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An automated processing chains for surface temperature monitoring on Earth's most active volcanoes by optical data from multiple satellites

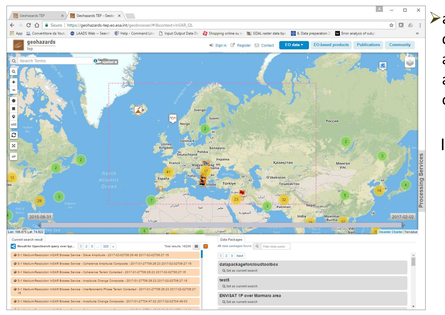
Malvina Silvestri , Massimo Musacchio, Maria Fabrizia Buongiorno

Istituto Nazionale di Geofisica e Vulcanologia, Centro Nazionale Terremoti, Rome, Italy

The Geohazards Exploitation Platform (GEP) is one of six Thematic Exploitation Platforms developed by ESA to serve data user communities. As a new element of the ground segment delivering satellite results to users, these cloud-based platforms provide an online environment to access information, processing tools, computing resources for community collaboration. The aim is to enable the easy extraction of valuable knowledge from vast quantities of satellite-sensed data now being produced by Europe's Copernicus programme and other Earth observation satellites. In this context, the estimation of surface temperature on active volcanoes around the world is considered. E2E processing chains have been developed for different satellite data (ASTER, Landsat8 and Sentinel 3 missions) using thermal infrared (TIR) channels by applying specific algorithms. These chains have been implemented on the GEP platform enabling the use of EO missions and the generation of added value product such as surface temperature map from not skilled users. This solution will enhance the use of satellite data and improve the dissemination of the results saving valuable time (no manual browsing, downloading or processing is needed) and producing time series data that can be speedily extracted from a single co-registered pixel, to highlight gradual trends within a narrow area. Moreover, thanks to the high-resolution optical imagery of Sentinel 2 (MSI), the detection of lava maps during an eruption can be automatically obtained. The proposed lava detection method is based on a contextual algorithm applied to Sentinel-2 NIR (band 8 - 0.8 μm) and SWIR (band 11 - 1.61 μm and band 12 - 2.19 μm) data. Examples derived by last eruptions on Mt. Etna active volcano is showed.

GEP Platform

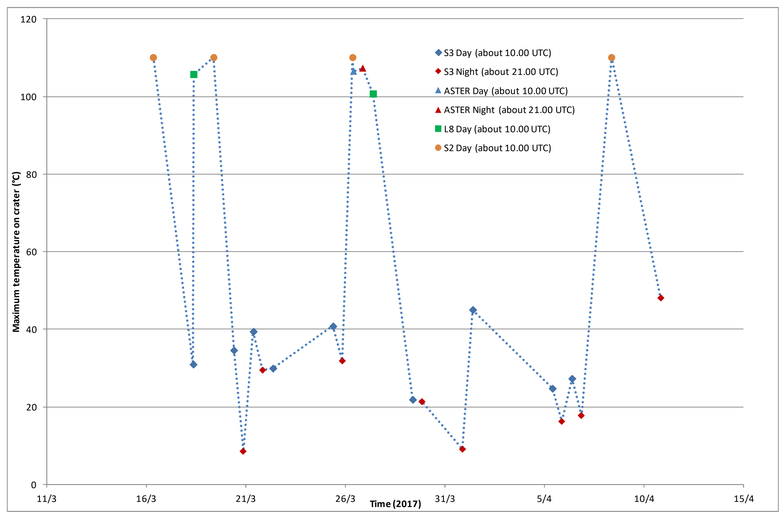
- on demand processing for specific user needs and systematic processing to address common information needs of the geohazards community as a whole;



- as well as massive processing on multi-tenant computing resources on the Cloud that will address the challenges of monitoring tectonic areas on a global basis, and of studying a range of geohazards.

In the context of the VOLcanoes Thermal Application for GEP, INGV has setup an E2E processing chain (named **STEMP**) for the generation of **S**urface **TEMP**erature maps over volcanic areas fitting the Researcher and Users needs from new EO missions data such as ASTER, Landsat-8, Sentinel-3 and during the eruption hot spot maps with Sentinel-2.

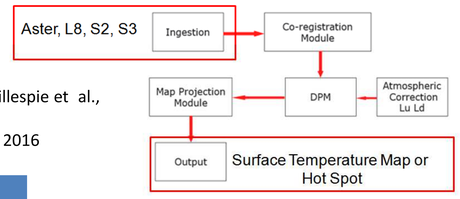
Time Series production



Time series can be produced using all EO data available and considering i.e. the maximum value of surface temperature on Mt. Etna volcano. In the figure, the high variability has been due to the use of different type of remote sensor over the entire time series, operated from 4 different satellites (ASTER, L8, SENTINEL-2 and SENTINEL -3, see table for spatial and temporal resolution). Sentinel-2 data are used only for hot spot detection.

