UN-SPIDER / ZFL Regional Virtual Expert Meeting for Southern Africa "Space-based Solutions for Disaster Risk Management and Emergency Response"

"Multi-Temporal Radar Interferometry Analysis for Volcanic Activity Early Warning"

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UN-SPIDER

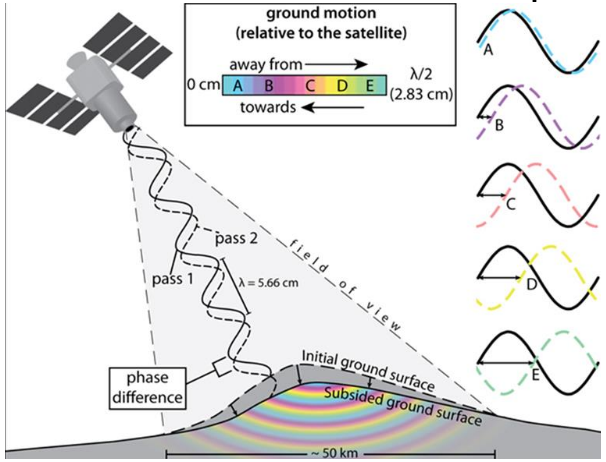
Aim:

to show an example of how the Earth Observation (EO) technologies are a useful tool to detect slope instability before a volcanic collapse event, and how a last eruption could provide us an opportunity to improve warning systems based on Big SAR Data.

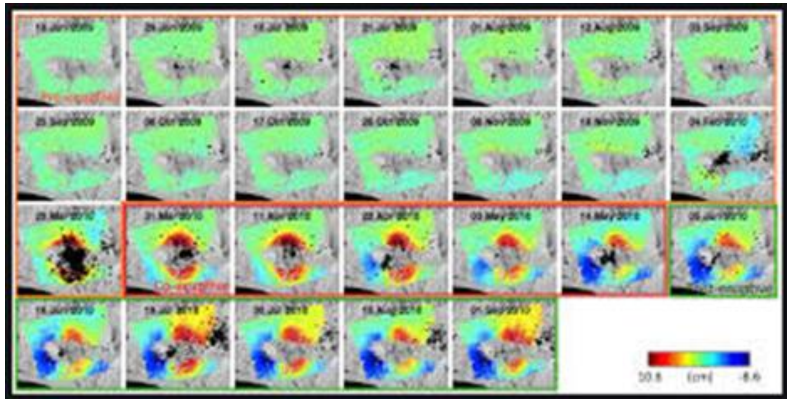
Previous work:

- Krakatau Volcano
- Taal Volcano
- Nevado del Chillan

How Works a InSAR technique?



