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Main morpho-structural changes and eruptions of Etna in 2016-2019 captured by satellite observations

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Aims of the study

- To assess the possible relation of summit intracrater vent opening (pit) at Mt. Etna (Sicily; Italy), during the period 2016-2019, with volcanic thermal anomalies detected from space integrating Landsat 8 OLI and Sentinel 2 MSI observations.

- To verify the usefulness of the NHI (Normalized Hotspot Indices) tool in supporting the operational monitoring of Mt. Etna.

Method: NHI algorithm

The NHI algorithm (Marchese et al., 2019) combines two normalized indices to identify and map volcanic thermal anomalies by means of Sentinel 2 MSI and Landsat 8 OLI data

$$NHI_{SWIR} = \frac{L_{2.2} - L_{1.6}}{L_{2.2} + L_{1.6}}$$

$$NHI_{SWNIR} = \frac{L_{1.6} - L_{0.8}}{L_{1.6} + L_{0.8}}$$

where, L2.2, L1.6, and L0.8 are the TOA radiances [W·m-2·sr-1·m-1] measured, for each pixel of the analyzed scene, at around 2.2 µm, 1.6 µm(SWIR), and 0.8 µm (NIR) wavelengths. Values of $NHI_{SWIR} > 0$ OR $NHI_{SWIR} > 0$ indicate volcanic hotspots.

Marchese, F.; Genzano, N.; Neri, M.; Falconieri, A.; Mazzeo, G.; Pergola, N. A Multi-Channel Algorithm for Mapping Volcanic Thermal Anomalies by Means of Sentinel-2 MSI and Landsat-8 OLI Data. Remote Sensing 2019, 11(23), 2876, https://doi.org/10.3390/rs11232876

Data: Landsat 8-OLI and Sentinel 2 MSI

Main features of MSI (MultiSpectral Instrument) sensor (in red the SWIR bands)

MSI spectral channel	Central wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
1	443	20	60
2	490	65	10
3	560	35	10
4	665	30	10
5	705	15	20
6	740	15	20
7	783	20	20
8	842	115	10
8A	865	20	20
9	945	20	60
10	1375	30	60
11	1610	90	20
12	2190	180	20

Main features of OLI (Operational Land Imager) sensor (in red the SWIR bands)

OLI spectral channel	Central wavelength (nm)	Bandwidth (nm)	Spatial resolution (m)
1	443	16	30
2	482.6	60	30
3	561.3	57	30
4	654.6	37	30
5	864.6	28	30
6	1609.1	85	30
7	2201.7	187	30
8	590	172	15
9	1373	20	30

Mt. Etna (Sicily; Italy)

Analysis of Mt. Etna activity of 2016-2019

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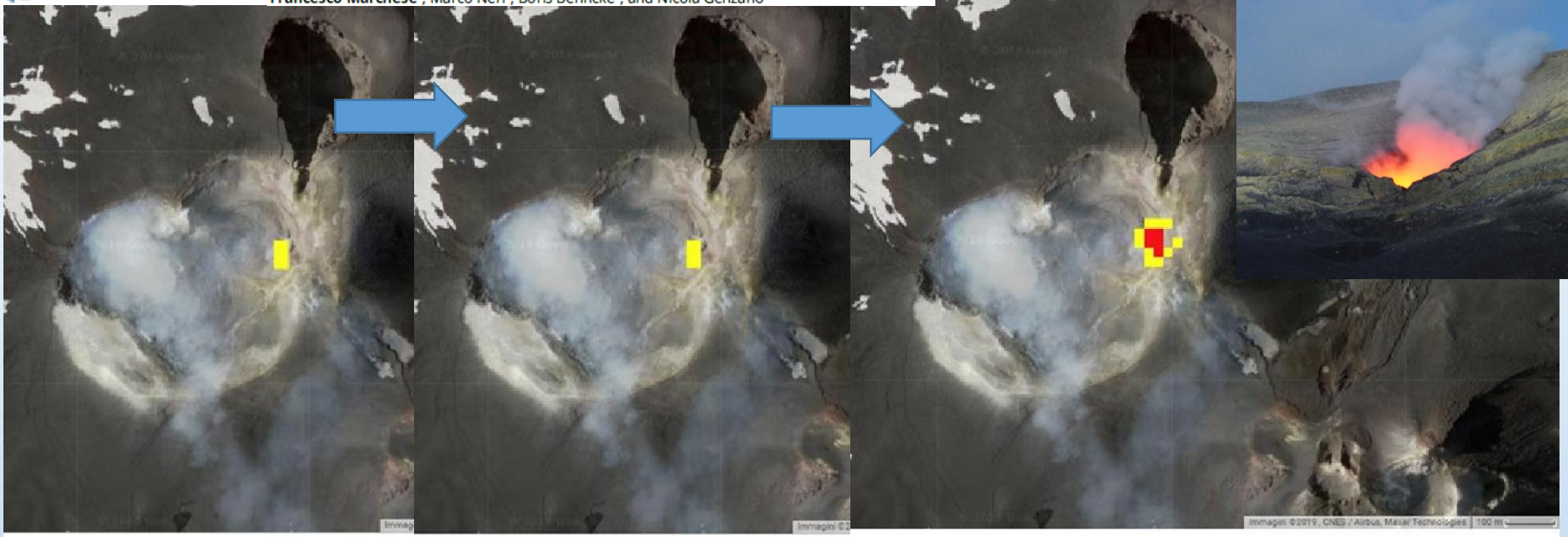
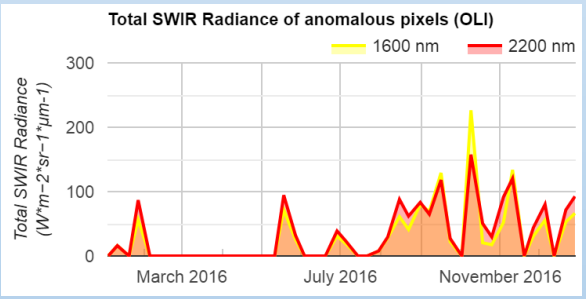
Francesco Marchese[1], Marco Neri[2], Boris Behncke[2], and Nicola Genzano[3]

