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Timely mapping and quantification of the 2021 Etna lava flows through the exploitation of multi-sensors remote-sensing data

Cristina Proietti, Massimo Cantarero, and Emanuela De Beni

(cristina.proietti@ingv.it)

Etna volcano has four summit craters that are characterized by periodic strombolian and lava fountaining episodes, often associated with lava flows. In the last years, the most active was the South East Crater that on 2021 produced more than fifty paroxysms that gave rise to lava flows rapidly propagating towards East, South, and South-West. Etna summit area is visited by thousands of tourists, especially in the summertime, thus it is important to evaluate the hazard related to lava flow emplacement. For this reason, we were urged to timely map the lava flows emplaced during each paroxysm whose frequency was as high as two events in 24 hours. This task has been accomplished through the integration of different remote sensing techniques, based on data availability and weather conditions. Several satellite images (Sentinel-2 MSI, Aster, Ecotress, Skysat, Landsat-8 OLI and TIRS) allowed us to map the lava flow field at spatial resolutions from 0.7 to 90 meters. Unoccupied Aerial System (UAS) surveys also allowed to acquire visible and thermal images, with high-spatial resolution, of the lava flows. Finally, thermal images acquired from the permanent network of cameras, managed by the Istituto Nazionale di Geofisica e Vulcanologia, were re-projected into the topography at 5-meter spatial resolution. The various remote sensing data enable the mapping of the lava flows and compiling a geodatabase that registers the main geometrical parameters (e.g. length, area, average thickness). The joint exploitation of remote-sensing data acquired through multi-sensors enabled, for the first time on Etna, to timely and accurately characterize frequently occurred effusive events.