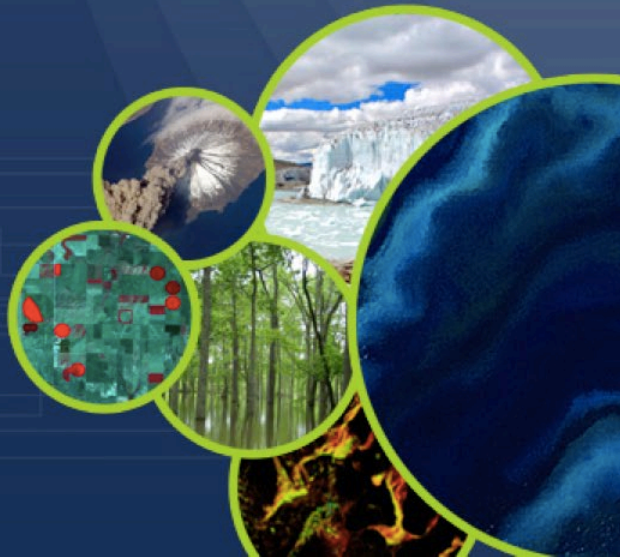
Committee on Earth Observation Satellites

Geohazard Supersites and Natural Laboratories (GEO-GSNL)



Stefano Salvi (Chair of the GEO-GSNL initiative)

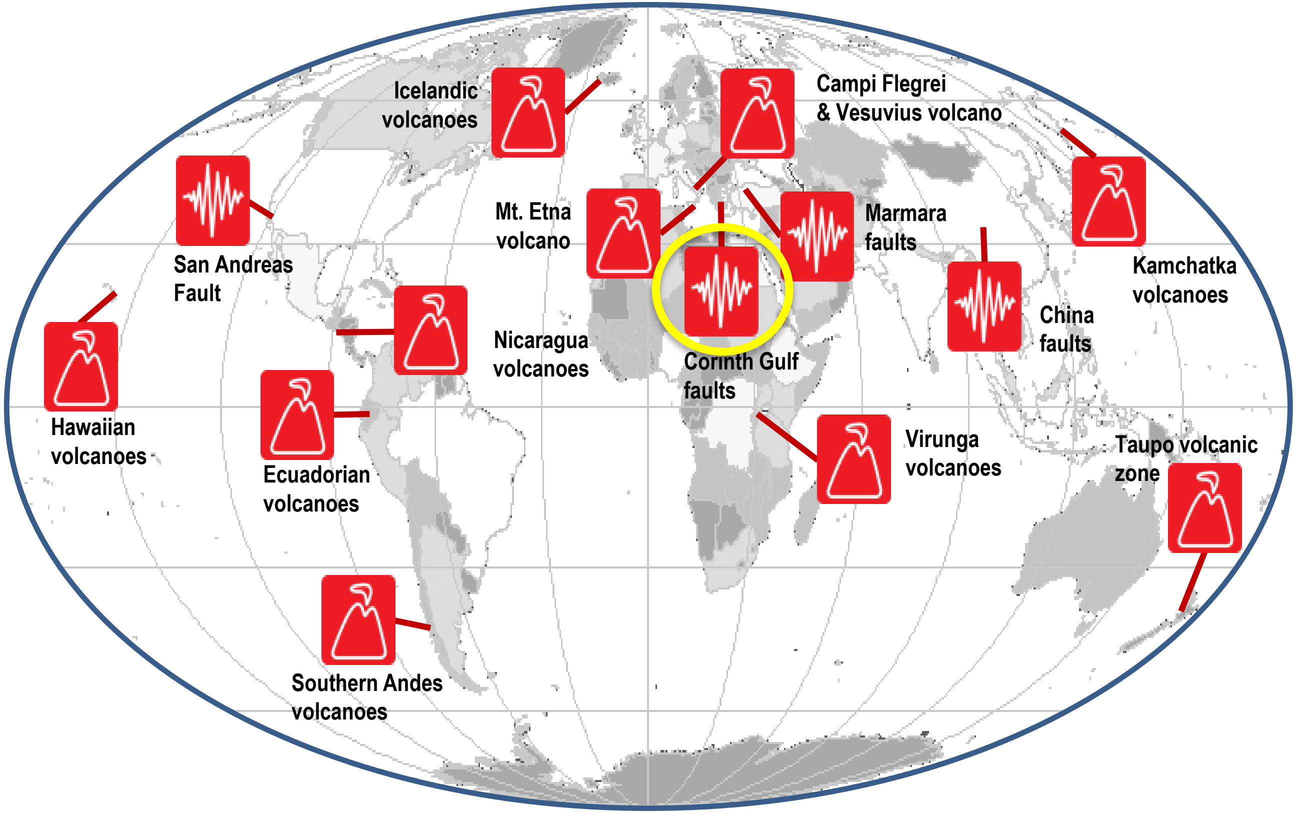
WG Disasters 19, Cordoba
18-20 April, 2023

Status of Supersites

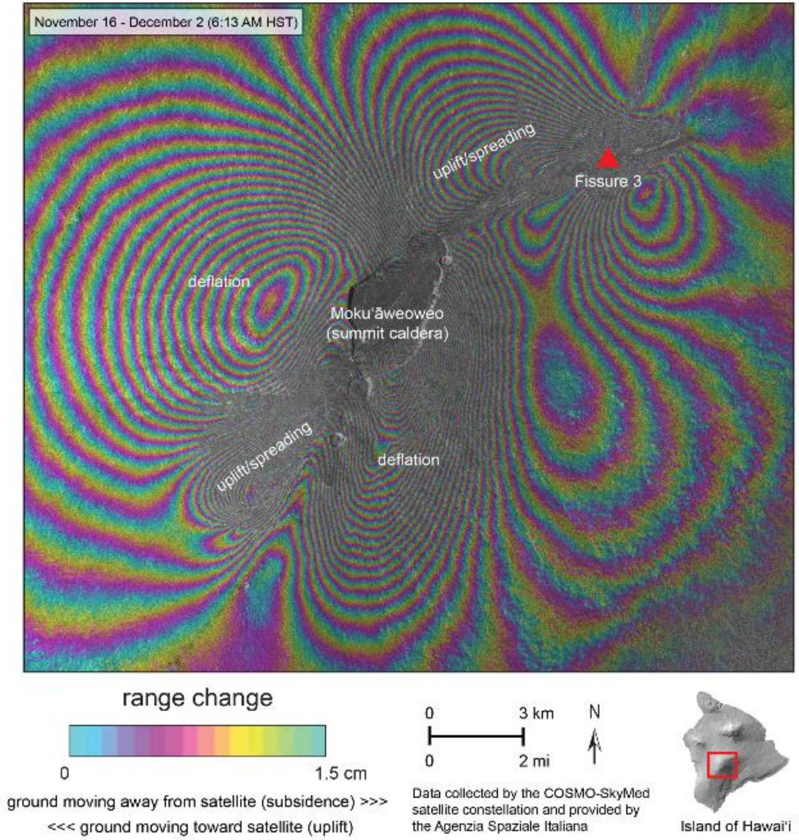
GSNL is presently a network of 14 Supersites/NL

13 are presently supported by CEOS

Renewal of support to the Enceladus Supersite to be discussed today.



Hawaii volcano Supersite

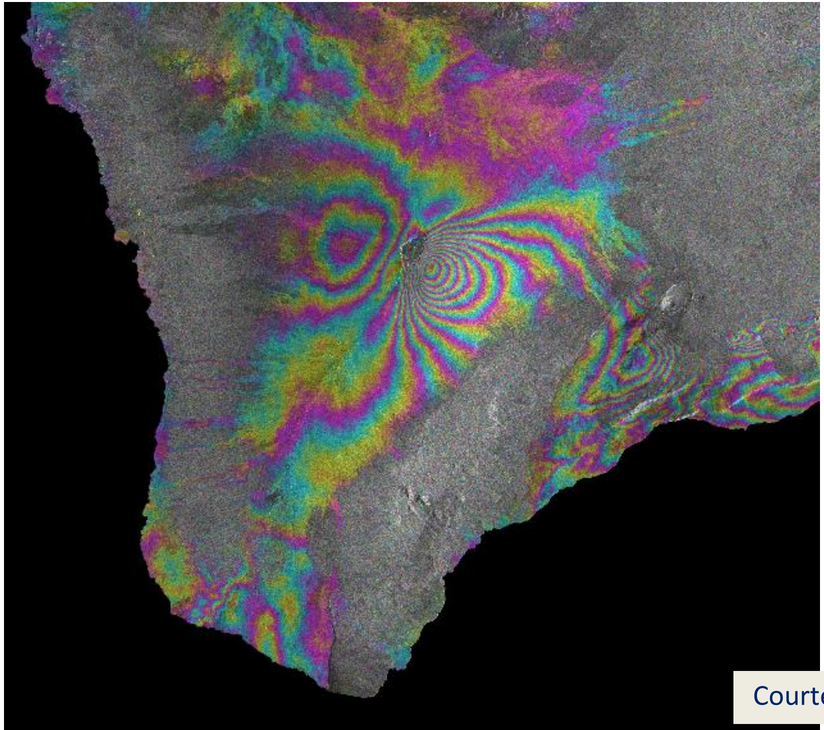


CSK interferogram used to monitor volcano edifice deflation and fracture opening (lateral spreading) during the last Mauna Loa eruption, in late 2022

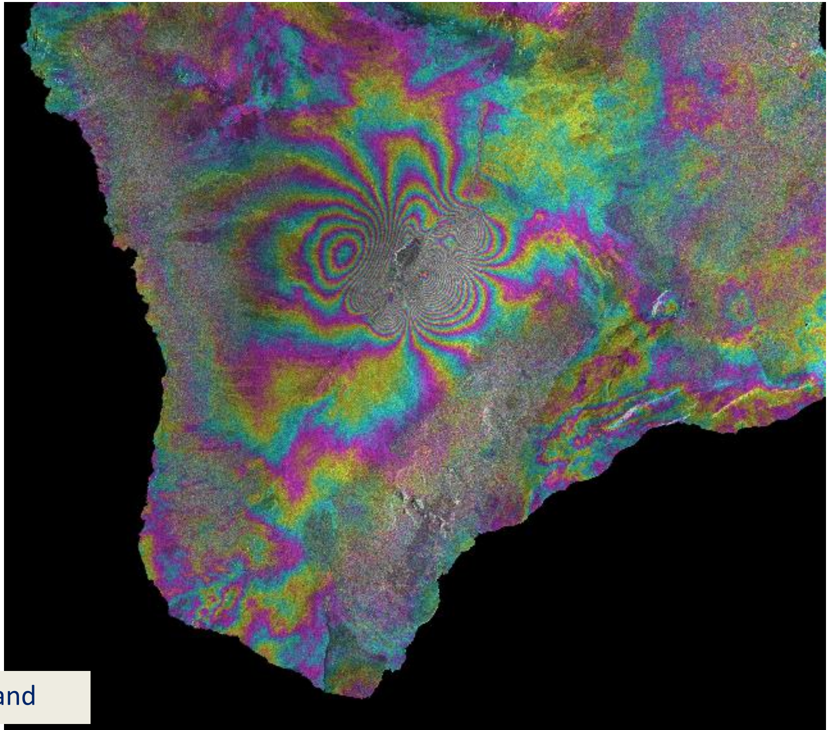
Courtesy of M. Poland

Hawaii volcano Supersite

Long term, pre-eruptive inflation at Mauna Loa from a 4-year Sentinel 1 interferogram

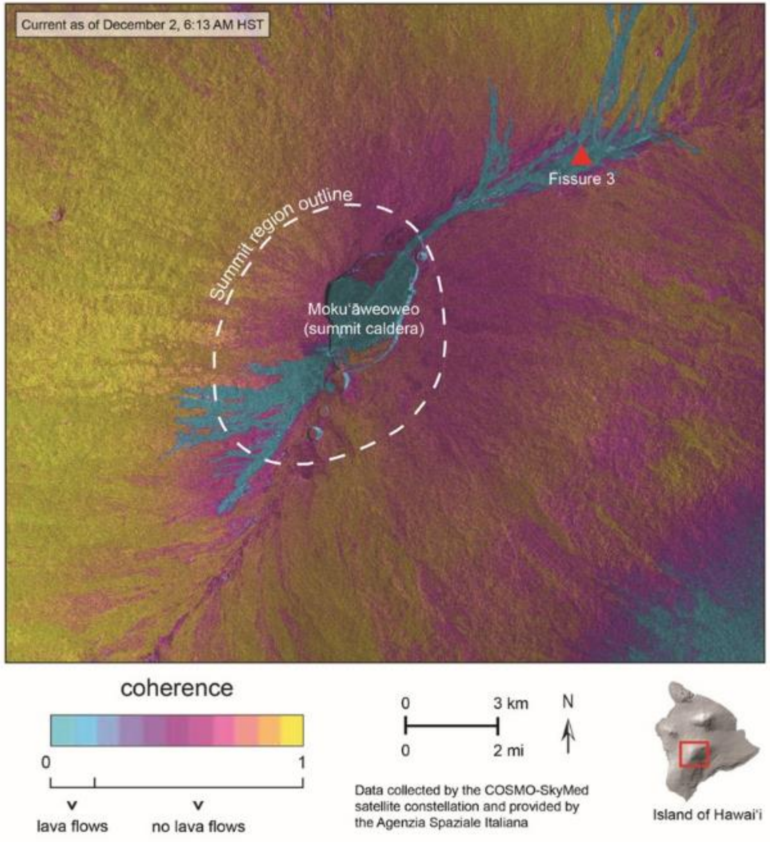


S1 deformation pattern (mainly deflation) during the late 2022 eruption



Courtesy of M. Poland

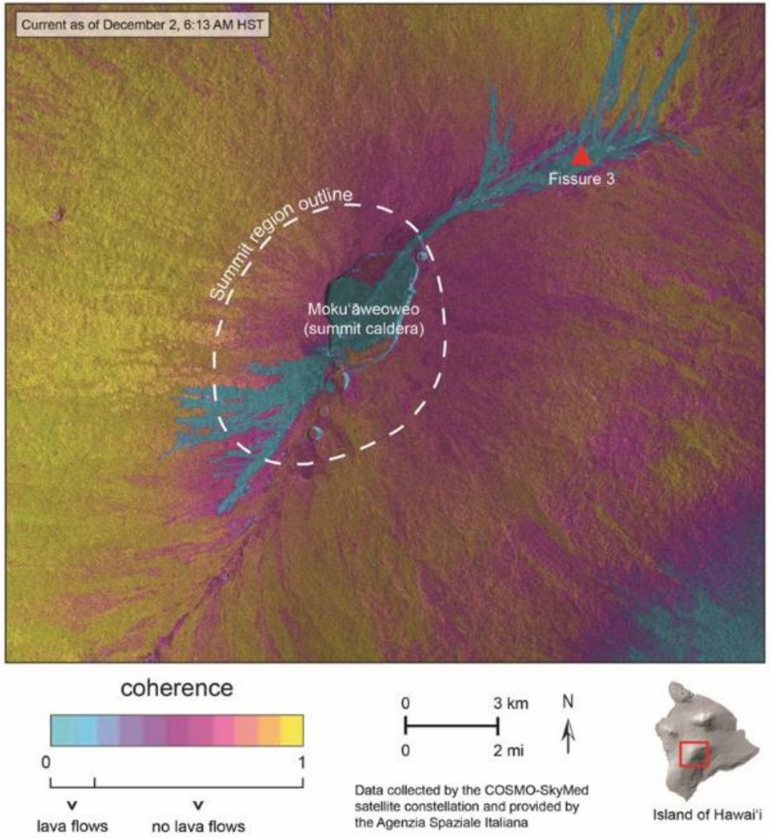
Hawaii volcano Supersite



CSK coherence used to map lava flows during the last Mauna Loa eruption, in late 2022

