A tutorial to quantify BAM earthquake using SNAP

Dinh HO TONG MINH

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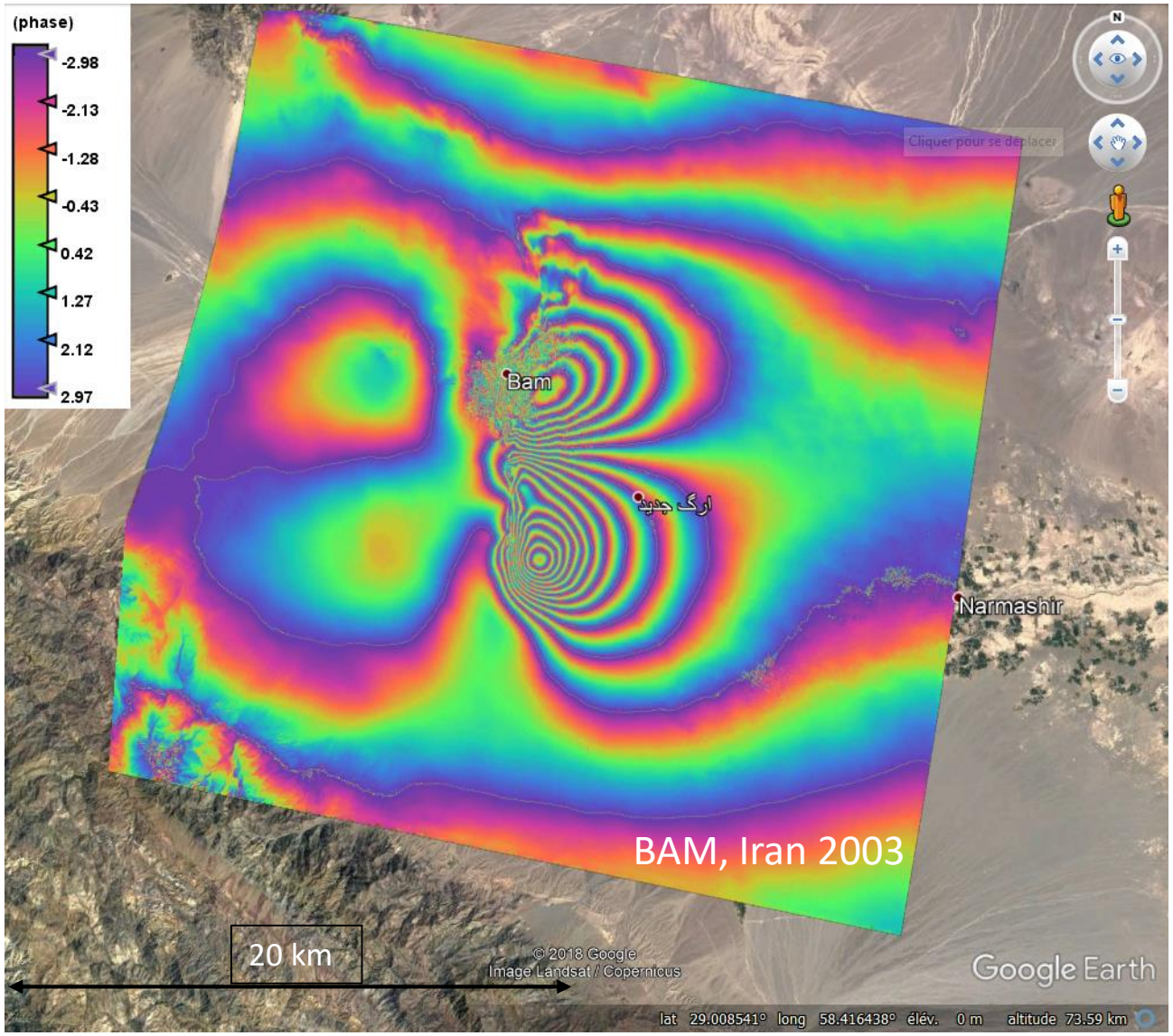
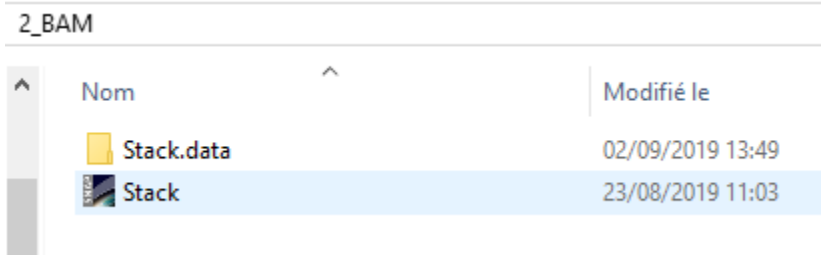
Video: https://youtu.be/Uc-5F9Vz04w

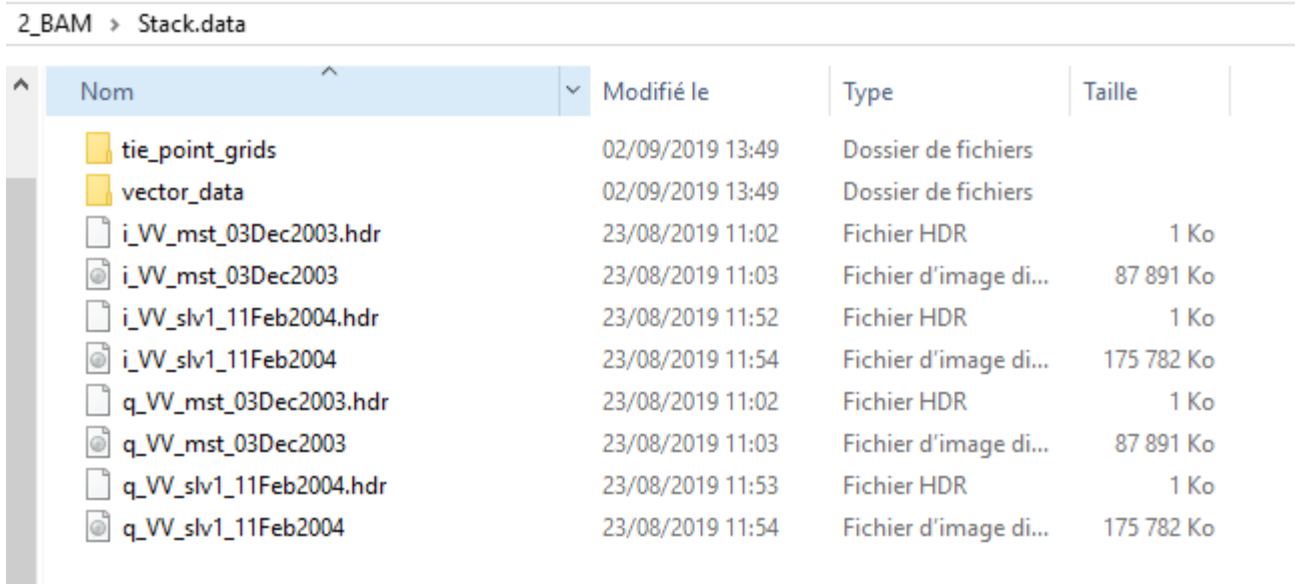
https://github.com/BAMInSAR

Goal: be able to form and understand this interferogram.

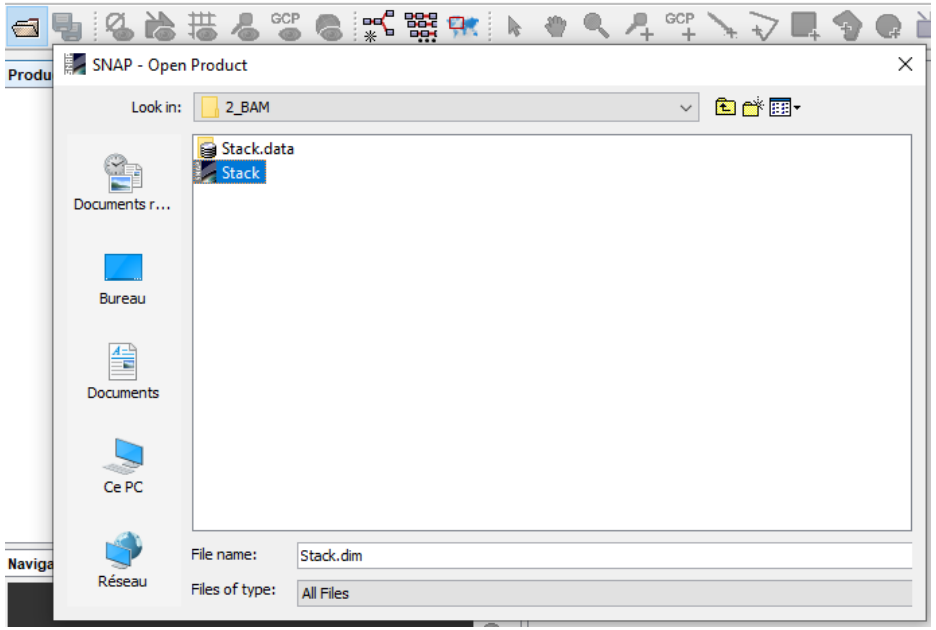


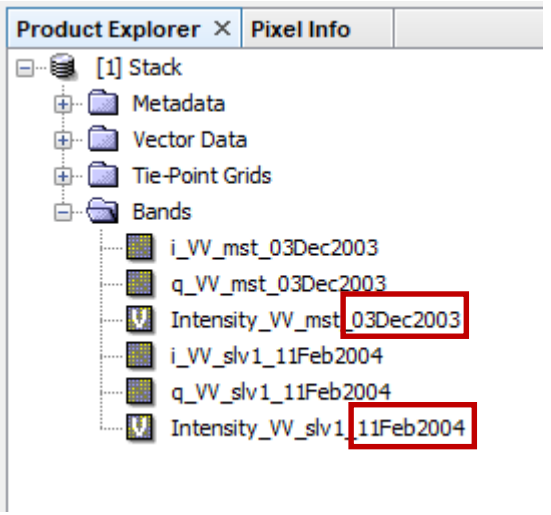
Preparation ENVISAT ASAR SLC dataset:

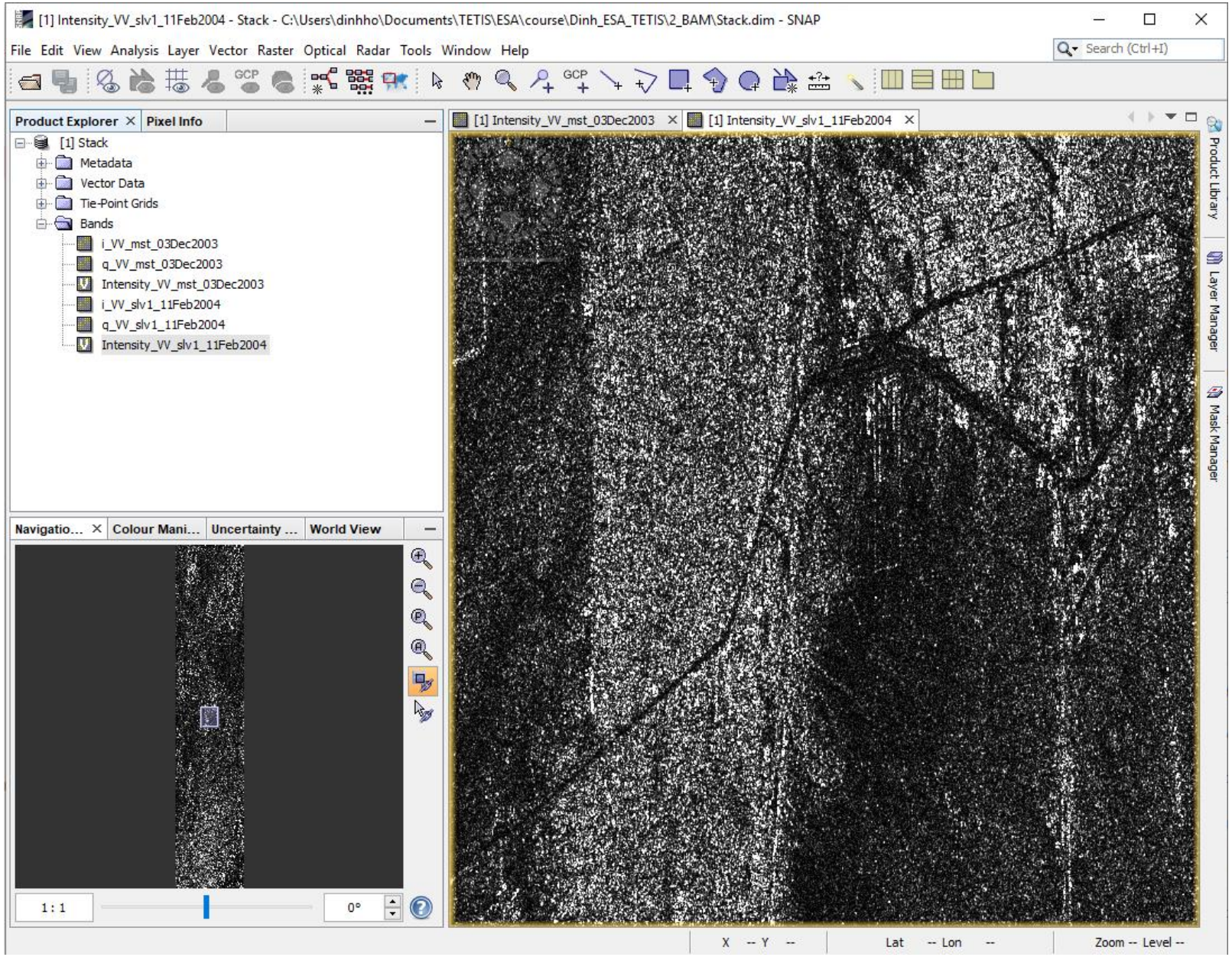




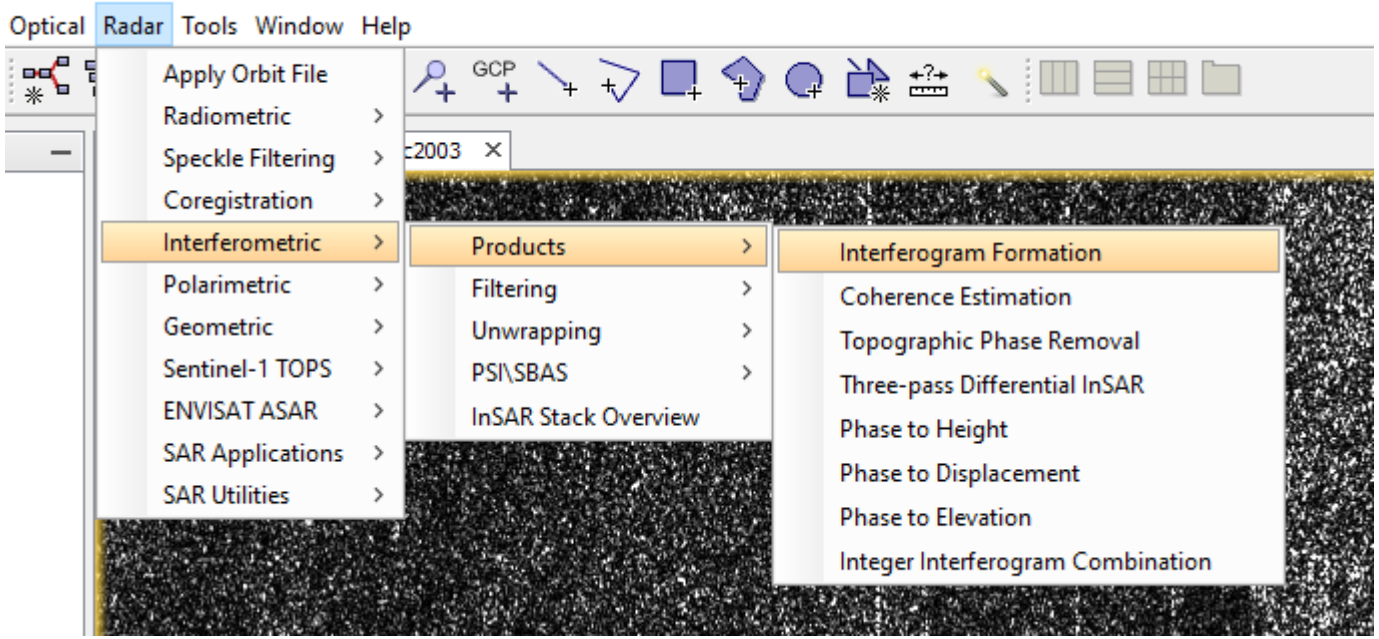
Preparation ENVISAT ASAR SLC dataset:



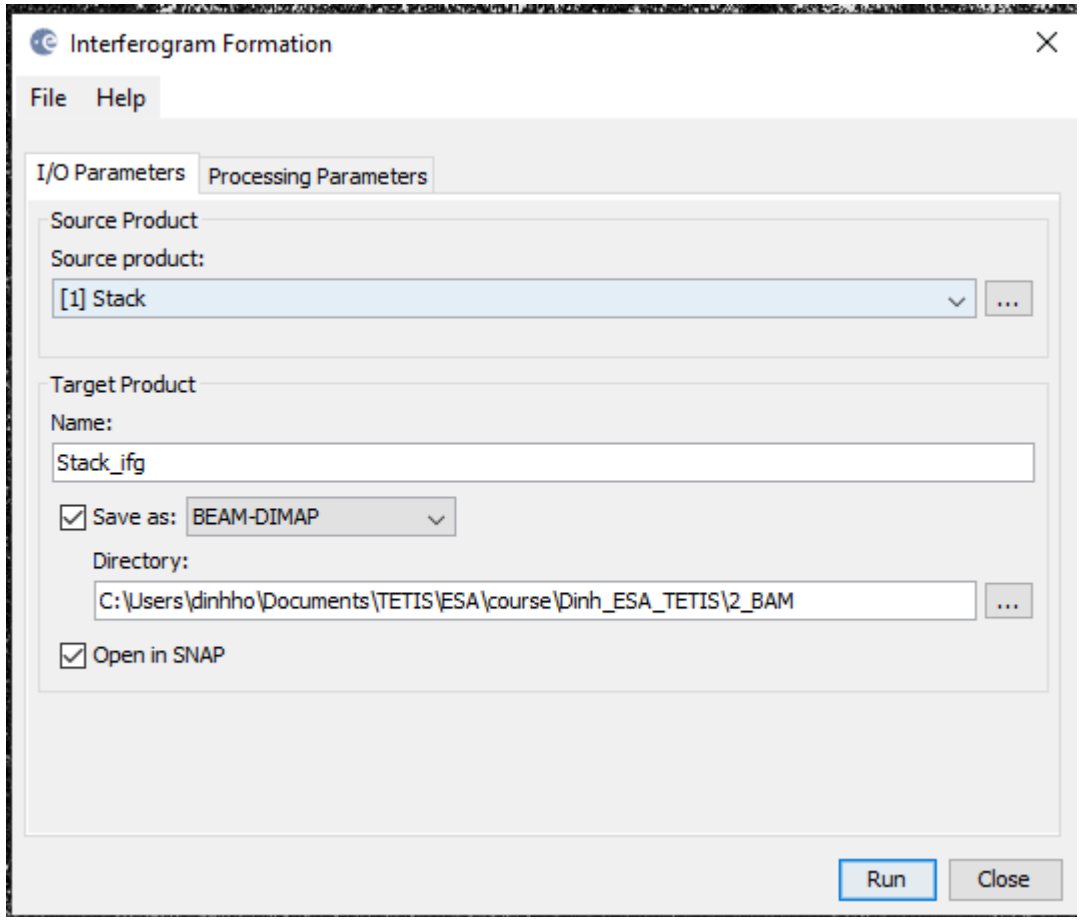


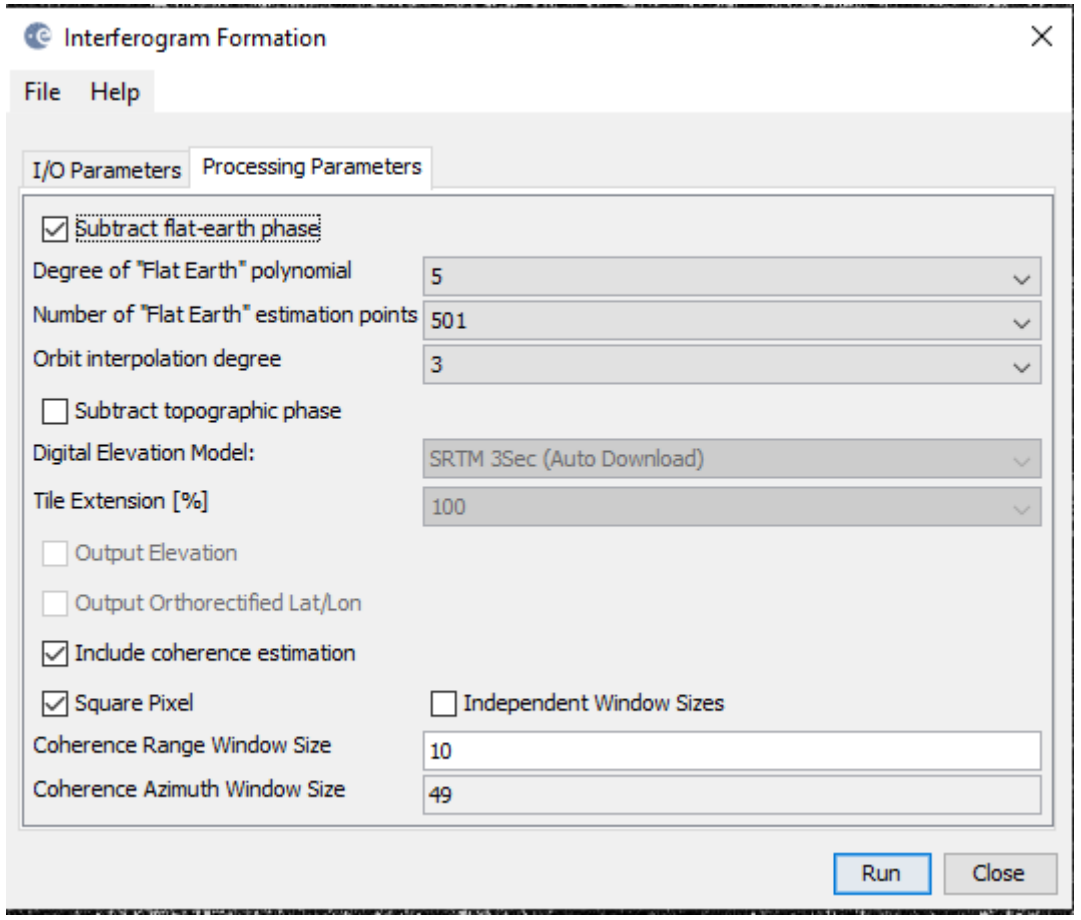

[1] Intensity_VV_slv1_11Feb2004 - Stack - C:\Users\dinhho\Documents\TETIS\ESA\course\Dinh_ESA_TETIS\2_BAM\Stack.dim - SNAP
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Product Explorer
Pixel Info
[1] Stack
Metadata
Vector Data
Tie-Point Grids
Bands
i_VV_mst_03Dec2003
q_VV_mst_03Dec2003
Intensity_VV_mst_03Dec2003
i_VV_slv1_11Feb2004
q_VV_slv1_11Feb2004
Intensity_VV_slv1_11Feb2004
Navigatio...
Colour Mani...
Uncertainty ...
World View
1 : 1
0°
[1] Intensity_VV_mst_03Dec2003
[1] Intensity_VV_slv1_11Feb2004
Product Library
Layer Manager
Mask Manager
X -- Y --
Lat -- Lon --
Zoom -- Level --

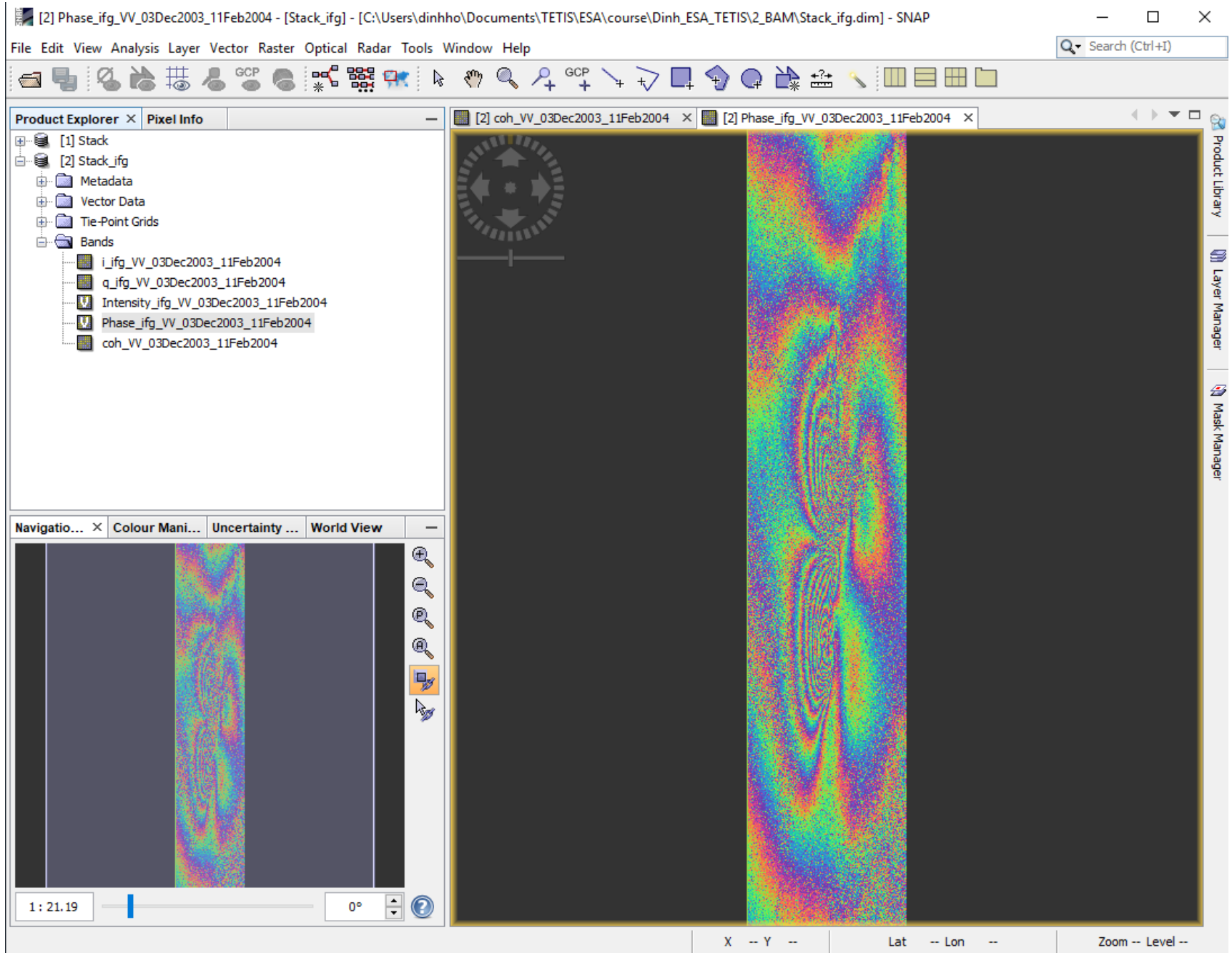
Interferogram formation:



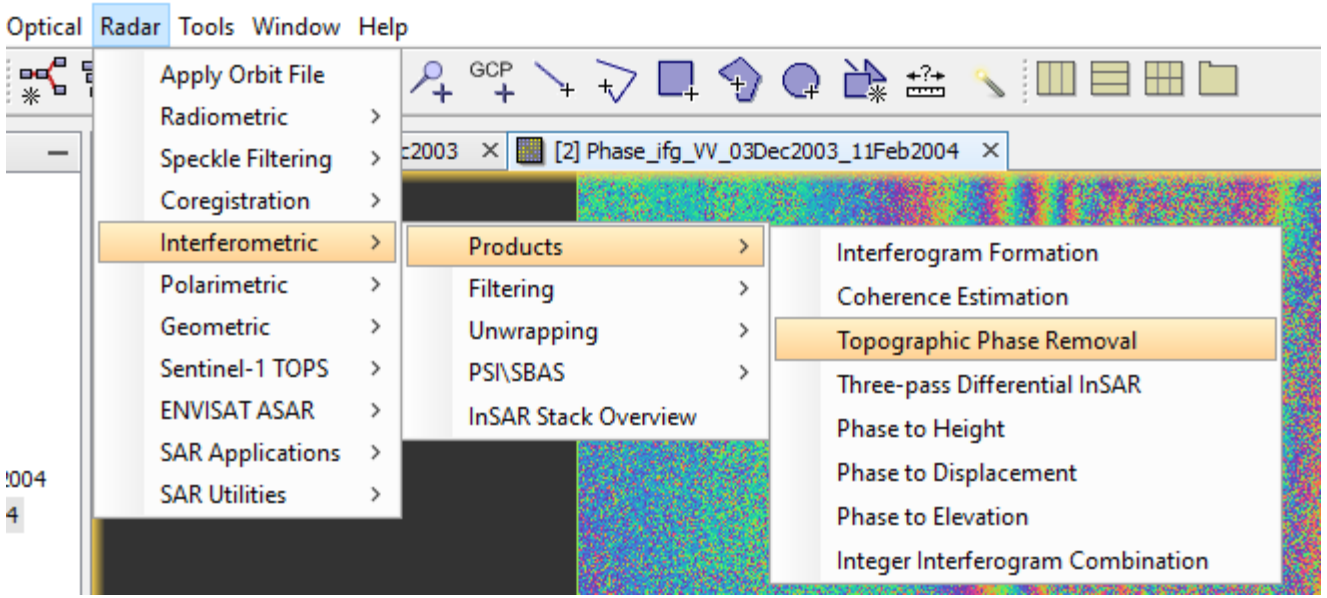
Interferogram formation:



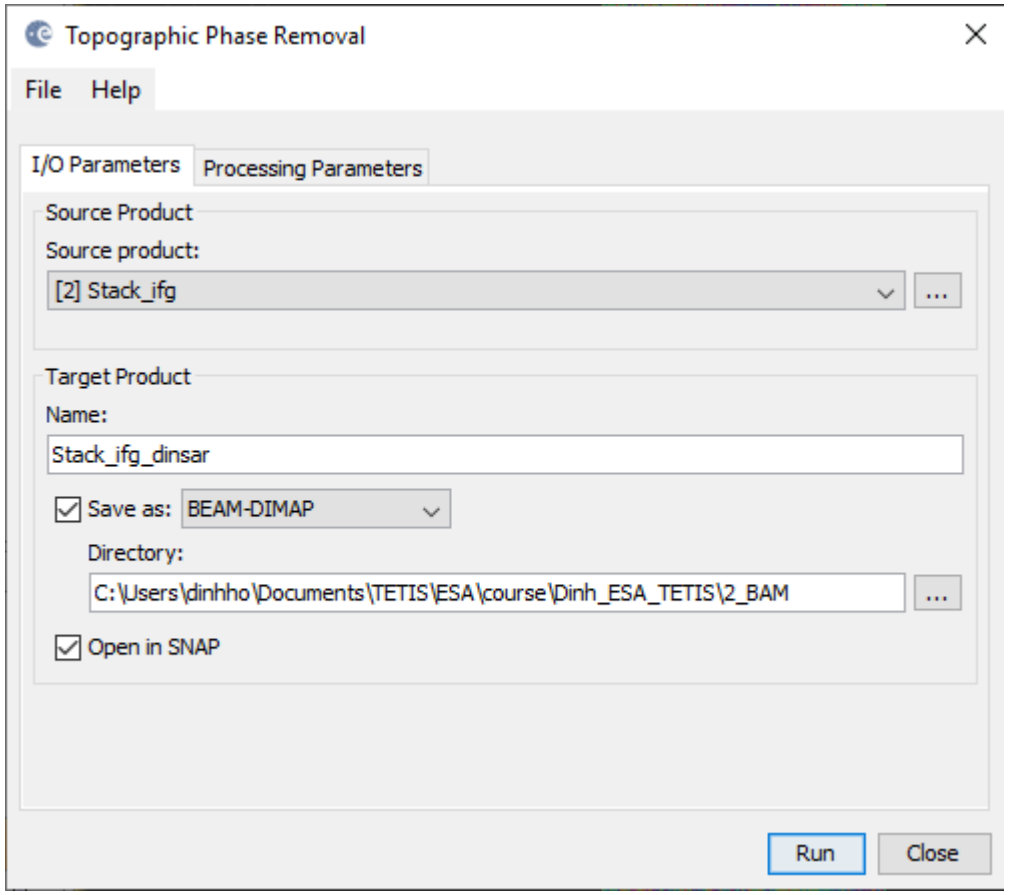


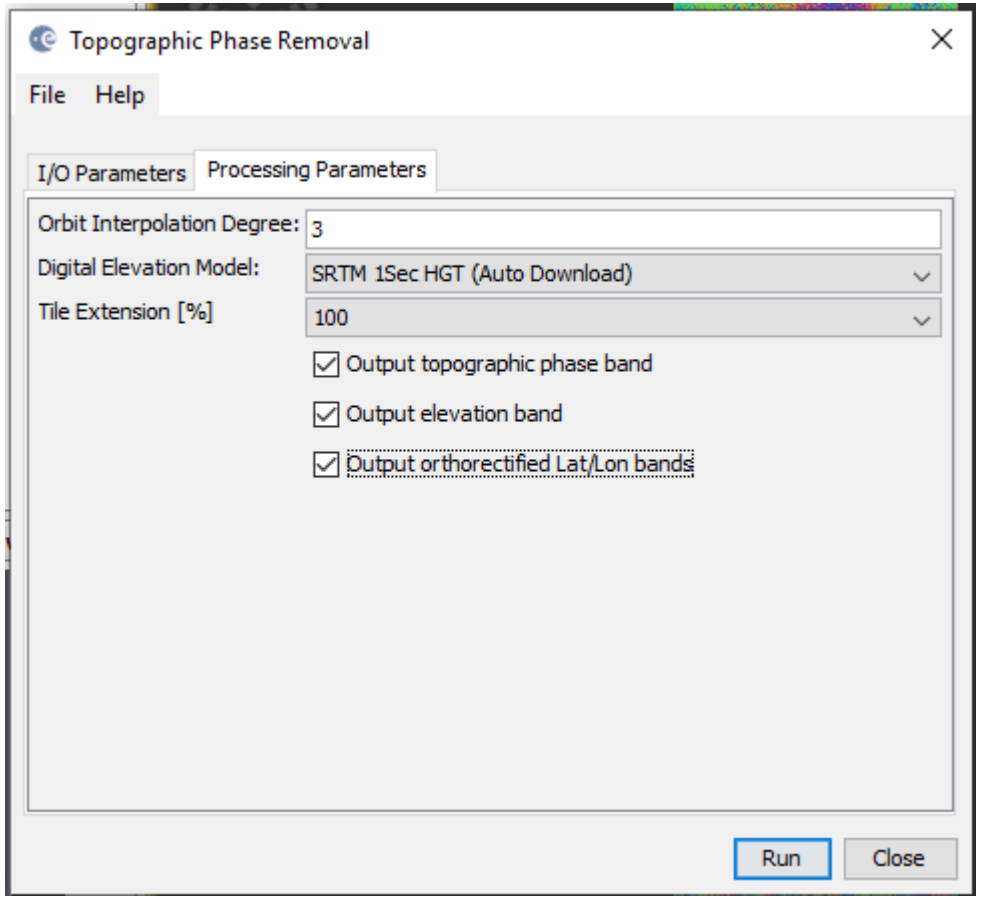

[2] Phase_ifg_VV_03Dec2003_11Feb2004 - [Stack_ifg] - [C:\Users\dinhho\Documents\TETIS\ESA\course\Dinh_ESA_TETIS\2_BAM\Stack_ifg.dim] - SNAP
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Product Explorer
Pixel Info
[1] Stack
[2] Stack_ifg
Metadata
Vector Data
Tie-Point Grids
Bands
i_ifg_VV_03Dec2003_11Feb2004
q_ifg_VV_03Dec2003_11Feb2004
Intensity_ifg_VV_03Dec2003_11Feb2004
Phase_ifg_VV_03Dec2003_11Feb2004
coh_VV_03Dec2003_11Feb2004
Navigatio...
Colour Mani...
Uncertainty ...
World View
1 : 21.19
0°
[2] coh_VV_03Dec2003_11Feb2004
[2] Phase_ifg_VV_03Dec2003_11Feb2004
Product Library
Layer Manager
Mask Manager
X -- Y --
Lat -- Lon --
Zoom -- Level --

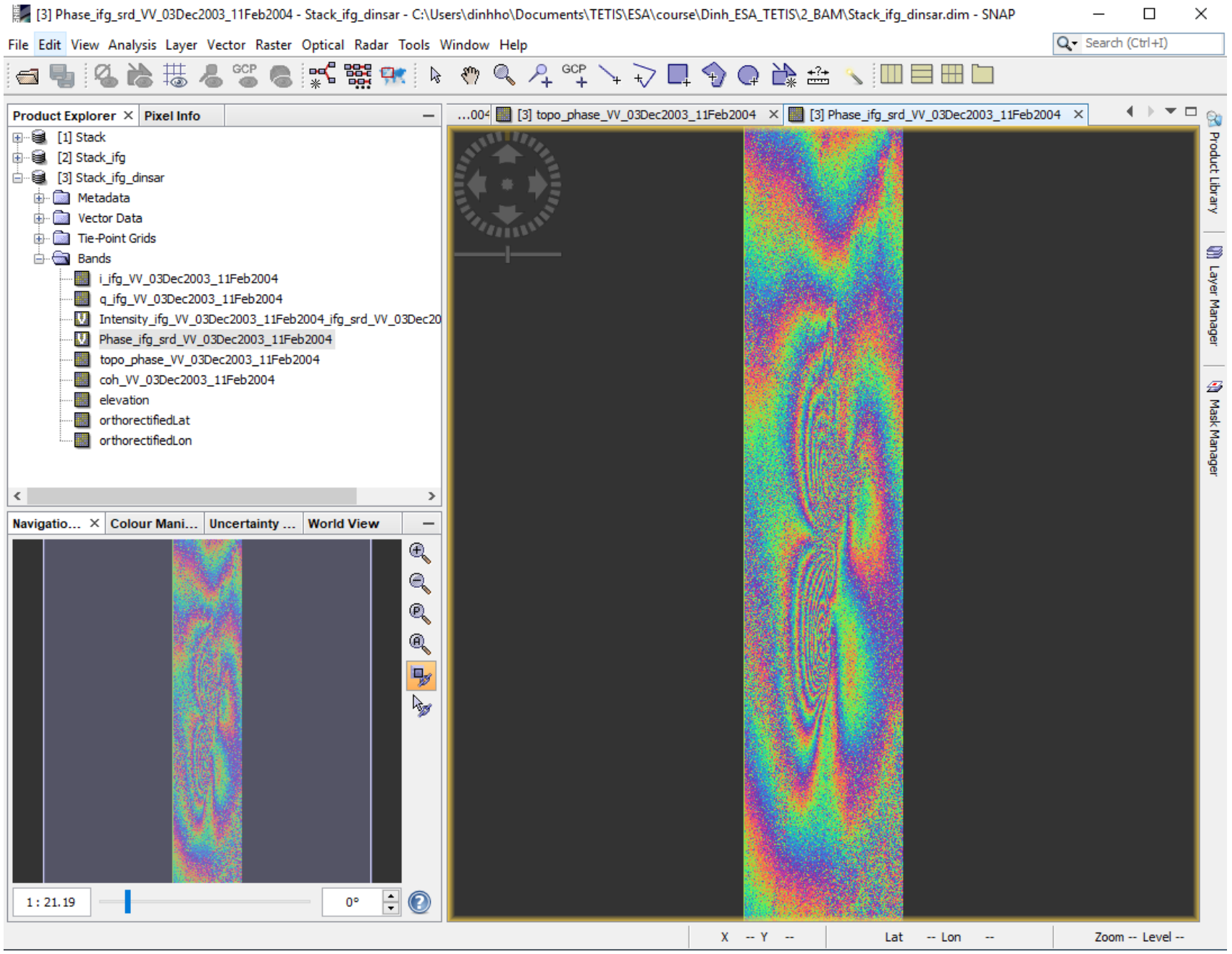
Topography removal:



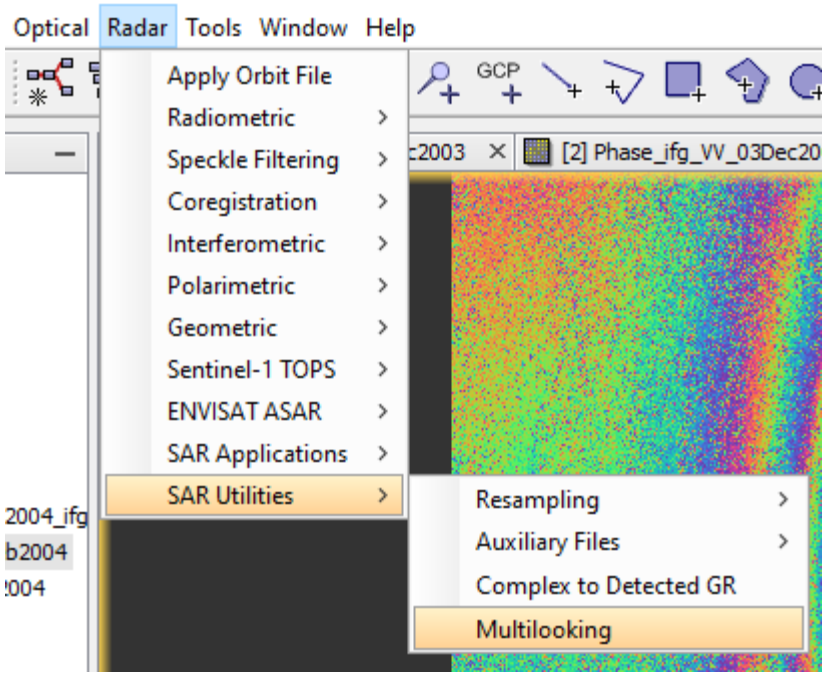
Topography removal:



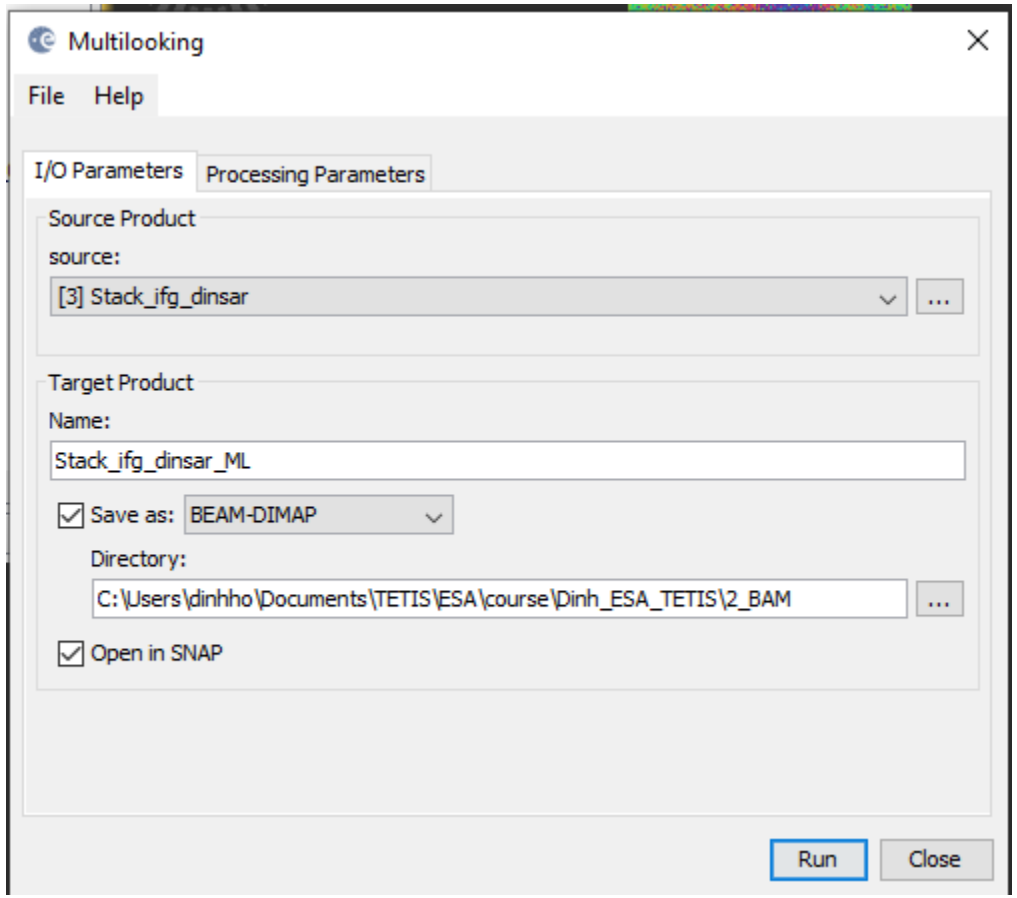


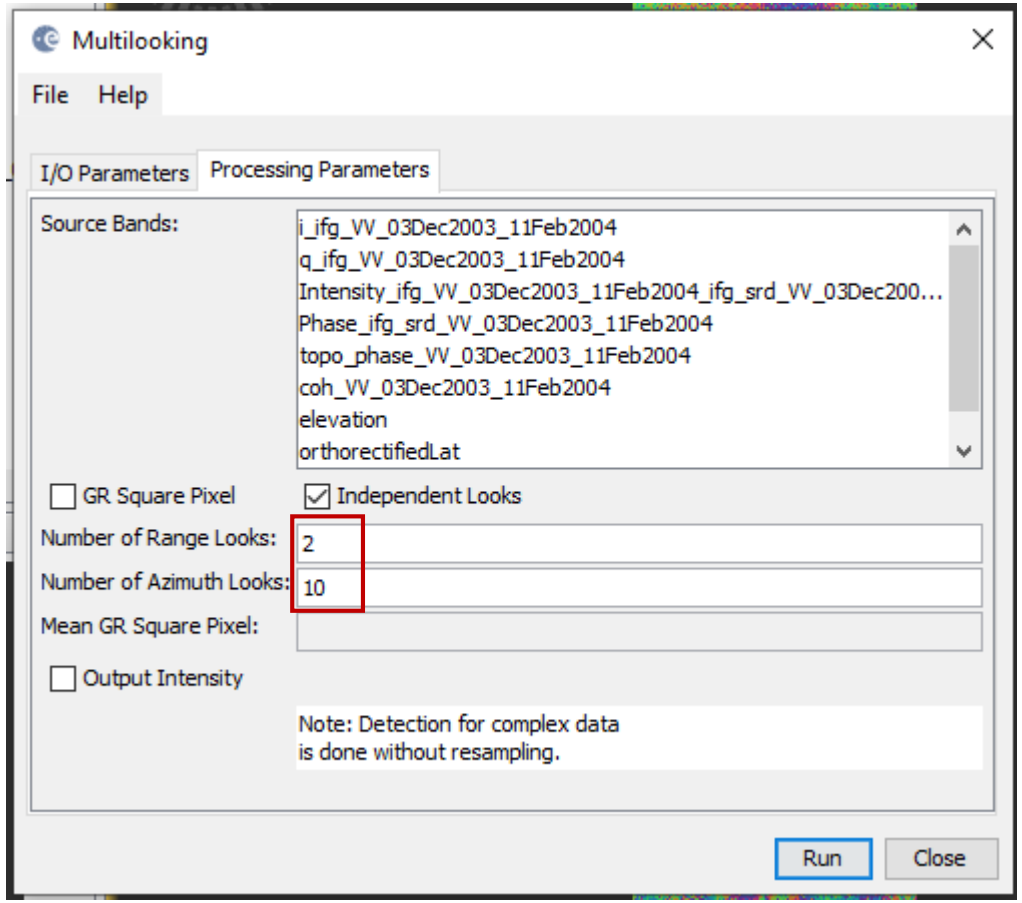

[3] Phase_ifg_srd_VV_03Dec2003_11Feb2004 - Stack_ifg_dinsar - C:\Users\dinhho\Documents\TETIS\ESA\course\Dinh_ESA_TETIS\2_BAM\Stack_ifg_dinsar.dim - SNAP
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Product Explorer
Pixel Info
[1] Stack
[2] Stack_ifg
[3] Stack_ifg_dinsar
Metadata
Vector Data
Tie-Point Grids
Bands
i_ifg_VV_03Dec2003_11Feb2004
q_ifg_VV_03Dec2003_11Feb2004
Intensity_ifg_VV_03Dec2003_11Feb2004_ifg_srd_VV_03Dec20
Phase_ifg_srd_VV_03Dec2003_11Feb2004
topo_phase_VV_03Dec2003_11Feb2004
coh_VV_03Dec2003_11Feb2004
elevation
orthorectifiedLat
orthorectifiedLon
Navigatio...
Colour Mani...
Uncertainty ...
World View
1 : 21.19
0°
[3] topo_phase_VV_03Dec2003_11Feb2004
[3] Phase_ifg_srd_VV_03Dec2003_11Feb2004
Product Library
Layer Manager
Mask Manager
X -- Y --
Lat -- Lon --
Zoom -- Level --

