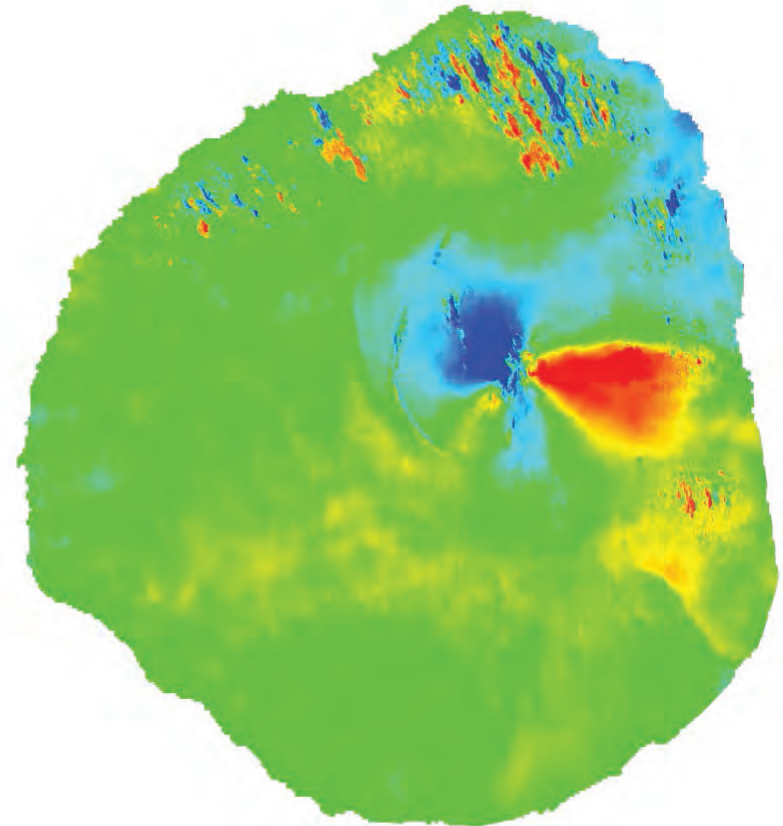


Practical Exercise

Measuring Ground Deformation

November 2016

- Familiarize with open source ESA SNAP/Sentinel-1 Toolbox
- Training on TOPS Differential SAR Interferometry (DInSAR) for measuring ground deformation
- Provide instruction on step-by-step interferometric processing of Sentinel-1 TOPS data (incl. parameters, tips etc.)
- End-to-end show case (Fogo Volcano eruption)



Contains modified
Copernicus Sentinel data [2014]

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

S1A_IW_SLC__1SSV_20141103T195043_20141103T195057_003122_00395A_F396.zip

S1A_IW_SLC__1SSV_20141127T195042_20141127T195056_003472_004117_2B48.zip

[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_32_09.zip & srtm_32_10.zip

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



EXERCISE

Sentinel-1 TOPS

Interferometry with S1TBX

PART 1

TOPS InSAR Processing

PART 2

Phase Unwrapping using SNAPHU

PART 3

Displacement Measurements &
Terrain Geocoding



Geocoded Terrain Corrected
S1 TOPS Ground Displacement Map

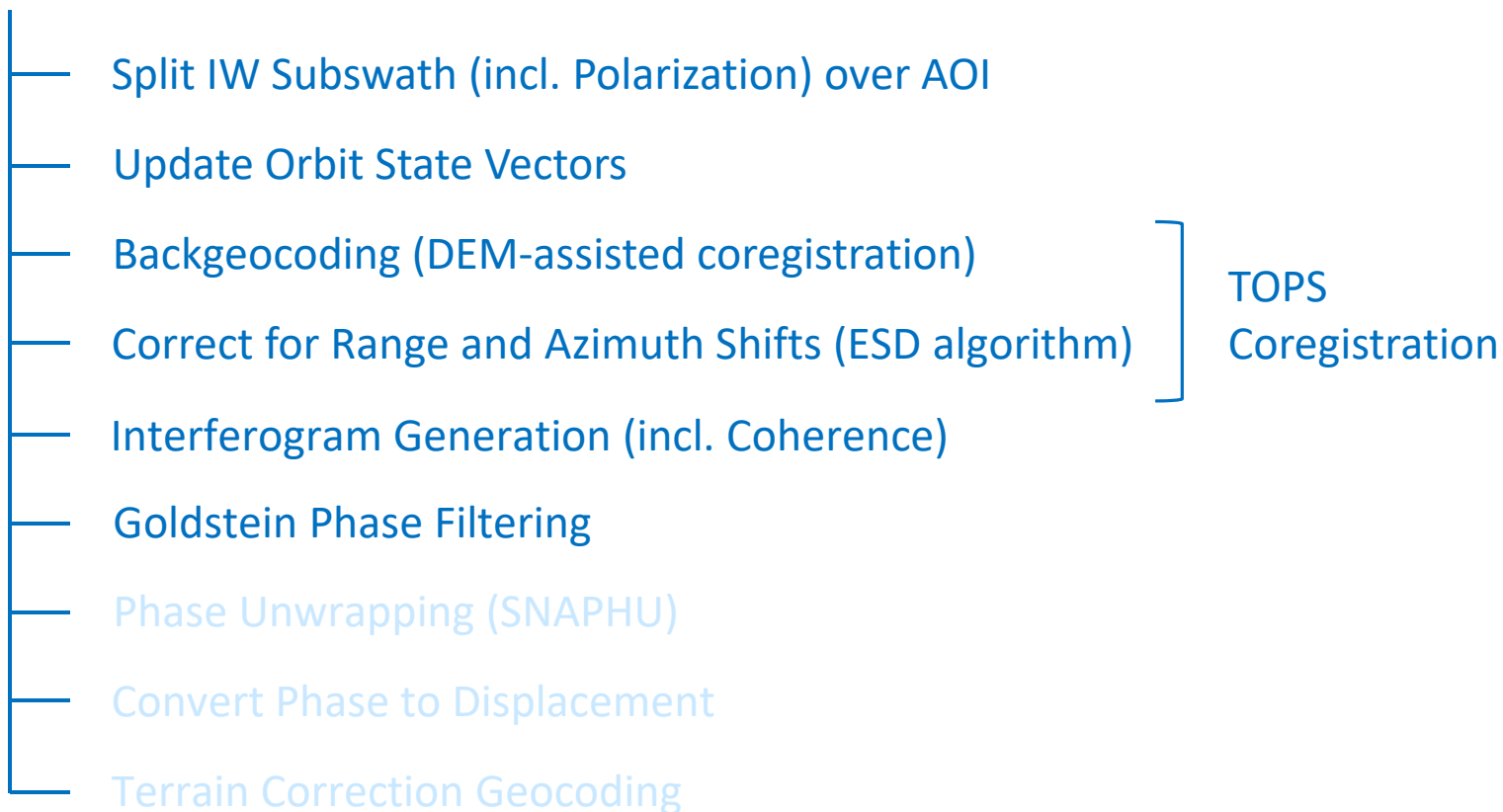
EXERCISE

PART 1

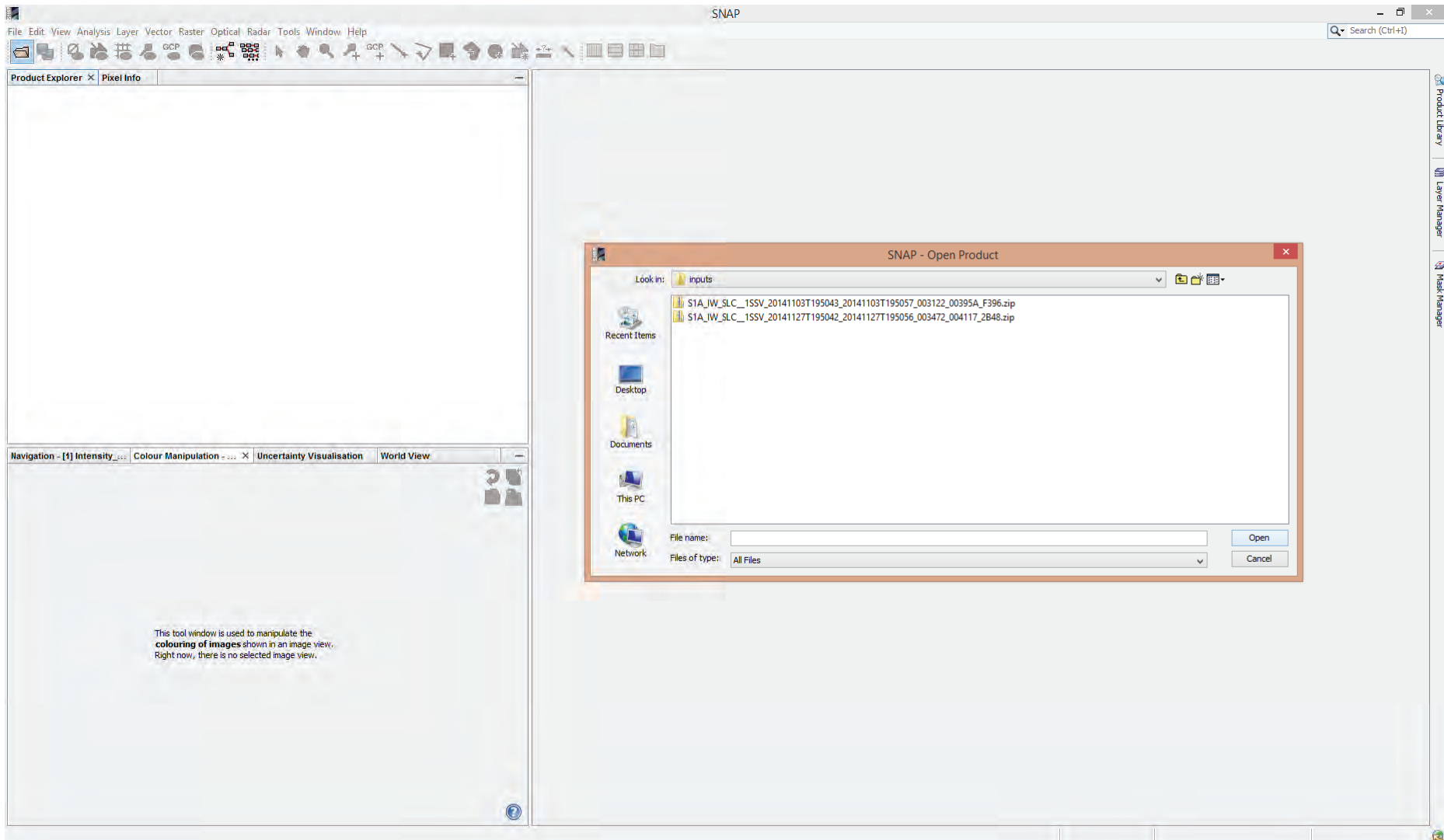
Sentinel-1 TOPS InSAR Processing



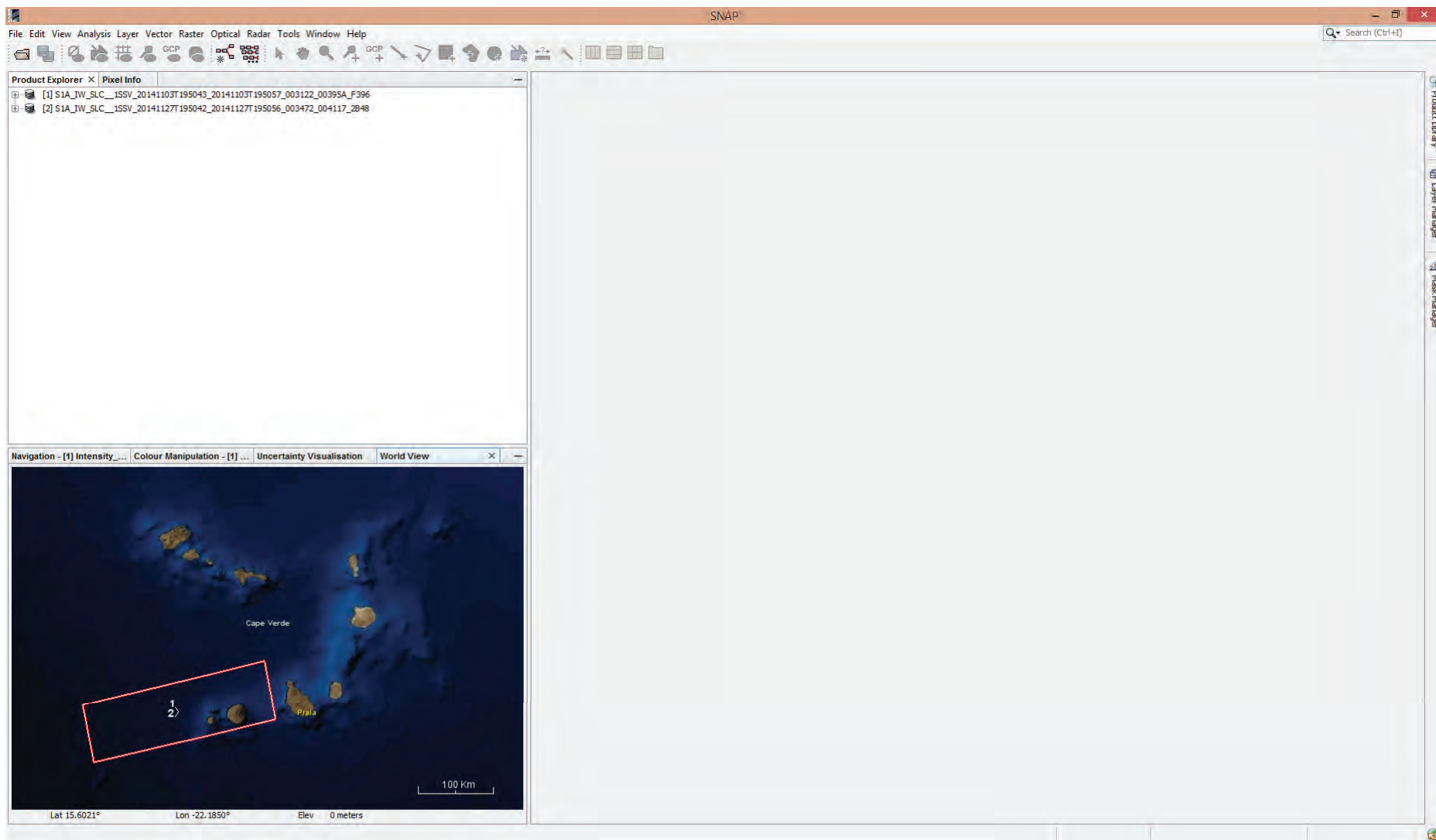
EXERCISE Processing Steps (PART 1)



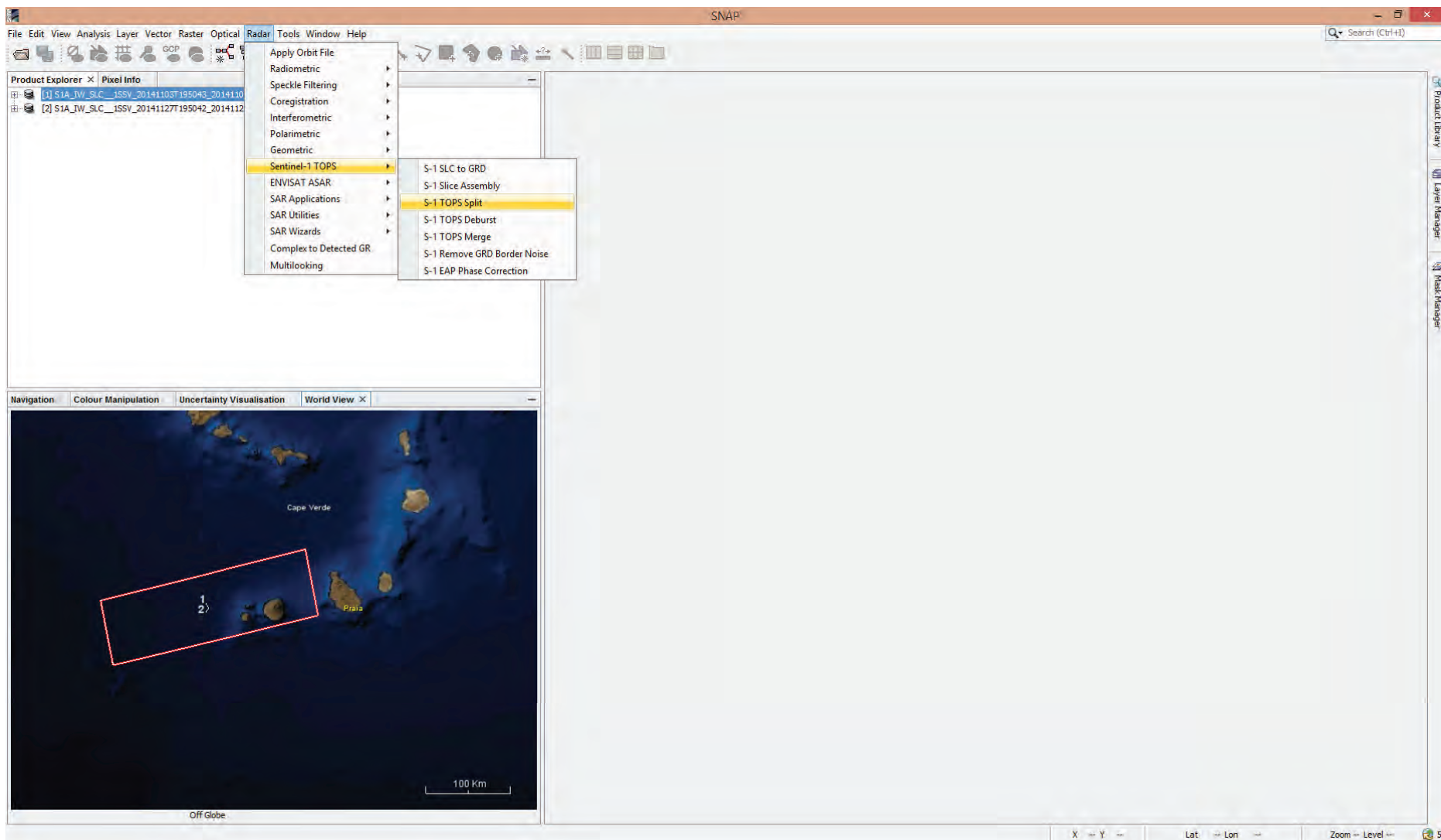
Read Sentinel-1 SLC Products (directly *.zip files)



Sentinel-1 IW TOPS (Swath of 250km)

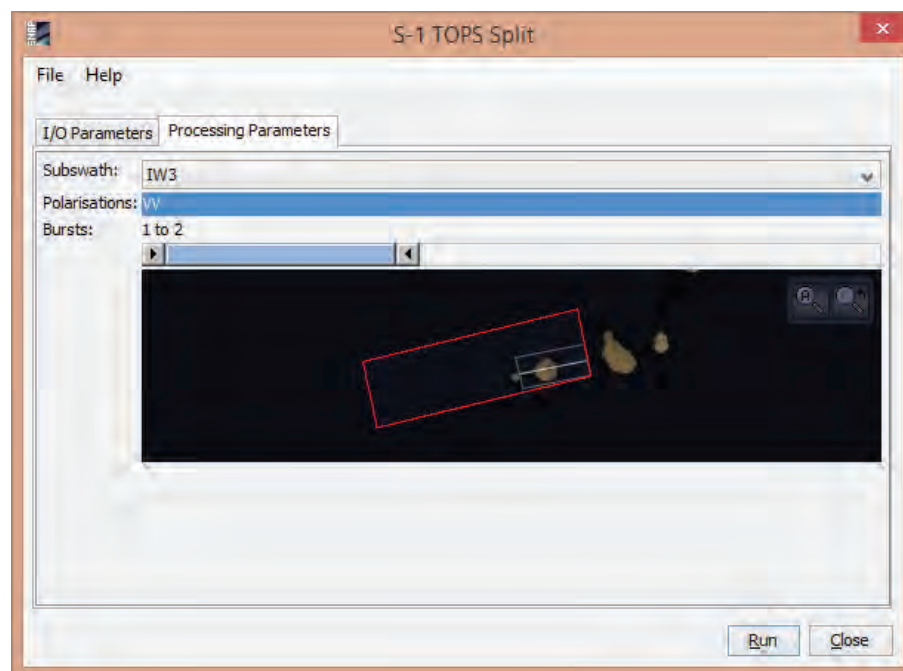
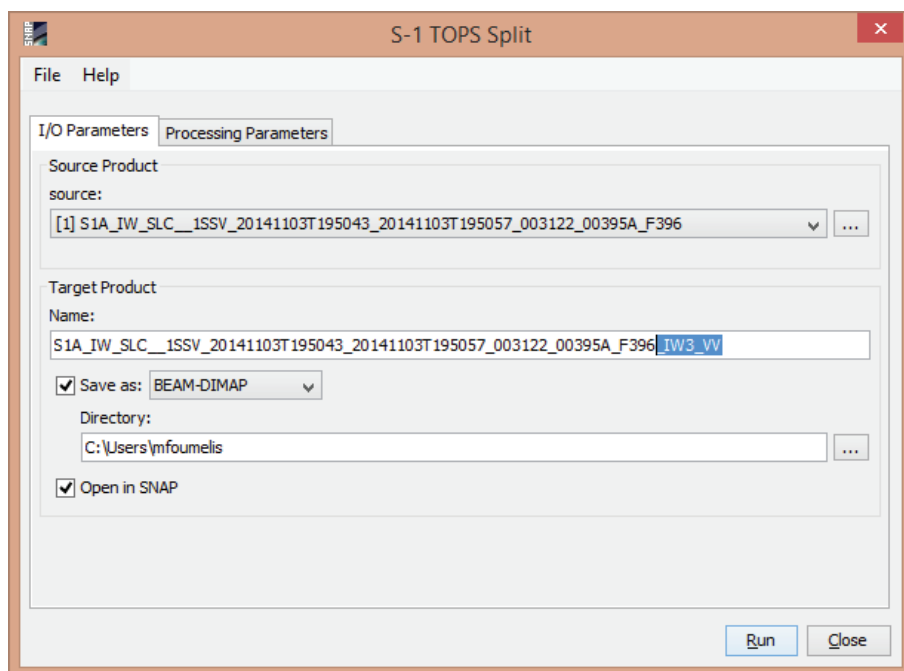


Splitting S1 SLC Products (@Subswath and Burst level)

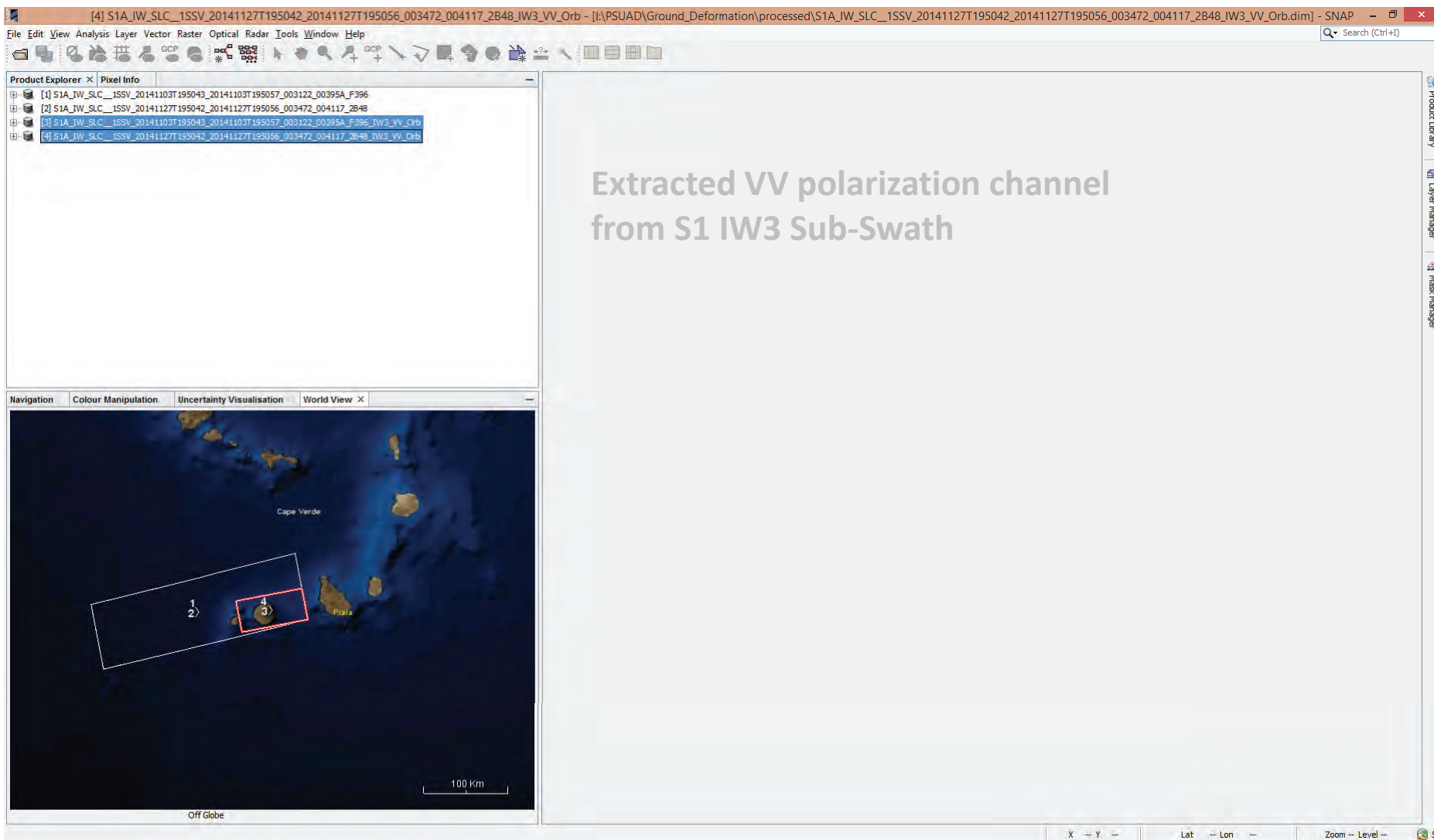


Splitting S1 SLC Products (@ Subswath and Burst level)

Selection of sub-swath (IW1, IW2 & IW3), burst and polarization (VV & VH)



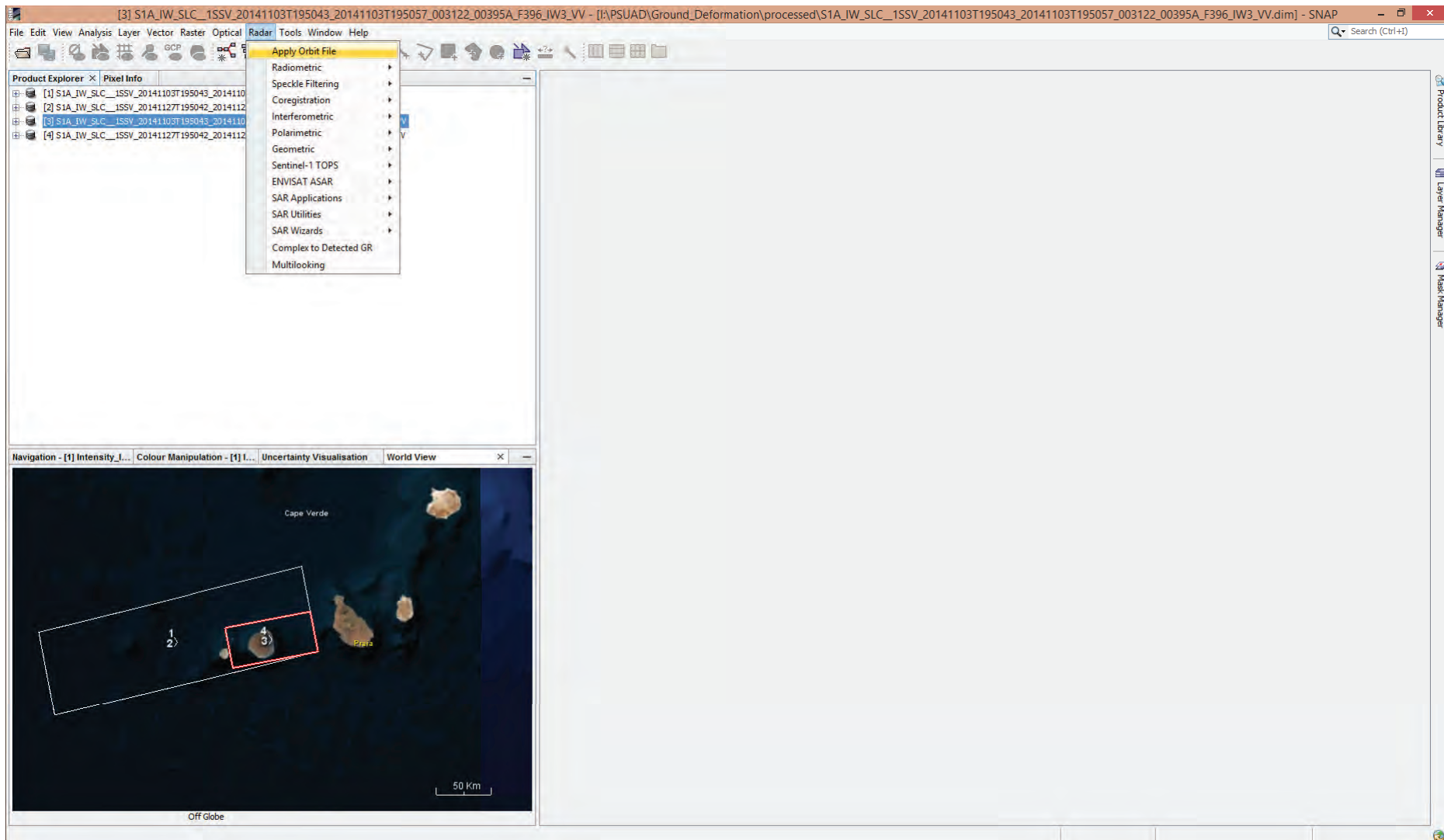
Splitting S1 SLC Products (@ Subswath and Burst level)



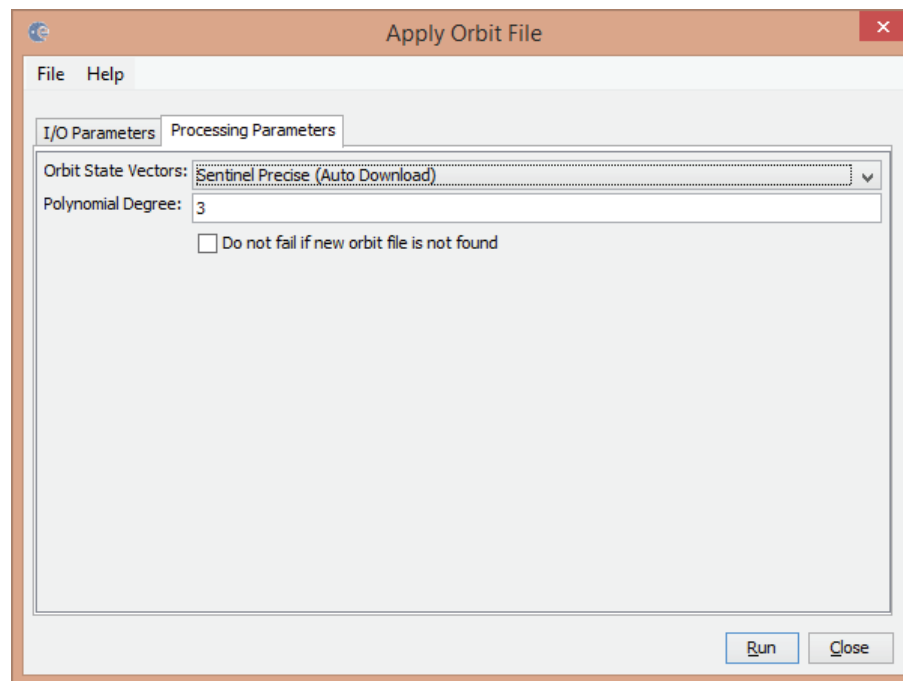
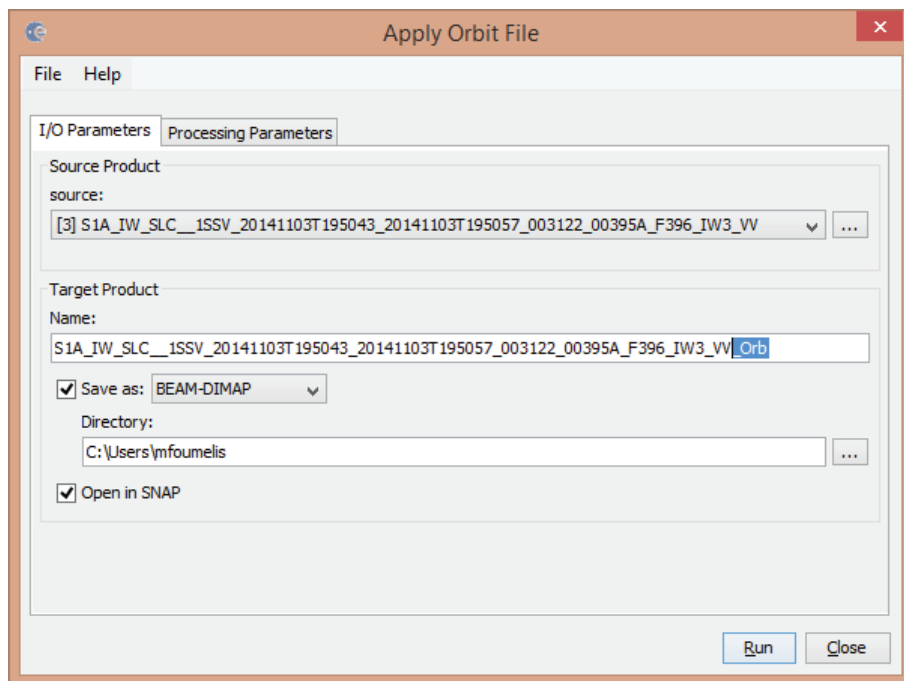
The screenshot displays the SNAP (Sentinel Application Platform) software interface. The title bar indicates the active file is '[4] S1A_IW_SLC__1SSV_20141127T195042_20141127T195056_003472_004117_2B48_IW3_VV_Orb - [I:\PSUAD\Ground_Deformation\processed\S1A_IW_SLC__1SSV_20141127T195042_20141127T195056_003472_004117_2B48_IW3_VV_Orb.dim] - SNAP'. The interface includes a menu bar (File, Edit, View, Analysis, Layer, Vector, Raster, Optical, Radar, Tools, Window, Help) and a toolbar with various processing tools. The 'Product Explorer' panel on the left lists four products, with the fourth product, 'S1A_IW_SLC__1SSV_20141127T195042_20141127T195056_003472_004117_2B48_IW3_VV_Orb', selected. The 'Pixel Info' panel shows details for the selected product. The main map area displays a satellite image of Cape Verde, with a white rectangular box labeled '1' and a red rectangular box labeled '4' indicating specific sub-swath areas. A scale bar at the bottom right of the map indicates 100 km. The 'Navigation' panel at the bottom shows the map's coordinates and zoom level.

