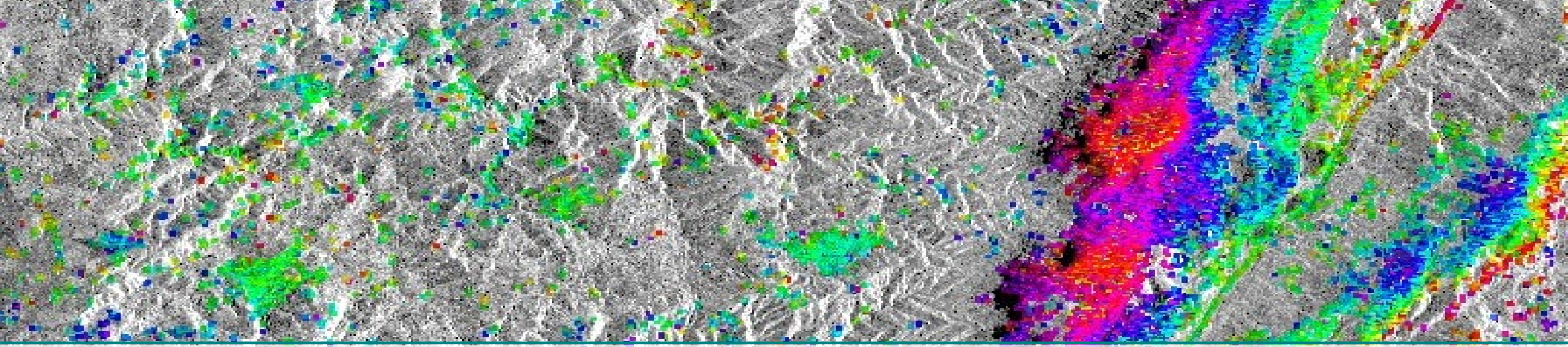
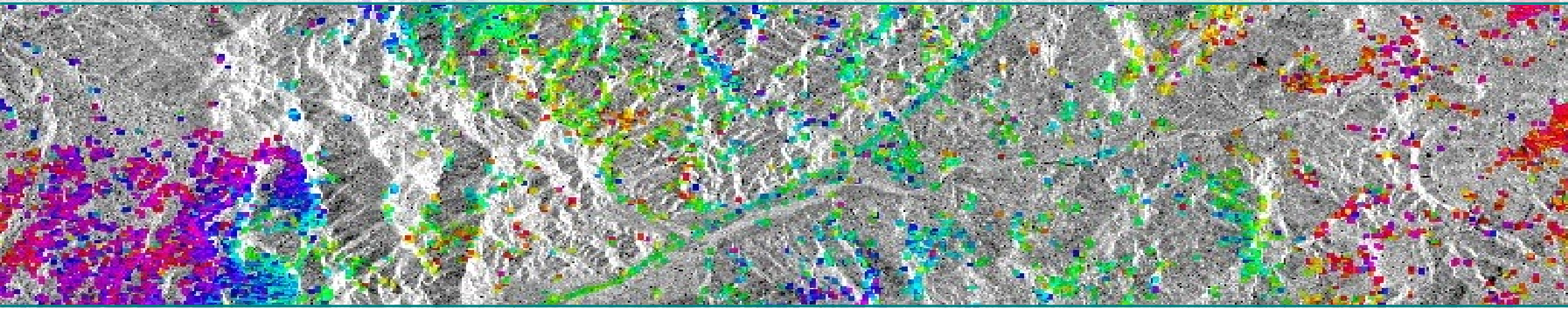


UniCA-DSCG activities for Sos Enattos site characterization

Prof. Maria Teresa Melis - Dott. Francesco Dessì, PhD – University of Cagliari



ET EINSTEIN TELESCOPE

XIII ET Symposium, Cagliari T-Hotel, May 8 – 12, 2023

UNICA DSCG PEOPLE

- Prof. Maria Teresa Melis
- Prof. Antonio Funedda
- Prof. Stefania Da Pelo
- Prof. Silvio Ferrero
- Dott. Elisabetta Dore
- Dott. Fabrizio Cocco
- Dott. Camille Rossignol
- Dott. Francesco Dessì

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Activities

Remote sensing:

a) **a) SAR (Synthetic Aperture Radar) processing in order to evaluate ground deformation rates;**

b) Thermal data acquisition by UAV for the characterization of **geological lineaments**.

Improvement of the geological knowledge:

a) Considering the evidences of neotectonics recently detected in other sectors of the Sardinia block, and in order to evaluate the potential activity of the main faults in north-eastern Sardinia, the faults dating will be carried out.

b) A petrological study and dating of the rocks, using modern high resolution microanalytical techniques.

Understanding of the Groundwater circulation:
in order to define groundwater quality and the conditions of water circulation, an hydro-geochemistry and isotopic analysis of fluids circulation will be done with the improvement of the knowledge of the hydrogeological setitng

Geodata management and sharing:
A dedicated Geographic Information System (GIS) environment (local and web) to support the reconstruction of the geological model and to share all anew and available data has been produced.

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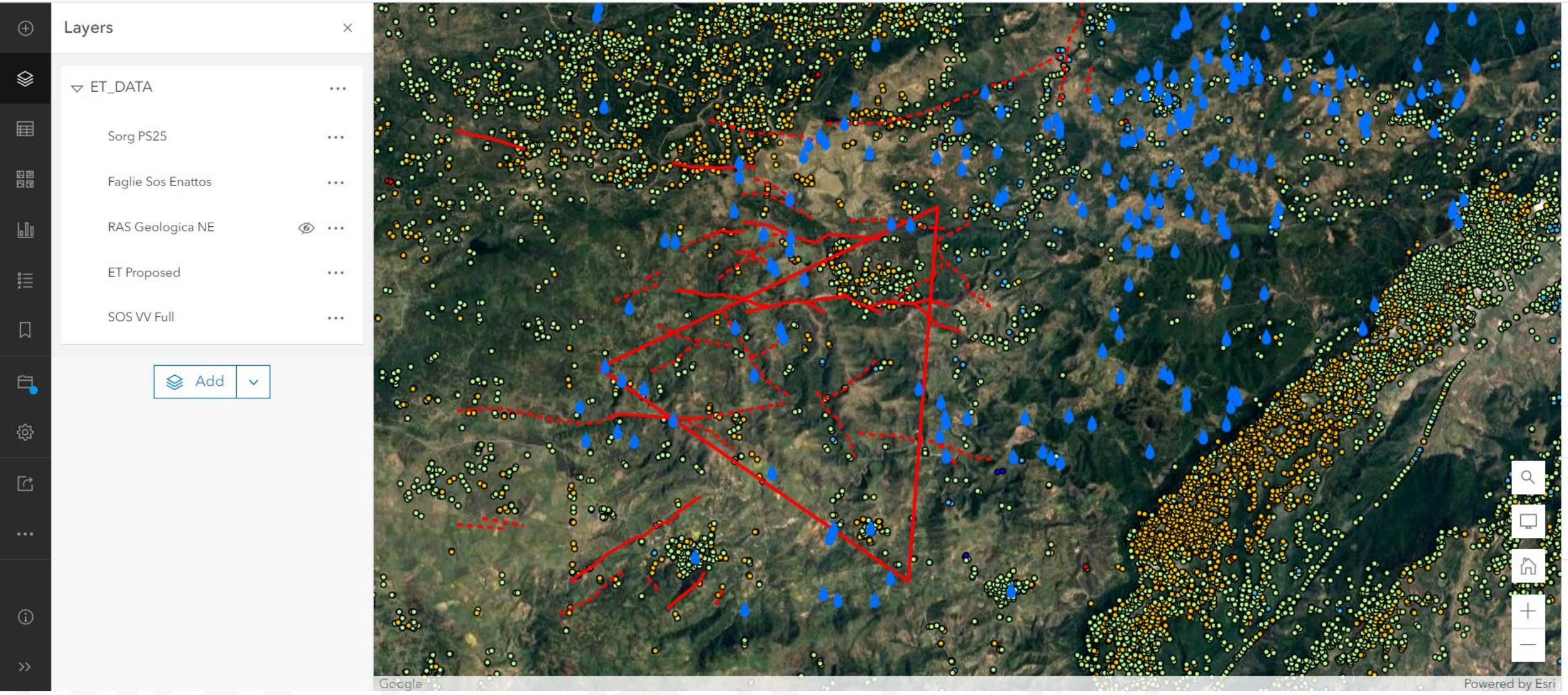
SHARING data platform based on ArcGiS on line