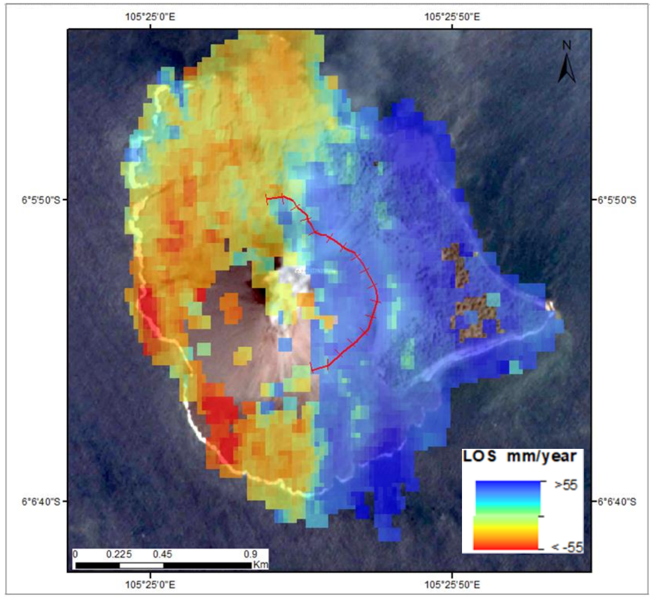
Multitemporal INSAR

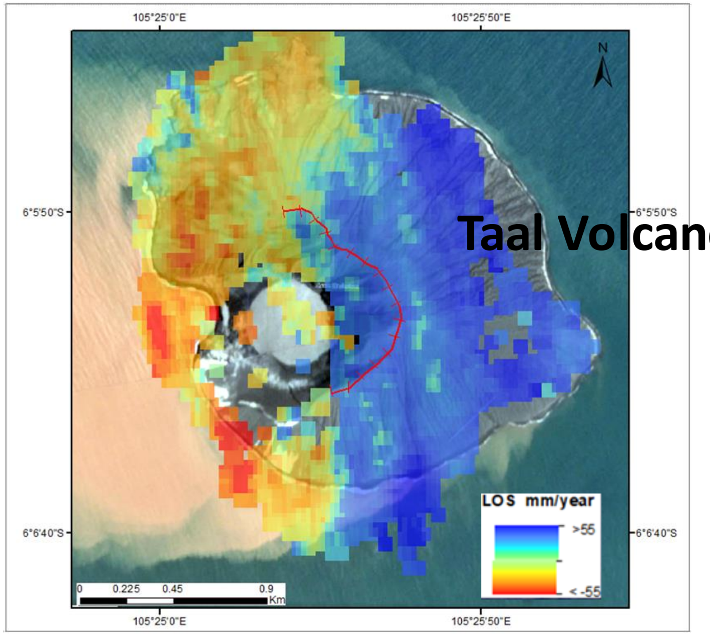


Ground deformation

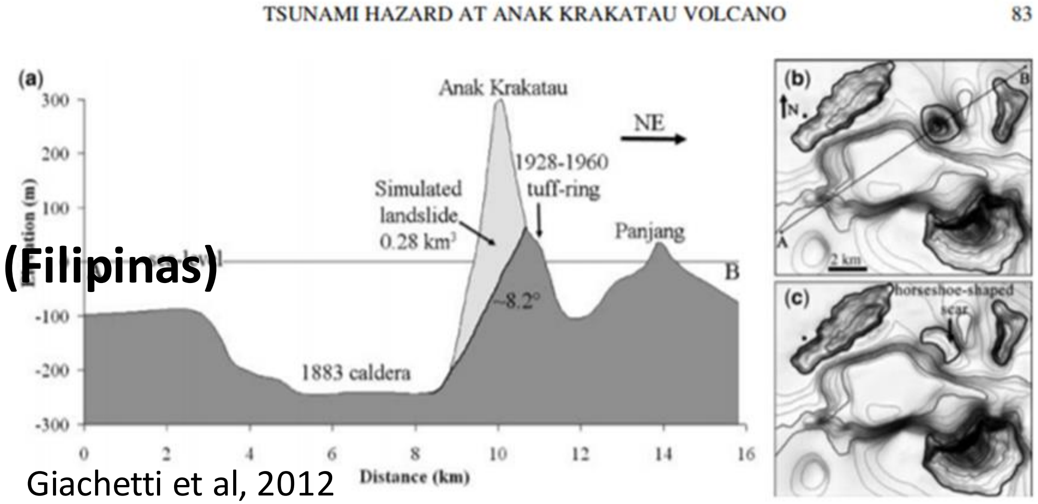
$$\delta\phi_{int} = \delta\phi_{defo} + \delta\phi_{atmos} + \Delta\phi_{orbit} + \delta\Delta\phi_{topo} + \delta\phi_{noise}$$

Multitemporal analysis June-December
Ascending orbit (27-07-2018 /07-12-2018)
Mean desplacement velocity





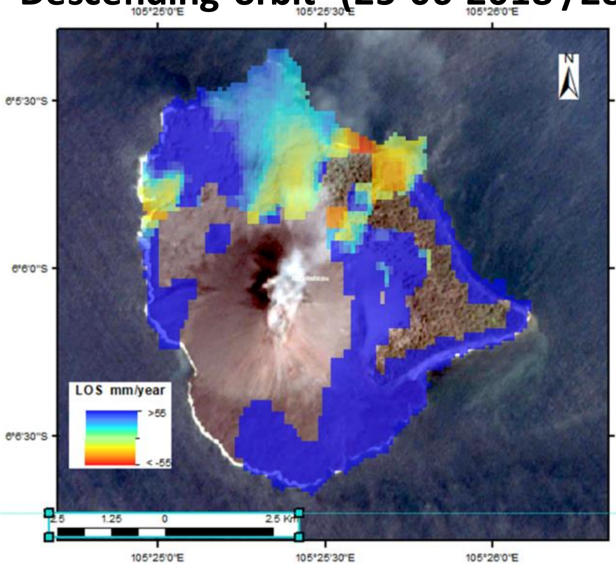
Cross section of batimetry and ancient Krakatau Volcano

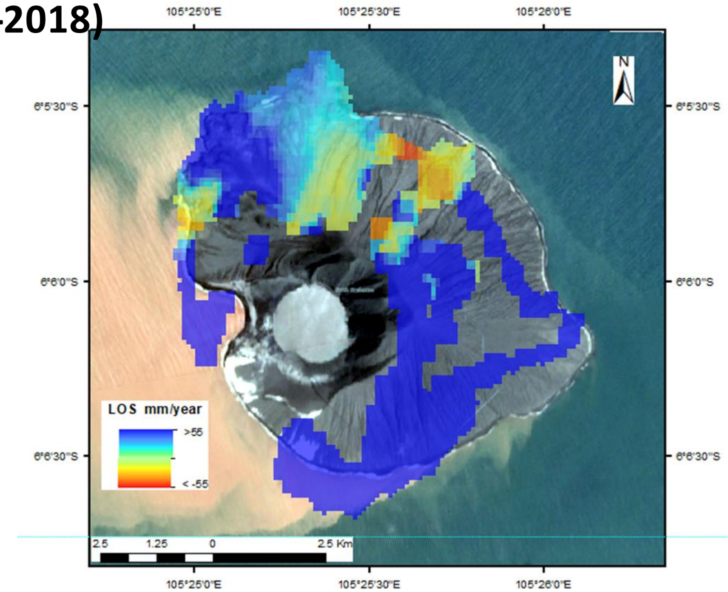


Giachetti et al, 2012

Taal Volcano (Filipinas)

Multitemporal analysis June-December
Descending orbit (25-06-2018 /28-11-2018)





