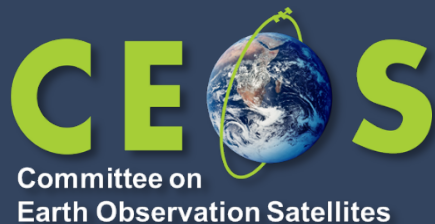


# WGDisasters 24

Geohazard Supersites and  
Natural Laboratories  
(GEO-GSNL)

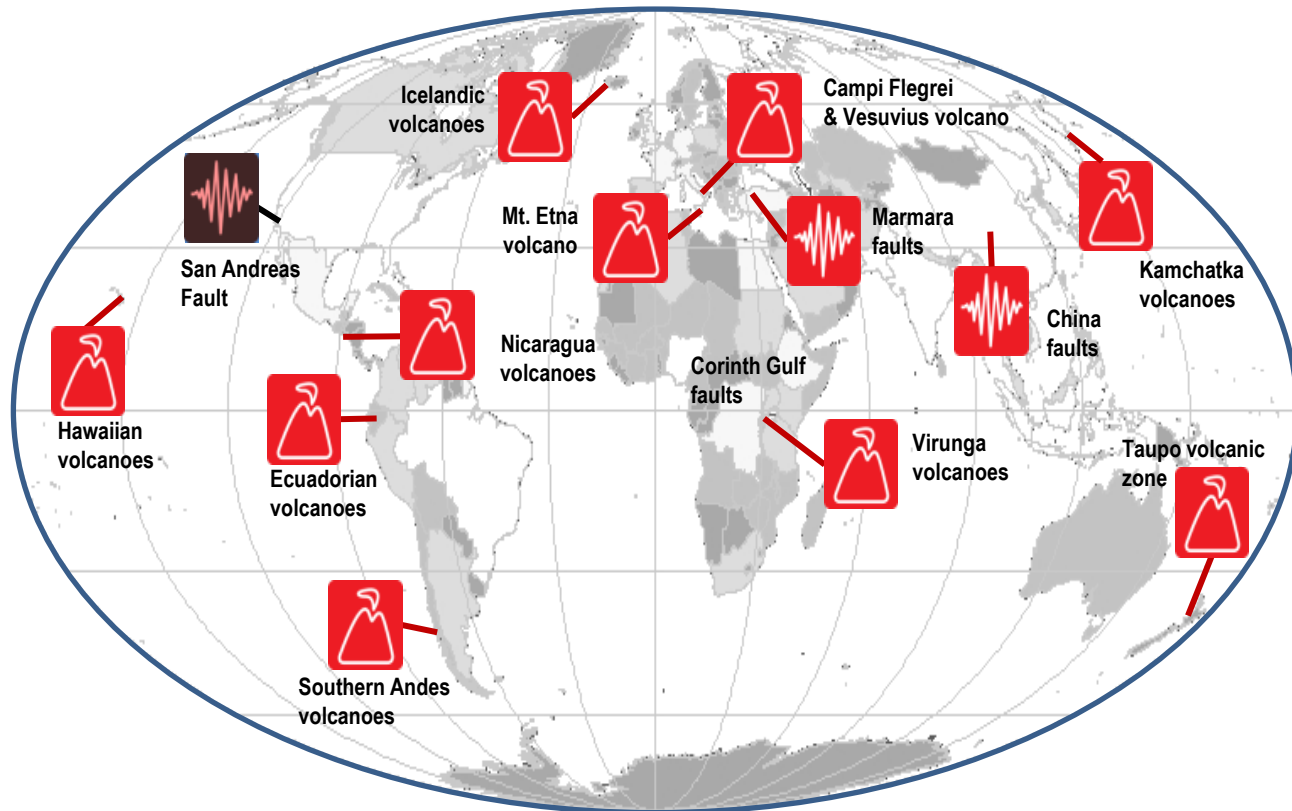


**Stefano Salvi - INGV  
GSNL - GEO Flagship  
WGDisasters-24**

**San Carlos de Bariloche,  
30 September-2 October 2025**



A network of  
**12 Supersites**  
and a  
**Natural Laboratory**



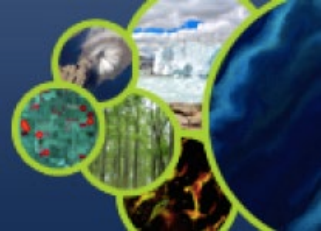


- **Satellite data providers** (Space Agencies)
- **In situ data providers:** The Supersite Coordinators belong to the local hazard monitoring Institutes
- **The Supersite scientific community,** including over 150 scientists worldwide

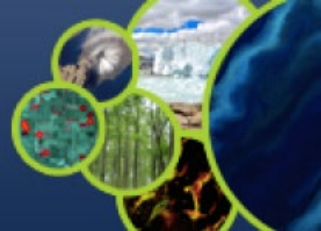




- San Andreas Fault NL 4<sup>th</sup> report. Expected in October 2025, possible delay due to US government shutdown...



- November 2025: Iceland 6<sup>th</sup> report
- November 2025: Ecuador 5<sup>th</sup> report
- November 2025: Virunga 4<sup>th</sup> report
- November 2025: Southern Andes 4<sup>th</sup> report
- November 2025: China 2<sup>nd</sup> report



The initial Coordinator (Yun Shao at AIR-CAS) retired in 2024.

The new Coordinator is Ming Liu, at the Laboratory of Target Microwave Properties (LAMP), in Deqing.

I visited him in July and discussed the main Supersite issues. He assured that they will act to solve them.



- **Southern Andes Supersite:** see pres. by Federico Carballo (SEGEMAR/OAVV)
- **Etna Supersite**
- **Iceland Supersite**
- **Hawaii Supersite**
- **Campi Flegrei-Vesuvius Supersite**
- **Virunga Supersite**
- **Ecuador Supersite**





# CL-HOTSAT Satellite Volcano Monitoring System



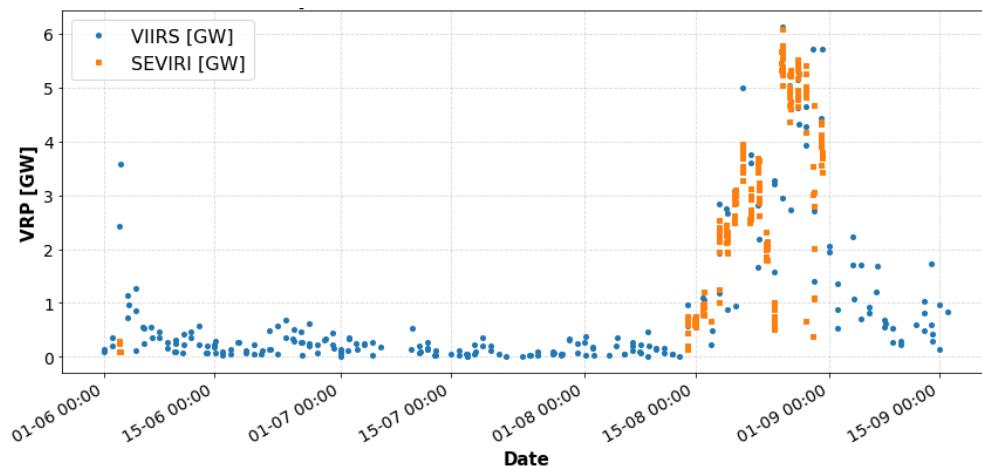
2 June 2025  
Lava Fountain +  
Pyroclastic  
Density Current

[Video](#)



