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PYFLOW 2.0. A new open-source software for quantifying the impact and depositional properties of dilute pyroclastic density currents

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Dilute pyroclastic density currents (DPDC) are ground-hugging turbulent gas-particle flows that move down volcano slopes under the combined action of density contrast and gravity. DPDCs are dangerous for human lives and infrastructures both because they exert a dynamic pressure in their direction of motion and transport volcanic ash particles, which remain in the atmosphere during the waning stage and after the passage of a DPDC. Deposits formed by the passage of a DPDC show peculiar characteristics that can be linked to flow field variables with sedimentological models.

Here we present PYFLOW_2.0, a significantly improved version of the code of Dioguardi and Dellino (2014) that was already extensively used for the hazard assessment of DPDCs at Campi Flegrei and Vesuvius (Italy). In the latest new version the code structure, the computation times and the data input method have been updated and improved. A set of shape-dependent drag laws have been implemented as to better estimate the aerodynamic drag of particles transported and deposited by the flow. A depositional model for calculating the deposition time and rate of the ash and lapilli layer formed by the pyroclastic flow has also been included. This model links deposit (e.g. componentry, grainsize) to flow characteristics (e.g. flow average density and shear velocity), the latter either calculated by the code itself or given in input by the user. The deposition rate is calculated by summing the contributions of each grainsize class of all components constituting the deposit (e.g. juvenile particles, crystals, etc.), which are in turn computed as a function of particle density, terminal velocity, concentration and deposition probability. Here we apply the concept of deposition probability, previously introduced for estimating the deposition rates of turbidity currents (Stow and Bowen, 1980), to DPDCs, although with a different approach, i.e. starting from what is observed in the deposit (e.g. the weight fractions ratios between the different grainsize classes). In this way, more realistic estimates of the deposition rate can be obtained, as the deposition probability of different grainsize constituting the DPDC deposit could be different and not necessarily equal to unity.

Calculations of the deposition rates of large-scale experiments, previously computed with different methods, have been performed as experimental validation and are presented. Results of model application to DPDCs and turbidity currents will also be presented.

Dioguardi, F, and P. Dellino (2014), PYFLOW: A computer code for the calculation of the impact parameters of Dilute Pyroclastic Density Currents (DPDC) based on field data, Powder Technol., 66, 200-210, doi:10.1016/j.cageo.2014.01.013

Stow, D. A. V., and A. J. Bowen (1980), A physical model for the transport and sorting of fine-grained sediment by turbidity currents, Sedimentology, 27, 31-46