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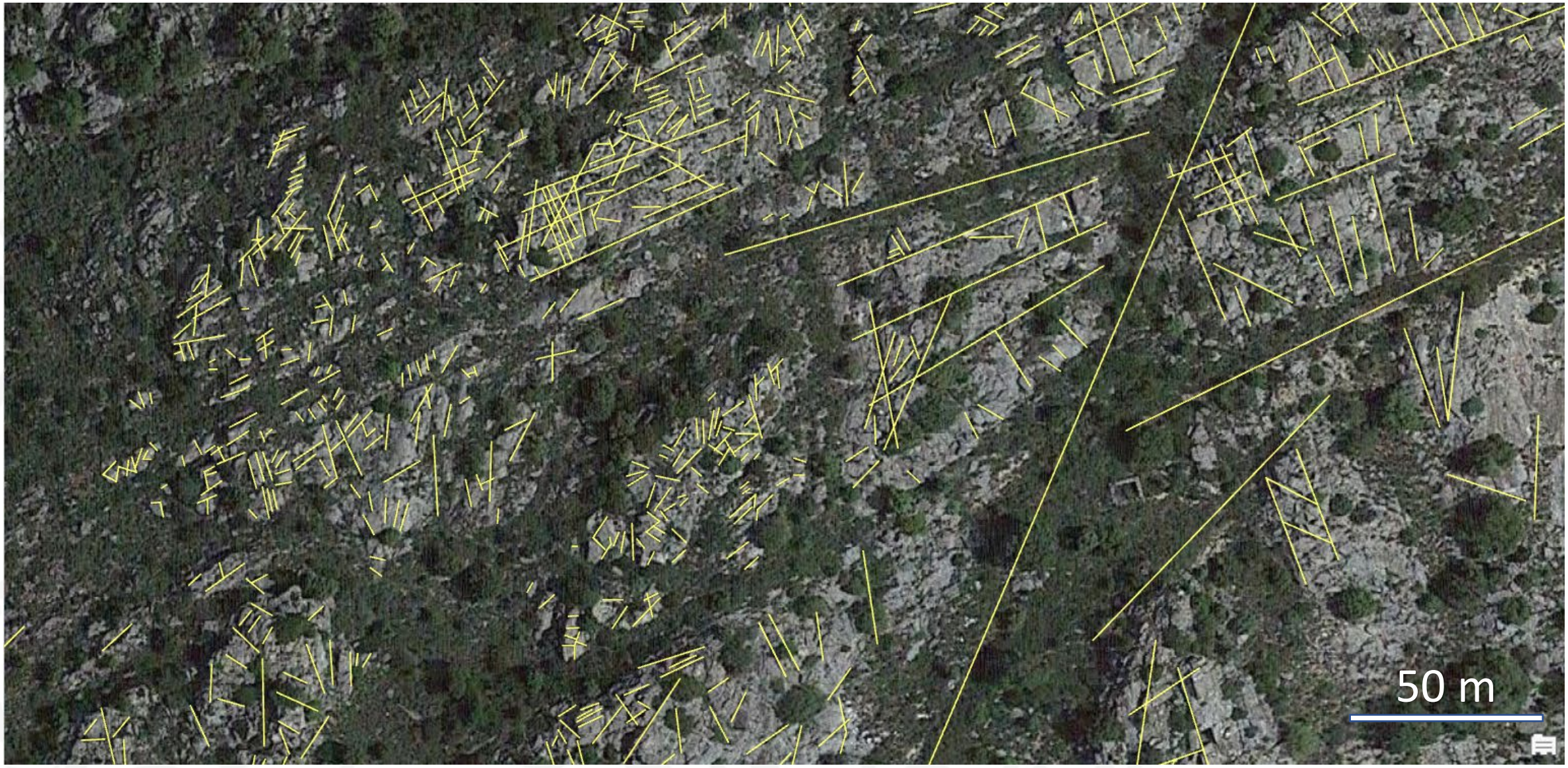
Linear structural features by photointerpretation



UAV survey with thermal camera

- Air or water circulation in the open fractures allows t detect their temperature. With dry conditions, the temperature of the air in the fractures can be significantly higher than the surface air temperature, resulting in a significant heat flux anomaly from the rock.
- The heating of a fracture is a function of its opening: very open fractures allow the passage of hot air flows, while tight or filled discontinuities exhibit much lower thermal intensity.
- Groundwater flow usually cools down fractured zone

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SAR DATA APPLICATION: measuring ground deformation

- **Purpose: Measure ground deformation in SOS ENATTOS area with Remote Sensing data – SAR**
- Overview of StaMPS PSI processing chain
- Application: issues and workarounds
- First results and developements

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Sentinel 1 ESA

The Sentinel-1 mission is based on a constellation of two satellites (A and B units). Sentinel-1 carries a C-band Synthetic Aperture Radar (SAR), and provides continuity of ERS and ENVISAT SAR types of missions. It allows all-weather and day/night imaging capability.

End of mission of the Copernicus Sentinel-1B satellite 03 August 2022. Copernicus Sentinel-1A remains fully operational. Strong efforts have been deployed to launch Sentinel-1C as early as possible, the current plans target a launch in the second quarter of 2023.

opernicus
Europe's eyes on Earth

esa
European Space Agency

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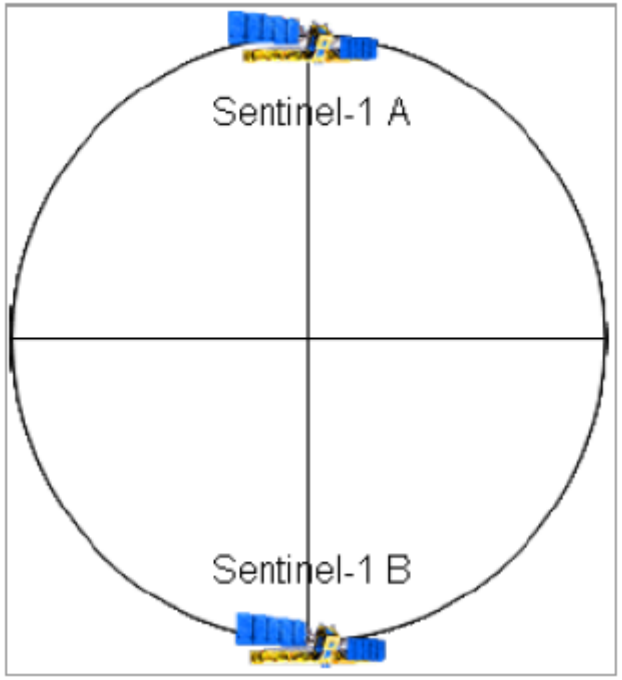
Sentinel 1 orbit

- SENTINEL-1 is in a near-polar, sun-synchronous orbit with a 12 day repeat cycle and 175 orbits per cycle for a single satellite. Both SENTINEL-1A and SENTINEL-1B share the same orbit plane with a 180° orbital phasing difference. With both satellites operating, the repeat cycle is 6 days.



