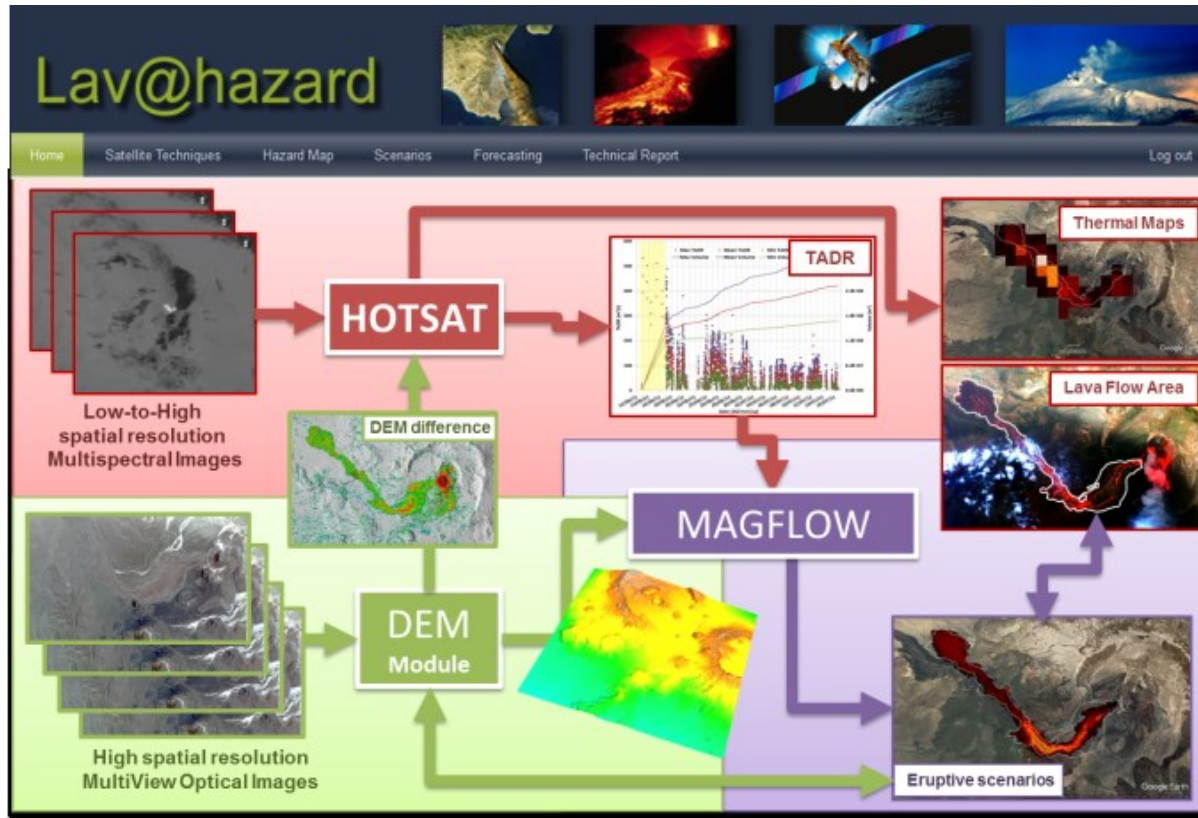




Analyzing the 2011 eruption of Nabro volcano using satellite remote sensing and numerical modeling of lava flows



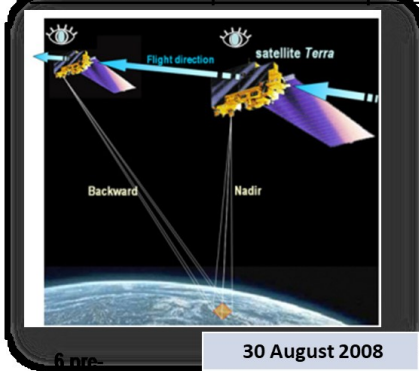
C. Del Negro, G. Ganci, A. Cappello, G. Bilotta and C. Corradino
email:ciro.delnegro@ingv.it



Methodology:

1. Pre-eruptive DEM production from high resolution stereo pairs
2. Detection of thermal anomalies from multispectral satellite data
3. Production of thermal maps
4. Radiant heat flux estimation computed for thermally anomalous images
5. Preliminary TADR estimation by straightforward conversion of the radiant heat flux
6. Preliminary production of lava flow scenarios using TADR and pre-eruptive DEM
7. Syn-eruptive DEM production from high resolution stereo pairs
8. Calibration of TADR using DEM-derived volume
9. Refinement of lava flow scenarios using DEM-calibrated TADR
10. Validation of lava flow scenarios using higher resolution thermal and thickness maps.