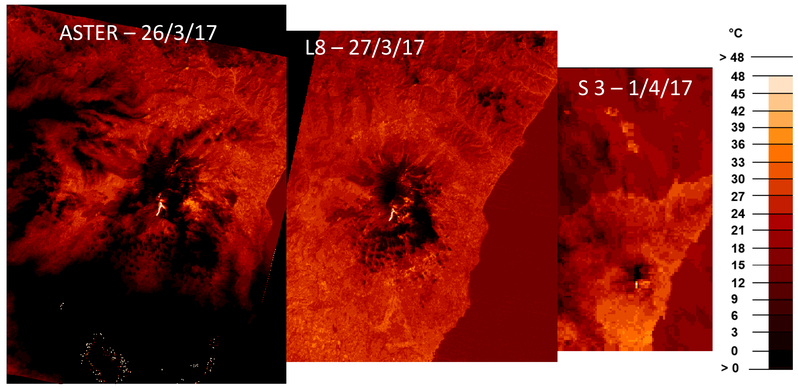
Data, Method and Results

- DEM for the topography
- In situ atmospheric parameter data provided by University of Wyoming to remove the effect of the atmosphere on the EO satellite data
- Surface Temperature Map produced following Gillespie et al., (1998), Barsi et al., (2003)
- Hot Spot Map produced following Murphy et al., 2016

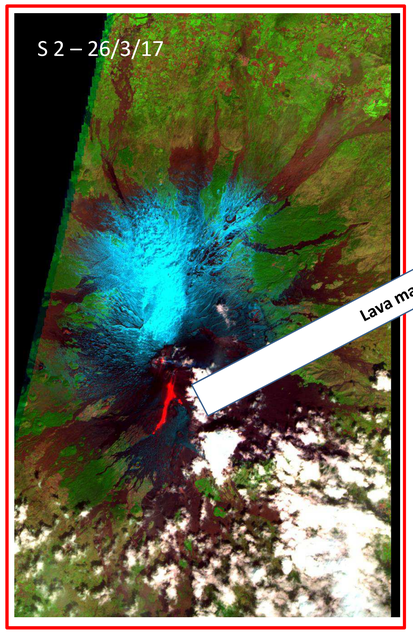


SENSOR	Spatial Resolution (mt)	Temporal Resolution
ASTER	90	16 days
LANDSAT-8	100	16 days
SENTINEL-2	20	About 6 days
SENTINEL-3	1000	2 per days

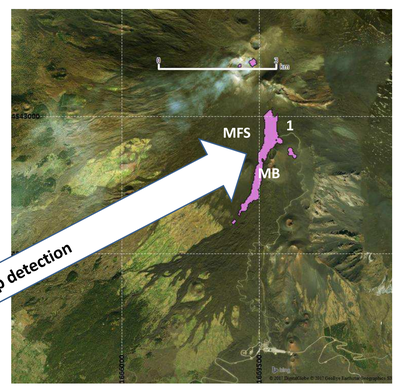
Example of Surface temperature using ASTER, L8, S3 on Mt. Etna volcano during the last eruption (daytime acquisition)



Hot Spot detection with SENTINEL-2



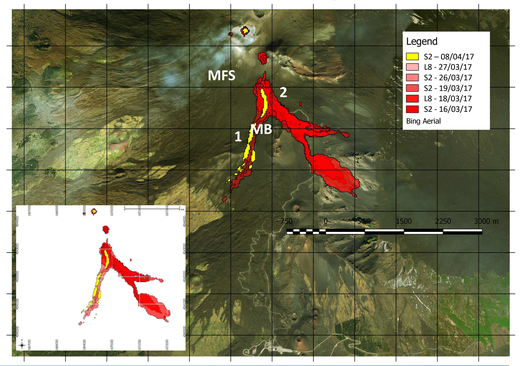
Lava map detection



Considering the results obtained using Sentinel-2 and L8 data, the lava flow is divided into variuos flows that were behind and around the northern Monti Barbagallo (MB) cone.

1 – On 25 March 2017, the most advanced active lava flow had bypassed the western flank of Monti Barbagallo, flowing toward Southwest, following an existing morphological feature between Monti Barbagallo and Monte Frumento Supino (MFS). At the time of observation, the active lava flow length was about 1.3 km

2 On 28 March 2017, a second lava flow had bypassed from the eastern part of Monti Barbagallo. At the time of observation the most advanced active lava front was at 2780 m above sea level. As a whole, the morning of 28 March, the active lava flow was length about 1.3 km



Thanks to the availability of Sentinel-2 and L8, using STEMP the trend of the lava flow has been produced during the last eruption on Mt. Etna volcano (March 2017).

References and acknowledgments

❖ Barsi, J.A., Barker J.L., Schott J.R. (2003). *An Atmospheric Correction Parameter Calculator for a Single Thermal Band Earth-Sensing Instrument*. IGARSS03, 21-25 July 2003, Centre de Congres Pierre Baudis, Toulouse, France.
❖ Gillespie A. R., Matsunaga T., Rokugawa S., Hook S. J. (1998). *Temperature and emissivity separation from Advanced Spaceborne Thermal Emission and Reflection Radiometer (ASTER) images*. IEEE Transactions on Geoscience and Remote Sensing, 36, 1113-1125.
❖Murphy S.W., Filho de Souza C.R., Wright R., Sabatino G., Pabon R.C. (2016). *HOTMAP: Global hot target detection at moderate spatial resolution. Remote Sensing of Environment* http://dx.doi.org/10.1016/j.rse.2016.02.027

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