Estimated Fault Location of Anak Krakatau Volcano

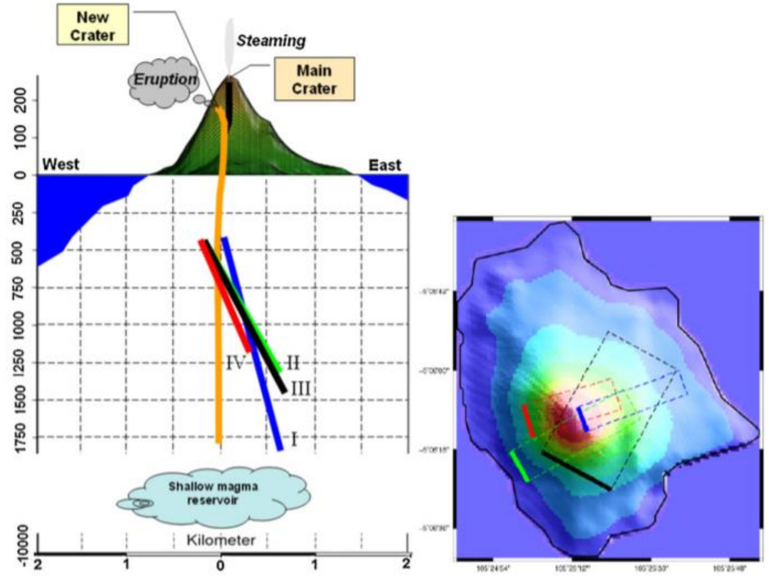
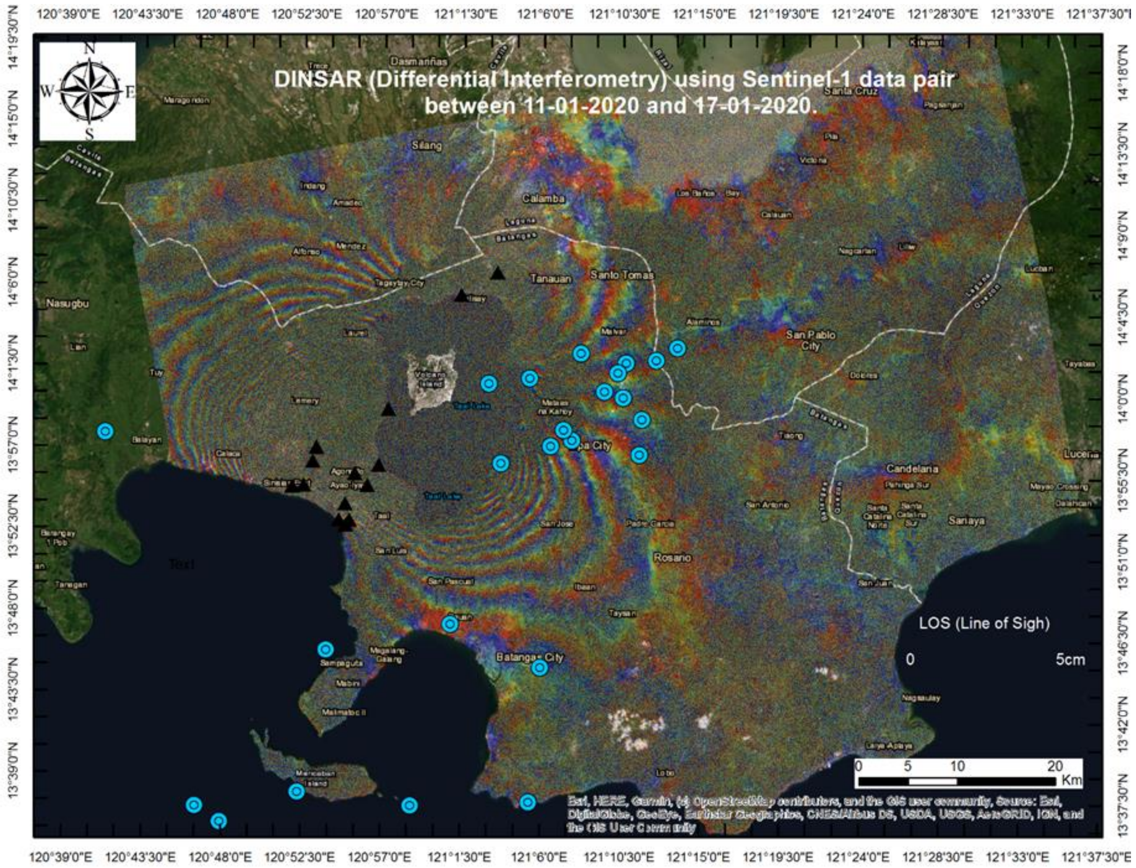


