



Ημερίδα: Η συμβολή της Τεχνικής Γεωλογίας στην πρόληψη και αντιμετώπιση Γεωκινδύνων

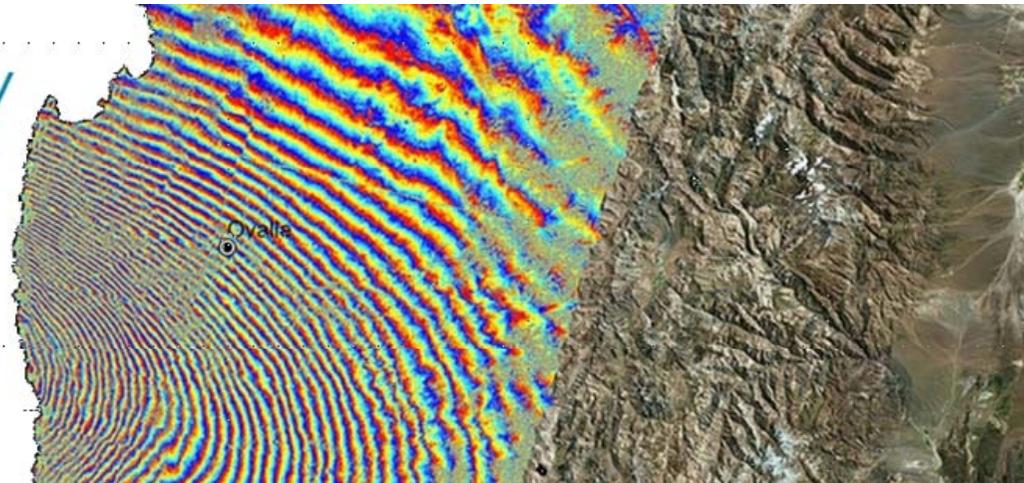
# Η πλατφόρμα έγκαιρης ενημέρωσης geObservatory για τη συστηματική παρακολούθηση γεωκινδύνων

Δρ. Ιωάννης Παπουτσής  
Εντεταλμένος Ερευνητής ΙΑΑΔΕΤ/ΕΑΑ

geObservatory



BEYOND



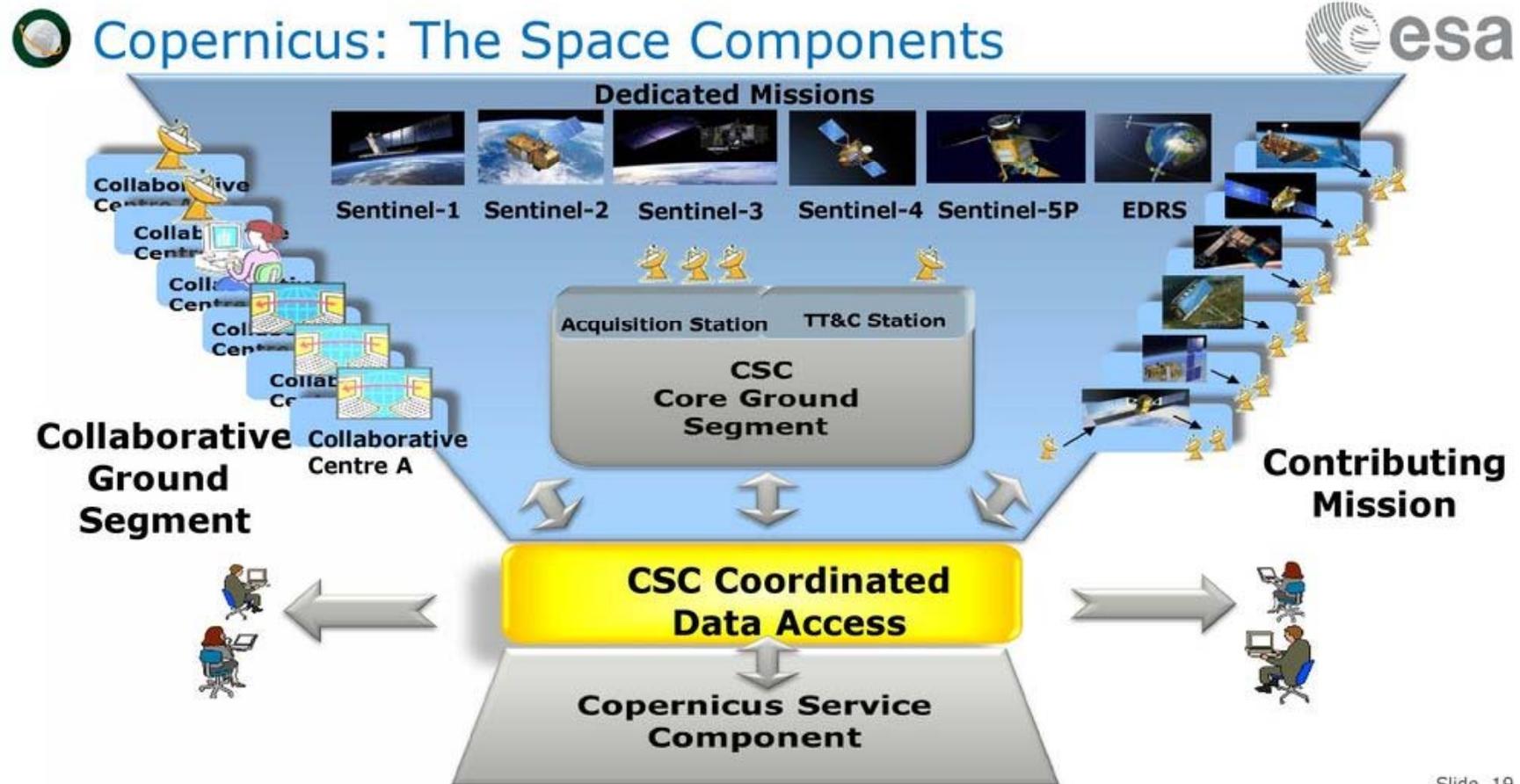


## Outline

- Copernicus access Hubs
  - National Mirror Sites
  - geObservatory
  - Monitoring volcanic activity in Kīlauea, Hawaii
- } Fragmented data access