Courtesy of M. Poland

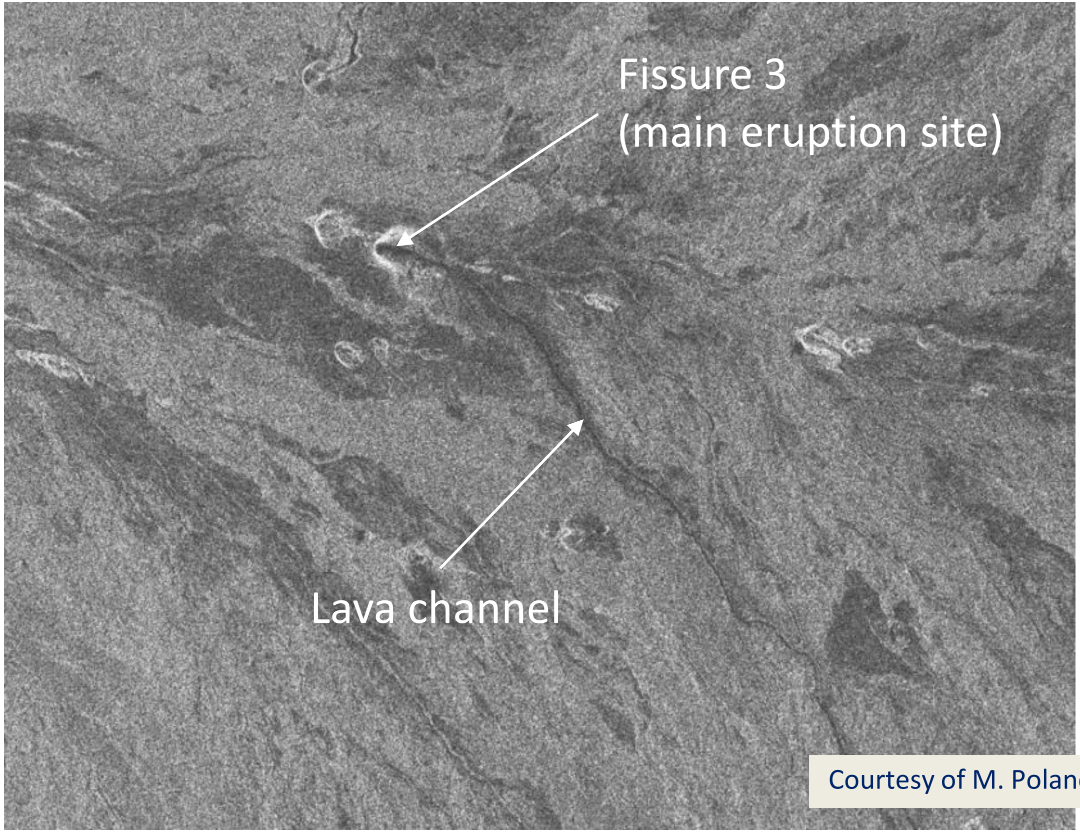
Hawaii volcano Supersite



CSK coherence used to map lava flows during the last Mauna Loa eruption, in late 2022

Courtesy of M. Poland

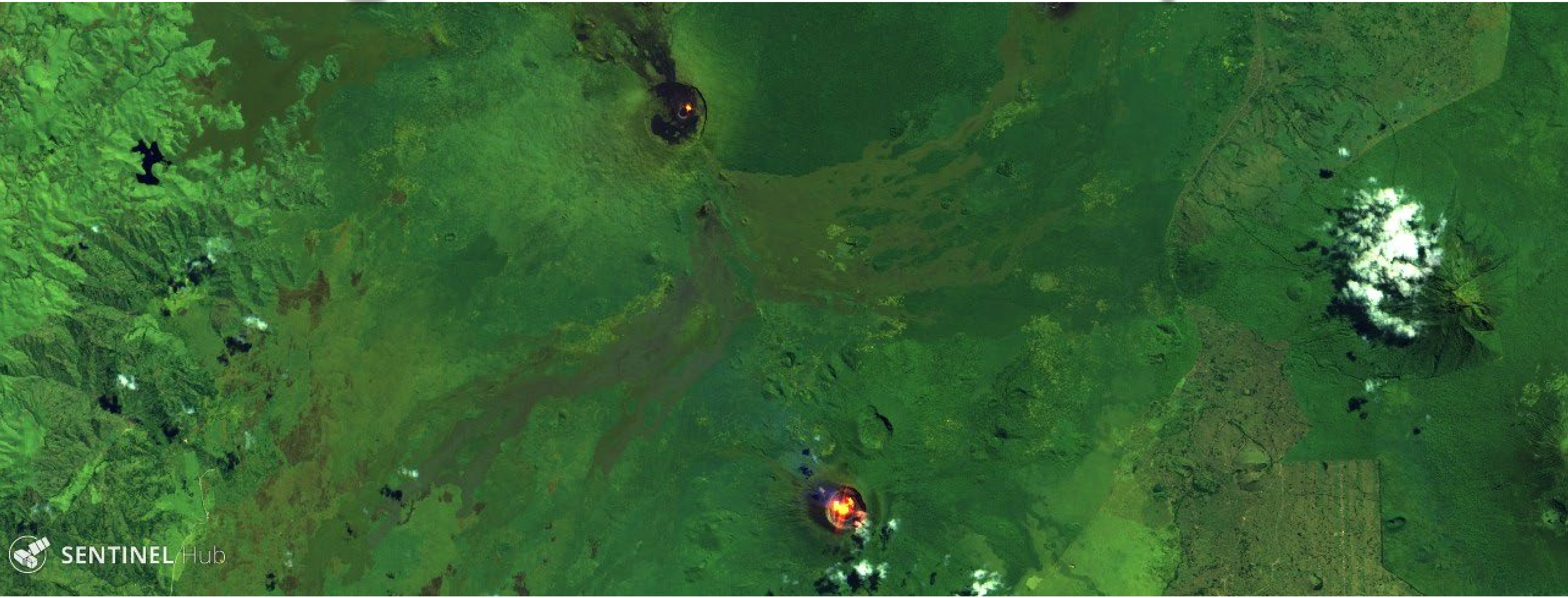
Hawaii volcano Supersite



Courtesy of M. Poland

Radar amplitude of a C-band Radarsat-2 image of Mauna Loa, used to monitor the fractures and lava flows at high resolution during the late 2022 eruption.

Virunga Geohazards Supersite



Charles Balagizi
Virunga Supersite coordinator
Goma Volcano Observatory

GEO Geohazards Supersites and Natural Laboratories

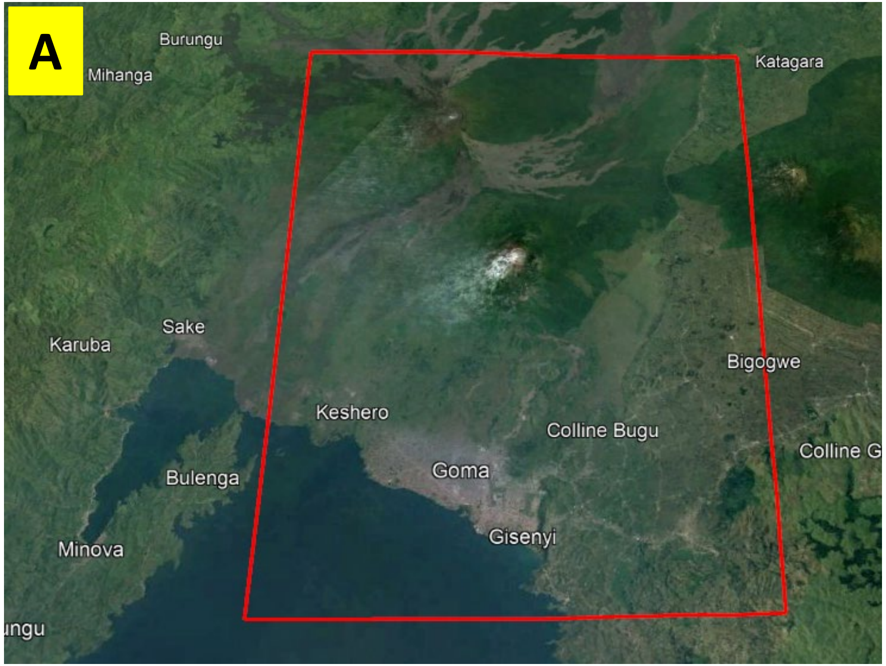
The Committee on Earth Observation Satellites

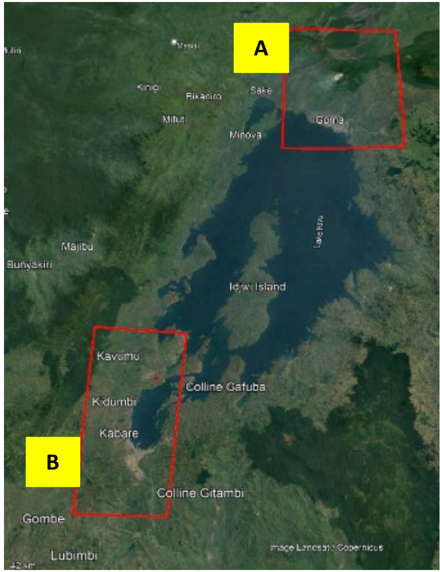
1. Access to Earth Observation imagery

1.1. We continue to access COSMO-Skymed, Pleiades images

1.2 Request has been made to access SAOCOM 1 images (produced by Comisión Nacional de Actividades Espaciales, Argentina)

1.3. New programming has been made to collect Pleiades images in the Nyiragongo and Nyamulagira field (A), this will be the second coverage after the May 2021 Nyiragongo eruption. Another collection has been requested for Bukavu (B) as there



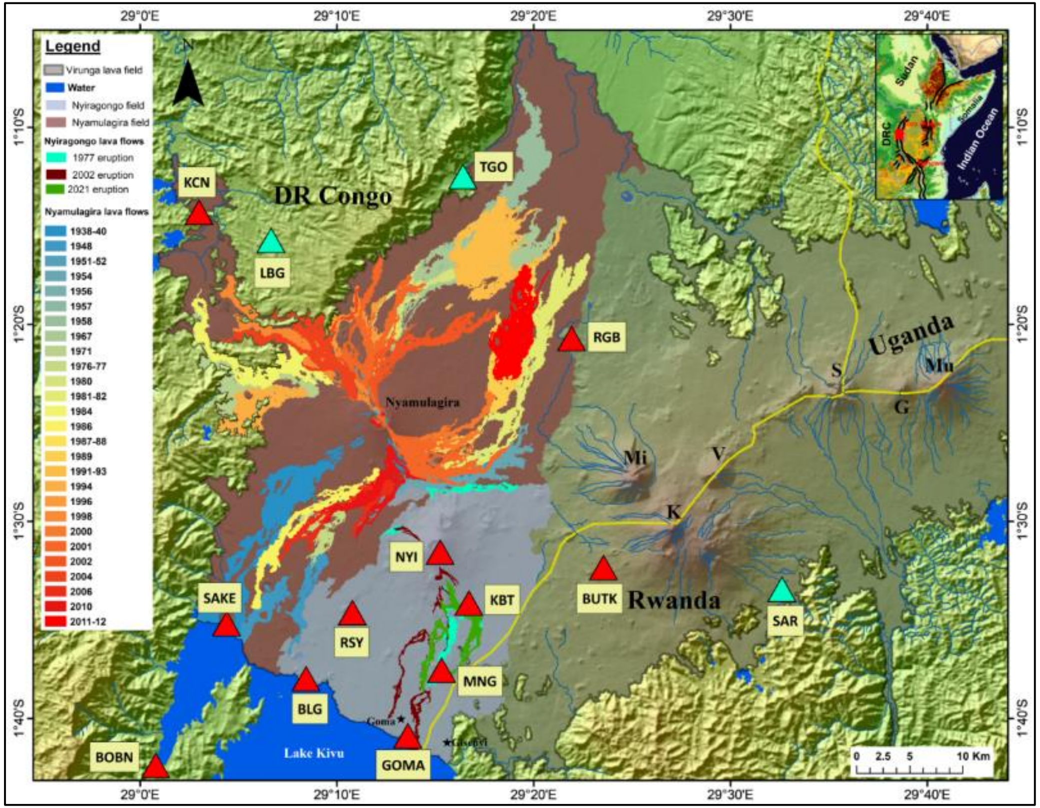


2. Supporting GVO for ground-based data collection

1. The Goma Volcano Observatory has almost finished to building up its own seismic network (12 stations), data is telemetered to the Observatory and processed there.

