ESA–MOST Dragon 4 Cooperation

ADVANCED LAND REMOTE SENSING INTERNATIONAL TRAINING COURSE

“龙计划4”高级陆地遥感国际培训班

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GLACIER - SAR InSAR DATA PROCESSING IN SNAP

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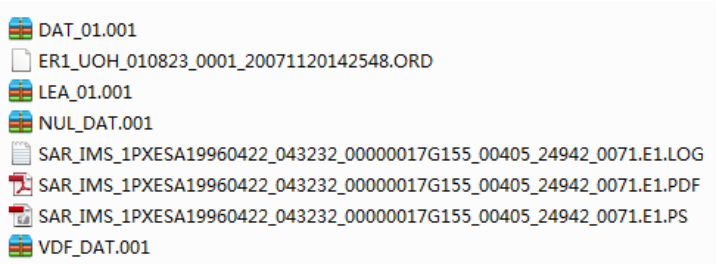
Goals of the Exercise

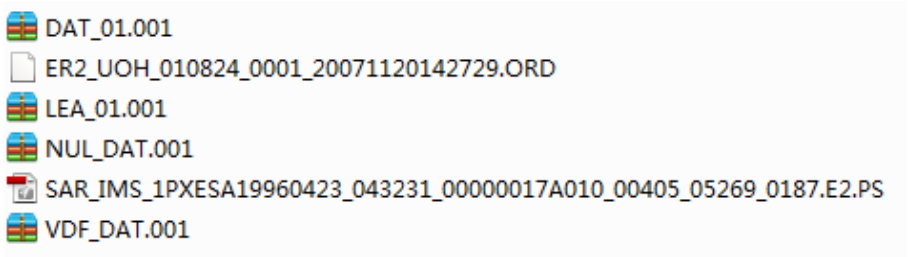
- Familiarize with ESA SNAP
- Training on Glacier InSAR data Using Differential Interferometry (DInSAR)
- Provide instruction on stey-by-step processing of ALOS1 data

  (incl. parameters, tips etc.)
- End-to-End show case

Input Dataset

- **A set of ERS SLCs**





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

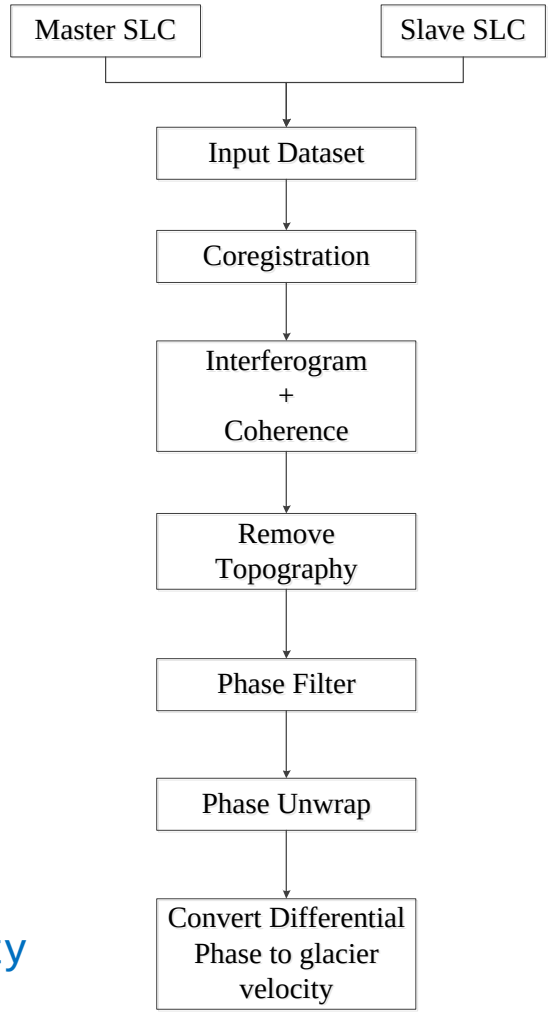
  srtm_55_06.zip

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

Interferometric Processing

Processing Steps

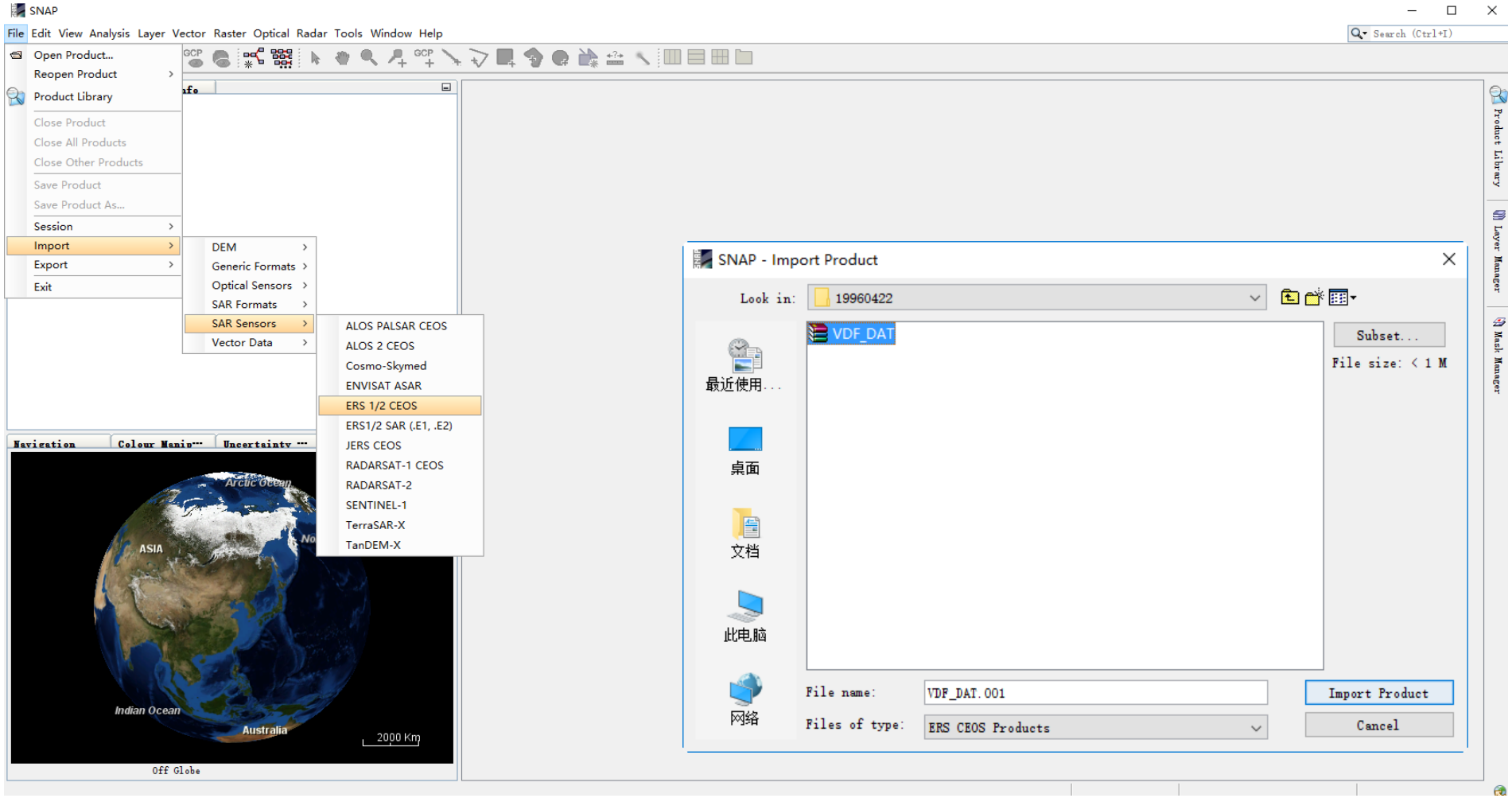
- Open a pair of ERS SLC Products
- Apply InSAR Optimized Coregistration
- Generate Interferogram and Coherence
- Apply Topographic Phase Removal
- Goldstein Phase Filtering
- Phase Unwrapping(SANPHU)
- Convert Differential Phase to glacier velocity



Part one: Open a pair of ERS SLC products

Step1-Open the products:

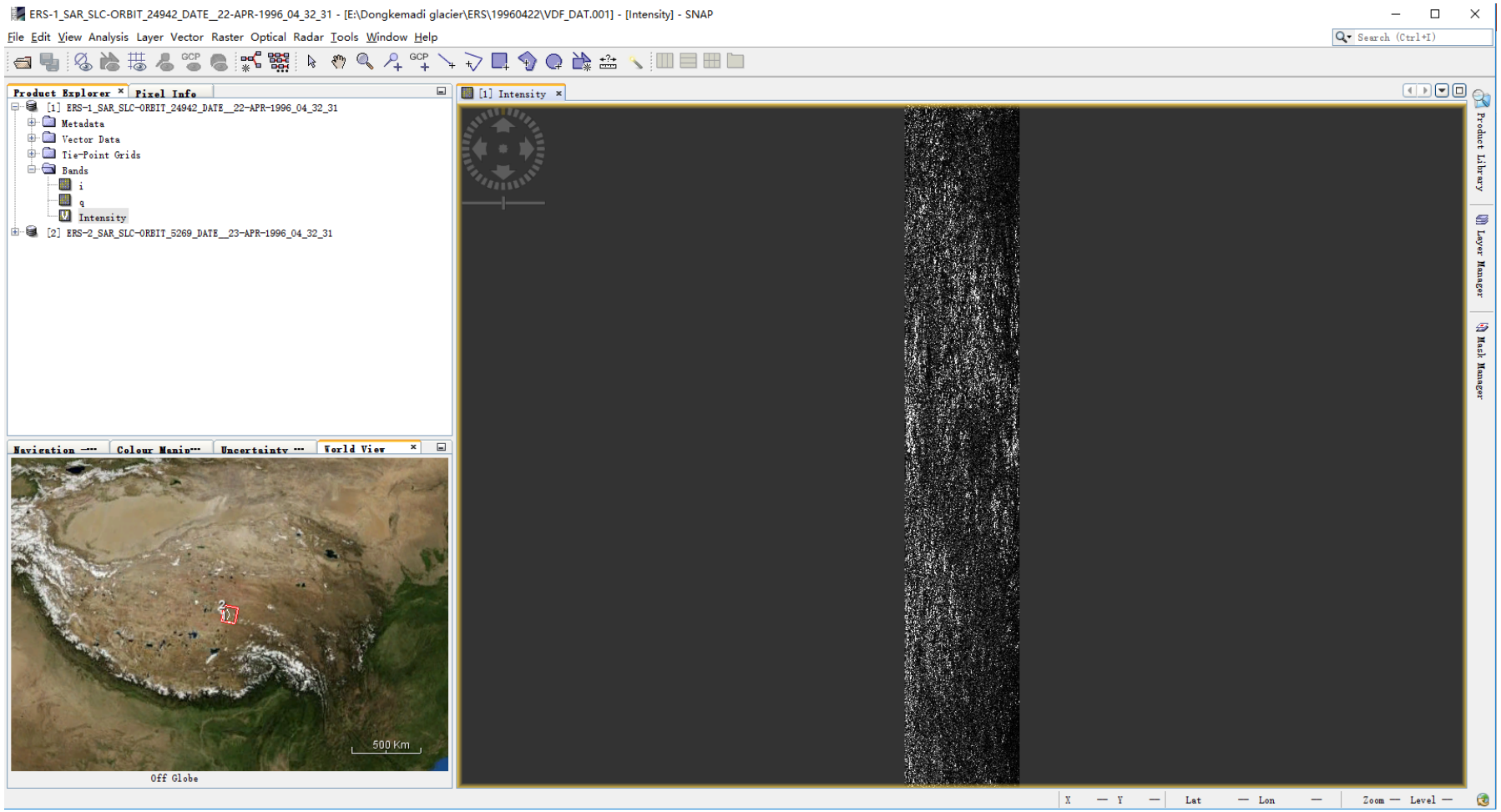
Use the Import button in the top toolbar and browse for the location of the products. Select the ERS 1/2 CEOS file from the product folder and press Import Product.



