10TH ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

SNAP exercise: Forest monitoring using Sentinel-1

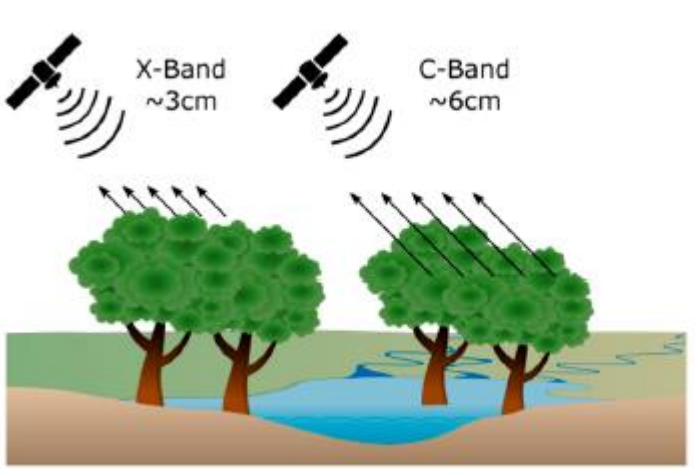
Magdalena Fitrzyk RSAC c/o ESA

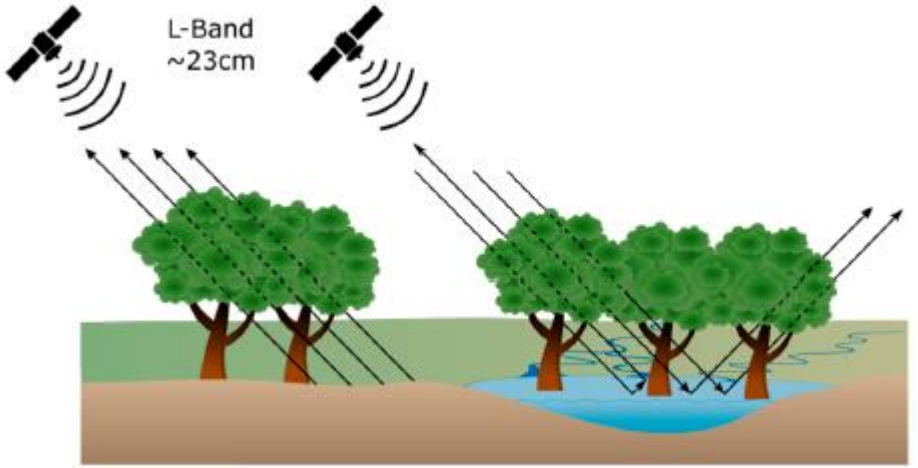
Objectives

- Familiarizing with SNAP toolbox
- Familiarizing with Sentinel-1 GRD prodcucts
- Calculation of backscatter intensity from Sentinel-1 detcted products
- Analysis of temporal backscatter signatures for various land cover types
- Change detection over AOI (Beijing Daxing International Airport)

Introduction

Different penetration capability, depending on wavelength





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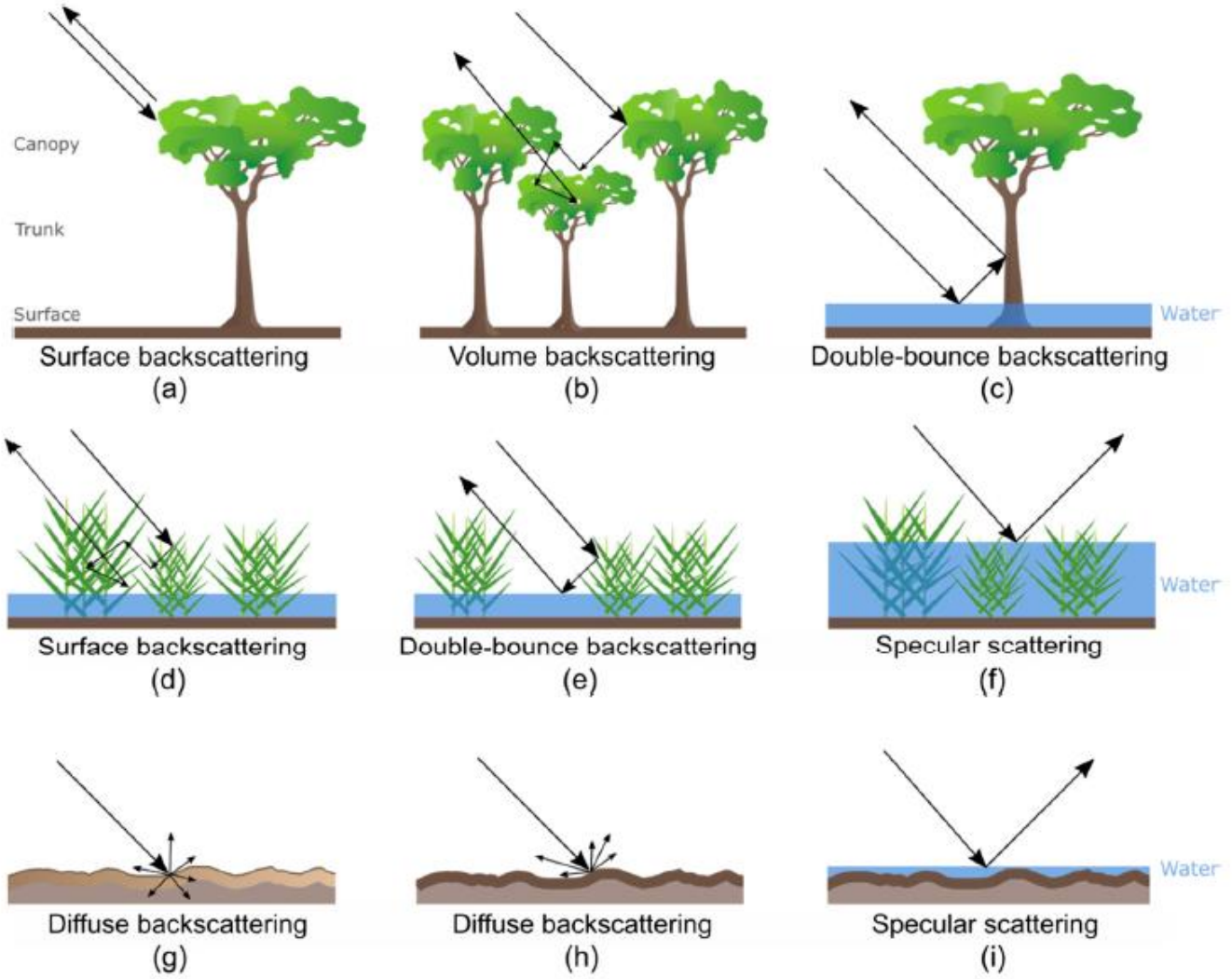


Introduction

Input data: multitemporal stack of Sentinel-1 GRDH images over South America

10 September 2021

S1B_IW_GRDH_1SDV_20210910T094944_20210910T095009_028634_036ADE_6409

1 September 2017

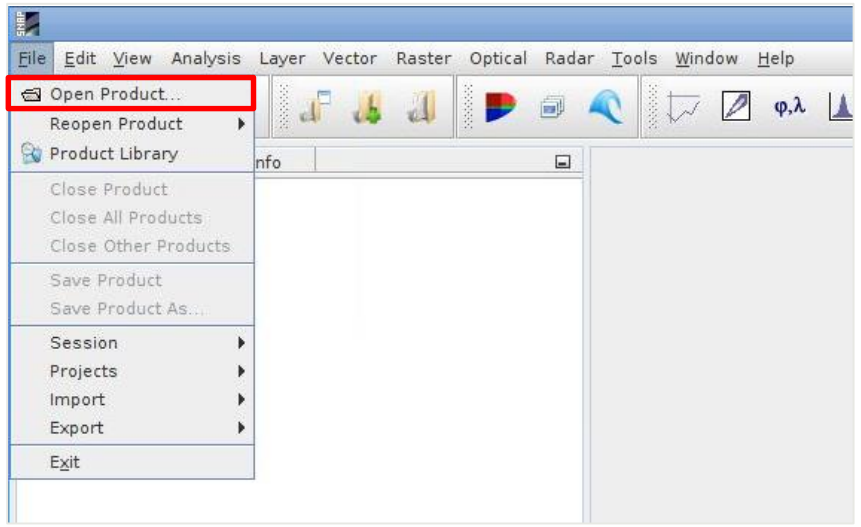
S1A_IW_GRDH_1SDV_20170901T094957_20170901T095023_018180_01E8CD_9CB1

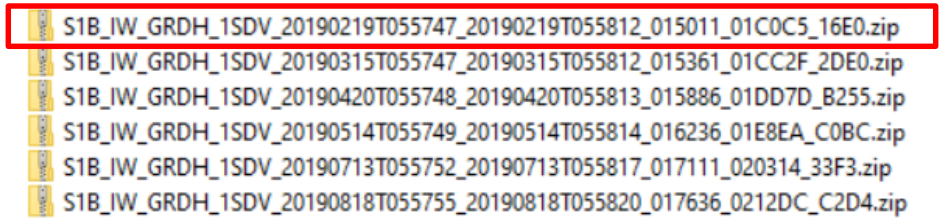
Output:

- temporal backscatter signatures for various land cover types
- change detection – deforestration in Brazil

