Course 09: RADAR IMAGING TECHNOLOGY

Practice : Deformation map based on Sentinel 1 data (DInSAR)

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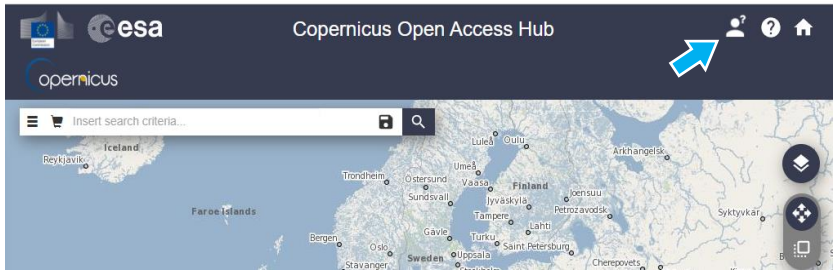
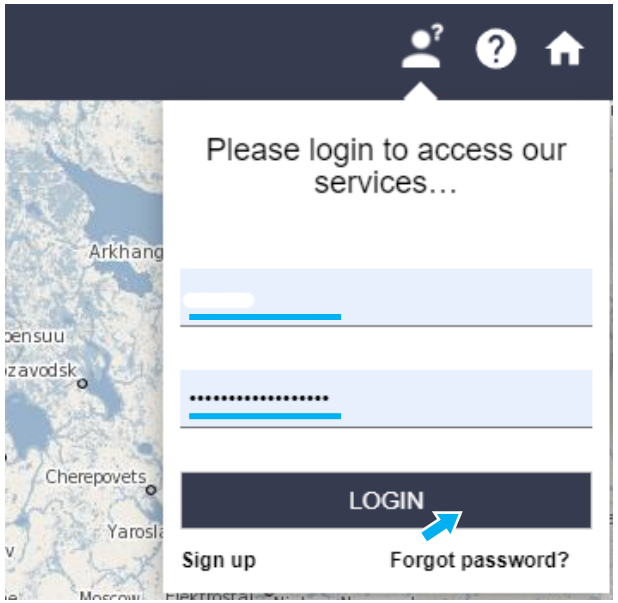
Step 1. Download data

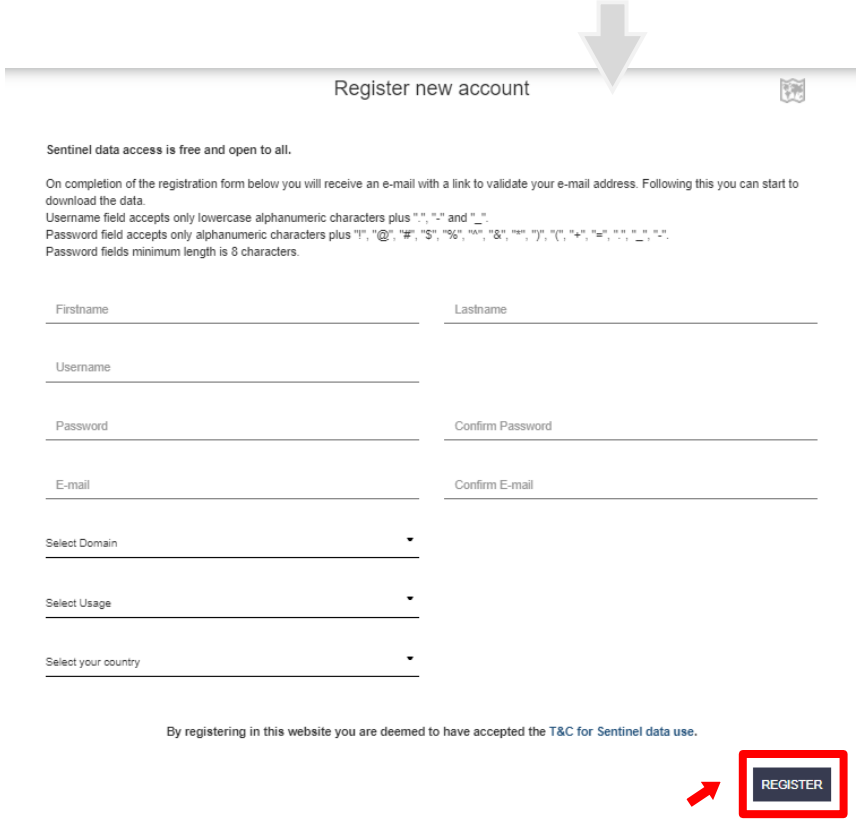
Variant 1. Copernicus Open Access Hub

1. Open link https://scihub.copernicus.eu/dhus/#/home and login or register





or

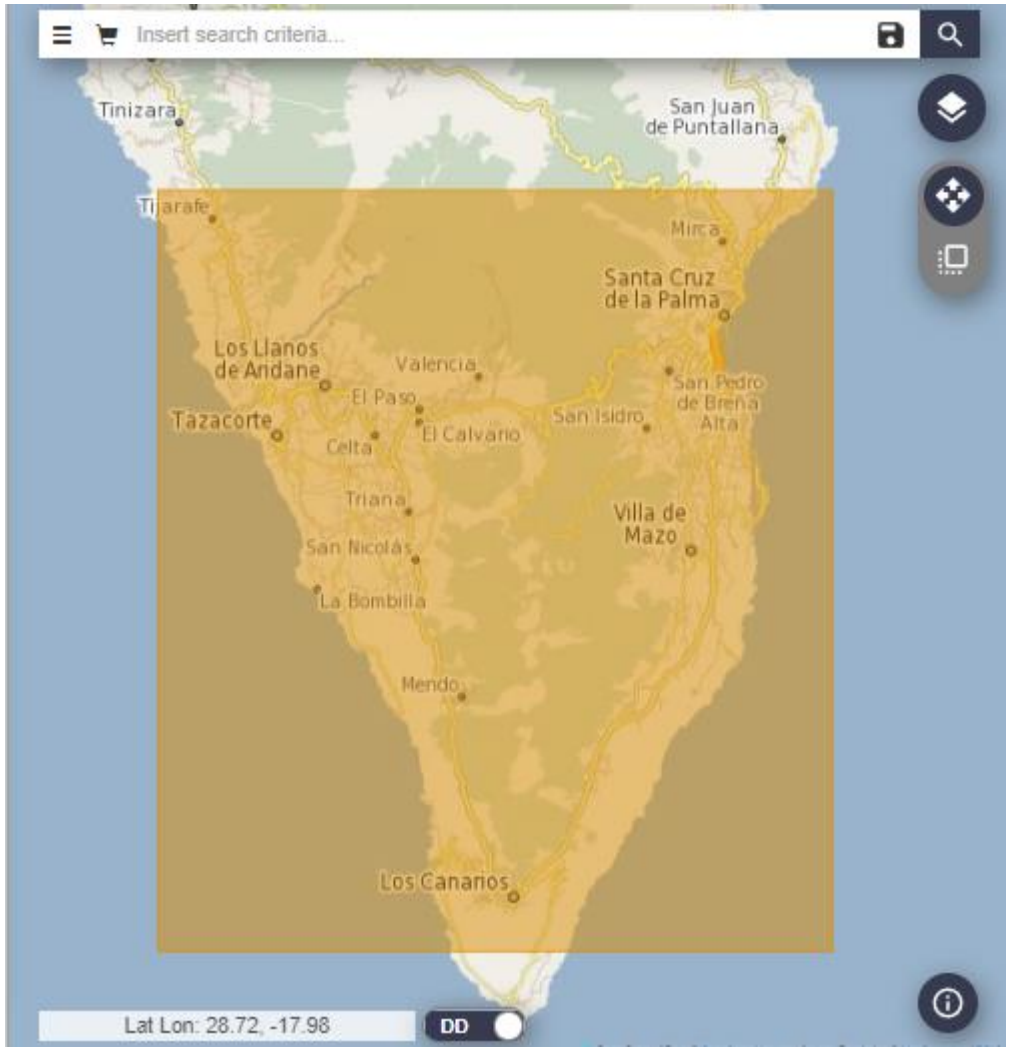


Step 1. Download data

Variant 1. Copernicus Open Access Hub

2. Find the necessary territory on the map and select it by holding down the right button of the manipulator.

*Right click again to remove the selection area.



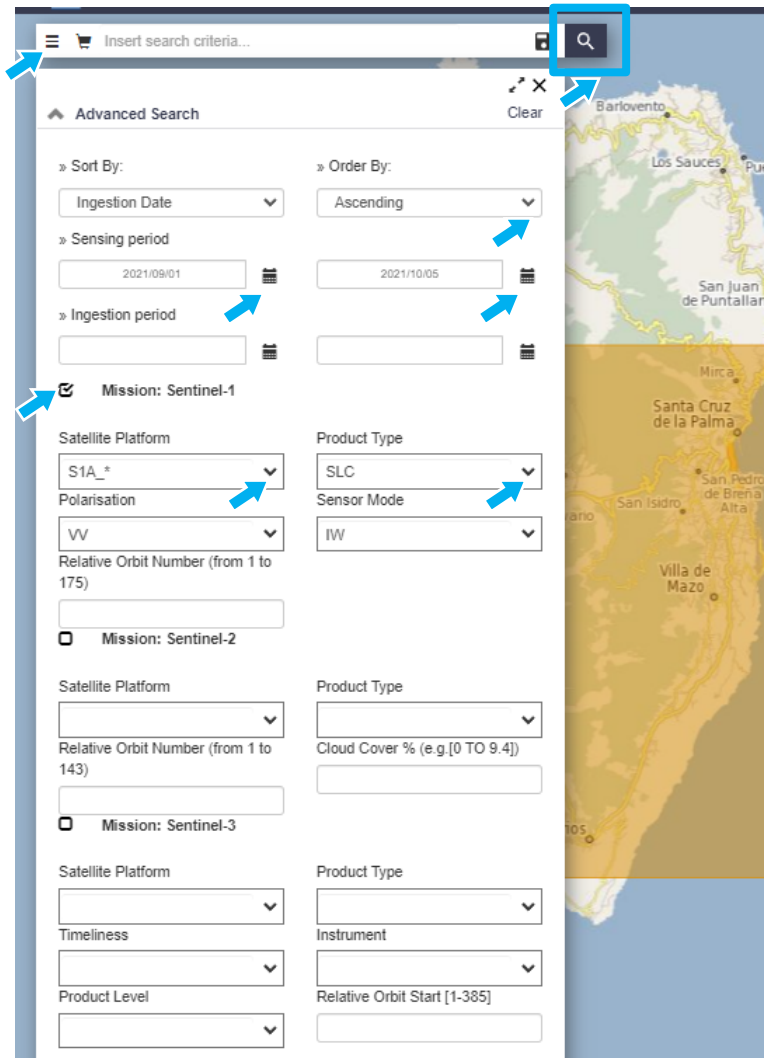
The 2021 Cumbre Vieja eruption began in September 2021 [28°36′54″N 17°52′07″W]

- From September 9, seismic activity began to be recorded on the island.
- Eruptions on the Cumbre Vieja volcanic ridge began on September 19, 2021.
- On the night of September 29, lava reached the ocean and formed a ledge.
- On September 30, frozen lava formed a peninsula in the ocean with an area of more than 20 hectares.

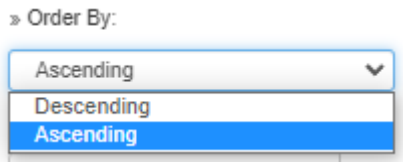
Step 1. Download data

Variant 1. Copernicus Open Access Hub

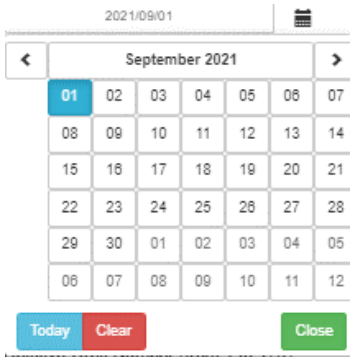
3. Configuring search parameters



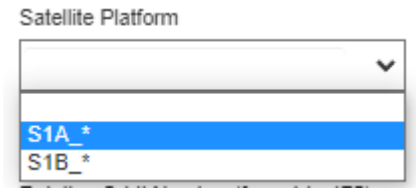
3.1 You can chose 1 variant orbit



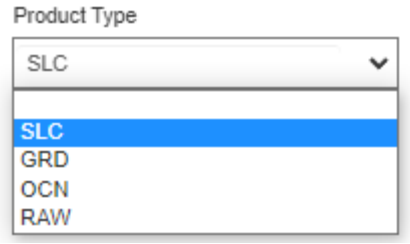
3.2 Select the date interval with a margin



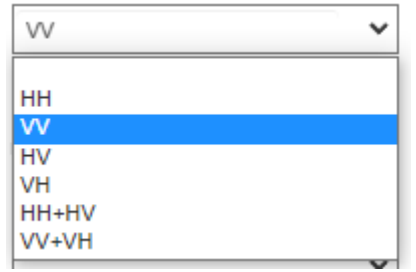
3.3 Select one and satellites or leave the field blank



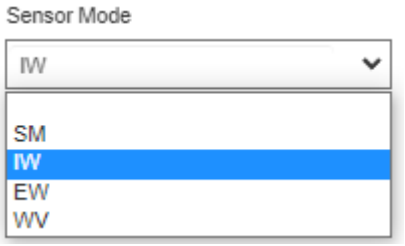
3.4 Select SLC product



3.5 Select VV or VV+VH polarization



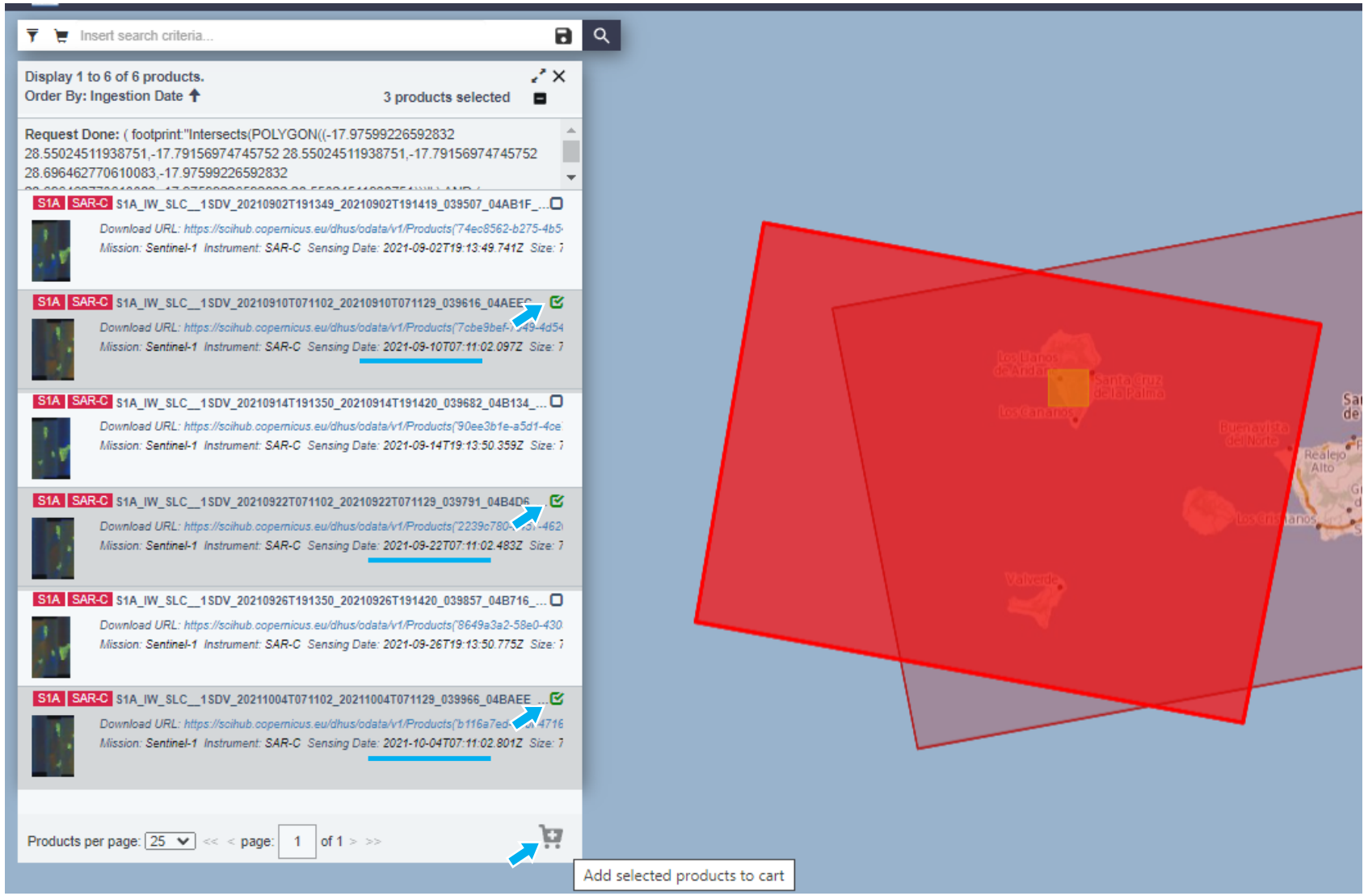
3.6 Select IW sensor mode



Step 1. Download data

Variant 1. Copernicus Open Access Hub

4. Chose images

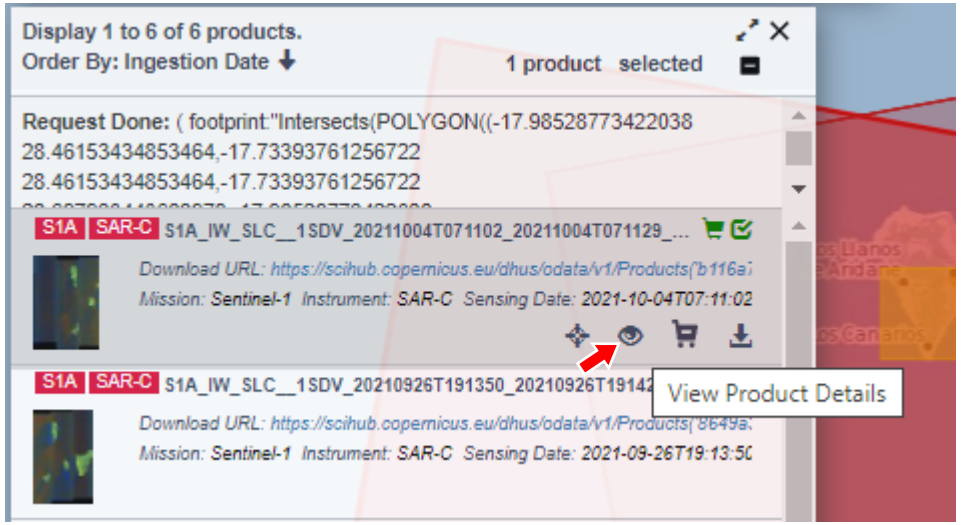


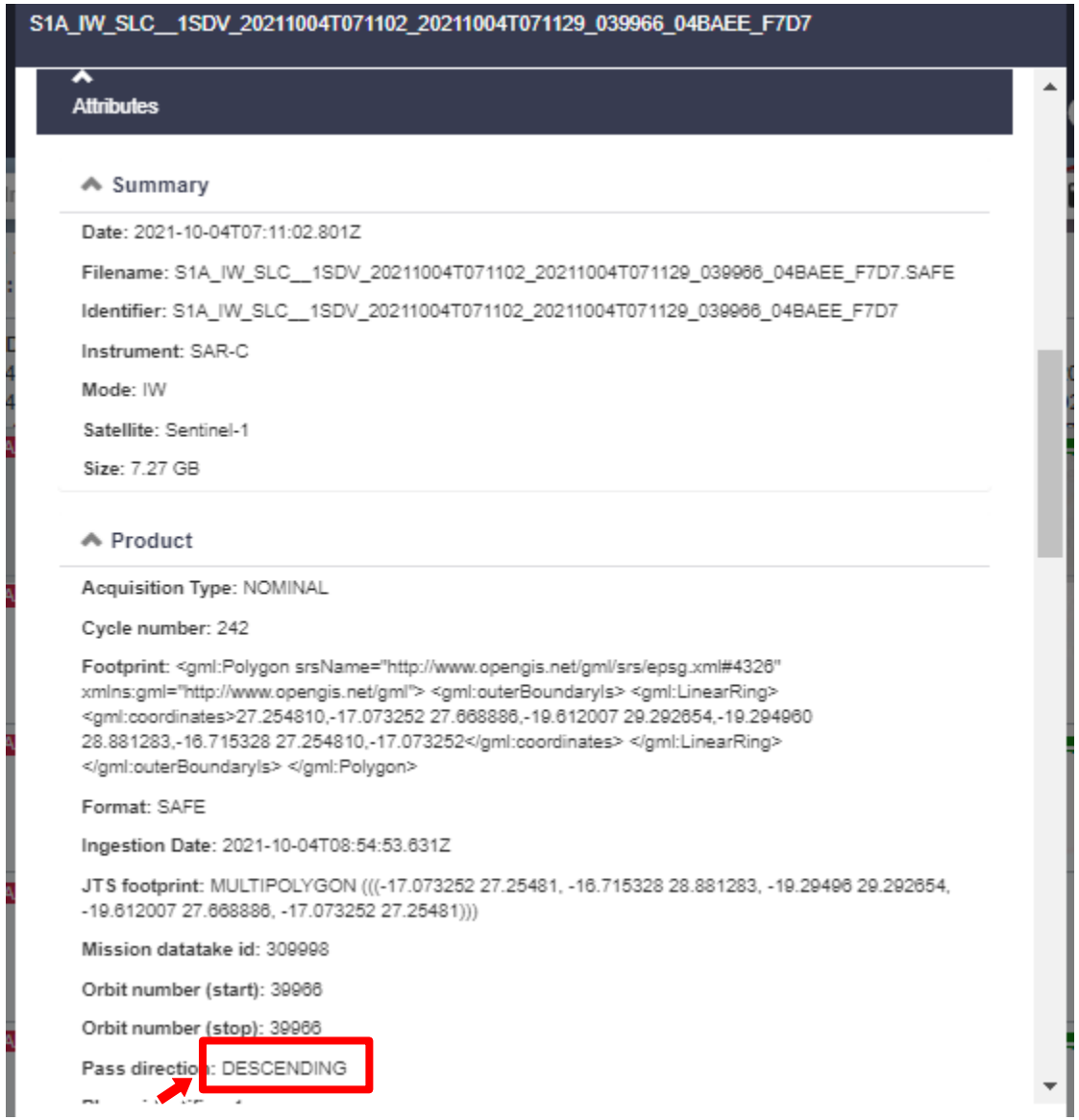
When you select an image, it is highlighted in the map area. Pay attention to the choice of images related to one orbit

Step 1. Download data

Variant 1. Copernicus Open Access Hub

4. Chose images





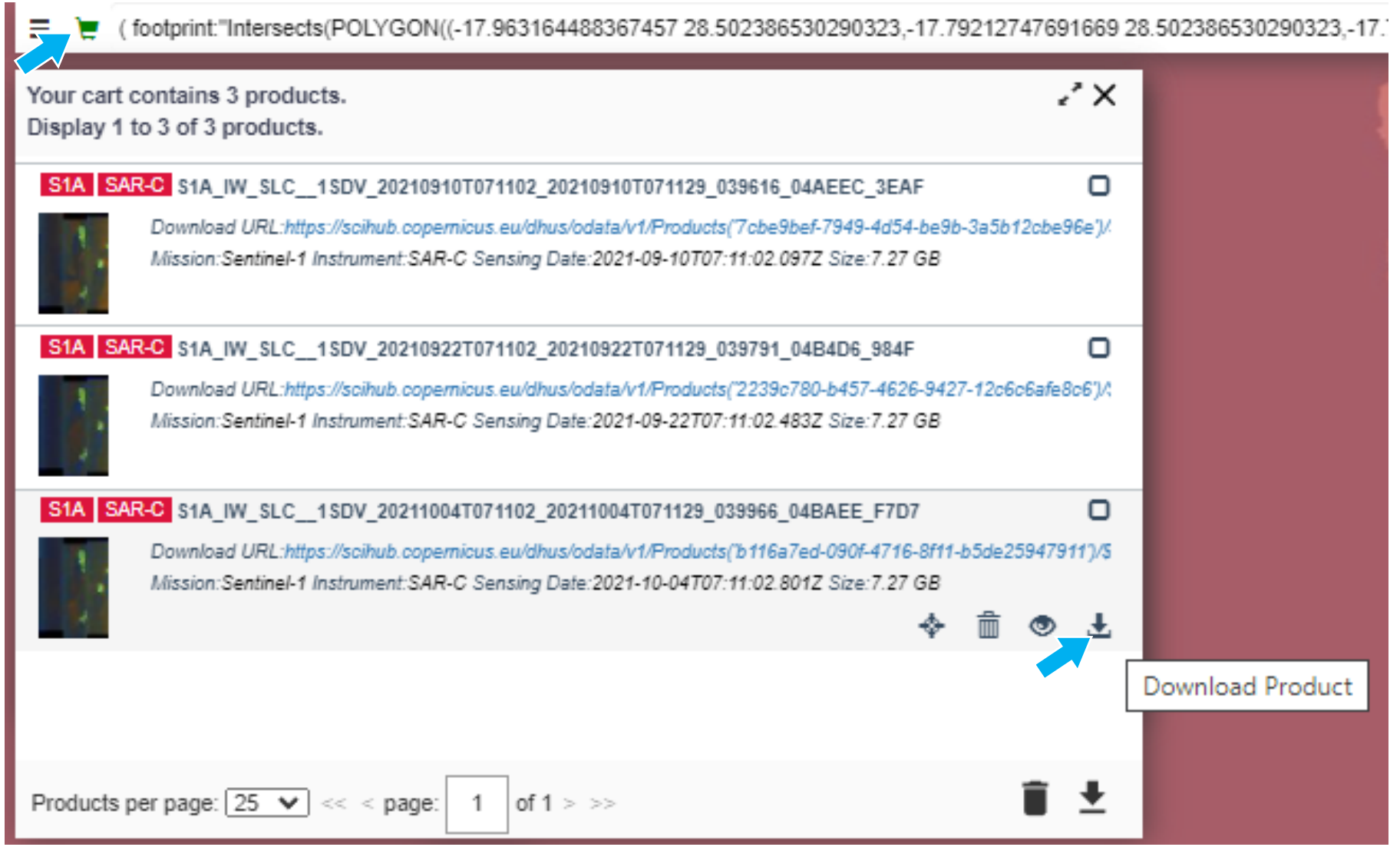
It is advisable to check the parameters of the selected image by clicking on the eye sign. This is necessary because filtering often does not work well for the orbit.