2. GEO-GSNL has donated 5 GNSS stations to GVO, which will be delivered to the GVO by end of April 2013. A local bank has also donated 5 other GNSS stations. These 10 stations will soon be installed in the field of Nyiragongo and Nyamulagira volcanoes.

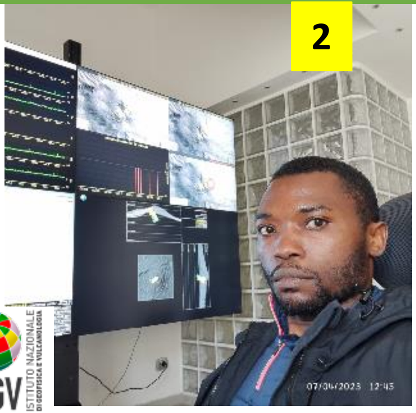
The GNSS network will then be operational, and will be the second network for ground based data collection.



3. VDAP has donated a West Systems Portable Fluxmeter. This equipment allows the measurement of CO_2 and H_2S fluxes from both the soil and Lake Kivu. It is used for the monitoring of Nyiragongo volcano, and the assessment of CO_2 and H_2S hazards in the mazukus (extremely dangerous gas vents)

2. Training of local scientists

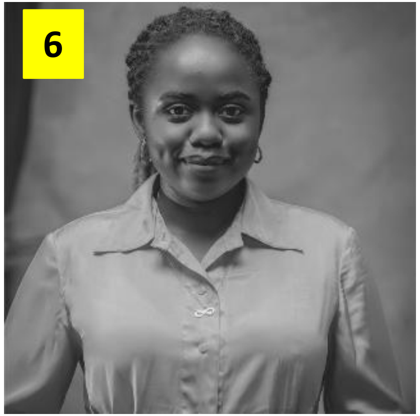
Albert Kyambikwa, a GVO junior researcher is attending the last year of a masters in volcanology at University at Buffalo Funded by University of Buffalo



Arsène Sadiki, a GVO junior researcher is having 1,5 years training in seismology at INVG Catania, Funded by ICTP

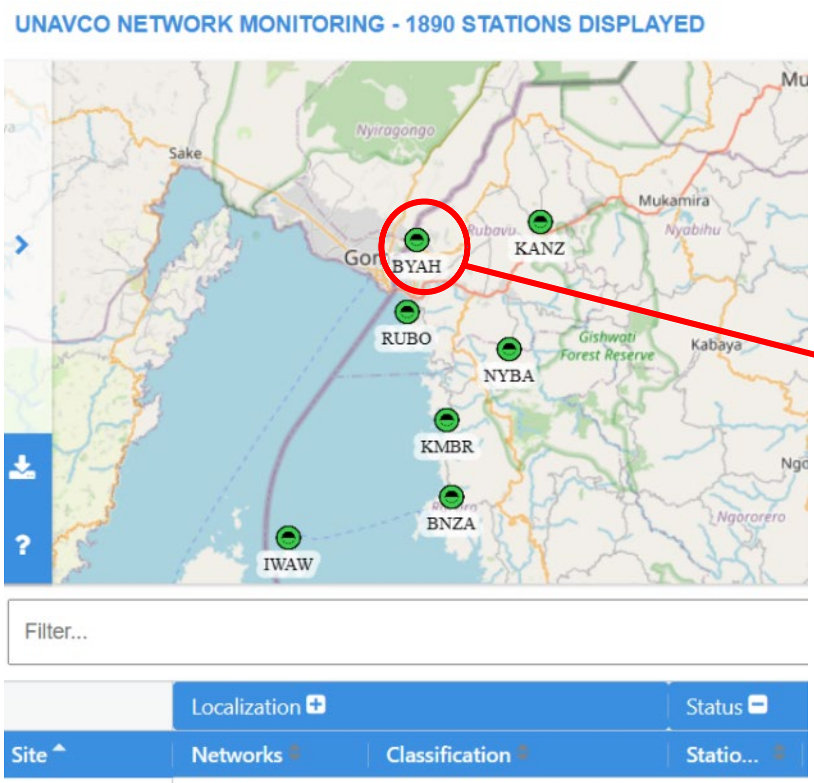
Marcellin Kasereka, a GVO junior researcher is having 2 years masters in analytical chemistry at University of Burundi

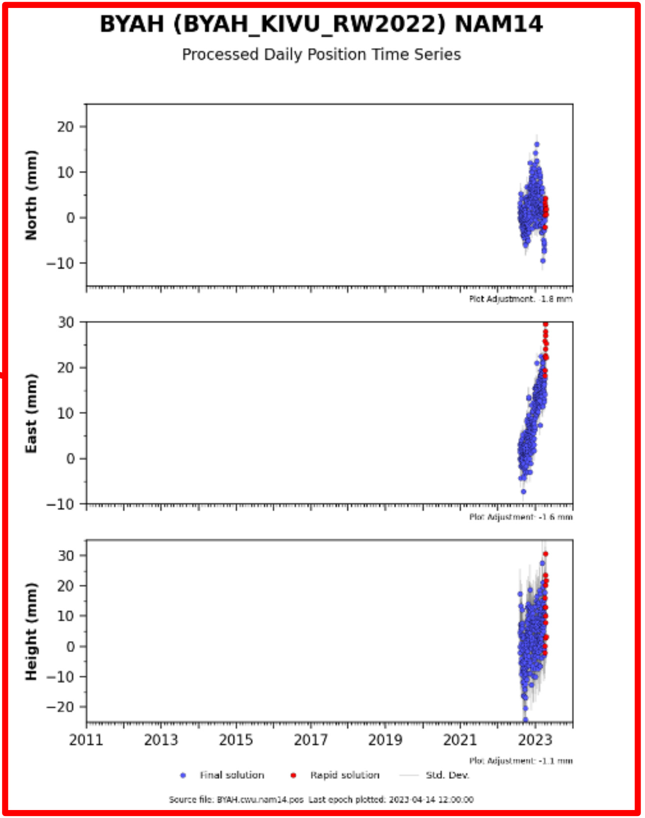
Olivier Munguiko (4) a GVO junior researcher and Titus Habiyakare (5) a seismologist from Rwanda, will attend the CSAV courses in Hawaii from June to August. Funded by USGS-VDAP



MOSANGE Thérèse from University of Goma is having a 2 years masters in Environmental Sciences at Abomey Calavi University (Benin), with a scholarship from Abomey Calavi

3. DATA OPEN ACCESS: 7 GNSS stations in Rwanda are open, part of the UNAVCO network



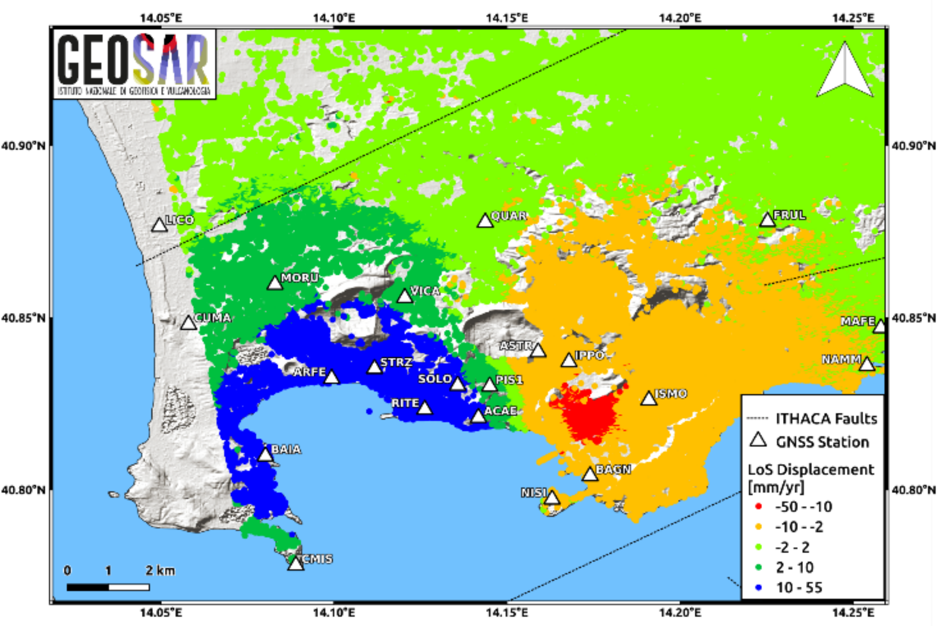


[UNAVCO Network Monitoring Map]

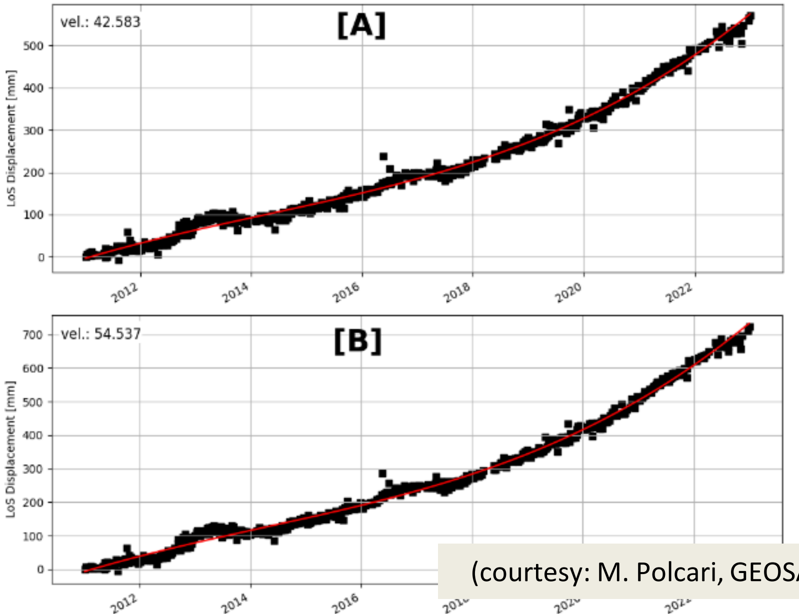
Campi Flegrei – Vesuvius Supersite

COSMO-SkyMed multi-temporal analysis

Mean LoS velocity map (CSK ascending, 2011-2022)



InSAR time series for two PSs close to the cGNSS RITE [A] and Pozzuoli Cathedral [B] stations

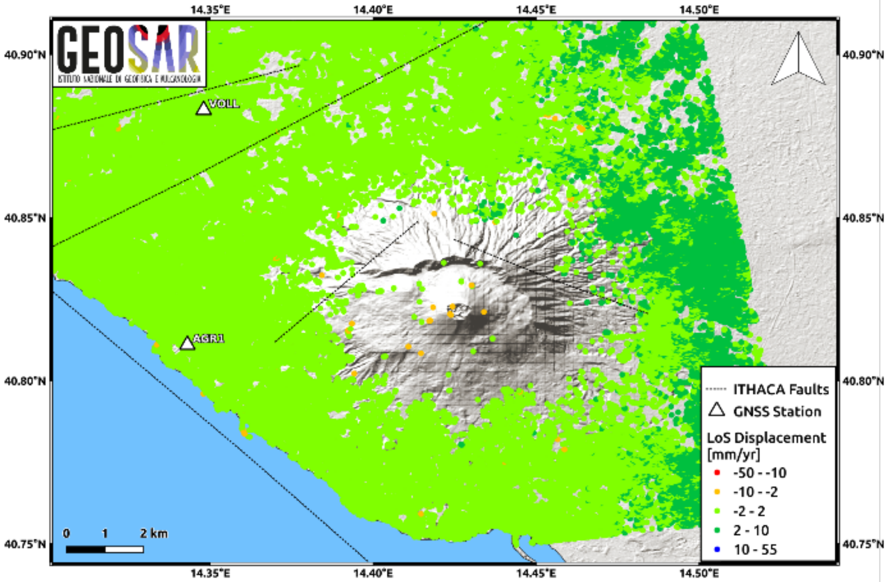


(courtesy: M. Polcari, GEOSAR Lab)

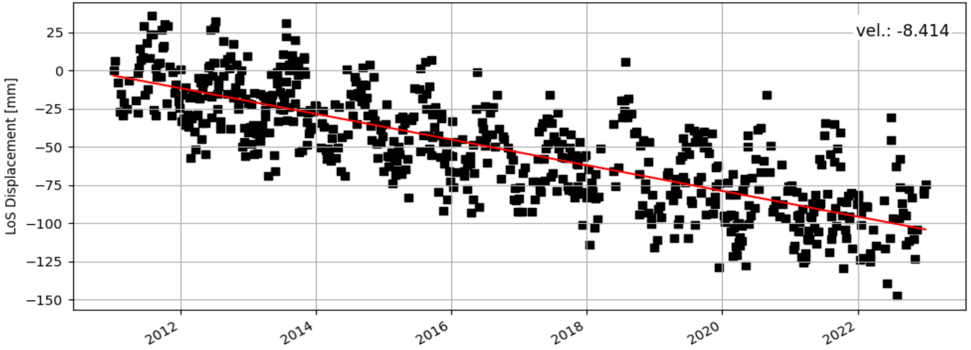
Campi Flegrei – Vesuvius Supersite

COSMO-SkyMed multi-temporal analysis - Mt. Vesuvius

Mean LoS velocity map (CSK ascending, 2011-2022)



