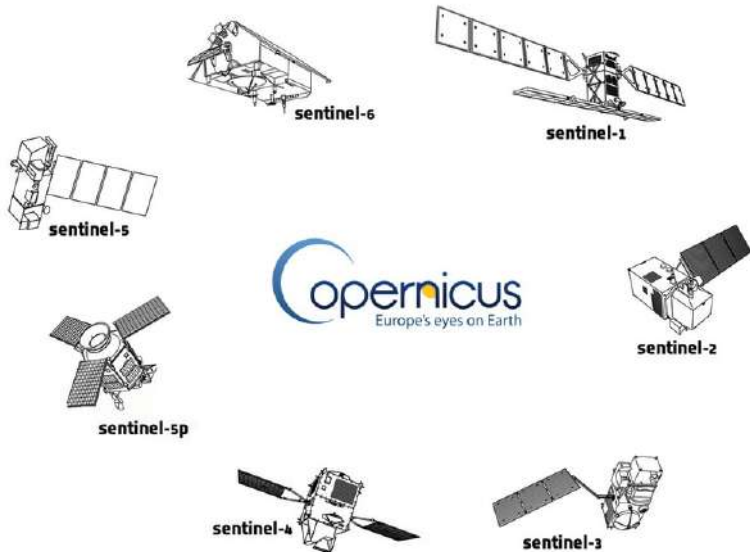


Remote Sensing: brief overview

Alessandro Sebastianelli

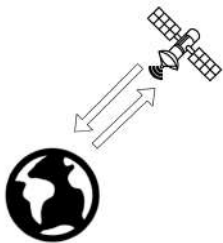
May 2022

Copernicus and its Sentinels



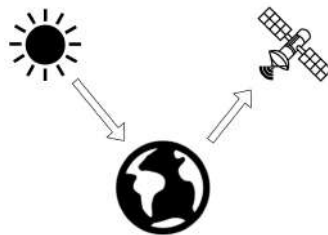
Active vs Passive Sensors

Active Sensor



Sentinel-1
Sentinel-3

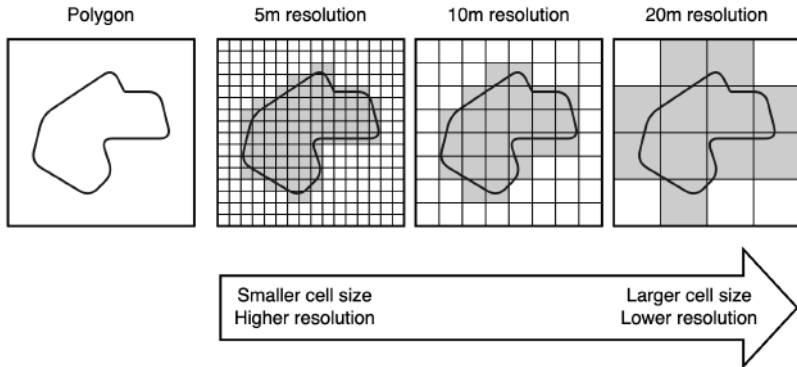
Passive Sensor



Sentinel-2
Sentinel-5p

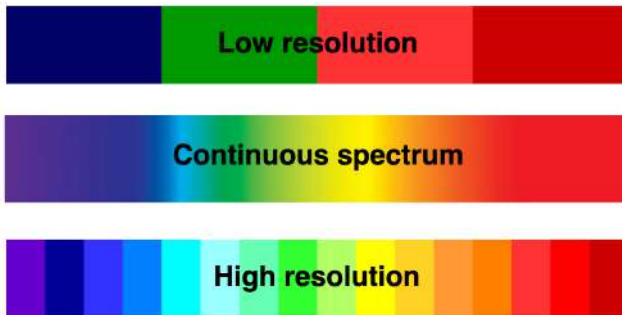
Resolutions (1)

Spatial Resolution: it represents the smallest possible feature that can be detected. The spatial resolution quantifies the capability to separate two close targets. The pixel size is often considered as spatial resolution. It depends on the design of the sensor, while the pixel size depends on the digital sampling of the signal.