We chose an ascending orbit, and the selected image has a descending orbit. It is important that a pair of images have the same orbit, no matter which one.

Step 1. Download data

Variant 1. Copernicus Open Access Hub

5. Download images

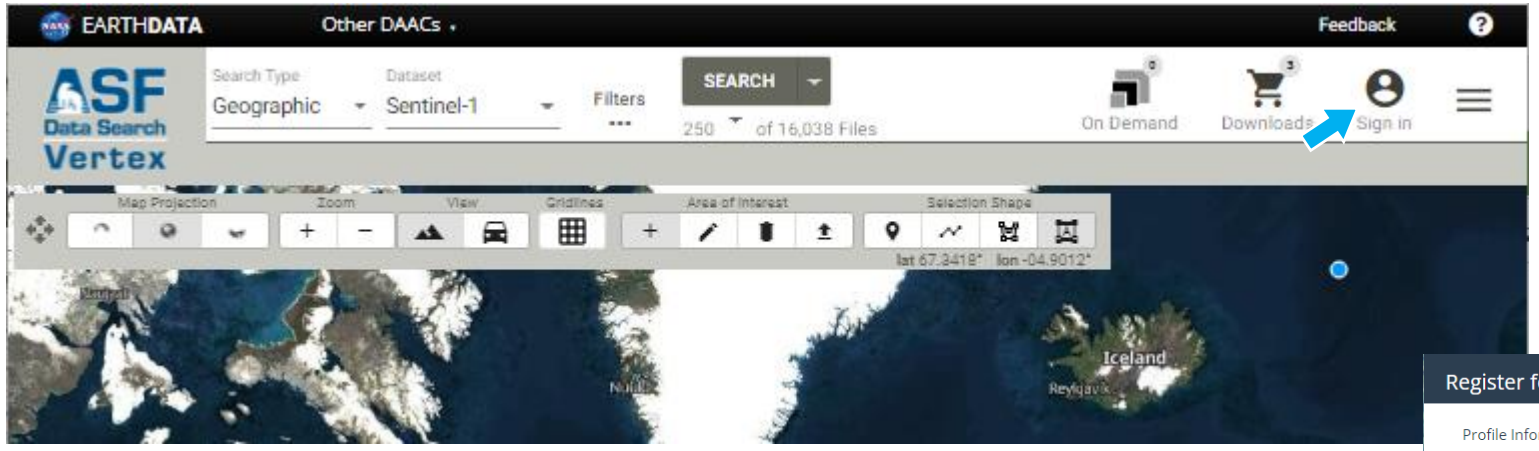


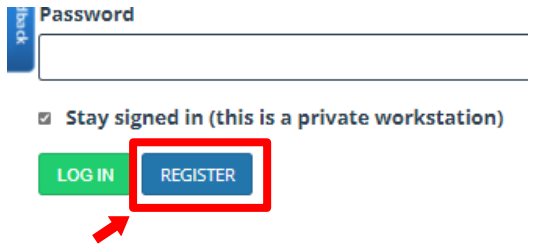
I. PREPARATION

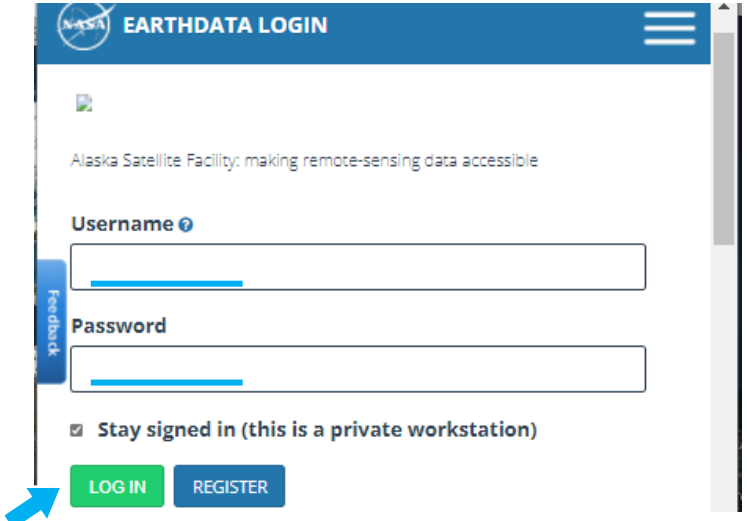
Step 1. Download data

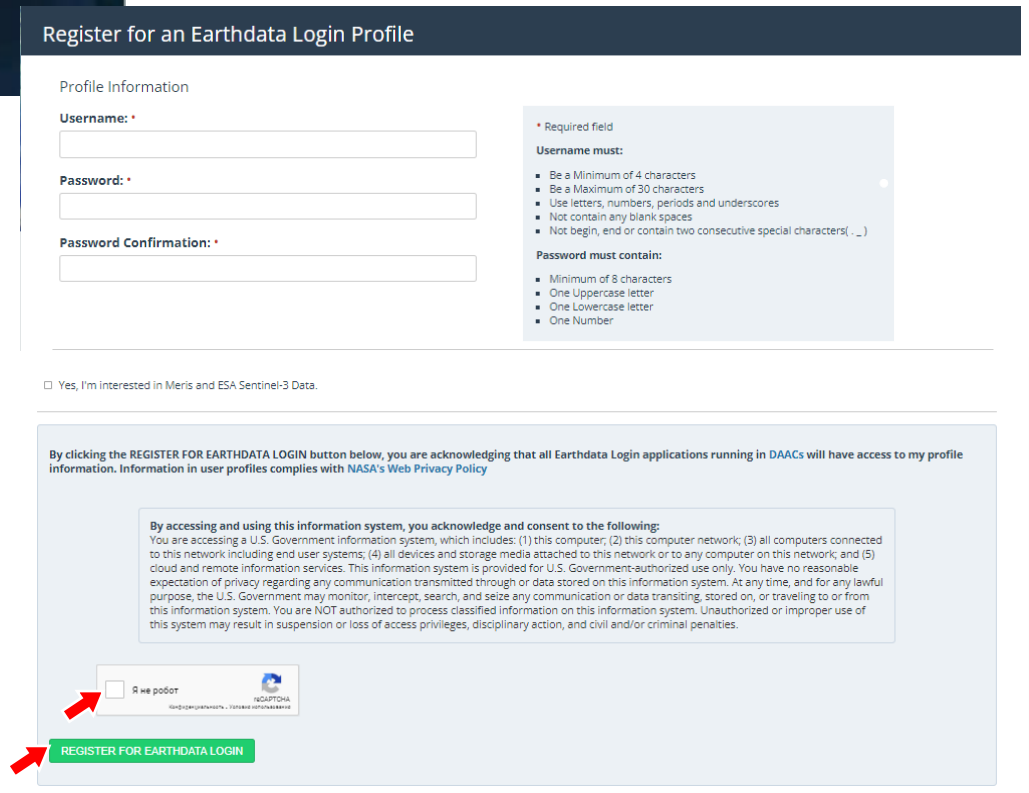
Variant 2. ASF Data Search Vertex

1. Open link https://search.asf.alaska.edu/#/ and login or register







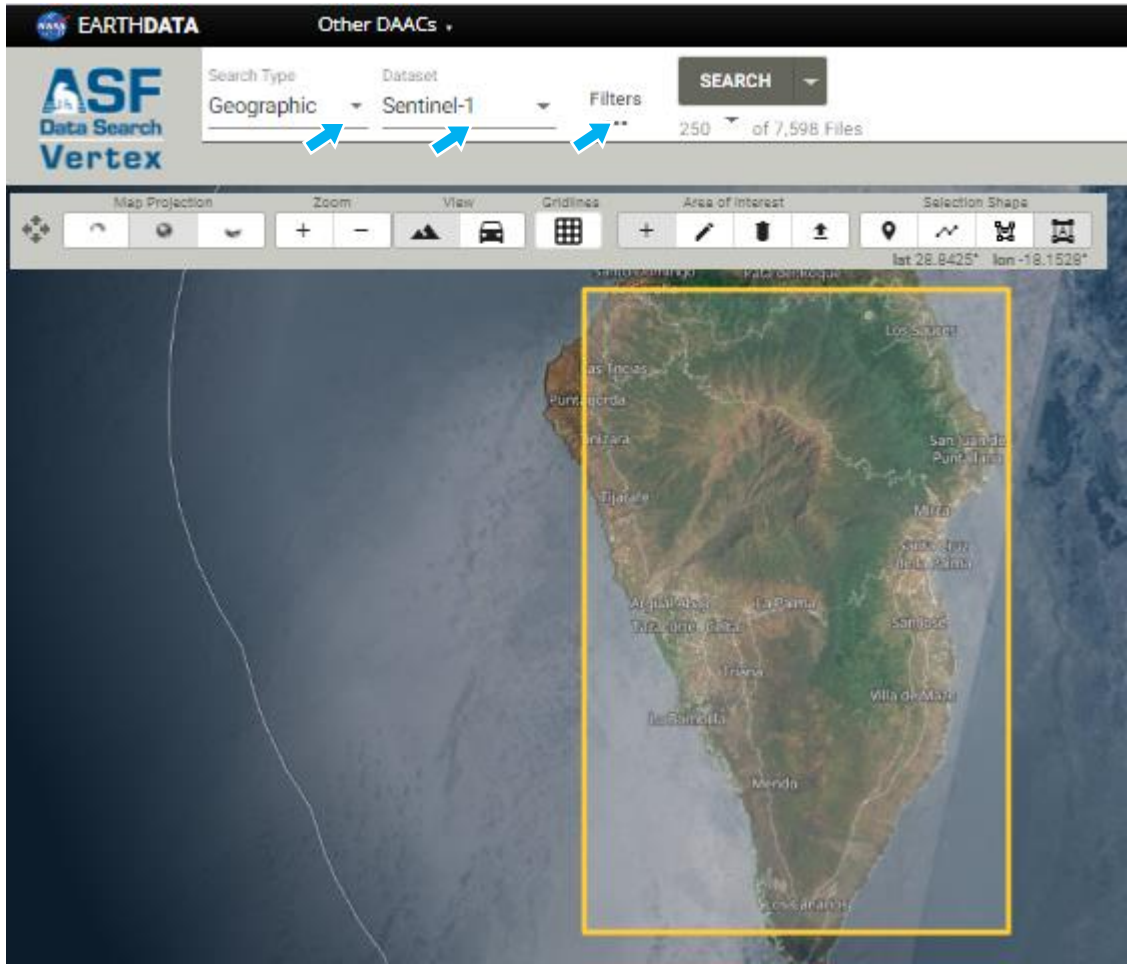


Step 1. Download data

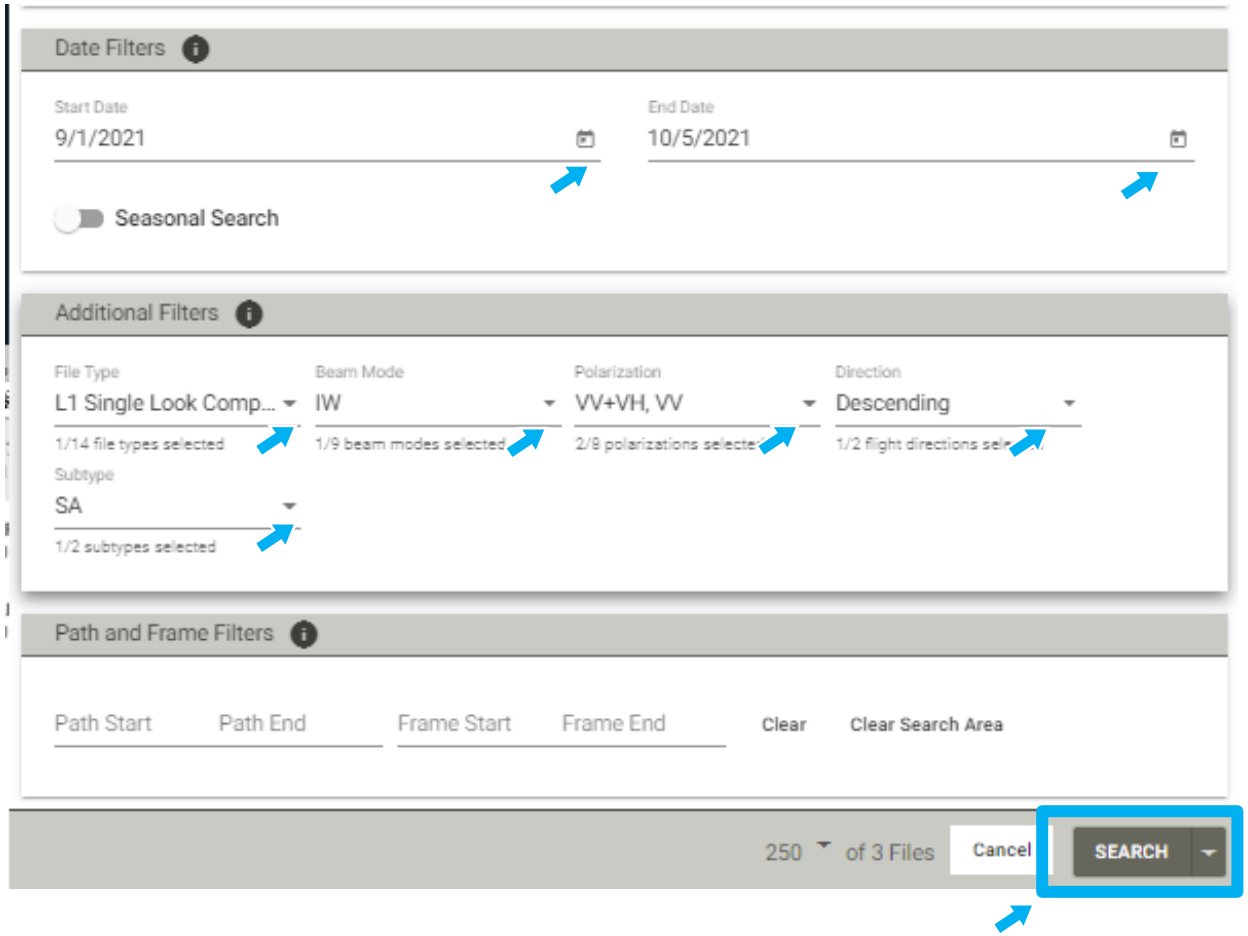
Variant 2. ASF Data Search Vertex

2. Select Search type “Geografic” find Sentinel-1 data

3. Find the necessary territory on the map and select it by holding down the right button of the manipulator.



4. Select “Filters” for configuring search parameters

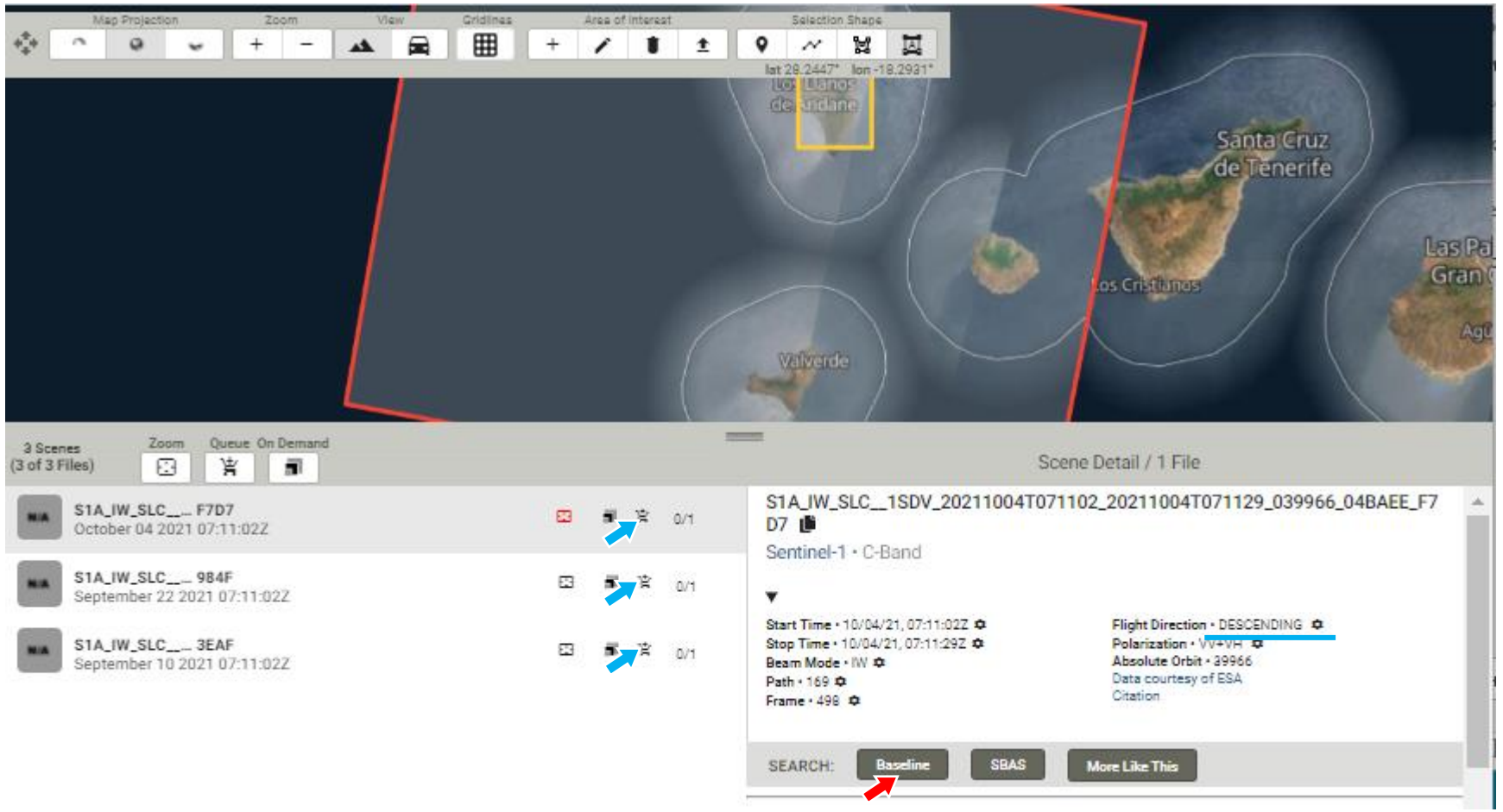


* use similar Copernicus Open Access Hub options

Step 1. Download data

Variant 2. ASF Data Search Vertex

5. Add images to the basket, check the orbit parameters in the right window.

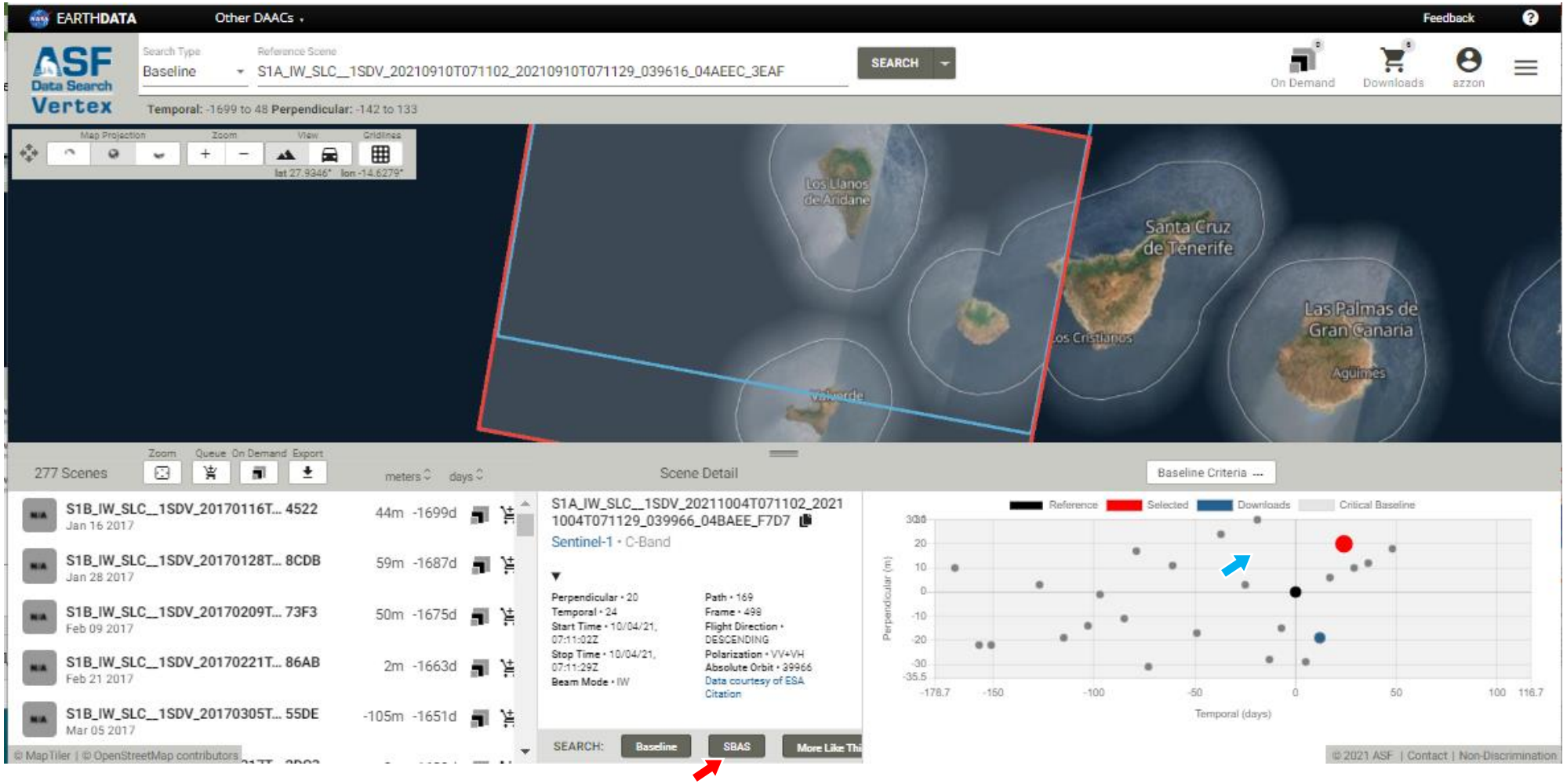


By clicking on the Baseline item, you can go to the selection of images by the distance between them in meters and days.

Step 1. Download data

Variant 2. ASF Data Search Vertex

6. Baseline search type

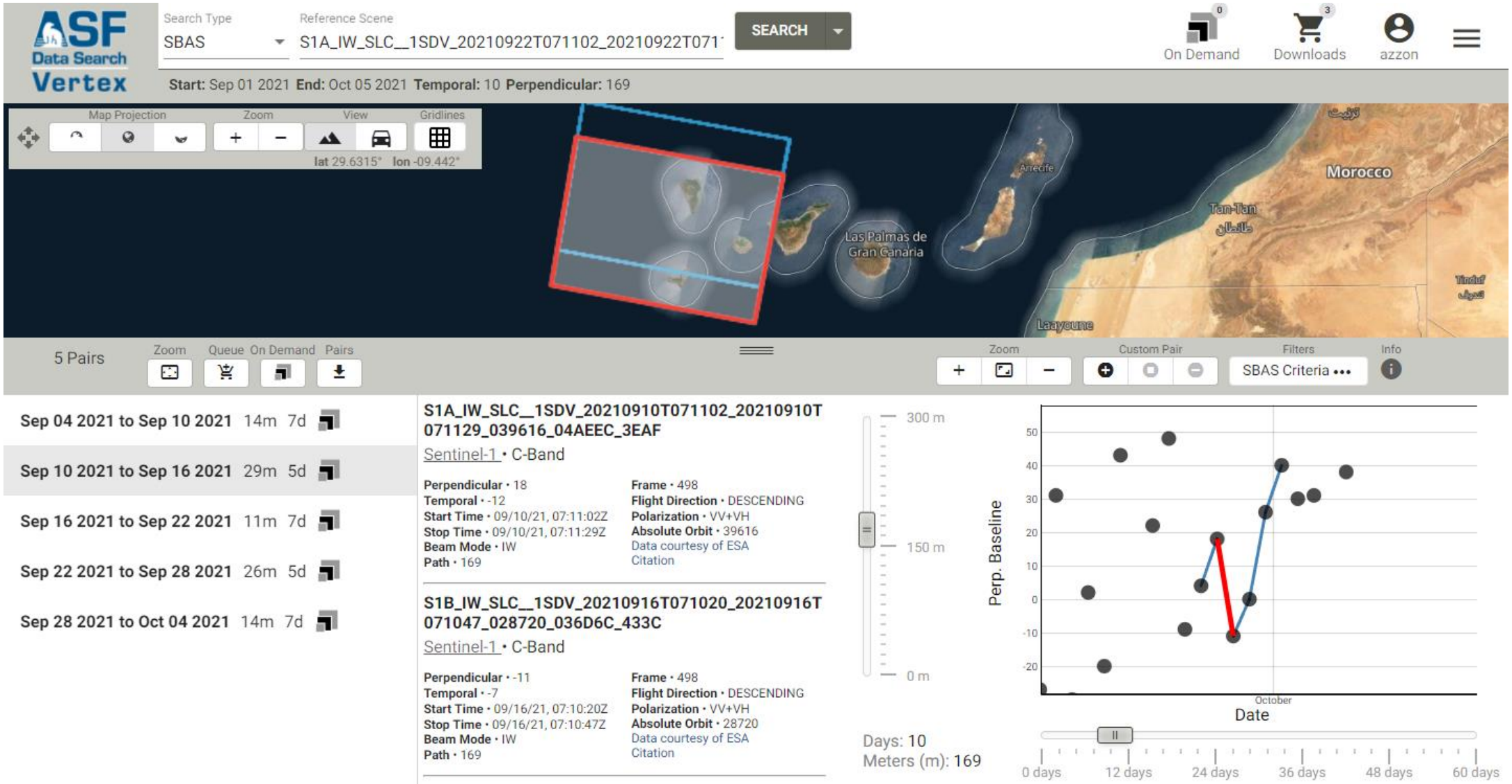


You can go to SBAS, in this option of image search, you can build a chain of images with minimum distance and time requirements for the selected area.