Sentinel 1 operational modes

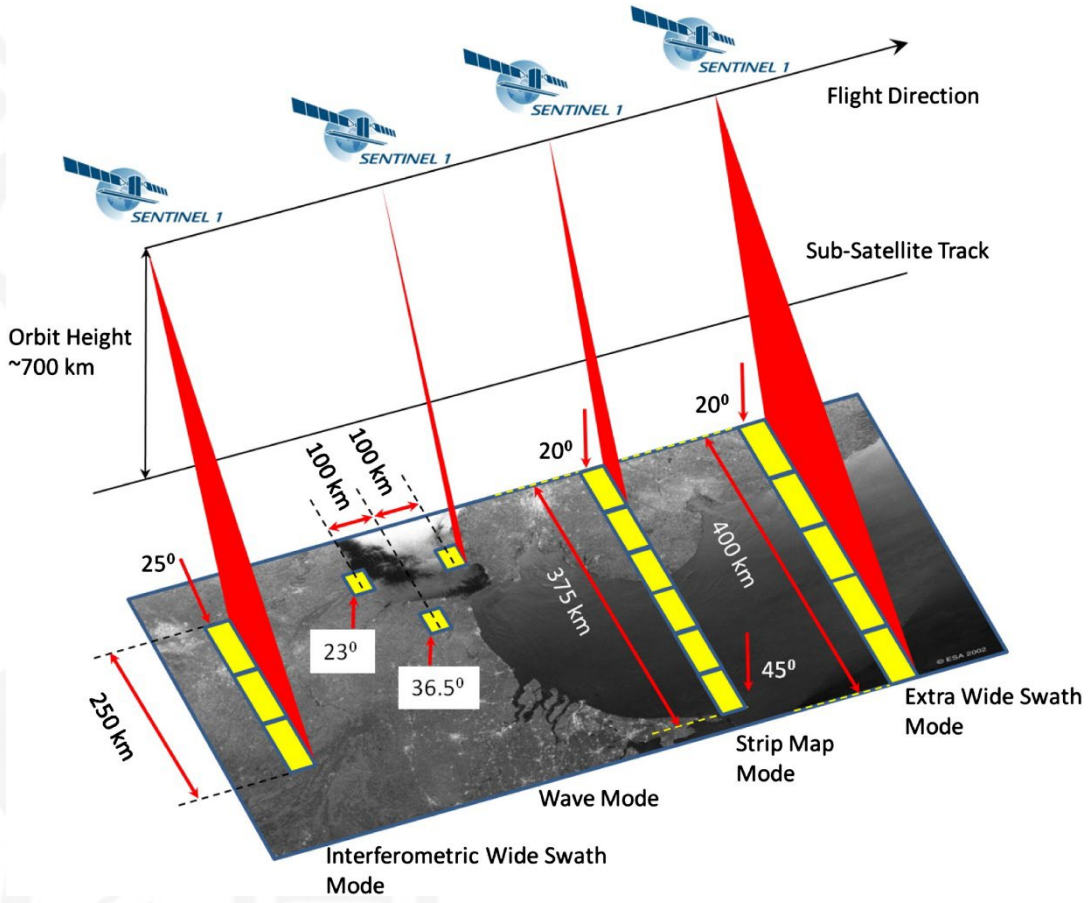
- Main modes:

1) Interferometric wide-swath mode at 250 km and 5×20 m spatial resolution

2) Wave-mode images of 20×20 km and 5×5 m spatial resolution (at 100 km intervals)

Additional modes:

- Strip map mode at 80 km swath and 5×5 m spatial resolution
- Extra wide-swath mode of 400 km and 20×40 m spatial resolution



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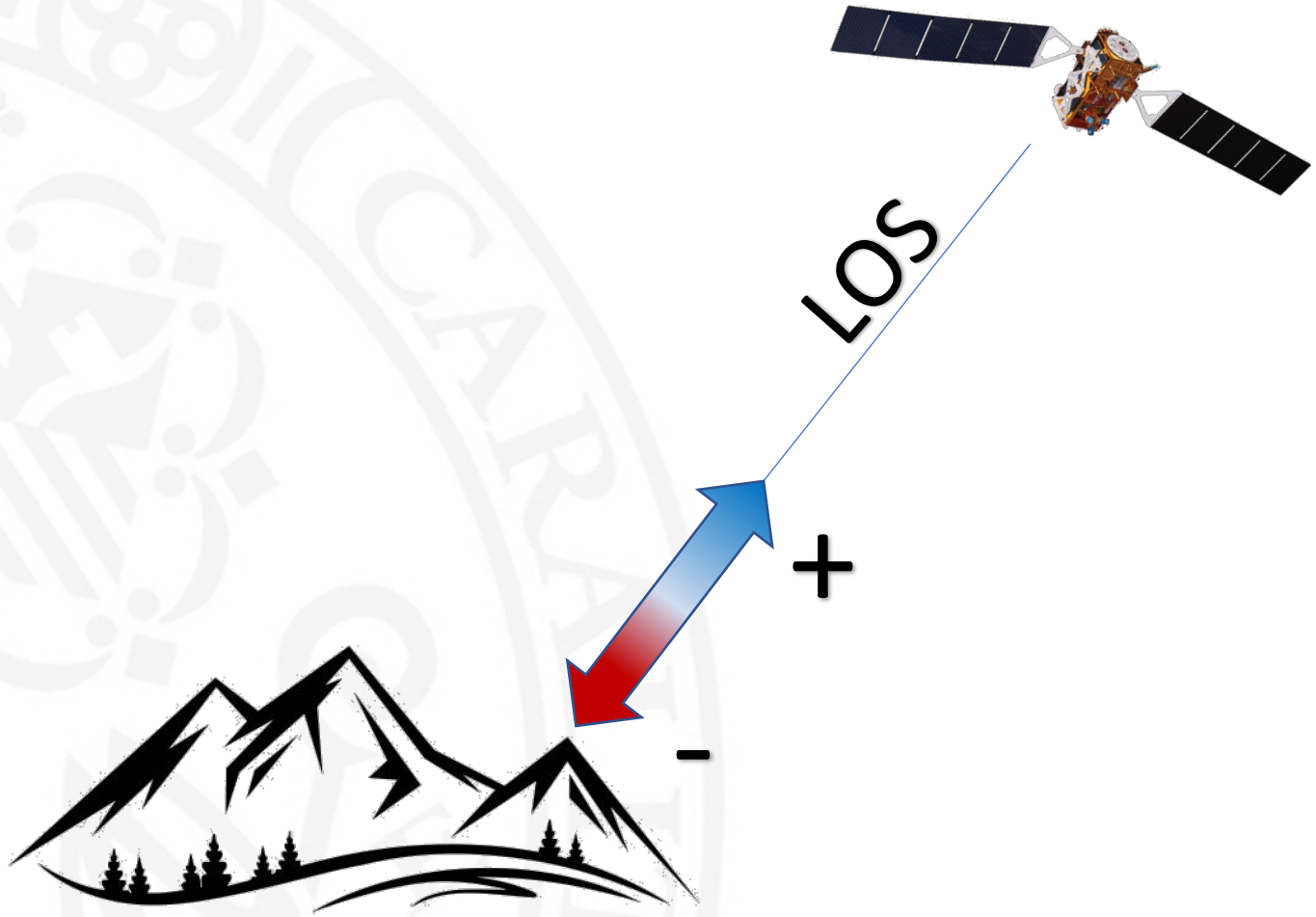
Some basics

- SAR does not see the objects from directly on nadir, like most optical sensors.

- The view is from an angle on the side, also known as line of sight, or LOS.