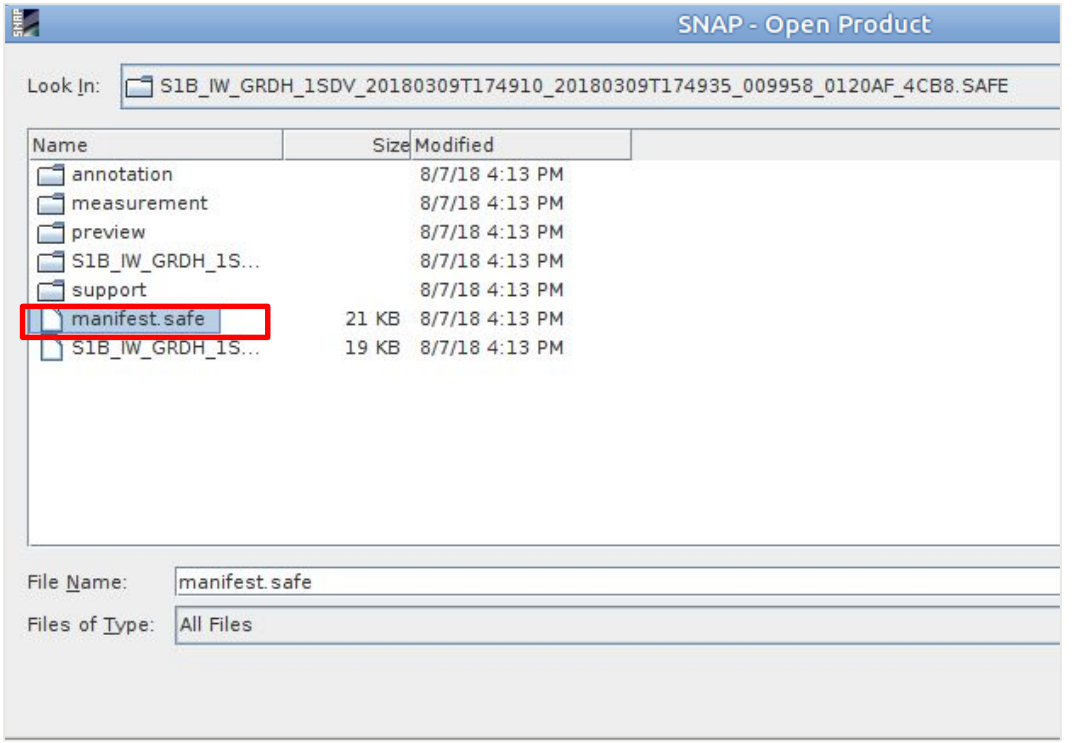
Data preparation

1. Opening the S1 data





For unzipped products



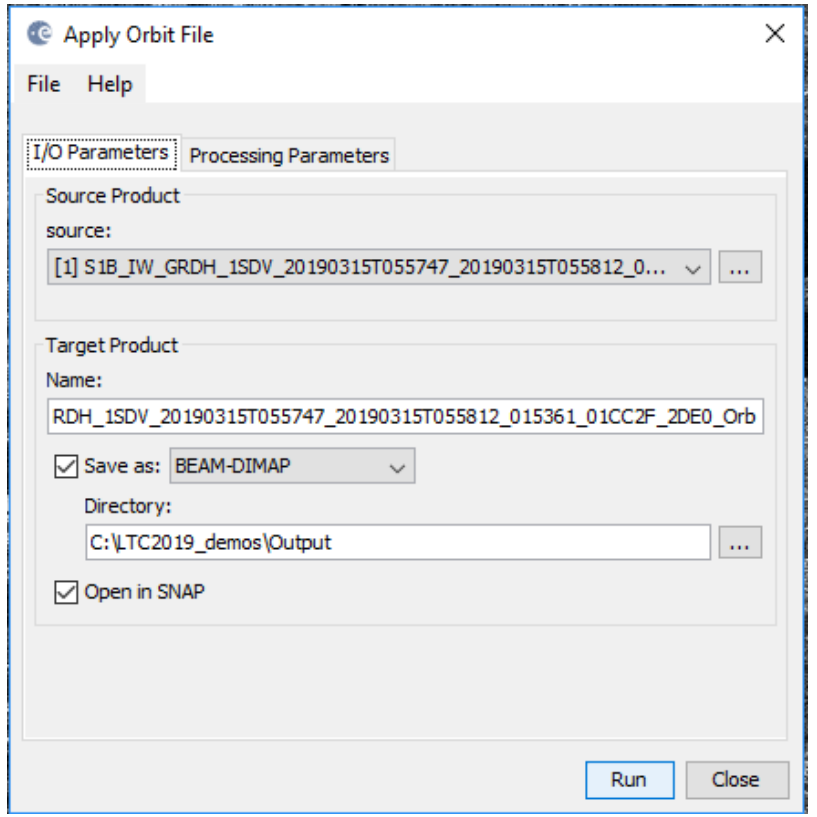
Data processing

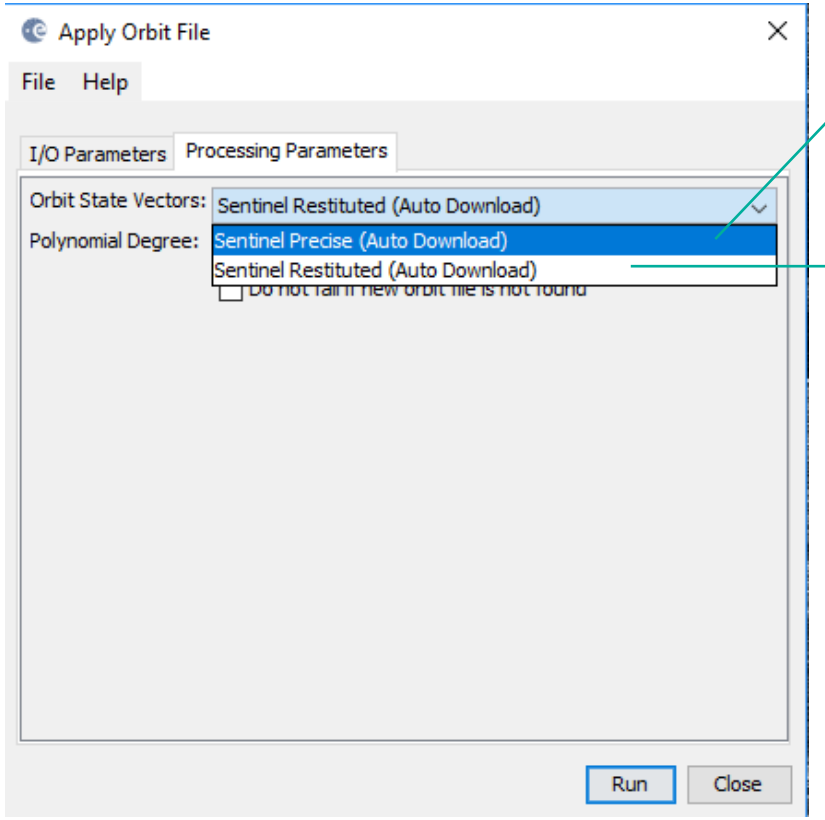
- Updating orbits
- Remove Thermal Noise
- Radiometric calibration
  Conversion of image intensity to sigma0 providing the radar backscatter
- Speckle filtering
  Filtering the inherent salt and pepper like texturing called speckles
- Terrain correction
  Compensate for geometric distortions caused by topographical variations of a scene and the tilt of satellite sensor
- Creating a subset of S1 GRDH images
  Spatial subset depending on the AOI
- Creating a multitemporal stack
  Collocation spatially overlapping products (based on geolocation)
- Linear to dB conversion
  Compensate for very high dynamic range in visualisation
- Stack statistics and analysis of temporal backscatter signatures

Updating orbits

Radar / Apply orbit file

The orbit file provides accurate satellite position and velocity information. Based on this information, the orbit state vectors in the abstract metadata of the product are updated.





POEORB - few weeks after acq.

RESORB – within few hours

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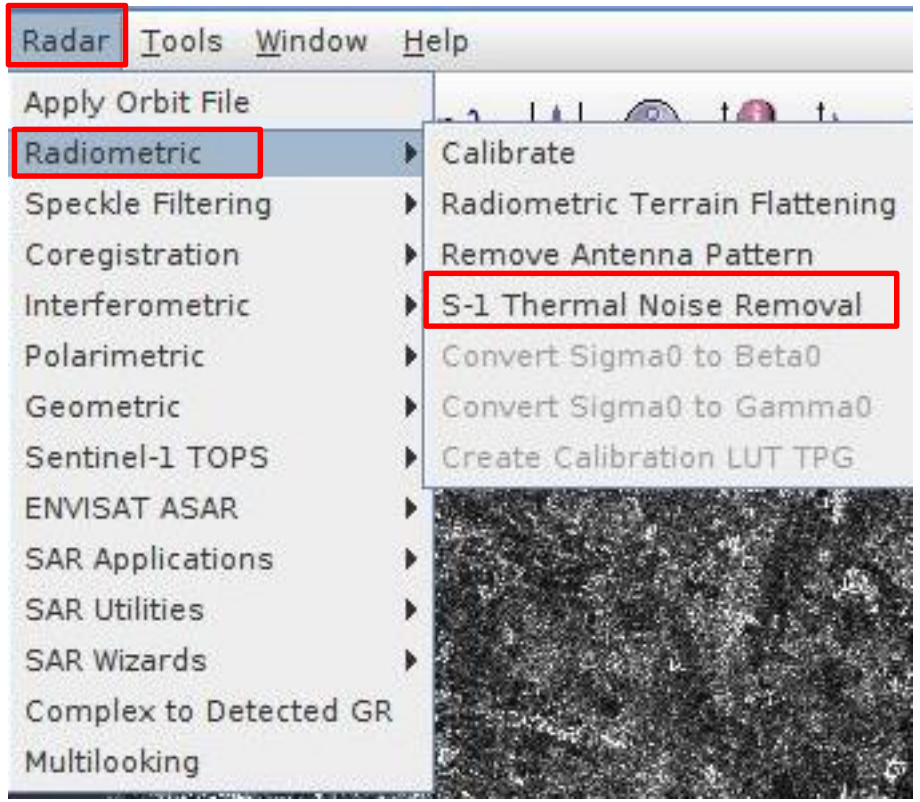
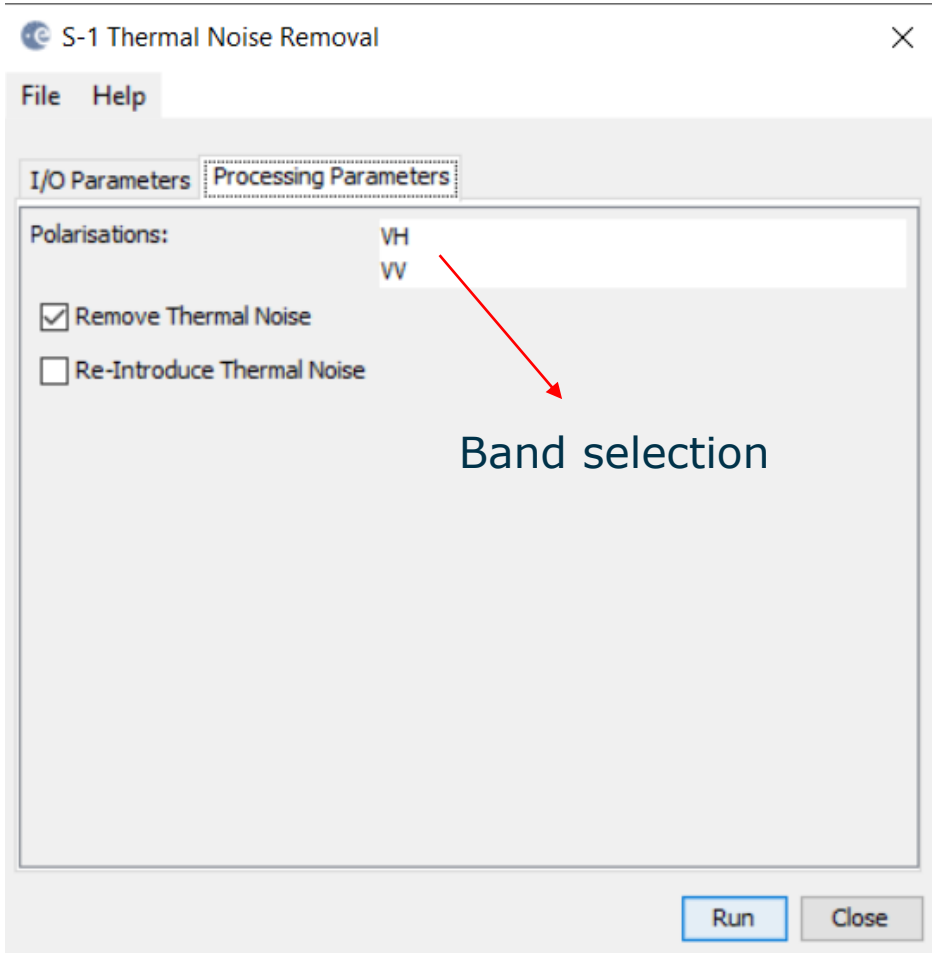
Thermal Noise Removal

Radar/Radiometric/S-1 Thermal Noise Removal





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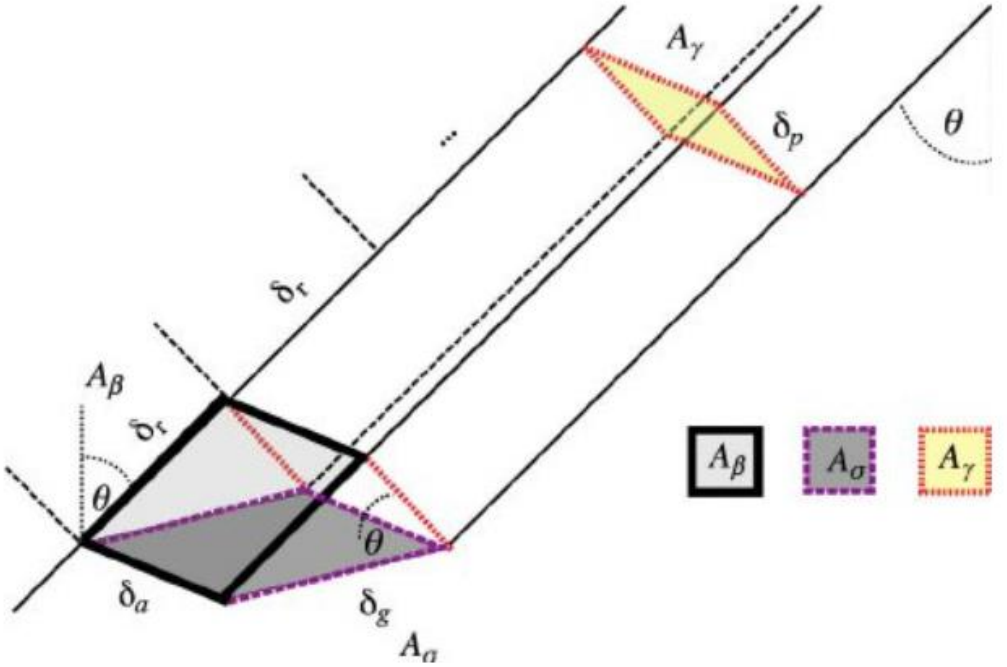
Radiometric Calibration

From image pixel values or digital numbers (DNs) we can derive:

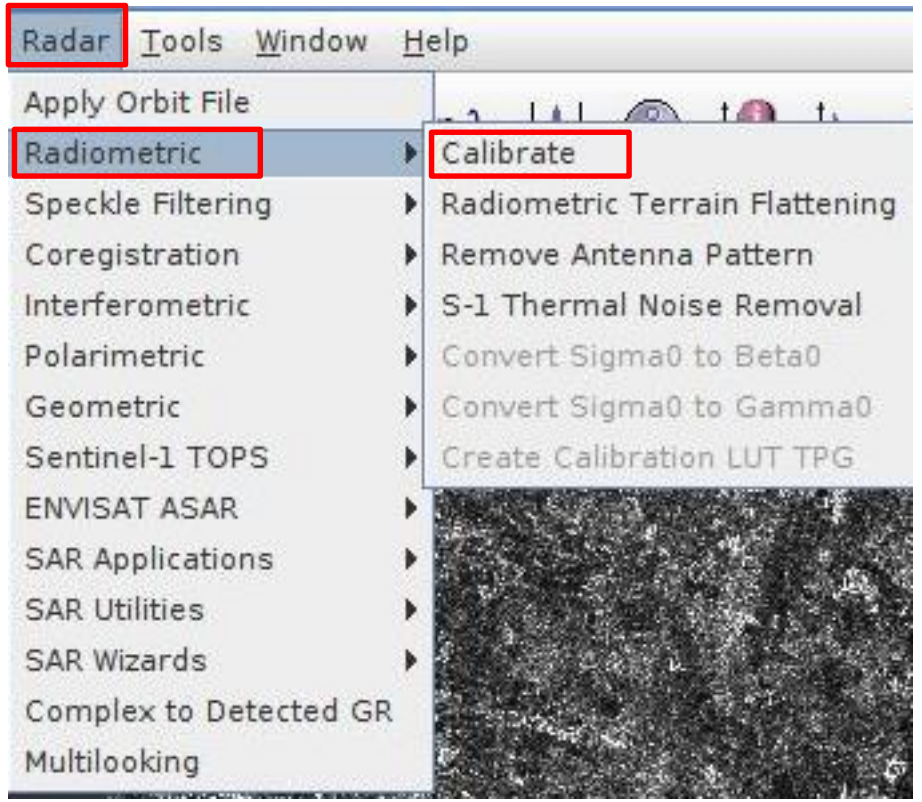
Beta Naught – radar brightness coefficient, reflectivity per unit area in slant range which is dimensionless

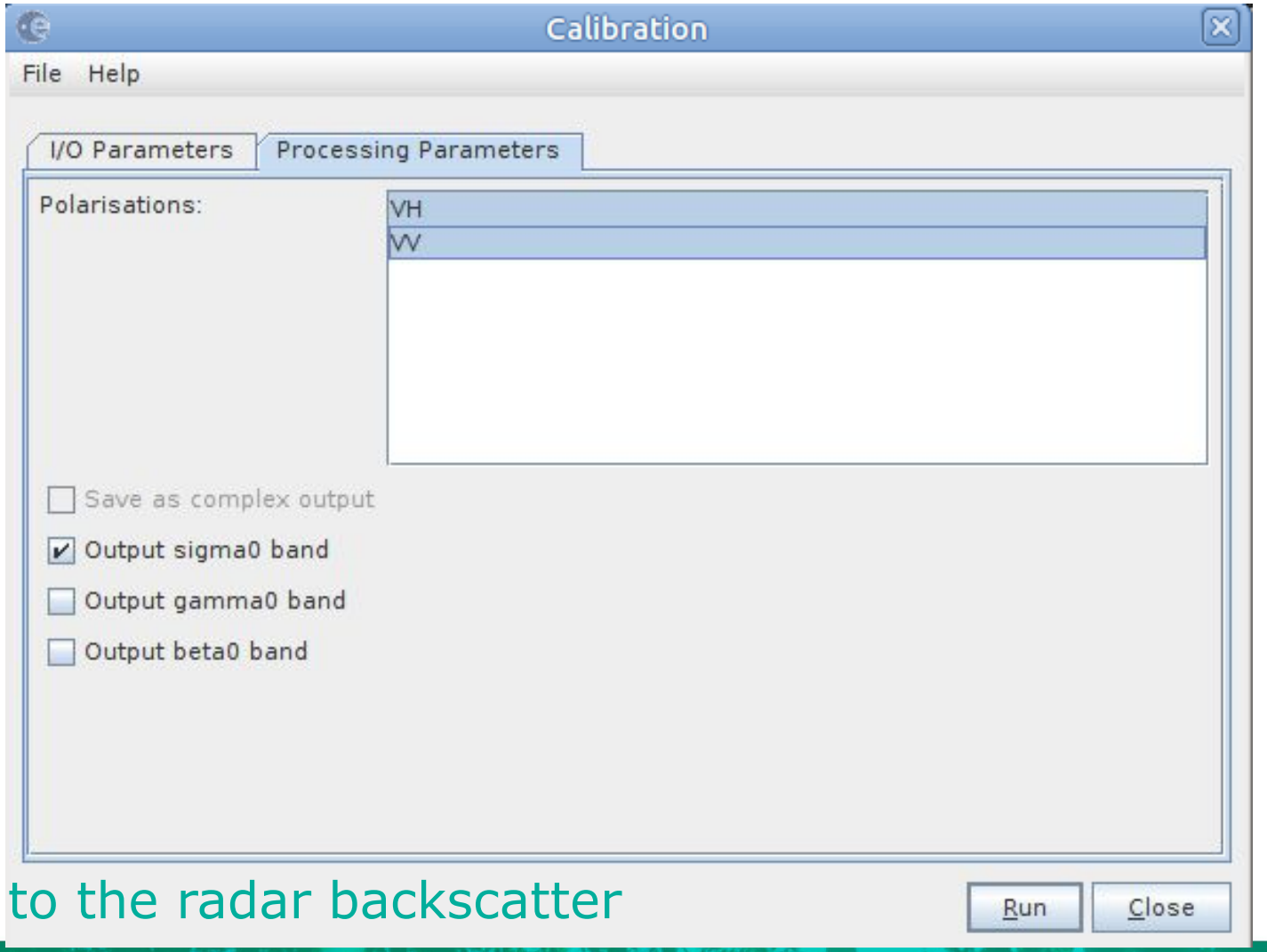
Sigma Naught – power returned to the antenna from ground (distributed scatterer) in dB. A number comparing the strength of the signal to that expected from an area of one square meter. It is defined with respect to the nominal horizontal plane and is varying with incidence angle, wavelength, polarisation and scattering surface itself



Radiometric Calibration

Radar/Radiometric/Calibrate





Pixel values can be directly related to the radar backscatter

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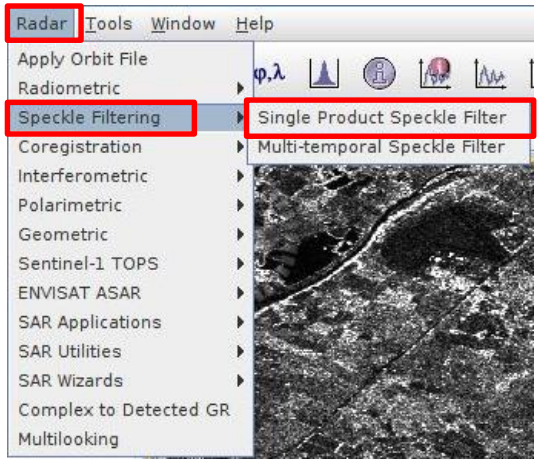
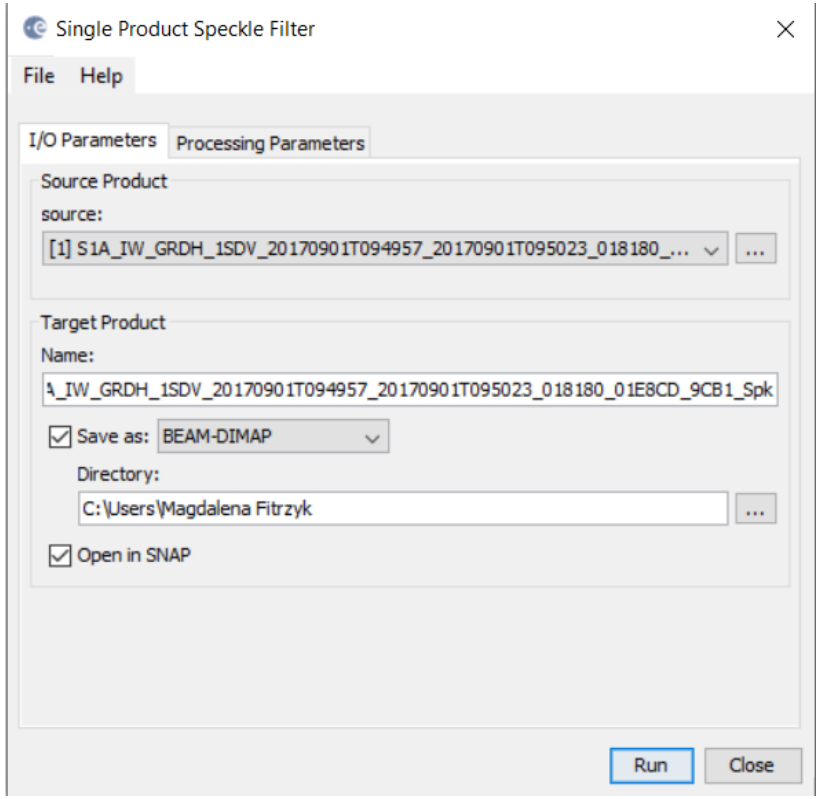
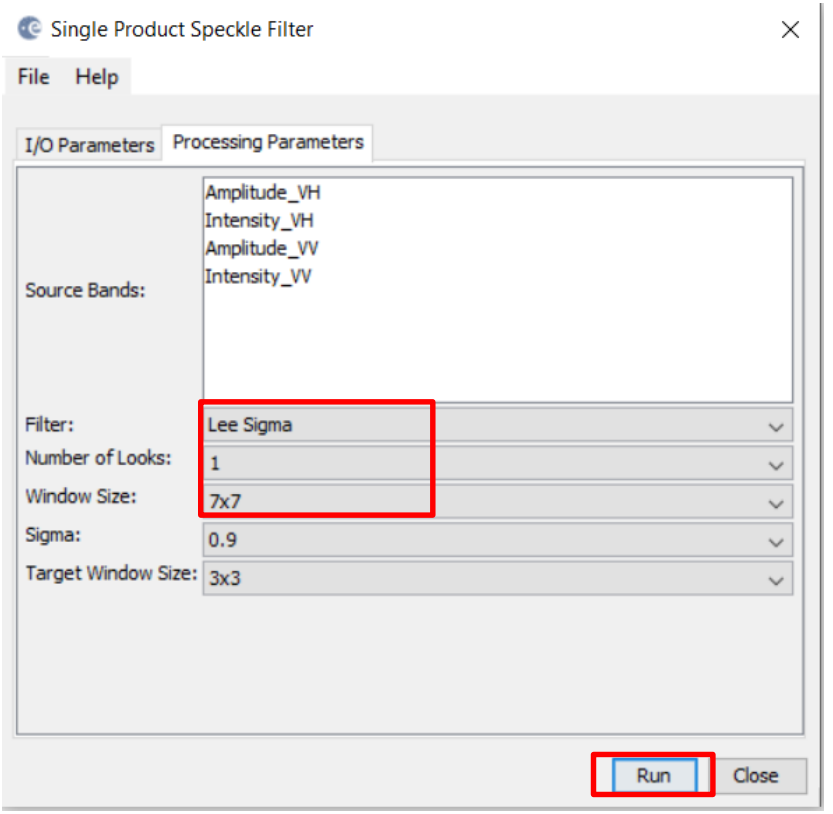
Speckle filtering