Step 1. Download data

Variant 2. ASF Data Search Vertex

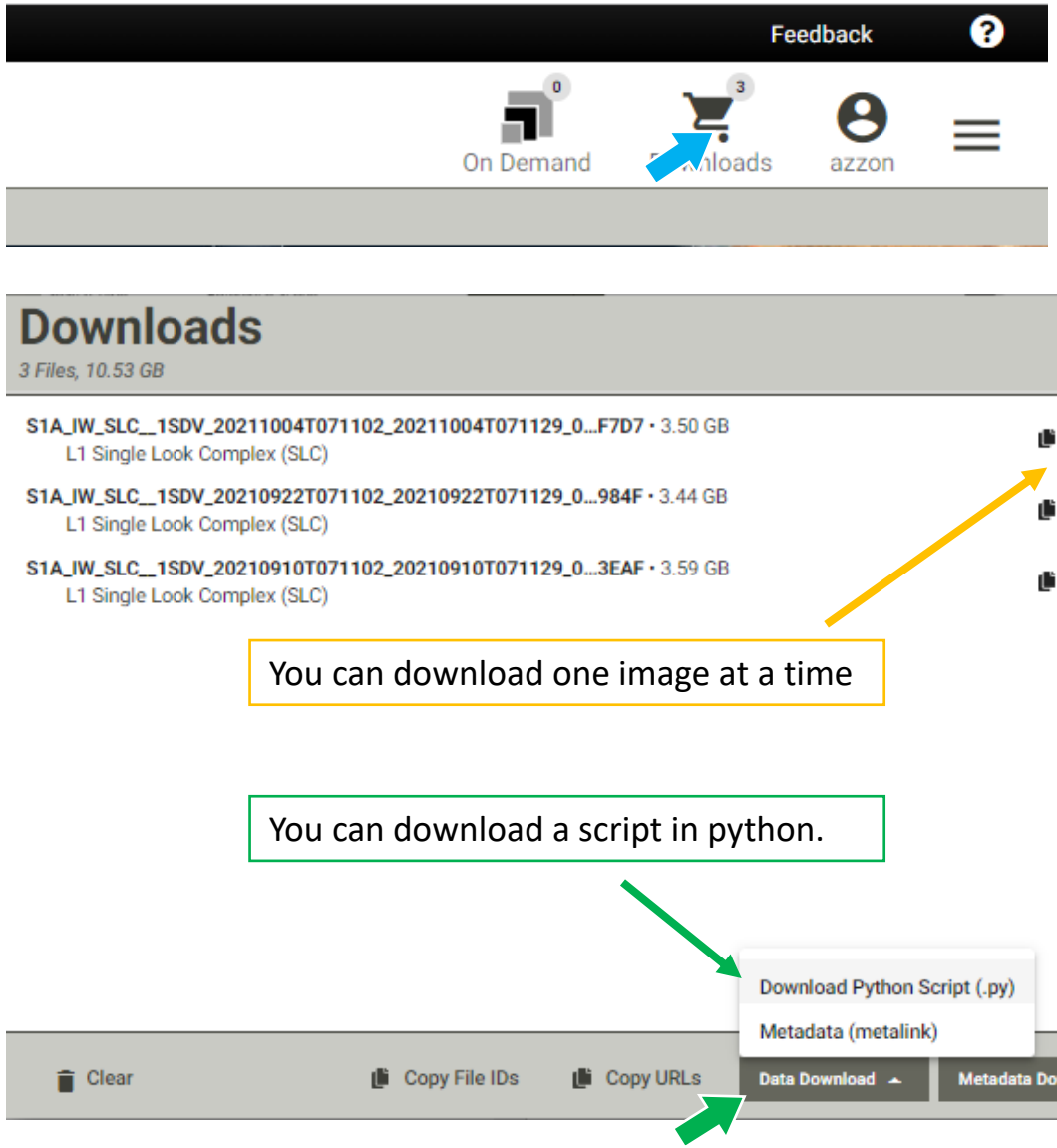
7. SBAS search type



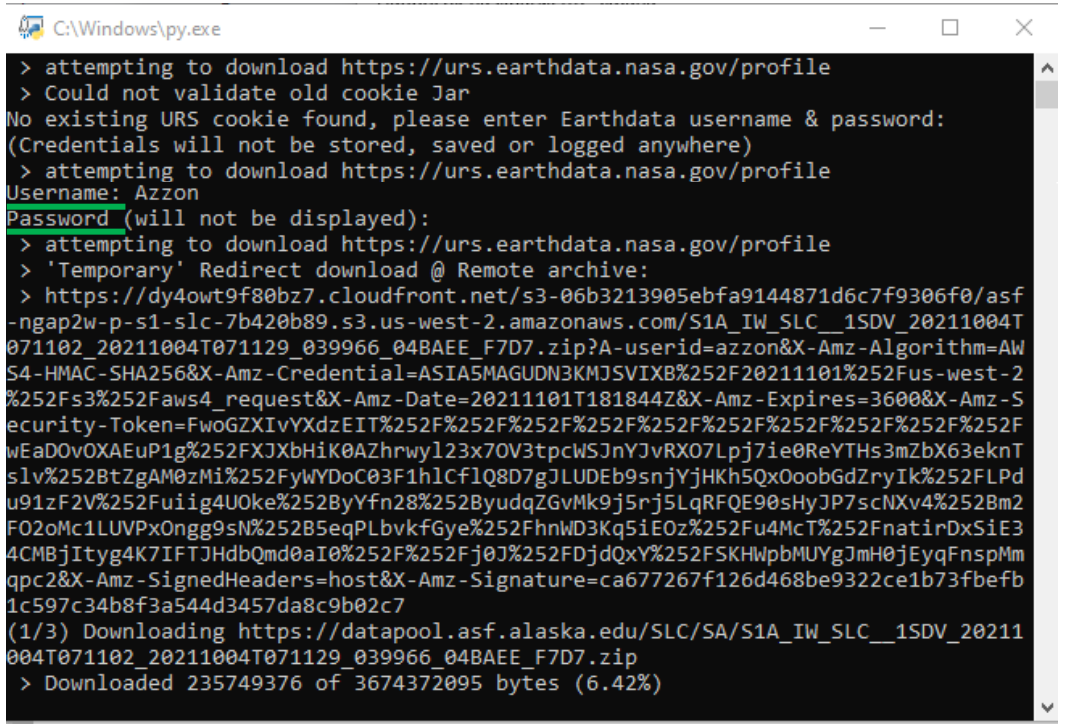
Step 1. Download data

Variant 2. ASF Data Search Vertex

8. After adding images, go to the cart.



After launching it, you must specify the login and password from ASF Data Search Vertex.



**This method allows you to upload a large number of images and guarantees the integrity of the uploaded files.*

Step 2. Install program

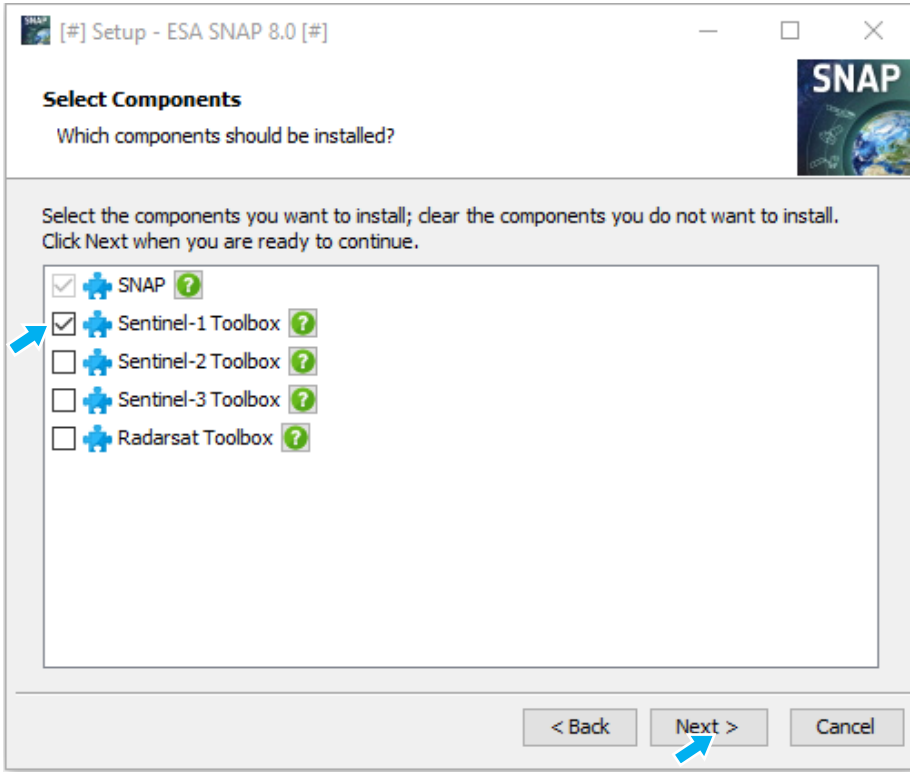
Program 1. SNAP

1. **Open link https://step.esa.int/main/download/snap-download/**

2. **Choose the one from the following table which suits your needs.**

	Windows 64-Bit	Windows 32-Bit	Mac OS X	Unix 64-bit
Sentinel Toolboxes	These installers contain the **Sentinel-1**, **Sentinel-2**, **Sentinel-3** Toolboxes, download size is close to 800MB.			
	Main Download Mirror Download	Main Download Mirror Download	Main Download Mirror Download	Main Download Mirror Download
SMOS Toolbox	These installers contain only the **SMOS Toolbox**, download size is close to 500MB. Download also the Format Conversion Tool (Earth Explorer to NetCDF) and the user manual.			
	Main Download Mirror Download	Main Download Mirror Download	Main Download Mirror Download	Main Download Mirror Download
All Toolboxes	These installers contain the **Sentinel-1**, **Sentinel-2**, **Sentinel-3** Toolboxes, **SMOS** and **PROBA-V** Toolbox, download size is close to 1GB.			
	Main Download Mirror Download	Main Download Mirror Download	Main Download Mirror Download	Main Download Mirror Download

