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Thermal IR monitoring of active volcanic areas: instruments and methodologies used at Campi Flegrei Caldera (Italy) in the period 2004-2010 and new technological implementations to plan in near future.

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Since October 2004 two permanent remote monitoring stations equipped with IR sensors are operative at Campi Flegrei volcanic area for continuous long-term volcanological surveillance.

The system consists of two Remote Monitoring Stations (RMS), with remote control of the calibration and shooting functionalities of IR sensors, and of a Control Unit that manages the system parameters for each RMS.

The IR cameras used are NEC Thermo Tracer TS7302 with uncooled focal plane array measuring systems (microbolometer technology 320x240 pixel) which are inside a protective housing made in special stainless steel resistant to corrosive elements and with a shooting window of germanium glass, transparent to the thermal wavelengths.

The Control Unit is located at the surveillance center of INGV-Osservatorio Vesuviano in Naples and communicate with the RMS through GSM frequency network and an emergency system on radio frequency network. This unit allows to configure times and shooting parameters and to run the automatic uploading of the remotely acquired thermal images.

The first thermal monitoring station is inside the Solfatara crater and acquires scenes of the SE inner slope since July 2004, at the intersection of two active, SW-NE and NW-SE, main faults where are located the major fumaroles. The second station is placed at Pisciarelli on the outer eastern flank of the Solfatara volcano, characterized by heavy water vapor and CO_2 emissions. This station (TITANO) is operative since October 2006 and is a portable station, as the protective housing, containing the thermal camera, is placed over a tripod equipped with telescopic joints.

In order to minimize the influence of atmospheric conditions on the image quality, an advanced filtering of the temporal series of measured temperature values is performed. Filters are developed using statistical methods and taking into account the trends of temperatures measured in areas of IR images representative of the background. All the correction are made using IR images only and data analysis is performed with NEC analysis software and freeware tools. The final product is a plot of the filtered maximum temperature values, measured in selected areas of the IR image, versus time.

A new thermal monitoring system is currently in development for a permanent station at Vesuvius crater and for a new TITANO portable station. The RMS will perform a total control of the FLIR camera through a user-friendly graphic interface and will manage a data logger for air temperature and humidity measurements which are used for real time correction of IR images to be acquired. The system will get scenes at preconfigured time intervals (using a programmable timer specifically designed) and also could be easily reconfigured to acquire scenes on demand. The RMS will connect to the surveillance centre using WiFi network (or eventually by radio frequency network) and send the internally stored IR images to a chosen PC. The RMS will not need a Control Unit located at surveillance centre as it can be configured directly using a Remote Desktop connection from everywhere; this peculiarity gives great flexibility to the way you would like access to the station. Properly configured, the RMS will acquire data for months, in absence of any WiFi or radio frequency connection, as it can rely on a large internal data storage capability. Optionally the station will be equipped with a conventional video camera which can transmit the analogic signal using a video server hardware.

Future implementations for this monitoring system look on MatLab and Simulink applications as the next step to obtain a full automated, real time, elaboration of IR data aimed to represent the thermal energy flux trends which currently are obtained only with human interaction.