GROUP ON EARTH OBSERVATIONS | Geohazard Supersites & Natural Laboratories

Status of the GEO Geohazard Supersites initiative

Stefano Salvi - Chair of the GSNL initiative

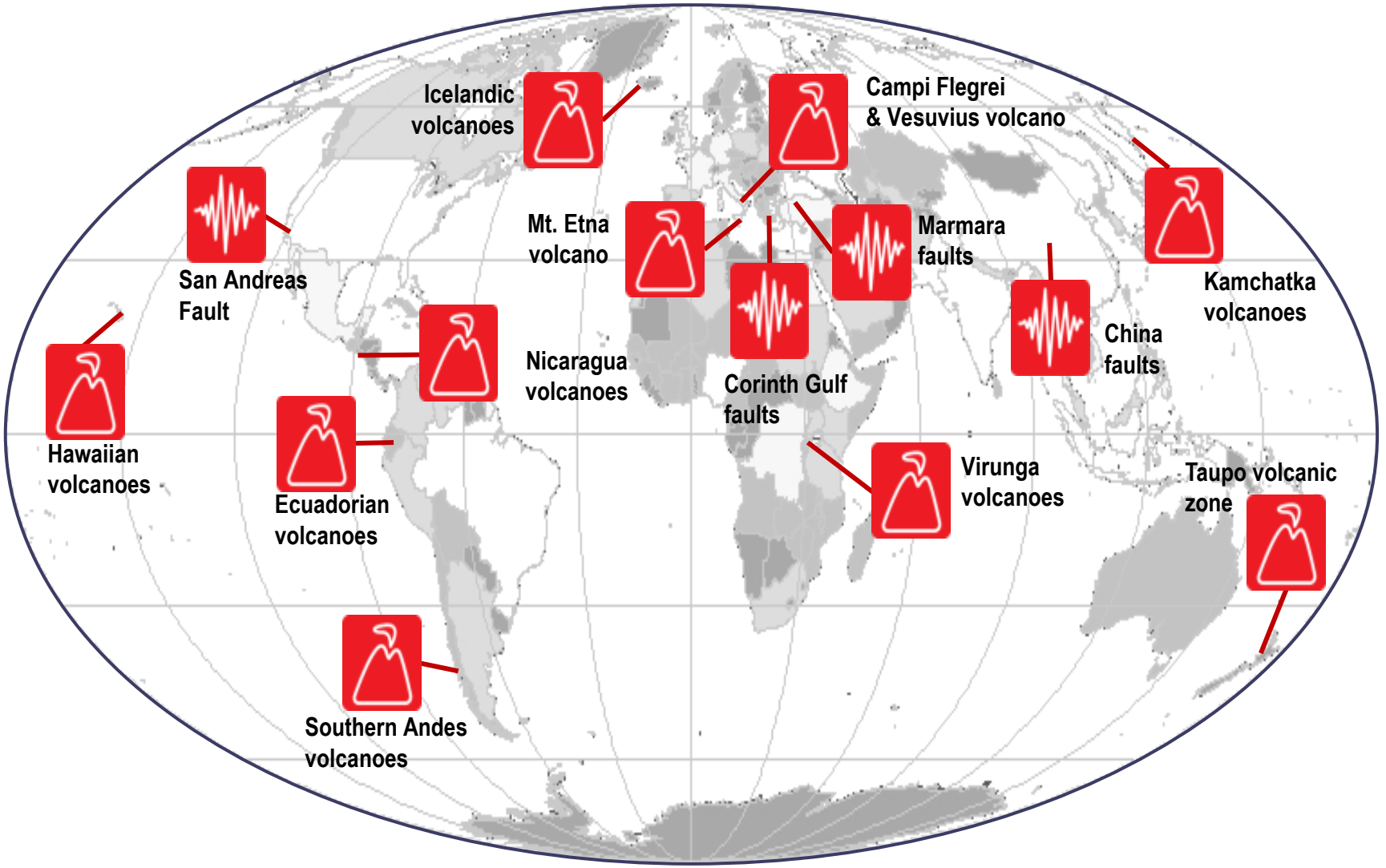
GSNL splinter meeting @ EGU 2023

Objectives of the GEO-GSNL initiative

1. To promote **Open Science** and **international collaboration**, providing open and easy access to space- and ground data, knowledge, capacities and resources;
2. to demonstrate how Open science can generate better geohazard information to be **operationally** used by decision makers in risk management and reduction;
3. to promote **innovation** in technologies, processes and communication models.

GSNL is presently a network of 14 Supersites/NL

Renewal of support to the Enceladus Supersite to be approved soon.



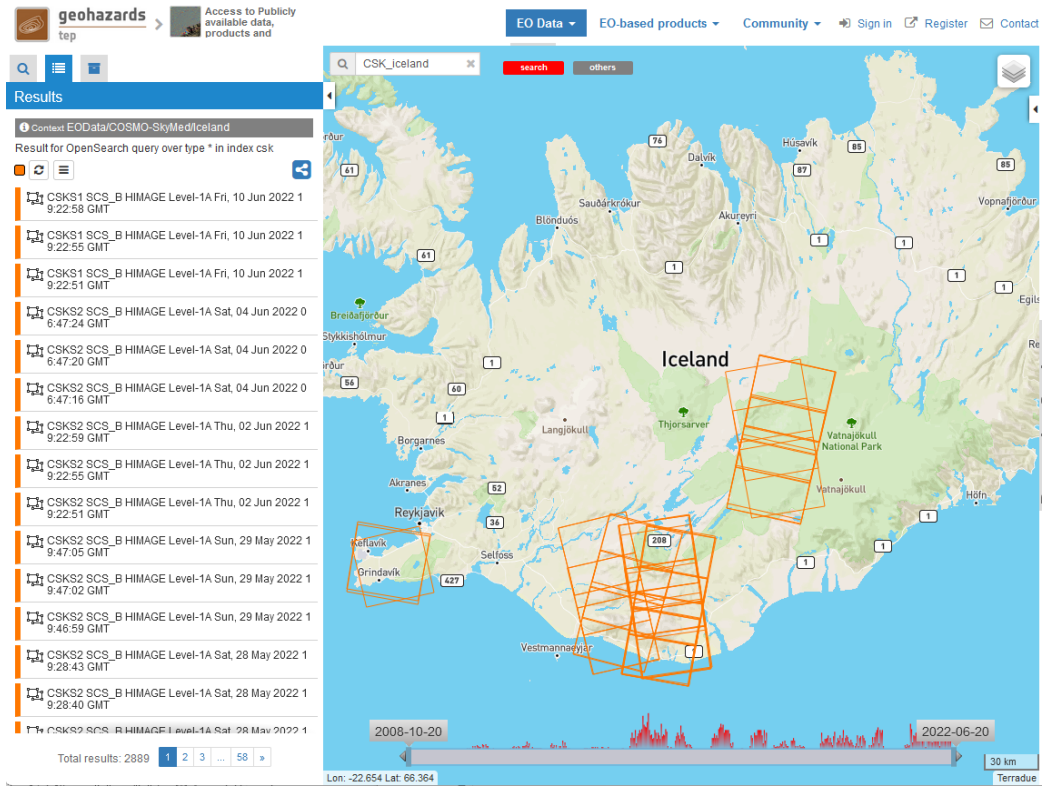
Supersite coordinators

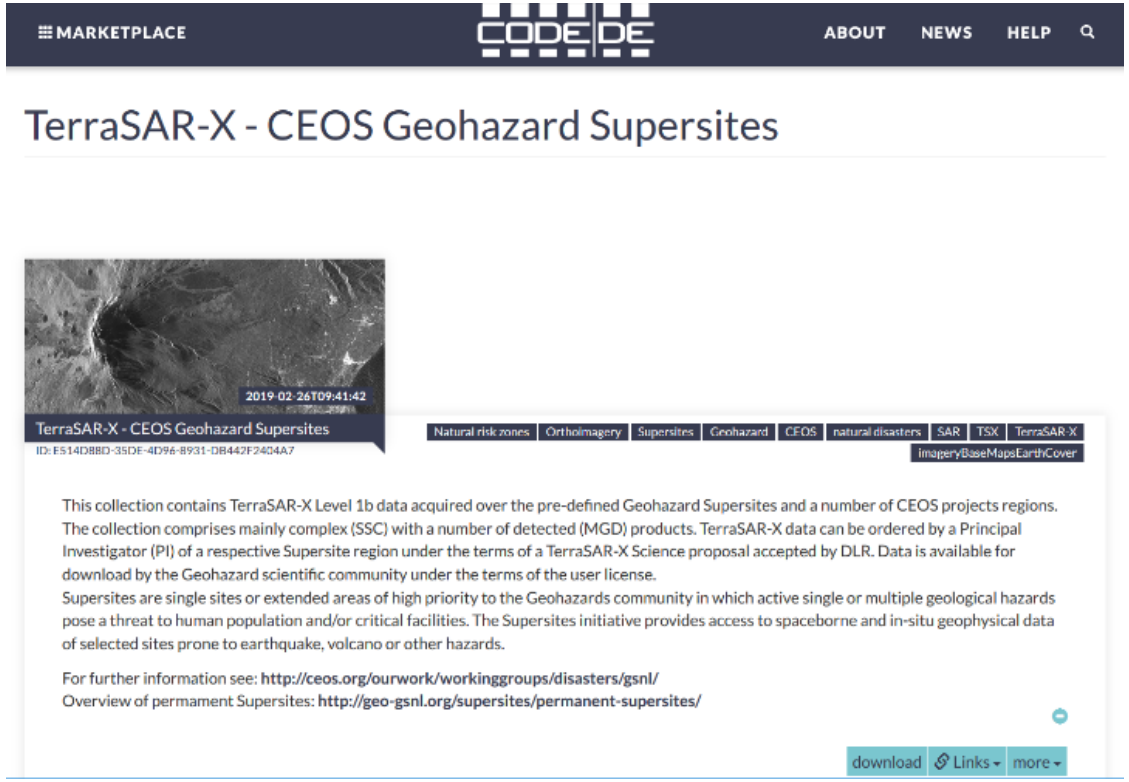
Supersites are coordinated by scientific institutes which have a national mandate to provide scientific support to government agencies for DRM

			Institution
1			USGS-HVO, USA
2			Univ. of Iceland - IMO
3	***Etna volcano***	G. Puglisi	INGV - Italy
4	***Campi Flegrei / Vesuvius***	S. Borgstrom	INGV - Italy
5	***Western North Anatolian Fault***	S. Ergintav,	KOERI, Turkey
6	***Taupo Volcano***	I. Hamling	GNS Science, NZ
7	***Ecuador volcanoes***	P. Mothes	Inst. Geofísico, Ecuador
8	***Corinth Gulf / Ionian Islands***	S. Lalechos	EPPO-OASP, Greece
9	***San Andreas Fault Nat. Lab.***	C. Wicks	USGS, USA
10	***Southern Andes volcanoes***	L. Lara	SERNAGEOMIN, Chile
11	***Virunga volcanoes***	C. Balagizi	GVO, DR Congo
12	***Kamchatka volcanoes***	A. Shevchenko	IVS, Kamchatka - Russia
13	***China faults***	Y. Shao	AIR - CAS, China
14	***Nicaragua volcanoes***	I. Cruz Martínez	INETER-Nicaragua

Open EO data

- CEOS space agencies provide access to hundreds (3-500) of satellite images per year at each Supersite, for a total monetary value in excess of 7 M$/year.
- Data and results are made accessible through community portals: GEP, DLR's CODE-DE, UNAVCO-SSARA, EPOS ICS.



