

# → 7th ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

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# ESA SNAP SENTINEL-1 TOOLBOX

## MULTI-TEMPORAL ANALYSIS OF SENTINEL-1 SAR BACKSCATTERED INTENSITY

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# Goals of the Exercise

- Familiarize with open source **ESA SNAP** Toolbox.
- Familiarize with **Copernicus Sentinel-1** SAR products.
- Training on calculation and analysis of **backscatter coefficient** from Sentinel-1 detected products
- Review of manual as well as **batch processing** options of ESA SNAP Toolbox
- End-to-end showcase over the broader area of Bucharest (Hungary).



Contains modified  
Copernicus Sentinel data [2017]



# Input Dataset

- A set of **Sentinel-1A SLCs** `YYYYMMDDTHHMMSS`

`S1A_IW_GRDH_1SDV_20170709T163414_20170709T163439_017397_01D0F4_1BC0`

`S1A_IW_GRDH_1SDV_20170721T163415_20170721T163440_017572_01D647_D282`

`S1A_IW_GRDH_1SDV_20170802T163415_20170802T163440_017747_01DBA1_F344`

[downloadable @ <https://scihub.esa.int>]

- Sentinel-1 **Precise Orbits** (PODs) for the corresponding S1A dates (auxiliary data)

`S1A_OPER_AUX_POEORB_OPOD_*.EOF.zip`

[downloadable @ <https://qc.sentinel1.eo.esa.int>]

[stored locally @ `C:\Users\#username#\snap\auxdata\Orbits\Sentinel-1\POEORB\2014`]

- **Digital Elevation Model** (DEM) dataset from SRTM 3 arc-sec covering the Area of Interest (auxiliary data)

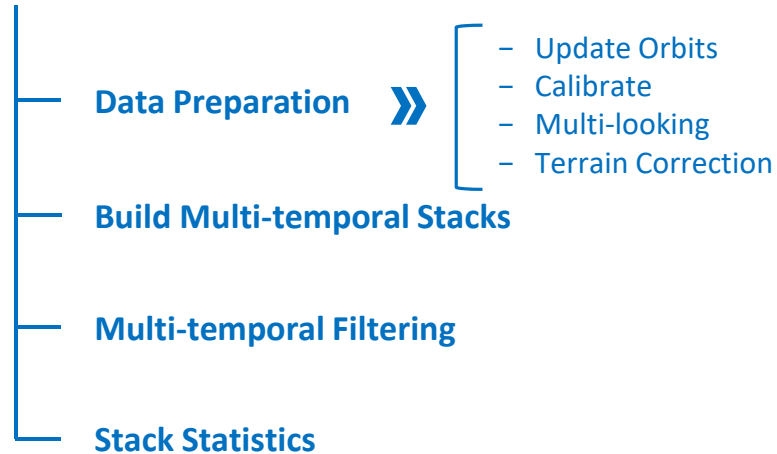
`srtm_40_03.zip`

[stored locally @ `C:\Users\#username#\snap\auxdata\dem\SRTM 3Sec`]

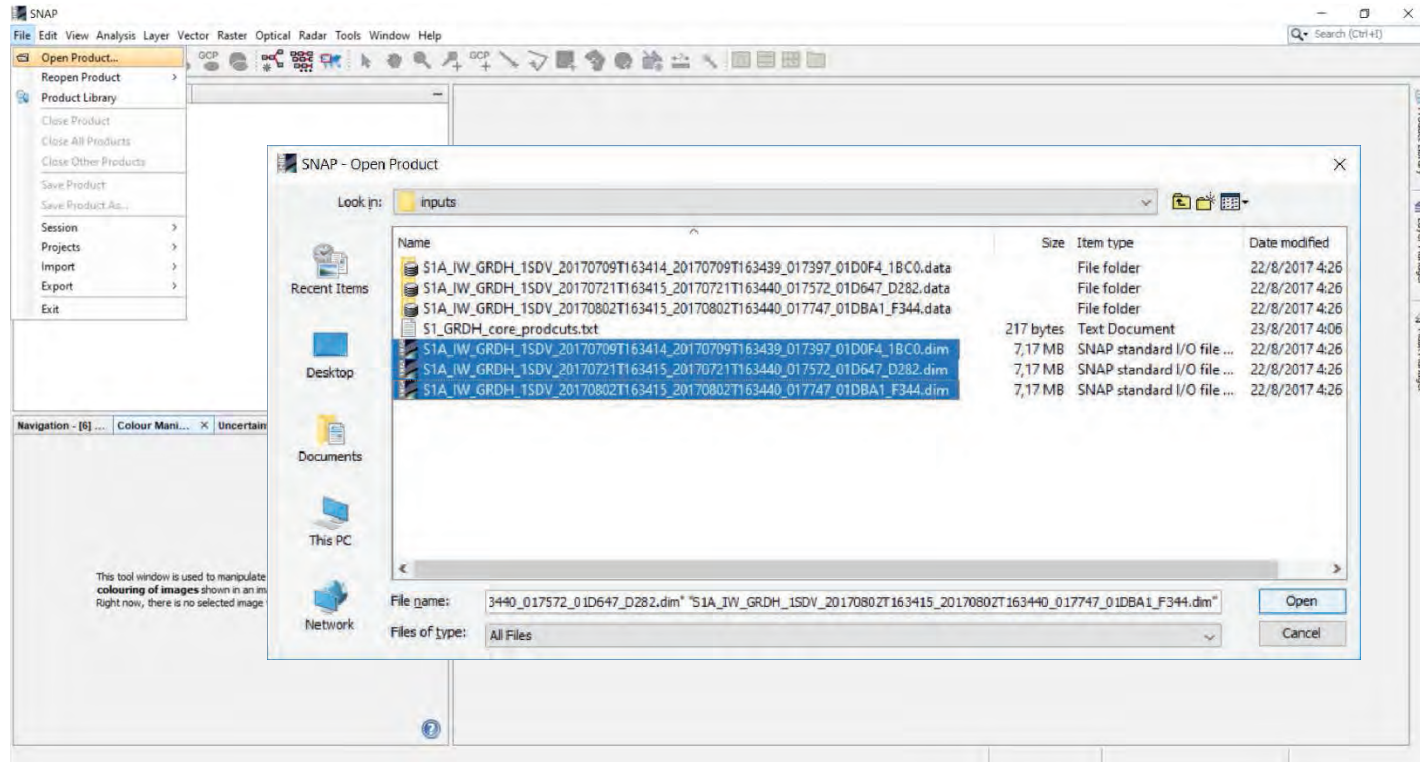


## EXERCISE

### Multi-temporal Analysis of Sentinel-1 SAR Backscattered Intensity



# Read Sentinel-1 SLC (Level-1) Products



# Building Automatic Processing Graph

The image displays two windows from the SNAP (Scientific Data Processing) software. The left window is the main SNAP interface, showing a 'Product Explorer' on the left with a list of satellite data products. The right window is the 'Graph Builder' window, titled 'Graph Builder: TOPSAR\_Orb\_Cal\_ML\_TC\_subset.xml'. It shows a workflow graph with the following steps: Read, Apply Orbit file, Calibration, Multilook, Terrain Correction, Subset, and Write. Below the graph, there are configuration options for each step, including Source Bands, Digital Elevation Model, DEM Resampling Method, Image Resampling Method, Source GR Pixel Spacings, Pixel Spacing, Pixel Spacing (deg), and Map Projection. The 'Run' button is visible at the bottom right of the Graph Builder window.

**Product Explorer:**

- [1] S1A\_IW\_GRDH\_1SDV\_20170709T163414\_20170709T163439\_017397\_01D0F4\_1BC0
- [2] S1A\_IW\_GRDH\_1SDV\_20170721T163415\_20170721T163440\_017572\_01D647\_02B2
- [3] S1A\_IW\_GRDH\_1SDV\_20170802T163415\_20170802T163440\_017747\_01D8A1\_F344

**Graph Builder: TOPSAR\_Orb\_Cal\_ML\_TC\_subset.xml**

**Workflow Graph:**

```
graph TD; Read --> ApplyOrbitFile[Apply Orbit file]; ApplyOrbitFile --> Calibration; Calibration --> Multilook; Multilook --> TerrainCorrection[Terrain Correction]; TerrainCorrection --> Subset; Subset --> Write;
```

**Configuration Options:**

- Source Bands: Sigma0\_VH, Sigma0\_VV
- Digital Elevation Model: SRTM 3Sec (Auto Download)
- DEM Resampling Method: BILINEAR\_INTERPOLATION
- Image Resampling Method: BILINEAR\_INTERPOLATION
- Source GR Pixel Spacings (az x rg): 20.0(m) x 20.0(m)
- Pixel Spacing (m): 20.0
- Pixel Spacing (deg): 1.796630568229043E-4
- Map Projection: WGS84(DD)
- ☒ Mask out areas without elevation ☐ Output complex data

**Buttons:** Load, Save, Clear, Note, Help, Run

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# Define Processing Parameters

The image displays four screenshots of the Graph Builder interface, showing different processing parameter configurations for TOPSAR data. Each screenshot shows a workflow graph with steps: Read, Apply-Orbit-File, Calibration, Multilook, Terrain-Correction, Subset, and Write.

**Graph Builder: TOPSAR\_Orb\_Cal\_ML\_TC\_subset.xml**

- Orbit State Vectors: Sentinel Precise (Auto Download)
- Polynomial Degree: 3
- ☒ Do not fail if new orbit file is not found
- ☐ Save as complex output
- ☒ Output sigma0 band
- ☐ Output gamma0 band
- ☐ Output beta0 band

**Graph Builder: TOPSAR\_Orb\_Cal\_ML\_TC\_subset.xml**

- Polarisations: VH, VV
- ☐ Save as complex output
- ☒ Output sigma0 band
- ☐ Output gamma0 band
- ☐ Output beta0 band

**Graph Builder: TOPSAR\_Orb\_Cal\_ML\_TC\_subset.xml**

- Source Bands: Sigma0\_VH, Sigma0\_VV
- ☒ GR Square Pixel
- ☐ Independent Looks
- Number of Range Looks: 2
- Number of Azimuth Looks: 2
- Mean GR Square Pixel: 20.0
- ☒ Output Intensity
- Note: Detection for complex data is done without resampling.