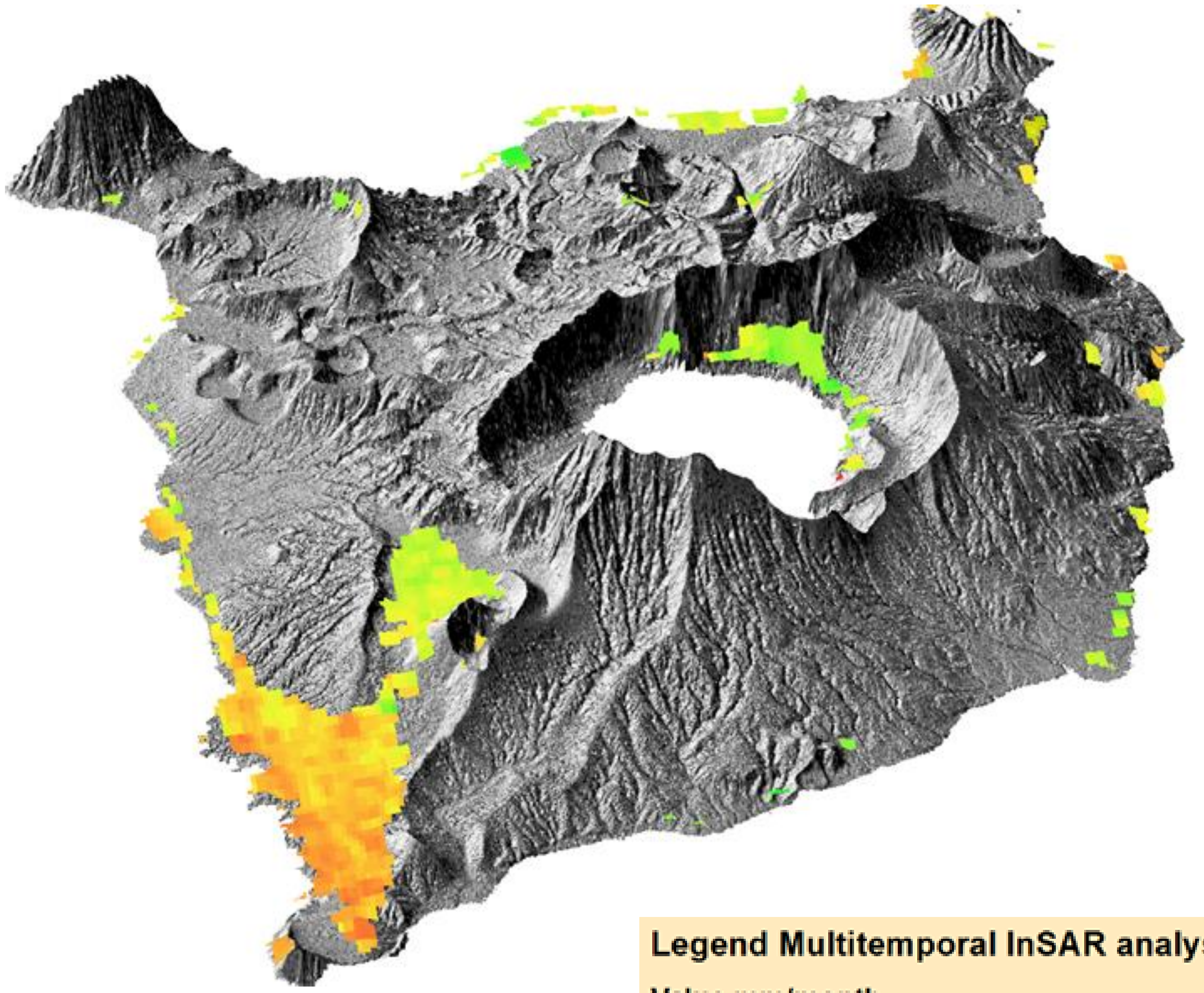
Fig. 6. The estimated location of rectangular fault for volcanic source model.

Agustan et al., 2012

Taal Volcano (Filipinas)

12January, 2020 started an importantexplosive type eruptive phase (phreatomagmatic)