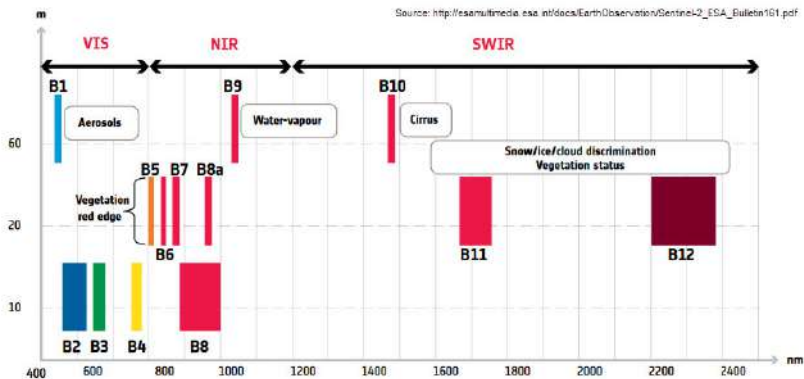
Resolutions (2)

Spectral Resolution: it represents the wavelength of the different frequency bands recorded. Spectral resolution describes the ability of a sensor to define fine wavelength intervals.



Resolutions (2)

Spectral Resolution: it represents the wavelength of the different frequency bands recorded. Spectral resolution describes the ability of a sensor to define fine wavelength intervals.



↑ Spatial resolution versus wavelength: Sentinel-2's span of 13 spectral bands, from the visible and the near-infrared to the shortwave infrared at different spatial resolutions ranging from 10 to 60 m on the ground, takes land monitoring to an unprecedented level.

Resolutions (3)

Radiometric Resolution: it refers to the number of different intensities of radiation the sensor is able to distinguish. The greater the radiometric resolution, the more accurate the sensed image will be.

8-bit radiance level

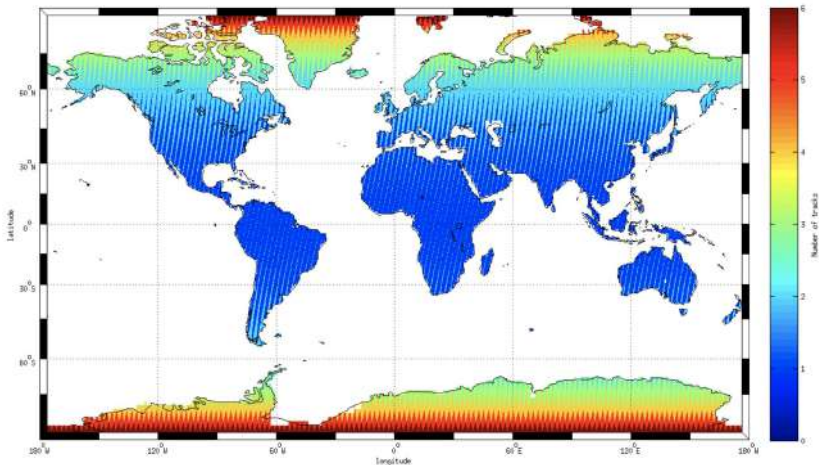


2-bit radiance level



Resolutions (4)

Temporal Resolution: is the frequency of flyovers by the satellite. This resolution can become relevant in time series studies or those requiring an averaged or mosaic image (e.g. change detection, deforestation monitoring)





Open Hub

Copernicus Open Access Hub

<https://scihub.copernicus.eu/dhus/#/home>

Main Page



Set parameters

The screenshot shows the 'Advanced Search' panel of the ESA OpenEO interface. The panel is divided into two sections for 'Mission: Sentinel-1' and 'Mission: Sentinel-2'. The 'Sentinel-1' section is currently active, indicated by a radio button. The search criteria are as follows:

- Sort By:** Ingestion Date
- Order By:** Descending
- Sensing period:** 2019/04/01 to 2019/11/30
- Ingestion period:** (empty)
- Mission:** Sentinel-1
- Satellite Platform:** S1A_*
- Polarisation:** (empty)
- Relative Orbit Number (from 1 to 175):** (empty)
- Product Type:** SLC
- Sensor Mode:** IW
- Collection:** (empty)

