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Uncertainty quantification in satellite-driven modeling to forecast lava flow hazards

Gaetana Ganci (1), Giuseppe Bilotta (1), Annalisa Cappello (1), Alexis Herault (1,2), Vito Zago (1,3), and Ciro Del Negro (1)

(1) Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania - Osservatiorio Etneo, Catania, Italy (gaetana.ganci@ingv.it), (2) Département Ingénierie Mathématique, Conservatoire des Arts et Metiers, Paris, France, (3) Dipertimento di Ingegneria Elettrica, Elettronica e Informatica, Università di Catania, Catania, Italy

Over the last decades satellite-based remote sensing and data processing techniques have proved well suited to complement field observations to provide timely event detection for volcanic effusive events, as well as extraction of parameters allowing lava flow tracking. In parallel with this, physics-based models for lava flow simulations have improved enormously and are now capable of fast, accurate simulations, which are increasingly driven by, or validated using, satellite-derived parameters such as lava flow discharge rates. Together, these capabilities represent a prompt strategy with immediate applications to the real time monitoring and hazard assessment of effusive eruptions, but two important key issues still need to be addressed, to improve its effectiveness: (i) the provision of source term parameters and their uncertainties, (ii) how uncertainties in source terms propagate into the model outputs.

We here address these topics considering uncertainties in satellite-derived products obtained by the HOTSAT thermal monitoring system (e.g. hotspot pixels, radiant heat flux, effusion rate) and evaluating how these uncertainties affect lava flow hazard scenarios by inputting them into the MAGFLOW physics-based model for lava flow simulations.

Particular attention is given to topography and cloud effect on satellite-derived products as well as to the frequency of their acquisitions (GEO vs LEO). We also investigate how the DEM resolution impact final scenarios from both the numerical and physical points of view.

To evaluate these effects, three different kinds of well documented eruptions occurred at Mt Etna are taken into account: a short-lived paroxysmal event, i.e. the 11-13 Jan 2011 lava fountain, a long lasting eruption, i.e. the 2008-2009 eruption, and a short effusive event, i.e. the 14-24 July 2006 eruption.