# Copernicus Sentinel Data Access

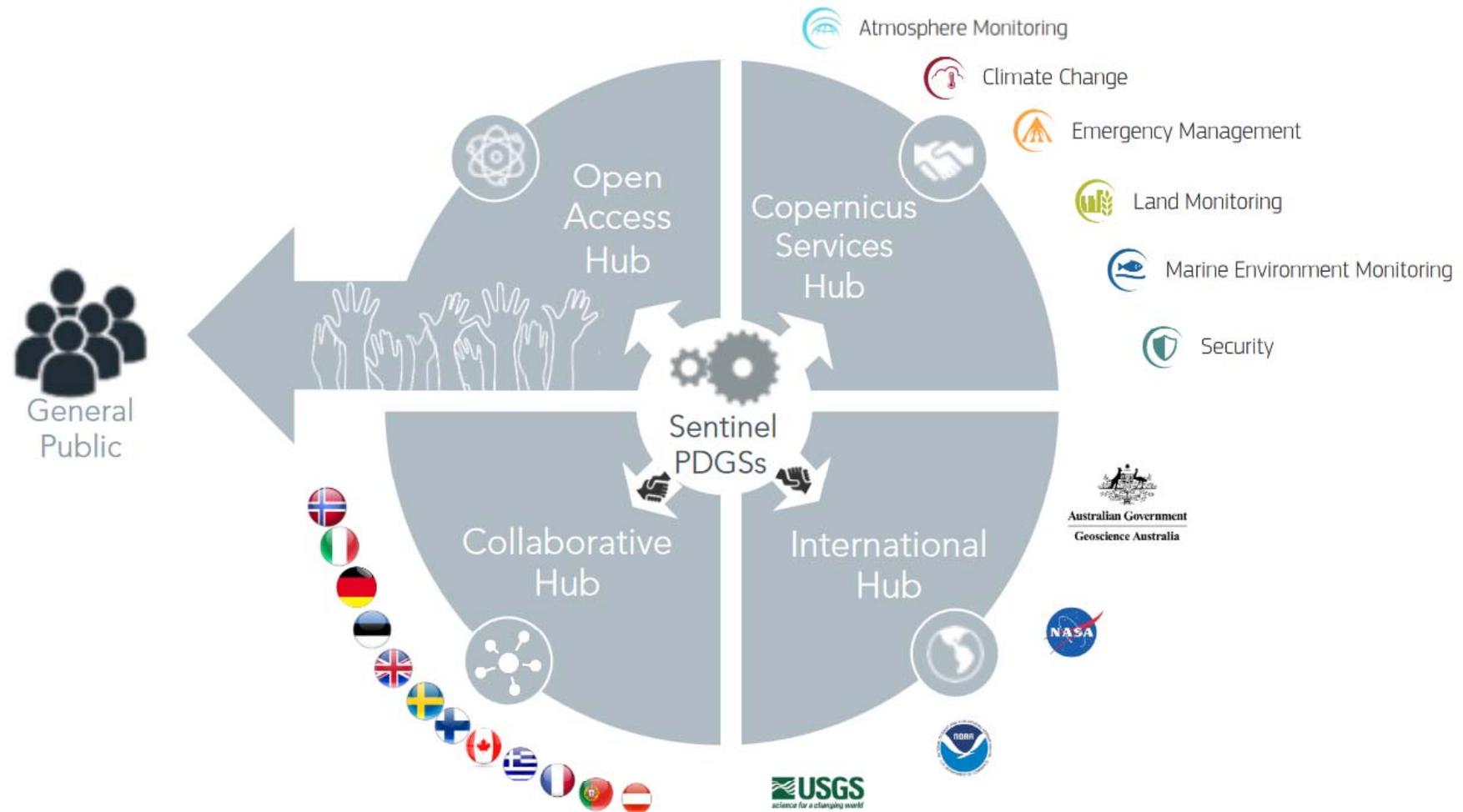


Slide 19



European Space Agency

# Copernicus Sentinel Data Access





# Sentinels Greek Hub | Operations bridge



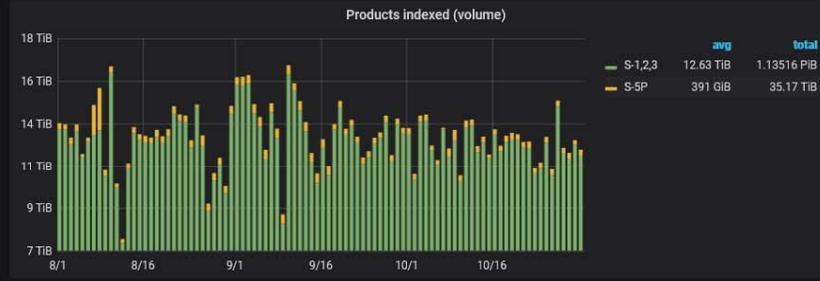
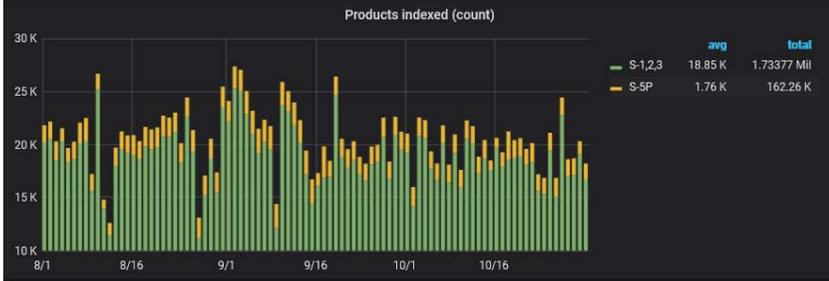


# Sentinels Greek Hub | Some numbers!

## What's coming in

On average:

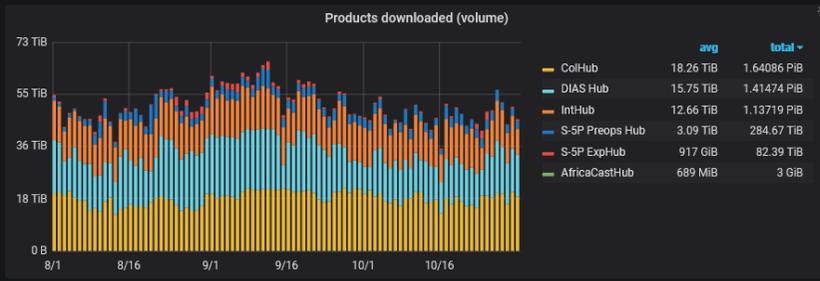
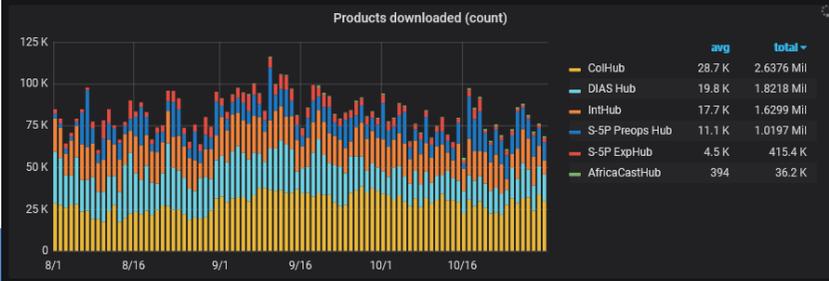
- ~20K products (13TiB) / day or
- ~600K products (390TiB) / month
- ~2 Gbps



## What's going out

On average:

- ~80K products (50TiB) / day or
- ~2.5M products (1.5PiB) / month
- ~6 Gbps





## The Greek Mirror Site: <https://sentinels.space.noa.gr/>



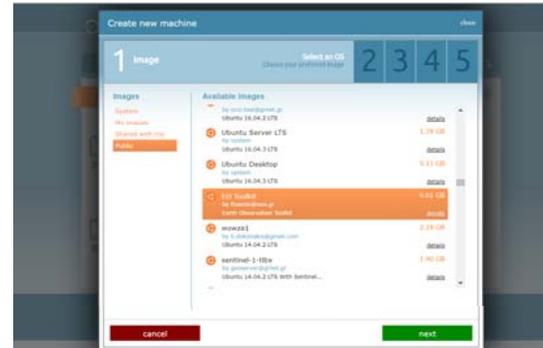
- Mirror Site is running on a high performance VM provided by GRNET
- Synchronizes products with remote copy from ColHub Node 1, 2 & 3 for a specified Area of Interest
- Rolling archive of 30 days using a 44TiB NAS storage

## The Greek Mirror Site: <https://sentinels.space.noa.gr/>

- Shibboleth support for academic user authentication



- EO Toolkit Linux image



- Online course for the use of the Mirror Site



- EOSC-hub linked with the Greek Mirror site



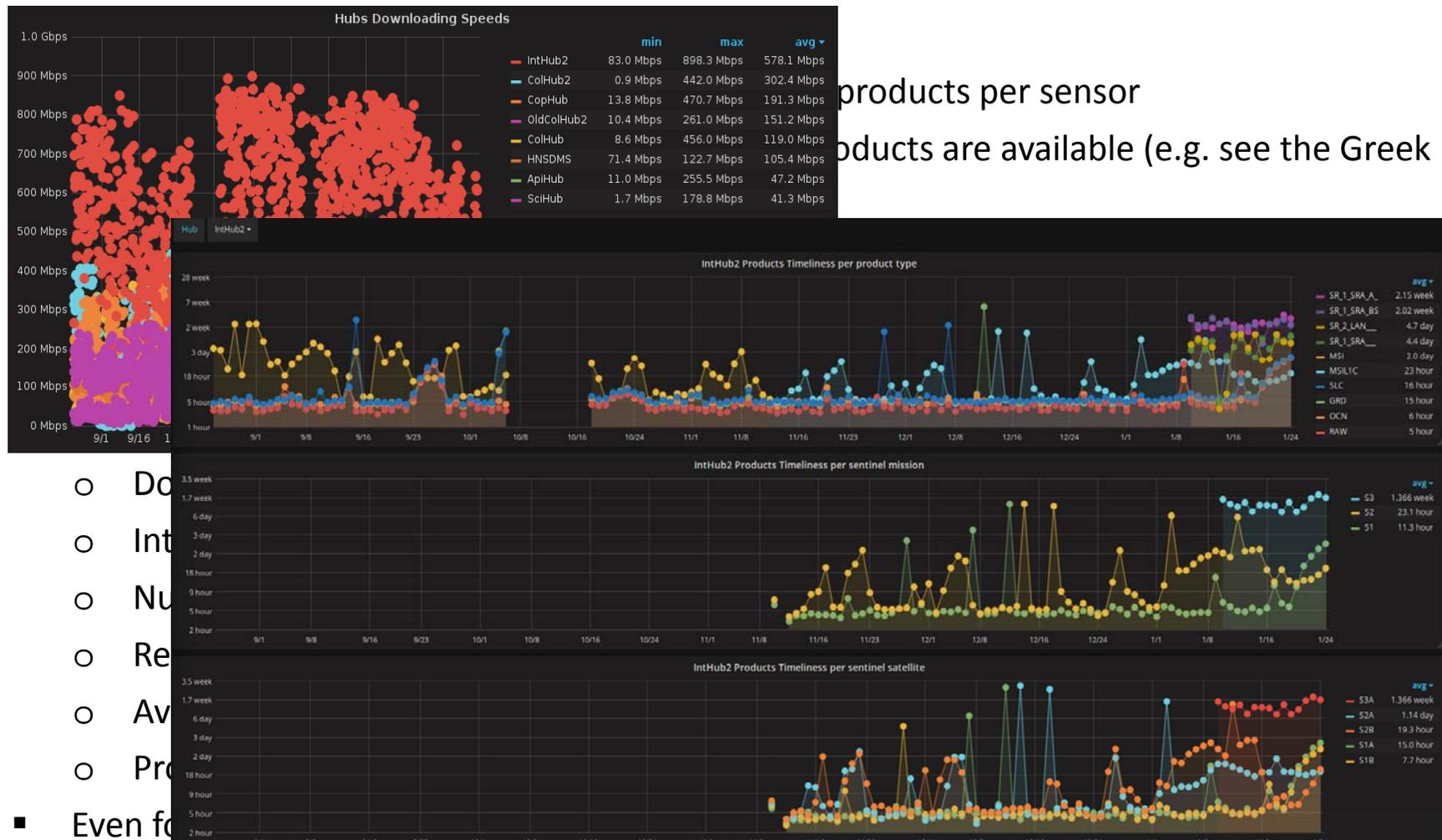


## Fragmented access to Sentinel data

- There are several Copernicus Hubs out there to access Sentinel data!
  - Core Hubs
    - ✓ Open Access Hub (formerly SciHub)
    - ✓ 4 DIAS Hubs
    - ✓ ApiHub
    - ✓ Copernicus Hub
  - **23** National Collaborative Ground Segments. Indicatively:
    - ✓ HNSDMS (Greece, <https://sentinels.space.noa.gr/>)
    - ✓ CODE-DE (Germany, <https://code-de.org/>)
    - ✓ FinHub (Finland, [http://nsdc.fmi.fi/services/service\\_finhub\\_overview](http://nsdc.fmi.fi/services/service_finhub_overview))
    - ✓ Peps (France, <https://peps.cnes.fr/rocket/>)



