Earth Observation Data Analysis

HOMEWORK03 - SURFACE DETECTION FROM SAR SENTINEL-1 DATA

Objective: explore Sentinel-1 SAR data for estimating vegetation cover, inland water, chlorophyll-a sea concentration and supervised classification within a region of interested (ROI).

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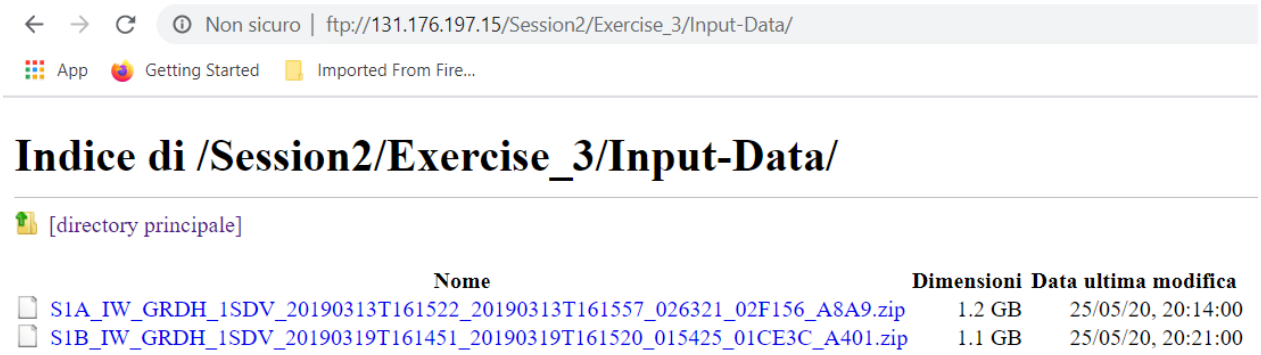
The input data is downloaded from this ftp:



The data that is going to be used ,based on ship detection, flood detection and earthquake detection :

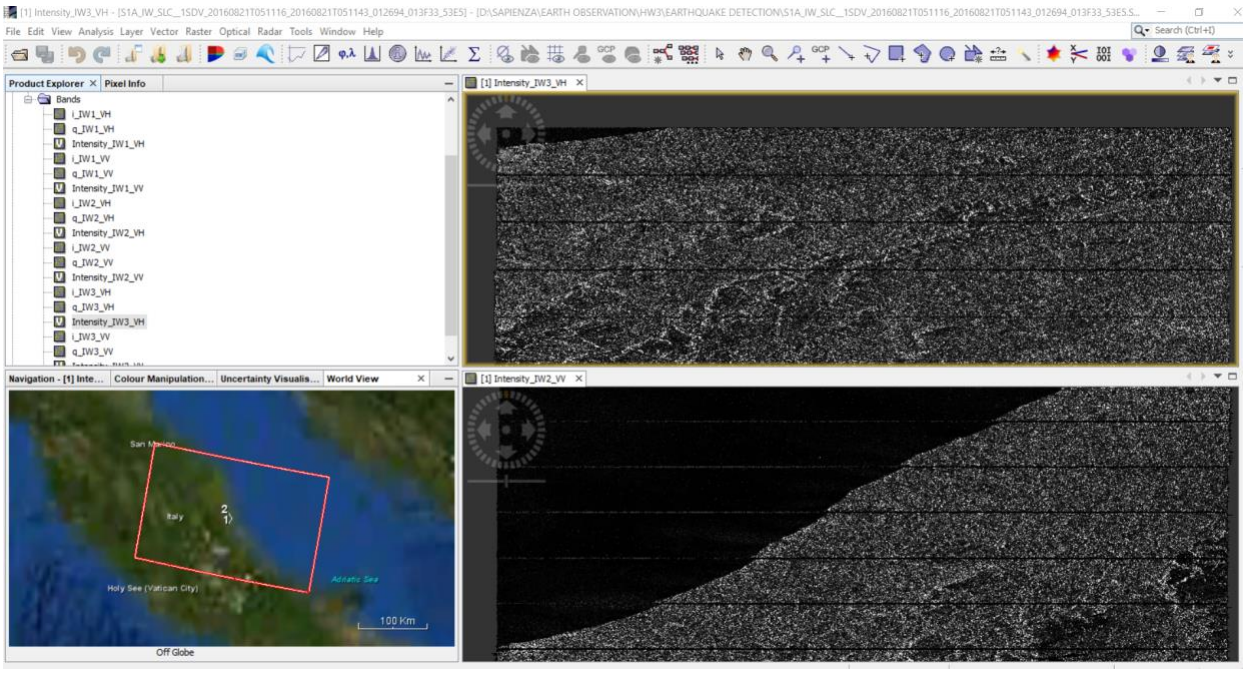
Download Sentinel-1 SAR data

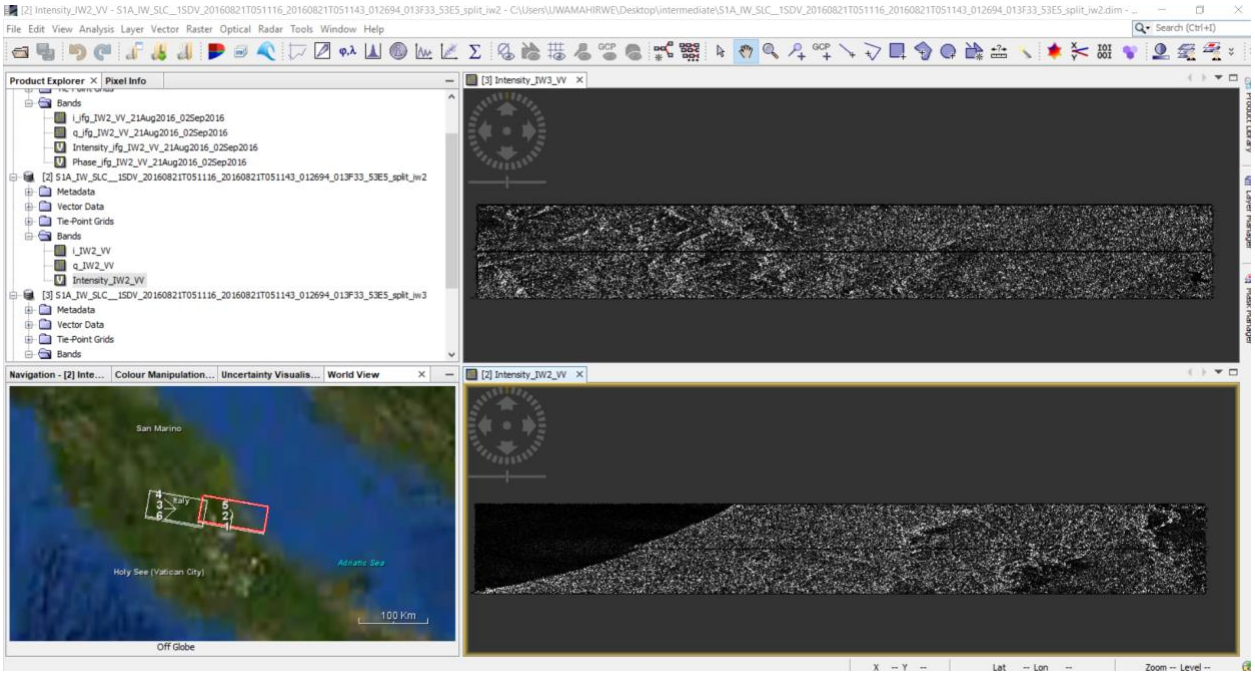
- ✓ Pre-Event Acquisition (master) - 21 August 2016
  S1A_IW_SLC__1SDV_20160821T051116_20160821T051143_012694_013F33_53E5.SAFE
- ✓ Post-Event Acquisition (slave) – 02 September 2016
  S1A_IW_SLC__1SDV_20160902T051117_20160902T051144_012869_014526_DFB4.SAFE
- ✓ Selected Product Ship detection:
  S1A_IW_GRDH_1SDV_20200128T050429_20200128T050454_030996_038F5D_4119.SAFE
- ✓ Selected Product Flood:
  S1A_IW_GRDH_1SDV_20190313T161522_20190313T161557_026 321_02F156_A8A9.SAFE
  S1B_IW_GRDH_1SDV_20190319T161451_20190319T161520_015425_01CE3C_A401.SAFE

1. EARTHQUAKE DETECTION BY SAR DIFFERENTIAL INTERFEROMETRY

Amatrice Earthquake in central Italy on 24 August 2016

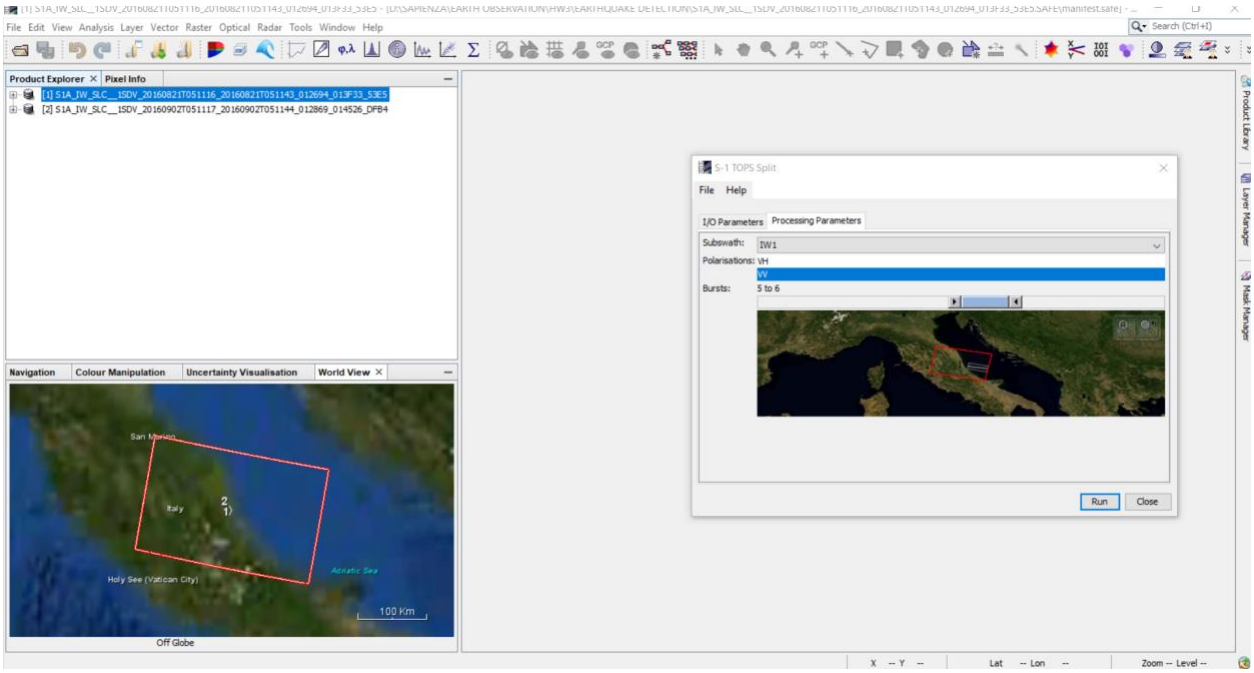
a. data band exploration and geolocation for IW2/IW3 subswaths for master/slave images

