



→ 6th ESA ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

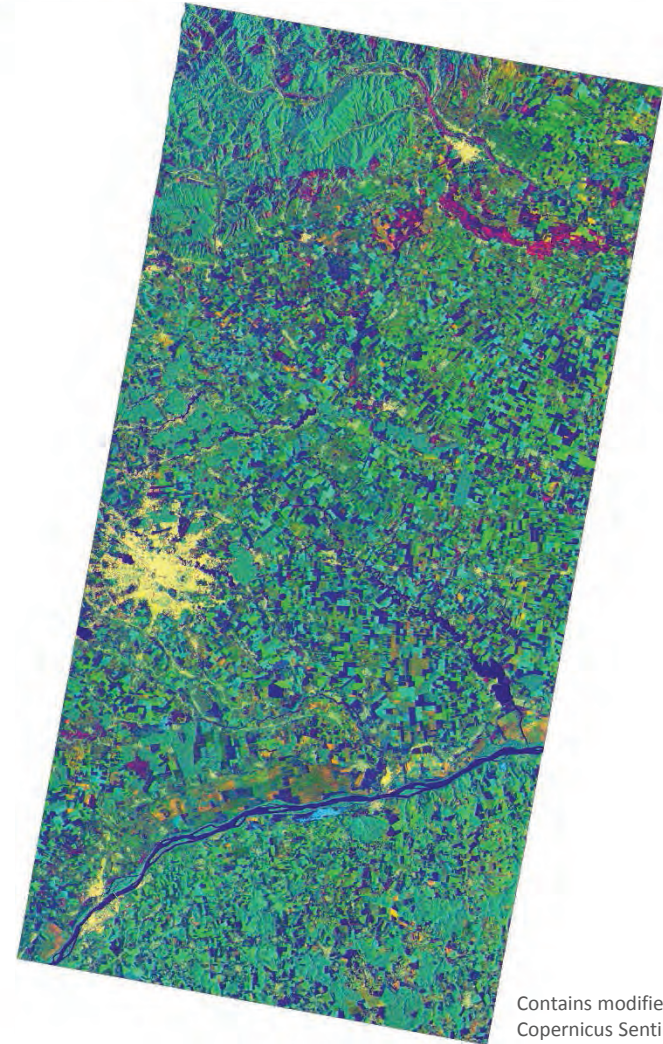
Sentinel-1 Toolbox RGB Composite for Land Cover/Use Monitoring

Michael Foumelis (RSAC c/o ESA-ESRIN)

14–18 September 2015 | University of Agronomic Science and Veterinary Medicine Bucharest | Bucharest, Romania

Goals of the Exercise

- Apply complex processing/analysis schemes for science applications using ESA Sentinel-1 Toolbox
- Training on the generation of complex products for land cover/use monitoring and classification purposes
- Provide instruction on step-by-step processing of Sentinel-1 data (incl. parameters, tips etc.)
- Demonstrate the potential for running in batch mode



Contains modified
Copernicus Sentinel data [2014]

Input Dataset

- A set of **Sentinel-1A SLC** images acquired in Oct. 2014

S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_8E6C.zip

S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361.zip

S1A_IW_SLC__1SDV_20150622T042104_20150622T042131_006481_008979_946E.zip

S1A_IW_SLC__1SDV_20150622T042129_20150622T042156_006481_008979_7B20.zip

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

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

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

[stored locally @ <C:\Users\mfoumelis\.snap\auxdata\Orbits\Sentinel-1\POEORB\2014>]

- **Digital Elevation Model** (DEM) dataset from SRTM 3 arc-sec (auxiliary data)

[stored locally @ <C:\Users\mfoumelis\.snap\auxdata\dem\SRTM 3Sec>]



EXERCISE

Generation of
Complex Sentinel-1
RGB Composites

PART 1

S1 Backscattering Coefficient from SLCs

PART 2

S1 Backscattering Stacks

PART 3

S1 TOPS InSAR Coherence

PART 3

Building Complex RGBs



RGB – **R**: Coherence, **G**: Average
Sigma0 & **B**: Difference Sigma0



EXERCISE

Sentinel-1 TOPS Backscattering Coefficient from Single Look Complex (SLC)

PART 1



Open Consecutive S1A TOPS SLC slices



SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Q Search (Ctrl+I)

Product Explorer × Pixel Info

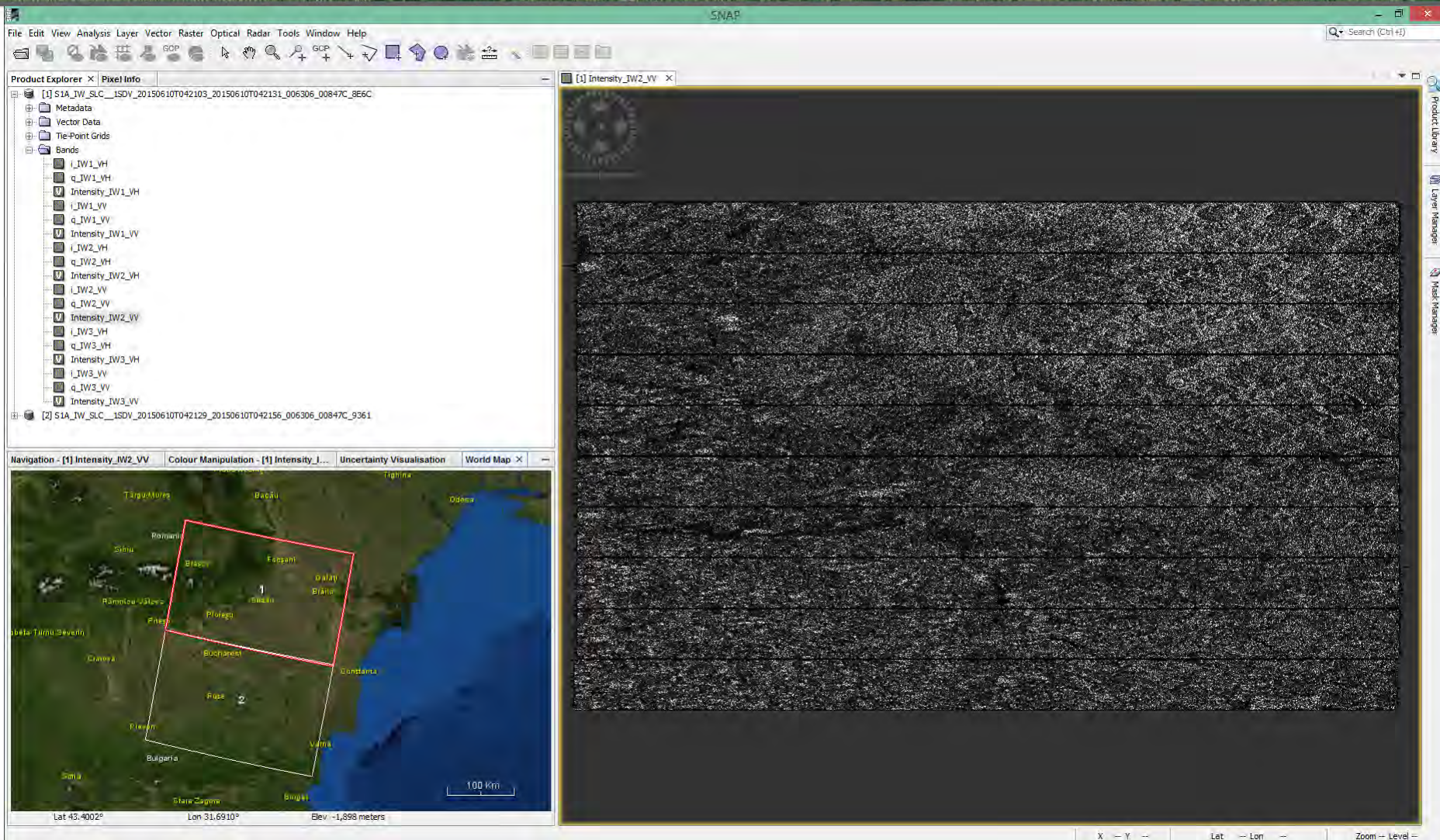
- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_BE6C
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361

Navigation Colour Manipulation Uncertainty Visualisation World Map ×

Off Globe



Visualization of Bursted S1A TOPS SLC







Assembly of Consecutive S1A TOPS SLC Slices (2/4)



SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer X Pixel Info

- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_8E6C
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361

Navigation Colour Manipulation Uncertainty Visualisation World Map X

Off Globe

100 Km

S-1 Slice Assembly

ProductSet-Reader SliceAssembly Write

| File Name | Type | Acquisition | Track | Orbit |
|---|------|-------------|-------|-------|
| S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_8E6C | SLC | 10Jun2015 | 109 | 6306 |
| S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361 | SLC | 10Jun2015 | 109 | 6306 |

2 Products

Help Run

X -- Y -- Lat -- Lon -- Zoom -- Level --



Assembly of Consecutive S1A TOPS SLC Slices (3/4)



SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Search (Ctrl+H)

Product Explorer × Pixel Info

- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_8E6C
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361

Navigation Colour Manipulation Uncertainty Visualisation World Map ×

Off Globe

100 Km

S-1 Slice Assembly

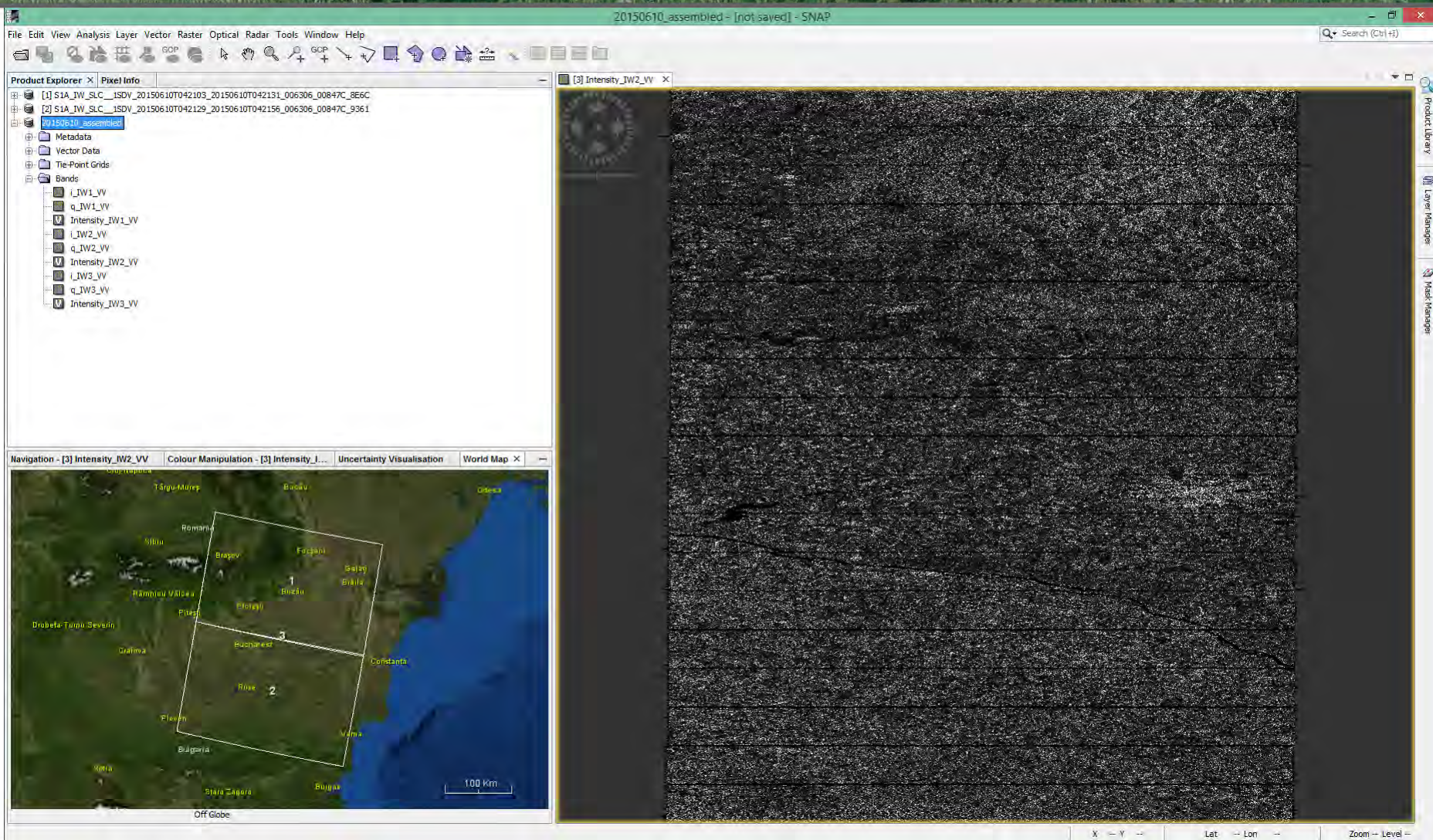
ProductSet-Reader SliceAssembly Write

Polarisations: VH

VV

Help Run

X -- Y -- Lat -- Lon -- Zoom -- Level --







Splitting Sub-Swaths In S1A TOPS SLC (2/3)



20150610_assembled - [not saved] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer Pixel Info

- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_8E6C
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361
- 20150610_assembled

Navigation Colour Manipulation Uncertainty Visualisation World Map X

Off Globe

100 Km

S-1 TOPS Split

File Help

I/O Parameters Processing Parameters

Subswath: IW2

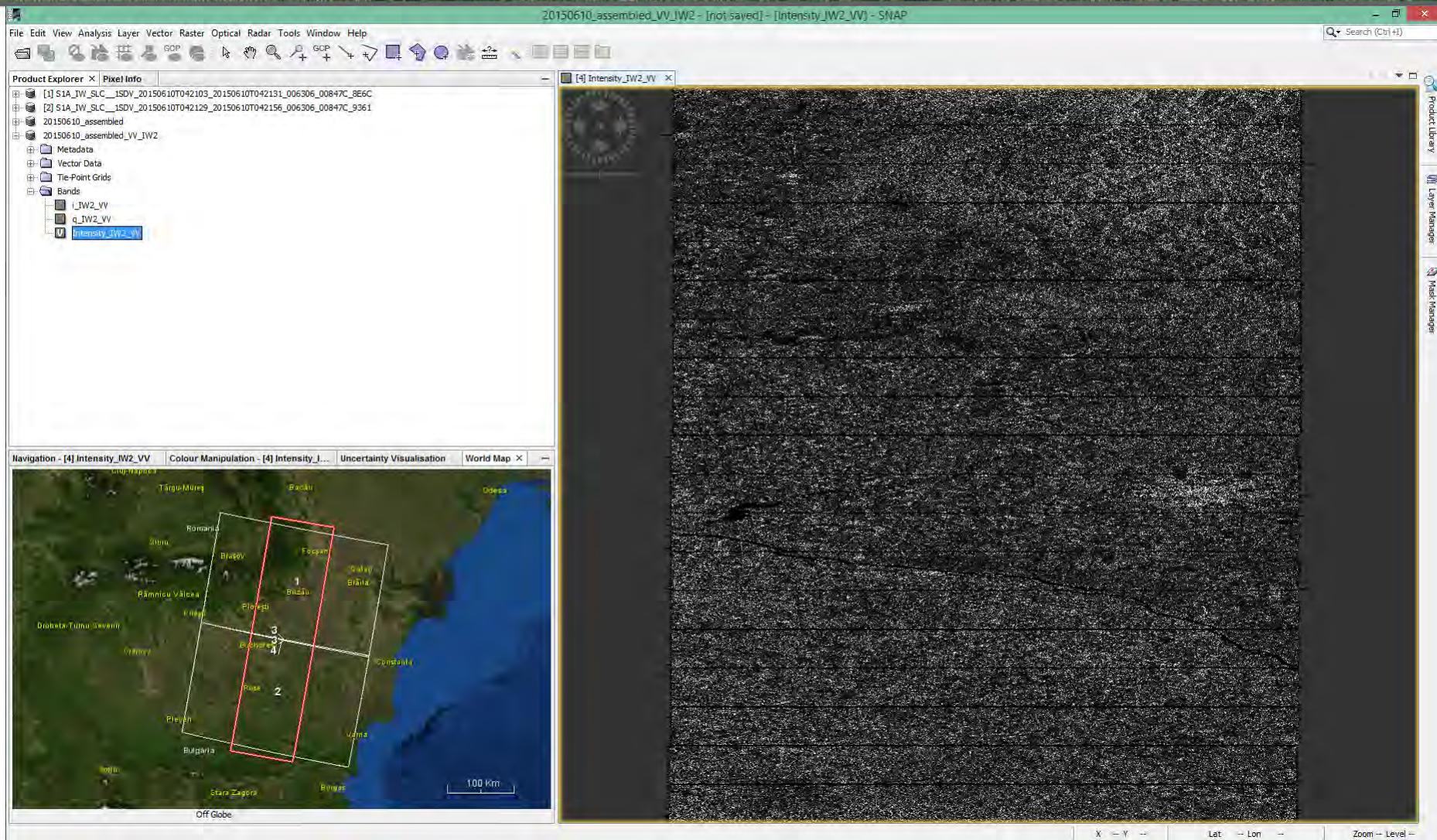
Polarisations: VV

Run Close

X -- Y -- Lat -- Lon -- Zoom -- Level --



Splitting Sub-Swaths In S1A TOPS SLC (3/3)