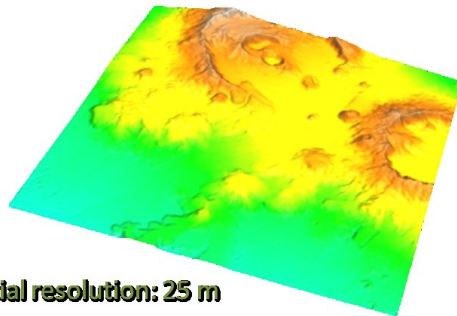
2011 Nabro Eruption: Pre-eruptive DEM



6 pre-
eruptive
DEM's from
cloud-free
ASTER
images
acquired on:

30 August 2008
5 January 2009
4 October 2009
24 January 2010
13 March 2010
17 April 2011

ASTER images were processed using the MicMac
ASTER (MMASTER) package [Girod et al., 2017]

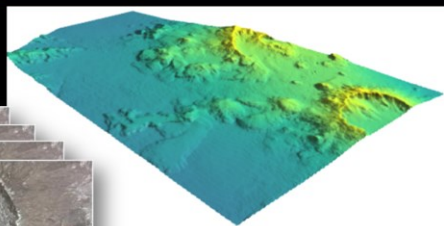


spatial resolution: 25 m

We integrated the 6 pre-eruptive DEMs by considering the median value of corresponding pixels in order to discard possible blunders and errors.



PlanetScope images were processed using the
MicMac software[Rupnik et al., 2017]

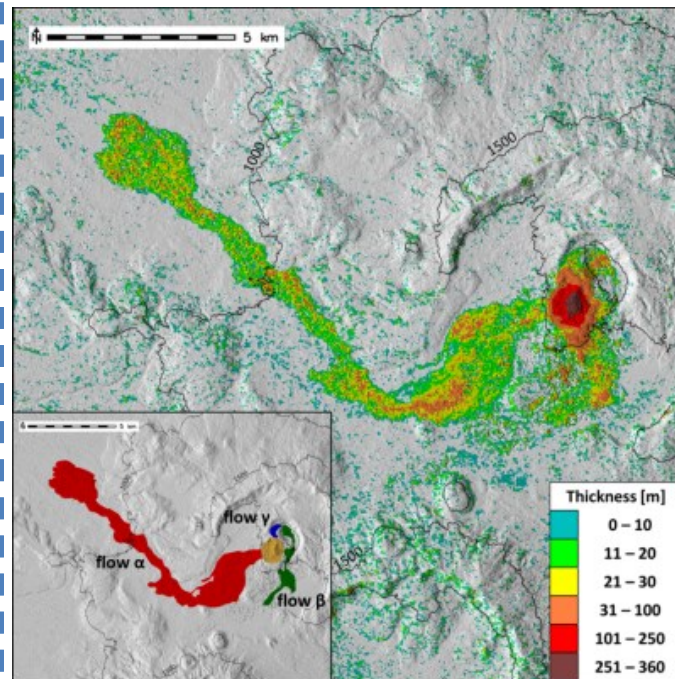


spatial resolution: 7 m

The post-eruptive DEM was produced by using seven PlanetScope scenes acquired on 2 and 12 May 2019 with off nadir angles ranging from 0.9 to 5 degrees.



