvio cornolti (2)
(1) Istituto Nazionale di Geofisica e Vulcanologia Sezione di Pisa, (2) Università degli Studi di Pisa

We have simulated the dynamics of pyroclastic density currents to quantify the influence of the vertical stratification of particle concentration on their propagation and runout. The polydisperse pyroclastic mixture is described by discretizing the grain-size distribution into N particle classes and by adopting a non-equilibrium Eulerian transport model, in which the gas and each particle class are described as interacting, compenetrating continua. Gas-particle and particle-particle interactions are expressed by semi-empirical drag and heat transfer terms, which allow the explicit description of non-equilibrium effects, including the selective settling of particles in the mixture which controls the stratification of the current. To describe the rheology of the particulate phases, especially in the dense basal portion of the flow (where inter-particle collisions play an important role) we have implemented a new model derived from the kinetic theory of polydisperse granular flows. The new kinetic model is validated against experimental results and compared with simple analytical models. In the case of finite volume currents, two- and three-dimensional simulations in a Cartesian domain well reproduce theoretical predictions based on scaling analysis and allow the quantification of the amount of energy dissipated during the flow, for different grain sizes and rheological models. For fine particles (having an equilibrium time much longer than the current characteristic time-scale), the current displays a behaviour comparable to that of homogeneous currents in the inertial regime. For coarse particles, an increase of momentum dissipation is observed, mainly associated to the removal of particles by progressive sedimentation and accumulation in the basal layer. In the case of subcritical currents (in which turbulent mixing is not a controlling factor and thermal effects do not play a major role in the dynamics), we propose a simplified relationship between the current energy and the distance from the source, which can be adopted in hazard assessment studies.