**Graph Builder: TOPSAR\_Orb\_Cal\_ML\_TC\_subset.xml**

- Source Bands: Sigma0\_VH, Sigma0\_VV
- Digital Elevation Model: SRTM 3Sec (Auto C)
- DEM Resampling Method: BILINEAR\_INTERP
- Image Resampling Method: BILINEAR\_INTERP
- Source GR Pixel Spacings (az x rg): 20.0(m) x 20.0(m)
- Pixel Spacing (m): 20.0
- Pixel Spacing (deg): 1.7966305682390
- Map Projection:
- ☒ Mask out areas without elevation
- ☐ Output complex

**Graph Builder: TOPSAR\_Orb\_Cal\_ML\_TC\_subset.xml**

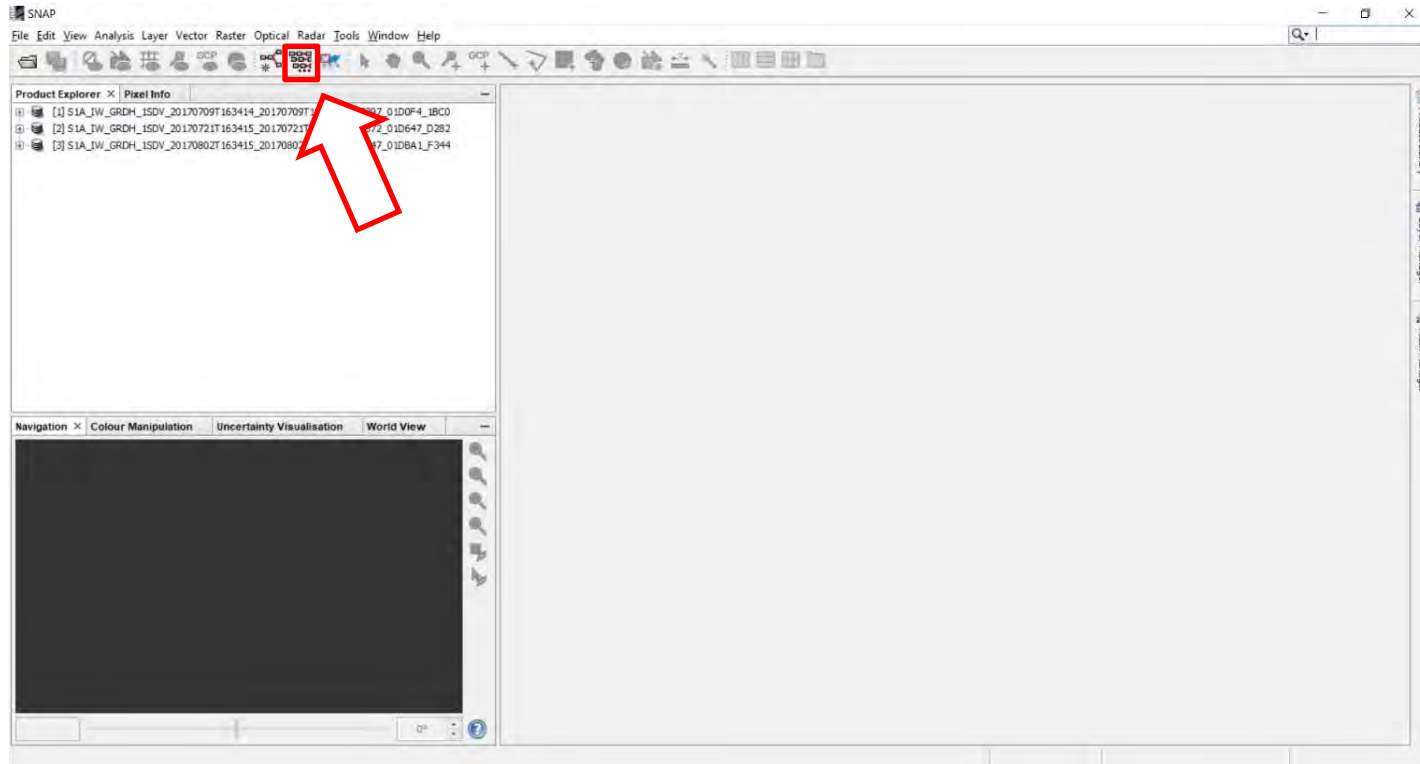
- Source Bands: Sigma0\_VH, Sigma0\_VV
- ☒ Copy Metadata
- ☐ Pixel Coordinates
- ☒ Geographic Coordinates
- POLYGON ((18.785 47.69, 19.36 47.69, 19.36 47.30, 18.785 47.30, 18.785 47.69, 18.785 47.69))

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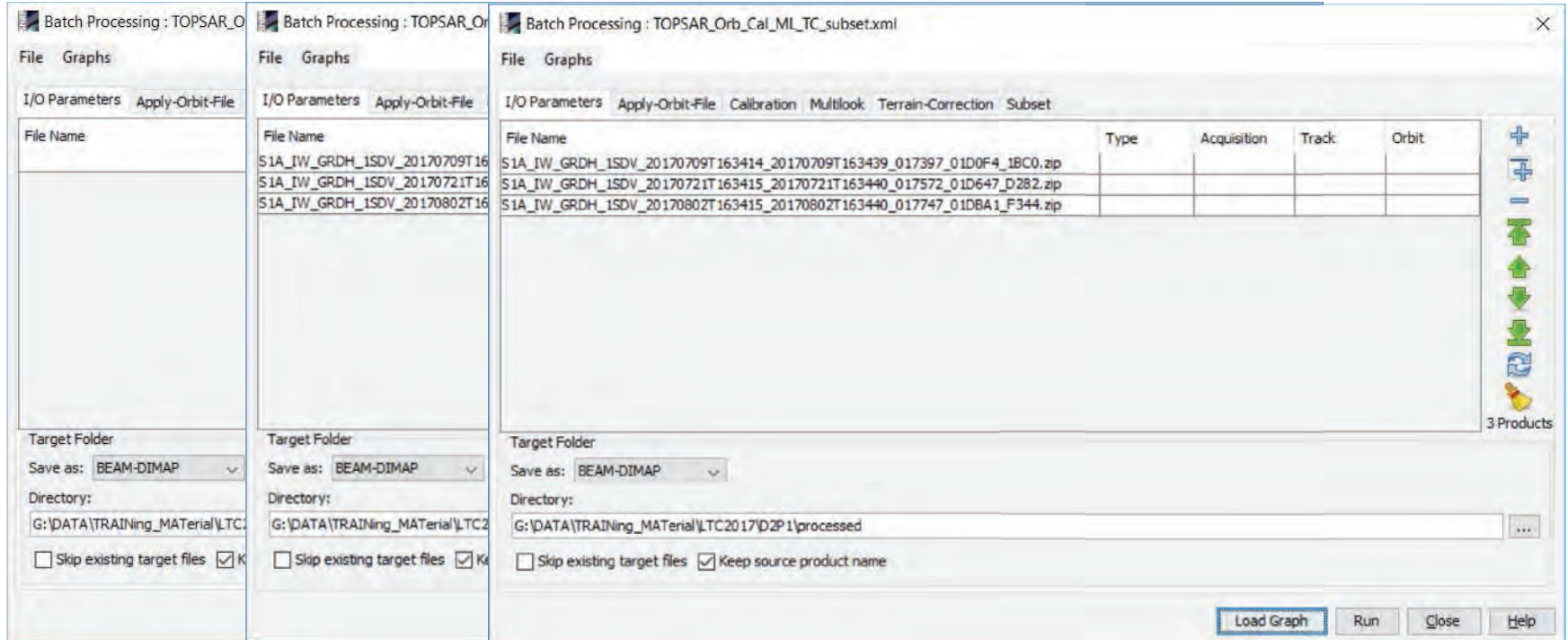
# SNAP Batch Processing Operator



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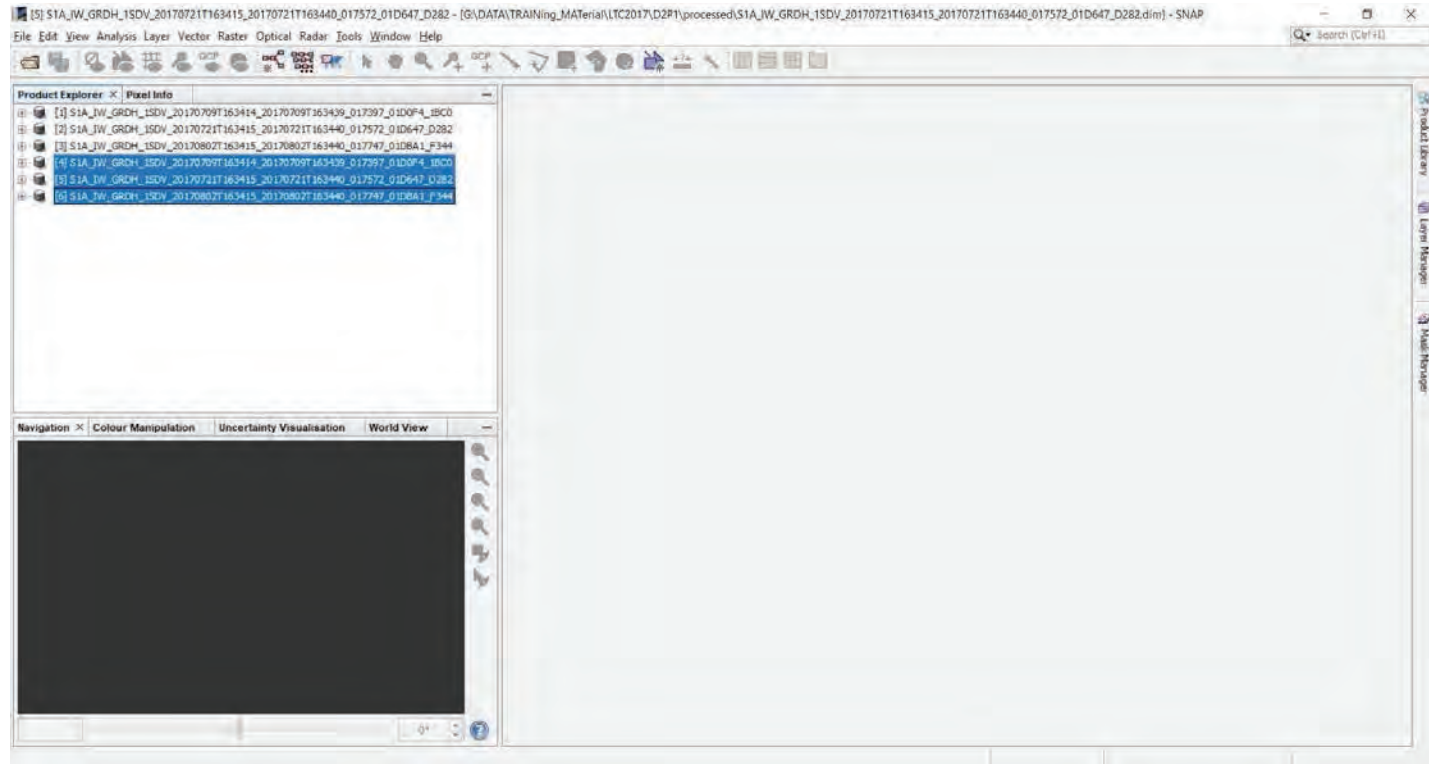
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# Apply Batch Processing (\*.xml file)