13 Ago - 1 Sept 2025  
Effusive Eruption

Volcanic Radiative Power on Etna  
June-August 2025



SEVIRI+VIIRS

Courtesy of G.Ganci, INGV

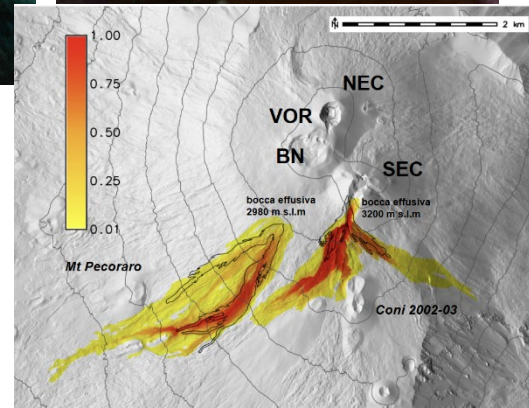




## MAPPING PYROCLASTIC & LAVA FLOWS



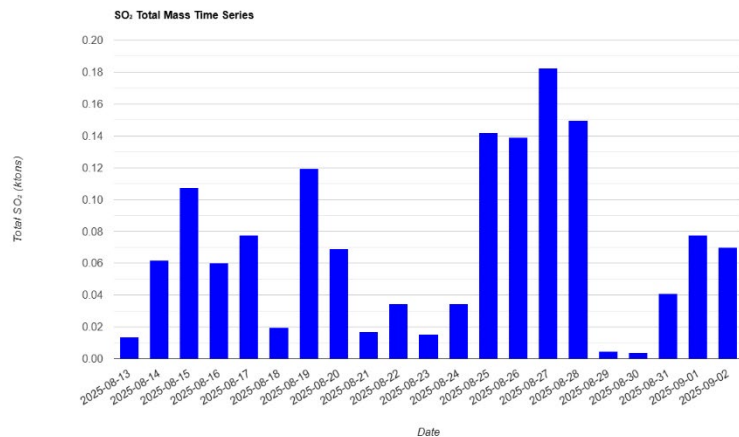
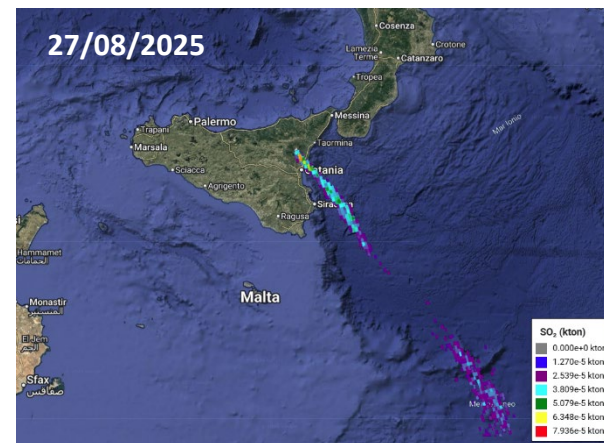
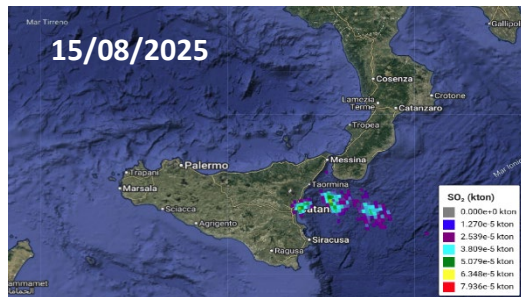
Pyroclastic flow area  $\approx 2 \text{ Mm}^2$



Courtesy of G.Ganci, INGV



## TROPOMI SO<sub>2</sub> MASS



Dozzo et al. 2025 A New Algorithm for the Global-Scale Quantification of Volcanic SO<sub>2</sub> Exploiting the Sentinel-5P TROPOMI and Google Earth Engine. Remote Sensing. <https://doi.org/10.3390/rs17030534>

Courtesy of G.Ganci, INGV



## ESAR

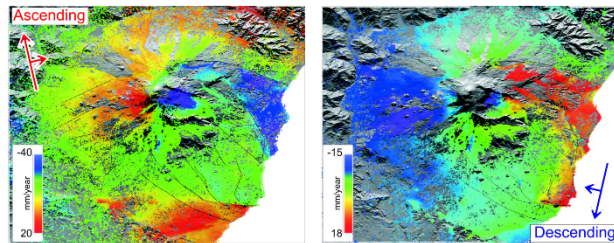
A WEB-GIS implemented by INGV-OE for an interactive visualization of InSAR Time Series

 ISTITUTO NAZIONALE DI GEOFISICA E VULCANOLOGIA

### Mt. Etna SAR (ESAR)

Sentinel-1A/1B

BETA Version



#### About this map

These interactive maps provides access to [EU Copernicus Sentinel-1 A-DInSAR](#) and CONAE SAOCOM products made by INGV-OE Remote Sensing Lab. SAOCOM stripmap data and SENTINEL 1 TOPSAR data are respectively provided by ASI and ESA to Mt. Etna Volcano Supersite, in the frame of GEO-GSHI initiative. Data were processed by the GAMMA software and StaMPS package (Hooper, 2008).

All Sentinel-1 results that are available for download are Derived Works of Copernicus data (2015-2016), subject to the following use conditions: "Terms and conditions for the use and distribution of sentinel data and service information".

"SAOCOM® Product - ©CONAE - (2020-2023). All rights reserved" Product processed under CONAE license in the framework of the SIASGE Cooperation Agreement CONAE-ASI."

#### Data citation

[Guglielmino F., Cassini C. \(2018\). Mt. Etna SAR \(ESAR\). Istituto Nazionale di Geofisica e Vulcanologia/INGV. <https://doi.org/10.13127/etna/esar>](#)

#### Credit

This service has been implemented in the frame of INGV-FISR project (Sale Operative integrate e Reti di Monitoraggio del futuro: FINGV 2.0)

#### Contact Us

#### Updates

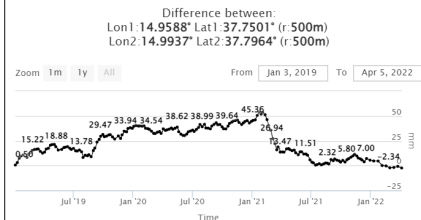
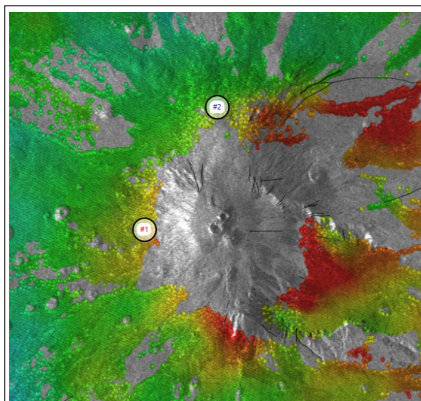
[Update Ascending \(2020-2023\)](#)

[Update Ascending \(2019-2022\)](#)



[Update Descending \(2015-2023\)](#)

[Update Ascending \(2018-2019\)](#)