Sentinel-1 Applying Precise Orbits (POD)



20150610_assembled_VV_IW2 - [not saved] - SNAP

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
- ASAR WSS
- Feature Extraction
- SAR Utilities
- Complex to Detected GR
- Multilooking

Product Explorer × Pixel Info

- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042103_000000000000_000000000000_000000000000
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042129_000000000000_000000000000_000000000000
- 20150610_assembled
- 20150610_assembled_VV_IW2

Navigation Colour Manipulation Uncertainty Visualisation World Map ×

Off Globe

100 Km

X -- Y -- Lat -- Lon -- Zoom -- Level --



Sentinel-1 POD Automatic Download



20150610_assembled_VV_IW2 - [not saved] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer Pixel Info

- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_8E6C
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361
- 20150610_assembled
- 20150610_assembled_VV_IW2

Navigation Colour Manipulation Uncertainty Visualisation World Map X

Off Globe

100 Km

Apply Orbit File

File Help

I/O Parameters Processing Parameters

Orbit State Vectors: Sentinel Precise (Auto Download)

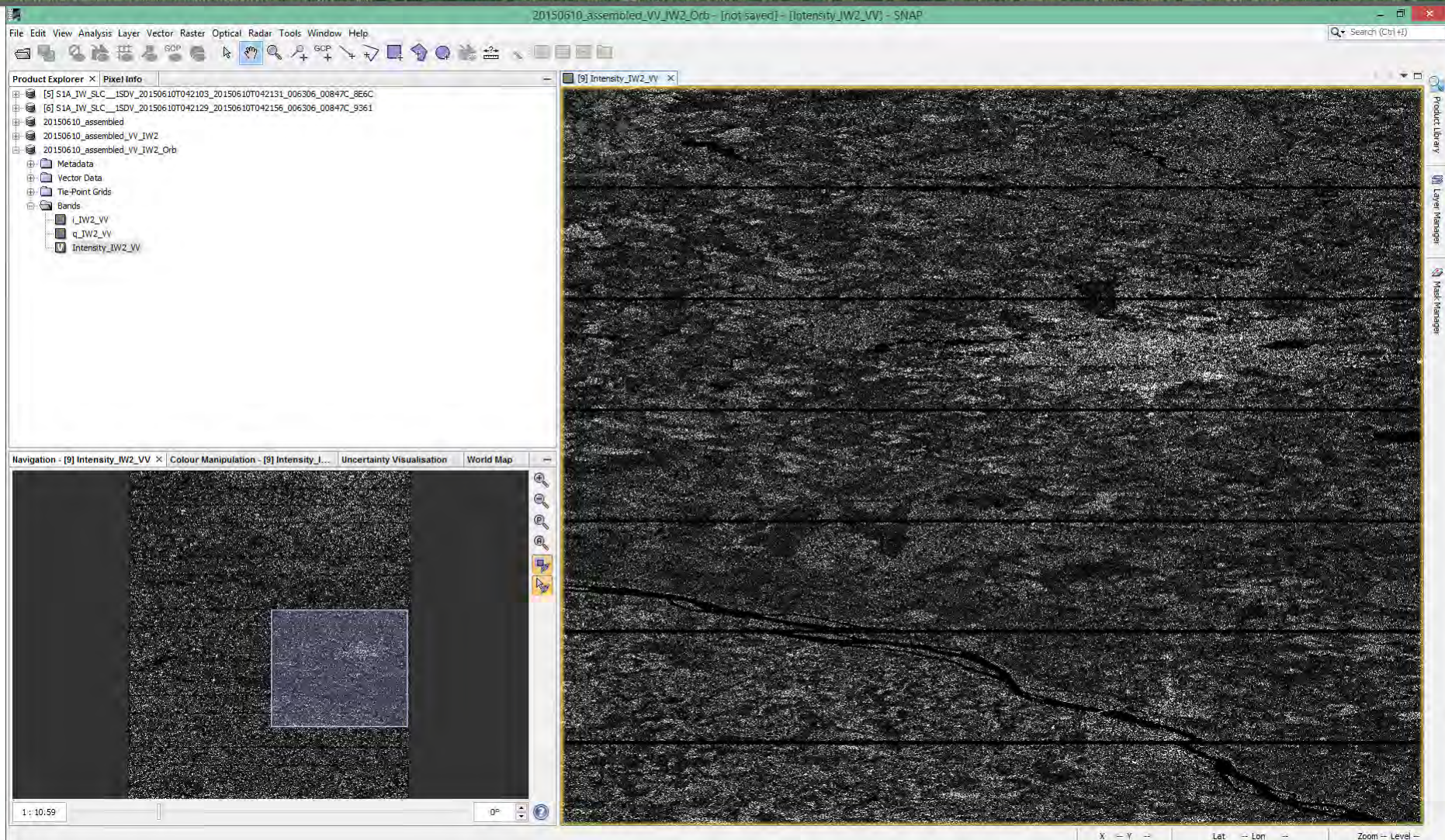
Polynomial Degree: 3

Run Close

X Y Lat Lon Zoom Level

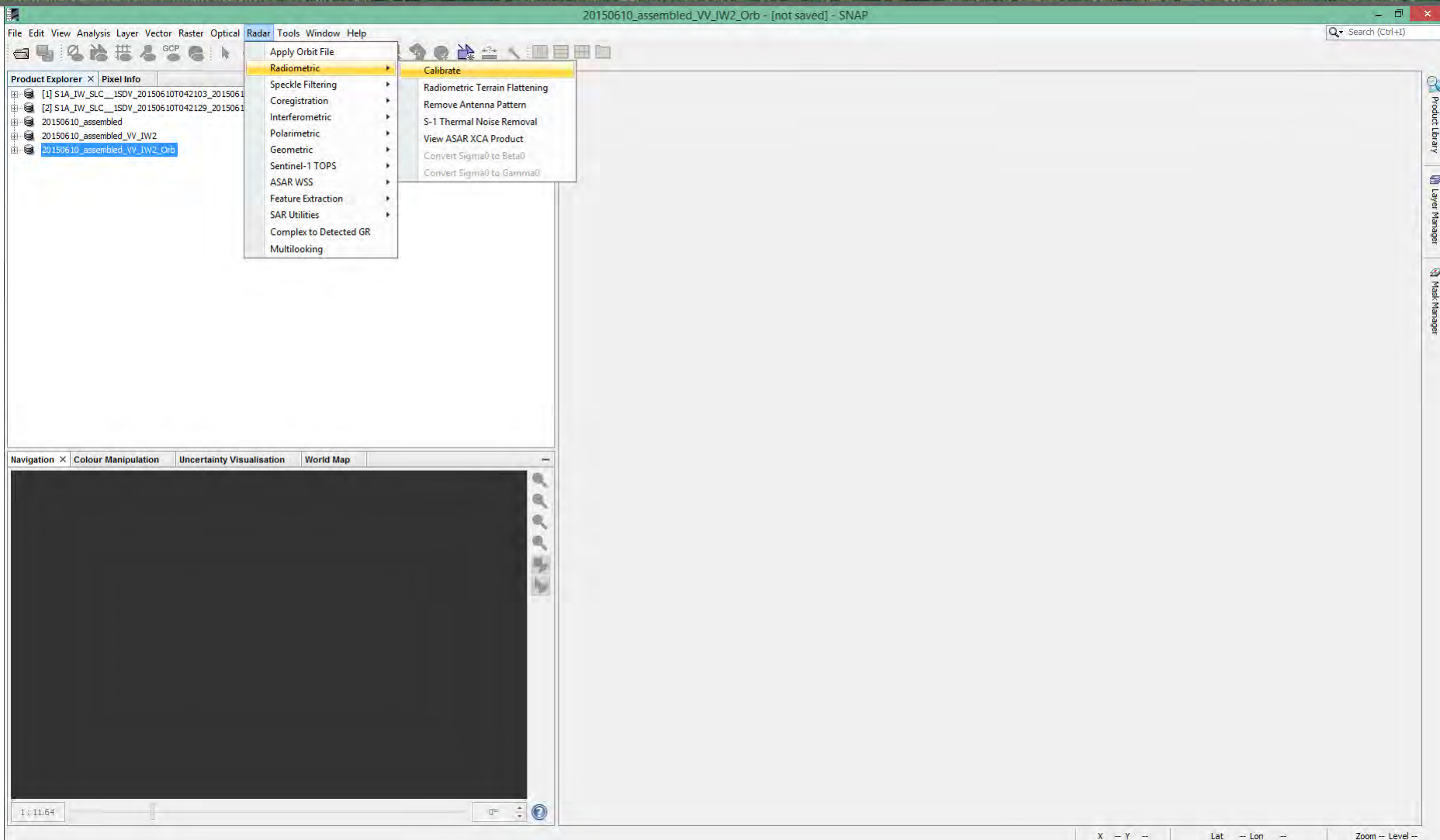


Sentinel-1 Applying Precise Orbits (POD)





Sentinel-1 Radiometric Calibration (1/3)





Sentinel-1 Radiometric Calibration (2/3)



20150610_assembled_VV_IW2_Orb - [not saved] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer Pixel Info

- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_8E6C
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361
- 20150610_assembled
- 20150610_assembled_VV_IW2
- 20150610_assembled_VV_IW2_Orb

Navigation Colour Manipulation Uncertainty Visualisation World Map

Calibration

File Help

I/O Parameters Processing Parameters

Polarisations: VV

☐ Save as complex output

☒ Output sigma0 band

☐ Output gamma0 band

☐ Output beta0 band

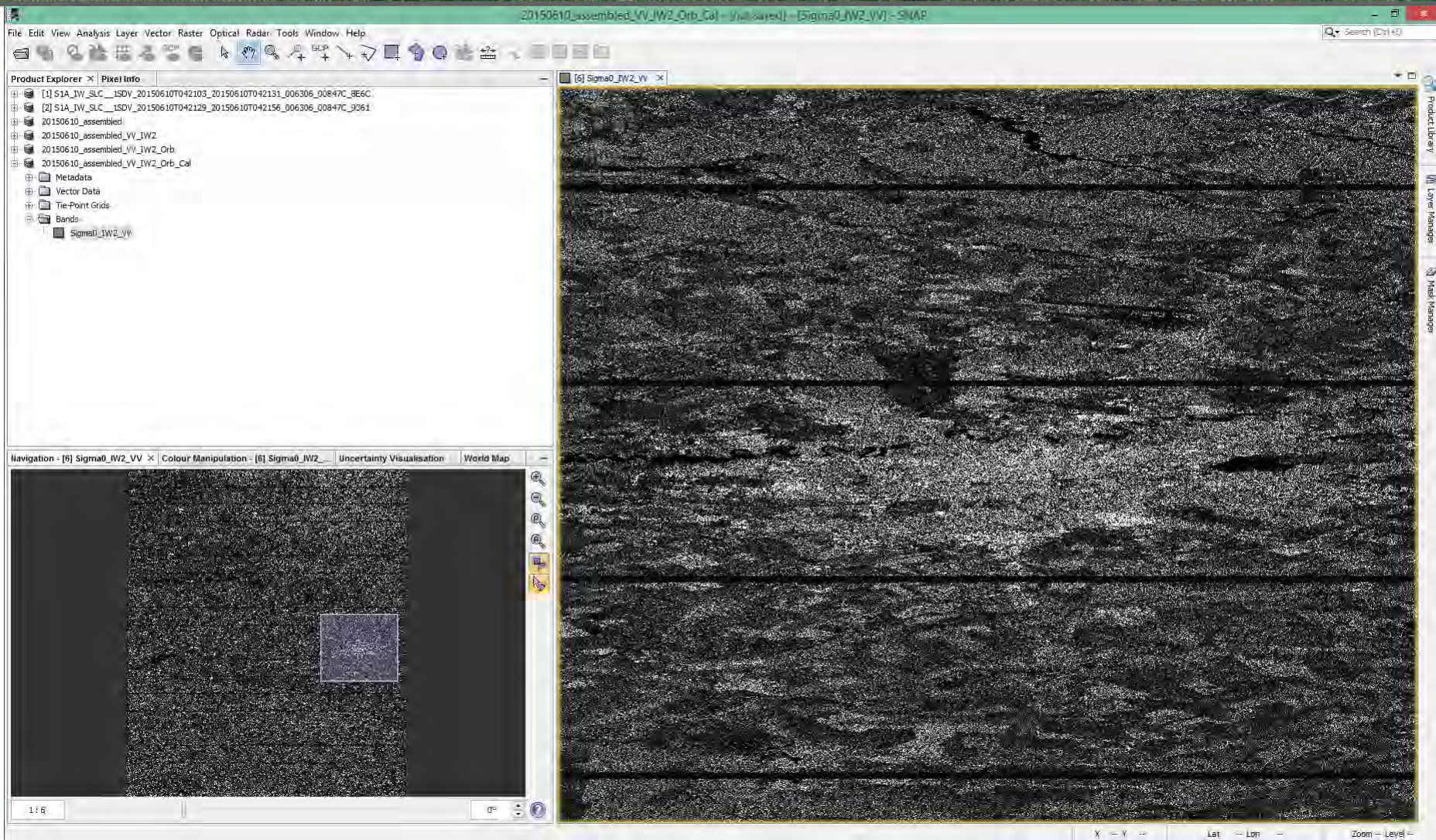
☐ Output DN band

Run Close

X Y Lat Lon Zoom Level

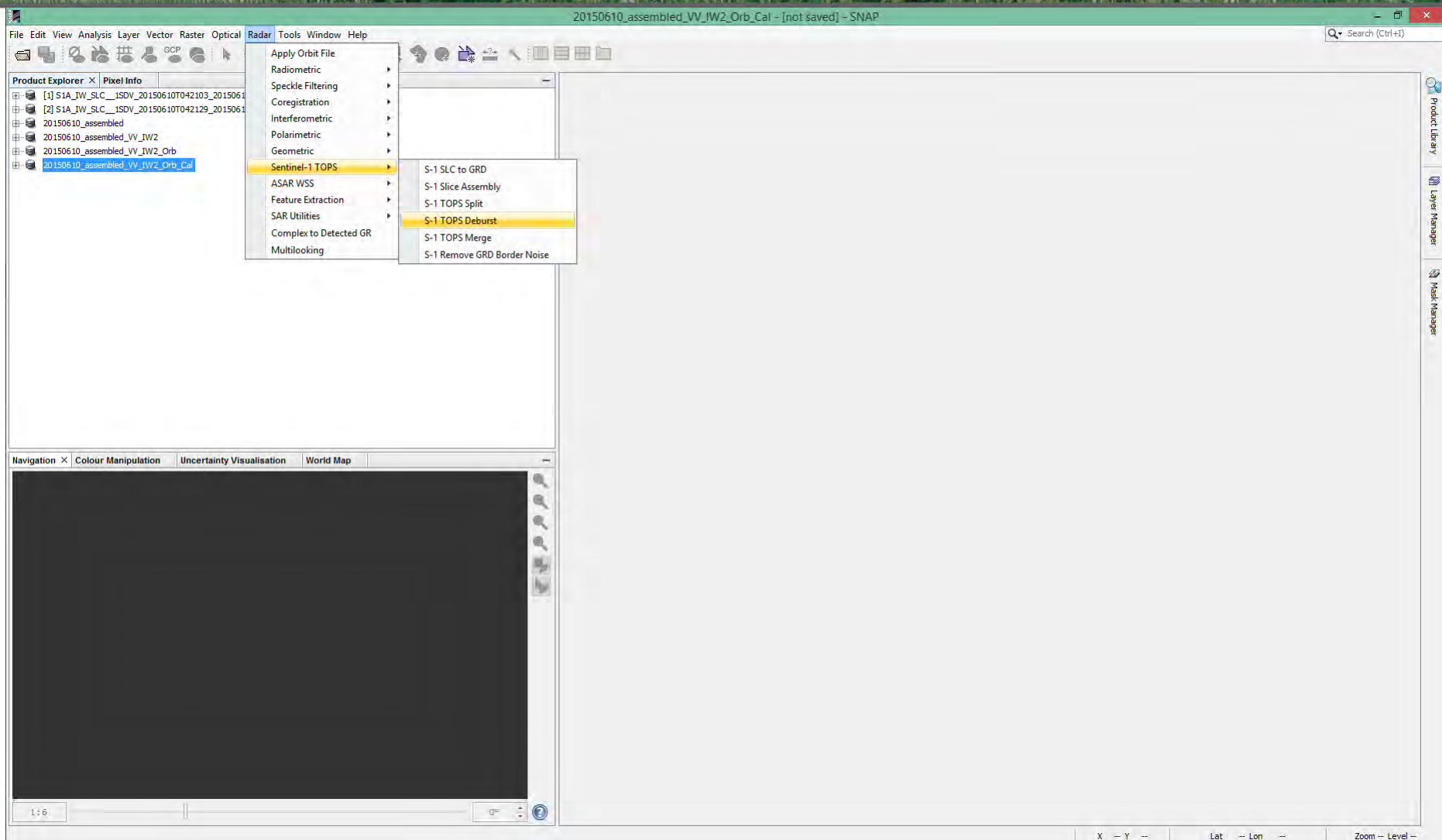


Sentinel-1 Radiometric Calibration (3/3)