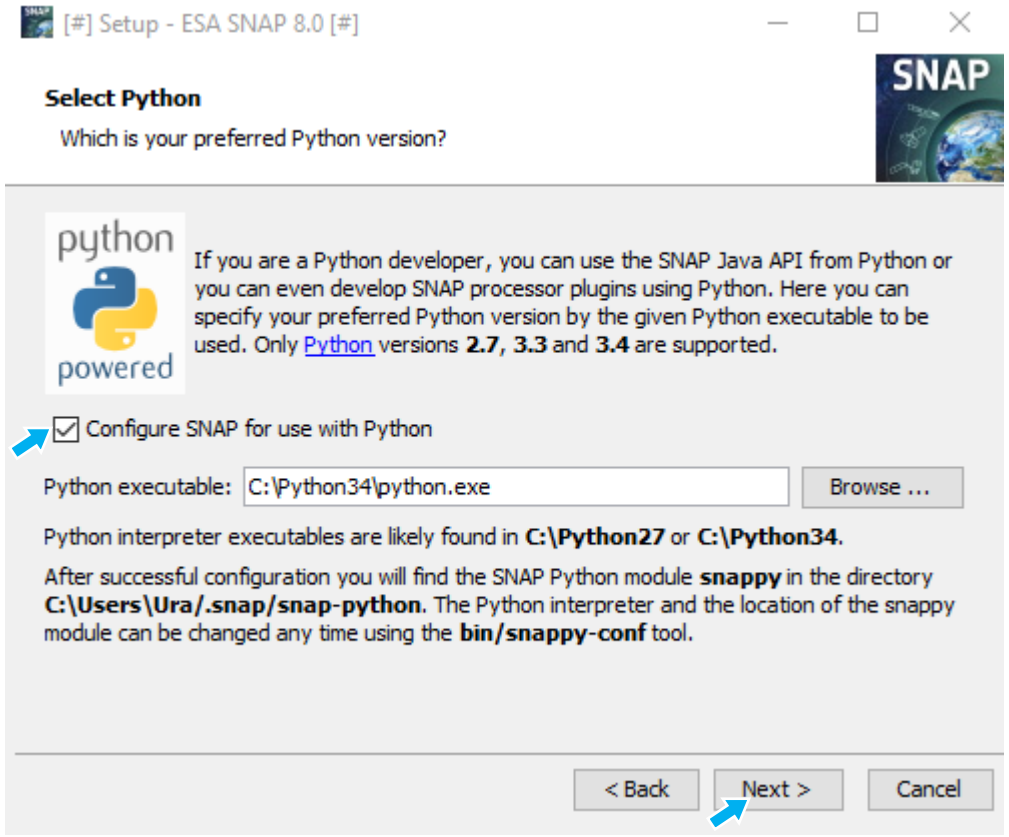
3. **Select the required components**



Step 2. Install program

Program 1. SNAP

4. If you have installed python, select "Configure SNAP ..." Otherwise, you can skip this item by clicking Next

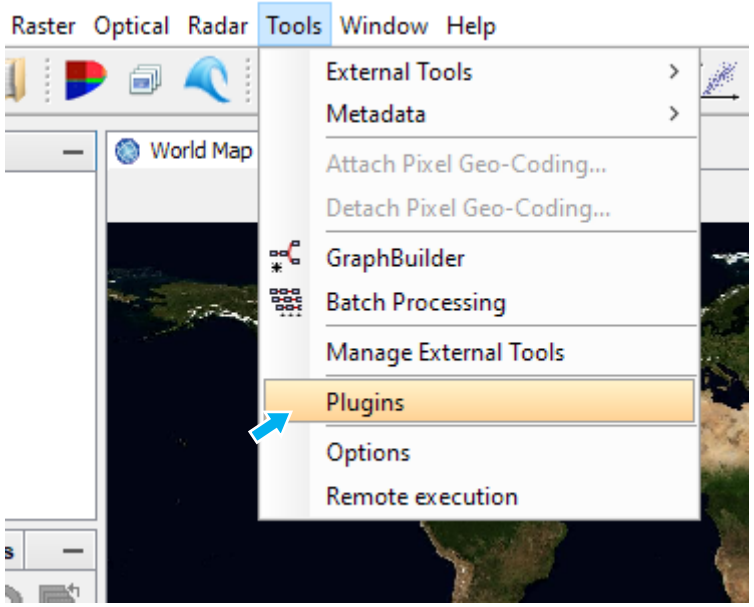


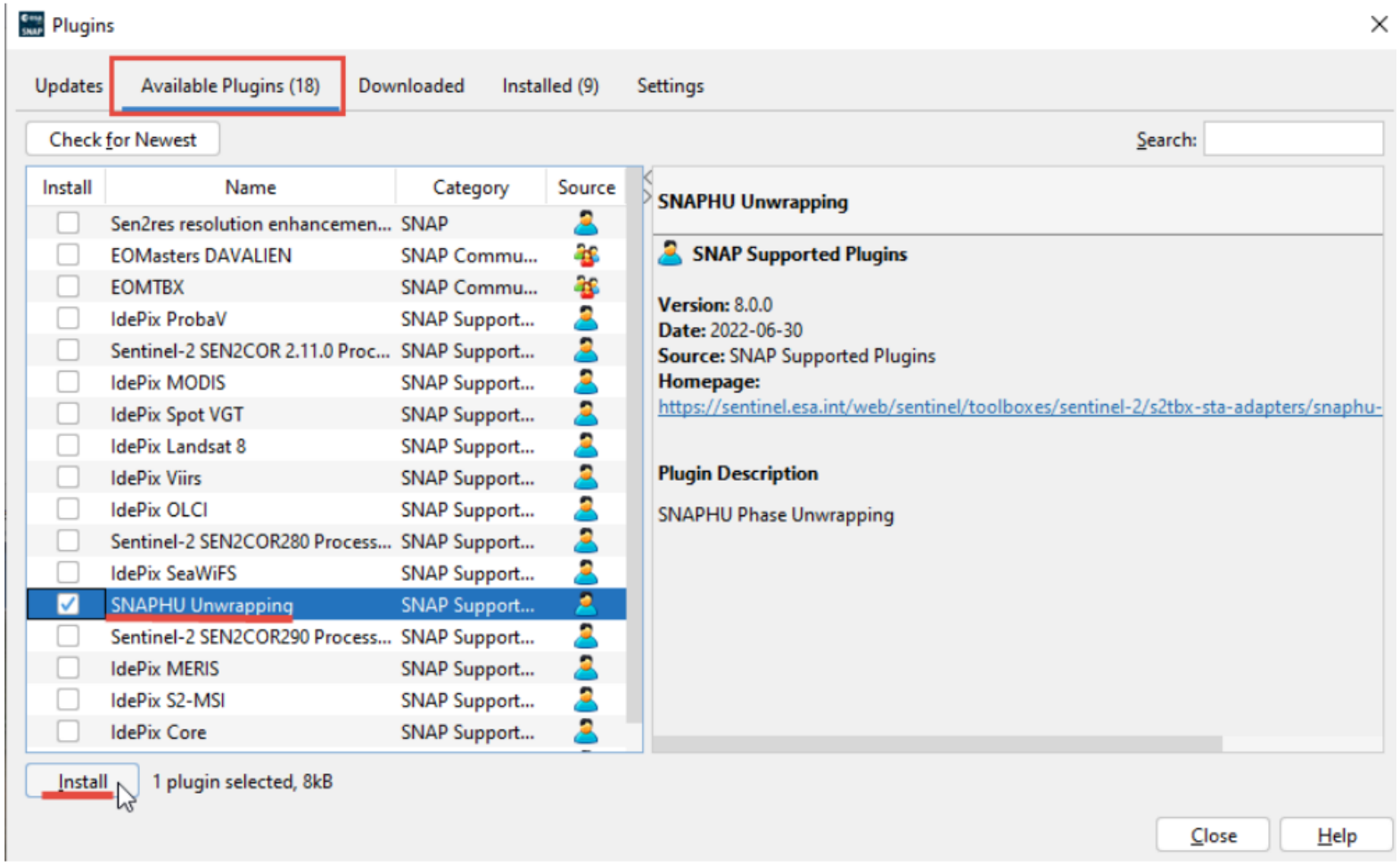
Step 2. Install program

Program 1. SNAP

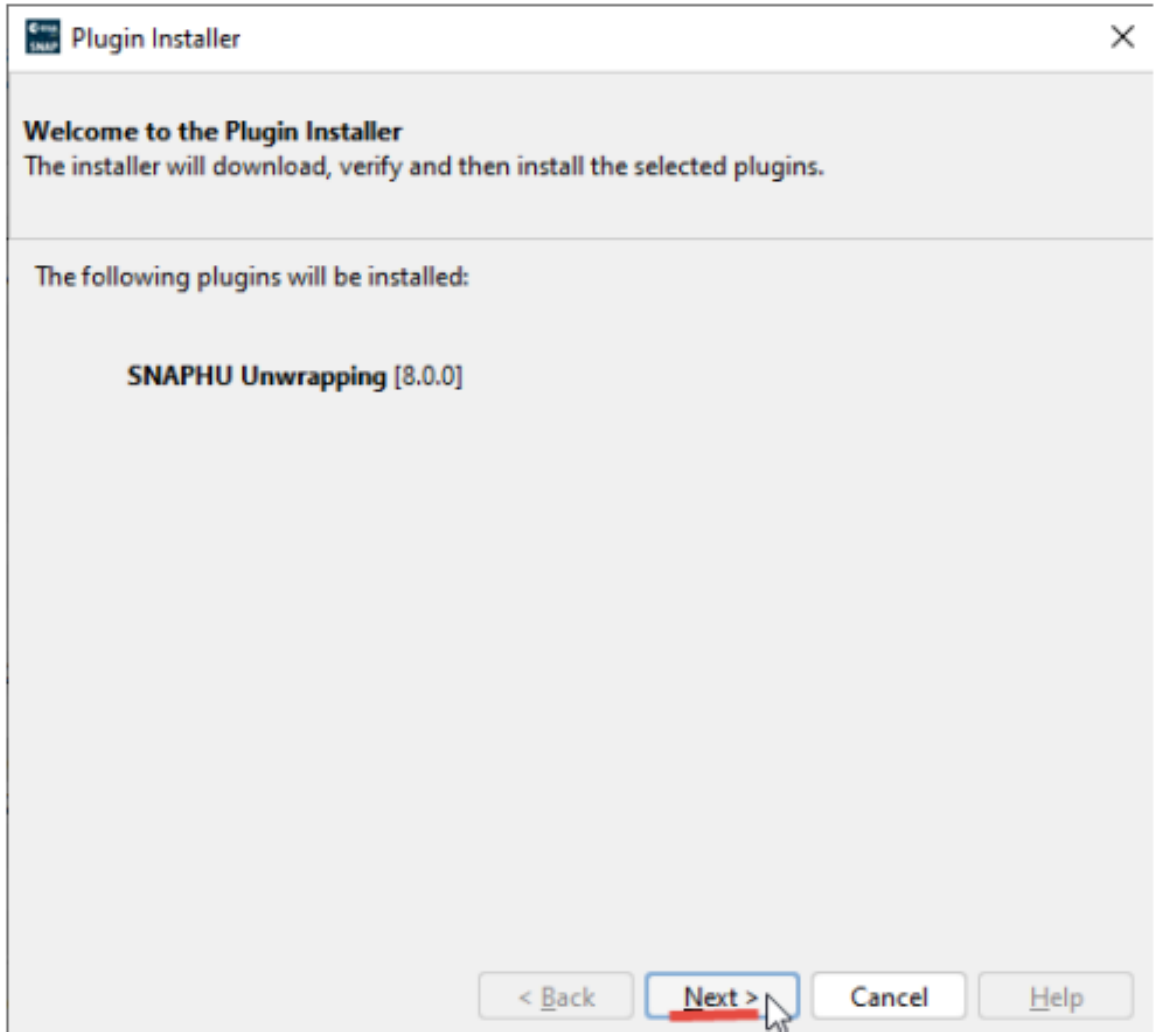
5. Install module SNAPHU

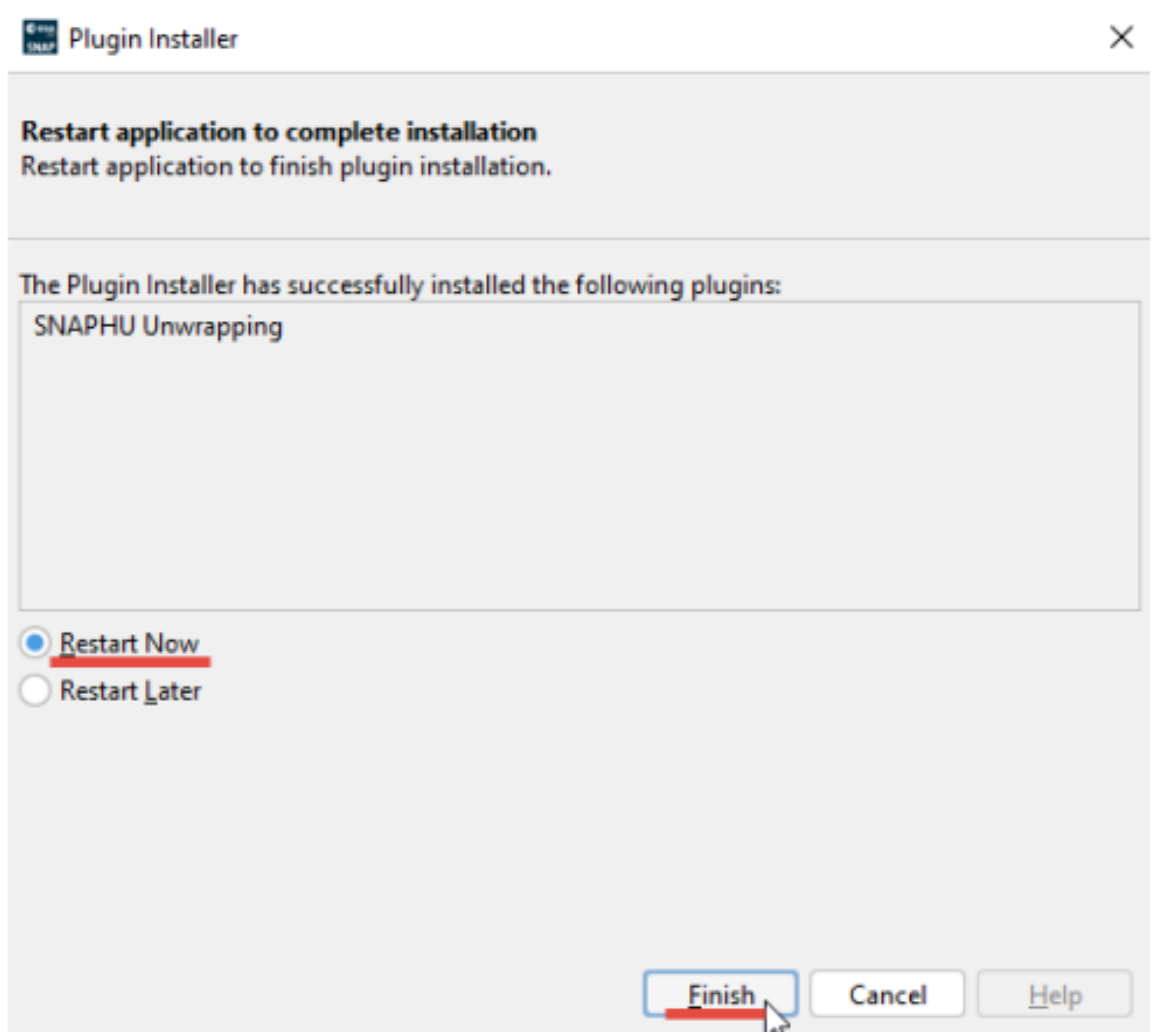
After starting SNAP





5. Install module SNAPHU

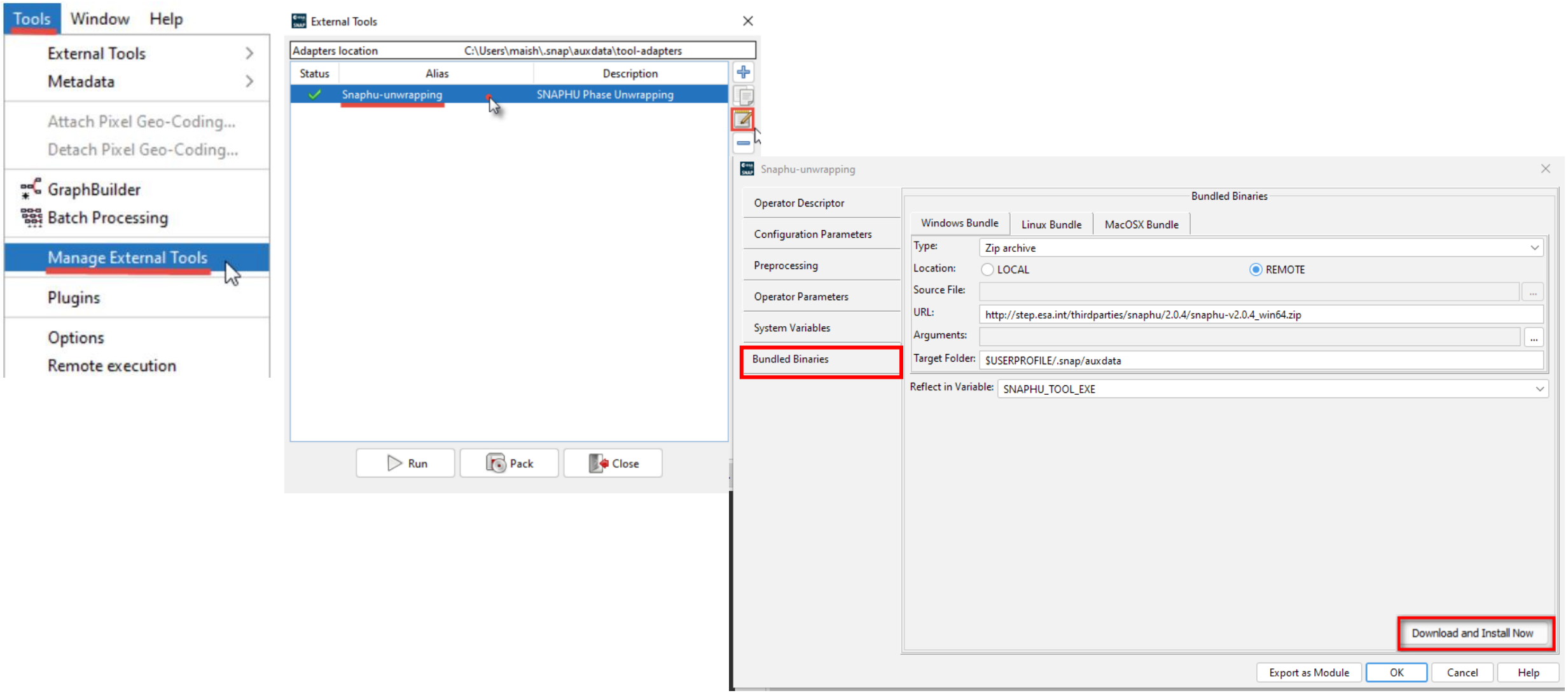




Step 2. Install program

Program 1. SNAP

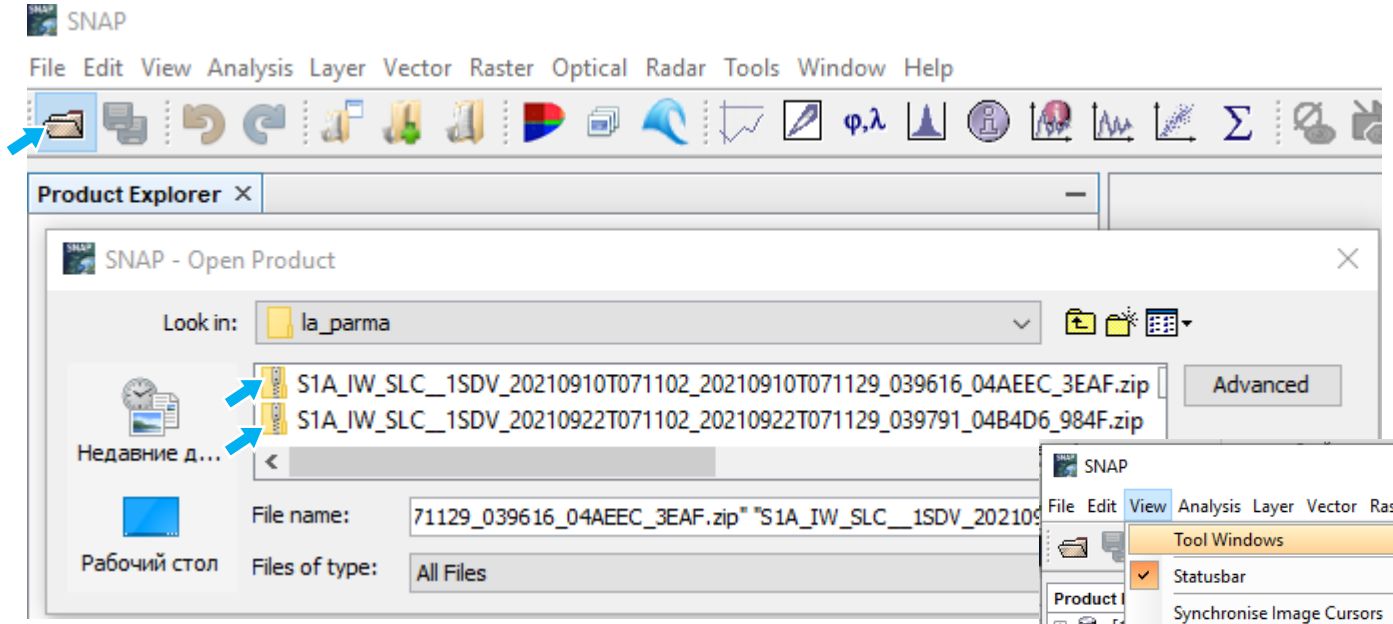
5. Install module SNAPHU



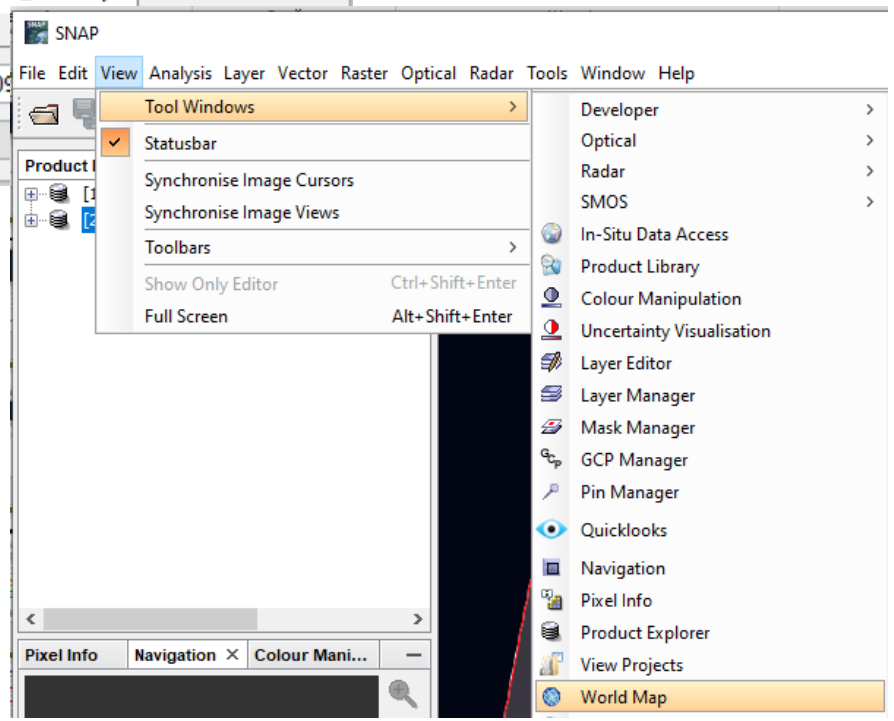
II. Displacement (DInSAR) 2 images

Stage 1. Import Level1 to SNAP

1. Open images



+ Enter



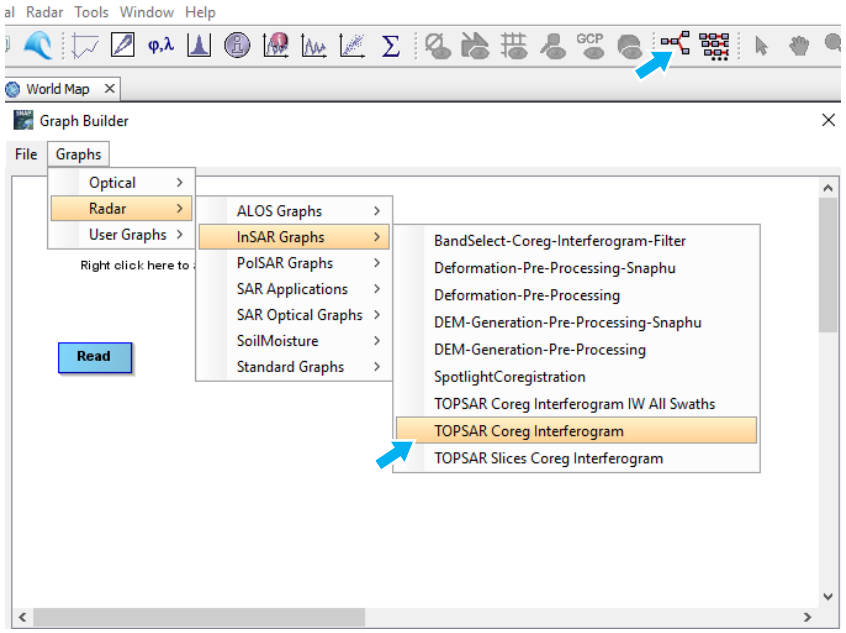
- Import Level1 to SNAP
- Coregistration
  - *Apply orbit*
  - *Back-geocoding*
  - *Enhanced Spectral Diversity*
- Interferogram formation
- Topographic phase removal
  - *Reference ellipsoid* + *DEM*
- Deburst
- Multilooking
- Goldstein Phase Filtering
- Export data for SNAPHU
- SNAPHU
- Phase Unwrapping
- Phase to Displacement Conversion
- Geocoding
- Export data
- Data analysis

II. Displacement (DInSAR) 2 images

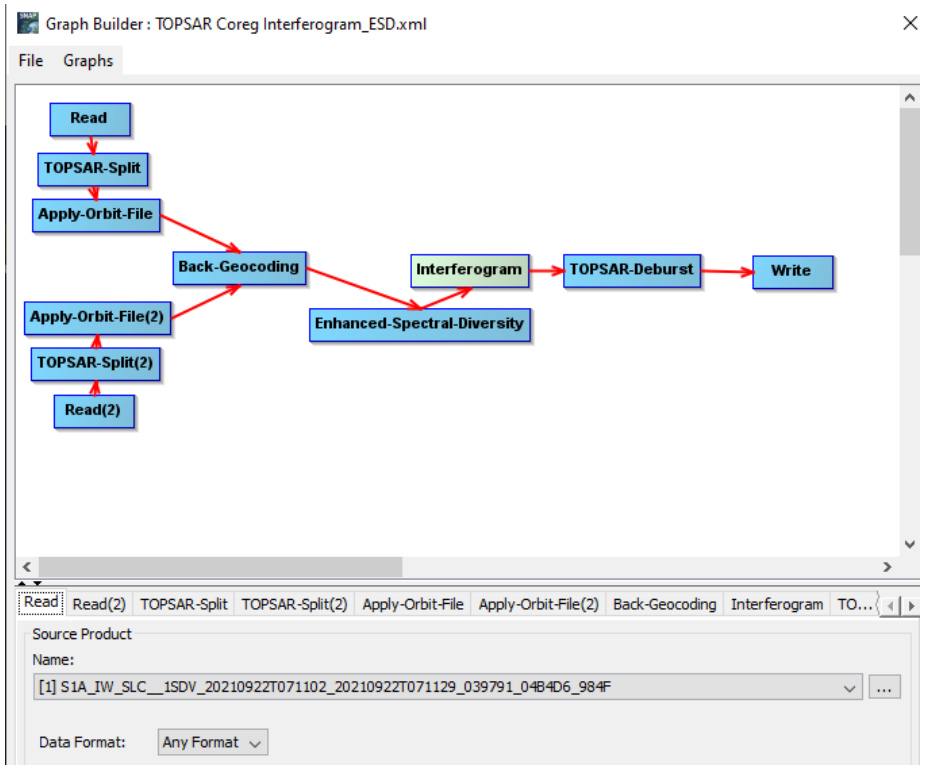
Stage 2. Coregistration and more

Variant 1. Load graph

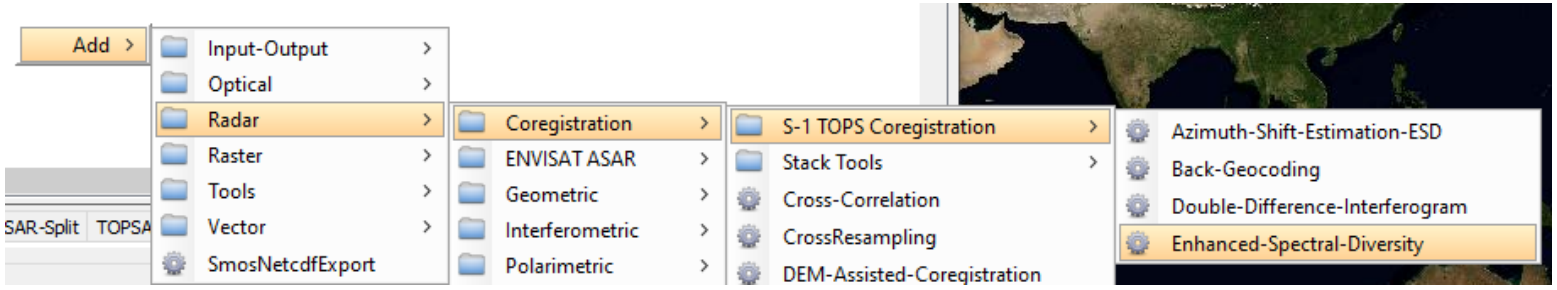
1. Load graph

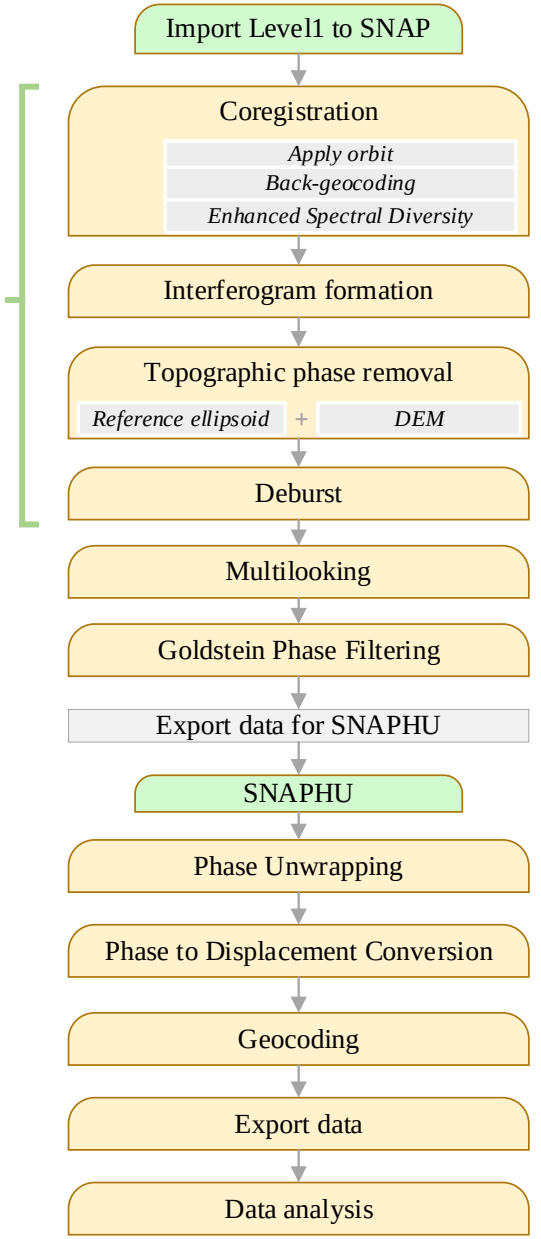


2. Correction graph and make settings



You can use prepared graph or create new (right click)



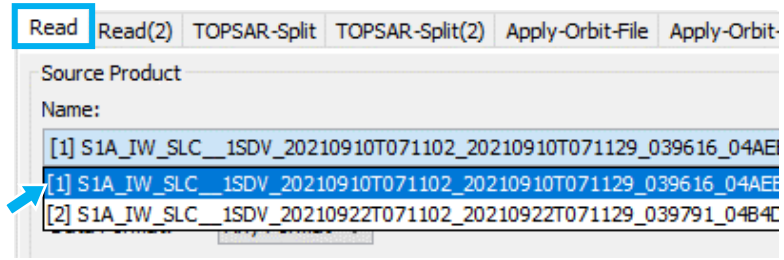


Stage 2. Coregistration

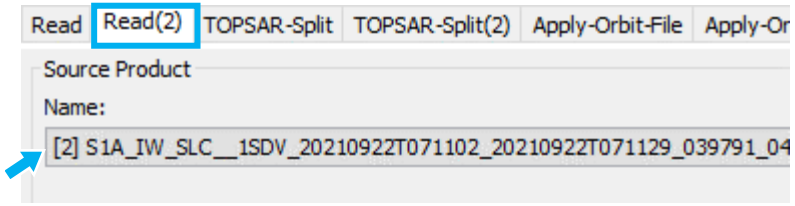
Variant 2. Menu SNAP

1. **Radar > Coregistration > S1 TOPS Coregistration > S-1 TOPS Coregistration with ESD**

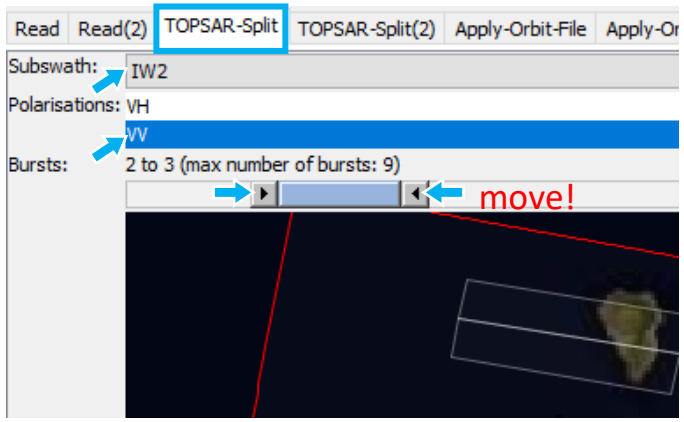
2. **Select first (master) image (date earlier)**



3. **Select second (slave) image**

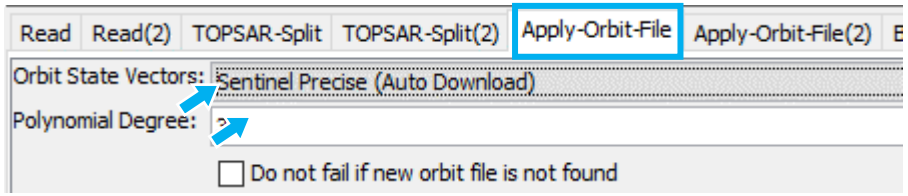


4. **Select sub swath and 2 burst above territory for first img.**



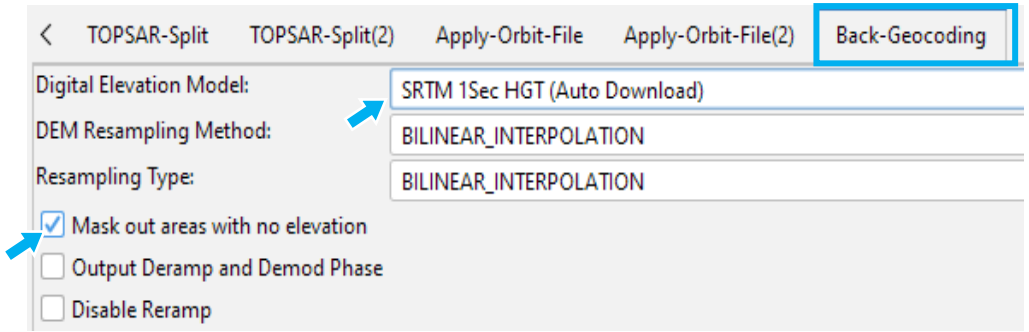
5. **Similarly select sub swath and 2 burst above territory for second img.**

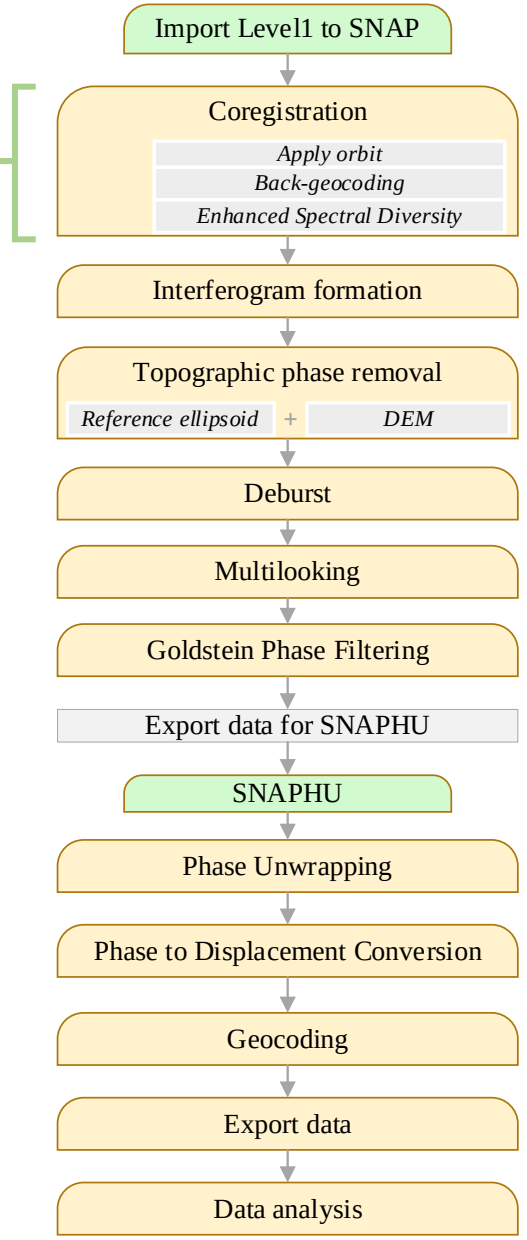
6. **Select precise orbit for first img.**