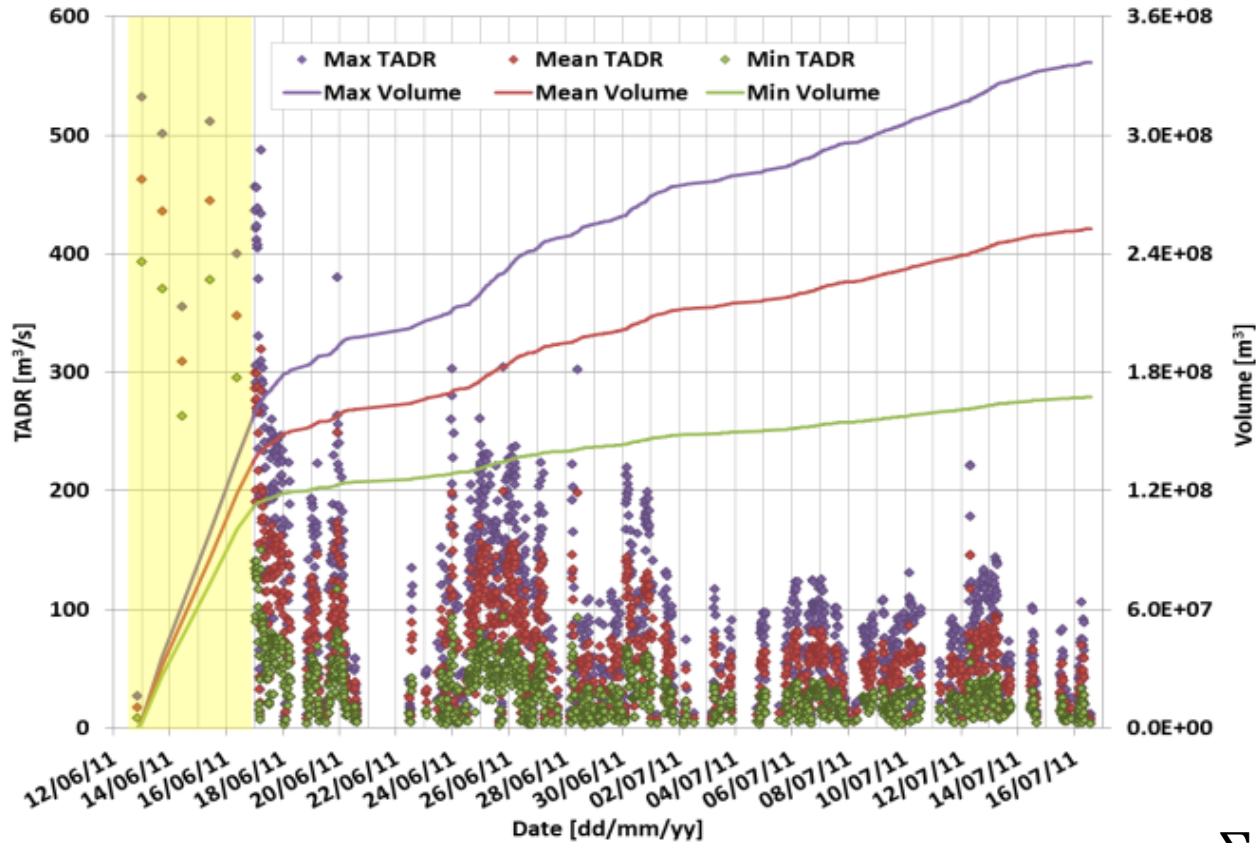
2011 Nabro Eruption: DEM differences



To compensate major discrepancies and achieve the maximum coherence, we accurately coregistered the 7 DEMs applying the Nuth and Kääb (2011) algorithm.



2011 Nabro Eruption: Time Averaged Discharge Rate



G Ganci, A Cappello, G Bilotta, C Del Negro (2020). How the variety of satellite remote sensing data over volcanoes can assist hazard monitoring efforts: The 2011 eruption of Nabro volcano Remote Sens. Environ.

