



# ESA SNAP Toolbox Introduction

## Detecting harvest from Sentinel-1 data



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- Familiarizing with Sentinel-1 SLC products
- Calculation of backscatter intensity from Sentinel-1 SLC products
- Calculation of interferometric coherence
- Analysis of coherence and intensity false colour composites

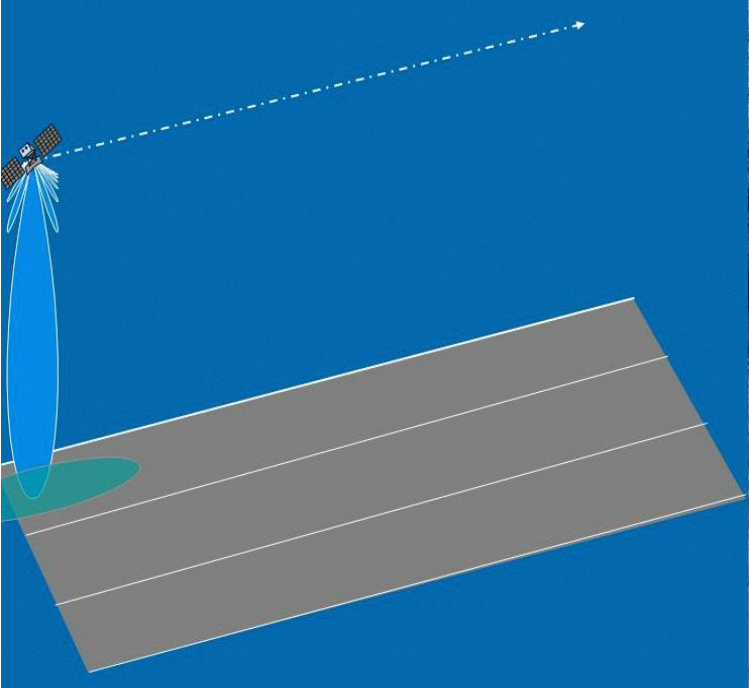
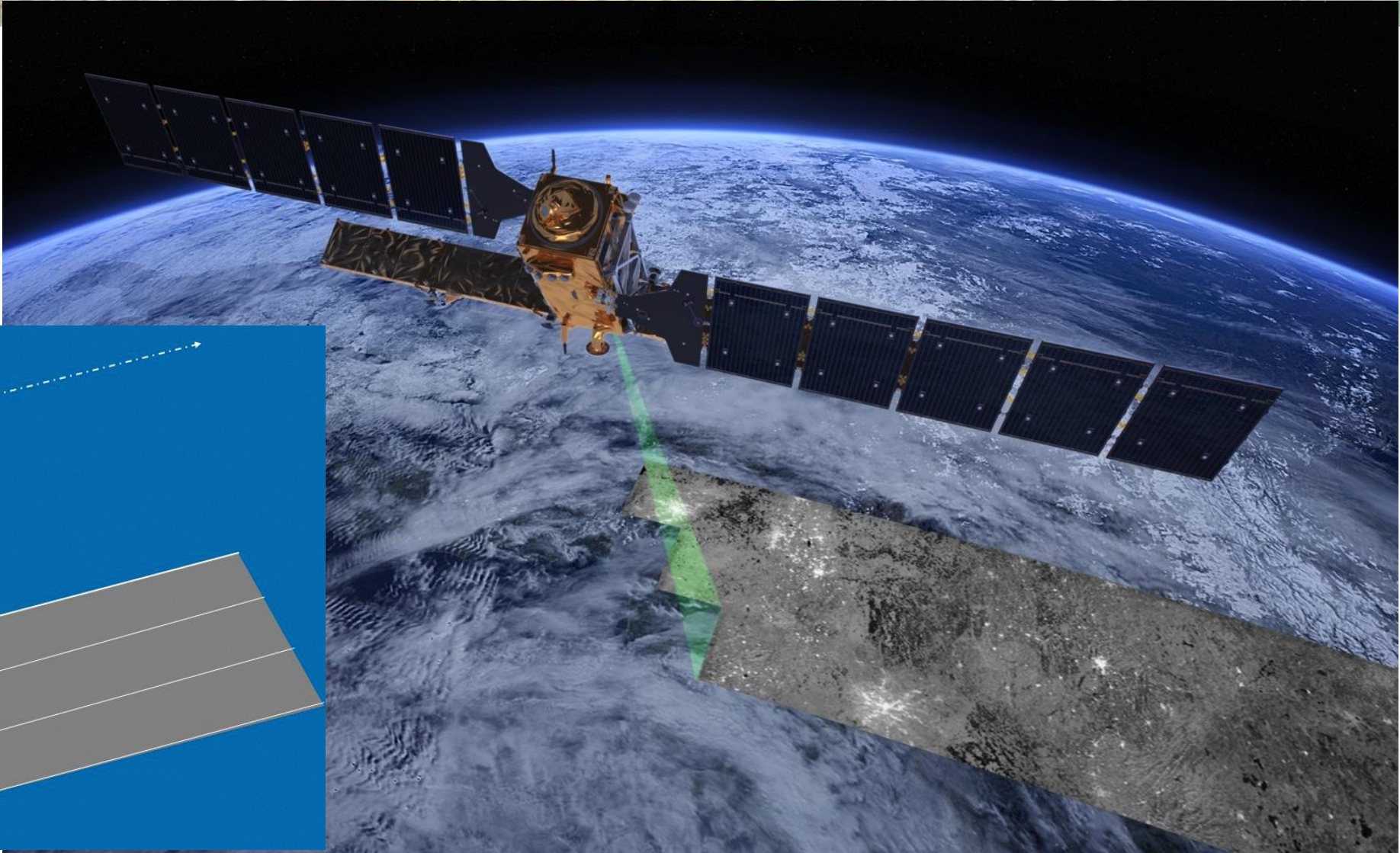
Input data: set of two Sentinel-1 SLCs

*S1A\_IW\_SLC\_\_1SDV\_20220308T044609\_20220308T044636\_042225\_05083C\_3949.zip*

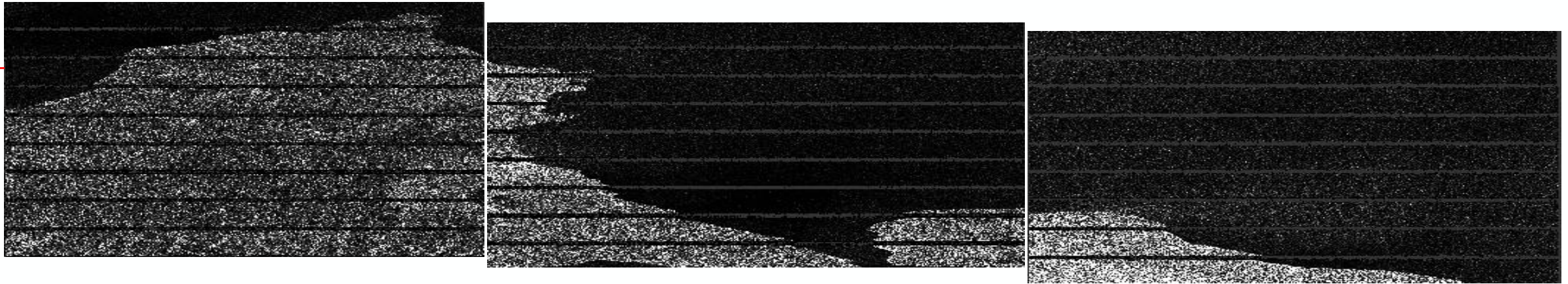
*S1A\_IW\_SLC\_\_1SDV\_20220320T044609\_20220320T044636\_042400\_050E29\_C715.zip*