7. **Similarly select precise orbit for second img.**

8. **Select DEM**

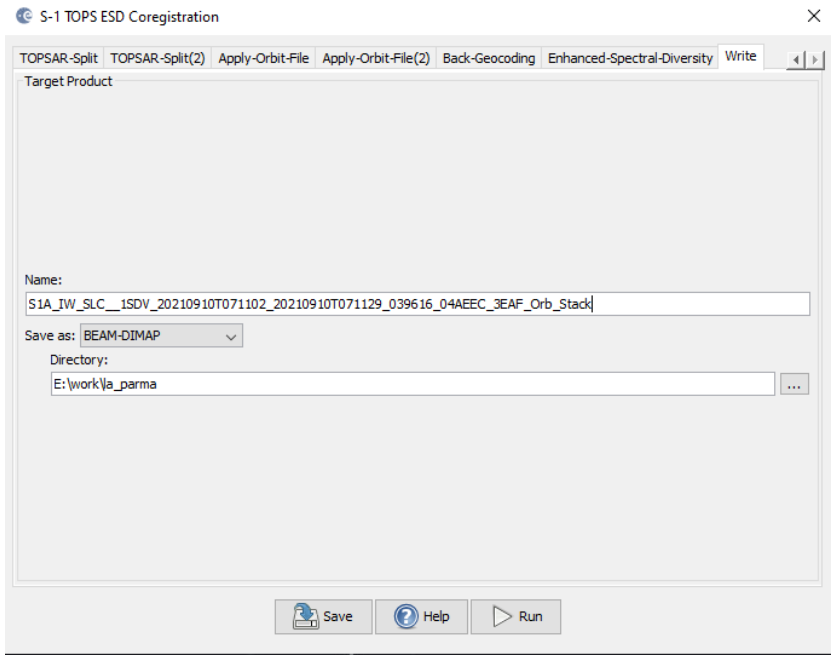




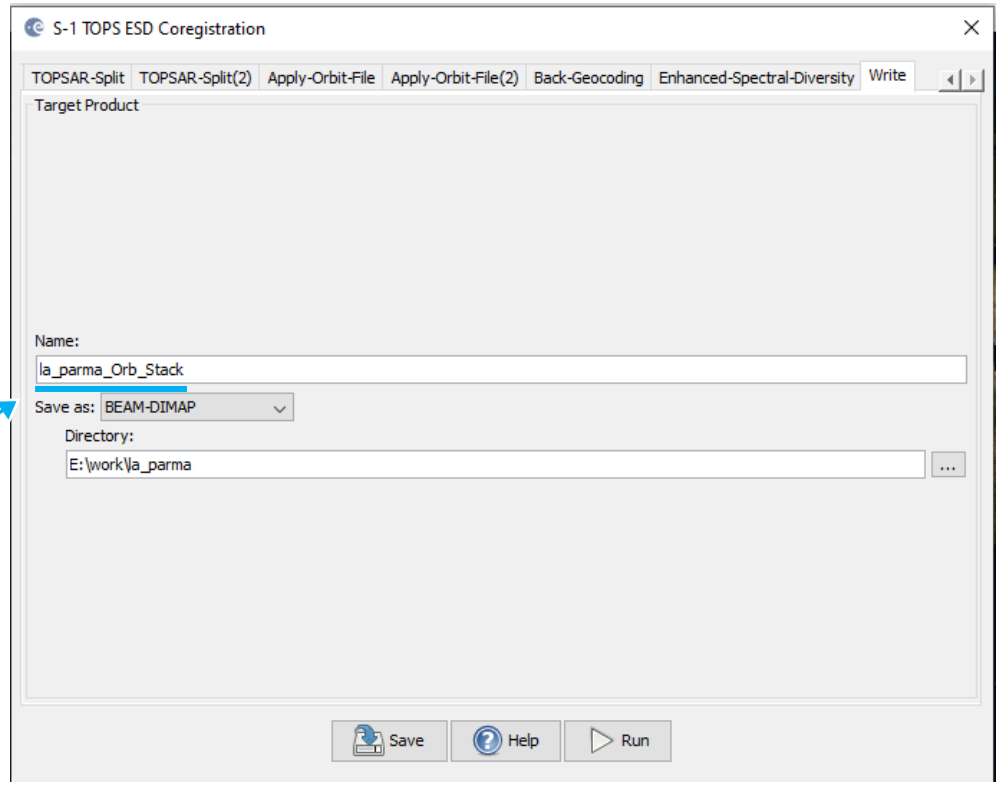
Stage 2. Coregistration

Variant 2. Menu SNAP

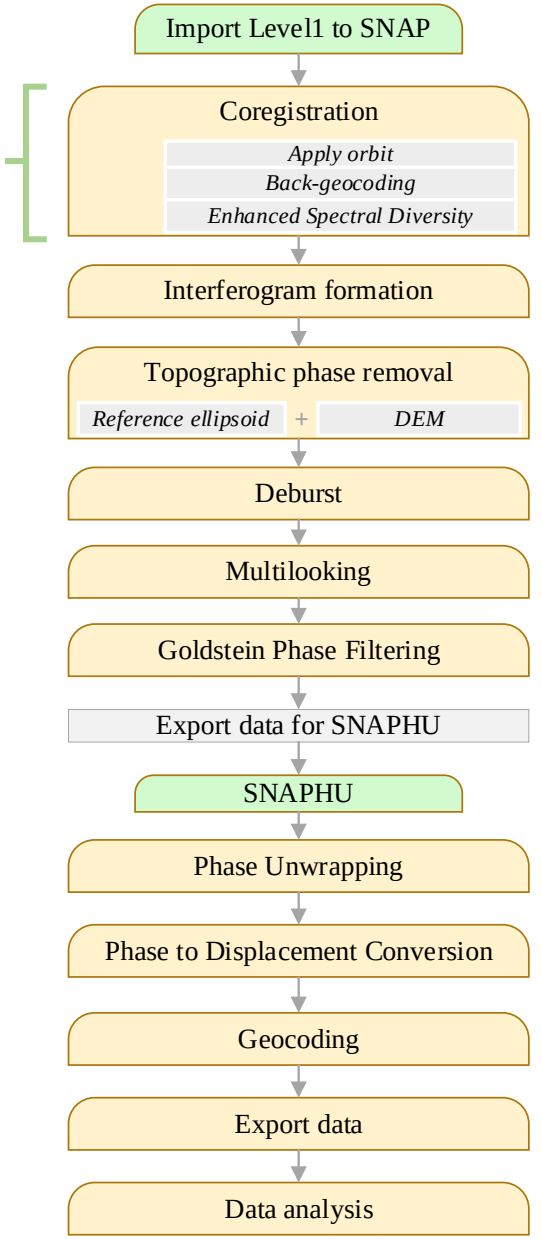
9. Write image



**settings Extended spectral diversity leave by default*



For convenience, the name can be abbreviated

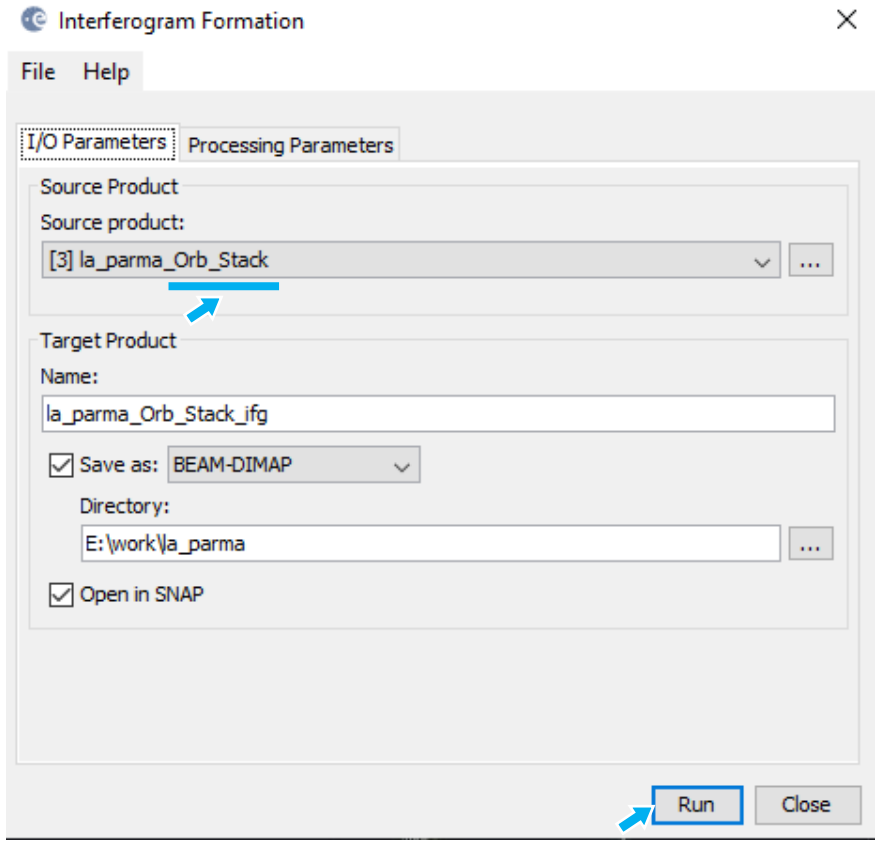


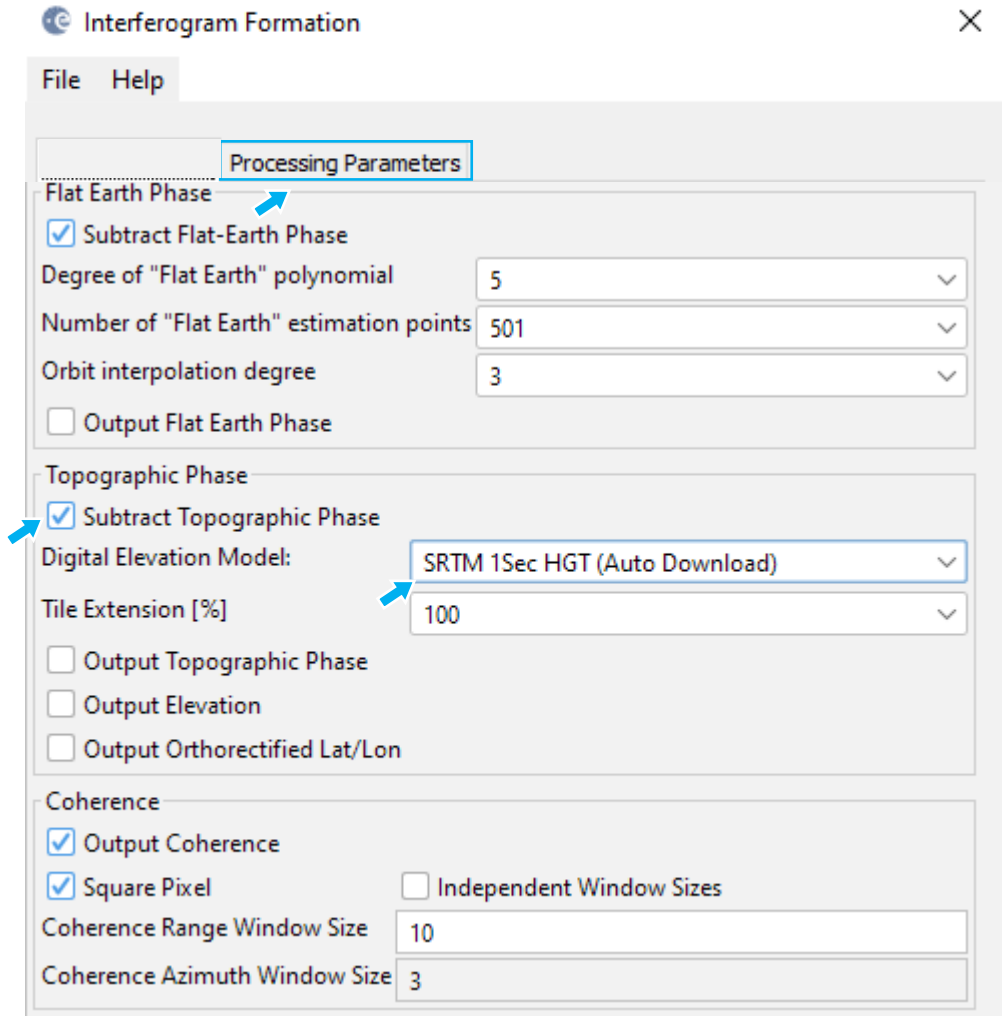
II. Displacement (DInSAR) 2 images

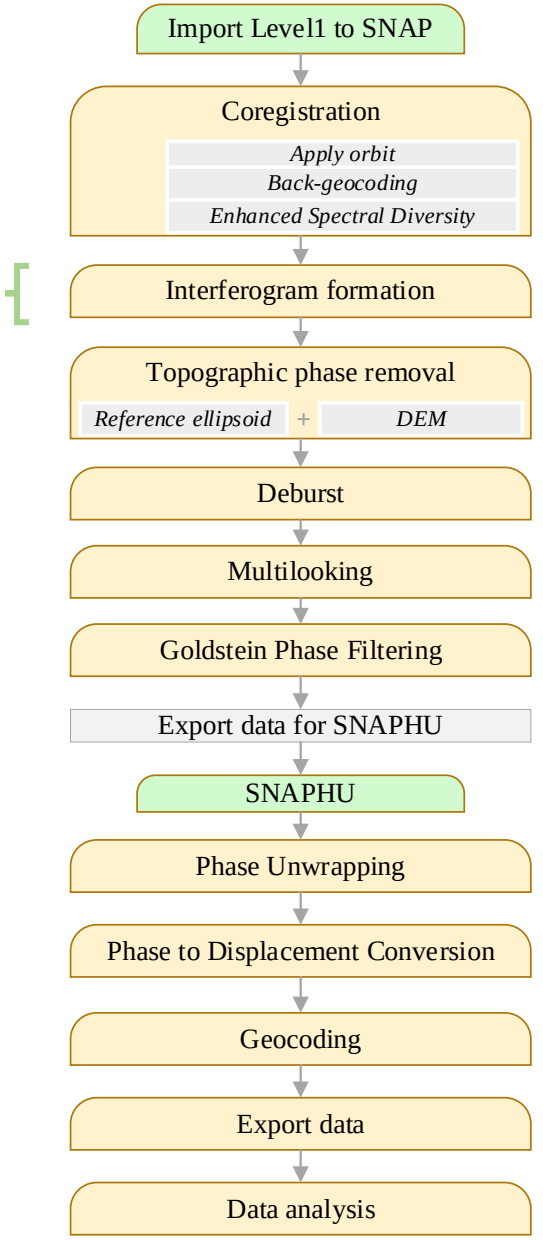
Stage 3. Create Interferogram + Topophase remove

Variant 2. Menu SNAP

1. Radar > Interferometric > Products > Interferogram Formation



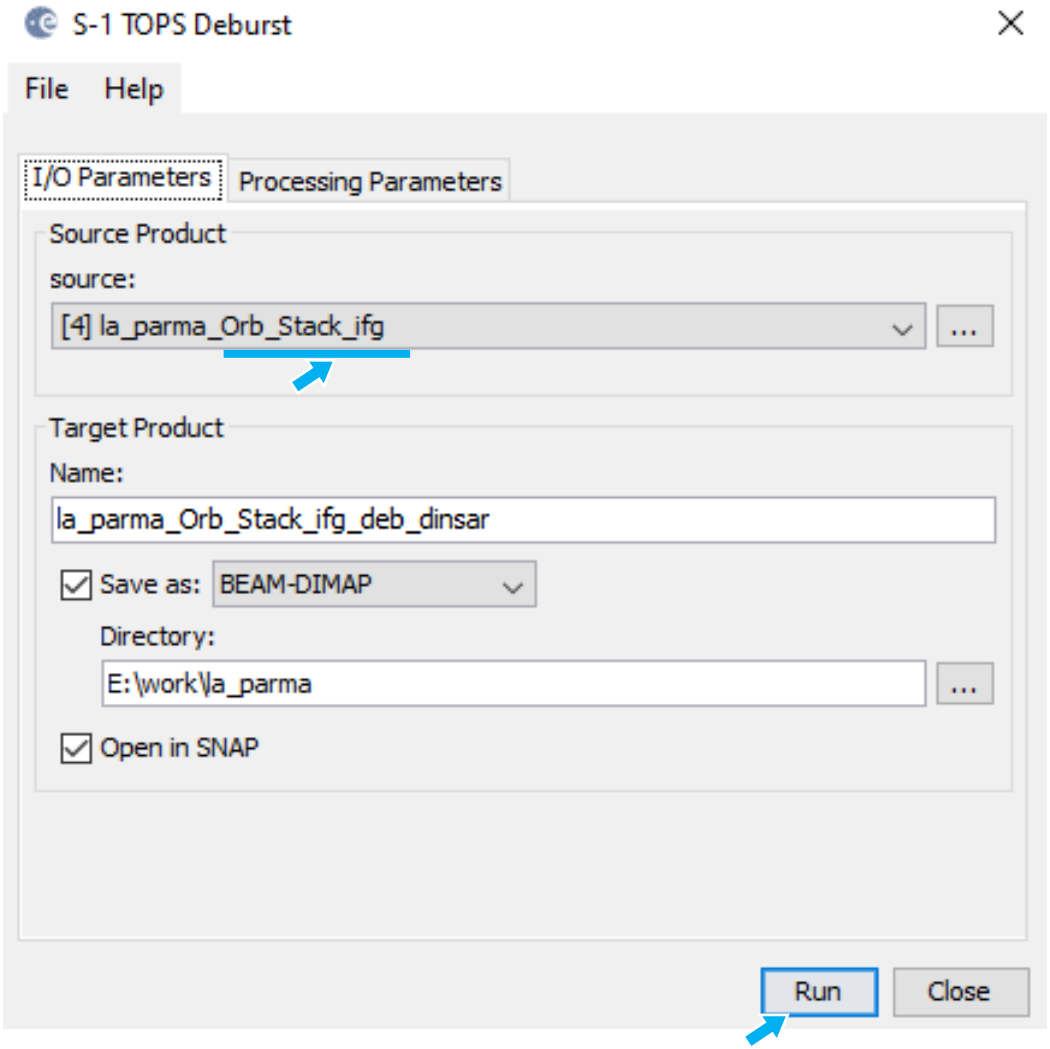


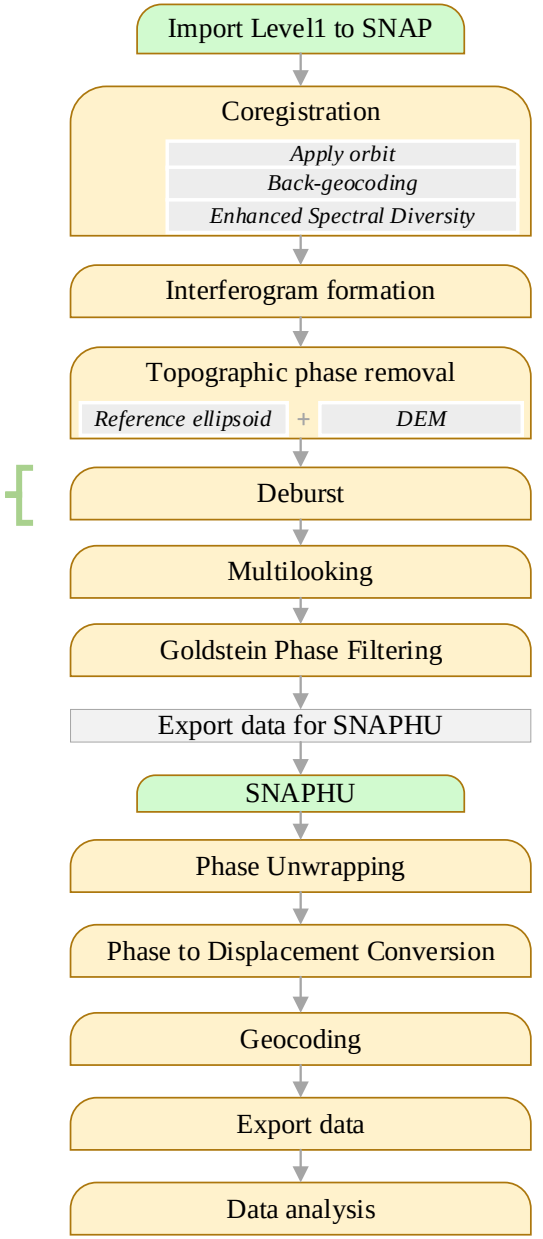


Stage 4. Deburst

Variant 2. Menu SNAP

1. Radar > Sentinel-1 TOPS > S-1 Deburst

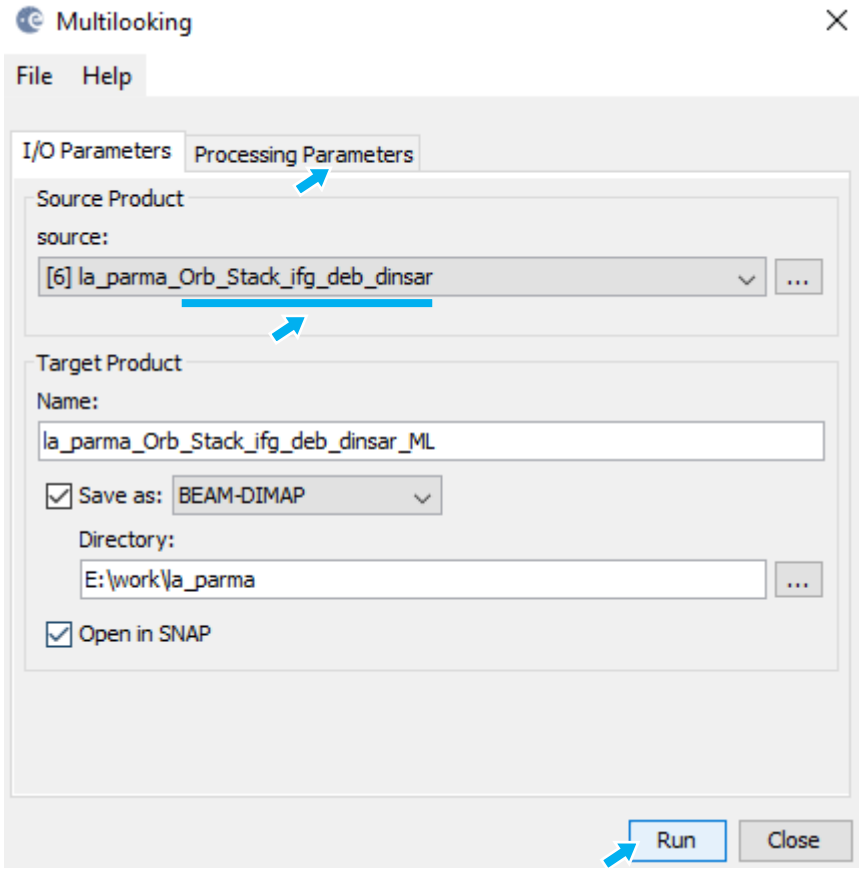


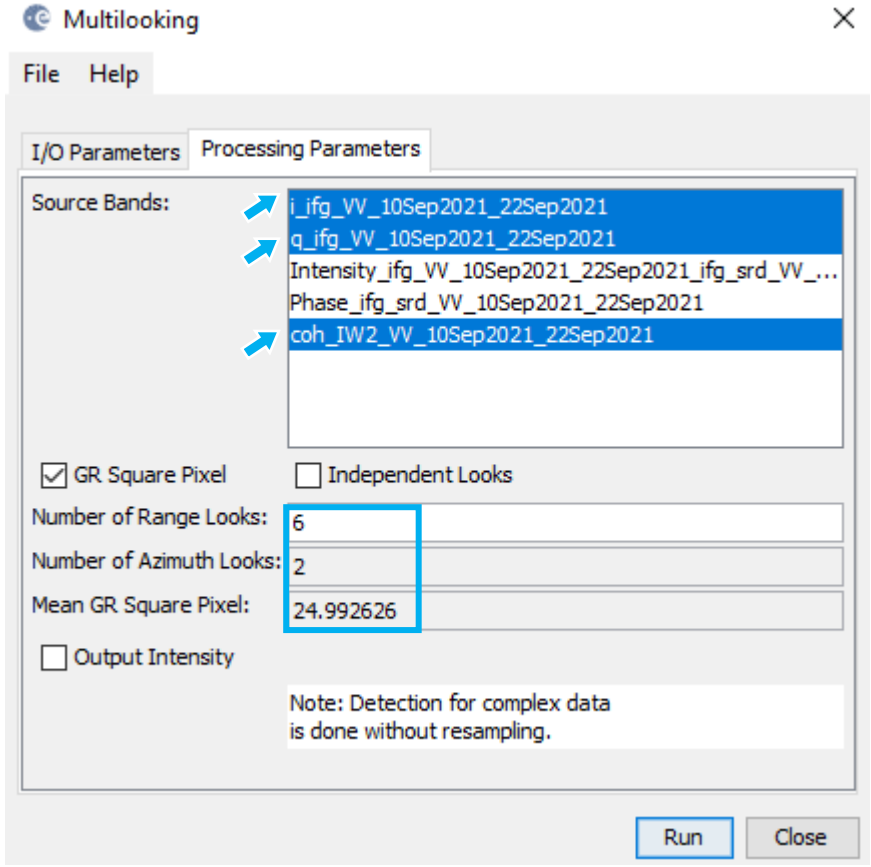


Stage 5. Multilooking

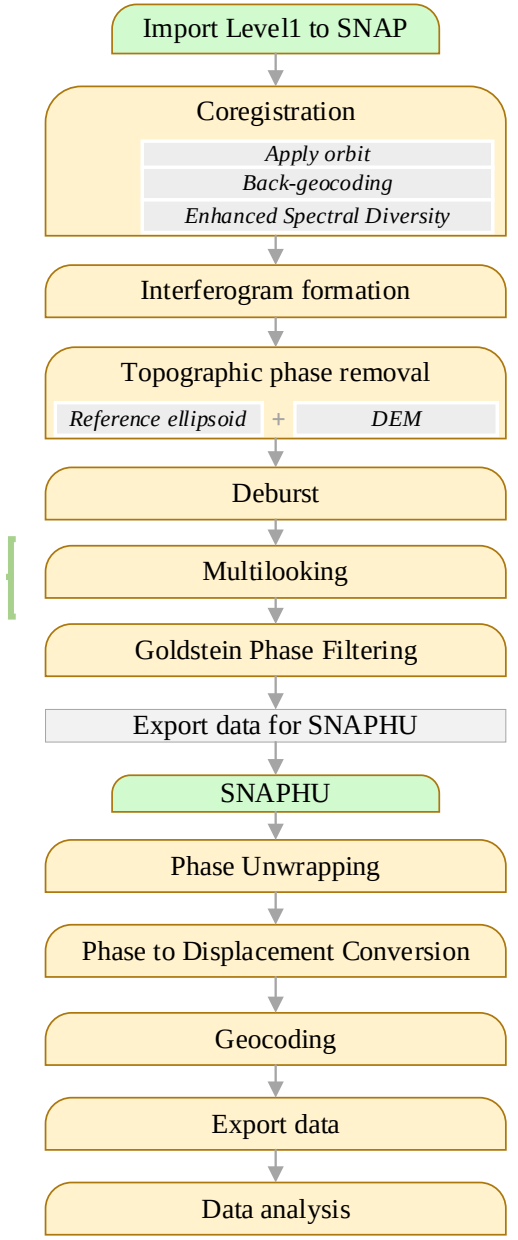
Variant 2. Menu SNAP

1. Radar > Sar utilities > Multilooking





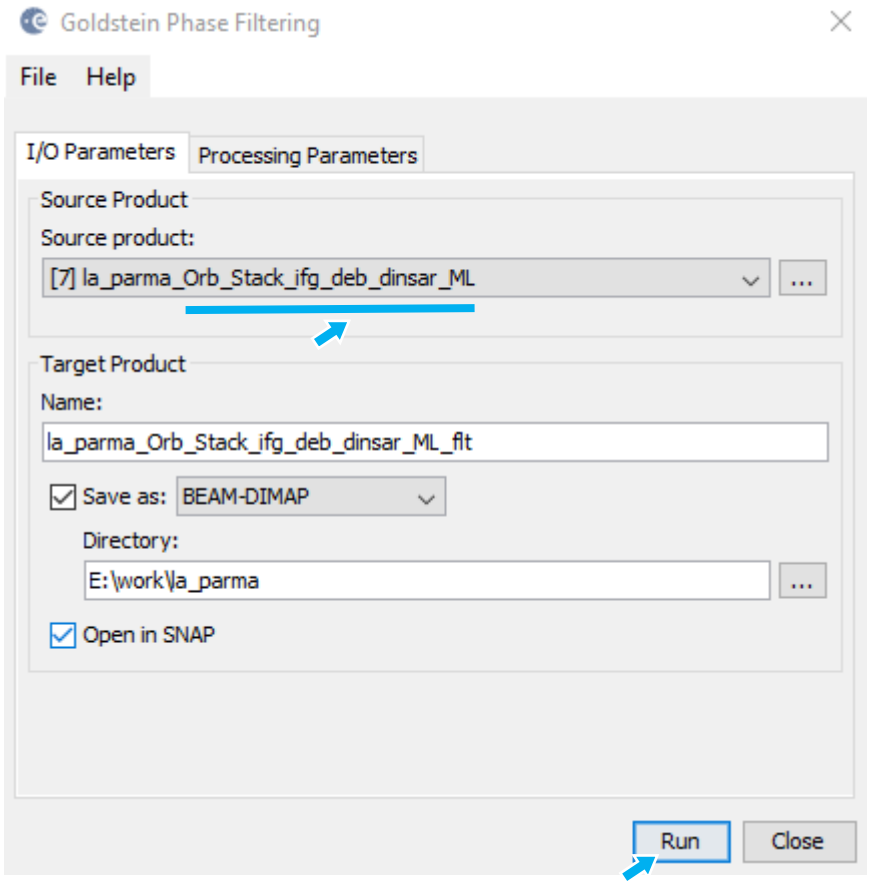
In the Number of Range Looks field, enter 6, which will result in a pixel size of about 26.5 meters. In essence, multi-looking performs a spatial average of a number of neighboring pixels (in our case, 6×2 pixels) to suppress noise and proportion the image correctly. This process comes at the expense of spatial resolution