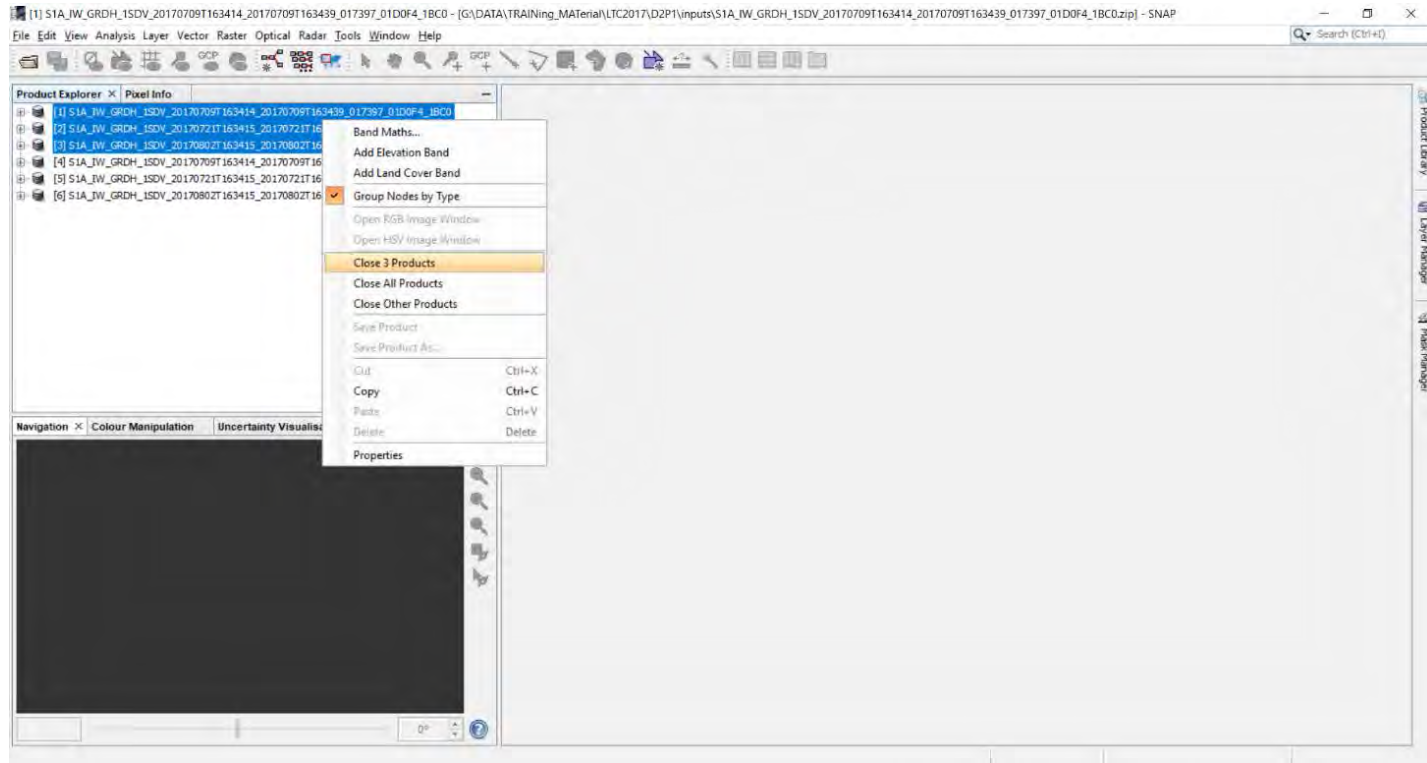
# Batch Processing Results | Products' Naming



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# Close Initial Products

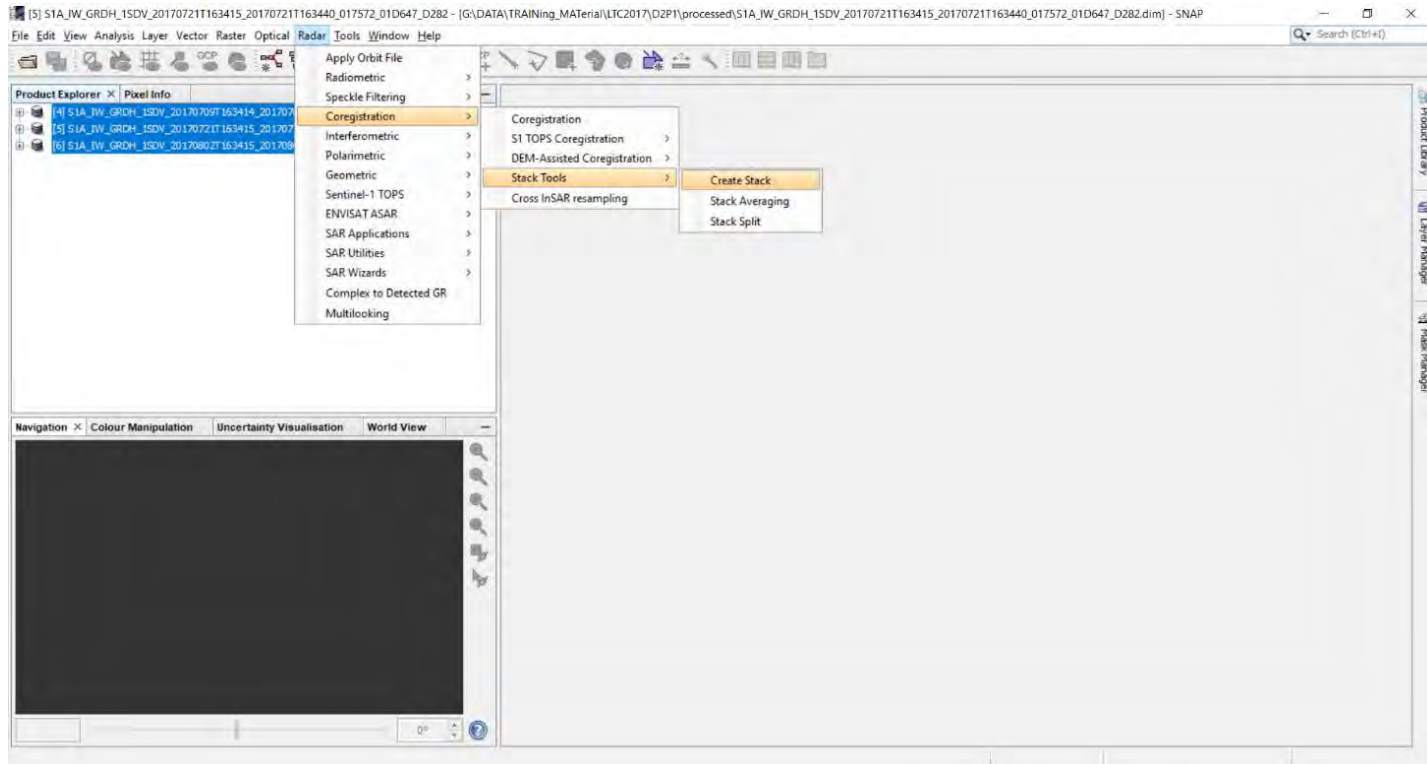


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# Create Stack (Container of Multiple Products)



# Create Stack Parameters

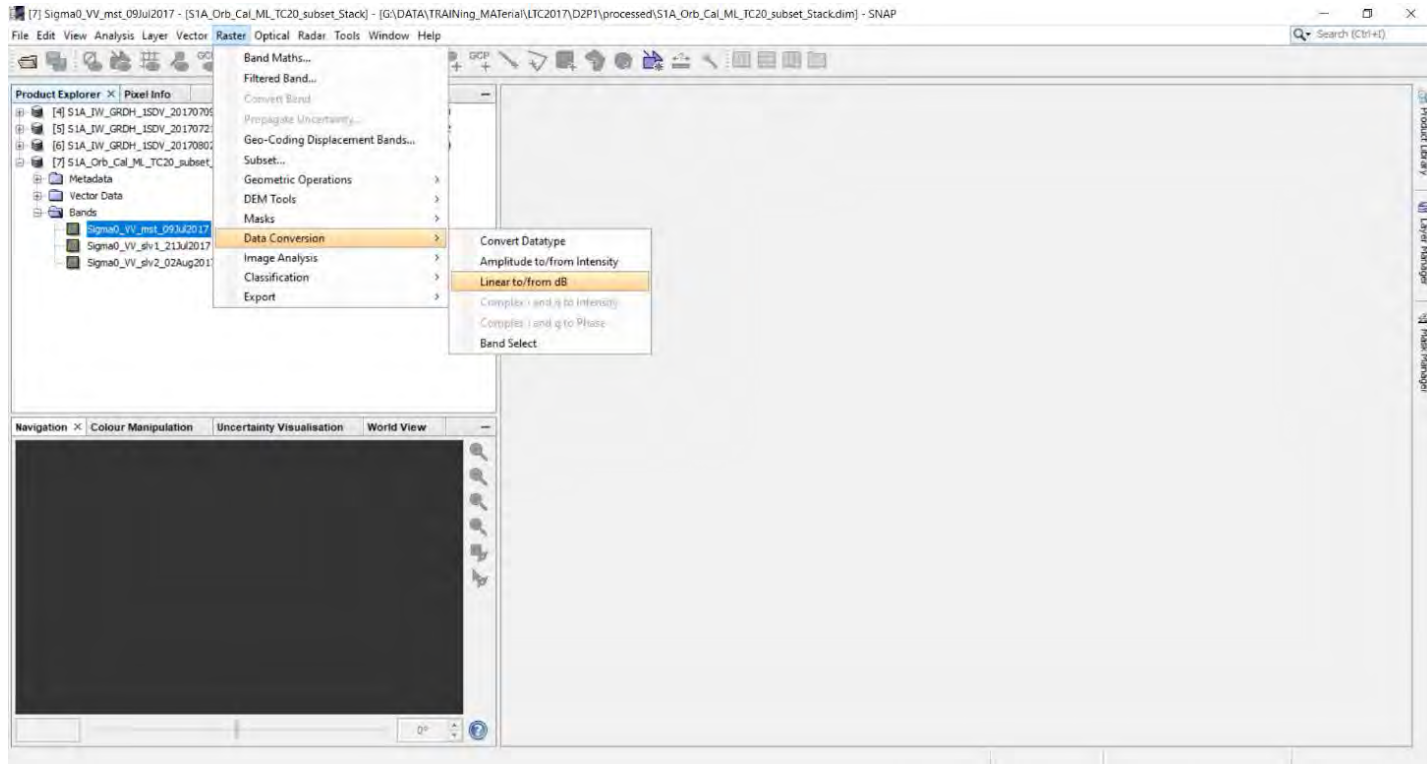
The screenshot shows a 'Create Stack' dialog box with four tabs. The first three tabs are labeled '1-ProductSet-Reader' and the fourth is '2-CreateStack'. The '2-CreateStack' tab is active, showing the following fields:

- Master:** (empty)
- Resampling Type:** (empty)
- Initial Offset Method:** (empty)
- Output Extents:** (empty)
- Find Optimal Mask:** (button)
- Name:** S1A\_Orb\_Col\_ML\_TC20\_subset\_Stack.dim
- Save as:** BEAM-DIMAP (dropdown menu)
- Directory:** G:\DATA\TRAINING\_MATERIAL\TC2017\DP1\processed (text field with a browse button)

At the bottom of the dialog, there are two buttons: 'Help' and 'Run'.