Output: coherence time series for harvest detection

# Sentinel-1 data acquisition



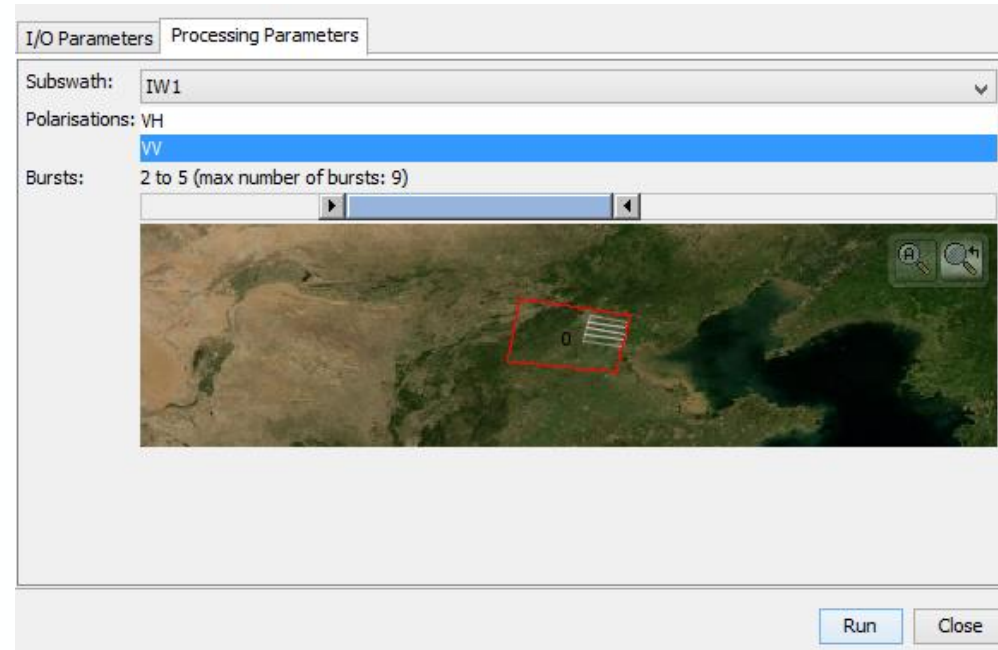
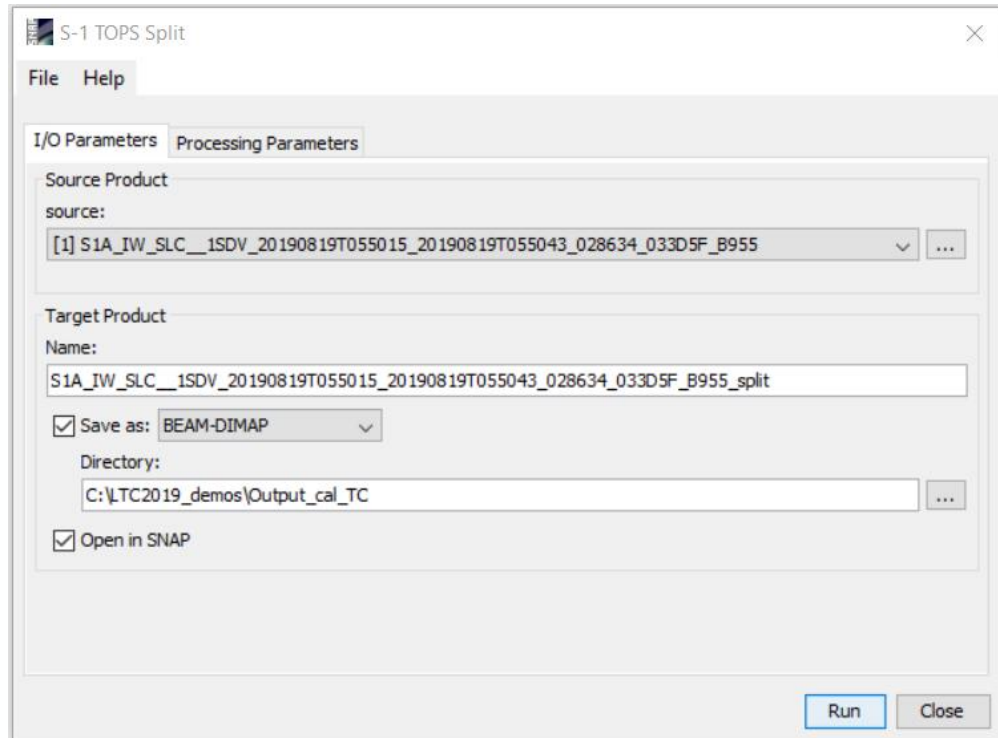
## Bursted IW SLC



→ TOPSAR Split to choose a subswath and bursts for the AOI

# Sentinel-1 TOPSAR Split

## Radar/Sentinel-1 TOPS/S-1 TOPS Split



- Selection of subswath
- Selection of polarization
- Selection of bursts

IW2

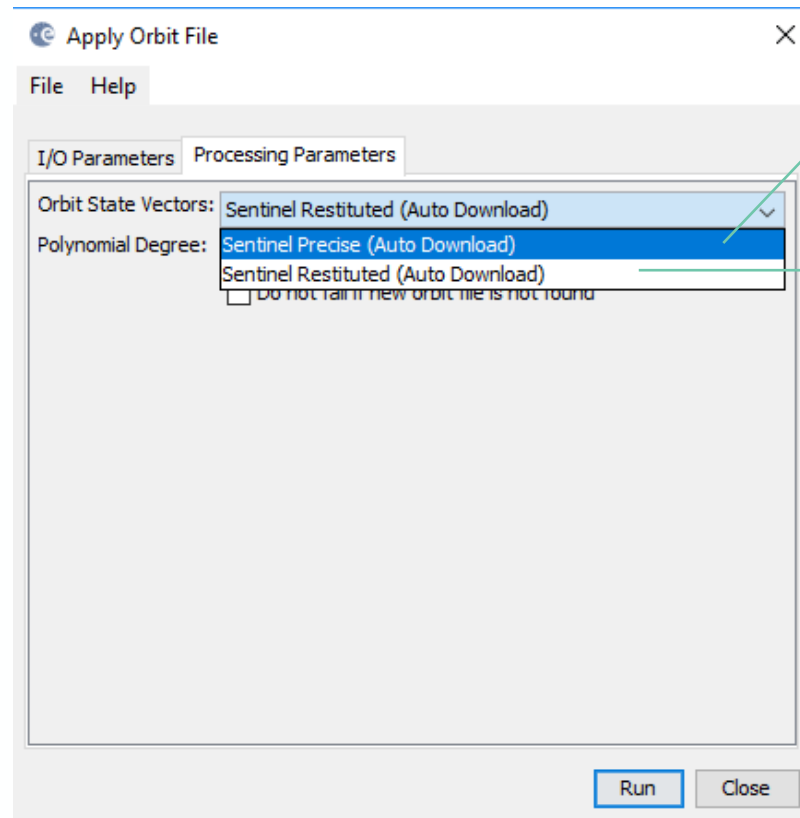
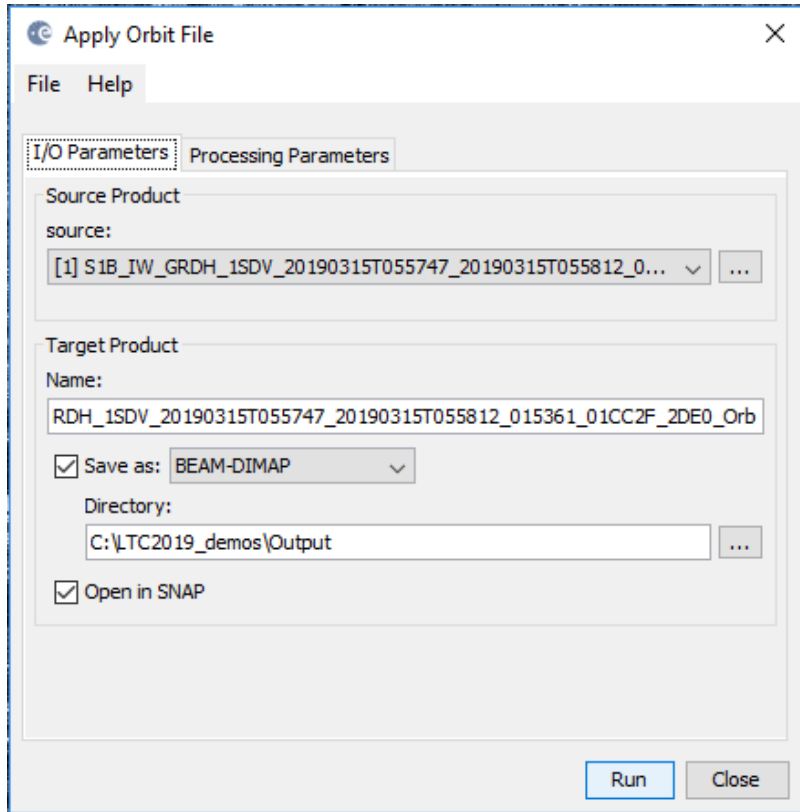
TOPS Split applied to both S-1 SLCs