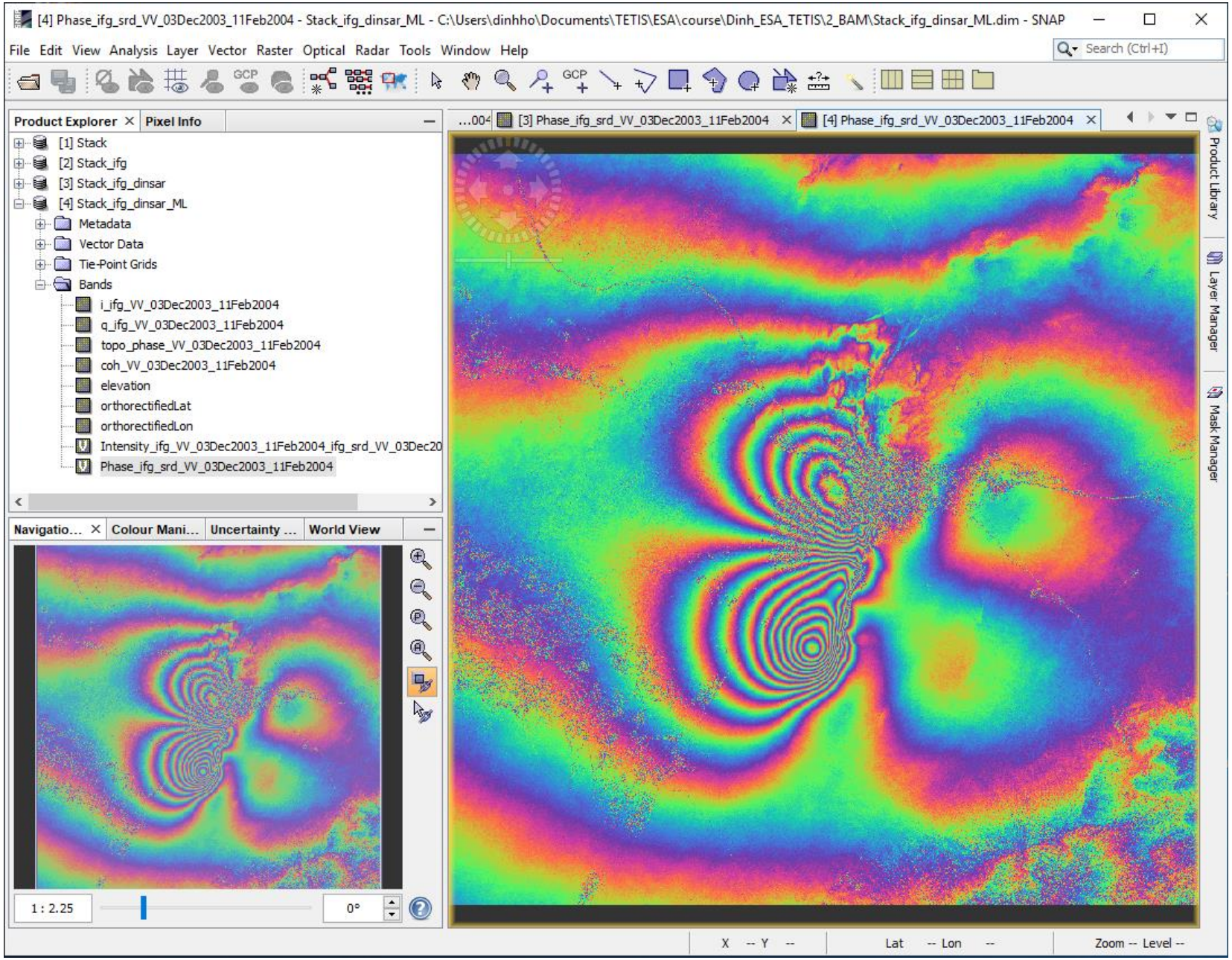
Reduce noise by multilooking:



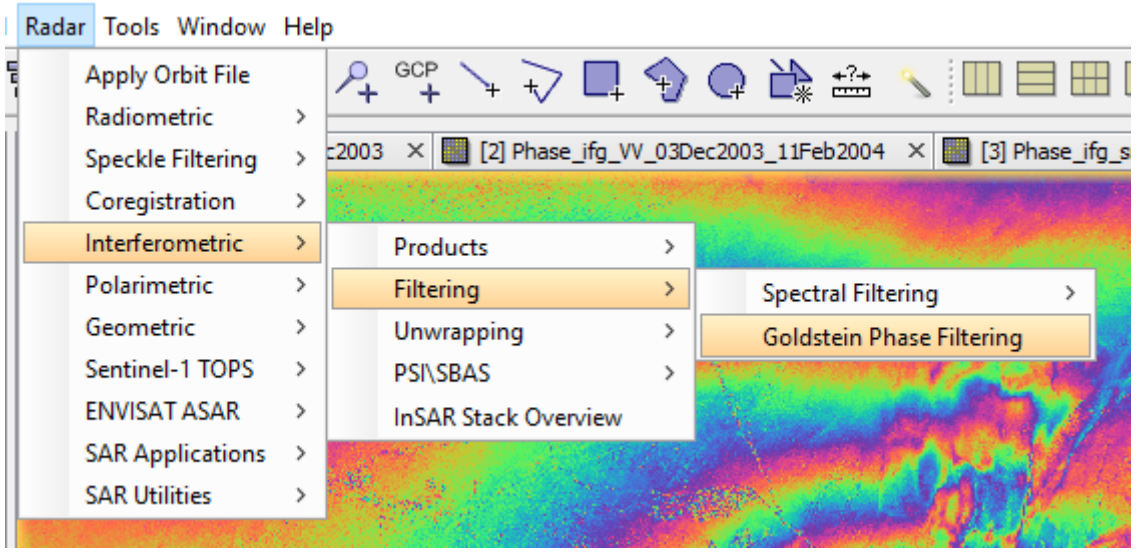
Reduce noise by multilooking:



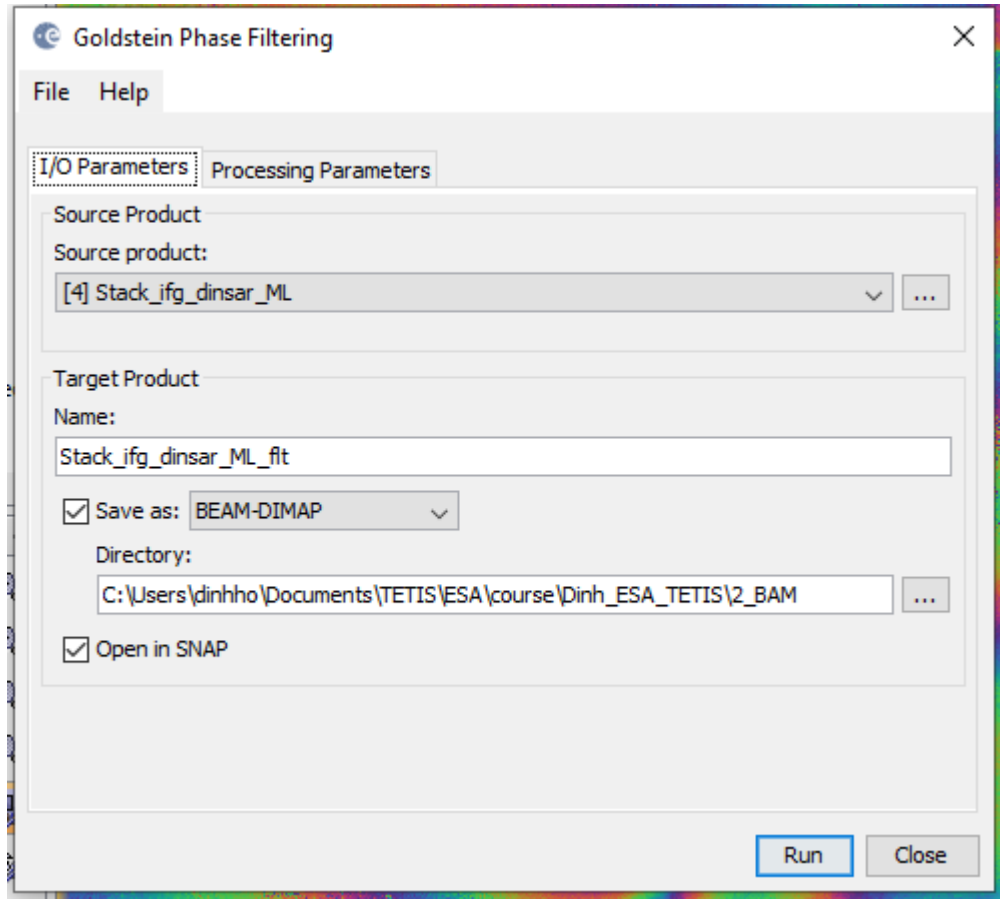


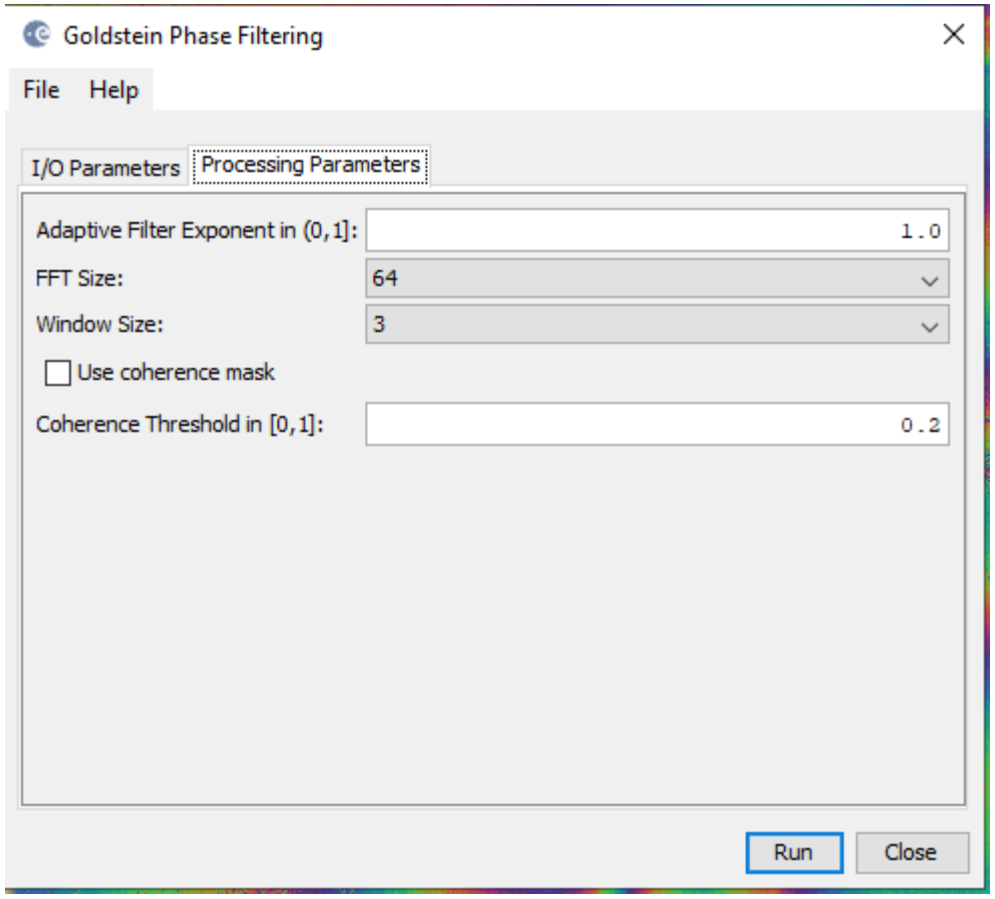

[4] Phase_ifg_srd_VV_03Dec2003_11Feb2004 - Stack_ifg_dinsar_ML - C:\Users\dinhho\Documents\TETIS\ESA\course\Dinh_ESA_TETIS\2_BAM\Stack_ifg_dinsar_ML.dim - SNAP
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Product Explorer
Pixel Info
[1] Stack
[2] Stack_ifg
[3] Stack_ifg_dinsar
[4] Stack_ifg_dinsar_ML
Metadata
Vector Data
Tie-Point Grids
Bands
i_ifg_VV_03Dec2003_11Feb2004
q_ifg_VV_03Dec2003_11Feb2004
topo_phase_VV_03Dec2003_11Feb2004
coh_VV_03Dec2003_11Feb2004
elevation
orthorectifiedLat
orthorectifiedLon
Intensity_ifg_VV_03Dec2003_11Feb2004_ifg_srd_VV_03Dec20
Phase_ifg_srd_VV_03Dec2003_11Feb2004
Navigatio...
Colour Mani...
Uncertainty ...
World View
1 : 2.25
0°
[3] Phase_ifg_srd_VV_03Dec2003_11Feb2004
[4] Phase_ifg_srd_VV_03Dec2003_11Feb2004
Product Library
Layer Manager
Mask Manager
X -- Y --
Lat -- Lon --
Zoom -- Level --

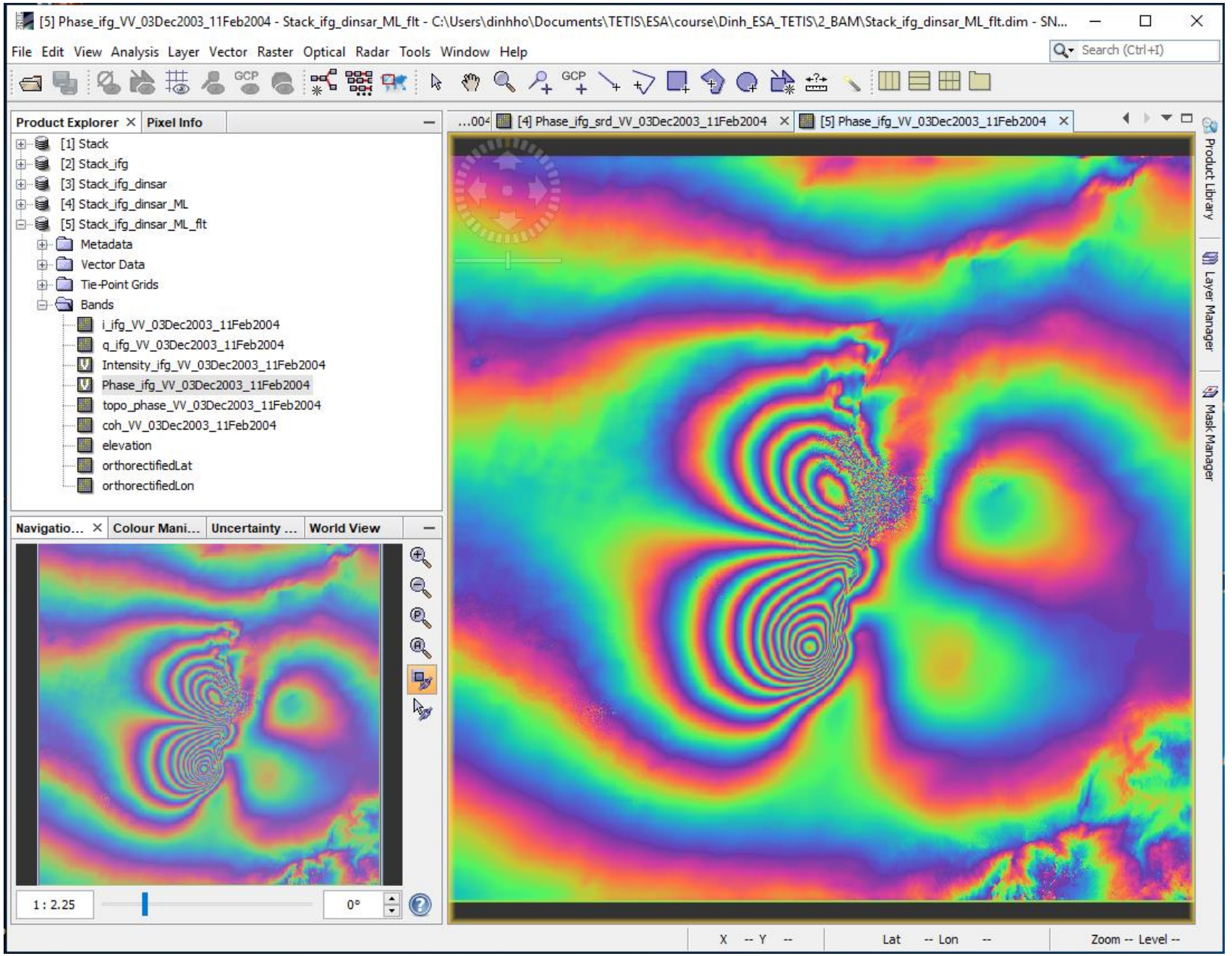
More reduce noise by filtering:



More reduce noise by filtering:






[5] Phase_ifg_VV_03Dec2003_11Feb2004 - Stack_ifg_dinsar_ML_flt - C:\Users\dinhho\Documents\TETIS\ESA\course\Dinh_ESA_TETIS\2_BAM\Stack_ifg_dinsar_ML_flt.dim - SN...
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
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Pixel Info
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[3] Stack_ifg_dinsar
[4] Stack_ifg_dinsar_ML
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Vector Data
Tie-Point Grids
Bands
i_ifg_VV_03Dec2003_11Feb2004
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Intensity_ifg_VV_03Dec2003_11Feb2004
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topo_phase_VV_03Dec2003_11Feb2004
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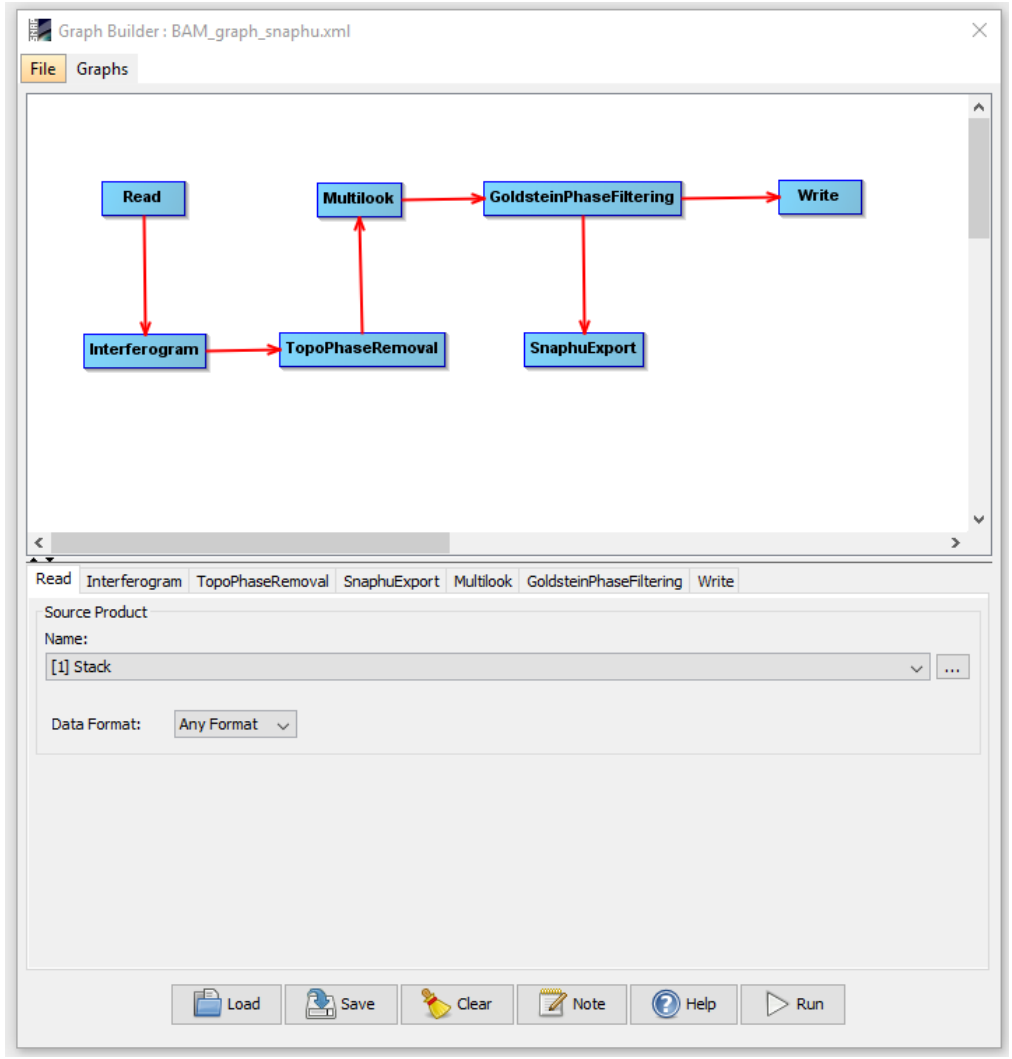
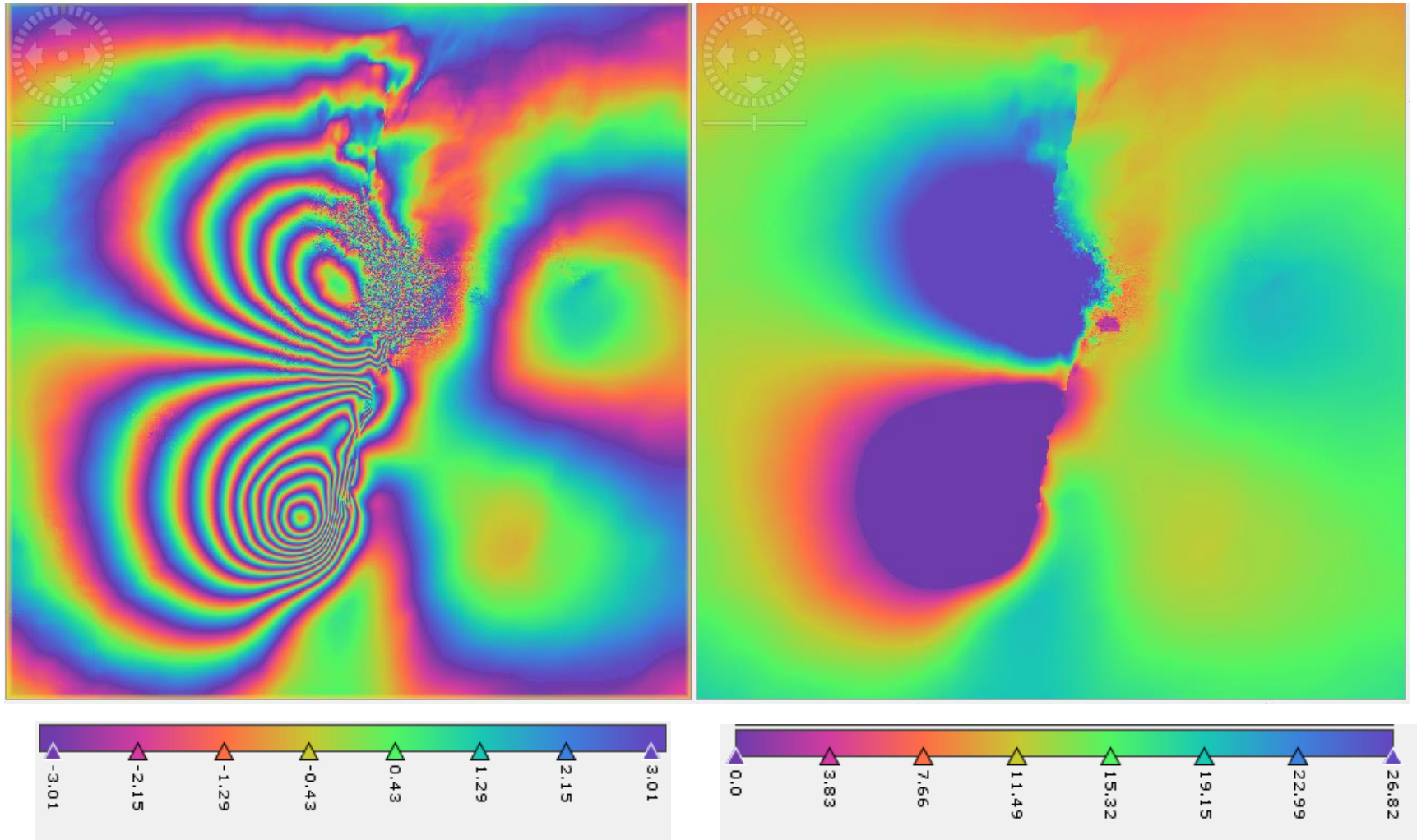
Navigatio...
Colour Mani...
Uncertainty ...
World View
1 : 2.25
0°
[4] Phase_ifg_srd_VV_03Dec2003_11Feb2004
[5] Phase_ifg_VV_03Dec2003_11Feb2004
Product Library
Layer Manager
Mask Manager
X -- Y --
Lat -- Lon --
Zoom -- Level --

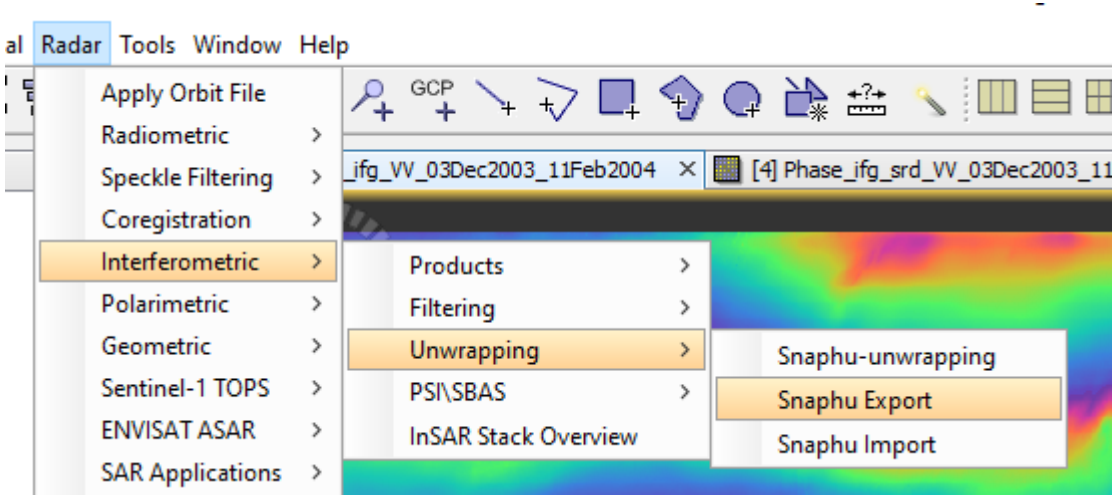
Trick: you can do all the above steps in one time by using this graph.



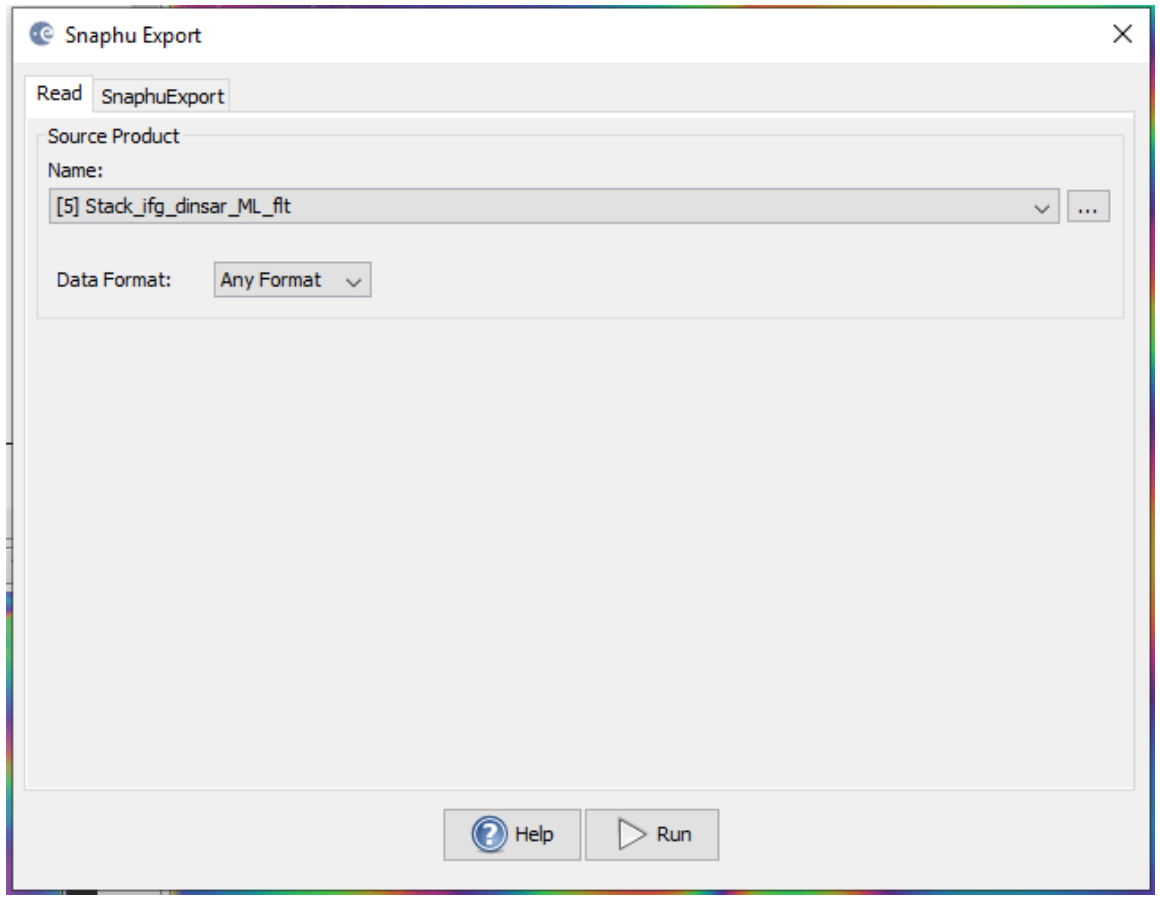
Phase unwrapping:

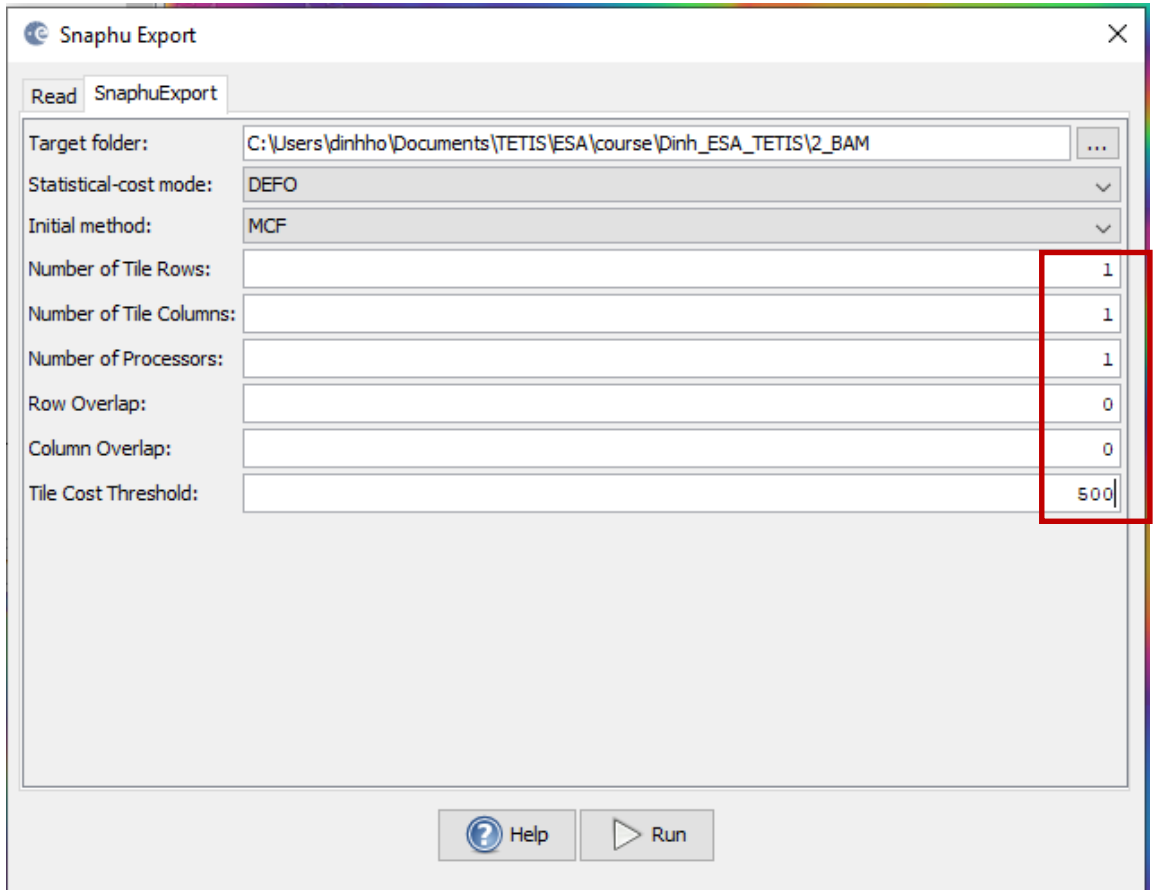


Phase unwrapping:

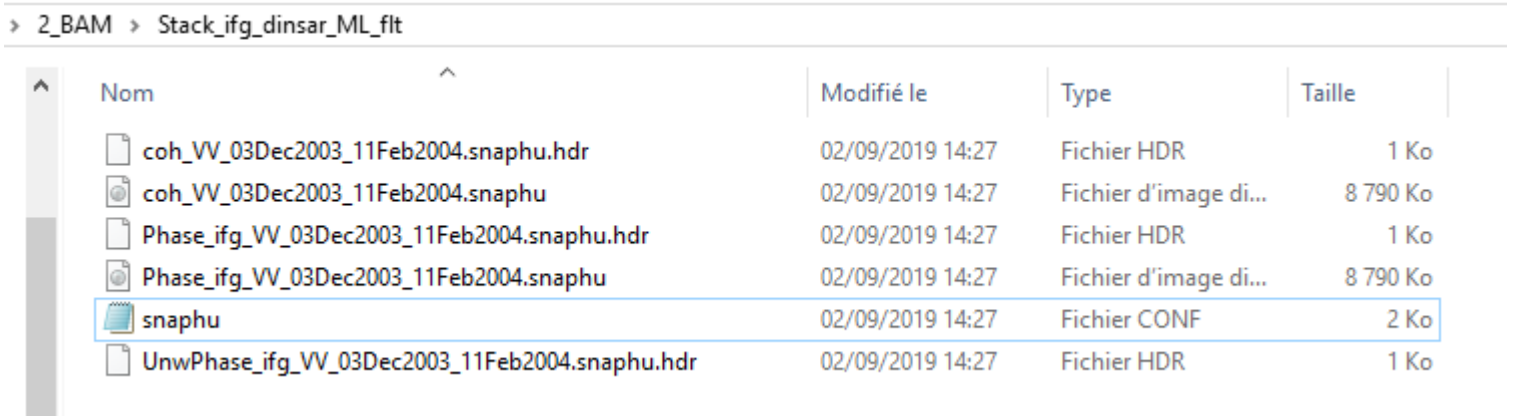


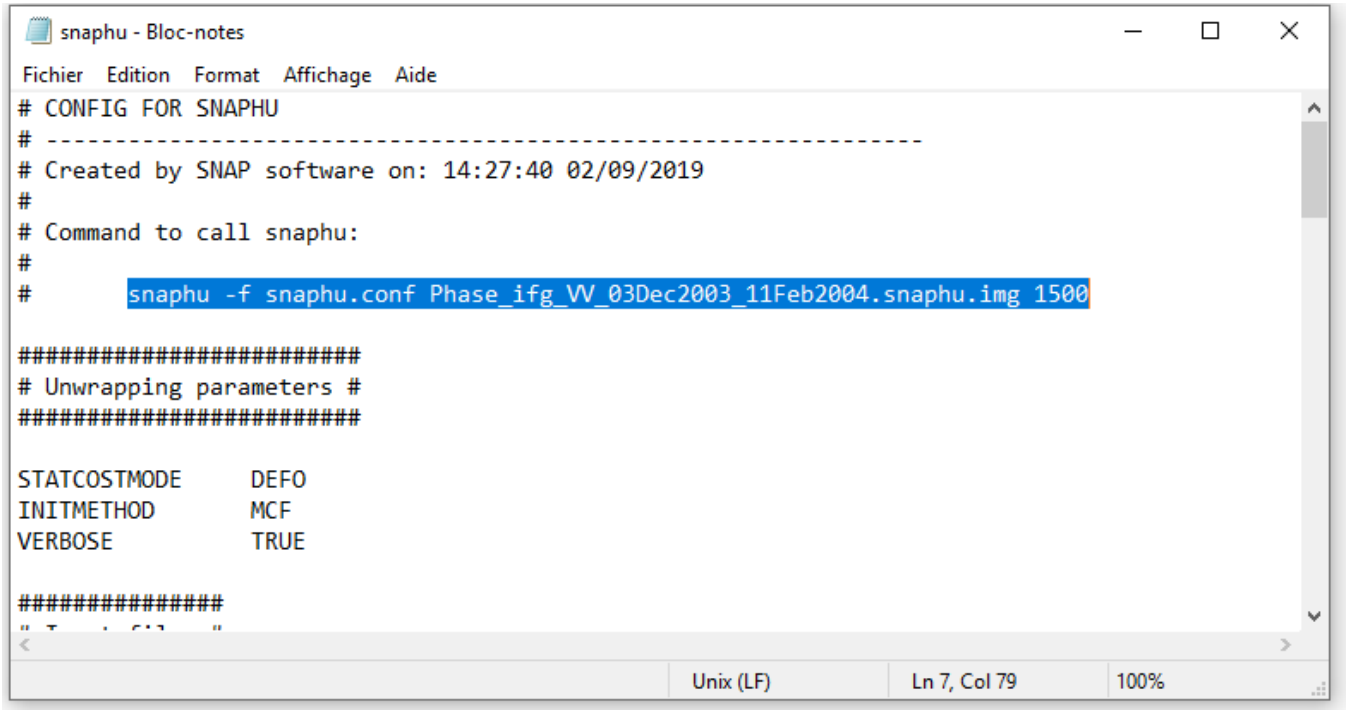
Phase unwrapping:





Phase unwrapping:





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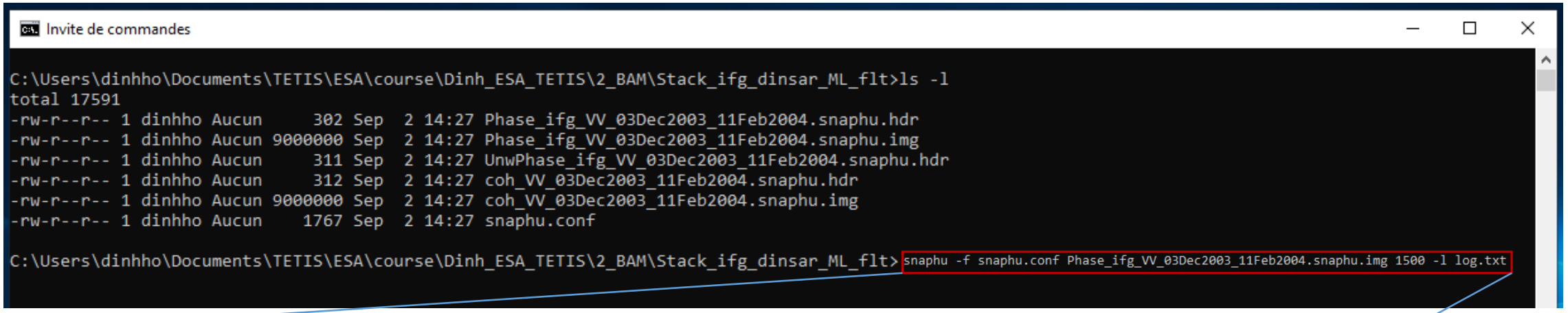


```
snaphu -f snaphu.conf Phase_ifg_VV_03Dec2003_11Feb2004.snaphu.img 1500 -l log.txt
```

```
snaphu v1.4.2
27 parameters input from file snaphu.conf (84 lines total)
Logging run-time parameters to file log.txt
Reading wrapped phase from file Phase_ifg_VV_03Dec2003_11Feb2004.snaphu.img
No weight file specified.  Assuming uniform weights
Reading correlation data from file coh_VV_03Dec2003_11Feb2004.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: 2
Number of nodes in network: 2247002
Flow increment: 1  (Total improvements: 0)
Treesize: 2247002    Pivots: 31029       Improvements: 843
Maximum flow on network: 2
Flow increment: 2  (Total improvements: 843)
Treesize: 2247002    Pivots: 0           Improvements: 0
Maximum flow on network: 2
Total solution cost: 1130143
Integrating phase
Writing output to file UnwPhase_ifg_VV_03Dec2003_11Feb2004.snaphu.img
Program snaphu done
Elapsed processor time:   0:01:29.98
Elapsed wall clock time:  0:01:32
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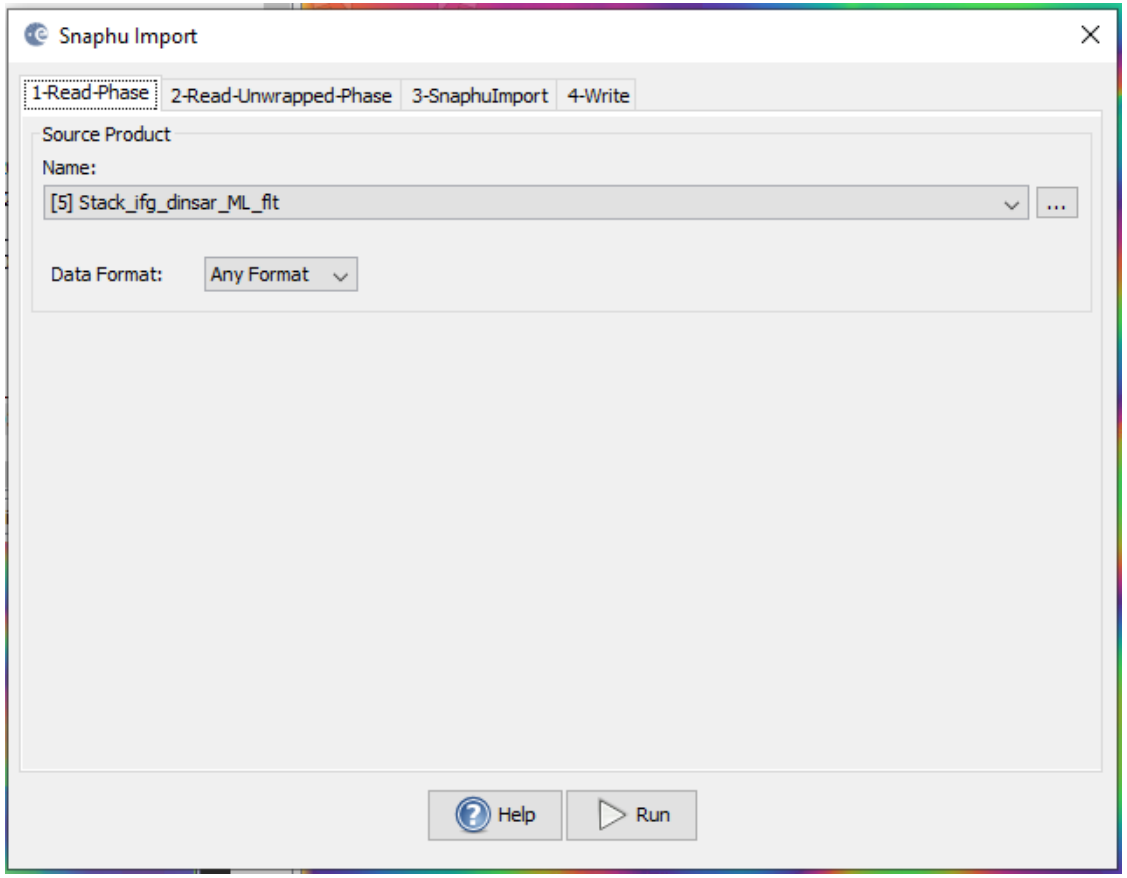
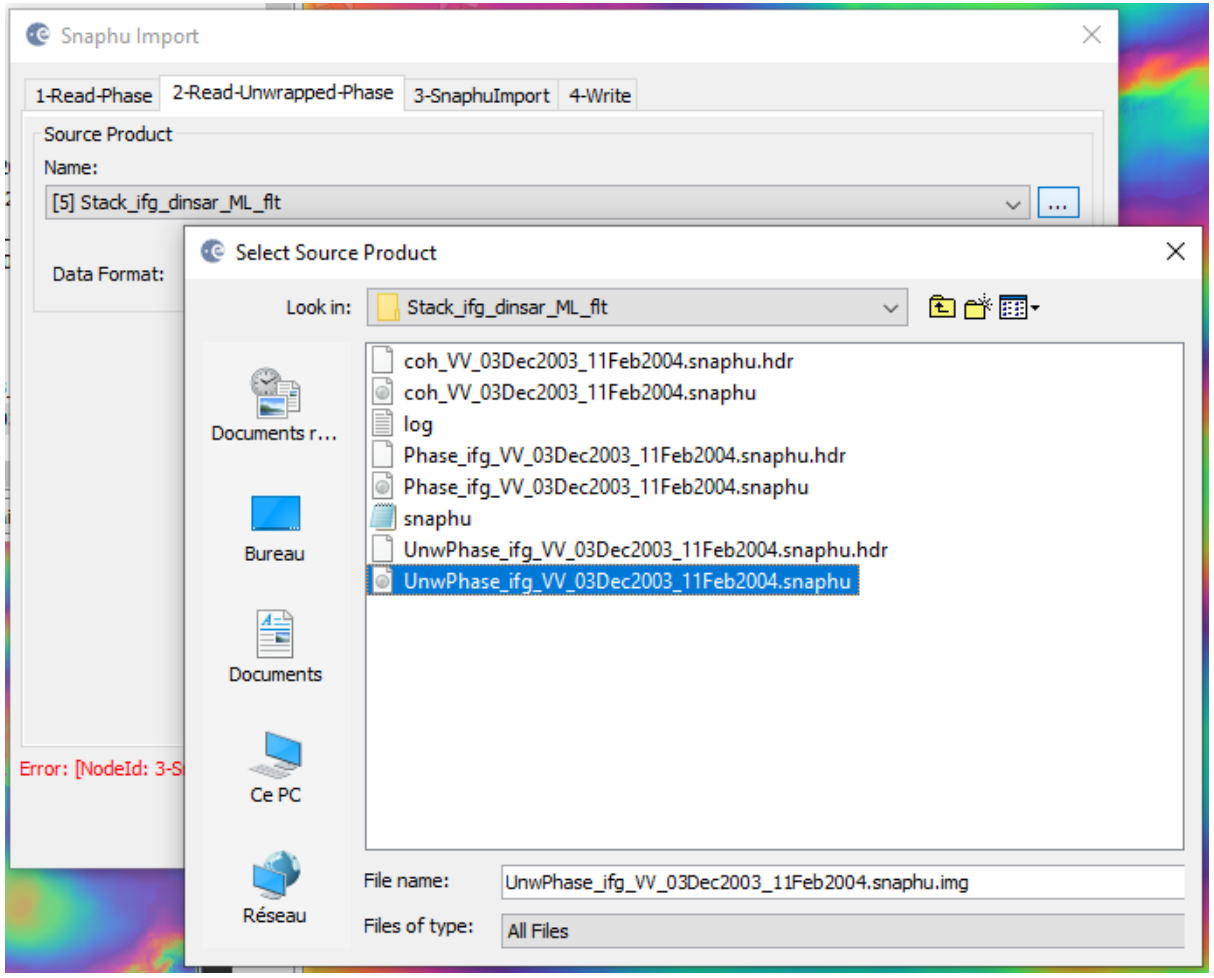
Import Phase unwrapping:





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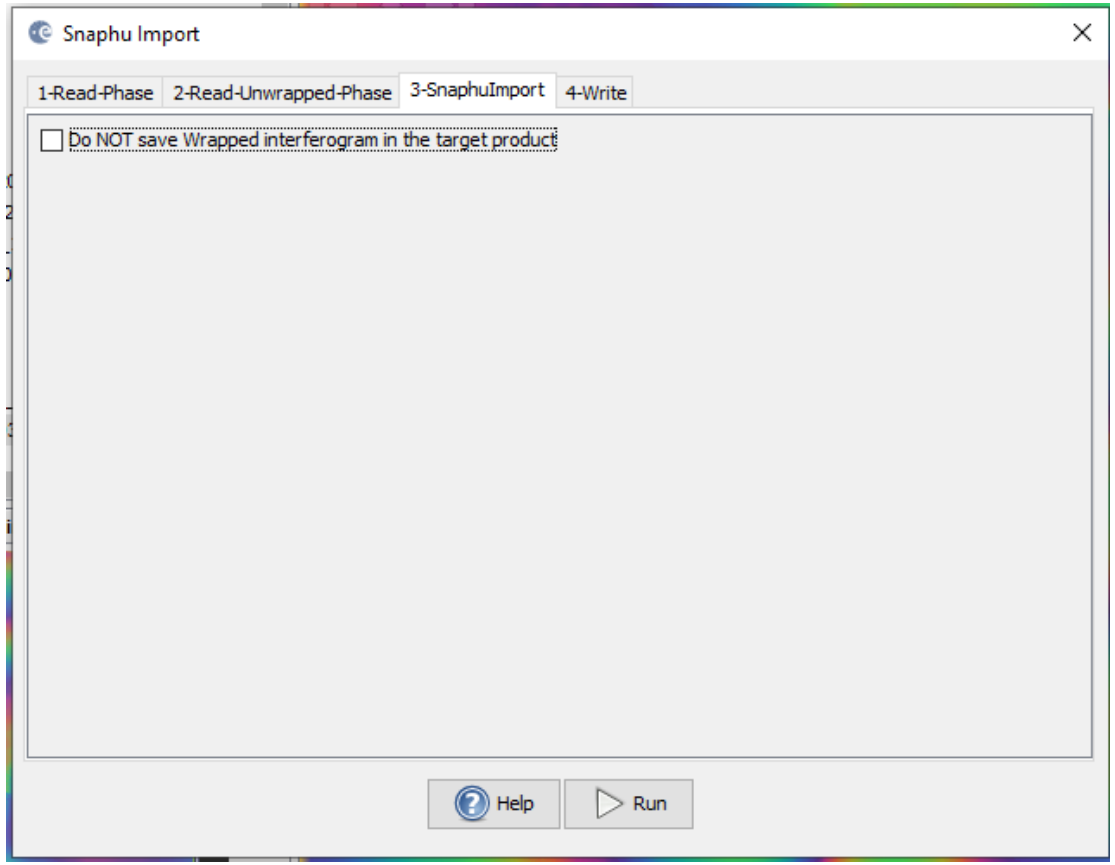

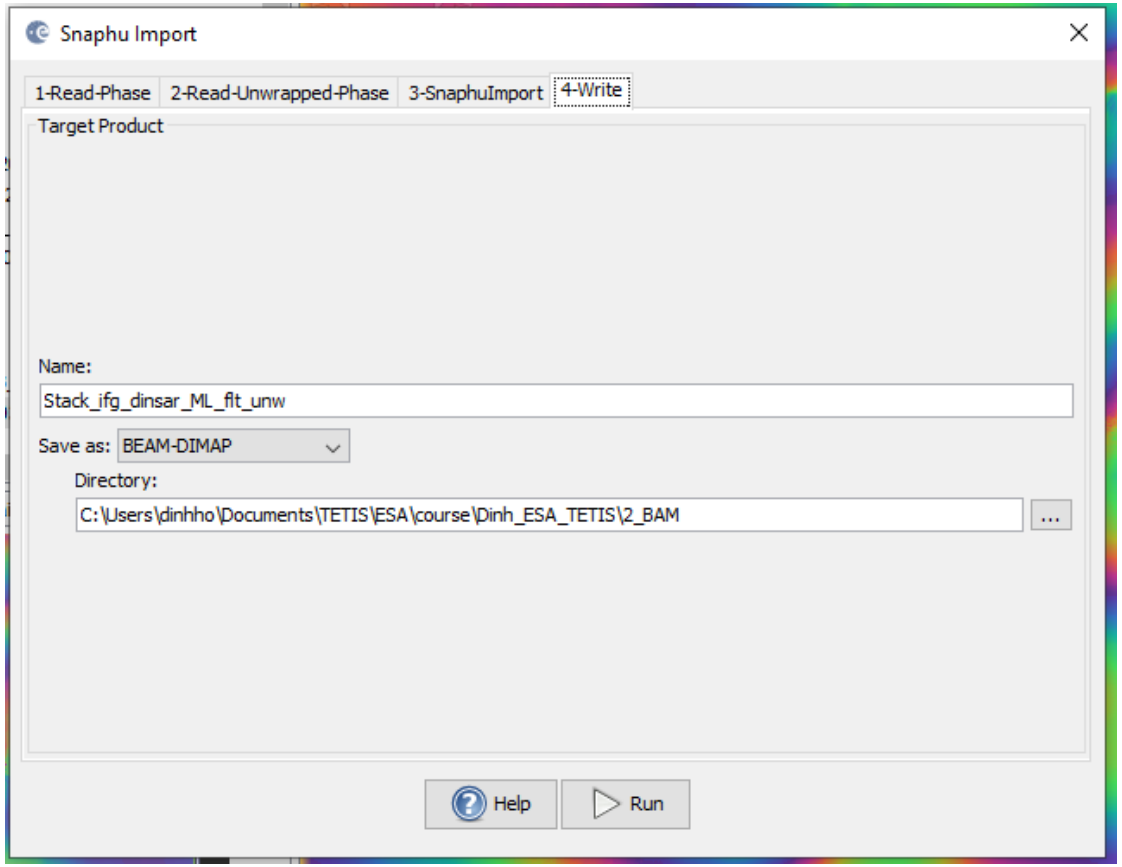

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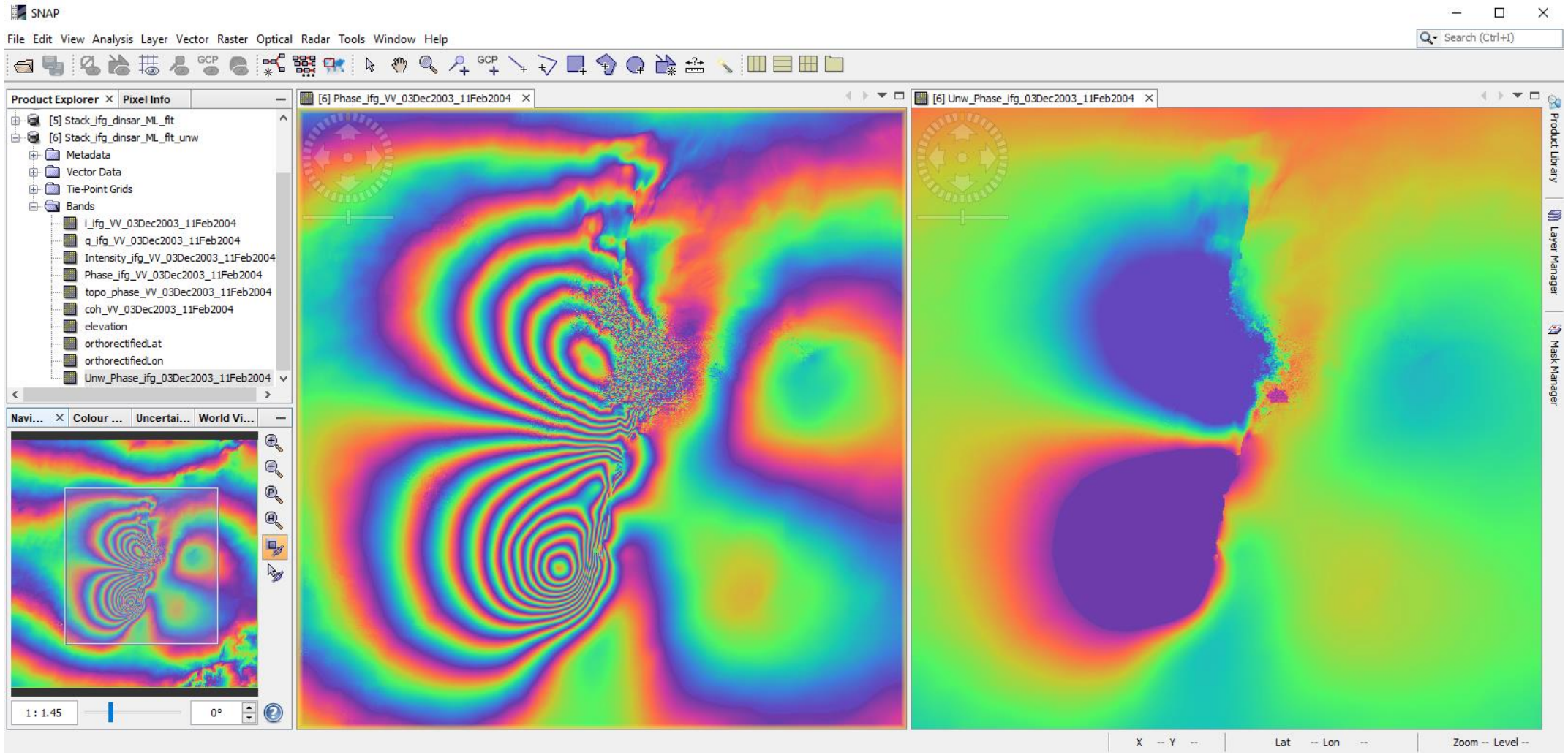

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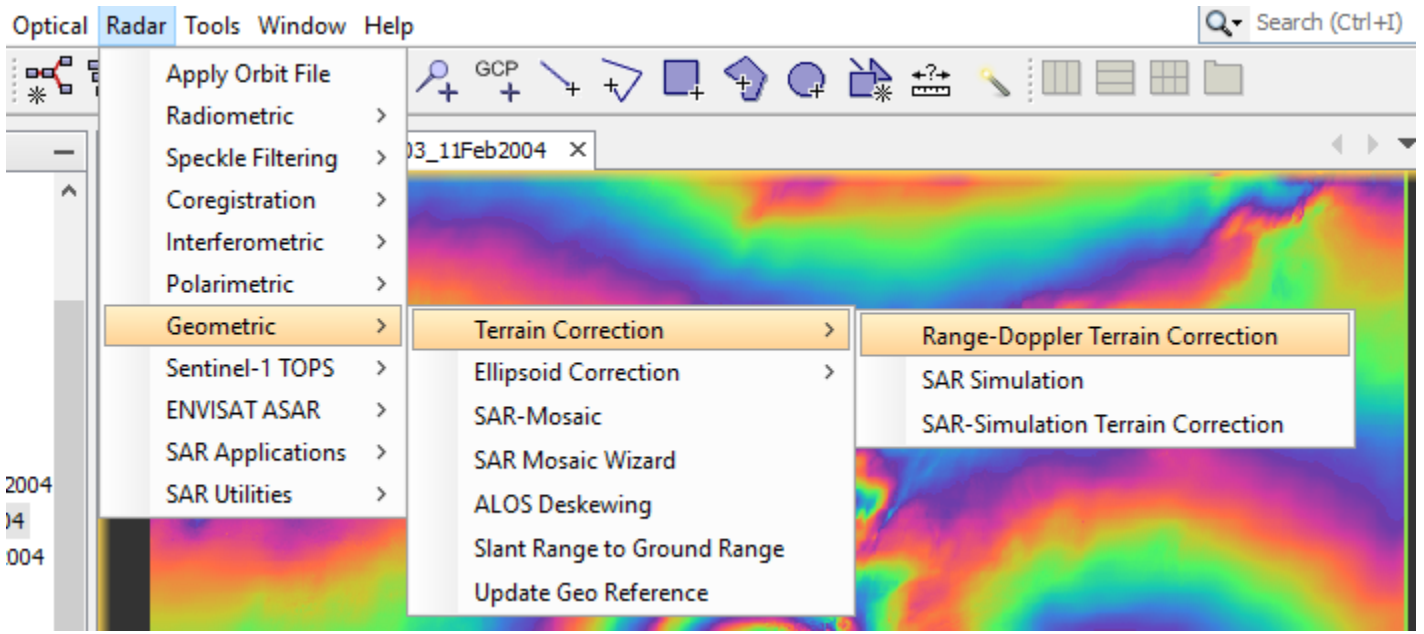
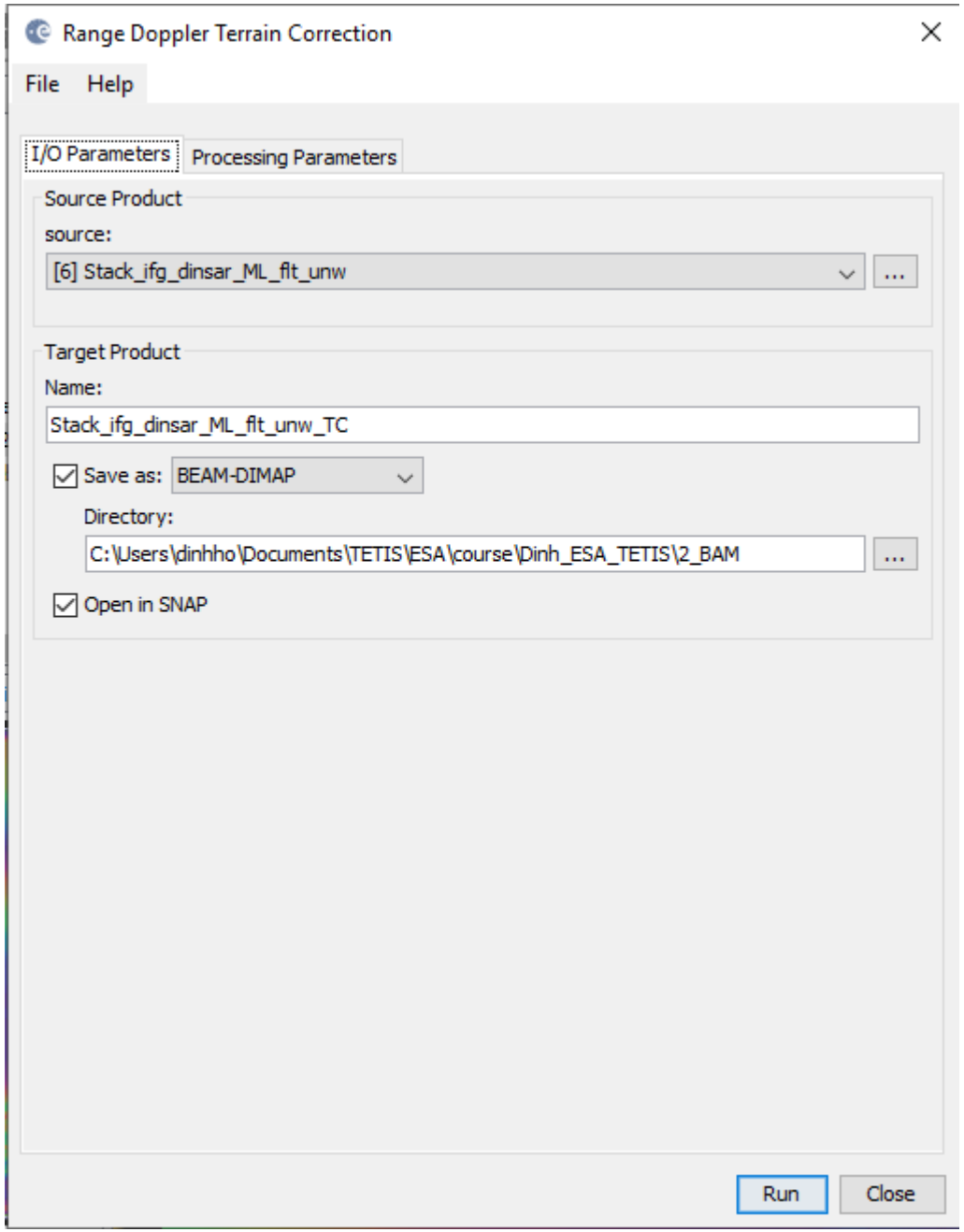
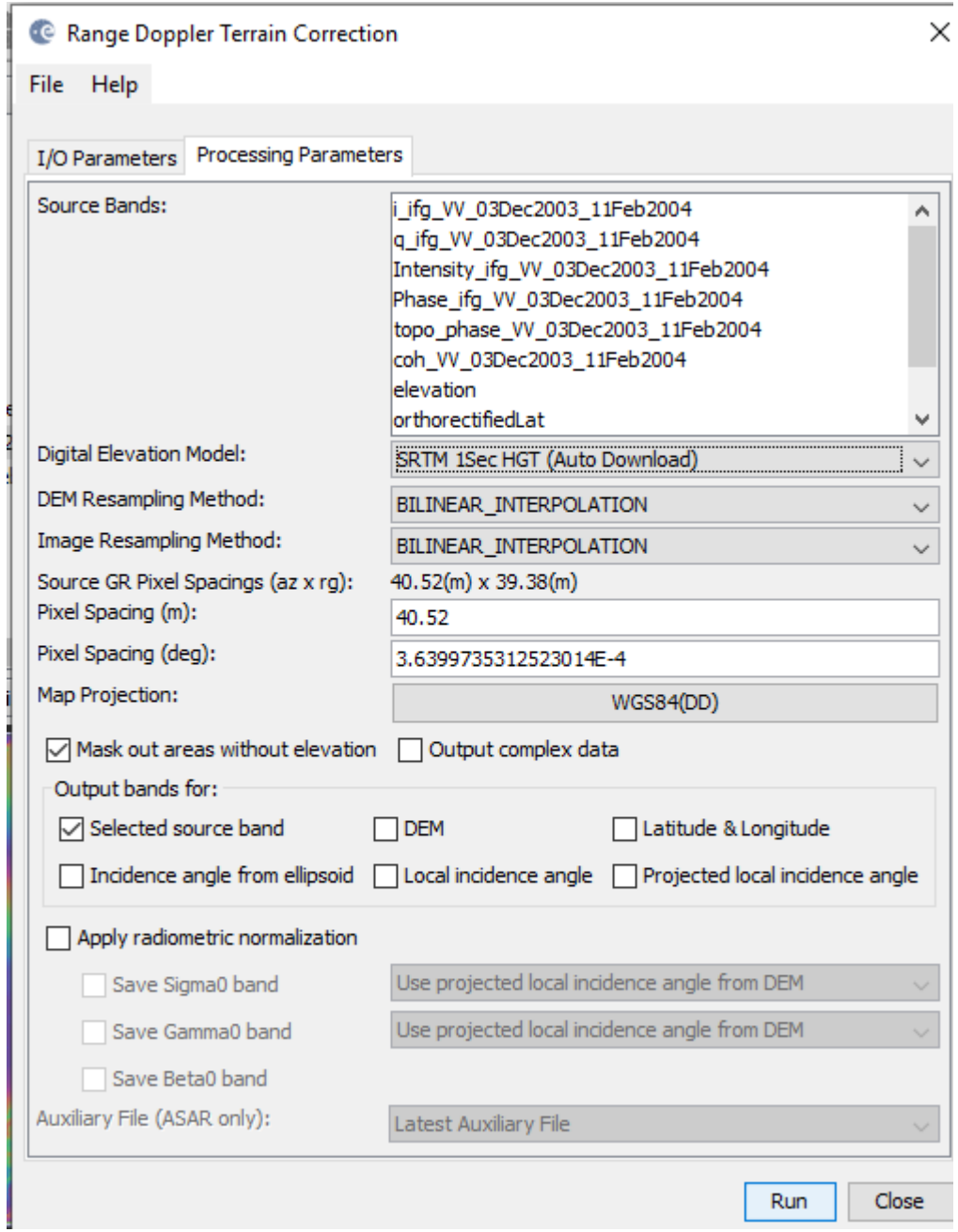

Optical
Radar
Tools
Window
Help
Search (Ctrl+I)
GCP
Apply Orbit File
Radiometric
Speckle Filtering
Coregistration
Interferometric
Polarimetric
Geometric
Sentinel-1 TOPS
ENVISAT ASAR
SAR Applications
SAR Utilities
Terrain Correction
Ellipsoid Correction
SAR-Mosaic
SAR Mosaic Wizard
ALOS Deskewing
Slant Range to Ground Range
Update Geo Reference
Range-Doppler Terrain Correction
SAR Simulation
SAR-Simulation Terrain Correction
03_11Feb2004
2004
04