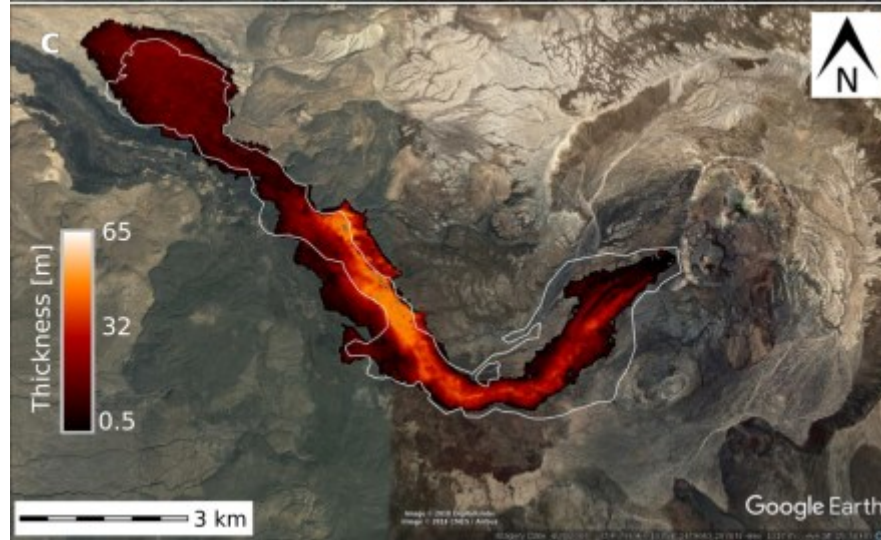
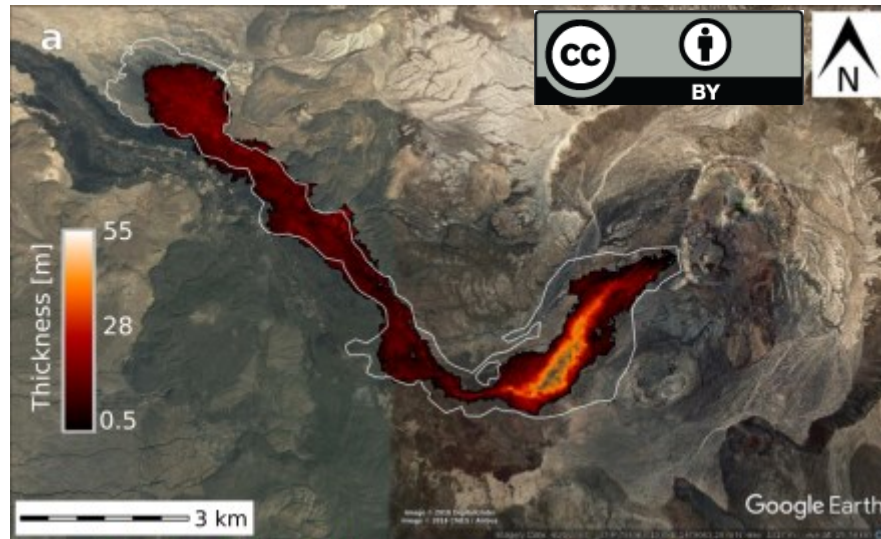
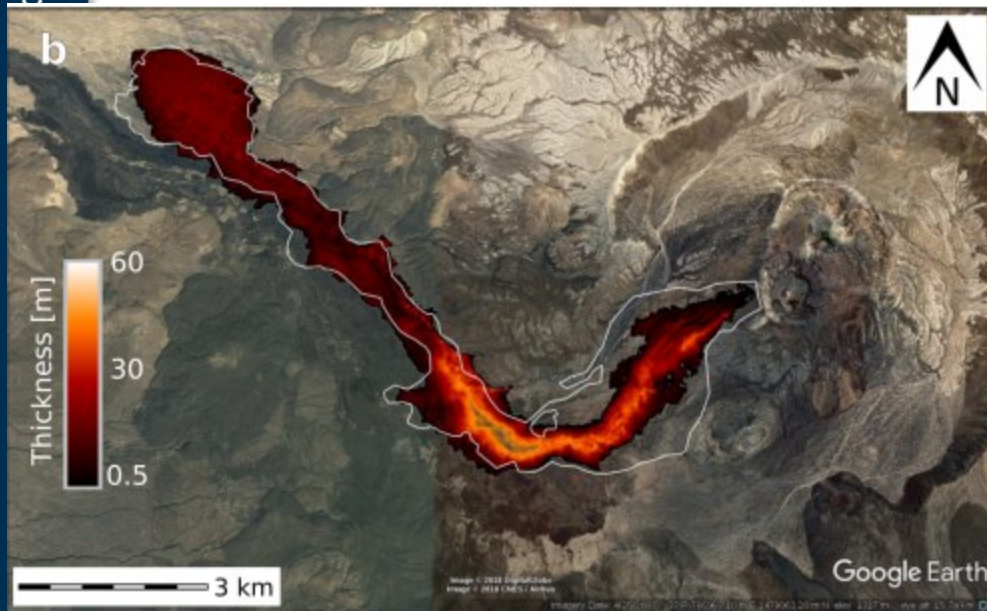
doi:10.1016/j.rse.2019.111426

