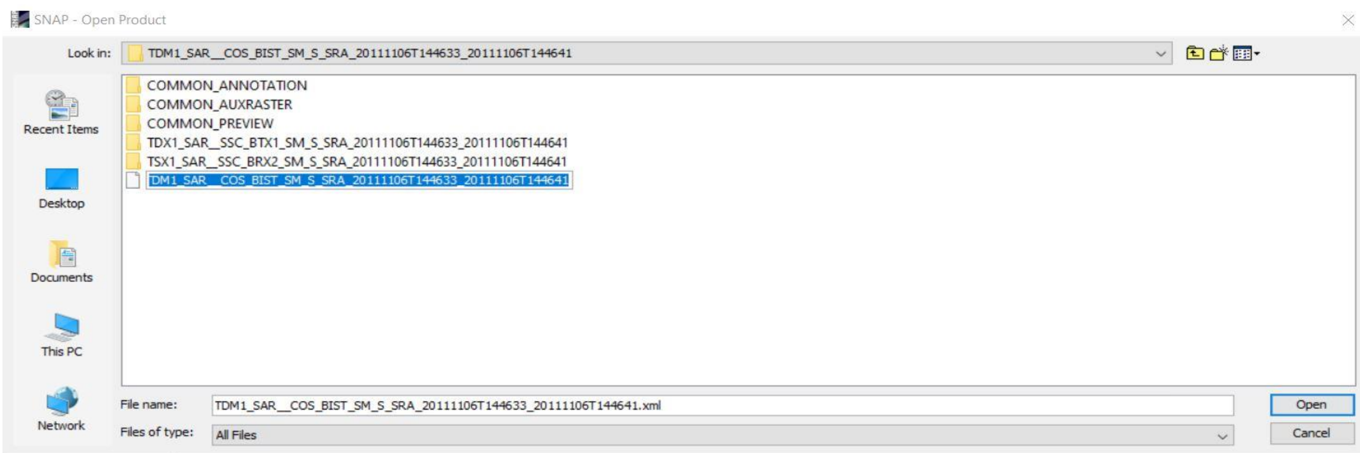
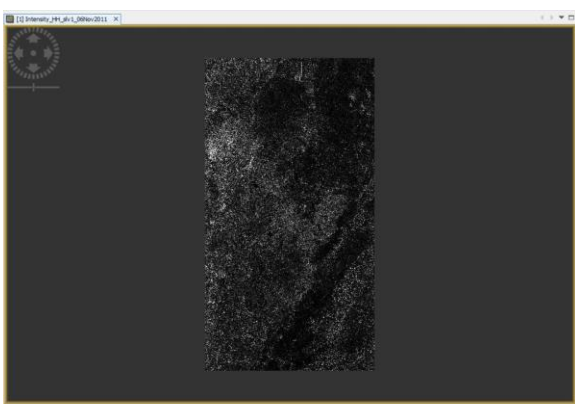
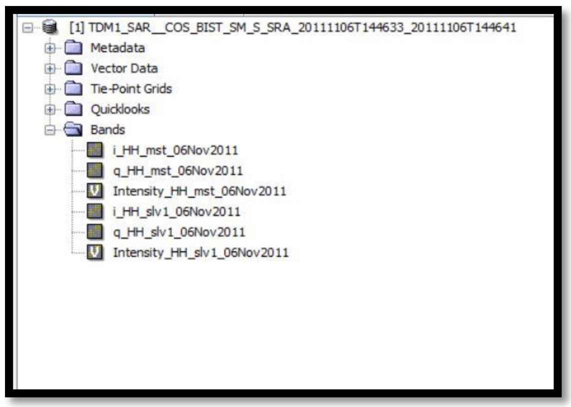
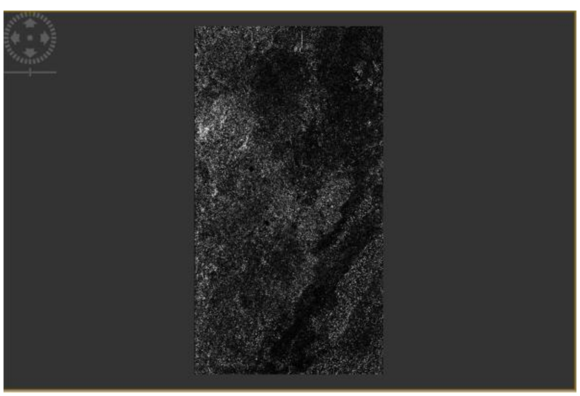
1-open product









2- interferogram

This operator computes (complex, with or without subtraction of the flat-earth (reference) phase. The reference phase is subtracted using a 2d-polynomial that is also estimated in this operator.

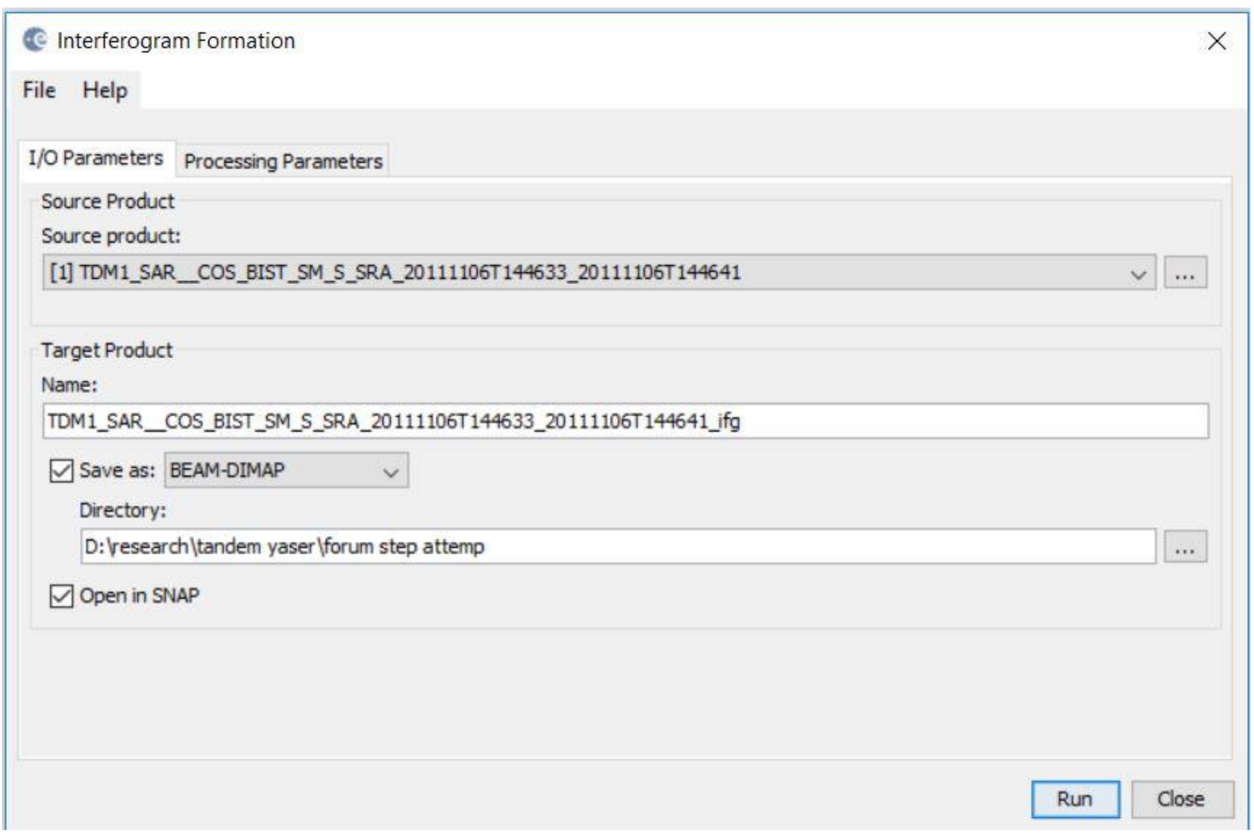
If the orbits for interferometric pair are known, the flat-earth phase is estimated using the orbital and metadata information and subtracted from the complex interferogram. The flat-earth phase is the phase present in the interferometric signal due to the curvature of the reference surface. The geometric reference system of the reference surface is defined by the reference system of satellite orbits (for now only WGS84 supported, which the reference system used by all space-borne SAR systems).

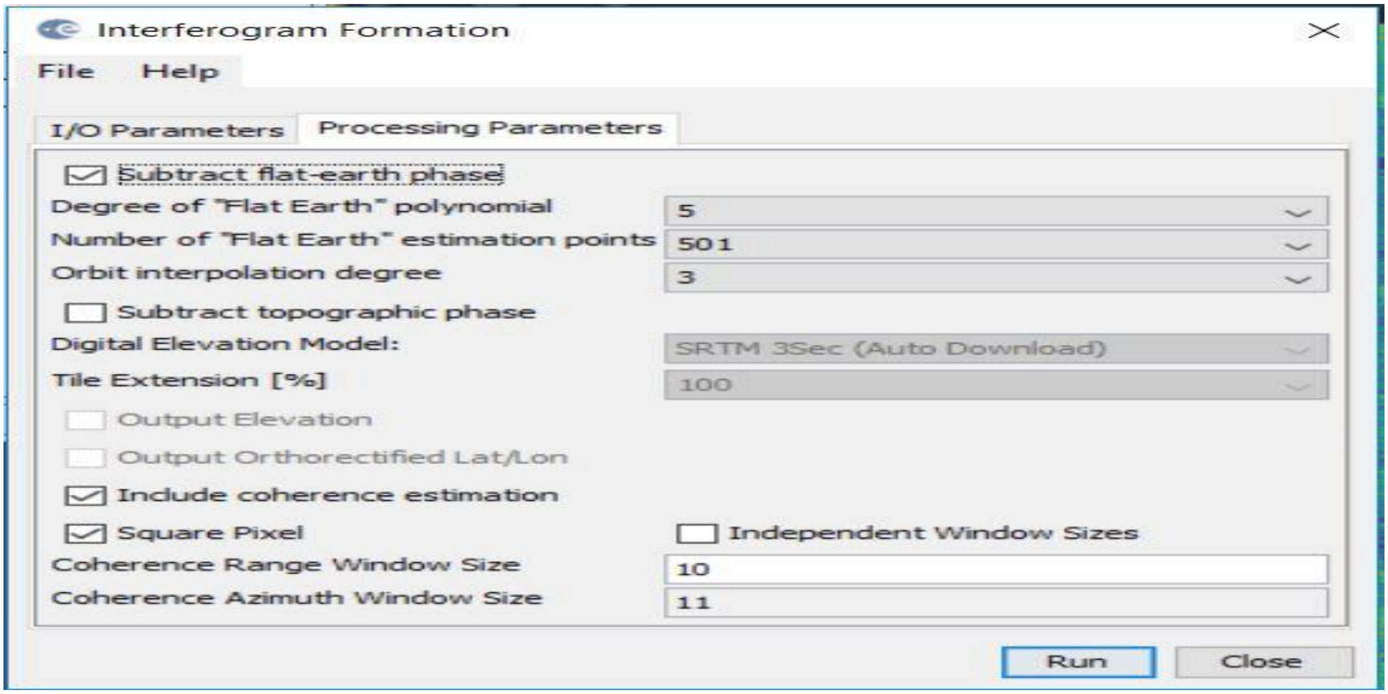
The flat-earth phase is computed in a number of points distributed over the total image, after which a 2d-polynomial is estimated (using least squares) fitting these 'observations', (e.g. plane can be fitted by setting the degree to 1.)