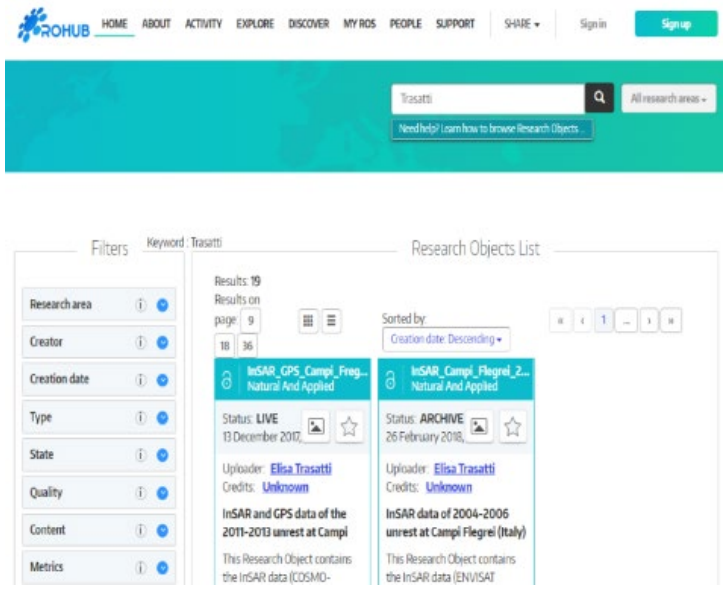


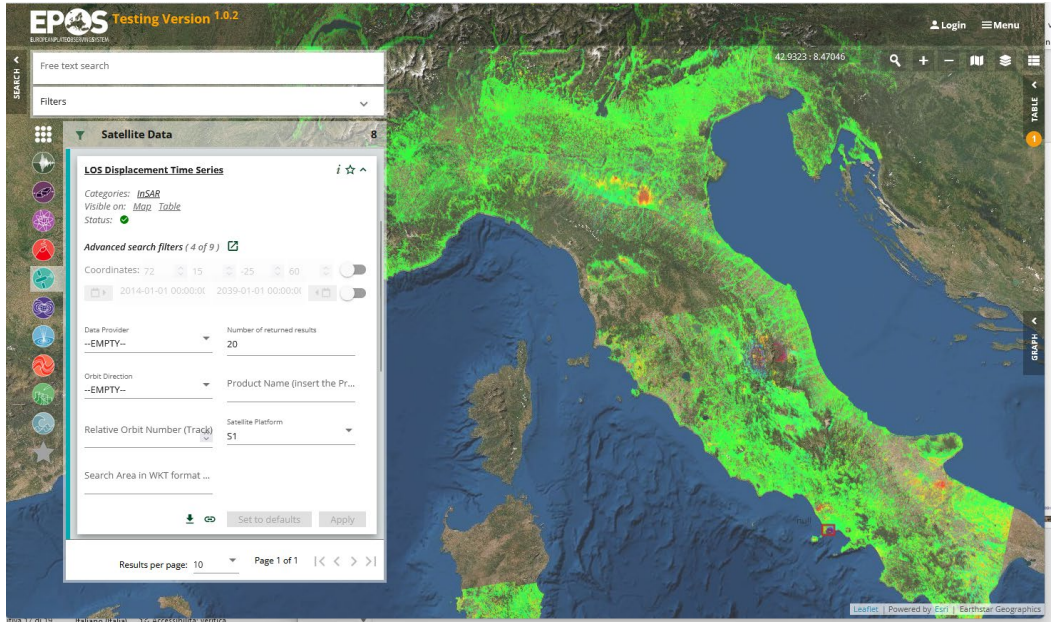
Annual image quota per Supersite

Supersite	COSMO-SkyMed	TerraSAR X	SAOCOM	Pléiades
Hawaii	250	70	Tbd	1200 km^2
Iceland	700	250	Tbd	5000 km^2
Etna	200	-	200	1200 km^2
Vesuvio	200	130	200	1200 km^2
Marmara	200	250	200	1200 km^2
Ecuador	200	130	Tbd	Not requested
New Zealand	200	130	Tbd	Not requested
Corinth Gulf	120	120	200	400 km^2
San Andreas Fault	1600	320	Tbd	Not requested
Southern Andes	400	150	Tbd	10000 km^2
Kamchatka volcanoes	100	150	200	12000 km^2
China faults	200	-	Tbd	4000 km^2
Virunga	450	-	200	11000 km^2
Nicaragua	200	135	Tbd	4000 km^2

Community research infrastructures

- The **Geohazard Exploitation Platform** (https://geohazards-tep.eu) is used to access and process satellite data. Processing is not free but can be sponsored by ESA.
- Services provided by **UNAVCO** (www.unavco.org) can be used to access EO and GNSS data and process them.
- The Research Object HUB (https://reliance.rohub.org) can be used to exchange knowledge.
- Services from the **EPOS** research infrastructure can be used to access satellite and in-situ data and research products. In the future also for data processing.





Training and capacity development

- We try to support Supersites where local scientists are in need of training and capacity development, mobilizing resources from other Supersites and project funding.
- At present we provide training on SAR data analysis and volcano/earthquake source modeling. We can organize further training courses on request.
- Opportunities for post-graduate education abroad can be identified with the help of the Supersite communities.
- In case of need we can help to identify resources for equipment, e.g. through donations or permanent loans.

GSNL resources

- GSNL is mainly functioning on in kind resources provided by the partners
- Several million Euro per year is the value of in-kind resources, made available as data, labour, infrastructures.
- Direct funding is normally obtained by the participants from national and international competitive calls.
- Further funding is sought for Supersites in less developed countries with support from GEO.

GSNL promotes fair and ethical research

We promote fair and ethical collaboration, which means that:

- Especially in less developed countries we pursue the active involvement of local scientists, such that there is a **transfer of knowledge** and **development of local capacities**.
- While promoting Open Science, we accept temporary data access limitations, negotiated in a specific **Supersite Data Policy**.
- **During a seismic/volcanic crisis,** the international scientific community should **support the local Response activities.** Public release of scientific results should be done in a responsible way, possibly coordinated by the local scientists.

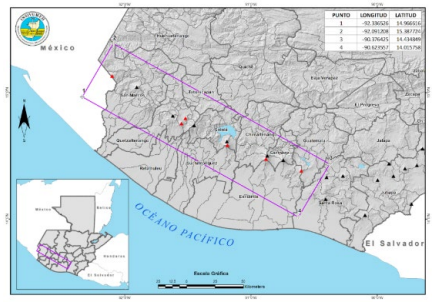
Progress in 2022

1. Renewed governance structure (see later)

2. SAOCOM L-band SAR and PRISMA Hyperspectral VNIR data can now be obtained by the Supersites Coordinators, thanks to CONAE and ASI

3. Information from Supersite data has proved crucial for managing volcanic crises, e.g.; for White Island, NZ; Reykjanes peninsula, IS, Mt. Etna, IT.

4. There is an ongoing proposal for a new Volcano Supersite in Guatemala.



4. The GSNL community is part of USGS VDAP training events in Latin America for volcano geodesists (last training event in Quito in summer 2022).

5. GSNL obtained financial resources from INGV to donate 5 GNSS stations to the Virunga Supersite in D.R. of Congo. <u>Further support is needed to develop local capacities.</u>

GSNL new governance 2022-2025

- After 11 years of operation as a GEO initiative, and following the growth of the Supersite network, the GSNL Scientific Advisory Committee decided it was time to establish a new governance structure.
- The new governance is operational starting March 2022, and is composed of a Steering Committee, a Management Board, and the initiative Chair.
- There are now stronger links to GEO and CEOS, and a more stringent commitment by the Supersite Coordinators
- Haris Kontoes is the liaison to the GEO DRR WG
- The CEOS WGD Chair (CNES) is a member of the GSNL Steering Committee, which includes representatives from the scientific associations IAVCEI and IASPEI.
- The CEOS DCT Chair (CONAE) is a member of the GSNL Management Board, which includes all the Supersite Coordinators plus two external members.
- The election for renewing the GSNL Chair will occur in 2023.

GSNL new Steering Committee

Composition:

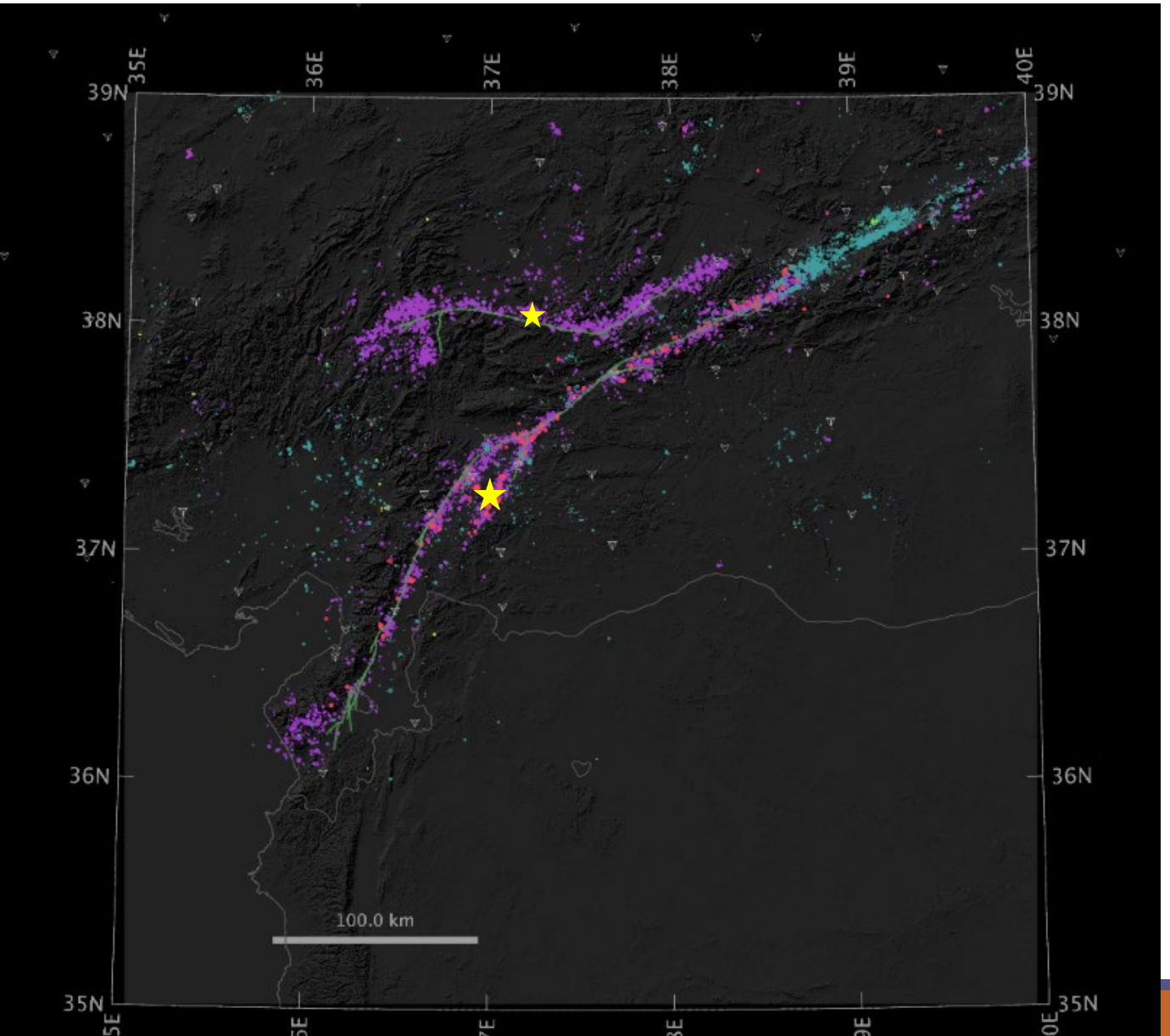
1. Stefano Salvi, INGV, Italy. Chair of the initiative;
2. Helene de Boissezon, CNES, France. Chair of the CEOS Working Group on Disasters;
3. Haris Kontoes, NOA-IAASARS, Greece (liaison to the GEO DRR WG);
4. Li Li, IGP-CEA, China (representing IASPEI)
5. Roberto Sulpizio, UniBa, Italy (representing IAVCEI)
6. two members of the GSNL Management Board (Florian Haslinger and one still tbd).