TADR curves are rescaled so that their integrals match the DEM-derived volumes by computing three constants for conversion (k_{TADR}) according to:

$$k_{TADR} = \frac{\sum \frac{1}{2} (t_i - t_{i-1}) (Q_i + Q_{i-1})}{V_{DEM}}$$



2011 Nabro Eruption: MAGFLOW scenarios



	Min TADR	Mean TADR	Max TADR
ACC_2D	0.78	0.83	0.77
CCS	0.69	0.74	0.66
ACC_3D	0.73	0.77	0.75

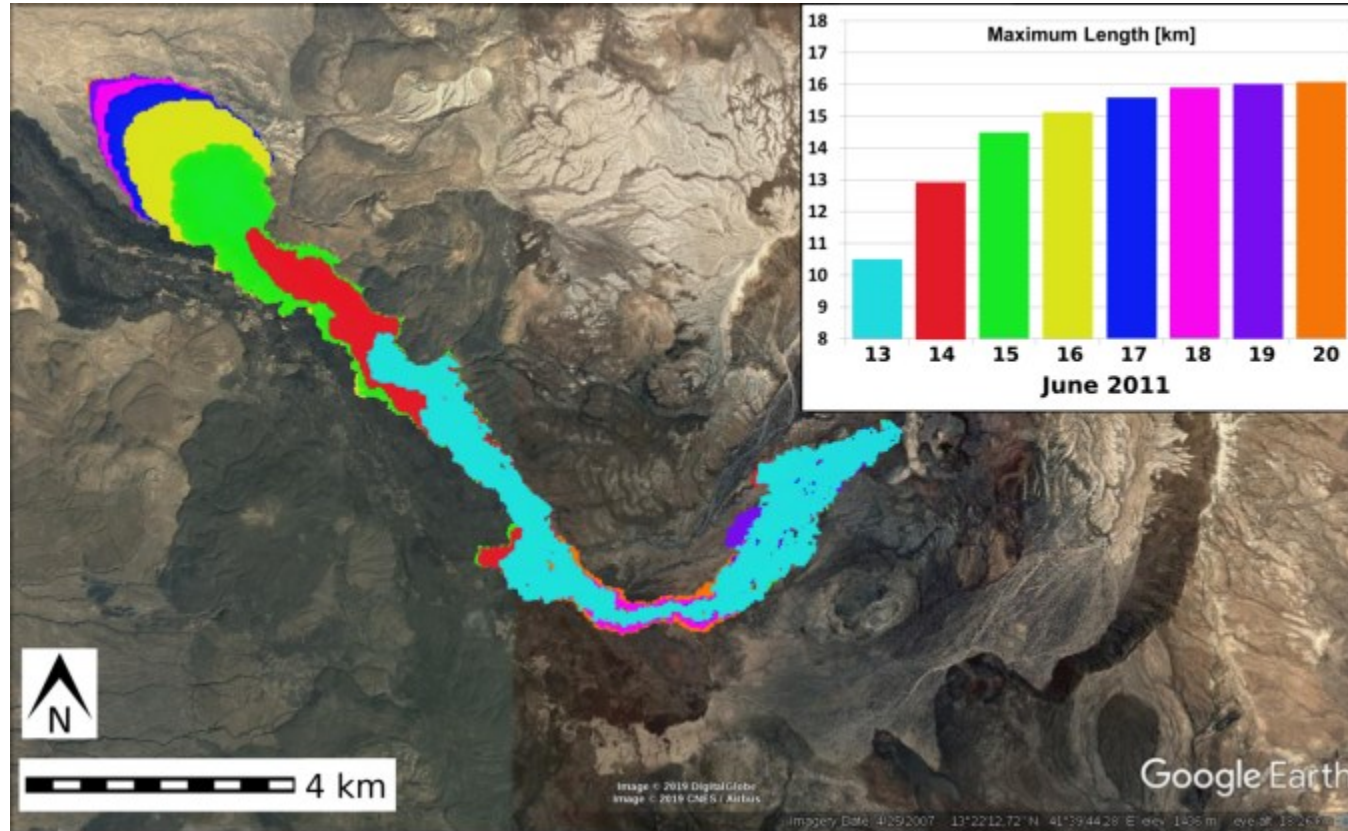




2011 Nabro Eruption: MAGFLOW retrospective analysis



The lava flow is likely to have reached 10.5 km in one day and the maximum length of 16.06 km on 20 June giving a maximum speed of ~ 0.44 km/h.



MAGFLOW scenarios with the mean TADR during the first 8 days of eruption. Colors represent the scenario at the end of each day. The inset shows the maximum length reached at each day.