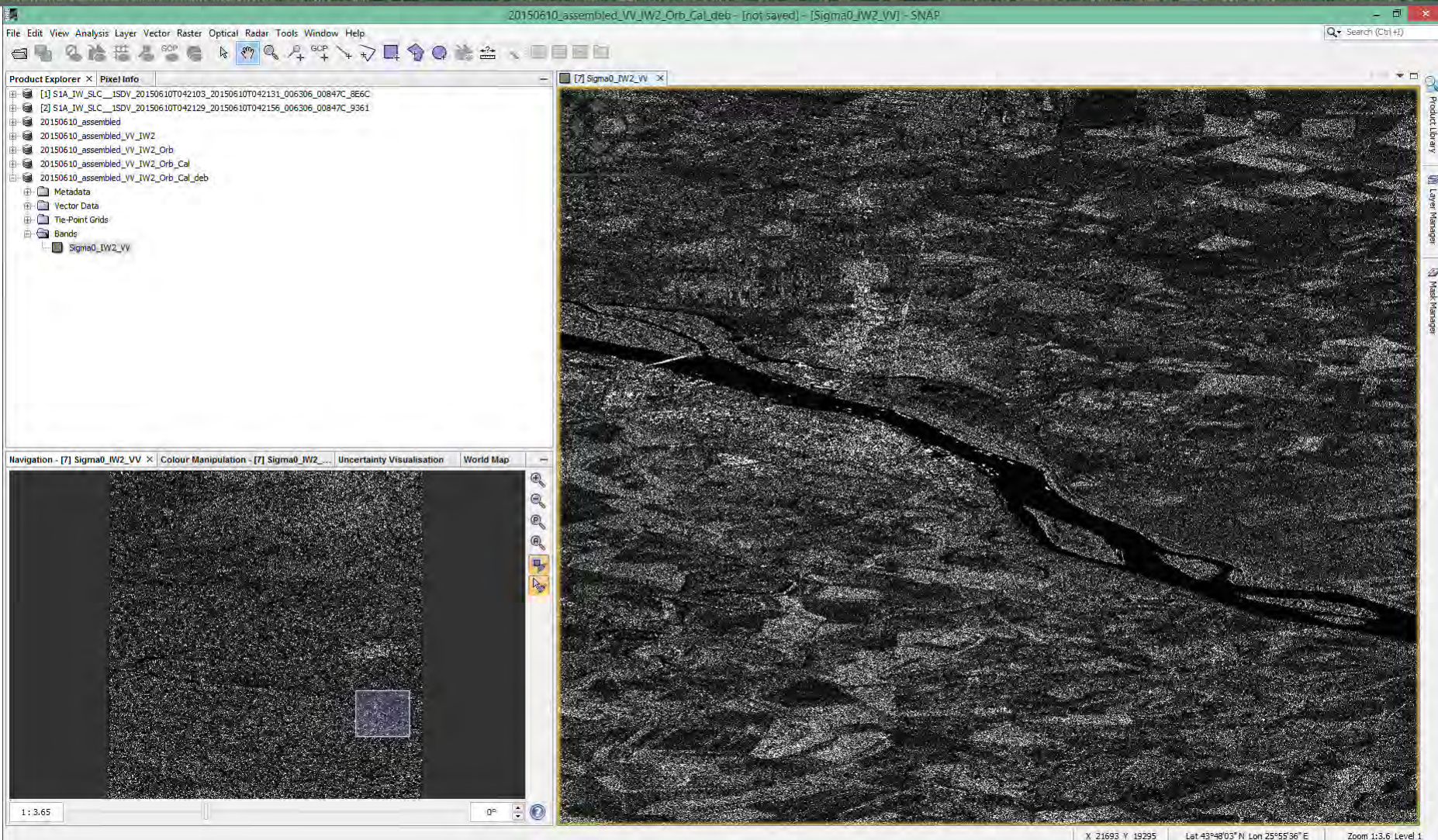


Sentinel-1 TOPS Debursting (1/2)





Sentinel-1 TOPS Debursting (2/2)







Sentinel-1 Spectral Filtering (2/3)



20150610_assembled_VV_IW2_Orb_Cal_deb - [not saved] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer × Pixel Info

- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_8E6C
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361
- 20150610_assembled
- 20150610_assembled_VV_IW2
- 20150610_assembled_VV_IW2_Orb
- 20150610_assembled_VV_IW2_Orb_Cal
- 20150610_assembled_VV_IW2_Orb_Cal_deb

Navigation × Colour Manipulation Uncertainty Visualisation World Map

1:3.65 0m

Single Product Speckle Filter

File Help

I/O Parameters Processing Parameters

Source Bands: Sigma0_IW2_VV

Filter: Gamma Map

Filter Size X: 3

Filter Size Y: 3

Estimate Equivalent Number of Looks ☒

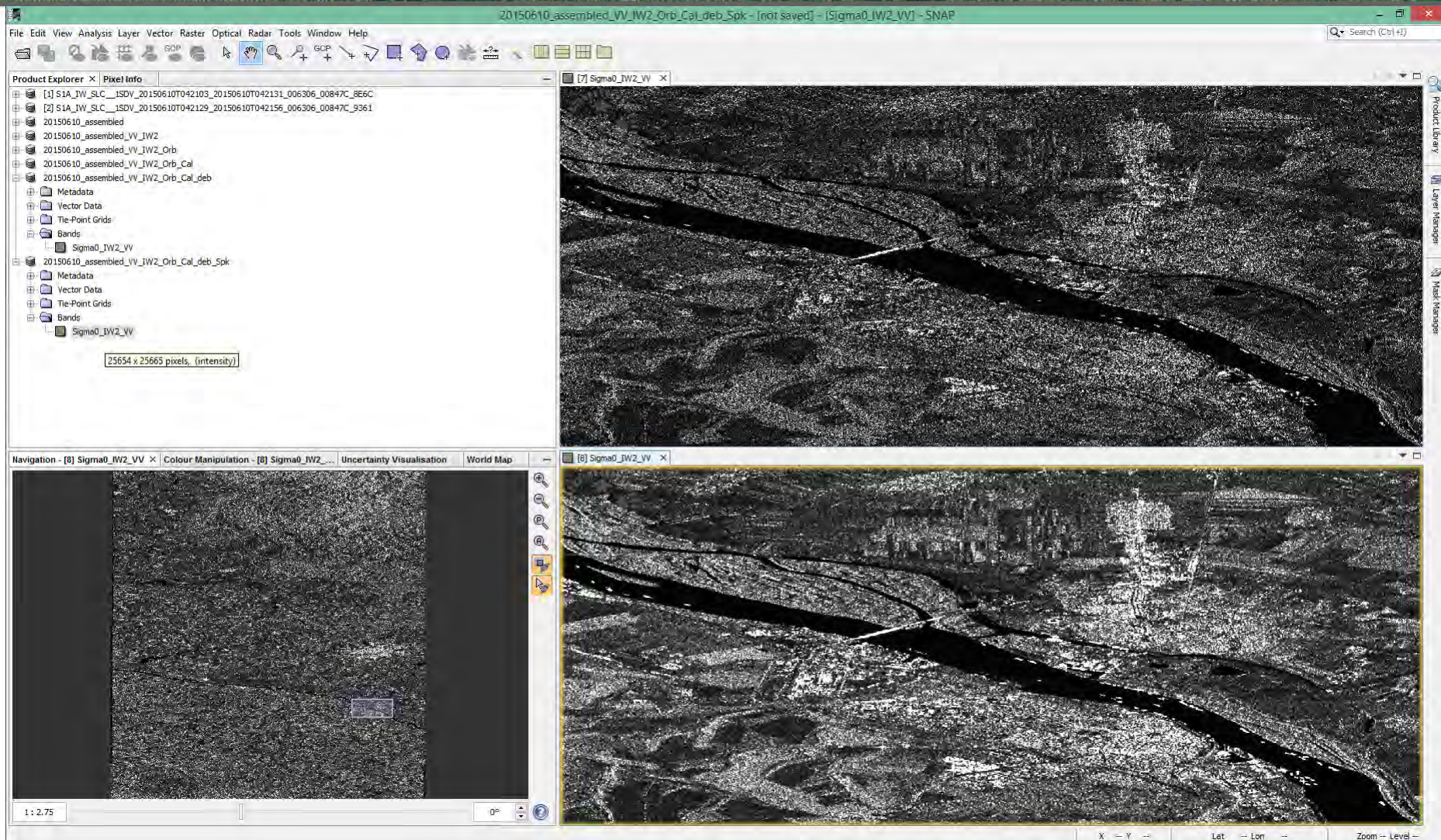
Number of Looks: 1.0

Run Close

X Y Lat Lon Zoom Level



Sentinel-1 Spectral Filtering (3/3)





SAR Multi-looking (1/4)



20150610_assembled_VV_IW2_Orb_Cal_deb_Spk - [not saved] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer × Pixel Info

- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042103_000000000000_000000000000_000000000000
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042129_000000000000_000000000000_000000000000
- 20150610_assembled
- 20150610_assembled_VV_IW2
- 20150610_assembled_VV_IW2_Orb
- 20150610_assembled_VV_IW2_Orb_Cal
- 20150610_assembled_VV_IW2_Orb_Cal_deb
- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk

Radar Tools Window Help

- Apply Orbit File
- Radiometric
- Speckle Filtering
- Coregistration
- Interferometric
- Polarimetric
- Geometric
- Sentinel-1 TOPS
- ASAR WSS
- Feature Extraction
- SAR Utilities
- Complex to Detected GR
- Multilooking

Navigation × Colour Manipulation Uncertainty Visualisation World Map

1 : 2,75

X Y Lat Lon Zoom Level



SAR Multi-looking (2/4)



20150610_assembled_VV_IW2_Orb_Cal_deb_Spk - [not saved] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer Pixel Info

- [1] S1A_IW_SLC__1SDV_20150610T042103_20150610T042131_006306_00847C_8E6C
- [2] S1A_IW_SLC__1SDV_20150610T042129_20150610T042156_006306_00847C_9361
- 20150610_assembled
- 20150610_assembled_VV_IW2
- 20150610_assembled_VV_IW2_Orb
- 20150610_assembled_VV_IW2_Orb_Cal
- 20150610_assembled_VV_IW2_Orb_Cal_deb
- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk

Navigation Colour Manipulation Uncertainty Visualisation World Map

1 : 2,75

Multilooking

File Help

I/O Parameters Processing Parameters

Source Bands: Sigma0_IW2_VV

☒ GR Square Pixel ☐ Independent Looks

Number of Range Looks: 8

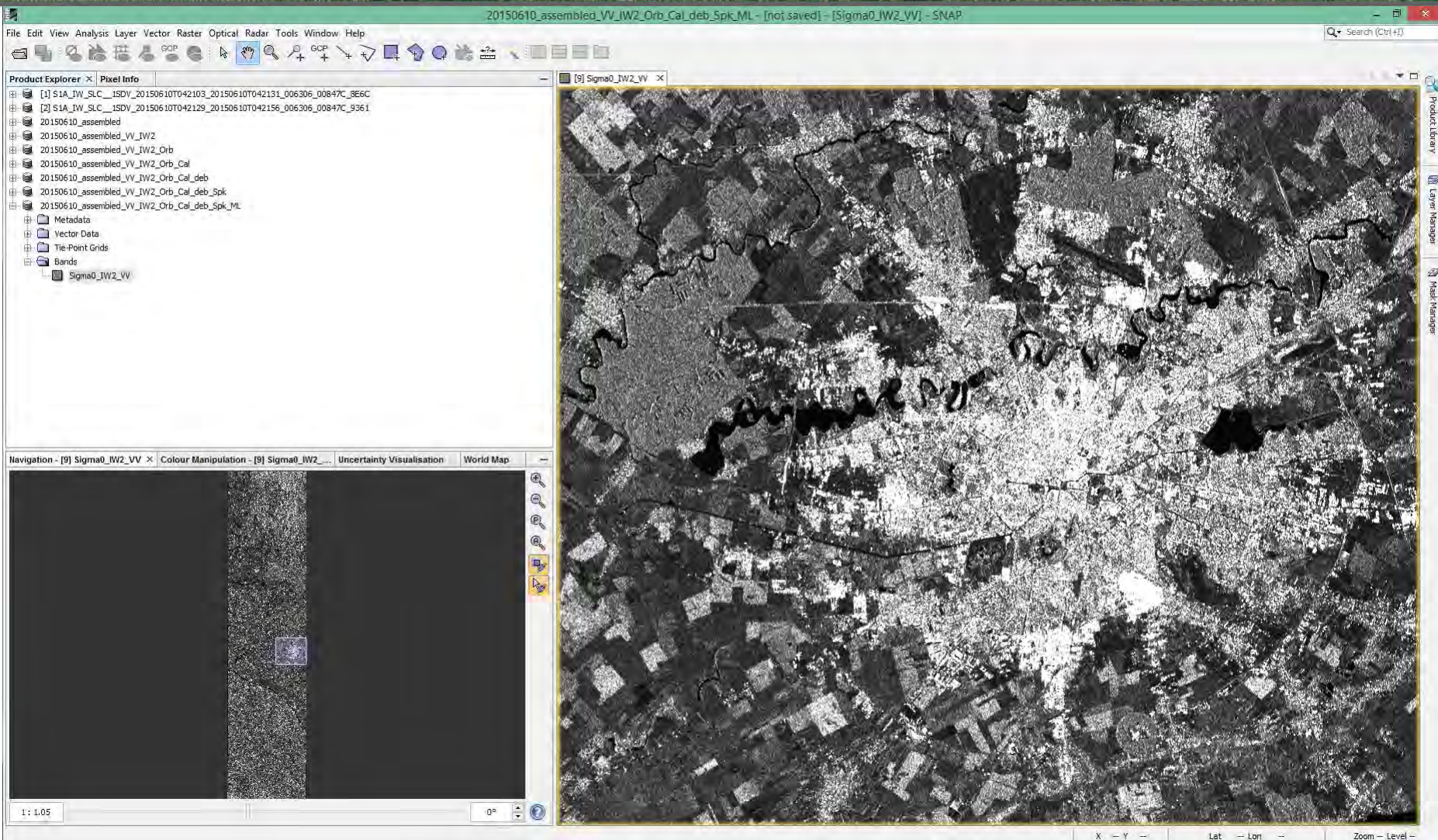
Number of Azimuth Looks: 2

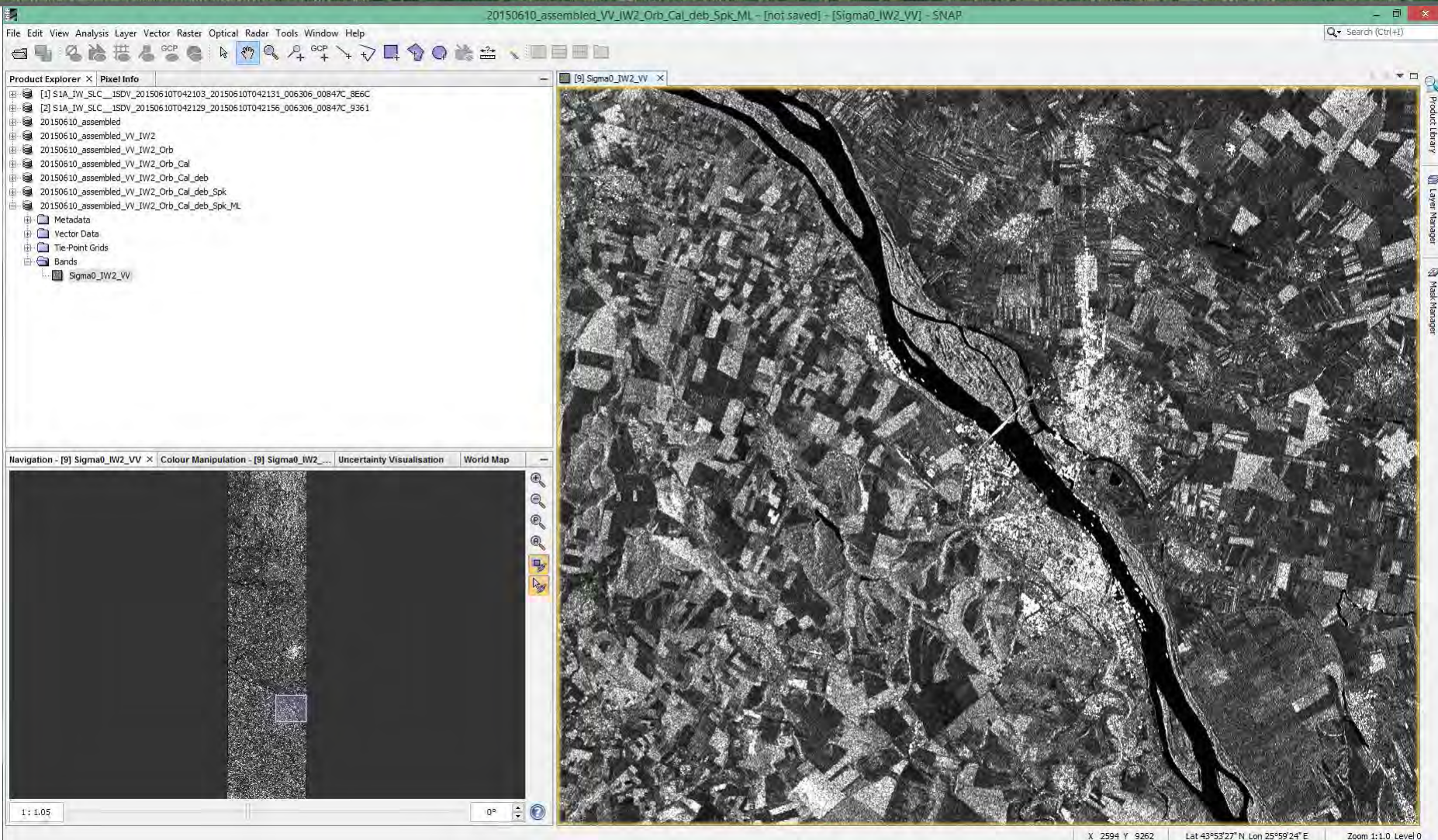
Mean GR Square Pixel: 28.680017

Note: Detection for complex data is done without resampling.

Run Close

X Y Lat Lon Zoom Level







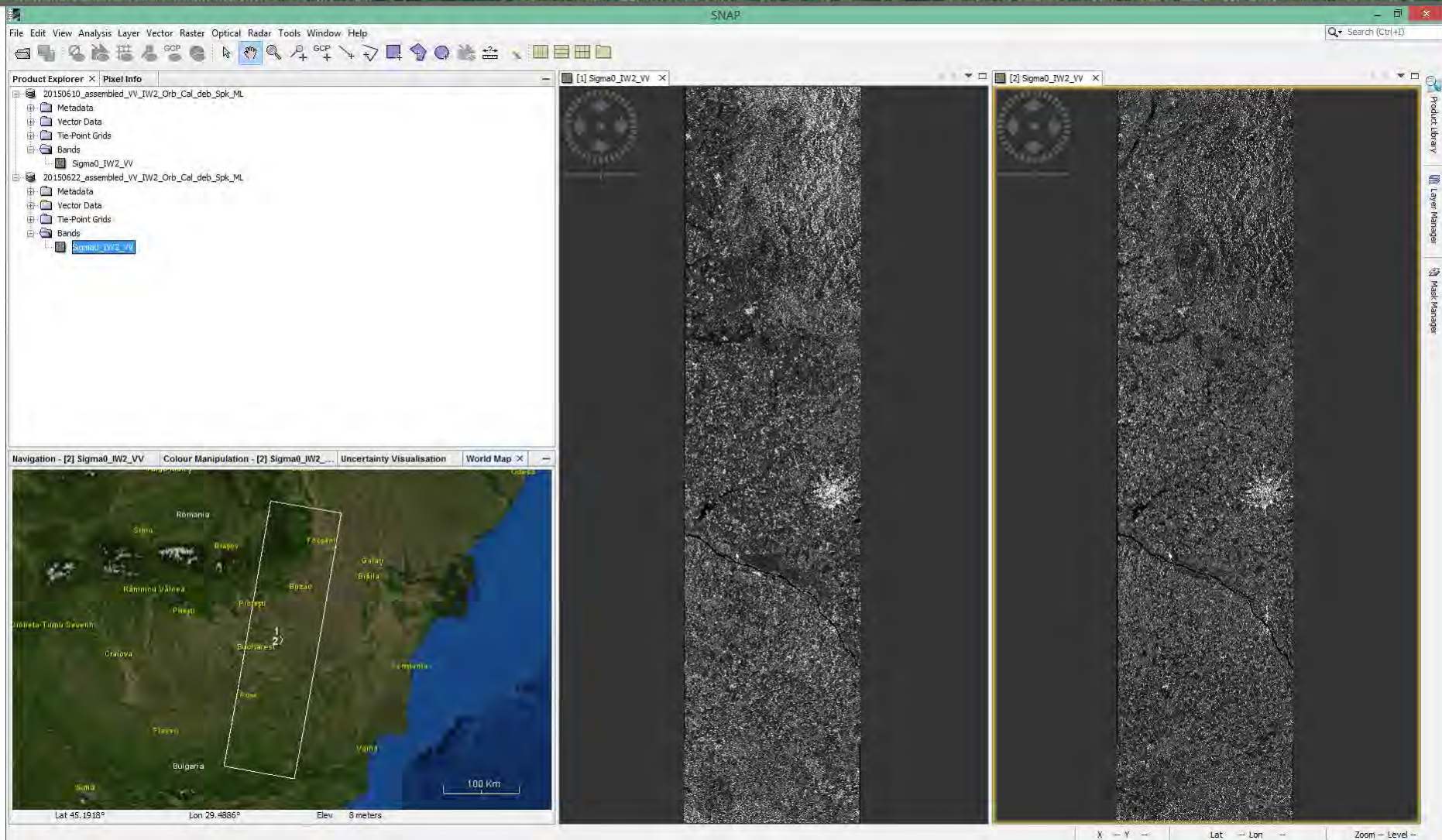
EXERCISE

Building Stacks of Sentinel-1 TOPS Backscattering Coefficient

PART 2



SAR Multi-looked Products



→ **6th ESA ADVANCED TRAINING COURSE ON LAND REMOTE SENSING**
14–18 September 2015 | University of Agronomic Science and Veterinary Medicine Bucharest | Bucharest, Romania



Create Data Stacks SAR Multi-looked Images (1/3)



The screenshot displays the SNAP software interface with the following components:

- Product Explorer:** Lists the loaded data products, including '20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML' and '20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML'. The 'Bands' sub-tree shows 'Sigma0_IW2_VV'.
- Menu:** The 'Radar' menu is open, showing options like 'Apply Orbit File', 'Radiometric', 'Speckle Filtering', 'Coregistration', 'Interferometric', 'Polarimetric', 'Geometric', 'Sentinel-1 TOPS', 'ASAR WSS', 'Feature Extraction', 'SAR Utilities', 'Complex to Detected GR', and 'Multilooking'. The 'Stack Tools' sub-menu is also open, showing 'Create Stack', 'Stack Averaging', and 'Stack Split'.
- Navigation:** A map view at the bottom left shows the location of the data in Romania, with a red rectangle indicating the area of interest. The map includes labels for cities like Sibiu, Braşov, Făgăraş, Galaţi, Brăila, Piteşti, Ploieşti, Buzău, Giurgiu, Bucureşti, Râmnicu Vâlcea, Craiova, Plevne, Vama, and Sinaia. A scale bar indicates 100 Km.
- Main View:** Two panels show the SAR data. The left panel is labeled '[1] Sigma0_IW2_VV' and the right panel is labeled '[2] Sigma0_IW2_VV'. Both panels show a grayscale image of the terrain.
- Bottom Bar:** Contains navigation controls for X, Y, Lat, Lon, and Zoom/Level.



Create Data Stacks

SAR Multi-looked Images (2/3)



20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML - [not saved] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer X Pixel Info

- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV

[1] Sigma0_IW2_VV [2] Sigma0_IW2_VV

Create Stack

1-ProductSet-Reader 2-CreateStack 3-Write

Master: S1A_IW_SLC__1SDV_20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML

Resampling Type: NEAREST_NEIGHBOUR

Initial Offset Method: GCP

Output Extents: Master

Find Optimal Master

Navigation - [2] Sigma0_IW2_VV Colour Manipulation - [2] Sigma0_IW2_VV Uncertainty Visualisation World Map X

Off Globe

100 Km

X Y Lat Lon Zoom Level



Create Data Stacks

SAR Multi-looked Images (3/3)



stack_non_coregi - [D:\WORKING\LTC2015_DSP1a\processed_SLC\stack_non_coregi.dim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer × Pixel Info

- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- stack_non_coregi
- Metadata
- Vector Data
- Tie-Point Grids
- Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015

Navigation Colour Manipulation Uncertainty Visualisation World Map ×

Off Globe

100 Km

X -- Y -- Lat -- Lon -- Zoom -- Level --



Co-registration of SAR Multi-looked Images (1/2)



stack_non_coregi - [D:\WORKING\LTC2015_D5P1a\processed_SLC\stack_non_coregi.dim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer × Pixel Info

- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- stack_non_coregi
- Metadata
- Vector Data
- Tie-Point Grids
- Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015

Tools Menu:

- Apply Orbit File
- Radiometric
- Speckle Filtering
- Coregistration**
 - InSAR Optimized Coregistration
 - S1 TOPS Coregistration
 - Automatic Coregistration**
 - Stack Tools
 - Cross InSAR resampling
- Interferometric
- Polarimetric
- Geometric
- Sentinel-1 TOPS
- ASAR WSS
- Feature Extraction
- SAR Utilities
- Complex to Detected GR
- Multilooking

Navigation Colour Manipulation Uncertainty Visualisation World Map ×

Off Globe

100 Km

X Y Lat Lon Zoom Level



Co-registration of S1A Multi-looked Images (2/2)



coregistered_stack_Spk_ML - [D:\WORKING\LTC2015_D5P1a\processed_SLC\coregistered_stack_Spk_ML.dim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer × Pixel Info

- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- [3] stack_non_coregi
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015
- [4] coregistered_stack_Spk_ML
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015

Navigation Colour Manipulation Uncertainty Visualisation World Map ×

Off Globe

100 Km

X Y Lat Lon Zoom Level



Stacked vs Coregistered Generate RGB Composites (1/5)



stack_non_coregi - [D:\WORKING\LTC2015_D5P1a\processed_SLC\stack_non_coregi.dim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer Pixel Info

- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- [3] stack_non_coregi
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2
 - Sigma0_IW2
- [4] coregistered_stack
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2
 - Sigma0_IW2

Band Maths...
Add Elevation Band
Group Nodes by Type
Open RGB Image Window
Open HSV Image Window
Close Product
Close All Products
Close Other Products
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
Delete
Properties

Navigation Colour Manipulation Uncertainty Visualisation World Map X

Off Globe

100 Km

X Y Lat Lon Zoom Level



Stacked vs Coregistered Generate RGB Composites (2/5)



stack_non_coregi - [D:\WORKING\LTC2015_D5P1a\processed_SLC\stack_non_coregi.dim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer × Pixel Info

- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- [3] stack_non_coregi
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015
- [4] coregistered_stack_Spk_ML
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015

Select RGB-Image Channels

Profile:

Red: Sigma0_IW2_VV_mst_10Jun2015

Green: Sigma0_IW2_VV_slv1_22Jun2015

Blue: Sigma0_IW2_VV_slv1_22Jun2015

☐ Store RGB channels as virtual bands in current product

OK Cancel Help

Navigation Colour Manipulation Uncertainty Visualisation World Map ×

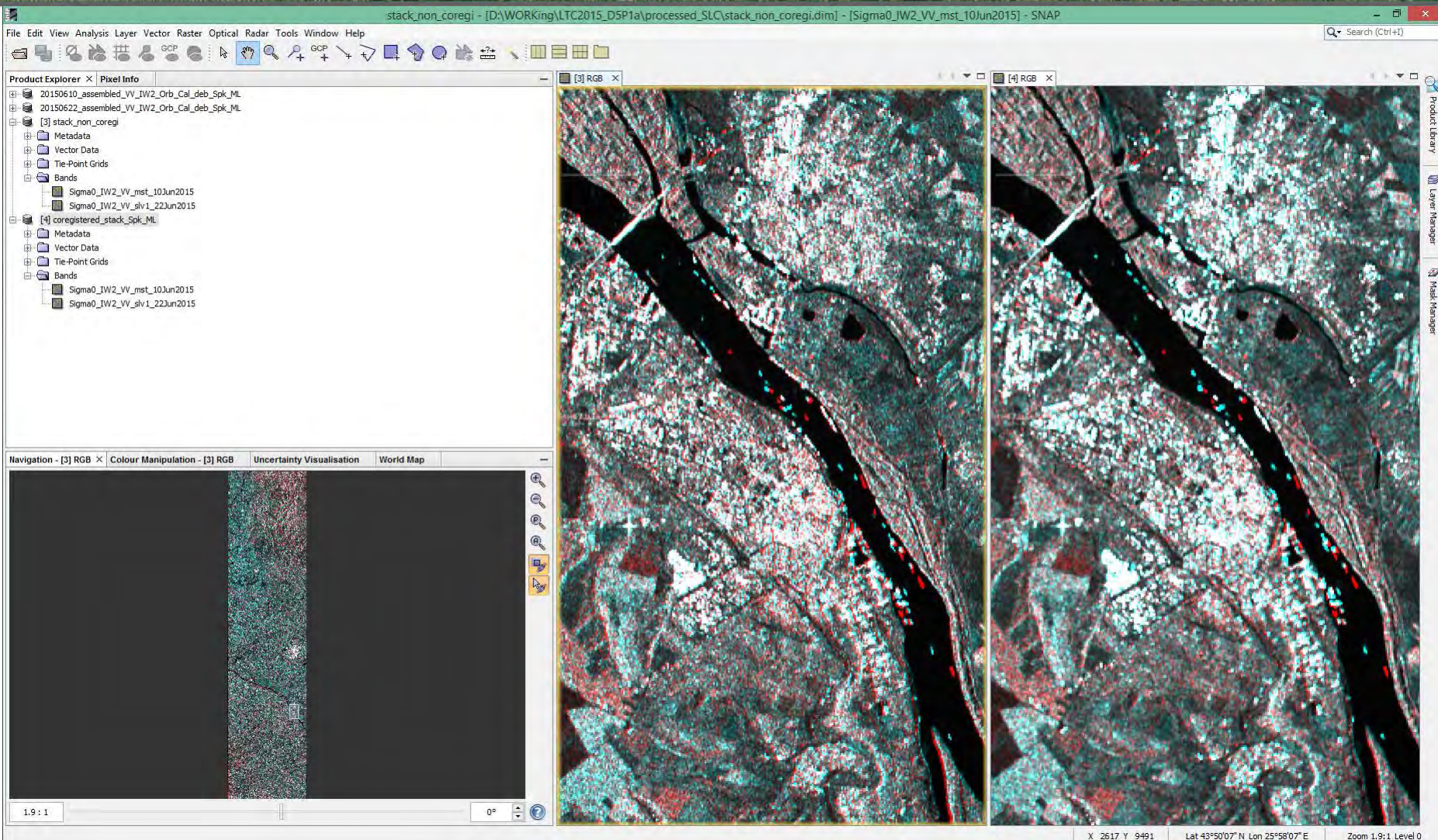
Off Globe

100 Km

X Y Lat Lon Zoom Level



Stacked vs Coregistered Generate RGB Composites (3/5)







Stacked vs Coregistered Generate RGB Composites (5/5)



stack_non_coregi - [D:\WORKing\LTC2015_D5P1a\processed_SLC\stack_non_coregi.dim] - [Sigma0_IW2_VV_mst_10Jun2015] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer × Pixel Info

- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- [3] stack_non_coregi
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015
- [4] coregistered_stack_Spk_ML
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015

Navigation - [3] RGB × Colour Manipulation - [3] RGB Uncertainty Visualisation World Map

1.7 : 1 0°

X 2358 Y 1443 Lat 45°48'31" N Lon 26°32'19" E Zoom 1.7:1 Level 0

Product Library Layer Manager Mask Manager



EXERCISE

Sentinel-1 TOPS Interferometric Coherence

PART 3



Assembled Sentinel-1 TOPS Complex Data (SLC)



20150622_assembled_VV_IW2 - [not saved] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer × Pixel Info

- 20150610_assembled_VV_IW2
- 20150622_assembled_VV_IW2

Navigation Colour Manipulation Uncertainty Visualisation World Map ×

Off Globe

100 Km

Product Library Layer Manager Mask Manager



TOPS Co-registration & InSAR Coherence Estimation



20150622_assembled_VV_IW2 - [not saved] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer × Pixel Info

- 20150610_assembled_VV_IW2
- 20150622_assembled_VV_IW2

Navigation Colour Manipulation Uncertainty Visualisation World Map ×

Off Globe

100 Km

Graph Builder: TOPSAR_Coreg_Coherence.xml

File Graphs

```
graph TD; Read[Read] --> AO1[Apply-Orbit-File]; Read2[Read(2)] --> AO2[Apply-Orbit-File(2)]; AO1 --> BG[Back-Geocoding]; AO2 --> BG; BG --> Coherence[Coherence]; Coherence --> TDB[TOPSAR-Deburst]; TDB --> Write[Write]
```

Read Read(2) Apply-Orbit-File Apply-Orbit-File(2) Back-Geocoding TOPSAR-Deburst Write Coherence

Target Product

Name: srp_cc_IW2_VV

☒ Save as: BEAM-DIMAP

Directory: D:\WORKing\UTC2015_DSP\ia\processed_SLC

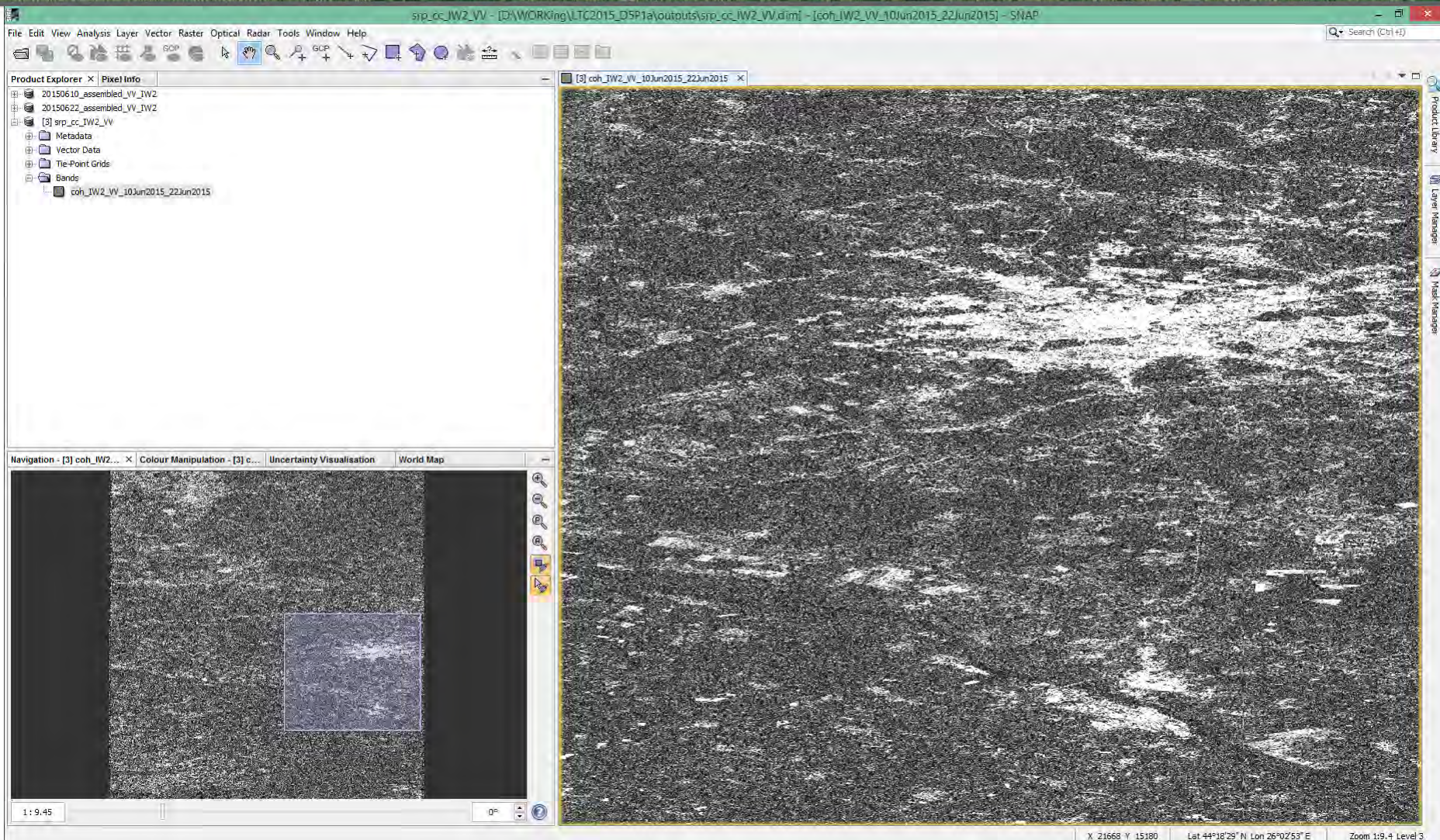
☒ Open in SNAP

Load Save Clear Note Help Run



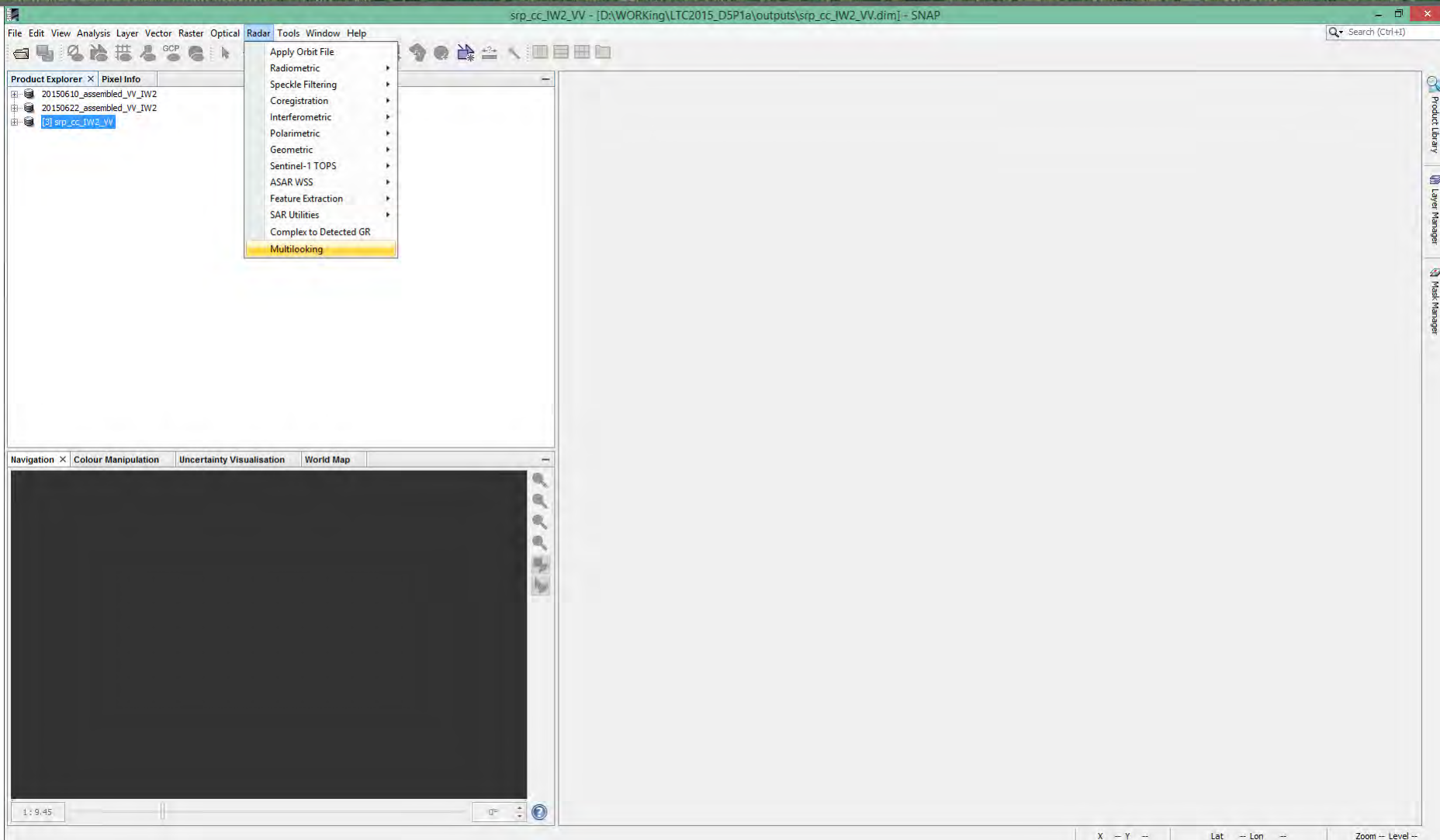
Interferometric Coherence

SAR range-Doppler Geometry



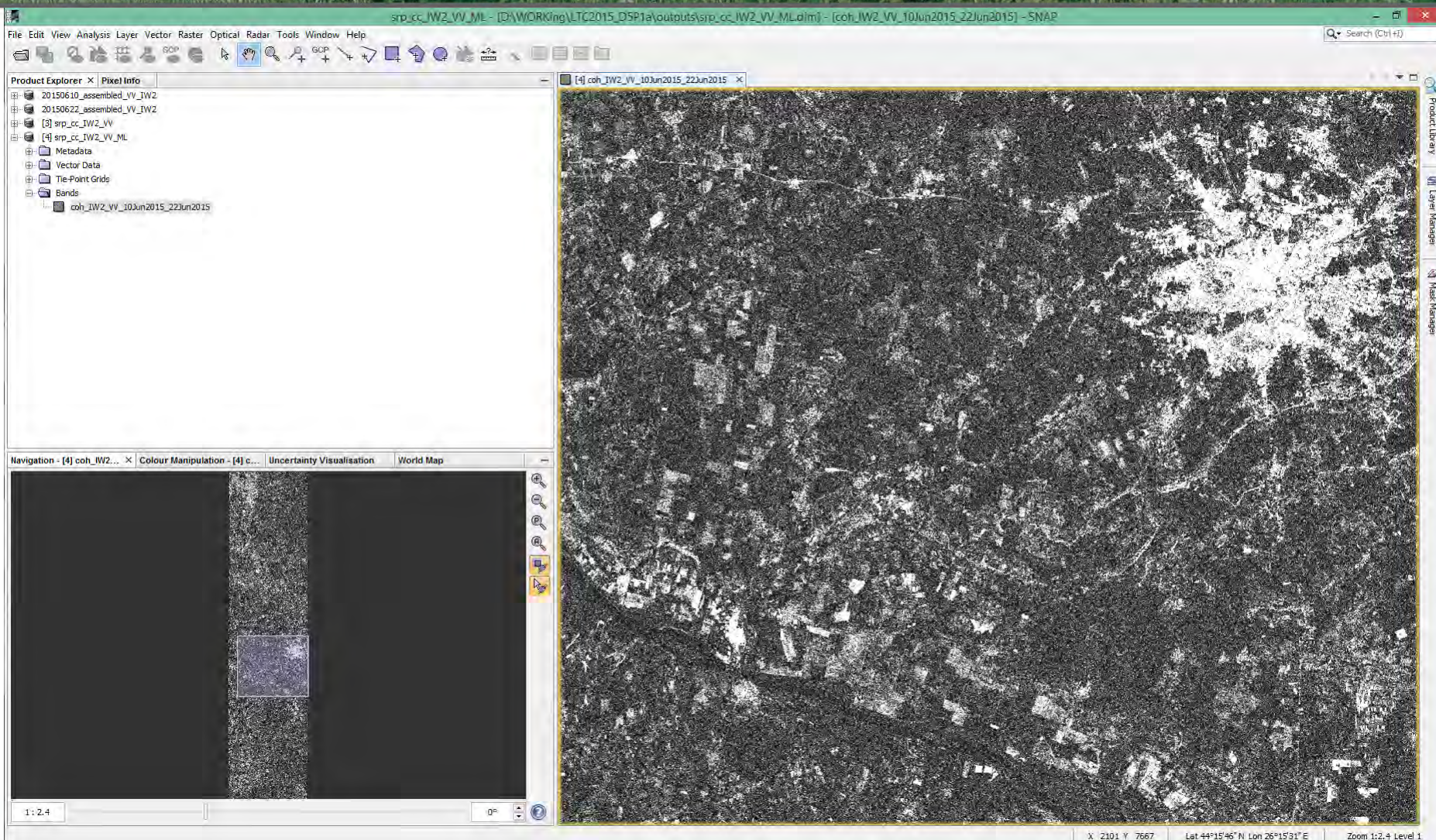


Interferometric Coherence Multi-looking





InSAR Coherence Multi-looked





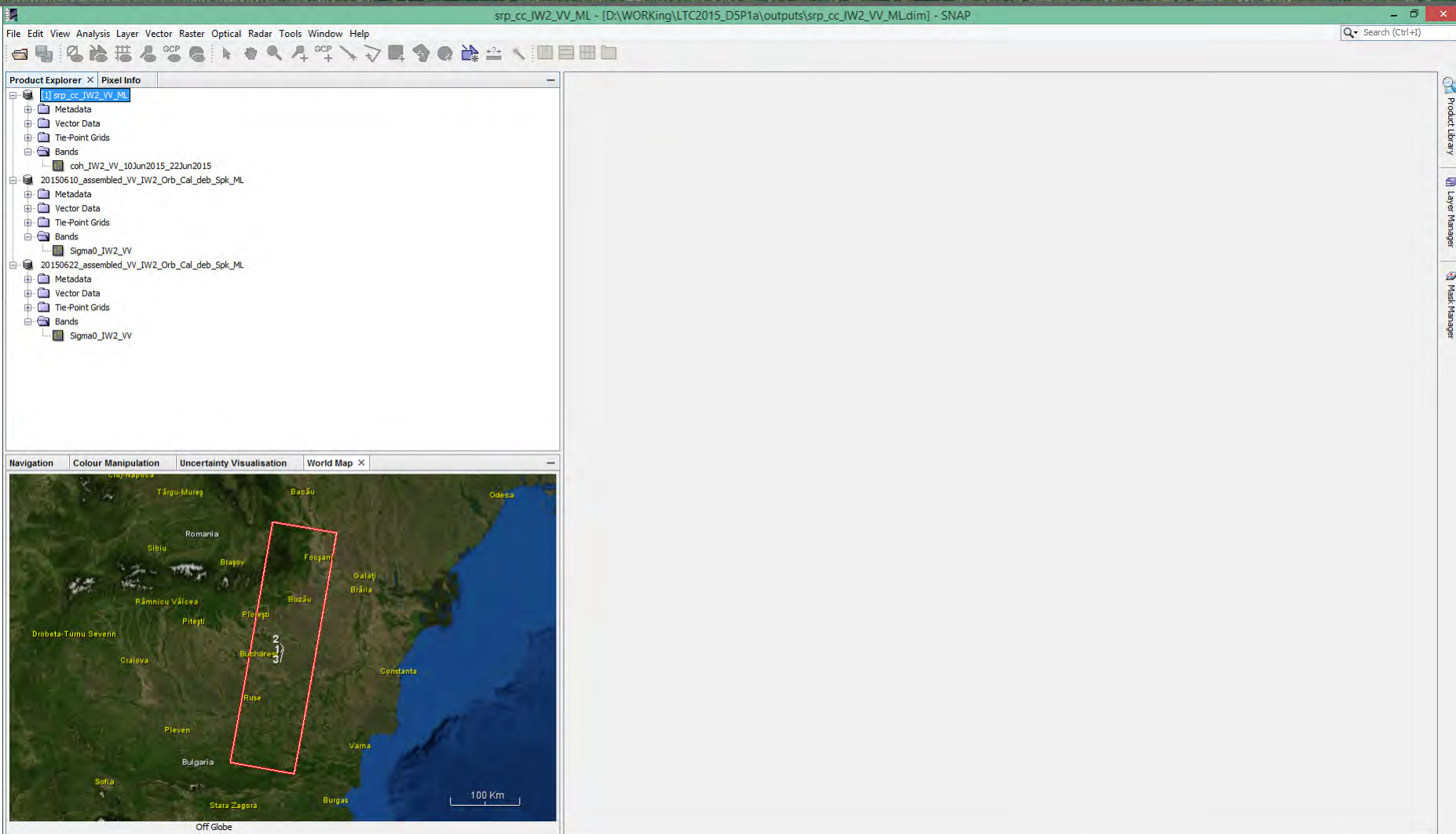
EXERCISE

Generation of Complex Sentinel-1 TOPS RGB Composites (Do It Yourself Exercise)