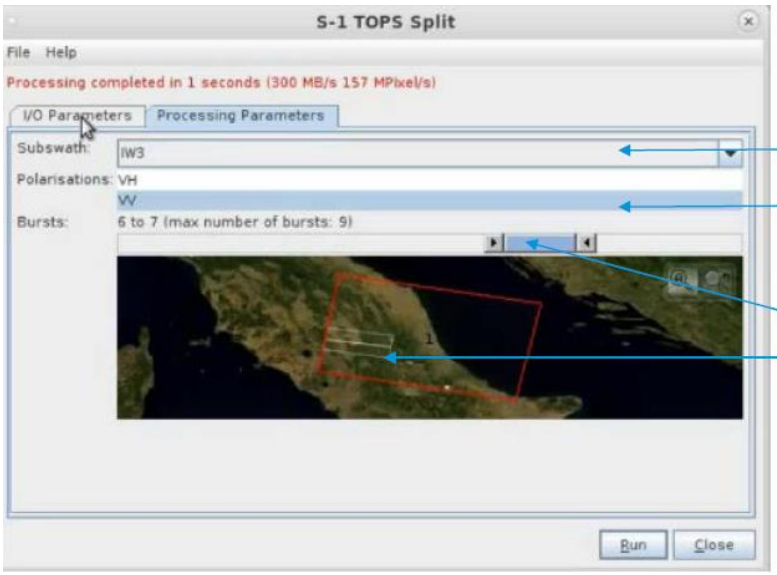




b. <u>Subswath/burst TOPSAR splitting</u>

we change subswath IW2 and IW3 then we choose polarization to VV and change bursts to 5-6 to IW2 and subswath IW3 to VV polarization then bursts to 6-7

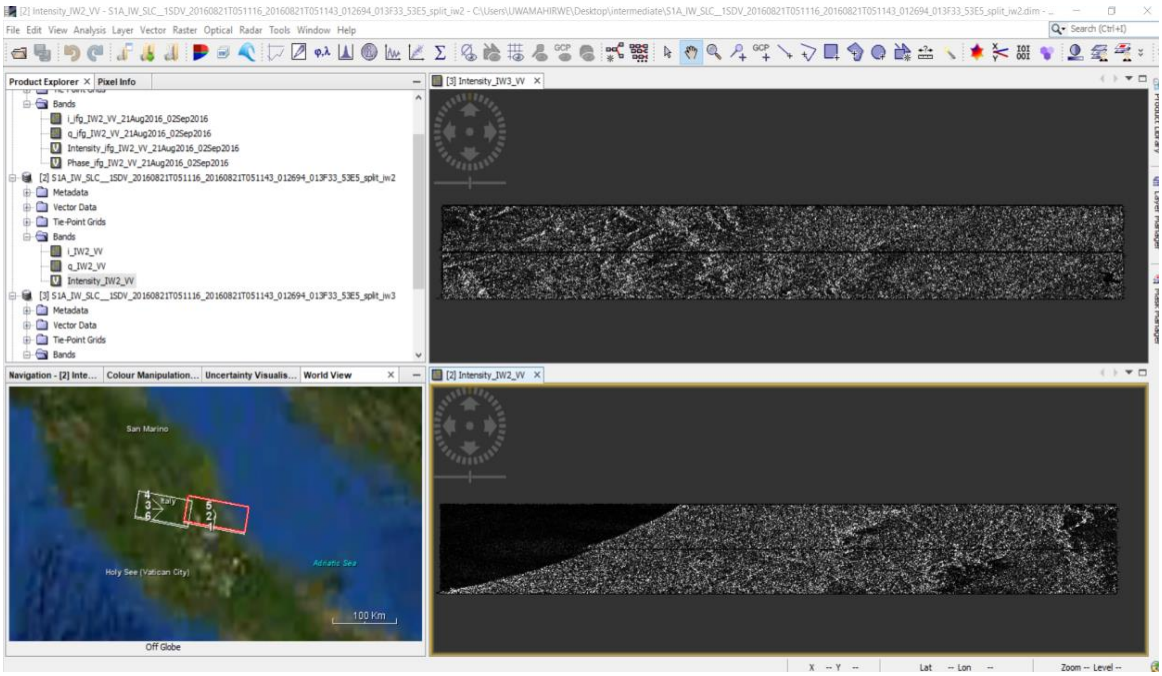




Subswath IW3

VV Polarisation

Bursts: 6-7

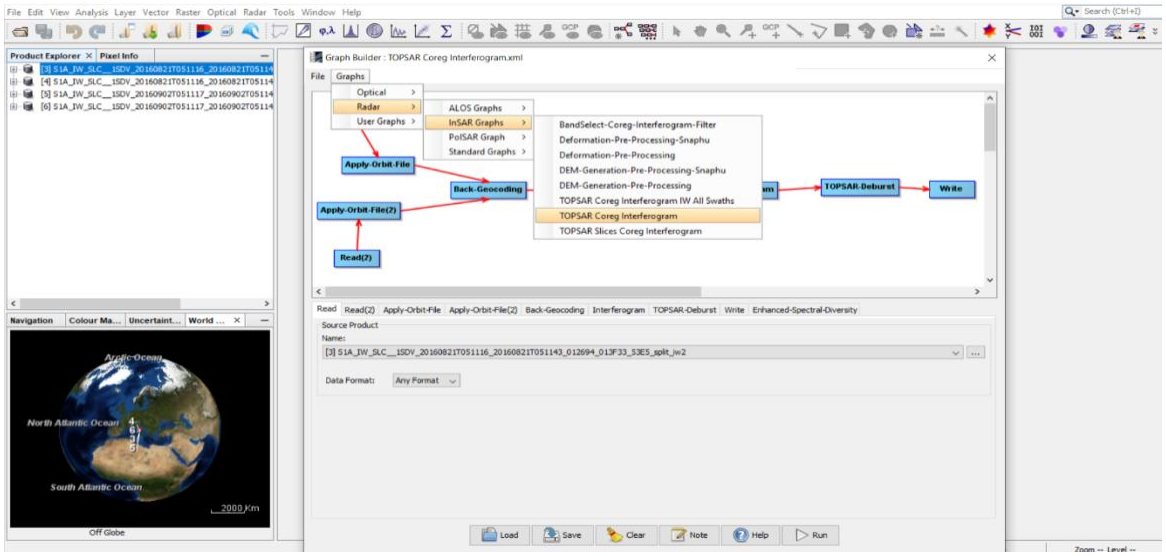


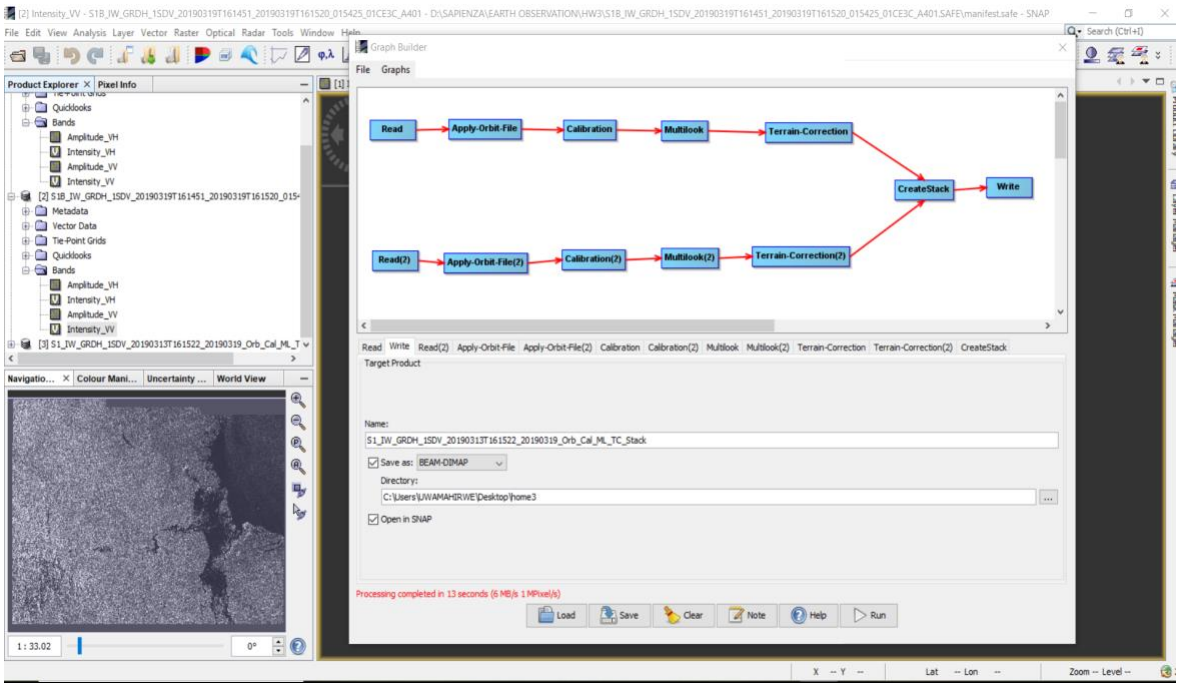
c. Orbit precising and interferogram generation/backgeocoding

Passing from linear scale to the logarithmic scale
Changing detection between master and slave

IW2 vs IW3
Due to the operating mode of sentinel 1,we have to observe the intensity mode IW2 in bands which has 9 burst, Before splitting this product we shall use the mode TOPSAR ,since the earthquake didn't take the whole region we have to save some computation time by taking the small place where we know that has had effect due to the earthquake, we will select some few area after the earthquake.