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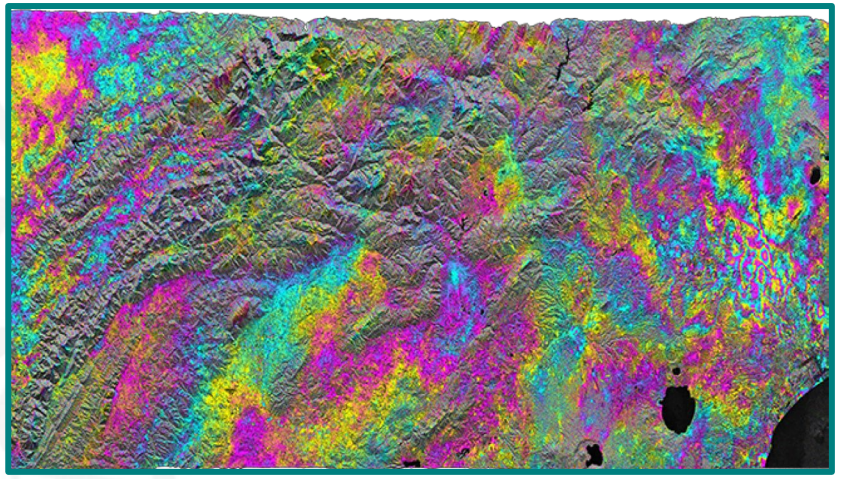
Some basics

- SAR can be used to monitor and track displacement by using the phase that is collected alongside its amplitude.
- The phase-change shows minor shifts on the ground surface related to the moment a specific part of the wave hits the ground
- The change in time can be tracked in between images and used to find ground surface change.



Sentinel-1 Interferogram

InSAR = Interferometric SAR

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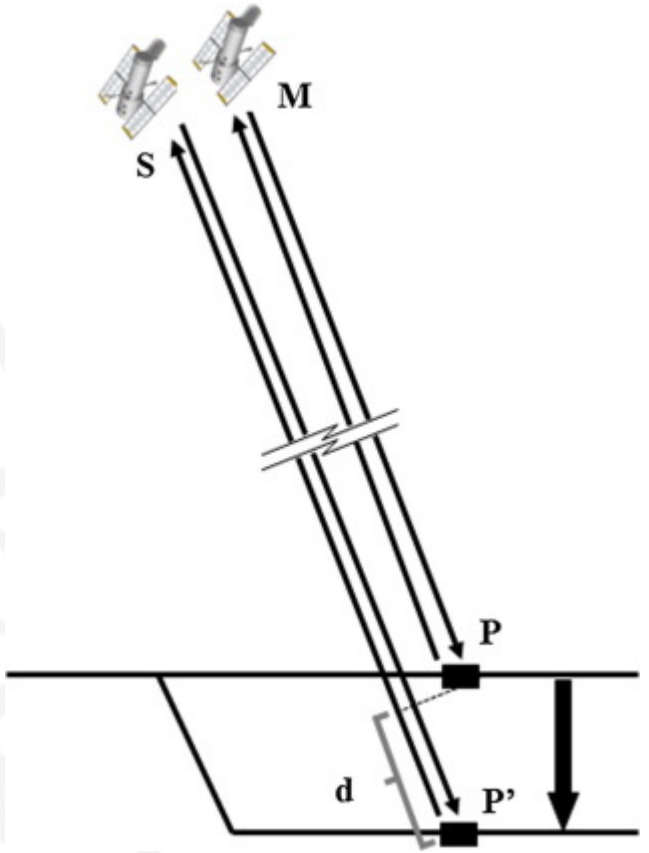
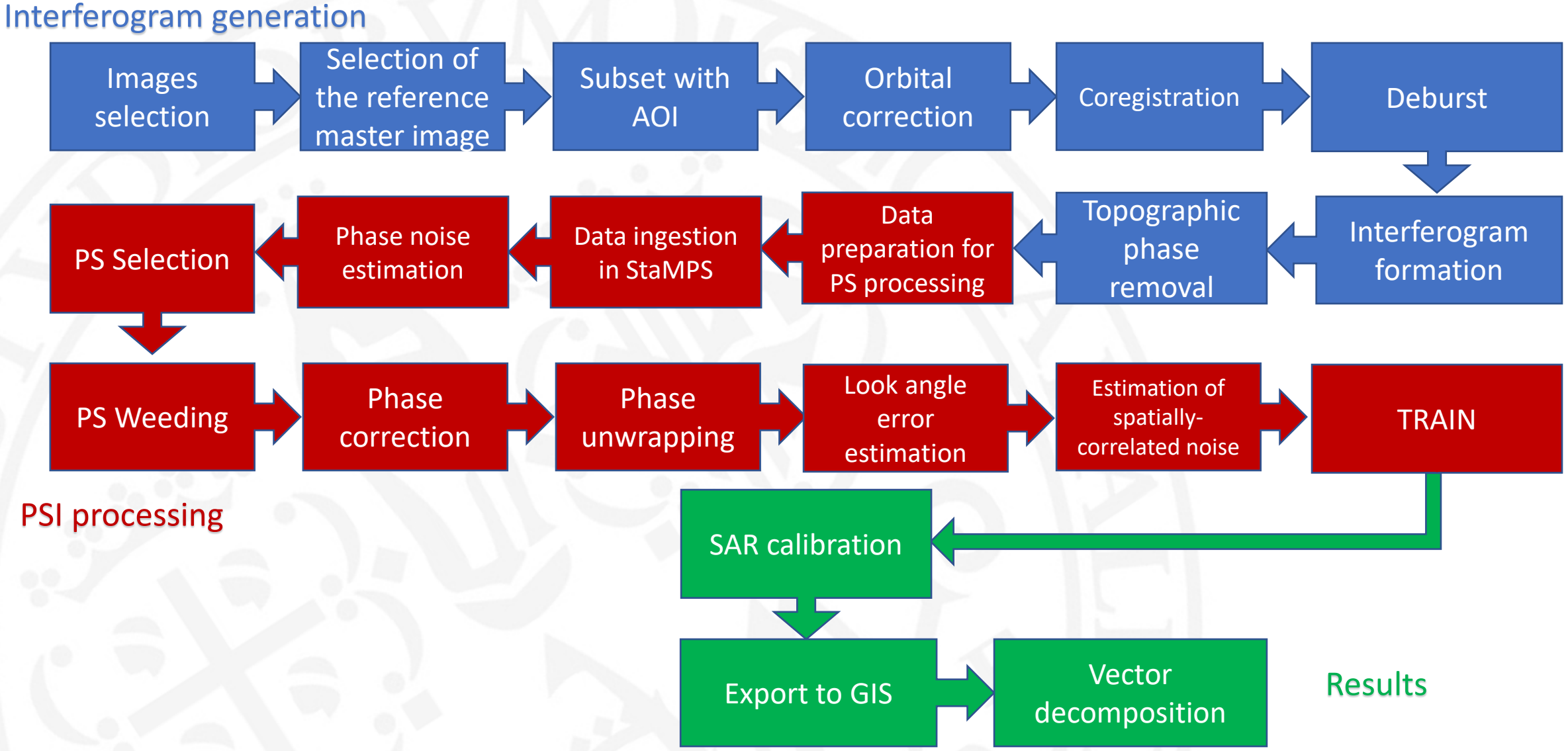
PSI – Persistent Scatterer Interferometry

- Persistent Scatterer Interferometric technique involves the observation of radar phase changes measured for repeated acquisitions. Large numbers of permanent scatterers are analyzed to determine velocity of movement along sight. The method allows to measure terrain movements with an error of 1.2 mm/year.

StaMPS (Stanford Method for Persistent Scatterers) is a software package that implements an InSAR persistent scatterer (PS) method



Processing workflow



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First test

- A first test has been carried out on a small area (250 sq km) in Sos Enattos surroundings.
- Sentinel 1 data, acquired from January 2021 to July 2022, have been processed in order to get Vertical Velocities .
- For the first performance test 46 images acquired by descending orbit and 48 images acquired by ascending orbit have been utilized.

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Some issues..