Multitemporal ascending analysis
Period: july 2019- January 2020

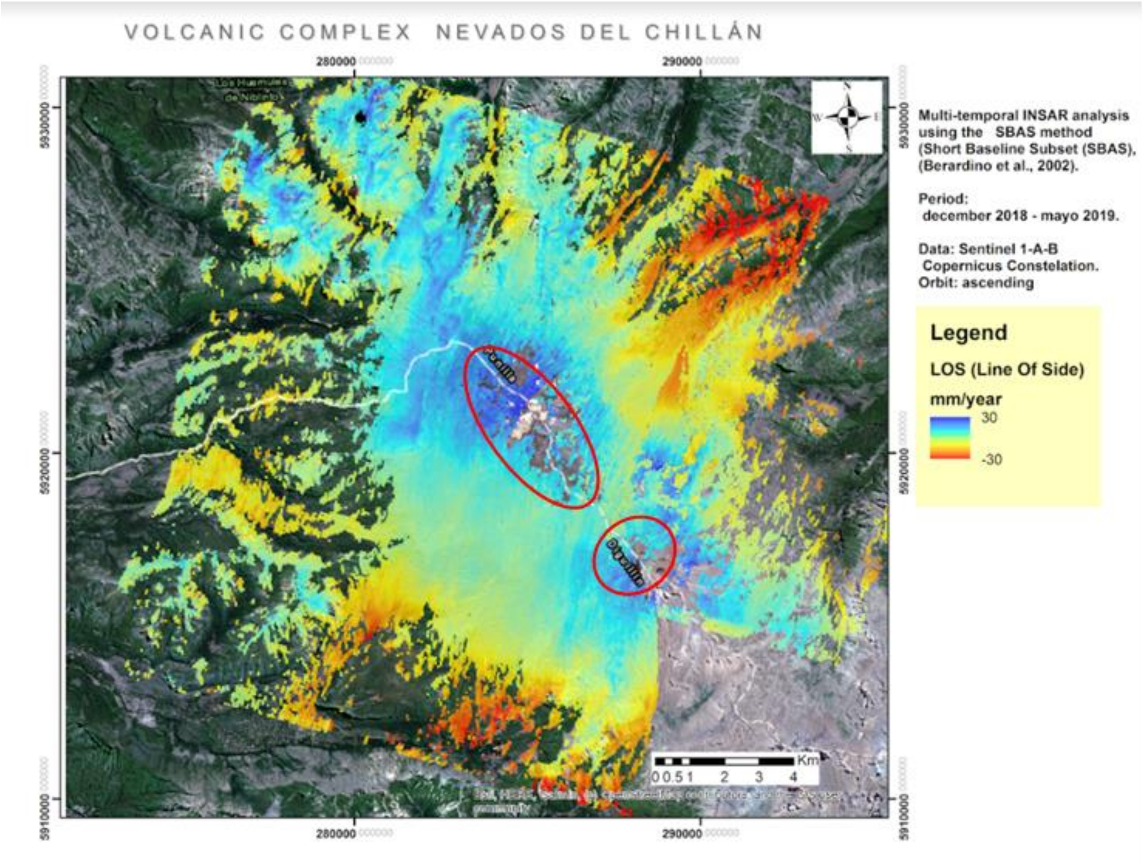
Legend Multitemporal InSAR analysis

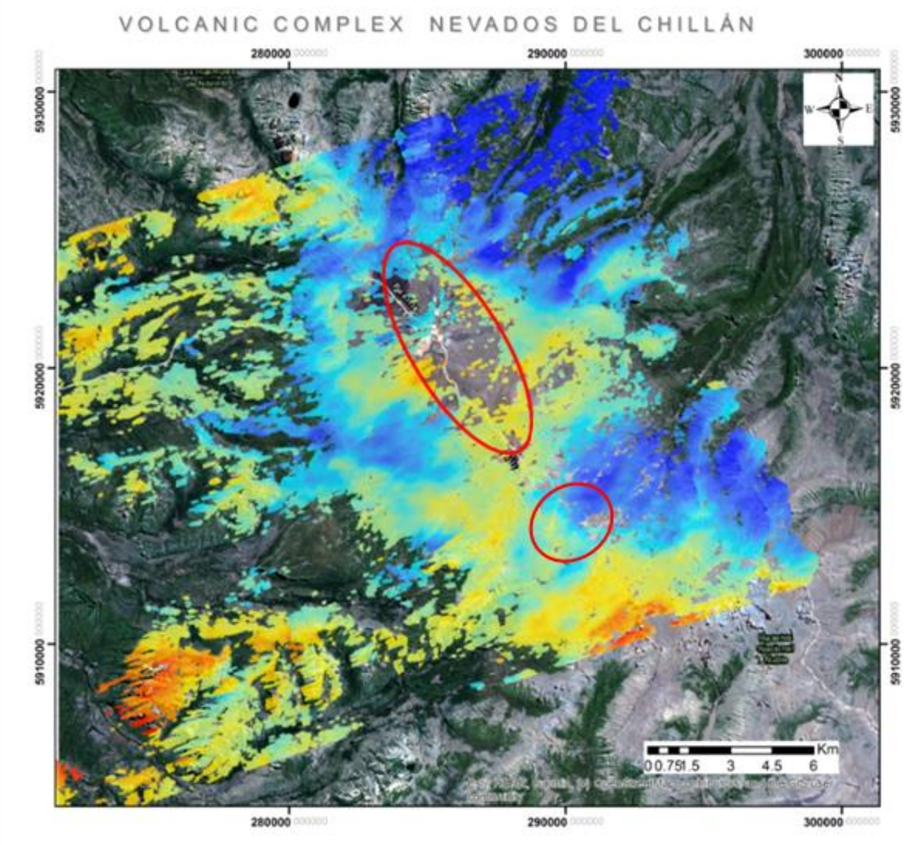
Value mm/month

High : 197.345

Low : -91.1964

Nevado del Chillan Volcanic Complex





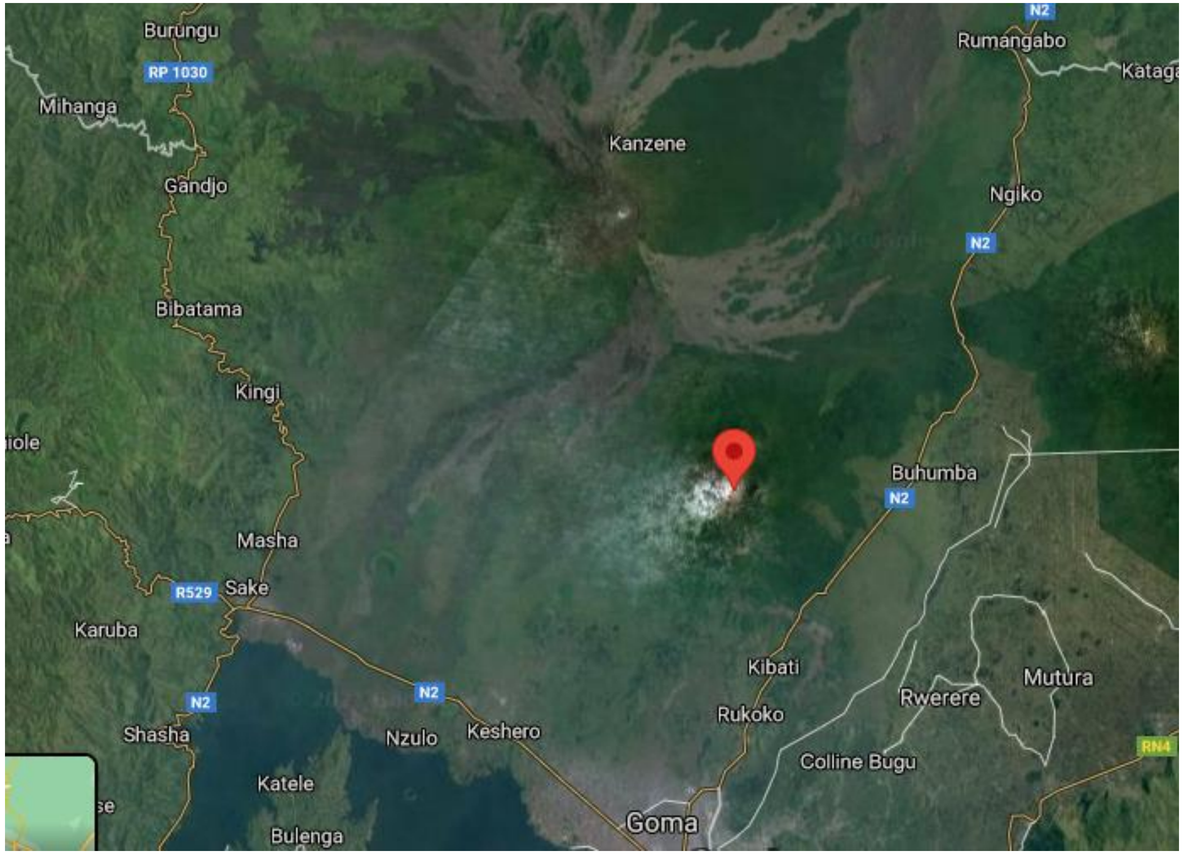