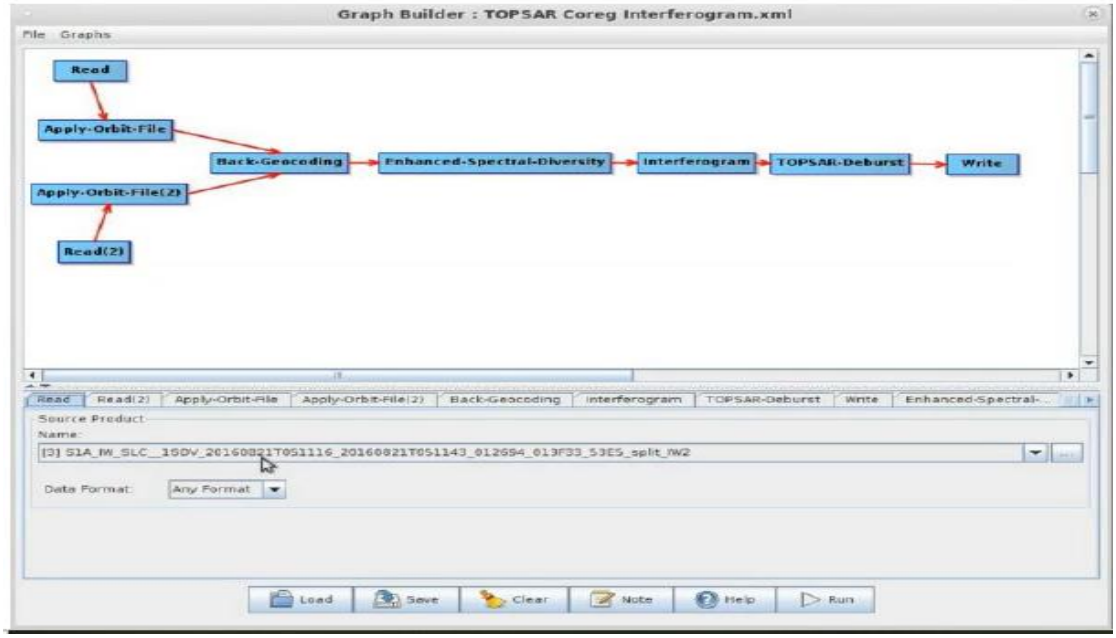
Back geo-coding is used to register the master acquisition and slave acquisition
Before computing the compute, the interferogram, we added enhanced spectral diversity operator which is needed to compensate some issues that are present between two consecutive burst.
The first read operator should have the master acquisition of 20160821… and the second read should have the slave acquisition 20160902.


Graph Builder : TOPSAR Coreg Interferogram.xml
Optical
Radar
User Graphs
ALOS Graphs
InSAR Graphs
PolSAR Graph
Standard Graphs
BandSelect-Coreg-Interferogram-Filter
Deformation-Pre-Processing-Snaphu
Deformation-Pre-Processing
DEM-Generation-Pre-Processing-Snaphu
DEM-Generation-Pre-Processing
TOPSAR Coreg Interferogram IW All Swaths
TOPSAR Coreg Interferogram
TOPSAR Slices Coreg Interferogram
Apply-Orbit-File
Back-Geocoding
Apply-Orbit-File(2)
Read(2)
TOPSAR-Deburst
Write
Load
Save
Clear
Note
Help
Run

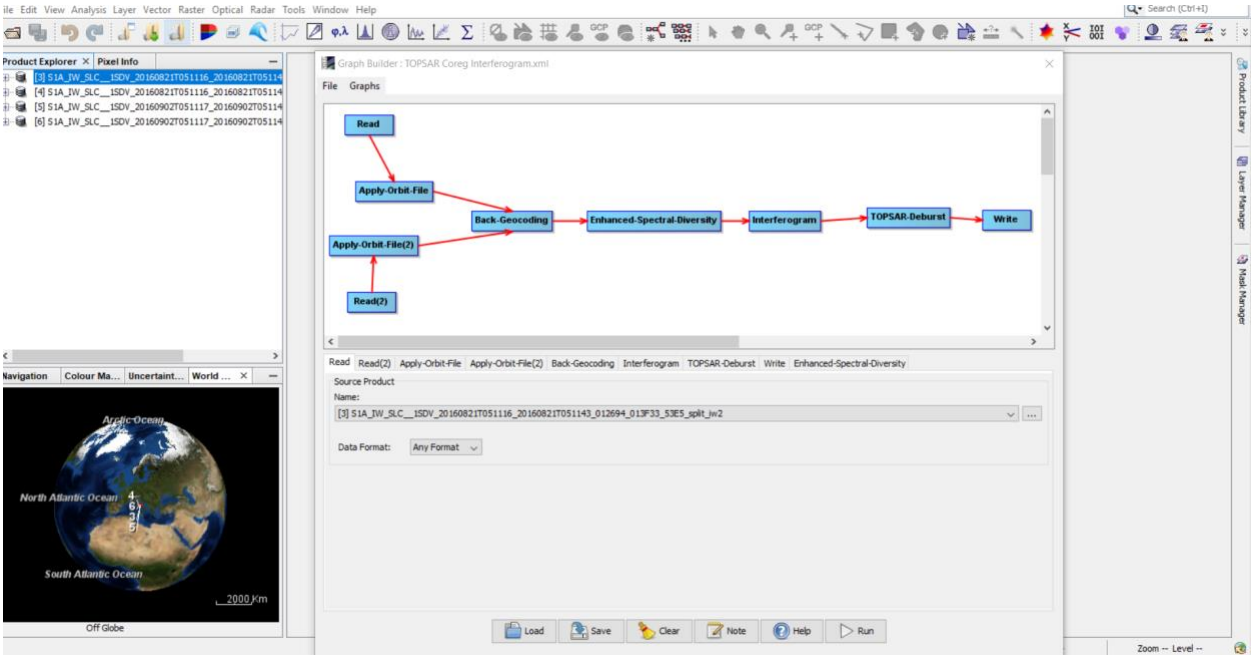

Graph Builder
Read
Apply-Orbit-File
Calibration
Multilook
Terrain-Correction
CreateStack
Write
Read(2)
Apply-Orbit-File(2)
Calibration(2)
Multilook(2)
Terrain-Correction(2)
Target Product
Name:
Save as:
Directory:
Open in SNAP
Processing completed in 13 seconds (6 MB/s 1 MPixel/s)
Load
Save
Clear
Note
Help
Run

d. Spectral-diversity enhancement and TOPSAR debursting

Graphs->Radar->InSAR Graphs->TOPSAR Coreg Interferogram Adapt the graph template removing the "TOPSAR Split" blocks (already applied) and adding the "Enhanced Spectral Diversity"



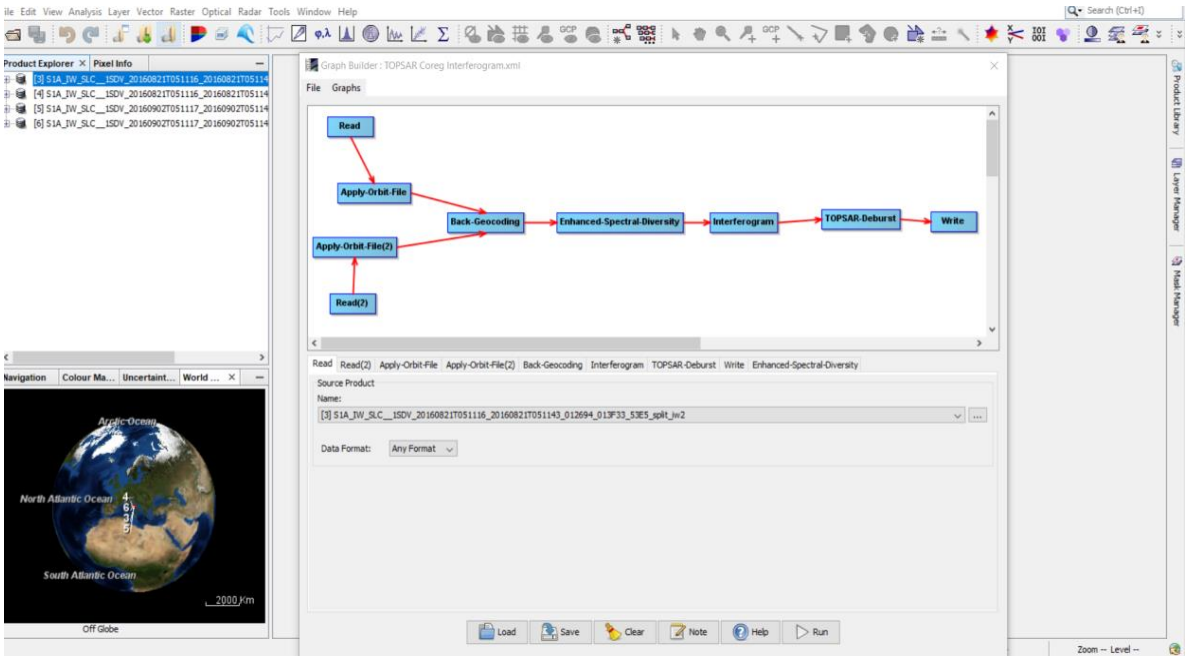
e. interferogram flattening and coherence generation