Spatial filtering with weighted average of selected filter across the image

Speckle filtering

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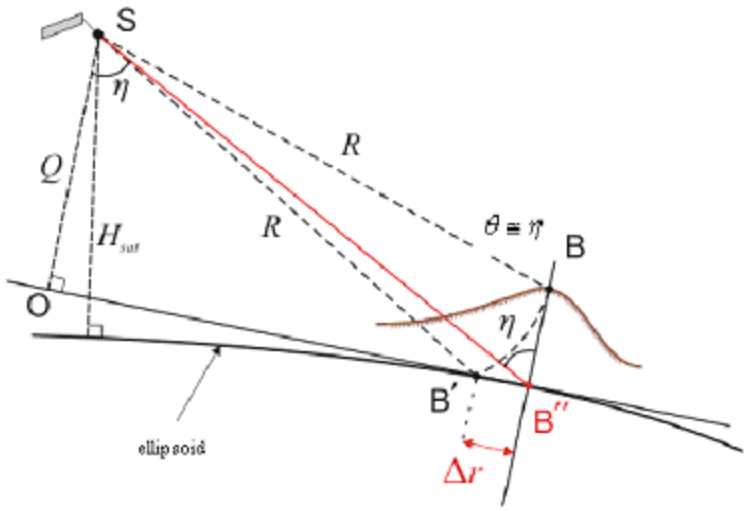
Terrain correction & Geocoding

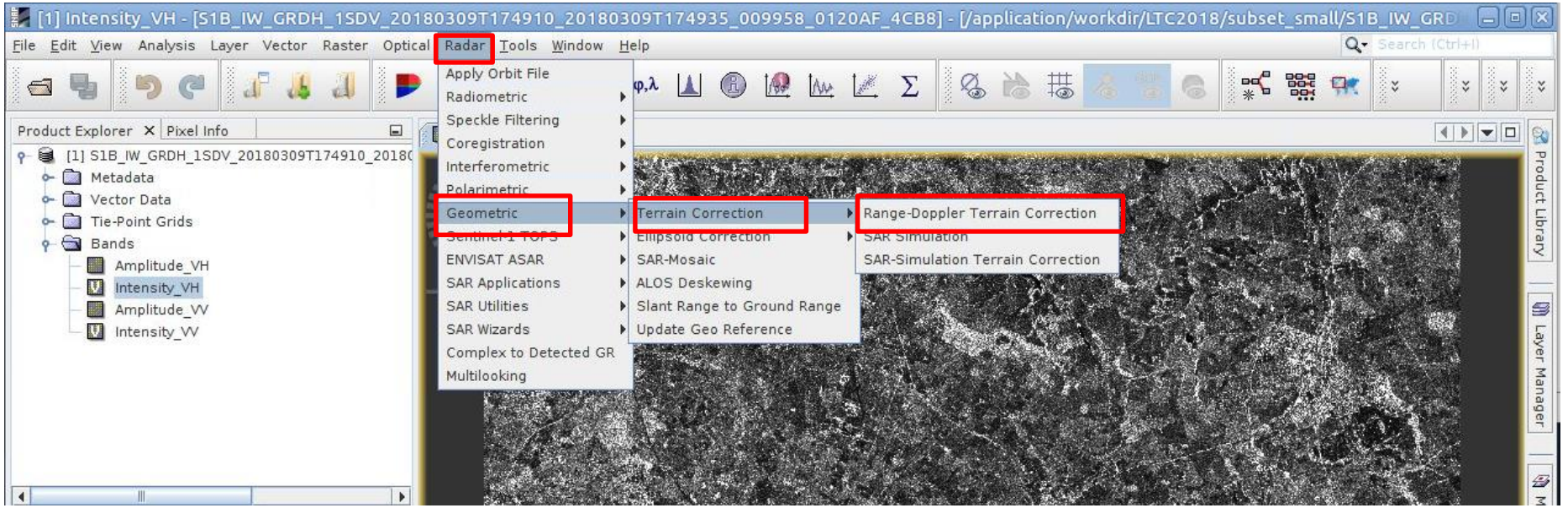


Point **B** with elevation **h** above the ellipsoid is imaged at position B’ in SAR image, though its real position is **B"**. The offset Δr between B' and **B"** exhibits the effect of topographic distortions

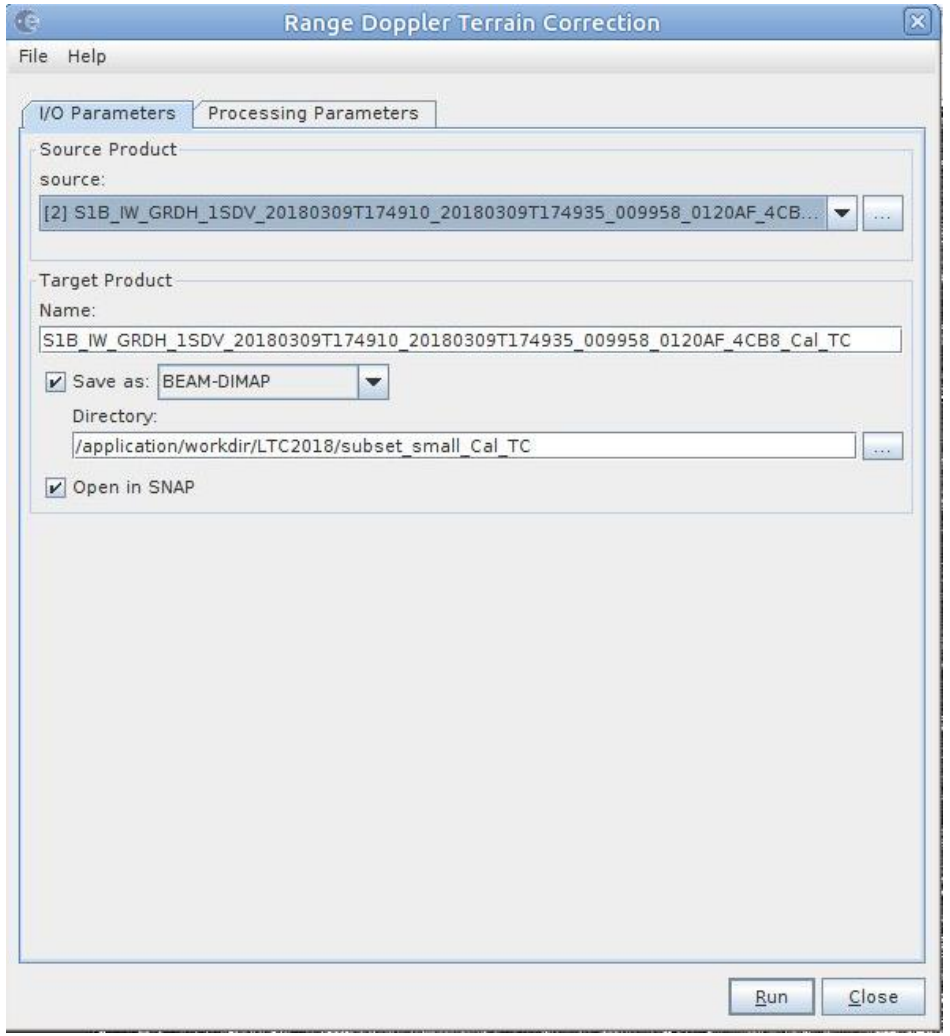
Terrain Correction allows geometric overlays of data from different sensors and/or geometries.