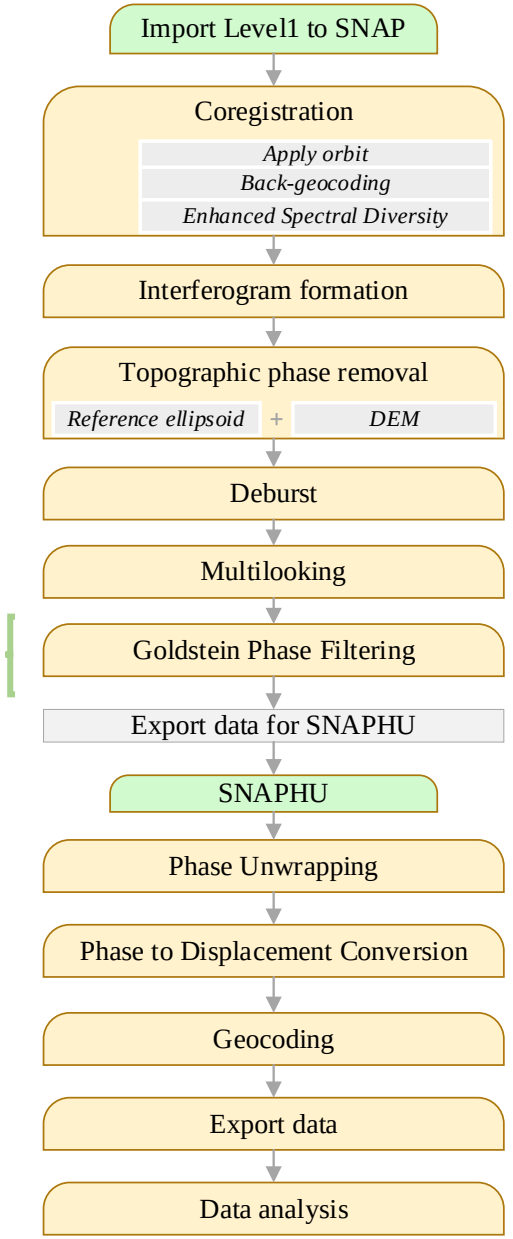


Stage 6. Goldstein Phase Filtering

Variant 2. Menu SNAP

1. Radar > Interferometric > Filtering > Goldstein Phase Filtering

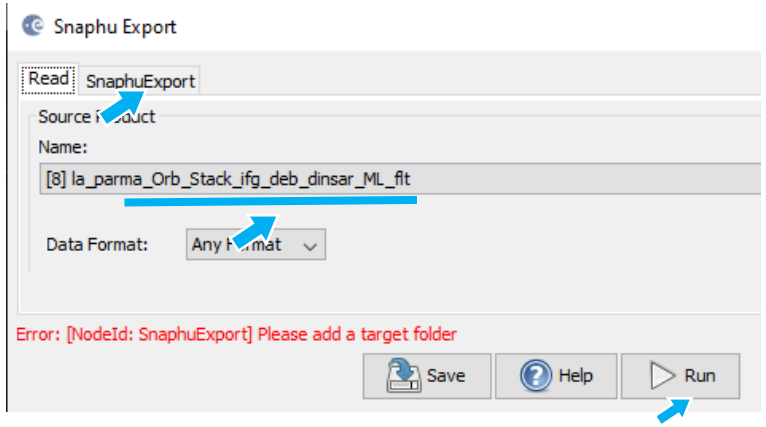




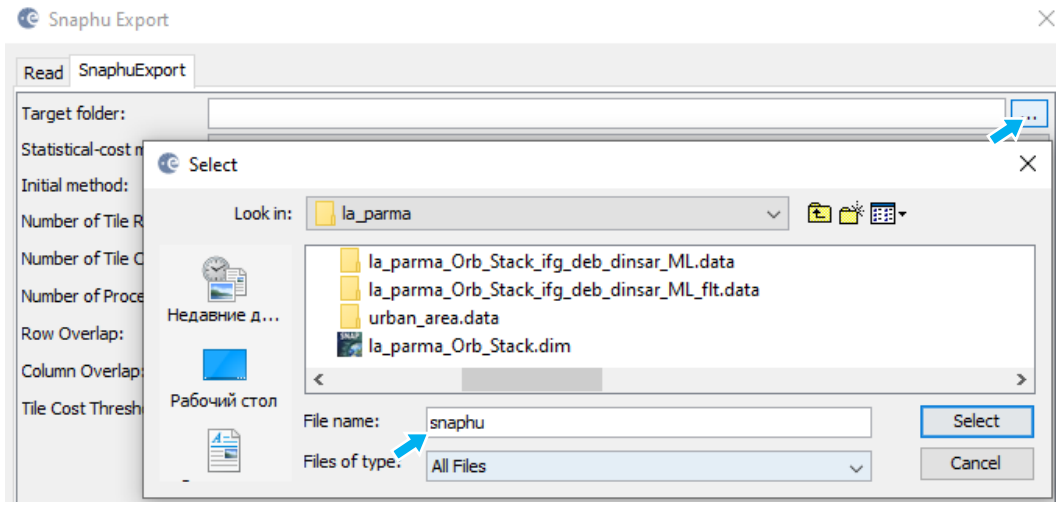
Stage 7. Snaphu Export

Variant 2. Menu SNAP

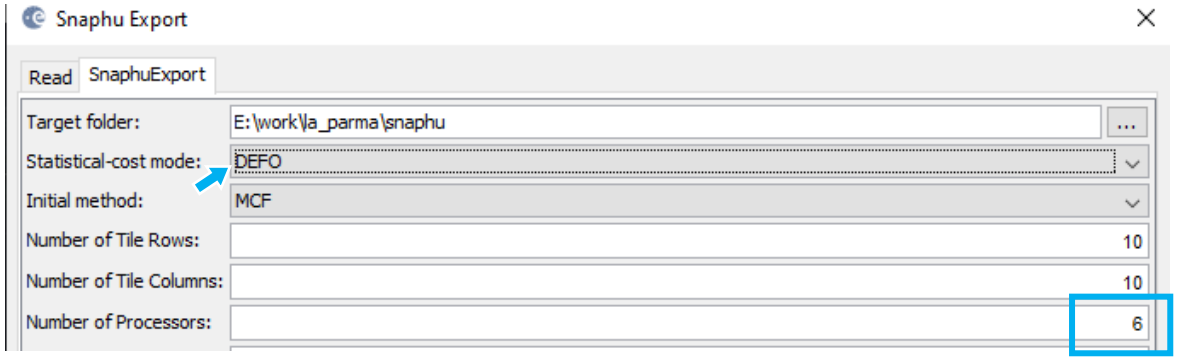
1. Radar > Interferometric > Unwrapping > Snaphu Export



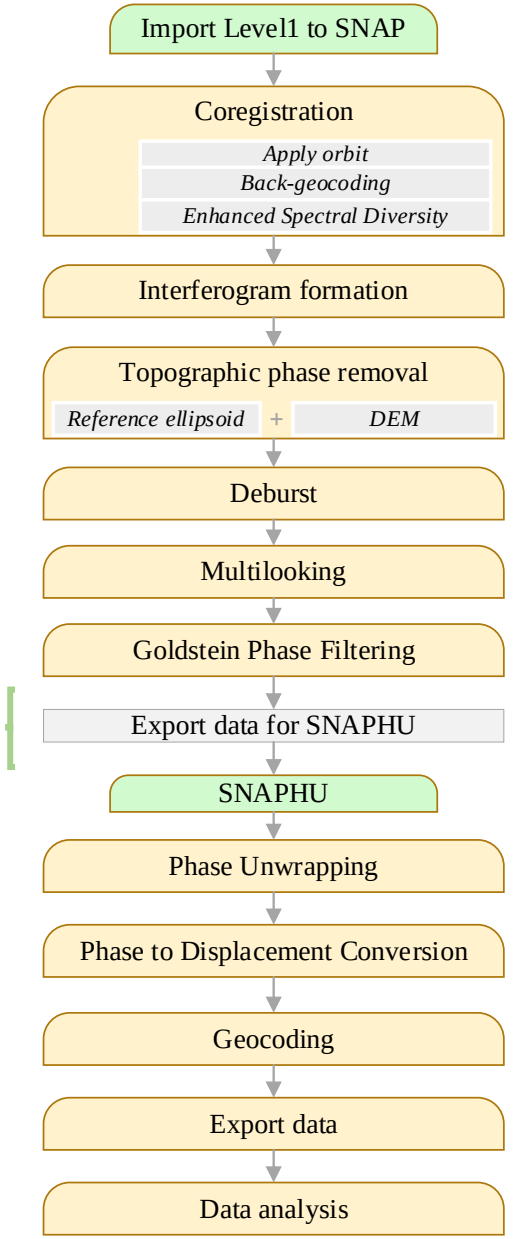
2. Open target folder and write name “snaphu”



3. Select DEFO for deformation mapping



this depends on the CPU you have

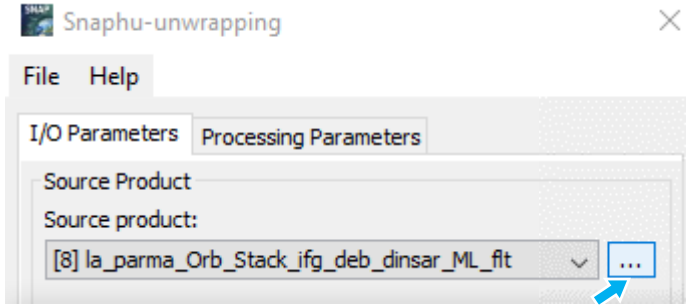


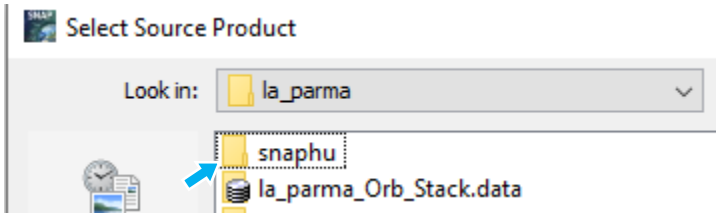
Stage 8. Snaphu Unwrapping phase

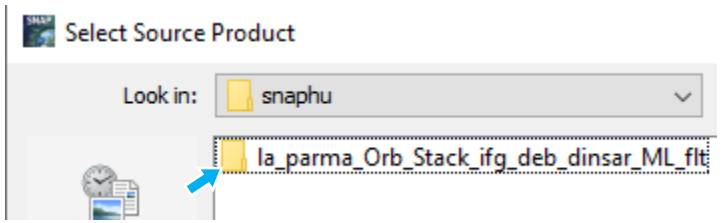
Variant 2. Menu SNAP

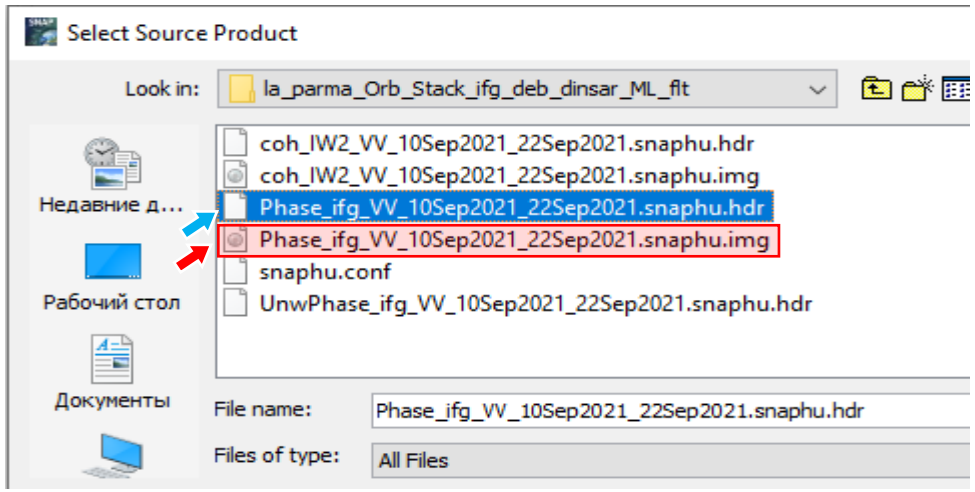
1. Radar > Interferometric > Unwrapping > Snaphu-unwrapping

2. Select phase source



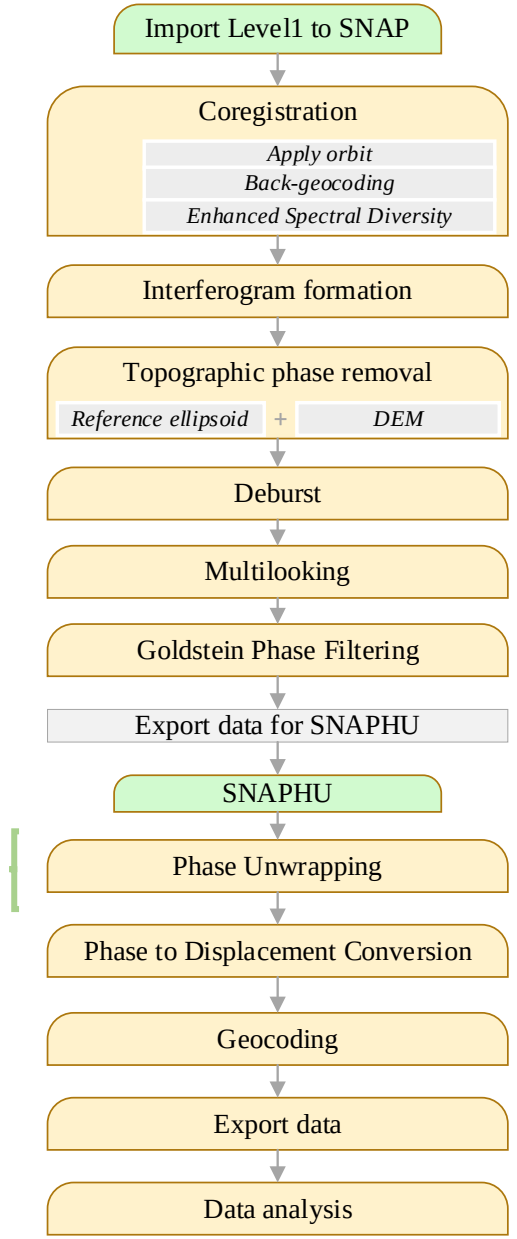






*select file "Phase_ifg_.....snaphu.hdr“ for SNAP before version 9

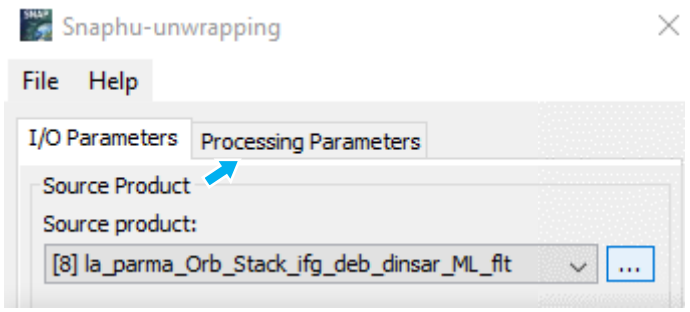
*select file "Phase_ifg_.....snaphu.img“ for SNAP after version 10



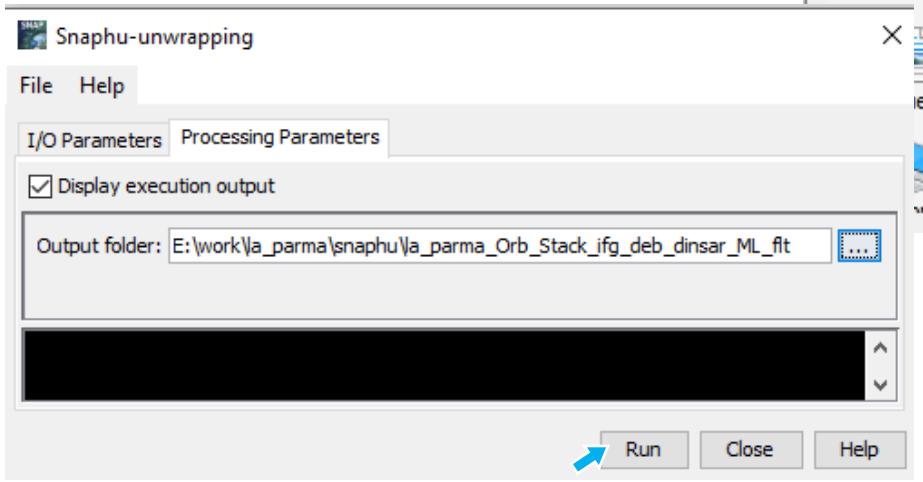
Stage 8. Snaphu Unwrapping phase

Variant 2. Menu SNAP

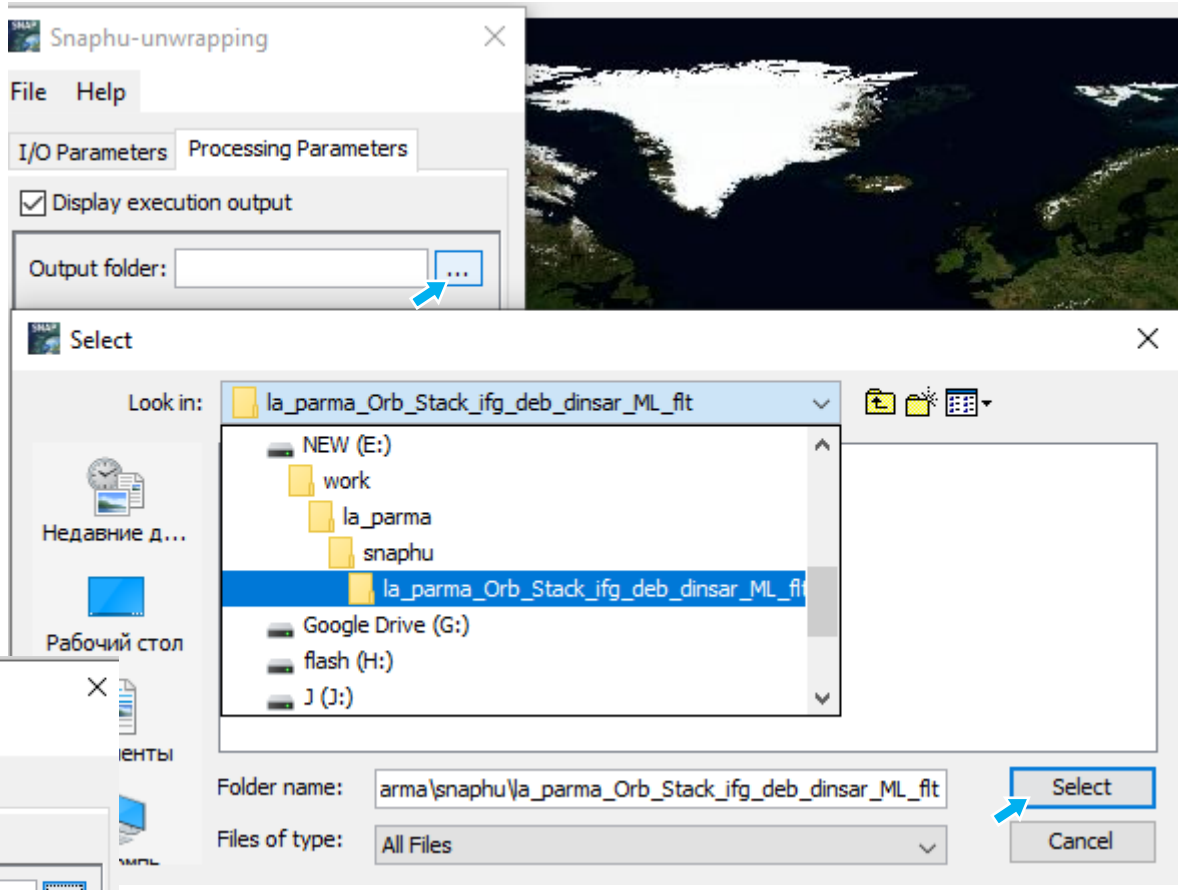
3. Select processing parameters

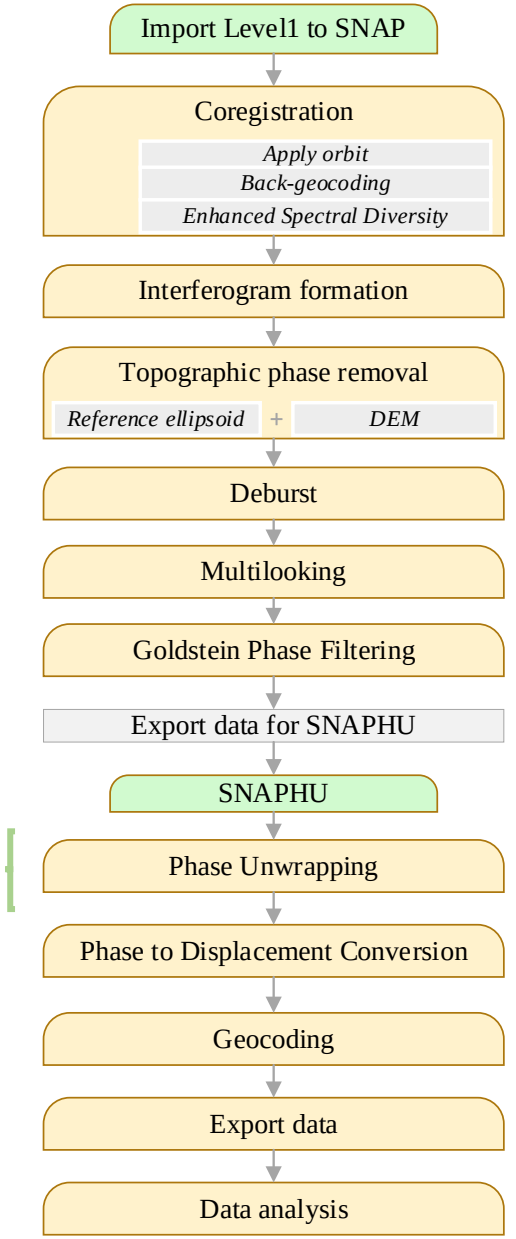


Folder were you selected file "Phase_ifg_.....snaphu.hdr" and had file "UnwPhase_ifg_...snaphu.img"