A polynomial of degree 5 normally is sufficient to model the reference phase for a full SAR scene (approx 100x100km). While, a lower degree might be selected for smaller images, and higher degree for 'long-swath' scenes. Note that the higher order terms of the flat-earth polynomial are usually small, because the polynomial describes a smooth, long wave body (ellipsoid). To recommended polynomial degree, that should ensure the smooth surface for most image sizes and areas of the world is 5th degree.

In order to reduce the noise, as the post-processing step, you can perform multilooking (with Multilook Operator). Multilooking has to be performed separately on 'virtual' bands phase or intensity. In future releases complex Multilook operator will be released. Note that in case of ESA's ERS and Envisat sensors, the factor 5:1 (azimuth:range) or similar ratio between the factors is chosen to obtain approximately square pixels (20x20 m^2 for factors 5 and 1). Of course the resolution decreases if multilooking is applied.nterferogram formation

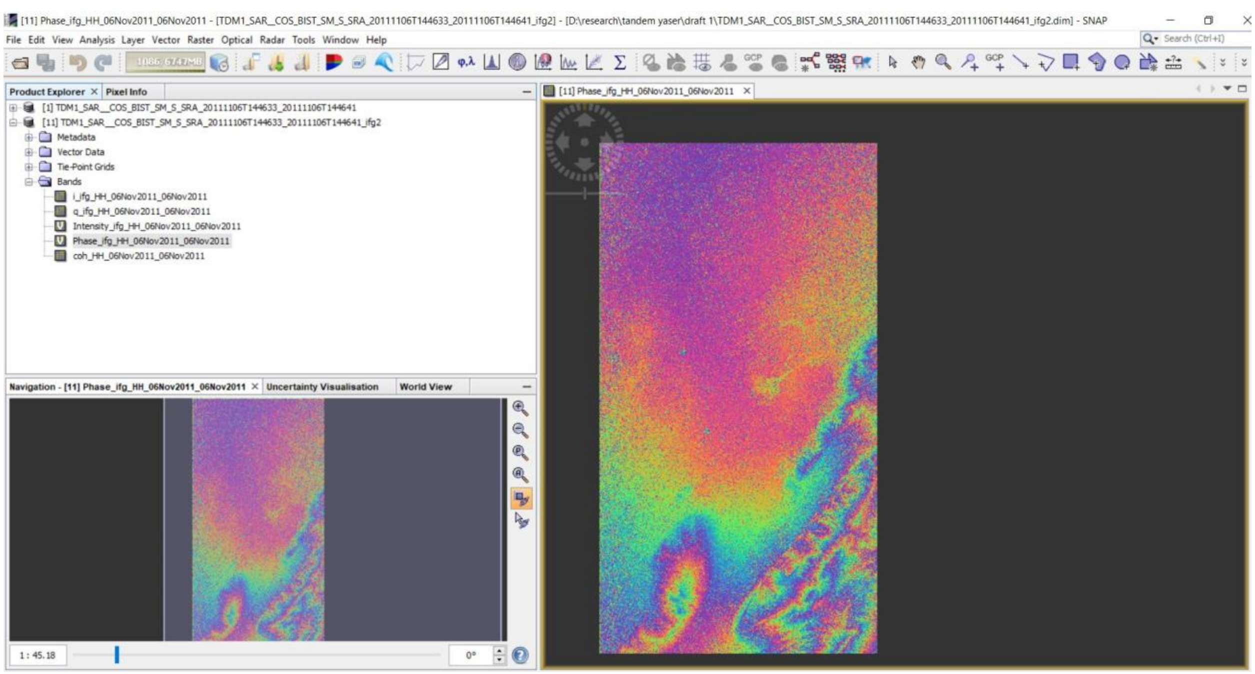
Interferogram formation before processing