Extracted VV polarization channel
from S1 IW3 Sub-Swath

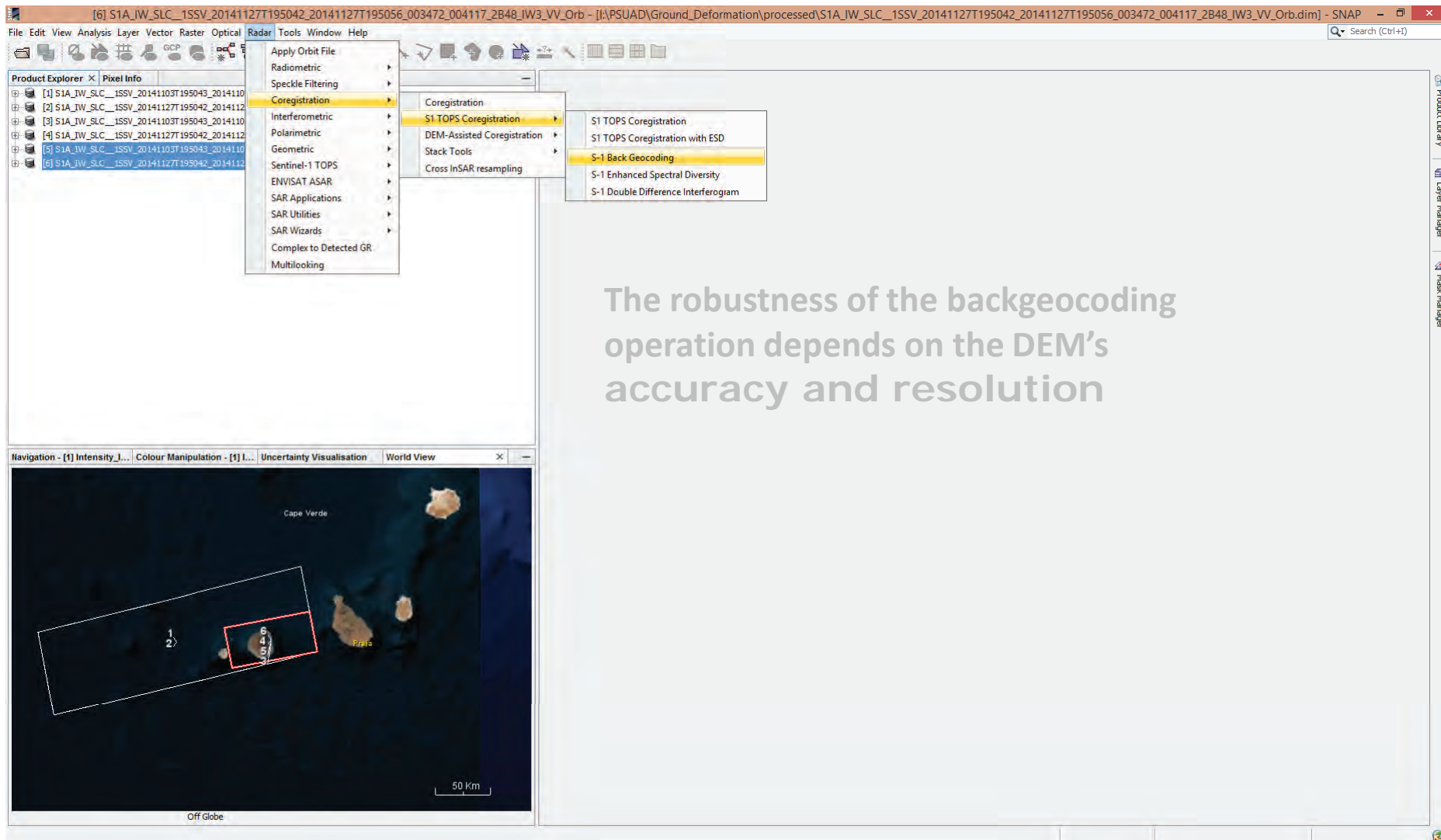
Update Orbital Information (Orbit State Vectors)



Automatically adding suffixes (product_*) indicating processing implemented



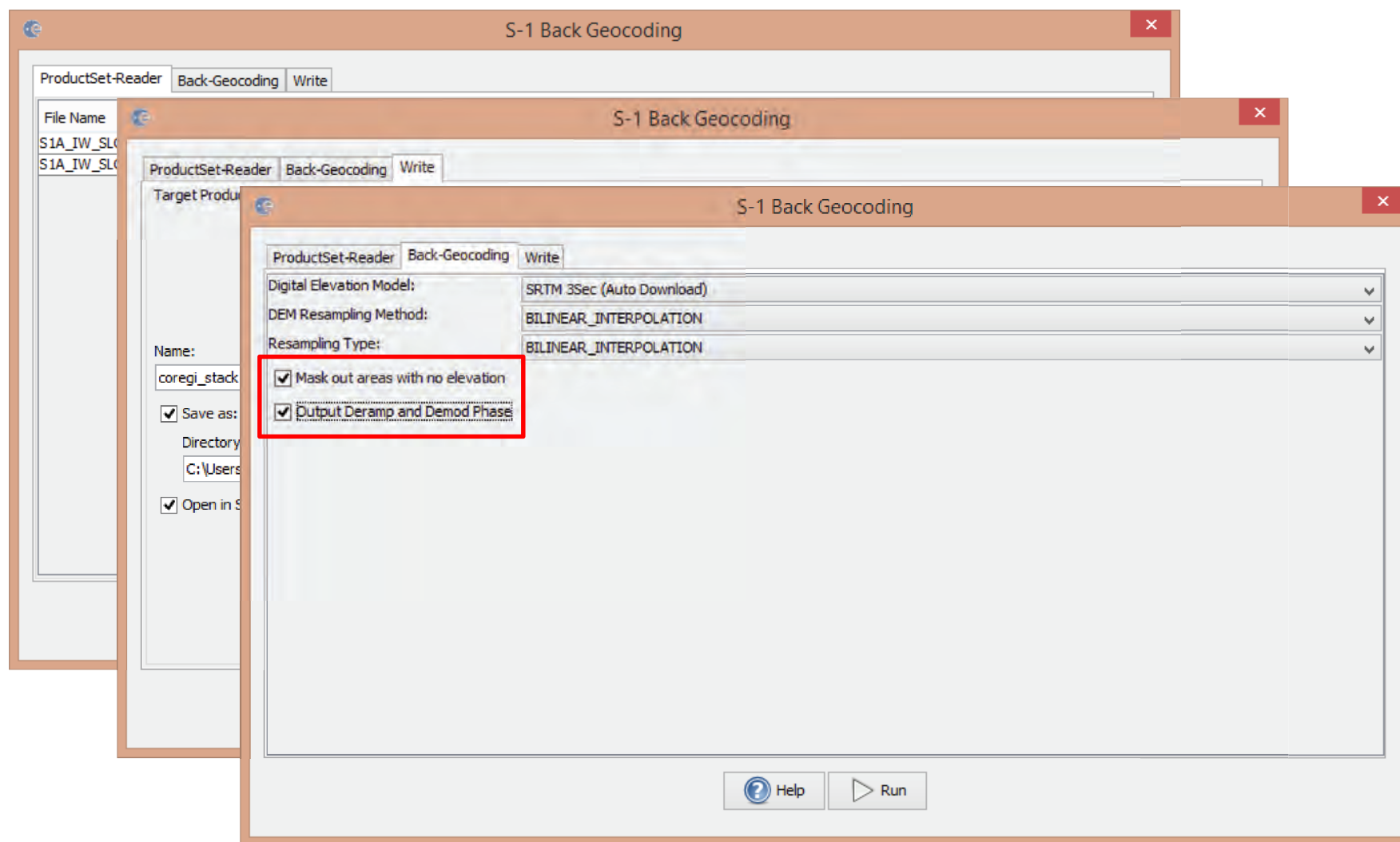
Back-geocoding TOPS SLCs (Geometric Co-registration)



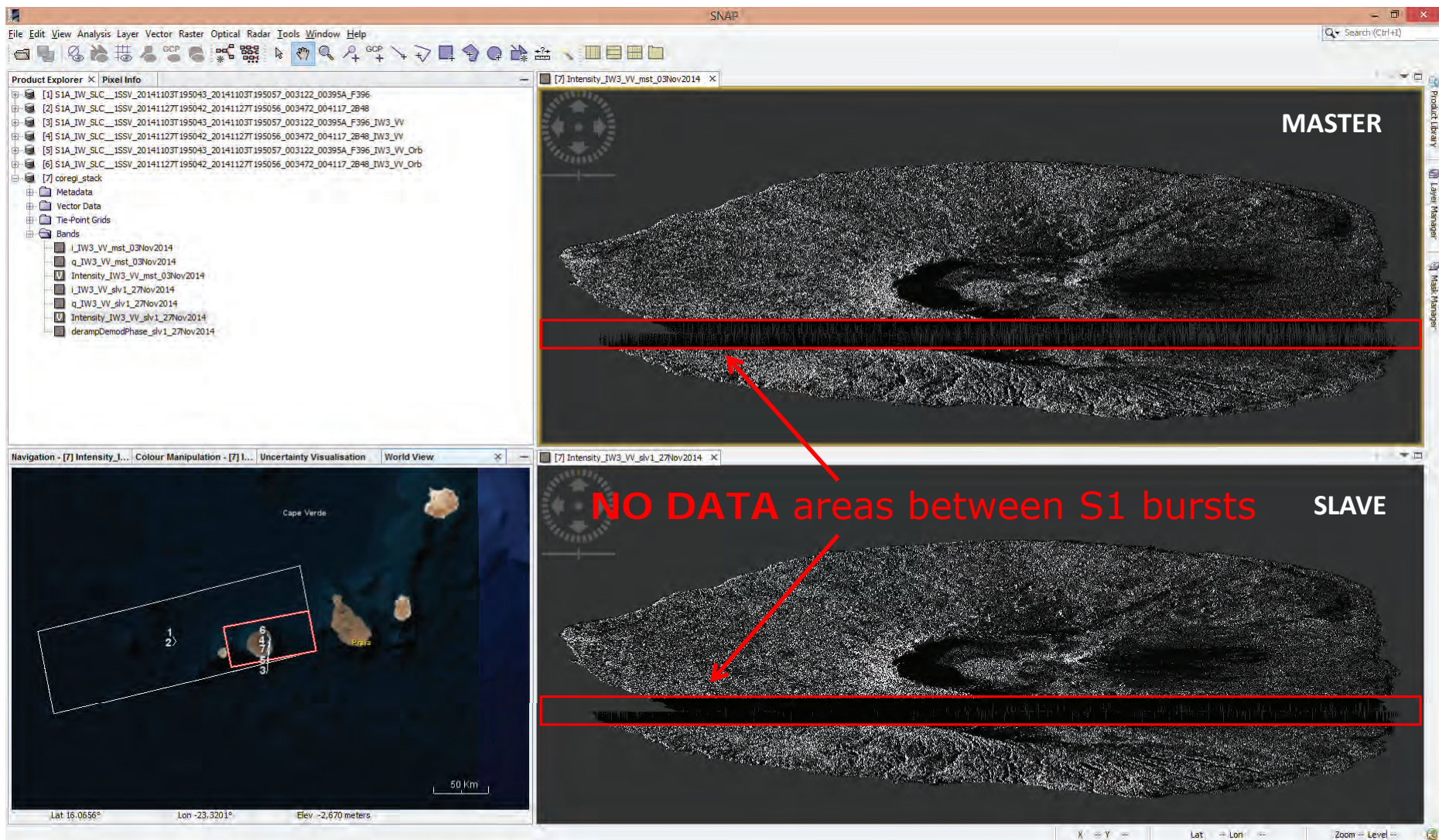
The screenshot displays the SNAP (Sentinel Application Platform) software interface. The main window shows a list of products in the 'Product Explorer' on the left, including S1A_IW_SLC_1SSV_20141127T195042_20141127T195056_003472_004117_2B48_IW3_VV_Orb. The 'Tools' menu is open, and the 'Coregistration' submenu is selected, showing the 'S-1 Back Geocoding' option. The 'World View' window at the bottom shows a map of Cape Verde with a red rectangle indicating the area of interest. A scale bar indicates 50 Km.

The robustness of the backgeocoding operation depends on the DEM's accuracy and resolution

Back-geocoding TOPS SLCs (Geometric Co-registration)

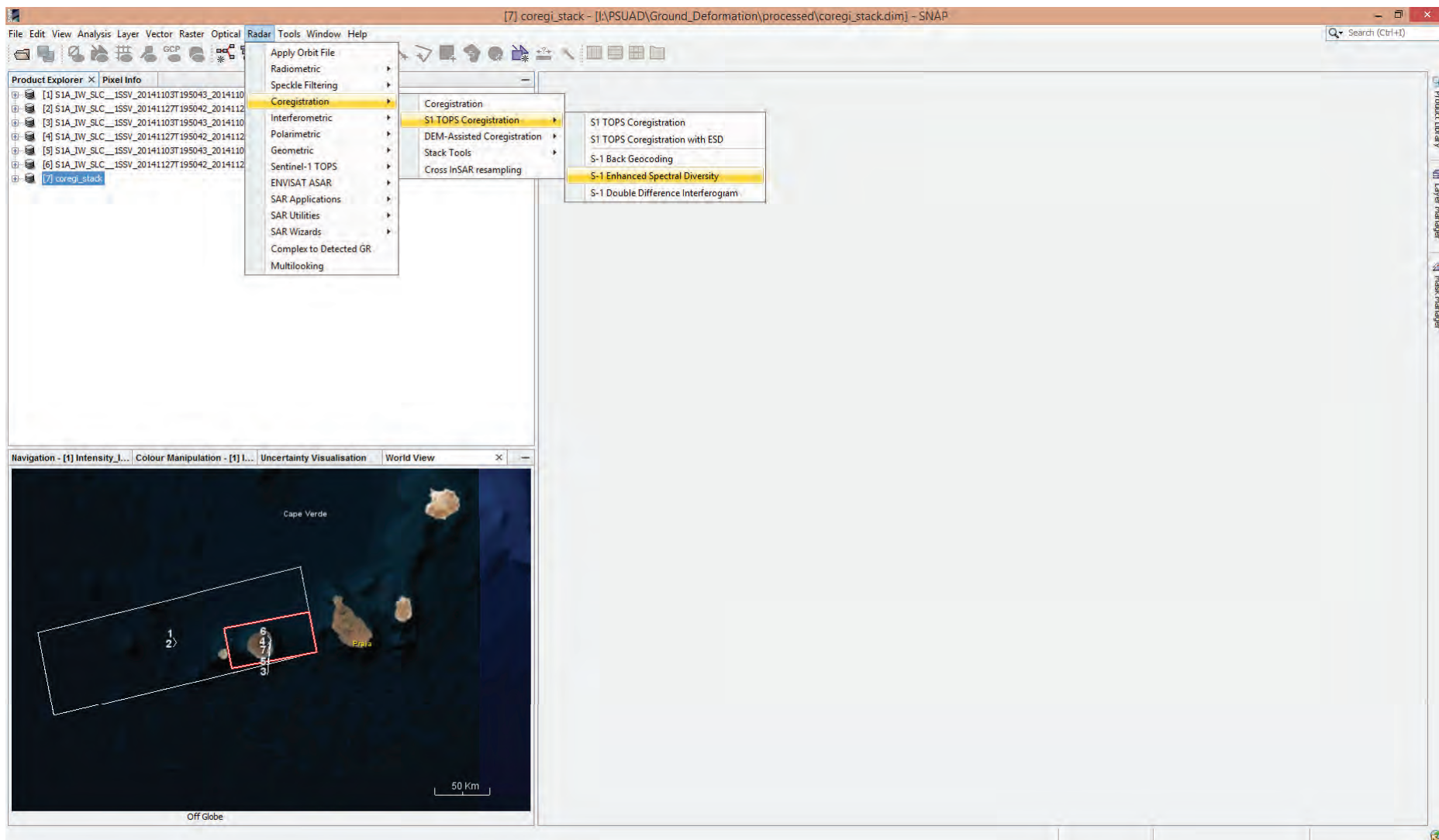


S1 TOPS Co-registered Stack

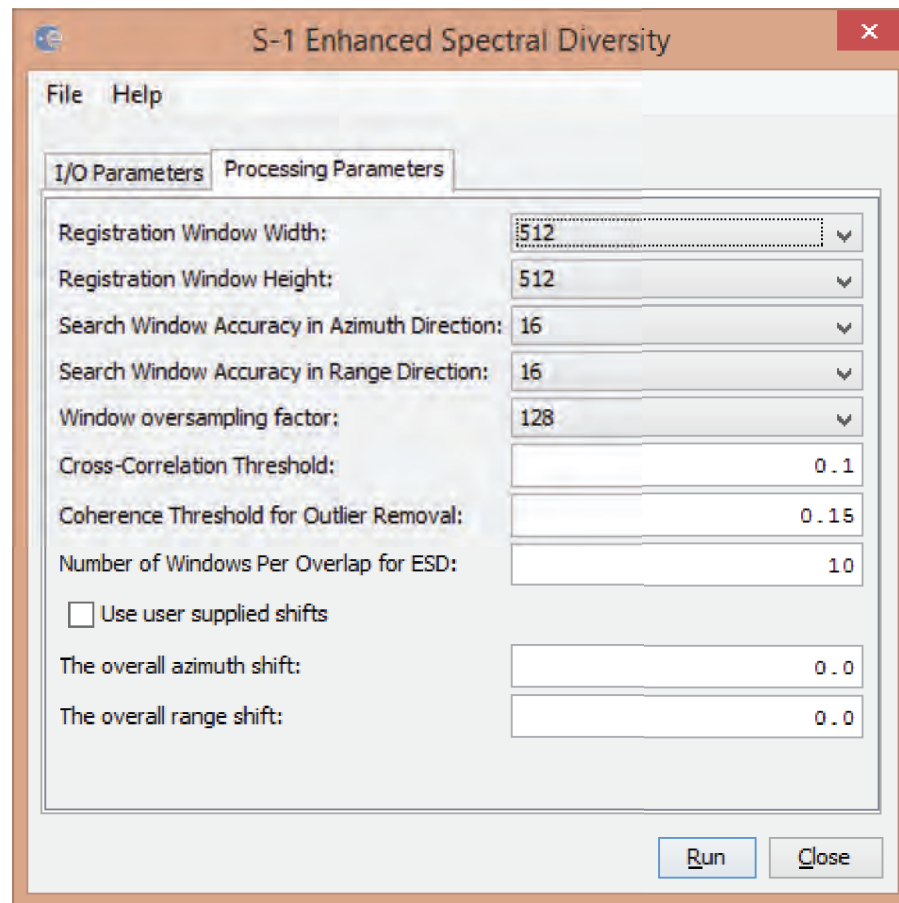


Improvement of Co-registration Accuracy

Enhanced Spectral Diversity (ESD)



Implementation of the
Enhanced Spectral Diversity (ESD)
algorithm for correcting shifts in
range and azimuth direction
considering the burst overlap areas

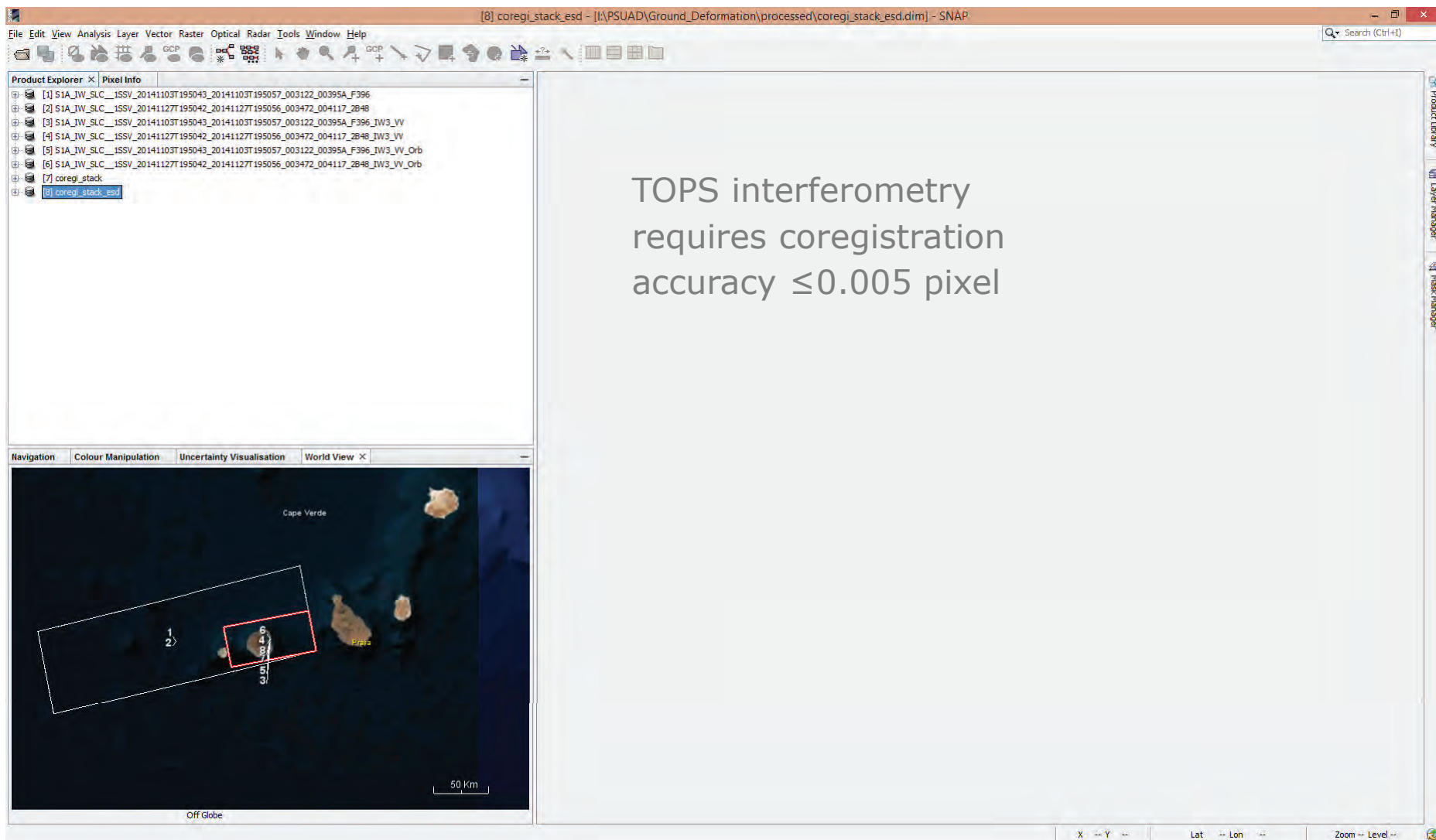


The screenshot shows a software window titled "S-1 Enhanced Spectral Diversity" with a menu bar containing "File" and "Help". Below the menu bar are two tabs: "I/O Parameters" and "Processing Parameters". The "Processing Parameters" tab is active, displaying the following settings:

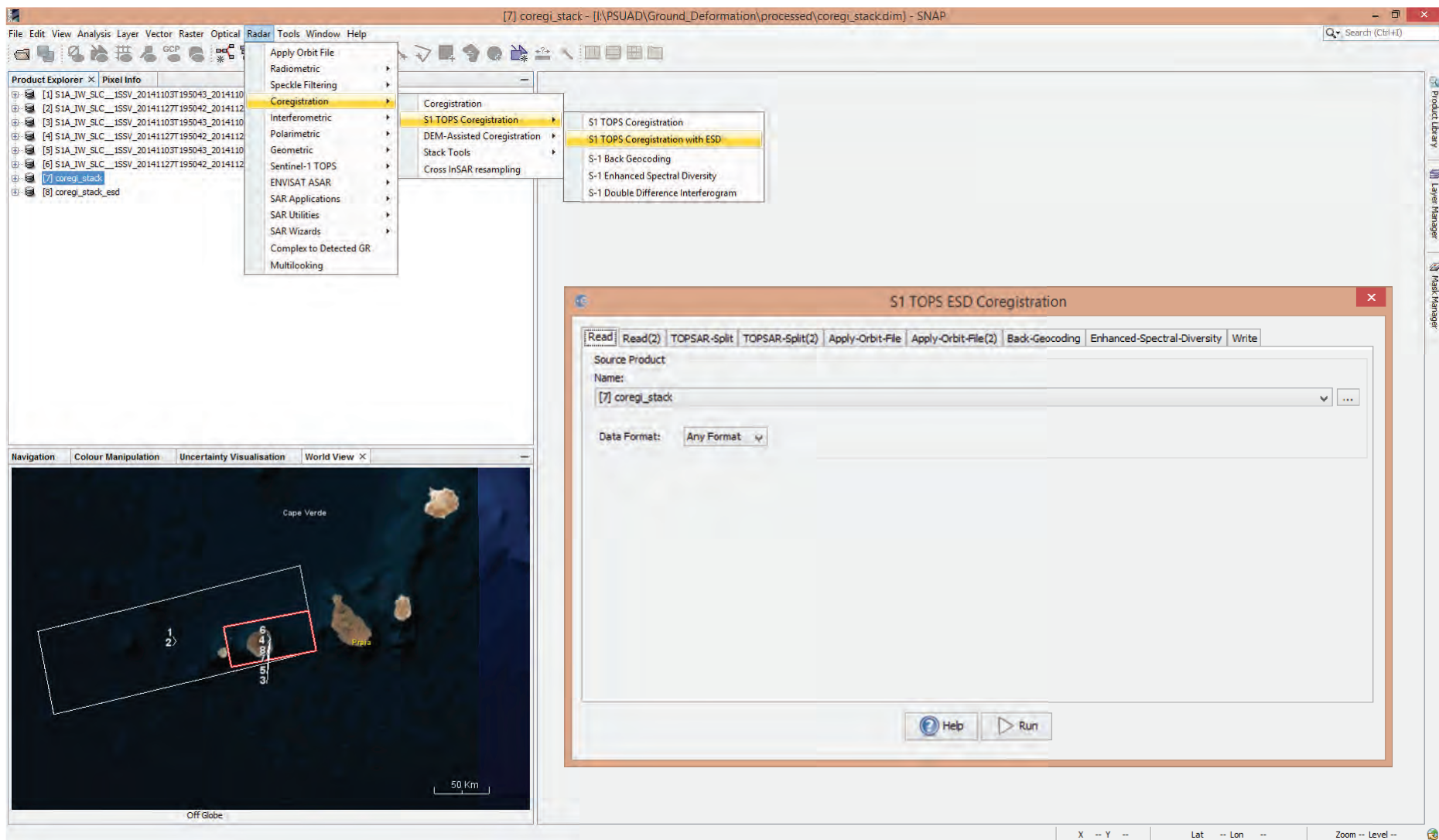
Parameter	Value
Registration Window Width:	512
Registration Window Height:	512
Search Window Accuracy in Azimuth Direction:	16
Search Window Accuracy in Range Direction:	16
Window oversampling factor:	128
Cross-Correlation Threshold:	0.1
Coherence Threshold for Outlier Removal:	0.15
Number of Windows Per Overlap for ESD:	10
<input type="checkbox"/> Use user supplied shifts	
The overall azimuth shift:	0.0
The overall range shift:	0.0

At the bottom right of the window are two buttons: "Run" and "Close".

S1 TOPS ESD Co-registered Stack



Alternative Option for TOPS Coregistration (all-in-one)



The screenshot displays the SNAP (Scientific Data Processing) software interface. The main window is titled "[7] coregi_stack - [I:\PSUAD\Ground_Deformation\processed\coregi_stack.dim] - SNAP". The menu bar includes File, Edit, View, Analysis, Layer, Vector, Raster, Optical, Radar, Tools, Window, and Help. The Product Explorer on the left shows a list of products, with "coregi_stack" selected. The Tools menu is open, showing the "Coregistration" option, which is further expanded to show "S1 TOPS Coregistration with ESD". The "S1 TOPS ESD Coregistration" dialog box is open, showing the "Read" tab. The "Source Product" is set to "[7] coregi_stack". The "Data Format" is set to "Any Format". The "Run" button is visible at the bottom right of the dialog. The bottom left panel shows a map of Cape Verde with a red rectangle indicating the area of interest. The bottom right panel shows the "Navigation" and "World View" tabs.