InSAR time series (2011-2022) for a PS in the Great Cone area

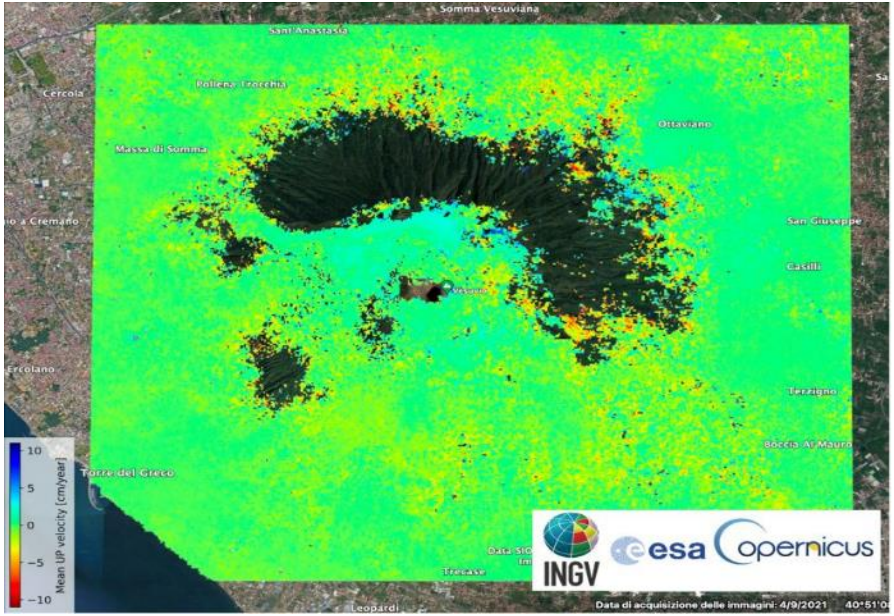


(courtesy: M. Polcari, GEOSAR Lab)

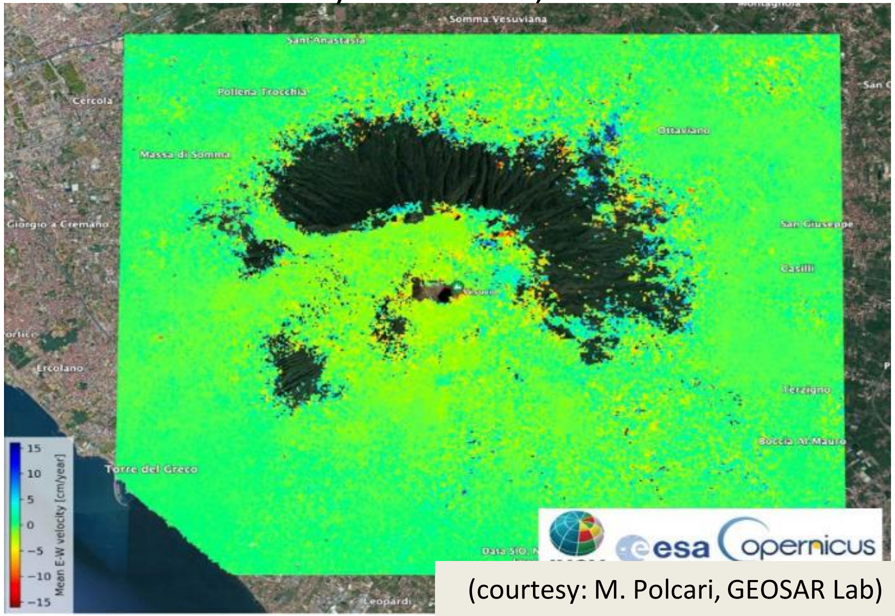
Campi Flegrei – Vesuvius Supersite

Sentinel 1A data processing/decomposition - Mt. Vesuvius

Mean UP velocity map (S1-A, 11.01.2022 - 24.12.2022) - IWS data, TOPS mode

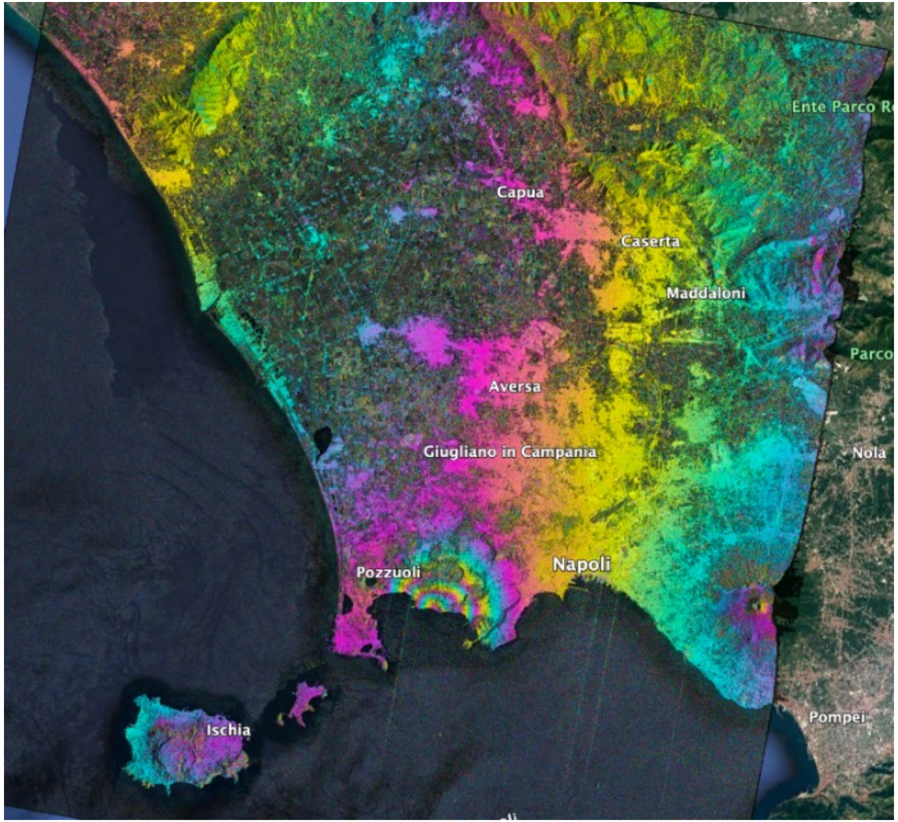


Mean E-W velocity map (S1-A, 11.01.2022 - 24.12.2022) - IWS data, TOPS mode



(courtesy: M. Polcari, GEOSAR Lab)

Campi Flegrei – Vesuvius Supersite



SAOCOM InSAR data processing and validation (first results)

SAOCOM stripmap interferogram
(2020.03.13 - 2023.02.02)

(courtesy: Sven Borgstrom – INGV-OV)

Taupo volcano Supersite

A main focus of the NZ volcano supersite continues to be around Whakarri/White Island.

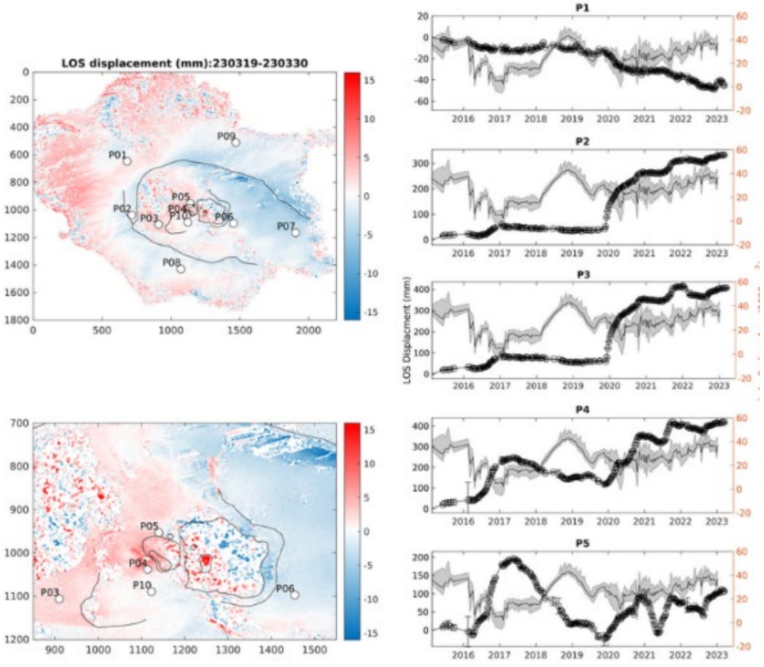
SAR/InSAR remains the main source of data coming from the island and continues to be vital for ongoing monitoring efforts.

C- and X-band SAR were instead unable to capture ground deformation during an unrest episode in Taupo caldera

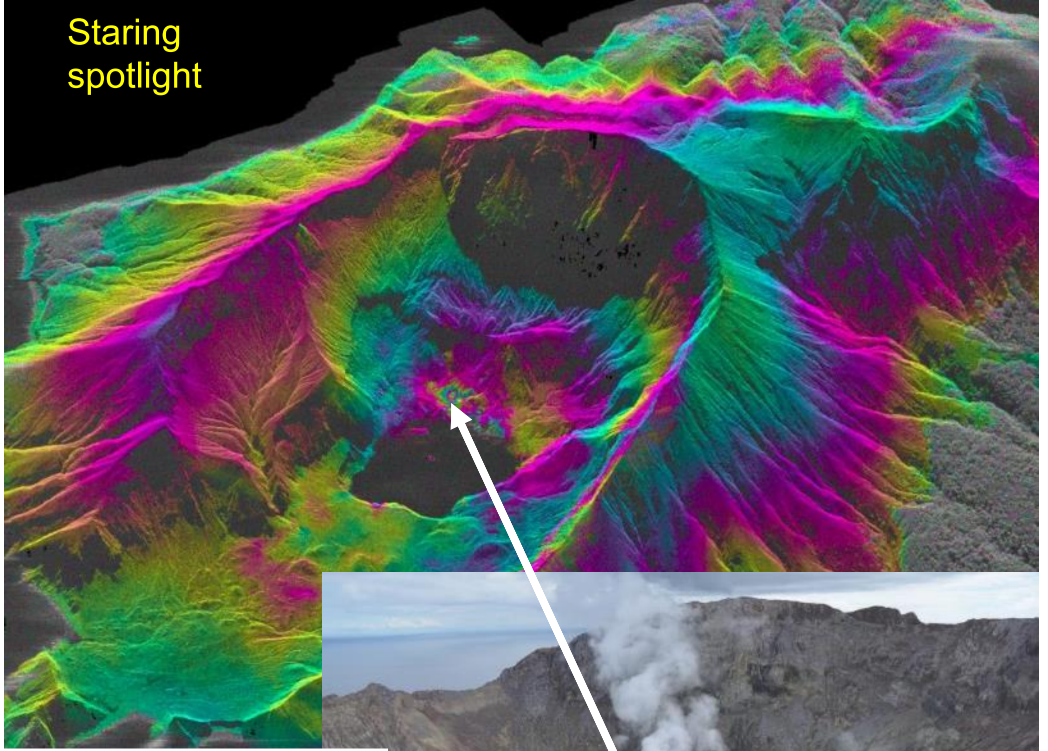
(courtesy: Sven Borgstrom – INGV-OV)

White Island

TSX staring spotlight data

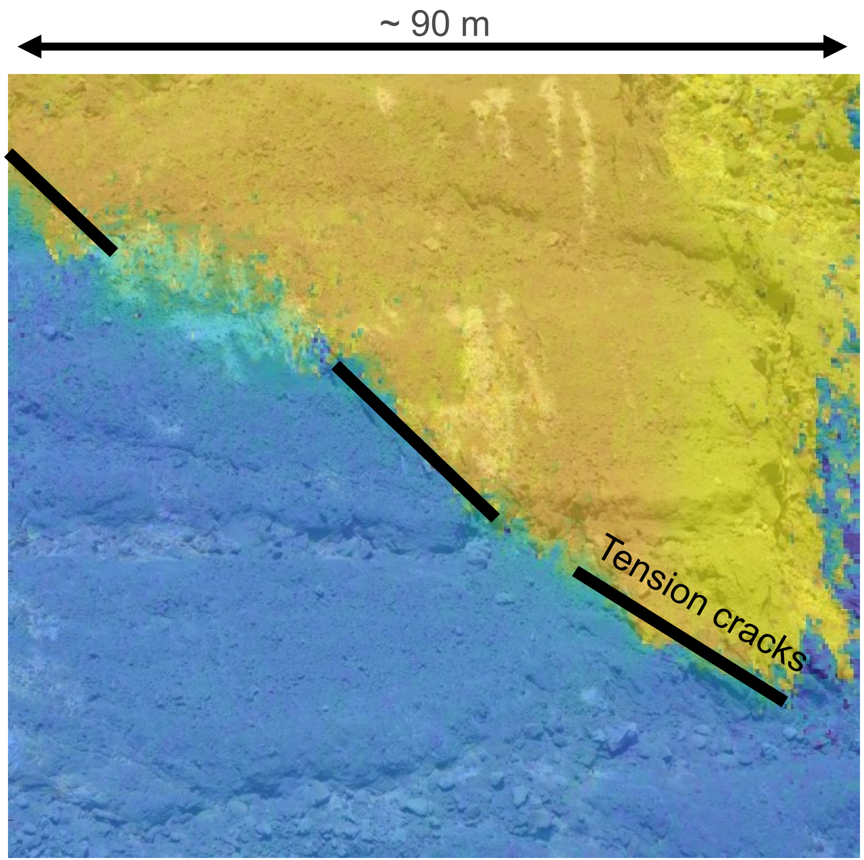


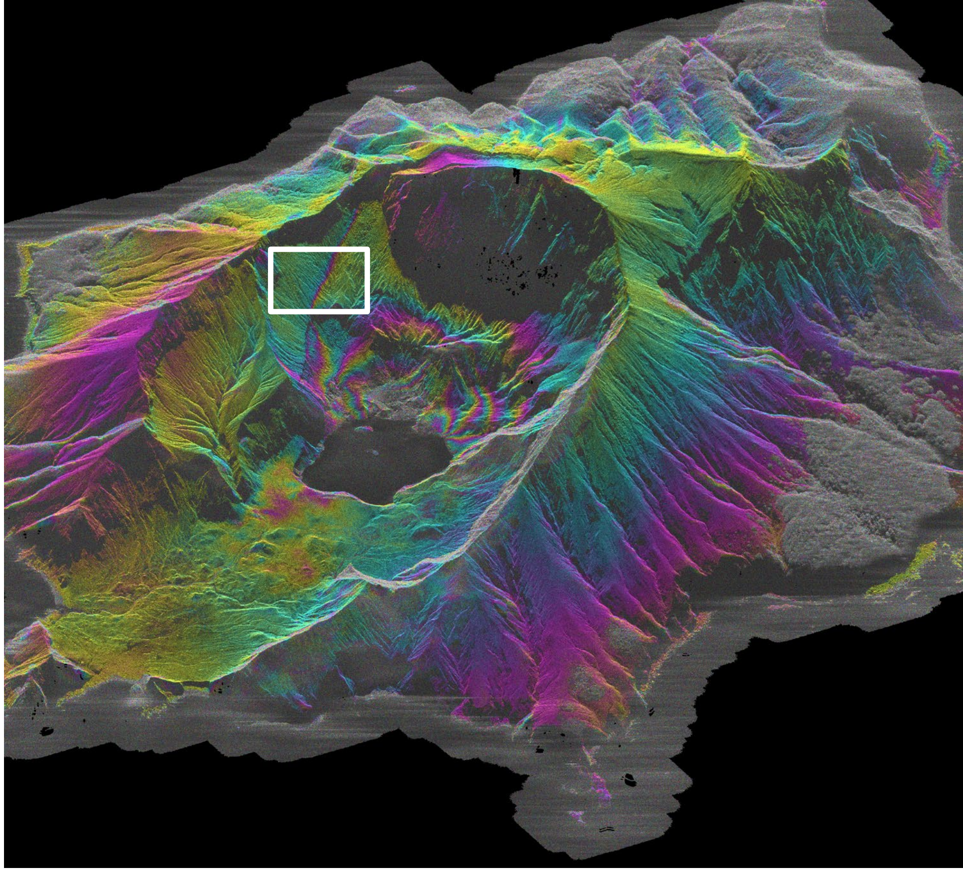
(courtesy: Ian Hamling, GNS Science)



Deformation at White Island is currently dominated by shallow hydrothermal activity within crater floor and creep of SW crater wall.