GSNL new Management Board

Composition:

- the GSNL Chair,
- the 14 Supersite Coordinators,
- the Chair of the CEOS Data Coordination Team (Laura Frulla, CONAE),
- two experienced scientists/technologists in the fields of interest (Florian Haslinger, ETH, and one still tbd)

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

Kahramanmaraş Event Supersite

‡Ù¸ Kahramanmaraş Event Supersite

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‡Ẁį Kahramanmaraş Supersite web pages

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Kahramanmaraş Supersite EO data

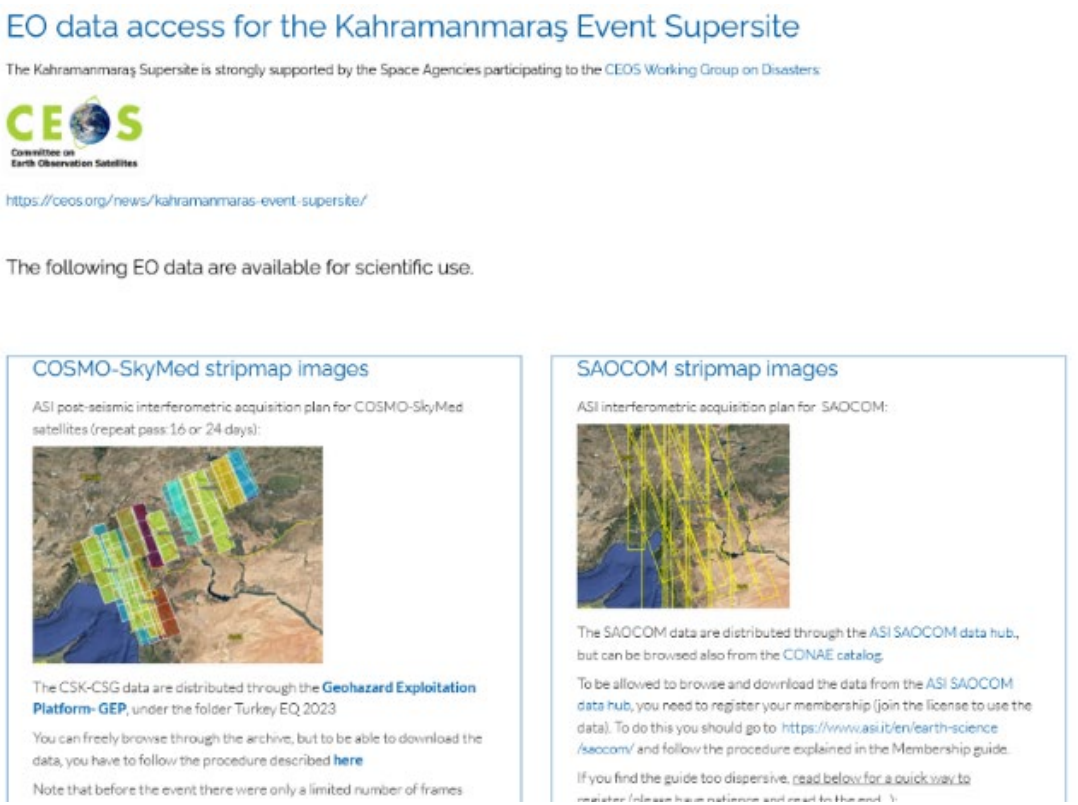
Four space agencies support the Event Supersite:

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 !

Supersites presentations

Virunga Supersite – Charles Balagizi, GVO

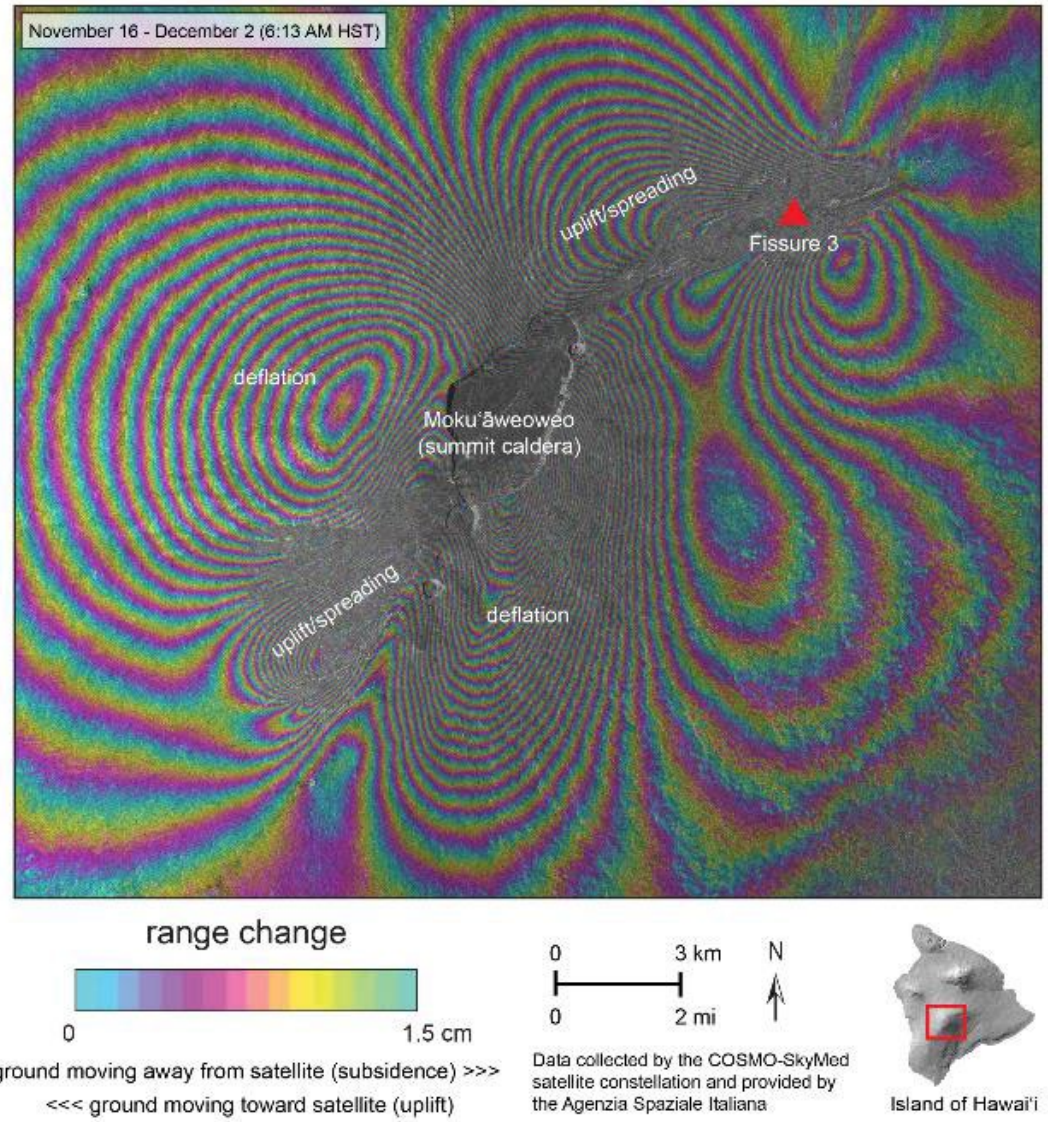
Iceland Supersite – Michelle Parks, IMO

Etna Supersite – Giuseppe Puglisi, INGV

Further scientific results at Supersites

- Hawaii,
- Campi Flegrei – Vesuvius
- Taupo
- Kamchatka

Hawaii volcano Supersite

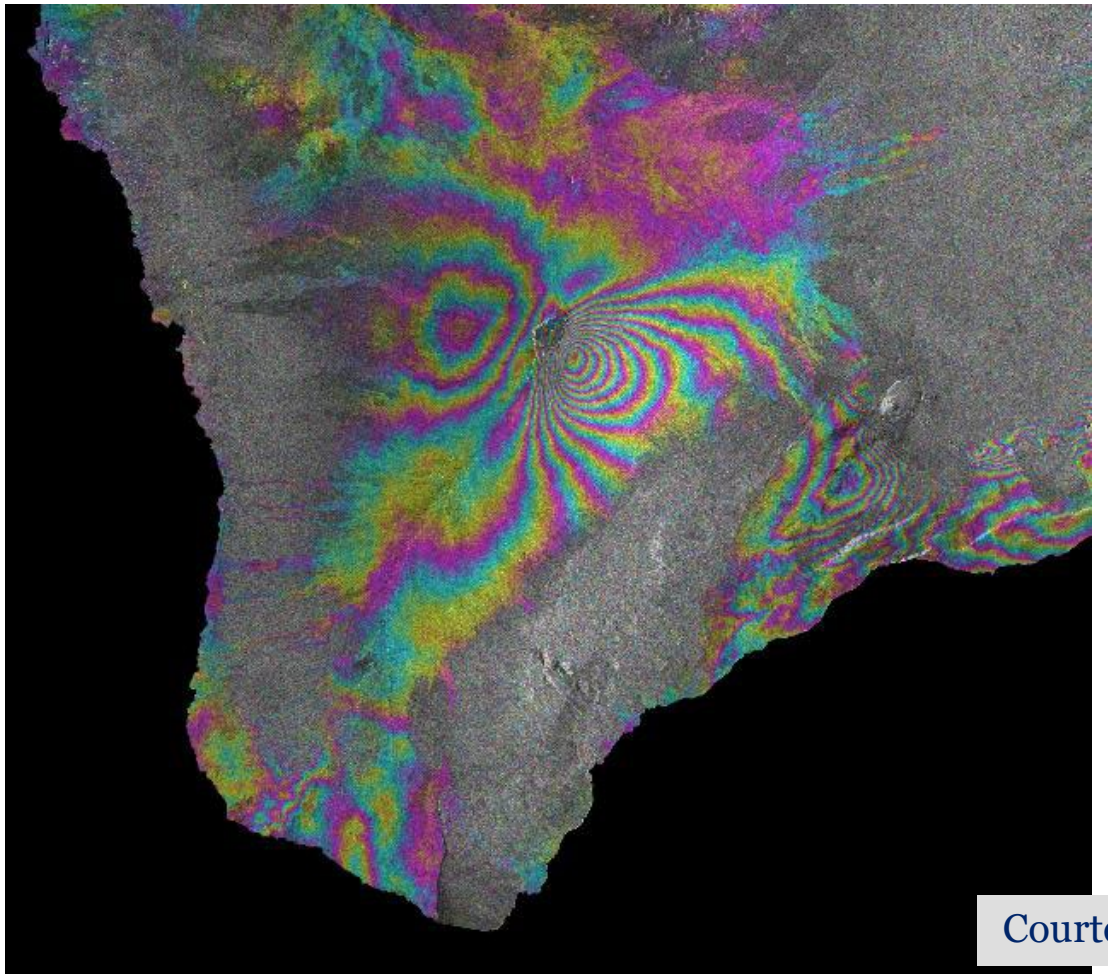


CSK interferogram used to monitor volcano edifice deflation and fracture opening (lateral spreading) during the last Mauna Loa eruption, in late 2022