Sentinel-1 TOPS Interferogram Generation



Product Explorer

[1] S1A_IW_SLC__1SSV_20141103T195043_20141103

[2] S1A_IW_SLC__1SSV_20141127T195042_20141127

[3] S1A_IW_SLC__1SSV_20141103T195043_20141103

[4] S1A_IW_SLC__1SSV_20141127T195042_20141127

[5] S1A_IW_SLC__1SSV_20141103T195043_20141103

[6] S1A_IW_SLC__1SSV_20141127T195042_20141127

[7] coregi_stack

[8] coregi_stack_esd

Pixel Info

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

Products

Filtering

Unwrapping

PSI/SBAS

InSAR Stack Overview

Interferogram Formation

Coherence Estimation

Topographic Phase Removal

Three-pass Differential InSAR

Phase to Height

Phase to Displacement

Phase to Elevation

Integer Interferogram Combination

Navigation

Colour Manipulation

Uncertainty Visualisation

World View

Cape Verde

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Interferogram Formation

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

☒ Include coherence estimation

☒ Square Pixel

Coherence Range Window Size 20

Coherence Azimuth Window Size 5

☐ Independent Window Sizes

Run

Close

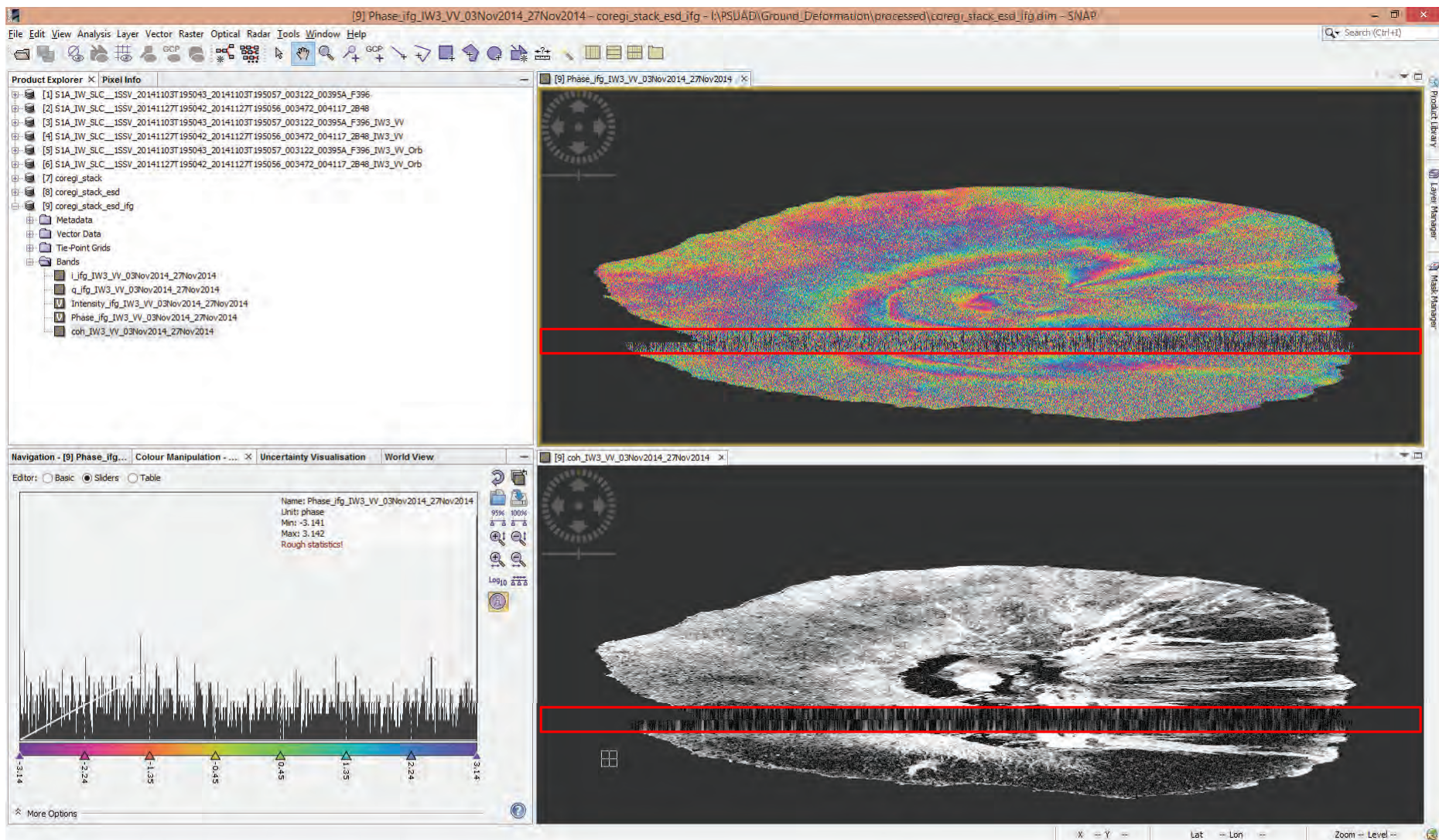
X -- Y --

Lat -- Lon --

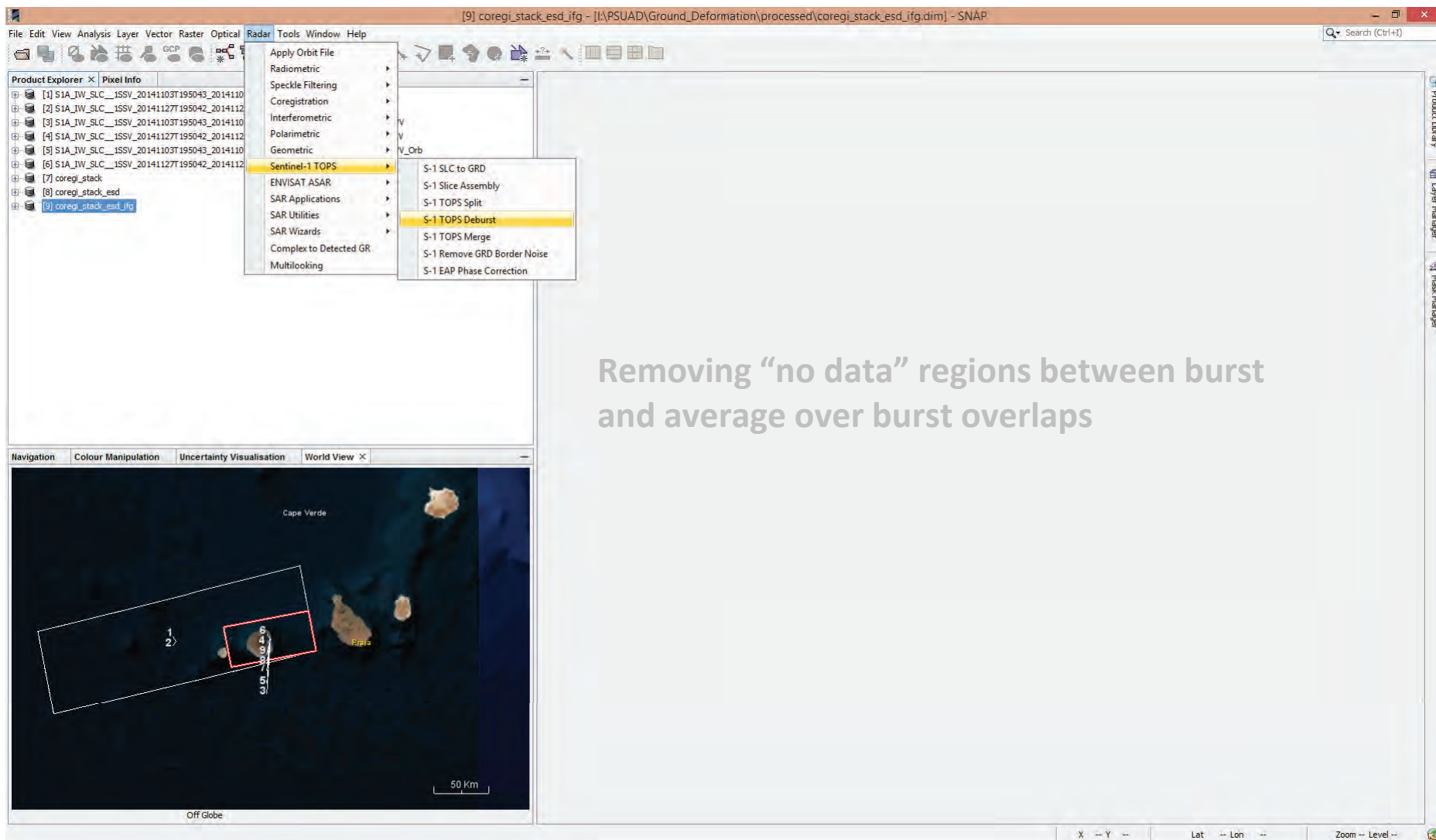
Zoom -- Level --



Sentinel-1 TOPS InSAR (InSAR Phase & Coherence)

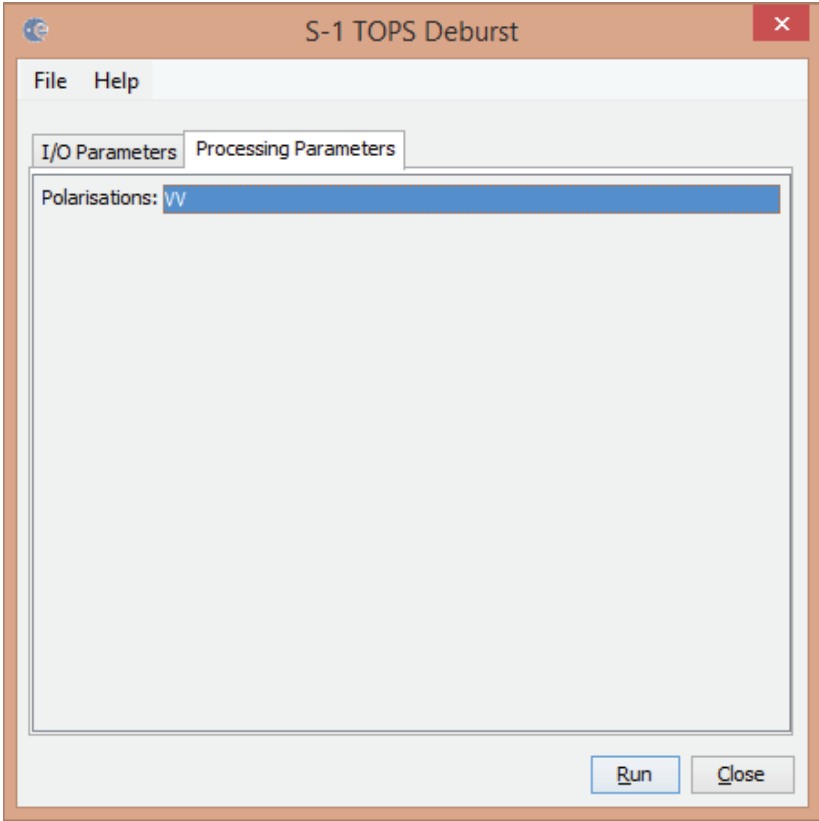
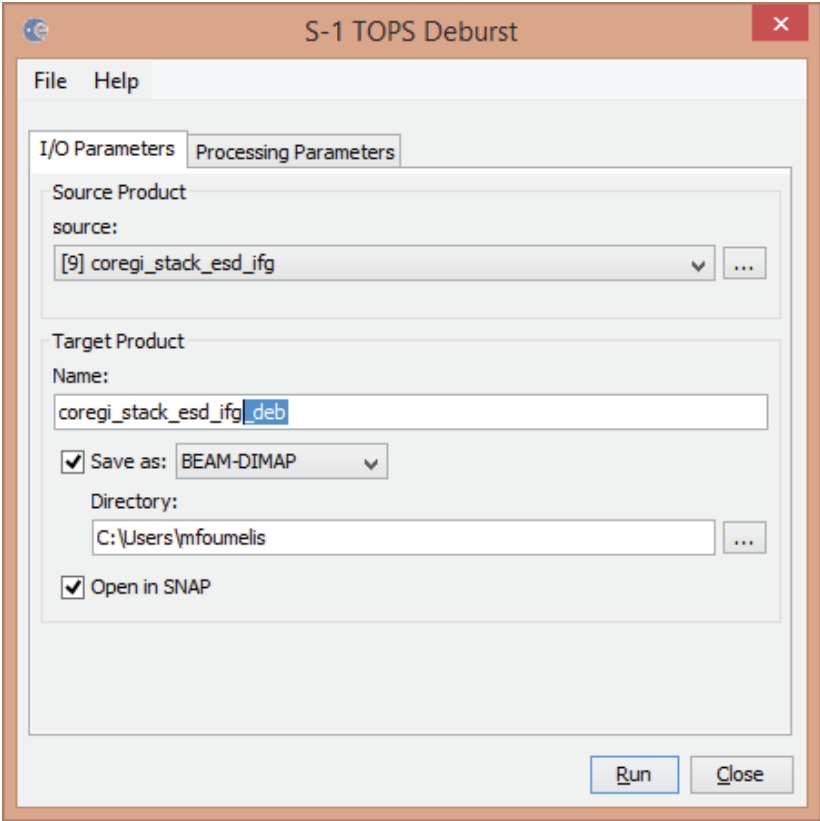


Sentinel-1 TOPS Deburst

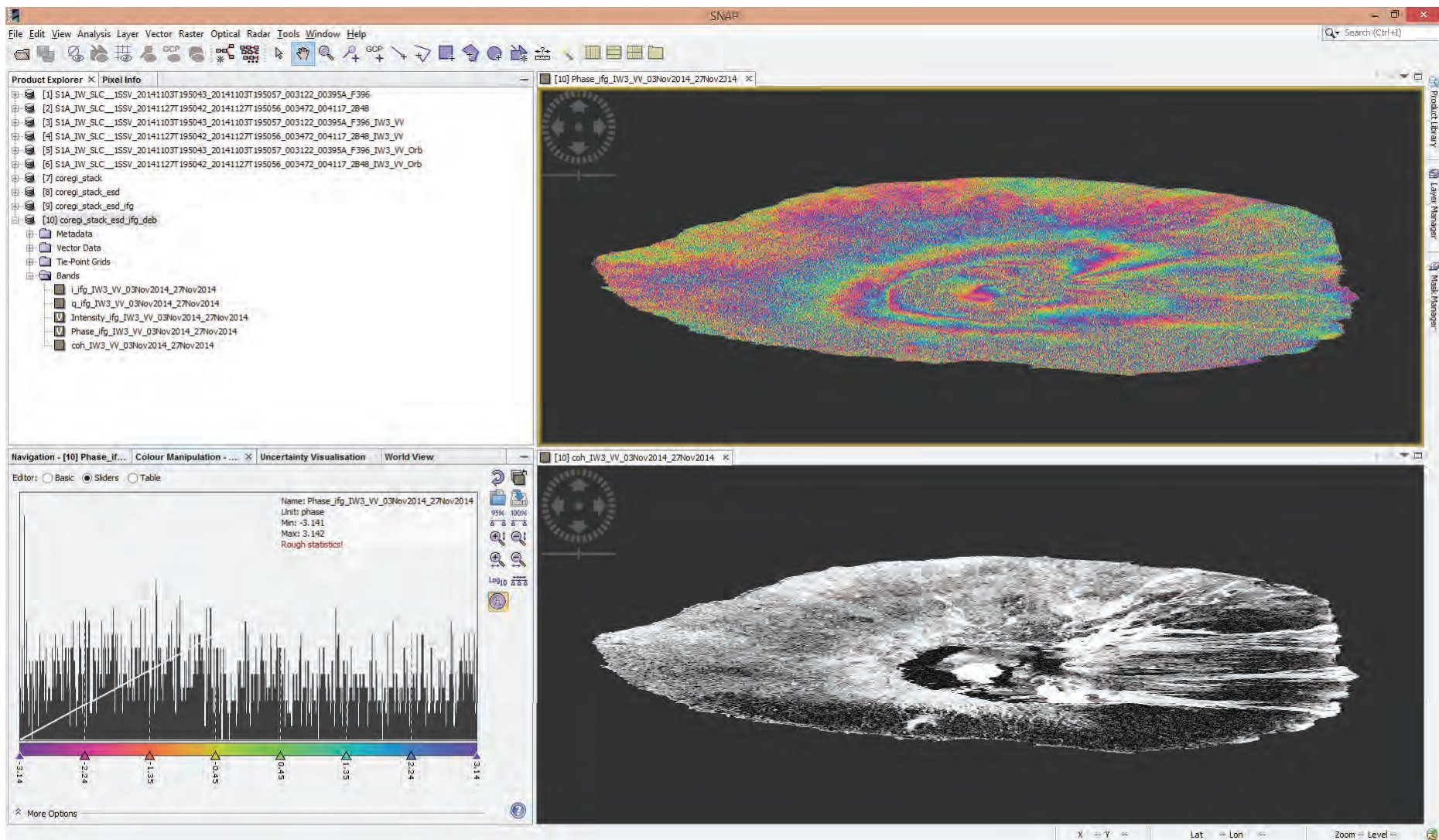


The screenshot displays the SNAP (Sentinel Application Platform) software interface. The main window shows a list of products in the 'Product Explorer' on the left, including S1A_IW_SLC__1SSV_20141103T195043_20141110 and coregi_stack_esd_ifg. The 'Radar' menu is open, and the 'Sentinel-1 TOPS' sub-menu is selected, highlighting the 'S-1 TOPS Deburst' option. The 'World View' at the bottom shows a map of Cape Verde with a red rectangular region of interest and a 50 Km scale bar. The text 'Removing "no data" regions between burst and average over burst overlaps' is overlaid on the right side of the interface.

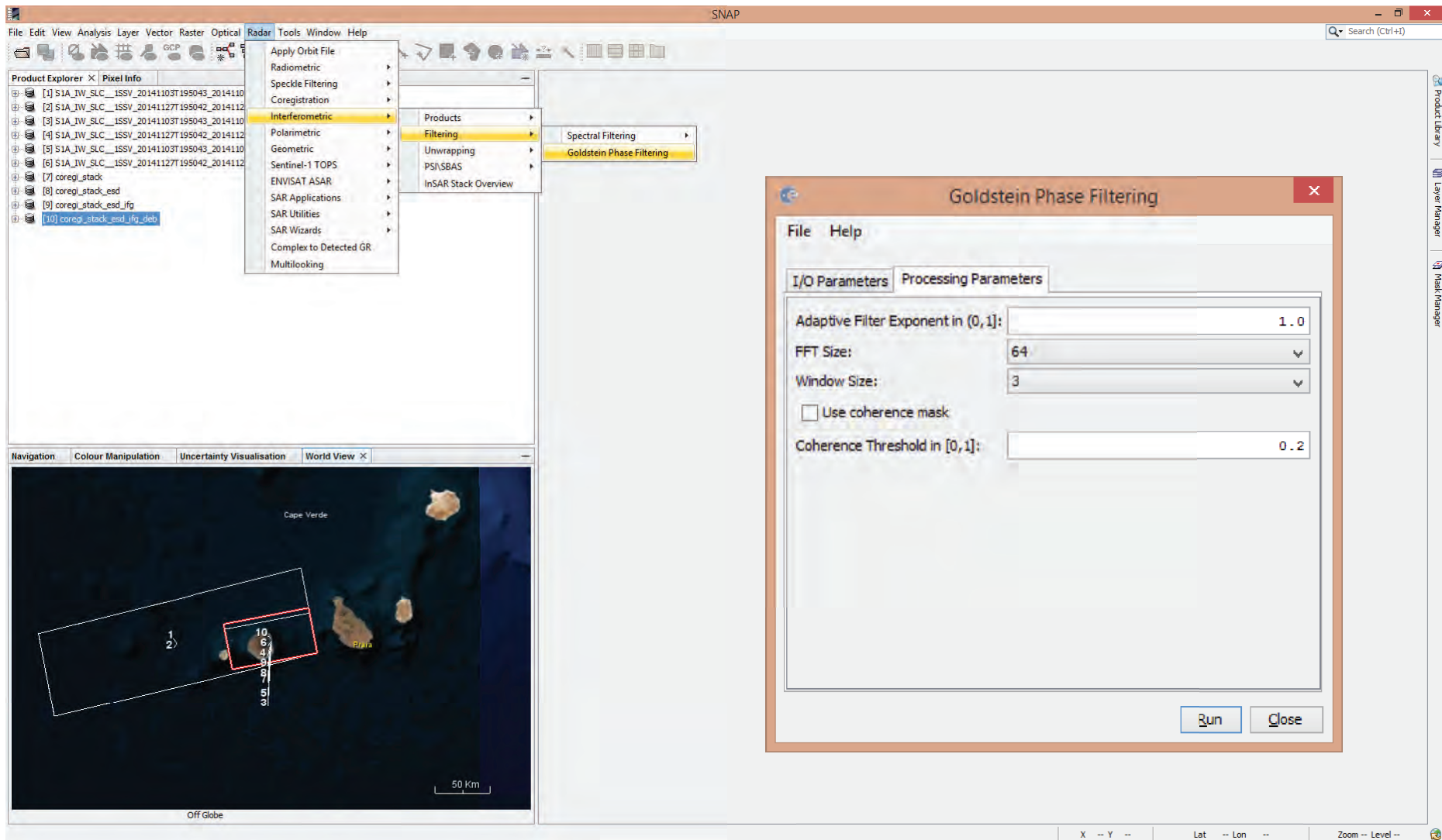
Removing "no data" regions between burst and average over burst overlaps



S1 Debursed Products (InSAR Phase & Coherence)



Goldstein Phase Filtering (Adaptive Filter)

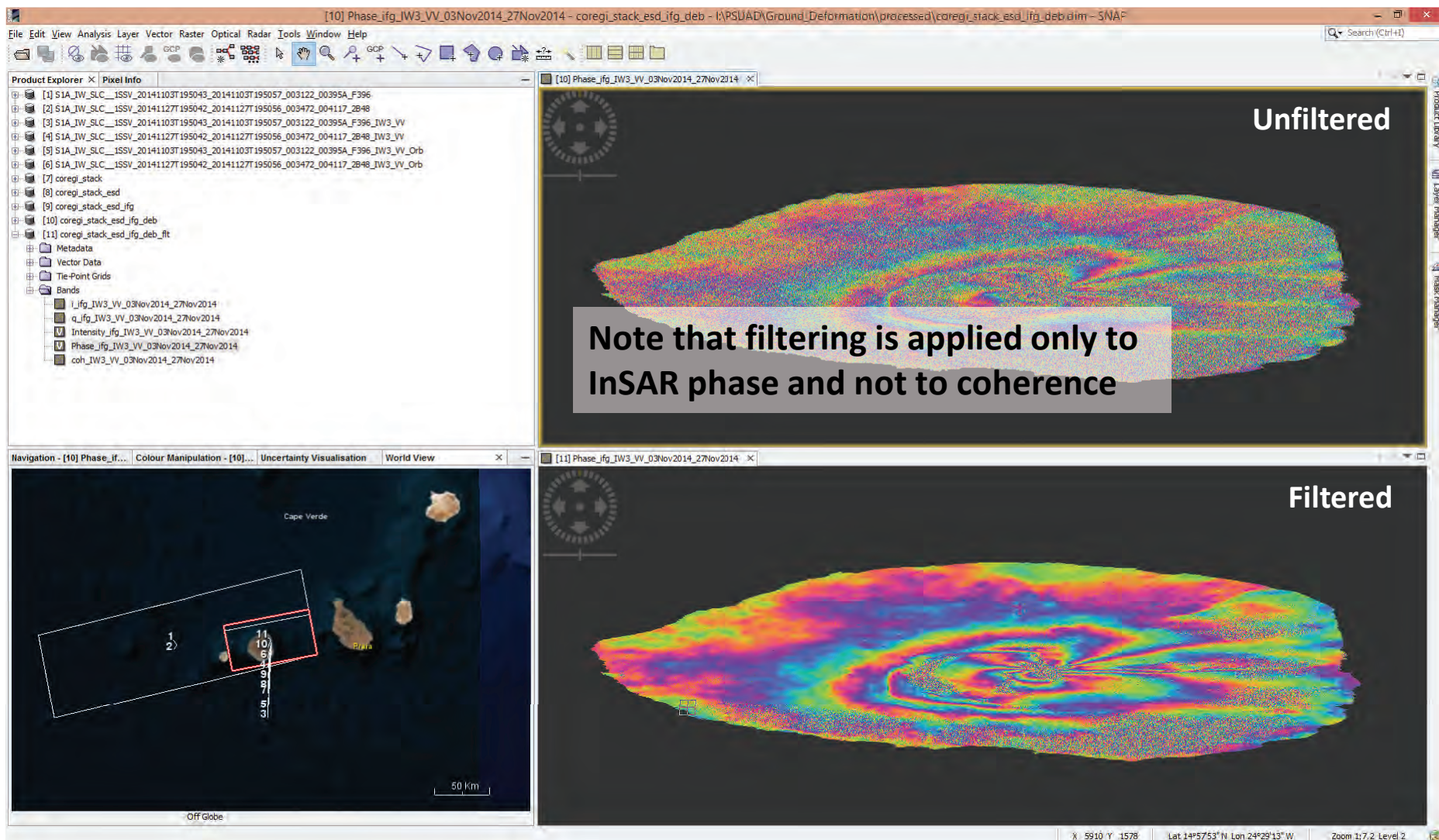


The screenshot displays the SNAP (Scientific Data Processing) software interface. The main window shows a map of Cape Verde with a red rectangular region of interest. The 'Product Explorer' on the left lists various SAR data products. The 'Tools' menu is open, showing the 'Interferometric' sub-menu, which includes 'Goldstein Phase Filtering'. The 'Goldstein Phase Filtering' dialog box is open, showing the 'Processing Parameters' tab. The parameters are as follows:

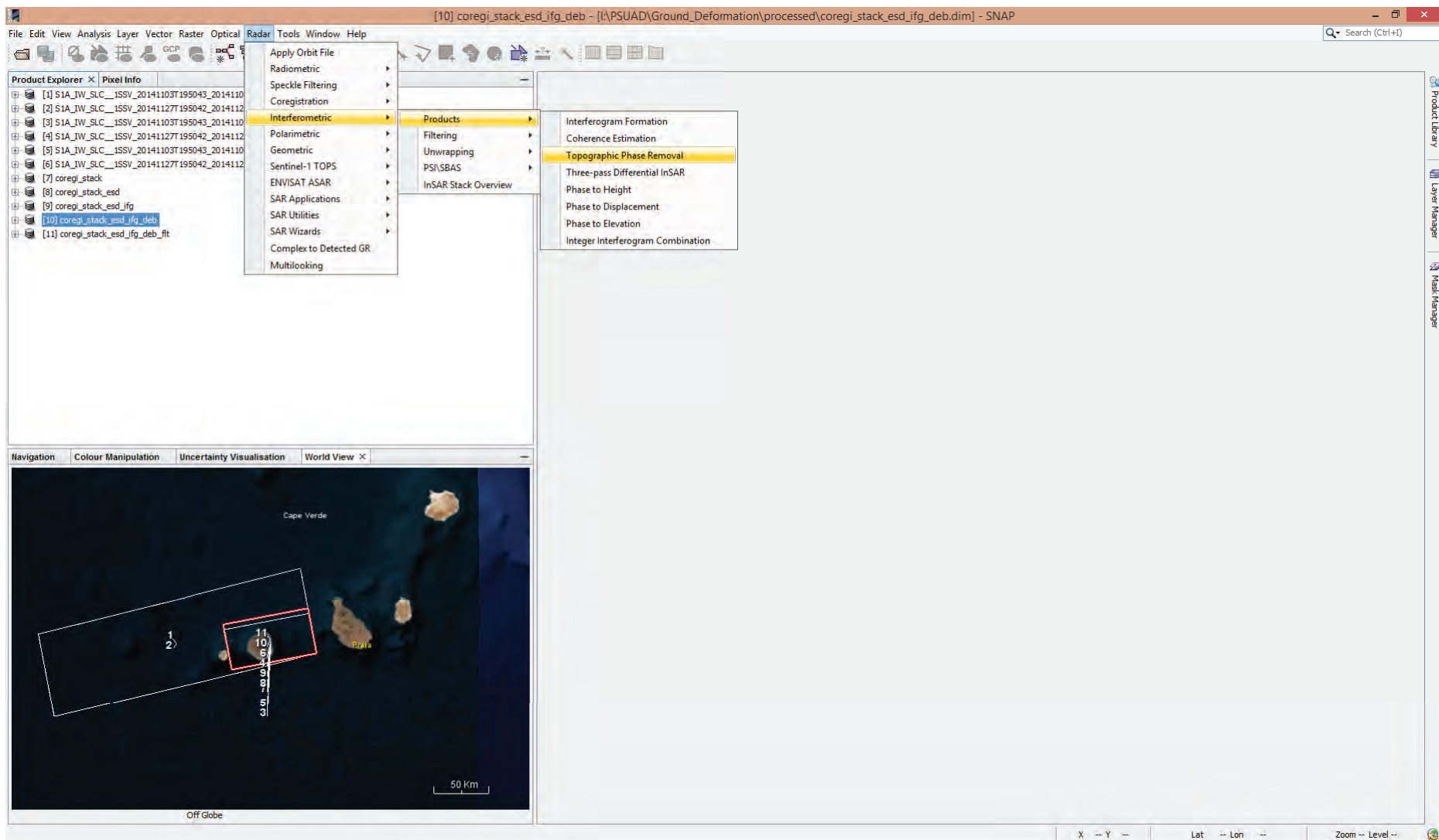
Parameter	Value
Adaptive Filter Exponent in $[0, 1]$:	1.0
FFT Size:	64
Window Size:	3
Use coherence mask:	<input type="checkbox"/>
Coherence Threshold in $[0, 1]$:	0.2

The dialog box has 'Run' and 'Close' buttons at the bottom right. The main window also shows a 'World View' tab with a map of Cape Verde and a scale bar indicating 50 Km.