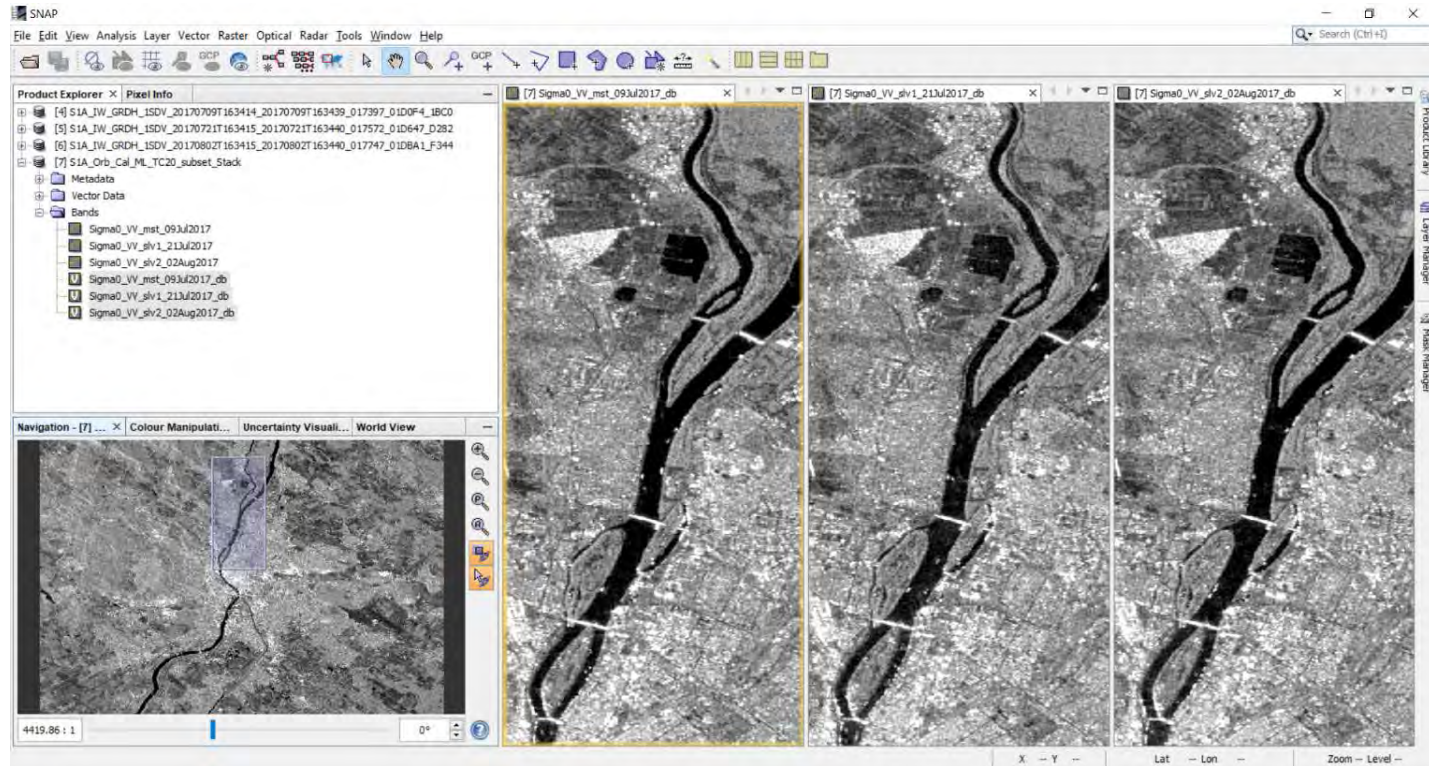
# Convert Backscatter (Linear to dB Scale)



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# Visual Inspection of Mutli-temporal dataset