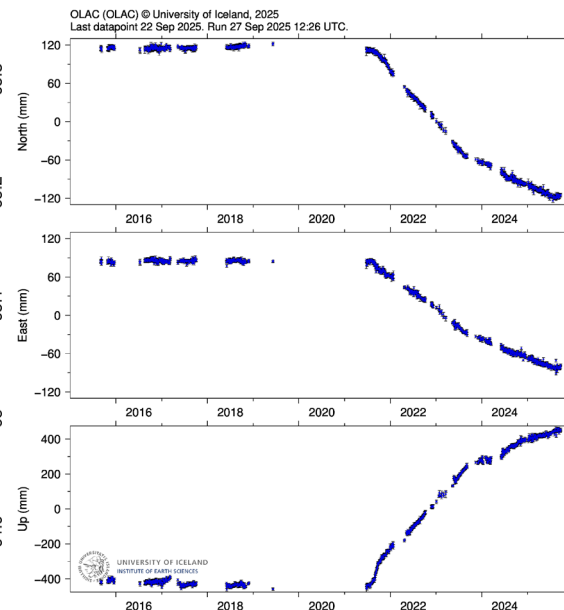
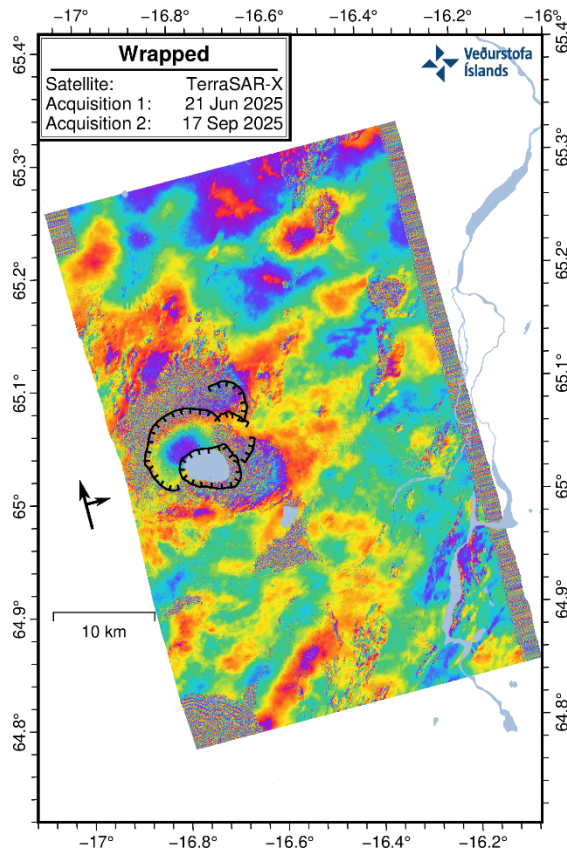
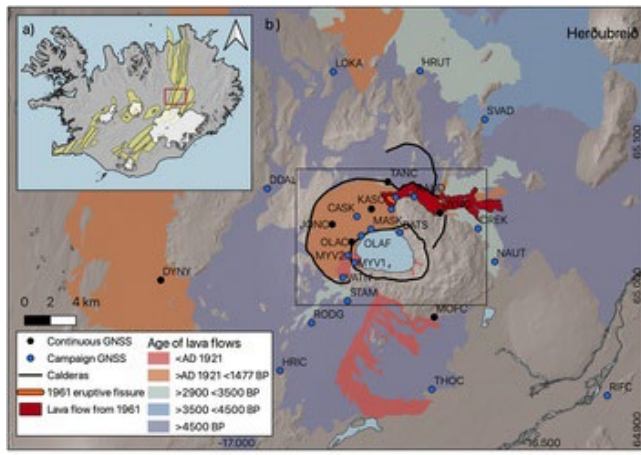






## Askja volcano

Unrest at Askja volcano commenced in July 2021 and as of September 2025 the volcano continues to inflate. Supersite data is extremely important for the continued monitoring of this volcano.

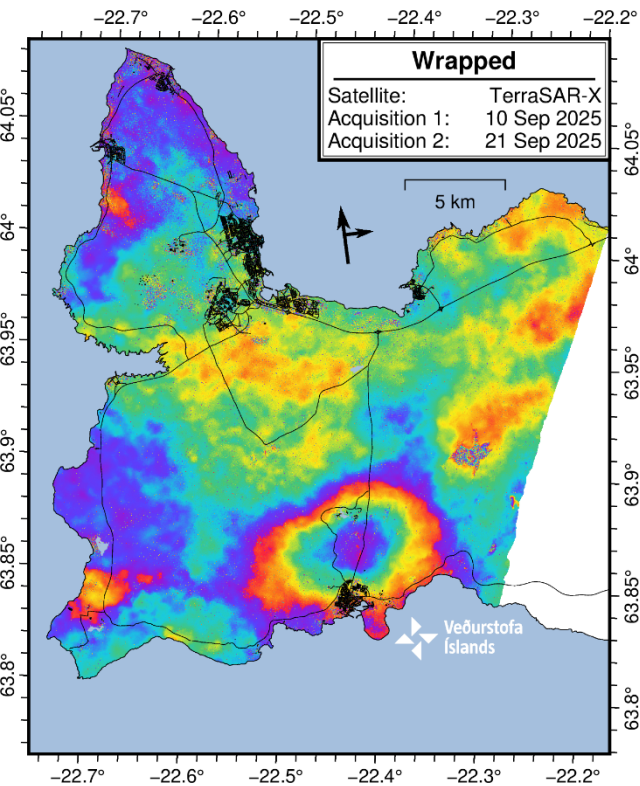


Courtesy of M. Parks, IMO

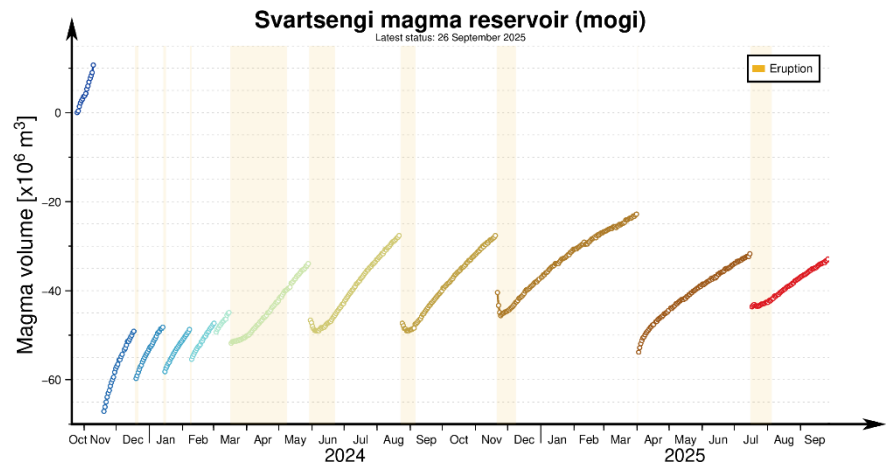


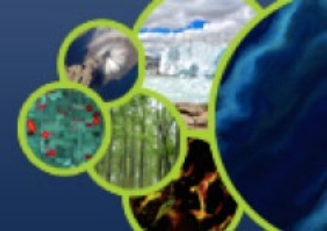
## Svartsengi volcanic system, Reykjanes Peninsula

Volcanic unrest and eruptions continue within the Svartsengi volcanic system on the Reykjanes Peninsula. The 11th dike intrusion and 9th eruption (since 10 November 2023) occurred on the 16 July 2025 and the magma reservoir began reinflating within a few days.

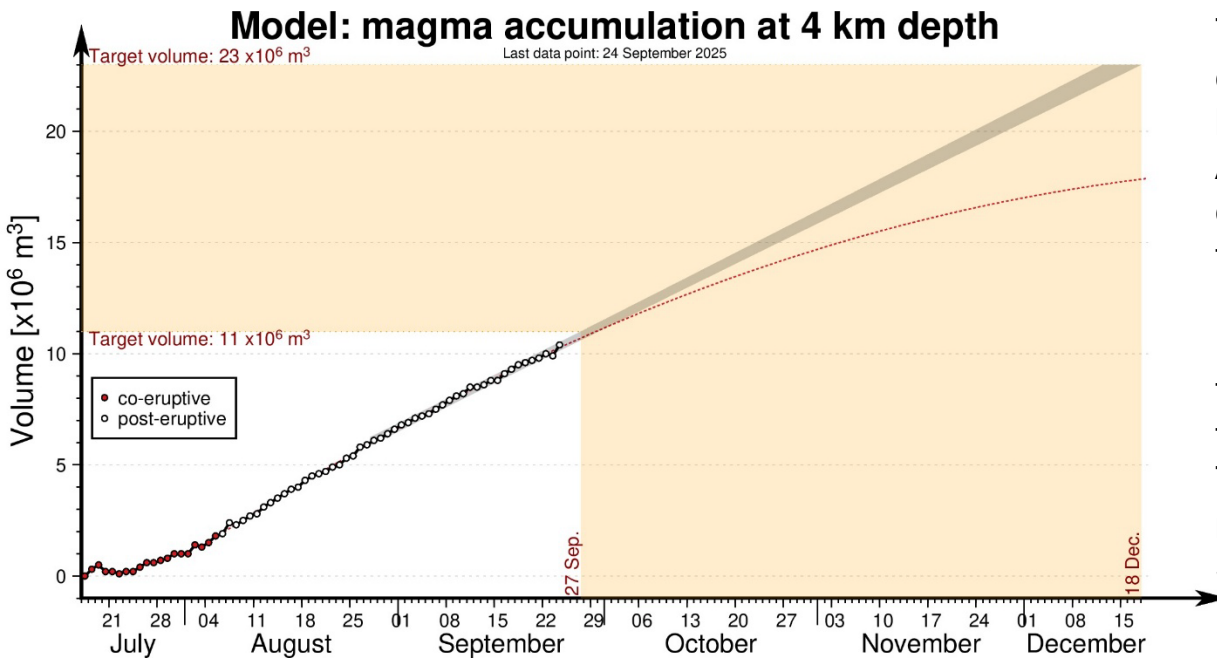


Courtesy of M. Parks, IMO





## Svartsengi volcanic system, Reykjanes Peninsula



The Svartsengi volcanic system is entering a new period of increased likelihood of an eruption. Analysis of past events has enabled an estimate of the volume range required to trigger the next diking event/eruption.