S1 Filtered InSAR Phase



Topographic Phase Removal (Differential InSAR Phase)



Topographic Phase Removal (Differential InSAR Phase)

Topographic Phase Removal

File Help

I/O Parameters Processing Parameters

Source Product

Source product:

[10] coregi_stack_esd_ifg_deb

Target Product

Name:

coregi_stack_esd_ifg_deb_dinsar

☒ Save as: BEAM-DIMAP

Directory:

C:\Users\mfoumelis

☒ Open in SNAP

Run Close

Topographic Phase Removal

File Help

I/O Parameters Processing Parameters

Orbit Interpolation Degree: 3

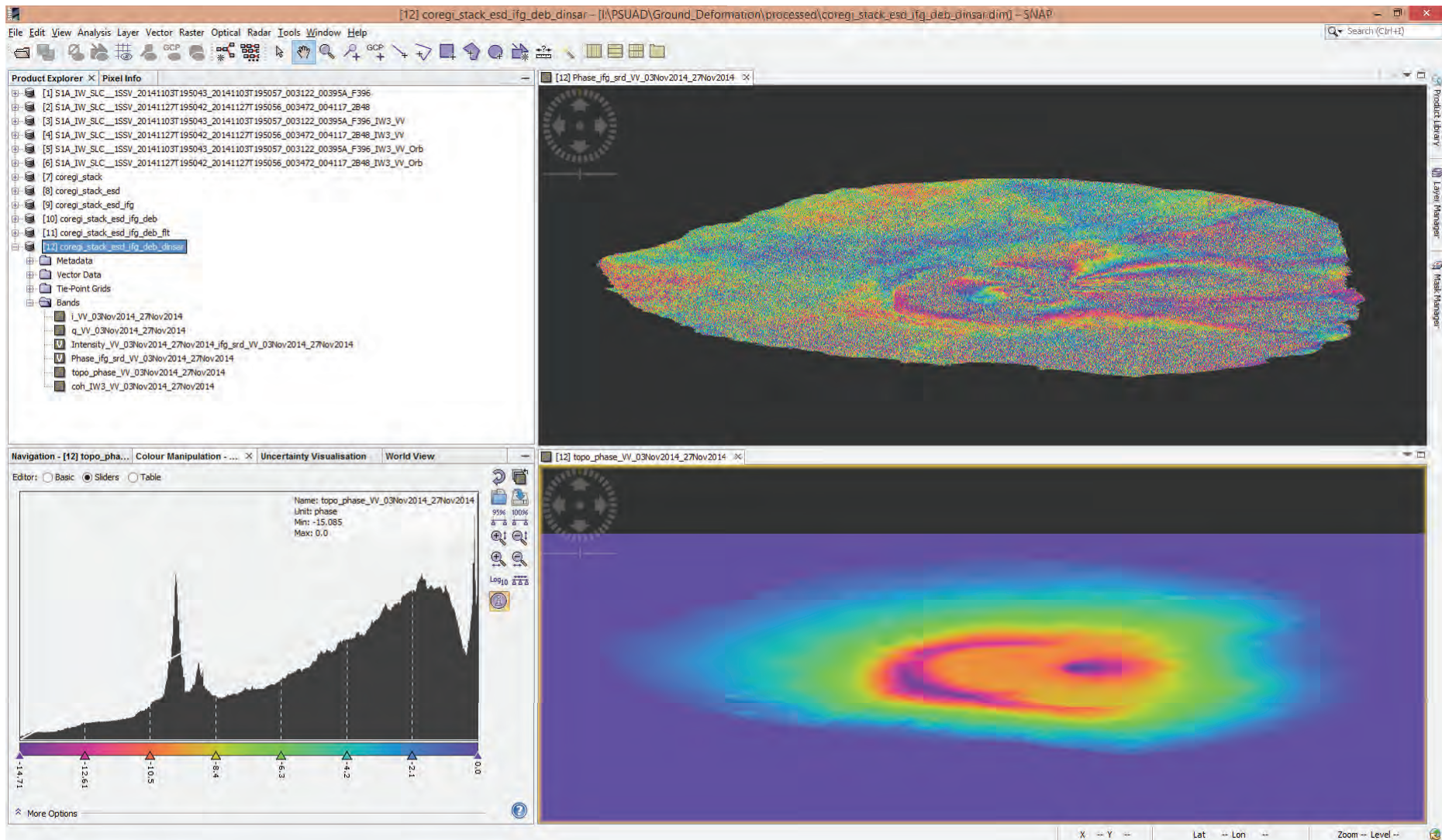
Digital Elevation Model: SRTM 3Sec (Auto Download)

Topo Phase Band Name: topo_phase

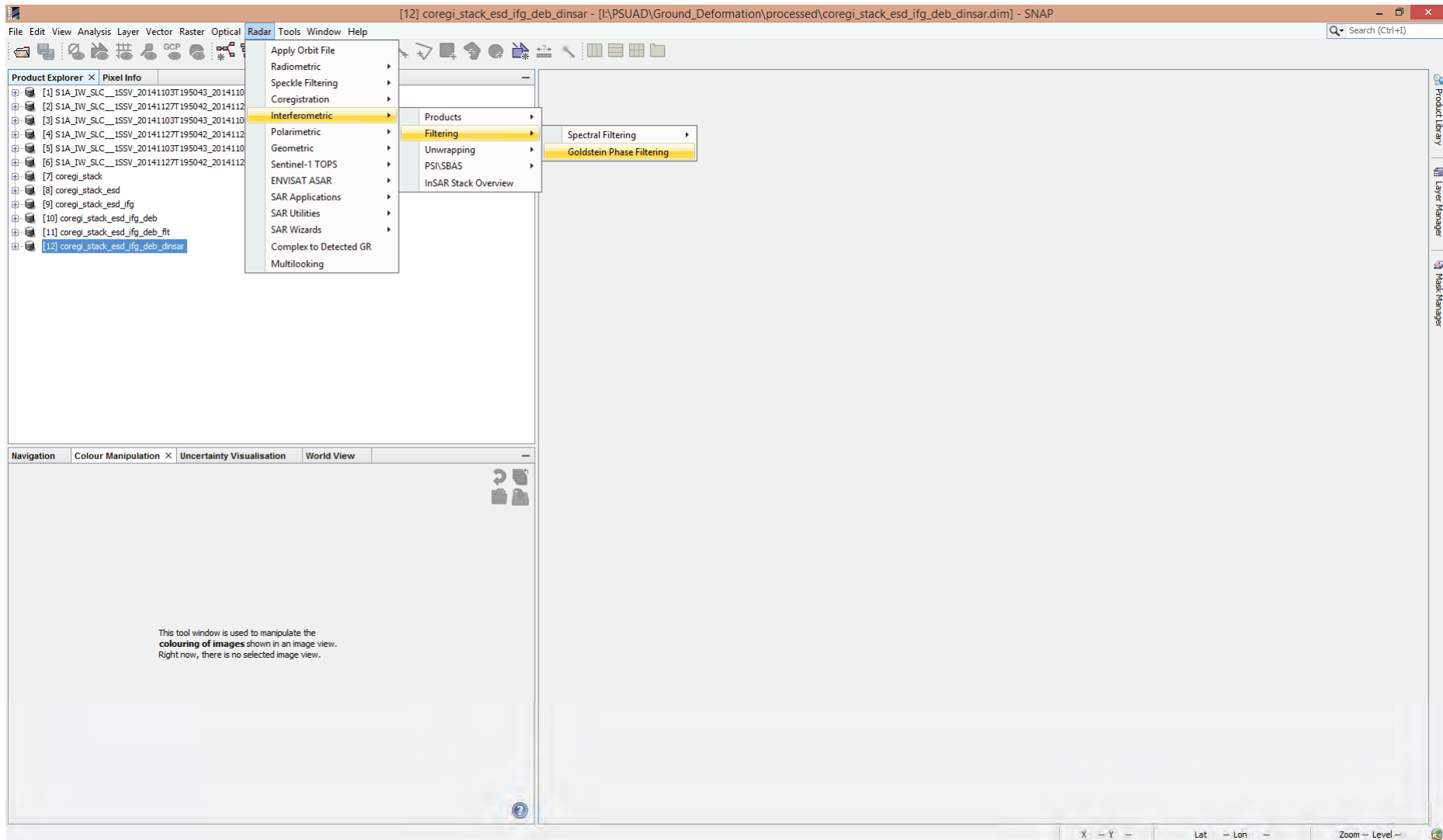
Tile Extension [%] 100

Run Close

Differential Interferogram & Simulated Topo Phase



Differential Phase Filtering (Goldstein Filter)



Differential Phase Filtering

Goldstein Phase Filtering

File Help

I/O Parameters Processing Parameters

Source Product

Source product:

[12] coregi_stack_esd_ifg_deb_dinsar

Target Product

Name:

coregi_stack_esd_ifg_deb_dinsar_fit

☒ Save as: BEAM-DIMAP

Directory:

C:\Users\mfoumelis

☒ Open in SNAP

Run Close

Goldstein Phase Filtering

File Help

I/O Parameters Processing Parameters

Adaptive Filter Exponent in $(0,1]$: 1.0

FFT Size: 64

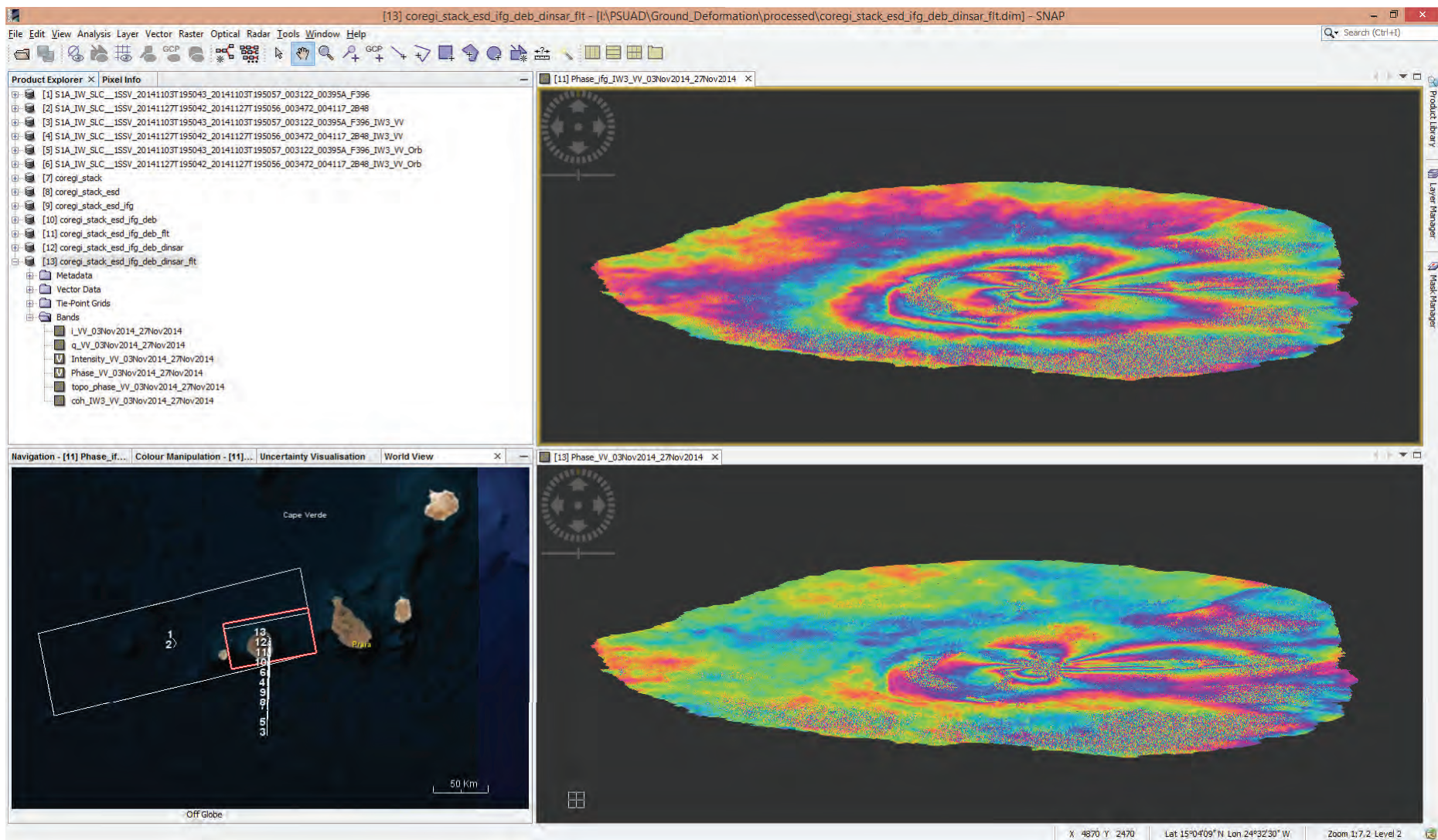
Window Size: 3

☐ Use coherence mask

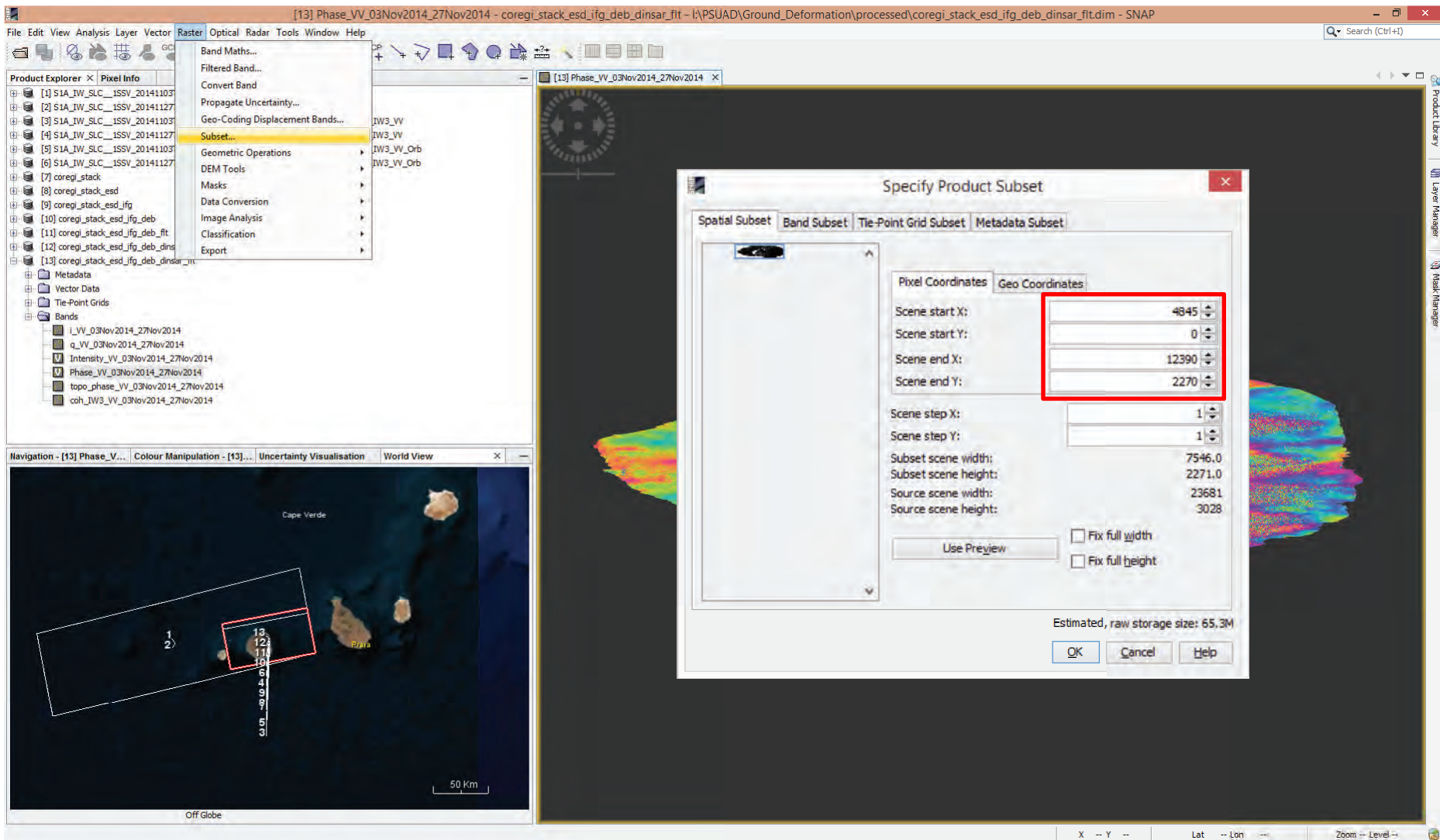
Coherence Threshold in $[0,1]$: 0.2

Run Close

S1 Filtered DInSAR Phase



Spatial Subset over AOI



The screenshot displays the SNAP (Scientific Data Processing) software interface. The main window shows a map of Cape Verde with a red rectangular Area of Interest (AOI) selected. The 'Product Explorer' on the left lists various data products, including 'I_VV_03Nov2014_27Nov2014' and 'q_VV_03Nov2014_27Nov2014'. The 'Raster' menu is open, showing options like 'Band Maths...', 'Filtered Band...', 'Convert Band', 'Propagate Uncertainty...', 'Geo-Coding Displacement Bands...', 'Subset...', 'Geometric Operations', 'DEM Tools', 'Masks', 'Data Conversion', 'Image Analysis', 'Classification', and 'Export'. The 'Subset...' option is highlighted. A 'Specify Product Subset' dialog box is open, showing the 'Spatial Subset' tab. The dialog box contains fields for 'Scene start X', 'Scene start Y', 'Scene end X', 'Scene end Y', 'Scene step X', and 'Scene step Y'. The 'Scene start X' field is highlighted with a red box, showing the value 4845. The 'Scene end X' field shows the value 12390. The 'Scene end Y' field shows the value 2270. The 'Scene step X' and 'Scene step Y' fields show the value 1. The 'Subset scene width' is 7546.0, 'Subset scene height' is 2271.0, 'Source scene width' is 23681, and 'Source scene height' is 3028. The 'Estimated, raw storage size' is 65.3M. The 'Use Preview' button is visible. The 'OK', 'Cancel', and 'Help' buttons are at the bottom of the dialog box.

Product Explorer: Pixel Info

- [1] S1A_IW_SLC__1SSV_20141103T...
- [2] S1A_IW_SLC__1SSV_20141127T...
- [3] S1A_IW_SLC__1SSV_20141103T...
- [4] S1A_IW_SLC__1SSV_20141127T...
- [5] S1A_IW_SLC__1SSV_20141103T...
- [6] S1A_IW_SLC__1SSV_20141127T...
- [7] coregi_stack
- [8] coregi_stack_esd
- [9] coregi_stack_esd_ifg
- [10] coregi_stack_esd_ifg_deb
- [11] coregi_stack_esd_ifg_deb_fit
- [12] coregi_stack_esd_ifg_deb_dinsar_fit
- [13] coregi_stack_esd_ifg_deb_dinsar_fit

Navigation: [13] Phase_VV_03Nov2014_27Nov2014 - Colour Manipulation - [13]... - Uncertainty Visualisation - World View

Off Globe

50 Km

Specify Product Subset

Spatial Subset | Band Subset | Tie-Point Grid Subset | Metadata Subset

Pixel Coordinates | Geo Coordinates

Scene start X: 4845

Scene start Y: 0

Scene end X: 12390

Scene end Y: 2270

Scene step X: 1

Scene step Y: 1

Subset scene width: 7546.0

Subset scene height: 2271.0

Source scene width: 23681

Source scene height: 3028

Use Preview

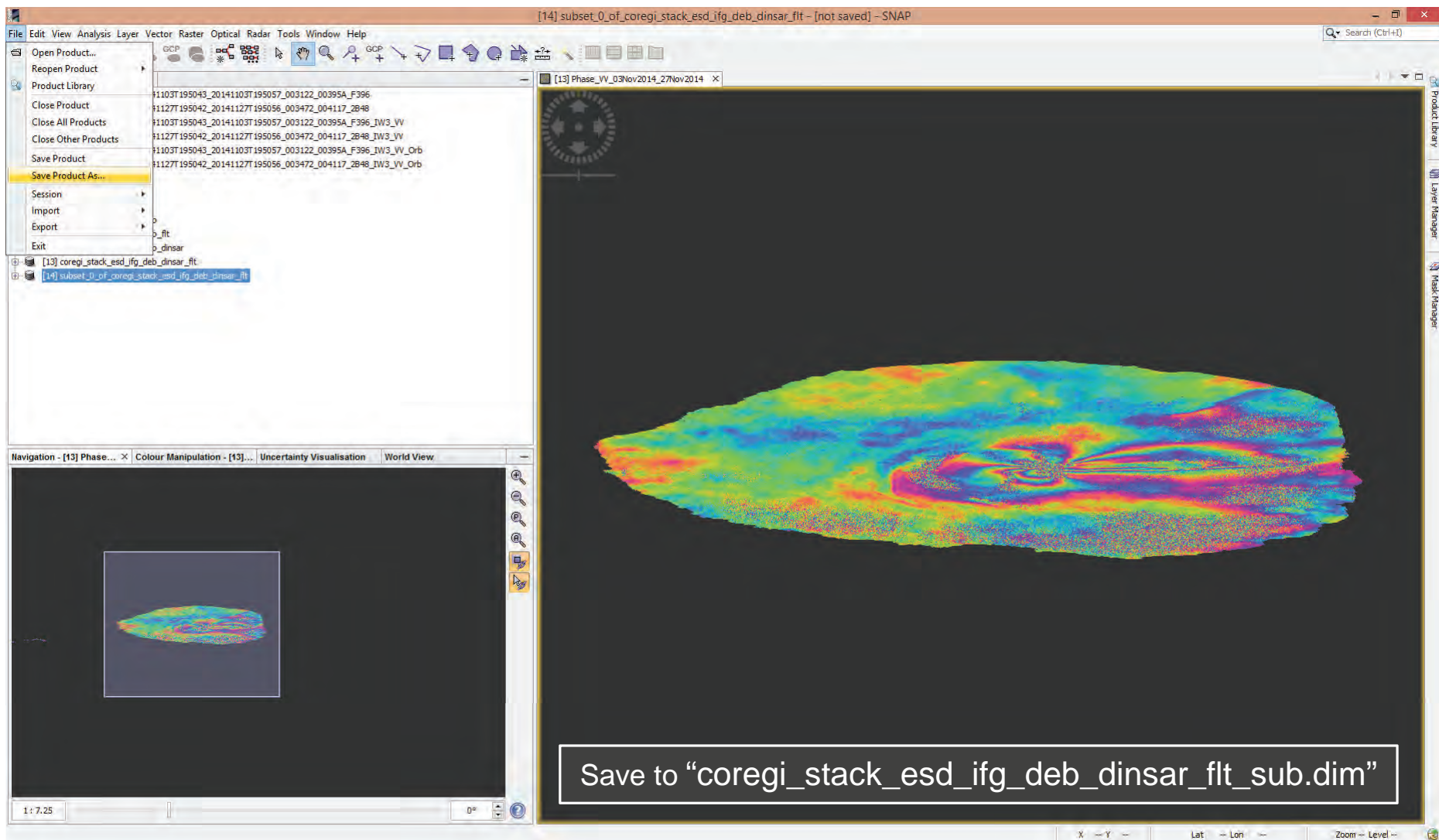
Fix full width

Fix full height

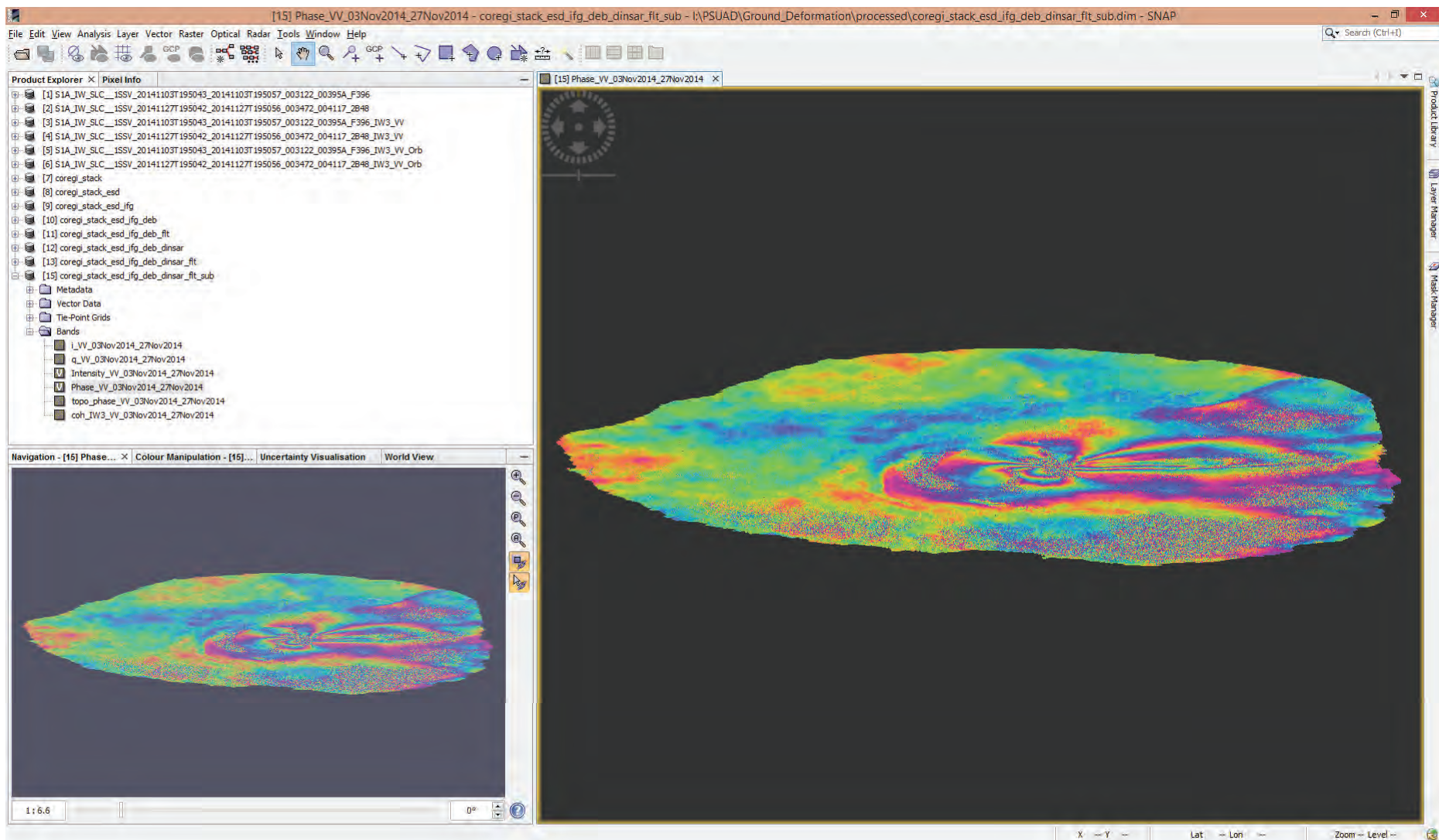
Estimated, raw storage size: 65.3M

OK Cancel Help

Spatial Subset over AOI

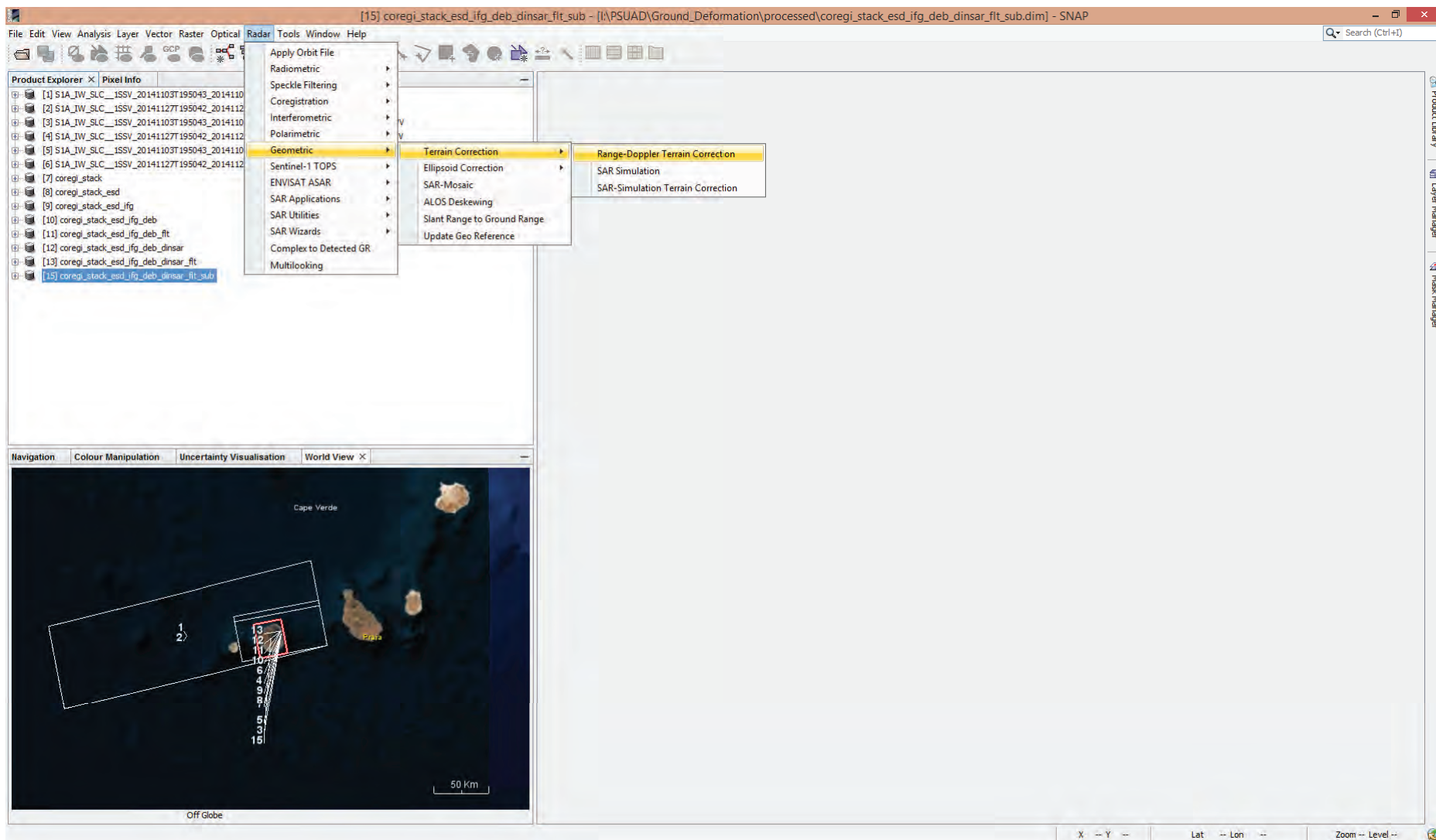


S1 TOPS Filtered DInSAR Phase (Wrapped)

