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NON-EQUILIBRIUM MULTIPHASE FLOW EFFECTS IN PYROCLASTIC DENSITY CURRENTS

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The dynamics and thermodynamics of pyroclastic density currents generated by volcanic column collapse were investigated by using a two-dimensional, transient, multiphase flow model. The model accounts for full mechanical and thermal non-equilibrium conditions between the gas continuous phase and N different particulate phases through the solution of the fundamental conservation equations for each phase. Interphase effects were expressed in terms of gas-particle and particle-particle interactions whereas sub-grid turbulence effects in gas phase were described through an effective viscosity. Several simulations were performed and analyzed to investigate the effect of the multiparticle formulation of the model on the pyroclastic density current generation and emplacement. The development of a vertically stratified turbulent flow produced by the column collapse and its velocity and temperature profiles are discussed. Mechanical and thermal decoupling between the continuous gas phase and the N dispersed solid phases is quantified and interpreted by using the characteristic response time of each particulate phase. The non-homogeneous mechanical behavior of different particle sizes induces the formation of a sharp vertical stratification of the flow that results to be formed by a basal concentrated rapid granular flow underlying a dilute suspension current. Non-equilibrium effects between particles of different sizes are controlled by particle-particle collisions in the basal layer of the flow, whereas particle dispersal and elutriation in the suspension current are determined by the gas-particle drag. Simulation results appear to be consistent with the reconciling model of pyroclastic density currents that considers pyroclastic flow and surges as the two end-members of a turbulent transport system characterized by the local unsteady gas-particle interaction under the effect of gravity.