Part one: Open a pair of ERS SLC products

Step2-View the product:

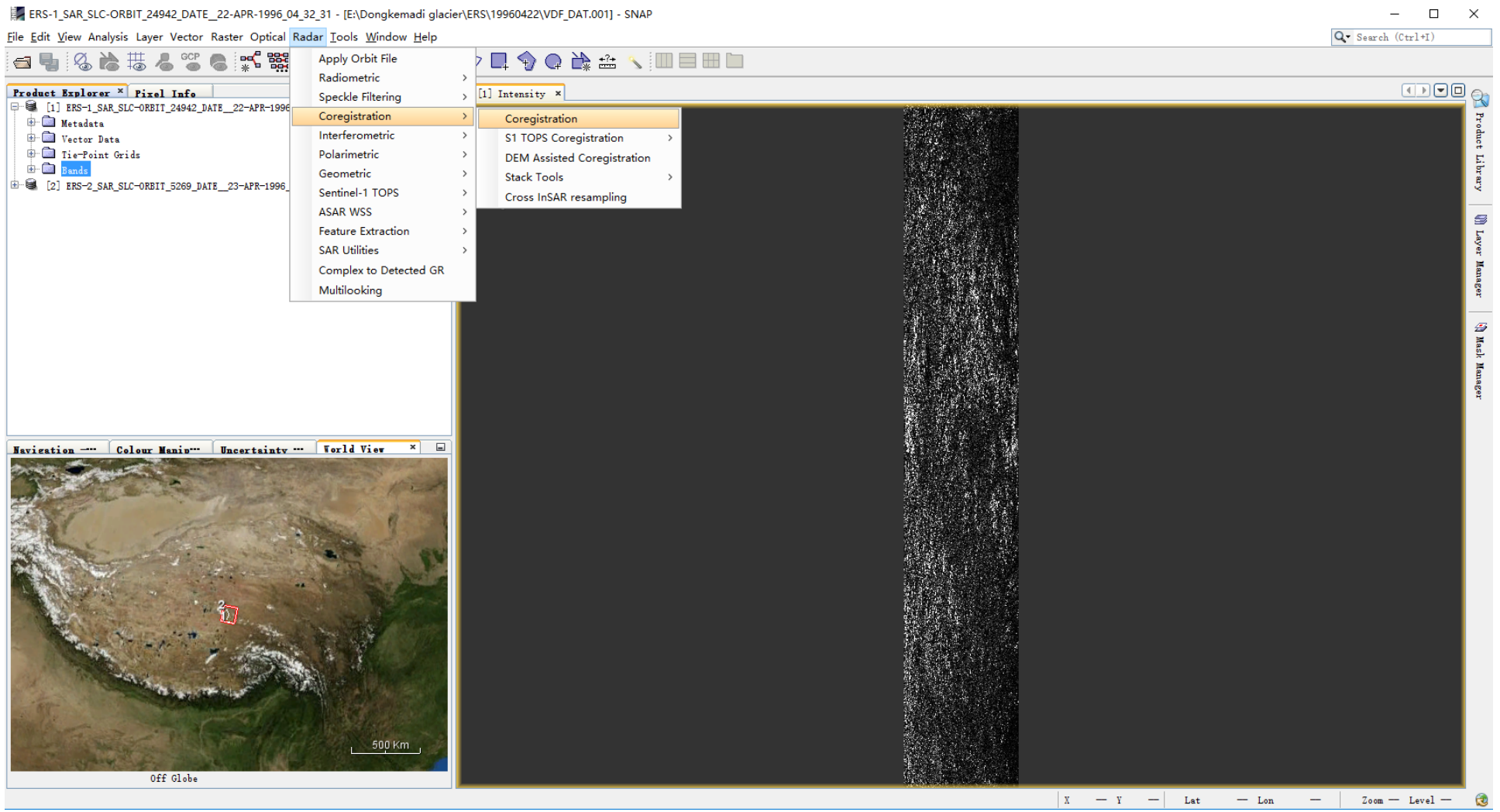
In the Products View you will see the opened products. Within the product bands, you will find three bands containing the real(i) , imaginary(q) and intensity .



Products View

Part two: Coregistering the Data

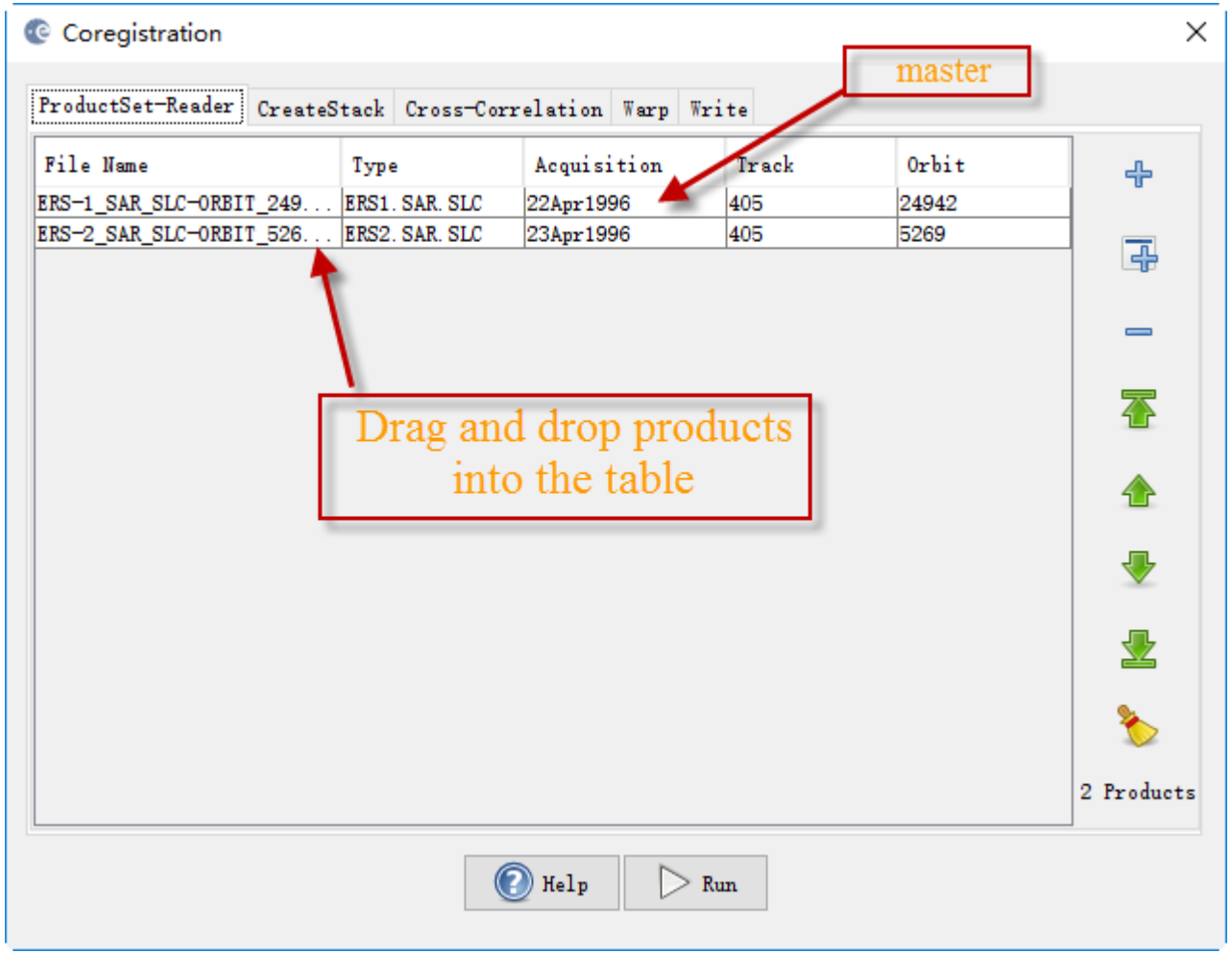
Step3-Coregister the images into a stack: Select Coregistration in the Coregistration menu.



Select Coregistration

Part two: Coregistering the Data

Drag and drop first the subset product. This will be your master image. Then drag and drop the other product. This will be your slave image.