Along strike changes along slip boundary

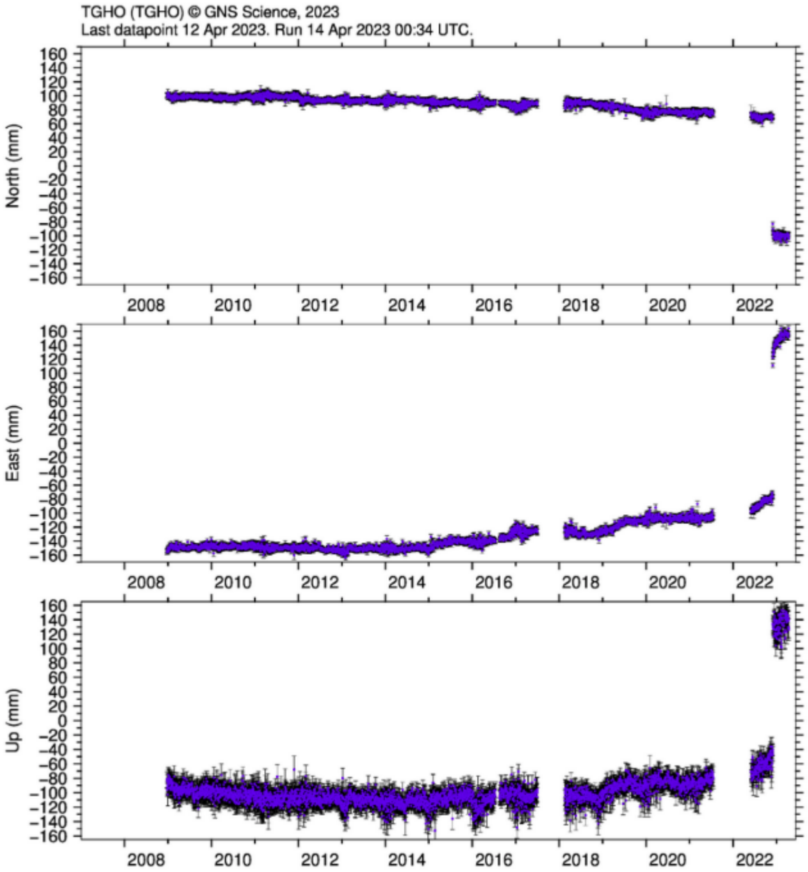


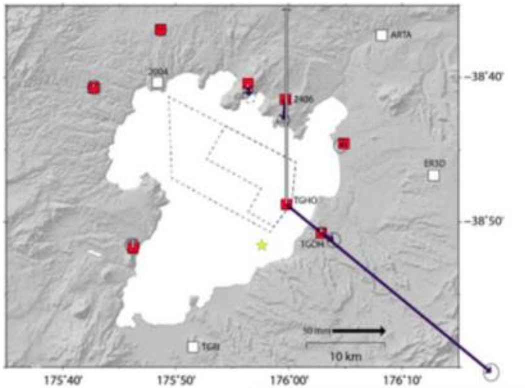


- Using the staring spotlight allows us to differentiate regions of elevated strain along the landslide failure boundary

(courtesy: Ian Hamling, GNS Science)

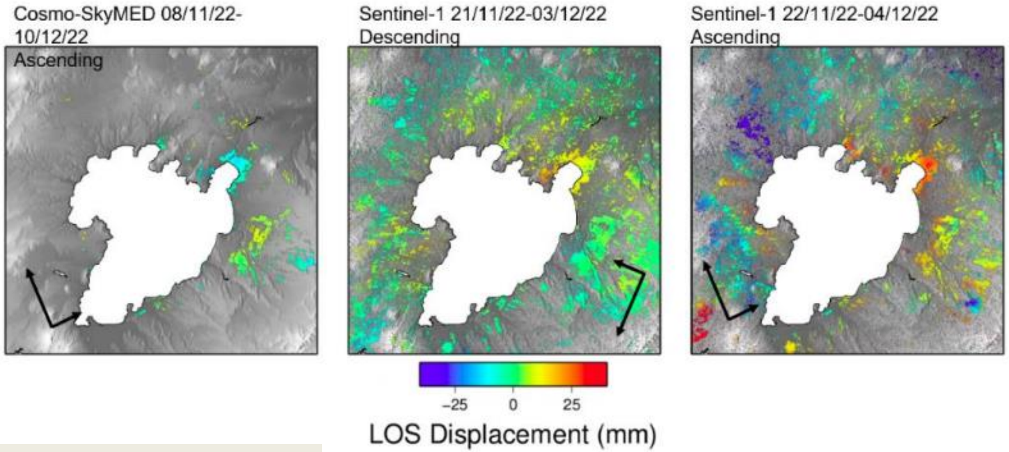
Taupo caldera unrest episode





More than 1000 earthquakes since start of 2022 including Mw 5.7 in December 2022 which generated a small tsunami and ~15 cm of uplift in the centre of the lake.

Unfortunately, poor coherence and rapid drop in displacement pattern meant it wasn't visible with InSAR



(courtesy: Ian Hamling, GNS Science)

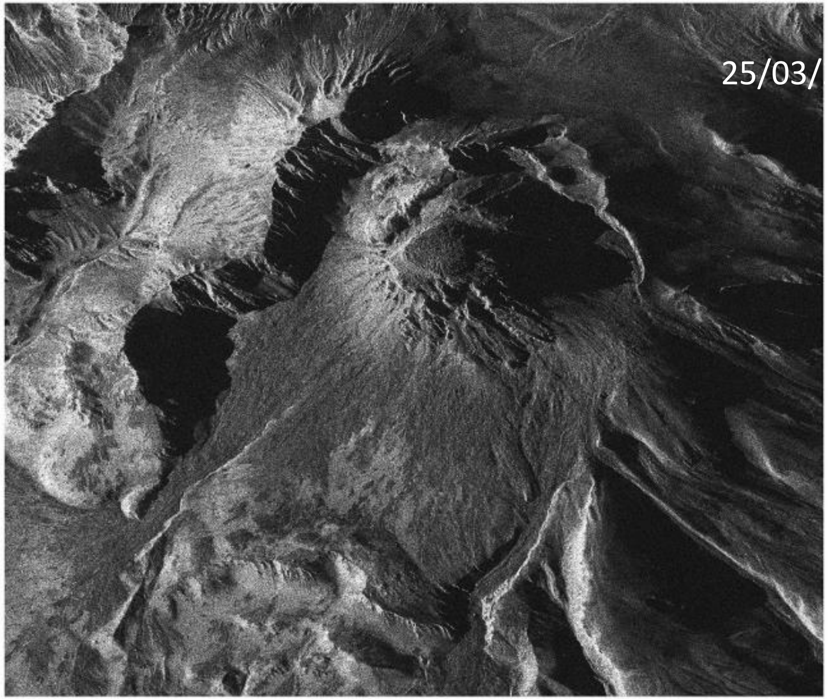
Kamchatka-Kuriles Supersite activity

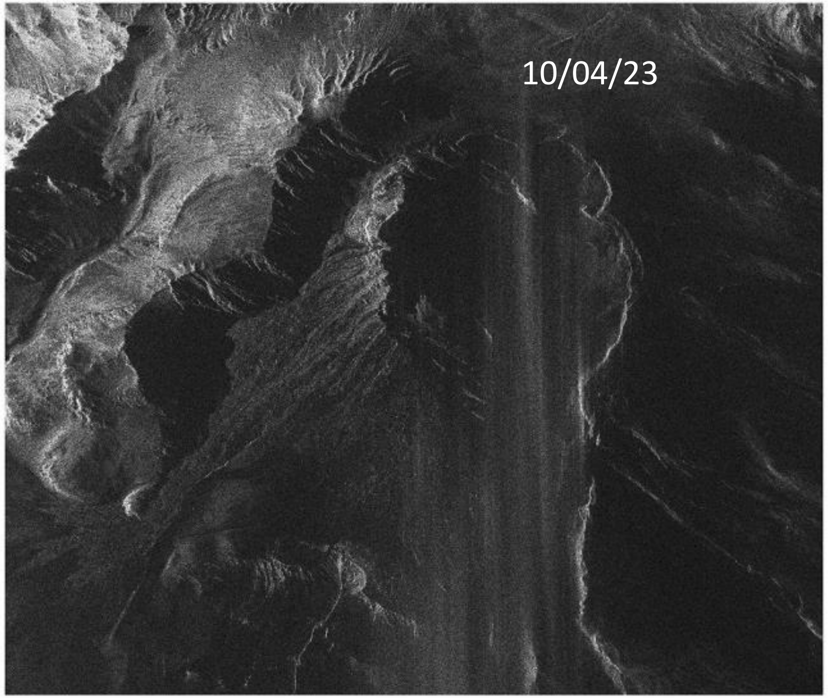
Supersite coordinator – Dr. Alina Shevchenko

German Research Center for Geosciences (GFZ)

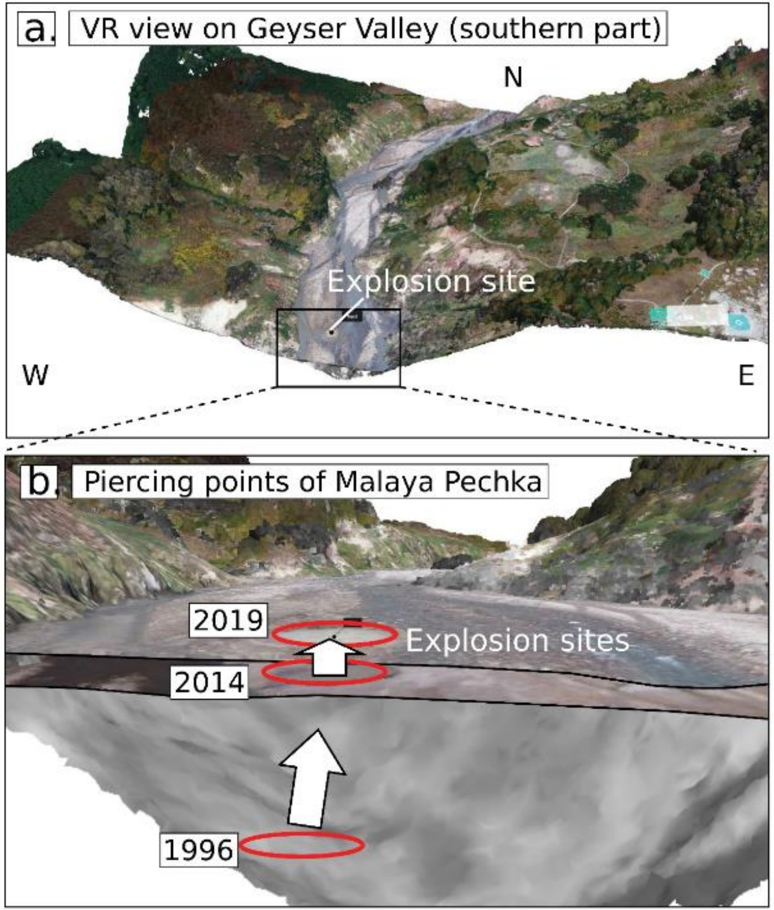
Since May 2022 7 sets of Pleiades tri-stereo data, 75 sets of TerraSAR-X data, and more than 150 sets of COSMO-SkyMed data were acquired over Kamchatka and Kuriles volcanoes.

In particular, COSMO-SkyMed amplitude data were used to reveal the geomorphological effect of the recent violent eruption of Shiveluch Volcano, while the edifice of the volcano was obscured by the dense ash plume.





The image on the right shows the almost complete destruction of the lava dome and large crater and collapse scar formation.



Identification of a newly emerging explosion site in the Geyser Valley, Kamchatka Peninsula, which is a field of geysers and other thermal features.