PART 4



Input Data





Creating Data Stack (1/3)



srp_cc_IW2_VV_ML - [D:\WORKing\LTC2015_D5P1a\outputs\srp_cc_IW2_VV_MLdim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer X Pixel Info

- 1 srp_cc_IW2_VV_ML
- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML

Tools Menu:

- Apply Orbit File
- Radiometric
 - Speckle Filtering
- Coregistration
 - InSAR Optimized Coregistration
 - S1 TOPS Coregistration
 - Automatic Coregistration
- Stack Tools
 - Create Stack
 - Stack Averaging
 - Stack Split
- Cross InSAR resampling
- Interferometric
- Polarimetric
- Geometric
- Sentinel-1 TOPS
- ASAR WSS
- Feature Extraction
- SAR Utilities
- Complex to Detected GR
- Multilooking

Navigation Colour Manipulation Uncertainty Visualisation World Map X

Off Globe

100 Km

srp_cc_IW2_VV_ML - [D:\WORKing\LTC2015_D5P1a\outputs\srp_cc_IW2_VV_MLdim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer X Pixel Info

- [1] srp_cc_IW2_VV_ML
- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML

Navigation Colour Manipulation Uncertainty Visualisation World Map X

Off Globe

100 Km

1-ProductSet-Reader 2-CreateStack 3-Write

Master: srp_cc_IW2_VV_ML

Resampling Type: NEAREST_NEIGHBOUR

Initial Offset Method: GCP

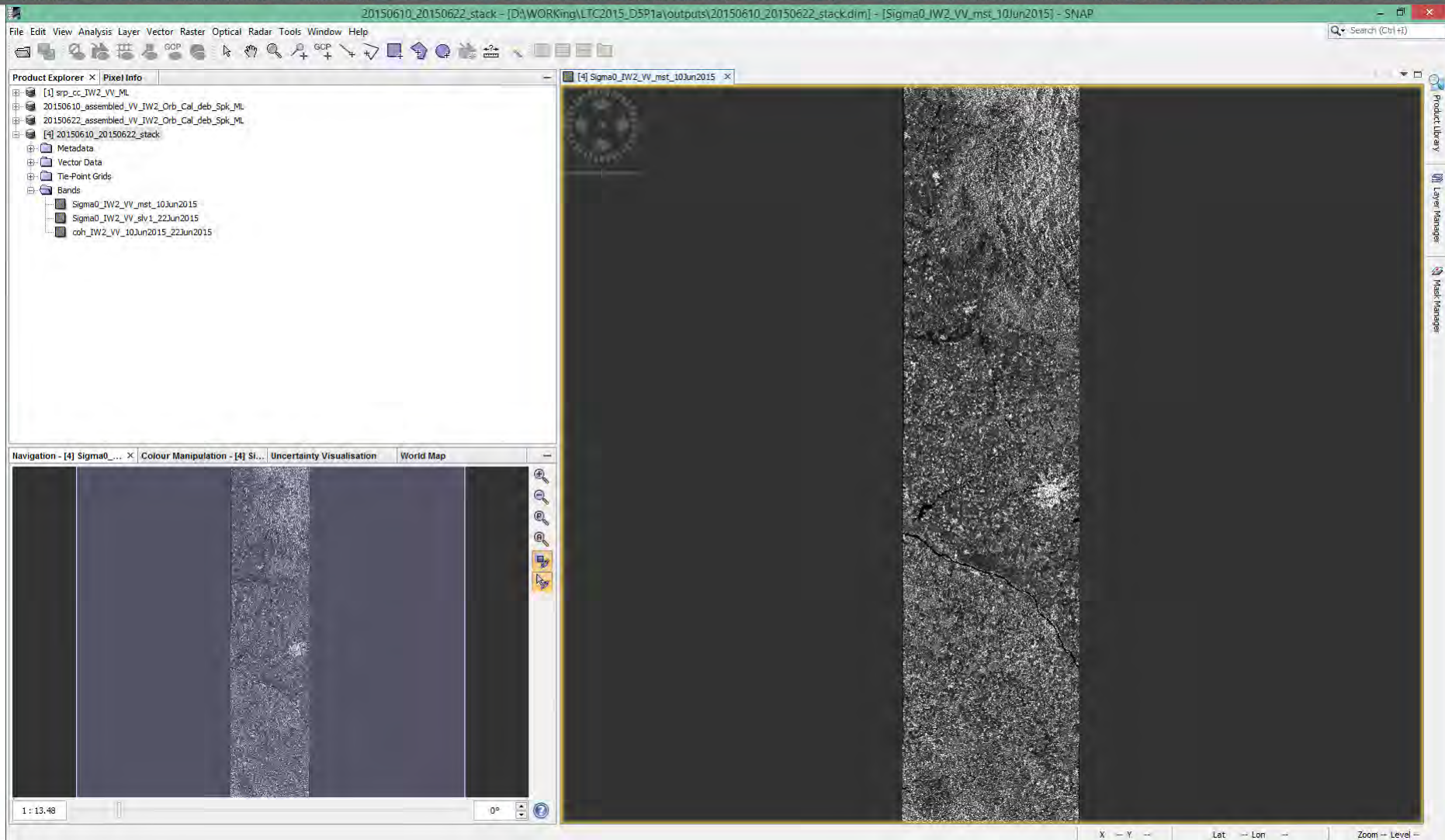
Output Extents: Master

Find Optimal Master

Help Run



Creating Data Stack (3/3)





Subset over AOI (1/3)



20150610_20150622_stack - [D:\WORKing\LTC2015_D5P1a\outputs\20150610_20150622_stack.dim] - [Sigma0_IW2_VV_mst_10Jun2015] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer X Pixel Info

- [1] srp_cc_IW2_VV_ML
- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- [4] 20150610_20150622_stack
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv_1_22Jun2015
 - coh_IW2_VV_10Jun2015_22Jun2015

Navigation - [4] Sigma0... X Colour Manipulation - [4] St... Uncertainty Visualisation World Map

1 : 13.48 0°

X Y Lat Lon Zoom Level

Geometry from WKT
WKT from Geometry
Export Transit Pixels
Export Mask Pixels
Export View as Google Earth KMZ
Export View as Image
Export Colour Palette as File
Export Colour Legend as Image
Spatial Subset from View...
Copy Pixel-Info to Clipboard



Subset over AOI (2/3)



20150610_20150622_stack - [D:\WORKing\LTC2015_D5P1a\outputs\20150610_20150622_stack.dim] - [Sigma0_IW2_VV_mst_10Jun2015] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer X Pixel Info

- [1] srp_cc_IW2_VV_ML
- 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- [4] 20150610_20150622_stack
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv_1_22Jun2015
 - coh_IW2_VV_10Jun2015_22Jun2015

Navigation - [4] Sigma0... X Colour Manipulation - [4] St... Uncertainty Visualisation World Map

1 : 13.48 0°

Specify Product Subset

Spatial Subset Band Subset Tie-Point Grid Subset Metadata Subset

Pixel Coordinates Geo Coordinates

Scene start X: 70
Scene start Y: 3255
Scene end X: 3110
Scene end Y: 9800

Scene step X: 1
Scene step Y: 1

Subset scene width: 3041.0
Subset scene height: 6546.0
Source scene width: 3206
Source scene height: 12832

Use Preview ☐ Fix full width ☐ Fix full height

Estimated, raw storage size: 56.9M

OK Cancel Help

X Y Lat Lon Zoom Level





Range-Doppler Terrain Correction (1/2)



subset_20150610_20150622_stack - [D:\WORKing\LTC2015_D5P1a\outputs\subset_20150610_20150622_stackdim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer X Pixel Info

- [1] srp_cc_IW2_VV_ML
- [2] 20150610_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- [3] 20150622_assembled_VV_IW2_Orb_Cal_deb_Spk_ML
- [4] 20150610_20150622_stack
- [5] subset_20150610_20150622_stack

Tools Menu:

- Apply Orbit File
- Radiometric
 - Speckle Filtering
 - Coregistration
 - Interferometric
 - Polarimetric
- Geometric
 - Sentinel-1 TOPS
 - ASAR WSS
 - Feature Extraction
 - SAR Utilities
 - Complex to Detected GR
 - Multilooking
- Terrain Correction
 - Ellipsoid Correction
 - SAR-Mosaic
 - ALOS Deskewing
 - Slant Range to Ground Range
 - Update Geo Reference
 - Range-Doppler Terrain Correction
 - SAR Simulation
 - SAR-Simulation Terrain Correction

Navigation Colour Manipulation Uncertainty Visualisation World Map X

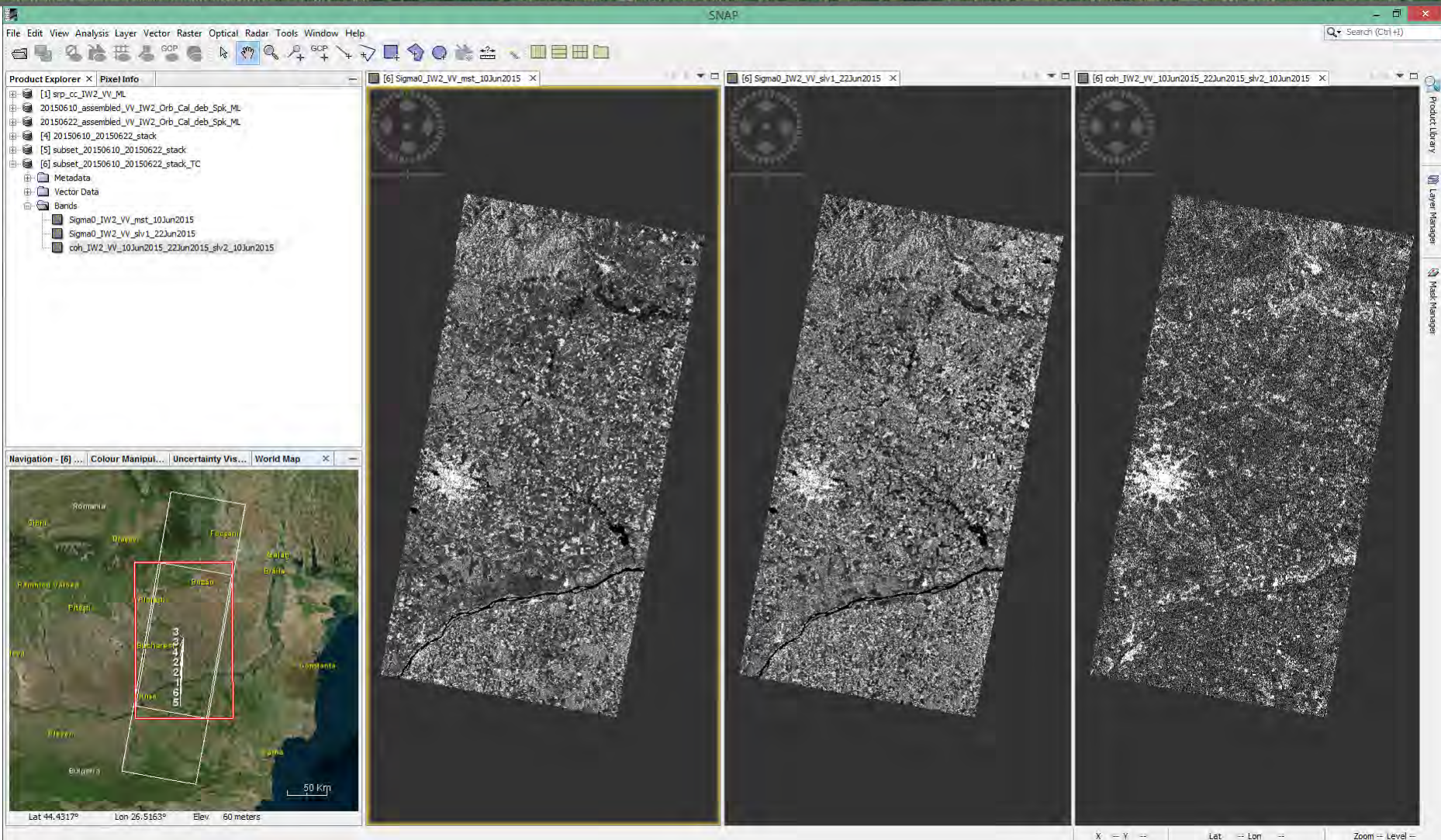
Off Globe

100 Km

X Y Lat Lon Zoom Level



Range-Doppler Terrain Correction (2/2)





Average Backscatter Image Band Math Tool (1/2)



subset_20150610_20150622_stack_TC - [D:\WORKing\LTC2015_D5P1a\outputs\subset_20150610_20150622_stack_TC.dim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Band Maths...

- Filtered Band...
- Convert Band
- Propagate Uncertainty...
- Geo-Coding Displacement Bands...
- Subset...
- Geometric Operations
- DEM Tools
- Masks
- Data Conversion
- Image Analysis
- Export

Product Explorer: Pixel Info

- [6] subset_20150610_20150622_stack_TC
- Metadata
- Vector Data
- Bands
 - Sigma0_IW2_VV_mst_10Jun
 - Sigma0_IW2_VV_slv1_22Jun
 - coh_IW2_VV_10Jun2015_22Jun

Navigation: Colour Manipul... Uncertainty Vis... World Map

Off Globe

50 Km

X Y Lat Lon Zoom Level



Average Backscatter Image Band Math Tool (2/2)



subset_20150610_20150622_stack_TC - [D:\WORKing\LTC2015_D5P1a\outputs\subset_20150610_20150622_stack_TC.dim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer Pixel Info

- [6] subset_20150610_20150622_stack_TC
 - Metadata
 - Vector Data
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015
 - coh_IW2_VV_10Jun2015_22Jun2015_slv2_10Jun2015

Navigation Colour Manipul... Uncertainty Vis... World Map

Off Globe

Band Maths

Target product:
[6] subset_20150610_20150622_stack_TC

Name: ave_sigma0

Description:

Unit:

Spectral wavelength: 0.0

☒ Virtual (save expression only, don't store data)

☒ Replace NaN and infinity results by NaN

☐ Generate associated uncertainty band

Band maths expression:
(Sigma0_IW2_VV_mst_10Jun2015 + Sigma0_IW2_VV_slv1_22Jun2015) / 2

Load... Save... Edit Expression...