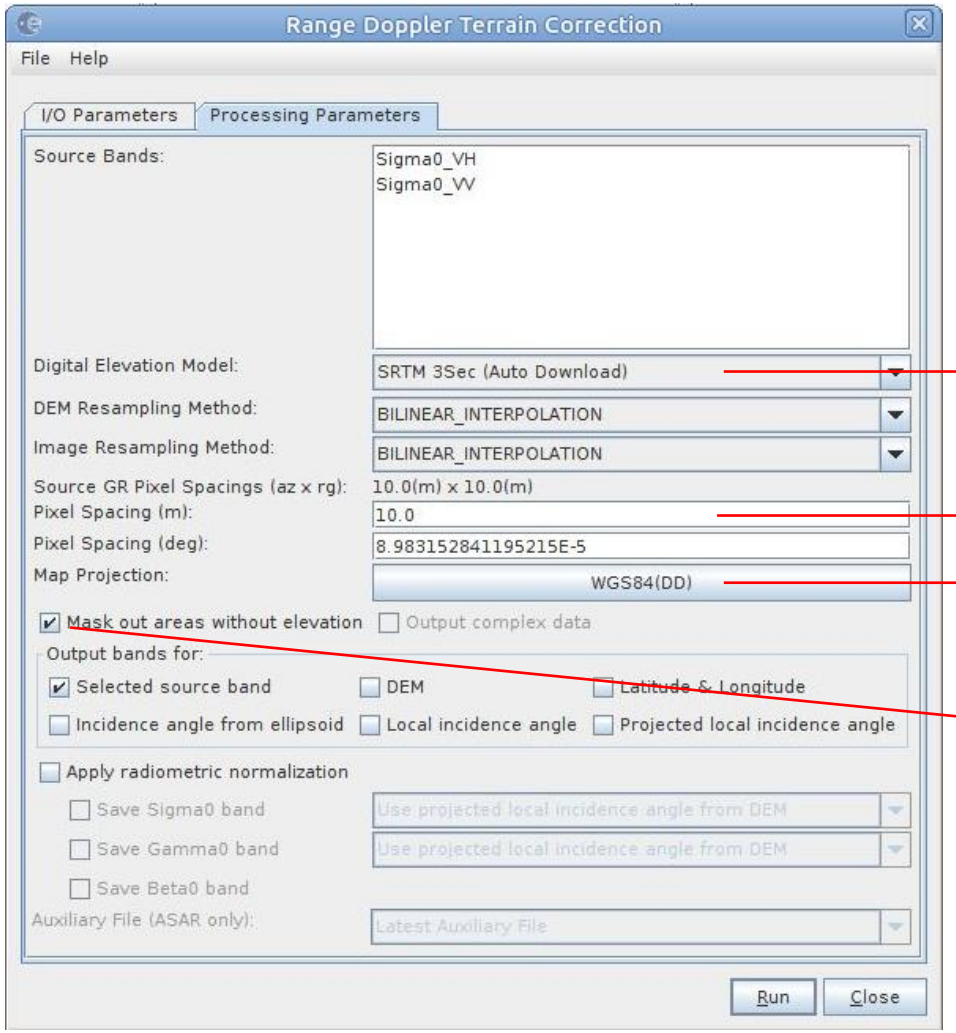
Terrain correction & Geocoding

Radar / Geometric / Terrain Correction / Range Doppler Terrain Correction



Terrain correction & Geocoding





DEM selection

Pixel spacing

Map projection

Masking areas without elevation

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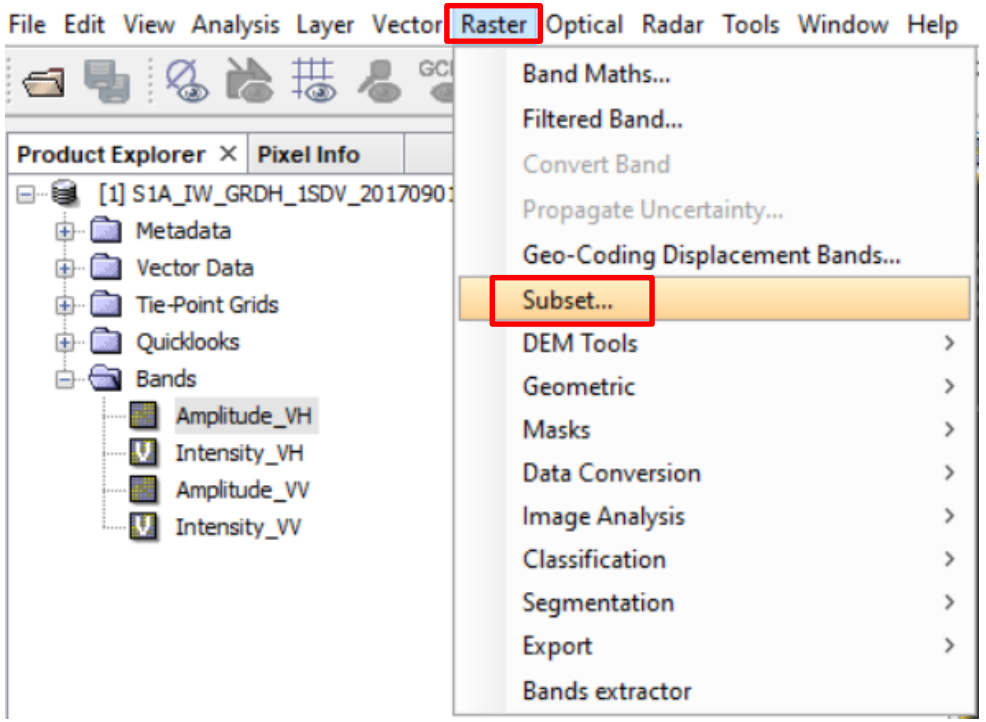
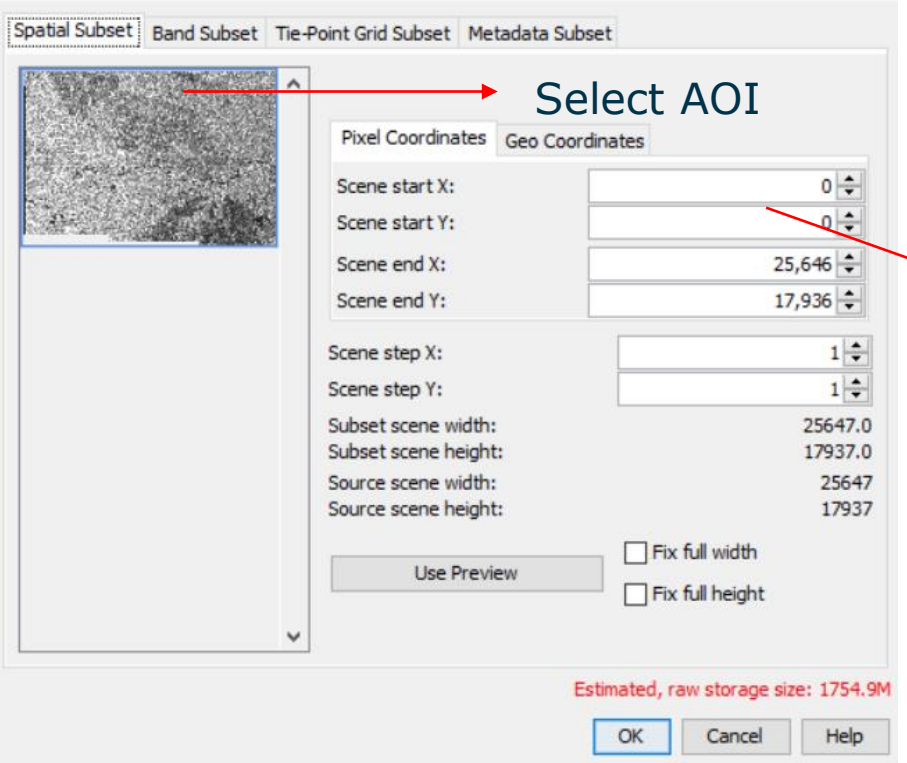
Subset


File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Product Explorer
Pixel Info
[1] S1A_IW_GRDH_1SDV_2017090
Metadata
Vector Data
Tie-Point Grids
Quicklooks
Bands
Amplitude_VH
Intensity_VH
Amplitude_VV
Intensity_VV
Band Maths...
Filtered Band...
Convert Band
Propagate Uncertainty...
Geo-Coding Displacement Bands...
Subset...
DEM Tools
Geometric
Masks
Data Conversion
Image Analysis
Classification
Segmentation
Export
Bands extractor


Spatial Subset
Band Subset
Tie-Point Grid Subset
Metadata Subset
Select AOI
Pixel Coordinates
Geo Coordinates
Scene start X: 0
Scene start Y: 0
Scene end X: 25,646
Scene end Y: 17,936
Scene step X: 1
Scene step Y: 1
Subset scene width: 25647.0
Subset scene height: 17937.0
Source scene width: 25647
Source scene height: 17937
Use Preview
Fix full width
Fix full height
Estimated, raw storage size: 1754.9M
OK
Cancel
Help
Coordinates of the AOI

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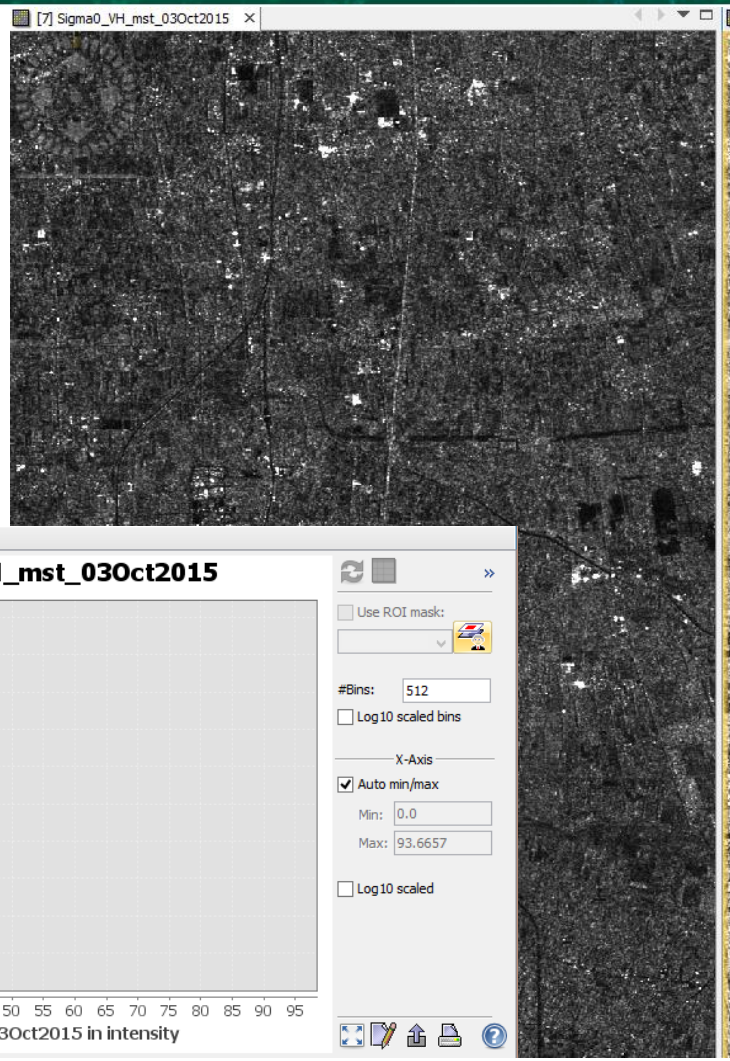
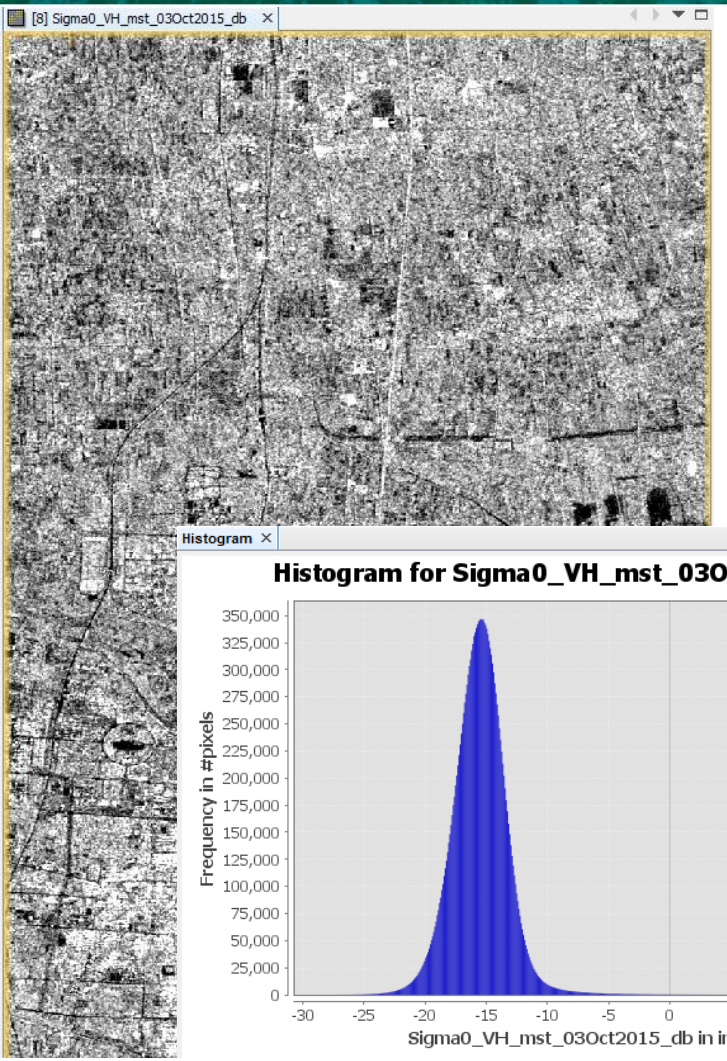
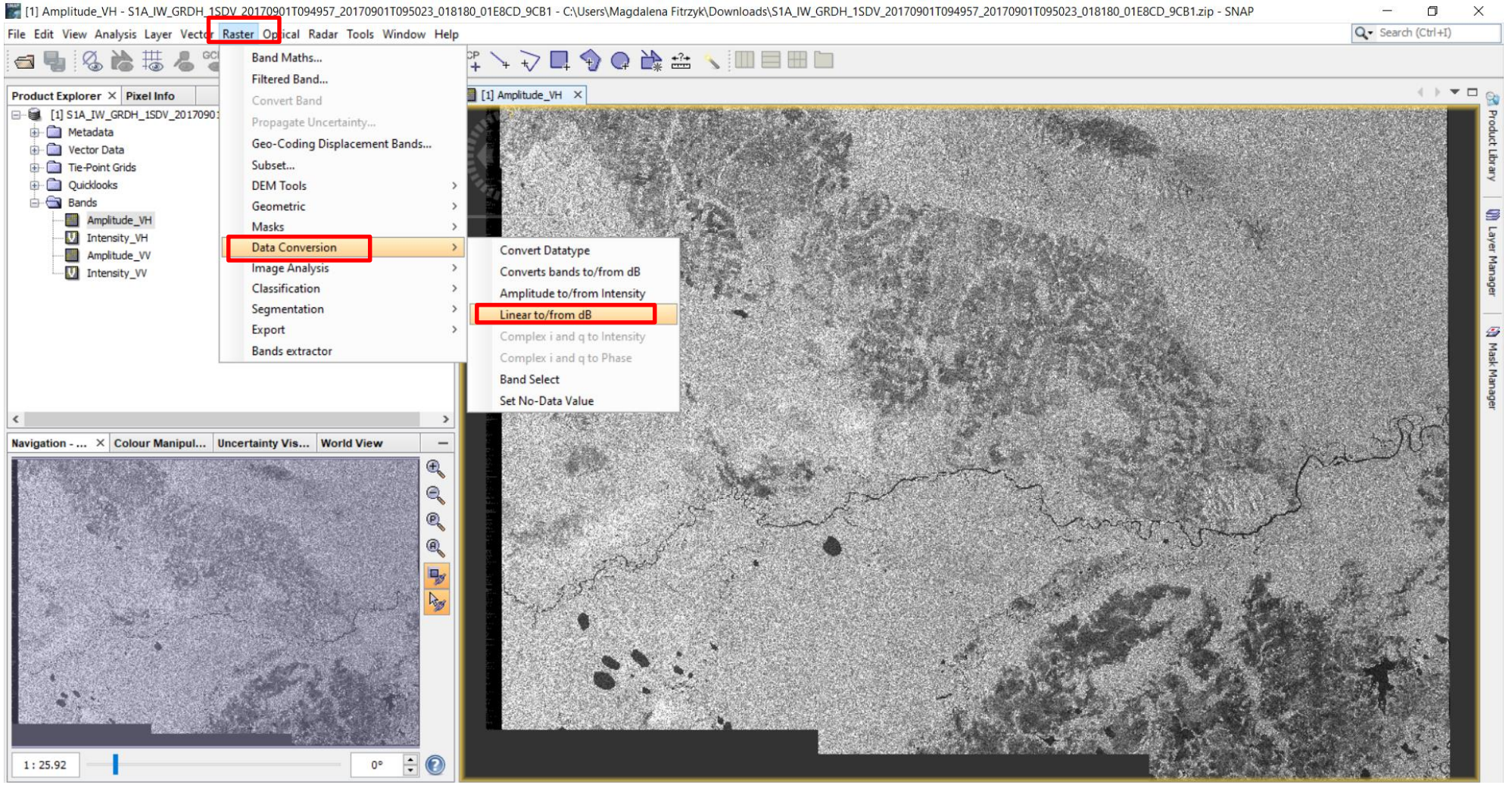
Linear vs dB comparison