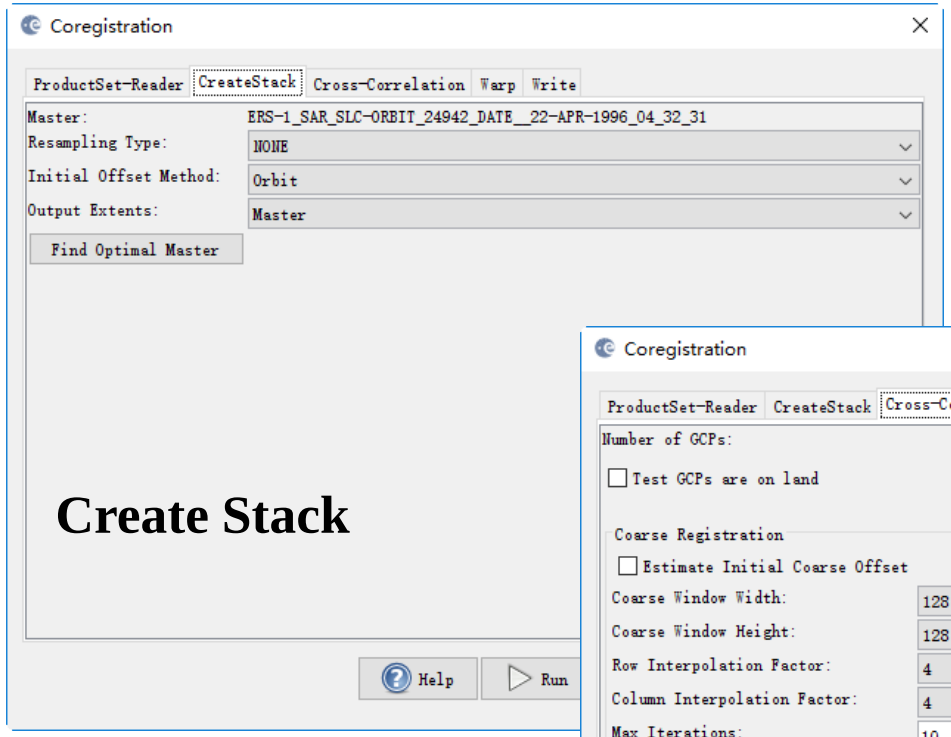


Add products into the Coregistration Dialog

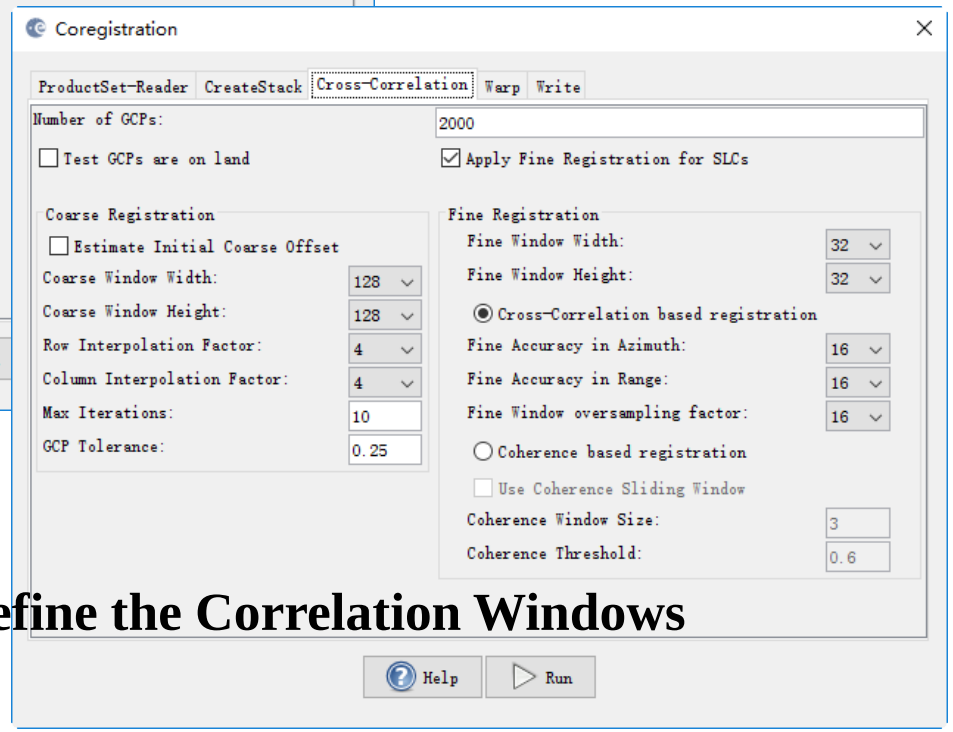
Part two: Coregistering the Data

In the Create Stack tab, the bands for master image and slave images should already be selected for you based on the order of the products given in the previous table.

In the Cross-Correlation tab, specify the number of Ground Control Points (GCPs) to use. The GCPs will be used as the center of a cross correlation window which will find the corresponding position from the slave image to the master image.



Create Stack

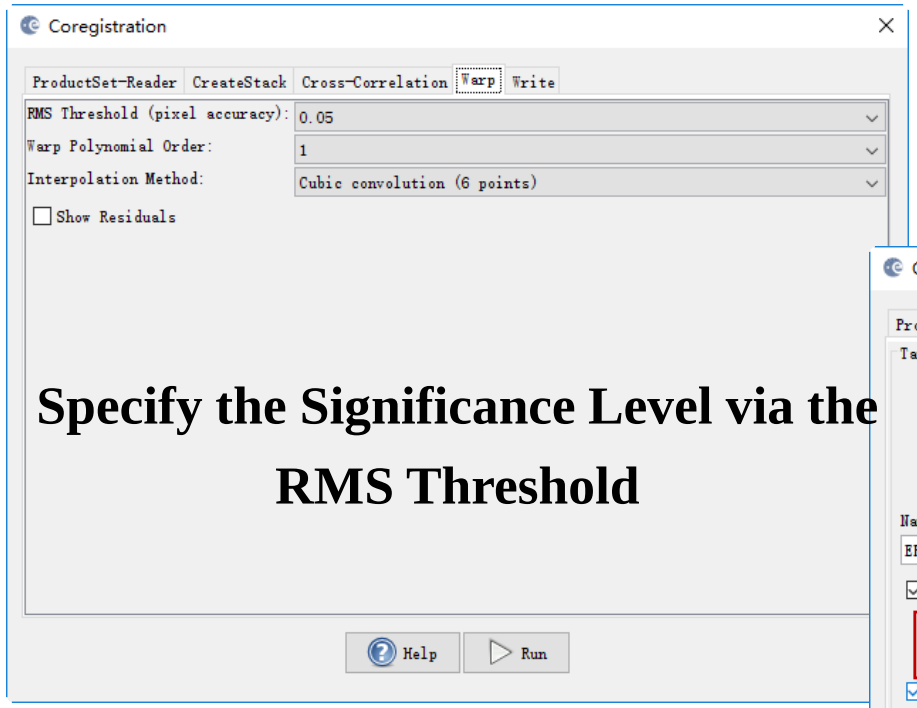


Define the Correlation Windows

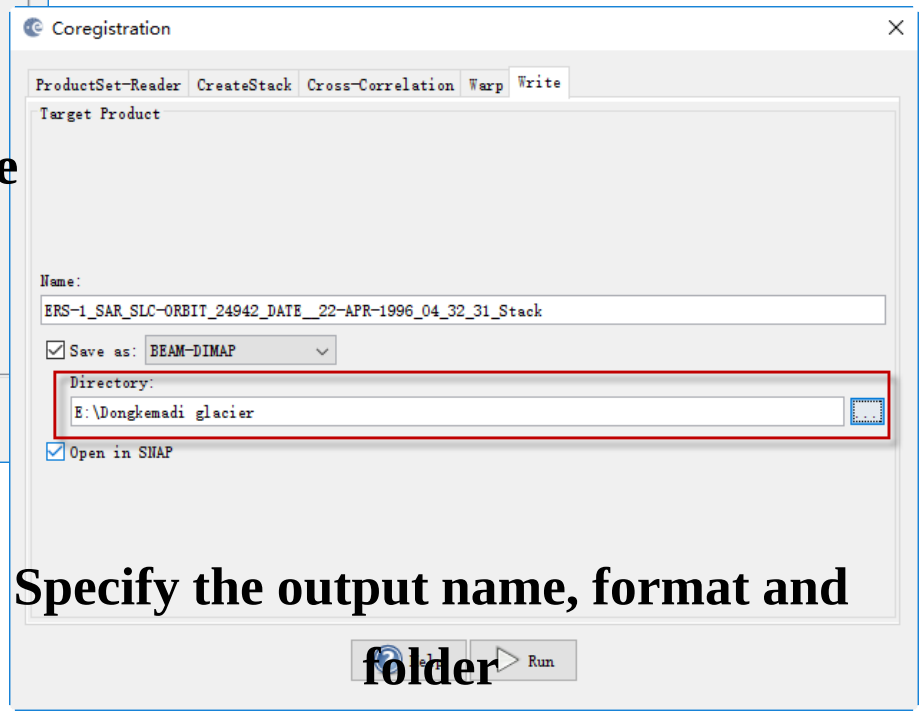
Part two: Coregistering the Data

In the Warp tab, the warp polynomial order applies a linear translation for order 1. Higher order warps should only be used when the images have been greatly distorted.

In the Write tab, specify the output folder and the target product name.



Specify the Significance Level via the RMS Threshold



Specify the output name, format and folder

Part three: Interferogram Formation and Coherence Estimation

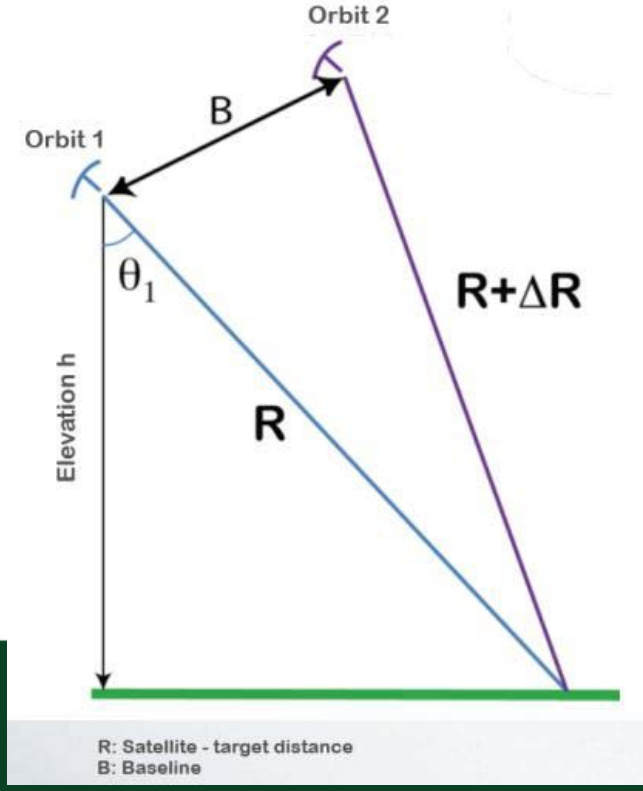
The interferogram is formed by cross multiplying the master image with the complex conjugate of the slave. The amplitude of both images is multiplied while the phase represents the phase difference between the two images.