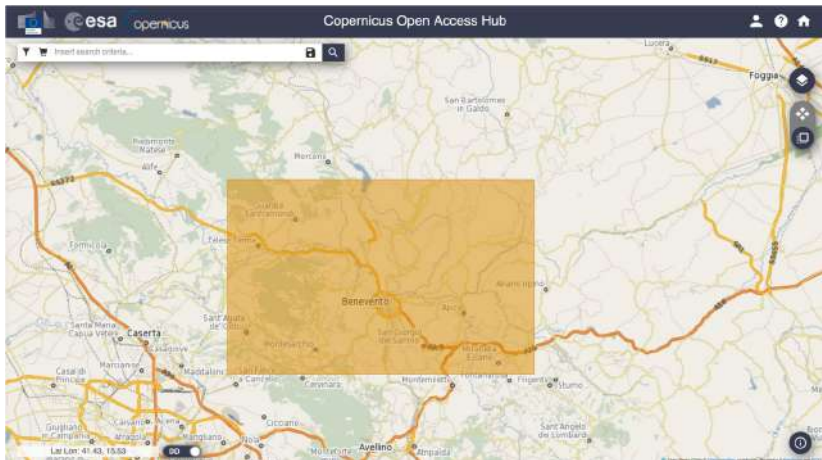
The 'Sentinel-2' section is inactive. Its parameters are:

- Satellite Platform:** (empty)
- Product Type:** (empty)
- Relative Orbit Number (from 1 to 175):** (empty)
- Cloud Cover % (e.g. [0 TO 9.4]):** (empty)

At the bottom of the panel, there is a 'DO' button and a map view toggle.

- ▶ Mission
- ▶ Platform
- ▶ Sensing Period (start and end date)
- ▶ Product type
- ▶ Acquisition mode

Select the AOI (Area Of Interest) (1)



Select the AOI (Area Of Interest) (2)

The screenshot displays the Copernicus Open Access Hub interface. On the right, a map of Europe shows a red polygon representing the Area Of Interest (AOI) over the Iberian Peninsula. On the left, a sidebar lists search results for SAR products. The sidebar includes a search bar, a filter for 'Display 1 to 25 of 90 products', and a list of products with their details and download links.

Copernicus Open Access Hub

Search:

Display 1 to 25 of 90 products.
Order By: Ingestion Date ↓

0 products selected

Request Done: (footprint:Intersects(POLYGON((14.465271202679394
41.02902484719748,15.068734327799604
41.02902484719748,15.068734327799604
14.465271202679394))))

S1A SAR-C S1A_IW_SLC__1SDV_20191030T165726_20191030T165737_028691...
Download URL: <https://datahub.copernicus.eu/files/dataset/1/Products/26802-640/>
Mission: Sentinel-1 Instrument: SAR-C Sensing Date: 2019-10-30T16:57:30.606

S1B SAR-C S1A_IW_SLC__1SDV_20191030T165734_20191030T165732_028691...
Download URL: <https://datahub.copernicus.eu/files/dataset/1/Products/26802-640/>
Mission: Sentinel-1 Instrument: SAR-C Sensing Date: 2019-10-30T16:57:04.846

S1A SAR-C S1A_IW_SLC__1SDV_20191029T012006_20191029T012014_028688...
Download URL: <https://datahub.copernicus.eu/files/dataset/1/Products/26802-640/>
Mission: Sentinel-1 Instrument: SAR-C Sensing Date: 2019-10-29T05:02:06.494

S1A SAR-C S1A_IW_SLC__1SDV_20191030T060348_20191030T060358_028690...
Download URL: <https://datahub.copernicus.eu/files/dataset/1/Products/26802-640/>
Mission: Sentinel-1 Instrument: SAR-C Sensing Date: 2019-10-24T06:03:40.794

S1A SAR-C S1A_IW_SLC__1SDV_20191024T060406_20191024T060432_028686...
Download URL: <https://datahub.copernicus.eu/files/dataset/1/Products/26802-640/>
Mission: Sentinel-1 Instrument: SAR-C Sensing Date: 2019-10-24T06:04:06.494

25 page 1 of 4 >>



Alaska Satellite Facility

<https://search.asf.alaska.edu/#/>

Main Page

The screenshot displays the ASF Data Search Vertex web application. The interface includes a header with the ASF logo, search filters, and user options. The main area features a map of North America and Europe, with a search bar and various map controls.