Interferogram formation

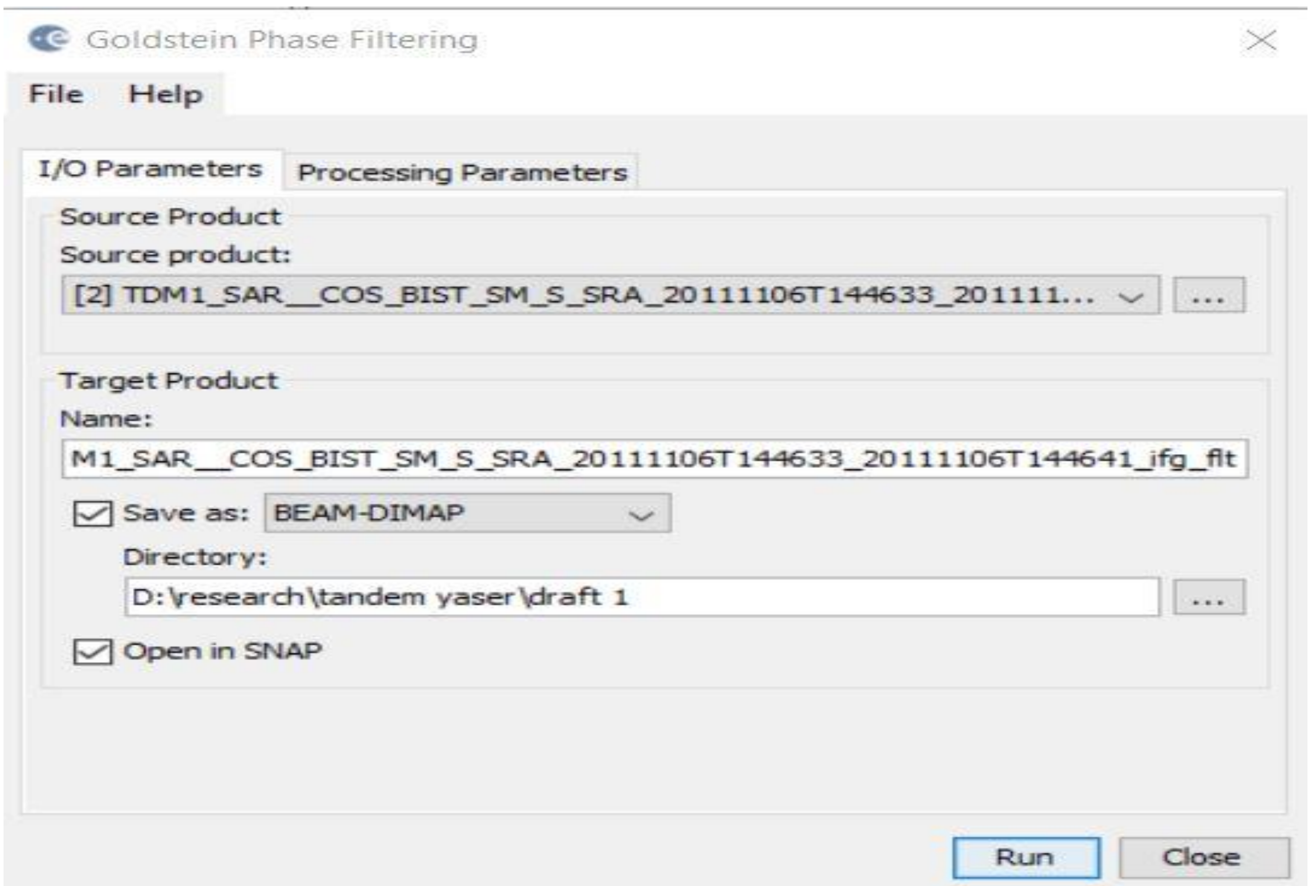
after processing

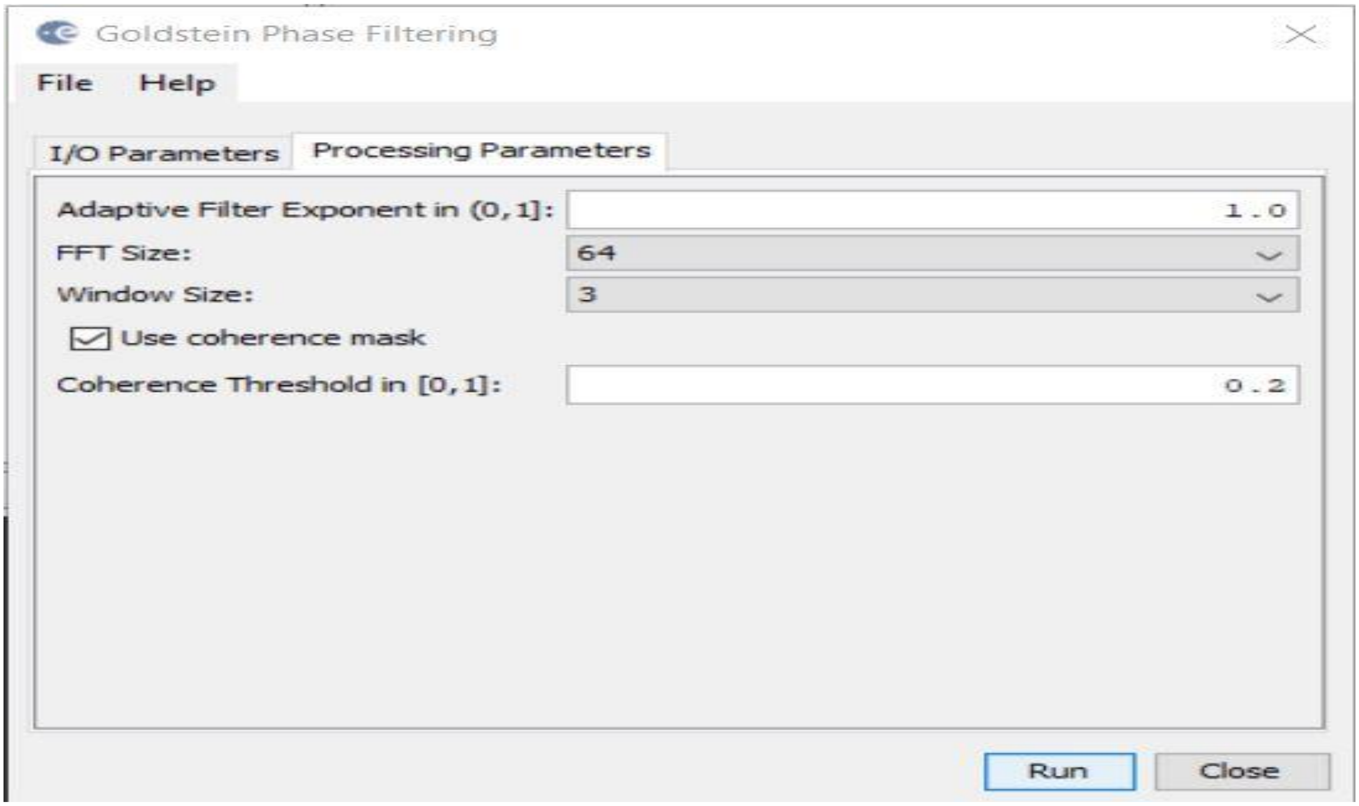


Golding filtering

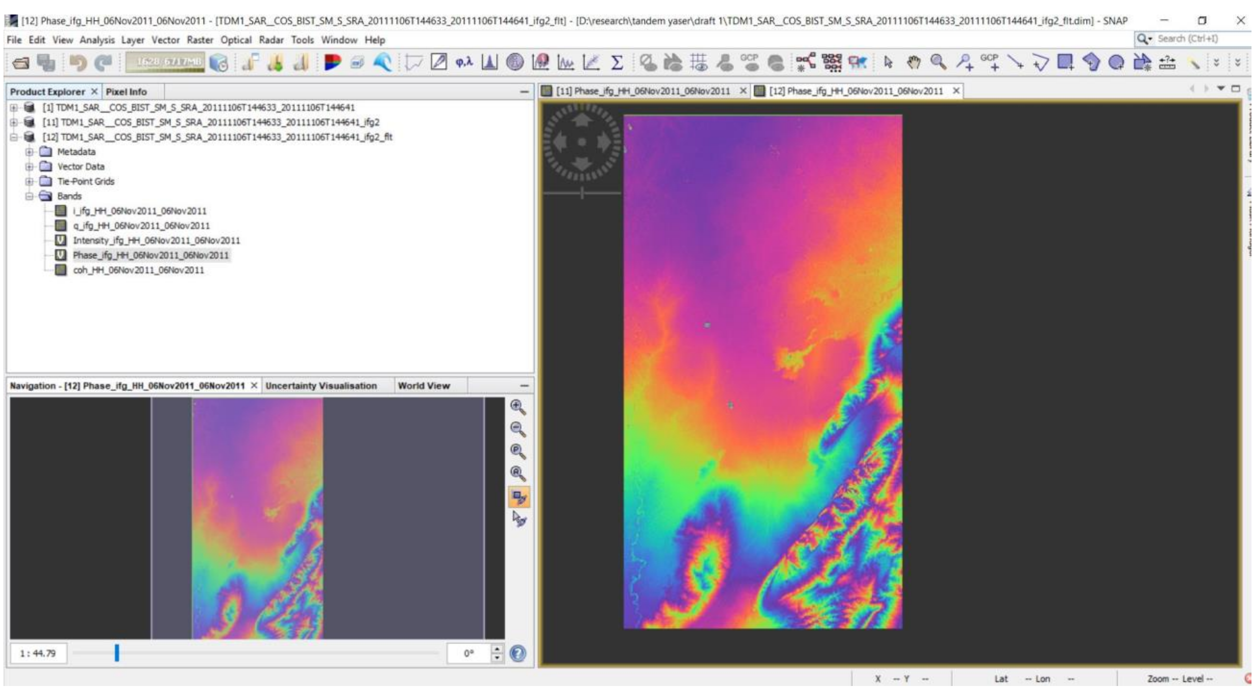
Phase filtering is a preprocessing technique that greatly reduces the residues in the later on phase unwrapping step and enhances the phase unwrapping accuracy. The method implemented in this operator is a nonlinear adaptive algorithm proposed by Goldstein and Werner [1] in 1998

before processing





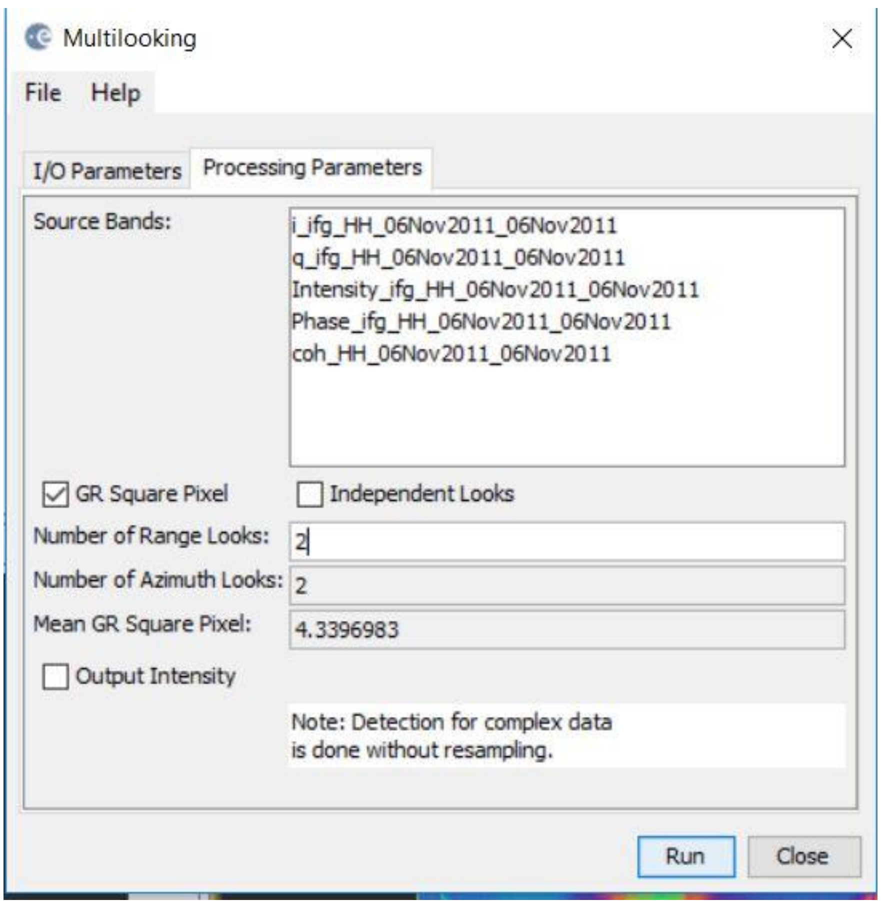
after processing



Multilook Operator

Generally, a SAR original image appears speckled with inherent speckle noise. To reduce this inherent speckled appearance, several images are incoherently combined as if they corresponded to different looks of the same scene. This processing is generally known as multilook processing. As a result the multilooked image improves the image interpretability. Additionally, multilook processing can be used to produce an application product with nominal image pixel size.

before processing



Multilook

Multilook Operator

Generally, a SAR original image appears speckled with inherent speckle noise. To reduce this inherent speckled appearance, several images are incoherently combined as if they corresponded to different looks of the same scene. This processing is generally known as multilook processing. As a result the multilooked image improves the image interpretability. Additionally, multilook processing can be used to produce an application product with nominal image pixel size.

Multilook Method

There are two ways to implement the multilook processing:

- The multilooked images can be produced by space-domain averaging of a single look image, either with or without specific 2D kernels by convolution.
- The multilook images can be produced by frequency-domain method using the sub-spectral band width.

This operator implements the space-domain multilook method by averaging a single look image with a small sliding window.

Selecting Range and Azimuth Looks

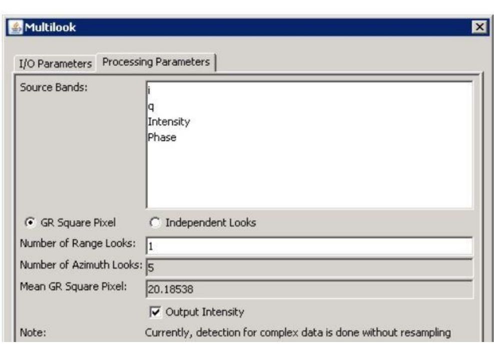
In selecting the number of range looks and the number of azimuth looks, user has two options:

- GR square pixel: the user specifies the number of range looks while the number of azimuth looks is computed based on the ground range spacing and the azimuth spacing. The window size is then determined by the number of range looks and the number of azimuth looks. As a result, image with approximately square pixel spacing on the ground is produced.
- Independent looks: the number of looks in range and azimuth can be selected independently. The window size is then determined by the number of range looks and the number of azimuth looks.