4. Select folder for unwrapped phase

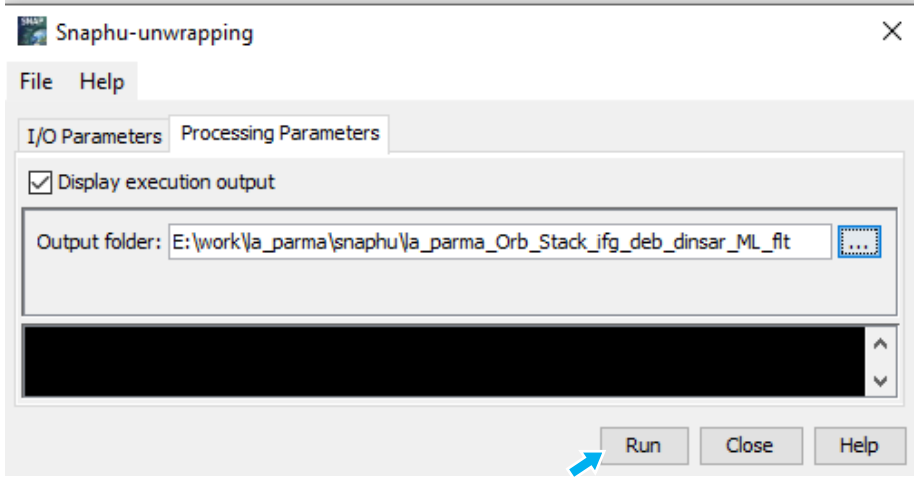




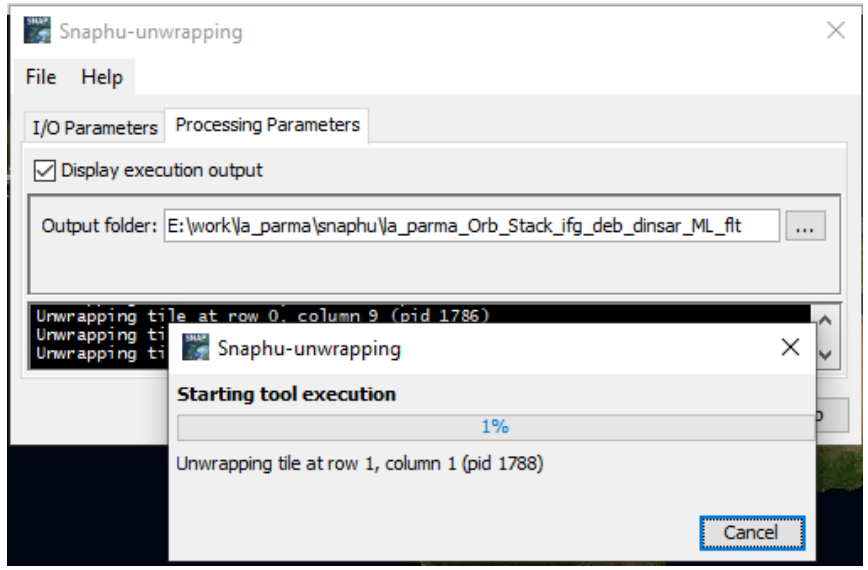
Stage 8. Snaphu Unwrapping phase

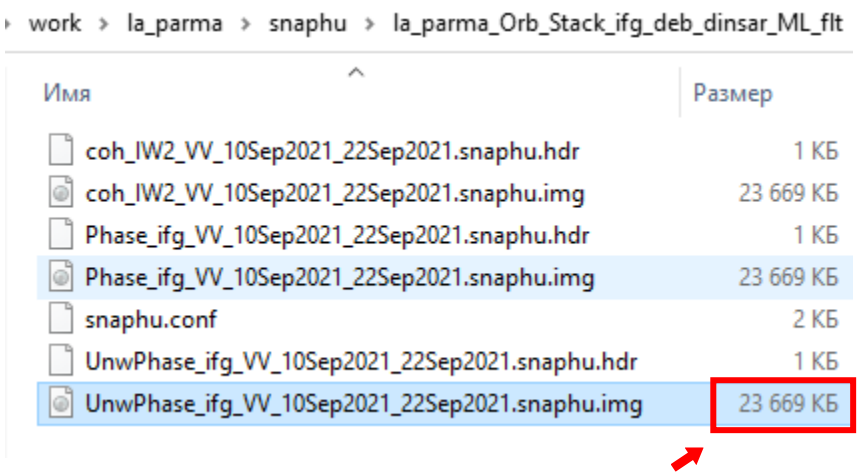
Variant 2. Menu SNAP

5. Run unwrapped phase

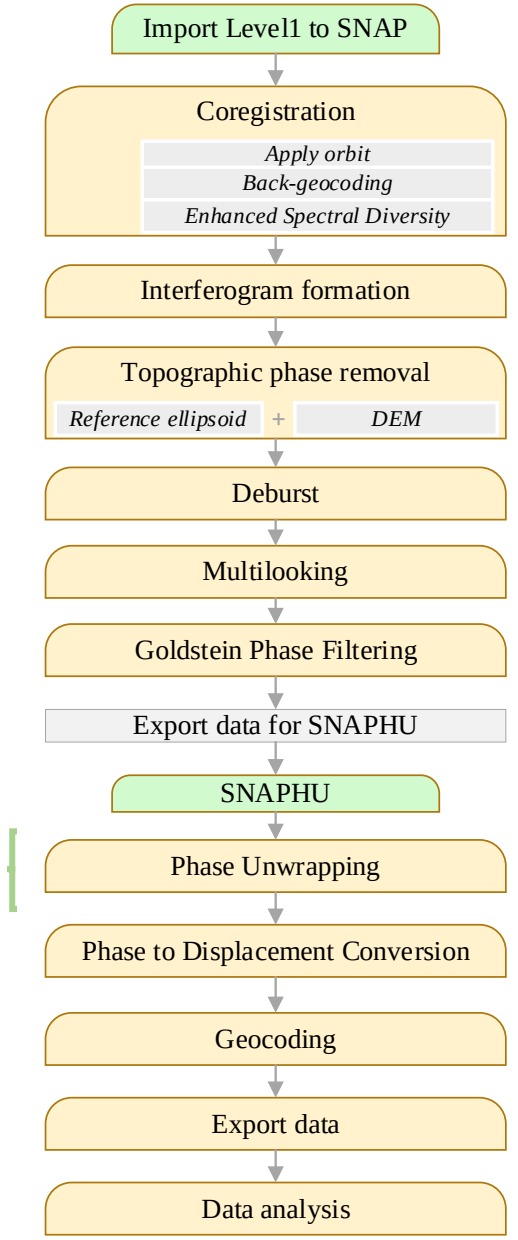


6. Normal view process





after process you get file UnwPhase_ifg_....snaphu.img size >>1kb



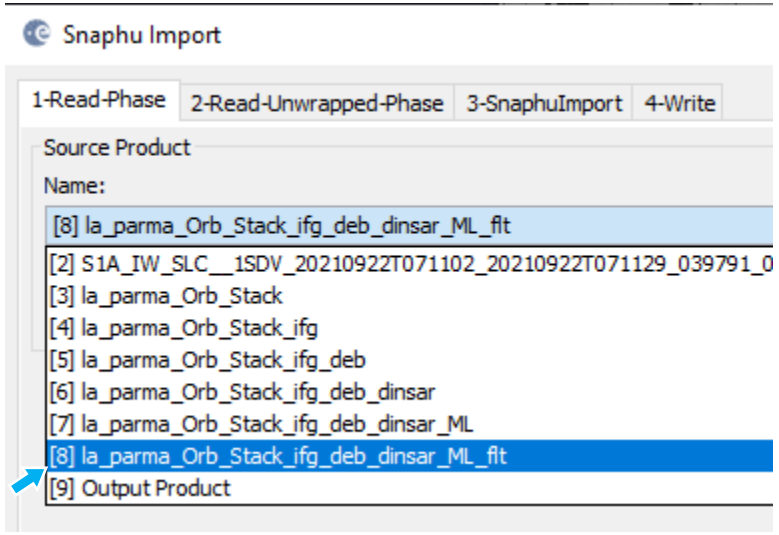
Stage 9. Snaphu import

Variant 2. Menu SNAP

1. Radar > Interferometric > Unwrapping > Snaphu import

2. Select image before unwrapping

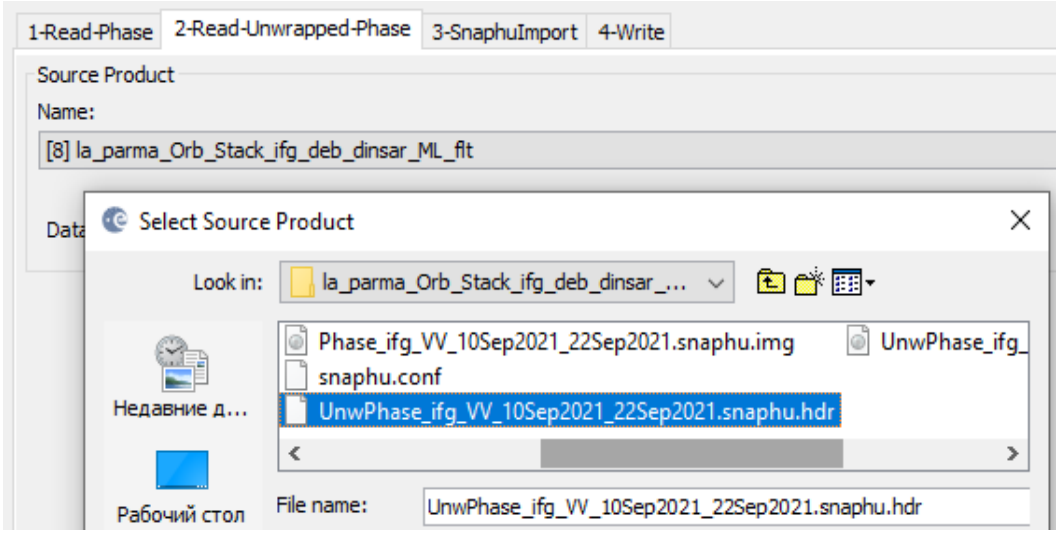
1-Read-Phase > select file "name_ML_Flt“

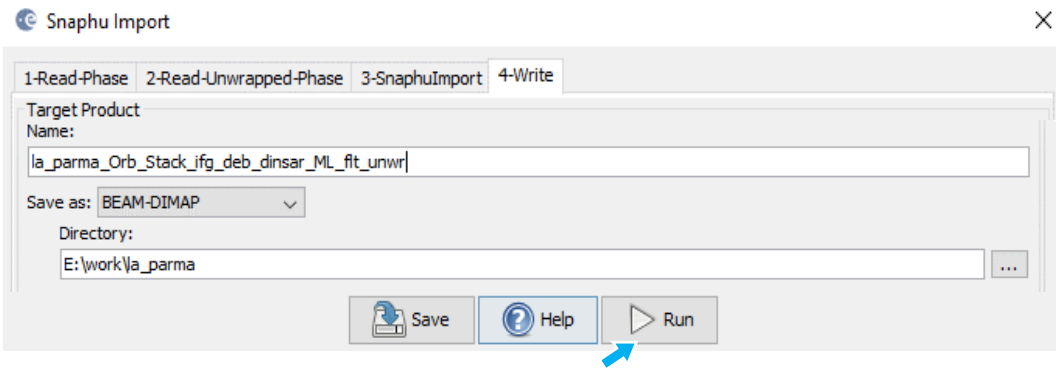


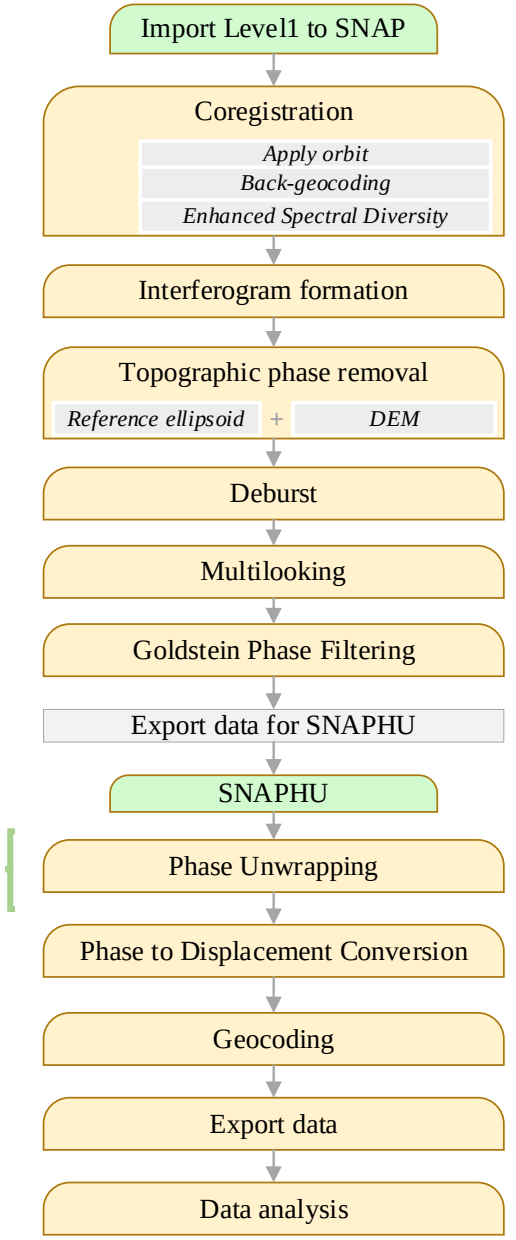
3-SnaphuImport -> not use buttom (use custom option)

3. Select file unwrapped phase

2-Read-Unwrapped-Phase > select file "UnwPhase_ifg_....snaphu.hdr"



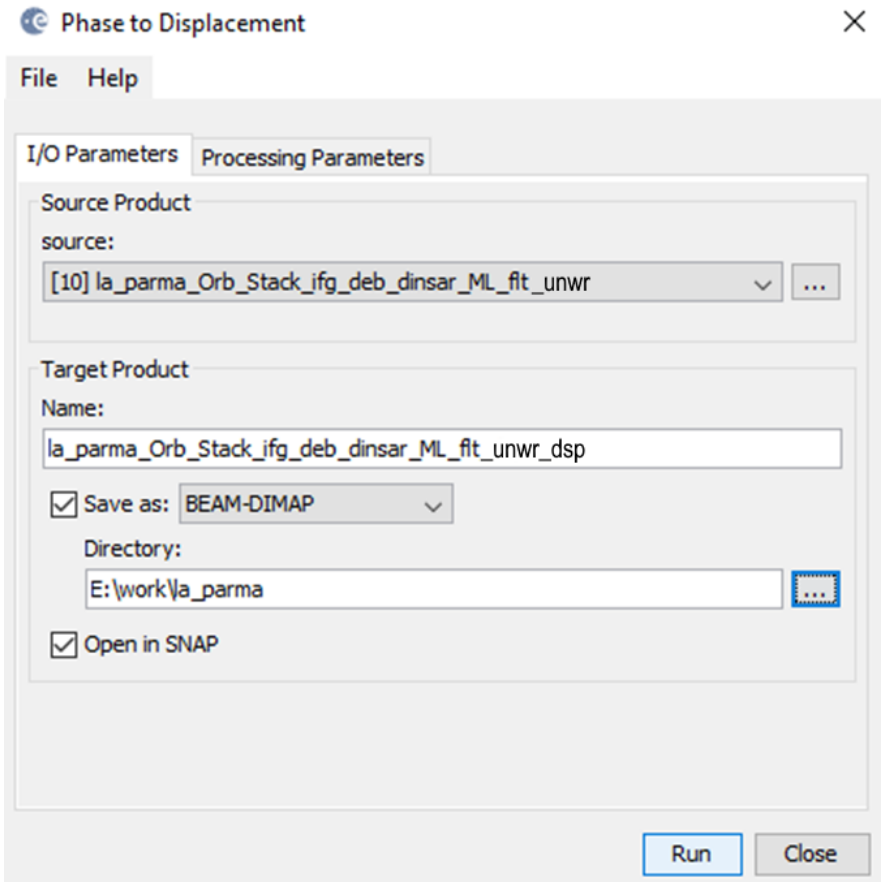




Stage 10. Phase to Displasement

Variant 2. Menu SNAP

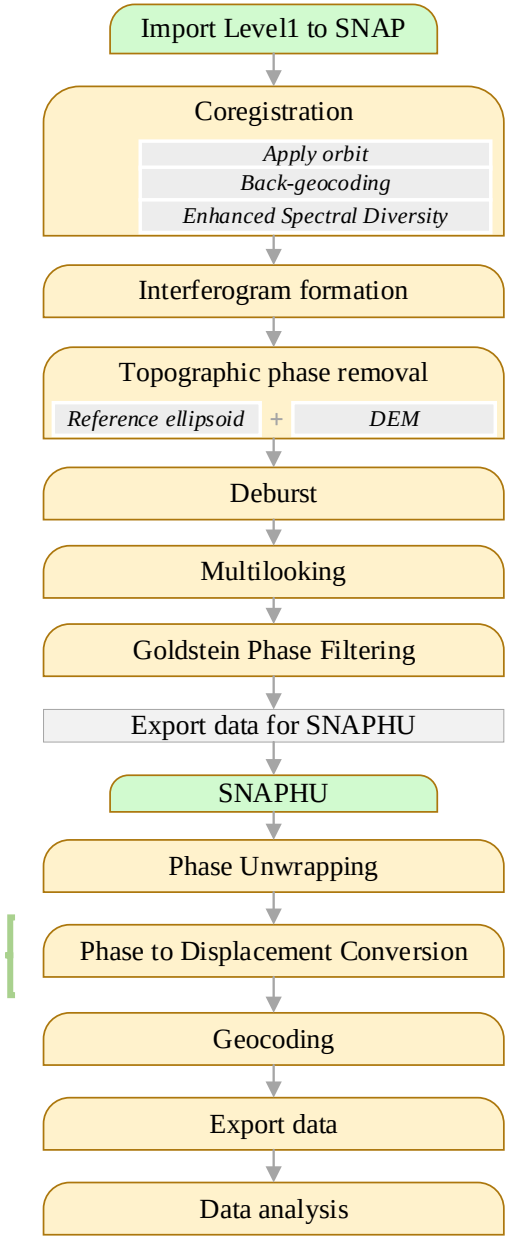
1. Radar > Interferometric > Products > Phase to Displacement.



Absolute vertical displacement in a setting with no horizontal movement can be calculated with the following expression, where the number 0.056 is the approximate value of Sentinel-1's wavelength in meters:

(0.056 * Unw_Phase_ifg_08Apr2016_20Apr2016) / (-4 * PI * cos(rad(incident_angle)))

1. In the **Product Explorer**, right click the unwrapped interferogram product and select **Band Maths**.
2. In the **Band Maths** window (Figure 8), set the **Name** to something appropriate, such as *Vertical_Displacement*.
a. Enter *meters* in the **Unit** field.
b. Uncheck **Virtual**.
c. In the **Band maths expression** field, paste the expression listed above.
3. Click <**OK**>. The new band will appear in the bands directory and when viewed, should look very similar to Figure 5.

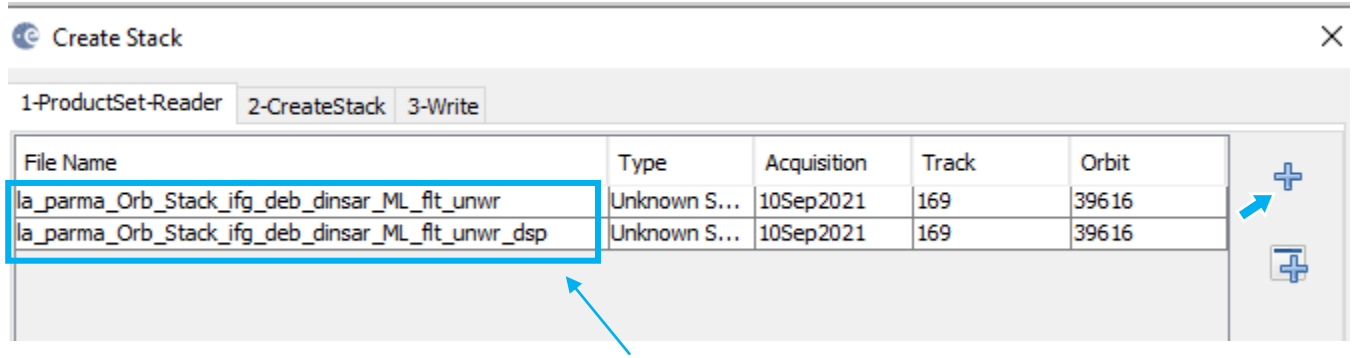


Stage 11. Geocoding.

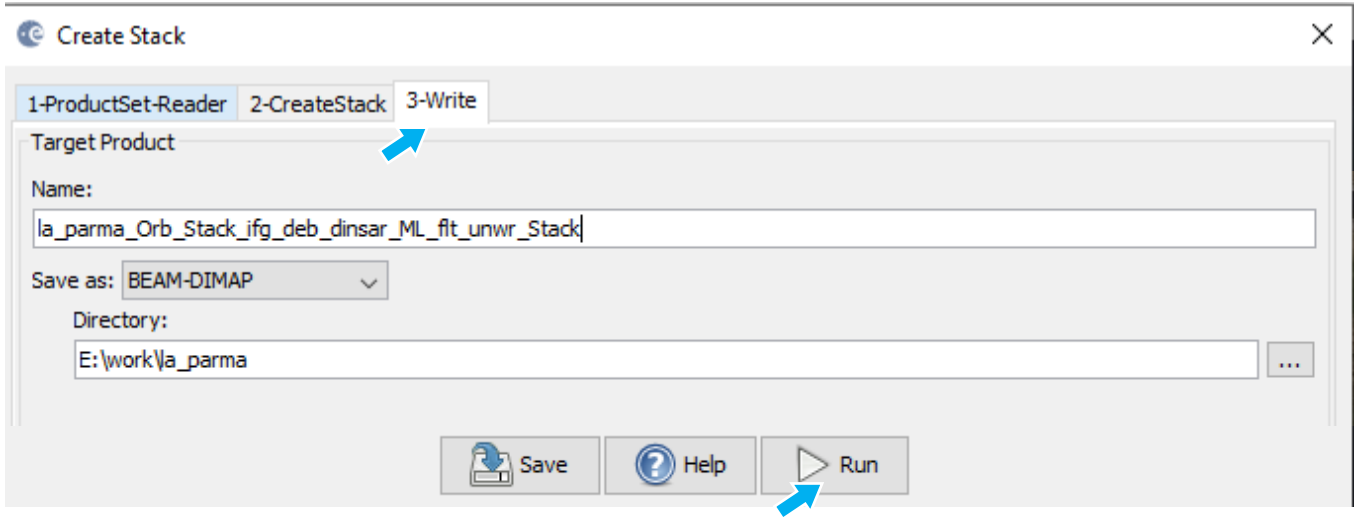
Variant 2. Menu SNAP

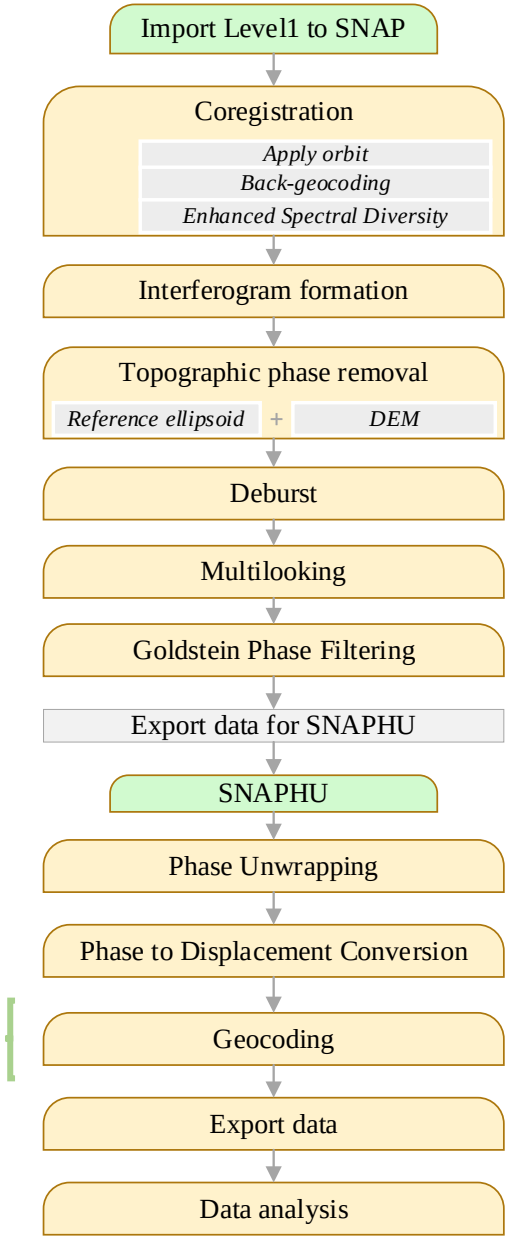
1. Create Stack.

Radar > Coregistration > Stack Tools > Create Stack.



Add “name_disp"+"name_unwrapped”



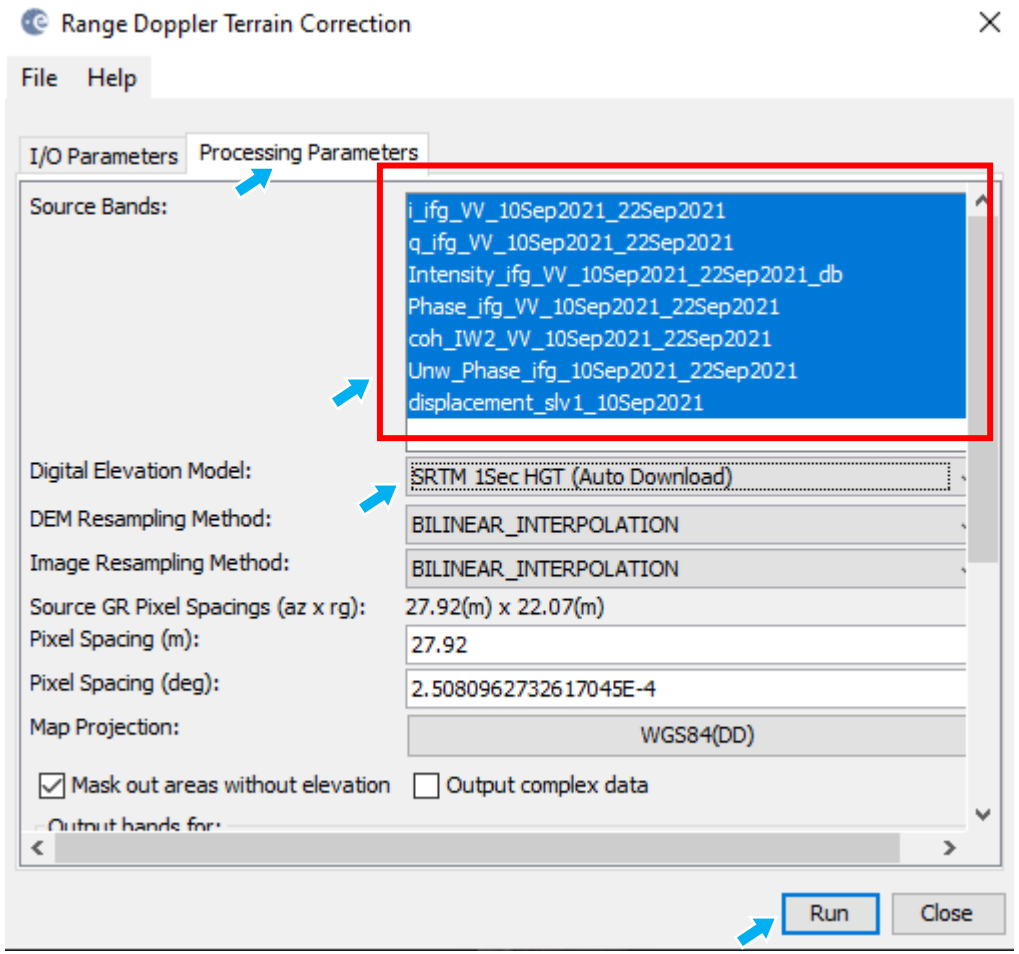


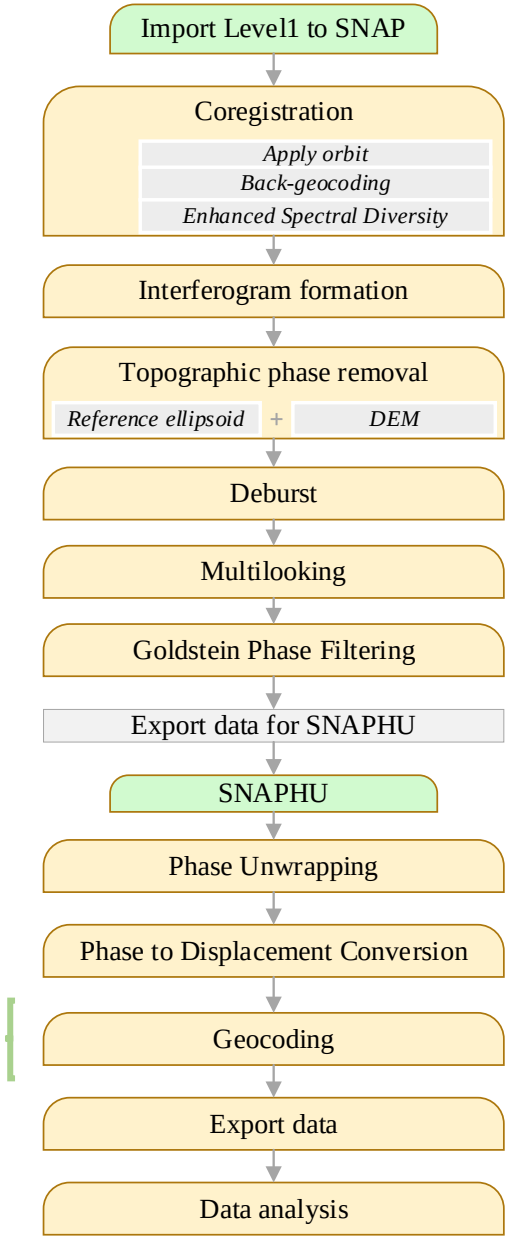
Stage 11. Geocoding.