OK Cancel Help

X -- Y -- Lat -- Lon -- Zoom -- Level --



Backscatter Difference Image Band Math Tool



subset_20150610_20150622_stack_TC - [D:\WORKing\LTC2015_D5P1a\outputs\subset_20150610_20150622_stack_TC.dim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer Pixel Info

- [6] subset_20150610_20150622_stack_TC
 - Metadata
 - Vector Data
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv_1_22Jun2015
 - coh_IW2_VV_10Jun2015_22Jun2015_slv_2_10Jun2015

Navigation Colour Manipul... Uncertainty Vis... World Map

Off Globe

Band Maths

Target product:
[6] subset_20150610_20150622_stack_TC

Name: diff_sigma0

Description:

Unit:

Spectral wavelength: 0.0

☒ Virtual (save expression only, don't store data)

☒ Replace NaN and infinity results by NaN

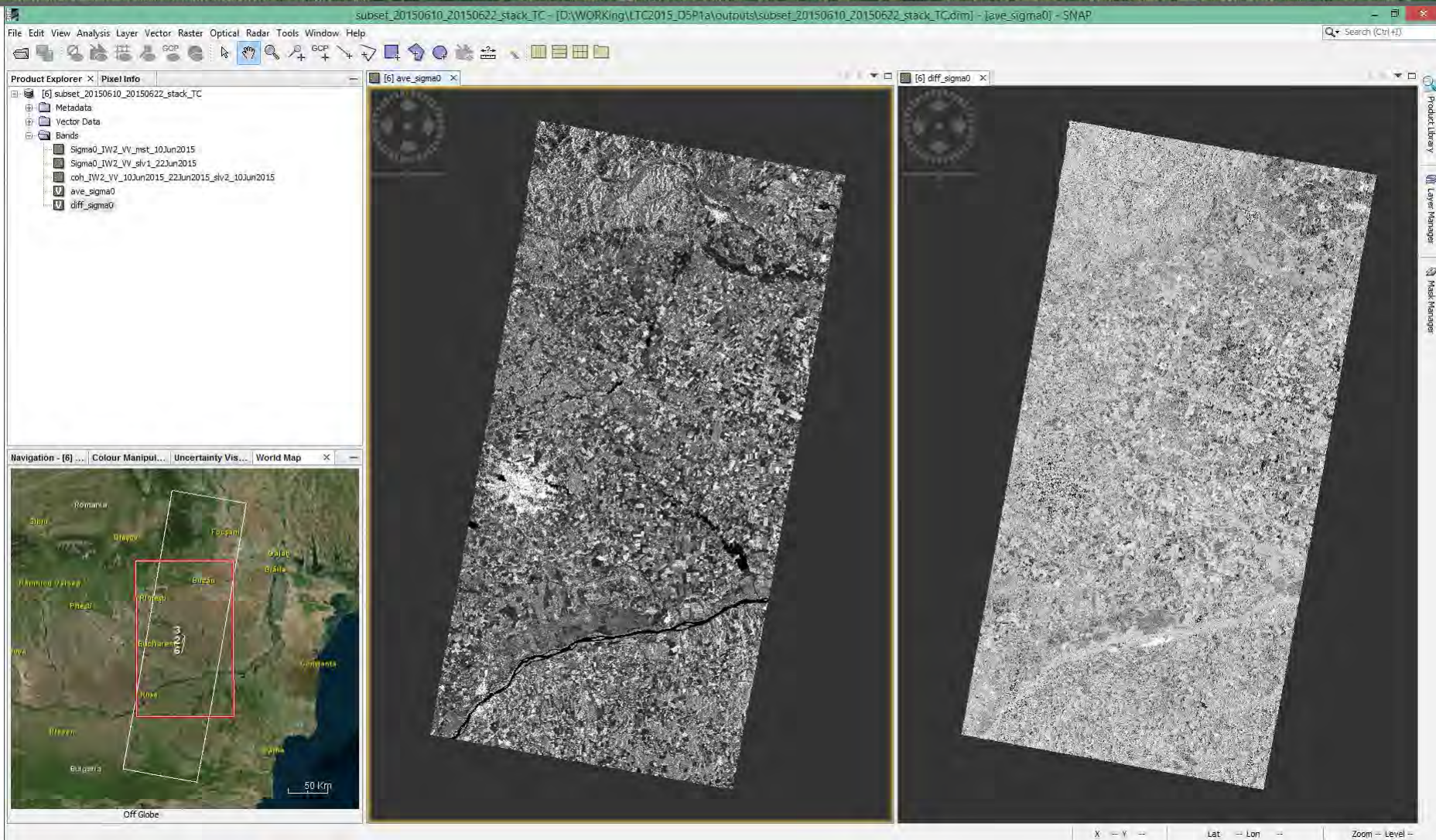
☐ Generate associated uncertainty band

Band maths expression:
Sigma0_IW2_VV_mst_10Jun2015 - Sigma0_IW2_VV_slv_1_22Jun2015

Load... Save... Edit Expression...

OK Cancel Help

X -- Y -- Lat -- Lon -- Zoom -- Level --





Linear to dB Scale Conversion



subset_20150610_20150622_stack_TC - [D:\WORKing\LTC2015_D5P1a\outputs\subset_20150610_20150622_stack_TC.dim] - [ave_sigma0] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer Pixel Info

- [6] subset_20150610_20150622_stack_TC
- Metadata
- Vector Data
- Bands
 - Sigma0_IW2_VV_mst_10Jun
 - Sigma0_IW2_VV_slv1_22Jun
 - coh_IW2_VV_10Jun2015_2
 - ave_sigma0
 - diff_sigma0

Raster

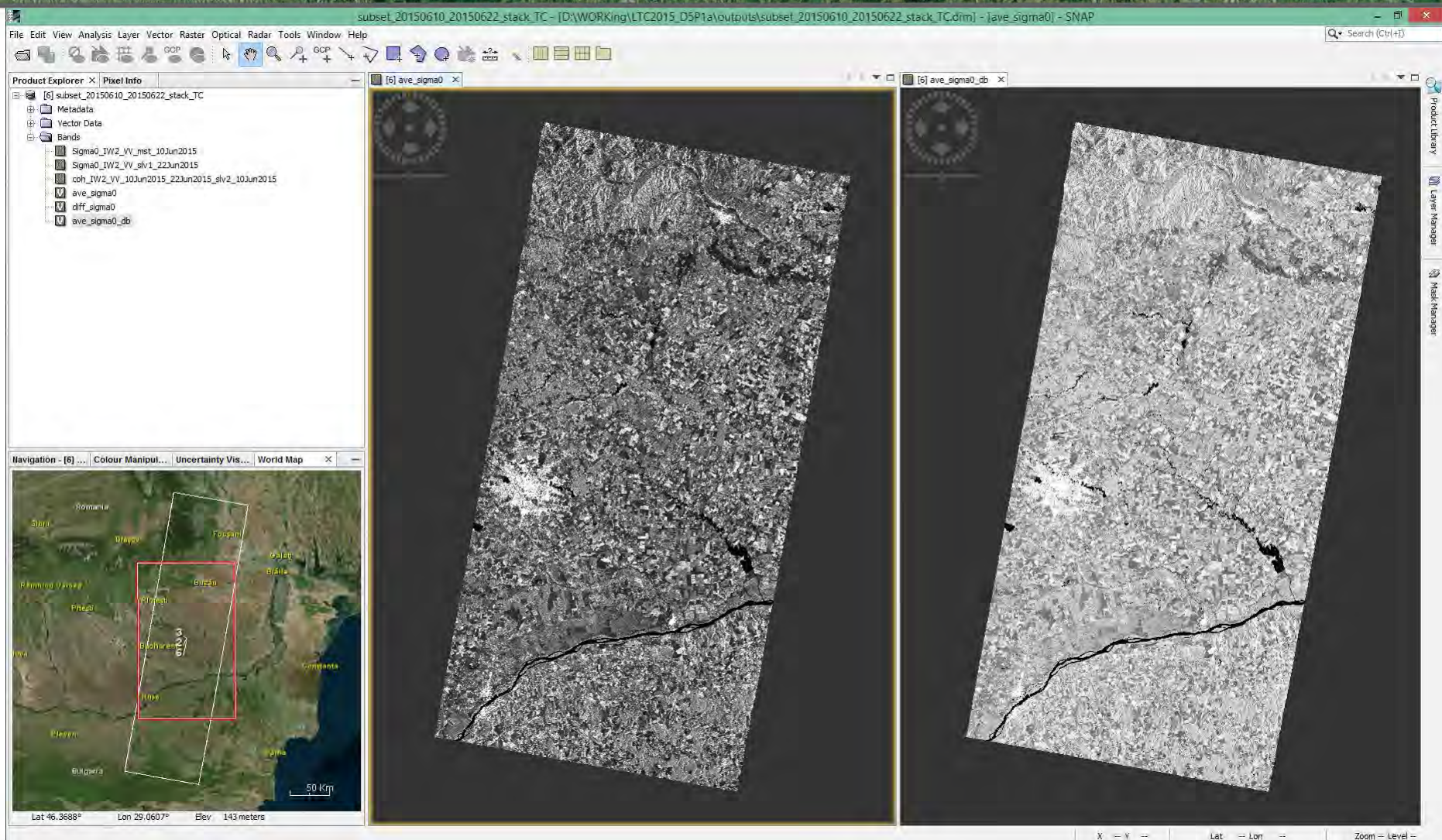
- Band Maths...
- Filtered Band...
- Convert Band
- Propagate Uncertainty...
- Geo-Coding Displacement Bands...
- Subset...
- Geometric Operations
- DEM Tools
- Masks
- Data Conversion
 - Amplitude to/from Intensity
 - Convert Datatype
 - Linear to/from dB
- Image Analysis
- Export

Navigation Colour Manipul... Uncertainty Vis... World Map

Off Globe

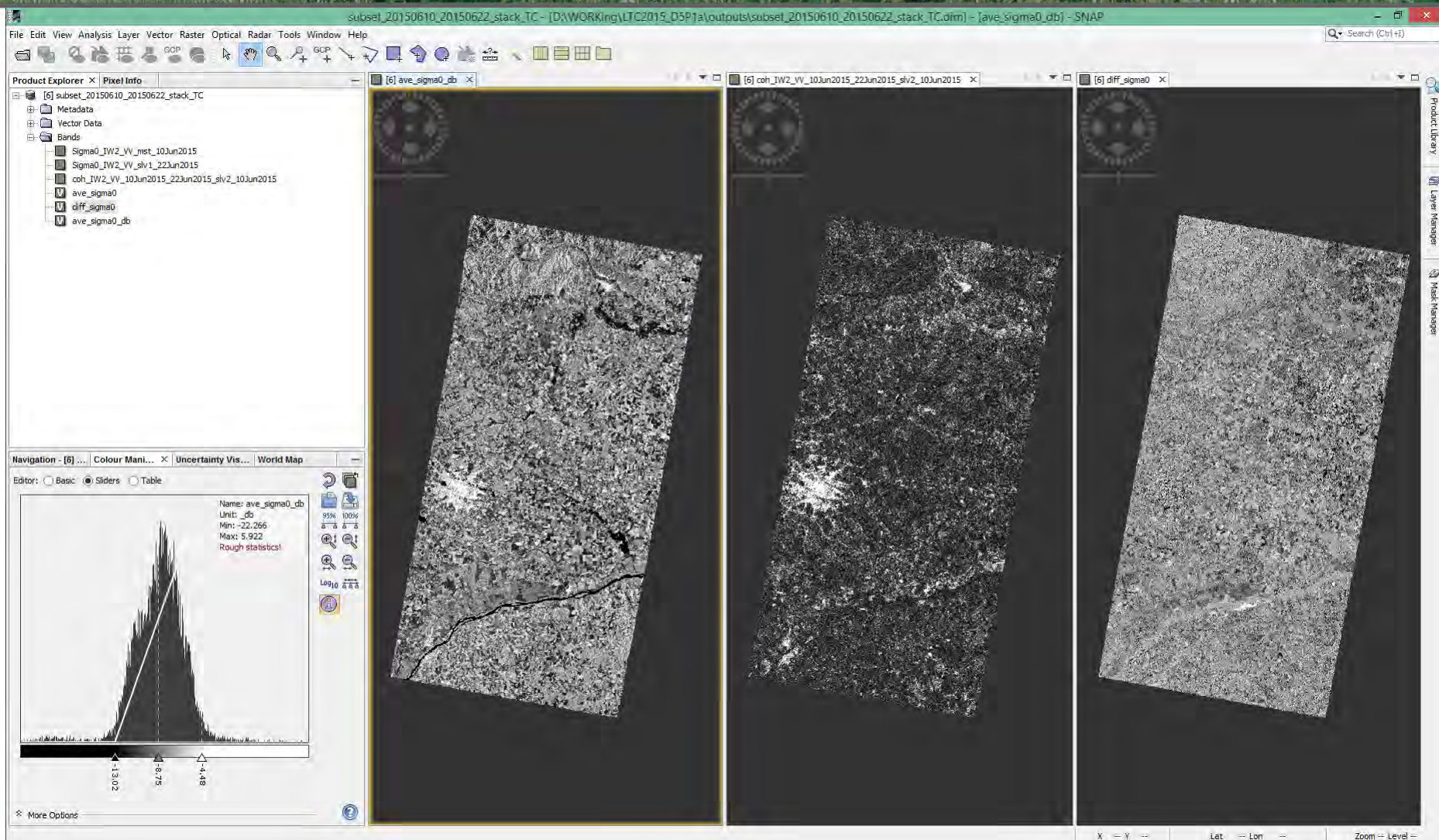
50 Km

X Y Lat Lon Zoom Level



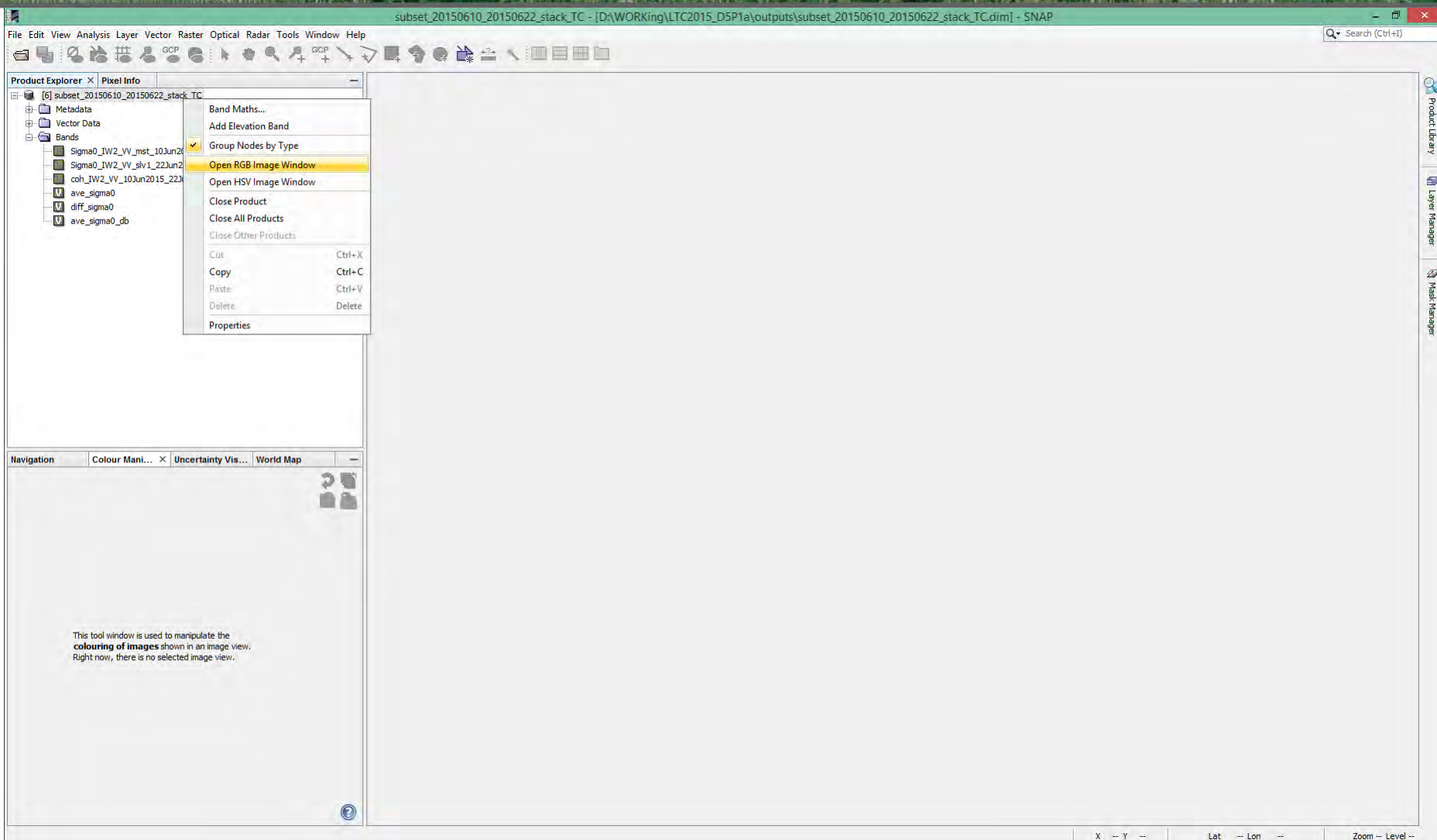


RGB Composite Generation Visualization of Input Images





RGB Composite Generation





RGB Composite Generation

R: Coherence, G: Average & B: Difference



subset_20150610_20150622_stack_TC - [D:\WORKing\LTC2015_D5P1a\outputs\subset_20150610_20150622_stack_TC.dim] - SNAP

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help

Product Explorer Pixel Info

- [6] subset_20150610_20150622_stack_TC
 - Metadata
 - Vector Data
 - Bands
 - Sigma0_IW2_VV_mst_10Jun2015
 - Sigma0_IW2_VV_slv1_22Jun2015
 - coh_IW2_VV_10Jun2015_22Jun2015_slv2_10Jun2015
 - ave_sigma0
 - diff_sigma0
 - ave_sigma0_db

Navigation Colour Mani... x Uncertainty Vis... World Map

This tool window is used to manipulate the **colouring of images** shown in an image view. Right now, there is no selected image view.