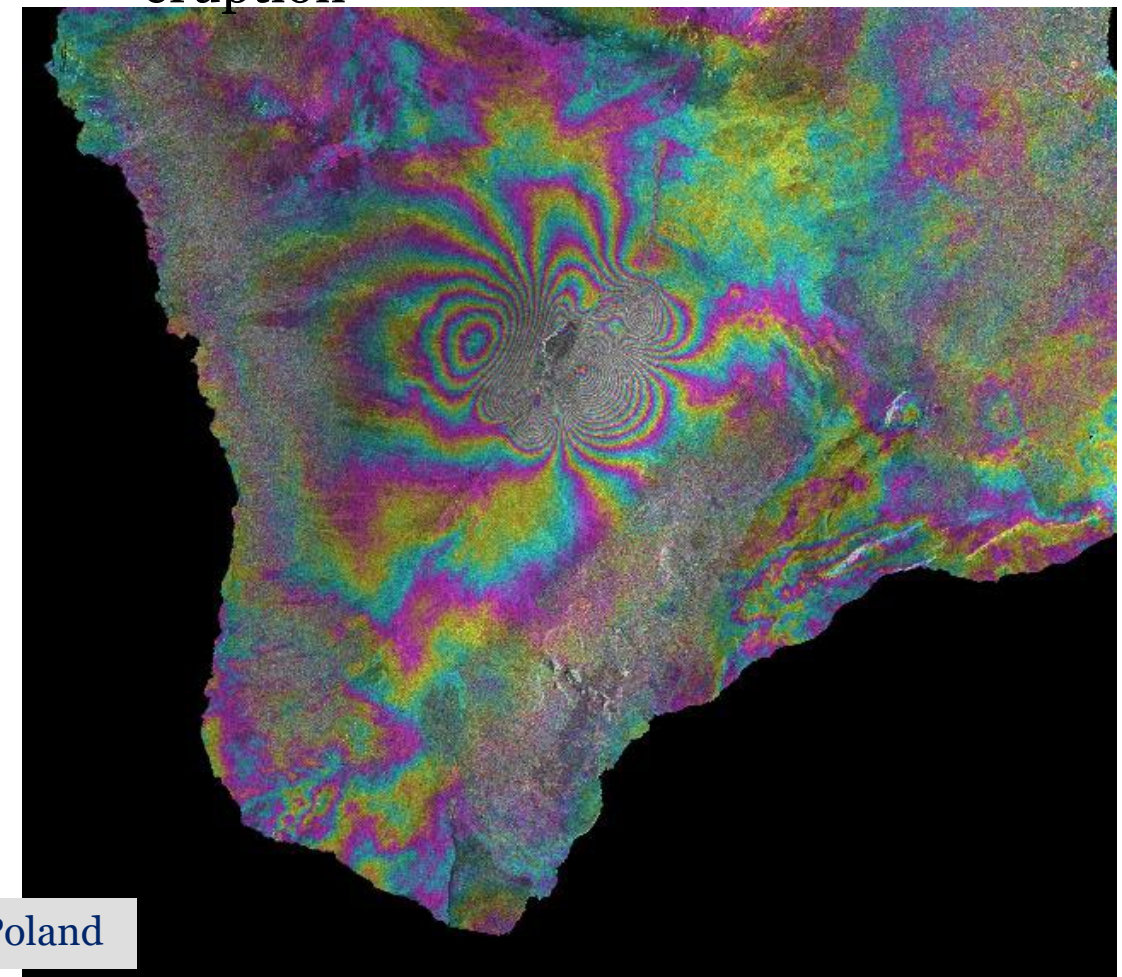
Courtesy of M. Poland

Hawaii volcano Supersite

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

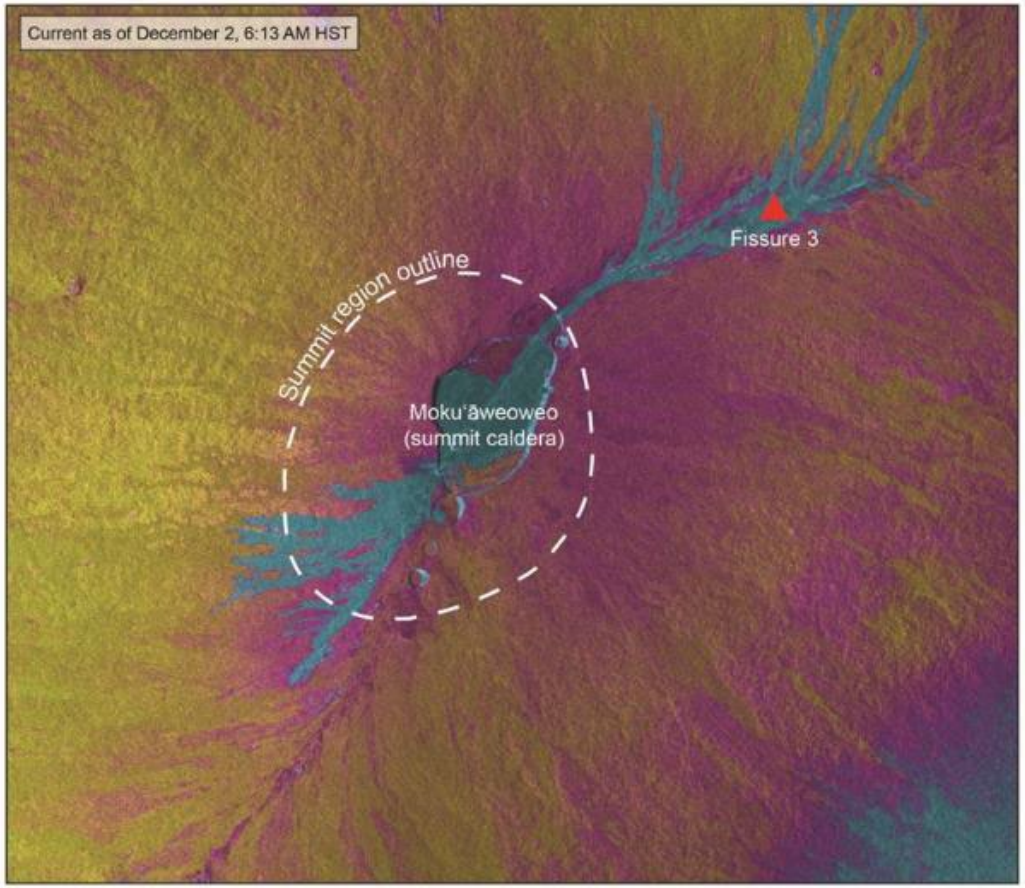


S1 deformation pattern (mainly deflation) during the late 2022 eruption



Courtesy of M. Poland

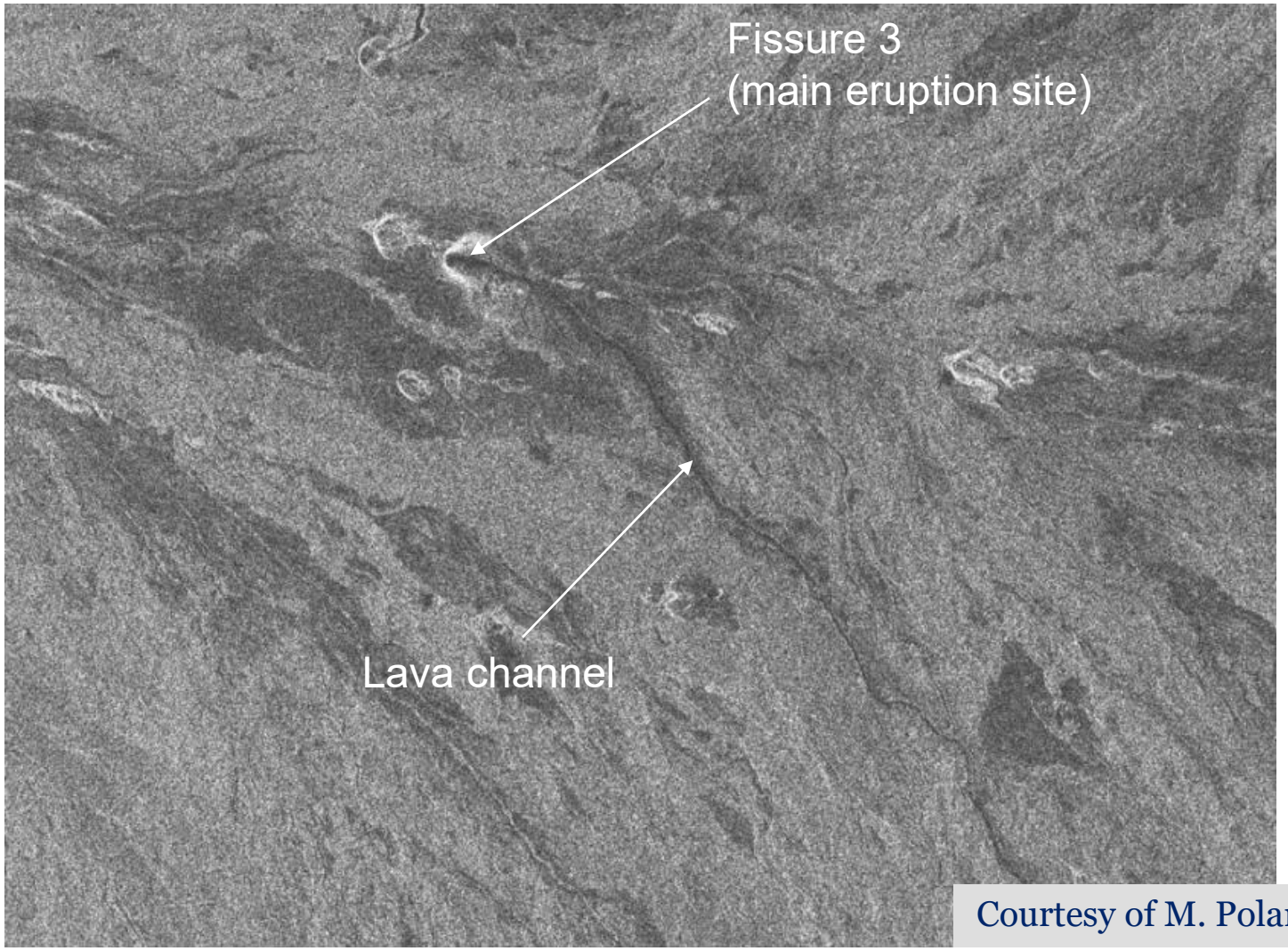
Hawaii volcano Supersite



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

Courtesy of M. Poland

Hawaii volcano Supersite

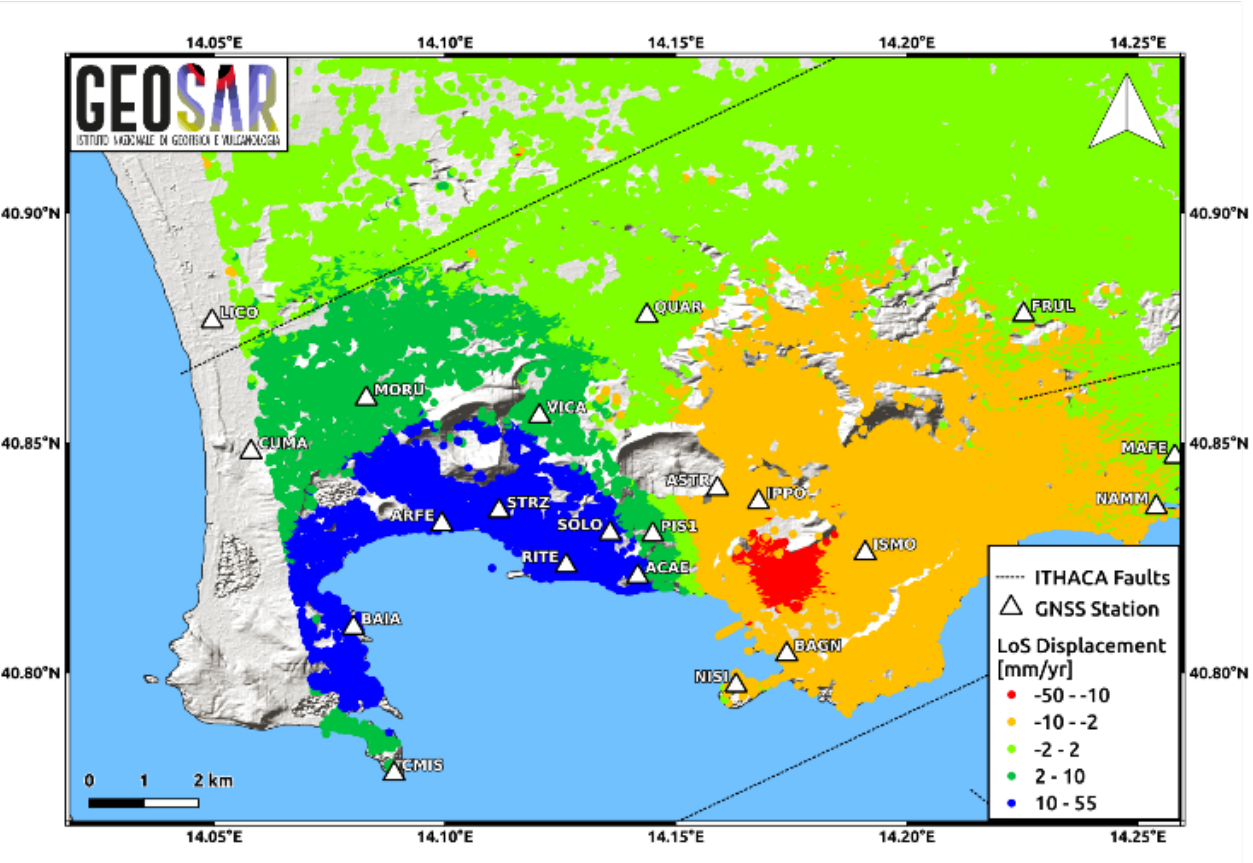