# Fragmented access to Sentinel data



products per sensor

products are available (e.g. see the Greek

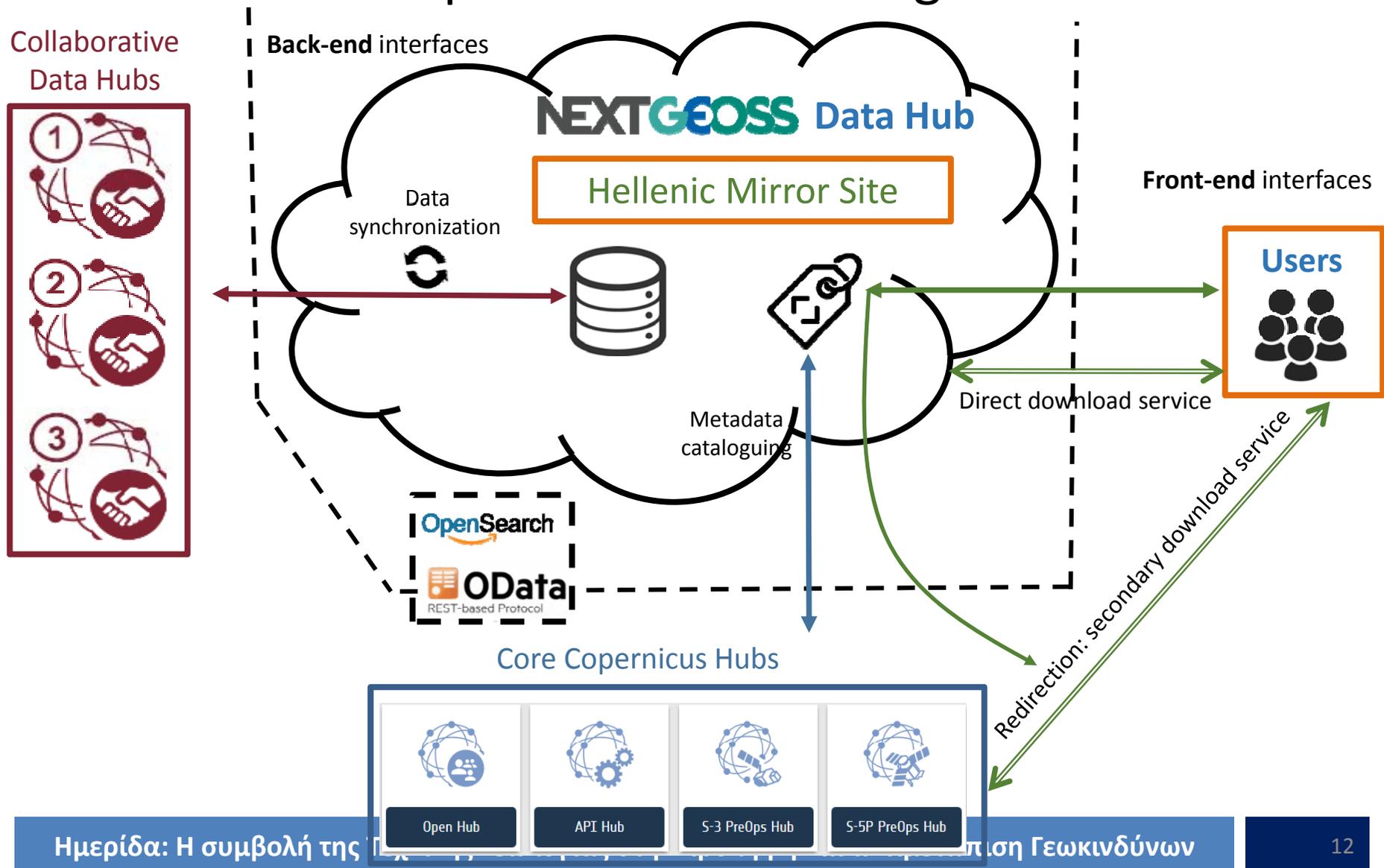
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- Even fo



## Our concept to tackle data fragmentation

- Develop an umbrella application to federate access to Sentinel data
- The application will connect in the back-end to most of the available Hubs, but this will be transparent to the user
- The front-end will be Data Hub Software (DHuS - <https://sentineldatahub.github.io/DataHubSystem/>):
  - Well-known GUI for the users
  - Incorporates OpenData and OpenSearch APIs
  - DHuS 2.0 just released!

# Our concept to tackle data fragmentation





## Advantages

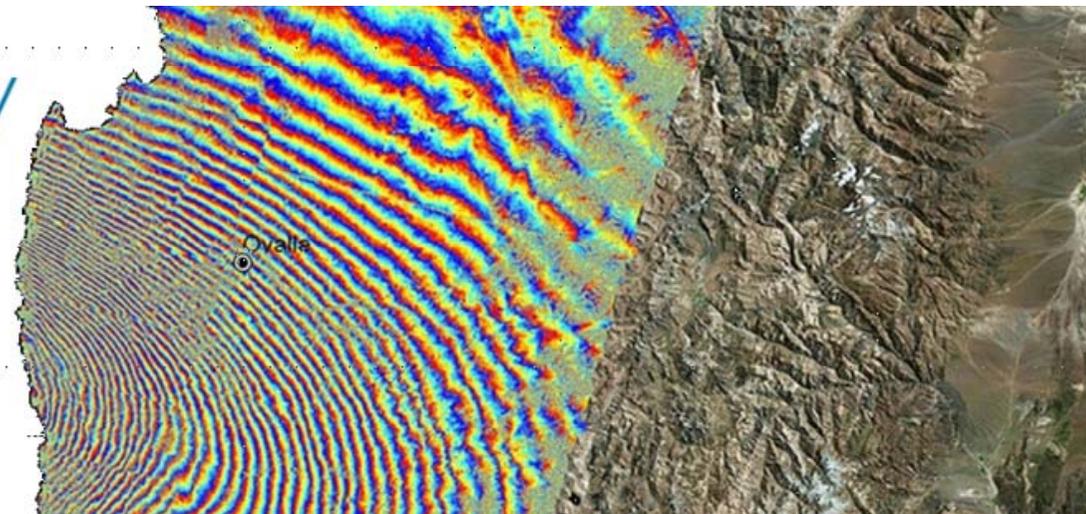
- Linking federated Copernicus Sentinel Hubs
- Access to a single hub instead of looking across several Sentinel Hubs to find the appropriate products for your application
- Access to all Sentinel mission data, no geographic restrictions
- Better timeliness and reduced lead times for accessing Sentinel products  
-----> more important for disaster management applications
- Less performance variability by exploiting Hub diversity



geObservatory



BEYOND

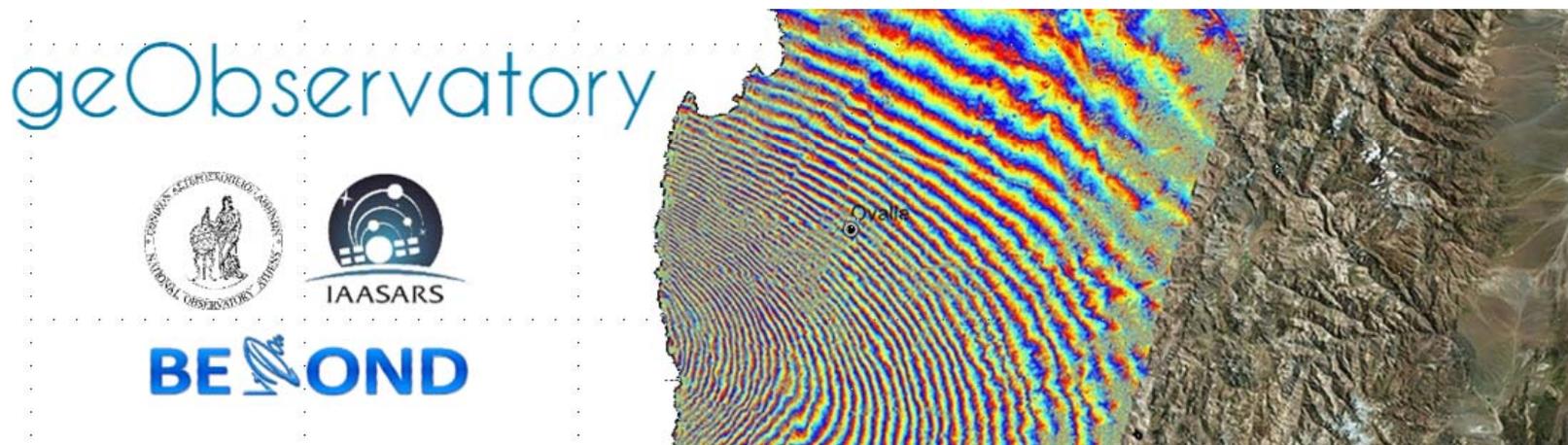




## geObservatory | In a nutshell

GeObservatory is activated in major geohazard events (earthquakes, volcanic activity, landslides, etc.) and automatically produces a series of Sentinel-1 based co-event interferograms (DInSAR) to map the surface deformation associated with the event.