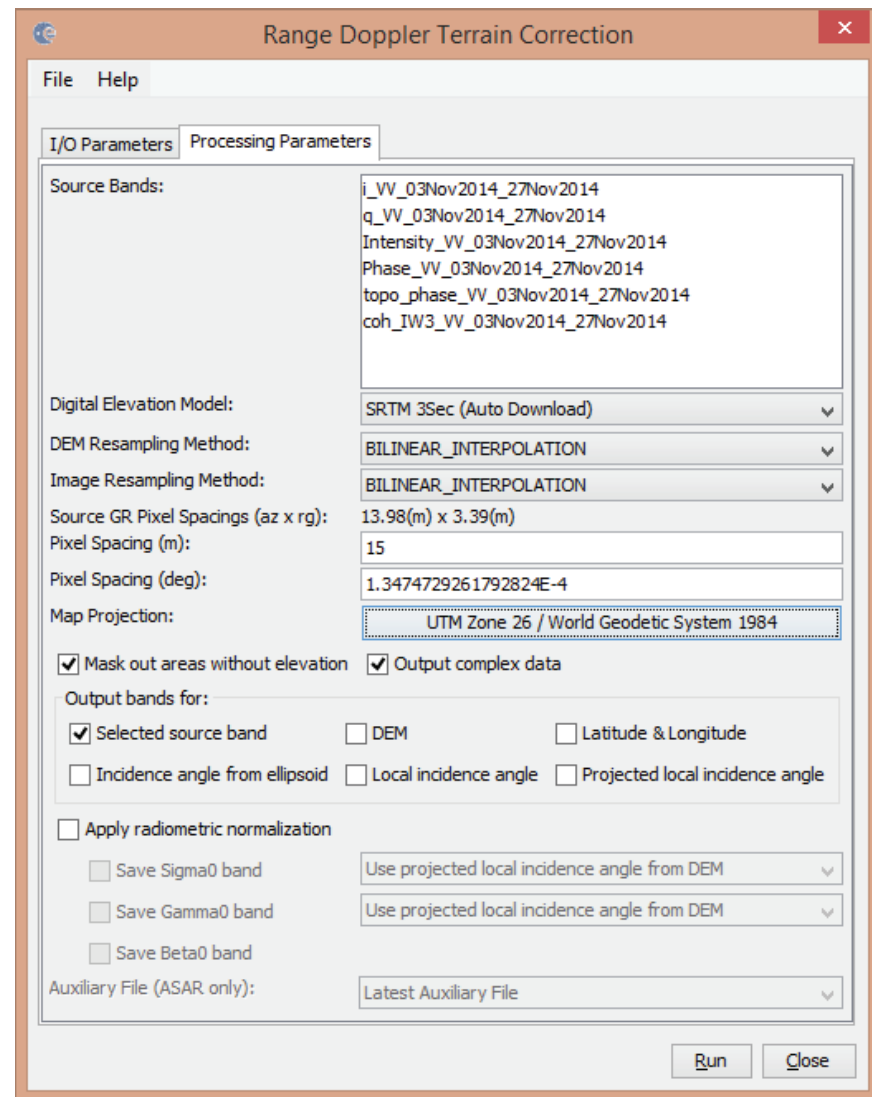
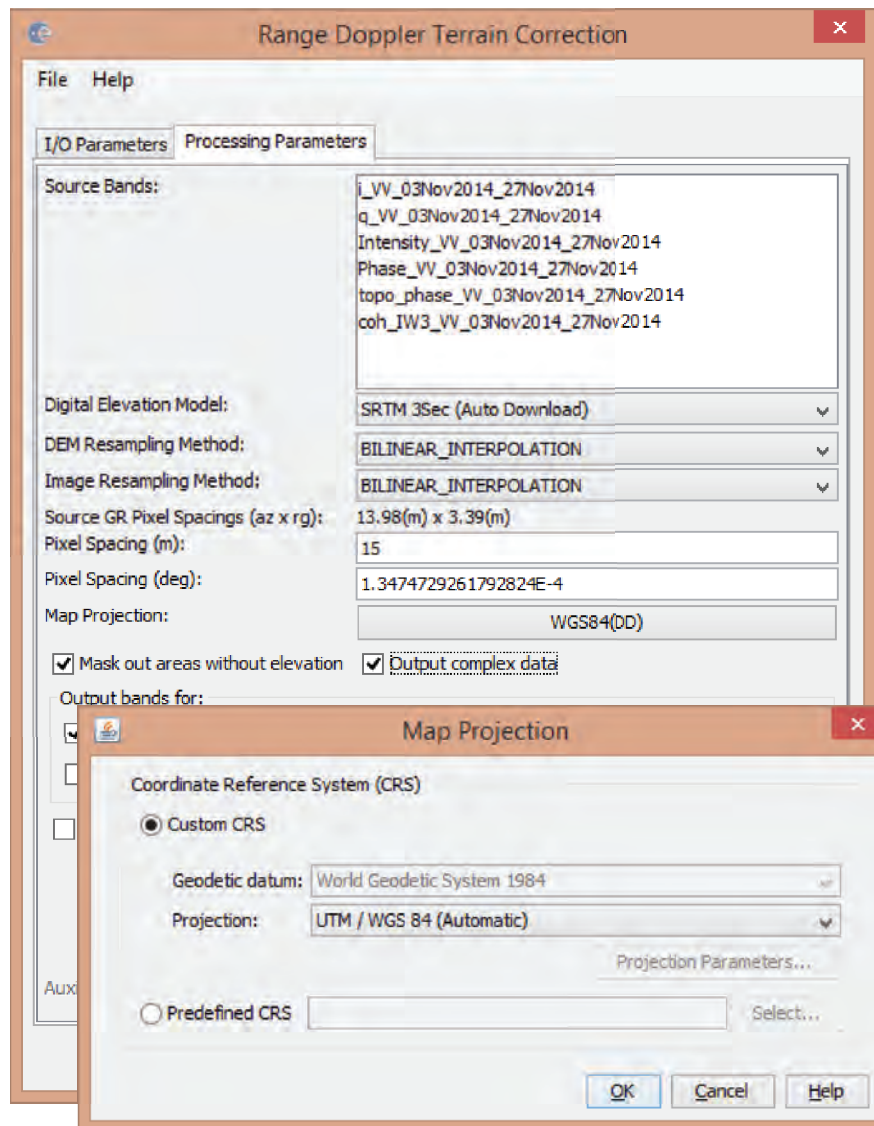


Geocoding of Wrapped DInSAR Phase & Coherence

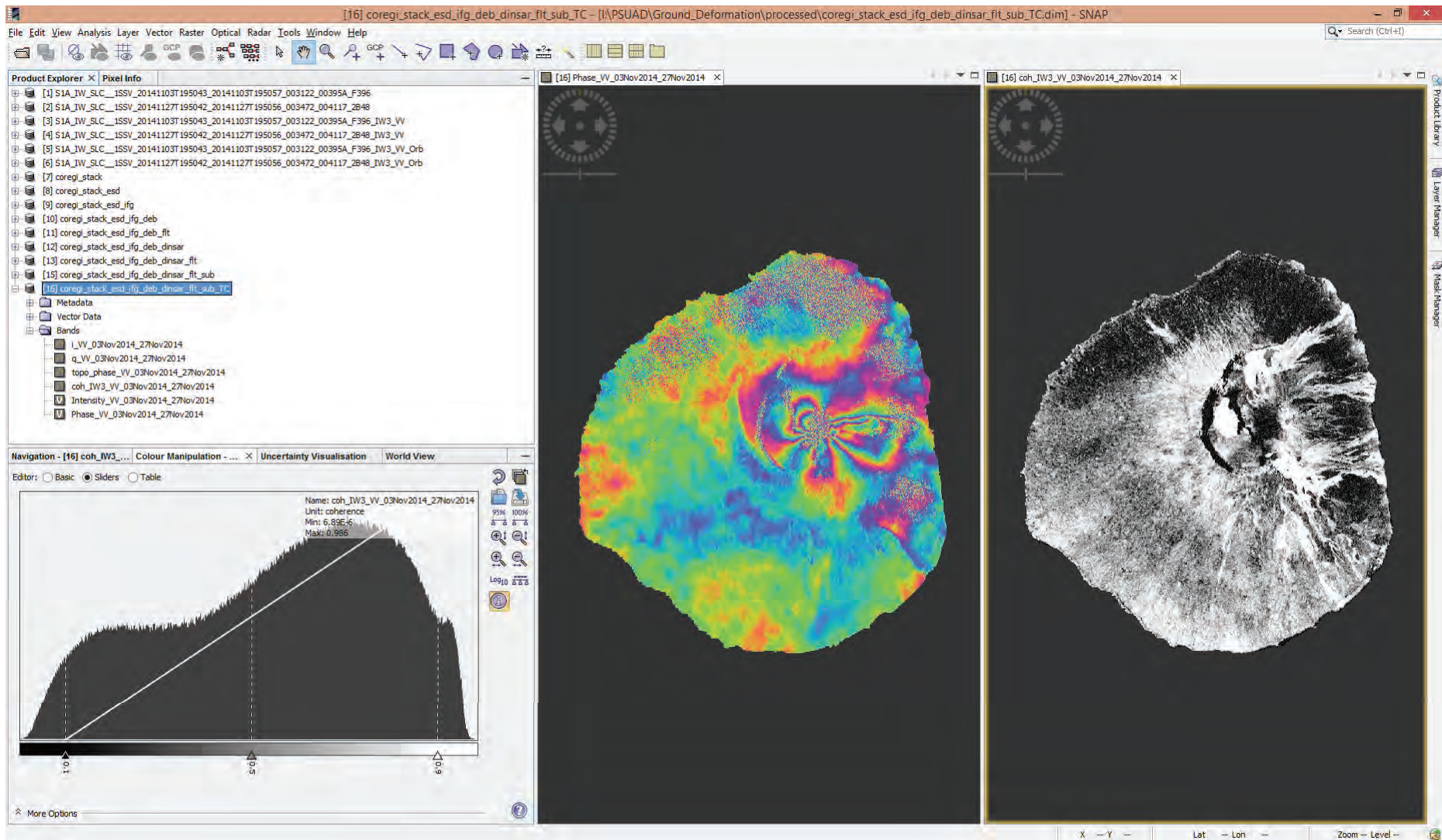
Range-Doppler Terrain Correction approach



Range-Doppler Terrain Correction



Terrain Corrected S1 TOPS Differential Interferogram & Coherence Levels



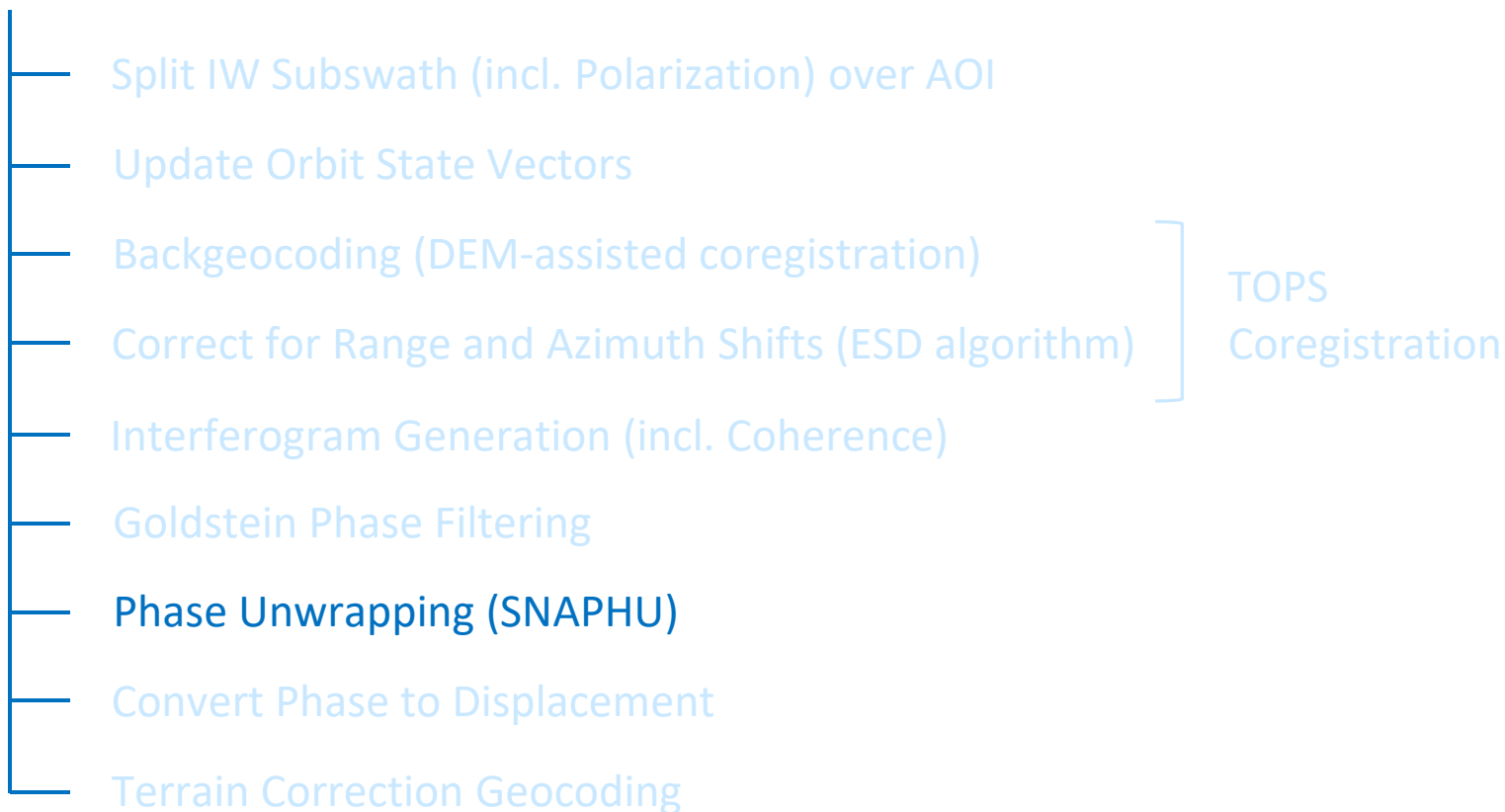
EXERCISE

PART 2

Unwrapping using SNAPHU

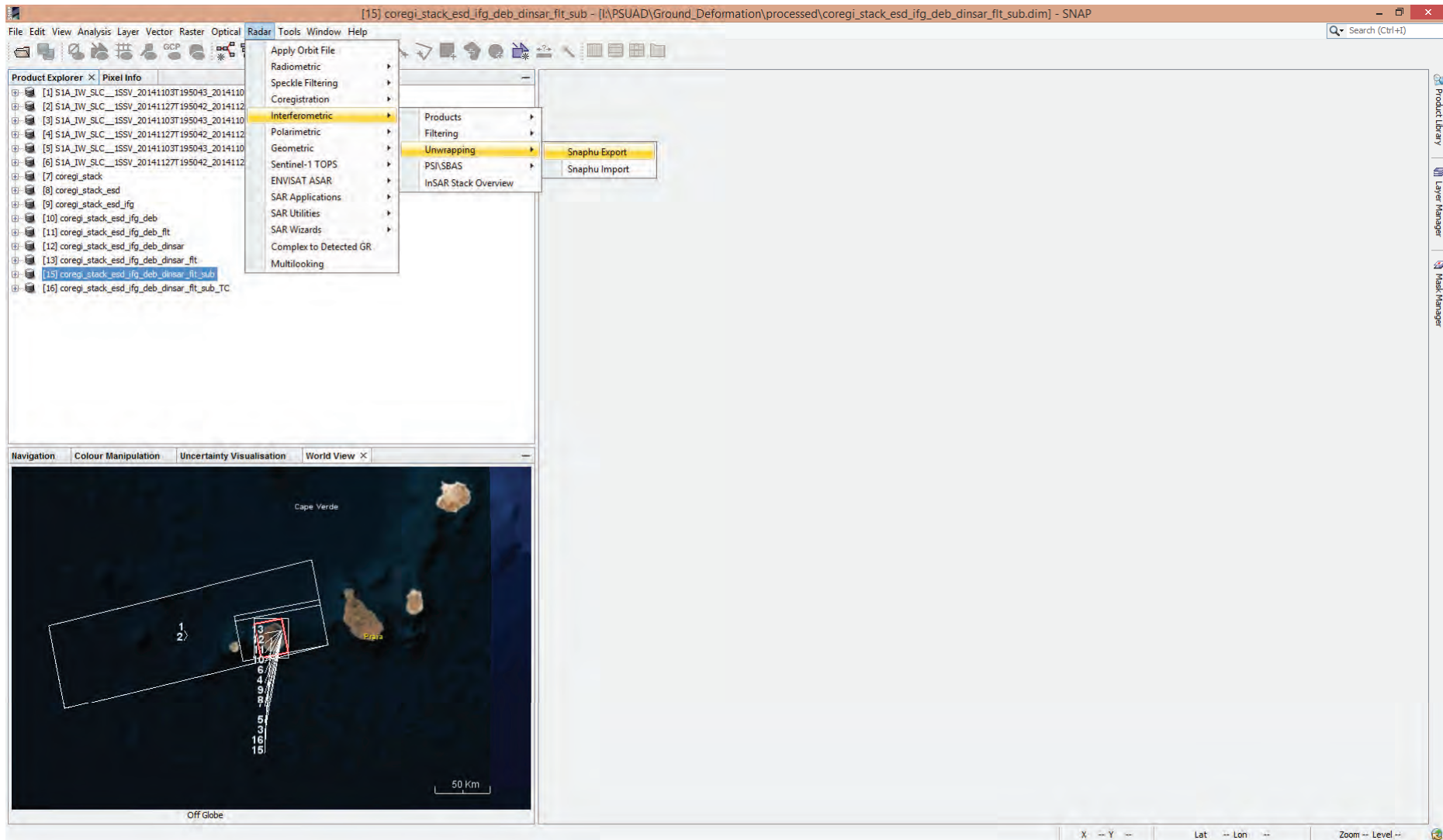


EXERCISE Processing Steps (PART 2)



Phase Unwrapping

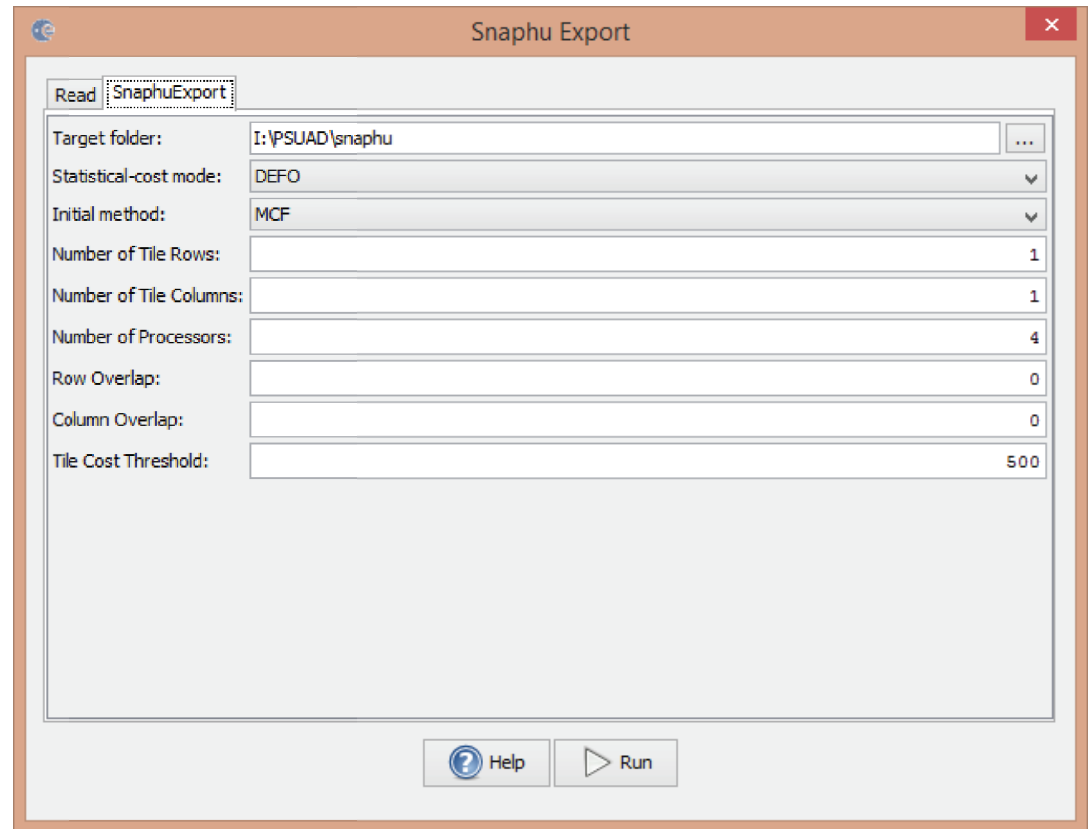
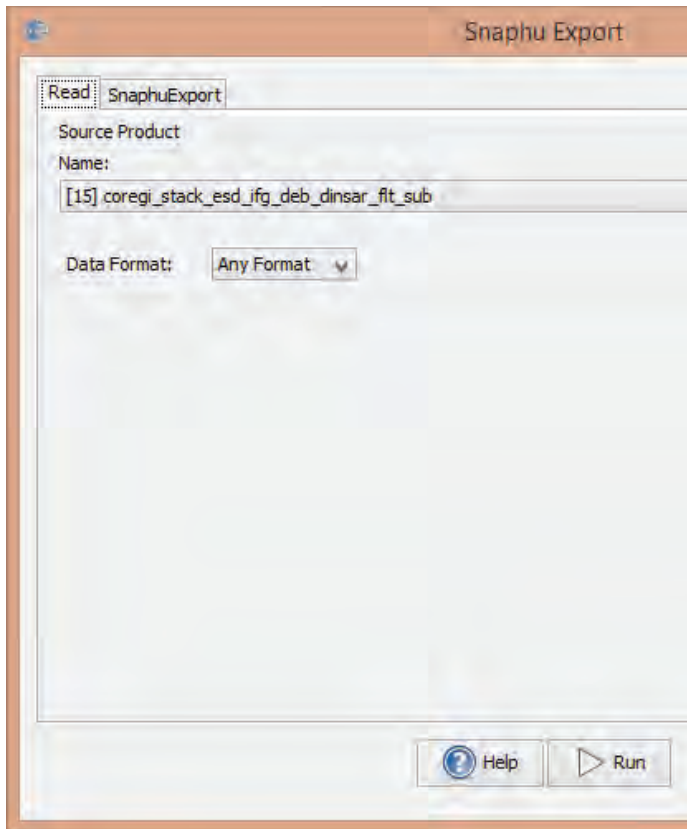
Statistical-cost Network-flow Algorithm for Phase Unwrapping (SNAPHU)



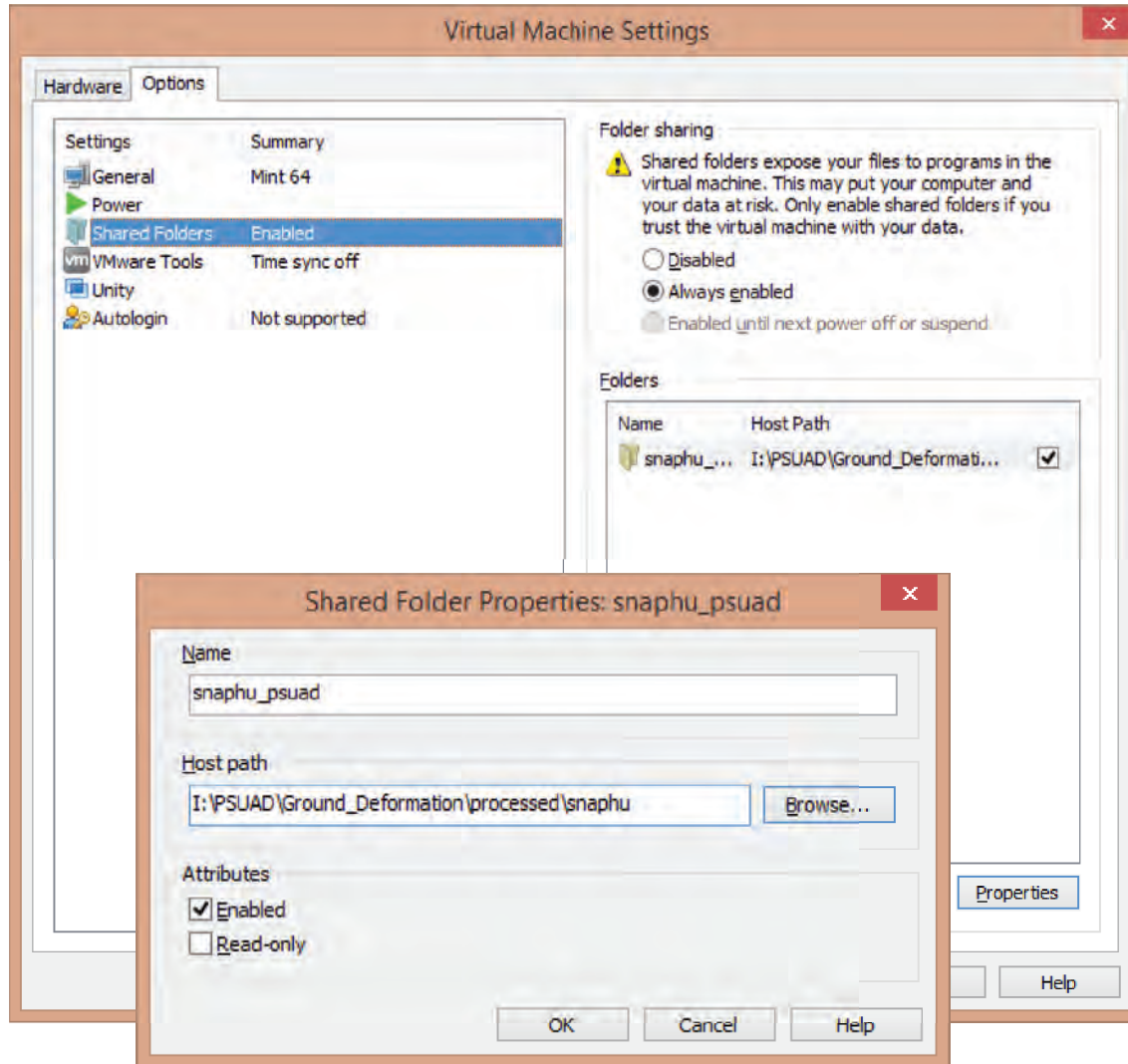
Phase Unwrapping Export to SNAPHU format

Export files required by SNAPHU to “...\outputs\snaphu” folder

Copy wrapped phases to “...\outputs\snaphu”



Phase Unwrapping Virtual Machine (VM) Setup



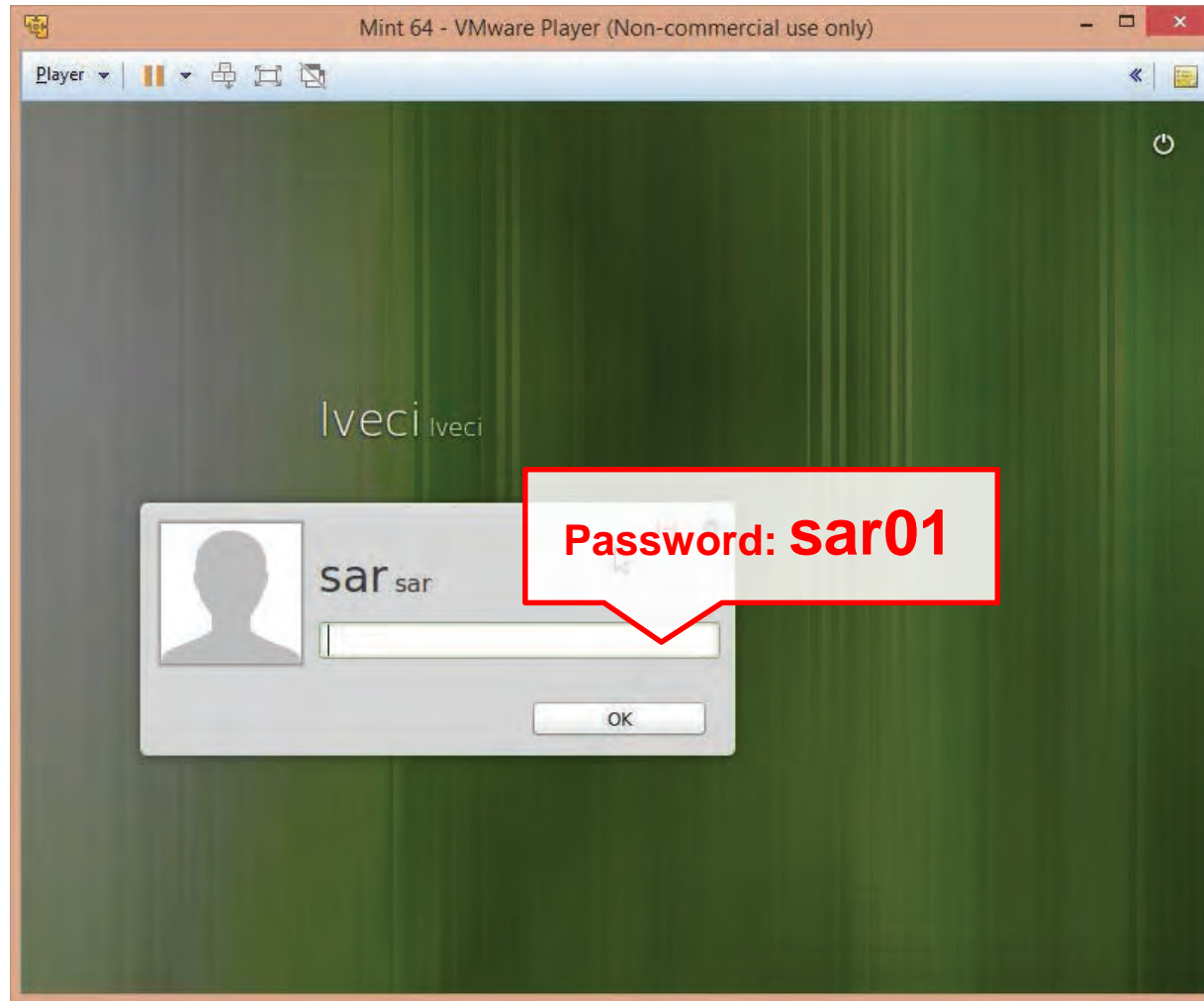
Download and install the dedicated Linux VM on Windows to run SNAPHU and apply phase unwrapping

http://sourceforge.net/projects/s1tbx/files/snaphu_vm/SAR%20Mint%202064.zip/download

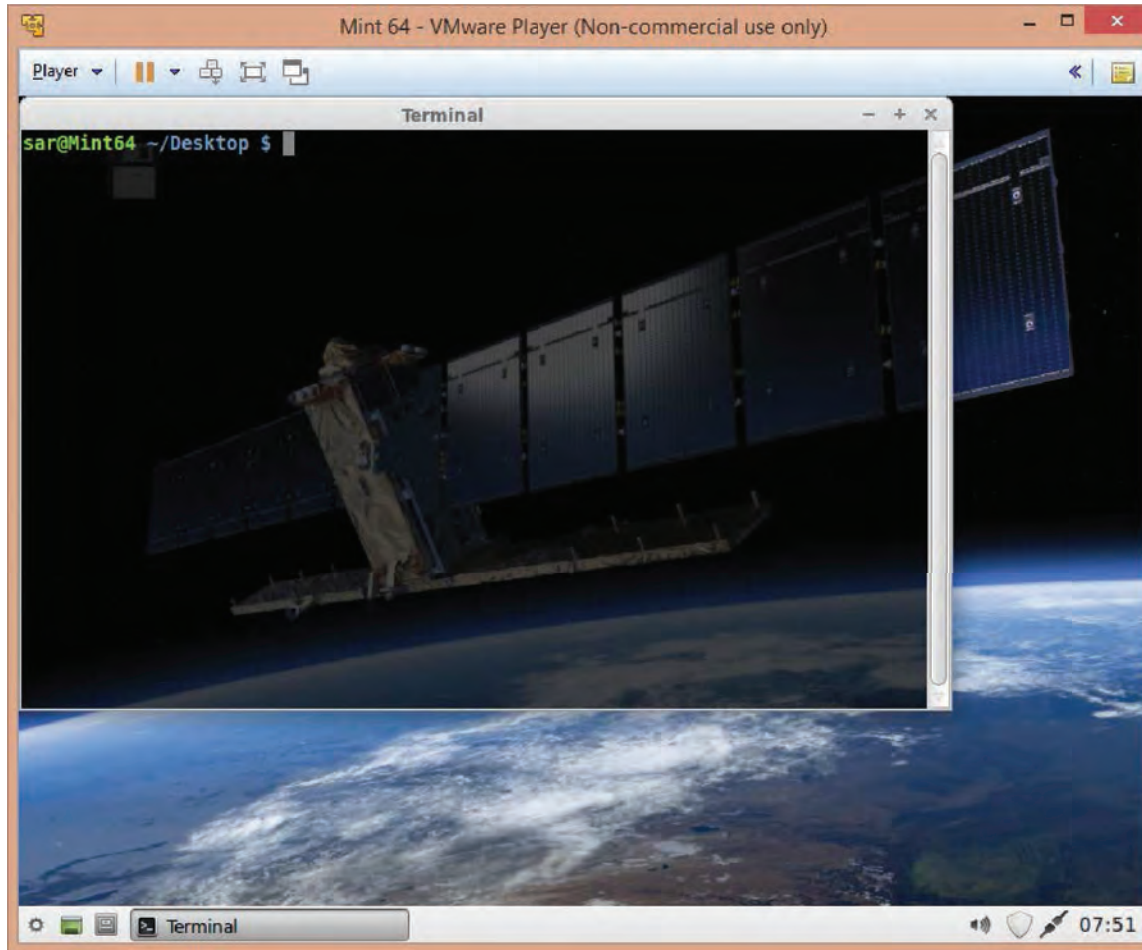
Open the VMware player and browse for the virtual machine

Edit the virtual machine settings to increase the memory and setup a shared folder between Linux and Windows.