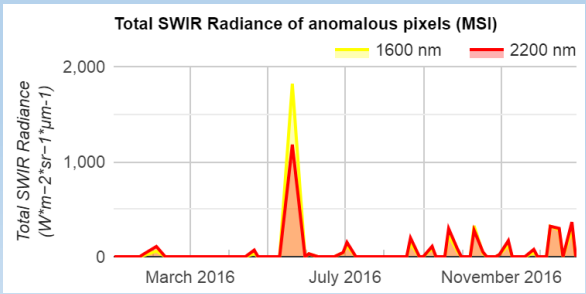


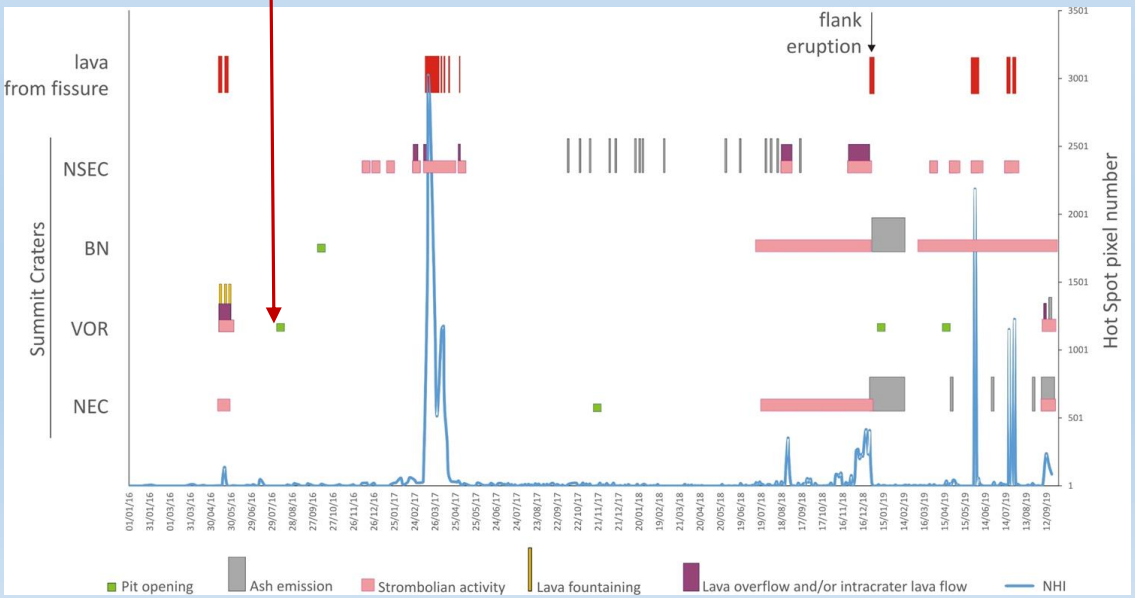
05/07/2016 – Lands

06/08/2016 – Landsa

10/10/2016 – Sentinel 2 MSI







Reference