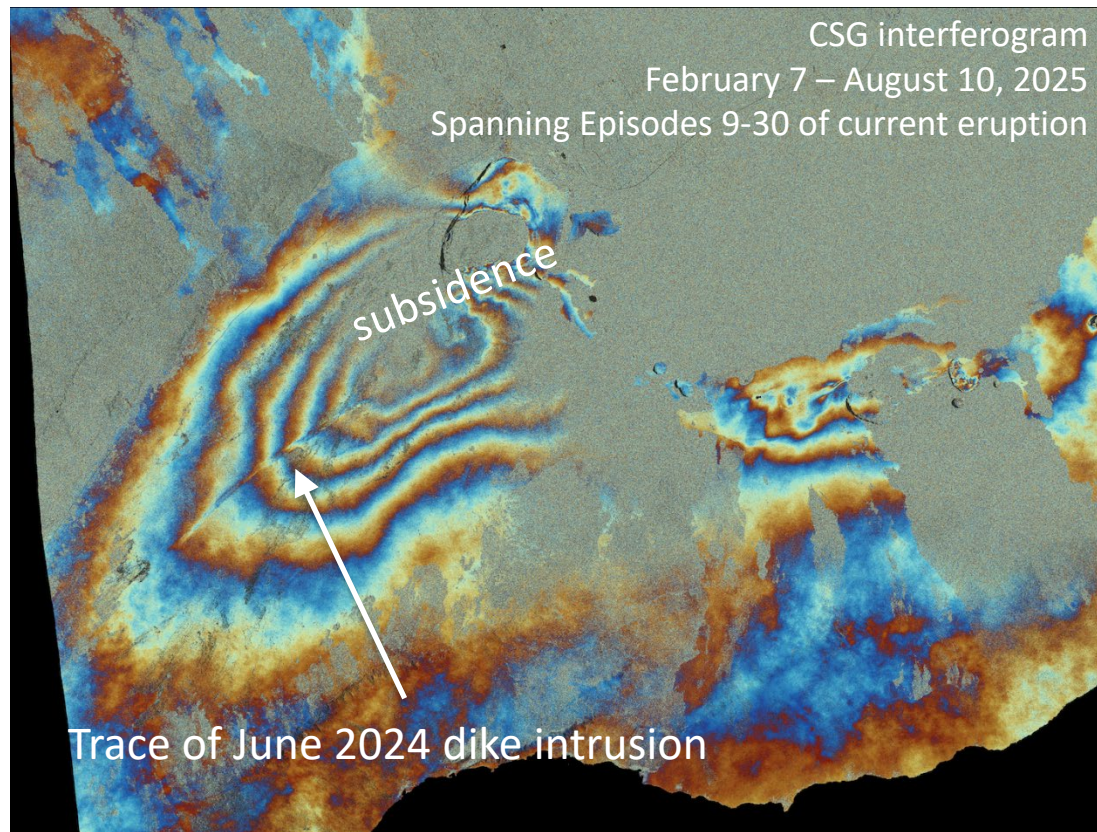
By using a geodetic model, it is possible to calculate the time needed to recharge these specific volumes. The lower bound target volume of 11 million cubic meters was reached on 27 September.





CSG interferogram spanning part of the ongoing lava fountaining eruption at Kilauea. Data show overall subsidence of the summit region, as well as a linear zone of disturbance that corresponds to the trace of a dike that erupted in June 2024 along the volcano's southwest rift zone.

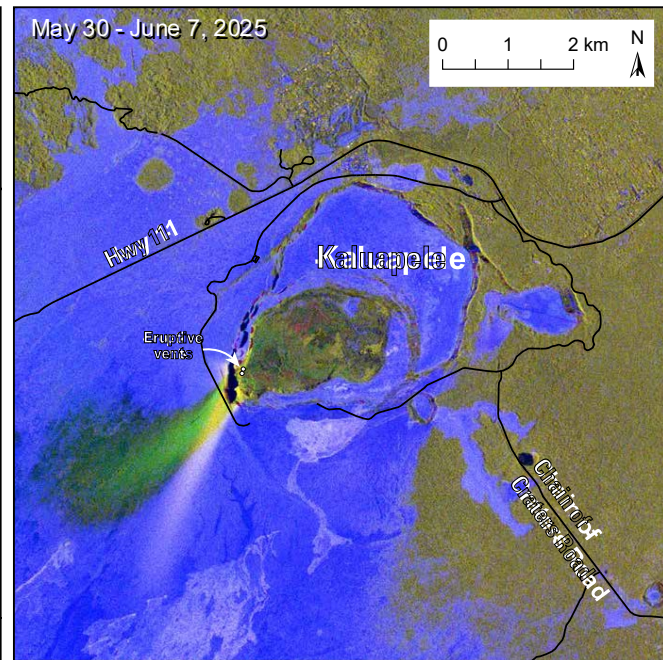
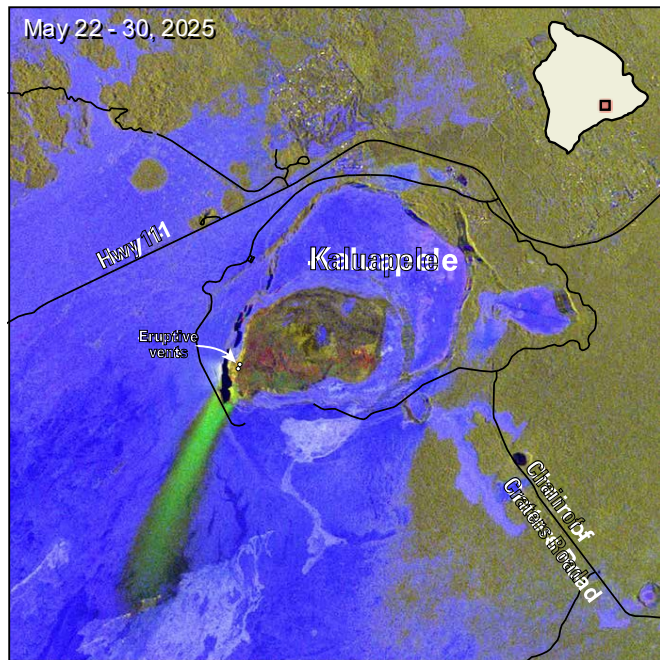
Courtesy of M. Poland, USGS







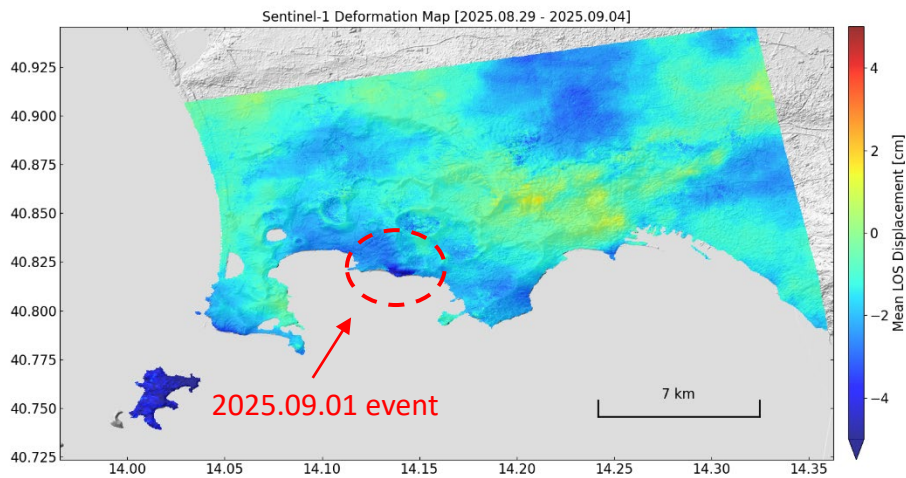
“Volcanic flow maps” made from R-G-B combination of second-generation COSMO-SkyMed HV amplitude images (R and G) and coherence spanning the two dates (B). Changes due to new deposits are bright green and indicate tephra from lava fountaining episodes.