Variant 2. Menu SNAP

2. Range-Doppler Terrain Correction

Radar > Geometric > Terrain Correction > Range-Doppler Terrain Correction.

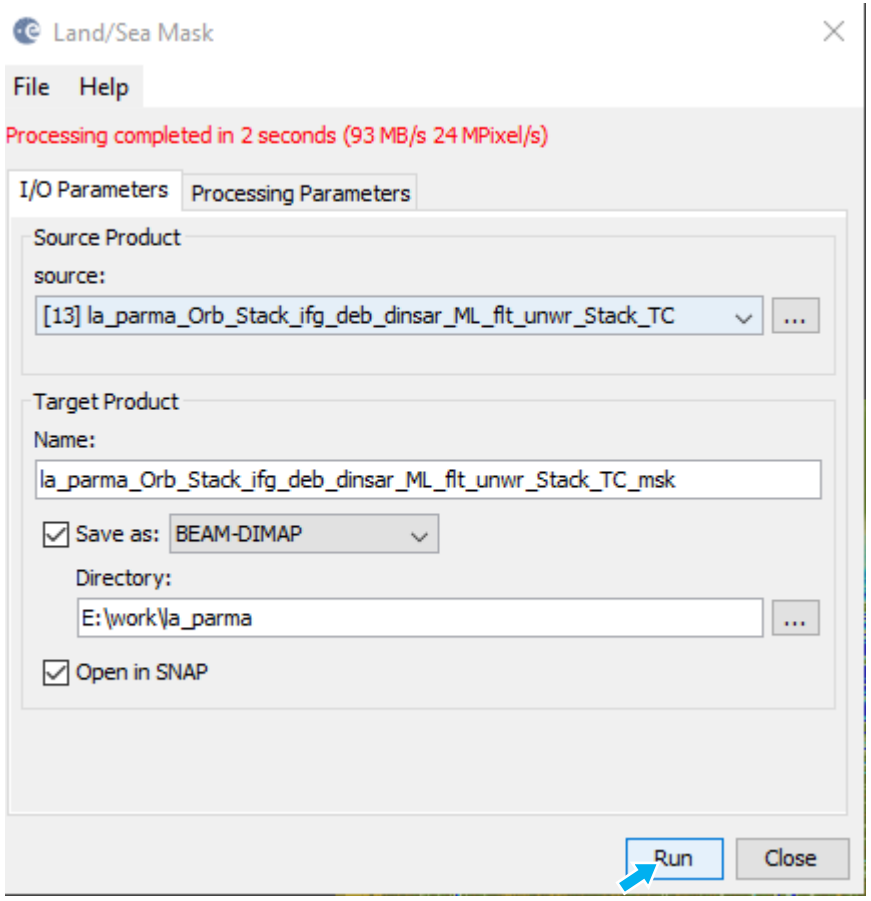


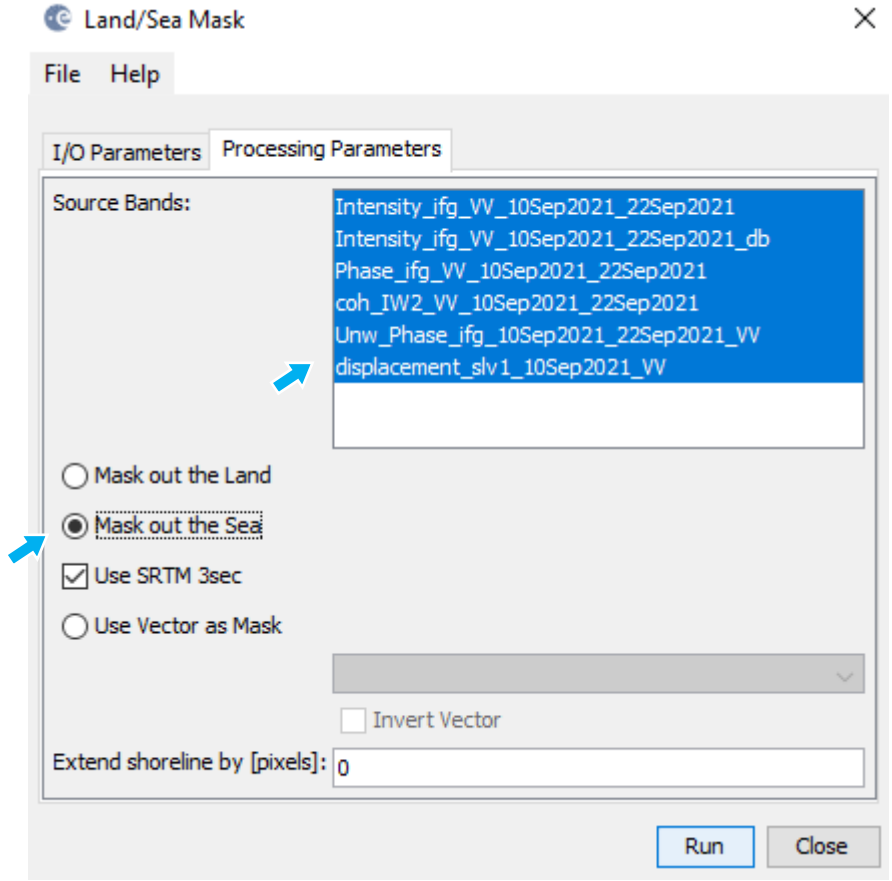


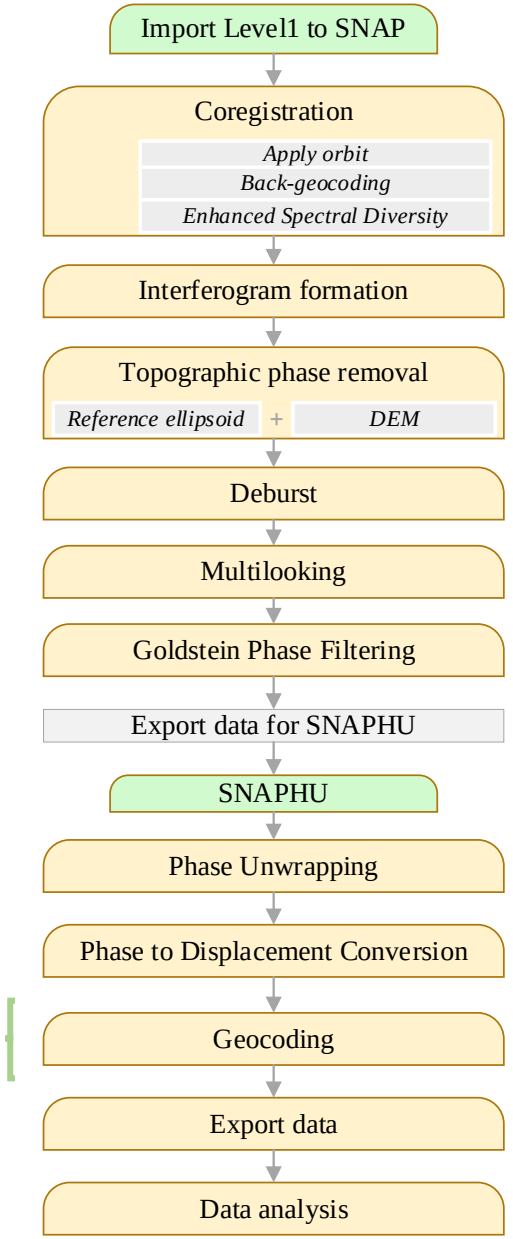
Stage 11. Geocoding.

Variant 2. Menu SNAP

3. Mask Out Areas of Water



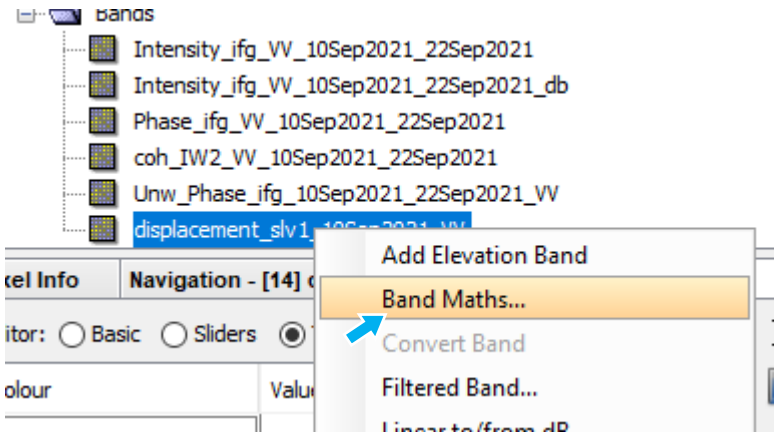


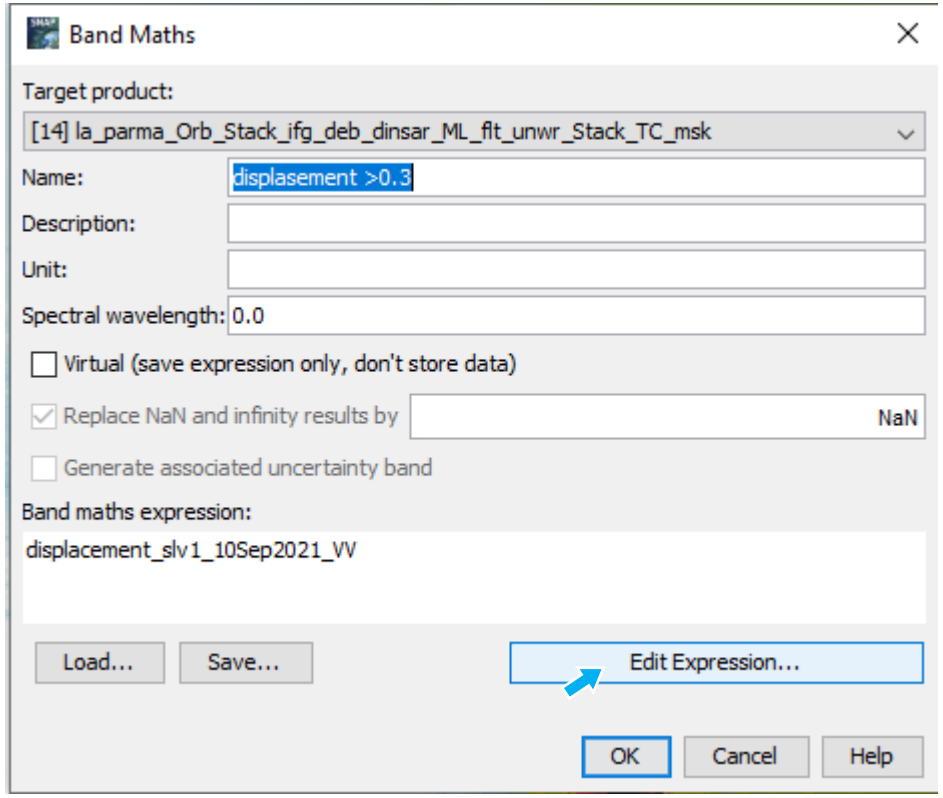


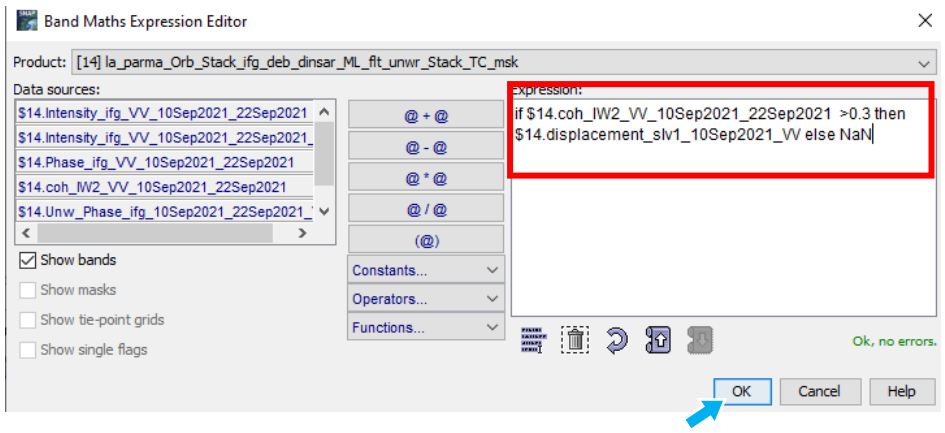
Stage 11. Geocoding.

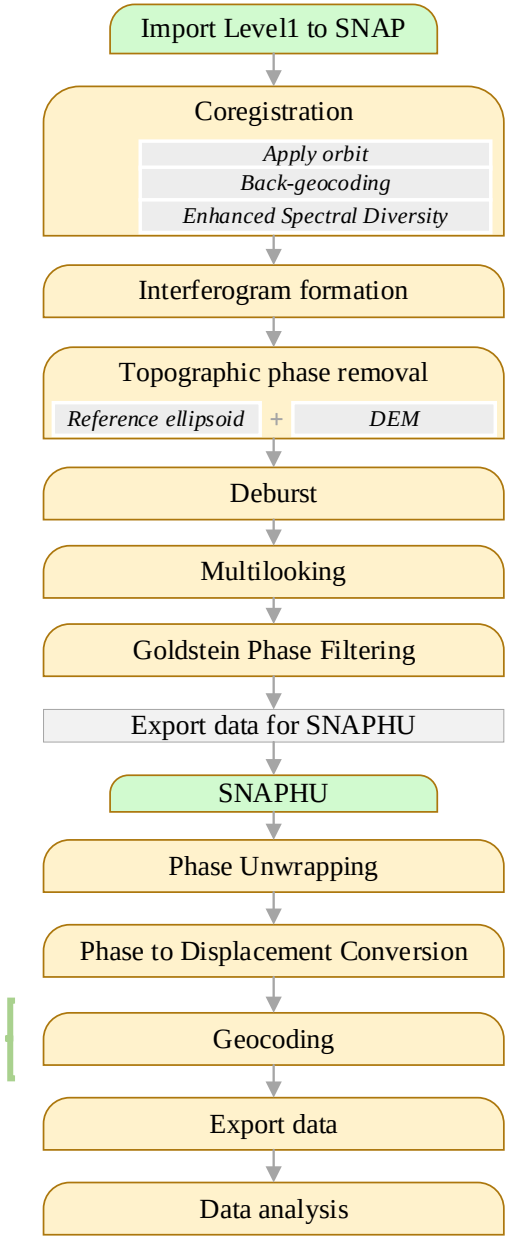
Variant 2. Menu SNAP

4. Mask Out Areas of Low Coherence





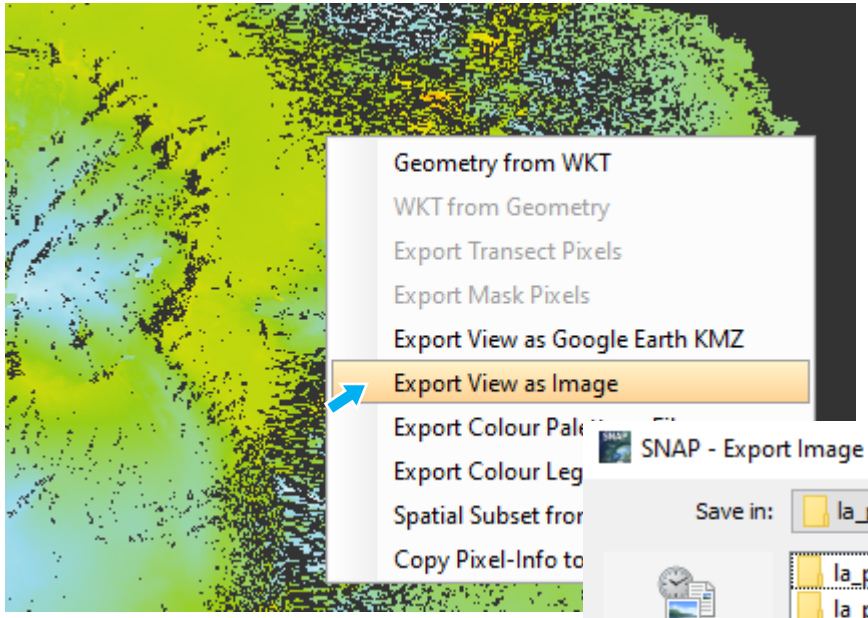


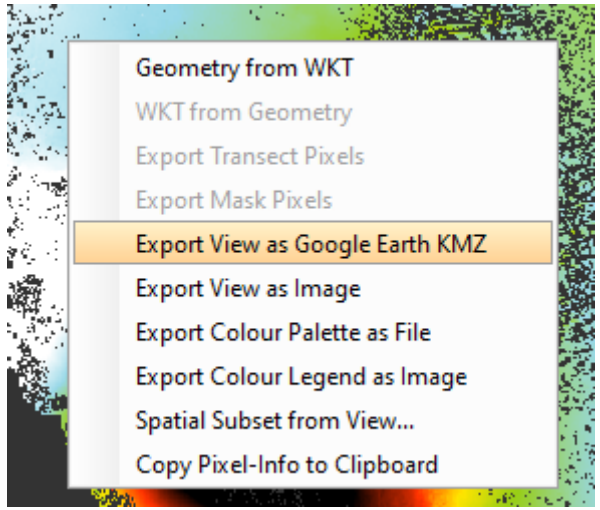


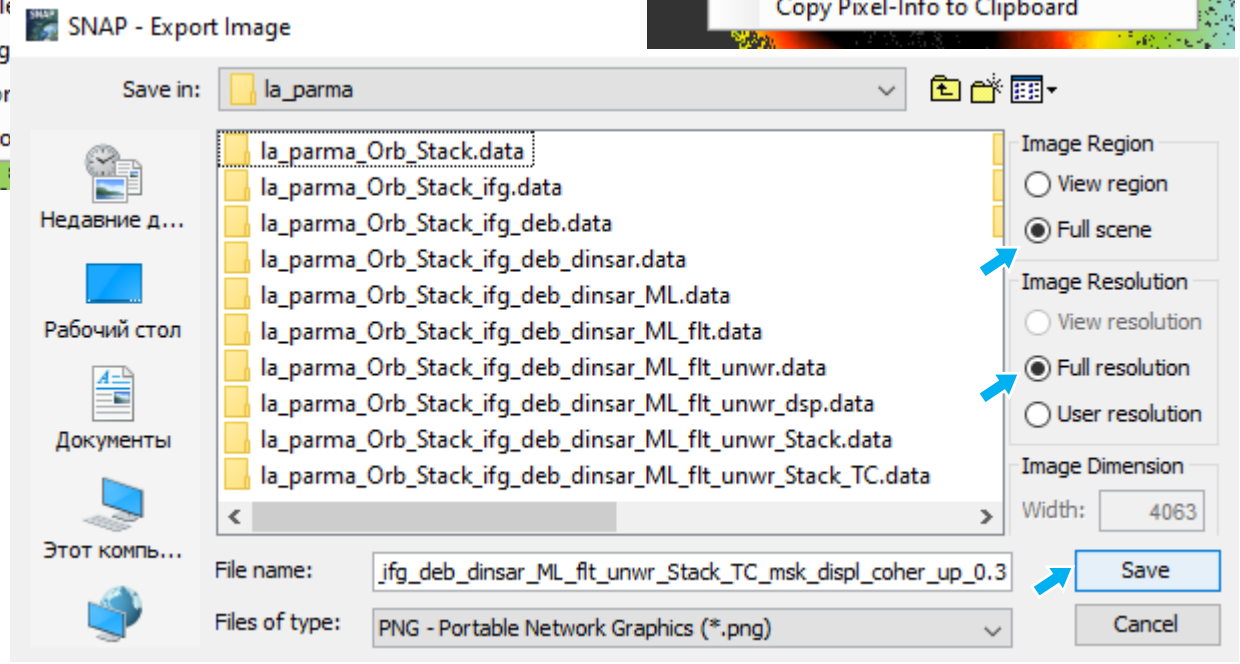
Stage 12. Export data

Variant 2. Menu SNAP

1. Right-click in the view area on your masked and re-colored displacement map







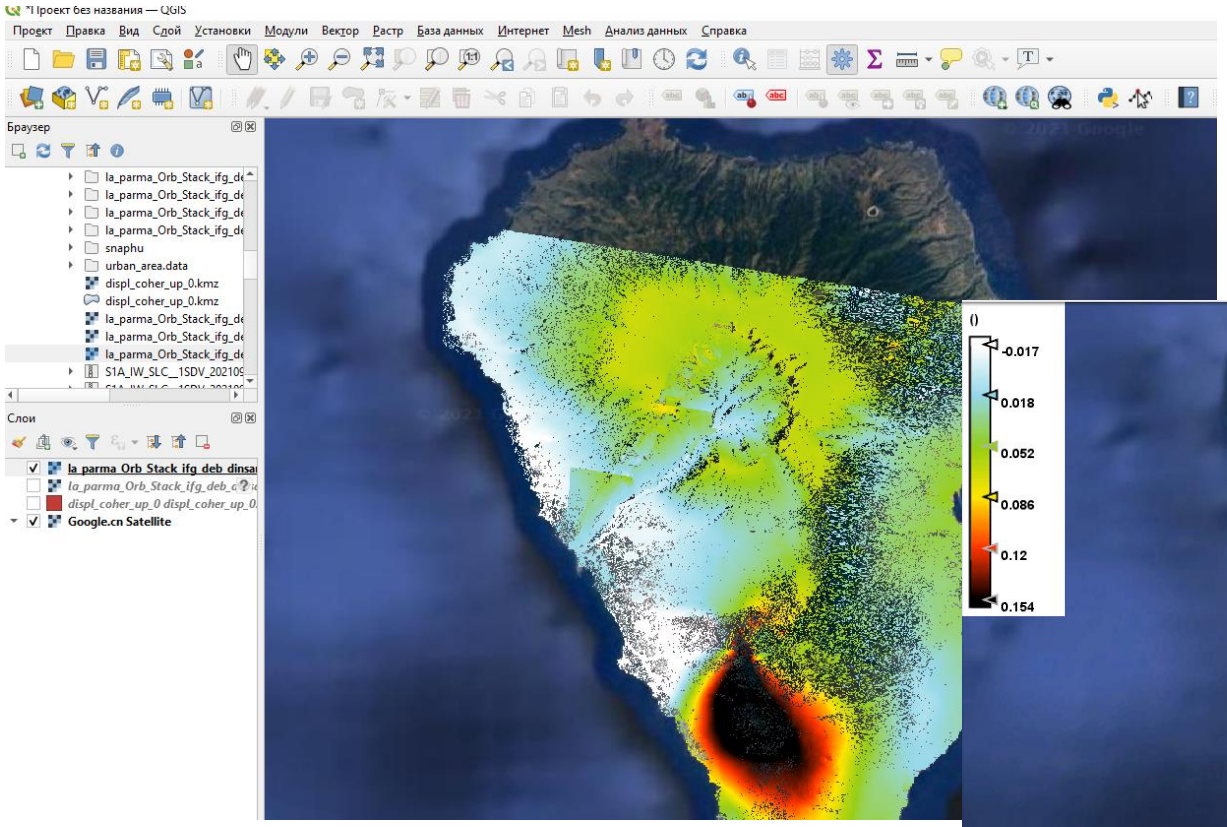
- Import Level1 to SNAP
- Coregistration
  - *Apply orbit*
  - *Back-geocoding*
  - *Enhanced Spectral Diversity*
- Interferogram formation
- Topographic phase removal
  - *Reference ellipsoid* + *DEM*
- Deburst
- Multilooking
- Goldstein Phase Filtering
- Export data for SNAPHU
- SNAPHU
- Phase Unwrapping
- Phase to Displacement Conversion
- Geocoding
- Export data
- Data analysis

II. Displacement (DInSar) 2 images

Stage 13. Data analysis

Variant 2. Menu SNAP

1. Qgis



2. Google Earth