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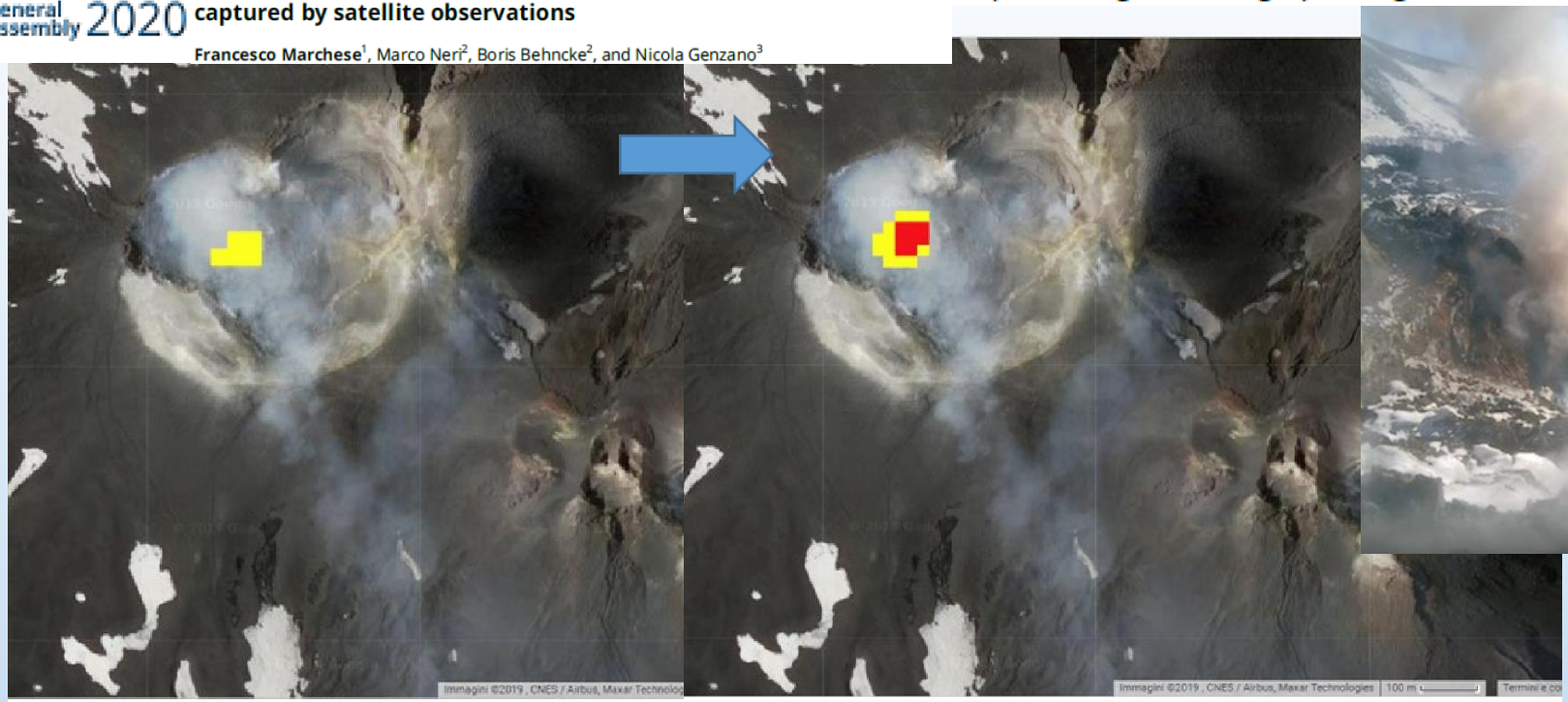
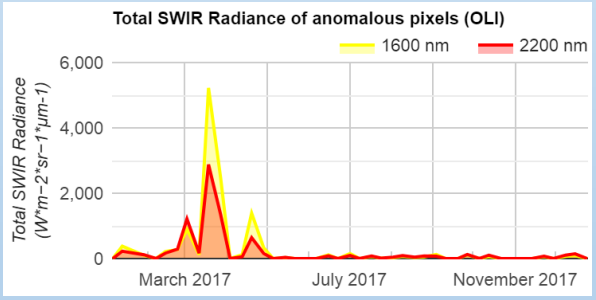
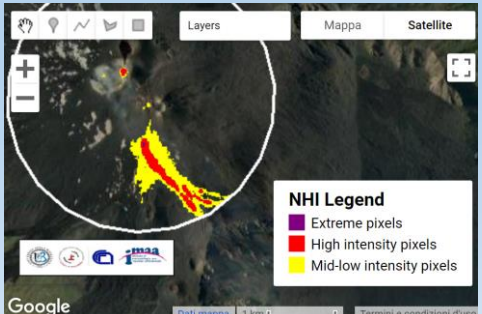
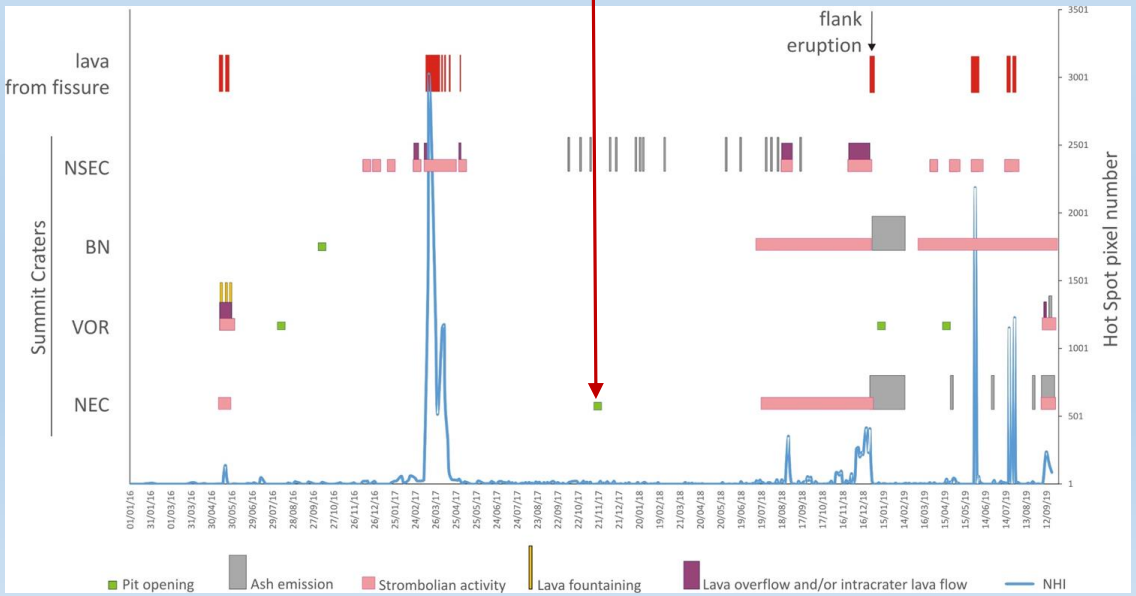