# STEP 1

## Interferometric Coherence

# Applying orbit files

*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.*

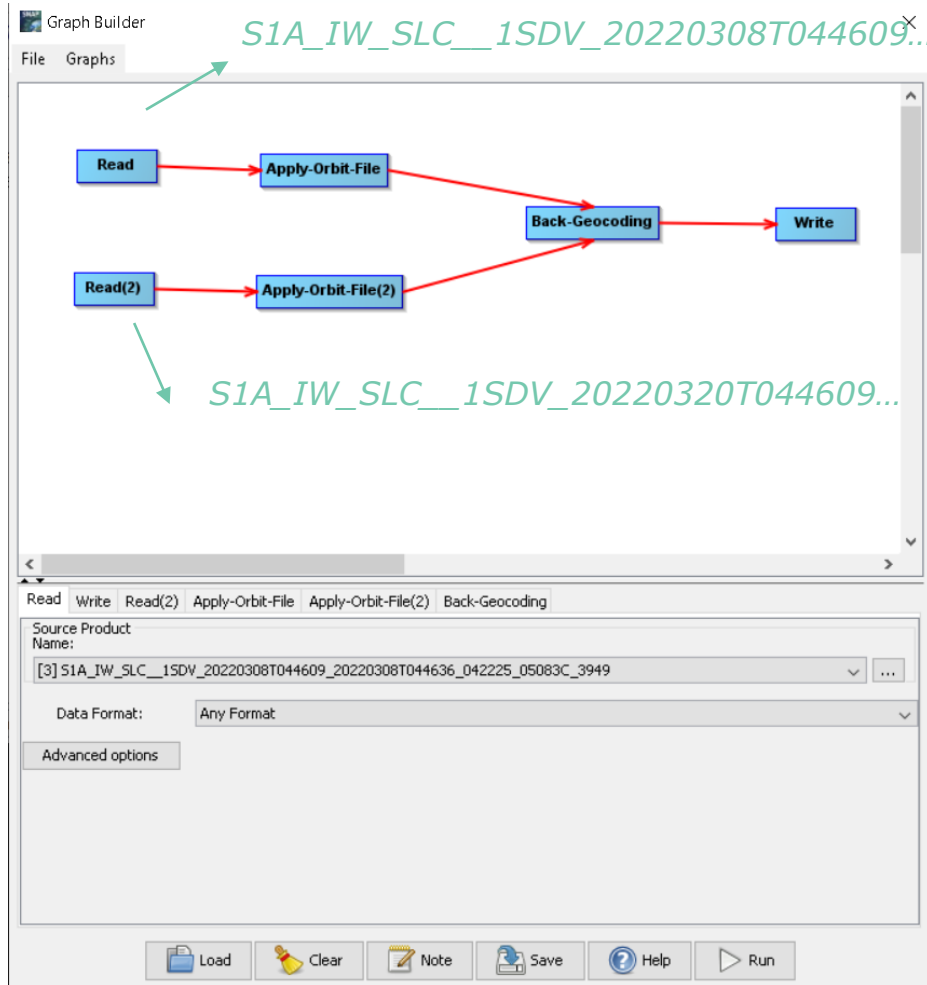


POEORB - few weeks after acq.

RESORB - within few hours



# Coregistration



Co-registration of two S-1 SLC split products (master/reference and slave/secondary) of the same sub-swath using the orbits of the two products and a Digital Elevation Model (DEM).

- [2] 20220308\_20220320
  - Metadata
  - Vector Data
  - Tie-Point Grids
  - Bands
    - i\_IW2\_VH\_mst\_08Mar2022
    - q\_IW2\_VH\_mst\_08Mar2022
    - Intensity\_IW2\_VH\_mst\_08Mar2022
    - i\_IW2\_VV\_mst\_08Mar2022
    - q\_IW2\_VV\_mst\_08Mar2022
    - Intensity\_IW2\_VV\_mst\_08Mar2022
    - i\_IW2\_VH\_slv1\_20Mar2022
    - q\_IW2\_VH\_slv1\_20Mar2022
    - Intensity\_IW2\_VH\_slv1\_20Mar2022
    - i\_IW2\_VV\_slv1\_20Mar2022
    - q\_IW2\_VV\_slv1\_20Mar2022
    - Intensity\_IW2\_VV\_slv1\_20Mar2022

→ Coregistered bands in one product

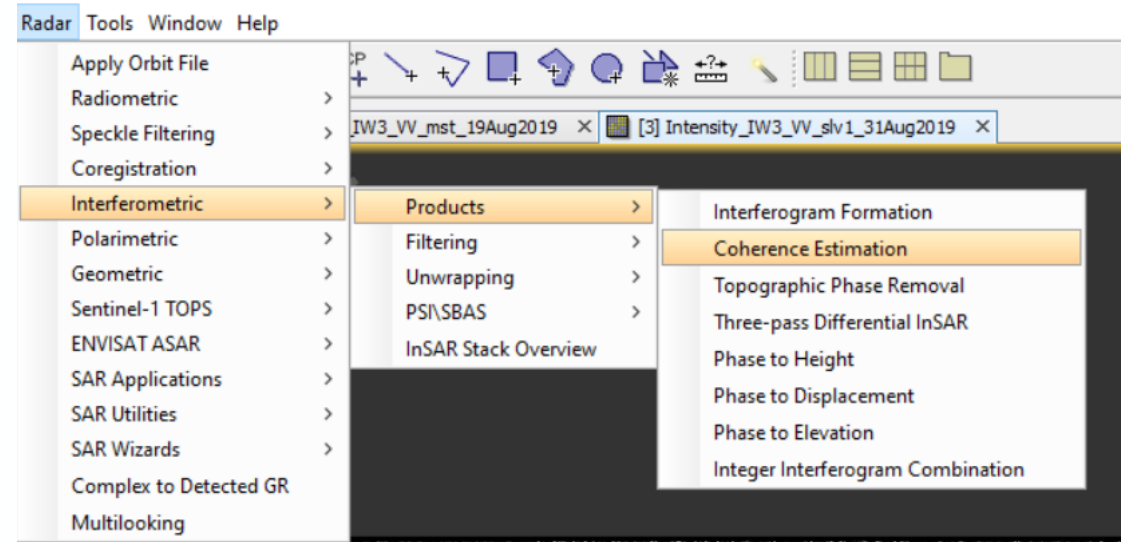
## COHERENCE

Measure of correlation between phase in two SAR complex images

Ranging from 0 (no correlation) to 1

Coherence may be affected by:

- Local slope
- Properties of the surface
- Time lag between acquisitions
- The perpendicular baseline
- Poor coregistration