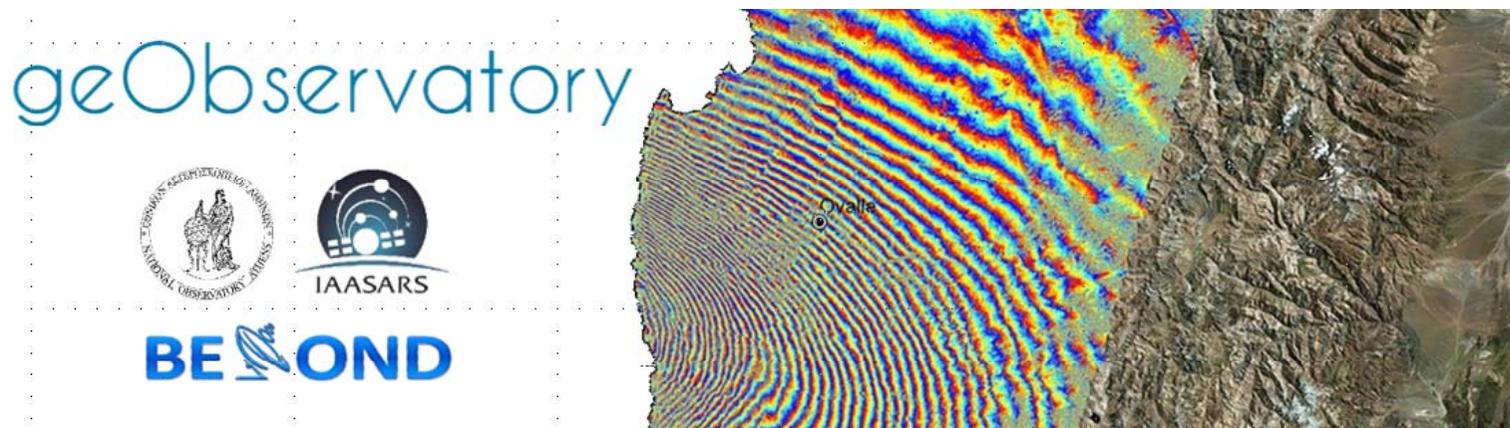
<http://beyond-eocenter.eu/index.php/web-services/geohub>



## geObservatory | Activation

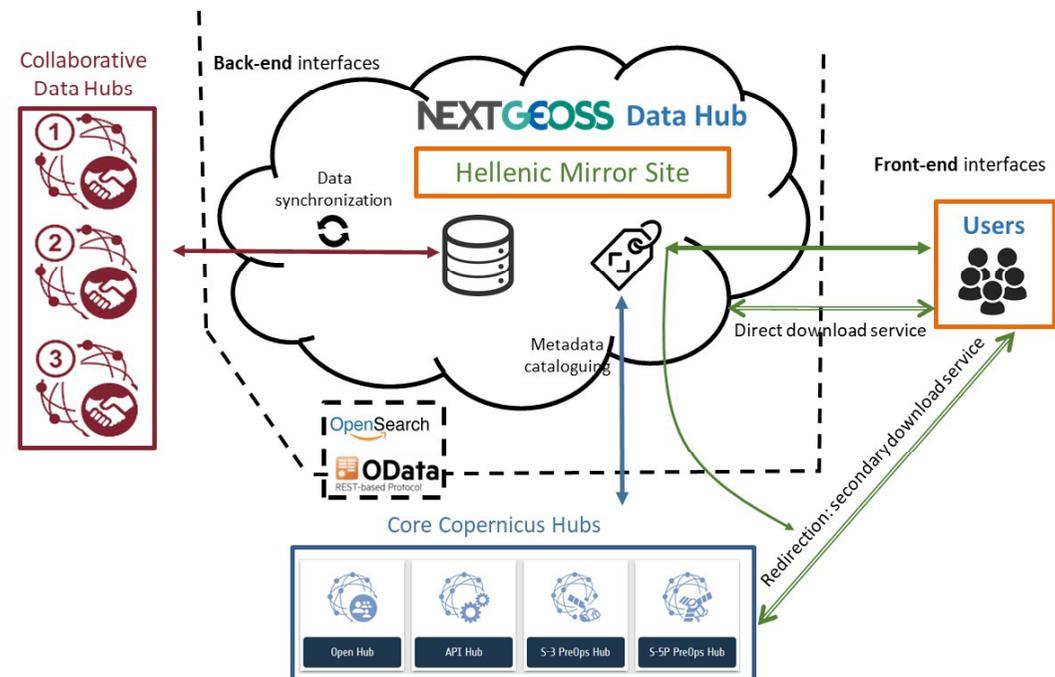
- Manual activation. An authorized user provides to the application a json file delineating the Area of Interest and registering the timestamp of the event.
- Automatic activation. GeObservatory connects to [EMSC](#) and is activated when a major earthquake occurs. Criteria for the activation of GeObservatory is the magnitude of the earthquake and its depth.

<http://beyond-eocenter.eu/index.php/web-services/geohub>



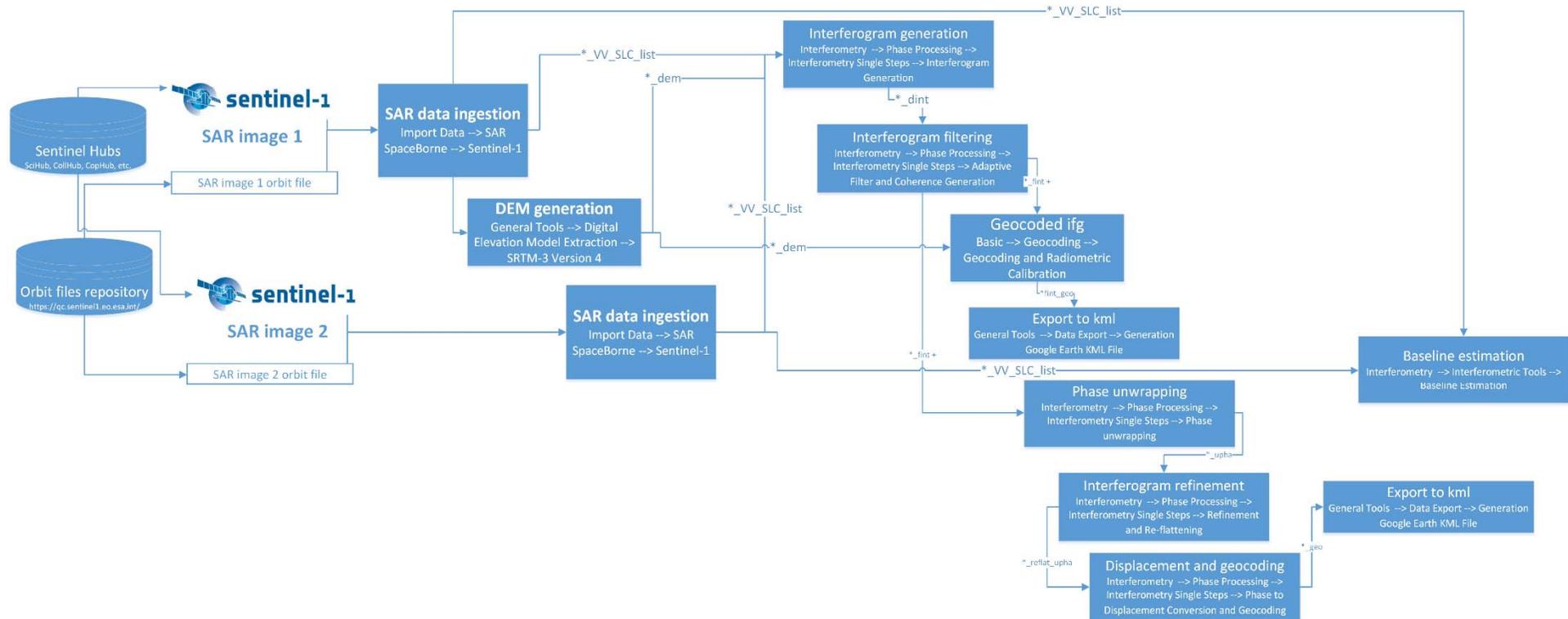
# geObservatory | Input data

After the system is triggered, the application automatically scans different Copernicus hubs, including the Greek Collaborative Ground Segment, to find the appropriate Sentinel-1 satellite data for interferometry.