MULTITEMPORAL SBAS ANALYSIS IN NYIRAGONGO VOLCANO

Background

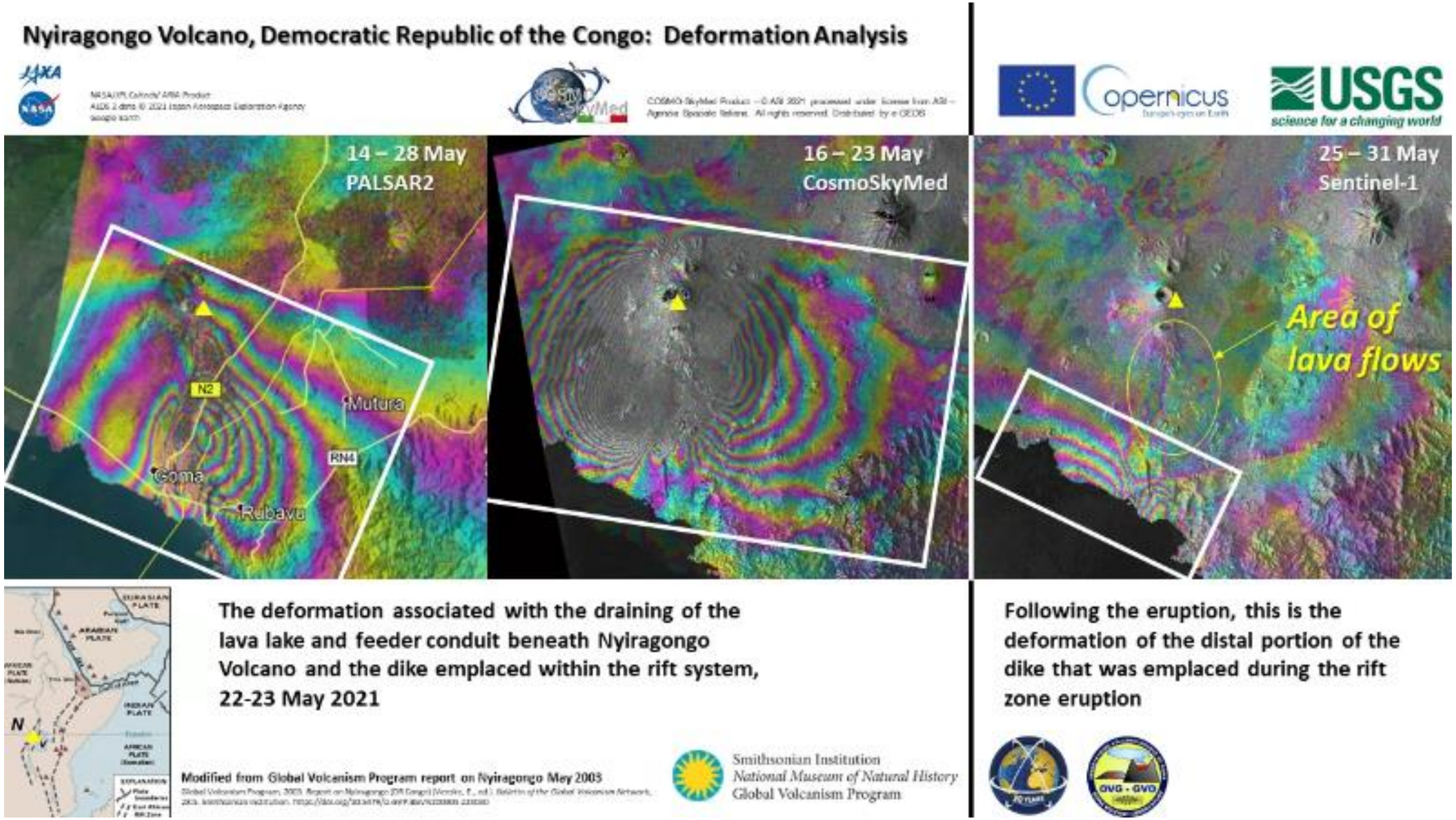
Nyiragongo volcano its located in the Democratic Republic of the Congo at 10km from Goma City.

-At least 15 deaths have been confirmed and at least 3000 were displaced or relocated.

-Last erupted in 2002, killing 250 people and making 120,000 homeless.