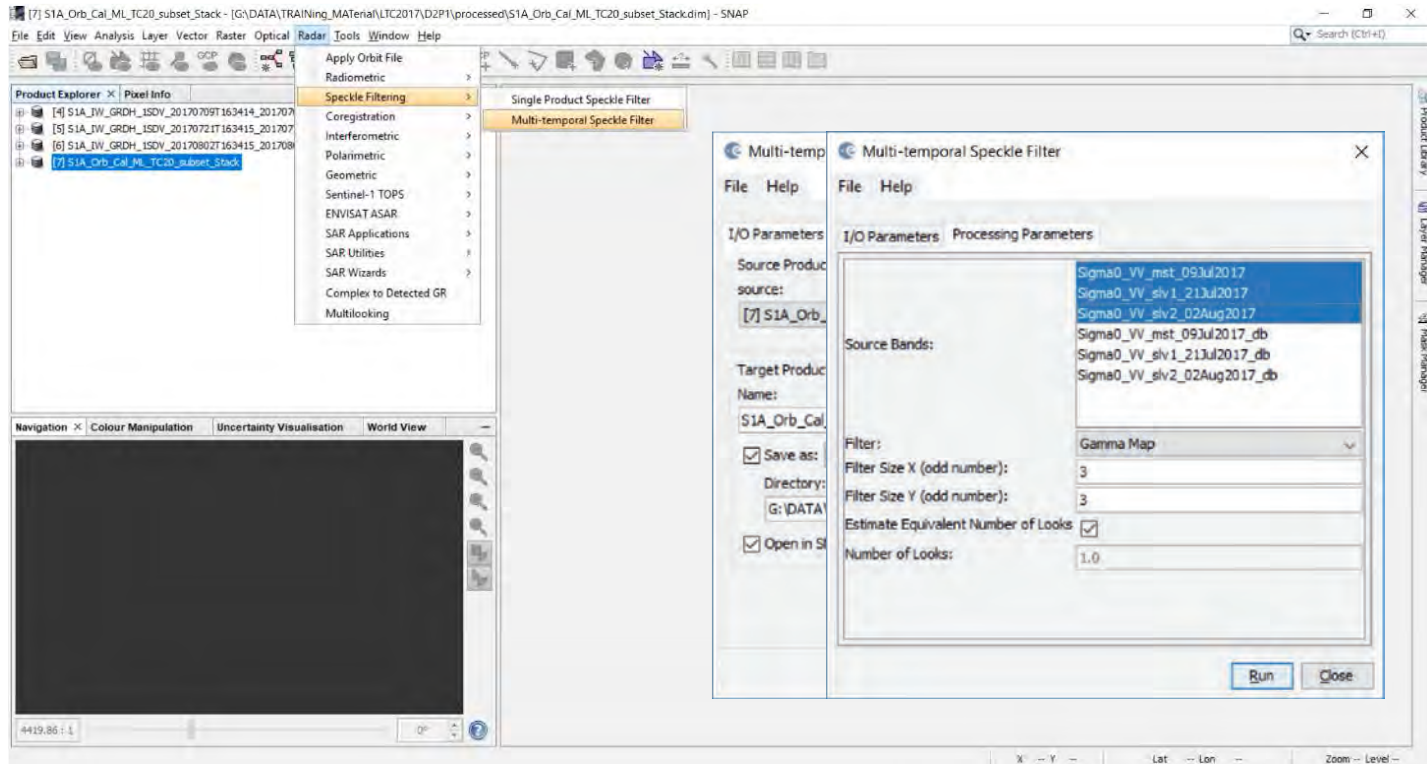


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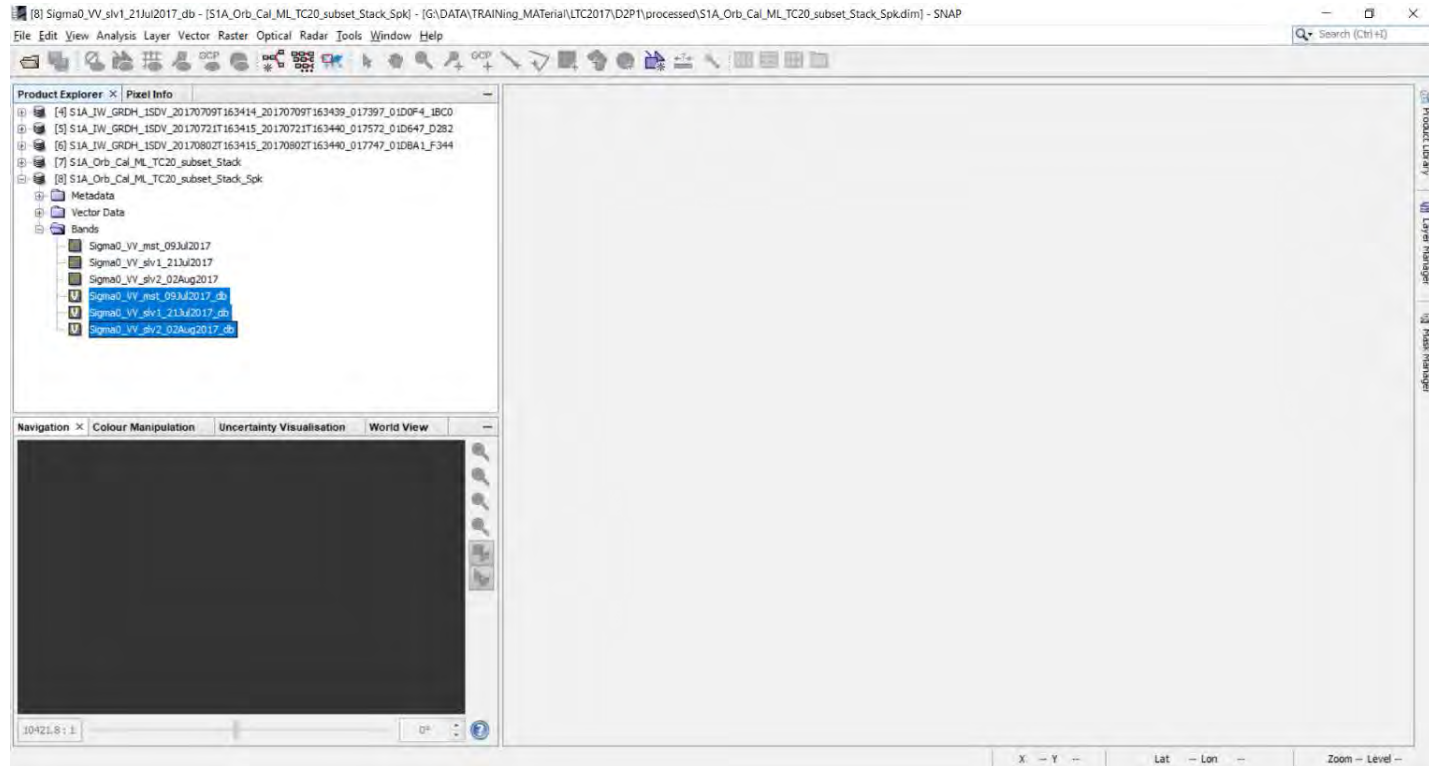
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# Mutli-temporal Speckle Filtering



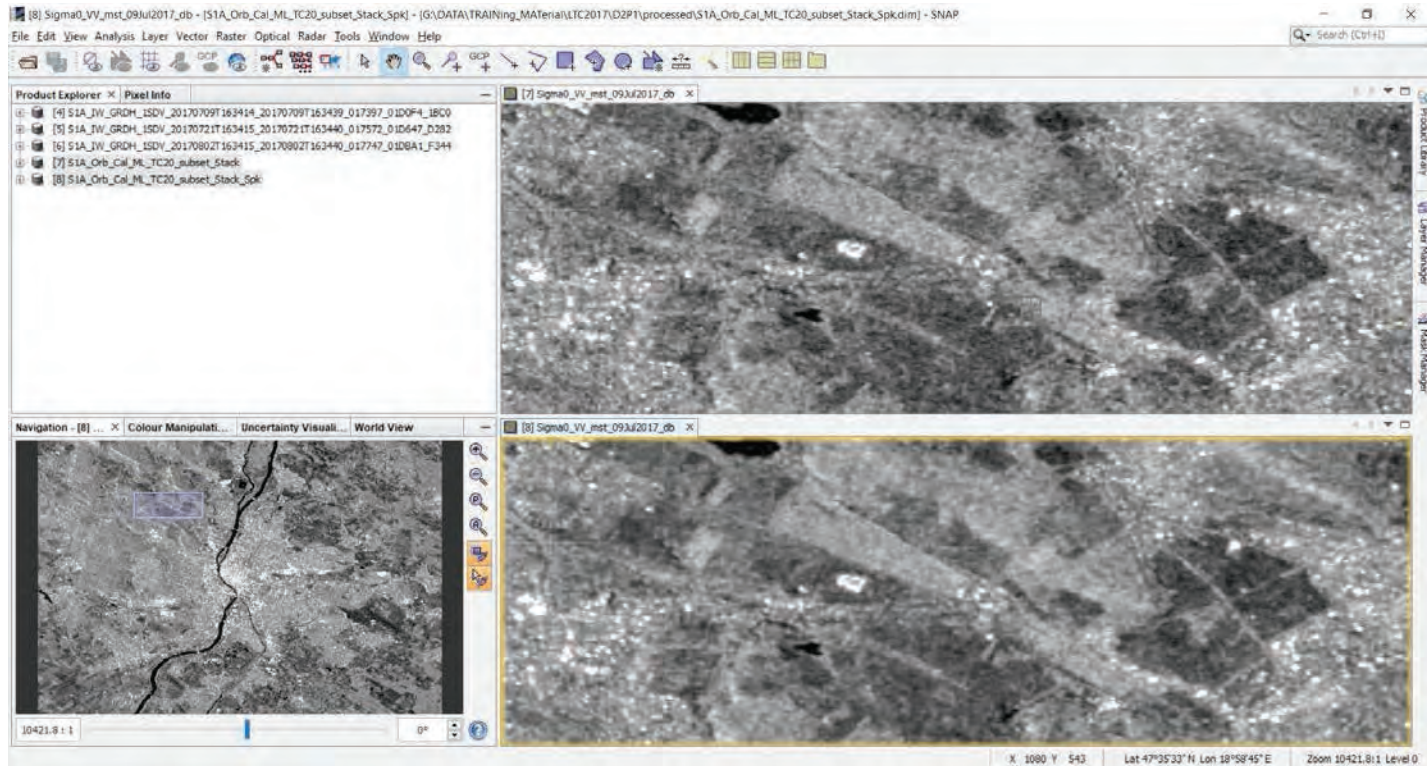
# Convert Backscatter (Linear to dB Scale)



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# Evaluate Performance of Multi-temporal Filter 1/2