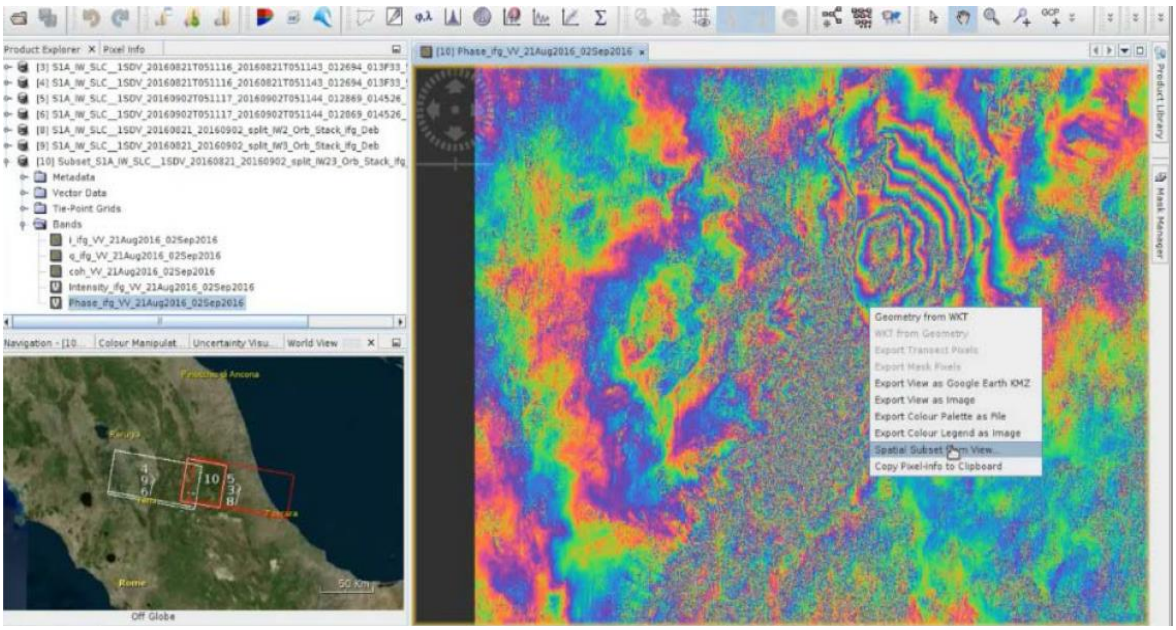


f. topographic phase subtraction and ROI subsetting
g. phase filtering and multilooking
h. no-data subsetting for smaller ROI

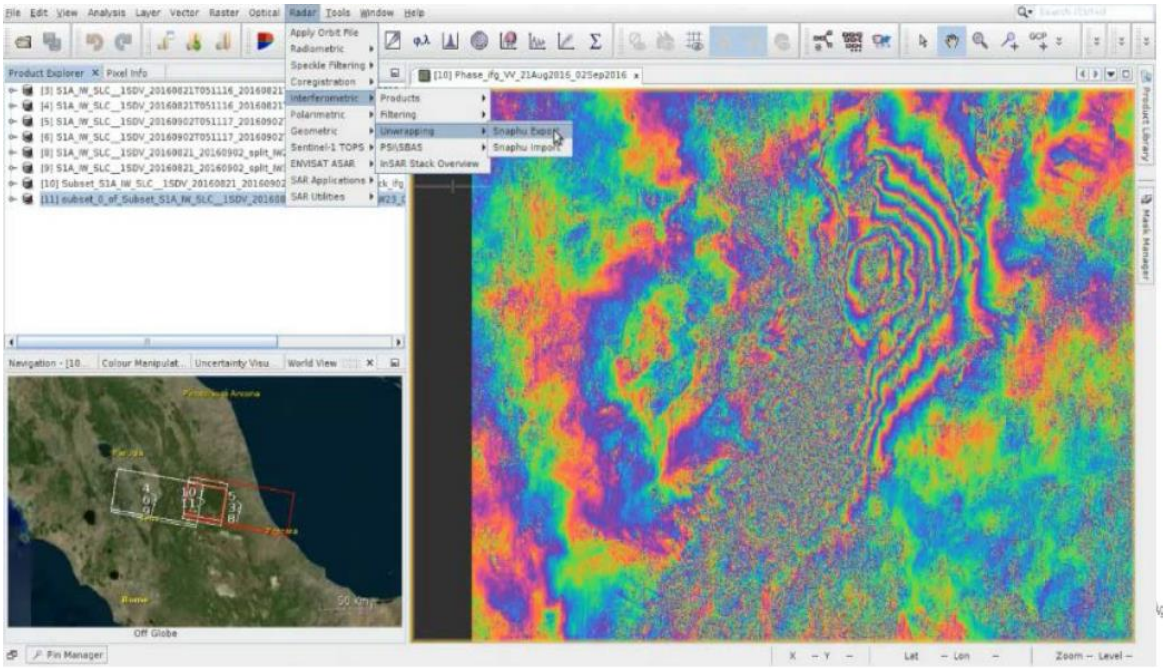
The formulation of this three exercises(f,g,h) is one process which hold many operators and each operators has its own features but some of them ,we changed their features others we let it by default as it is discussed down here.

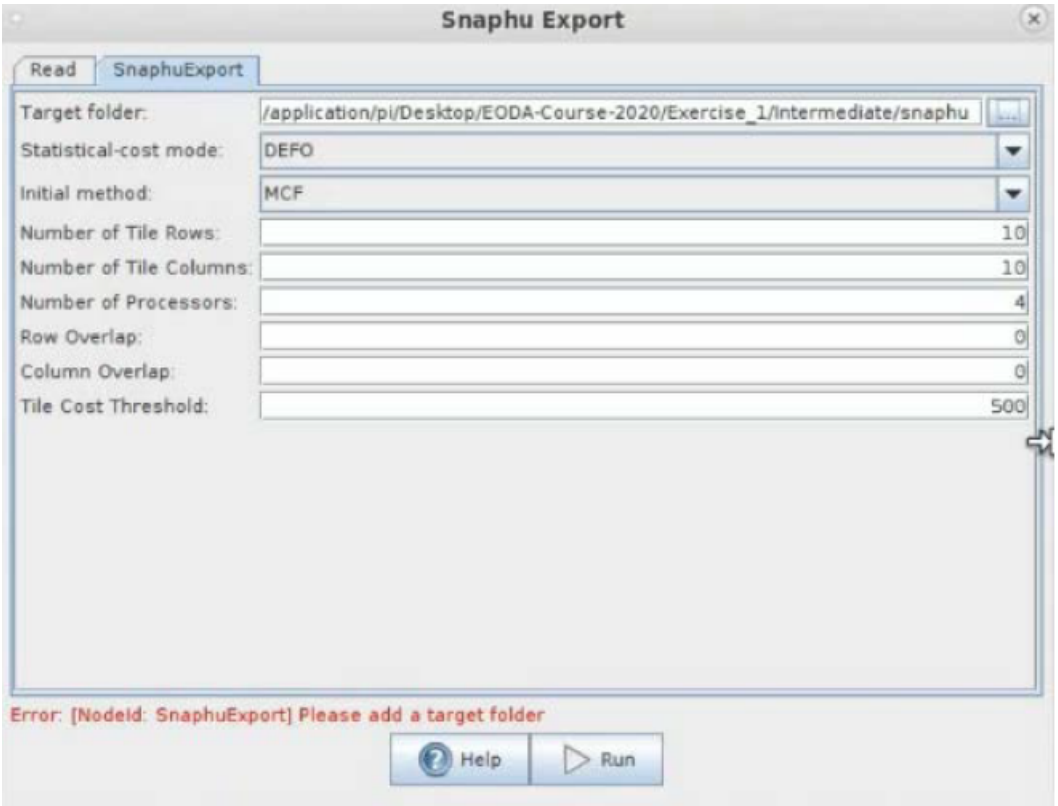
After creating the IW2 and IW3 interferogram we need to merge them and run the following workflow:
Subtract the topographic phase (Differential SAR Interferometry)
Subsetting over defined AOI
Goldstein Phase Filtering
Multilooking


Graph Builder : TOPSAR Coreg Interferogram.xml
File Graphs
Read
Apply-Orbit-File
Back-Geocoding
Enhanced-Spectral-Diversity
Interferogram
TOPSAR-Deburst
Write
Apply-Orbit-File(2)
Read(2)
Source Product
Name:
Data Format:
Any Format
Load
Save
Clear
Note
Help
Run
Arctic Ocean
North Atlantic Ocean
South Atlantic Ocean
2000 Km
Off Globe

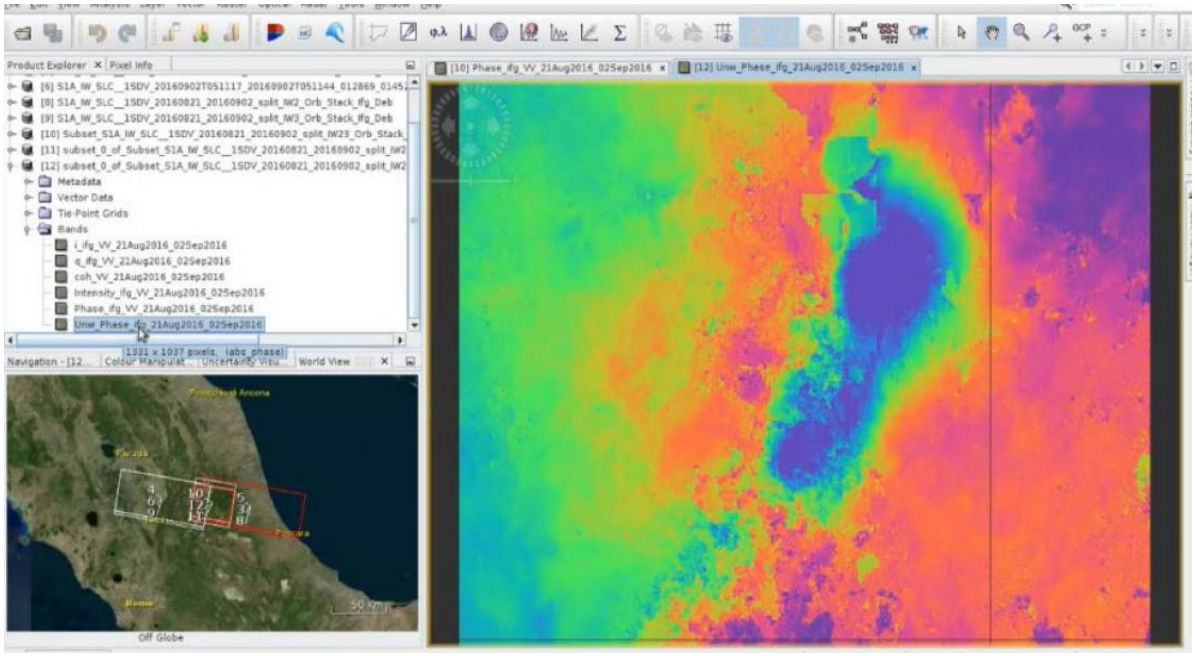

Product Explorer
Pixel Info
Metadata
Vector Data
Tie-Point Grids
Bands
i_ifg_VV_21Aug2016_02Sep2016
q_ifg_VV_21Aug2016_02Sep2016
coh_VV_21Aug2016_02Sep2016
Intensity_ifg_VV_21Aug2016_02Sep2016
Phase_ifg_VV_21Aug2016_02Sep2016
Geometry from WKT
Export View as Google Earth KMZ
Export View as Image
Export Colour Palette as File
Export Colour Legend as Image
Copy Pixel-info to Clipboard
Rome
50 Km
Off Globe