- SAR data is heavy (around 4 GB for each input image)
- Even with a relatively powerful workstation (multi core CPUs, RAM, SSD disks) processing time takes a **lot of hours or days**

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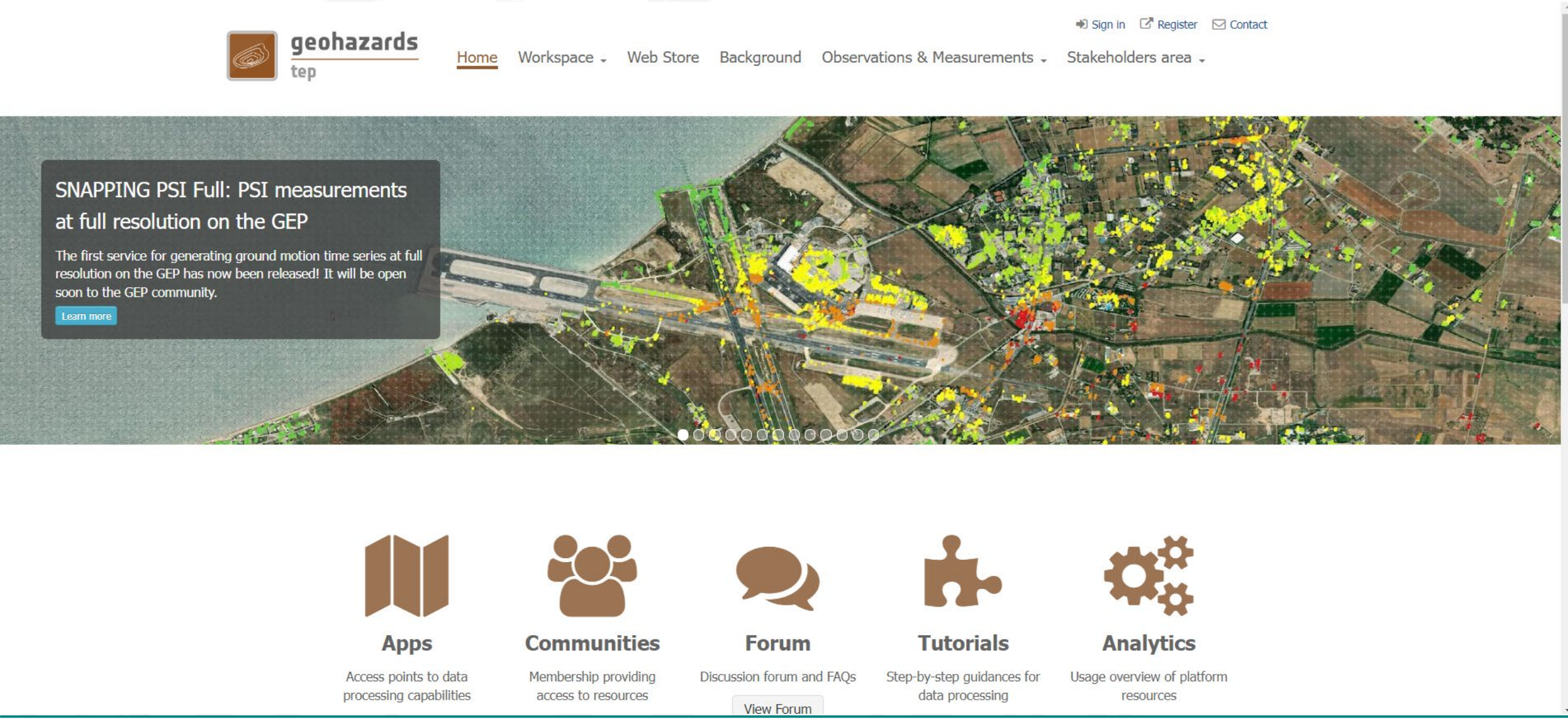
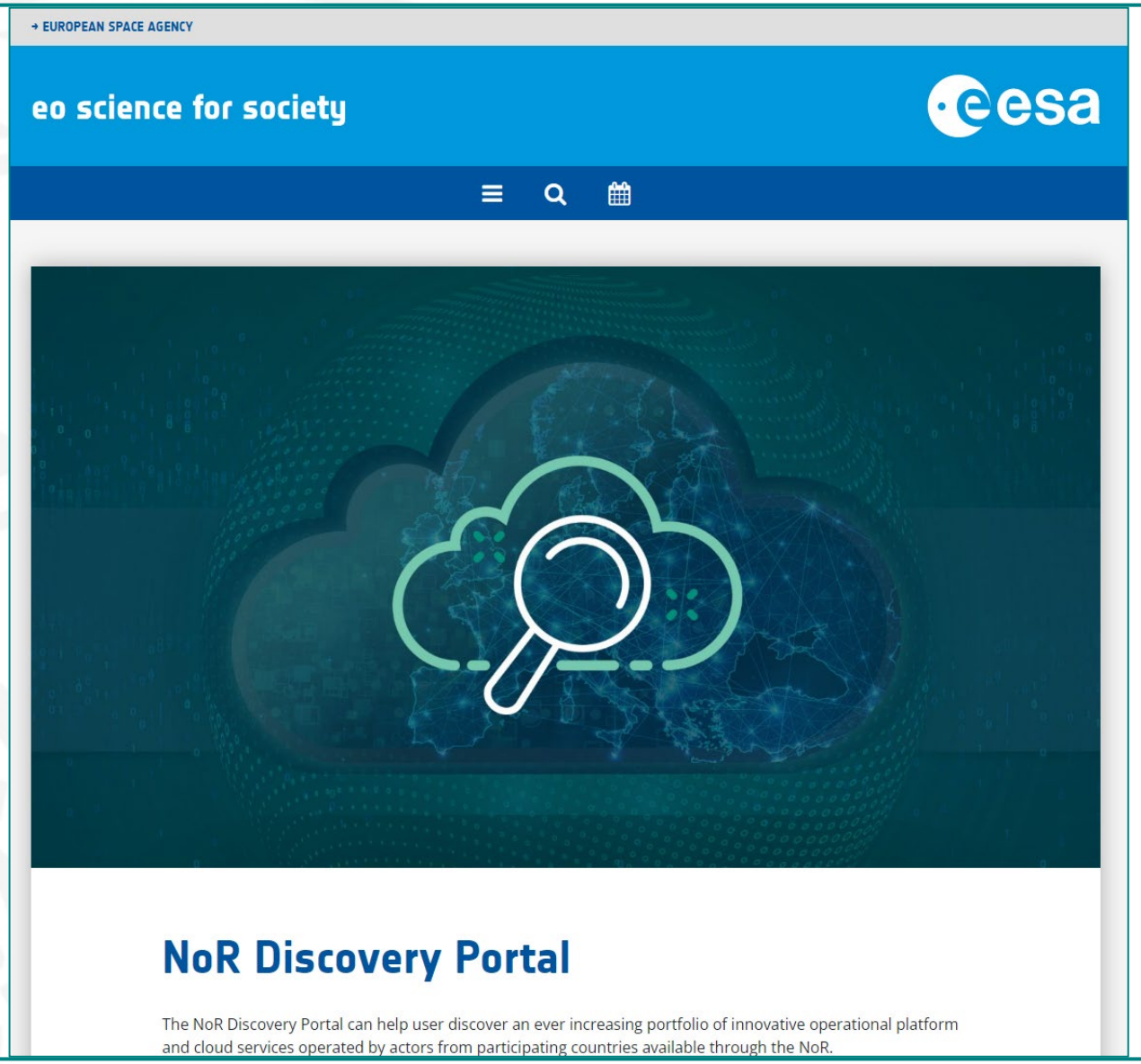
Workaoround https://geohazards-tep.eu