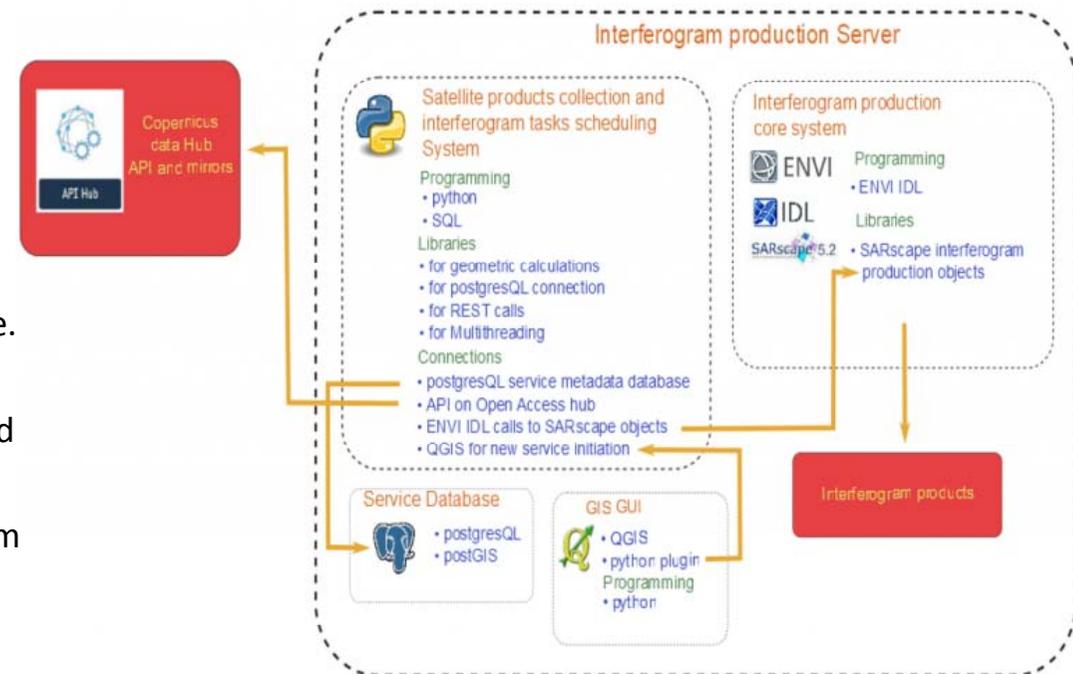
# geObservatory | Interferometric processing



# geObservatory | Application orchestrator

Application server which orchestrates the entire service are:

- The “Products collection and Task scheduling service” written in python. This program initiates the request processing, finds and downloads the necessary satellite inputs and controls the output production tasks. A QGIS plugin has also been developed to manually trigger GeObservatory through a user interface.
- The Service Metadata Database (postgresql) that contains processing information, input and output metadata
- The ENVI SARscape module is the interferogram production engine. The “Products collection and Task scheduling service” execute commands from ENVI sarscape module using IDL scripts in order to create the interferograms
- The IDL scripts that execute the main interferogram tasks calling the sarscape commands.



## geObservatory | Interferograms

- High resolution tiff available for download
- Quicklook interferogram in PNG
- Online viewing using Leaflet technology



Image Opacity:





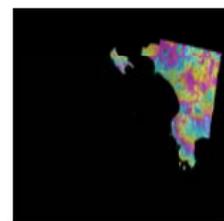
# geObservatory | Front-end

- HOME
- HOW DOES IT WORK?
- SENTINEL DATA
- DISCLAIMER

- Recent Events
- Historic Events



### Last 5 events

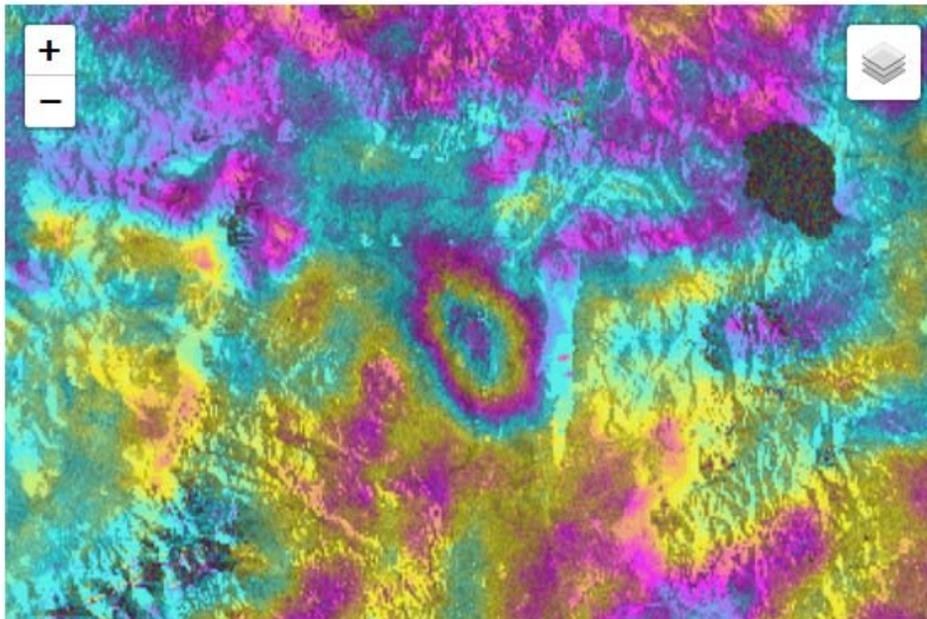


IONIAN SEA (2018-10-25 22:54:51)

# WESTERN TURKEY (2019-03-20 06:34:27)

Earthquake location: WESTERN TURKEY

Magnitude: 6.4

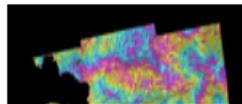


Leaflet | Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, AeroGrid, IGN, IGP, UPR-EGP, and the GIS User Community, Data © OpenStreetMap



## Interferograms

Ascending



Type: co-seismic

Master: 2019-03-16 16:06:08

Slave: 2019-03-22 16:06:52

# IONIAN SEA (2018-10-25 22:54:51)

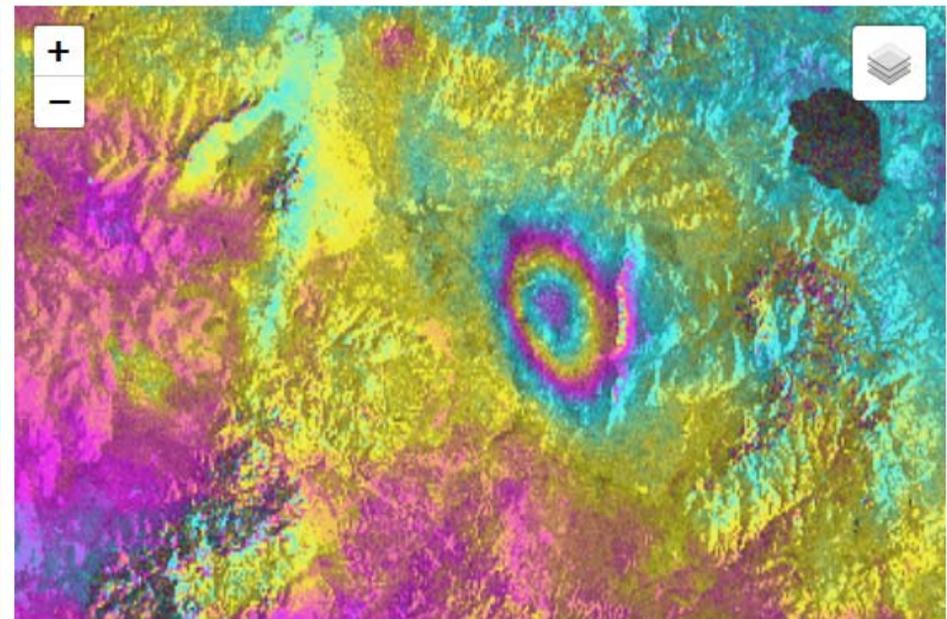
Earthquake location: IONIAN SEA

Magnitude: 6.6

Depth: 10 km

Time: 2018-10-25 22:54:51

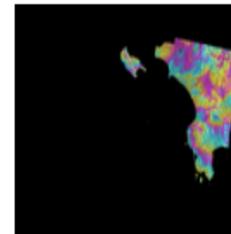
Coordinates: 37.52 , 20.57



Leaflet | Tiles © Esri — Source: Esri, i-cubed, USDA, USGS, AEX, GeoEye, Getmapping, AeroGrid, IGN, IGP, UPR-EGP, and the GIS User Community, Data © OpenStreetMap