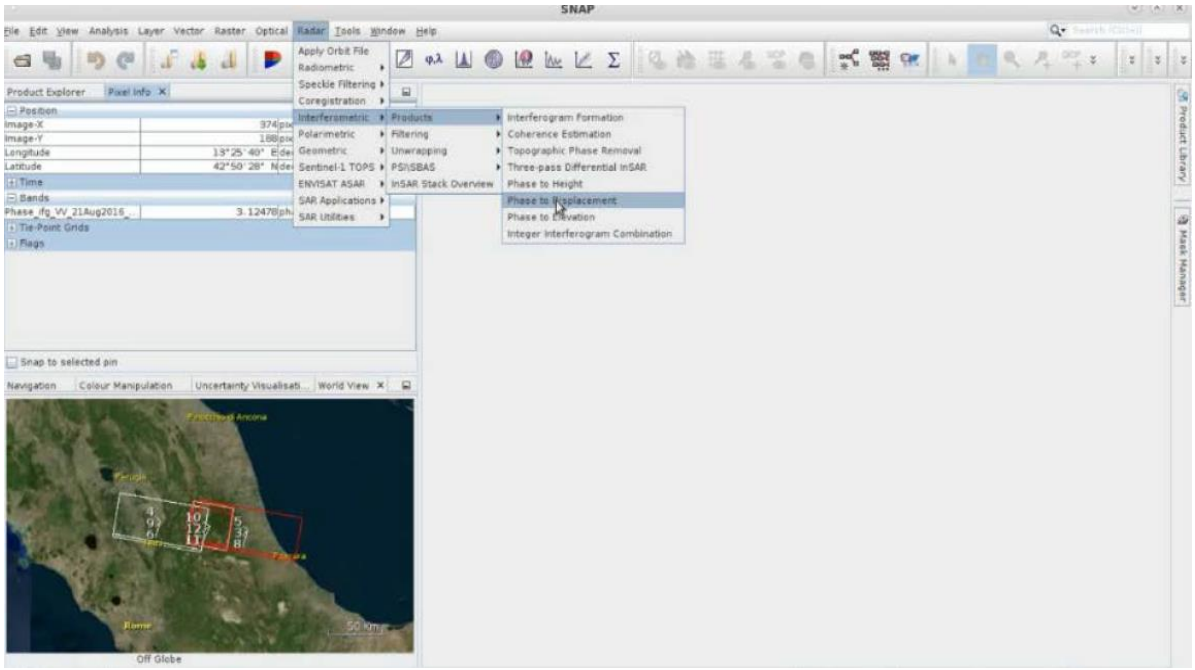
i. Phase-unwrapping by SNAPHU external operator



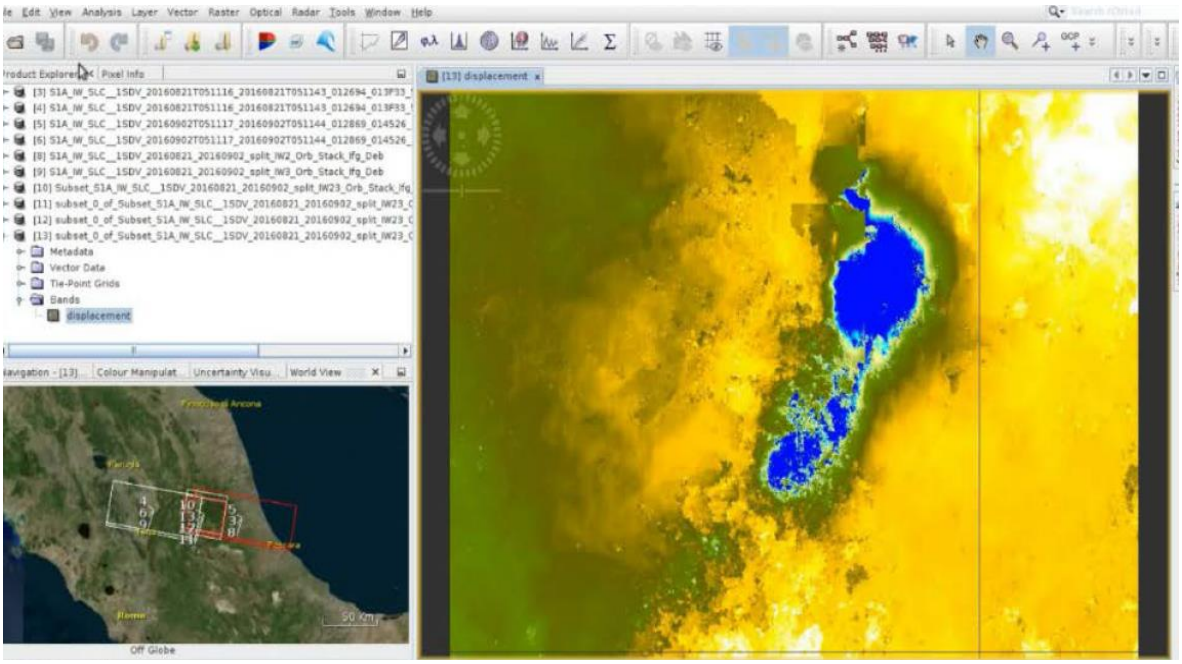


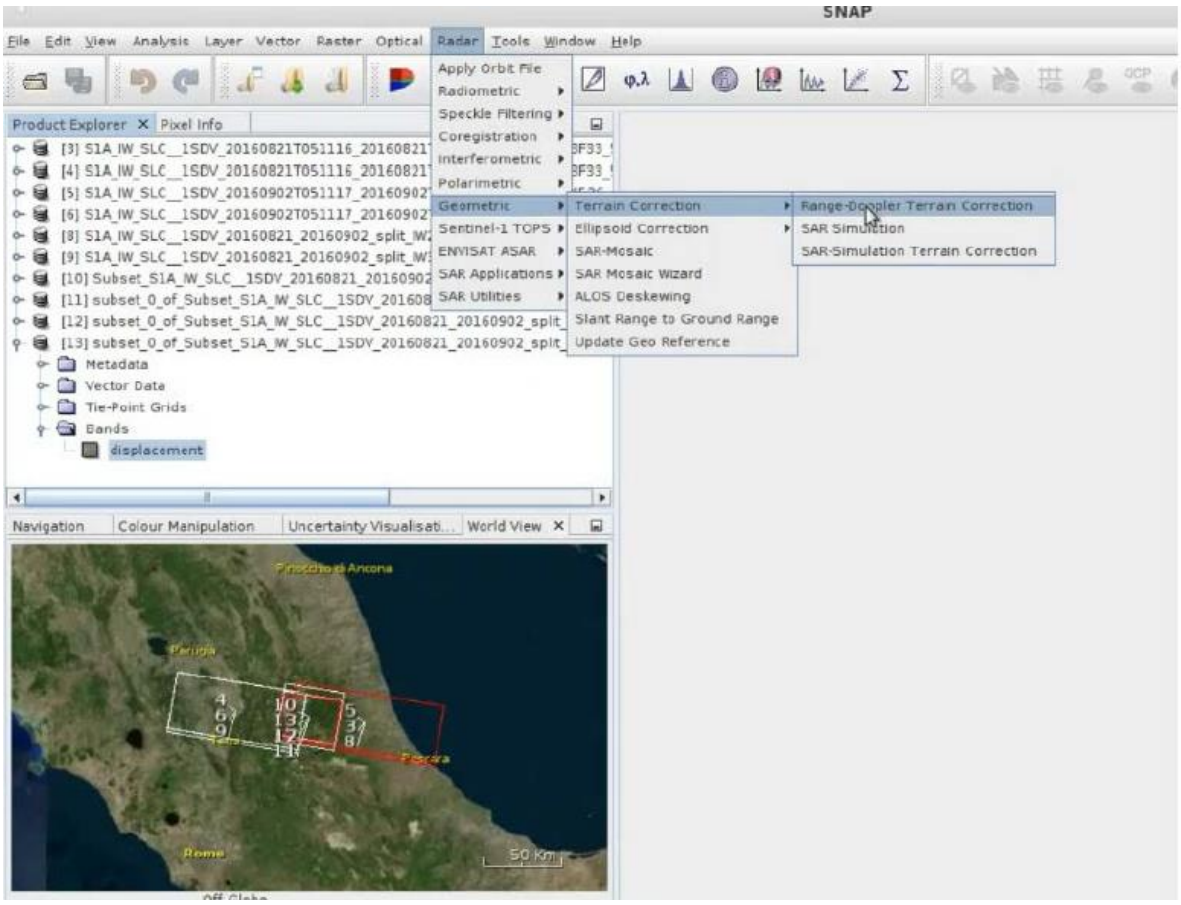
j. phase-to-displacement conversion along line-of-sight (LOS)