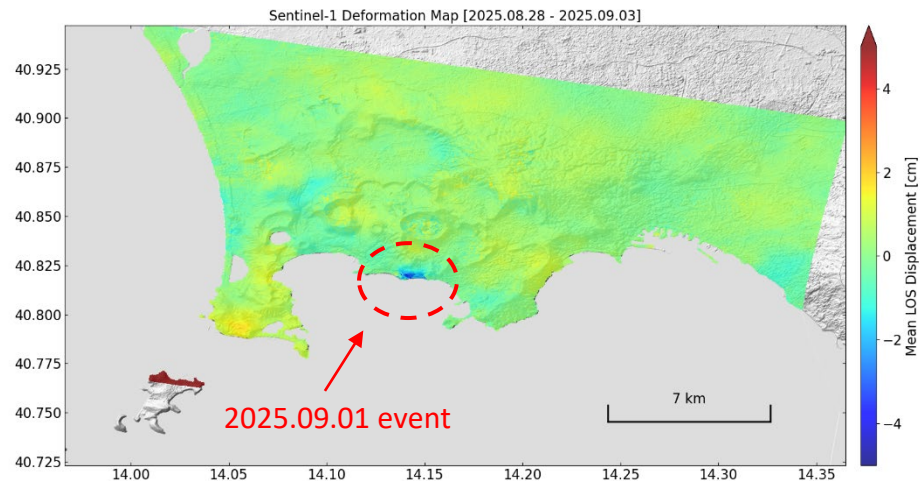


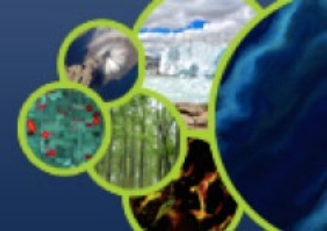
## Deformation due to the Sept.01, 2025, M=4.0 event

*(2025.08.29 - 2025.09.04) S1 Ascending orbit*



*(2025.08.28 - 2025.09.03) S1 Descending orbit*



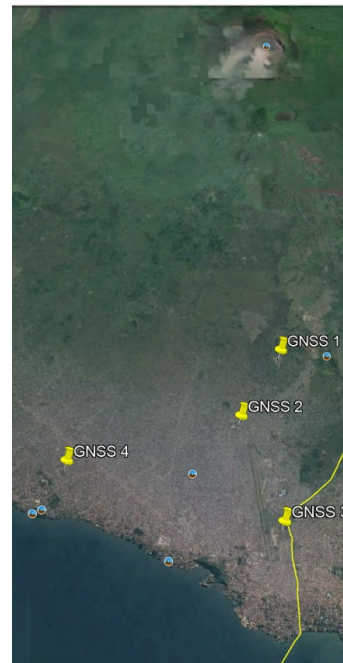


## Supporting GVO ground-based monitoring

The 5 GNSS stations donated by the GEO-GSNL to GVO are being deployed in Goma city and around, at secured places to follow up the evolution of the Nyiragongo 2002 and 2021 eruptive dykes.

We continue to access COSMO-Skymed, Pleiades images and SAOCOM 1 images

Courtesy of C. Balagizi, GVO





**Dissemination - the Virunga Supersite was presented at :**

GEO Global Forum 2025 in Roma, 5-9 May, 2025

GEO Global Platform for Disaster Risk Reduction, Geneva 2-6 June, 2025

IAVCEI 2025 Scientific Assembly, Geneva June 29 – July 4, 2025

Workshop on Advancing Volcanic Hazards in Early Warnings for All, Geneva 7-9 July, 2025

**Major issues:**

Volcanic hazards map need to be updated after the Nyiragongo 2021 eruption

Hi-res DEM from Pleiades images is still incomplete due to high cloud coverage

The war has slowed down ground monitoring

We are still lacking funding to finance our activities



8 volcanoes on the continent and 3 in the Galapagos islands are monitored with InSAR (Sentinel 1, TerraSAR-X, COSMO-SkyMed) imagery, which are combined with GPS, tilt, seismic, gas, visual, ground, and satellite thermal data to evaluate weekly the volcano's status (quiet, reactivating, or erupting).

For IGEPN, access to imagery and processing capacity provided by GSNL/CEOS is invaluable for providing frequent assessments of volcanoes status to local authorities, civil defense agencies and the public in general.

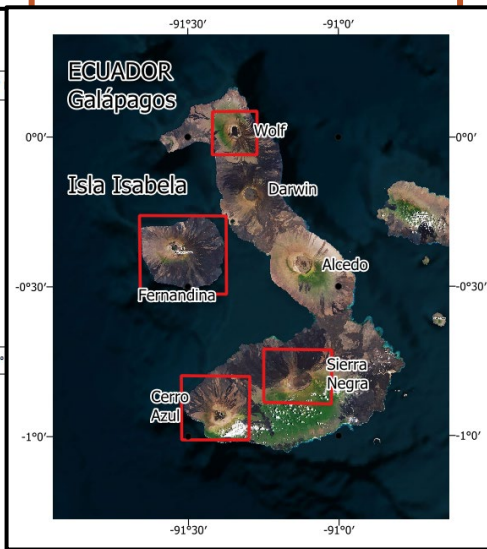
Daily reports for volcanoes Sangay and Reventador are available on the IGEPN's website and in the archives.

Courtesy of S. Aguaiza, IGEPN

### On the continent



### Galapagos Islands



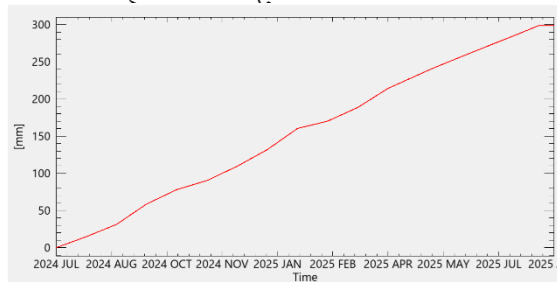
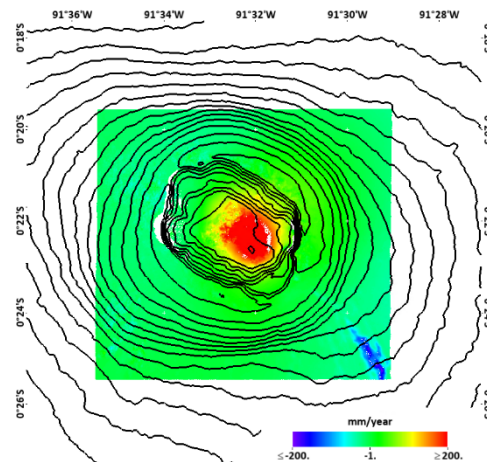


Velocity maps and ground motion time series shows inflation at volcanoes which in some cases can be a precursor to eruption.

