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Modeling and simulations for evaluating the hazard posed by lava flows on Etna Volcano

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Scenario forecasting of lava flows provides an excellent opportunity for assessing the hazard posed by on-going effusive eruptions. That challenge has inspired the INGV-CT to develop two different models to simulate lava flows. The first model, named MAGFLOW, is based on a cellular automata structure in which the evolution function is a steady state solution of the Navier-Stokes equations and heat transfer (due to radiative losses) and solidification effects are modeled via a temperature dependent viscosity. The model was validated comparing simulated lava flows with the real ones occurred at Mt Etna during the 2001, 2004, and 2006 eruptions, showing that the code works properly fitting well-constrained eruption data sets. Moreover, MAGFLOW represented the central part of a extensive methodology for the hazard assessment at Mt Etna.
A second numerical model, based on Smoothed Particle Hydrodynamics (SPH) approach was recently developed by INGV-CT. This model allow to solve the equations of motion of a compressible fluid with a Lagrangian approach. Materials are discretized into particles that can move subject to equations of motion arising from the governing partial differential equations. The particles are moving interpolation points that carry with them physical properties and state information, such as the mass of the fluid that the particle represents, its temperature, momentum, enthalpy, density, and other properties. The inter-particle forces are calculated by smoothing the information from nearby particles in a way that the resultant particle motion is consistent with the motion of a corresponding real fluid, as determined by the governing equation.
Both models are part of a monitoring chain that starting from real-time infrared satellite data acquired by different sensors, is able to furnish a detailed prediction of the path of a lava flow. We tested our tool on the last Etna eruption occurred here between 2008 and 2009. The good agreement between simulated and mapped flow areas indicates that model-based inundation predictions, driven by thermal satellite data, provide a powerful tool for assessing the hazard posed by on-going effusive eruptions.