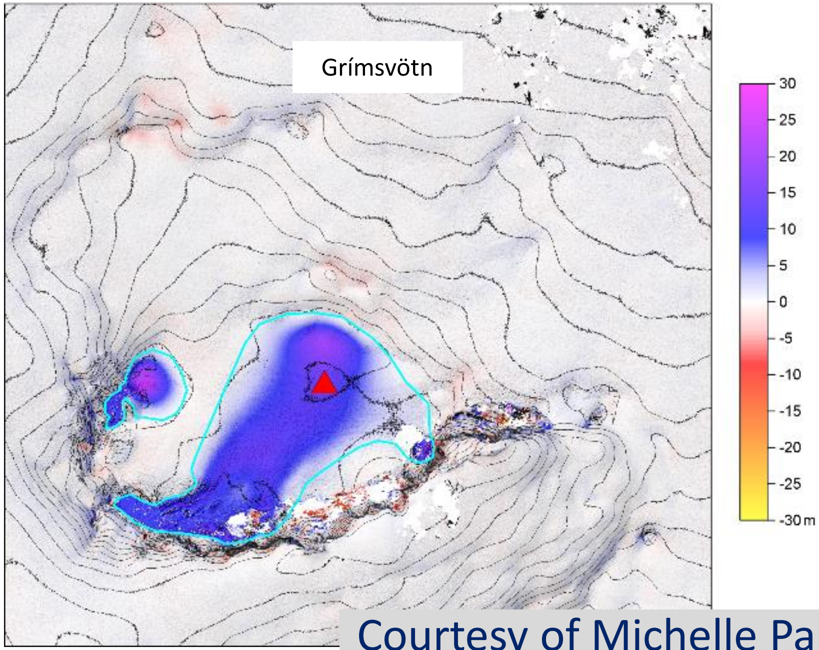
Using archive aerial images, in-situ data, Pleiades tri-stereo and recent UAV data we revealed morphological and thermal details of the new vent. We developed a conceptual model and highlighted the hazard potential of thermal features buried by landslides and clastic deposits. The work highlights the need for careful assessment and monitoring of geomorphological and hydrological changes at geyser sites.

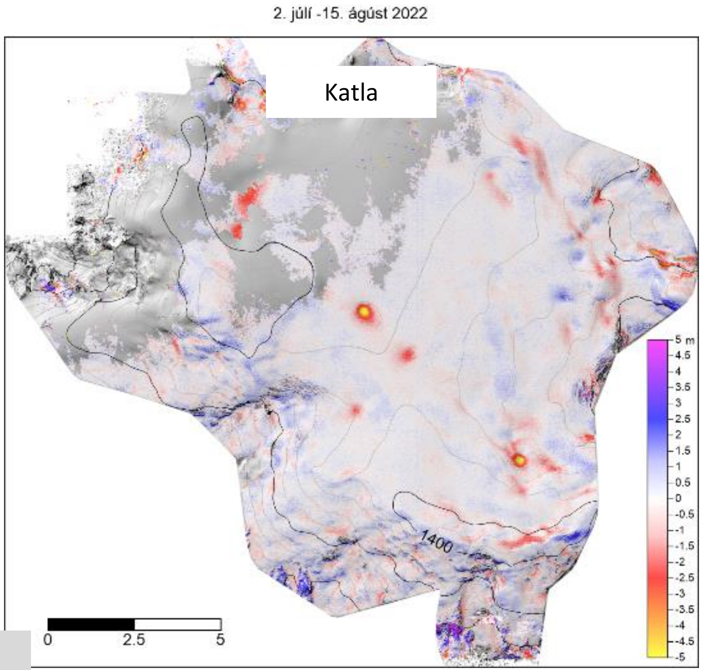
The close-up of the Malaya Pechka site shows three overlapping datasets: the steep valley in 1996, the image after lahar and alluvial deposition in 2014, and further sediment added in 2018/2019.

Allahbakhshi et al., 2023 https://doi.org/10.3390/geohazards4010005

Iceland volcano Supersite

Pleiades stereo images were acquired over four ice-covered volcanoes: Katla, Grímsvötn, Bárðarbunga and Öræfajökull, and used to generate maps of elevation change





Courtesy of Michelle Parks (IMO)

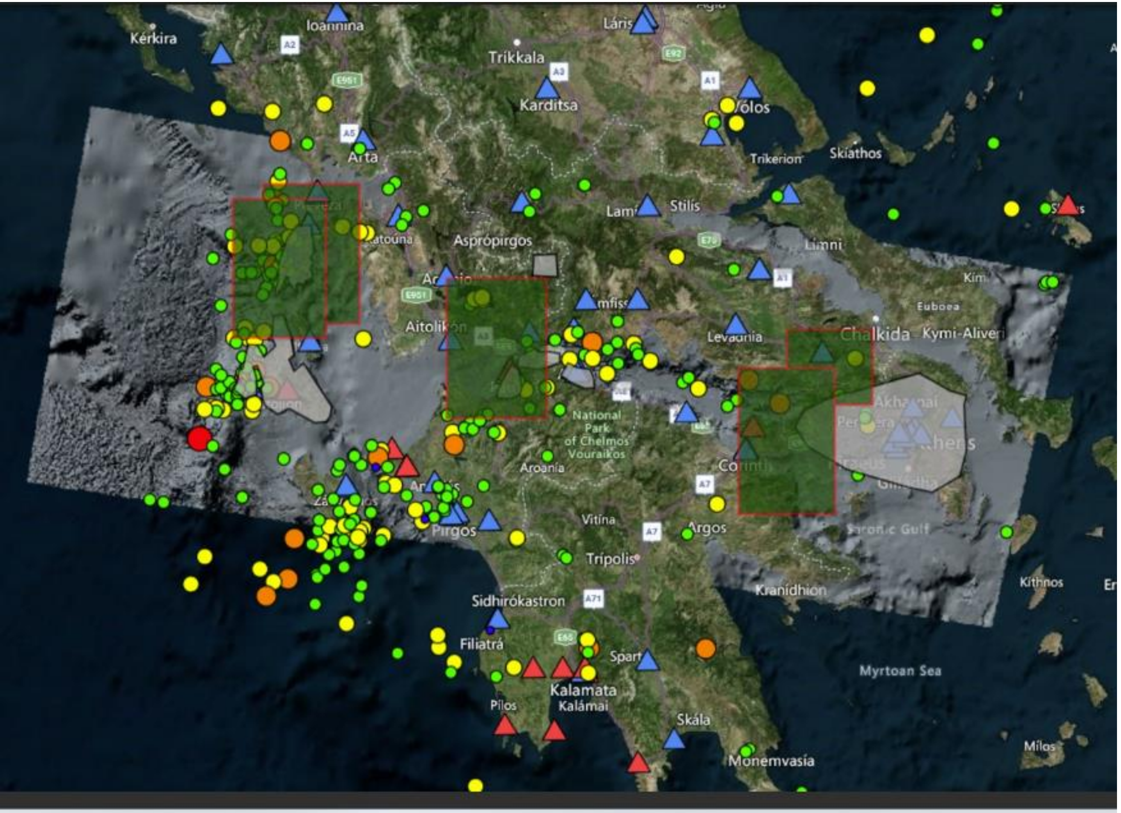
Iceland volcano Supersite

2022 usage of supersite data

- TSX – 184 images
- CSK – 680 images
- Sentinel-1 – 631 images
- Pleiades – 5000 km^2

There are no issues to report from supersite users.

Enceladus Supersite



The coordinator submitted in November 2022 a new proposal addressing the issues which caused the suspension of CEOS support.

The coordinator reported some ongoing activity.

Enceladus Supersite

The Supersite is now studied by some EC research projects:

STABLE : STructural stABiLity risk assessment, http://www.stable-project.eu/the-project/
The Nafplion case stydy, using Sentinel1 and CosmoSkyMed

HARMONIA, http://harmonia-project.eu/
Pireaus case study, using combined GPS/GNSS and Sentinel 1

TRIQUETRA, https://triquetra-project.eu/pilot-sites/#pilotcase3
Aigina case study, using VHR satellite imagery and other methods in collaboration with DLR and Salzburg University

Enceladus Supersite

… and national research projects:

Co-protect cluster, https://co-protect.gr/index.php
EO leadership by Geosystem Hellas

PROION, https://proion-hellas.eu/index.php/en/home-2/
Monitoring of critical infrastructures in the Supersite with ground and EO data. Decision support tool

Collaboration with DRIC, https://www.dric-defkalion.org/
Disaster Resilience Innovation Cluster

BLUEL project, http://bluel.upatras.gr/
Monitor CH_4 and H_2S flows in the Patras Gulf and relate them to earthquake activity.

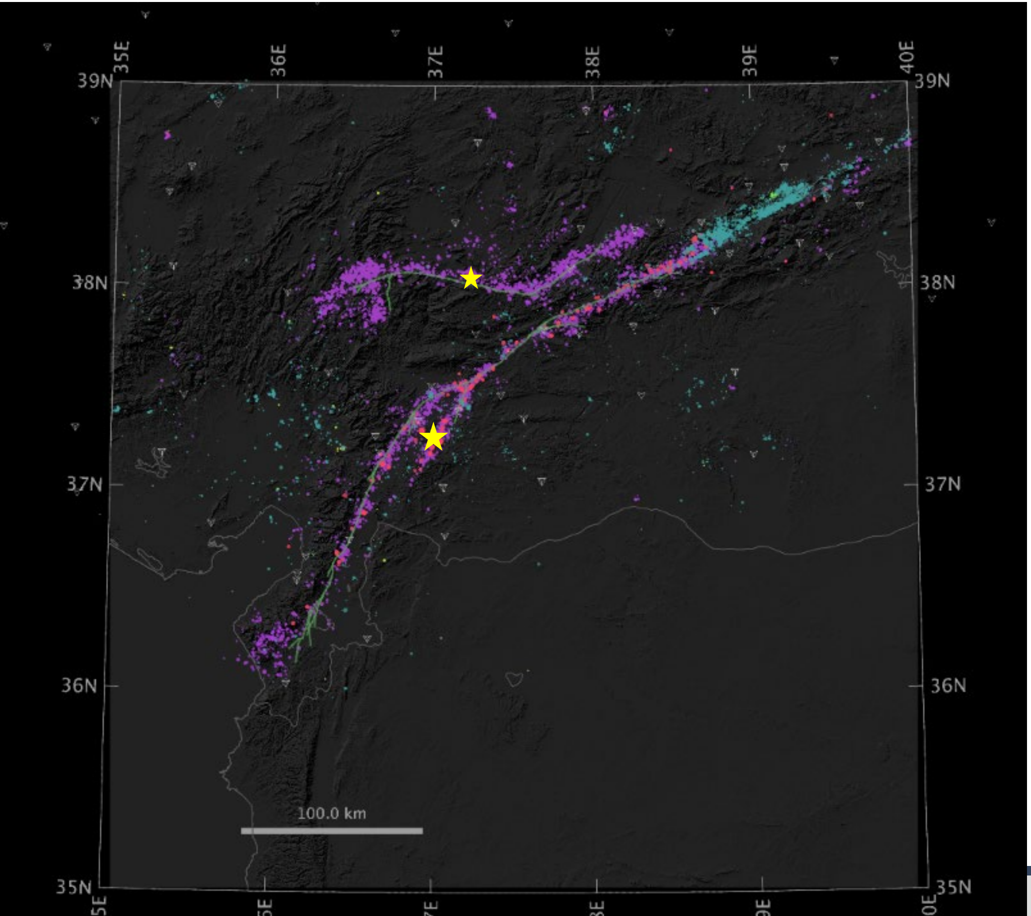
Enceladus Supersite

The new projects should guarantee that EO data are used to generate new science and provide information for public agencies.

A decision should be taken on reinstating the image provision. ASI and CNES approved the proposal.

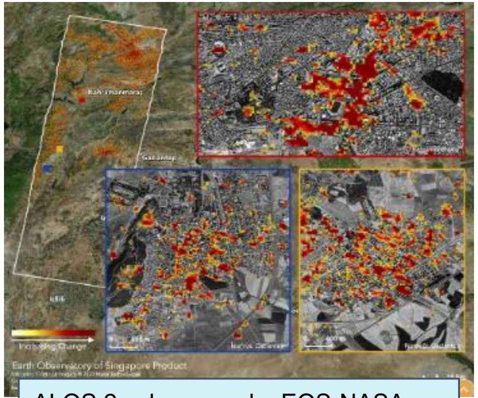
DLR ?

The Kahramanmaraş 2023 earthquake



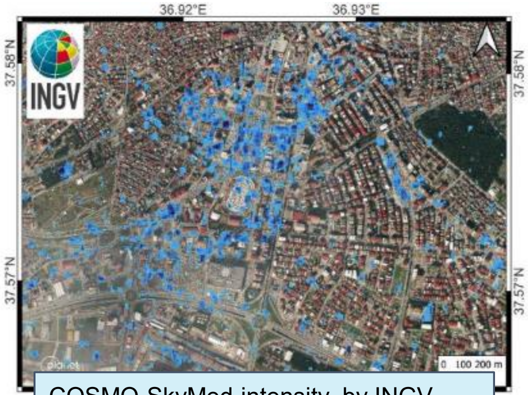
- Starts on February 6 at 4:17 a.m. local time
- Mw 7.8 mainshock on the East Anatolian Fault (left-lateral strike slip)
- 9-hours later an Mw 7.6 earthquake occurs on a separate branching fault
- To date over 12,000 aftershocks , up to Mw 6.7
- Final death toll >57,000
- >850,000 people are displaced
- >160,000 buildings destroyed
- Lenght of the main seismic ruptures: >400 km and >150 km

Results from EO data – damage proxy maps

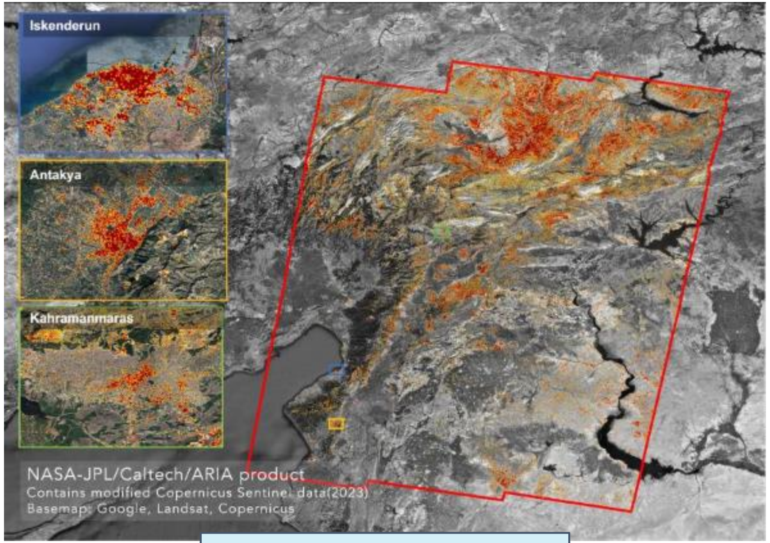


ALOS 2 coherence, by EOS-NASA

Damage proxy maps were rapidly computed from InSAR coherence or SAR intensity data and released to the responders.

