# Modeling dynamics and sedimentation of dilute pyroclastic density currents

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Dilute pyroclastic density currents (dilute PDCs, or surges) are lethal and destructive types of flows generated by volcanic eruptions. Such flows are typically unsteady, density-stratified and turbulent, producing a range of deposit characteristics. Here we discuss models aimed at improving our understanding of the first order dynamics that influence dilute PDC runout and damage potential. We also explore the mechanisms of sediment transport and deposition in order to link depositional characteristics with current dynamics. Model (1) comprises simulation of axi-symmetric flow and sedimentation from a steady-state, vertically uniform density current. Equations for conservation of mass, momentum, and energy are solved simultaneously, and effects of atmospheric entrainment, particle sedimentation, basal friction, temperature changes, and variations in current thickness and density are explored. The Rouse number and Brunt-Väisäla frequency are used to estimate the wavelength of internal gravity waves in a density-stratified current, in order to predict deposit bedform characteristics. The model predicts realistic runout distances and bedform wavelengths for several well-documented field cases, although results are heavily dependent on source conditions, grain-size characteristics, and entrainment and friction parameters. For instance, increasing particle settling velocity, by increasing particle size and/or decreasing total particle concentration, decreases both runout distance and bedform wavelength. Model (2) uses a one-dimensional hydraulic balance of sedimentation of clasts and entrainment of air for an idealized ash-cloud surge current moving away from the channeled PDC "avalanche" source. The idealized ash-cloud surge is assumed to flow normal or obliquely to an avalanche track along a series of 1D flow paths defined by digital topography and broken into segments of constant slope and arbitrary length. In its existing form a series of starting points for 1D surge calculations are selected along the PDC channel, or arbitrarily specified within the modeled pyroclastic flow inundation limits, while mass flux is provided as an input parameter.

In both models, the surges move laterally while entraining air and sedimenting particles until their bulk densities fall below that of ambient air, signifying lift-off and defining the surge deposit limit. Deposit limits are used to define the possible area that may be inundated by surges. For both models, preliminary runs for test cases are consistent with observations, but because our existing formulations are based on depth-averaged equations, assumptions about density stratification and corresponding Brunt-Väisäla frequencies are oversimplified. Future model development seeks to quantify controls on density profile, and make use of experimental observations of sedimentation mechanics in controlled laboratory experiments.

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