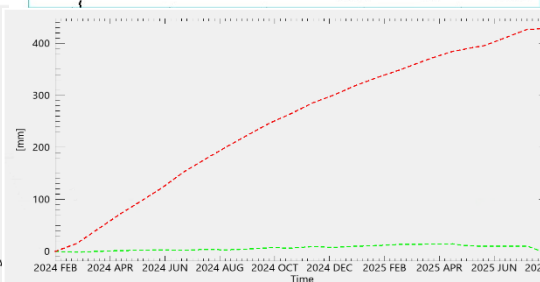
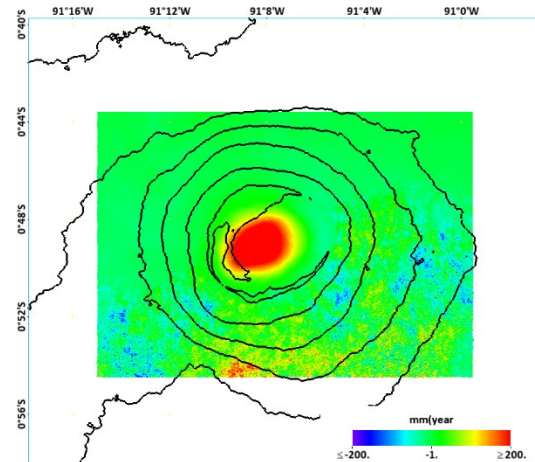
11 volcanoes are monitored weekly-biweekly by IGEPN with Sentinel-1, TerraSAR-X and CSK imagery.

Courtesy of S. Aguaiza, M. Yopez, P. Mothes, IGEPN

**Fernandina volcano**

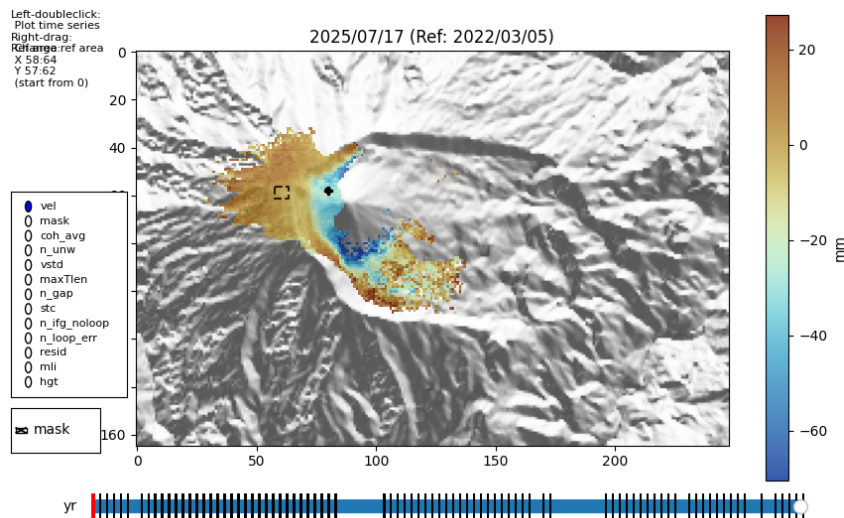


**Sierra Negra volcano**

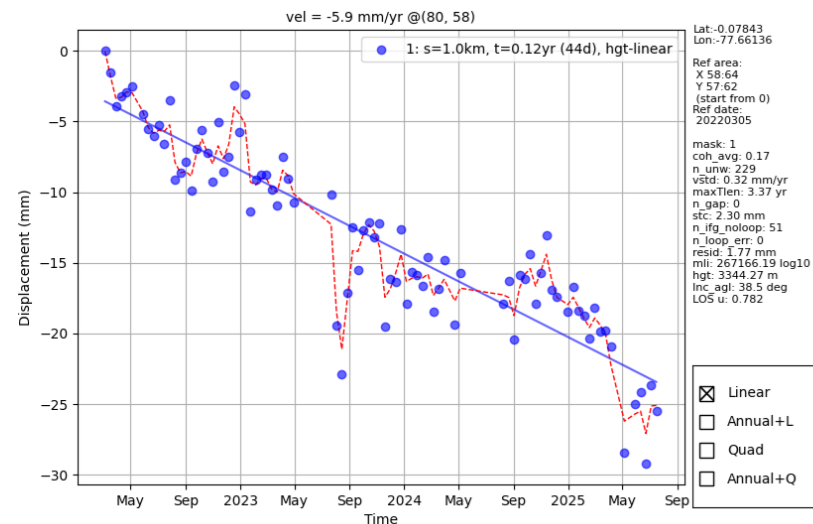




## El Reventador volcano, Sentinel 1 Ascending 03/2022 - 07/2025



Velocity map. Blue color shows deflation in the flank of the volcano.



Time series shows nearly constant deflation in Reventador volcano.





## **In-house training at INGV premises:**

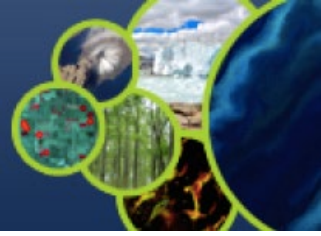
- 2 Virunga Supersite researchers in 2025 (with a 1 year fellowship)
- 1 GVO researcher in 2026 (with a 1-year fellowship)

## **InSAR courses 2025:**

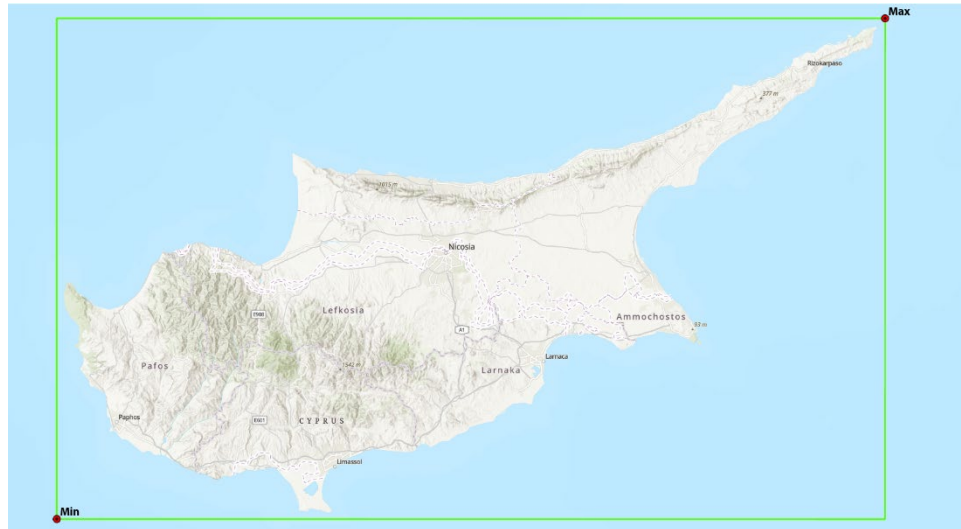
INGV held a short InSAR course for Southern Andes Supersites researchers

## **Provision of cloud resources for data processing:**

GSNL continues to give access to Virtual Machines for InSAR processing to the Supersites (presently for Ecuador and Southern Andes Supersites). Service provided by PSNC, a Polish center for HPC and INGV.