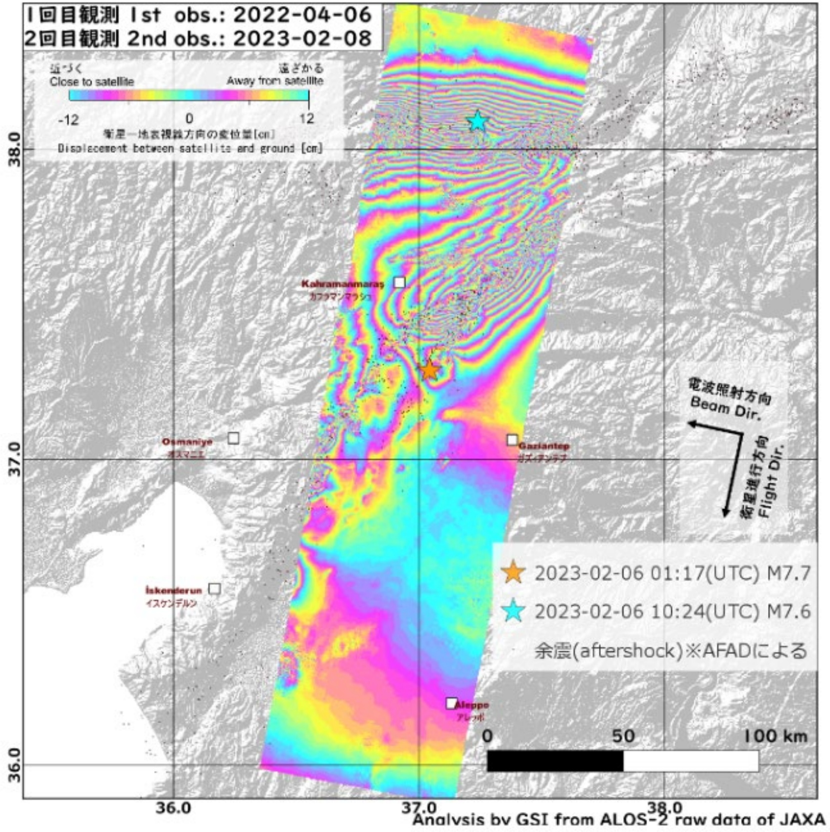


COSMO-SkyMed intensity, by INGV



S1 coherence, by NASA-JPL

Results from EO data – ground deformation

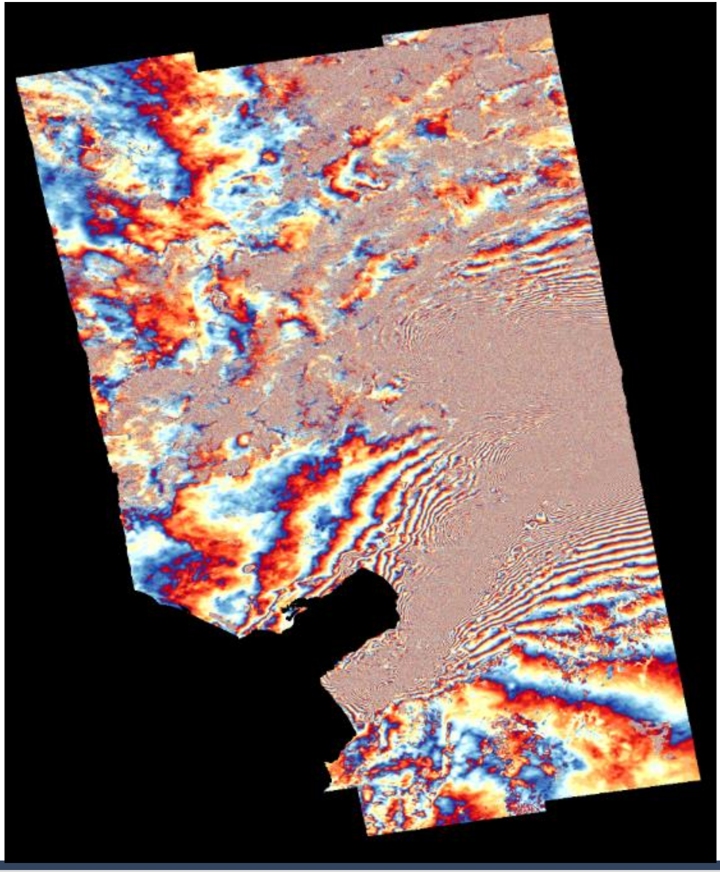


First post-event image for co-seismic ground displacement mapping: ALOS 2 stripmap of February 8.

Although only partially covered, the displacement field due to the two main ruptures is evident.

Interferogram processed by GSI

Results from EO data – ground deformation

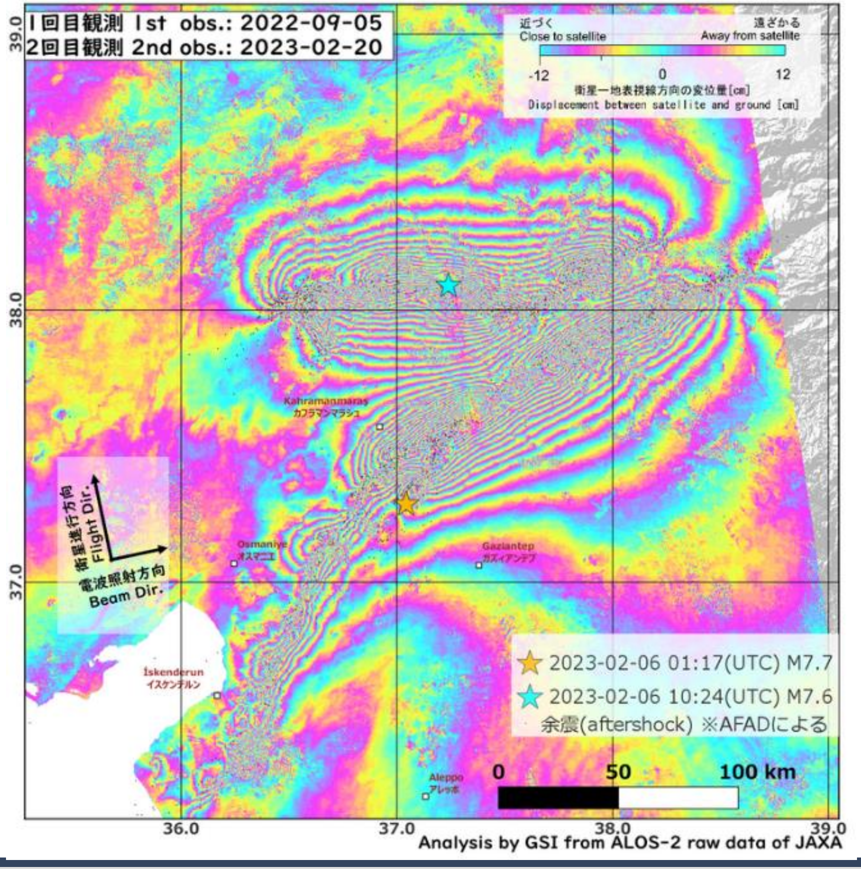


First post-event S1 image acquired on February 9.

The high deformation gradients exceed the capacity of S1 InSar to measure ground motion over a large area.

Interferogram processed by COMET

Results from EO data – ground deformation

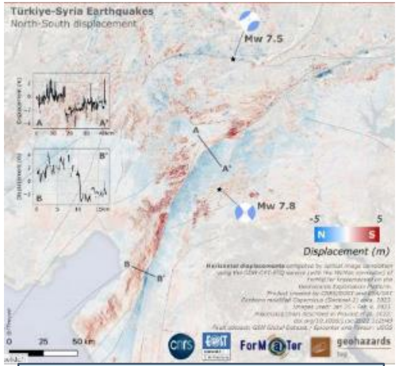


Most complete mapping of the co-seismic ground displacement: ALOS 2 scansar image of February 20

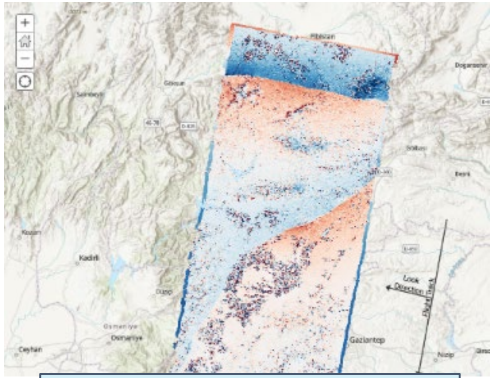
The sheer dimension of the fault ruptures is evident: >400 km for the Mw 7.8 mainshock and > 200 km for the Mw 7.6 one

Interferogram processed by GSI

Co-seismic deformation from P.O.T.

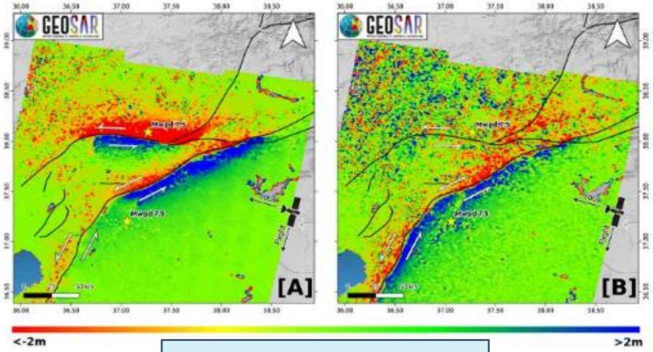


S2, processed by ForM@Ter

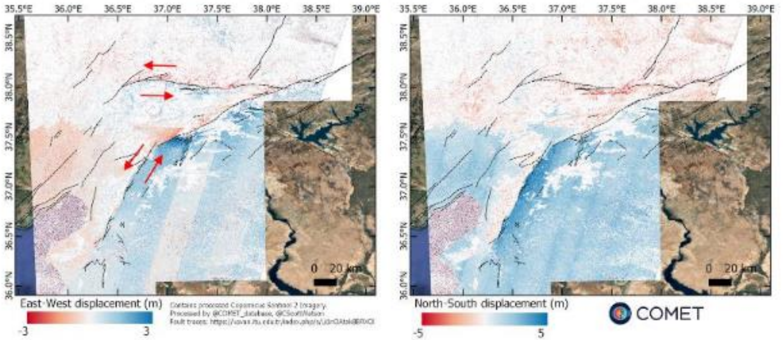


Alos-2, processed by NASA-JPL

Pixel offset tracking was also used to measure ground displacements, from S2 optical data (on the E-W and N-S components), from S1 and ALOS-2 amplitudes (on the range and azimuth components)