## Interferograms

Descending



Type: co-seismic

Master: 2018-10-20 04:39:26

Slave: 2018-10-26 04:40:08

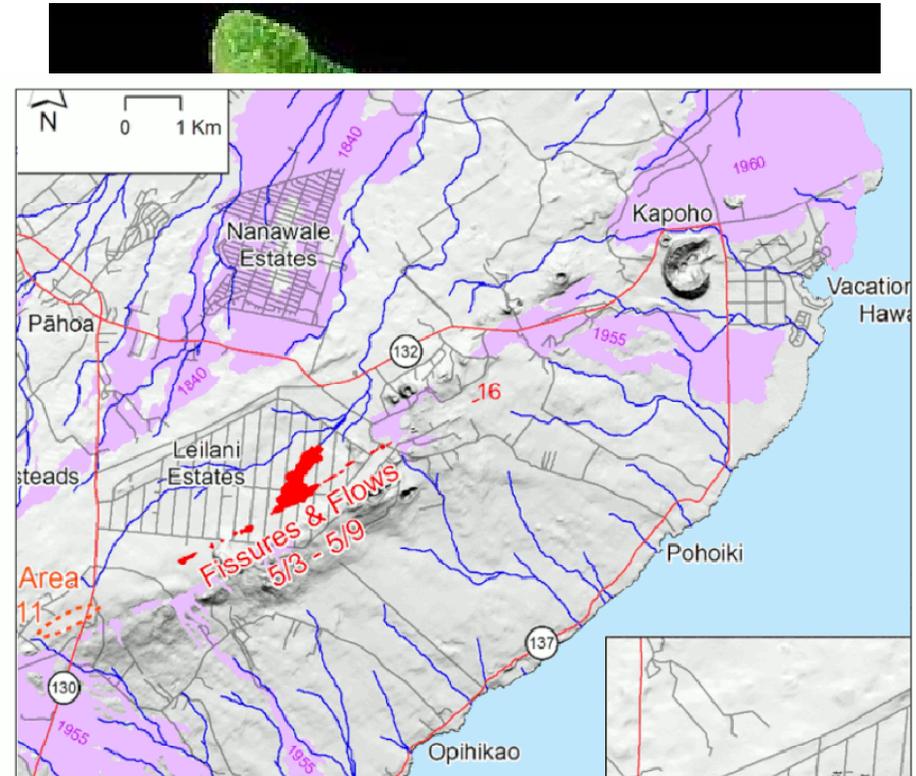
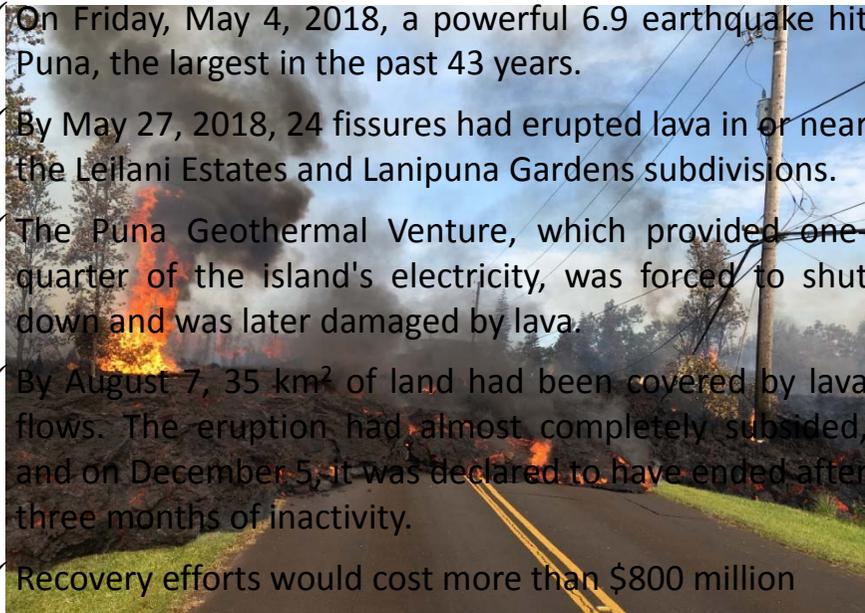
Orbit Number: 80

Mode: DESCENDING

[Download \(TIF\)](#) [Download \(Low Resolution\)](#) [Preview](#)

## geObservatory | Kīlauea volcano, Hawaii

- ✓ Intense micro-seismic activity in the wider area of the Kīlauea volcano in Hawaii occurred during 26/4-2/5/2018.
- ✓ Suddenly, on Thursday 3/5 a volcanic crack appeared near the road network in lower Puna region, from which lava and hot steam appeared. The Civil Protection instructed residents of the Puna community (~10,000) to leave their homes immediately.
- ✓ On Friday, May 4, 2018, a powerful 6.9 earthquake hit Puna, the largest in the past 43 years.
- ✓ By May 27, 2018, 24 fissures had erupted lava in or near the Leilani Estates and Lanipuna Gardens subdivisions.
- ✓ The Puna Geothermal Venture, which provided one-quarter of the island's electricity, was forced to shut down and was later damaged by lava.
- ✓ By August 7, 35 km<sup>2</sup> of land had been covered by lava flows. The eruption had almost completely subsided, and on December 5, it was declared to have ended after three months of inactivity.
- ✓ Recovery efforts would cost more than \$800 million



Source: USGS

# geObservatory | Kīlauea volcano, Hawaii

✓ BEYOND responded immediately and activated the geObservatory

## ISLAND OF HAWAII, HAWAII (2018-05-04 22:32:57)

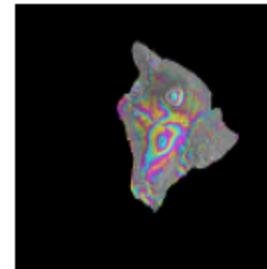
Earthquake location: ISLAND OF HAWAII, HAWAII

Magnitude: 6.5

Depth: 30 km

Time: 2018-05-04 22:32:57

Coordinates: 19.39 , -155.41



Type: co-seismic

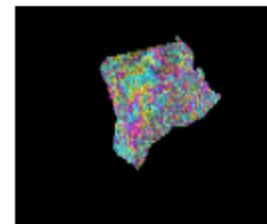
Master: 2018-04-23 16:15:24

Slave: 2018-05-05 16:15:25

Orbit Number: 87

Mode: DESCENDING

[Download \(TIF\)](#) [Download \(Low Resolution\)](#) [Preview](#)



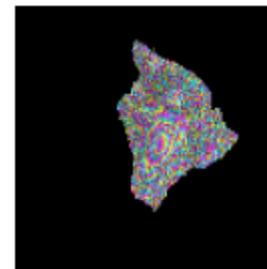
Type: co-seismic

Master: 2018-05-02 04:30:26

Slave: 2018-05-08 04:29:48

Orbit Number: 124

Mode: ASCENDING



Type: pre-seismic

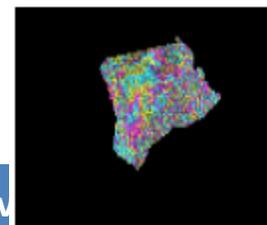
Master: 2018-04-23 16:15:24

Slave: 2018-04-11 16:15:24

Orbit Number: 87

Mode: DESCENDING

[Download \(TIF\)](#) [Download \(Low Resolution\)](#) [Preview](#)



Type: pre-seismic

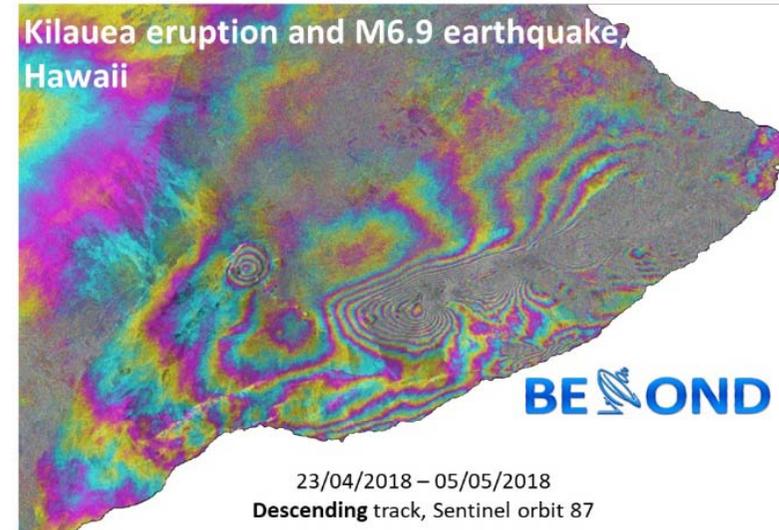
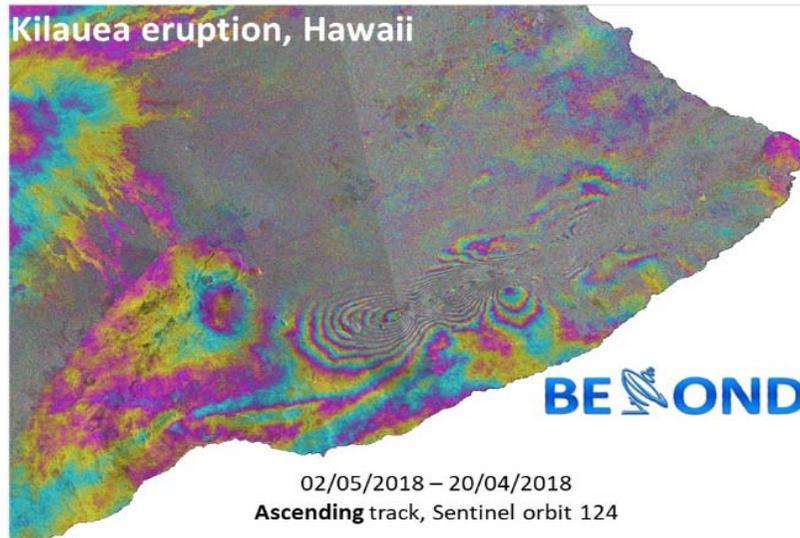
Master: 2018-05-02 04:30:26

Slave: 2018-04-20 04:30:26

Orbit Number: 124

Mode: ASCENDING

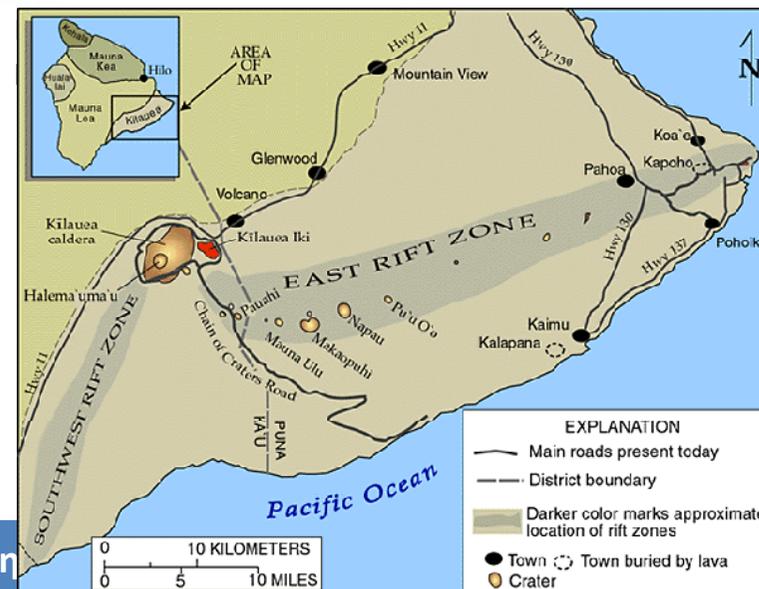
# geObservatory | Kīlauea volcano, Hawaii



IFG #1: Covers only the pre-earthquake volcanic eruption period.