# Interferometric Coherence

## Radar/Interferometric/Products/Coherence

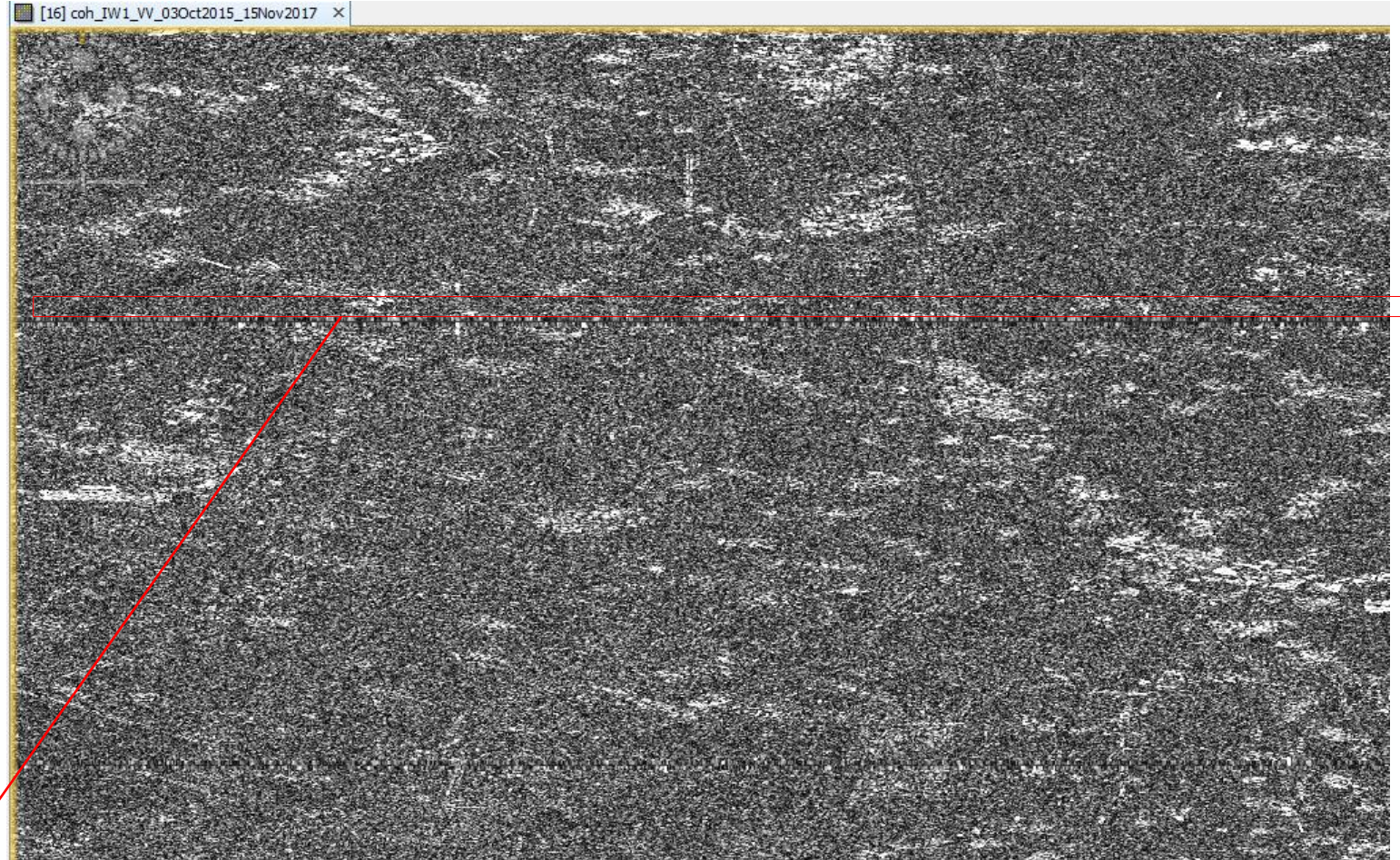
Coherence Estimation

File Help

I/O Parameters Processing Parameters

- Subtract flat-earth phase
- Degree of "Flat Earth" polynomial: 5
- Number of "Flat Earth" estimation points: 501
- Orbit interpolation degree: 3
- Subtract topographic phase
- Digital Elevation Model: SRTM 3Sec (Auto Download)
- Tile Extension [%]: 100
- Square Pixel
- Independent Window Sizes
- Coherence Range Window Size: 10
- Coherence Azimuth Window Size: 2

Run Close



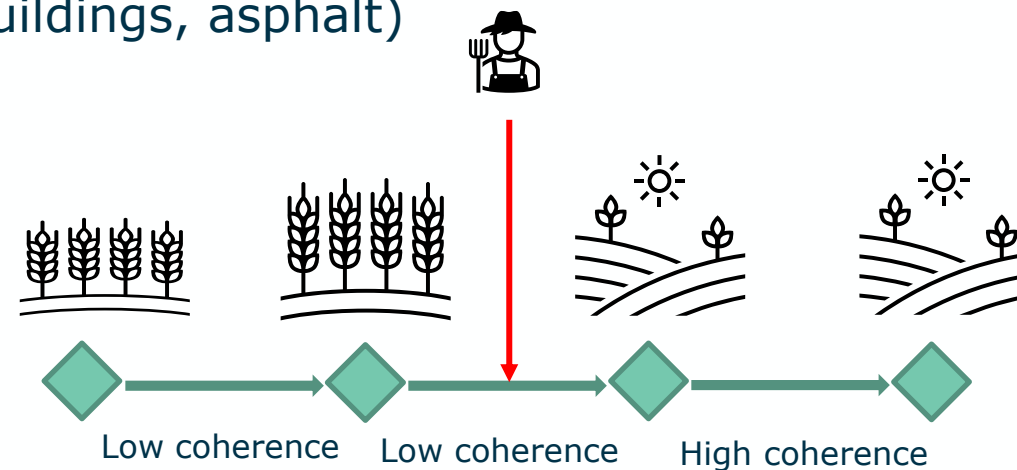
*Demarcation black-filled line between bursts*

# Interferometric Coherence



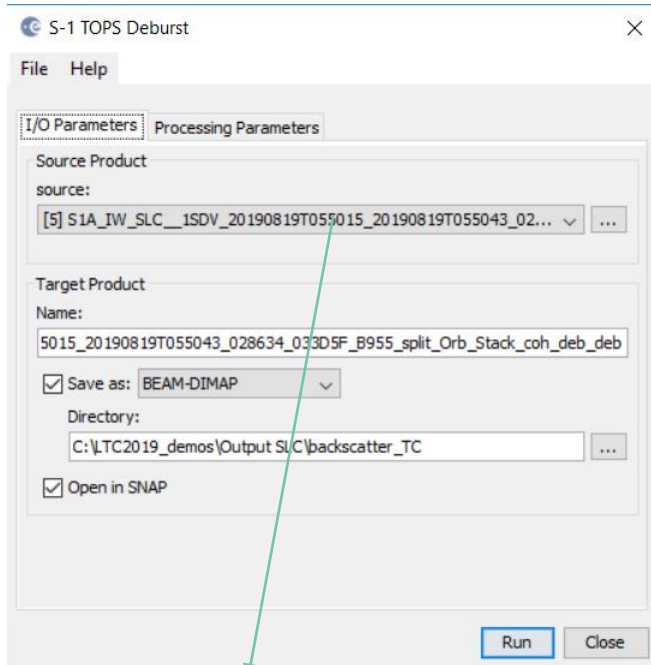
0 – no coherence, the area has changed (e.g. crop growth)

1 – high coherence, the area has not changed (e.g. buildings, asphalt)