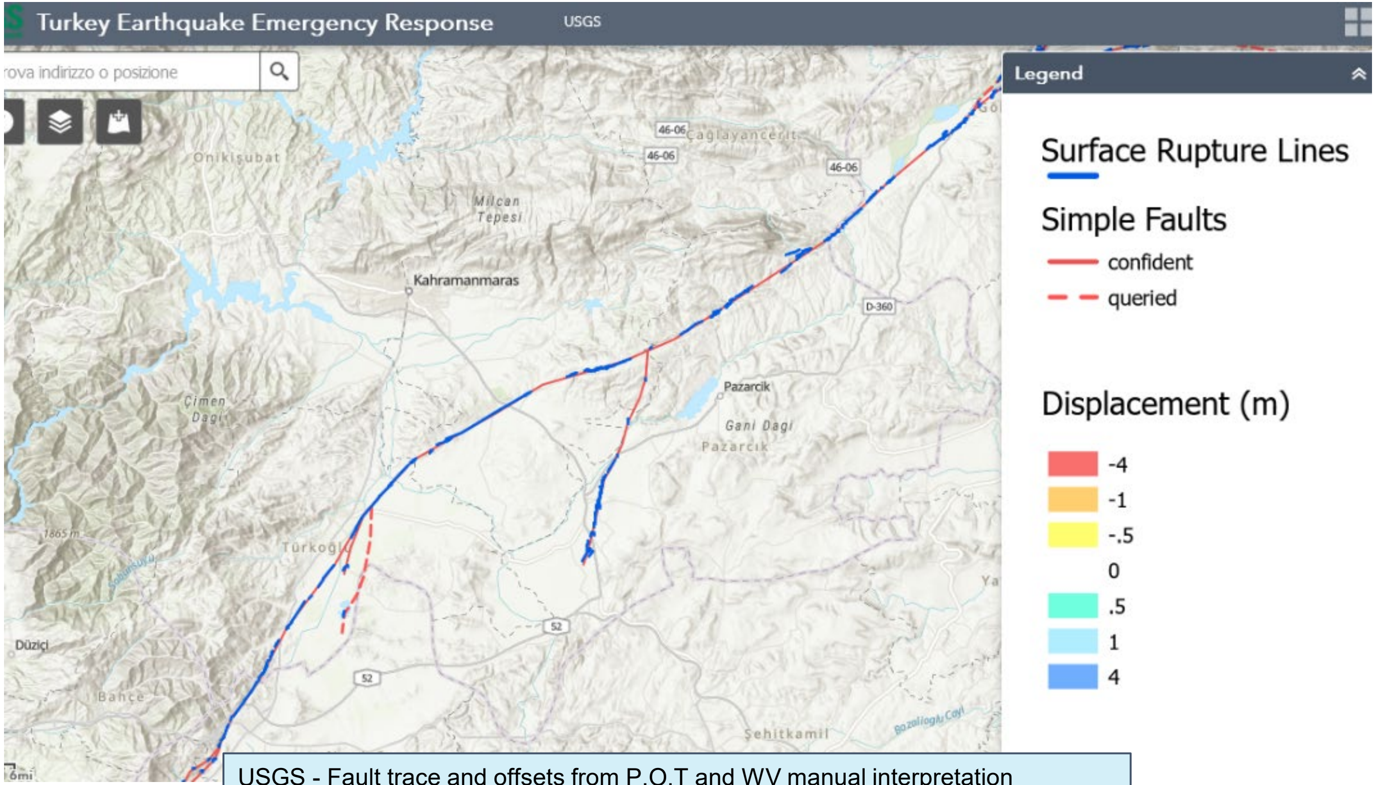


S1, processed by INGV



S2, processed by COMET

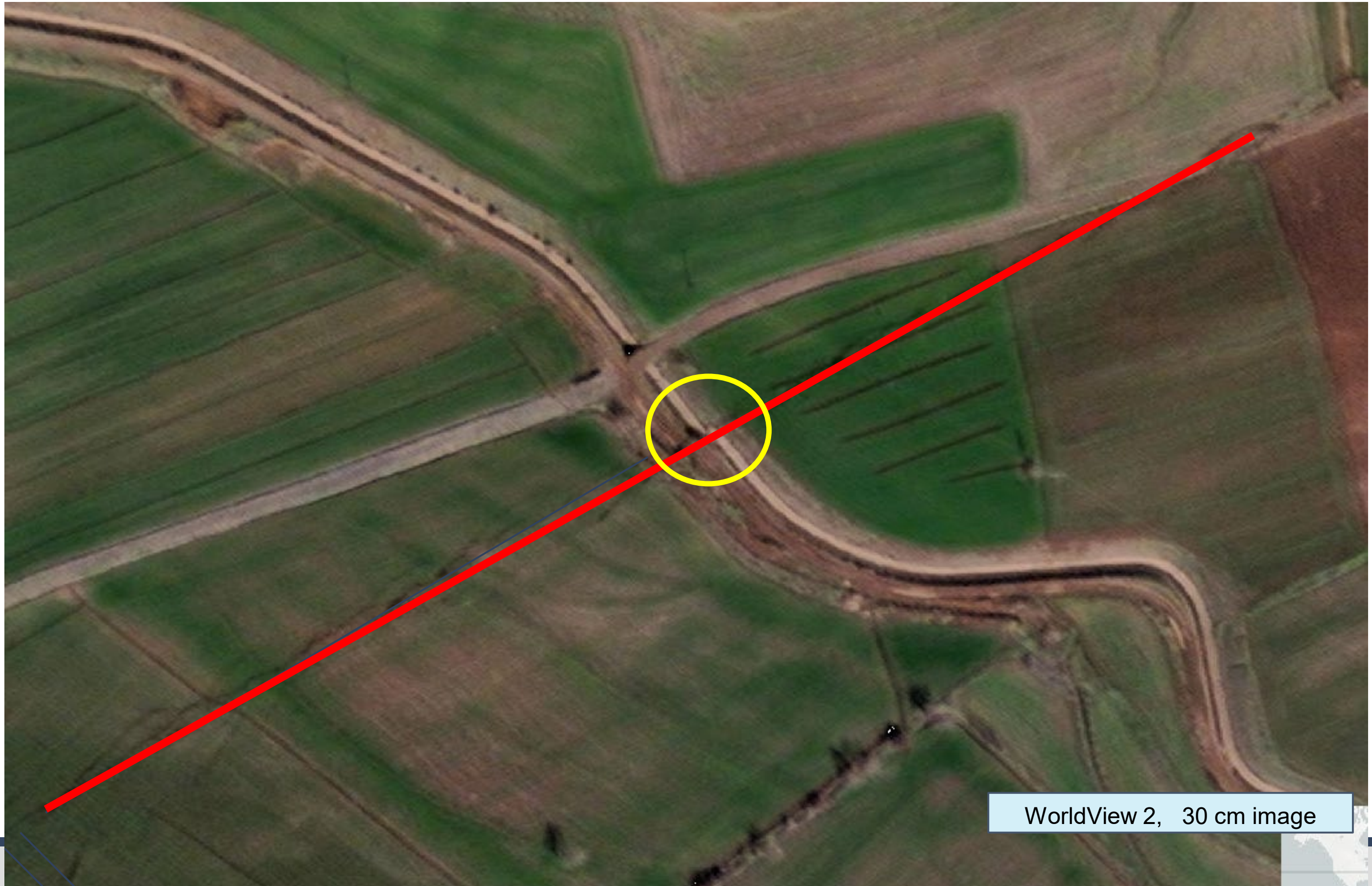
Fault mapping on VHR optical data



USGS - Fault trace and offsets from P.O.T and WV manual interpretation

Pixel offset tracking and VHR optical image analysis was used to measure the scarp left lateral offset, reaching > 5 m at places

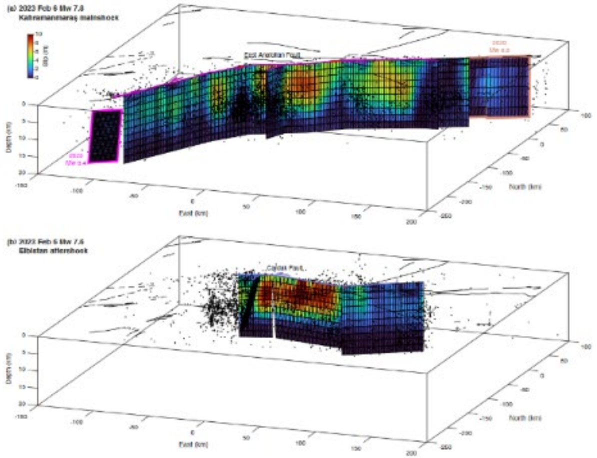
Fault mapping on VHR optical data



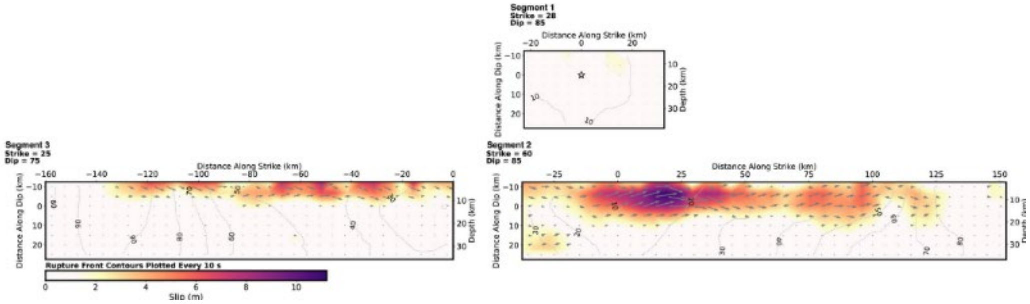
The fault scarp is very evident and continuous for hundreds of km, cutting across roads, urban areas and all types of utility lines.

Seismic source models

Inversion source models constrained by ground deformation from InSAR and P.O.T. and seismological data.



From Barbot et al.



From USGS NEIC

The Kahramanmaraş Event Supersite

It is coordinated by researchers from the Istanbul Technical University and KOERI, who provide scientific information to AFAD and other responding agencies.

The Supersite AoI includes areas where the additional stress transferred by the February 6 rupture may cause further fault activation in the next months/years.

The planned Supersite duration is one year.

The Kahramanmaraş Event Supersite

The main objective of the Kahramanmaraş Supersite is to promote scientific advancements in the following topics, using an Open Science approach:

- Earthquake cycle and seismic hazard.
- Co-seismic displacement field and post-seismic ground displacement and velocity.
- Source properties of the largest earthquakes of the sequence.
- Earthquake nucleation process.
- Fault segmentation and earthquake rupture.
- Coulomb stress transfer on nearby faults.
- Earthquake effects (impacts) on the natural and anthropogenic environments

The Kahramanmaraş Supersite web pages

On the Kahramanmaraş Supersite web pages we provide information on the availability and access to EO data specifically obtained from CEOS agencies, how to access in-situ observations from local ground networks, and how to publicly share data and scientific results.

http://geo-gsnl.org/supersites/event-supersites/active-event-supersites/kahramanmaras-event-supersite/

Kahramanmaraş Event Supersite

Event Supersite dedicated to the 6 February 2023 Kahramanmaraş, Türkiye earthquake sequence

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Important links (see more details at the end of this page):

Supersite open EO data access

Kahramanmaraş Science page

Scientific results from the global scientific community

Supersite area description

The East Anatolian Fault Zone (EAFZ) forms a plate boundary (~600 km) between the Arabian and Anatolian plates. Its southern extension connects to the Dead Sea Fault Zone (DSFZ) and creates a triple junction between Adana block, Anatolian and

The Kahramanmaraş earthquake

On 6 February 2023, early in the morning (4:17 a.m. local time), a magnitude 7.8 earthquake occurred on the East Anatolian fault resulting in massive destruction and loss of life in south-eastern Türkiye and northern Syria. As the strong

Open access to EO data

Thanks to ASI and CONAE we can provide Open Access to a large interferometric dataset, including pre-event images and post-event images, planned to be acquired until the end of 2023. We also list other sources of open data.

Supersite open EO data access page

Open access to in situ data

Continuous Seismic waveforms, event specific data and earthquake catalogs are accessible from AFAD, Earthquake Data Center System of Turkey (https://tdvms.afad.gov.tr) and from the Boğaziçi University, Kandilli Observatory and Earthquake Research Institute (http://www.koeri.boun.edu.tr/sismo/2/tr/)

30s and 1s GNSS data of the TUSAGA-Aktif GNSS network is available from https://www.tusaga-aktif.gov.tr/

The following data are openly accessible from the EPOS European Research Infrastructure portal.

- Instrumental earthquake parameters
- Seismogenic fault database
- Felt reports
- Moment tensor data
- Seismic waveforms distributed by KOERI
- PGA hazard maps for a mean return period of 475 yr

How to share your results

We ask you to share your work with the GSNL scientific community on the **Kahramanmaraş Supersite Science page.**

We recommend you make your results openly available in digital format (e.g. not just images but actual data values). You can use a CC-BY-4 license.

To ensure IP rights we invite you identify your results with a DOI. You can obtain a DOI using a number of free services (e.g., Zenodo, EarthArXiv)

Through this **Google Form** you can send us the reference to your results.

The Kahramanmaraş Supersite EO data

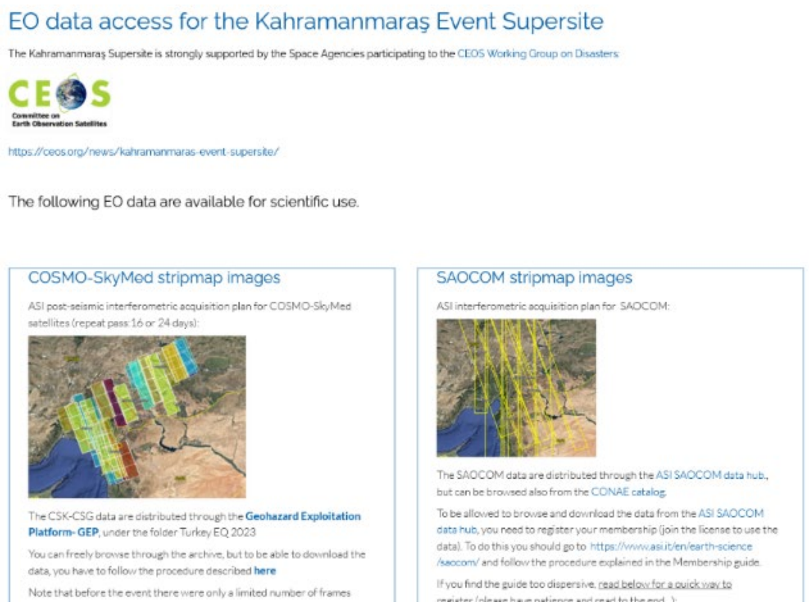
Four space agencies support the Event Supersite:

ASI is providing over 40 CSK-CSG stripmap images per month, across the entire AoI, plus over 100 SAOCOM stripmap images per month

CNES has agreed to acquire 5000 sq km of new Pléiades data (monoscopic quota)

CONAE will provide SAOCOM data outside the ZoE of ASI if needed

DLR will provide 250 TSX – TDX data



EO data access for the Kahramanmaraş Event Supersite

The Kahramanmaraş Supersite is strongly supported by the Space Agencies participating to the CEOS Working Group on Disasters

CEOS Committee on Earth Observation Satellites

https://ceos.org/news/kahramanmaras-event-supersite/

The following EO data are available for scientific use.

COSMO-SkyMed stripmap images

ASI post-seismic interferometric acquisition plan for COSMO-SkyMed satellites (repeat pass: 16 or 24 days):

The CSK-CSG data are distributed through the **Geohazard Exploitation Platform- GEP**, under the folder Turkey EQ 2023

You can freely browse through the archive, but to be able to download the data, you have to follow the procedure described **here**

Note that before the event there were only a limited number of frames

SAOCOM stripmap images

ASI interferometric acquisition plan for SAOCOM:

The SAOCOM data are distributed through the ASI SAOCOM data hub., but can be browsed also from the CONAE catalog.

To be allowed to browse and download the data from the ASI SAOCOM data hub, you need to register your membership (join the license to use the data). To do this you should go to https://www.asi.it/en/earth-science/saocom/ and follow the procedure explained in the Membership guide.

If you find the guide too dispersive, read below for a quick way to

Moreover, since the end of March, **JAXA** Alos 2 data are also available open and free !

For decision by CEOS DCT

Status of biennial reports:

- China seismic Supersite: 1° report outstanding, but should be nearly ready
- Ecuador and Taupo, NZ, volcano Supersites: 4° report to be delivered by the end of April
- San Andreas Fault NL: 3° report to be delivered at the end of May
- Nicaragua volcano Supersite; 1° report to be delivered at the end of May

We warmly thank the CEOS agencies
for the continuous support to
GEO-GSNL since 2012 !