→ Intense subsidence at the top of the volcano as magma material moves along the East Rift Zone and escapes to the eastern edge of the fault. The maximum deformation along this zone, located between the top of the volcano and the area where the lava was firstly observed, is approximately 60-70 cm.

Source:  
USGS





## geObservatory | Remark and future work

- 25 activations of geObservatory in 2018
- GeObservatory is a beta version application which is supported by the BEYOND team on a best effort basis.
- The interferometric products are generated on a fully automatic approach, without an intervention of an expert.
- Future functionalities:
  - Continuous monitoring of critical sites
  - Notification service through registration
  - Processing on the cloud, GPU enabled
  - Automatically decompose products to east-west and up-down vectors by combining descending & ascending imagery
  - Add 3<sup>rd</sup> party SAR mission data

Ευχαριστώ για την προσοχή σας

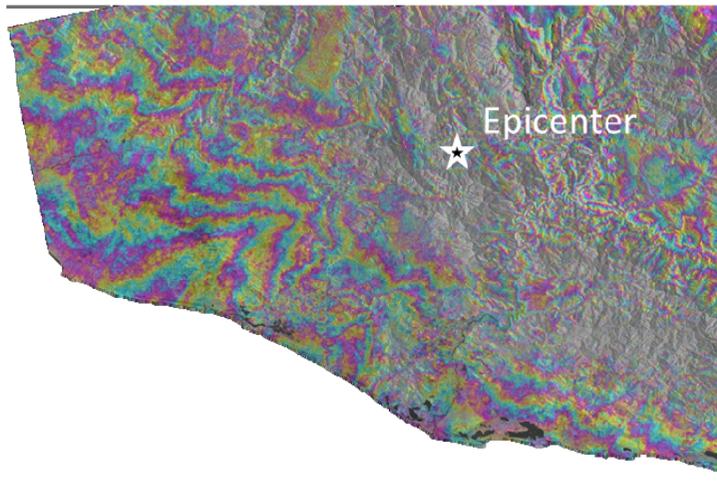


Ερωτήσεις??

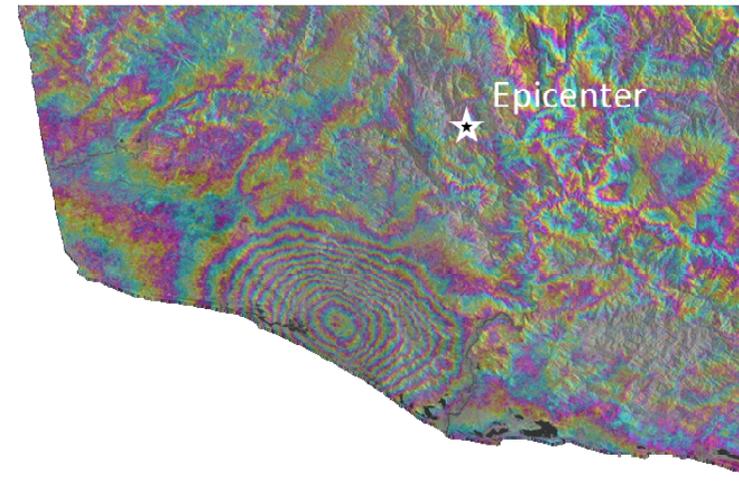
## geObservatory | Example

### Mexico EQ, Mw7.2 16/02/2018 23:39 UTC

**Pre-seismic interferogram**  
05/02/2018 – 13/01/2018  
Ascending  
Normal baseline: 71 m  
Altitude of ambiguity: 217 m  
Sentinel orbit 5



**Co-seismic interferogram**  
05/02/2018 – 17/02/2018  
Ascending  
Normal baseline: -9 m  
Altitude of ambiguity: 1643 m  
Sentinel orbit 5



# GeoHUB: Earthquake deformation mapping

Merryman Boncori et al., SRL 2015

**Data**

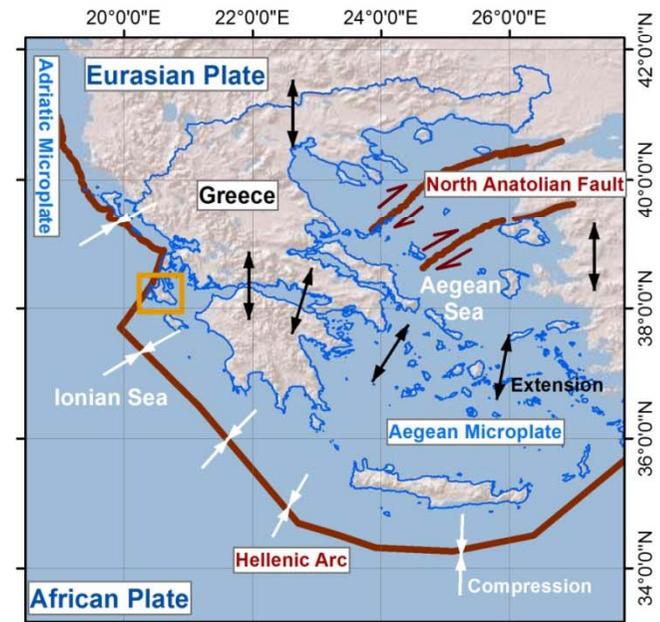
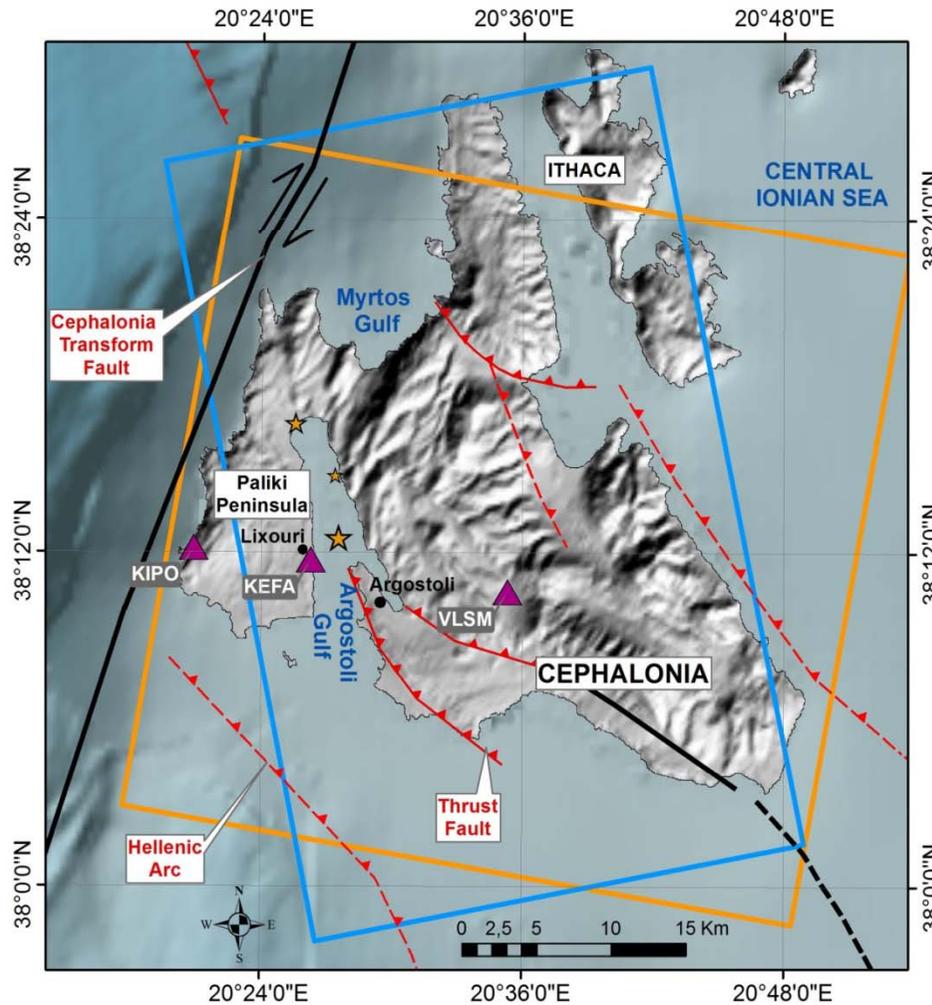
- NSN
- NOANET
- ENIGMA
- In-situ

**Services**

- Geodesy
- Modeling
- Hazard Ass.
- Large Proc.