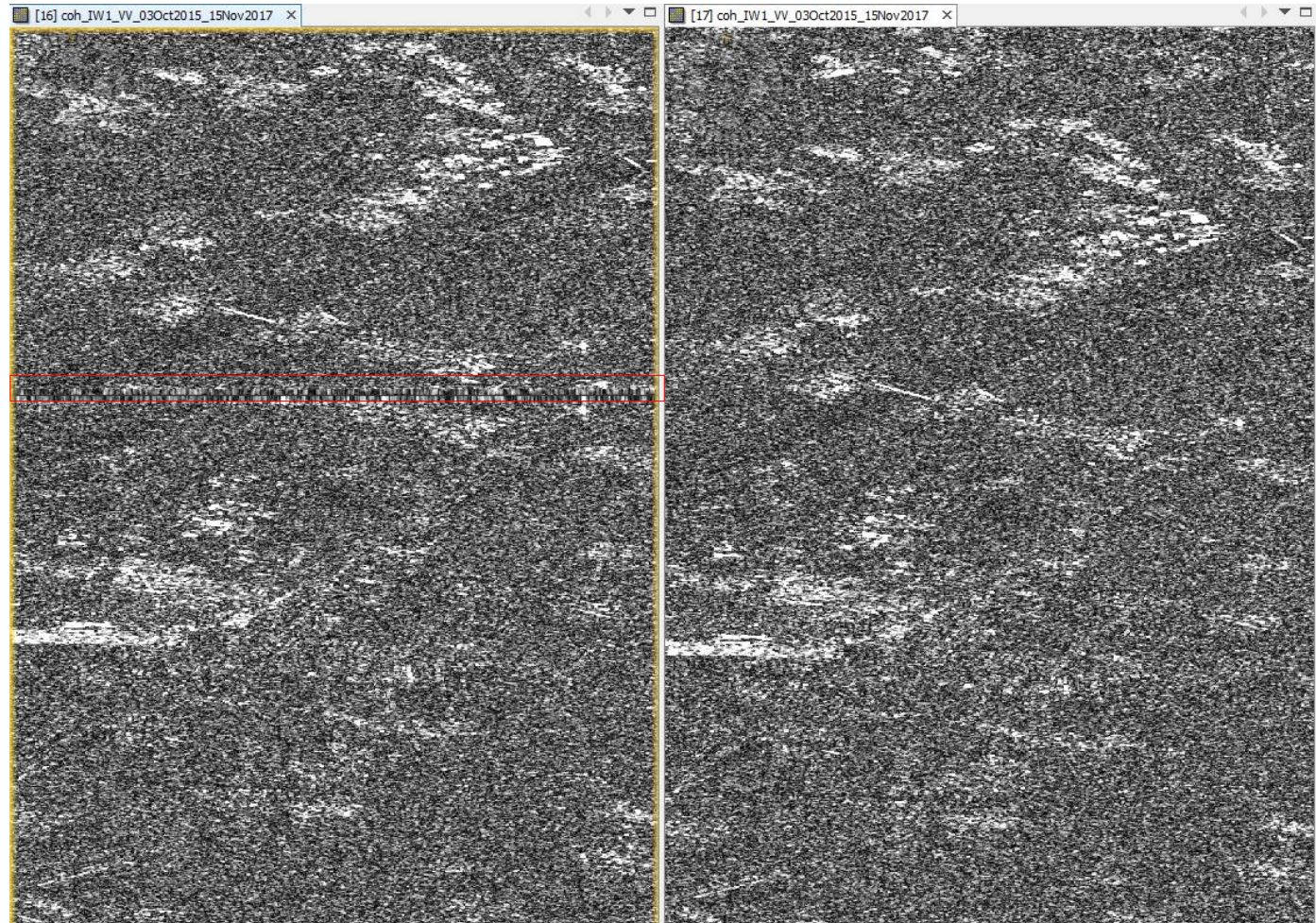


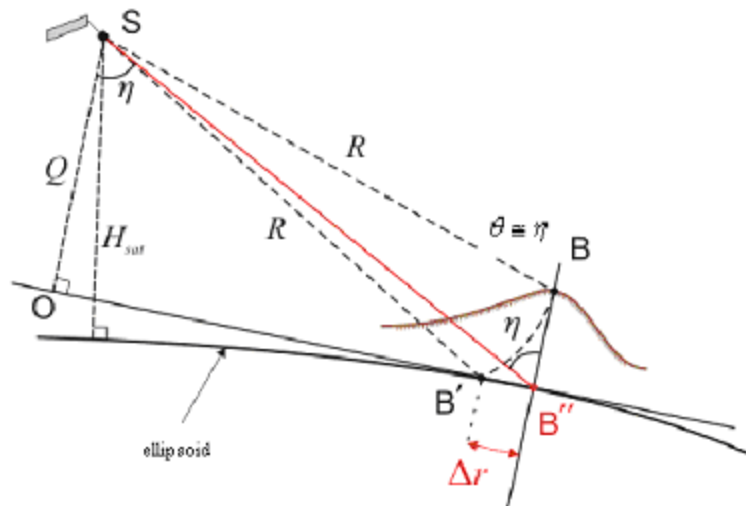
# S-1 TOPS Debursting

## Radar/Sentinel-1 TOPS/S-1 TOPS Deburst



Input: Coherence

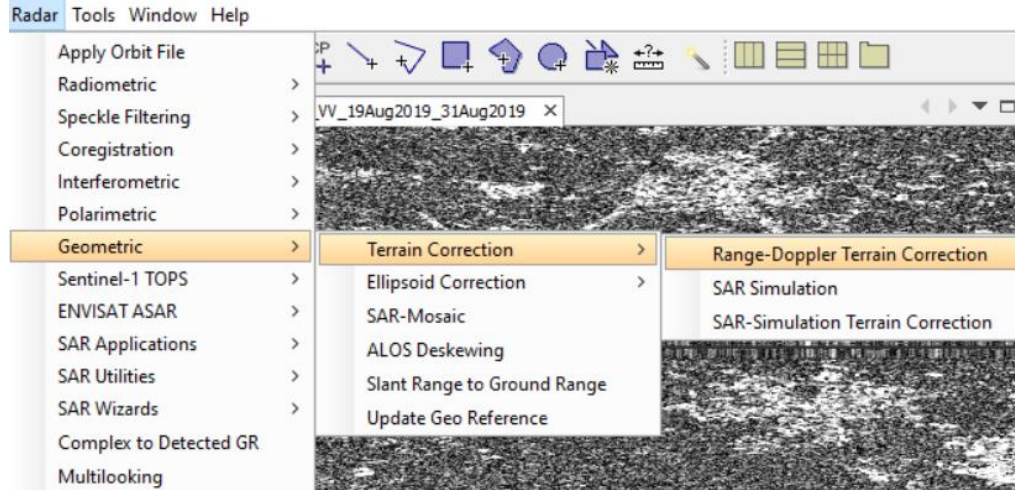




Point **B** with elevation **h** above the ellipsoid is imaged at position **B'** in SAR image, though its real position is **B''**. The offset  $\Delta r$  between **B'** and **B''** exhibits the effect of topographic distortions

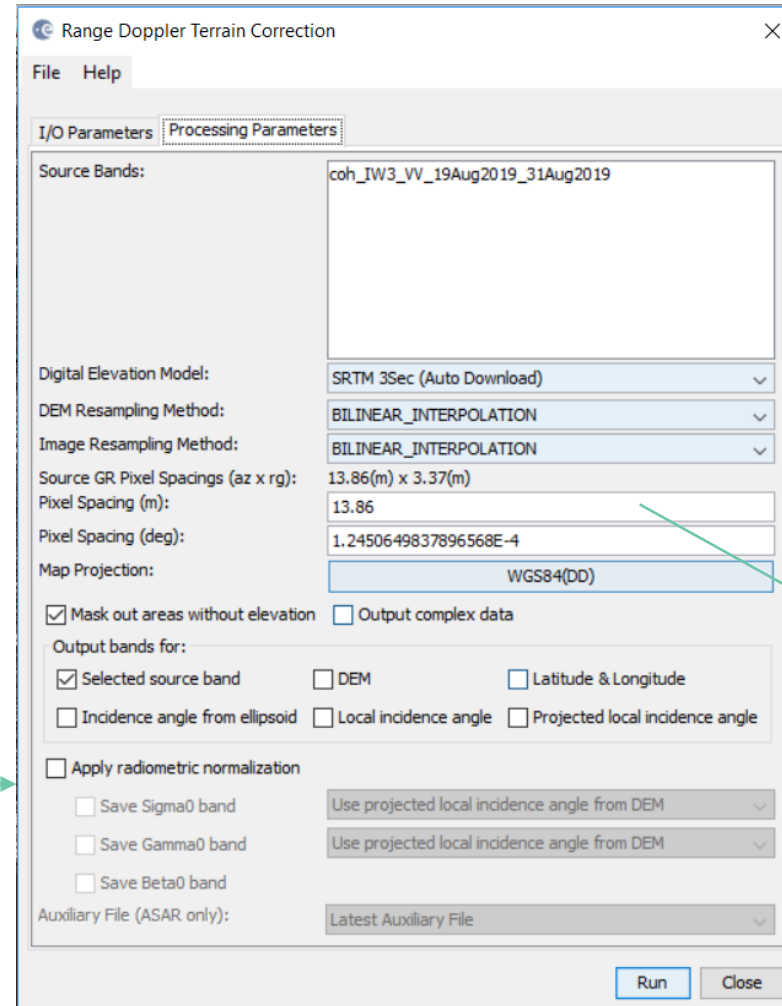
*Terrain Correction allows geometric overlays of data from different sensors and/or geometries.*