Header:

- ASF Data Search Vertex** logo
- Search Type:** Geographic
- Dataset:** Sentinel-1
- Area of Interest:** WKT
- Filters:** 350 of 10,571,756 Files
- SEARCH** button
- Downloads** icon
- Sign in** icon
- Menu** icon

Map Interface:

- Map Controls:** Includes a toolbar with icons for zooming, panning, and other map functions.
- Map Data:** A satellite map showing North America and Europe. Labels for countries like Canada, United States of America, Mexico, and various European countries are visible.
- Map Coordinates:** A small box in the top right corner of the map area displays the coordinates: **lat: 19.3452°** and **lon: -100.6514°**.
- Map Attribution:** At the bottom left, it says **MapTiler | © OpenStreetMap contributors**. At the bottom right, it says **© 2020 ASF | Contact | Non-Discrimination**.

Set parameters

The screenshot displays the ASF Data Search Vertex web application. The interface is divided into a left sidebar with a map, a central search filter panel, and a right sidebar with another map and navigation links.

Search Filters Panel:

- Search Type:** Geographic
- Start:** Jan 01 2019
- Date Filters:**
 - Start Date: 1/1/2019
 - End Date: 4/30/2019
 - ☐ Seasonal Search
- Additional Filters:**
 - File Type: L1 Single Look Comp... + IW (1/14 file types selected)
 - Swath Mode: (1/0 swath modes selected)
 - Polarization: (0/0 polarizations selected)
 - Direction: Ascending (1/2 flight directions selected)
 - Subtype: (0/2 subtypes selected)
- Path and Frame Filters:**
 - Path Start
 - Path End
 - Frame Start
 - Frame End
 - Clear

Map and Interface Elements:

- Left Map:** Shows a satellite view of the North Atlantic Ocean.
- Right Map:** Shows a map of Europe and North Africa with a "Click to start drawing" overlay.
- Top Right:** Includes icons for Downloads, Sign in, and a menu.
- Bottom:** Displays "250 of 48,197 Files" and a "SEARCH" button.
- Footer:** Includes a NASA logo and copyright information: "© 2020 ASF. | Contact | Non-Discrimination".

Select the AOI (Area Of Interest)

The screenshot displays the ASF Data Search Vertex interface. At the top, the search criteria are set to Geographic, Sentinel-1, and a POLYGON AOI. The map shows the Balkan region with a yellow rectangle highlighting the Area of Interest (AOI) over North Macedonia and Kosovo. Below the map, a list of 118 scenes is shown, with the first few entries visible:

- S1A_IW_SLC_1SDV_20190428T1649... 7038
- S1A_IW_SLC_1SDV_20190428T1648... 5412
- S1B_IW_SLC_1SDV_20190427T1656... FFE9
- S1B_IW_SLC_1SDV_20190427T1656... 196C
- S1A_IW_SLC_1SDV_20190426T1705... EF33

The selected scene details are shown on the right:

- Scene Detail:** S1A_IW_SLC_1SDV_20190428T164912_20190428T164939_026993_0309EC_7038
- Sentinel-1 - C-Band**
- Start Time:** 04/28/19, 16:49:12
- Beam Mode:** IW
- Path:** 145
- Frame:** 133
- Flight Direction:** ASCENDING
- Polarization:** VV/VH
- Absolute Orbit:** 20990
- Data courtesy of:** ESA
- L1 Single Look Complex (SLC):** 3.52 GB

The interface also includes a map toolbar, a search bar, and a list of filters. The bottom of the page shows the ASF logo and copyright information.