Phase Unwrapping VM Initialization



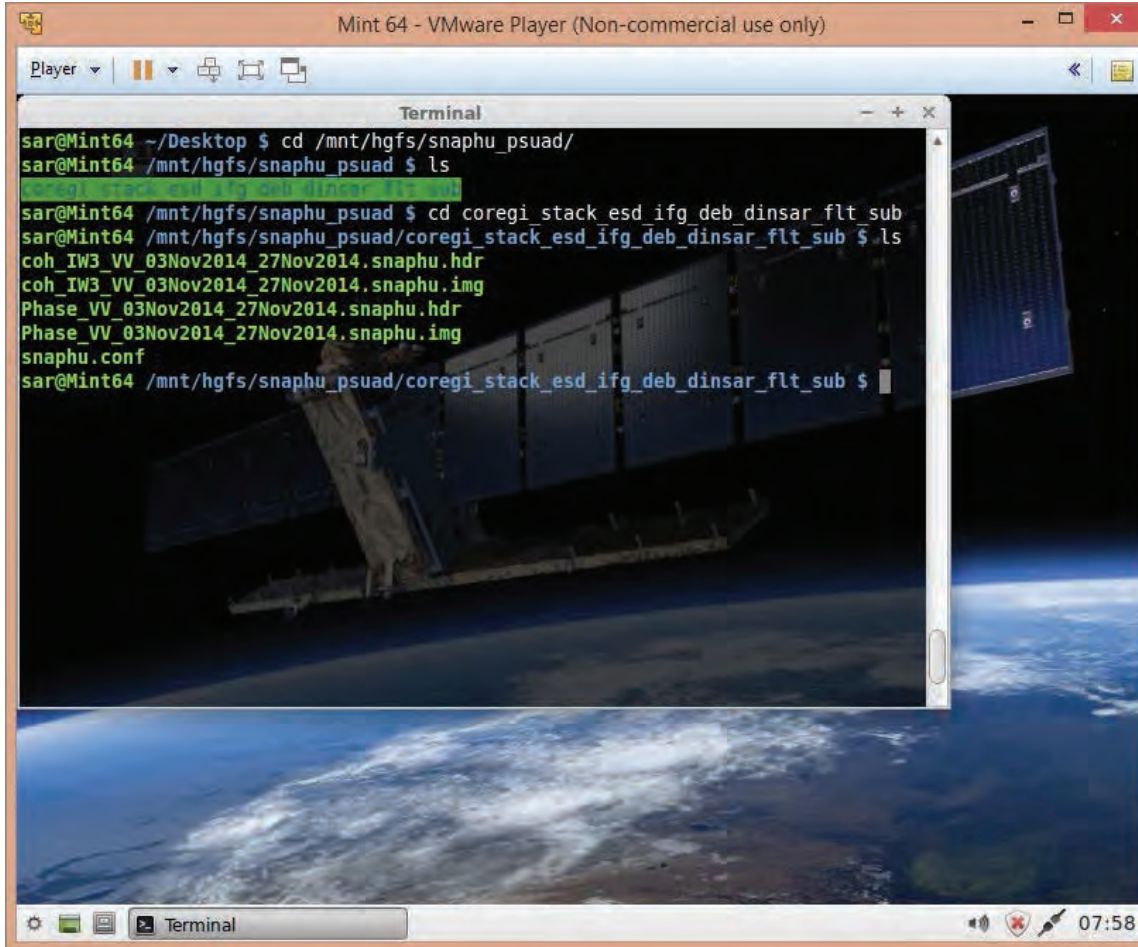
Phase Unwrapping Working in Linux Terminal



Right Click and select
“Open Terminal Here”

Phase Unwrapping

NAVigating to Processing Folder

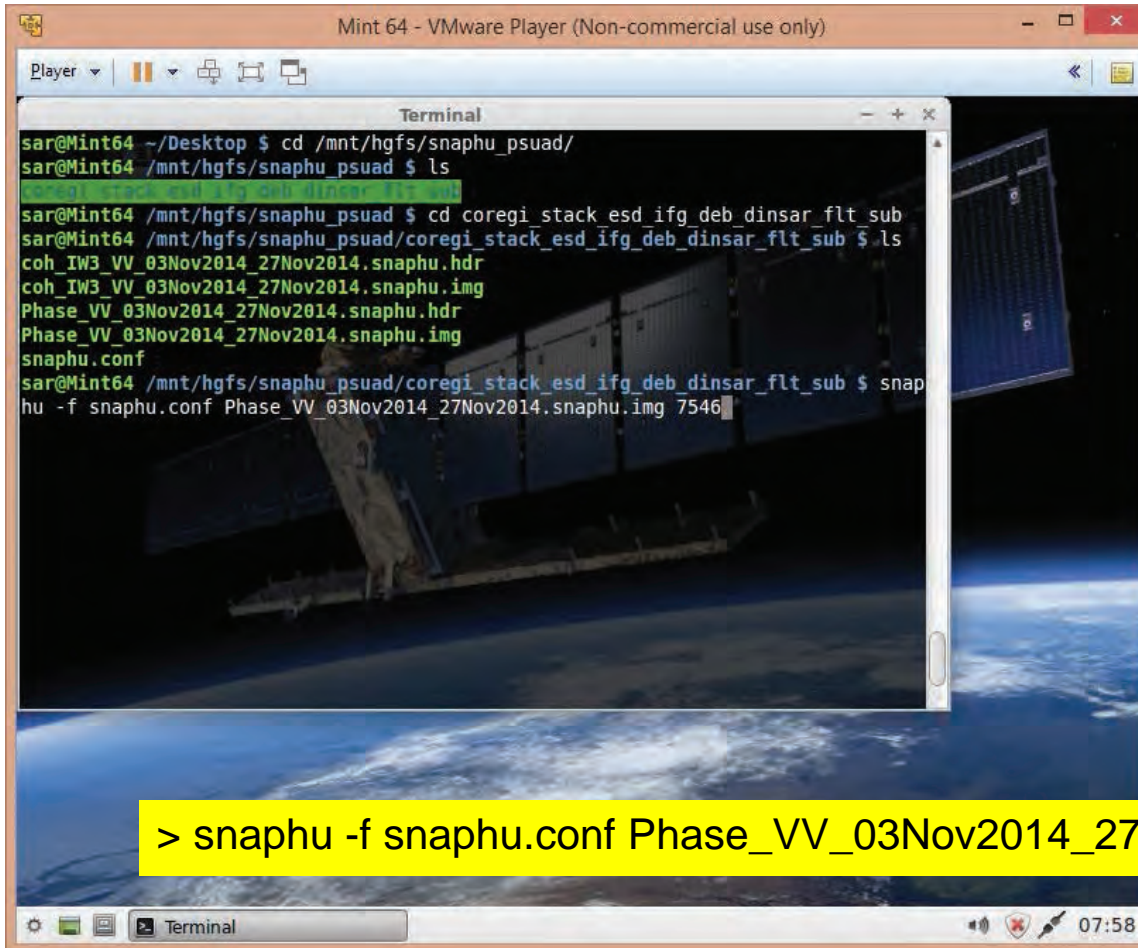


```
sar@Mint64 ~/Desktop $ cd /mnt/hgfs/snaphu_psuad/
sar@Mint64 /mnt/hgfs/snaphu_psuad $ ls
coregi_stack_esd_ifg_deb_dinsar_flt_sub
sar@Mint64 /mnt/hgfs/snaphu_psuad $ cd coregi_stack_esd_ifg_deb_dinsar_flt_sub
sar@Mint64 /mnt/hgfs/snaphu_psuad/coregi_stack_esd_ifg_deb_dinsar_flt_sub $ ls
coh_IW3_VV_03Nov2014_27Nov2014.snaphu.hdr
coh_IW3_VV_03Nov2014_27Nov2014.snaphu.img
Phase_VV_03Nov2014_27Nov2014.snaphu.hdr
Phase_VV_03Nov2014_27Nov2014.snaphu.img
snaphu.conf
sar@Mint64 /mnt/hgfs/snaphu_psuad/coregi_stack_esd_ifg_deb_dinsar_flt_sub $
```

> cd /mnt/hgfs/snaphu/

Phase Unwrapping

Running Predefined Unwrapping Command

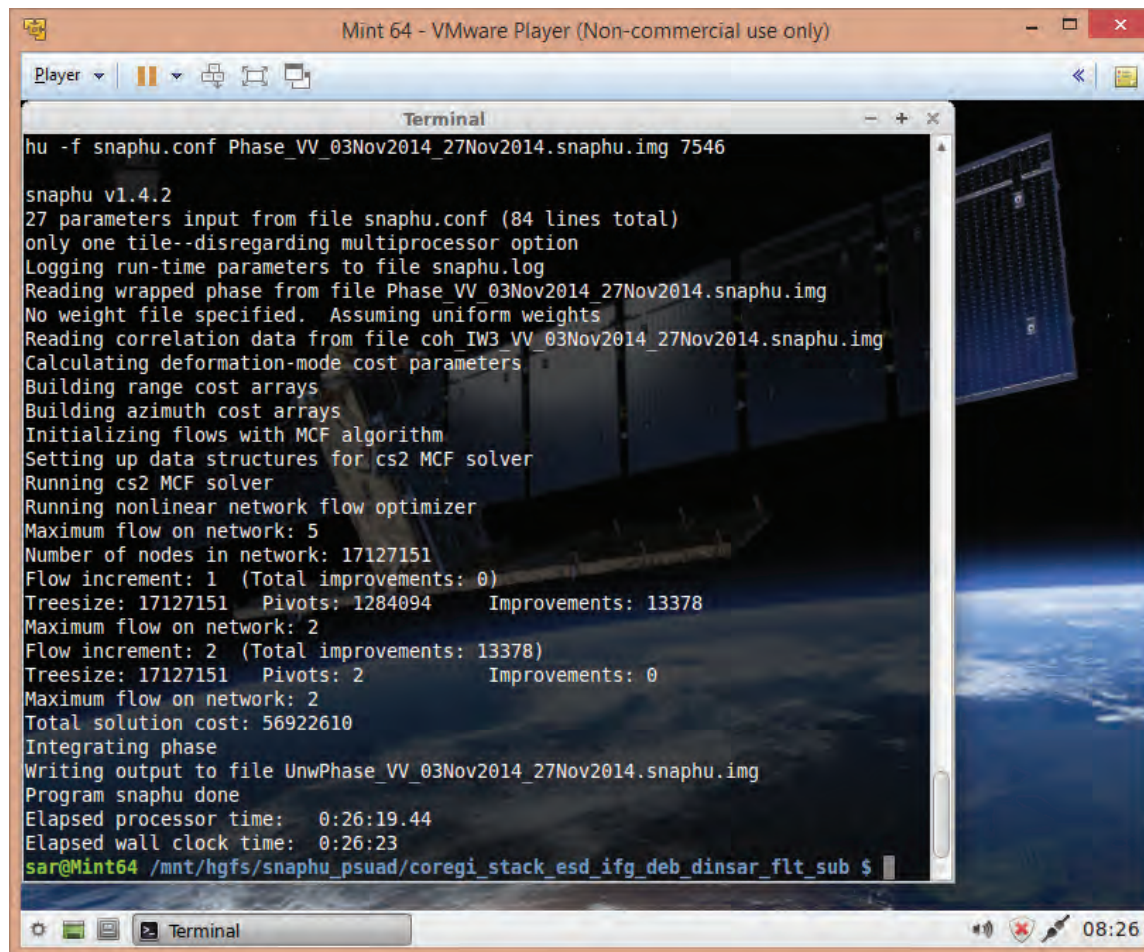


```
sar@Mint64 ~/Desktop $ cd /mnt/hgfs/snaphu_psuad/
sar@Mint64 /mnt/hgfs/snaphu_psuad $ ls
coregi_stack_esd_ifg_deb_dinsarflt_sub
sar@Mint64 /mnt/hgfs/snaphu_psuad $ cd coregi_stack_esd_ifg_deb_dinsarflt_sub
sar@Mint64 /mnt/hgfs/snaphu_psuad/coregi_stack_esd_ifg_deb_dinsarflt_sub $ ls
coh_IW3_VV_03Nov2014_27Nov2014.snaphu.hdr
coh_IW3_VV_03Nov2014_27Nov2014.snaphu.img
Phase_VV_03Nov2014_27Nov2014.snaphu.hdr
Phase_VV_03Nov2014_27Nov2014.snaphu.img
snaphu.conf
sar@Mint64 /mnt/hgfs/snaphu_psuad/coregi_stack_esd_ifg_deb_dinsarflt_sub $ snap
hu -f snaphu.conf Phase_VV_03Nov2014_27Nov2014.snaphu.img 7546
```

Unwrapping command
for the specific data
inputs can be found in
snaphu.conf

> snaphu -f snaphu.conf Phase_VV_03Nov2014_27Nov2014.snaphu.img 7546

Phase Unwrapping SNAPHU Processing

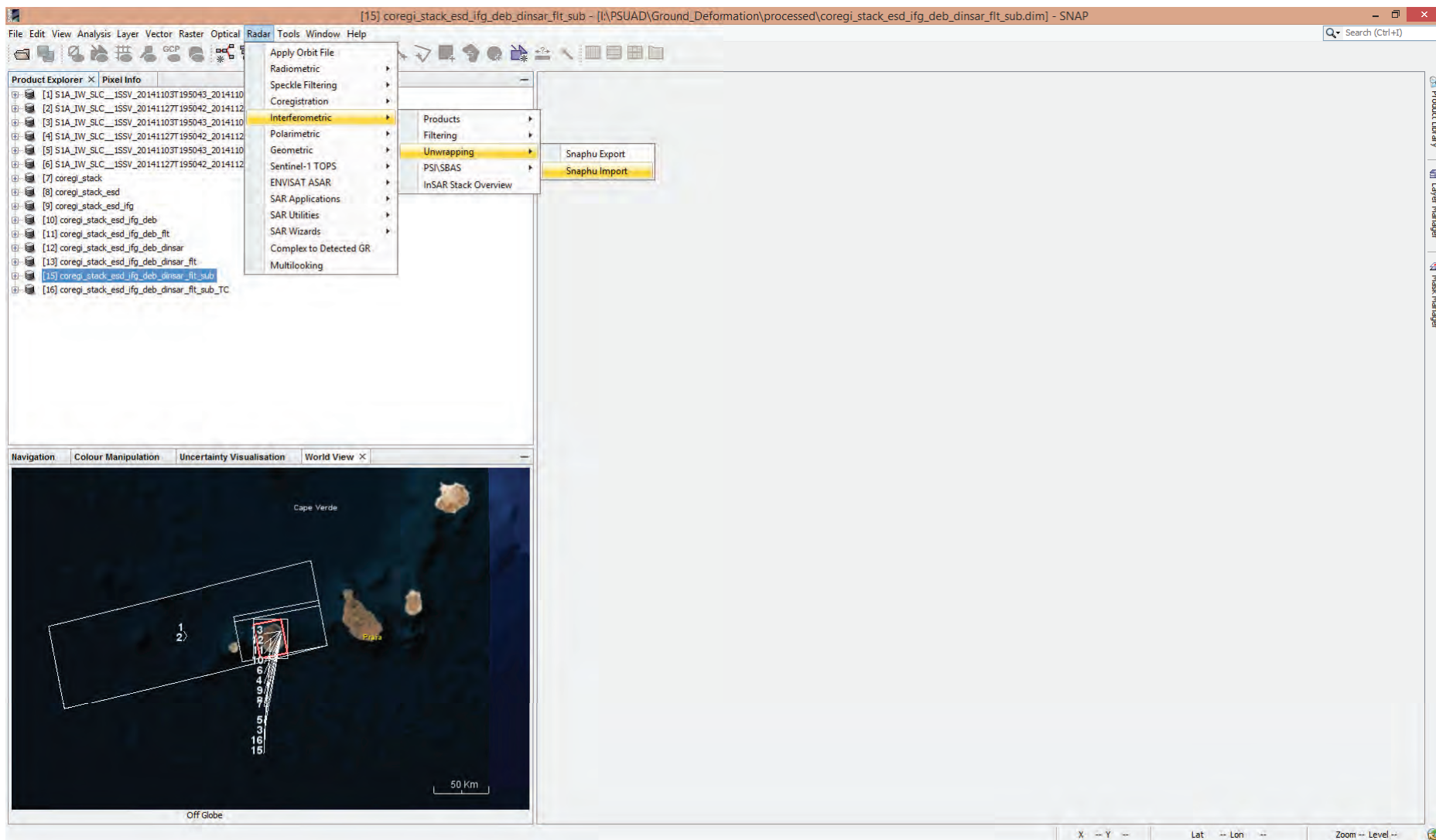


```
hu -f snaphu.conf Phase_VV_03Nov2014_27Nov2014.snaphu.img 7546

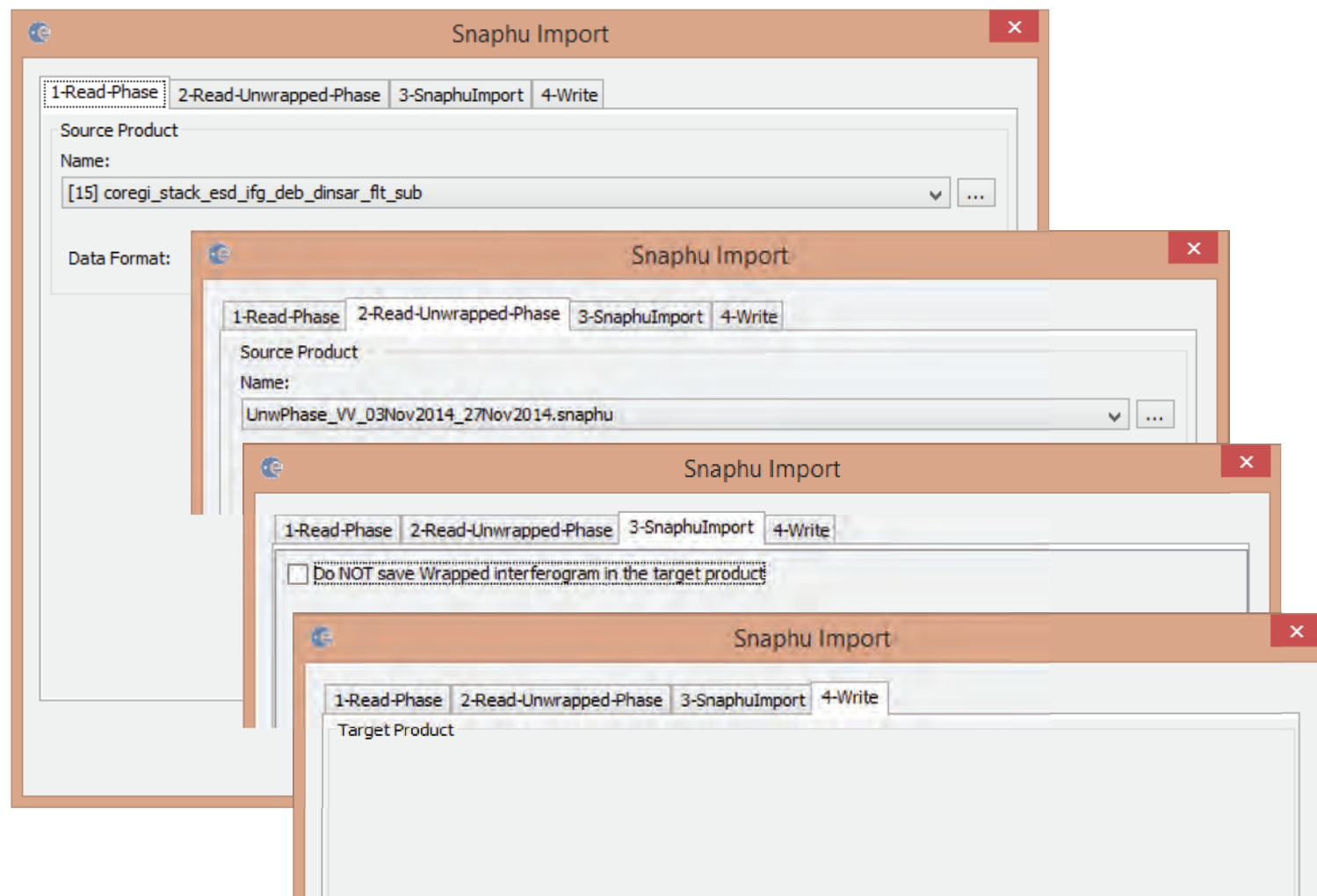
snaphu v1.4.2
27 parameters input from file snaphu.conf (84 lines total)
only one tile--disregarding multiprocessor option
Logging run-time parameters to file snaphu.log
Reading wrapped phase from file Phase_VV_03Nov2014_27Nov2014.snaphu.img
No weight file specified. Assuming uniform weights
Reading correlation data from file coh_IW3_VV_03Nov2014_27Nov2014.snaphu.img
Calculating deformation-mode cost parameters
Building range cost arrays
Building azimuth cost arrays
Initializing flows with MCF algorithm
Setting up data structures for cs2 MCF solver
Running cs2 MCF solver
Running nonlinear network flow optimizer
Maximum flow on network: 5
Number of nodes in network: 17127151
Flow increment: 1 (Total improvements: 0)
Treesize: 17127151 Pivots: 1284094 Improvements: 13378
Maximum flow on network: 2
Flow increment: 2 (Total improvements: 13378)
Treesize: 17127151 Pivots: 2 Improvements: 0
Maximum flow on network: 2
Total solution cost: 56922610
Integrating phase
Writing output to file UnwPhase_VV_03Nov2014_27Nov2014.snaphu.img
Program snaphu done
Elapsed processor time: 0:26:19.44
Elapsed wall clock time: 0:26:23
sar@Mint64 /mnt/hgfs/snaphu_psuad/coregi_stack_esd_ifg_deb_dinsarflt_sub $
```

Elapsed Time
00:26:23

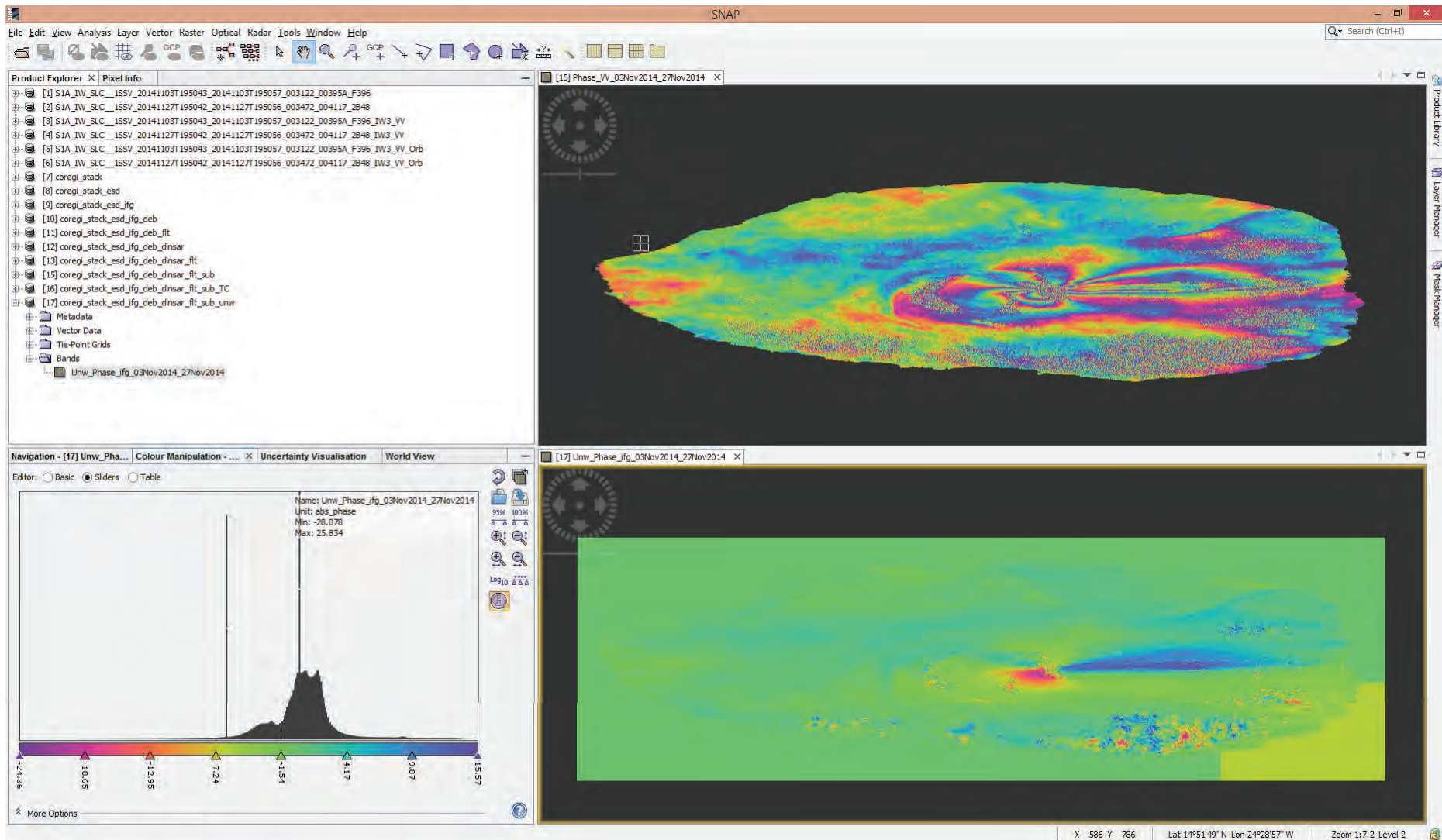
Phase Unwrapping Import from SNAPHU format



Phase Unwrapping Import from SNAPHU format



Unwrapped Differential Phase (in radians)



EXERCISE

PART 3

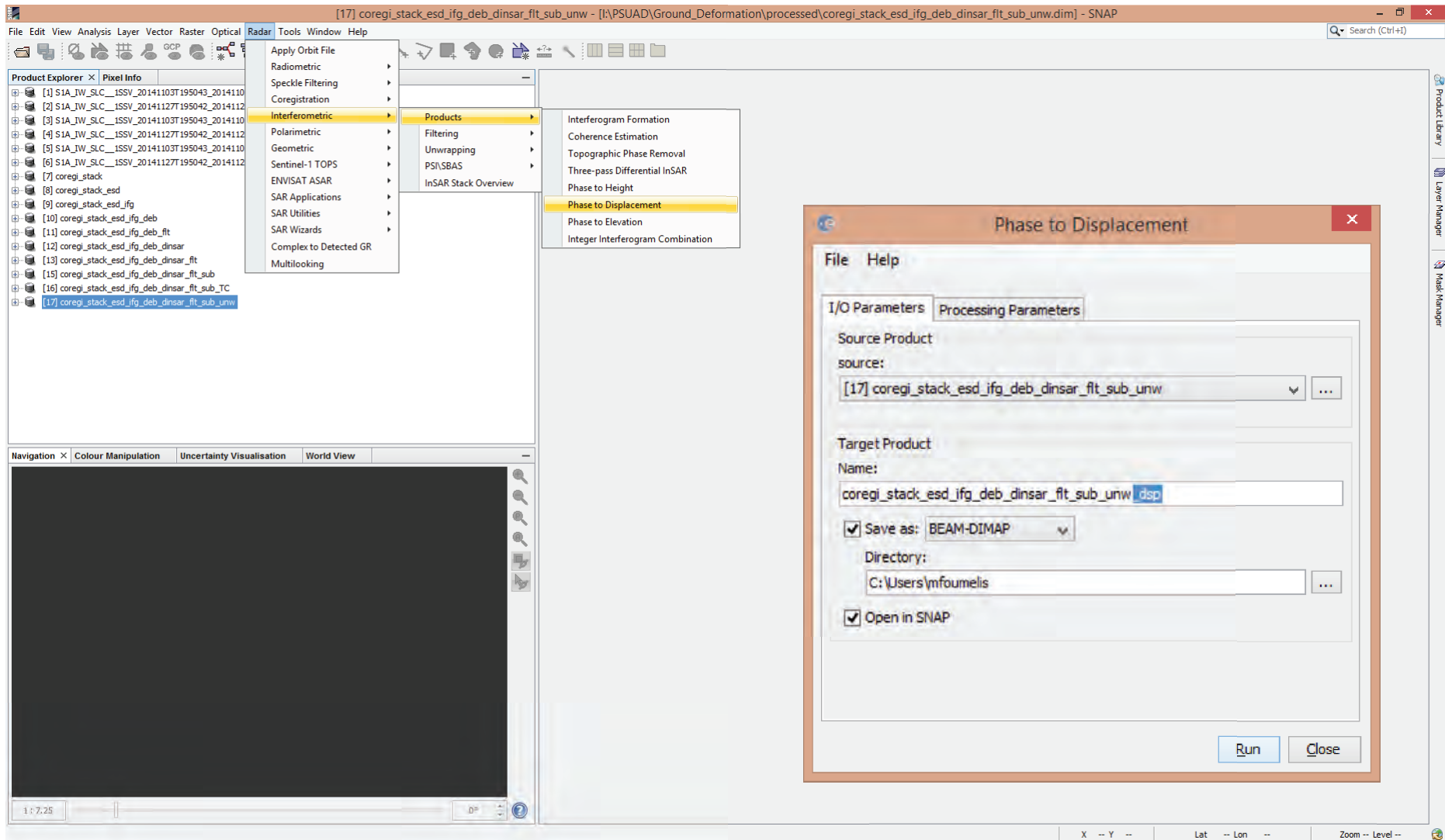
Displacement Measurements & Terrain Geocoding



EXERCISE Processing Steps (PART 3)