# Terrain Correction



Compensate for geometric distortions caused by topographical variations of a scene and the tilt of satellite sensor

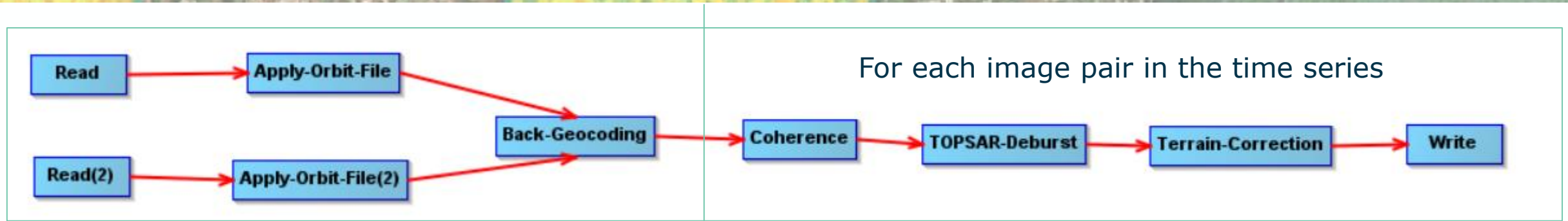
+ Geocoding



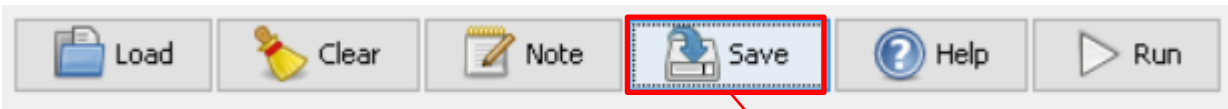
- Select:
- DEM
  - Resampling
  - Pixel spacing
  - Projection

Pixel spacing 20m

# Processing of the coherence time series



→ This part can be run in batch process



*Save the graph and run batch processing*



# Batch processing

Batch Processing : batch processin graph.xml

File Graphs

I/O Parameters Coherence TOPSAR-Deburst Terrain-Correction Write

File Name	Type	Acquisition	Track	Orbit
Stack	SLC	08Mar2022	153	42225
S1A_IW_SLC__1SDV_20220...	SLC	08Mar2022	153	42225
S1A_IW_SLC__1SDV_20220...	SLC	20Mar2022	153	42400

3 Products

Run remote Load Graph Run Close Help



*Add your data*

*Load your saved graph*

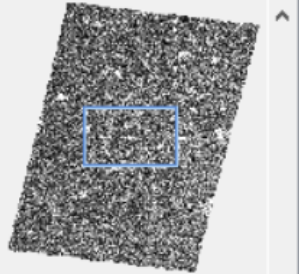
# Spatial Subset



## Raster/Subset

Specify Product Subset

Spatial Subset | Band Subset | Metadata Subset



Pixel Coordinates | Geo Coordinates

Scene start X: 4,282  
Scene start Y: 5,201  
Scene end X: 8,886  
Scene end Y: 8,096

Scene step X: 1  
Scene step Y: 1

Subset scene width: 4605.0  
Subset scene height: 2896.0  
Source scene width: 13169  
Source scene height: 13298

Use Preview  Fix full width  Fix full height


Estimated, raw storage size: 101.7M

OK Cancel Help

OR

Graph Builder : Step0\_Graph\_to\_subset inputs.xml

File Graphs




Read Subset Write

Copy Metadata

Pixel Coordinates  Geographic Coordinates

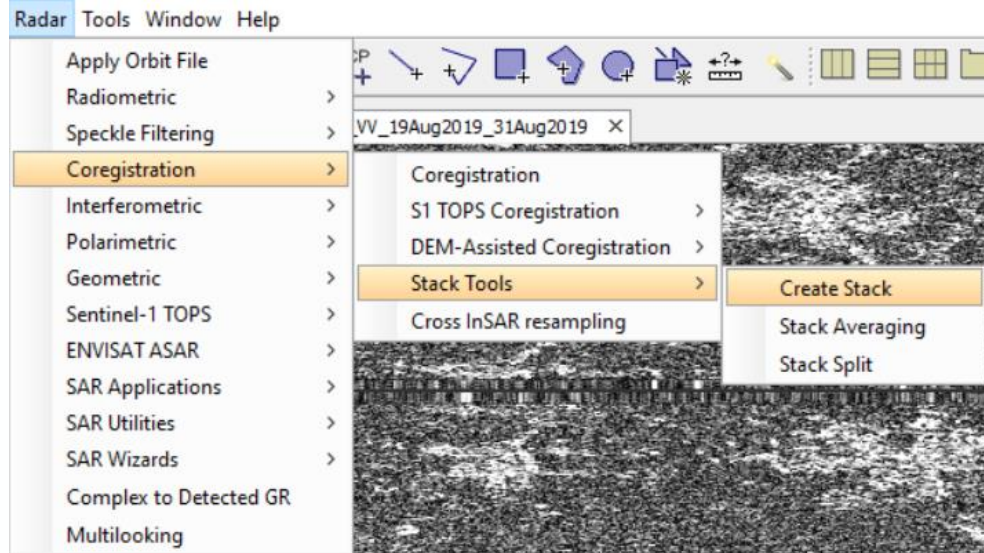
Reference band: coh\_IW2\_VH\_08Mar2022\_20Mar2022



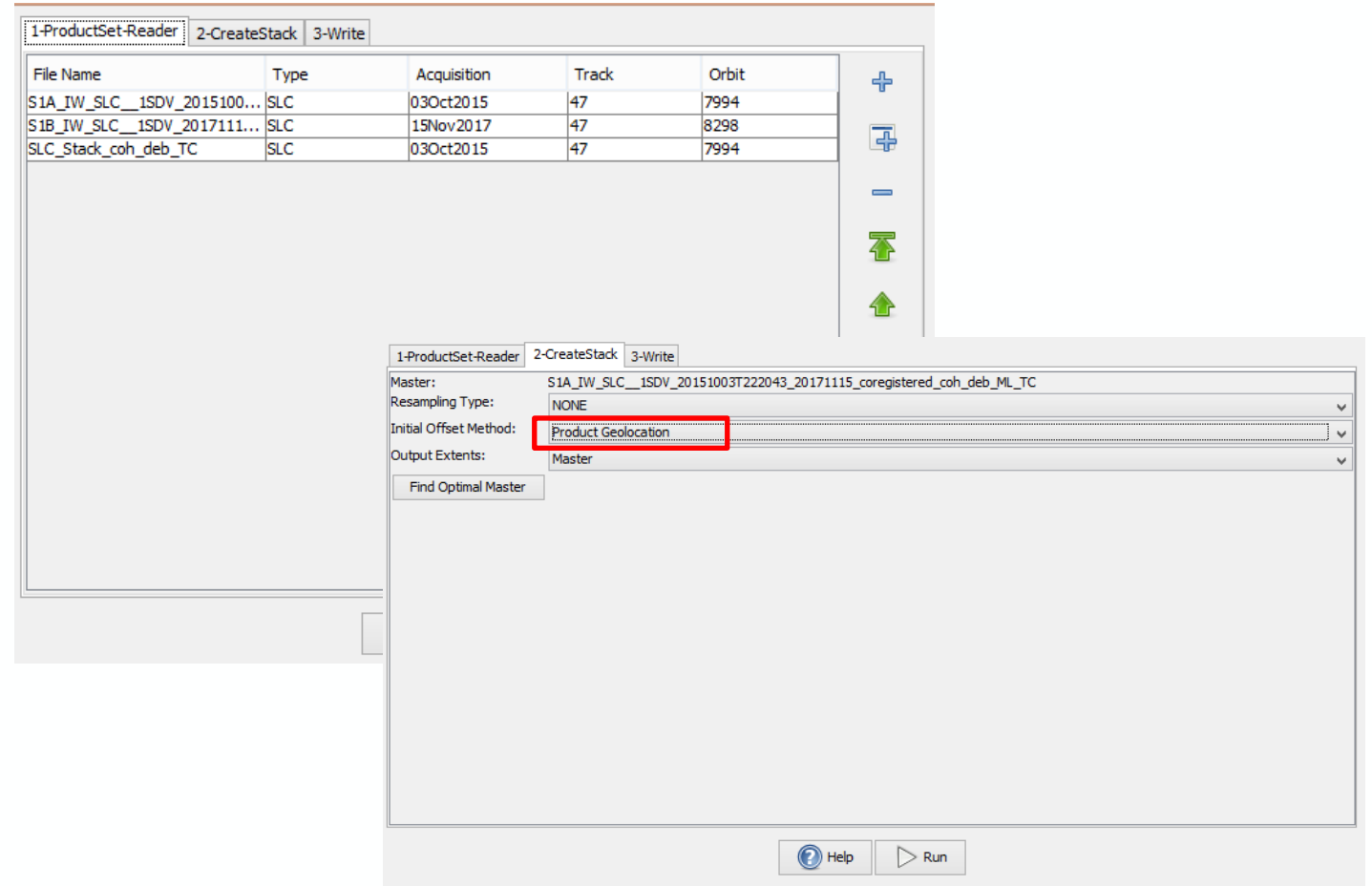
4746094 46.27157974243164, 20.740867614746094 46.4007453918457, 20.740867614746094 46.4007453918457)) Update