The interferometric phase variation $\Delta\emptyset$ is then proportional to ΔR divided by the transmitted wavelength λ.

$$\emptyset_1 = \frac{4\pi R}{\lambda}$$

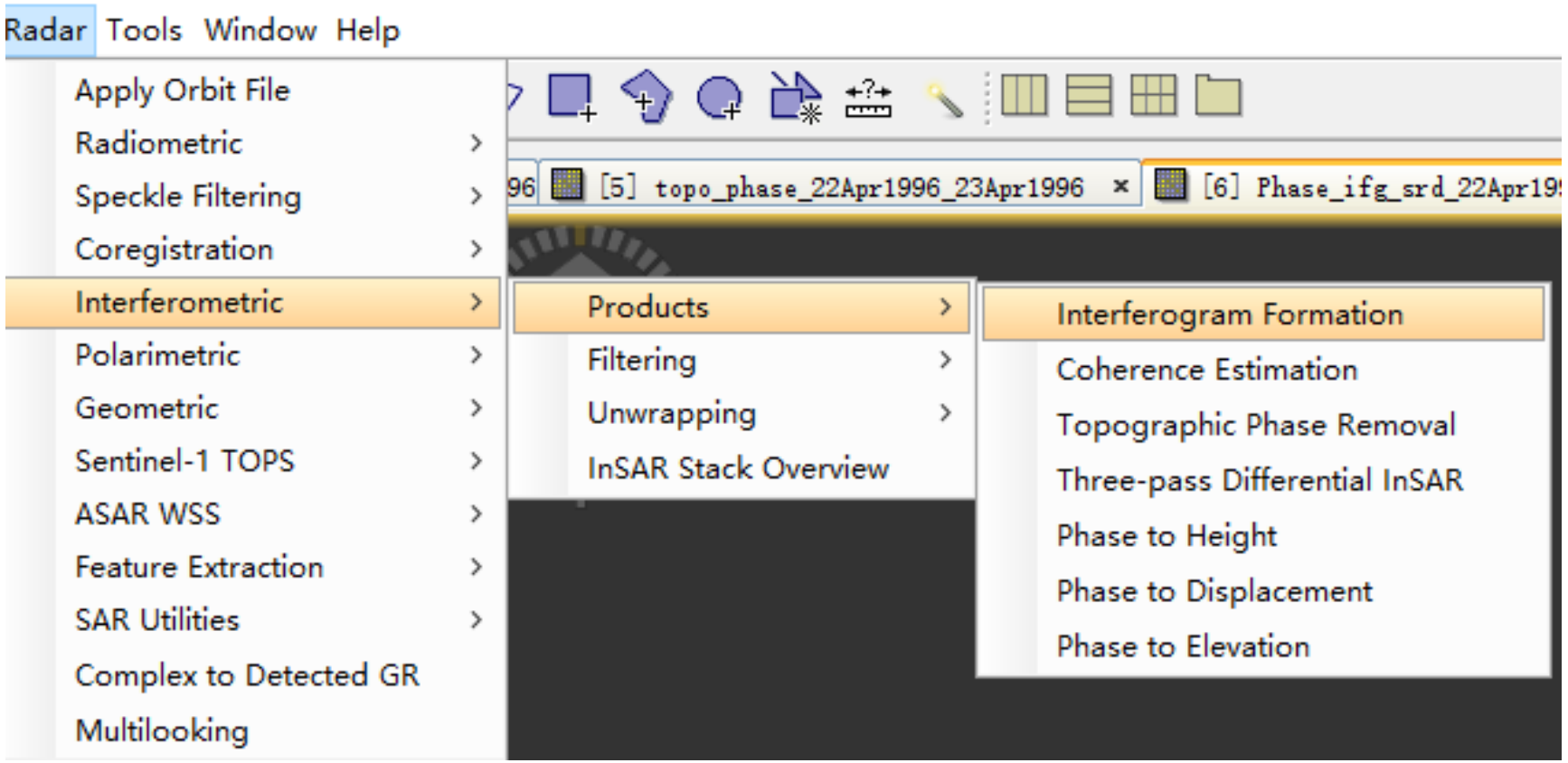
$$\emptyset_2 = \frac{4\pi(R + \Delta R)}{\lambda}$$

$$\Delta\emptyset = \emptyset_2 - \emptyset_1 = \frac{4\pi\Delta R}{\lambda}$$



Part three: Interferogram Formation and Coherence Estimation

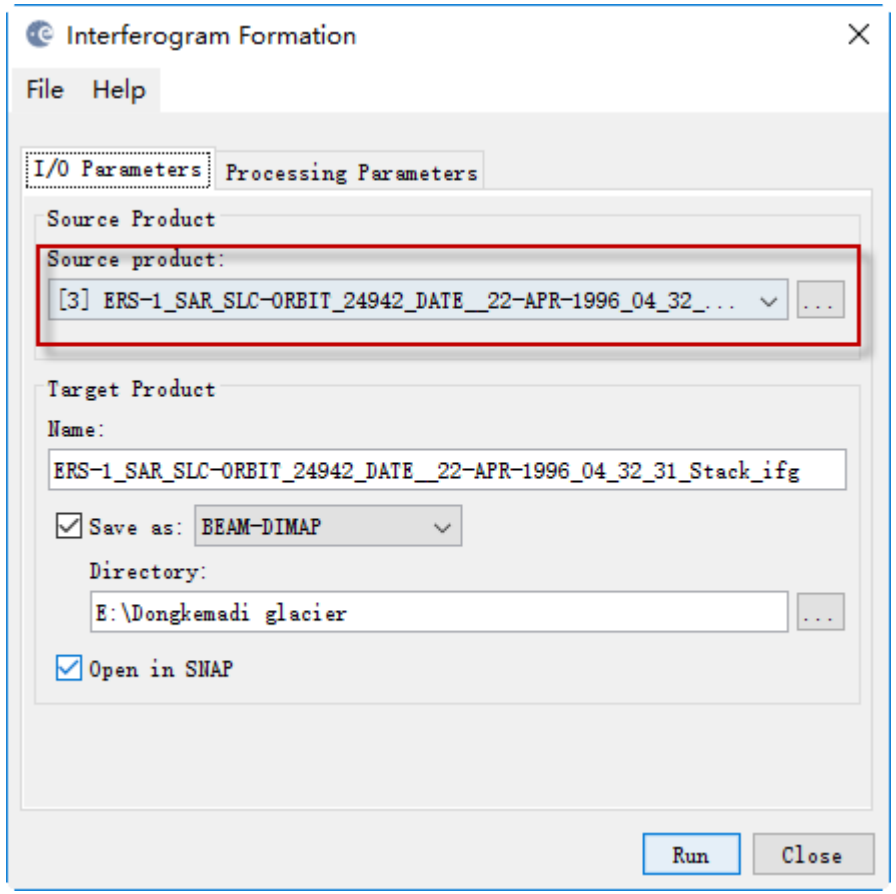
Step4-Form the Interferogram: Select the stack and select **Interferogram Formation** from the **InSAR Products** menu

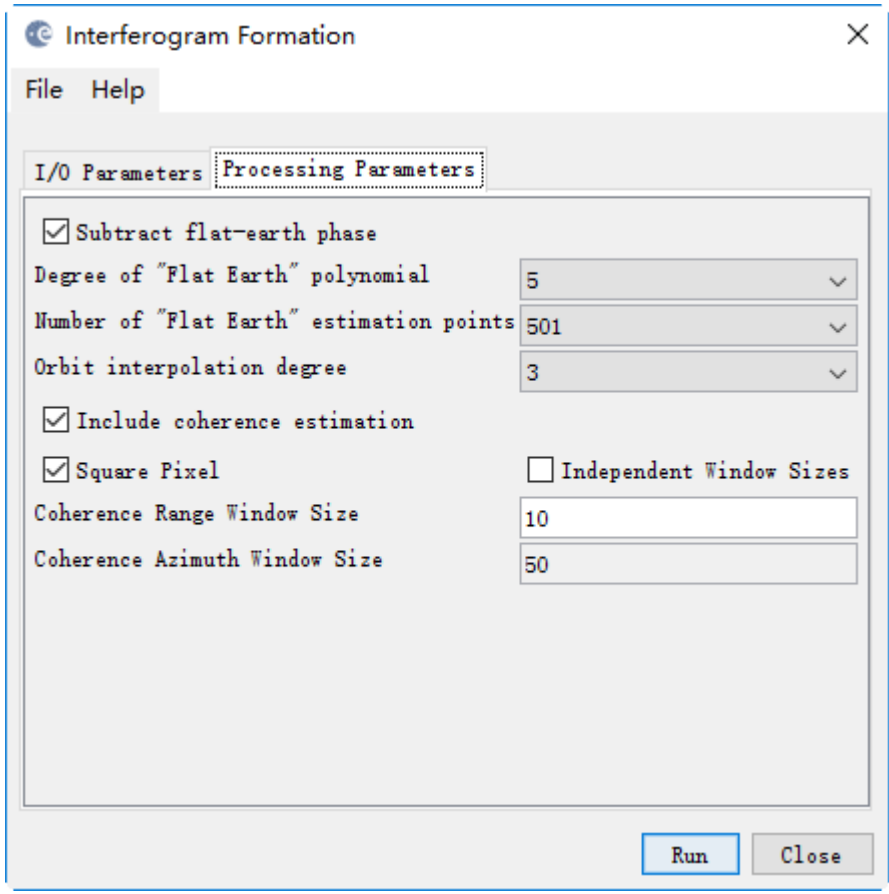


Select Interferogram Formation

Part three: Interferogram Formation and Coherence Estimation

In the interferogram formation step we shall remove the flat-Earth phase. The flat-Earth phase is the phase present in the interferometric signal due to the curvature of the reference surface.