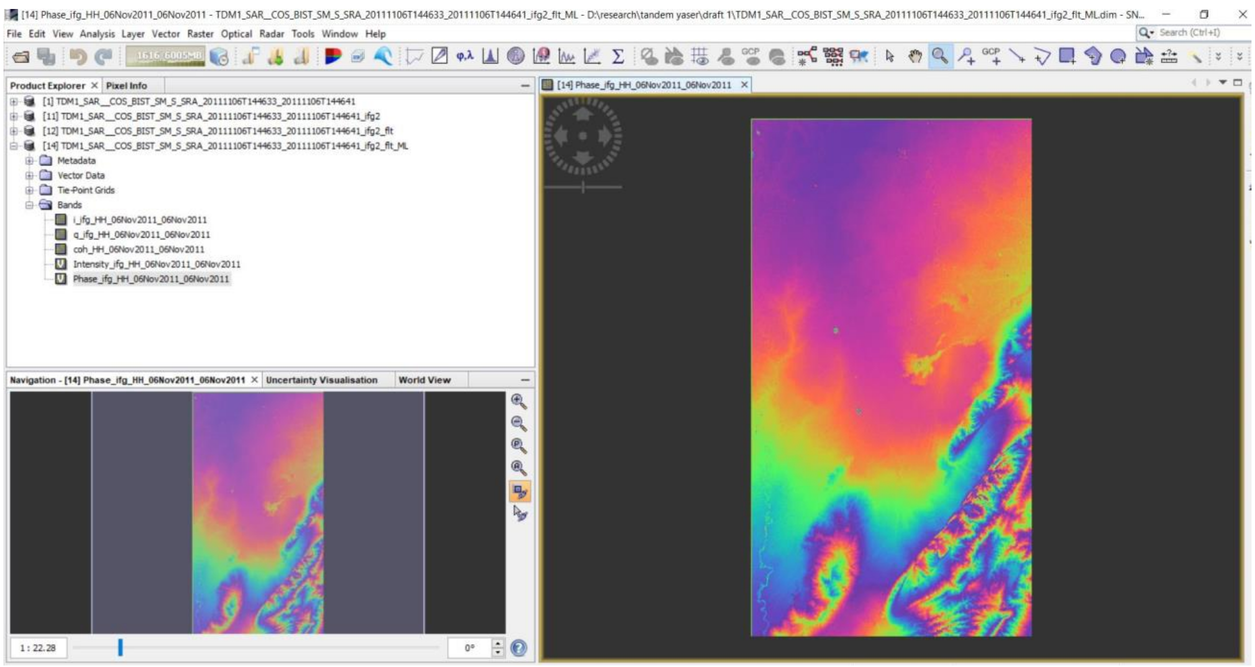
Parameters Used

The following parameters are used by the operator:

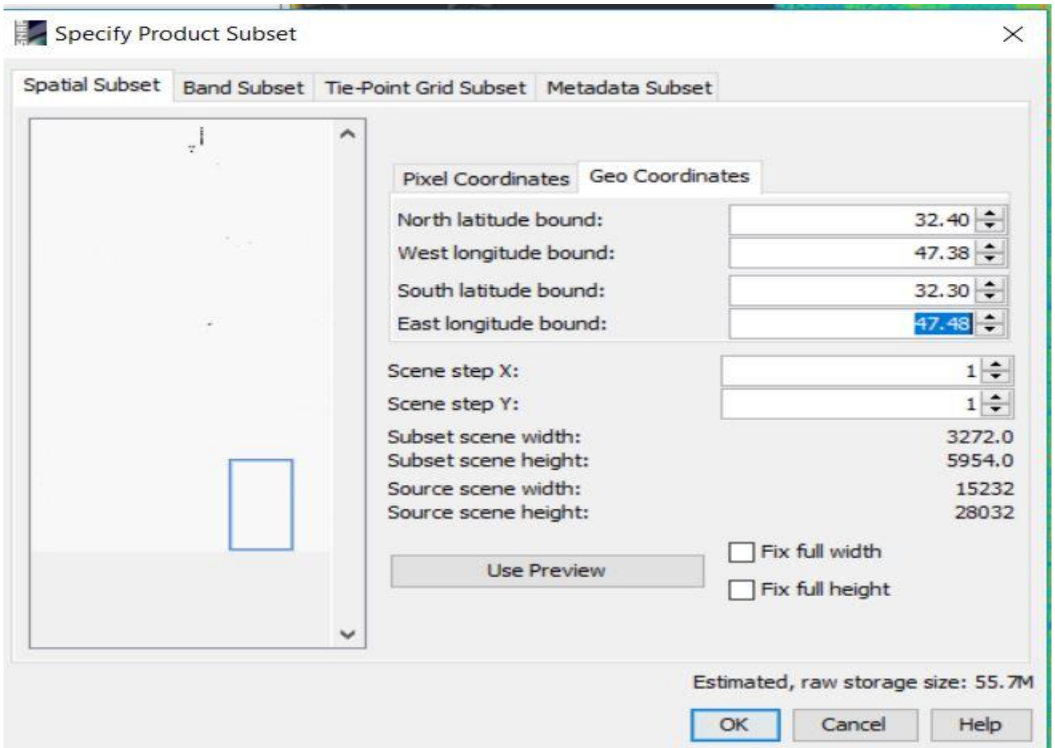
1. Source Band: All bands (real or virtual) of the source product. User can select one or more bands for producing multilooked images. If no bands are selected, then by default all bands are selected.
2. GR Square Pixel: If selected, the number of azimuth looks is computed based on the user selected number of range looks, and range and azimuth spacings are approximately the same in the multilooked image.
3. Independent Looks: If selected, the number of range looks and the number of azimuth looks are selected independently by the user.
4. Number of Range Looks: The number of range looks.
5. Number of Azimuth Looks: The number of azimuth looks.
6. Mean GR Square Pixel: The average of the range and azimuth pixel spacings in the multilooked image. It is computed based on the number of range looks, the number of azimuth looks and the source image pixel spacings, and is available only when 'GR Square Pixel' is selected.
7. Output Intensity: This checkbox is for complex product only. If not checked, any user selected bands (I, Q, intensity or phase) are multilooked and output individually. If checked, user can only select I/Q or intensity band and the output is multilooked intensity band.



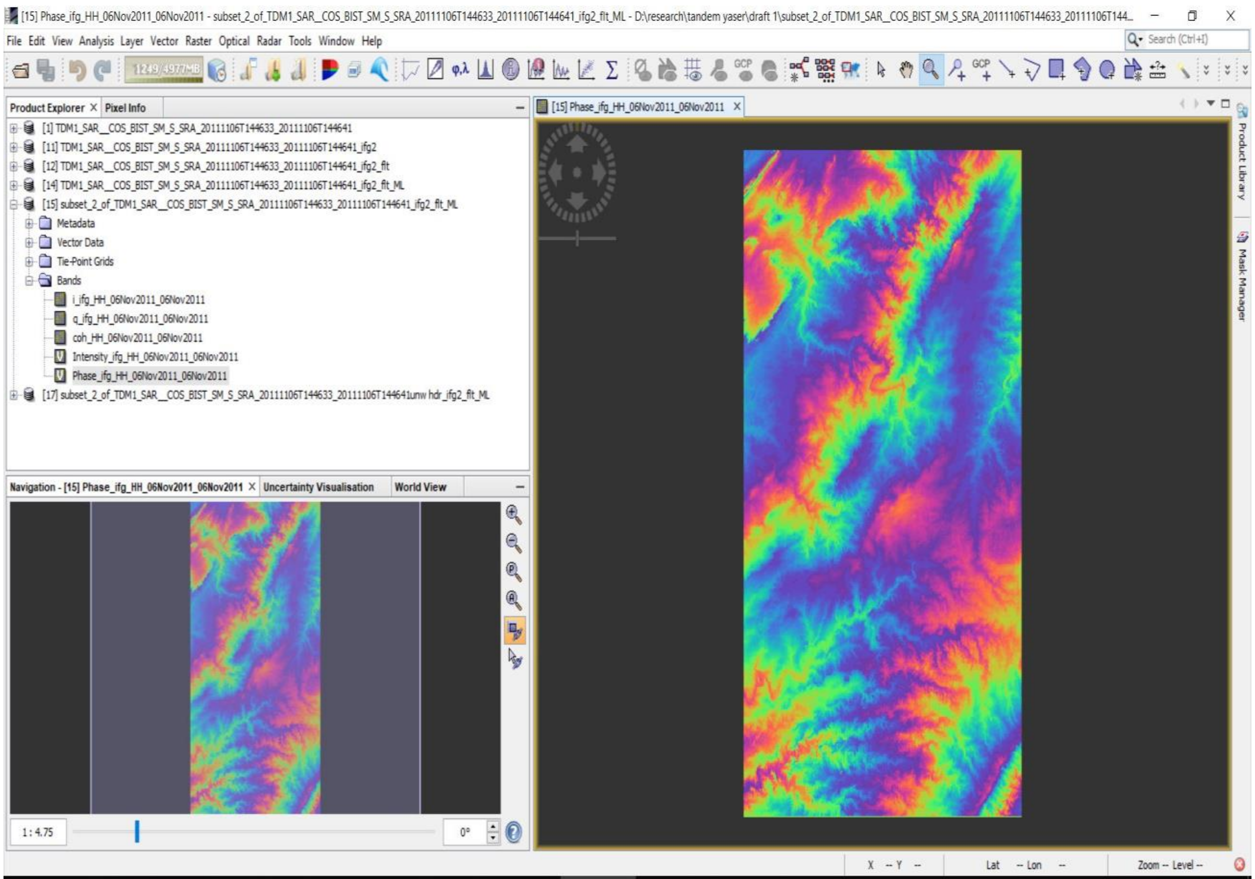
after processing



4-Create subset



Specify Product Subset
Spatial Subset
Band Subset
Tie-Point Grid Subset
Metadata Subset
Pixel Coordinates
Geo Coordinates
North latitude bound: 32.40
West longitude bound: 47.38
South latitude bound: 32.30
East longitude bound: 47.48
Scene step X: 1
Scene step Y: 1
Subset scene width: 3272.0
Subset scene height: 5954.0
Source scene width: 15232
Source scene height: 28032
Use Preview
Fix full width
Fix full height
Estimated, raw storage size: 55.7M
OK
Cancel
Help