Load Clear Note Save Help Run

# Creating Stack of coherence



Input: all coherence subset images





# Time series analysis

The screenshot shows the software interface with three main components:

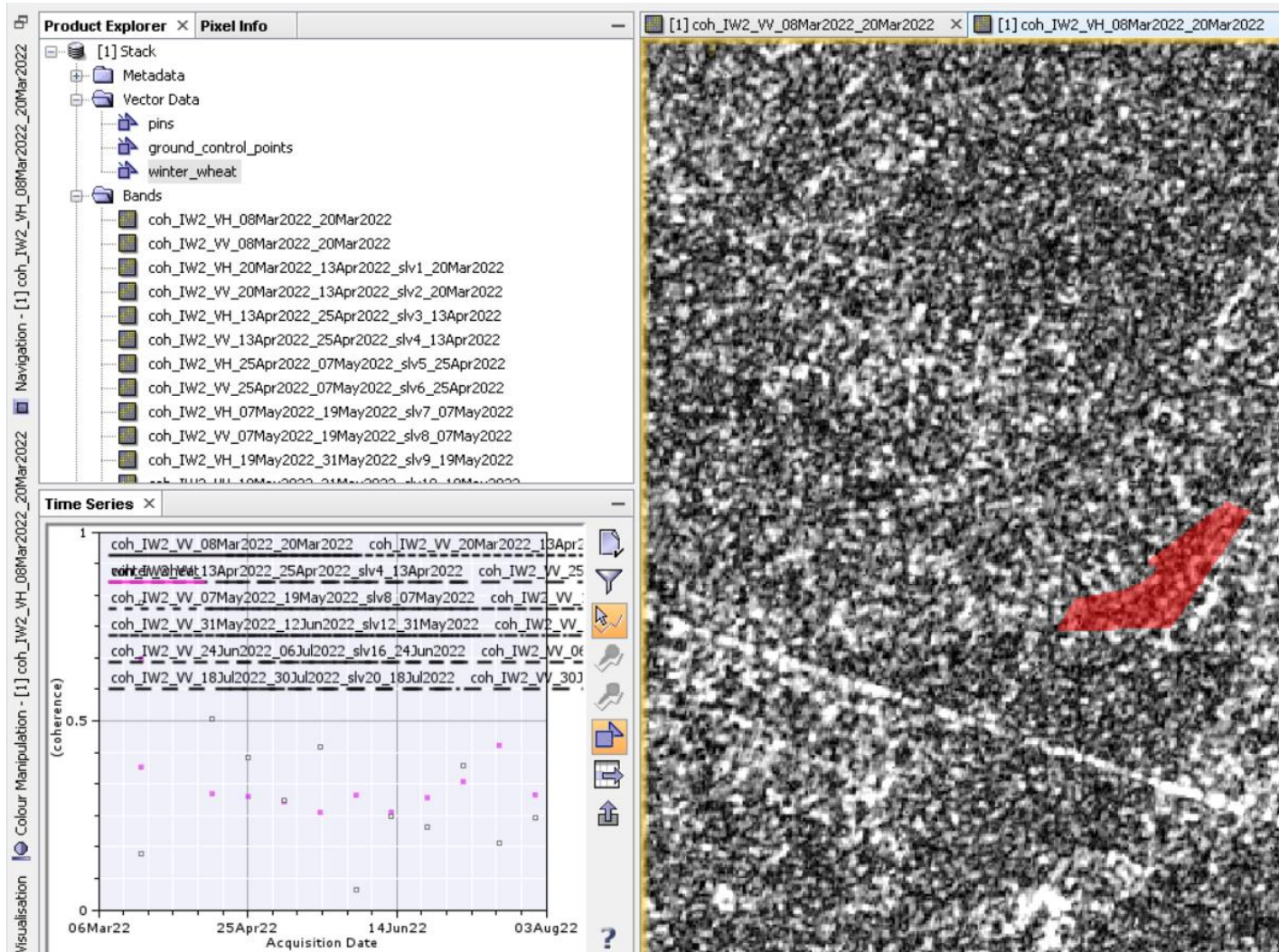
- Product Explorer:** A tree view on the left showing a stack of data including Metadata, Vector Data (pins, ground\_control\_points, winter\_barley\_06\_20), Bands, and Masks (winter\_barley\_06\_20).
- Time Series Filters:** A dialog box in the center with a list of bands. The 'Bands' tab is active, and several bands are checked, including 'coh\_IW2\_VV\_08Mar2022\_20Mar2022' and 'coh\_IW2\_VV\_20Mar2022\_13Apr2022\_slv2\_20Mar2022'. The 'Statistic' section has 'Mean' selected.
- Time Series Plot:** A graph at the bottom left showing coherence on the y-axis (0 to 0.8) and acquisition date on the x-axis (06Mar22 to 03Aug22). The plot shows a few data points with error bars.