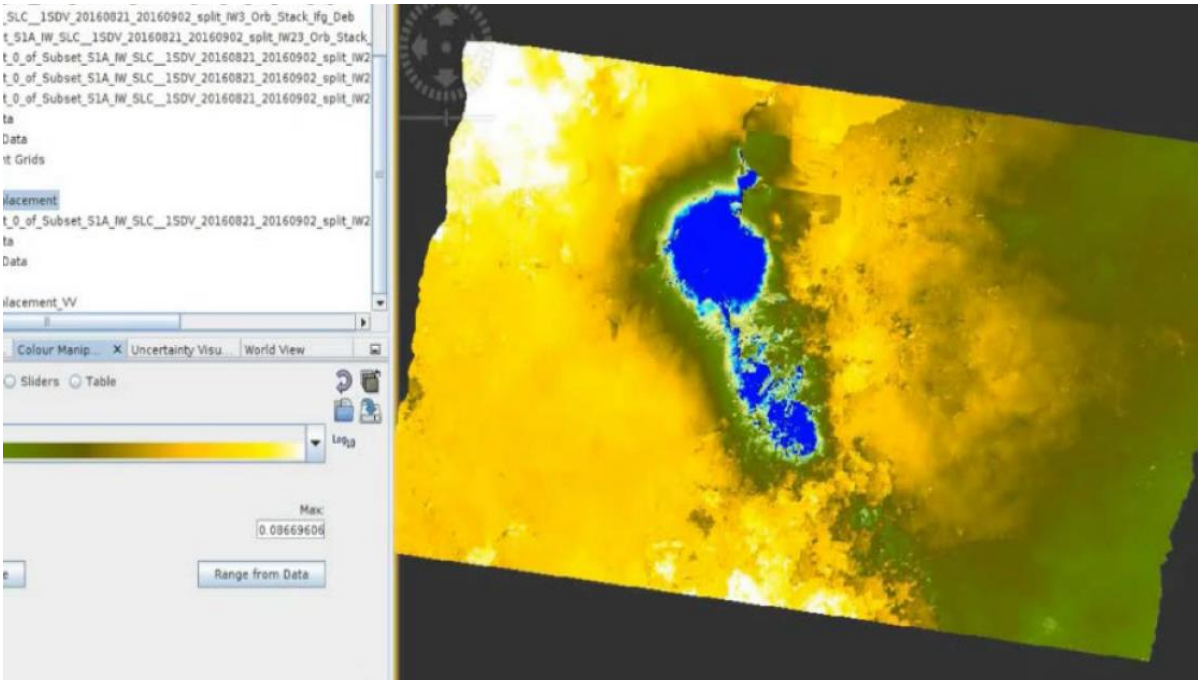




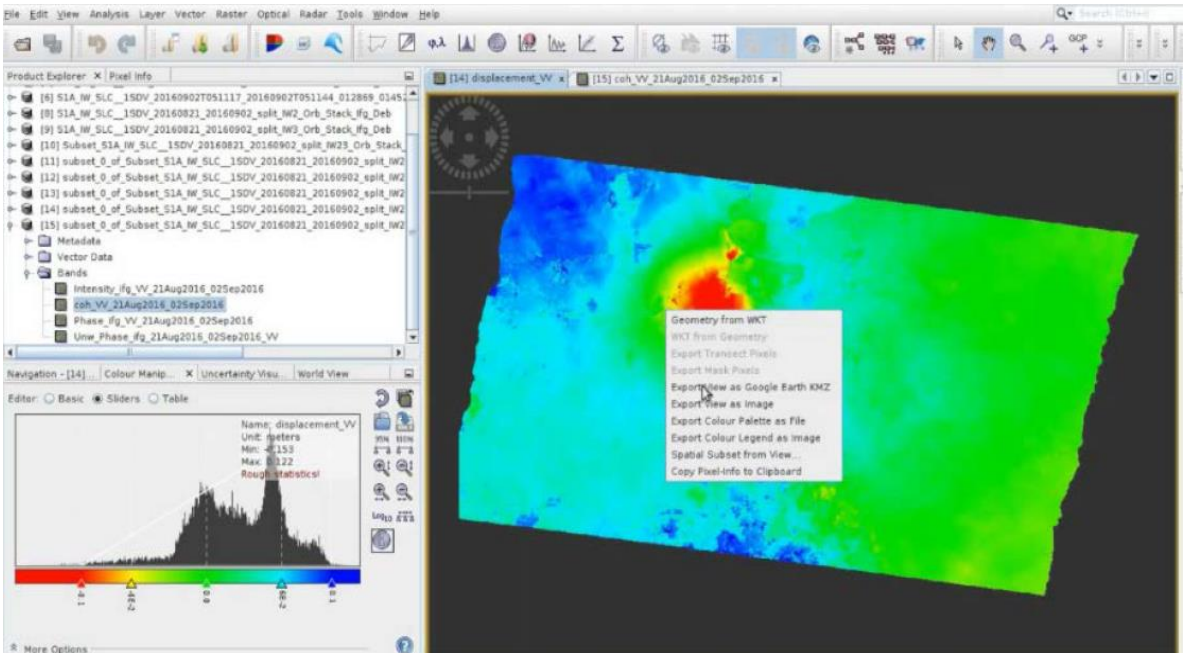
k. terrain-correction projection and false-color visualization



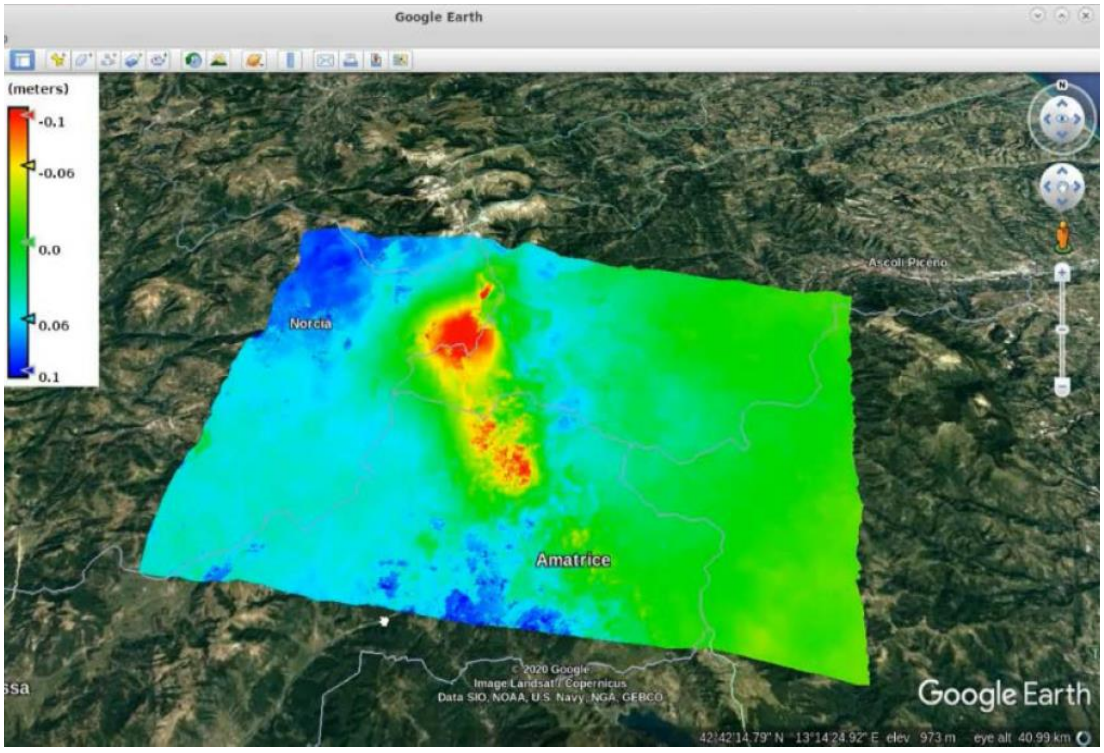




l. Exporting the terrain-corrected map as KMZ and visualizing on G-Earth.



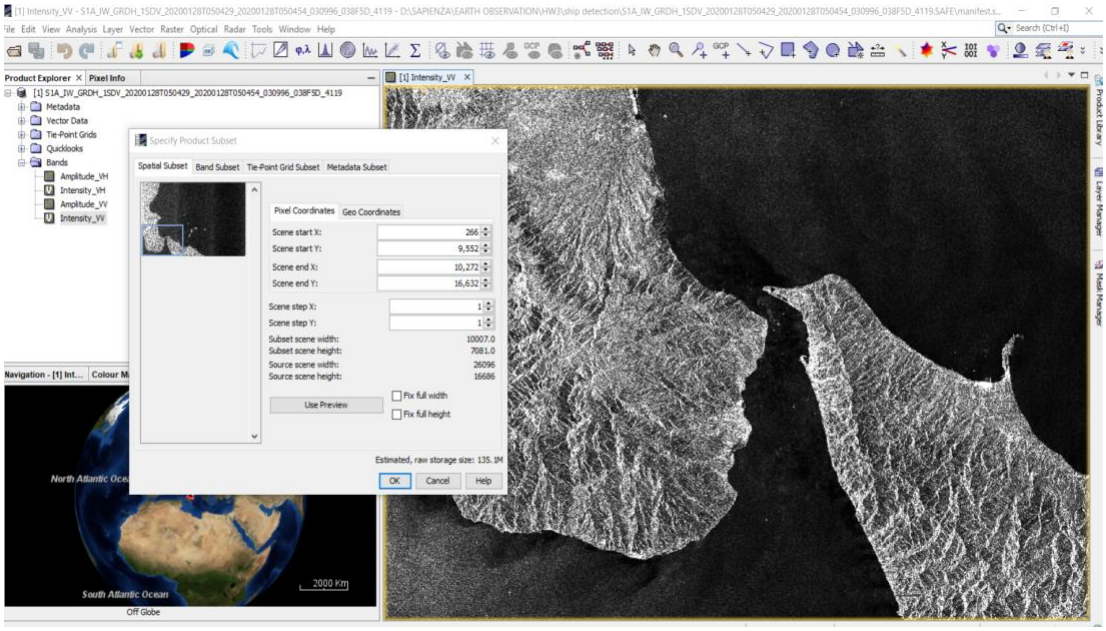
Mapping KMZ in Google Earth



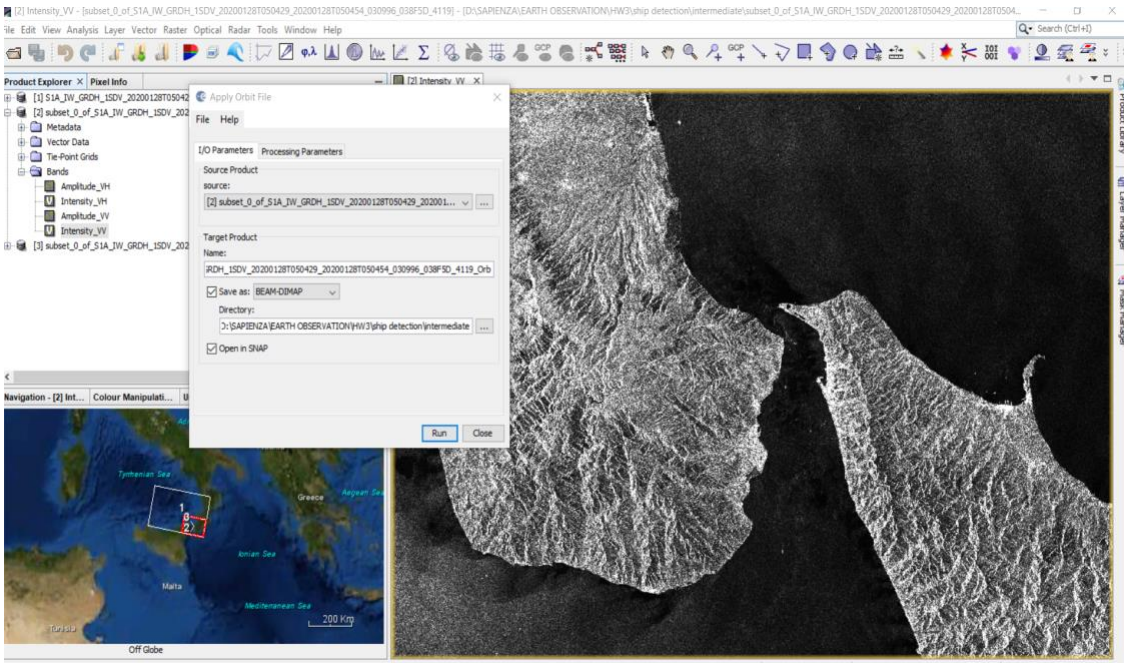
2. **SHIP DETECTION BY SAR BACKSCATTERING**
   Messina strait in southern Italy on 28 January 2020