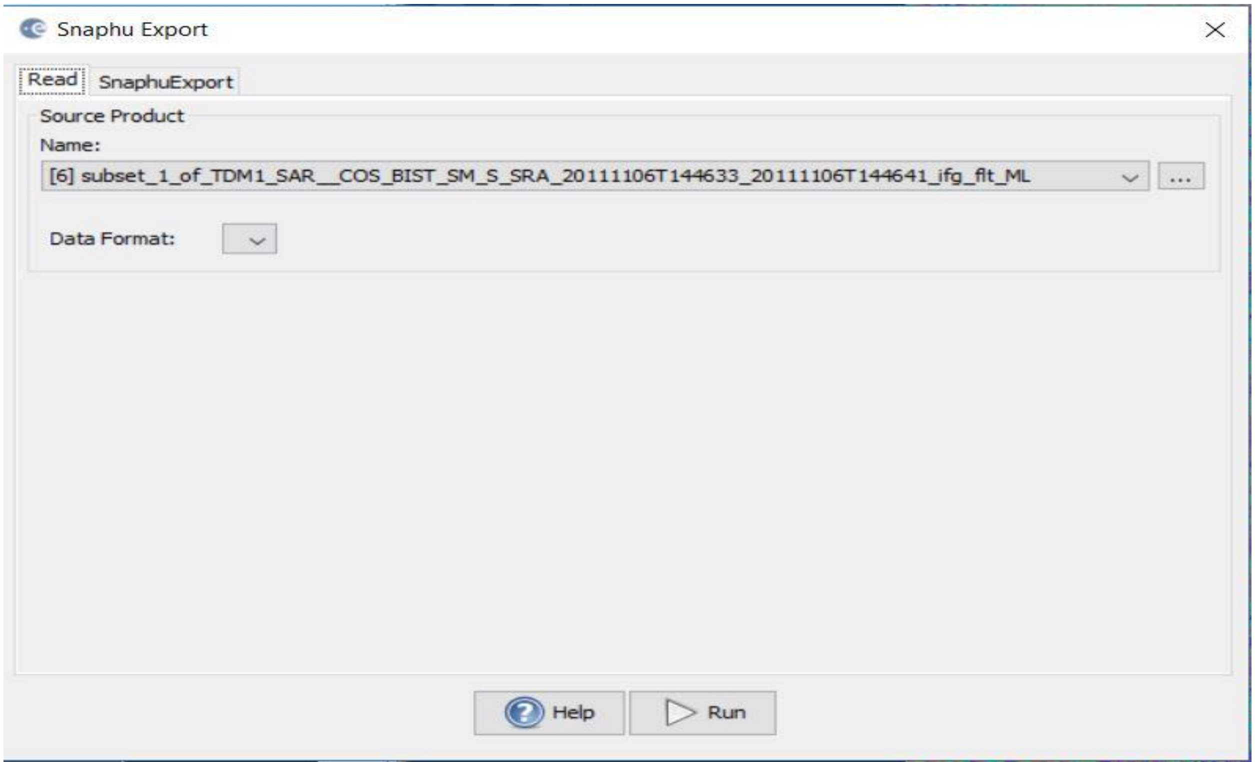
Exporting data for SNAPHU processing

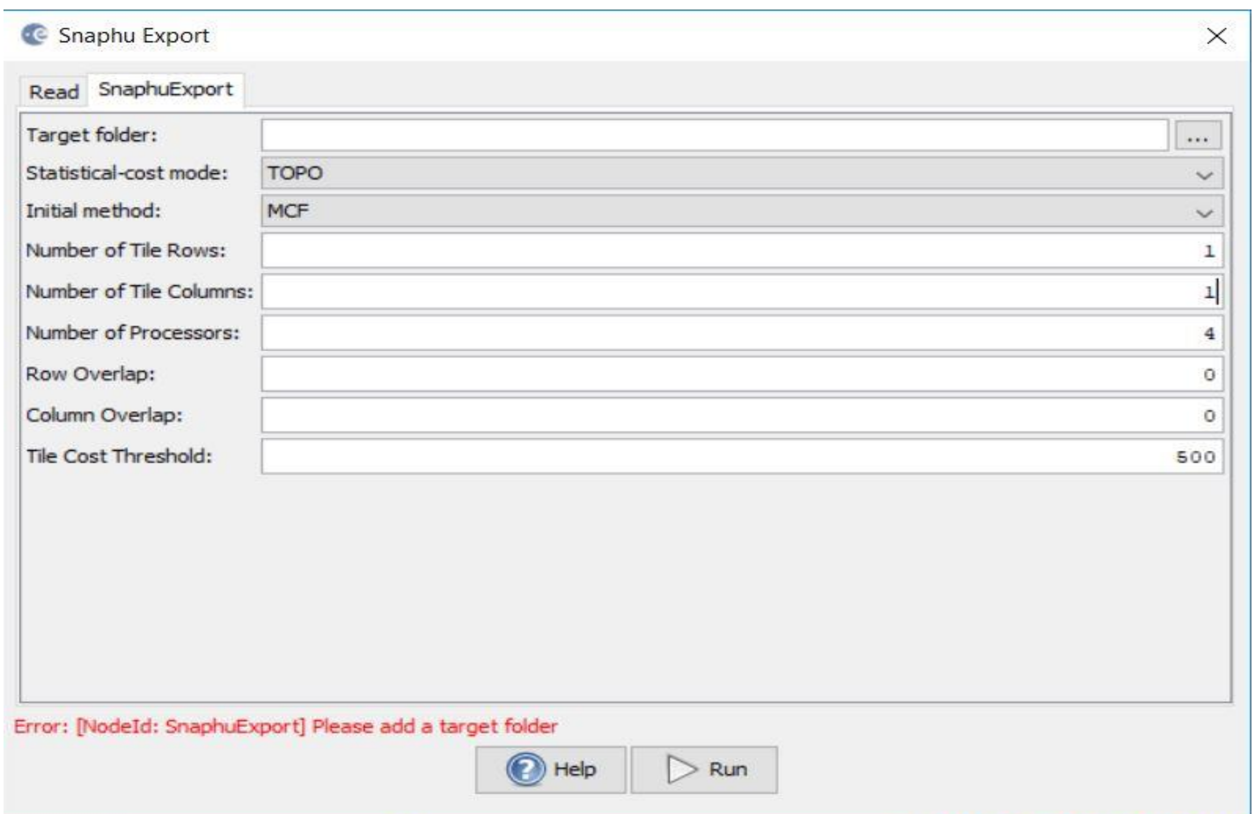
The main purpose of SNAPHU data export functionality is three-fold:

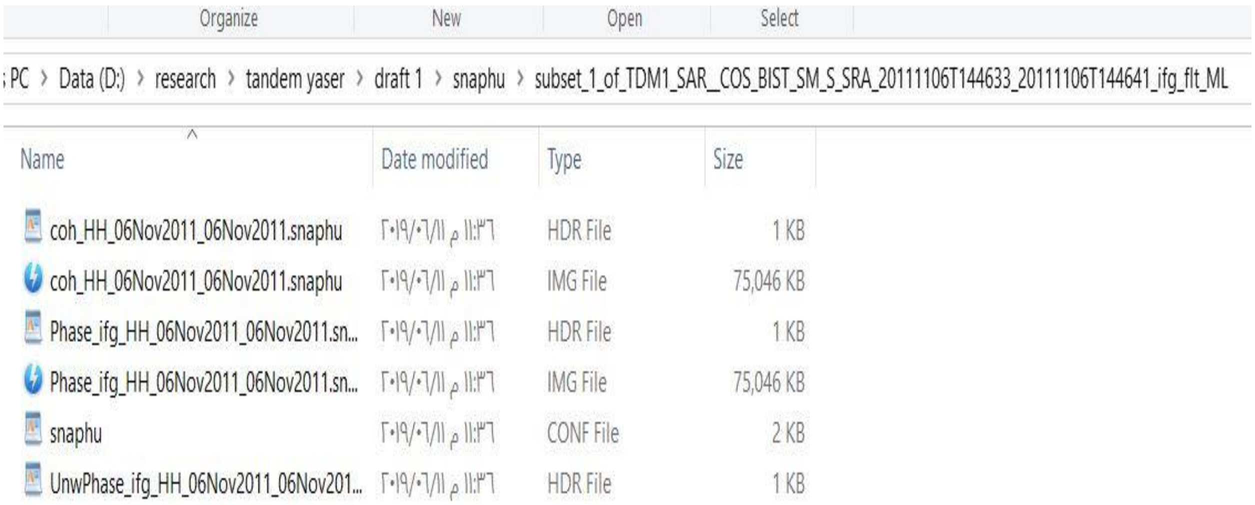
To export data (bands) in the format compatible for SNAPHU processing,

To build a SNAPHU configuration file (snaphu.conf), the file where processing parameters for SNAPHU are being stored,

To construct a container product that will store metadata and bands to be used when SNAPHU results are being ingested back into the Toolbox.


Snaphu Export
Read
SnaphuExport
Source Product
Name:
[6] subset_1_of_TDM1_SAR__COS_BIST_SM_S_SRA_20111106T144633_20111106T144641_ifg_flt_ML
Data Format:
Help
Run

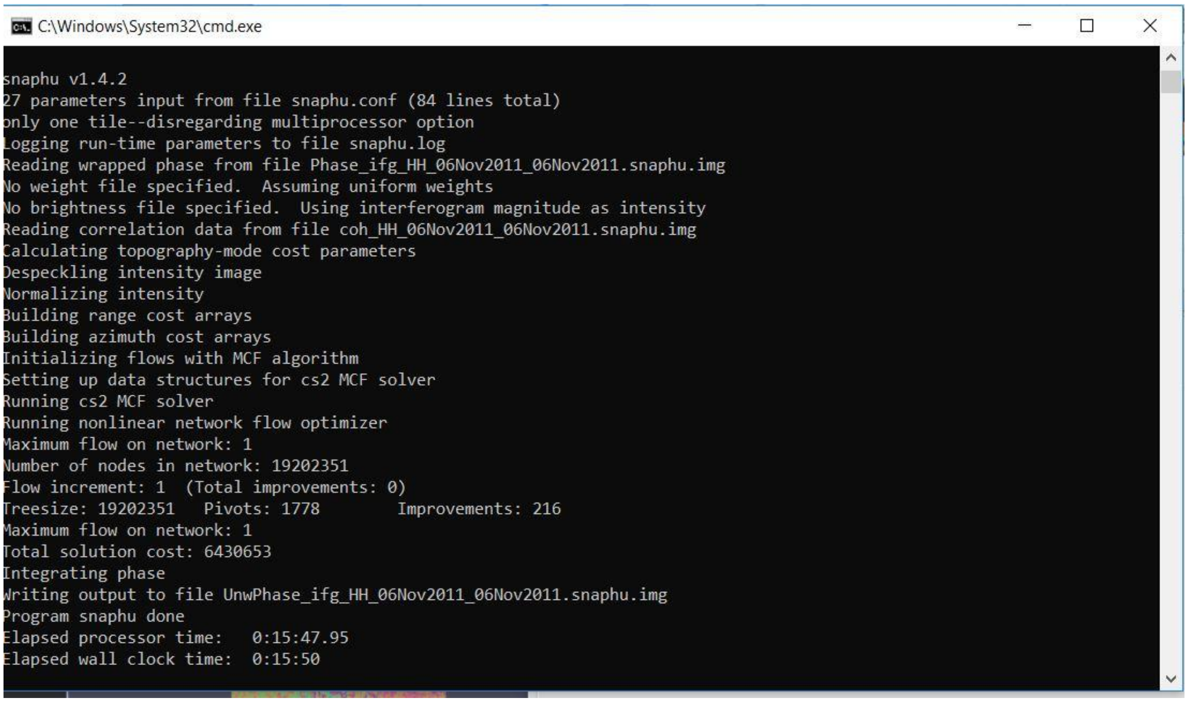

Snaphu Export
Read
SnaphuExport
Target folder:
Statistical-cost mode:
TOPO
Initial method:
MCF
Number of Tile Rows:
1
Number of Tile Columns:
1
Number of Processors:
4
Row Overlap:
0
Column Overlap:
0
Tile Cost Threshold:
500
Error: [NodeId: SnaphuExport] Please add a target folder
Help
Run