ESA Network of Resources Sponsorship



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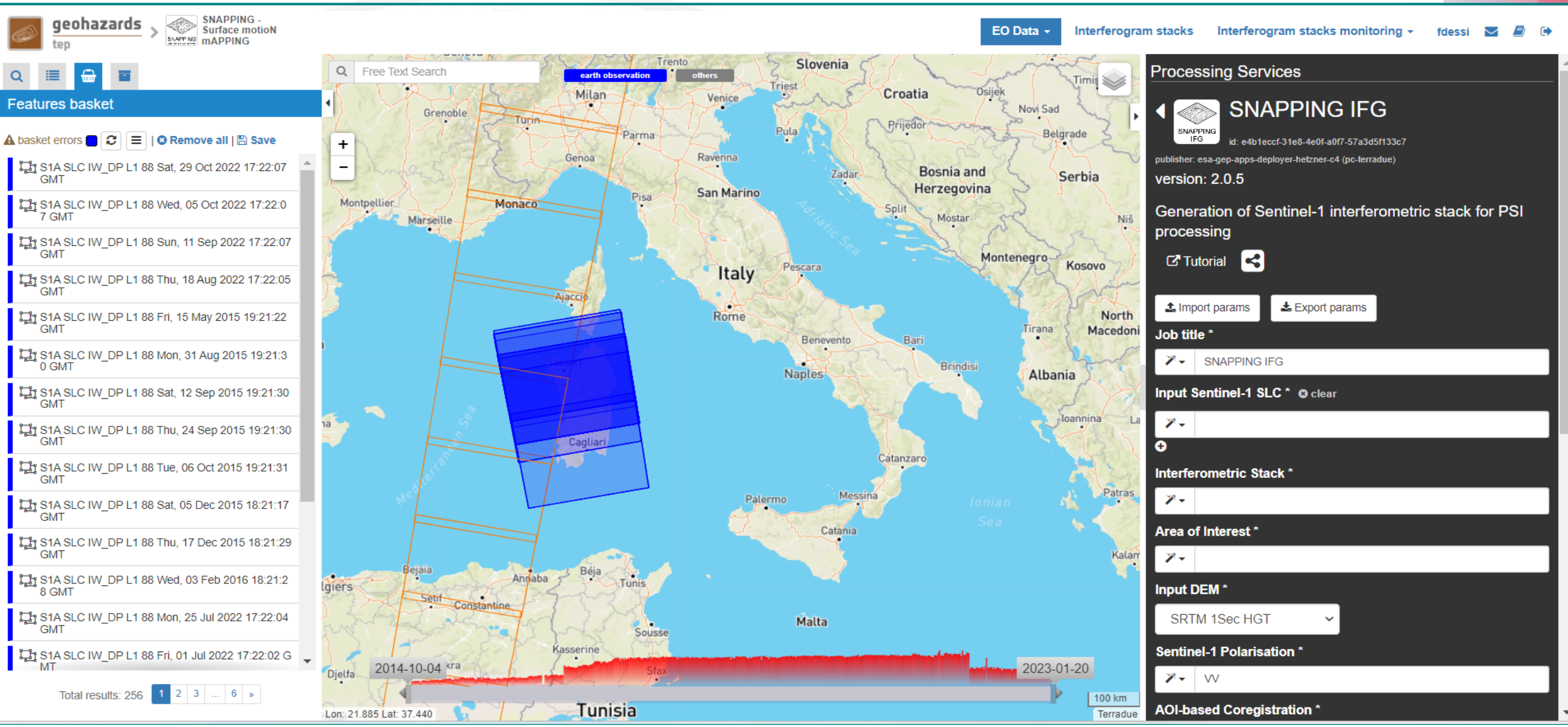
SNAPPING service

Surface motioN mAPPING (SNAPPING) service for the Sentinel-1 mission on the Geohazards Exploitation Platform (GEP)



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A good improvement!

- More than 2400 square kilometers as investigated area
- Around 8 years of acquisitions from May 2015 to October 2022
- More than 400 images
- Faster processing time (only 8 hours for PSI calculation related to Descending orbit)

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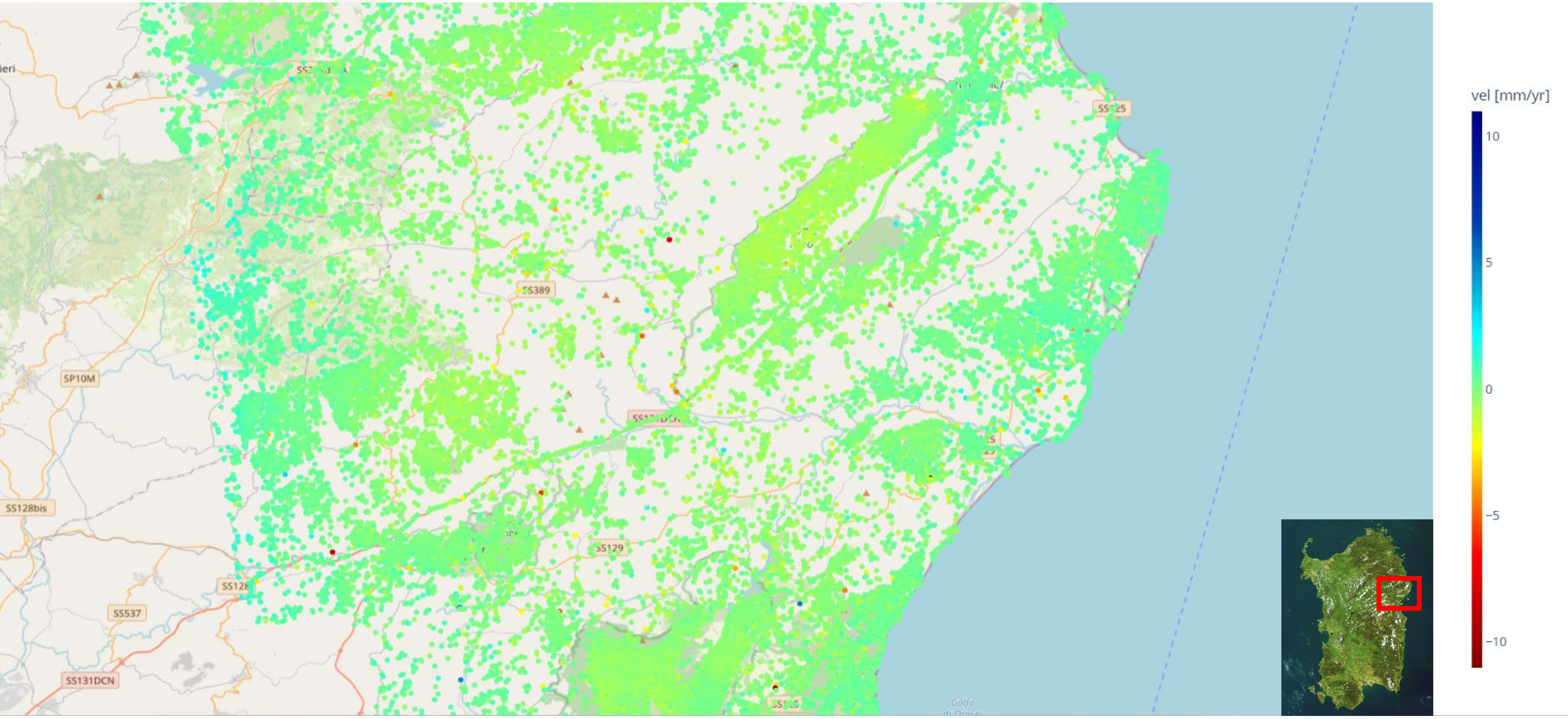
LOS Velocities – Ascending orbit



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LOS Velocities – Descending orbit