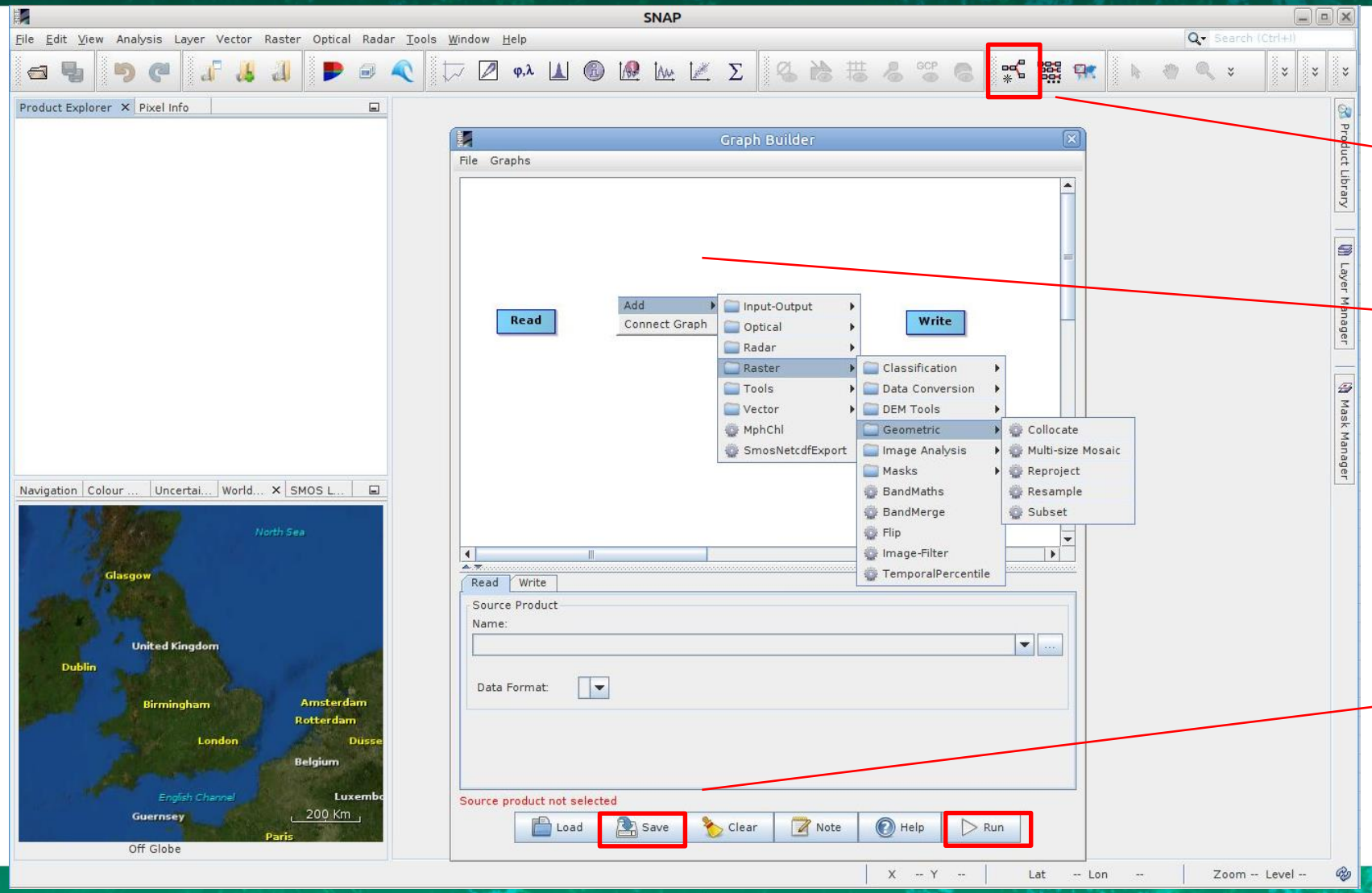




Conversion from linear to dB



Automatic Processing with Graph

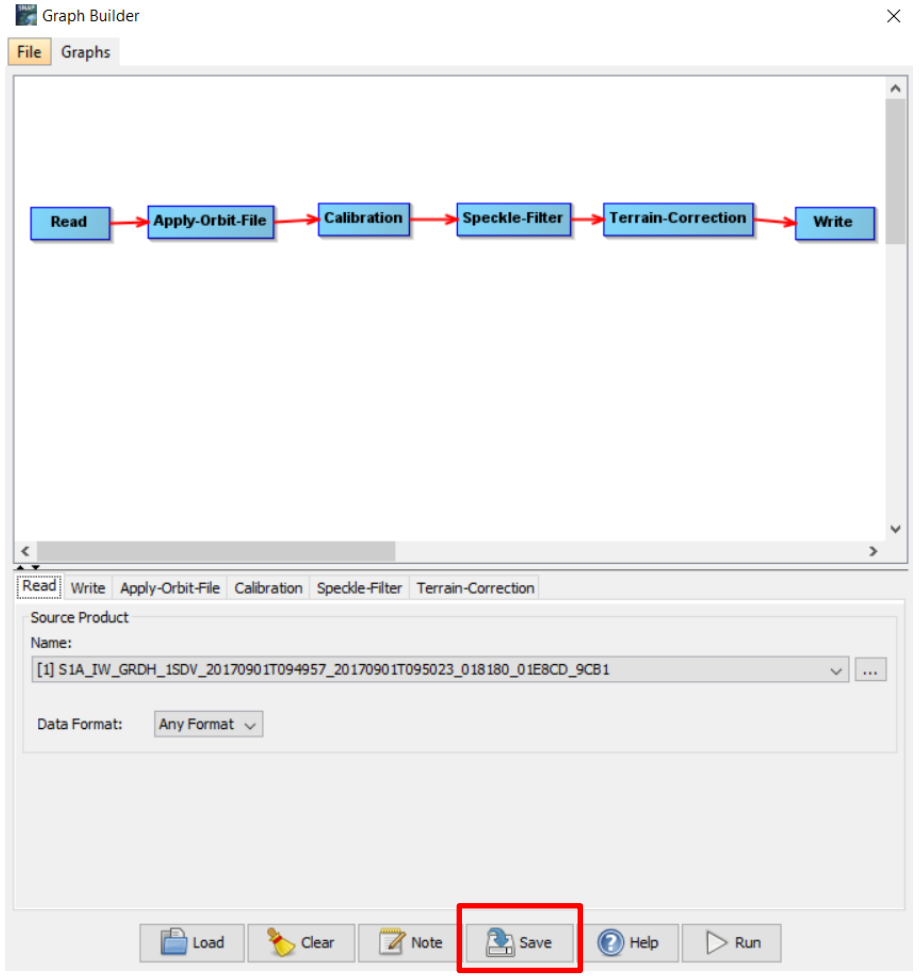


Graph Builder

Inserting blocks with particular processing operators (right mouse button)

Save the graph and/or Run

Automatic Processing with Graph – Calibration, Terrain Correction

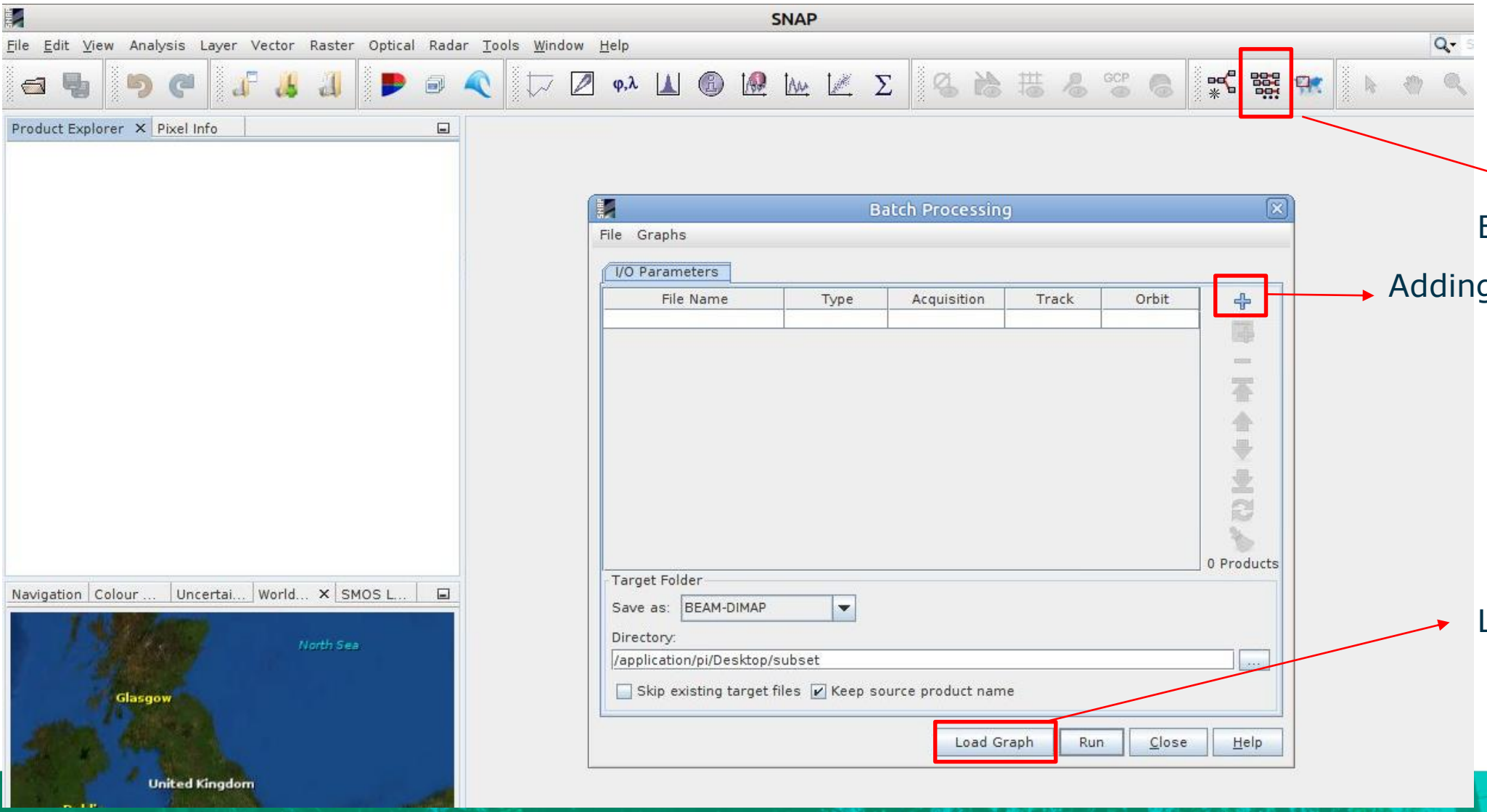


Apply Orbits: Sentinel Precise
Calibration: Output Sigma0
Speckle filter: Lee
Terrain Correction: pixel spacing 10m

The same settings like in manual processing!

