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HOTSAT volcano early warning system based on a combined use of SEVIRI and MODIS multispectral data

Gaetana Ganci[1,2], Annamaria Vicari[1], Sergio Bonfiglio[1,3], Ciro Del Negro[1]

[1] *Istituto Nazionale di Geofisica e Vulcanologia, Sezione di Catania, Catania, Italy*
[2] *Dipartimento di Ingegneria Elettrica Elettronica e Automatica, Università di Catania, Catania, Italy*
[3] *Dipartimento di Matematica e Informatica, Università di Catania, Catania, Italy*

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Multispectral infrared observations carried out by the spacecrafts have shown that remote sensing of high-temperature volcanic features is feasible and robust enough to turn into volcano monitoring. Especially meteorological satellites have proven a powerful instrument to detect and monitor dynamic phenomena, such as volcanic processes, allowing very high temporal resolution despite of their low spatial resolution. An automated GIS-integrated system for thermal volcano monitoring, called HOTSAT, was developed at INGV-CT for analyzing both EOS-MODIS and MSG-SEVIRI satellite data. The alert system is composed by three packages: Pre-processing, Product Generation and Post-processing. Each package consists of several independent executable modules. The modules of Pre-processing are necessary for initial images geolocation and calibration, the modules of Product Generation compute higher-level products from the satellite band data as volcano hot spots and radiant flux estimation, and the ones of Post-processing project raw geometry data to a cartographic reference system and export the elaborated outputs to a Google Map platform. To locate volcano hot spots, a new contextual algorithm is introduced taking advantages from both spectral and spatial comparison methods. On a first step, the spatial standard deviation is computed on the difference between middle infrared (MIR) and thermal infrared (TIR) temperatures. These data are used to set an adaptive threshold and detect "potential" hot pixels. Those pixels are then further assessed as true or false hotspot detections base on statistical thresholds test derived from the MIR brightness temperatures. Following this procedure, all the computations are based on dynamic thresholds reducing the number of false alarms due to atmospheric conditions. The derivation of radiant flux is computed at all "hot" pixels. This is carried out using the MIR radiance method introduced for forest fires. Following this approach, the radiant flux is proportional to the calibrated radiance associated to the hot part of the pixel computed as the difference between the observed hotspot pixel radiance in the MIR channel and the background radiance that would have been observed at the same location in the absence of thermal anomalies. The HOTSAT early warning system is now suitable to be employed in an operational system of volcano monitoring. To validate and test the system some real cases on Mt Etna are presented.