Courtesy of M. Poland

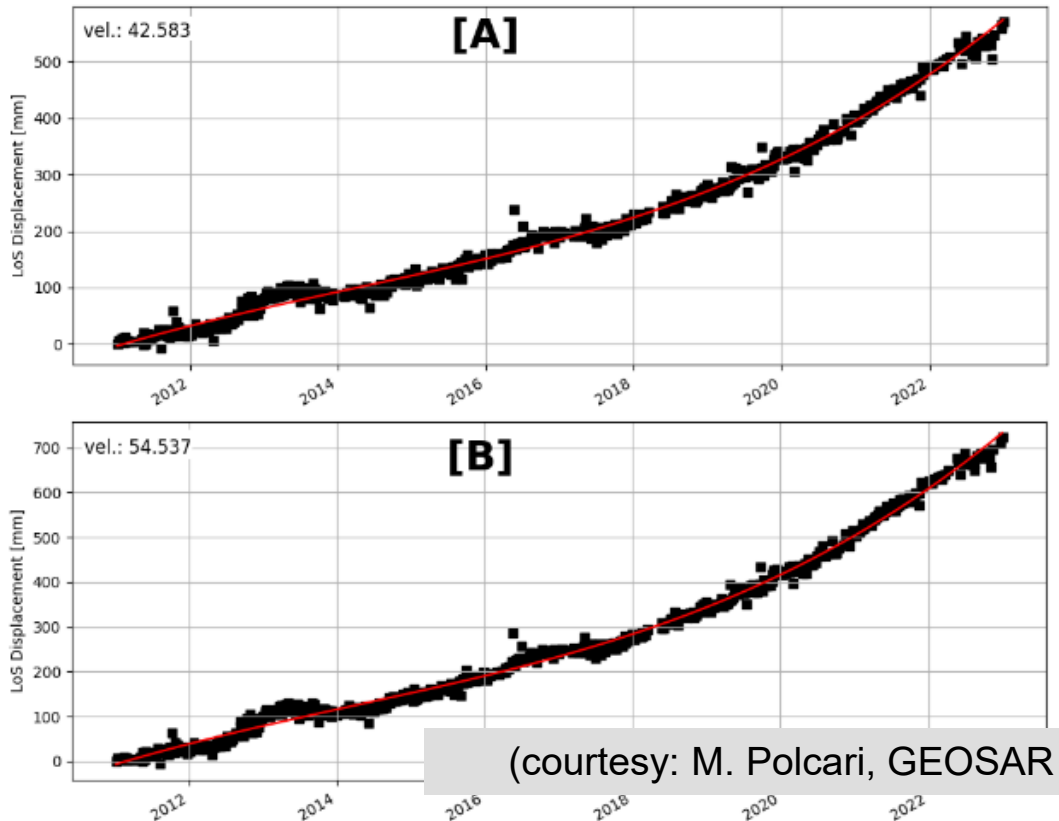
Radar amplitude of a C-band Radarsat-2 image of Mauna Loa, used to monitor the fractures and lava flows at high resolution during the late 2022 eruption.

Campi Flegrei-Vesuvius Supersite

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



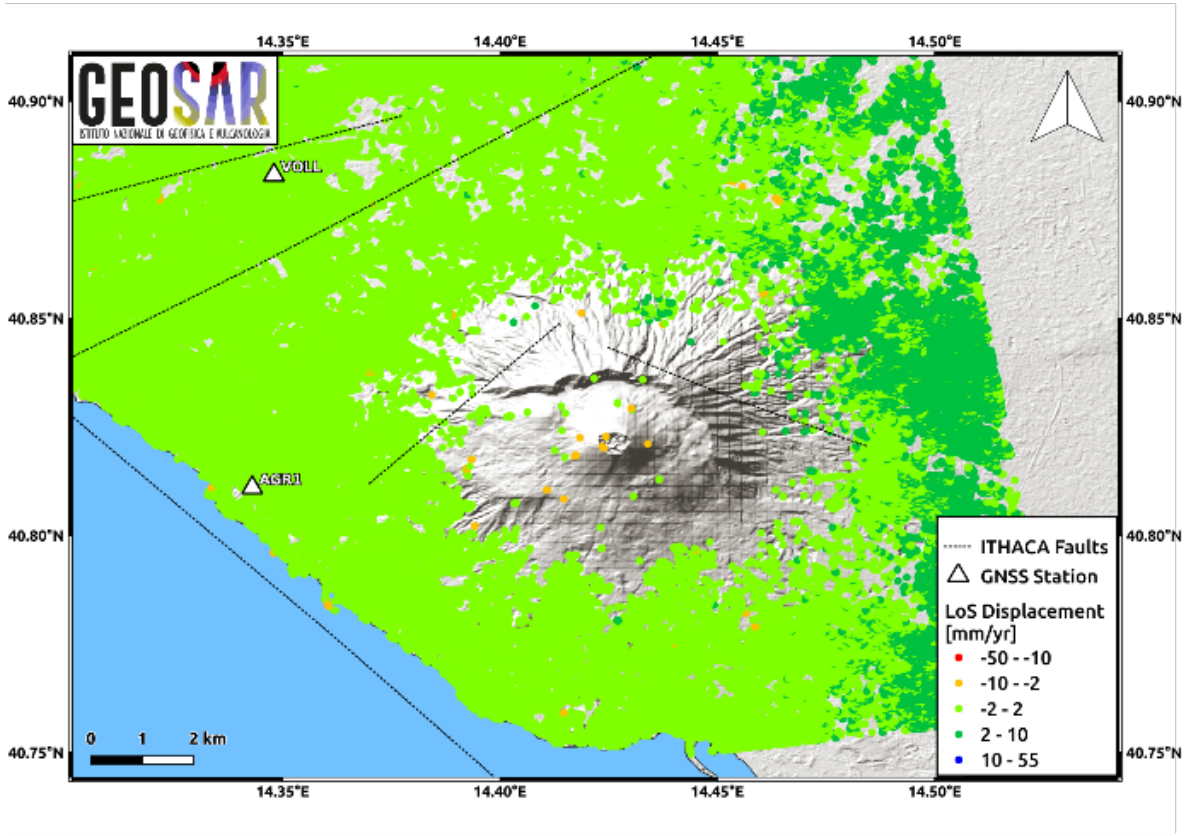
InSAR time series for two PSs close to the cGNSS RITE [A] and Pozzuoli Cathedral [B] stations



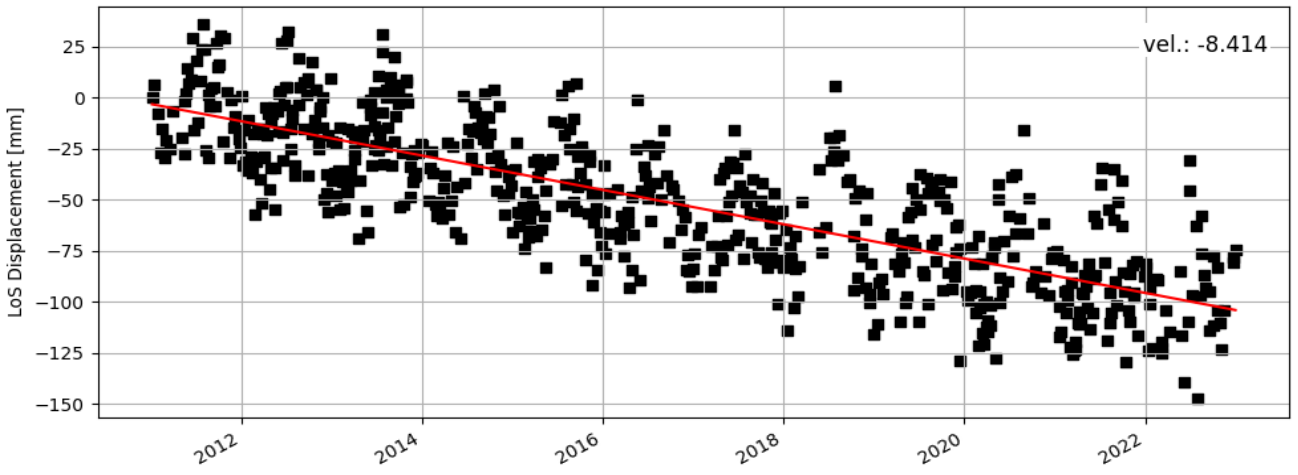
(courtesy: M. Polcari, GEOSAR Lab)