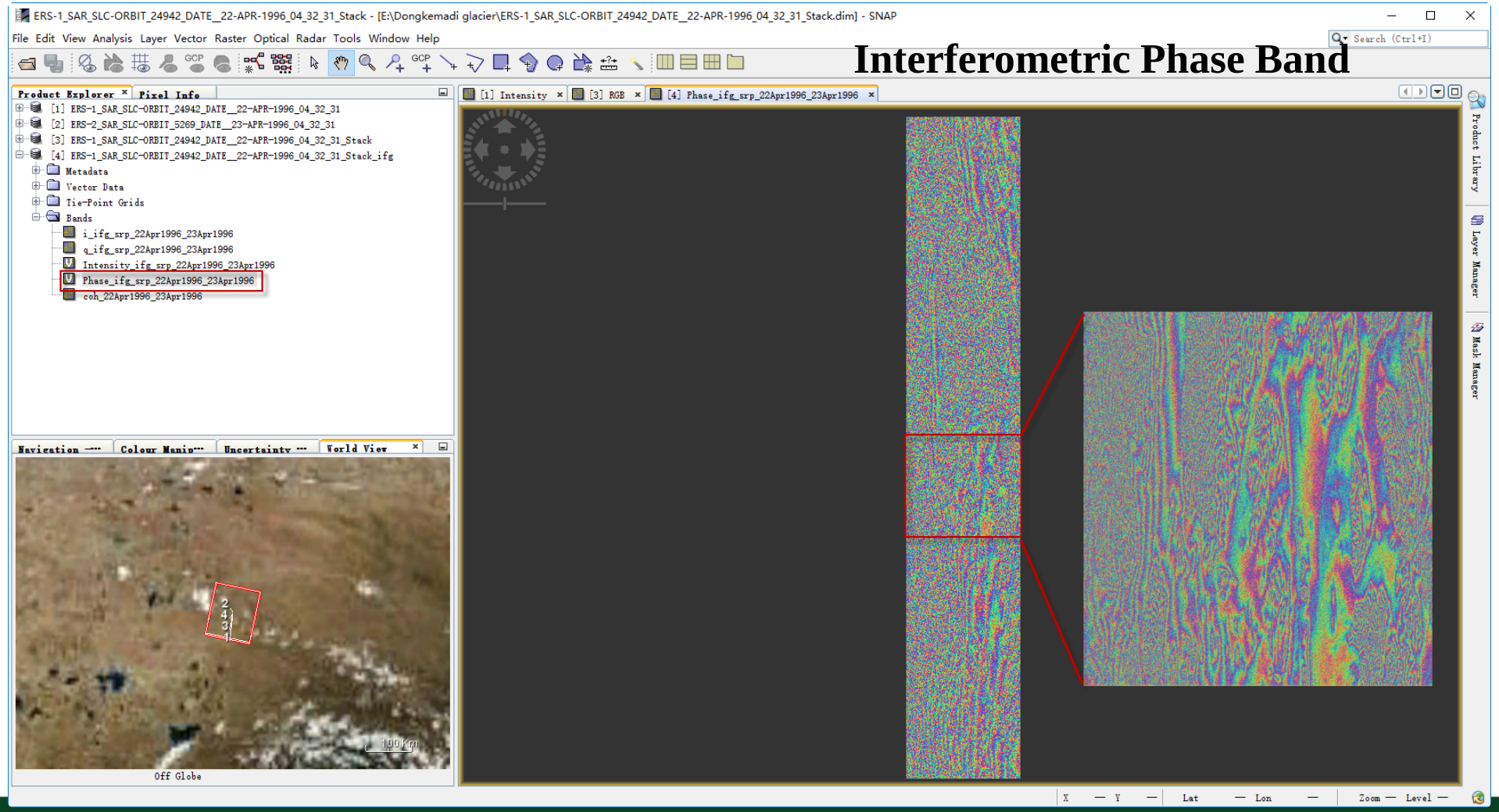




Interferogram Dialog

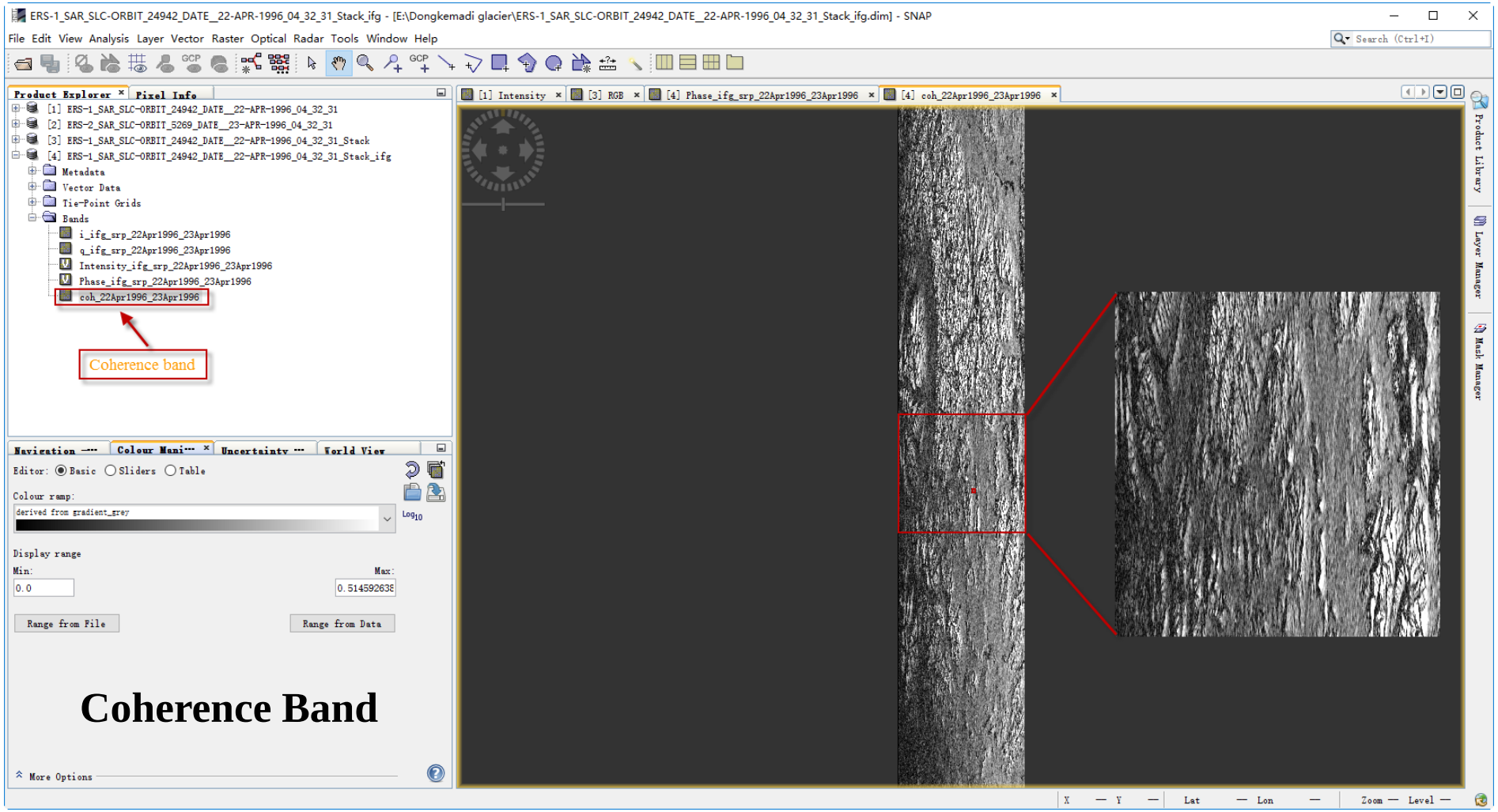
Part three: Interferogram Formation and Coherence Estimation

The interferogram product produced will contain a band for the interferometric phase.



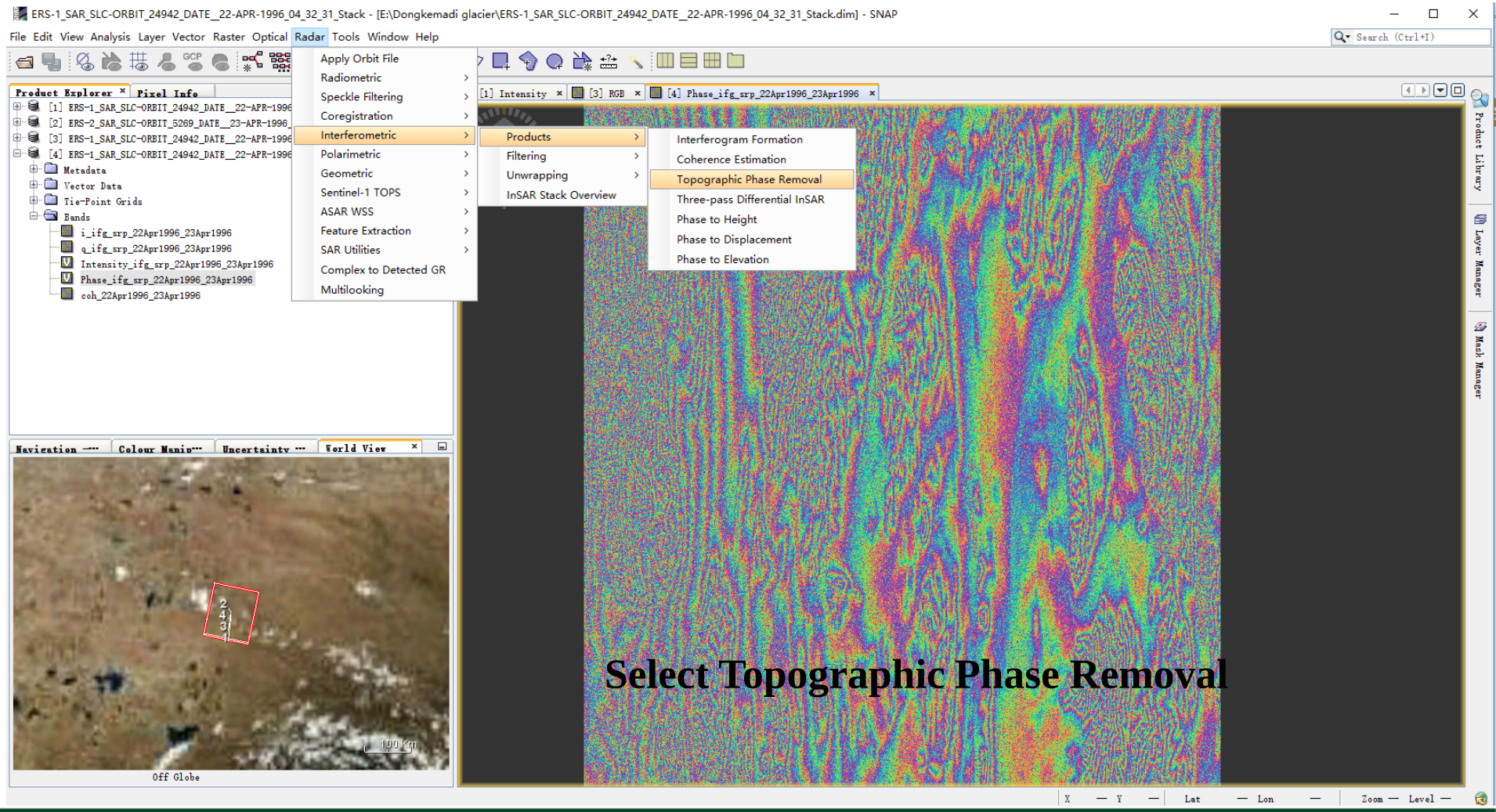
Part three: Interferogram Formation and Coherence Estimation

The interferogram product produced will contain a band for the coherence phase.