International Charter Space and Major Disasters



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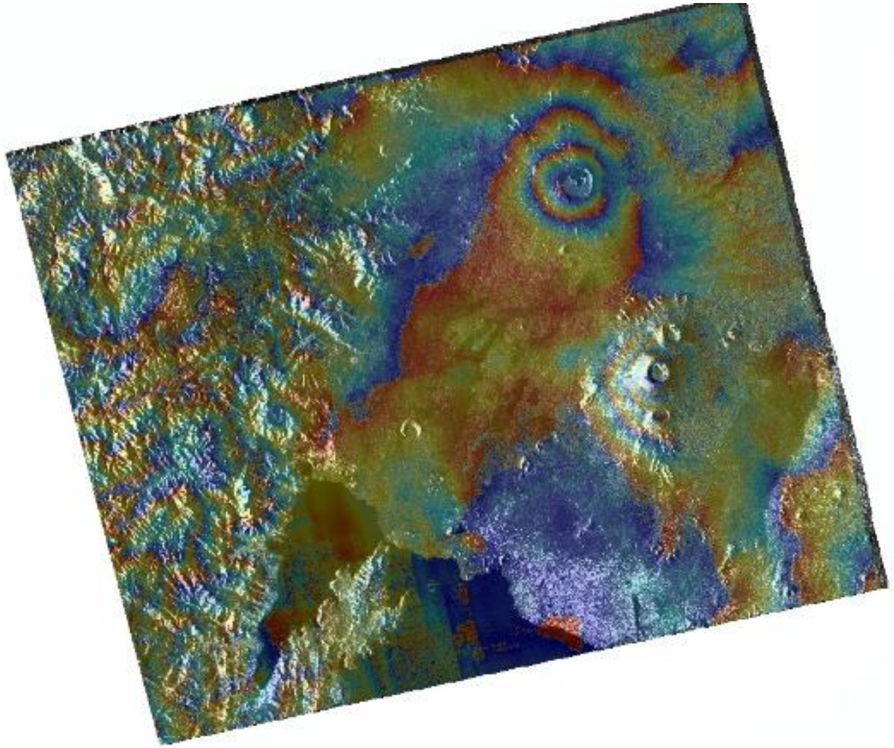
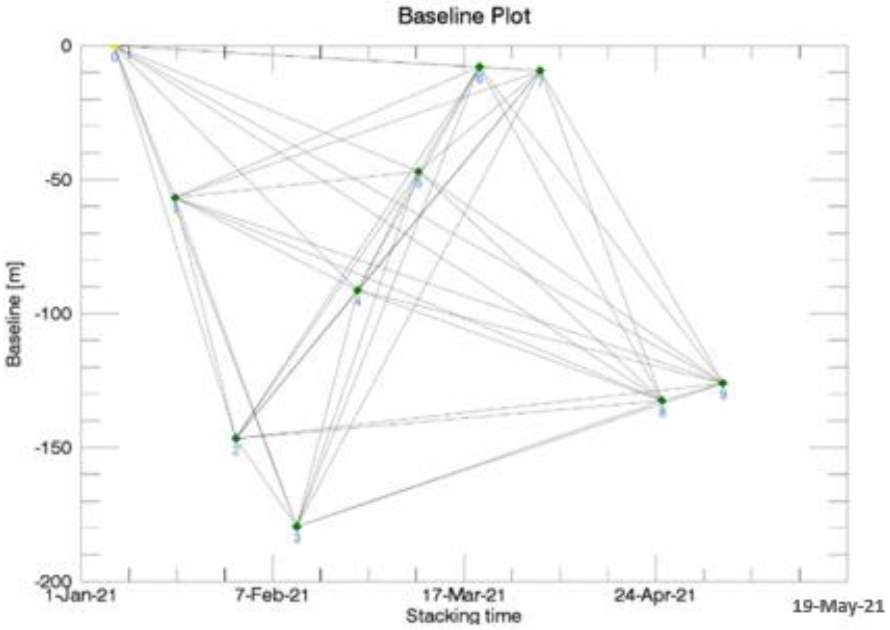
MULTITEMPORAL SBAS ANALYSIS IN NYIRAGONGO VOLCANO

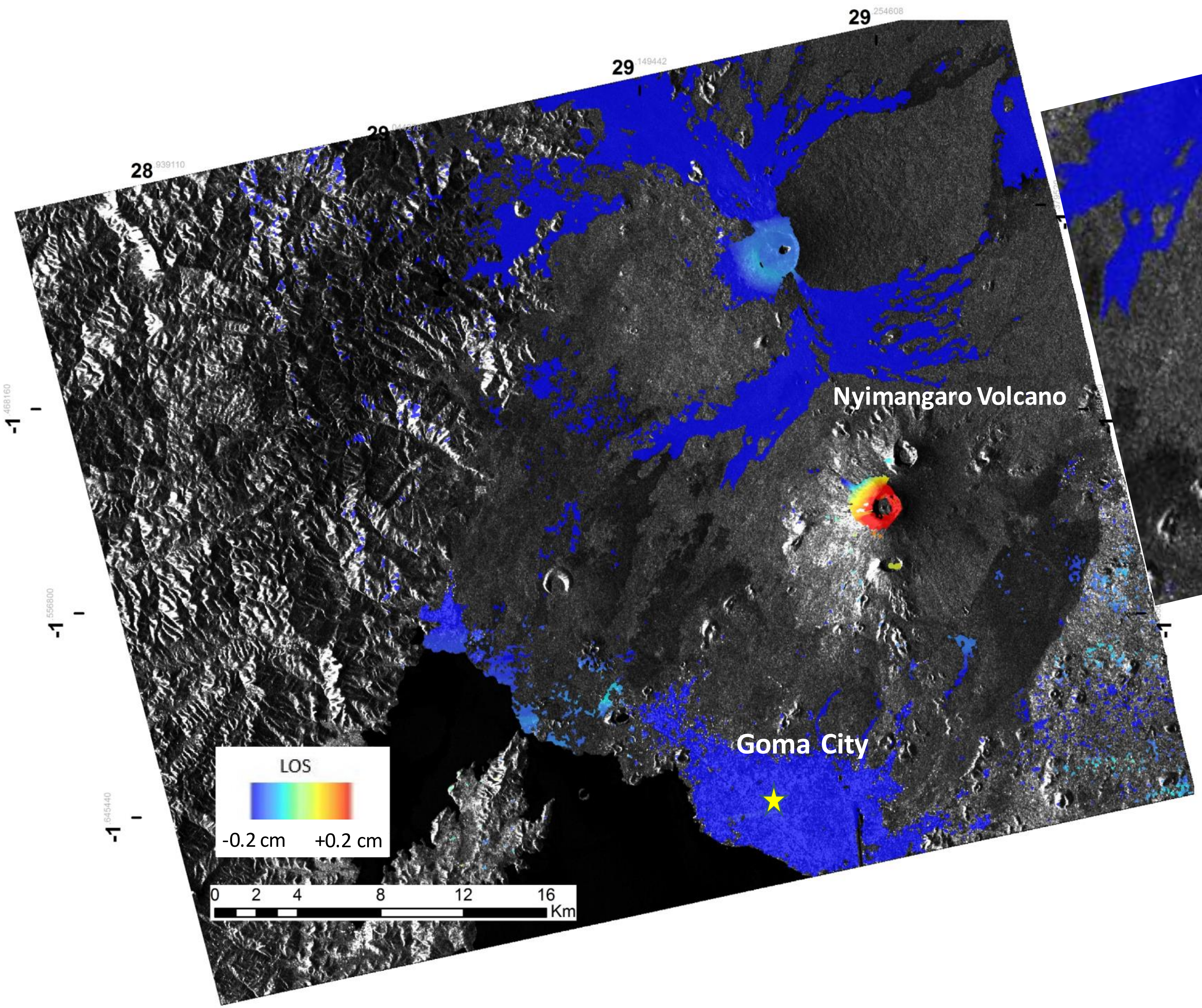
The SBAS analysis was carried out six moths earlier to last eruption in ascending orbit with a stacking of 15 images from Sentinel-1

