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An enhanced Cellular Automata model for pyroclastic flows

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An improved Cellular Automata model, PYR_hex1, for simulating pyroclastic flows, generated by collapsing volcanic columns, is here reported. It derives from a previous release [1], 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 characteristic of the previous model was the sensibility to spurious symmetries, which is typical in Cellular Automata modelling. A hexagonal tessellation was then adopted, in spite of the square one; such tessellation also permitted to minimise some approximations of the transition function.
Since a typical pyroclastic flow is not characterised by run-up effects, the motion is considered purely gravitational; moreover, the flow behaviour is considered independent on temperature.
The model takes into account the turbulence by translating it into simple macroscopic displacements of pyroclastic material between couples of cells
The major assumptions of the model are that pyroclastic material (mixture of gas and solid particles) is considered homogeneous in composition and the mixture of gases is reduced to a single gas. In addition, the mixture of solid particles is considered as compound by undifferentiated particles. 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.
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.
The model has been tested by carrying out several simulations of the 1991 eruption of Mt. Pinatubo (Philippines Islands). The results confirmed the improved ability of the model in simulating such real events.

References

[1] M.V. Avolio and G.M. Crisci and S. Di Gregorio and R. Rongo and W. Spataro. *Computers & Geosciences*, (in press).