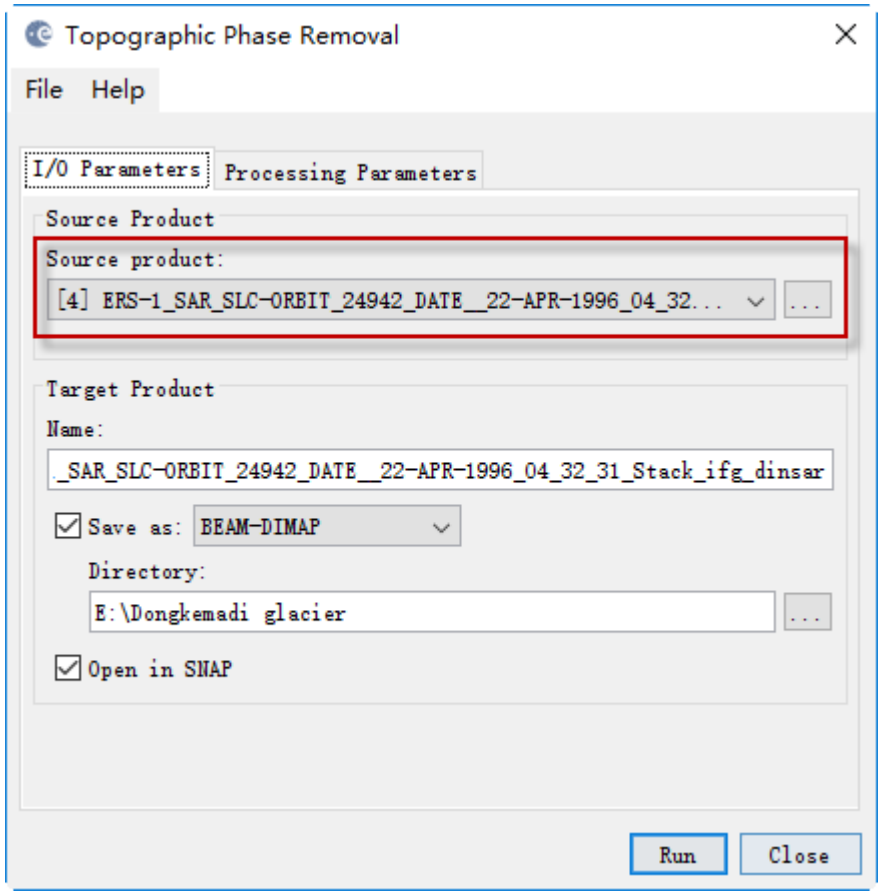


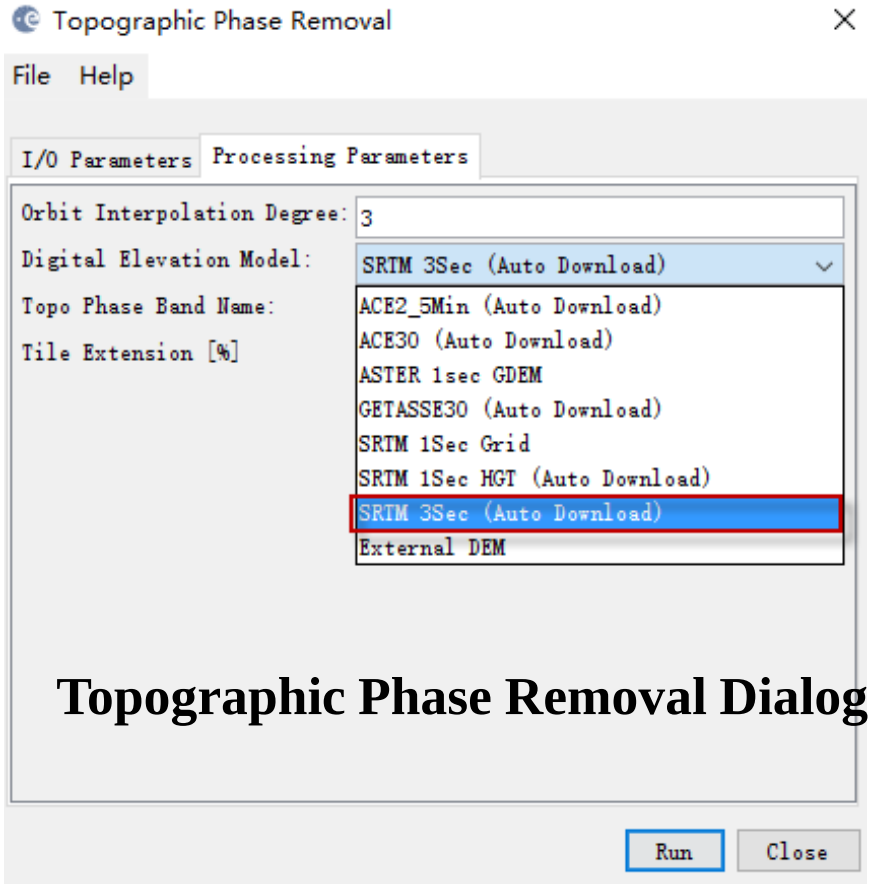
Part four: Topographic Phase Removal

Step5-Remove Topographic Phase: Select the interferogram product and go to the **Interferometric Products** menu. Select **Topographic Phase Removal**.