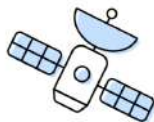


Google Earth Engine

<https://code.earthengine.google.com/>

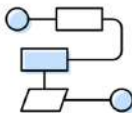
Google Earth Engine

Google Earth Engine combines a multi-petabyte catalog of satellite imagery and geospatial datasets with planetary-scale analysis capabilities. Scientists, researchers, and developers use Earth Engine to detect changes, map trends, and quantify differences on the Earth's surface. Earth Engine is now available for commercial use, and remains free for academic and research use.



Satellite Imagery

+



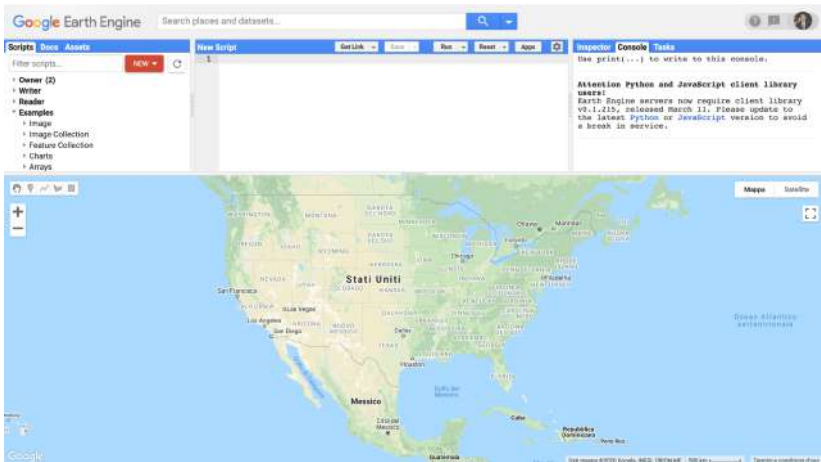
Your Algorithms

+

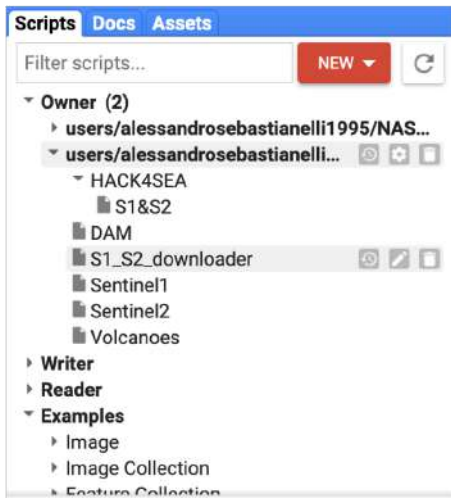


Real World Applications

Main Page



GEE Components (1)



Scripts

- ▶ Examples
- ▶ User code

Docs

- ▶ Code documentation

GEE Components (2)

The **code editor** allows to write and execute GEE code. GEE is based on Javascript, adapted properly to the platform. There exists also a Python API with the same functionalities, but it can be used only outside the web app.



```

S1_S2_downloader *
Get Link Save Run Reset Apps

1 26 var lon = 14.7781500
2 27 var lat = 41.1307000
3 28 var date = ee.Filter.date('2019-03-07', '2019-06-20')
4 29 var sizeinkm = 20
5 30
6 31 var zoom = 14
7 32
8 33
9 34
10 35 var polygon = get_coordinates_square(lat, lon, sizeinkm);
11 36 var geometry = ee.Geometry.Polygon(polygon);
12 37 Map.setCenter(lon, lat, zoom);
13 38
14 39
15 40 var s1dataset = ee.ImageCollection('COPERNICUS/S1_GRD')
16 41   .filterBounds(geometry)
17 42   .filter(date)
18 43   .filter(ee.Filter.listContains('transmitterReceiverPolarisation', 'VV'))
19 44   .filter(ee.Filter.listContains('transmitterReceiverPolarisation', 'VH'))
20 45   .filter(ee.Filter.eq('instrumentMode', 'IW'))
21 46   .filter(ee.Filter.eq('orbitProperties_pass', 'ASCENDING'))
  