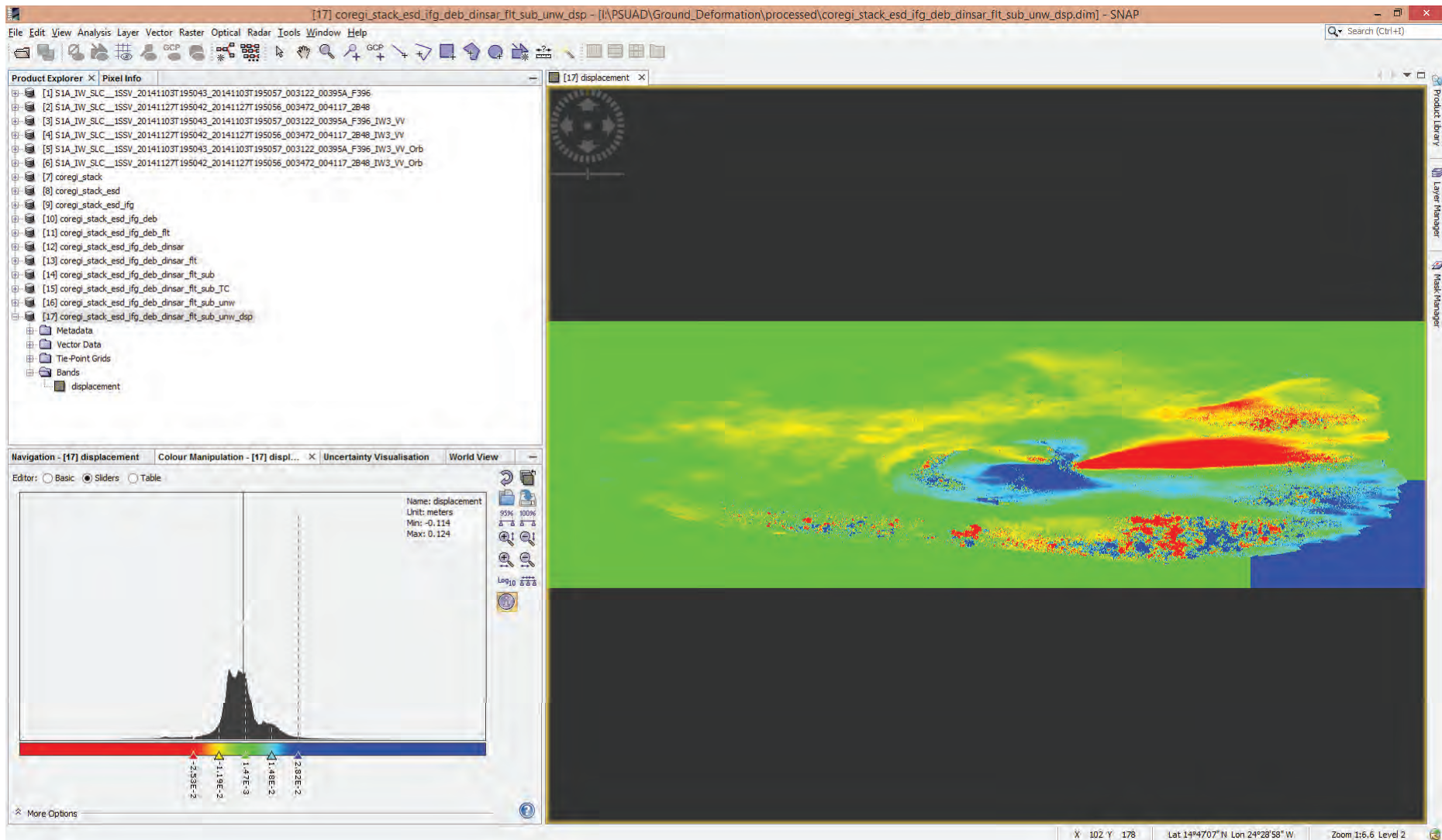


Conversion of Unwrapped Phase to Displacement

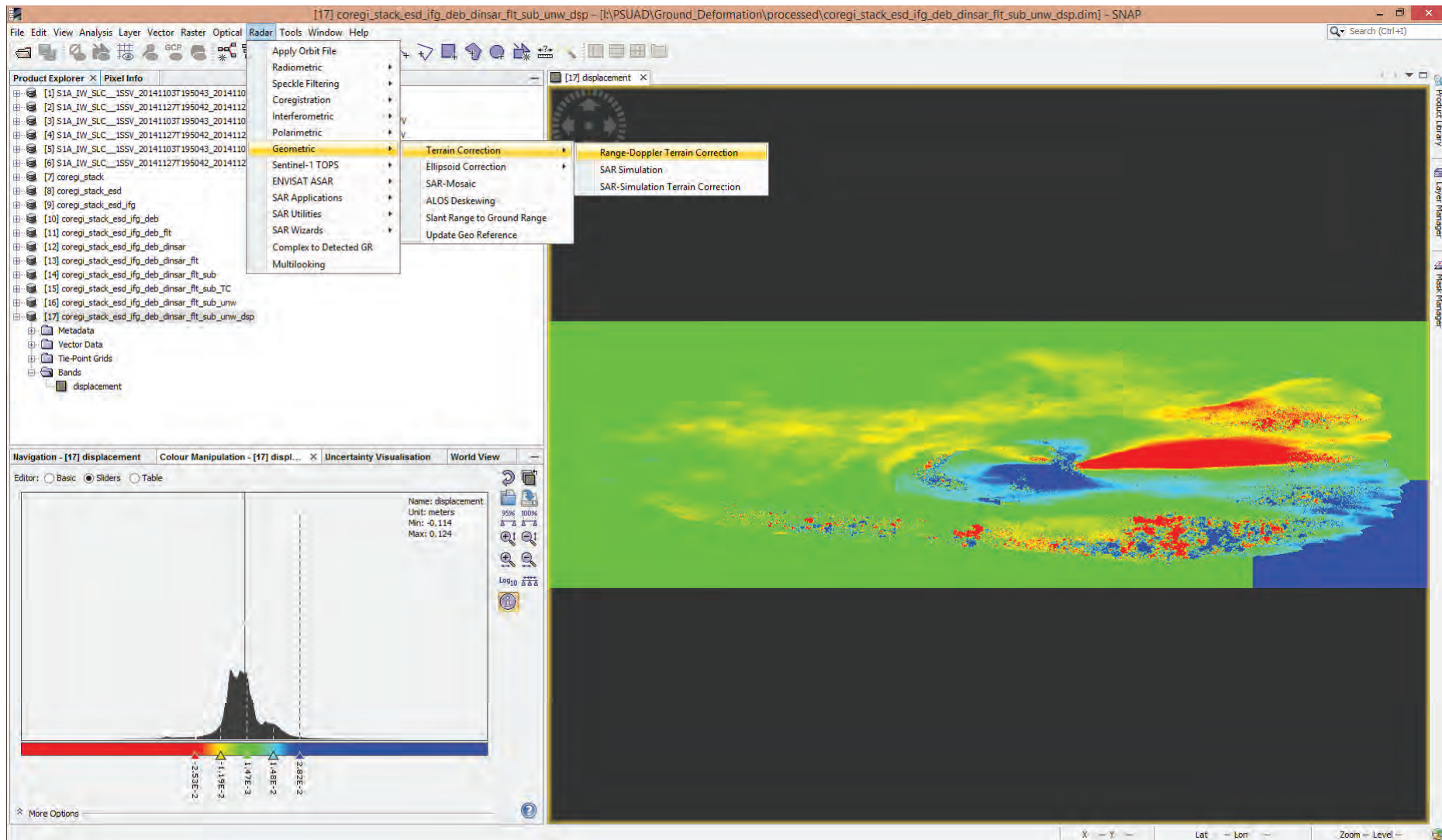


The screenshot displays the SNAP (Scientific Data Processing) software interface. The main window shows a list of products in the 'Product Explorer' on the left, with the selected product being '[17] coregi_stack_esd_ifg_deb_dinsar_fit_sub_unw'. The 'Radar' menu is open, and the 'Interferometric' sub-menu is selected, leading to the 'Phase to Displacement' option. The 'Phase to Displacement' dialog box is open, showing the 'Processing Parameters' tab. The 'Source Product' is set to '[17] coregi_stack_esd_ifg_deb_dinsar_fit_sub_unw'. The 'Target Product' name is 'coregi_stack_esd_ifg_deb_dinsar_fit_sub_unw_dsp'. The 'Save as' option is set to 'BEAM-DIMAP', and the 'Directory' is 'C:\Users\mfoumelis'. The 'Open in SNAP' checkbox is checked. The 'Run' button is visible at the bottom right of the dialog box.

Ground Displacement along the Line-of-Sight (LOS)



Geocoding of Sentinel-1 Ground Displacements



Geocoding of Sentinel-1 Ground Displacements

Range Doppler Terrain Correction

File Help

I/O Parameters Processing Parameters

Source Product

source:

[17] coregi_stack_esd_ifg_deb_dinsar_fit_sub_unw_dsp

Target Product

Name:

coregi_stack_esd_ifg_deb_dinsar_fit_sub_unw_dsp_TC

☒ Save as: BEAM-DIMAP

Directory:

C:\Users\mfoumelis

☒ Open in SNAP

Run Close

Range Doppler Terrain Correction

File Help

I/O Parameters Processing Parameters

Source Bands:

displacement

Digital Elevation Model:

SRTM 3Sec (Auto Download)

DEM Resampling Method:

BILINEAR_INTERPOLATION

Image Resampling Method:

BILINEAR_INTERPOLATION

Source GR Pixel Spacings (az x rg):

13.98(m) x 3.39(m)

Pixel Spacing (m):

15

Pixel Spacing (deg):

1.3474729261792824E-4

Map Projection:

UTM Zone 26 / World Geodetic System 1984

☒ Mask out areas without elevation ☐ Output complex data

Output bands for:

☒ Selected source band ☐ DEM ☐ Latitude & Longitude

☐ Incidence angle from ellipsoid ☐ Local incidence angle ☐ Projected local incidence angle

☐ Apply radiometric normalization

☐ Save Sigma0 band Use projected local incidence angle from DEM

☐ Save Gamma0 band Use projected local incidence angle from DEM

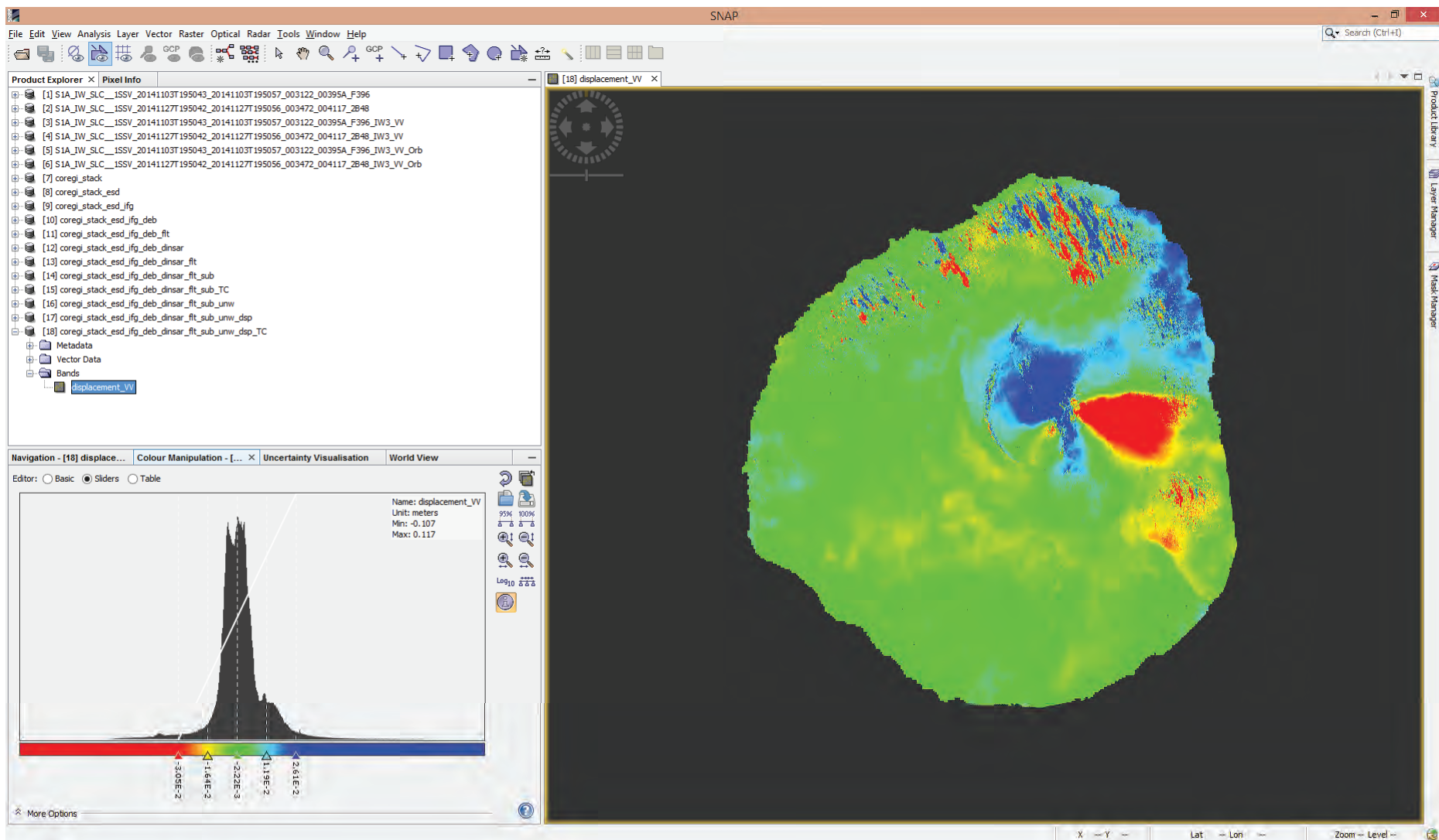
☐ Save Beta0 band

Auxiliary File (ASAR only):

Latest Auxiliary File

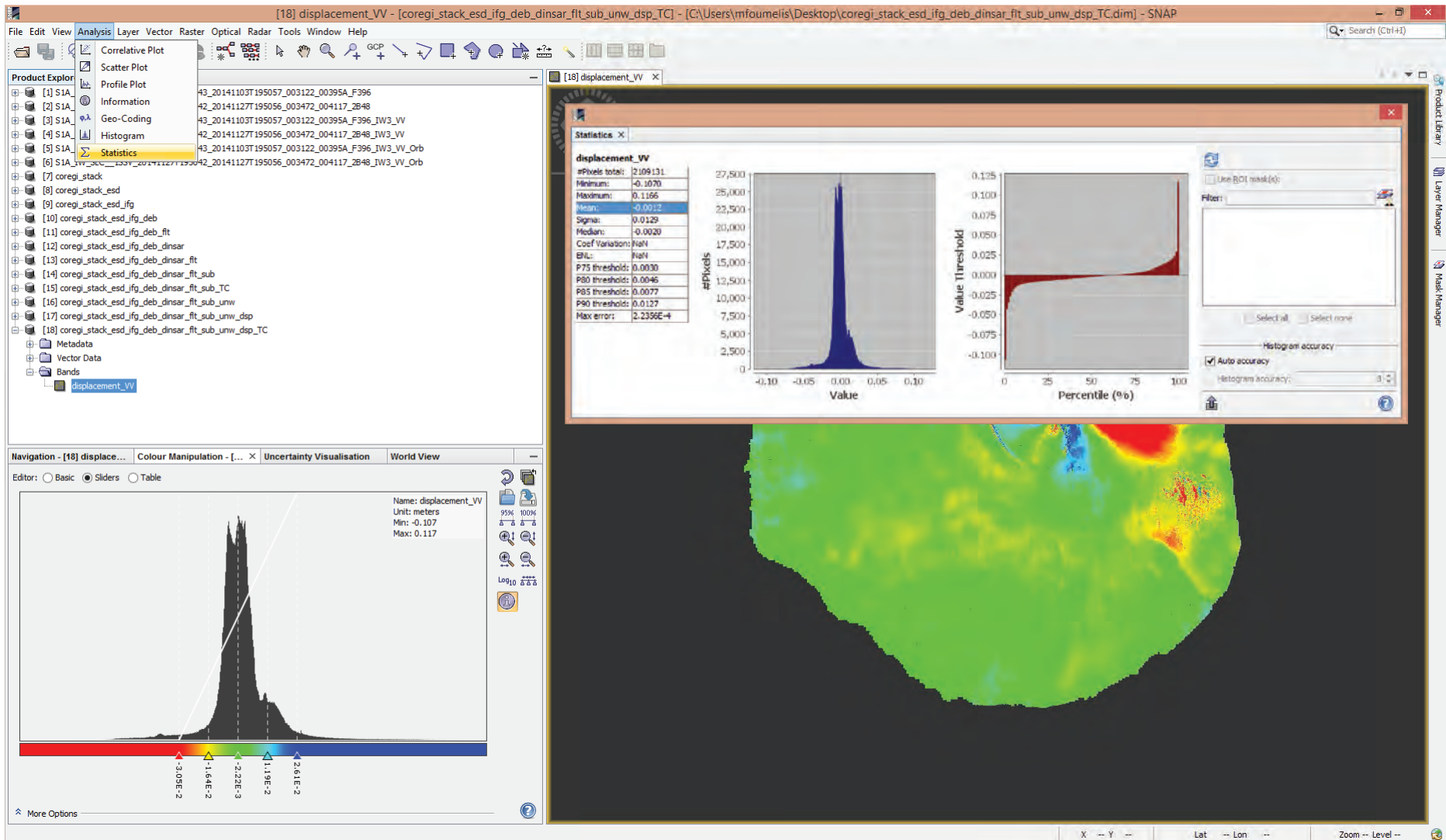
Run Close

Terrain Corrected S1 TOPS Ground Displacements

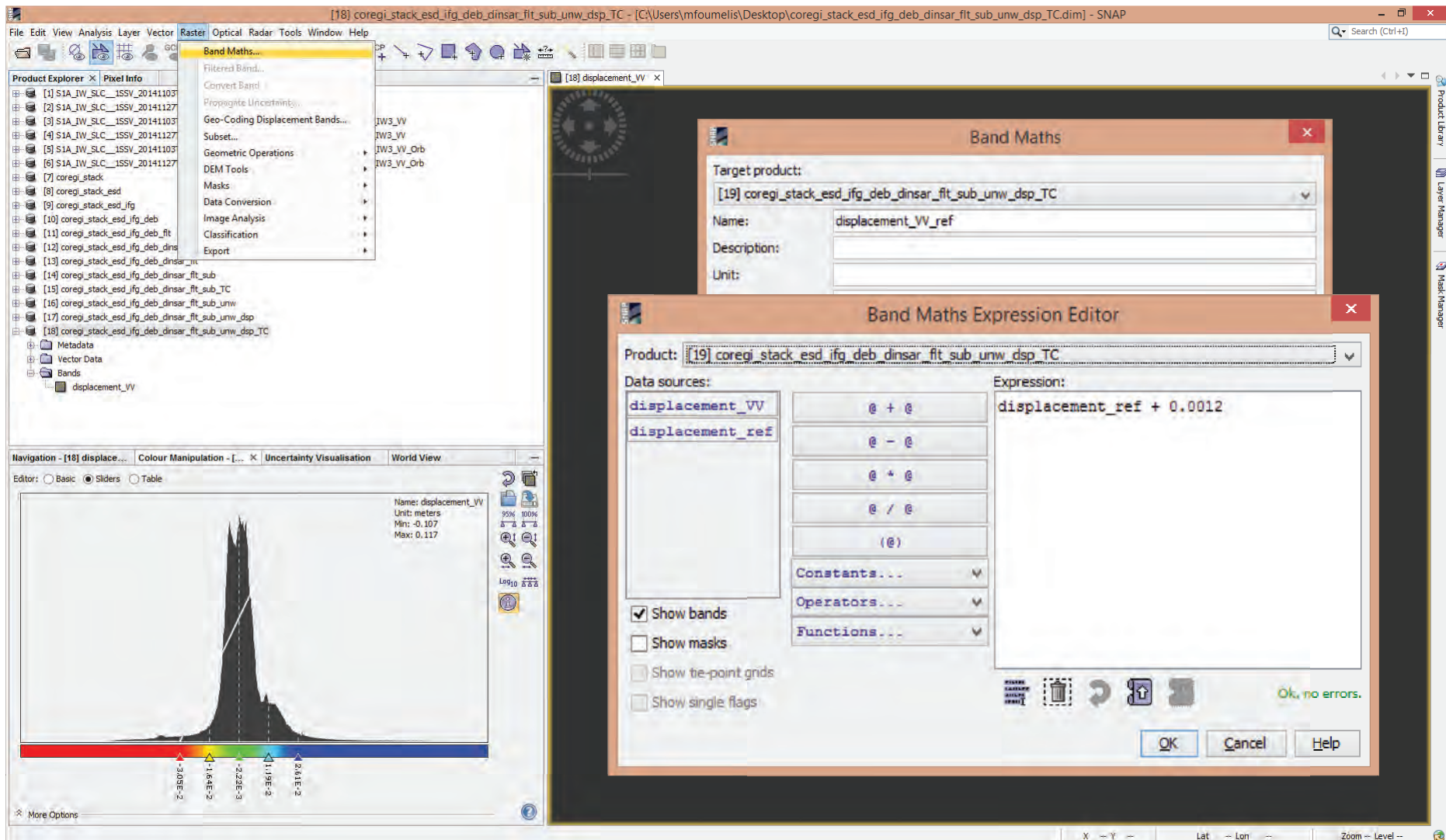


Post-processing

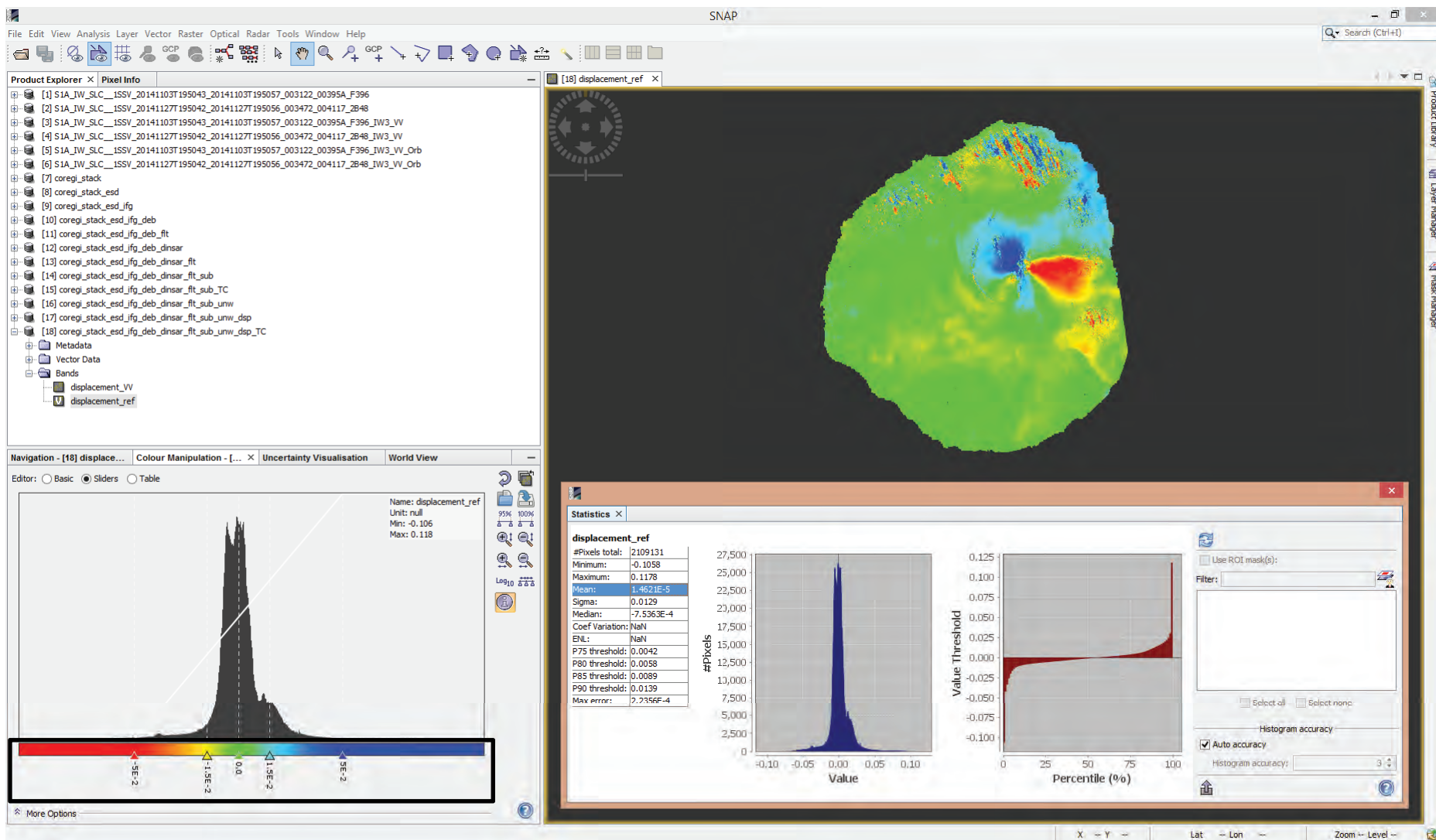
Selection of Local Reference



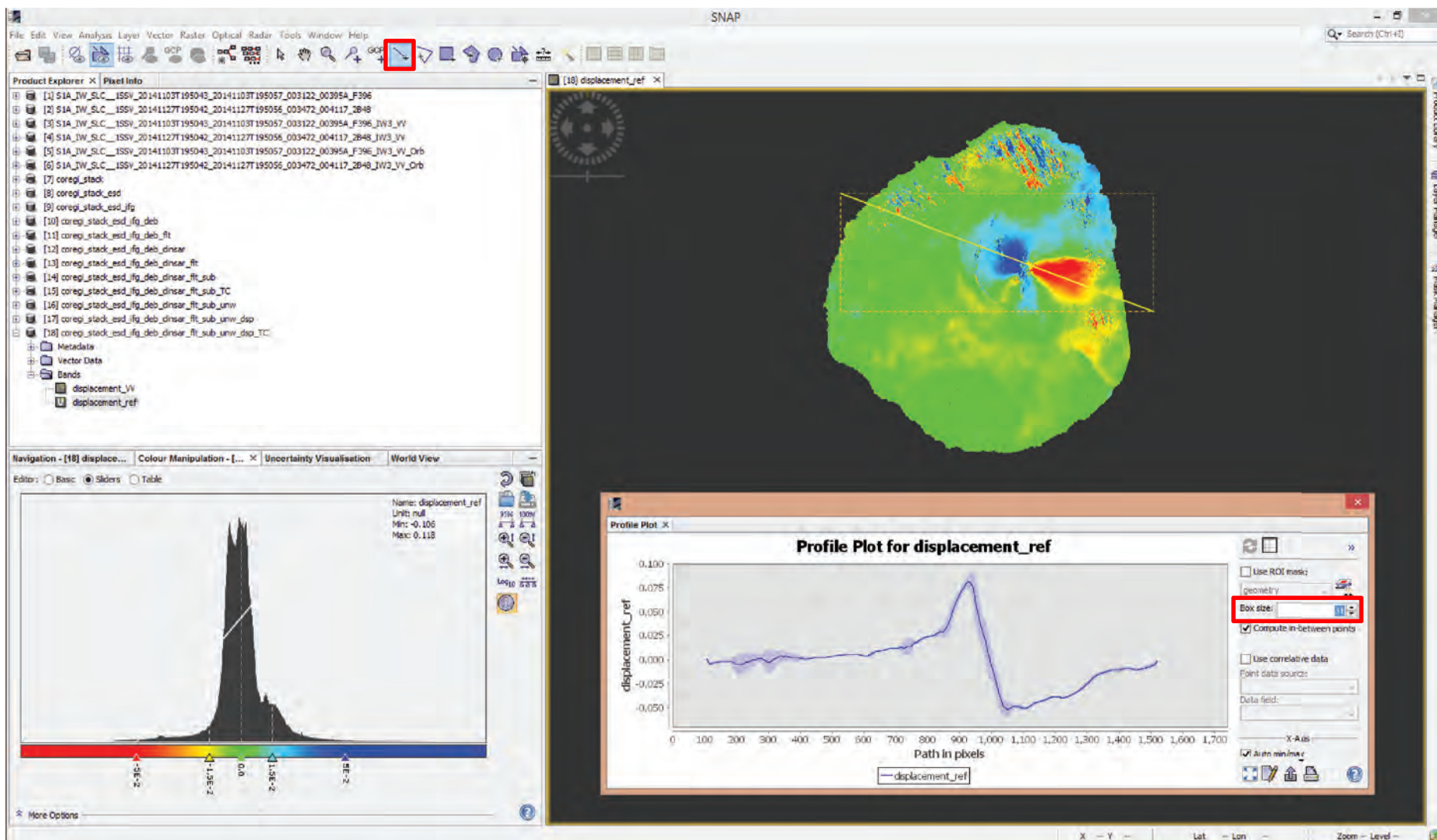
Post-processing Referencing Displacements