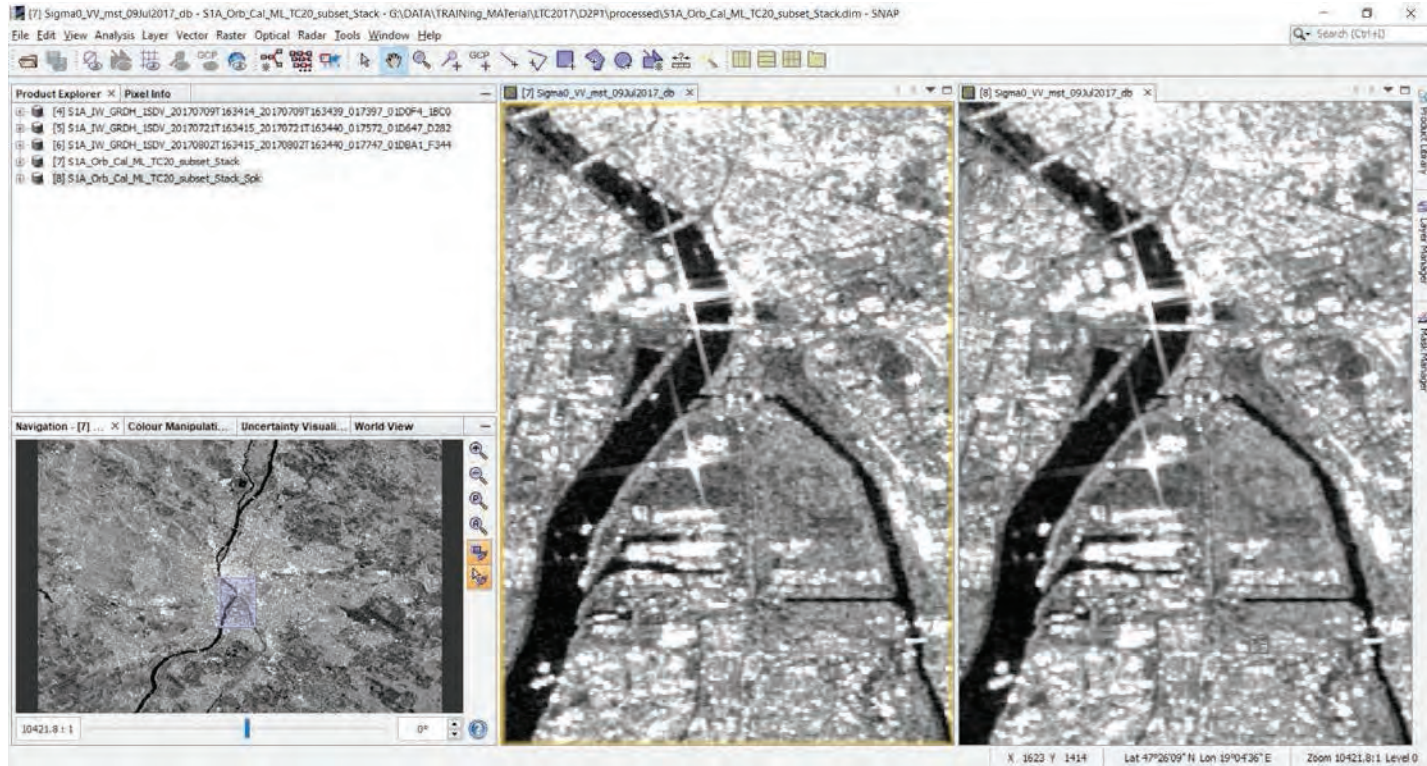


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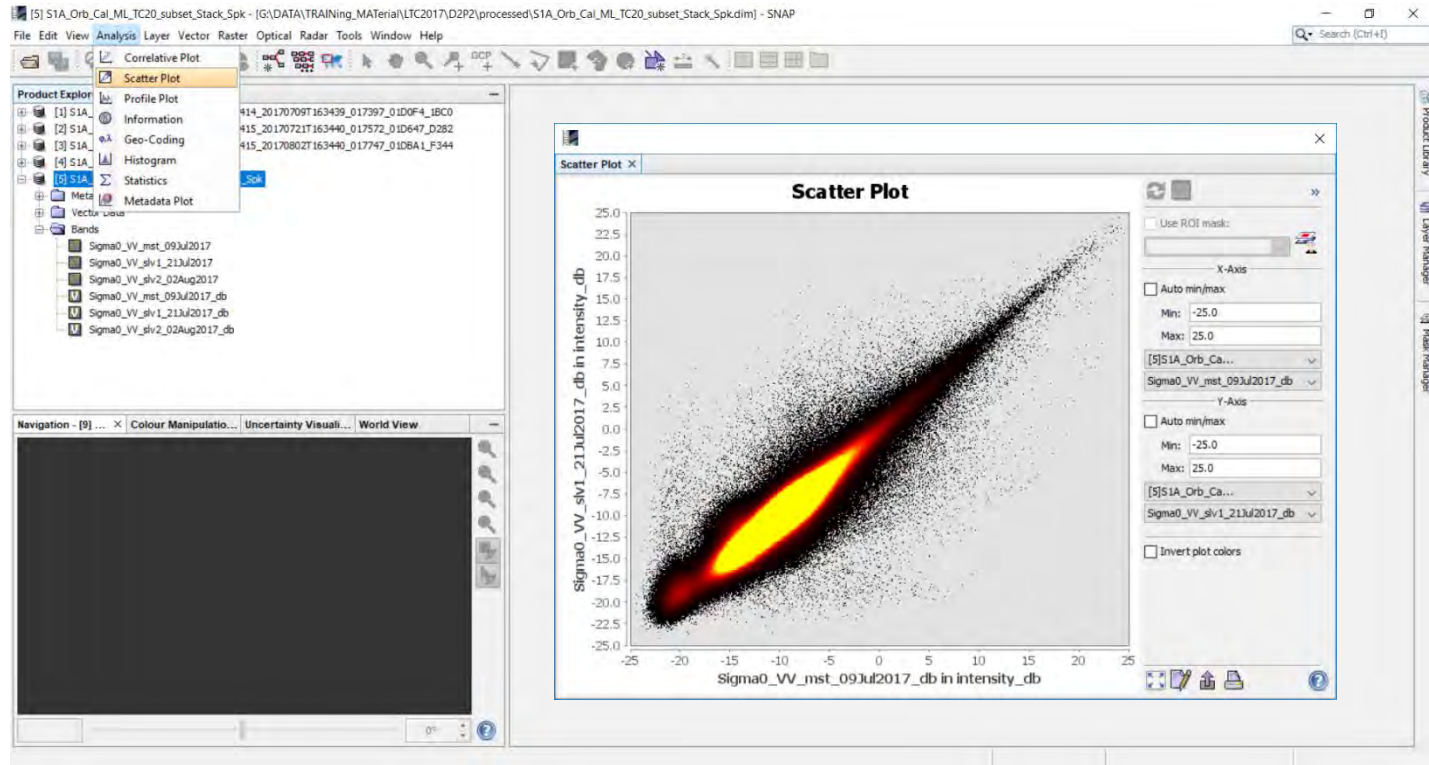
# Evaluate Performance of Multi-temporal Filter 2/2



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# Compare Filtered/Unfiltered Sigma0 Values | Scatter Plot

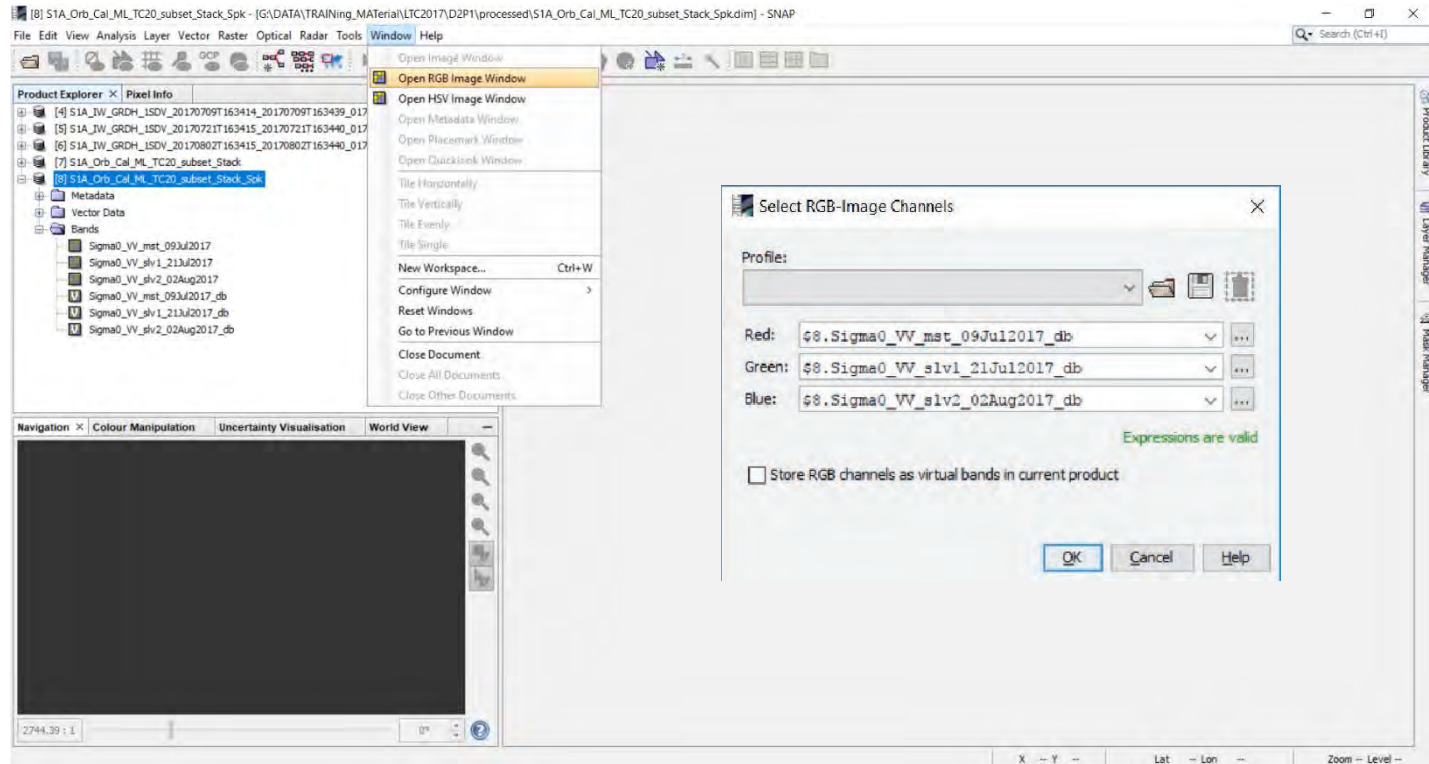


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# Generate RGB False Colour Composite

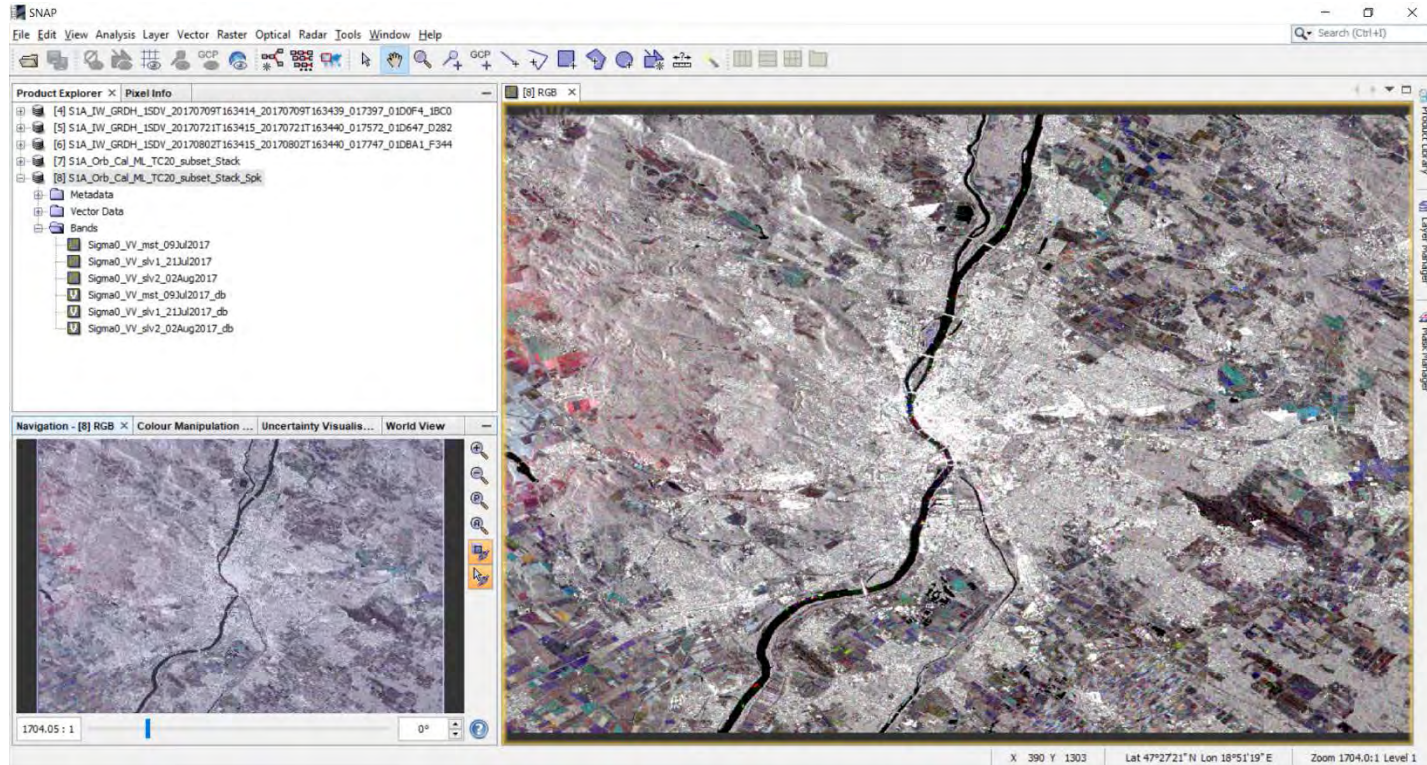


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# Generate RGB Composite >> R: 20170709 G: 20170721 B: 20170802