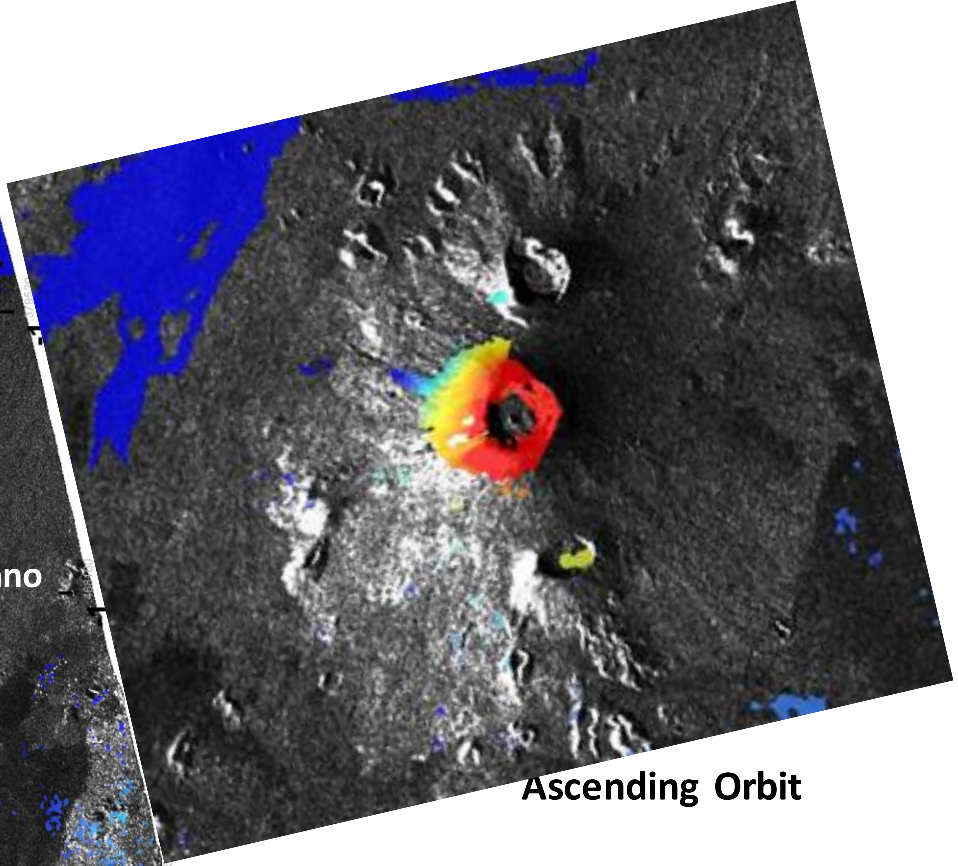
Method: SBAS (min baseline)
Software: GMTSAR
Baseline min/max : 15 / 182m



Example of Diferential Interferogram
Band C, period 7-May to 19-May 21







Ascending Orbit

Multitemporal Analysis:
01-Jan-21 to 19-May-21

The Nyimangaro Volcano shows a minimun deflation process (max 0.2 cm).

The complex phase was solved
In all those areas with a strong
backscattering response

Final Comments

- The preliminary results have shown a complex pattern of ground deformation in different active volcanoes.
- We presented InSAR evidence of inflation over east side of volcano (> 55mm) and deflation in the west side of volcanic cone (-24mm- 63mm) six months before the eruption.

- Sentinel allows to collect more data than any Earth observation program before, allowing the monitoring of volcanic activity even in small active volcanoes.

- The last eruptions in active volcanoes around the world allowing an opportunity to improve the early warning systems based on Big SAR Data