**Applications**

- Tectonics
- Volcanoes
- Landslides
- Subsidence

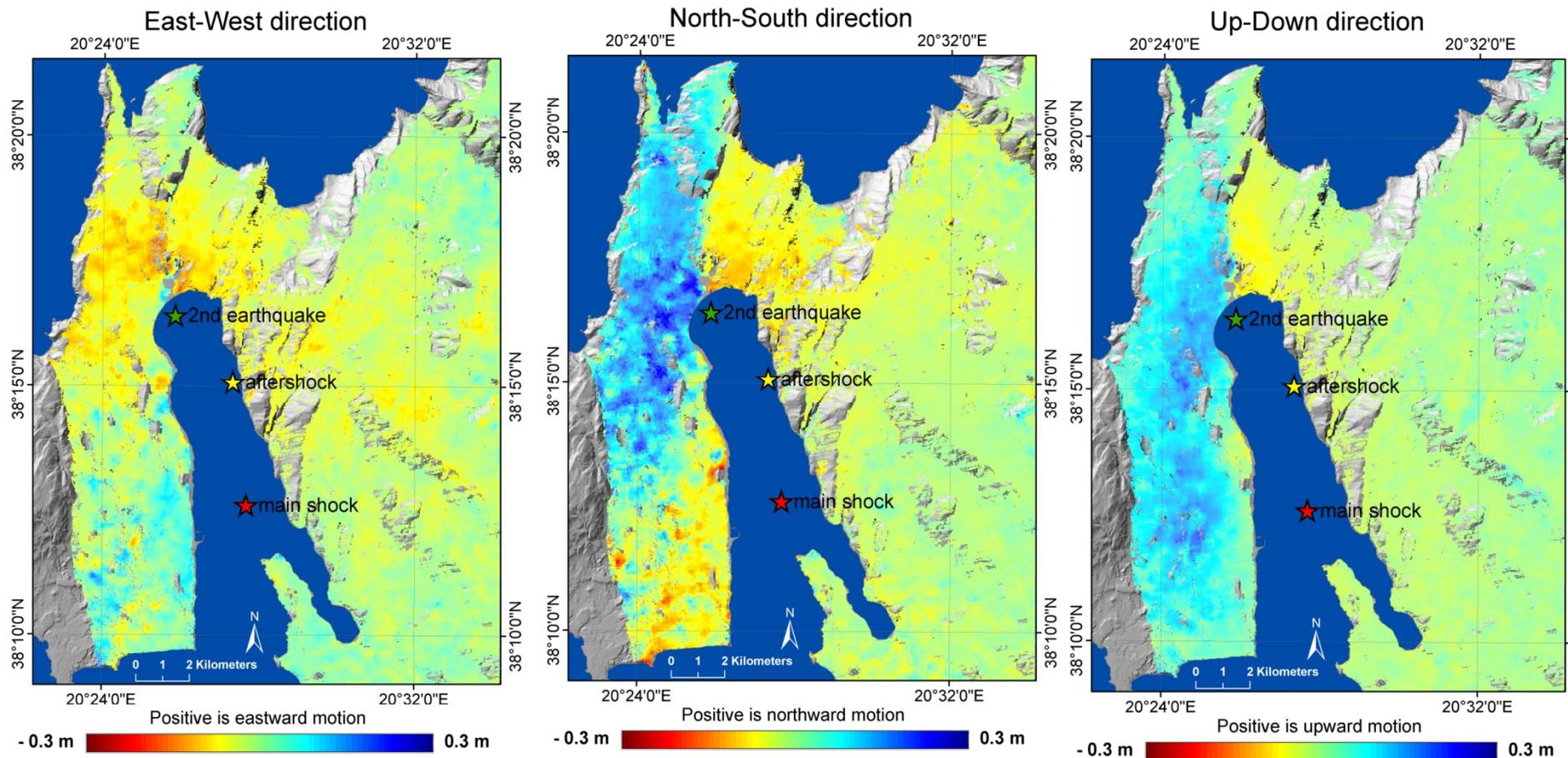


- |                          |                               |
|--------------------------|-------------------------------|
| <b>Mapped faults</b>     | <b>Main earthquake events</b> |
| --- Strike-slip inferred | ★ 26/1/2014 ML 5,1            |
| — Strike-slip            | ★ 3/2/2014 ML 5,7             |
| - - - Reverse inferred   | ★ 26/1/2-14 ML 5,9            |
| ▲▲ Reverse               |                               |
| <b>GPS stations</b>      | <b>SARframes</b>              |
| ▲ cGPS                   | □ COSMO-SkyMED                |
|                          | □ TerraSAR-X                  |

## GeoHUB: Earthquake deformation mapping

- 3D crustal deformation from TerraSAR-X & COSMO-SkyMed data
- Inversion to estimate fault parameters

Merryman Boncori et al., SRL 2015





# GeoHUB: Earthquake deformation mapping

## Italian earthquakes in 2016/2017

Papadopoulos et al., Pure and Applied Geophysics, 2017

### Data

CoIGS

NOANET

ENIGMA

In-situ

### Services

Geodesy

Modeling

Hazard Ass.

Large Proc.

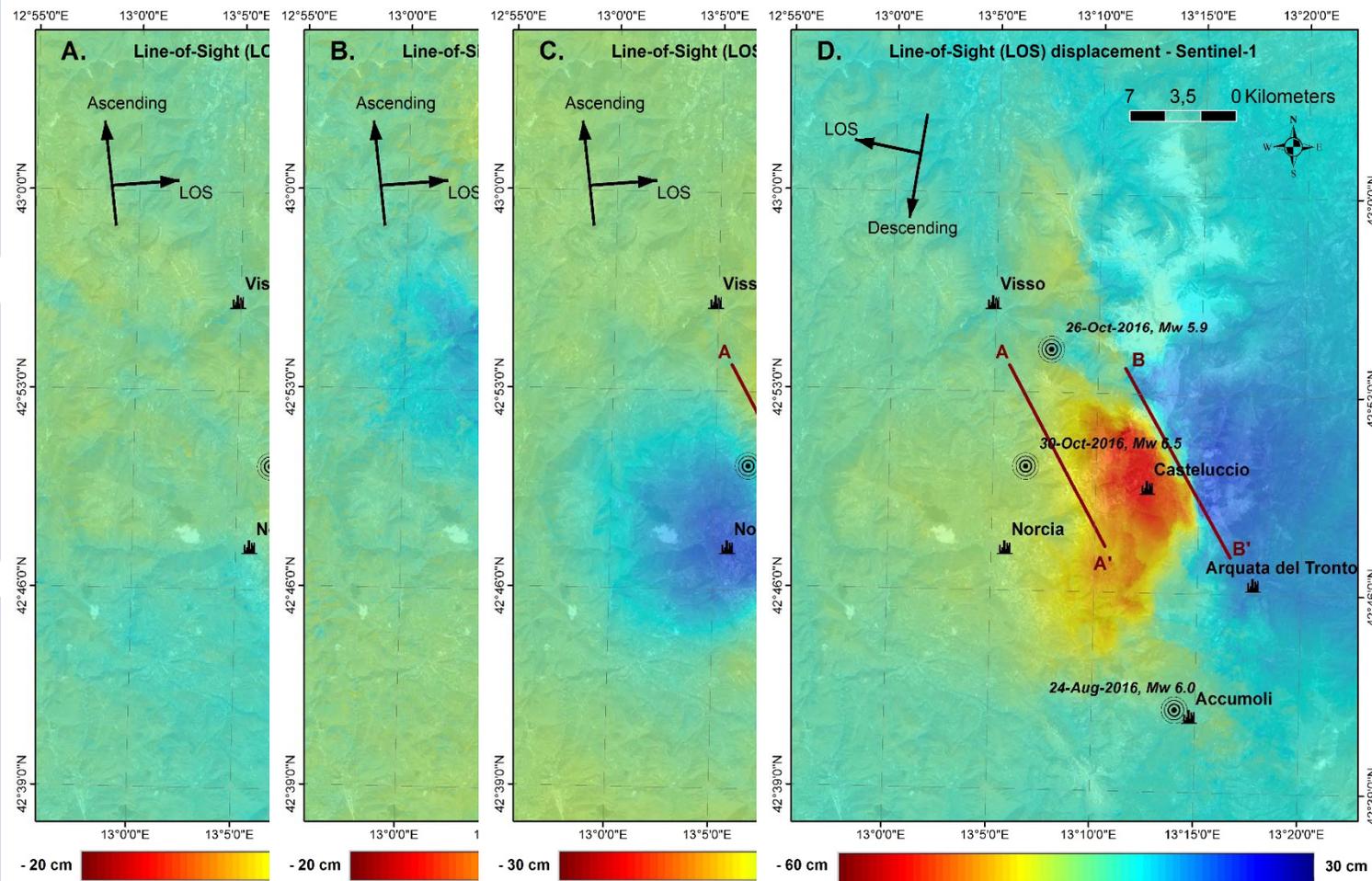
### Applications

Tectonics

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Subsidence





# GeoHUB: Earthquake deformation mapping

## Data

CoIGS

NOANET

ENIGMA

In-situ

## Services

Geodesy

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Large Proc.

## Applications

Tectonics

Volcanoes

Landslides

Subsidence