Campi Flegrei-Vesuvius Supersite

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



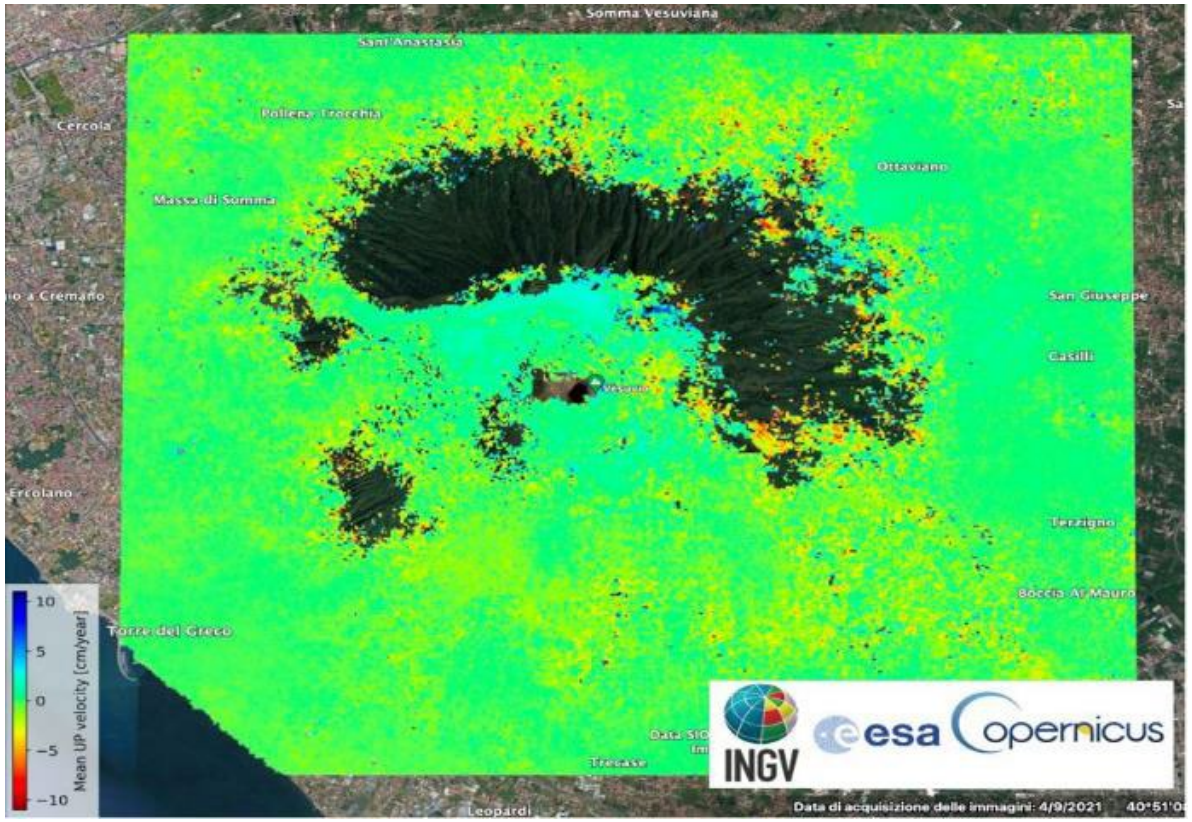
InSAR time series (2011-2022) for a PS in the Great Cone area



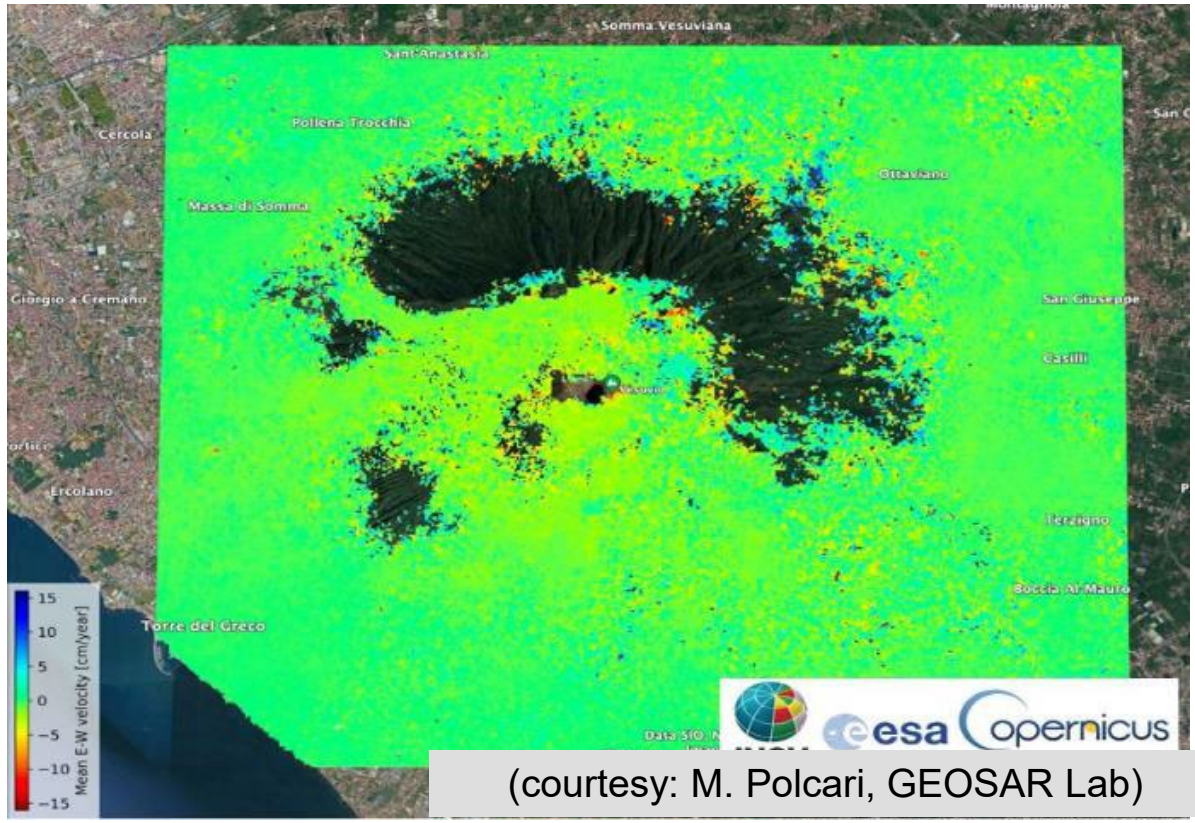
(courtesy: M. Polcari, GEOSAR Lab)

Campi Flegrei-Vesuvius Supersite

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

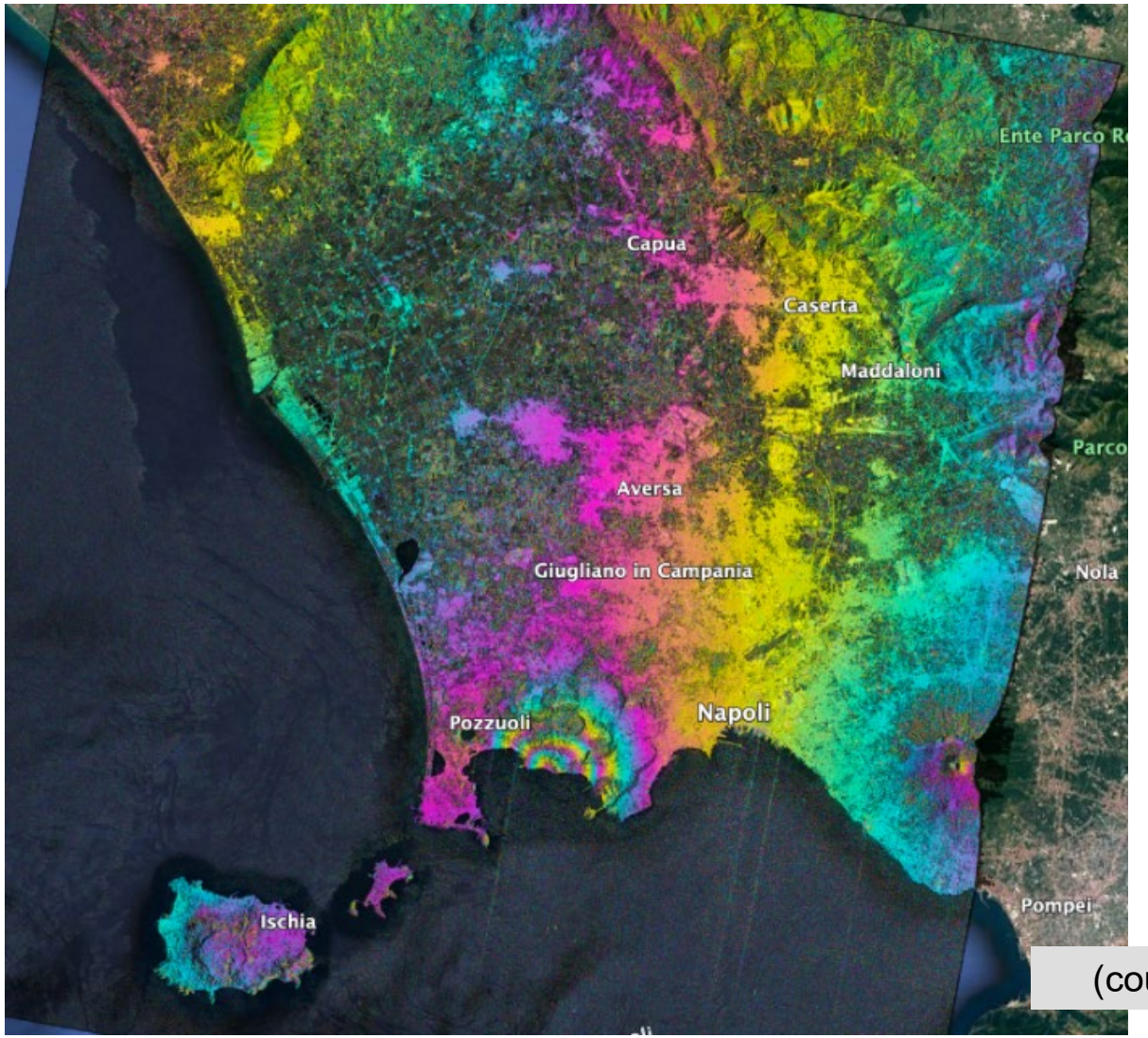


Mean E-W velocity map (S1-A, 11.01.2022 - 24.12.2022) - IWS data, TOPS mode



(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, NZ

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

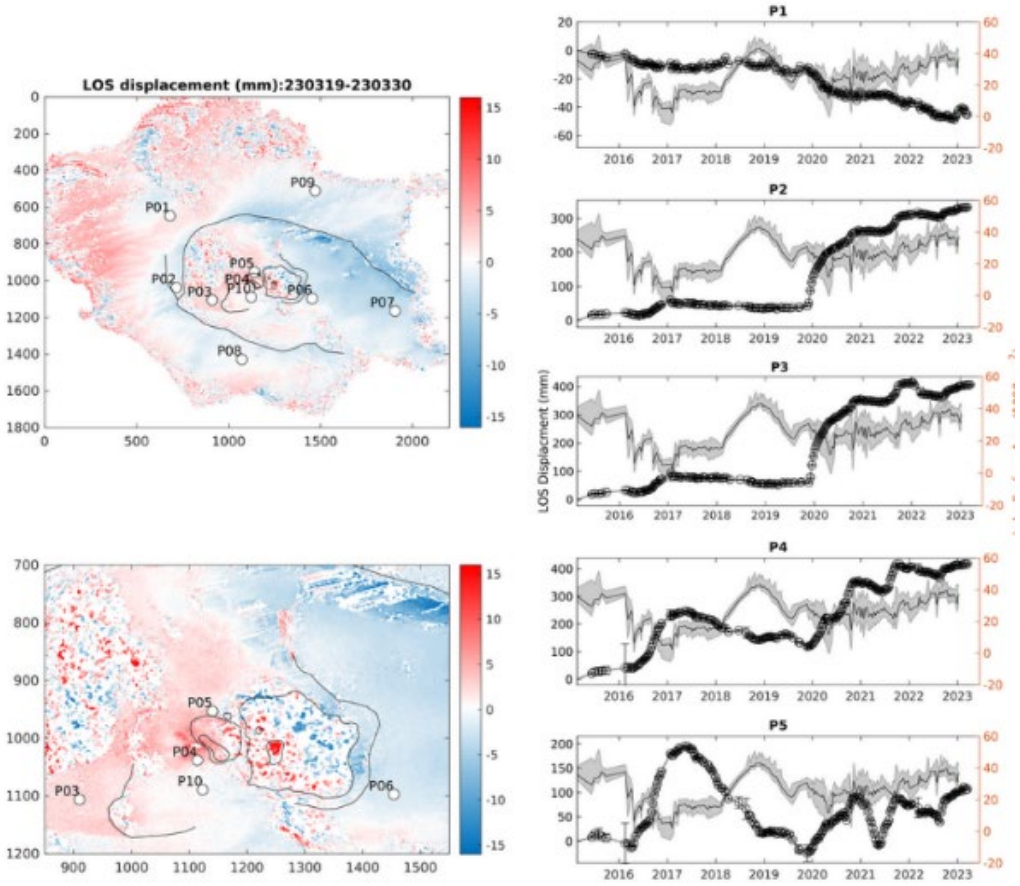
SAR/InSAR remains the main source of data coming from the island and continues to be vital for ongoing monitoring efforts.