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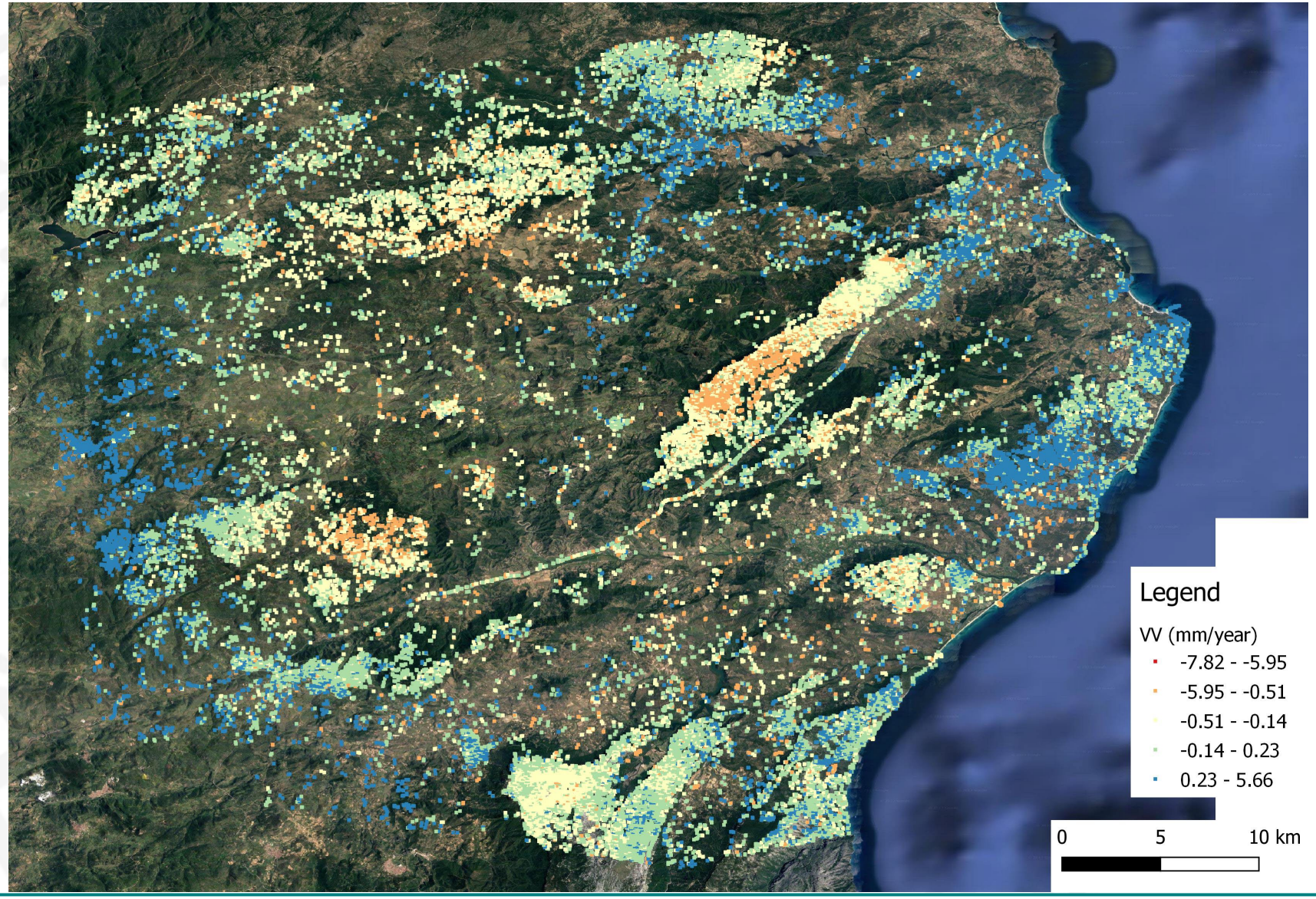
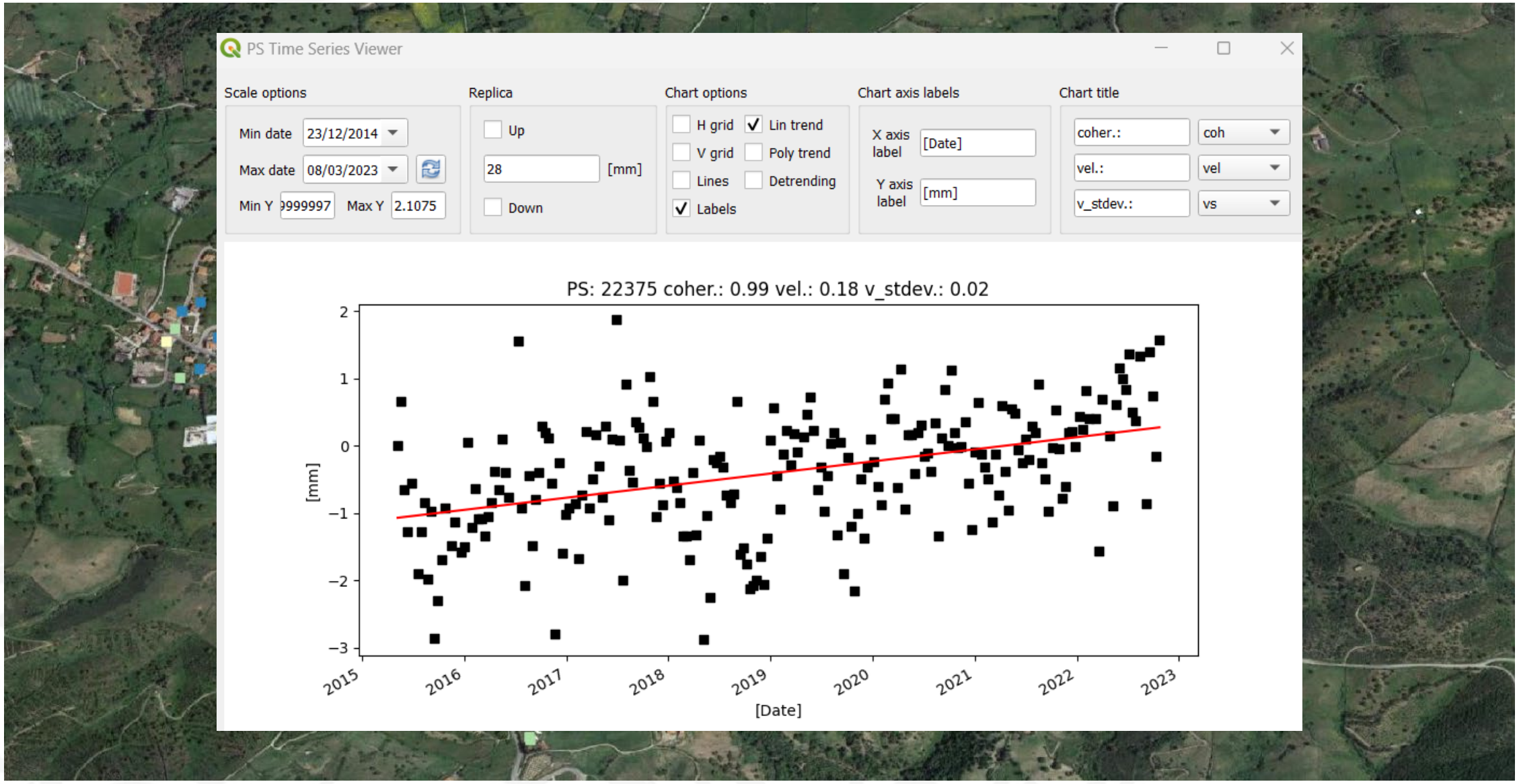
Vector decomposition – GIS – Vertical velocities