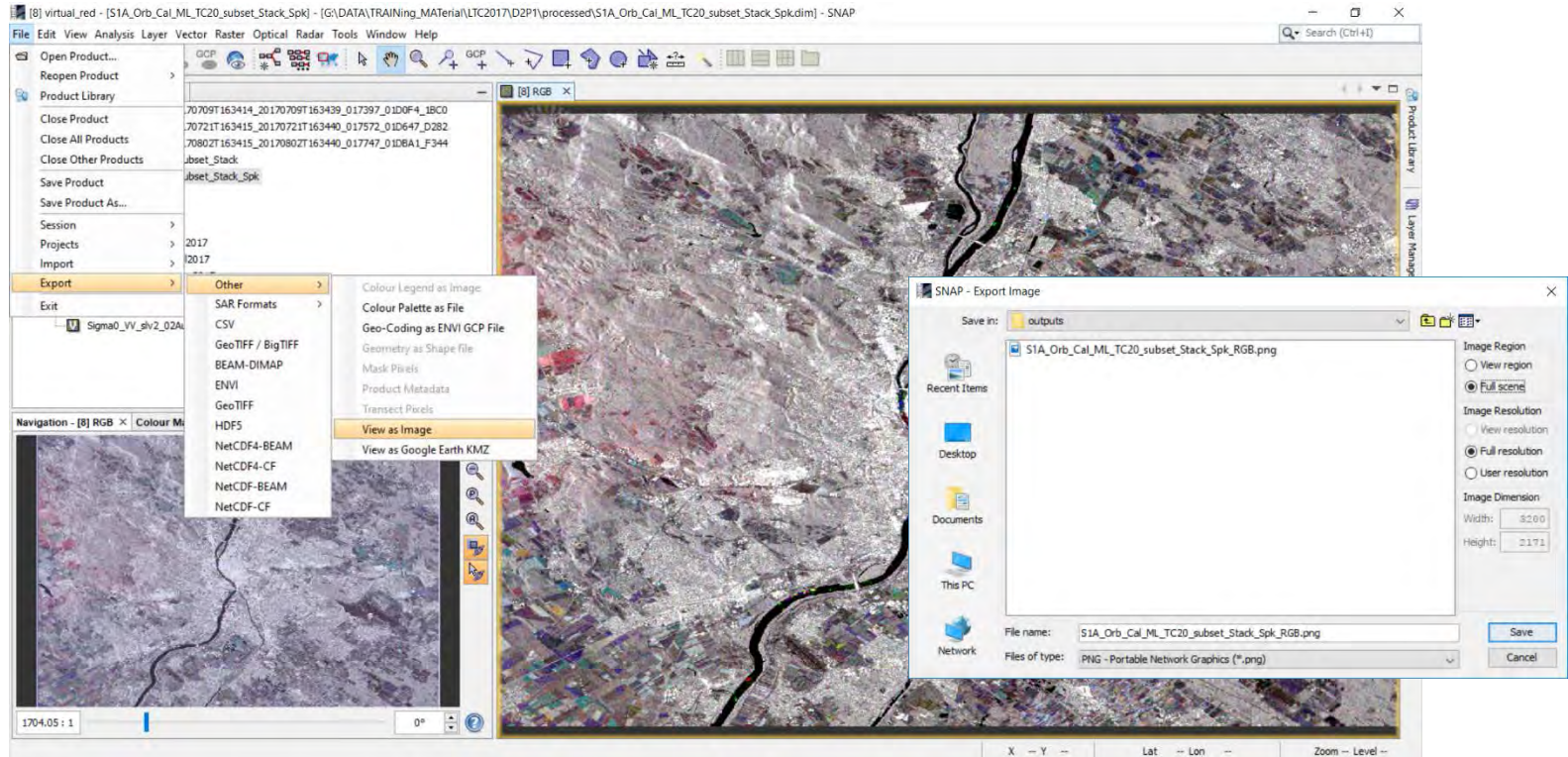


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# Export View as Image (\*.png)

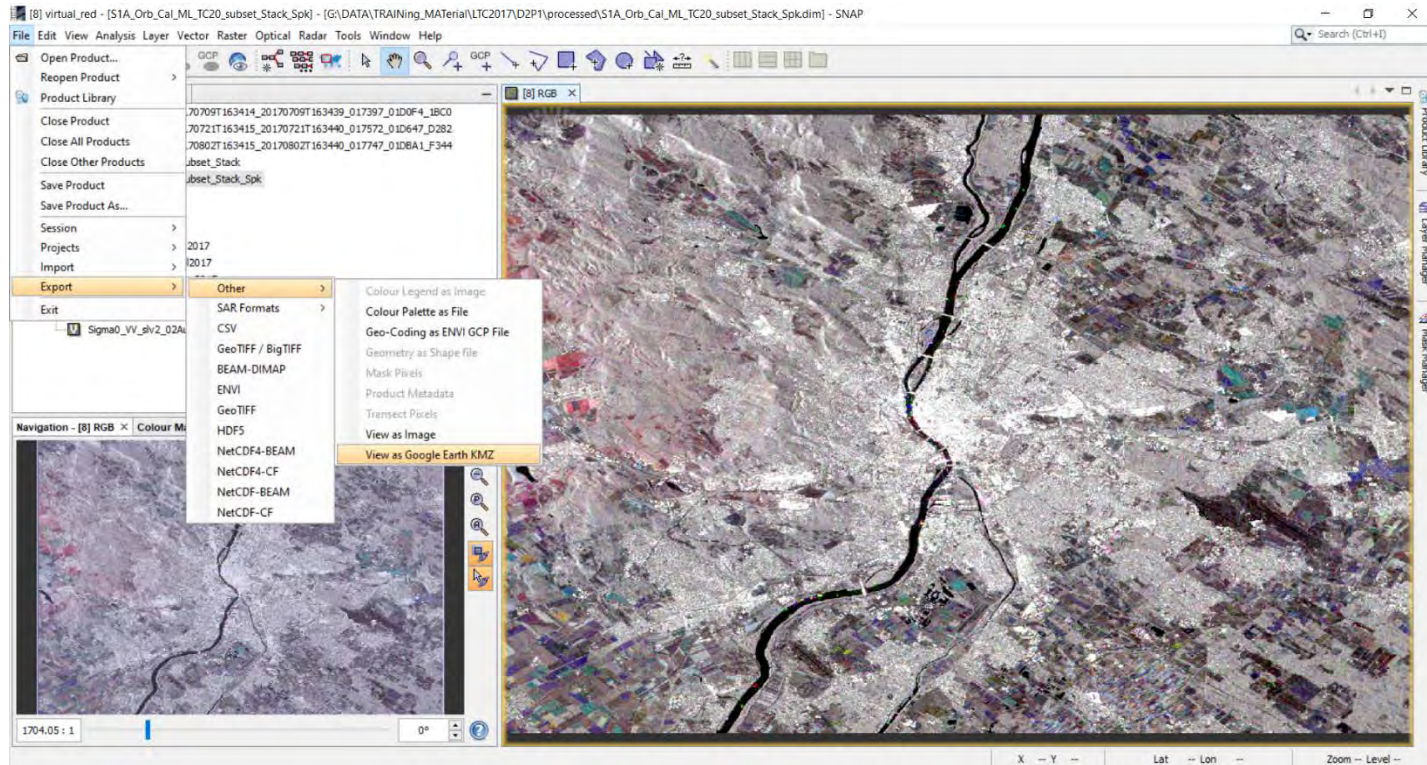


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# Export RGB Composite to Google Earth (\*.kmz file)