   Perform the SAR processing steps:
   a. data band exploration and subsetting for ROI

   we perform spatial subset in order to perform out interest which is Messina strait in southern Italy

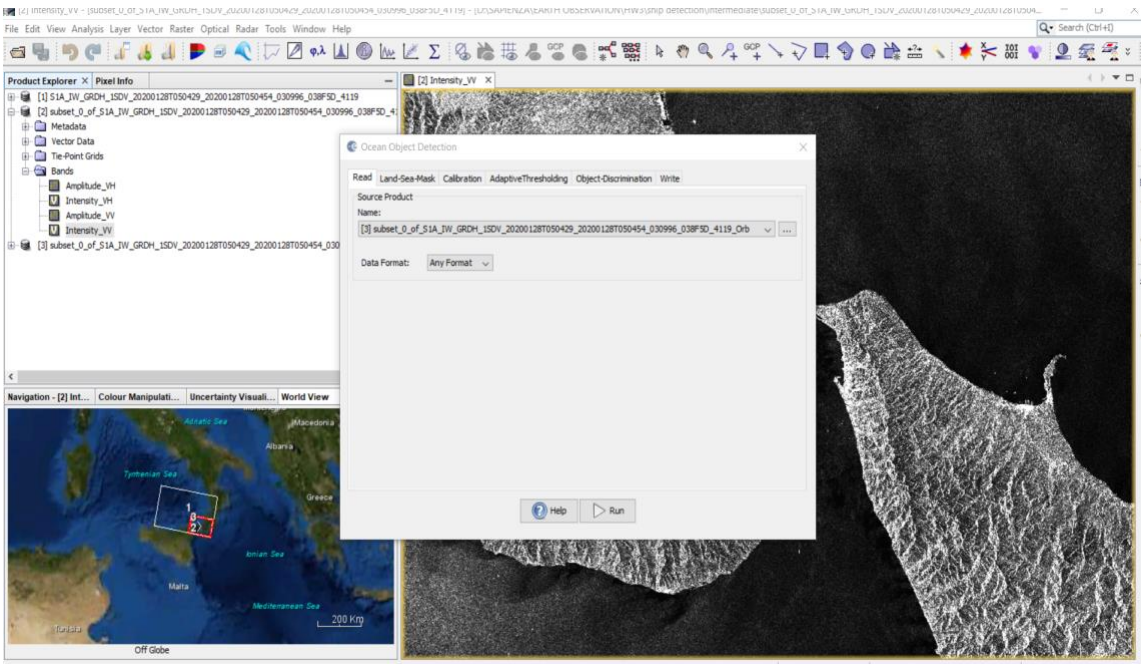


b. orbit precising

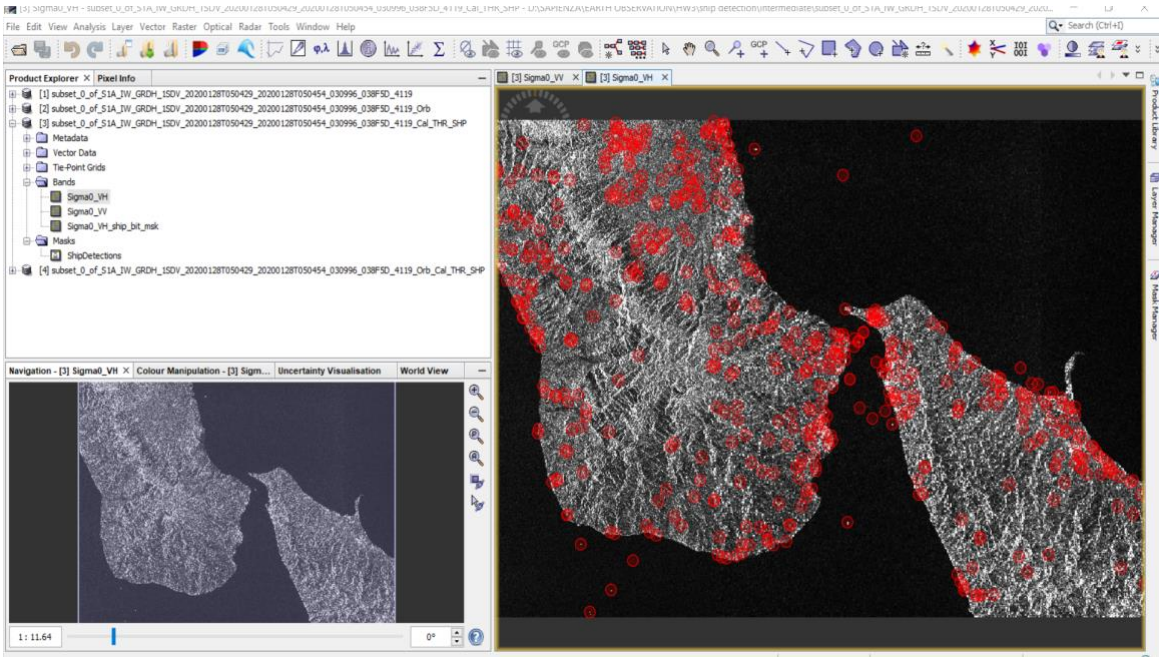


c. Land-sea masking and calibration

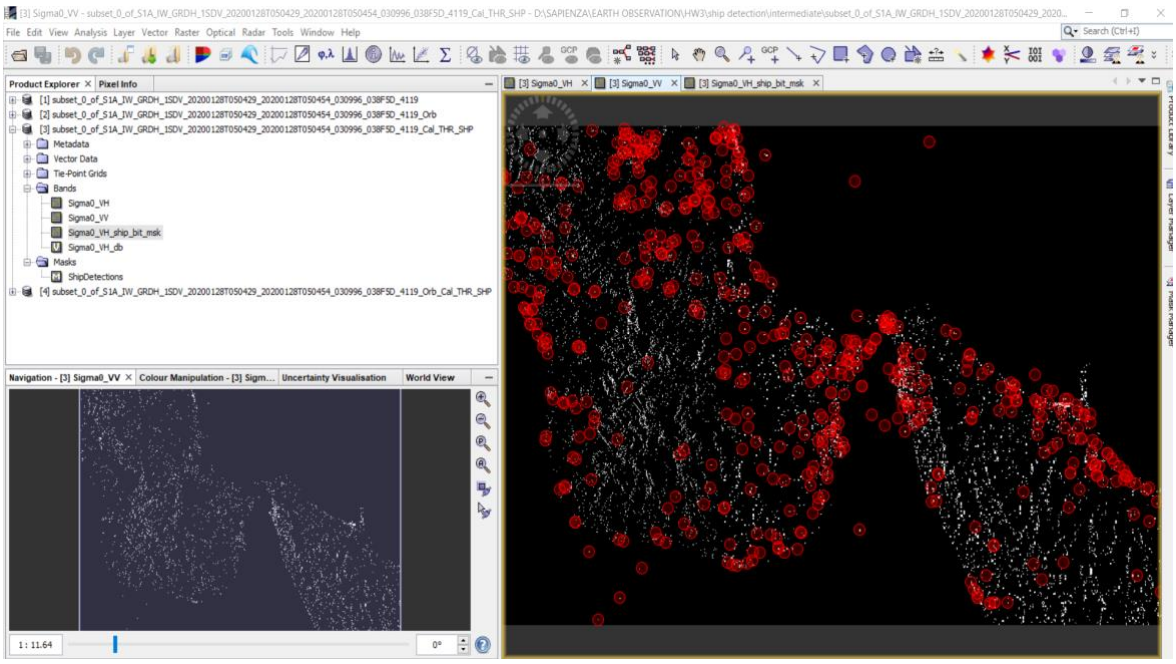
we have the workflow of the object detection from read >land-sea-mask > calibration->adaptive thresholding > object discrimination > write. Then we need to mask out the land because we are focusing on sea through then we increase the number of pixel up to 50, for calibration and adaptive thresholding ,we let with default value.



d. adaptive thresholding by appropriate windowing and probability of false alarm (PFA)



e. object discrimination by min-max sizing and conversion to decibels (dB)

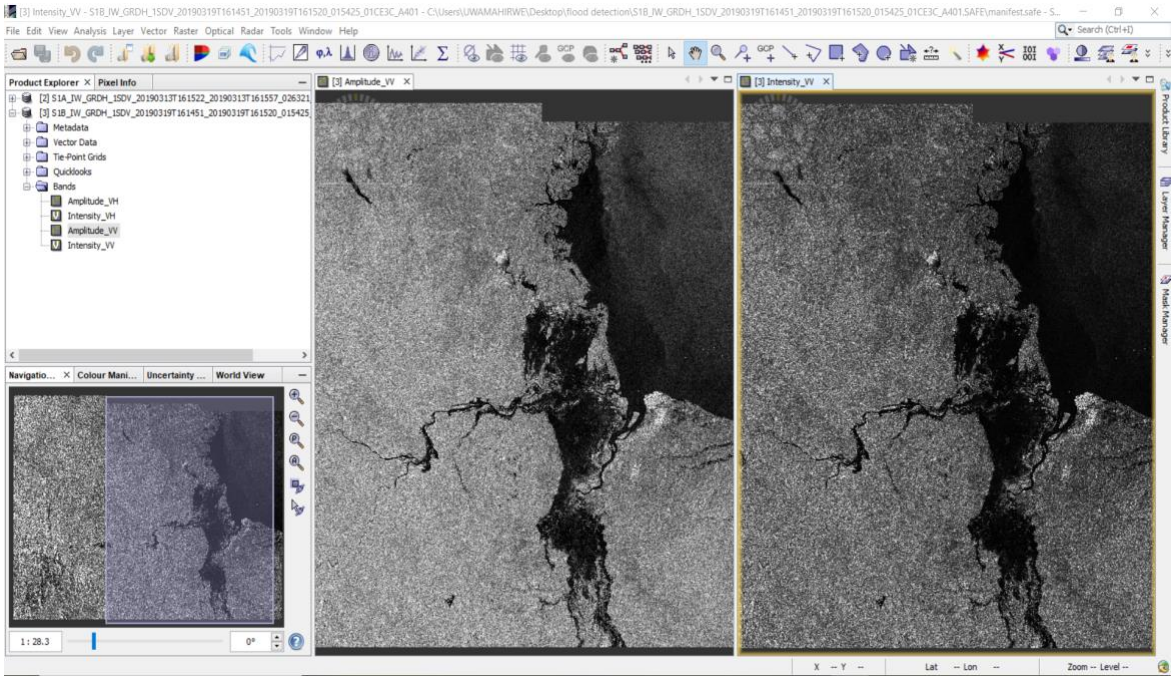


3. FLOOD DETECTION BY SAR BACKSCATTERING
Flood in Mozambico on 13 March 2019

Perform the DInSAR processing steps:

a. data band exploration and subsetting for ROI

we choose GRDH since we want to focus on amplitude and intensity



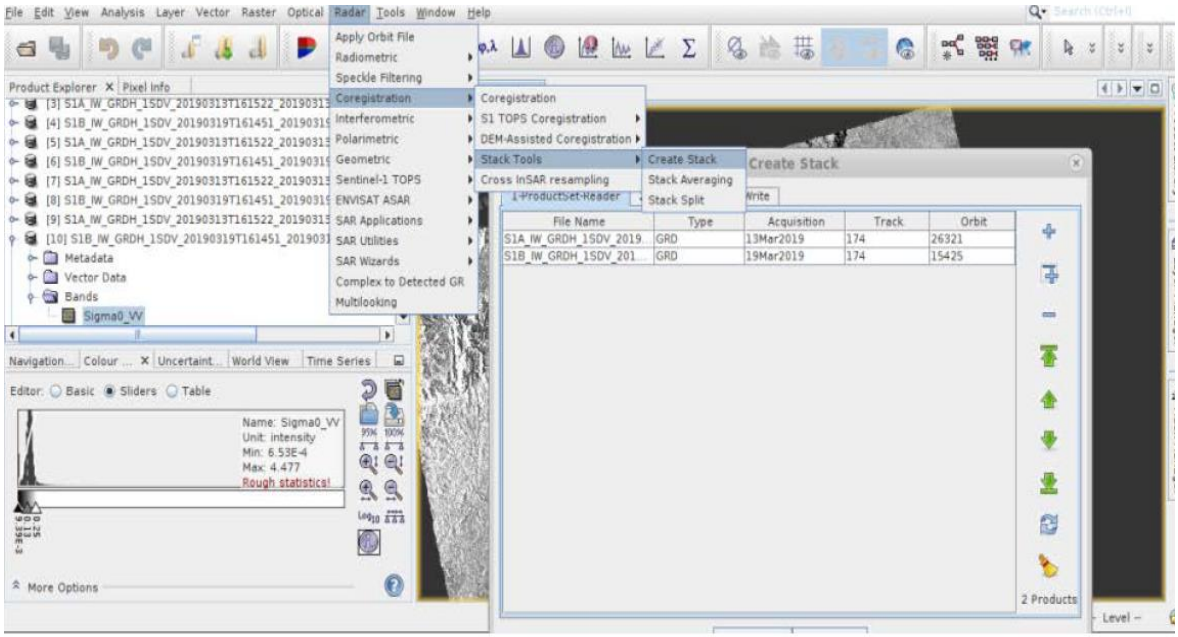
b. orbit precising and projection
c. calibration and multilooking
d. terrain correction
e. image stacking

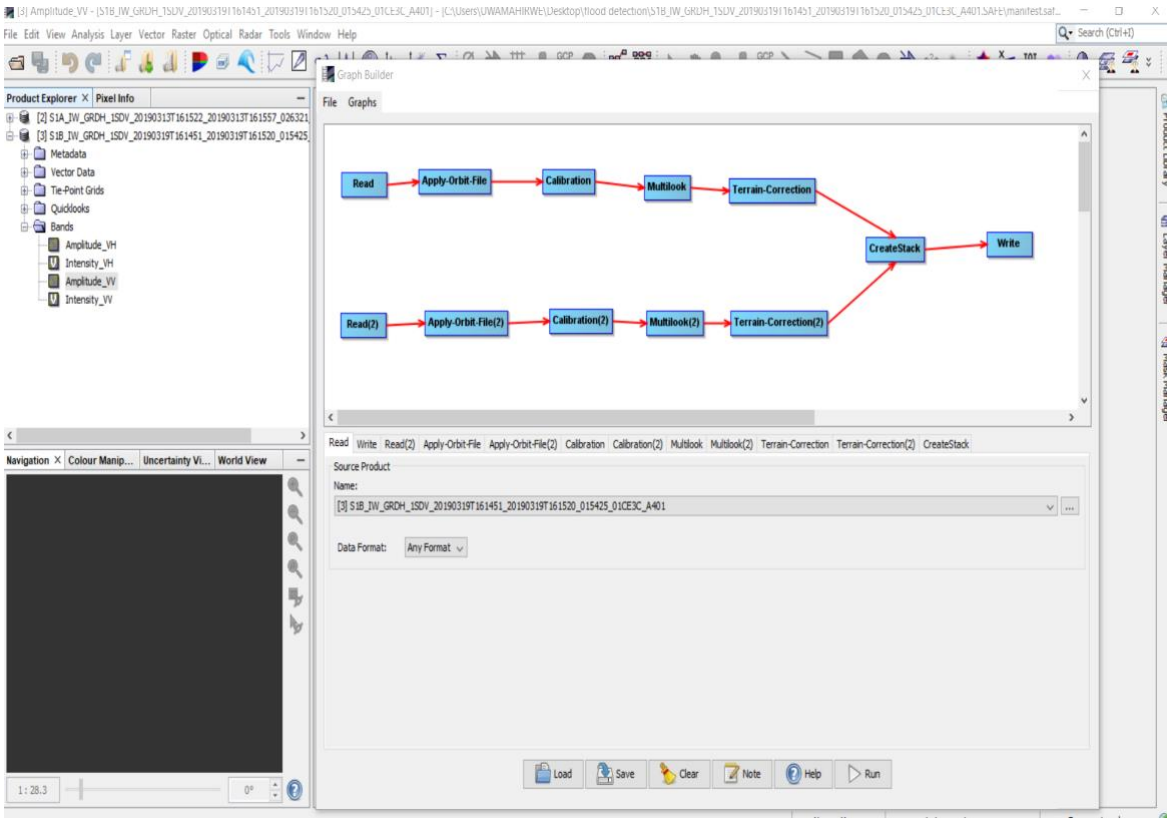
The formulation of this 4 exercises(b,c,d,e) is one process which hold many operators and each operators has it's own features but some of them ,we changed their features others we let it by default as it is discussed down here.

read -> apply-orbit-file-> calibration-> multilook -> terrain-correction ->
createstack -> write

read(2) -> apply-orbit-file(2)-> calibration(2)-> multilook(2) -> terrain-correction(2) ->

read operator 20190313 file then for apply-orbit-file operator we set default setting,on calibration operator we choose VV polarization and we choose the output sigma 0,on multilook operator,we increase the number of loops ,we can loose some pixel but we are looking forward to increase our multilooking model.terrain-correction operator we set by default,on create stack operot we change initial offset method to geolocation.


File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Apply Orbit File
Radiometric
Speckle Filtering
Coregistration
Interferometric
Polarimetric
Geometric
Sentinel-1 TOPS
ENVISAT ASAR
SAR Applications
SAR Utilities
SAR Wizards
Complex to Detected GR
Multilooking
Coregistration
S1 TOPS Coregistration
DEM-Assisted Coregistration
Stack Tools
Cross InSAR resampling
Create Stack
Stack Averaging
Stack Split
Create Stack
Write
File Name
Type
Acquisition
Track
Orbit
S1A_IW_GRDH_1SDV_2019...
GRD
13Mar2019
174
26321
S1B_IW_GRDH_1SDV_201...
GRD
19Mar2019
174
15425
2 Products
Product Explorer
Pixel Info
Metadata
Vector Data
Bands
Sigma0_VV
Navigation
Colour ...
Uncertaint...
World View
Time Series
Editor: Basic Sliders Table
Name: Sigma0_VV
Unit: intensity
Min: 6.53E-4
Max: 4.477
Rough statistics!
More Options


Graph Builder
File Graphs
Read
Apply-Orbit-File
Calibration
Multilook
Terrain-Correction
CreateStack
Write
Read(2)
Apply-Orbit-File(2)
Calibration(2)
Multilook(2)
Terrain-Correction(2)
Source Product
Name:
Data Format:
Any Format
Load
Save
Clear
Note
Help
Run

f. Thresholding, sigma-0-VV RGB combination and flood area detection

by convert our bands which are slave image and master image form linear to dB ,after than we need to change detection from created images by setting some condition based on Sigma0_VV_mst_13Mar2019_db and Sigma0_VV_slv1_19Mar2019_db

RED

(Sigma0_VV_mst_13Mar2019_db && Sigma0_VV_slv1_19Mar2019_db) ? if abs(Sigma0_VV_mst_13Mar2019_db -Sigma0_VV_slv1_19Mar2019_db)>3 then Sigma0_VV_slv1_19Mar2019_db else avg(Sigma0_VV_mst_13Mar2019_db,Sigma0_VV_slv1_19Mar2019_db) : NaN

GREEN

(Sigma0_VV_mst_13Mar2019_db && Sigma0_VV_slv1_19Mar2019_db) ? if abs(Sigma0_VV_mst_13Mar2019_db -Sigma0_VV_slv1_19Mar2019_db)>3 then Sigma0_VV_mst_13Mar2019_db else avg(Sigma0_VV_mst_13Mar2019_db,Sigma0_VV_slv1_19Mar2019_db) : NaN

BLUE

(Sigma0_VV_mst_13Mar2019_db && Sigma0_VV_slv1_19Mar2019_db) ? if abs(Sigma0_VV_mst_13Mar2019_db -Sigma0_VV_slv1_19Mar2019_db)>3 then Sigma0_VV_mst_13Mar2019_db else avg(Sigma0_VV_mst_13Mar2019_db,Sigma0_VV_slv1_19Mar2019_db) : NaN