```

GEE Components (3)



Console

- Terminal used to monitor activities, to print variables and to debug code

Tasks

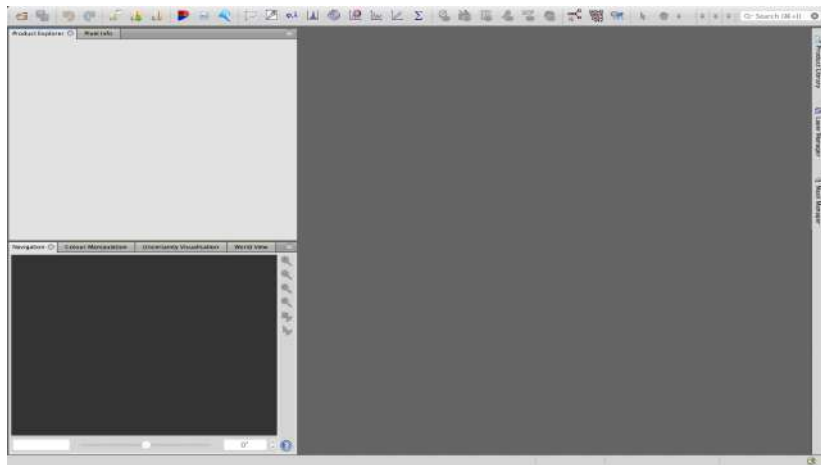
- It allows to monitor or to start tasks (e.g. download data)

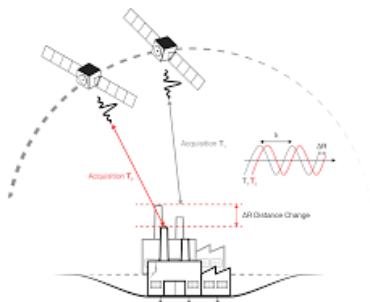


Sentinel Application Platform

<https://step.esa.int/main/download/>

Main Page



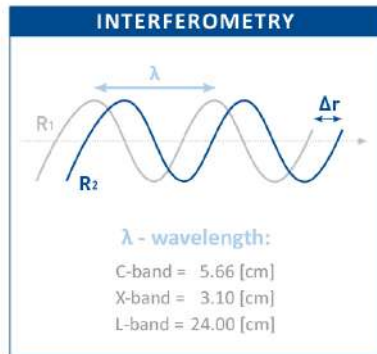
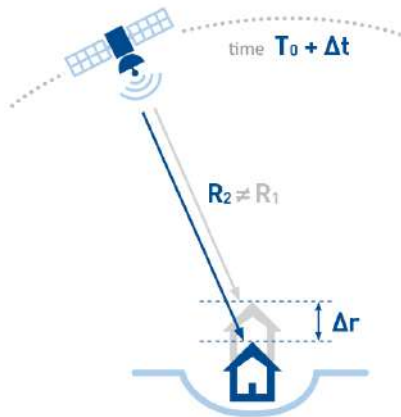