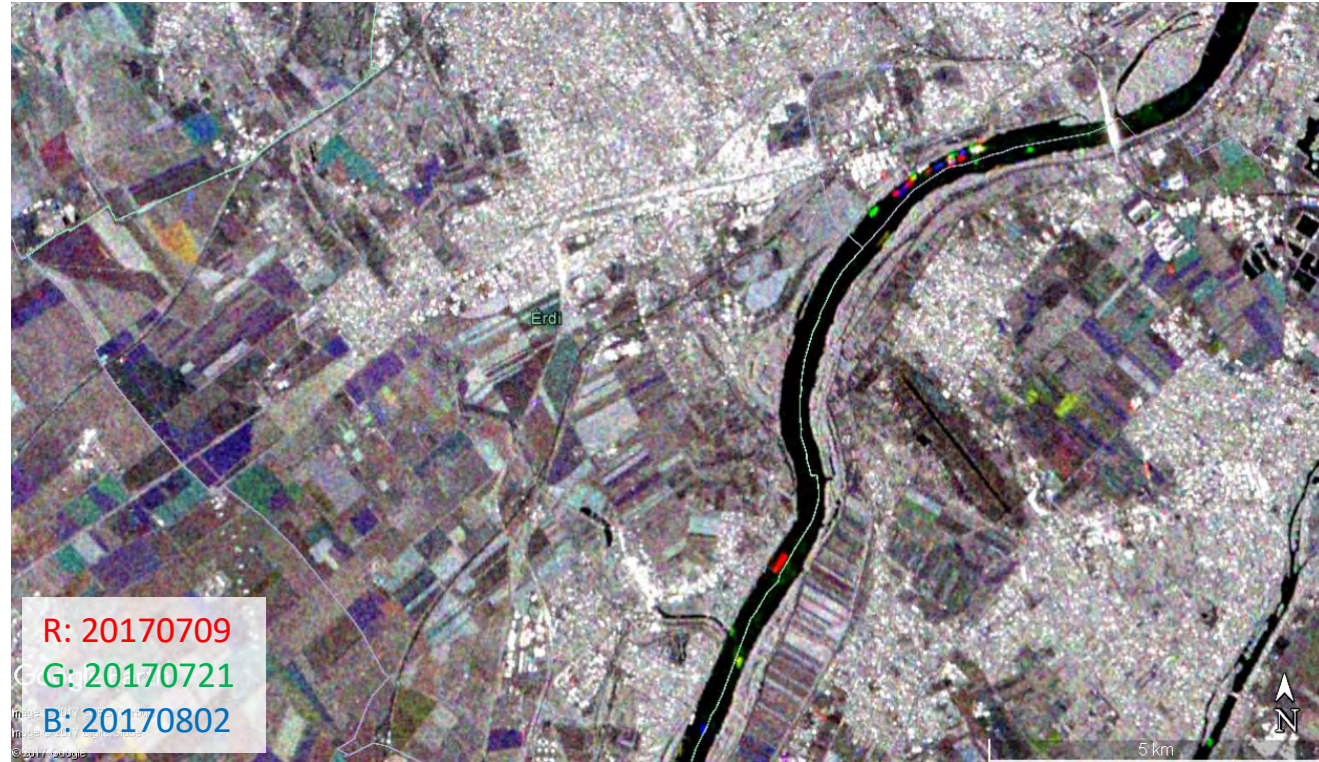


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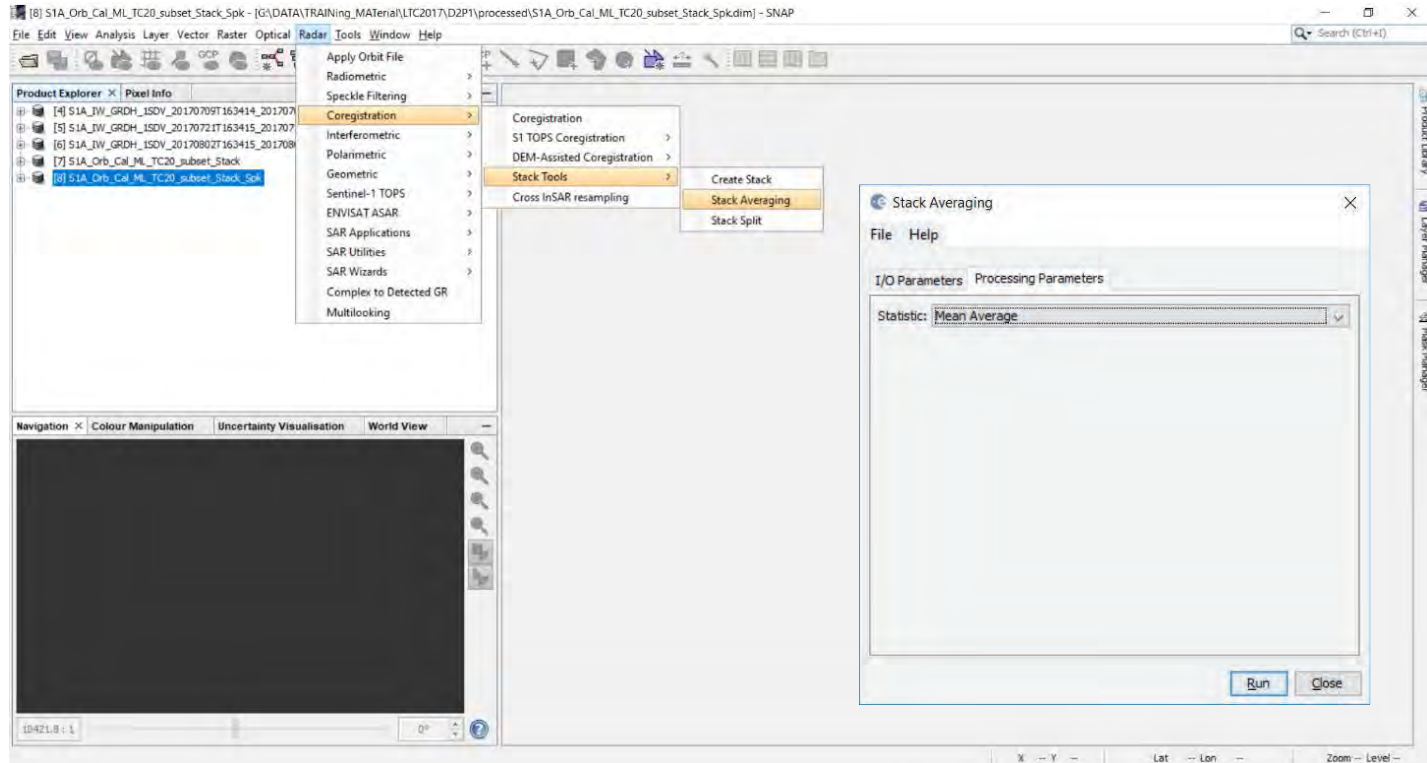
# Sentinel-1 Multi-temporal **6-days** Backscatter Coefficient Composite



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# Multi-temporal Stack Averaging

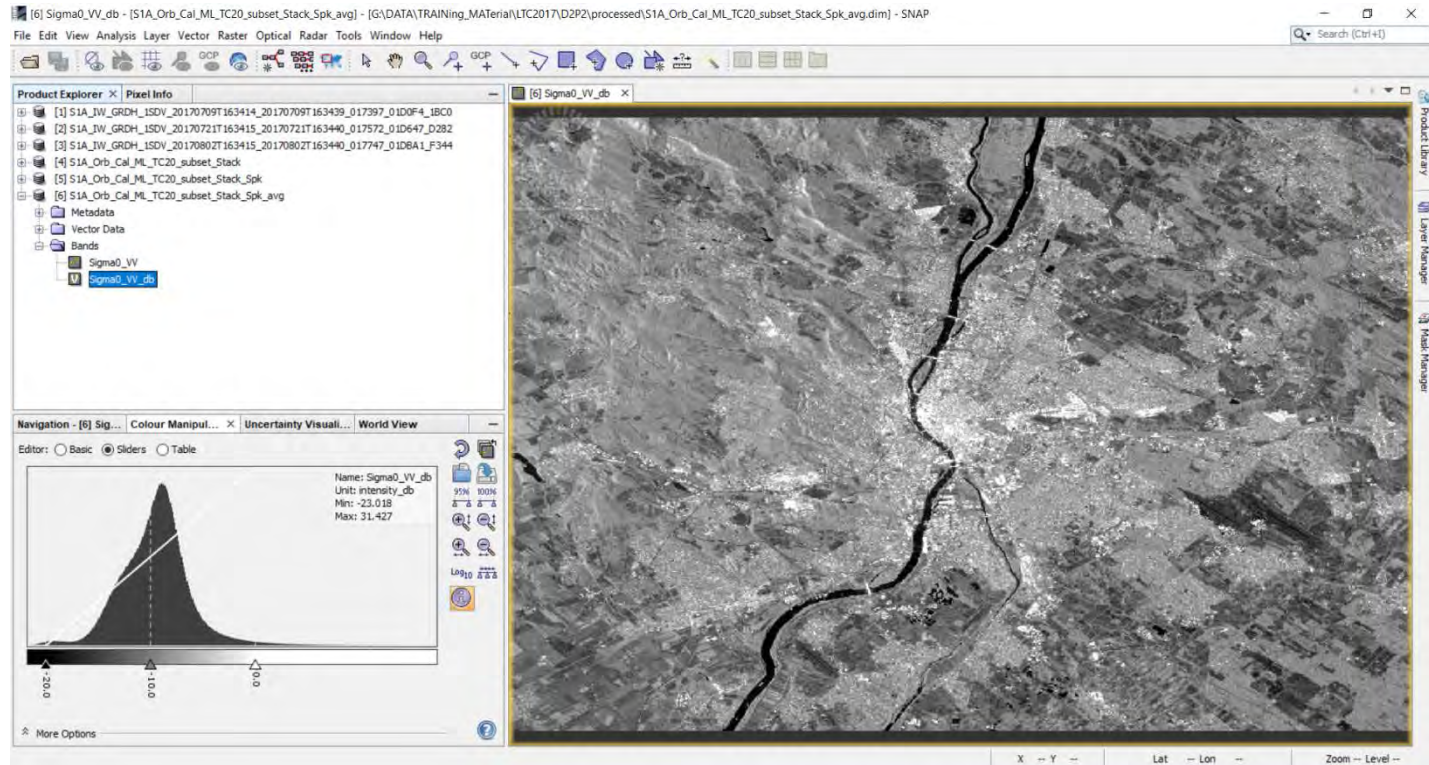


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# Convert Backscatter (Linear to dB Scale)

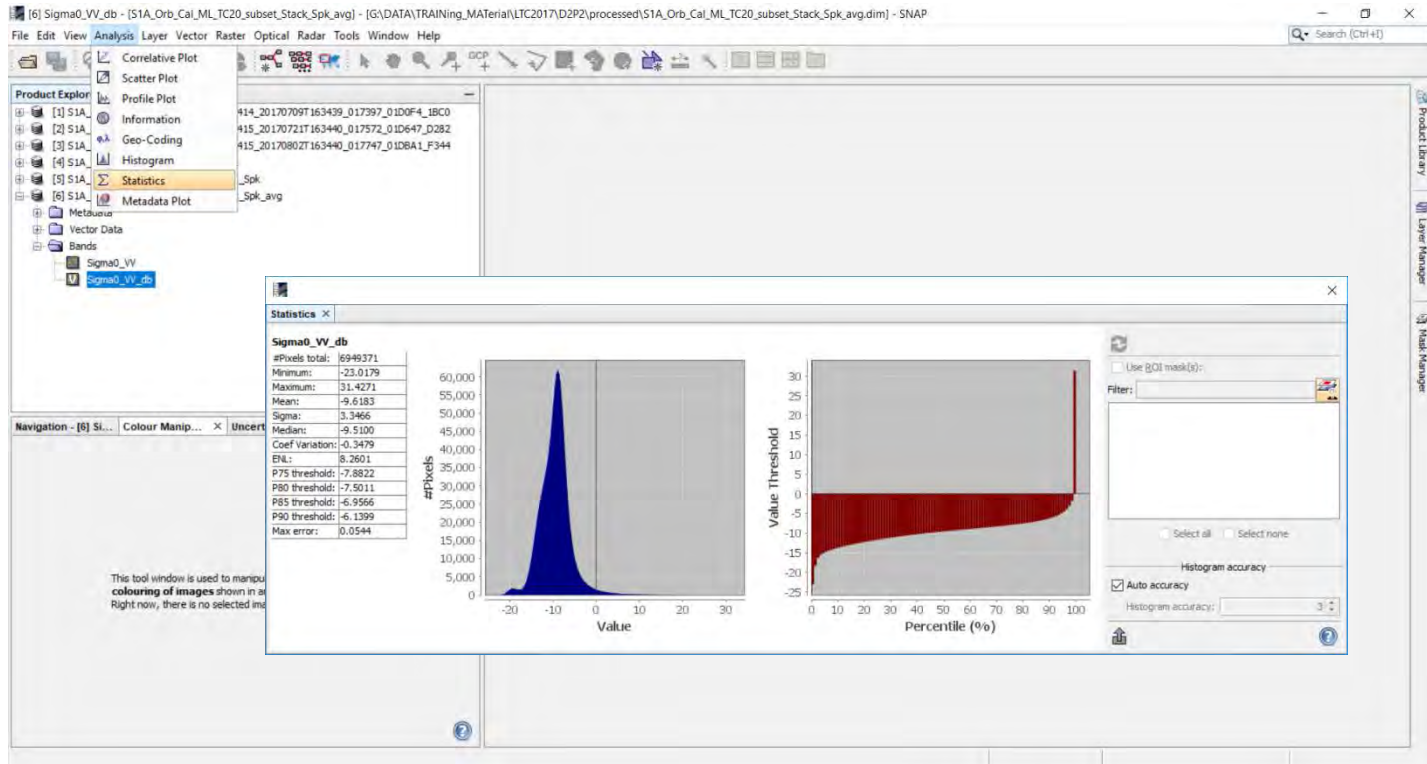


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# Extract Image Statistics



# Lesson Learnt

- A full range of **processing options for Copernicus Sentinel-1** core products are available in ESA's SNAP toolbox.
- The design and implementation of **processing graph** (\*.xml) in SNAP is straightforward.
- A processing graph can be run both via the **Graph Builder** and the **Batch operator**.
- Processing graphs are effected by **SNAP versioning**.
- Batch processing requires multiple **unique input/output files**.
- **Automatic monitoring** of an AOI shall be implemented in upcoming SNAP version 6.

Thank you