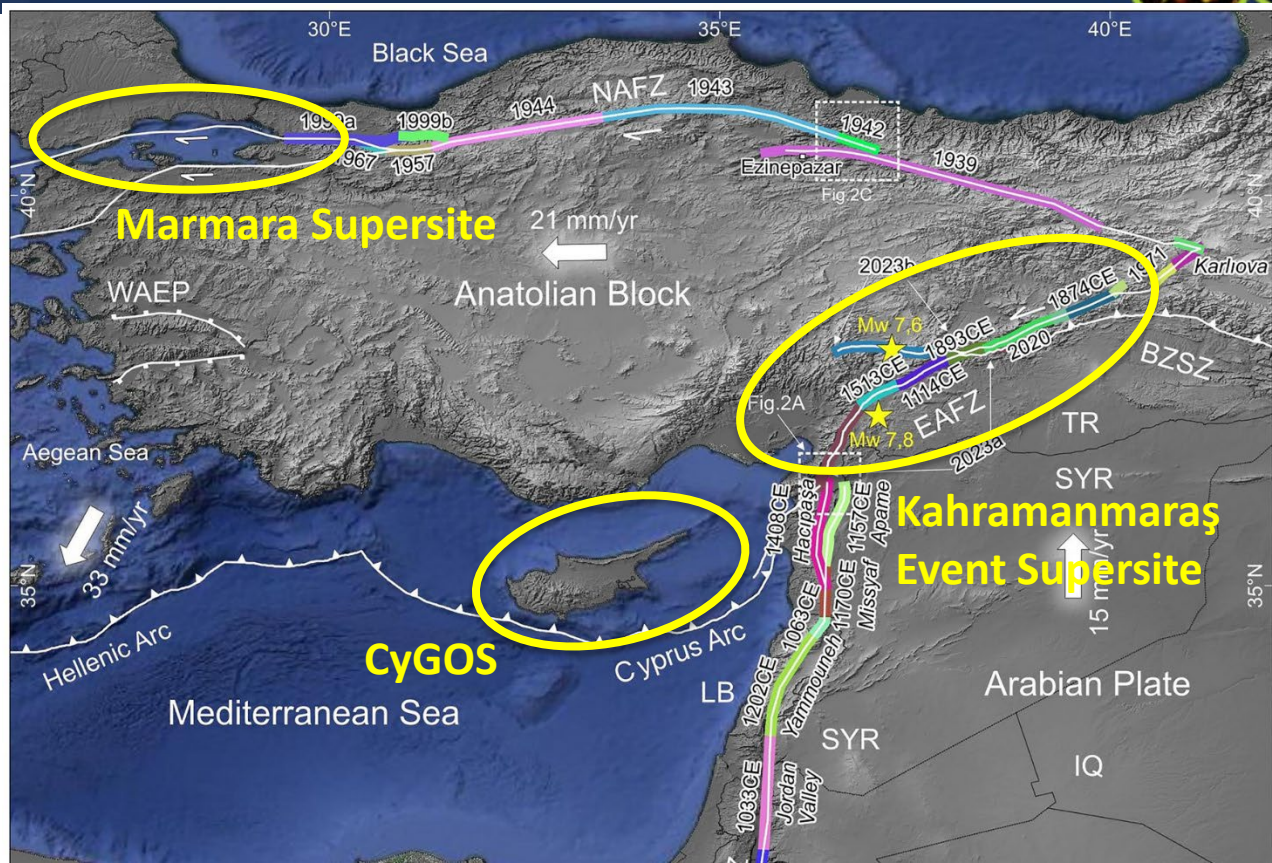
## Cyprus Geohazard Observatory Supersite (CyGOS)



# Cyprus Geohazard Observatory Supersite (CyGOS)

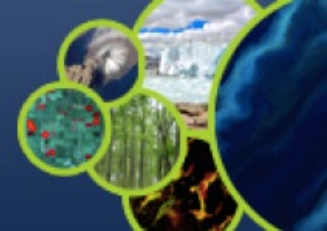


Cyprus is located at the African-Eurasian plates interface, in a tectonic context with very high seismic hazard. We have two other seismic Supersites in the area.

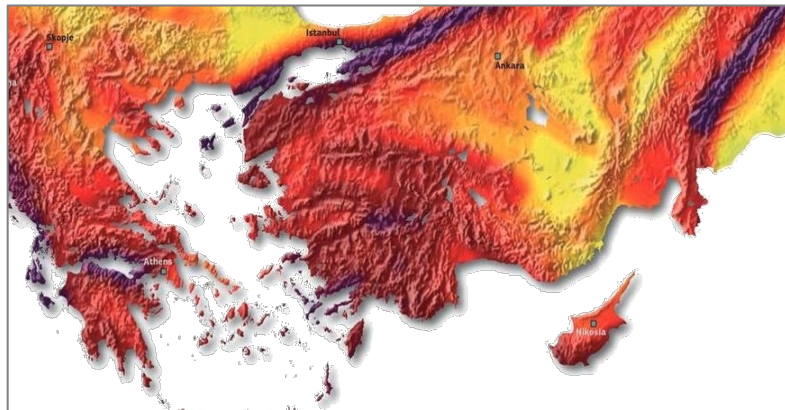




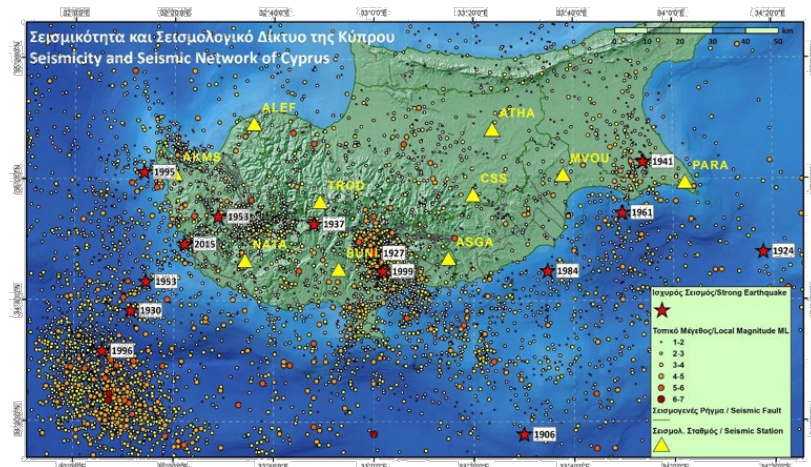
# Cyprus Geohazard Observatory Supersite (CyGOS)



## The European Seismic Hazard Map



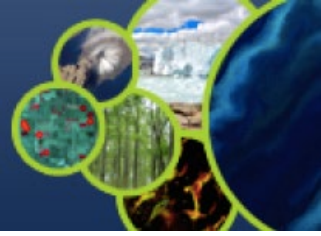
Ground shaking to be exceeded with a 10% probability in the next 50 years



Active landslides cause extensive  
property damages

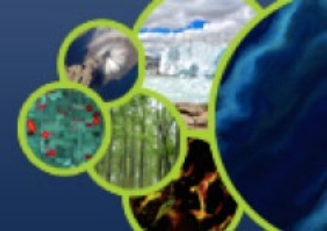


# Cyprus Geohazard Observatory Supersite (CyGOS)



## Objectives

- Establish a global observatory for the study of tectonic interactions, seismicity and geohazards
- Deploy a dense network of high-grade GNSS and InSAR monitoring stations.
- Provide open access to high-quality geohazard monitoring data to the global scientific community
- Develop a data access platform to facilitate access to geohazard-related observations
- Develop and maintain a validated, high-resolution national ground velocity model (CyGMS).
- Strengthen resilience to geohazards through enhanced monitoring capabilities, real-time alerts and rapid dissemination of actionable information.
- Foster collaboration among local and international scientific institutions and stakeholders.



**Coordinator:** Chris Danezis

Cyprus University of Technology, Chair of the Department of Civil Engineering and Geomatics

Head of the CyCLOPS Research Infrastructure, established in 2021 in collaboration with the German Aerospace Center (DLR).

[CyCLOPS: Cyprus Continuously Operating Geohazards Monitoring and Prevention System.](#)

He is also a founding member of the [ERATOSTHENES Center of Excellence](#) for Earth observation and geospatial information



## Available in situ data (open following EPOS RI data policy):

Type of data	Data source	Data access
GNSS time series	CyCLOPS GNSS CORS	CyCLOPS contributes three stations to EPOS and one station to EUREF-EPN. The data are provided to the broader public under the CC license. Data from other stations (in areas of interest) will also be provided.
Weather station data	CyCLOPS co-located meteorological sensors	Registered access via CyCLOPS data portal. Meteorological sensors will be provided two years after the completion of studies.
SAR corner reflectors	CyCLOPS SAR corner reflectors	Corner reflector coordinates will be provided through the CyCLOPS Data Portal. Plans for joining CEOS WGCV - SAR Subgroup (Cal\Val Portal)
Geological Data	Cyprus Geological Survey Department	Access to detailed geodatabase with, geohazards (landslides, rockfalls, sinkholes), general tectonics, active faults, lithology and borehole data
Seismic Data	Cyprus Geological Survey Department	Access to the seismic catalogue
Soil data	Cyprus Geological Survey Department	Access to advanced and detailed geodatabase, soil type, geochemistry and geomorphological mapping