save as GRD_Cal_TC.xml

Batch processing

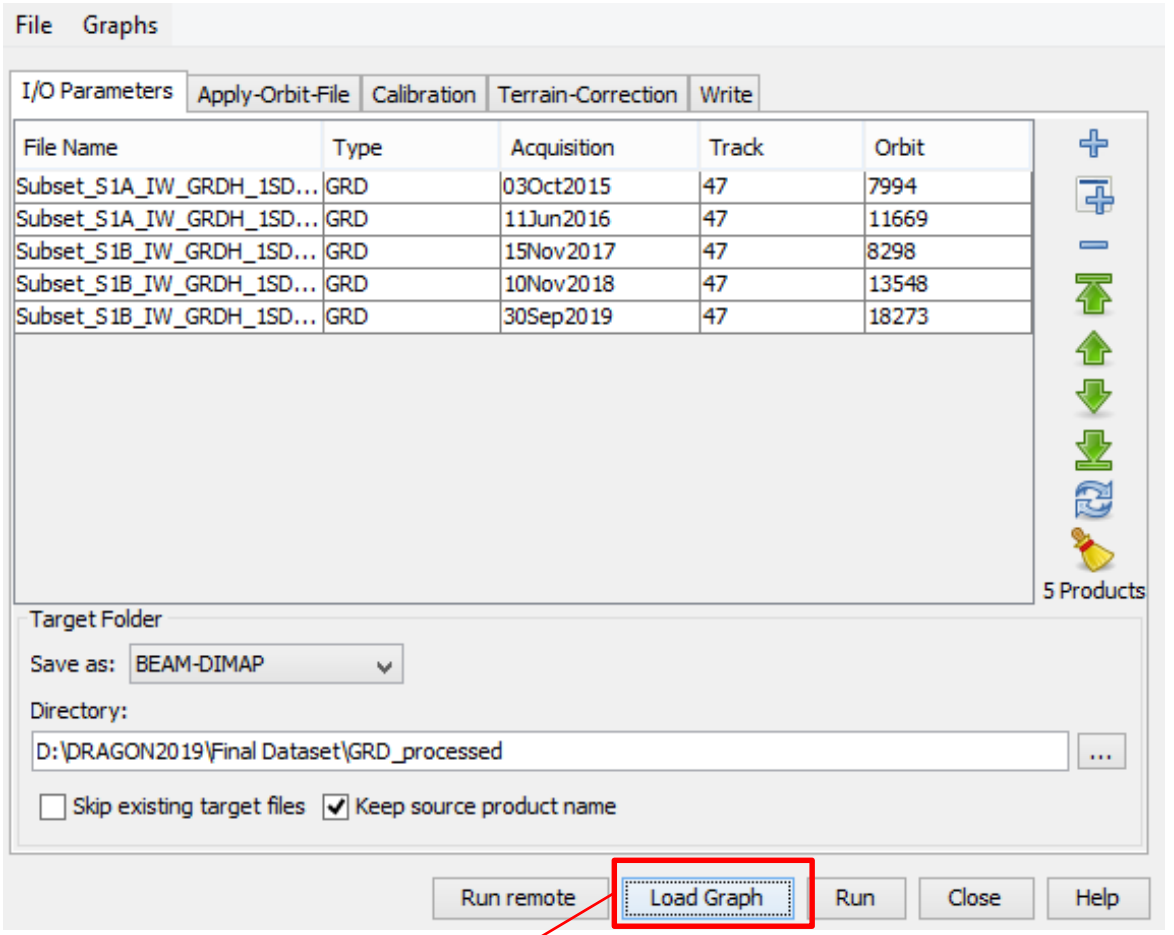


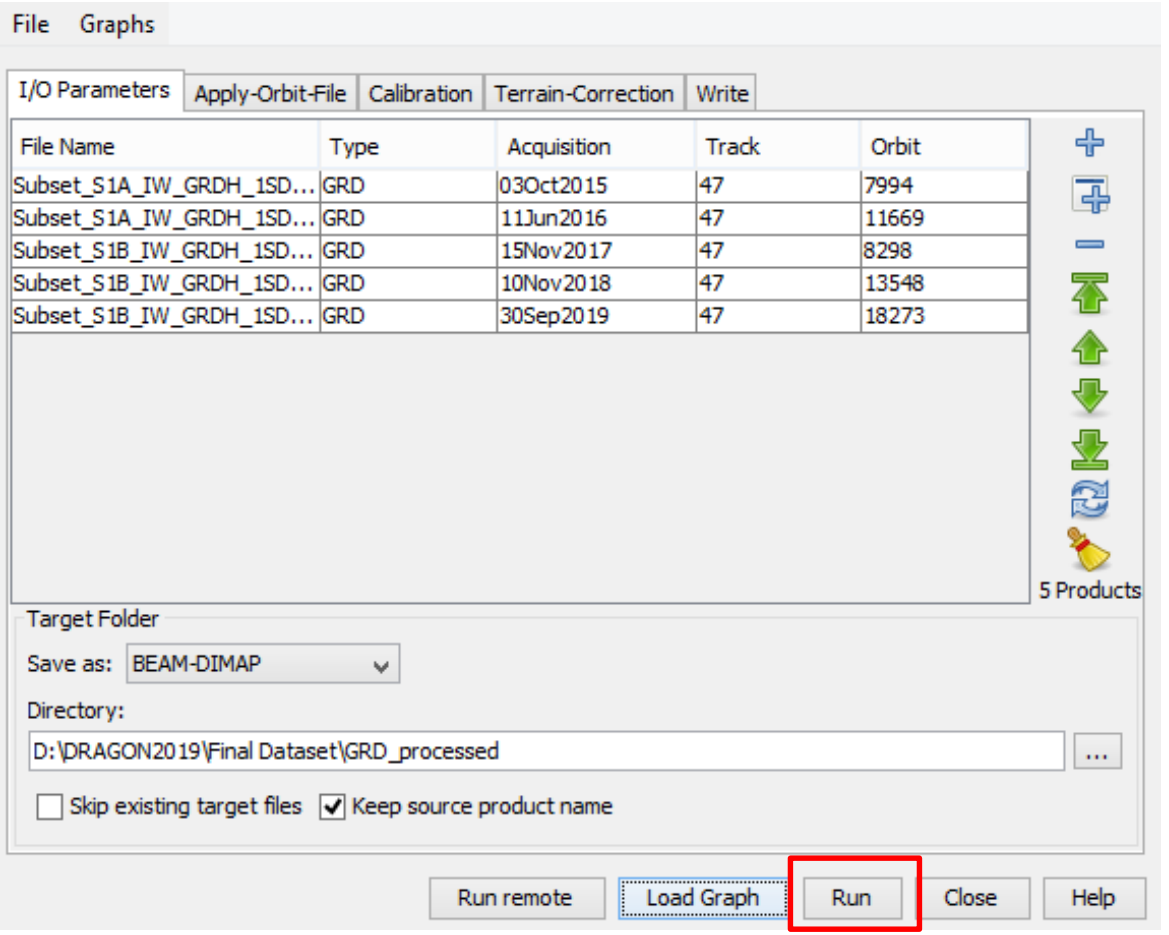
Batch processing tool

Adding data products

Loading the graph

Batch processing





Open previously saved graph GRD_Cal_TC.xml

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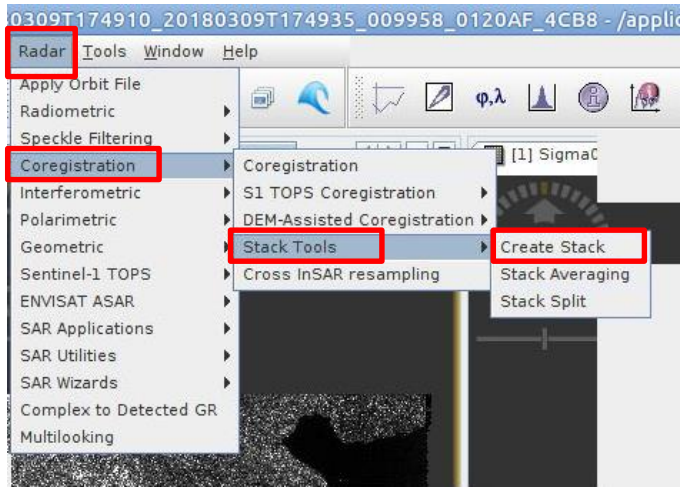
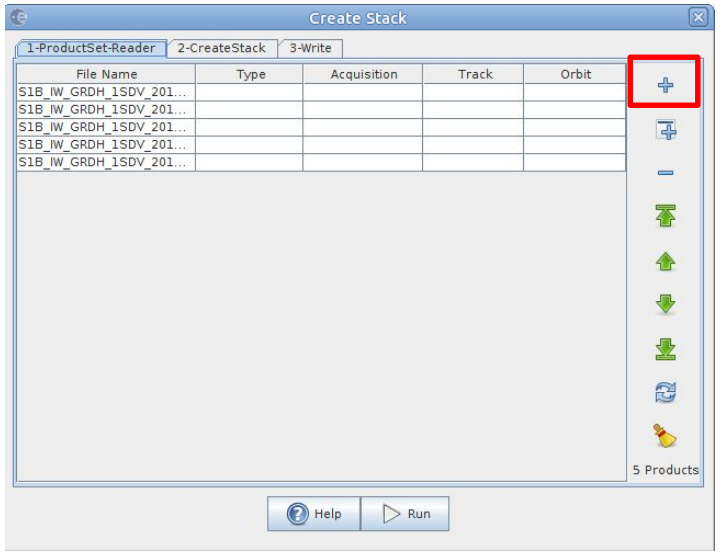
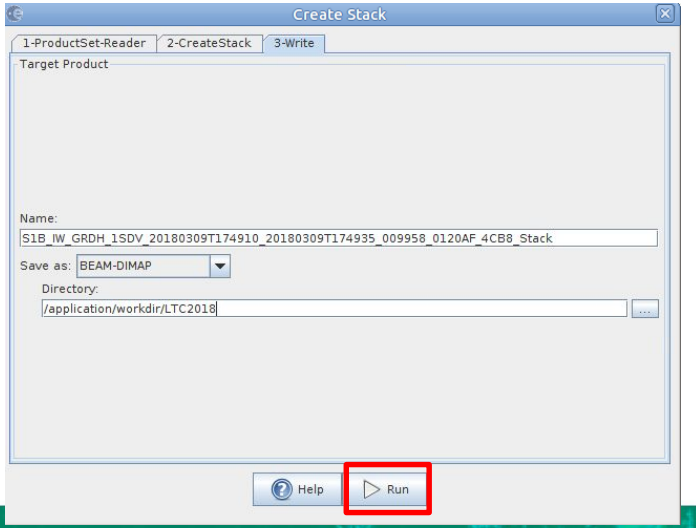
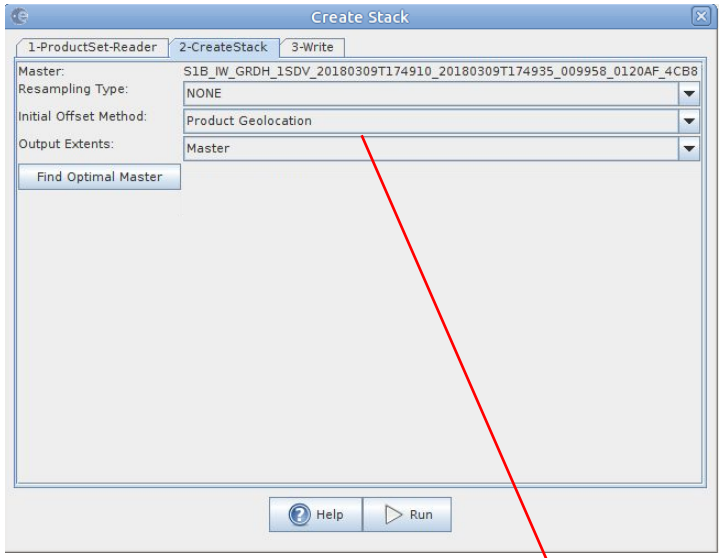
Creating multitemporal stack