004


Range Doppler Terrain Correction
File
Help
I/O Parameters
Processing Parameters
Source Product
source:
[6] Stack_ifg_dinsar_ML_flt_unw
Target Product
Name:
Stack_ifg_dinsar_ML_flt_unw_TC
Save as:
BEAM-DIMAP
Directory:
C:\Users\dinhho\Documents\TETIS\ESA\course\Dinh_ESA_TETIS\2_BAM
Open in SNAP
Run
Close


Range Doppler Terrain Correction
File
Help
I/O Parameters
Processing Parameters
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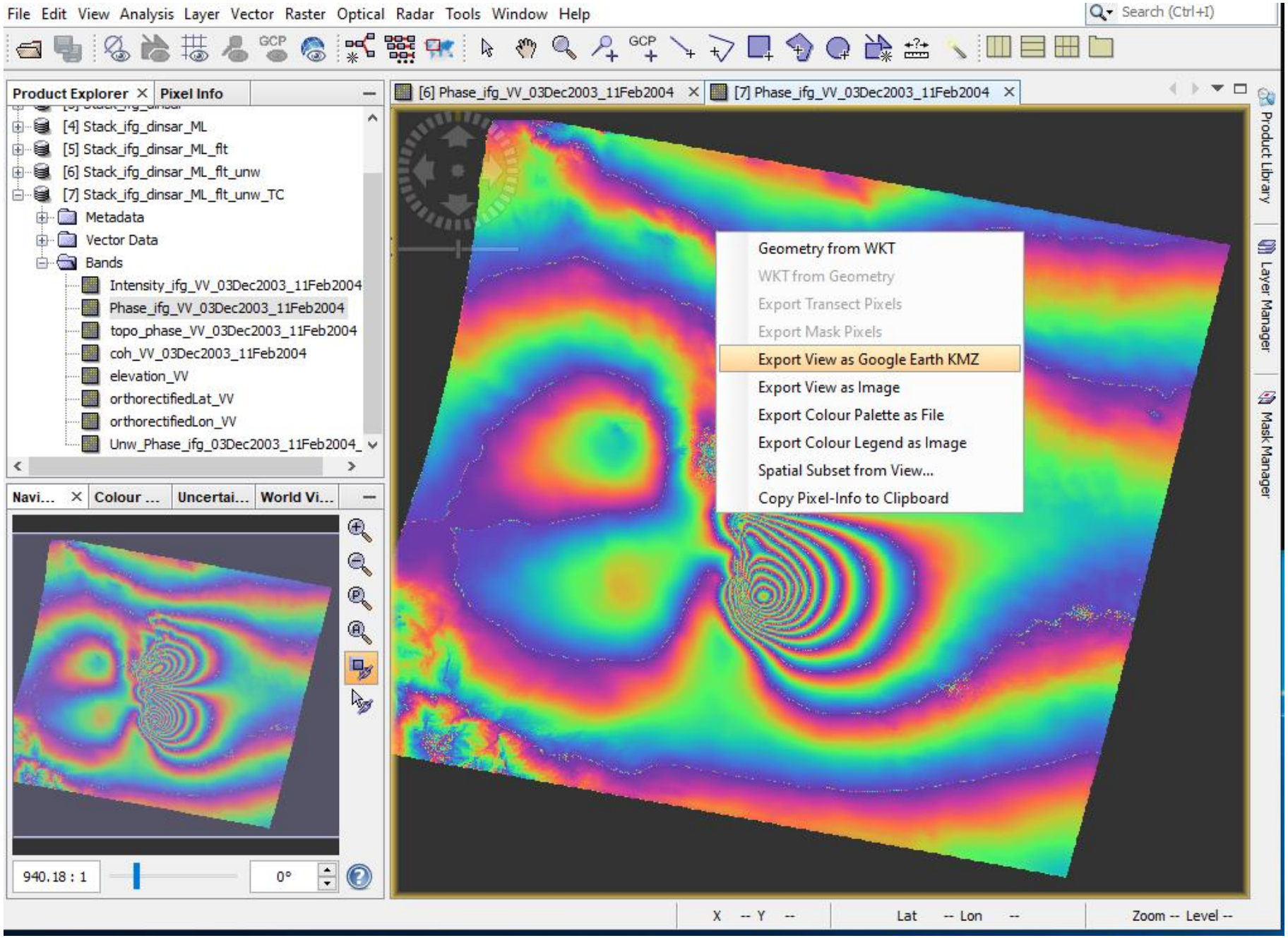
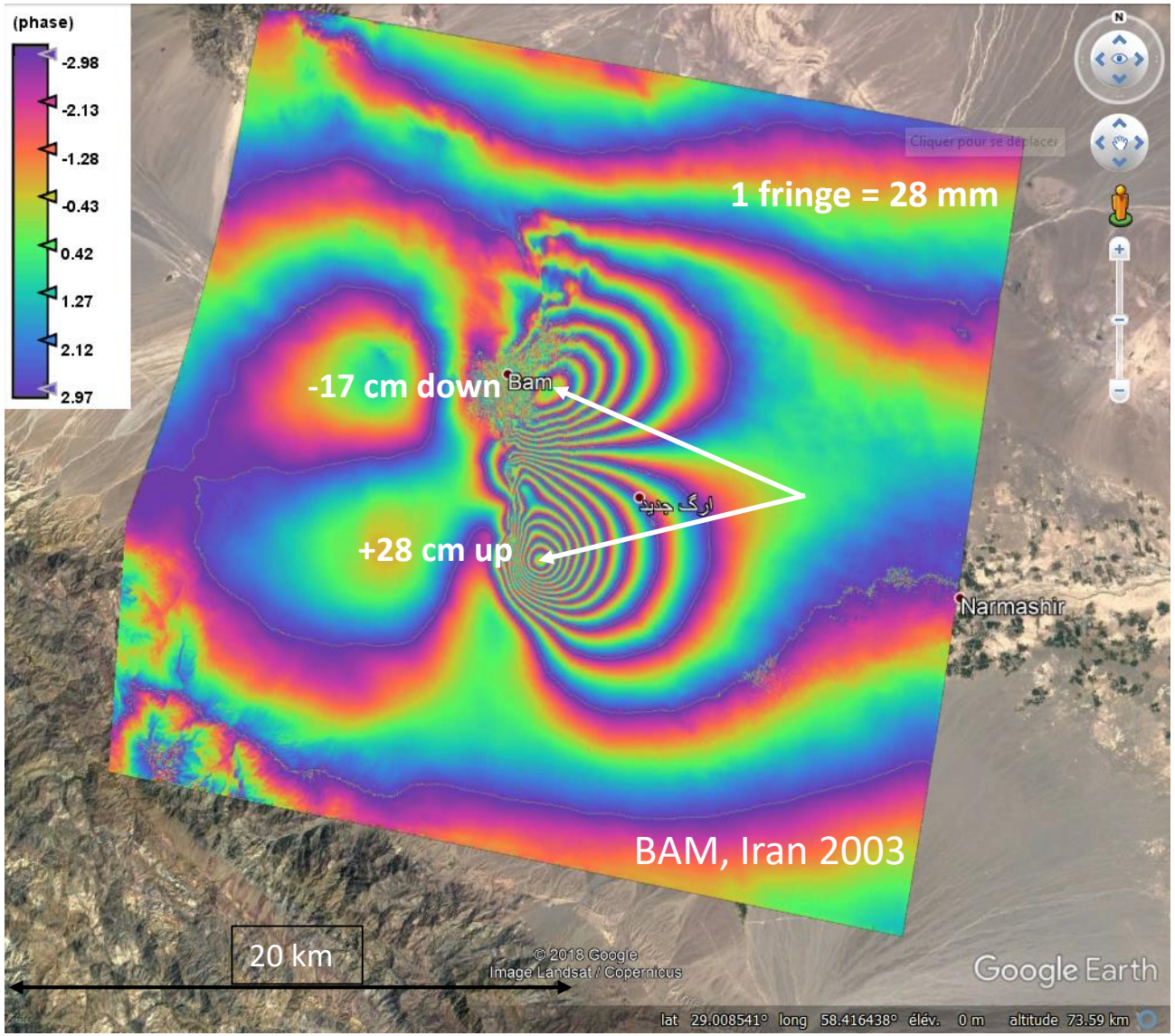
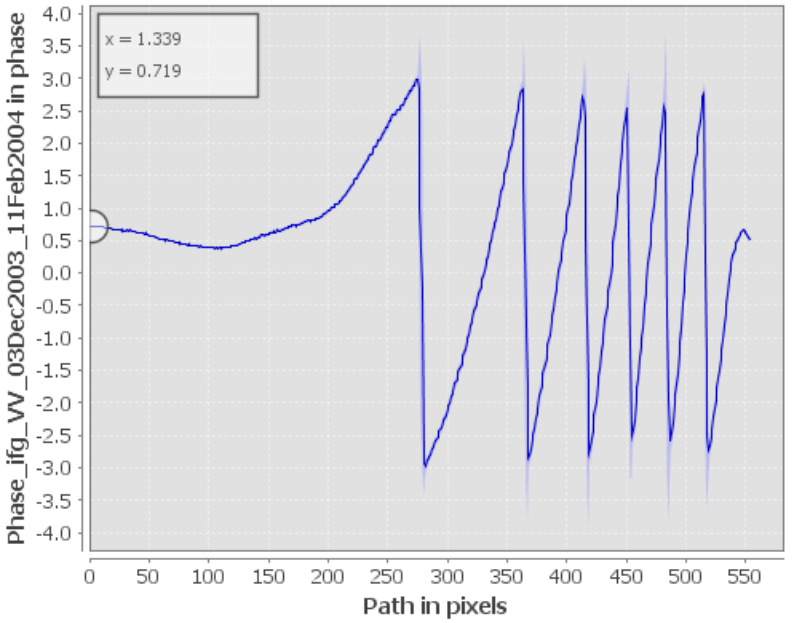
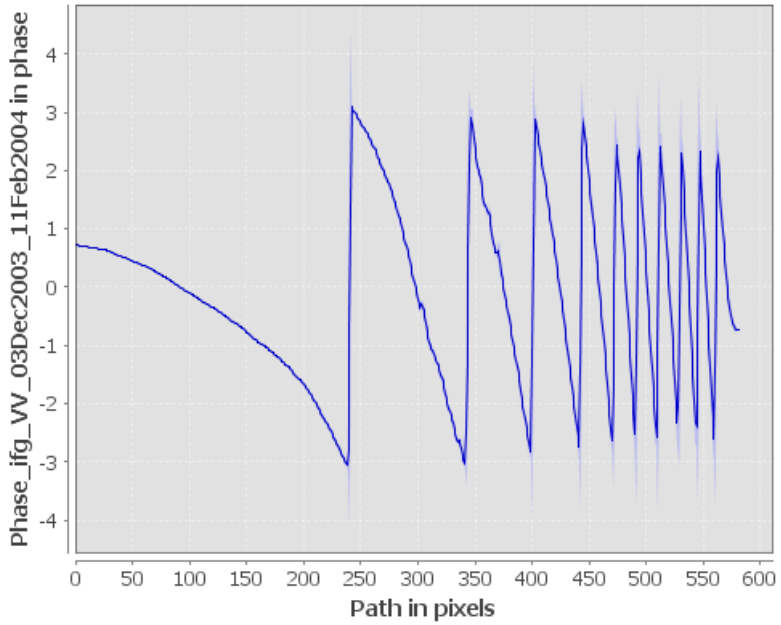
i_ifg_VV_03Dec2003_11Feb2004
q_ifg_VV_03Dec2003_11Feb2004
Intensity_ifg_VV_03Dec2003_11Feb2004
Phase_ifg_VV_03Dec2003_11Feb2004
topo_phase_VV_03Dec2003_11Feb2004
coh_VV_03Dec2003_11Feb2004
elevation
orthorectifiedLat
Digital Elevation Model:
SRTM 1Sec HGT (Auto Download)
DEM Resampling Method:
BILINEAR_INTERPOLATION
Image Resampling Method:
BILINEAR_INTERPOLATION
Source GR Pixel Spacings (az x rg):
40.52(m) x 39.38(m)
Pixel Spacing (m):
40.52
Pixel Spacing (deg):
3.6399735312523014E-4
Map Projection:
WGS84(DD)
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


File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Product Explorer
Pixel Info
[4] Stack_ifg_dinsar_ML
[5] Stack_ifg_dinsar_ML_flt
[6] Stack_ifg_dinsar_ML_flt_unw
[7] Stack_ifg_dinsar_ML_flt_unw_TC
Metadata
Vector Data
Bands
Intensity_ifg_VV_03Dec2003_11Feb2004
Phase_ifg_VV_03Dec2003_11Feb2004
topo_phase_VV_03Dec2003_11Feb2004
coh_VV_03Dec2003_11Feb2004
elevation_VV
orthorectifiedLat_VV
orthorectifiedLon_VV
Unw_Phase_ifg_03Dec2003_11Feb2004_
Navi...
Colour ...
Uncertai...
World Vi...
940.18 : 1
0°
[6] Phase_ifg_VV_03Dec2003_11Feb2004
[7] Phase_ifg_VV_03Dec2003_11Feb2004
Geometry from WKT
WKT from Geometry
Export Transect 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
Product Library
Layer Manager
Mask Manager
X -- Y --
Lat -- Lon --
Zoom -- Level --







One fringe corresponds to a deplacement of 28 mm in the light of sight linking between the ground and the satellite.