Select RGB-Image Channels

Profile:

Red: _IW2_VV_10Jun2015_22Jun2015_slv2_10Jun2015

Green: ave_sigma0_db

Blue: diff_sigma0

☐ Store RGB channels as virtual bands in current product

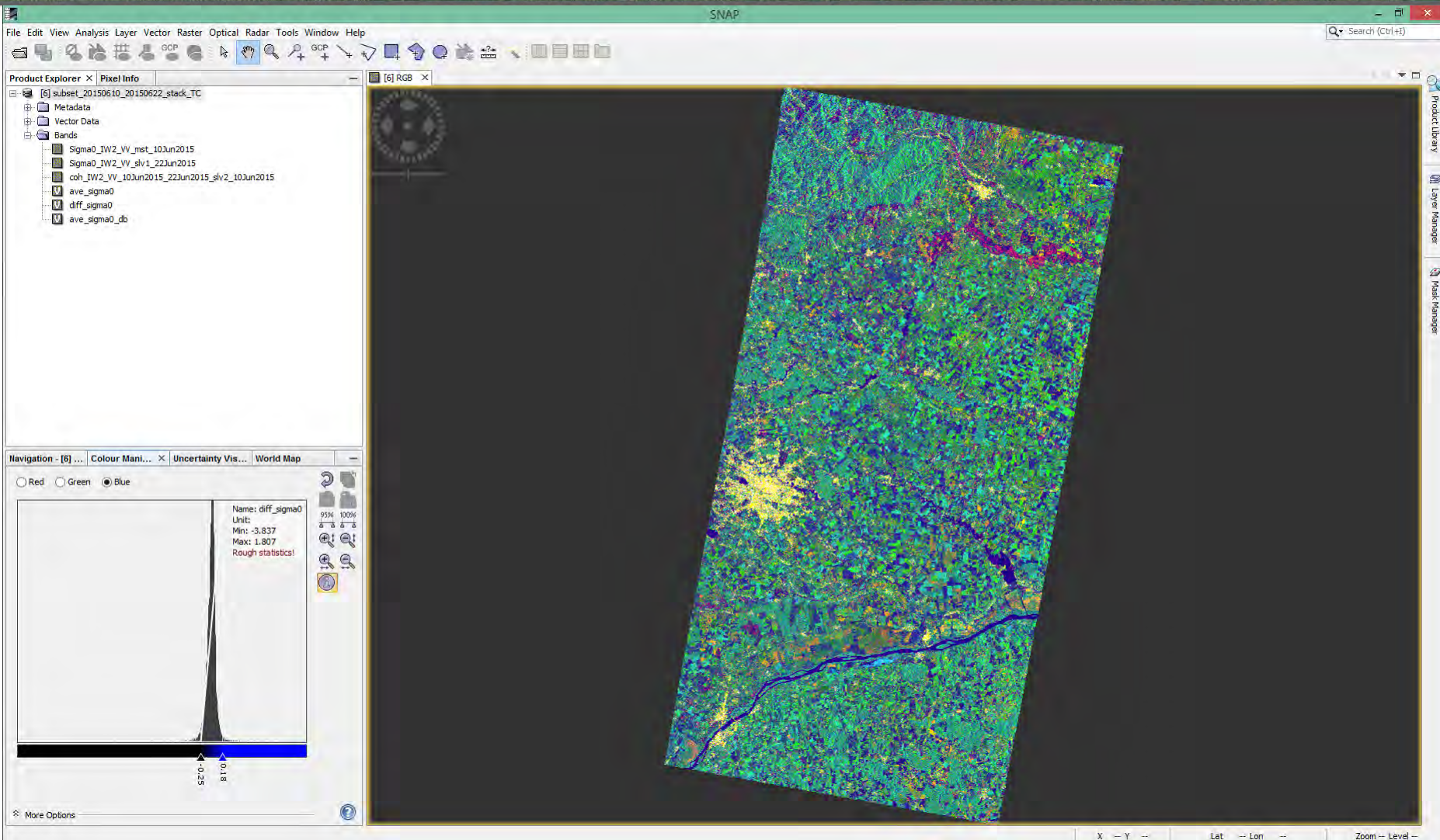
OK Cancel Help

X Y Lat Lon Zoom Level



RGB Composite

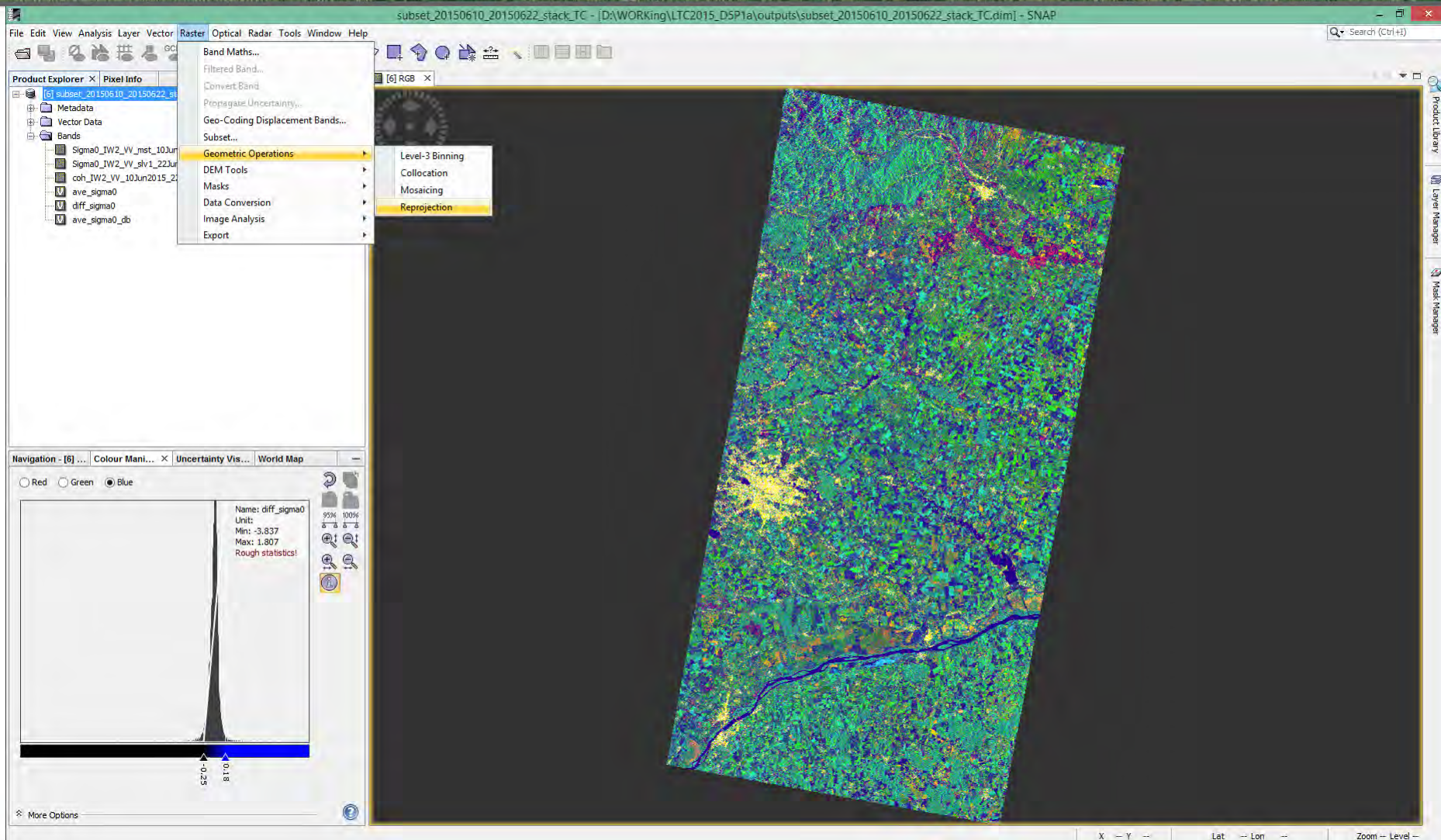
R: Coherence, G: Average & B: Difference





Export to Google Earth

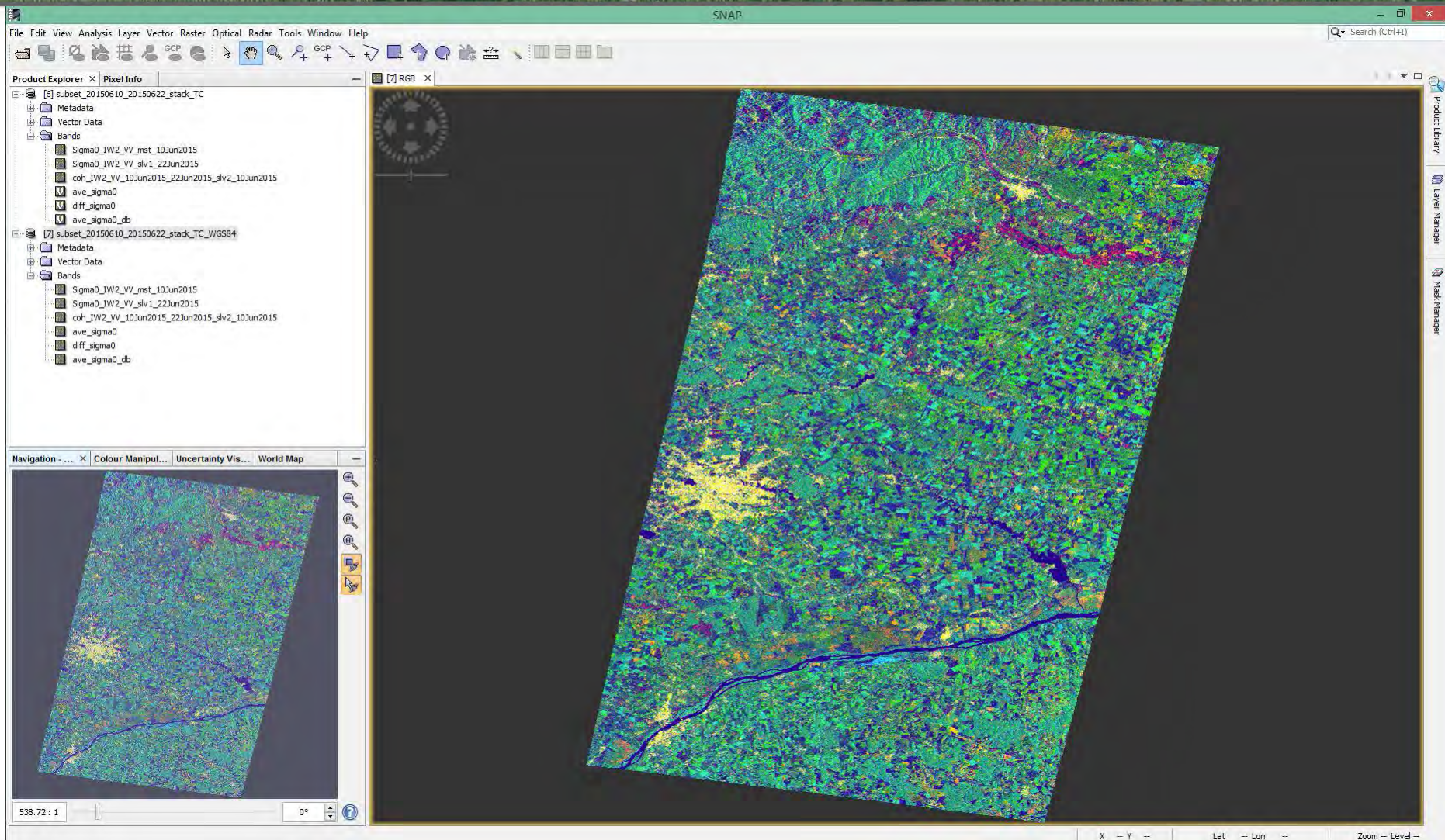
Transformation to Geographic Coords





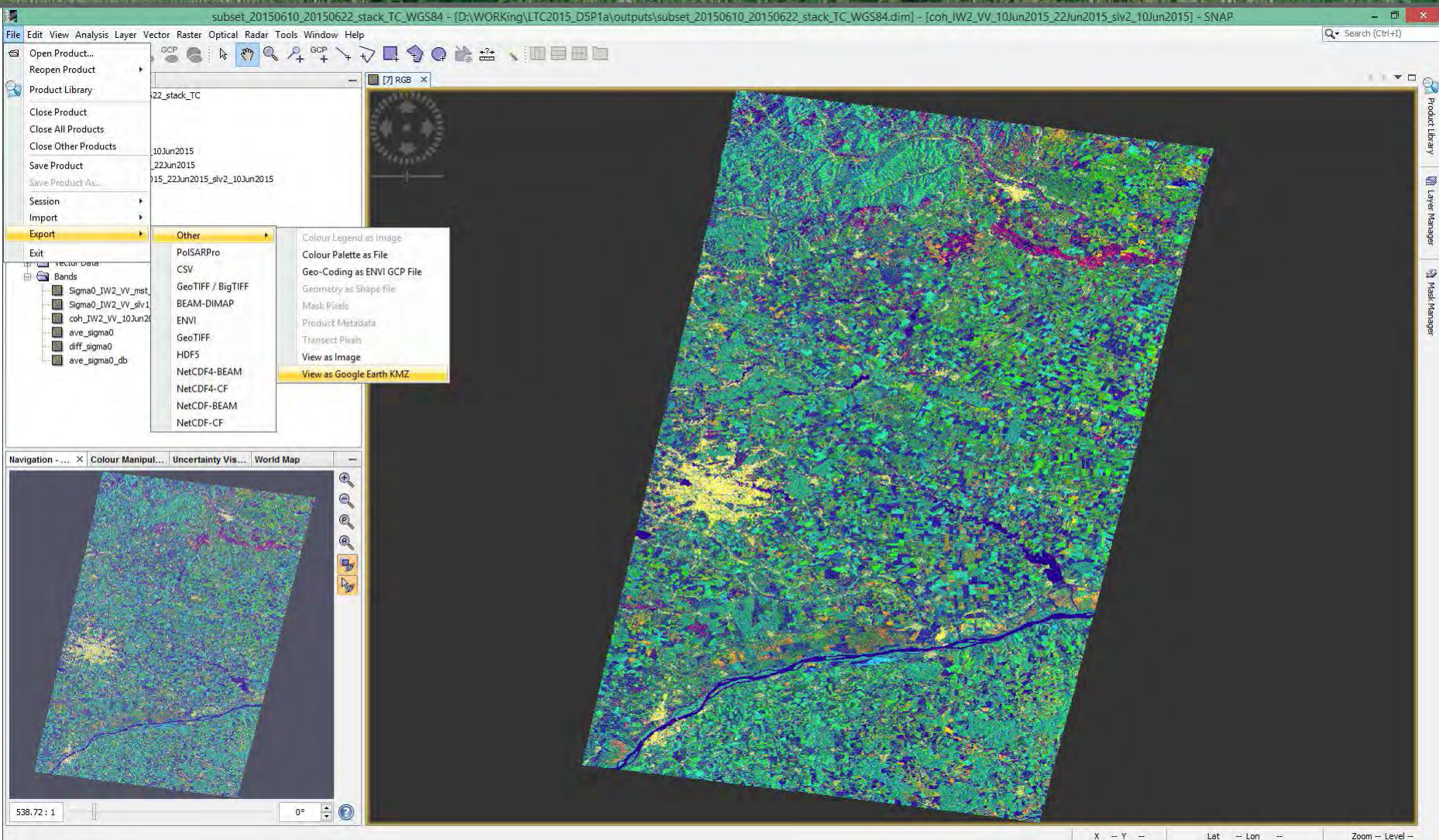
RGB Composite

Re-projected to Geographic Coords





Export Results Google Earth (.kmz) Format





Google Earth Viewer



Google Earth

File Edit View Tools Add Help

Search

Search

ex: NYC

Get Directions History

Places

- My Places
 - Sightseeing Tour
 - Make sure 3D Buildings layer is checked
- Temporary Places
 - RGB
 - [7] RGB
 - subset_20150610_20150622_stack_TC_WGS84

Layers

Earth Gallery >>

- Primary Database
 - Voyager New!
 - Borders and Labels
 - Places
 - Photos
 - Roads
 - 3D Buildings
 - Ocean
 - Weather
 - Gallery
 - Global Awareness
 - More

© 2015 Cnes/Spot Image Landsat

Google earth

Imagery Date: 4/10/2013 44°05'06.29" N 27°26'22.12" E elev 126 ft eye alt 83.65 mi

Tour Guide



Thank you