DInSAR: Differential Interferometric Synthetic Aperture Radar

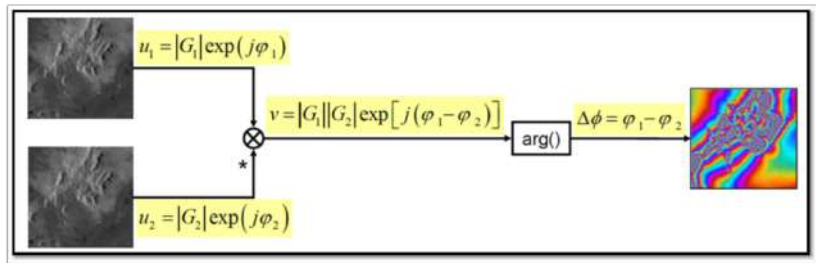
SAR vs Optical



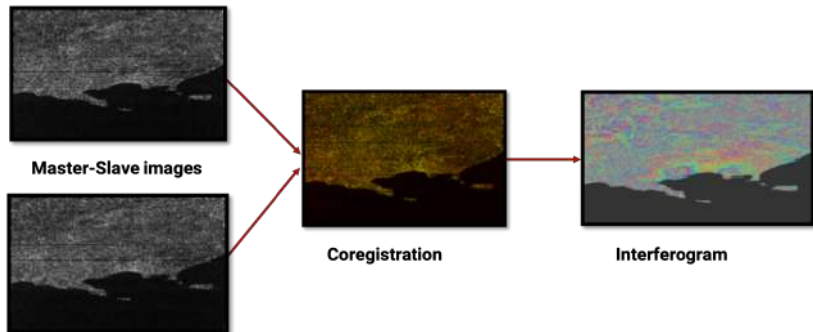
DInSAR (1)



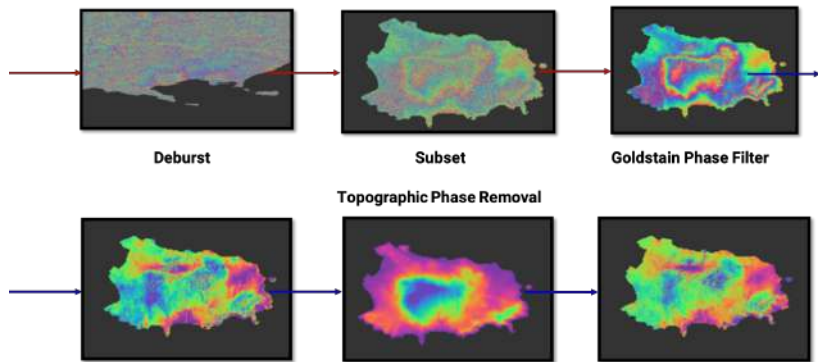
DInSAR (2)



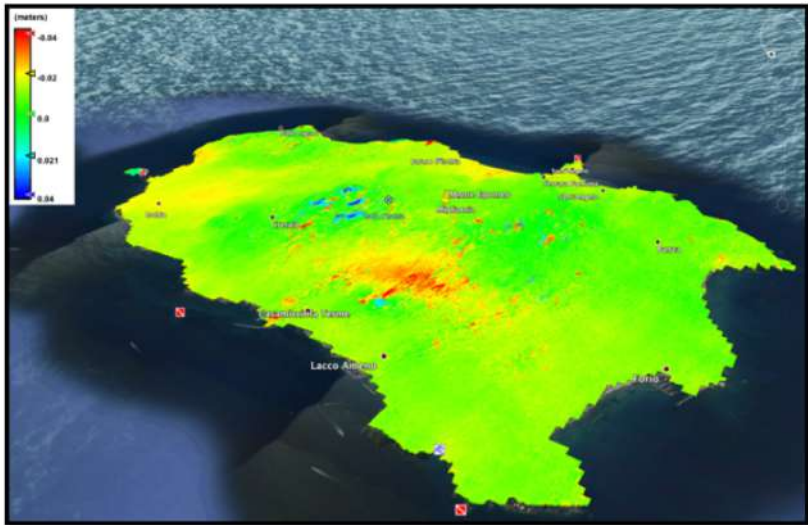
DInSAR (3)



DInSAR (4)



DInSAR (5)



Assignments

Assignment 1

- ▶ Register on Open Access Hub
- ▶ Download a Sentinel-2 image
- ▶ Open the image on SNAP or on QGIS

Assignment 2

- ▶ Register on Google Earth Engine
- ▶ Copy the code at
`https://github.com/Sebbyraft/GoogleEarthEngine/blob/master/sentinel_1_and_2_downloader.js`
- ▶ Paste the code in a new script on GEE
- ▶ Save the script and run it
- ▶ Change size in Km to change the size of the image
- ▶ Change the date
- ▶ Change lat and lon to change the geographical position
- ▶ Start the tasks for 1 Sentinel-1 and 1 Sentinel-2 image
- ▶ Download the data from Google Drive
- ▶ Open the images in SNAP or QGIS