Time series – Lula town



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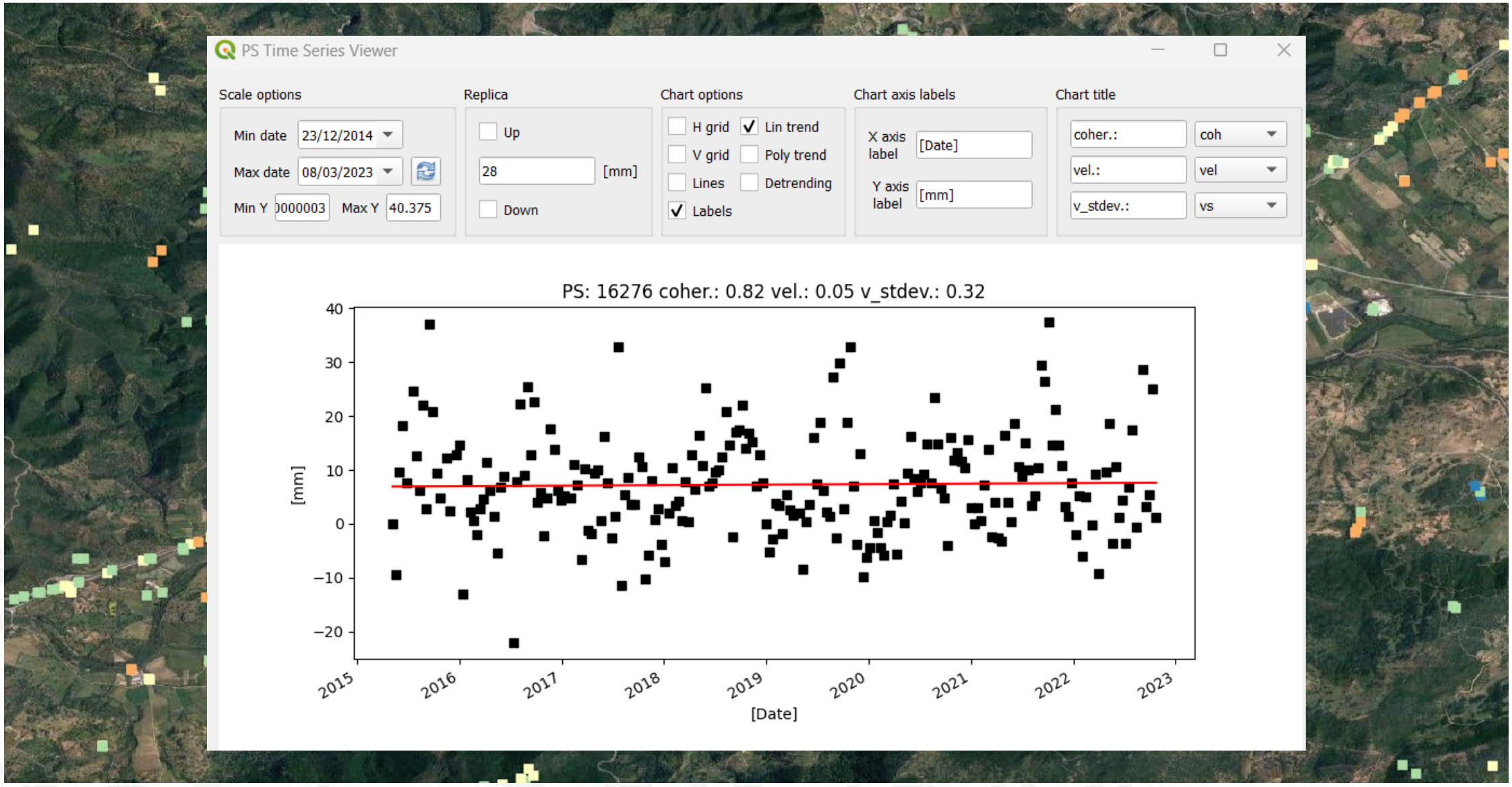
Time series – Roads



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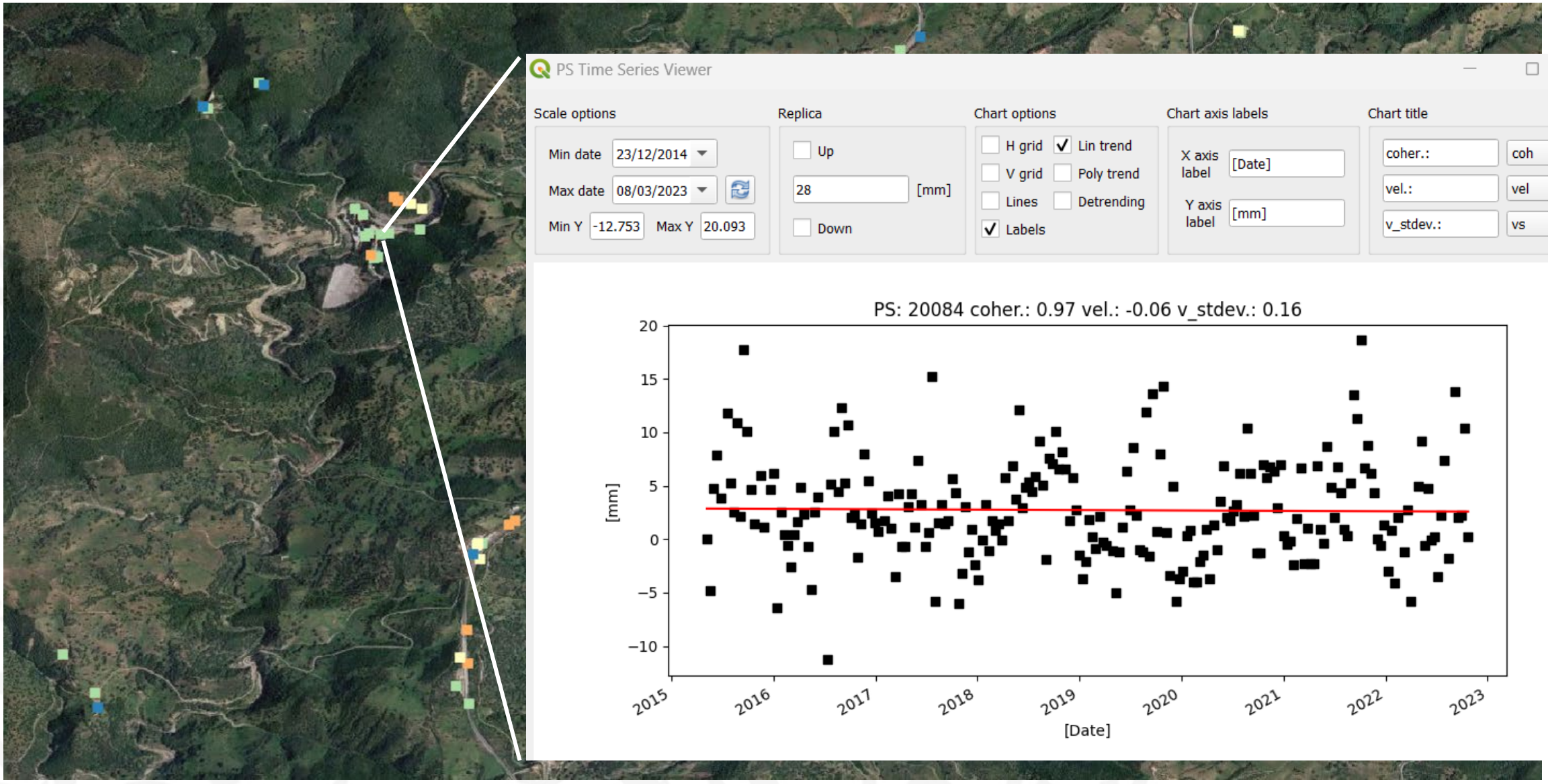
Time series – Sos Enattos mining site



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On the way

- Processing has been carried out with GNSS meauserements as reference. It is possible to cross some other data coming from GNSS network in order to get a further validation
- It could be important to improve this analysis with other radar data (ASI COSMO SkyMed)
- It is possible to cross check our results with other dataset

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Future

- It is possible to extend this procedure to next months acquisitions in order to get a continous monitoring system

- It is possible to apply decompostion formulas in order to get W-E displacement

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Thank you for your attention