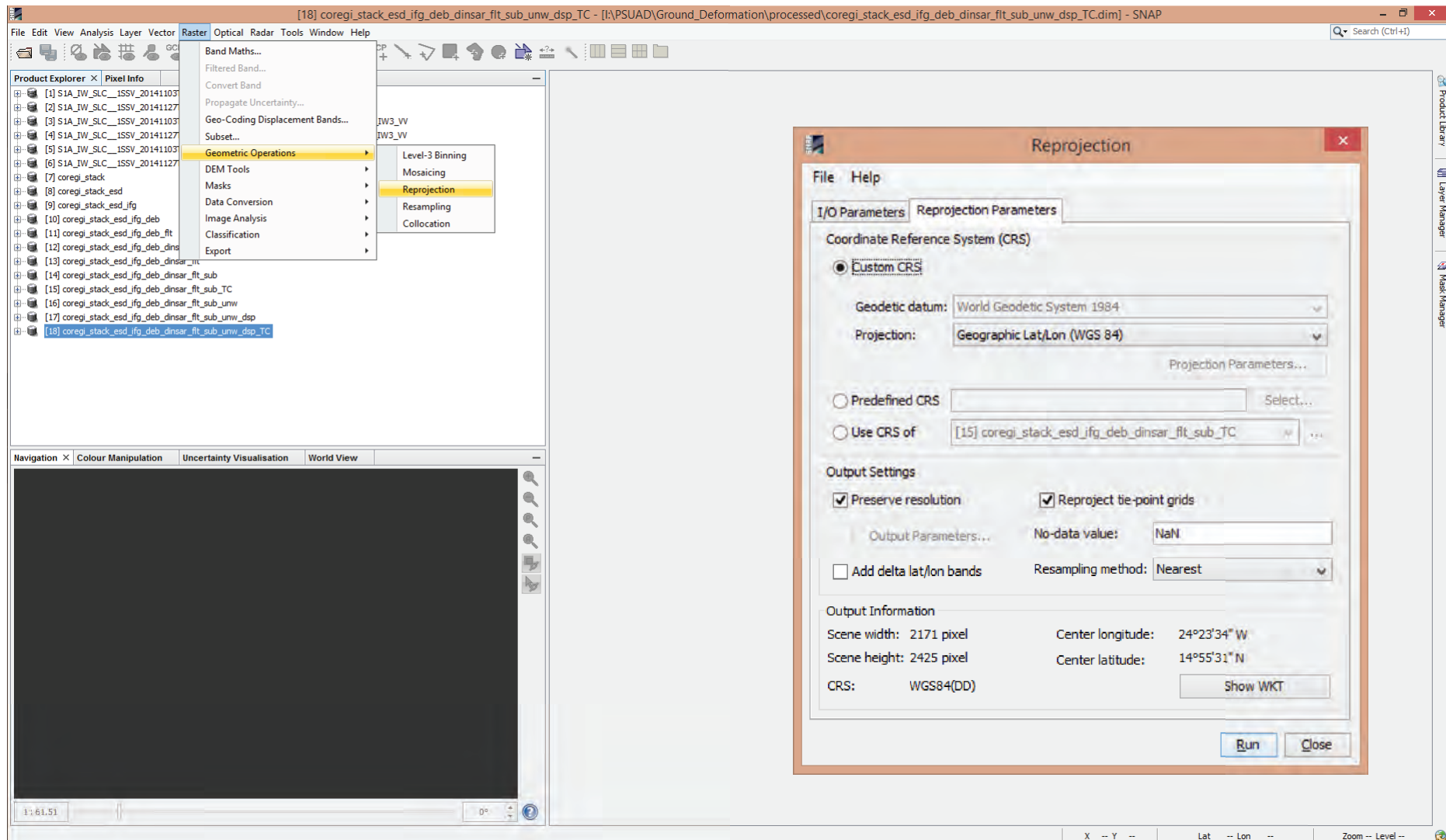
Post-processing Arranging Colour Ramps



Post-processing Spatial Profile Plots

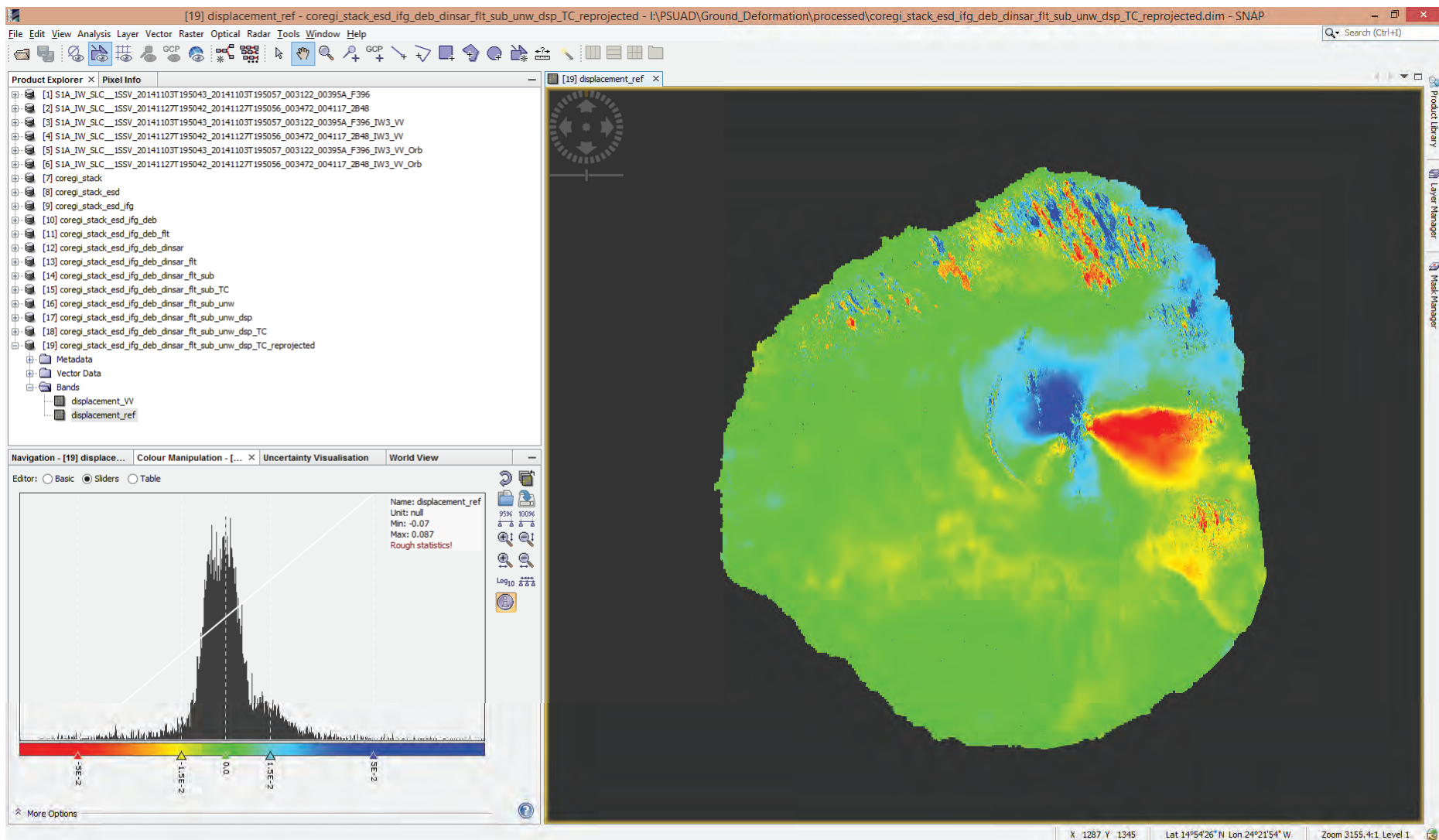


Data Reprojection Geographic Lat/Lon (WGS'84)

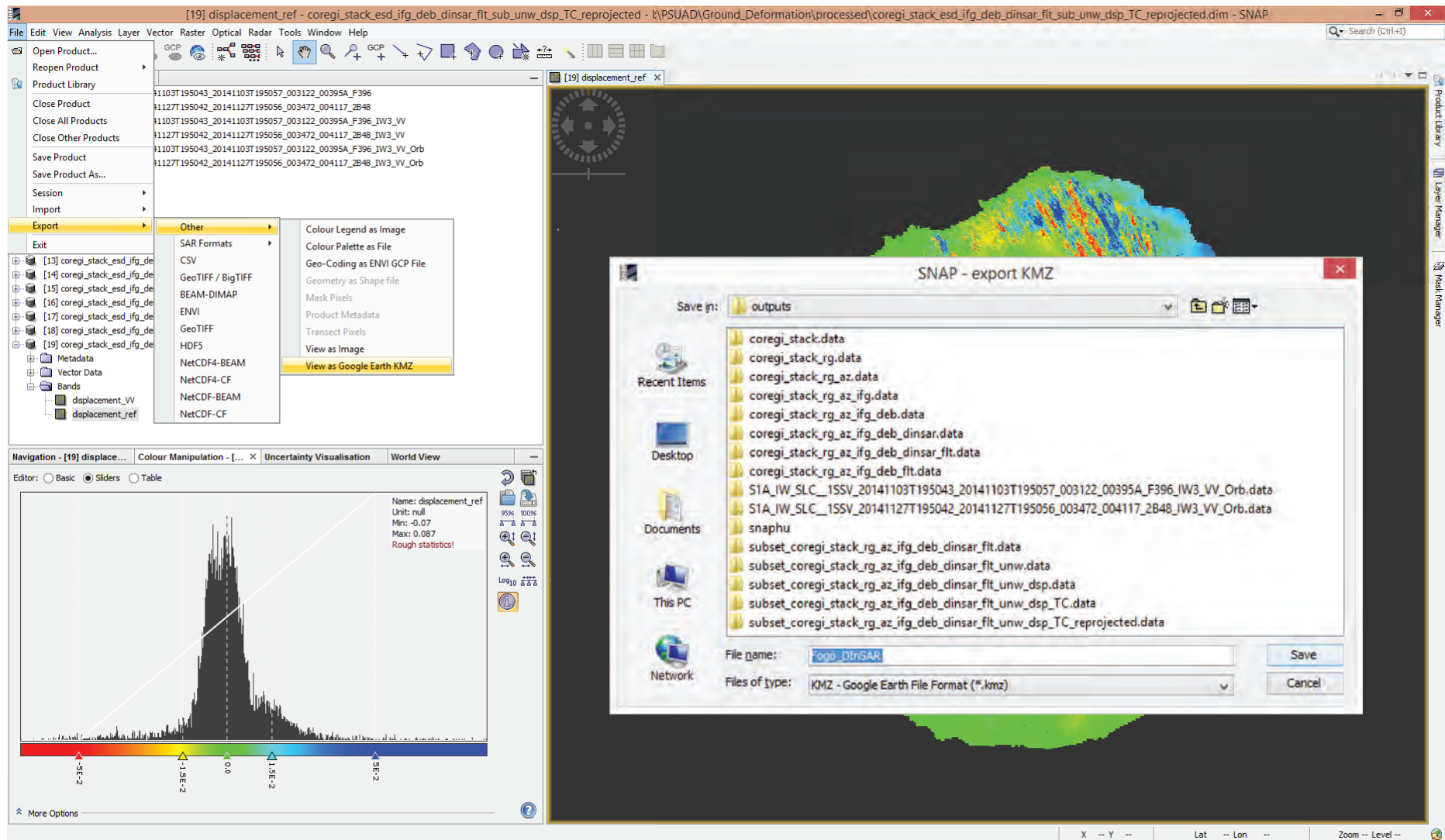


The screenshot displays the SNAP (Scientific Data Processing) software interface. The main window shows a list of data products in the Product Explorer on the left, with the file `[18] coregi_stack_esd_ifg_deb_dinsar_ft_sub_unw_dsp_TC` selected. The Raster menu is open, and the 'Reprojection' option is highlighted. A 'Reprojection' dialog box is open, showing the 'Reprojection Parameters' tab. The 'Coordinate Reference System (CRS)' section is set to 'Custom CRS' with 'Geodetic datum' as 'World Geodetic System 1984' and 'Projection' as 'Geographic Lat/Lon (WGS 84)'. The 'Output Settings' section has 'Preserve resolution' and 'Reproject tie-point grids' checked, and 'Resampling method' set to 'Nearest'. The 'Output Information' section shows scene width of 2171 pixels, scene height of 2425 pixels, and CRS as WGS84(DD). The 'Run' button is visible at the bottom right of the dialog.

Inspection of Reprojected Products



Export to Google Earth (*.kmz file)



The screenshot displays the SNAP (Scientific Data Processing) software interface. The main window shows a 3D visualization of a displacement field. The 'File' menu is open, and the 'Export' option is selected, leading to a submenu where 'View as Google Earth KMZ' is highlighted. A dialog box titled 'SNAP - export KMZ' is open, showing a list of files to be exported, including 'coregi_stack.data', 'coregi_stack_rg.data', 'coregi_stack_rg_az.data', 'coregi_stack_rg_az_ifg.data', 'coregi_stack_rg_az_ifg_deb.data', 'coregi_stack_rg_az_ifg_deb_dinsar.data', 'coregi_stack_rg_az_ifg_deb_dinsar_fit.data', 'coregi_stack_rg_az_ifg_deb_dinsar_fit_unw.data', 'coregi_stack_rg_az_ifg_deb_dinsar_fit_unw_dsp.data', 'coregi_stack_rg_az_ifg_deb_dinsar_fit_unw_dsp_TC.data', and 'coregi_stack_rg_az_ifg_deb_dinsar_fit_unw_dsp_TC_reprojected.data'. The 'File name' field is set to 'Fogo_DInSAR' and the 'Files of type' is set to 'KMZ - Google Earth File Format (*.kmz)'. The 'Save in' location is 'outputs'.

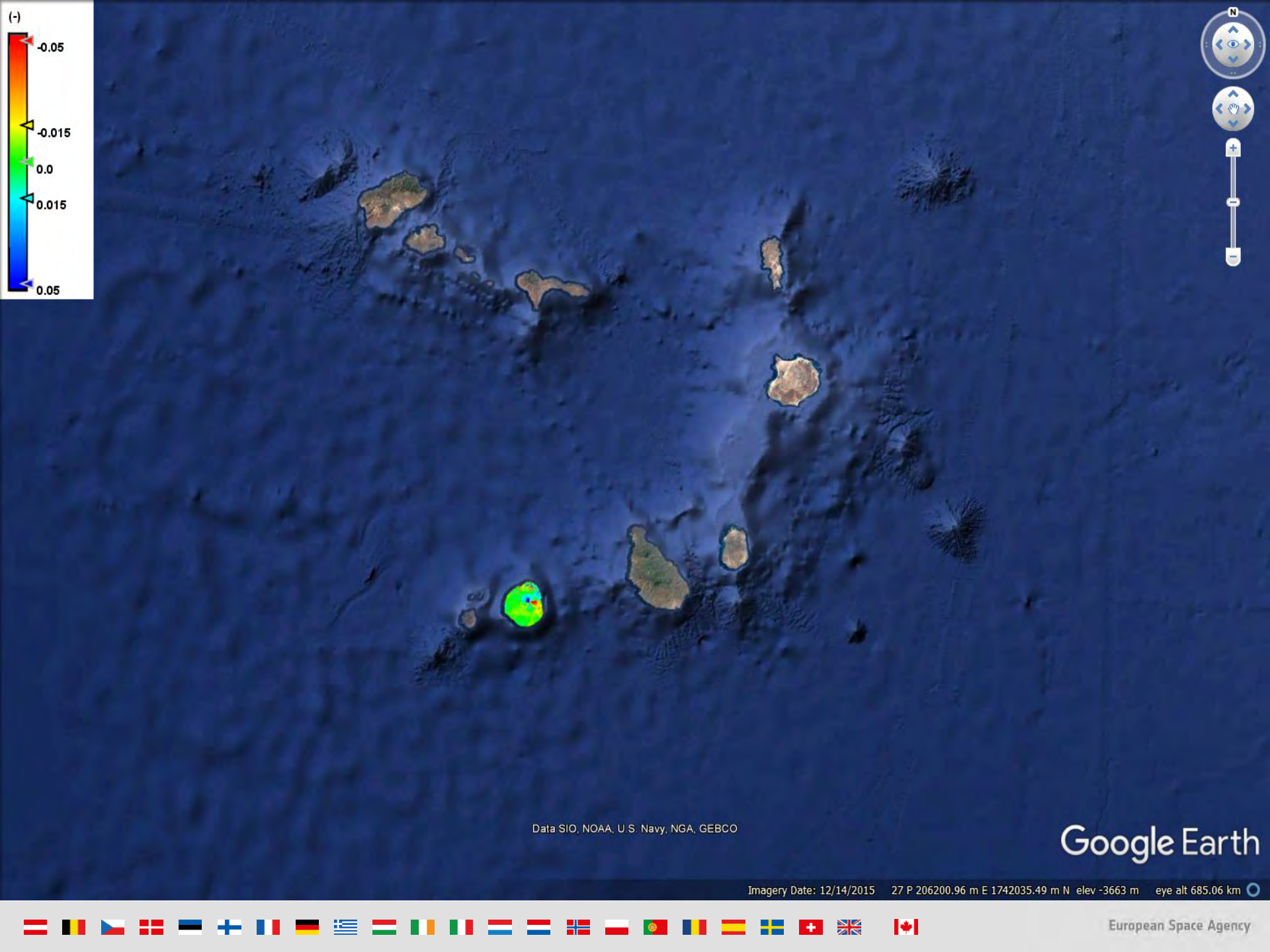
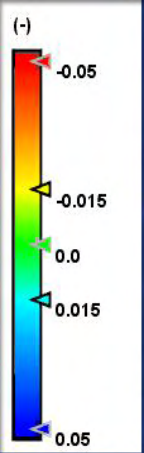
Navigation - [19] displac... Colour Manipulation - [...] x Uncertainty Visualisation World View

Editor: Basic Sliders Table

Name: displacement_ref
Unit: null
Min: -0.07
Max: 0.087
Rough statistics!

Log10

More Options



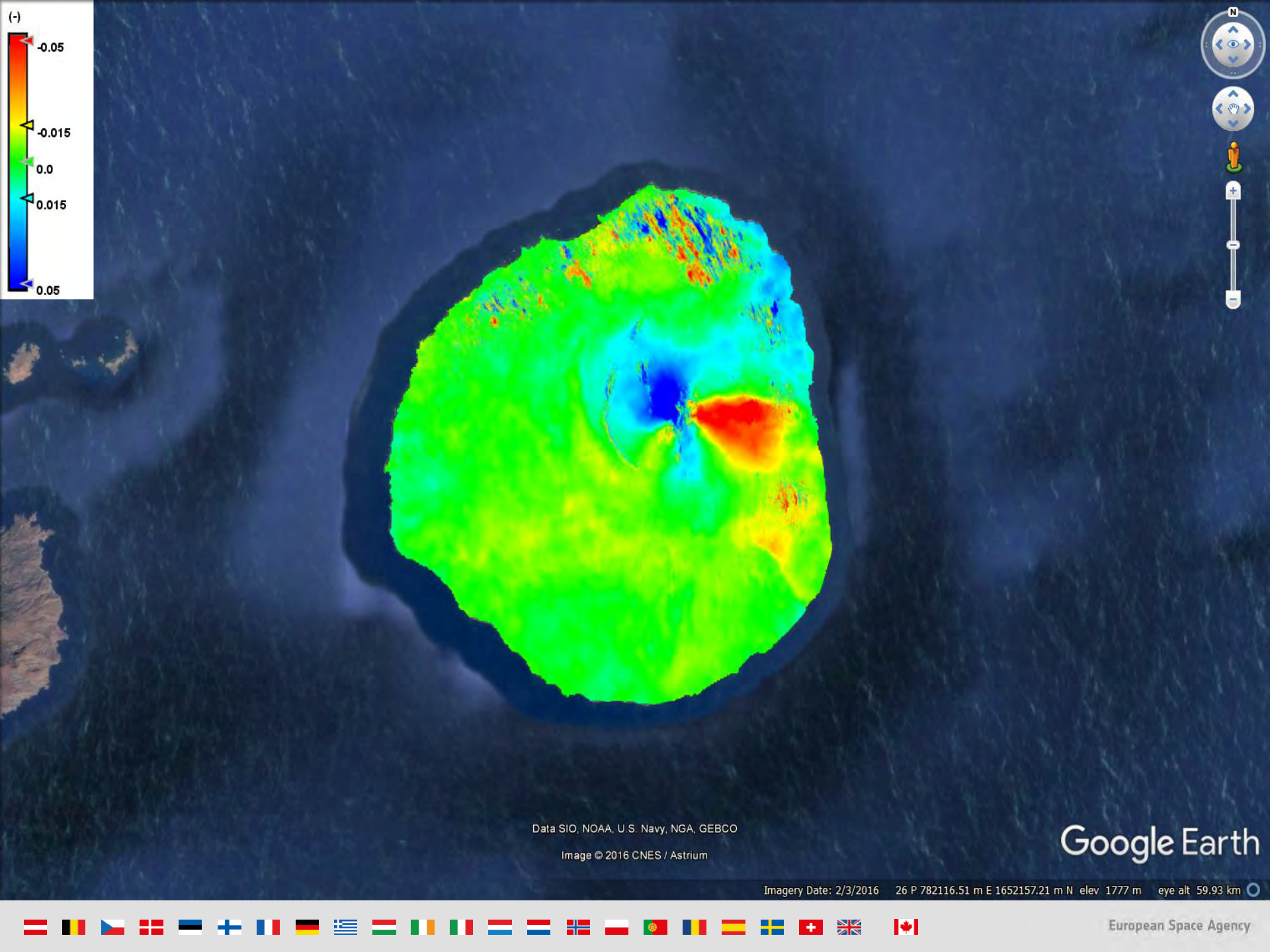
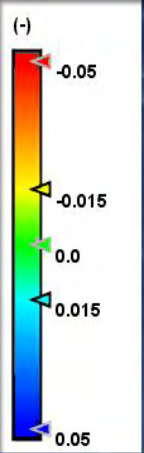
Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Google Earth

Imagery Date: 12/14/2015 27 P 206200.96 m E 1742035.49 m N elev -3663 m eye alt 685.06 km



European Space Agency



Data SIO, NOAA, U.S. Navy, NGA, GEBCO

Image © 2016 CNES / Astrium

Google Earth

Imagery Date: 2/3/2016 26 P 782116.51 m E 1652157.21 m N elev 1777 m eye alt 59.93 km



European Space Agency



Data SIO, NOAA, U.S. Navy, NGA, GEBCO

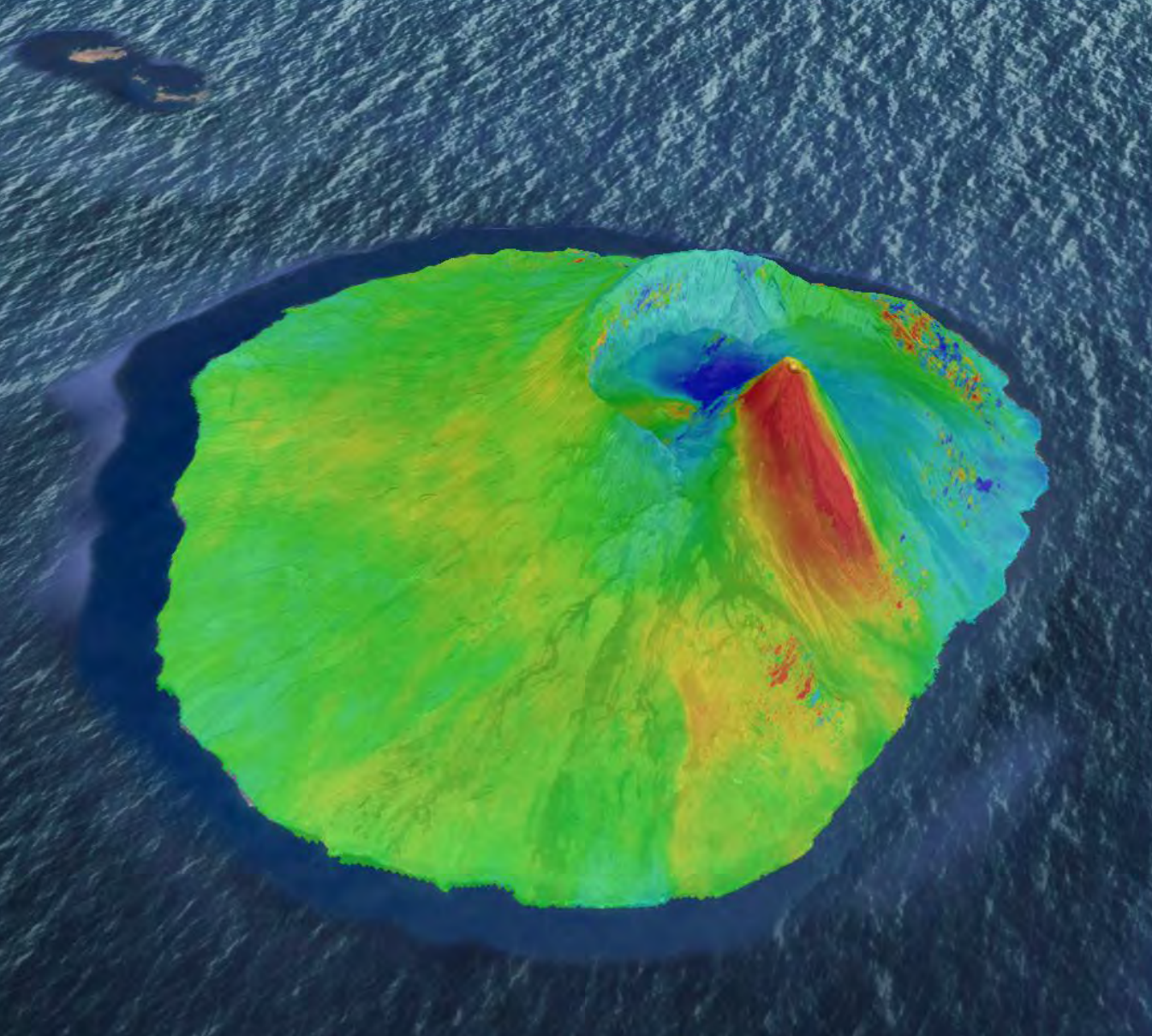
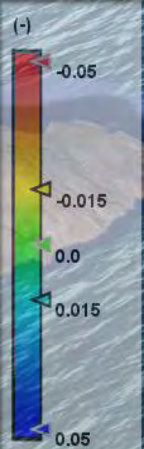
Image © 2016 CNES / Astrium

Google Earth

Imagery Date: 2/3/2016 26 P 781402.90 m E 1648118.86 m N elev 1270 m eye alt 41.53 km



European Space Agency



Data SIO, NOAA, U.S. Navy, NGA, GEBCO

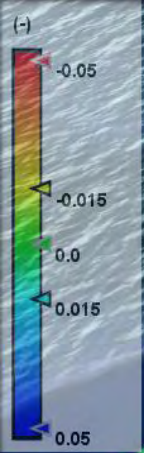
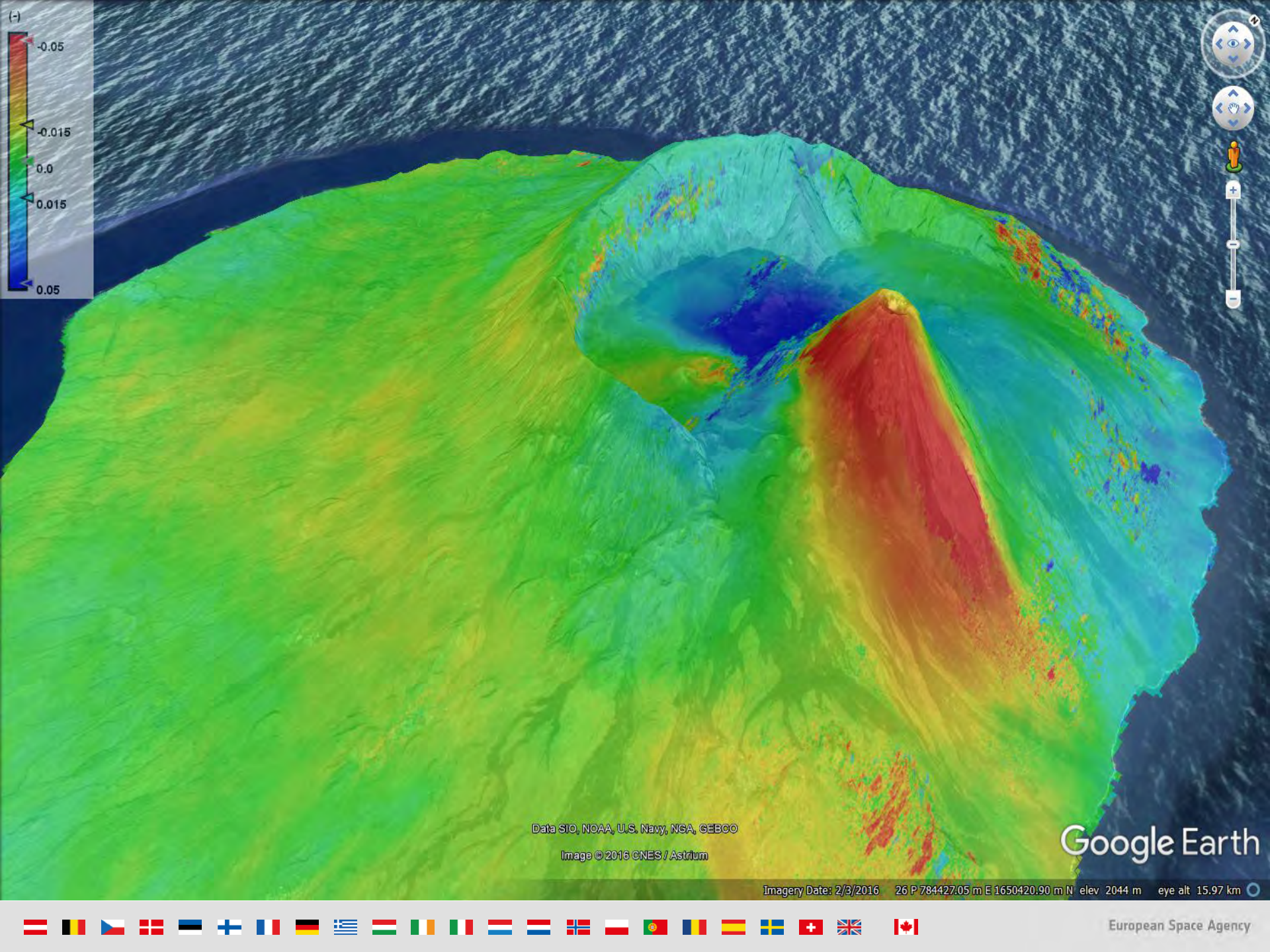
Image © 2016 CNES / Astrium

Google Earth

Imagery Date: 2/3/2016 26 P 784957.68 m E 1647944.00 m N elev 1218 m eye alt 26.86 km



European Space Agency



Data SIO, NOAA, U.S. Navy, NGA, GEBCO

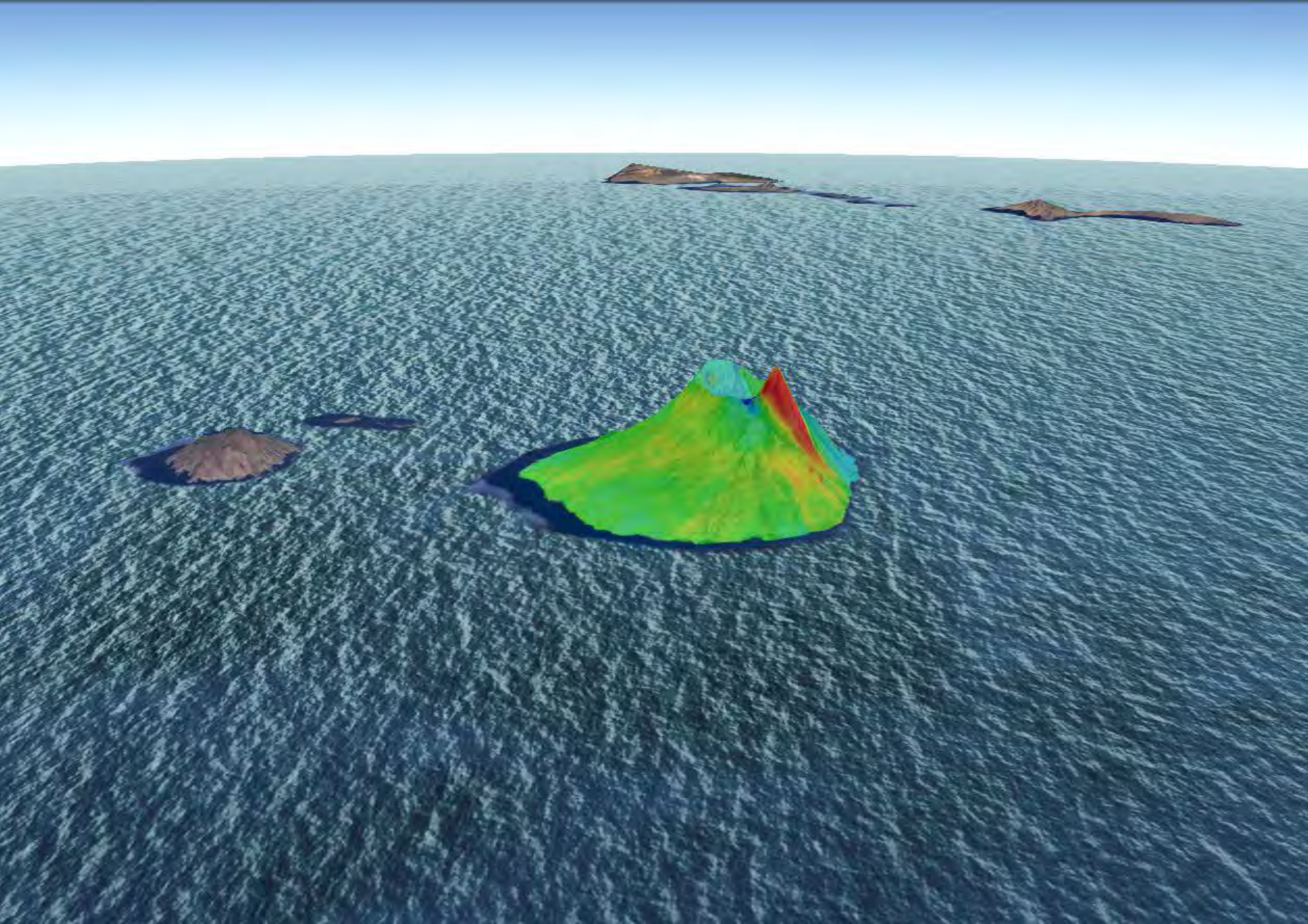
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Imagery Date: 2/3/2016 26 P 784427.05 m E 1650420.90 m N elev 2044 m eye alt 15.97 km



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