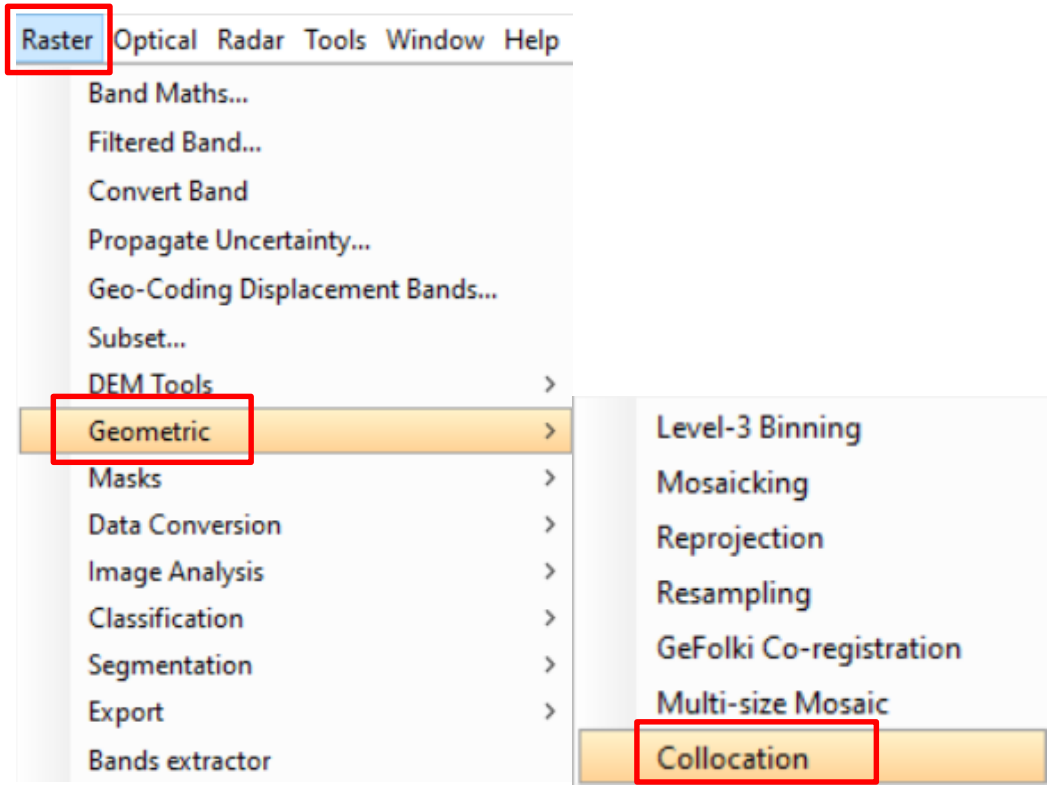


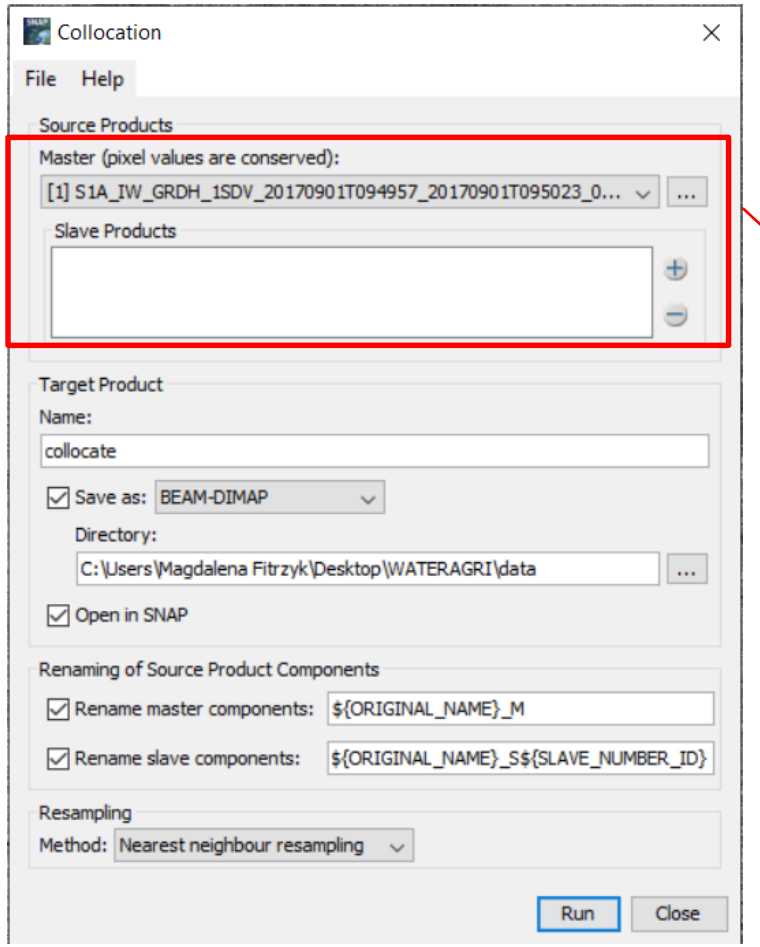


Collocating spatially overlapping images

- *Product geolocation (if terrain corrected)*
- *Orbits (if not terrain corrected)*

Collocation





Reference and secondary images to be collocated

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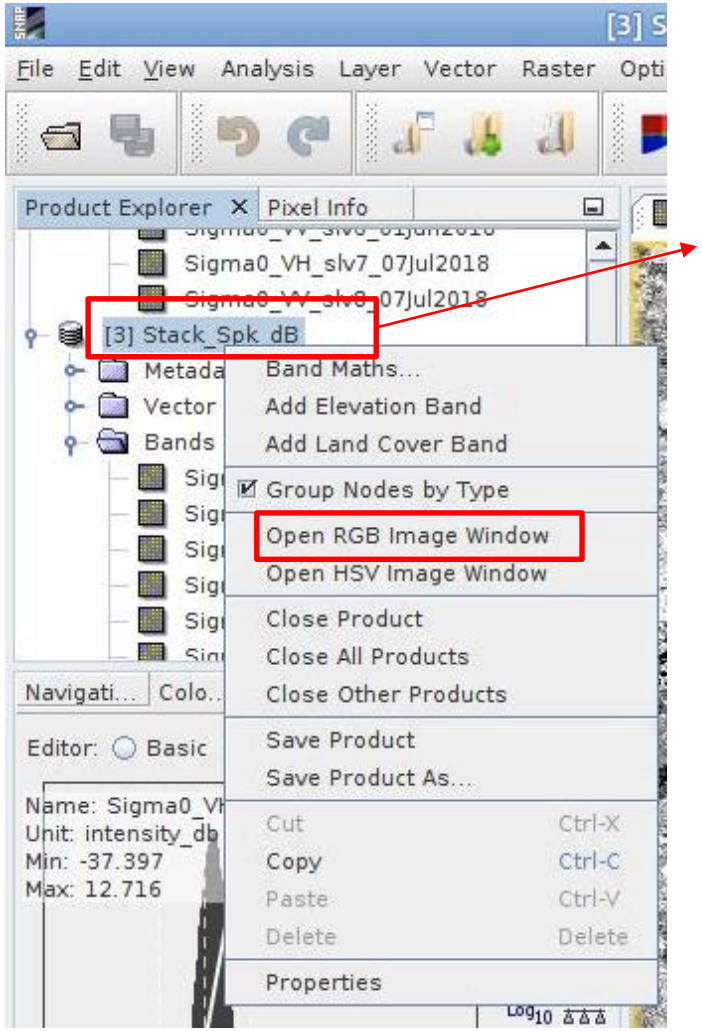
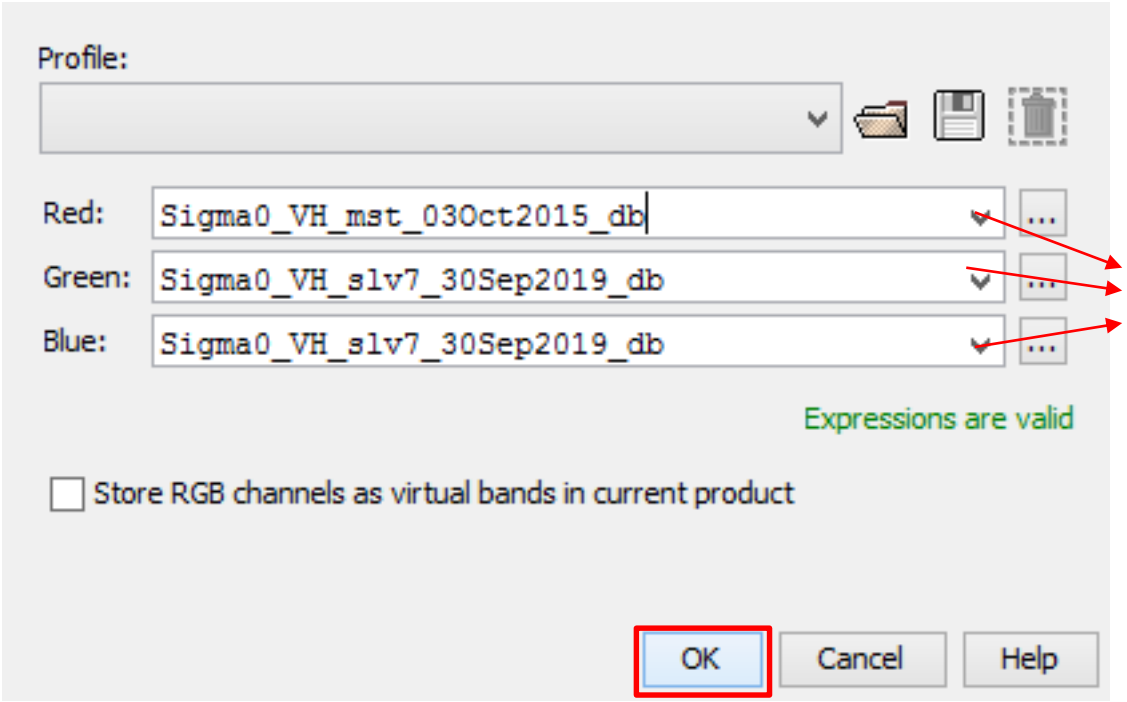
Visual inspection of the stack

RGB Composite

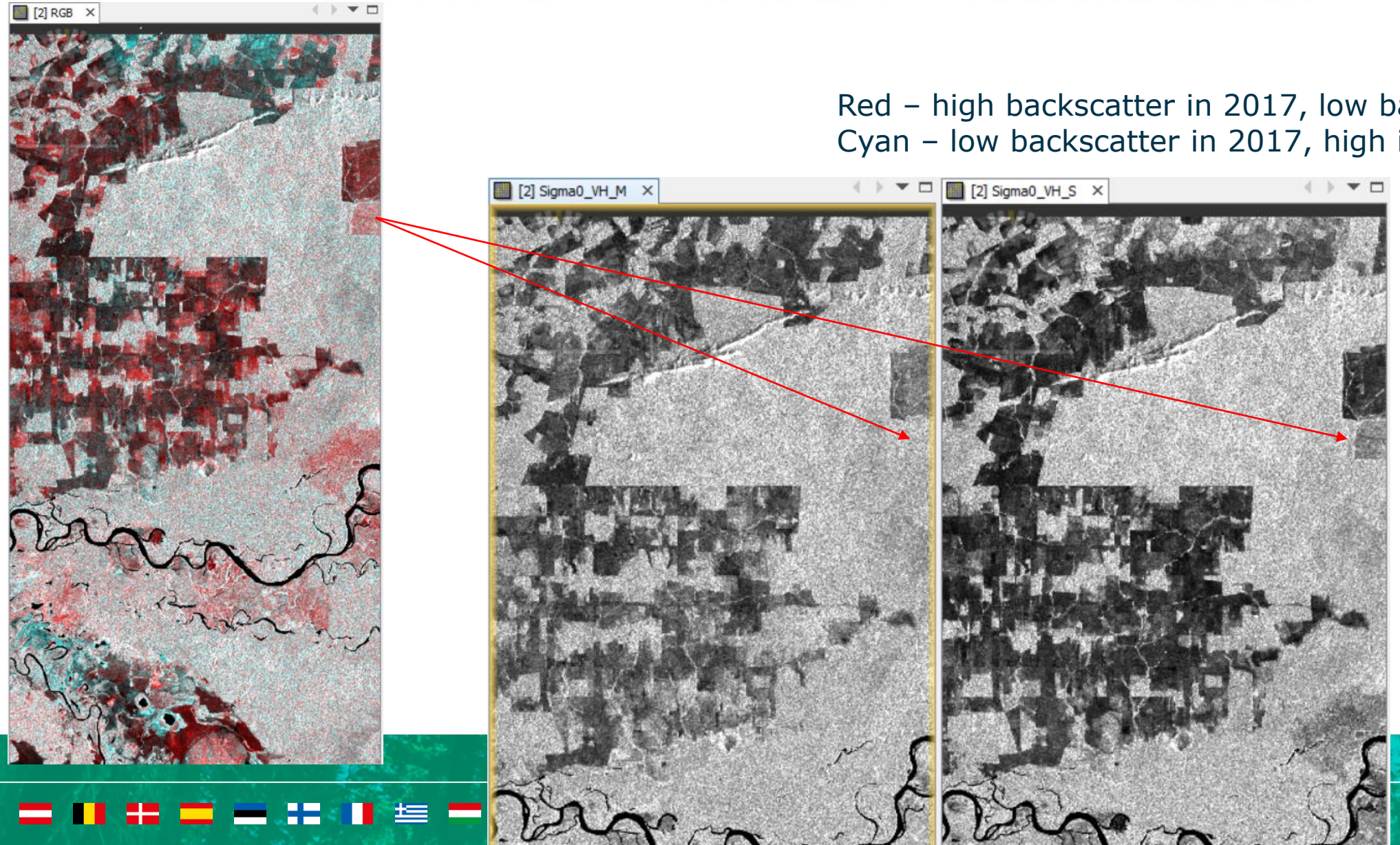


Right click on the product



Band selection

RGB Composite



Red – high backscatter in 2017, low backscatter in 2021
Cyan – low backscatter in 2017, high in 2021