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

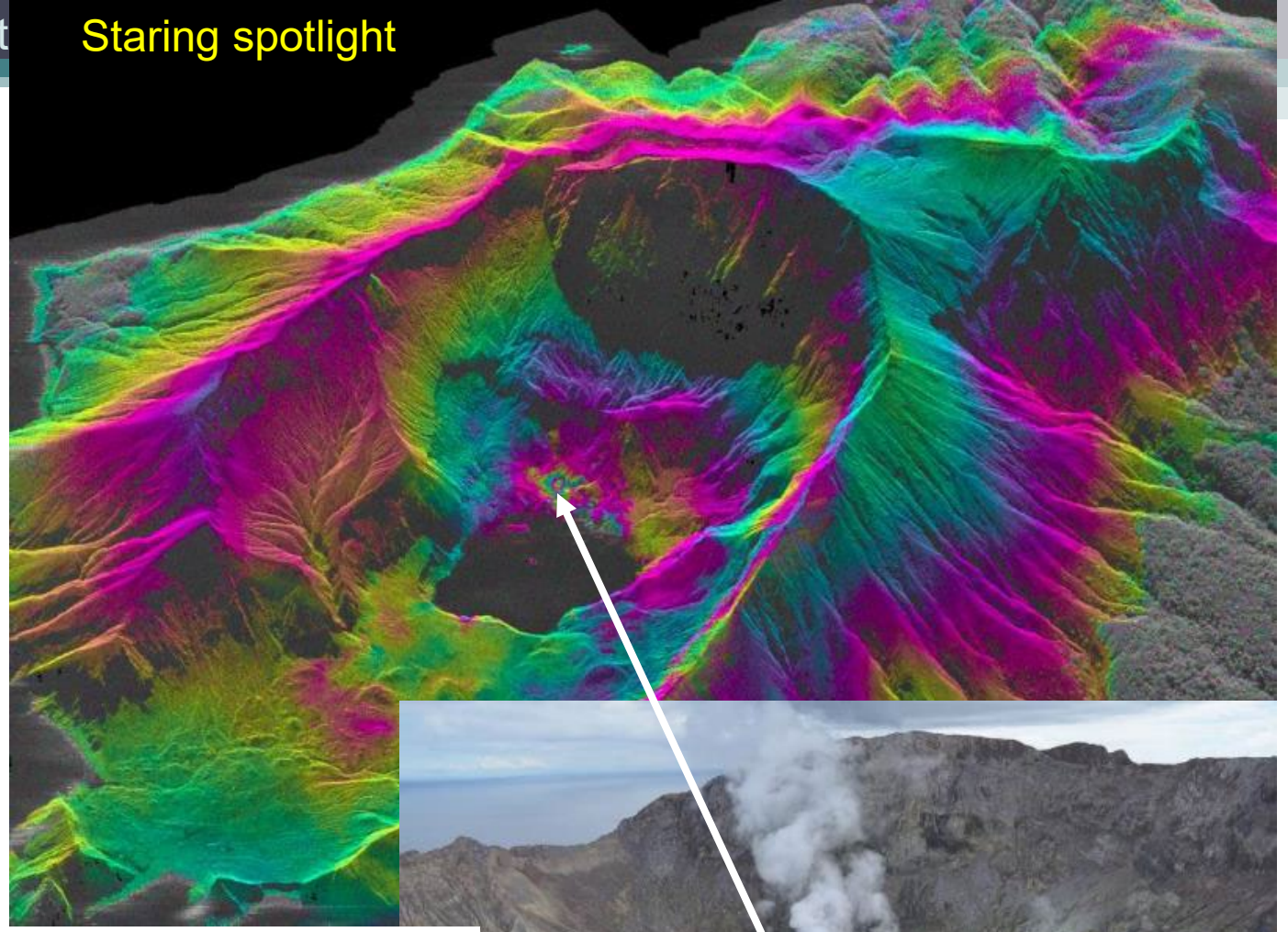
(courtesy: Ian Hamling, GNS Science)

White Island

TSX staring spotlight data

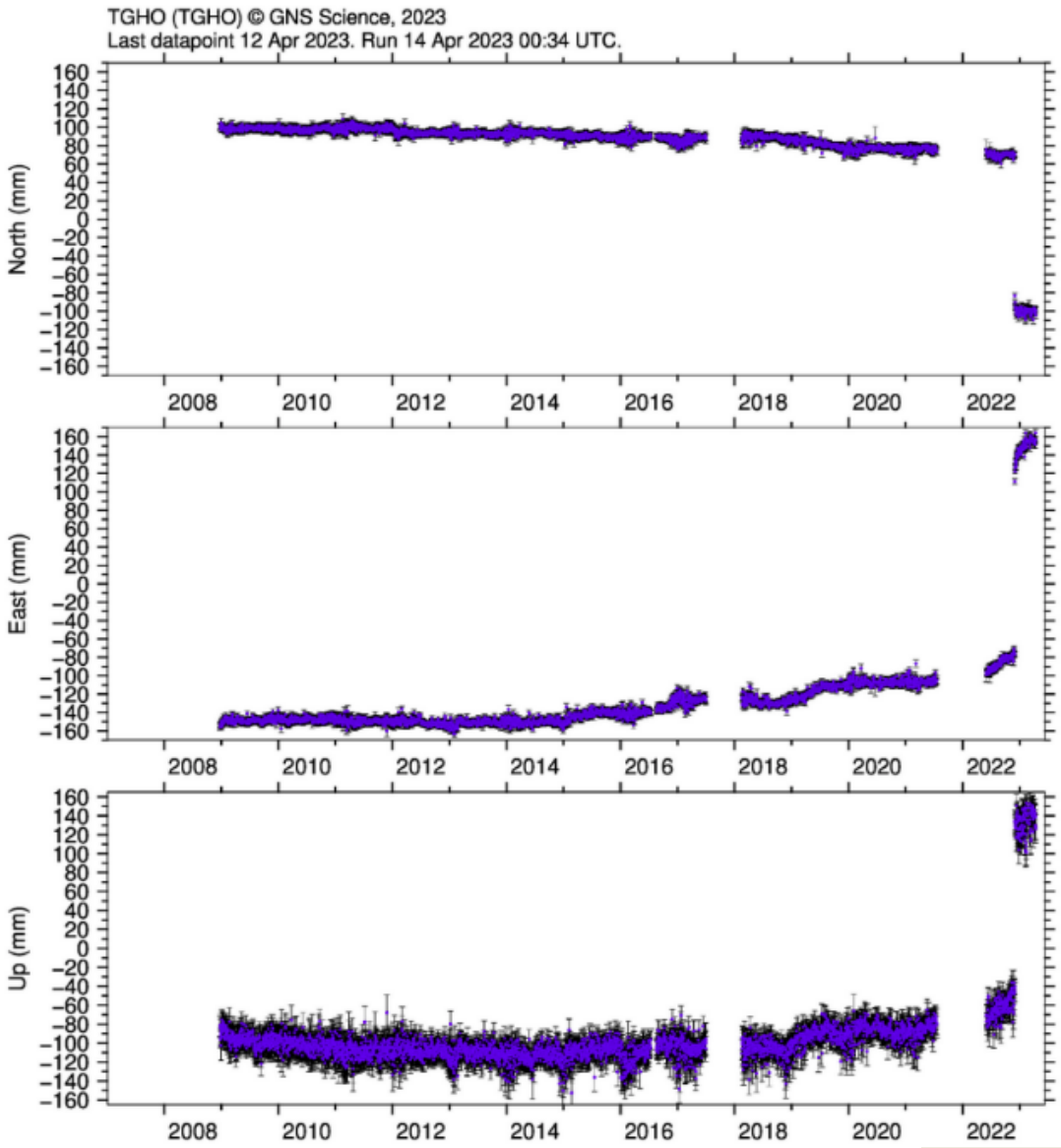


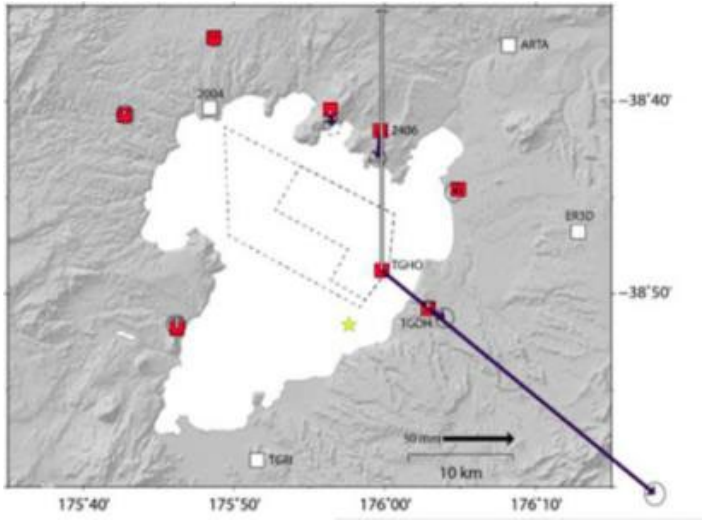
(courtesy: Ian Hamling, GNS Science)



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

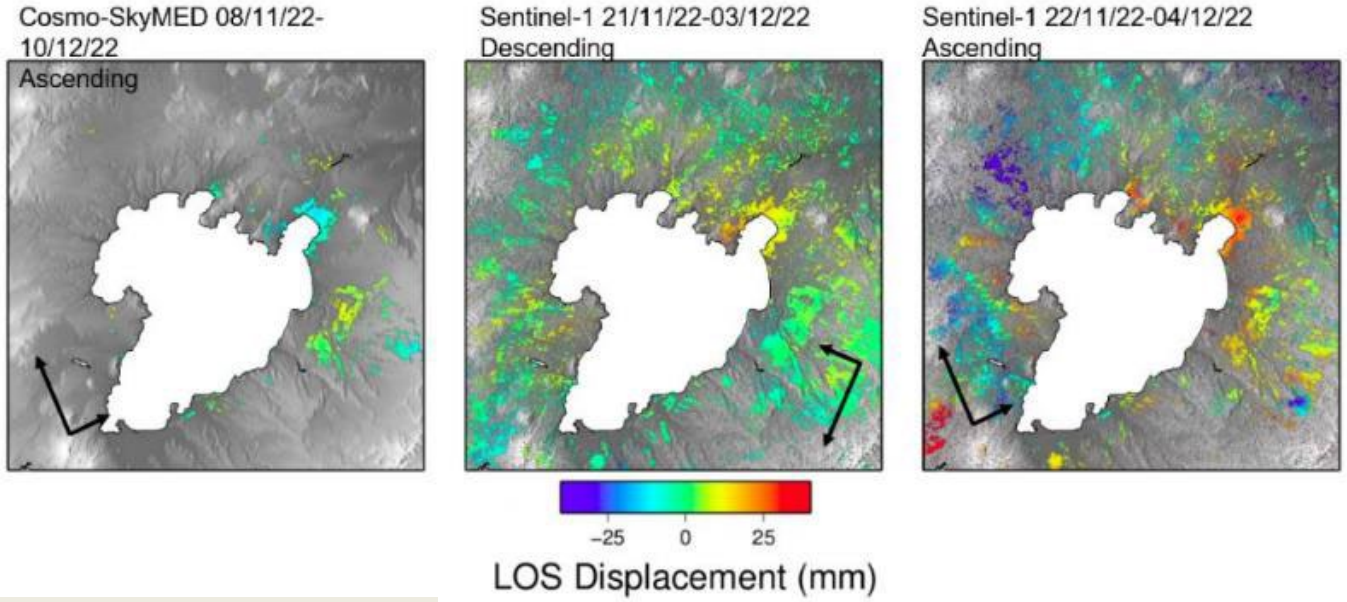
Taupo caldera unrest episode





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)