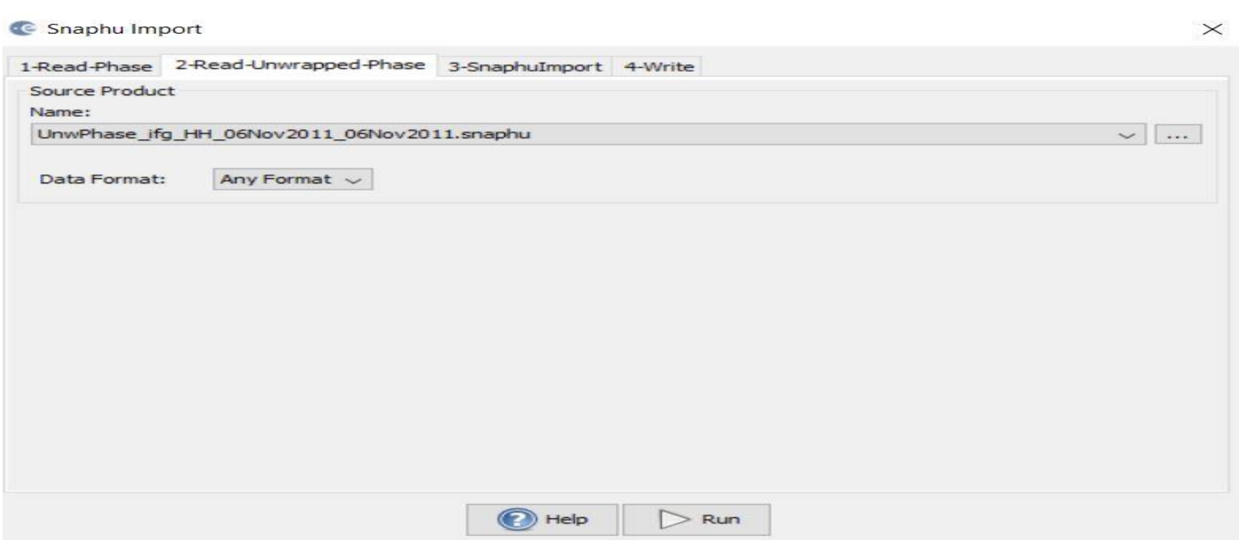


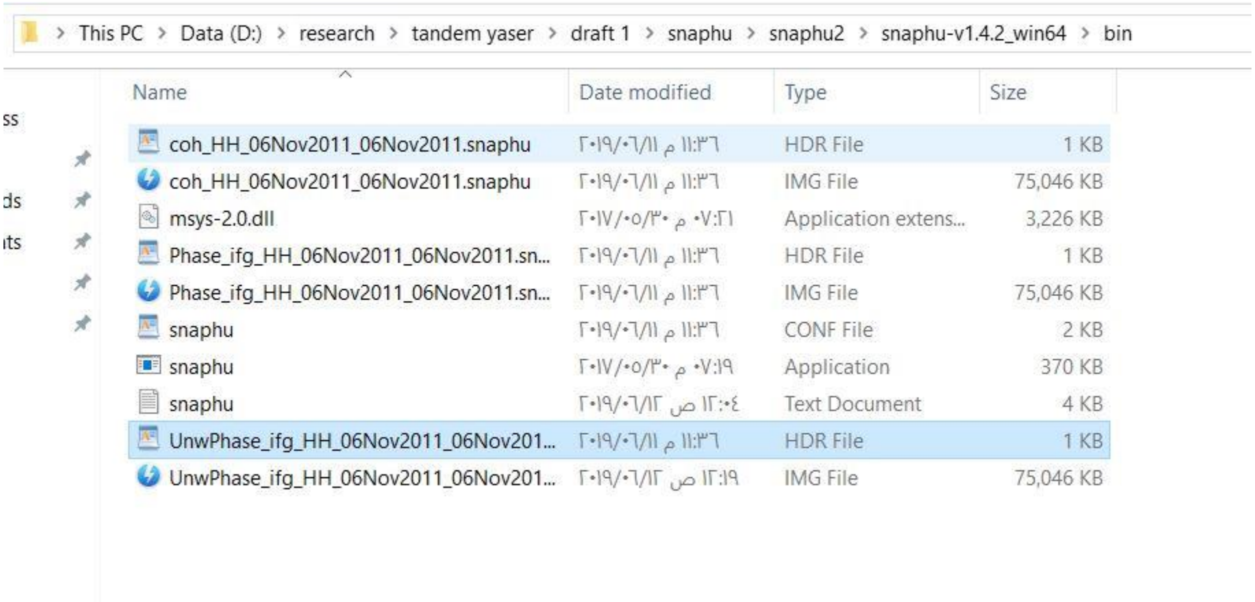
Phase Unwrapping

The principal observation in radar interferometry, is the two-dimensional relative phase signal, which is the 2pi-modulus of the (unknown) absolute phase signal. The forward problem, the wrapping of the absolute phase to the [-pi,pi) interval is straightforward and trivial. The inverse problem, the so-called **phase unwrapping**, due to inherent non-uniqueness and non-linearity, is one of the main difficulties and challenges in the application of radar interferometry.

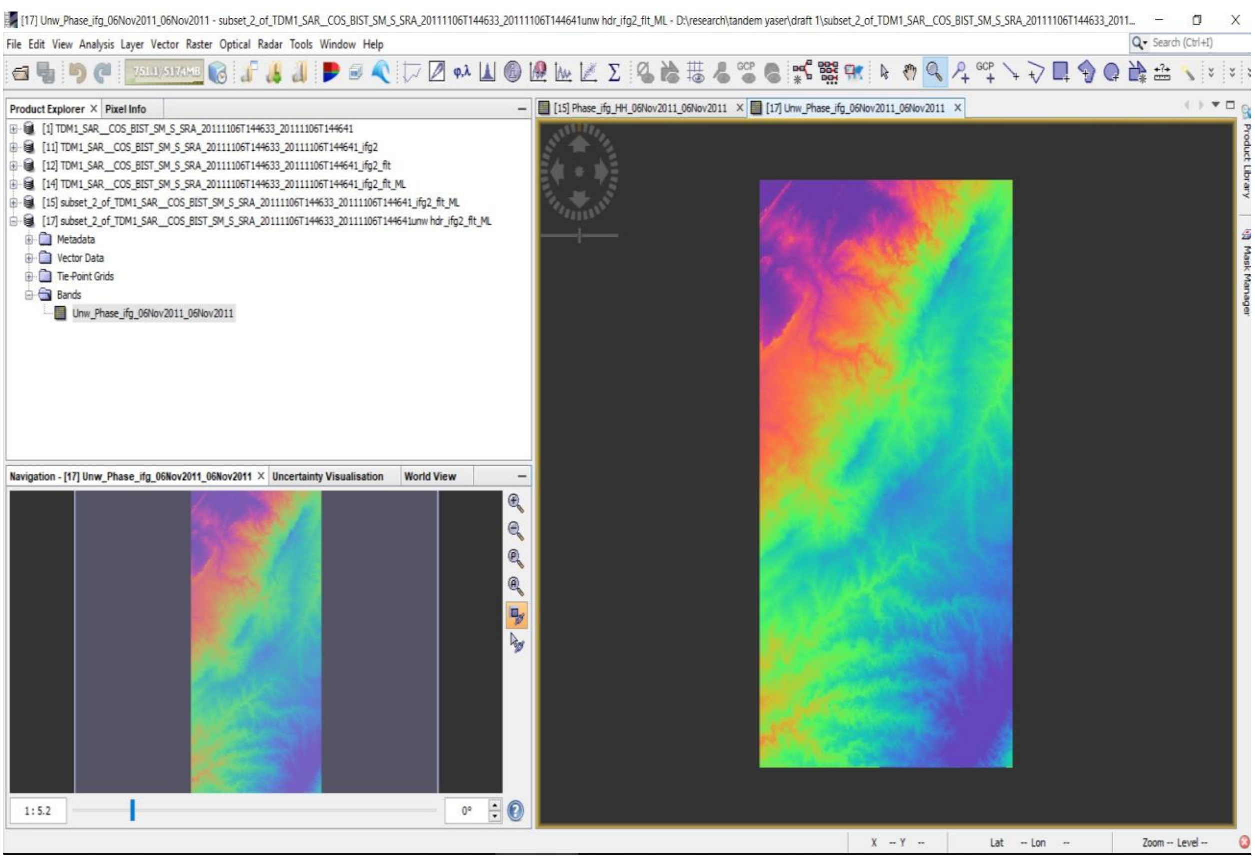
There are many proposed techniques to deal with the phase unwrapping problem. The variable phase noise, as well as the geometric problems, i.e., foreshortening and layover, are the main causes why many of the proposed techniques do not perform as desired. Furthermore, any of the given phase unwrapping techniques will not give a unique solution, and without additional a-priori information, or strong assumptions on the data behaviour, it is impossible to assess the reliability of the solution.