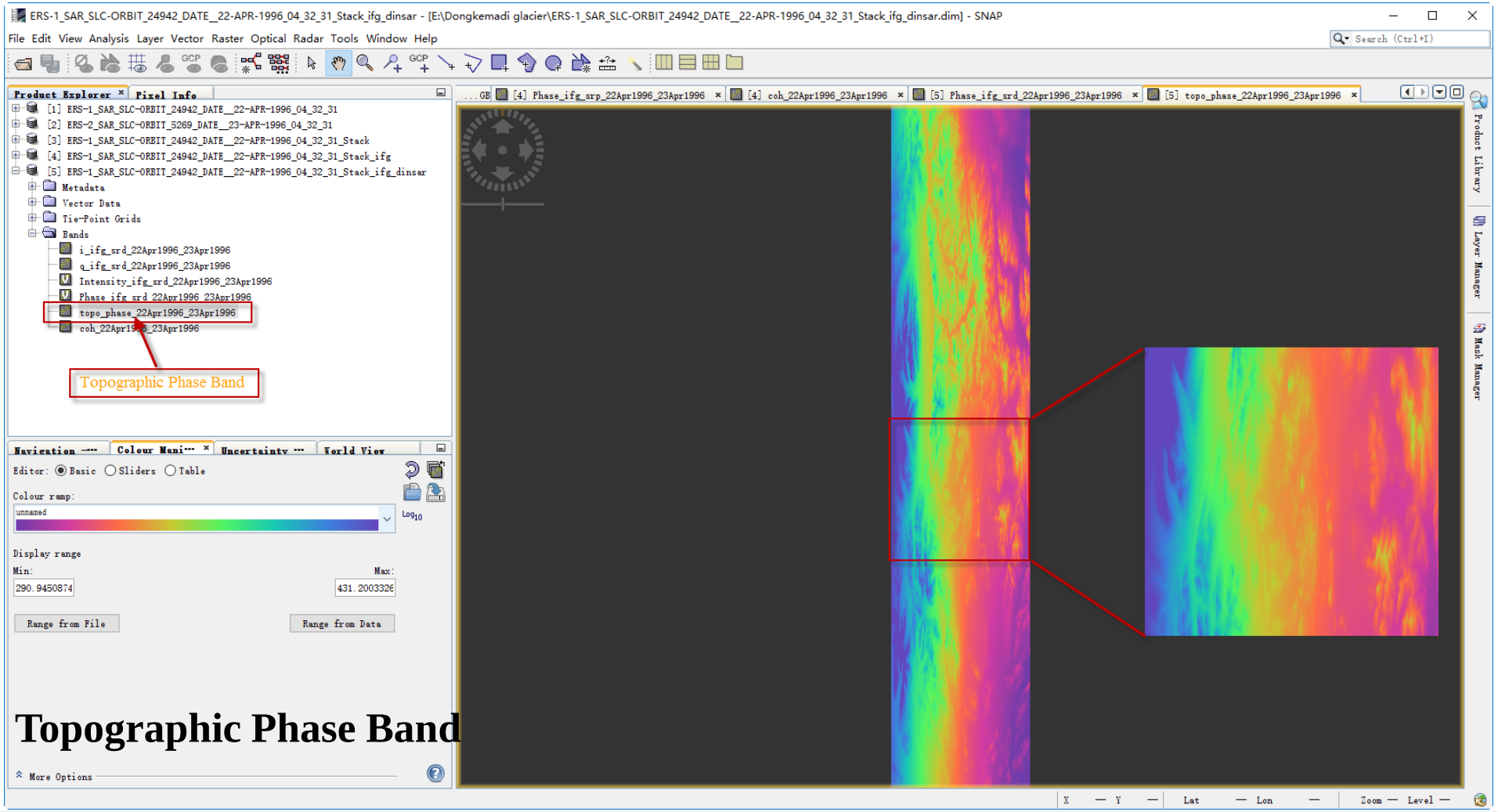
Part four: Topographic Phase Removal



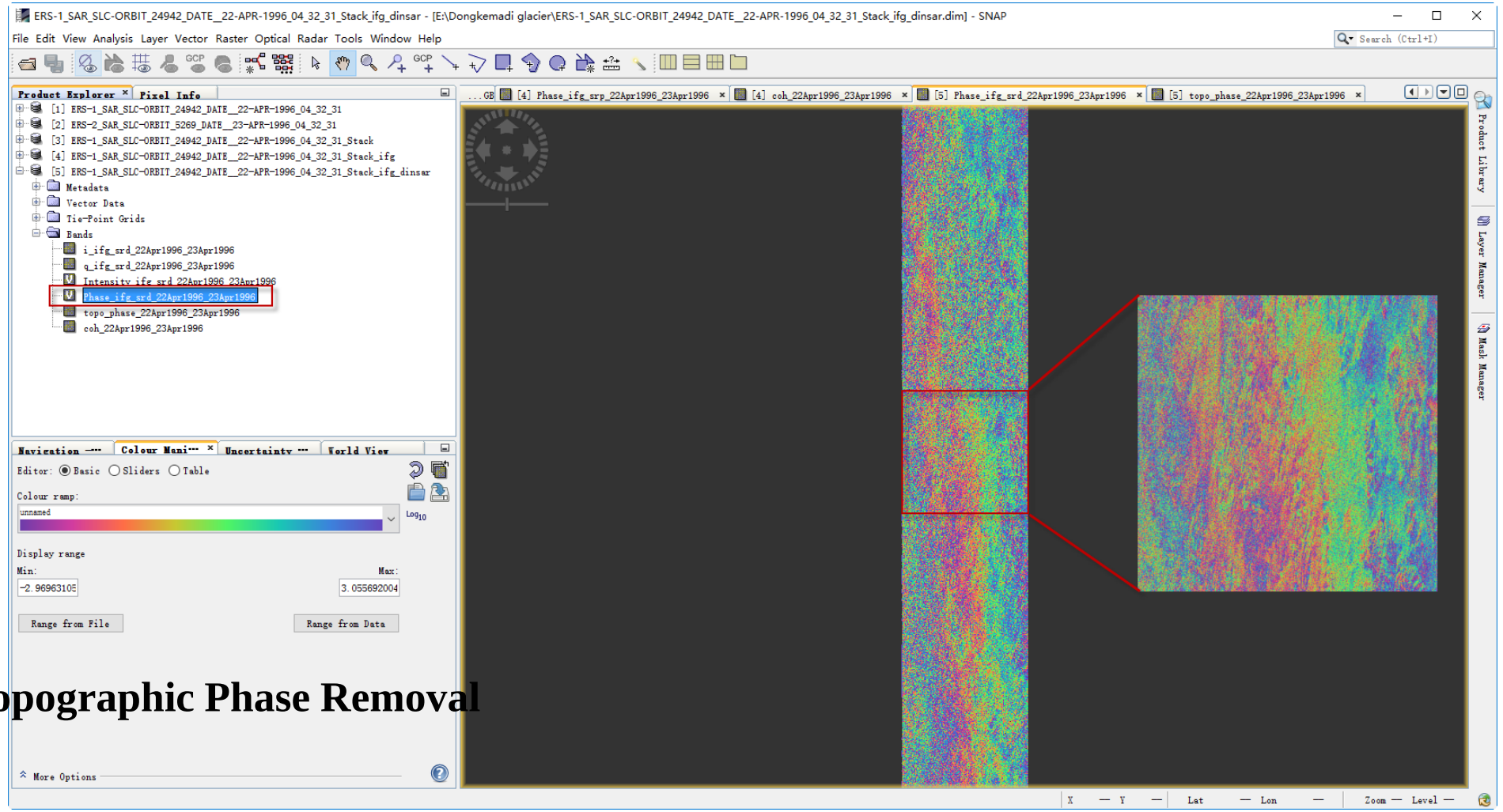


Topographic Phase Removal Dialog

Part four: Topographic Phase Removal



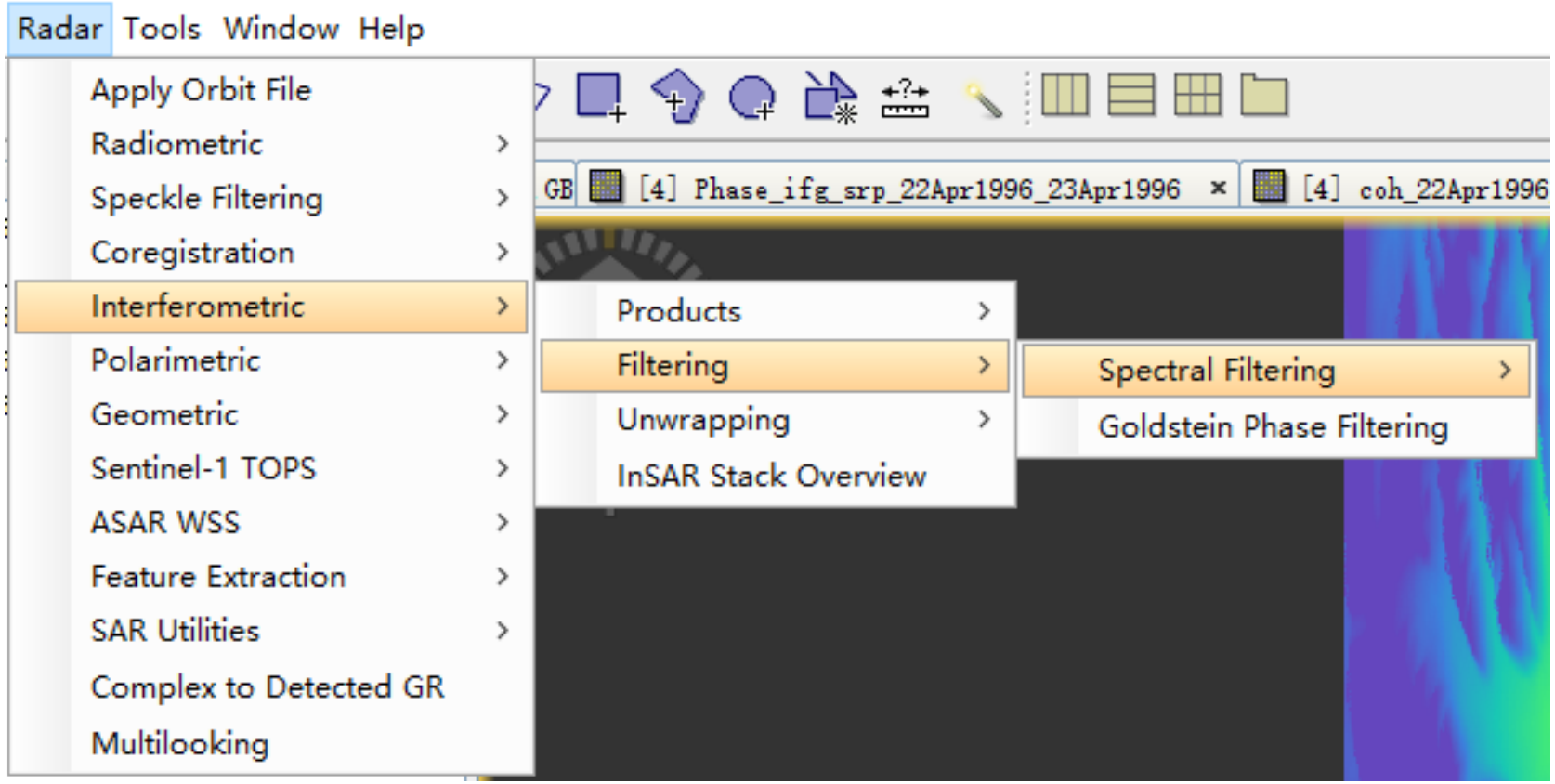
Part four: Topographic Phase Removal



Topographic Phase Removal

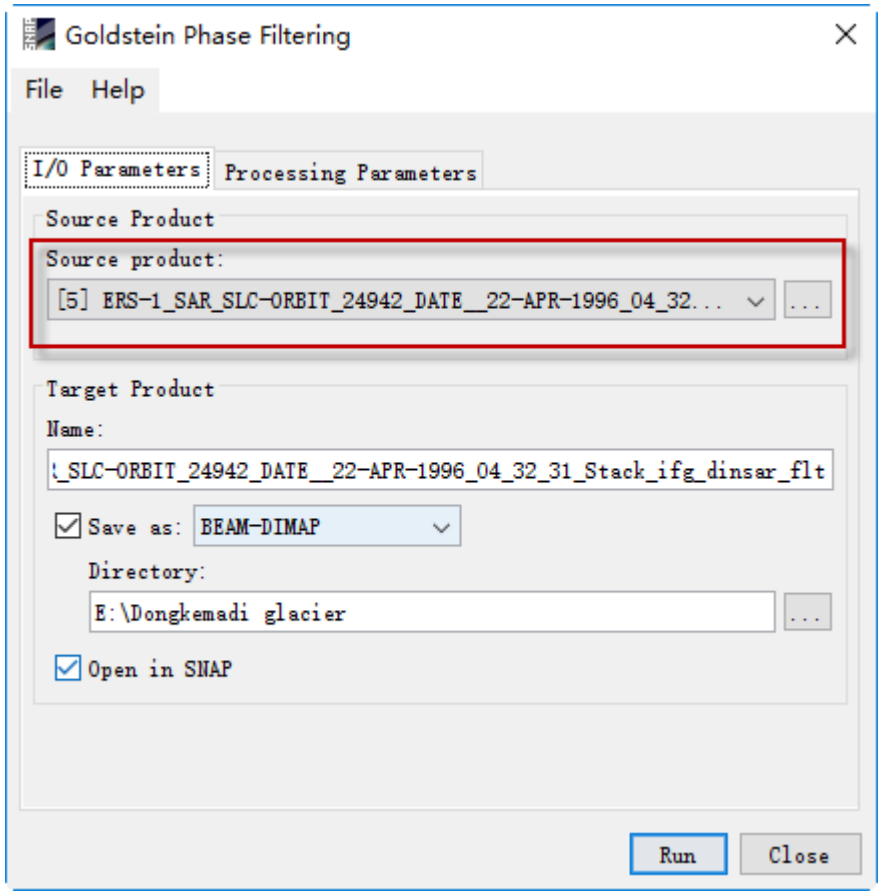
Part five: Phase Filtering

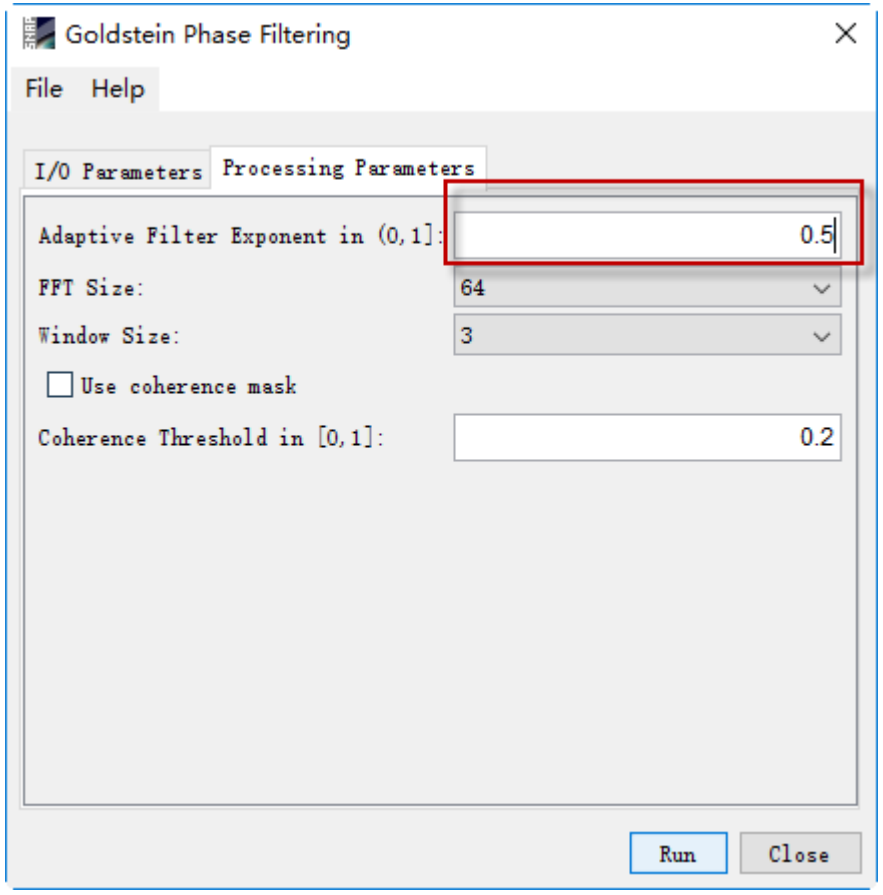
Step6-Phase Filtering: Select the Interferogram product and go to the InSAR Tools menu. Select Goldstein Phase Filtering.



