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Effect of topography on deposition from dilute pyroclastic density currents simulated by Ansys Fluent software

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Pyroclastic density currents are volcanic gas-particle flows that move along volcano flanks and over the neighboring topography. Flow particle concentration can vary between two end members, concentrated and dilute. When a pyroclastic density current interacts with an uneven topography, the flow-field variables (velocity, pressure, particle concentration) are drastically changed at the flow-substrate boundary. These changes may significantly affect the sedimentation rate and the resulting deposits can record such effects in their sedimentological features. Here we show, by means of numerical simulations, how a dilute pyroclastic density current interacts with four different types of topographies, namely: flat, one hill, one valley and two hills. The simulations are carried out by Ansys Fluent commercial software for applications in fluid dynamic engineering. Our numerical scheme treats the very fine particles as being in full thermo-mechanical equilibrium with the volcanic gas (pseudo-fluid phase), and the trajectories of the coarser particles are tracked by means of the pseudo-fluid solution (Lagrangian particles). There is a two-way coupling between the pseudo-fluid phase and Lagrangian particles, which accounts for the reciprocal mechanical effects of the two phases. Numerical results are then used to analyze the local effects of topography on the deposition of the Lagrangian particles, by monitoring with time and space the local changes at the boundary between the dilute pyroclastic density current and substrate. We use the sedimentation rate and grain-size distribution of the Lagrangian particles as proxies of the deposit features, and by these parameters we compare qualitatively the numerical results with the deposits of known eruptions: Mount St. Helens blast, Taupo ignimbrite and Vulcano surge deposits. The results reproduce qualitatively the natural deposits very well, and we conclude that Ansys Fluent software could be used in volcanology with success.