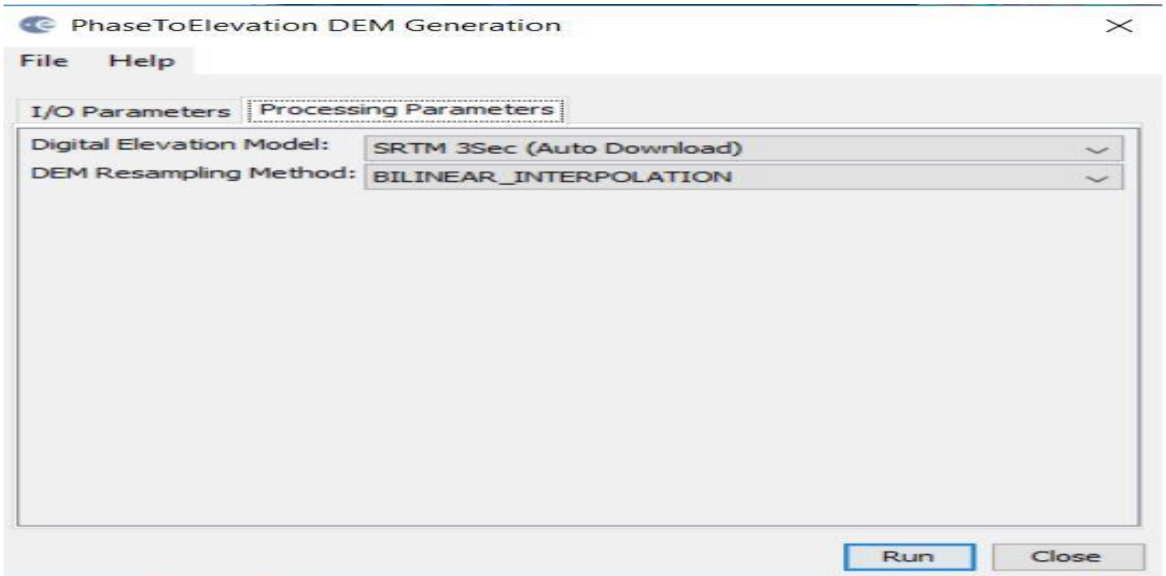


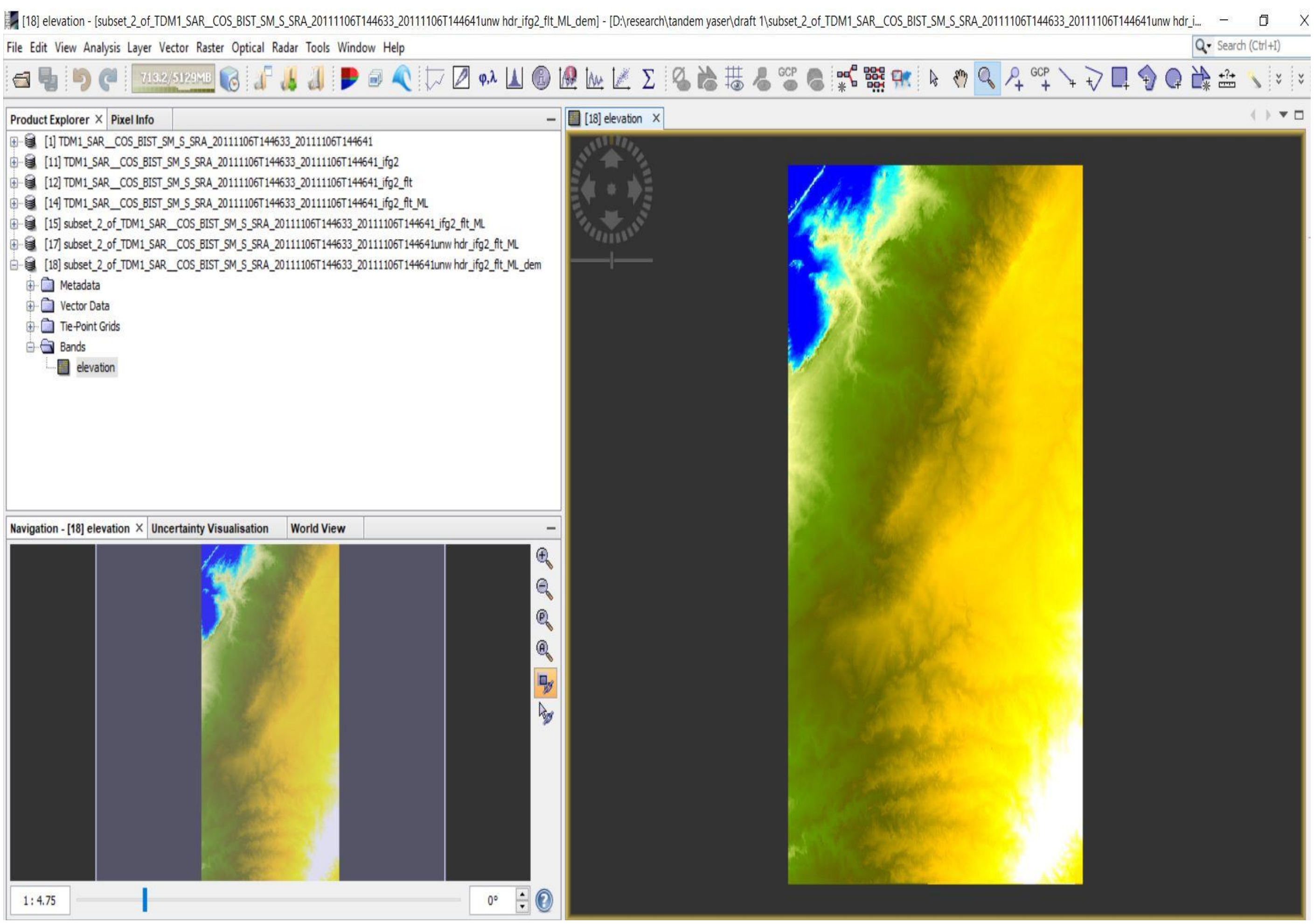


Phase Unwrapping after processing



Phase to elevation





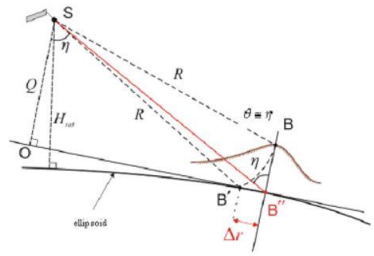
Range Doppler Terrain Correction

Orthorectification

Range Doppler Terrain Correction Operator

Due to topographical variations of a scene and the tilt of the satellite sensor, distances can be distorted in the SAR images. Image data not directly at the sensor's Nadir location will have some distortion. Terrain corrections are intended to compensate for these distortions so that the geometric representation of the image will be as close as possible to the real world.

The geometry of topographical distortions in SAR imagery is shown below. Here we can see that point **B** with elevation **h** above the ellipsoid is imaged at position **B'** in SAR image, though its real position is **B"**. The offset Δ_r between B' and **B"** exhibits the effect of topographic distortions.



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

Orthorectification Algorithm

The Range Doppler Terrain Correction Operator implements the Range Doppler orthorectification method [1] for geocoding SAR images from single 2D raster radar geometry. It uses available orbit state vector information in the metadata or external precise orbit (only for ERS and ASAR), the radar timing annotations, the slant to ground range conversion parameters together with the reference DEM data to derive the precise geolocation information.

DEM Supported

Currently, only the DEMs with geographic coordinates (P_{lat}, P_{lon}, P_h) referred to global geodetic ellipsoid reference WGS84 (and height in meters) are properly supported.

Various different types of Digital Elevation models can be used (ACE, GETASSE30, ASTER, SRTM 3Sec GeoTiff).

The STRM v.4 (3" tiles) from the Joint Research Center FTP (xftp.jrc.it) will automatically be downloaded in tiles for the area covered by the image to be orthorectified. The tiles will be downloaded to the folder .snap\AuxData\DEMs\SRTM_DEM\tiff. The .snap folder is located in your user folder.

Please note that for ACE and SRTM, the height information (being referred to geoid EGM96) is automatically corrected to obtain height relative to the WGS84 ellipsoid. For Aster Dem height correction is not yet applied.

Note also that the SRTM DEM covers area between -60 and 60 degrees latitude. Therefore, for orthorectification of product of high latitude area, different DEM should be used.

User can also use external DEM file in Geotiff format which, as specified above, must be with geographic coordinates (P_{lat}, P_{lon}, P_h) referred to global geodetic ellipsoid reference WGS84 (and height in meters).

Pixel Spacing

Besides the default suggested pixel spacing computed with parameters in the metadata, user can specify output pixel spacing for the orthorectified image.

The pixel spacing can be entered in both meters and degrees. If the pixel spacing in one unit is entered, then the pixel spacing in another unit is computed automatically.

The calculations of the pixel spacing in meters and in degrees are given by the following equations:

pixelSpacingInDegree = pixelSpacingInMeter / EquatorialEarthRadius * 180 / PI;

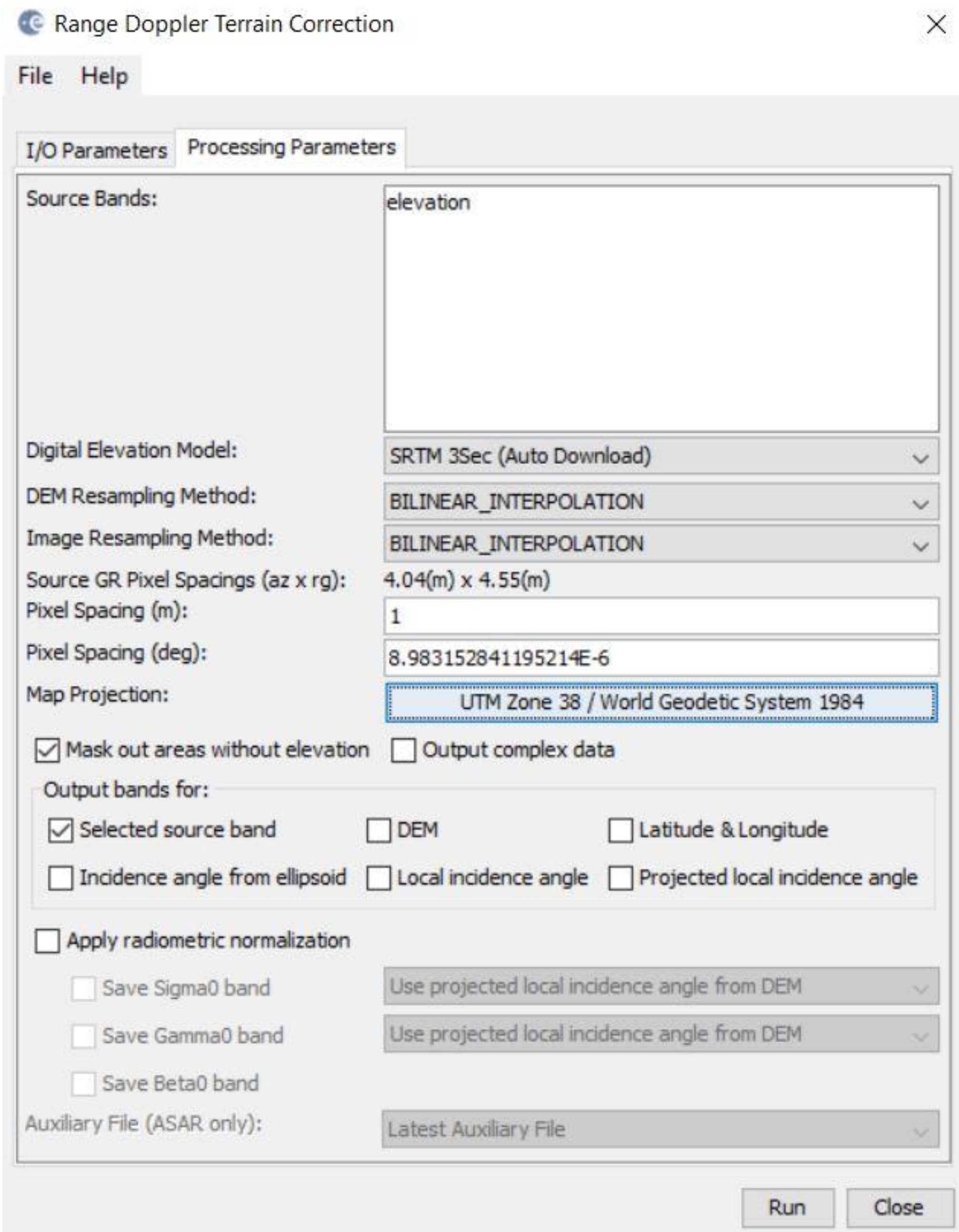
pixelSpacingInMeter = pixelSpacingInDegree * PolarEarthRadius * PI / 180;