## View/Tool Windows/Radar/Time series

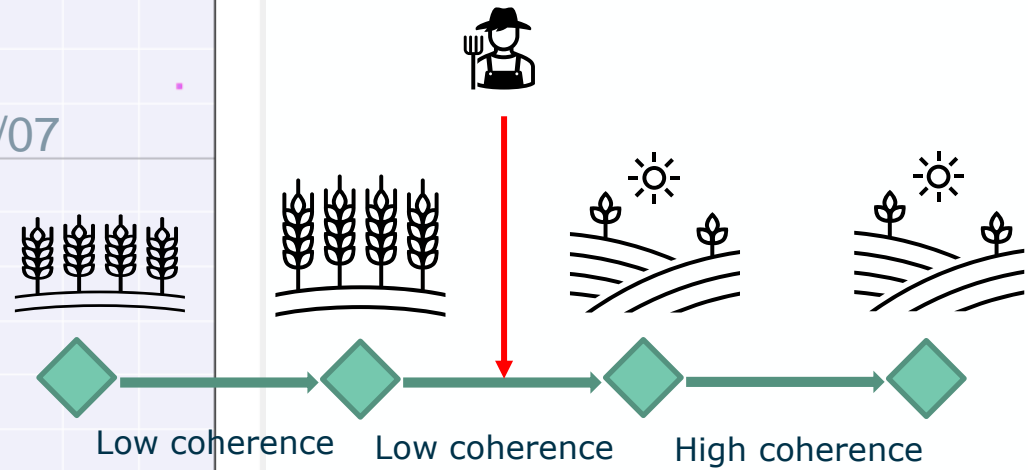
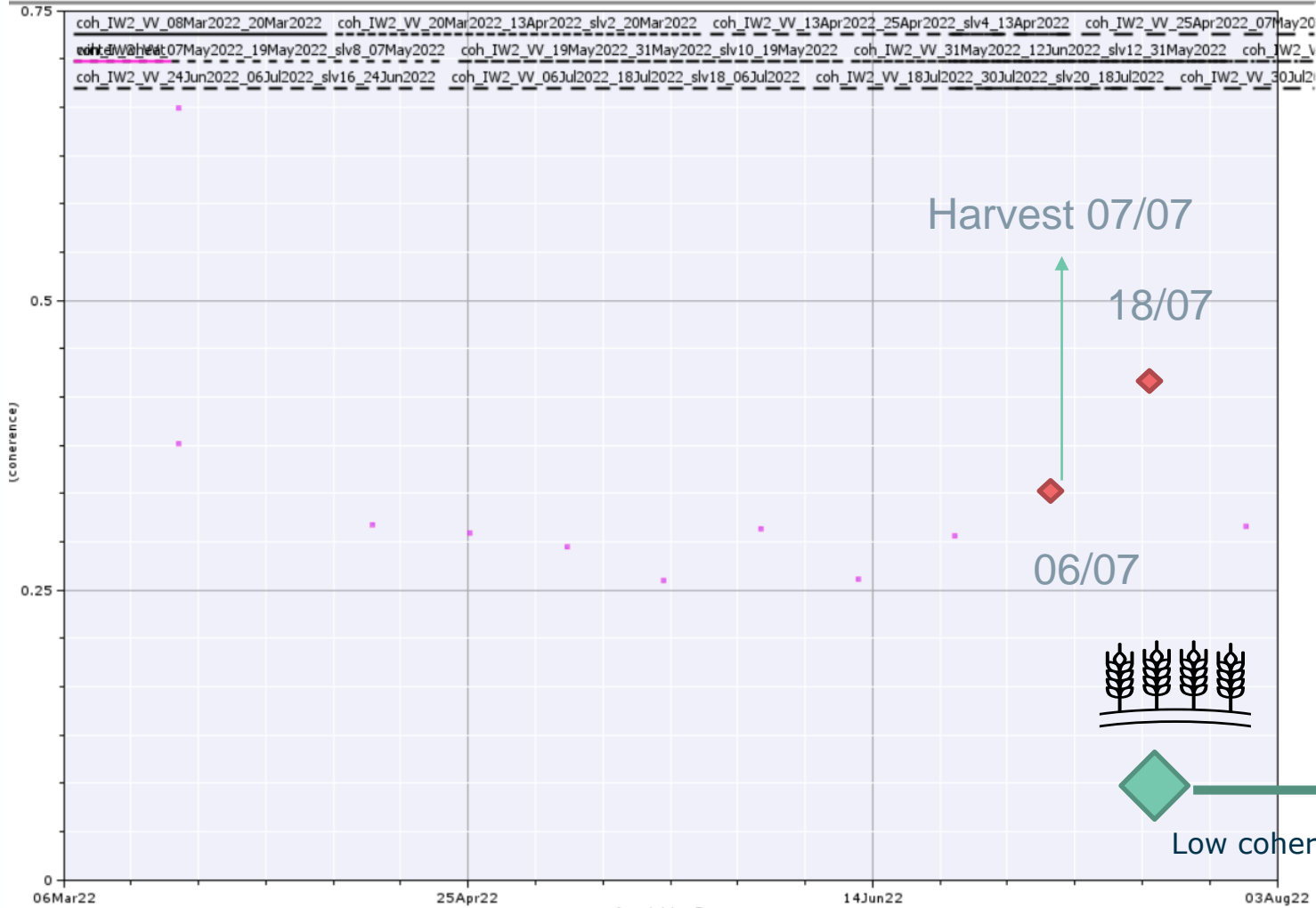
This is a close-up of the 'Time Series Filters' dialog box. It shows the 'Bands' tab with a list of bands. The 'winter\_wheat' band is highlighted with a pink bar. Below the list, the 'Statistic' section has 'Mean' selected. 'OK' and 'Cancel' buttons are at the bottom.

Select bands and mask (your geometry with the crop)

# Time series analysis



# Time series analysis



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

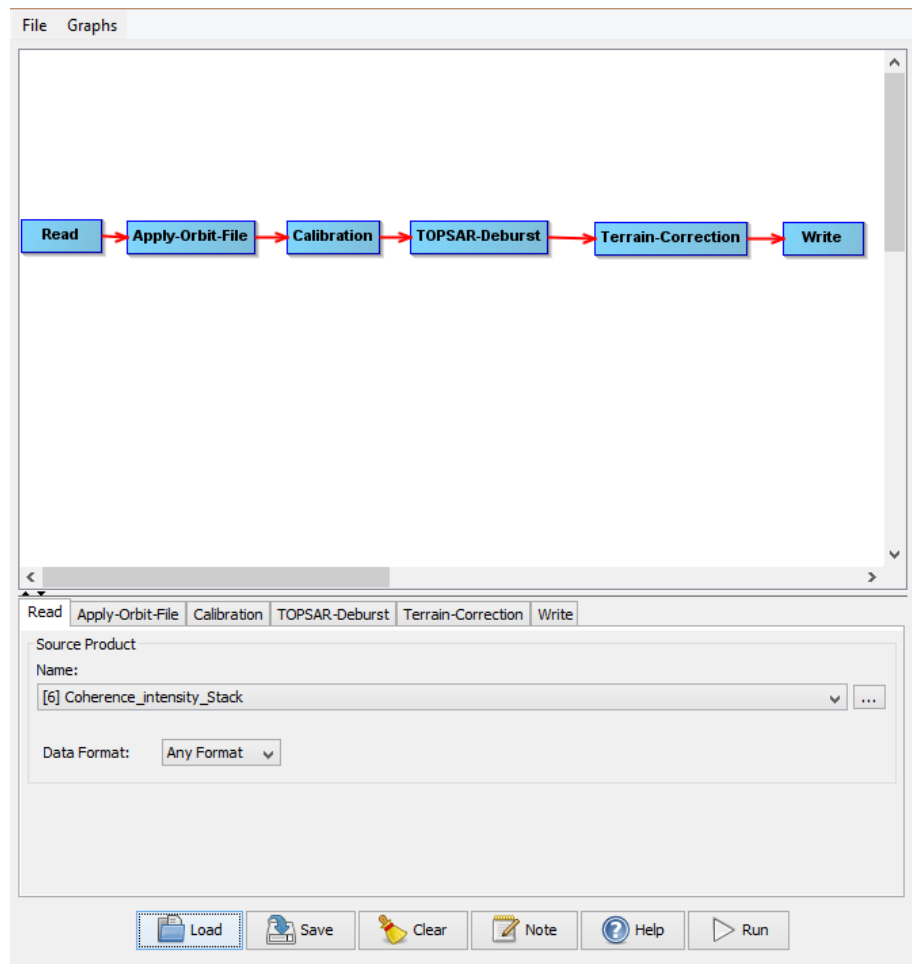
**Beta Naught** – radar brightness coefficient, reflectivity per unit area in slant range which is dimensionless

**Sigma Naught** – power returned to the antenna from the 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



# Backscatter Intensity product

MENU: *Graph Builder + Batch processing tool*



Input: Two splitted SLCs

The screenshot shows the Batch processing tool interface. It features a table with columns: File Name, Type, Acquisition, Track, and Orbit. Two rows of data are visible. A red box highlights the '+' and '+-' icons in the right margin of the table. Below the table, there is a 'Target Folder' section with a 'Save as:' dropdown set to 'BEAM-DIMAP', a 'Directory:' text box containing 'D:\DRAGON2019\Final Dataset\SLC\_processed\backscatter\_intensity', and checkboxes for 'Skip existing target files' (unchecked) and 'Keep source product name' (checked). At the bottom, there is a 'Load Graph' button highlighted with a red box, along with 'Run remote', 'Run', 'Close', and 'Help' buttons.

File Name	Type	Acquisition	Track	Orbit
S1A_IW_SLC__1SDV_20151...	SLC	03Oct2015	47	7994
S1B_IW_SLC__1SDV_20171...	SLC	15Nov2017	47	8298

### Sentinel-1 AWS-IW-VVH - IW-DV-VV-DECIBEL-GAMMA0-RADIOMETRIC-TERRAIN-CORRECTED

5 years    2 years    1 year    6 months    3 months    1 month

