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PYR-hex1: An improved Cellular Automata model for pyroclastic flows

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PYR-hex1 is a Cellular Automata model for simulating pyroclastic flows generated by collapsing volcanic columns. It derives from a previous release, which was applied to the simulation of the 1991 eruption of Mt. Pinatubo (Philippines Islands), and to the 1996 eruption at the Soufriere Hills (Montserrat Island). One weak point of the model was the sensibility to spurious symmetries, which is a typical problem in Cellular Automata modelling. A hexagonal tessellation was then adopted in the present release, in spite of the square one; such tessellation also permitted to minimise some approximations of the transition function. The following general assumptions have been adopted: 1) the mixture of gases is reduced to a single gas; 2) the mixture of solid particles is considered as compound by undifferentiated particles; 3) pyroclastic material (mixture of gas and solid particles) is considered homogeneous in composition; 4) the pyroclastic flow behaviour is considered independent on temperature; 5) the motion of pyroclastic flow is considered purely gravitational (and not characterised by run-up effect); 6) the complex behaviour of turbulence is translated into simple macroscopic displacements of pyroclastic material between couples of cells; 7) the energy loss is modelled in such a way that a higher energy (corresponding to turbulence conditions) involves greater energy losses, according to reasonable empirical laws; 8) the collapse of the pyroclastic column is modelled by a feeding mechanism during the first phase of the simulation. The numerical output determines both the area affected by the pyroclastic flow and the thickness of the deposit, from the beginning of the column collapse up to the exhaustion of deposition. PYR-hex1 has been tested against several simulations of the 1991 eruption of Mt. Pinatubo (Philippines Islands). Obtained results confirmed the improved ability of the model in simulating such real events.