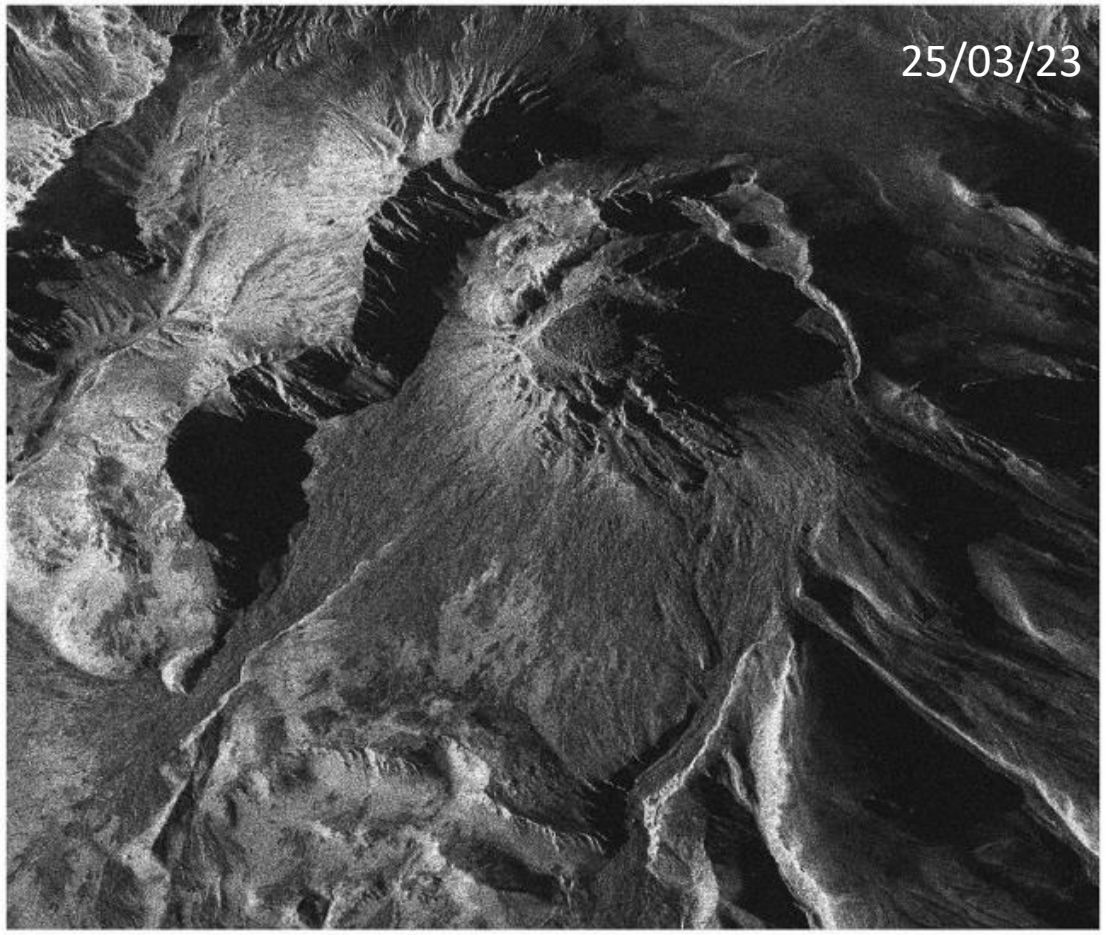
Kamchatka-Kuriles Supersite activity

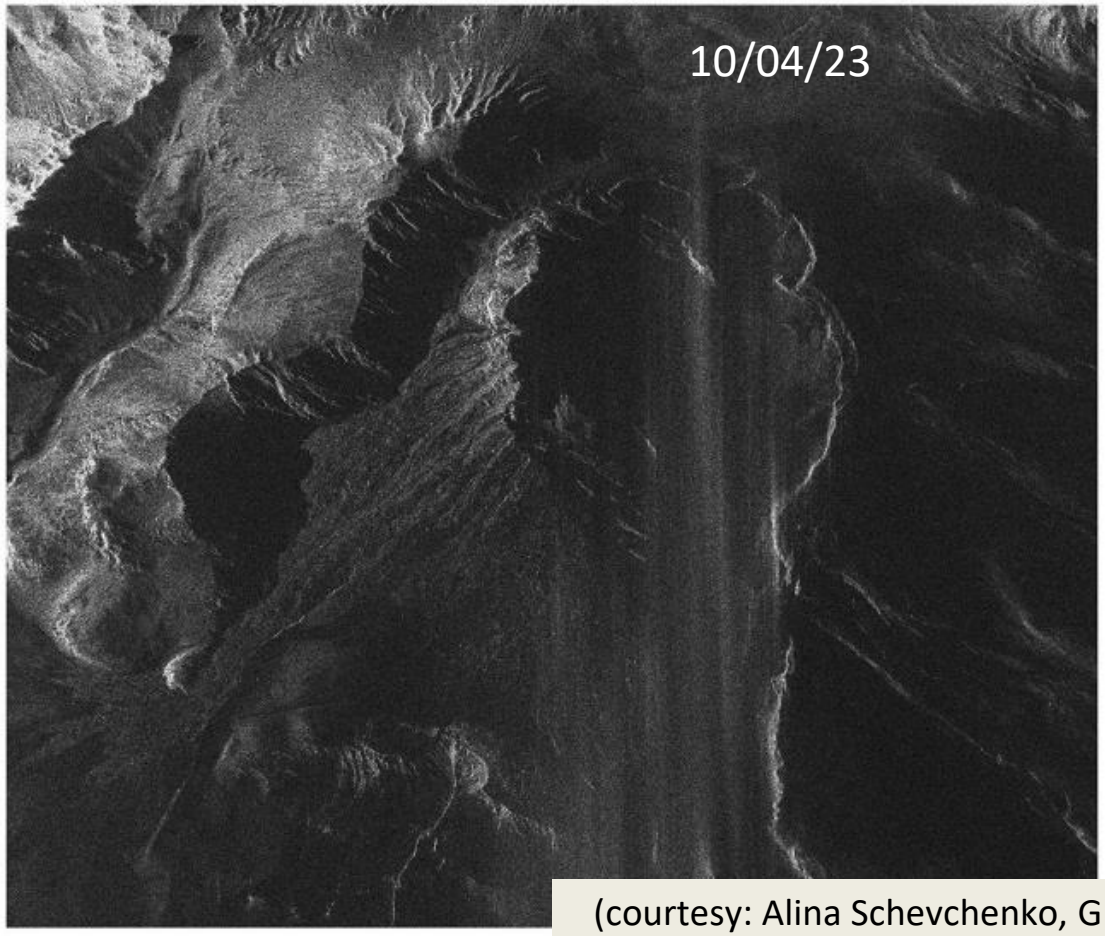
Supersite coordinator – Dr. Alina Shevchenko

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.

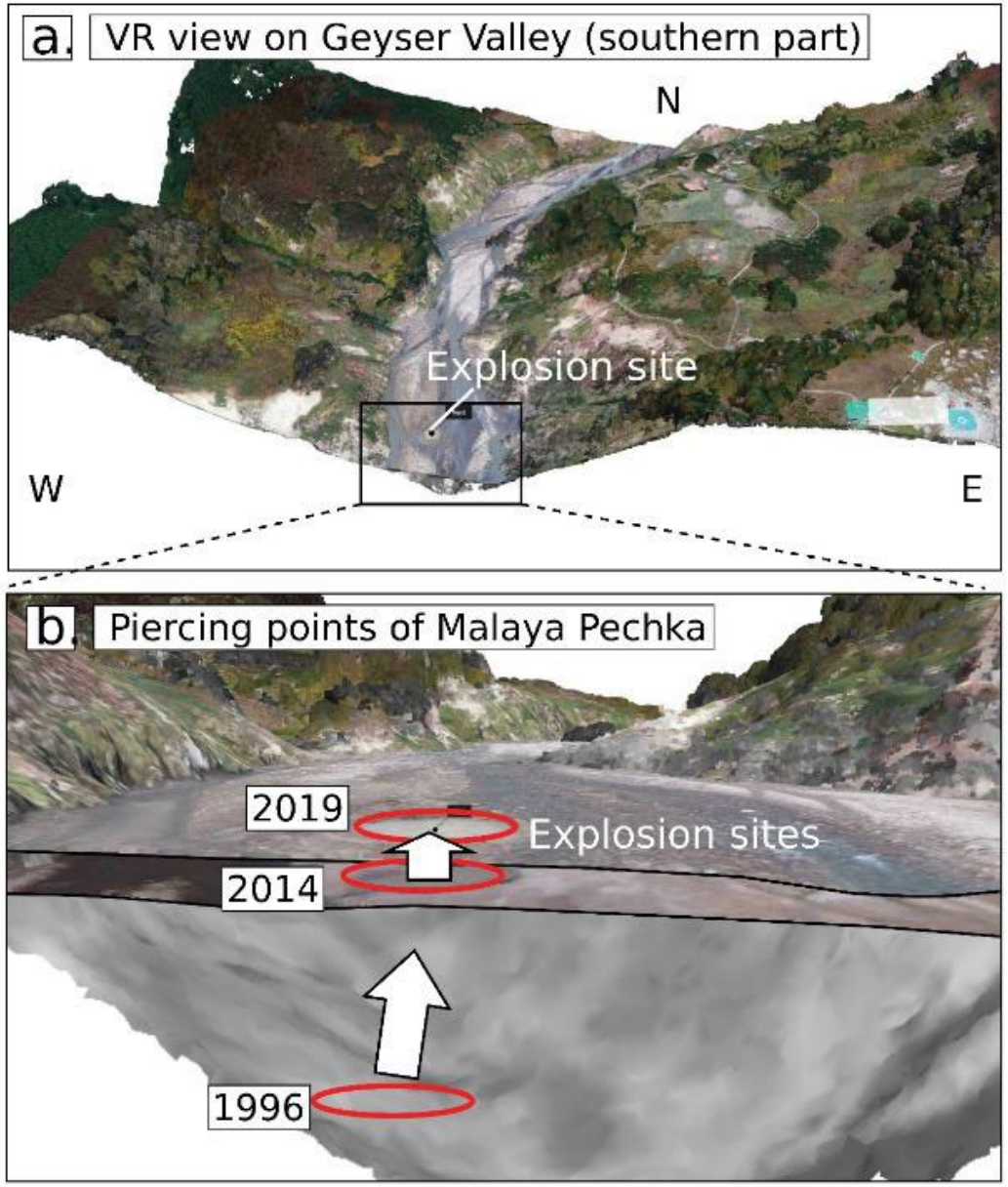
Shiveluch Volcano, while the edifice of the volcano was obscured by the dense ash plume.





(courtesy: Alina Schevchenko, GFZ)

The CSK amplitude images of the Shiveluch Volcano show the destruction of the lava dome 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