## EO data requested:

Type of data	Quantity (per year)	Use
TerraSAR-X Staring spotlight	104 (archive) 48 (new)	Landslide, tectonic deformation monitoring, calibration of CyCLOPS velocity model
TerraSAR-X High resolution spotlight	48 (new)	ditto
TanDEM-X DEM	Full Cyprus coverage from 2011 archive New full coverage requested for 2025	<ul style="list-style-type: none"> <li>• Update DEM for active landslides</li> <li>• Improve InSAR processing</li> <li>• Detect surface elevation changes</li> <li>• Support GNSS, InSAR integration</li> <li>• Update national terrain model</li> </ul>
COSMO-SkyMed Stripmap	48	<ul style="list-style-type: none"> <li>• National tectonic strain monitoring</li> <li>• Velocity model support</li> <li>• Supersite geohazard integration</li> </ul>
RADARSAT-2 Spotlight	48	<ul style="list-style-type: none"> <li>• GNSS-calibrated InSAR analysis</li> <li>• Coverage in coastal, mountain zones</li> <li>• Complement other sensors</li> </ul>



## EO data requested - 2:

Type of data	Quantity (per year)	Use
RADARSAT-2 Ultra Fine	48	<ul style="list-style-type: none"> <li>• GNSS-calibrated InSAR analysis</li> <li>• Coverage in coastal, mountain zones</li> <li>• Complement other sensors</li> </ul>
RADARSAT-2 Fine Mode	48	<ul style="list-style-type: none"> <li>• Broad-scale ground motion</li> <li>• Long-term velocity model</li> <li>• Complement Sentinel-1 coverage</li> </ul>
PAZ High Resolution Spotlight	48	<ul style="list-style-type: none"> <li>• High-resolution displacement monitoring</li> <li>• Enhanced stacking with TerraSAR-X and COSMO-SkyMed</li> <li>• GNSS-InSAR integration in vegetated/urban zones</li> </ul>
PAZ Staring Spotlight	48	<ul style="list-style-type: none"> <li>• Ultra high-resolution displacement detection and monitoring</li> <li>• Targeted displacement monitoring in dense urban/rural areas</li> </ul>
PAZ Stripmap	48	<ul style="list-style-type: none"> <li>• Wide-area interferometric monitoring</li> <li>• Support development of a national velocity model</li> <li>• Complement Sentinel-1 and RADARSAT coverages</li> </ul>



## EO data requested - 3:

Type of data	Quantity (per year)	Use
ICEYE Spot	48	<ul style="list-style-type: none"> <li>• Early warning and rapid-response applications</li> <li>• Slope stability analysis in high-risk zones</li> <li>• Sub-meter displacement detection</li> <li>• GNSS and InSAR synergy at local scales</li> </ul>
ALOS-PALSAR 2 Spotlight	48	<ul style="list-style-type: none"> <li>• High-resolution monitoring of selected landslides</li> <li>• Detailed slope stability assessment</li> <li>• GNSS + CR + ECR integration</li> </ul>
ALOS-PALSAR 2 Stripmap	48	<ul style="list-style-type: none"> <li>• National landslide and tectonic deformation monitoring</li> <li>• GNSS + InSAR integration</li> <li>• Vegetation penetration for slow-moving slope instabilities</li> </ul>
SAOCOM Stripmap	48	<ul style="list-style-type: none"> <li>• L-band InSAR for vegetated &amp; slow-moving landslides</li> <li>• Complementary analysis to ALOS-2 and NISAR</li> <li>• Improve coherence in rural areas</li> </ul>
UMBRA	48	<ul style="list-style-type: none"> <li>• Ultra-fine resolution monitoring of landslide-prone zones</li> <li>• Complementary analysis to TerraSAR-X and Cosmo-SkyMed</li> <li>• Integrate with ECR and GNSS arrays for mm-level tracking</li> </ul>



## EO data requested - 4:

Type of data	Quantity (per year)	Use
NovaSAR-1 Stripmap	48	<ul style="list-style-type: none"> <li>• Complementary S-band SAR analysis</li> <li>• Support wide-area displacement mapping</li> <li>• Test synergy with L- and X-band displacement results</li> </ul>
Capella Space Spotlight modes	48	<ul style="list-style-type: none"> <li>• Enhance temporal stack alongside TerraSAR-X, PAZ, and ICEYE</li> <li>• National strain mapping support</li> <li>• Integrate with GNSS and InSAR for displacement monitoring</li> </ul>
NISAR SweepSAR	48	<ul style="list-style-type: none"> <li>• GNSS &amp; InSAR integration</li> <li>• National velocity model enhancement</li> <li>• Monitoring displacement in vegetated terrain</li> </ul>
NISAR Stripmap and ScanSAR	48	<ul style="list-style-type: none"> <li>• Complementary to L-band displacement monitoring</li> <li>• Soil moisture estimation</li> </ul>

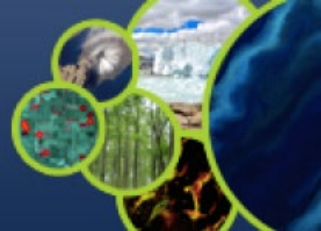


## EO data requested - 5:

Type of data	Quantity (per year)	Use
Pleiades Panchromatic, Multispectral	Full Archive 2 new coverages	<ul style="list-style-type: none"> <li>• Land Cover classification</li> <li>• Damage mapping after earthquake and/or landslides</li> <li>• Support for rapid impact mapping after geohazard events</li> <li>• Visual validation of InSAR results</li> <li>• Mapping of soil moisture and wetness index</li> <li>• Mapping of soil geochemistry / mineralogy</li> </ul>
Planetscope Multispectral – RGB + NIR	On demand	ditto
WorldView – 3 Panchromatic, Multispectral, and Short-Wave Infrared [SWIR]	On demand	ditto



# Cyprus Geohazard Observatory Supersite (CyGOS)



## **Decision on Cyprus Supersite support:**

ASI has agreed to support the Supersite with Stripmap CSK/CSG and SAOCOM data  
(Cyprus is in the ZoE)

DLR ... (note that DLR is part of the core team)

CNES ...

CSA ....

Others ...



After the end of ESA support for data hosting on the GEP, we still need to find a suitable web platform where all Supersite CEOS data can be discovered, and possibly downloaded, respecting the access and licensing conditions.

The EARTHSCOPE consortium has expressed interest in supporting this need. A presentation by Chris Crosby will follow.

**Decision by the Agencies:** accept the use of EARTHSCOPE facilities to harvest or host their data for dissemination

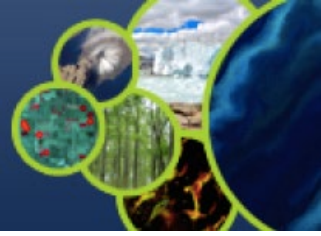




The draft guide on Supersite data access procedures was initially circulated in June 2024.

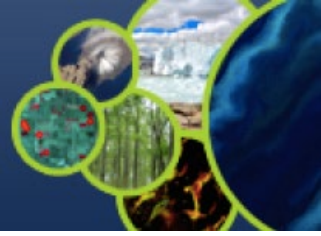
It has been revised and approved by ASI, DLR and CNES.

It is pending revision by CONAE.



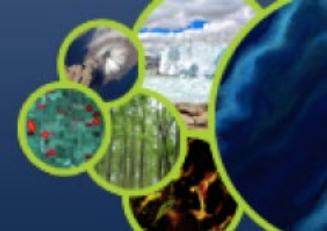
Athena Global was awarded a contract by INGV for:

- Providing support in the preparation of CEOS WGD fall meeting 2025
- Develop promotional materials for the Virunga and Ecuador Supersites
- Prepare a GSNL Engagement Strategy with donors and stakeholders, and develop a proposal for participation in the Understanding Risk 2026 event



In 2026 we will hold a virtual community meeting to:

- Verify the validity of the GSNL concept
- Identify present and future needs of the community
- Discuss possible engagement of other stakeholders (e.g. DRM)
- Renew the governance



We warmly thank the CEOS agencies  
for their continuous support  
since 2012 !