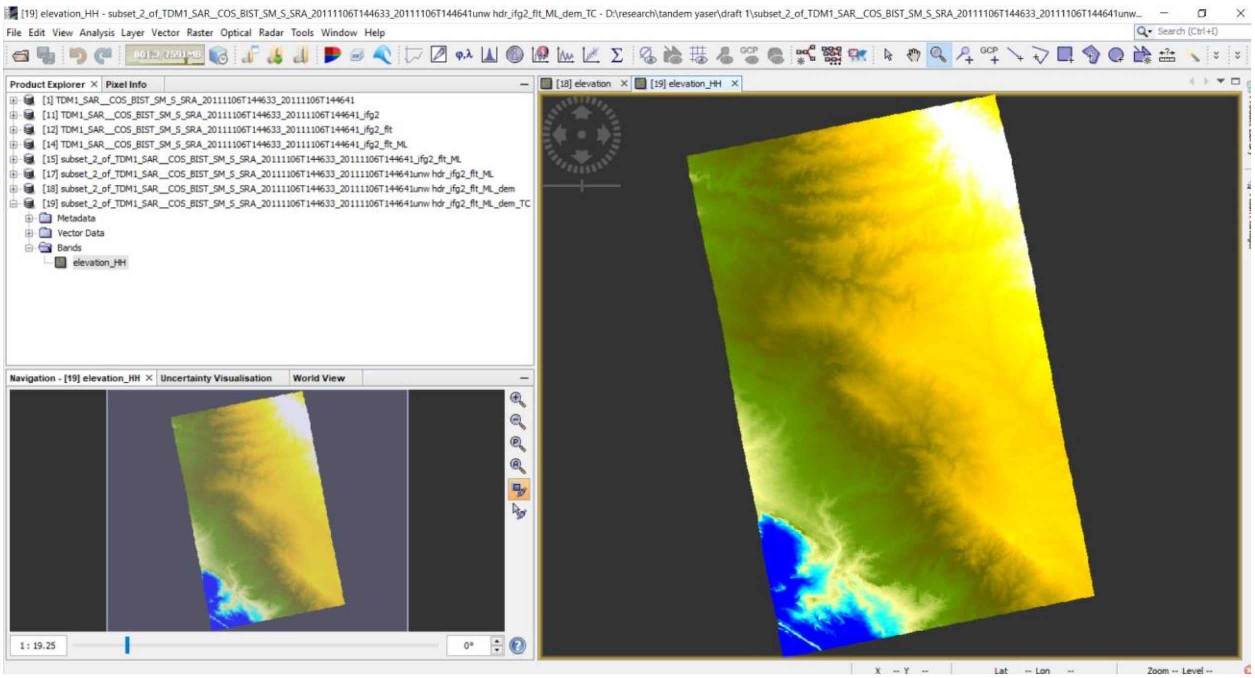
where EquatorialEarthRadius = 6378137.0 m and PolarEarthRadius = 6356752.314245 m as given in WGS84.

Radiometric Normalization

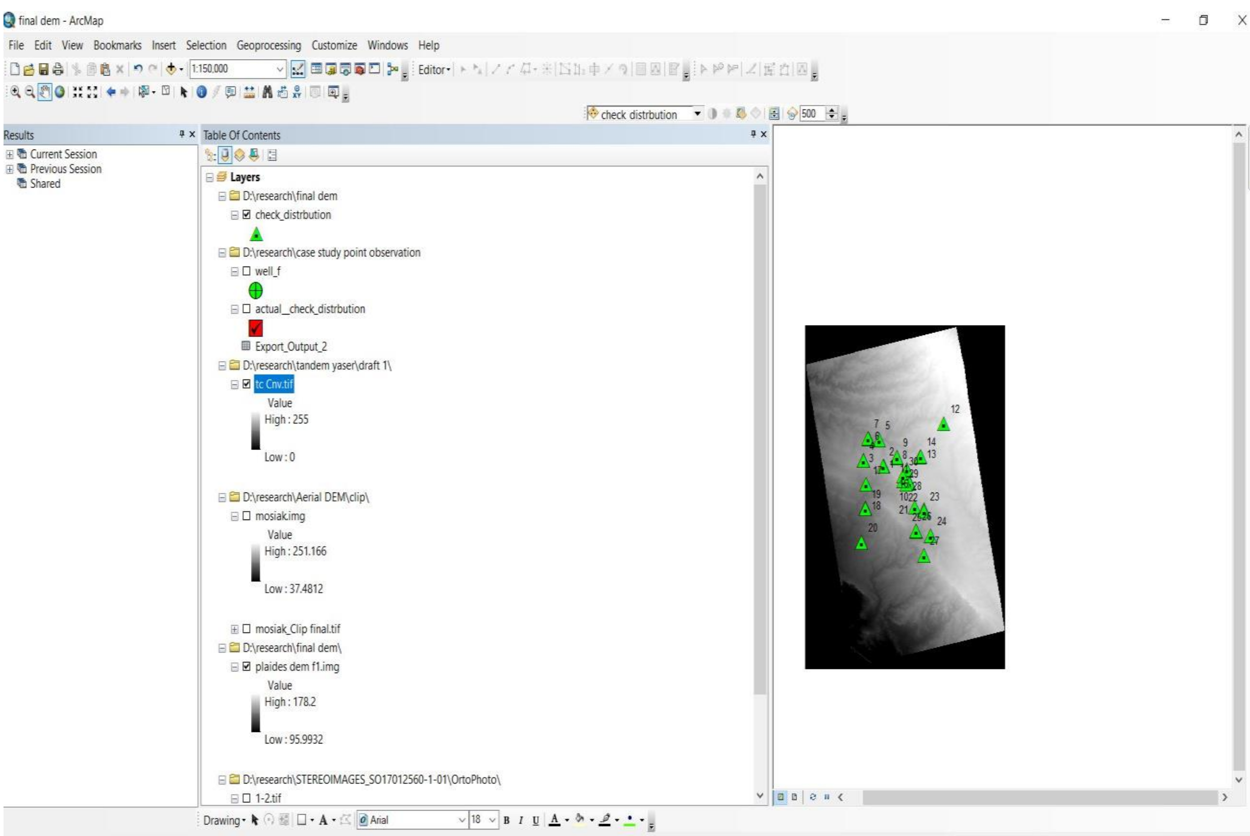
This option implements a radiometric normalization based on the approach proposed by Kellndorfer et al., TGRS, Sept. 1998 where

$$\sigma^0_{NORLIM} = \sigma^0_{Ellipsoid} \frac{\sin \vartheta_{DEM}}{\sin \vartheta_{Ellipsoid}}$$


Range Doppler Terrain Correction
File
Help
I/O Parameters
Processing Parameters
Source Bands:
elevation
Digital Elevation Model:
SRTM 3Sec (Auto Download)
DEM Resampling Method:
BILINEAR_INTERPOLATION
Image Resampling Method:
BILINEAR_INTERPOLATION
Source GR Pixel Spacings (az x rg):
4.04(m) x 4.55(m)
Pixel Spacing (m):
1
Pixel Spacing (deg):
8.983152841195214E-6
Map Projection:
UTM Zone 38 / 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



Open in arc map



result

OBJECTID	point	X	Y	Z gnss	z radar
1	1	727744.659	3582771.429	164.507	162
2	2	727727.137	3582776.567	163.967	159
3	3	726753.657	3582981.143	162.808	145
4	4	726776.408	3582987.664	162.265	145
5	5	727532.907	3583772.398	138.351	128
6	6	727020.024	3583810.516	140.885	121
7	7	727003.9	3583835.036	140.637	120
8	8	728378.341	3583092.464	158.52	163
9	9	728387.71	3583110.677	159.602	162
10	10	729001.334	3582129.857	173.761	188
11	11	728991.586	3582105.881	173.843	190
12	12	730649.765	3584424.29	177.654	225
13	13	729505.251	3583124.969	161.025	181
14	14	729516.888	3583145.892	160.235	181
15	15	728856.178	3582605.16	167.827	181
16	16	728861.309	3582626.488	166.948	180
17	17	726899.324	3582082.212	140.049	114
18	18	726865.165	3581134.333	128.564	95
19	19	726860.654	3581132.113	129.04	95
20	20	726682.556	3579799.717	107.512	62
21	21	729241.501	3581173.06	151.65	162
22	22	729683.315	3581085.591	148.32	160
23	23	729674.897	3581036.84	148.472	161
24	24	730018.382	3580063.877	144.058	158
25	25	729294.712	3580242.556	142.379	146
26	26	729301.327	3580249.557	142.258	146
27	27	729686.27	3579317.331	140.359	143
28	28	728819.546	3582061.356	169.231	180
29	29	728663.8	3582197.421	168.495	178
30	30	728671.543	3582392.603	172.726	184