22/11/2017 – Landsat 8 OLI

24/11/2017 – Sentinel 2 MSI







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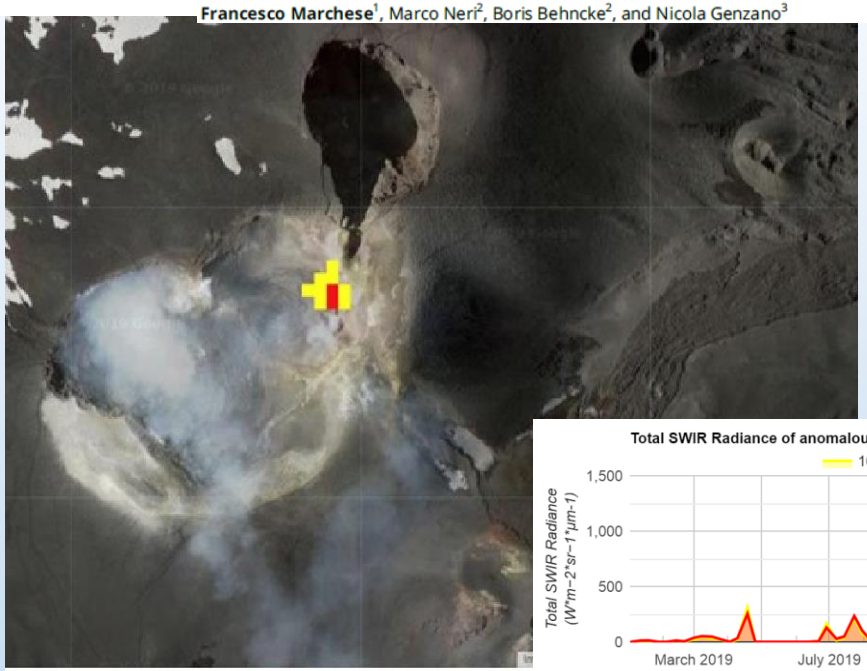
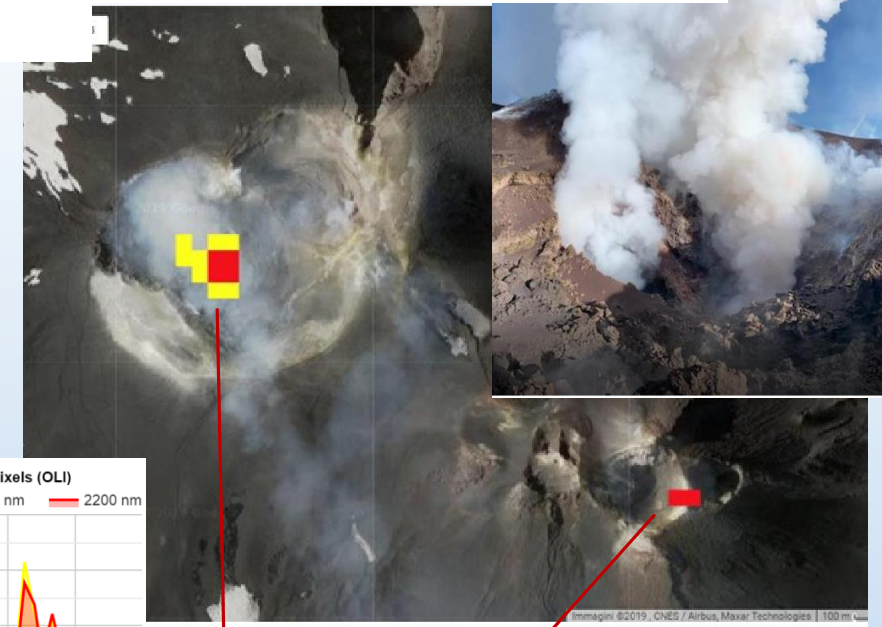
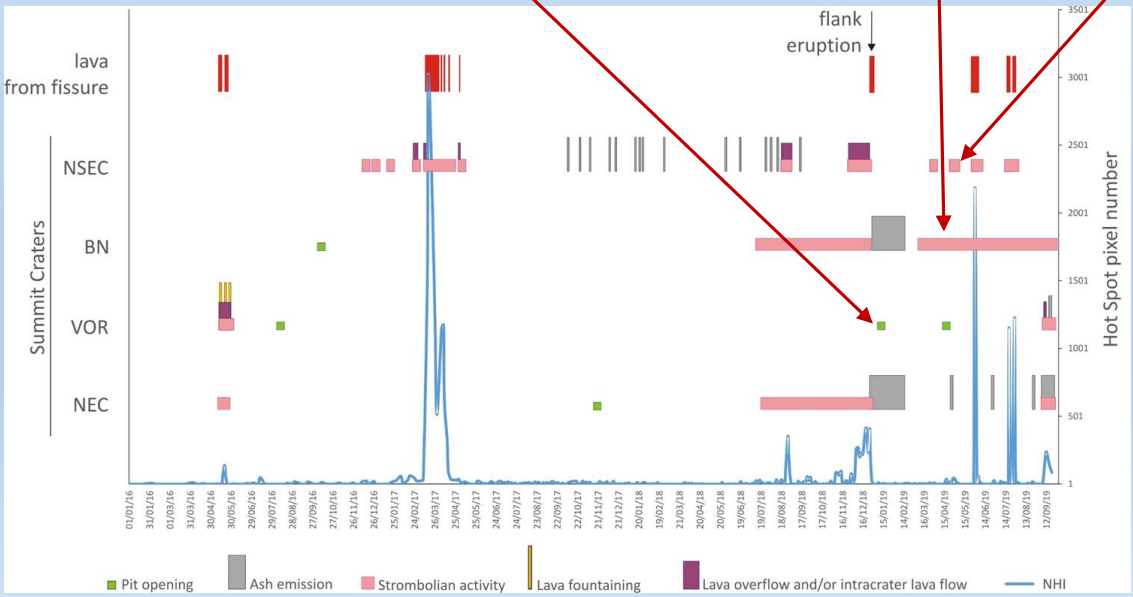




18/04/2019 – Landsat 8 OLI

08/01/2019 – Sentinel 2 MSI



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Conclusions

- Both explosive (mild strombolian) and effusive eruptions of Mt. Etna, occurring during the investigated period, were well identified by the NHI algorithm, through the tool available online at http://www.imaa.cnr.it/10066-open-data/712-nhi-normalized-hotspot-indices-tool

- The comparison of thermal anomaly products with ground-based observations has shown the identification of volcanic thermal anomalies before some pit (intracrater vent) opening, requiring further investigations to be assessed.

- Results demonstate the usefulness of NHI tool in supporting the operational monitoring of Mt. Etna, complementing information from other systems.