Select Phase Filtering

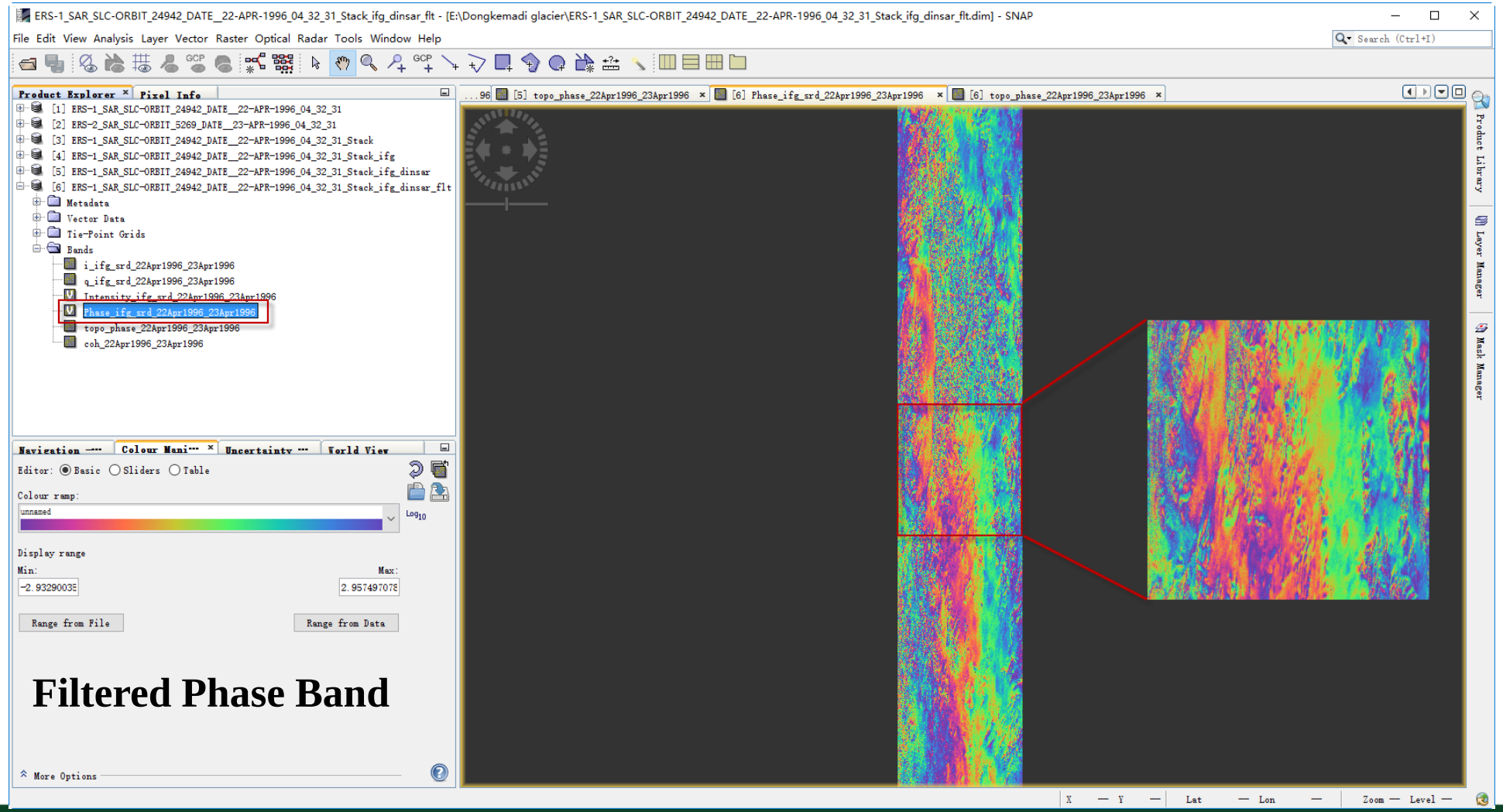
Part five: Phase Filtering





Phase Filtering Dialog

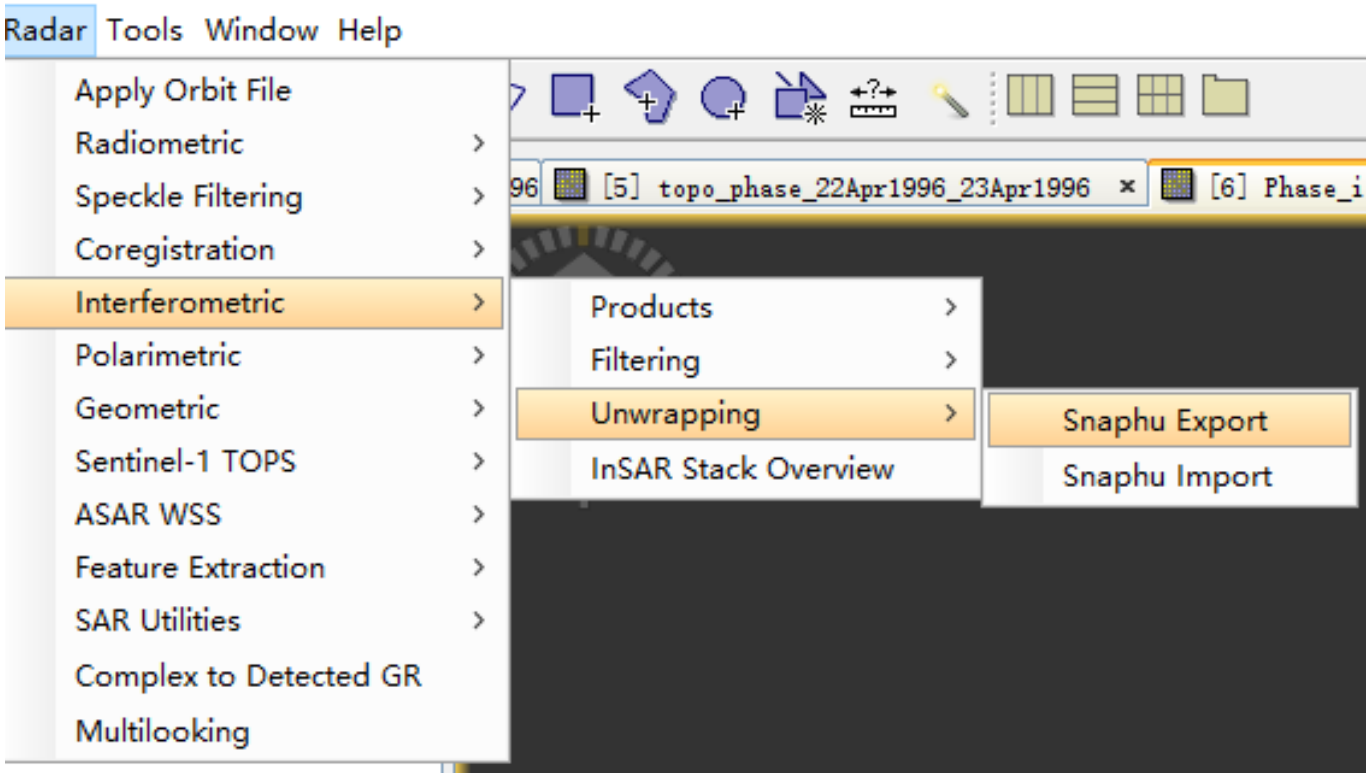
Part five: Phase Filtering



Filtered Phase Band

Part six: Phase Unwrapping

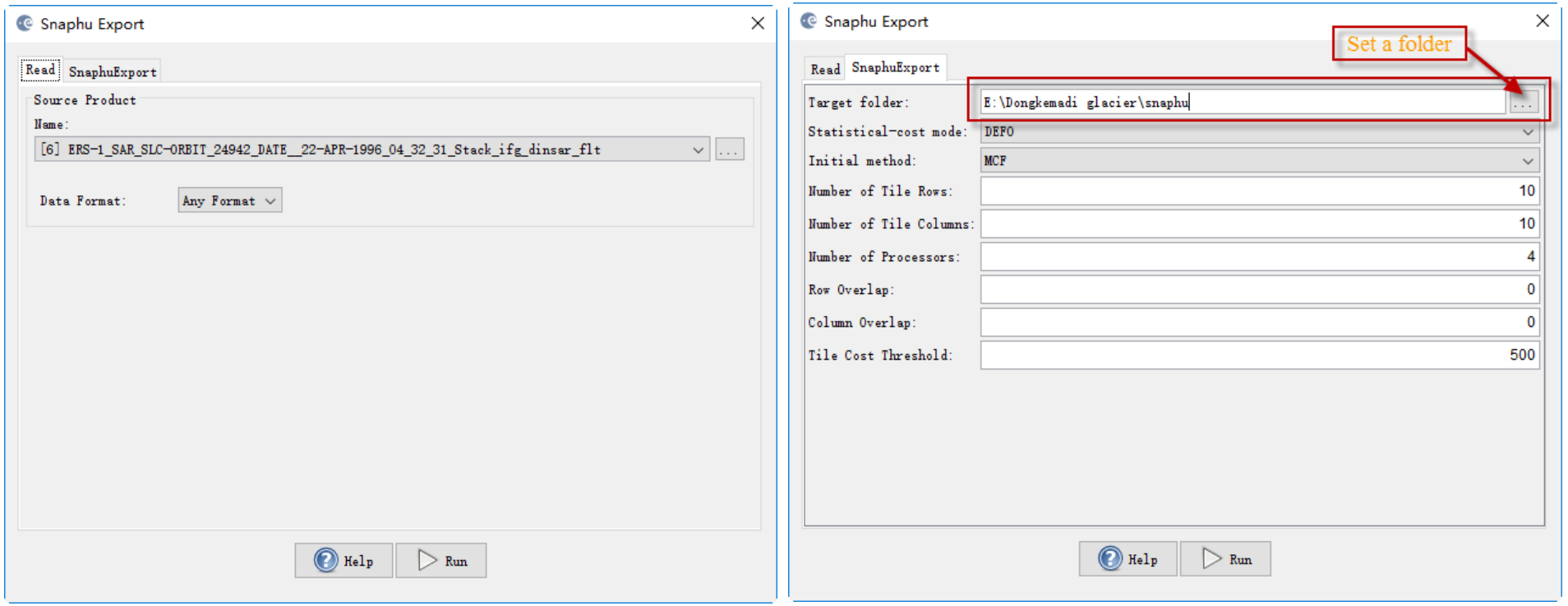
Step7-Export to Snaphu: Export the filtered flattened interferogram to SNAPHU.



Export to Snaphu

Part six: Phase Unwrapping

Select DEFO for deformation mapping.



Snaphu Export

Part seven: Unwrapping with SNAPHU

Snaphu is available for Linux only. Linux users simply need to install the software package by

apt-get install snaphu

Windows users can download a Linux VMWare virtual machine and use it to unwrap the phase.

http://sourceforge.net/projects/s1tbx/files/snaphu_vm/SAR%20Mint%2064.zip/download

The free VMWare Workstation Player can be downloaded from

https://my.vmware.com/web/vmware/downloads

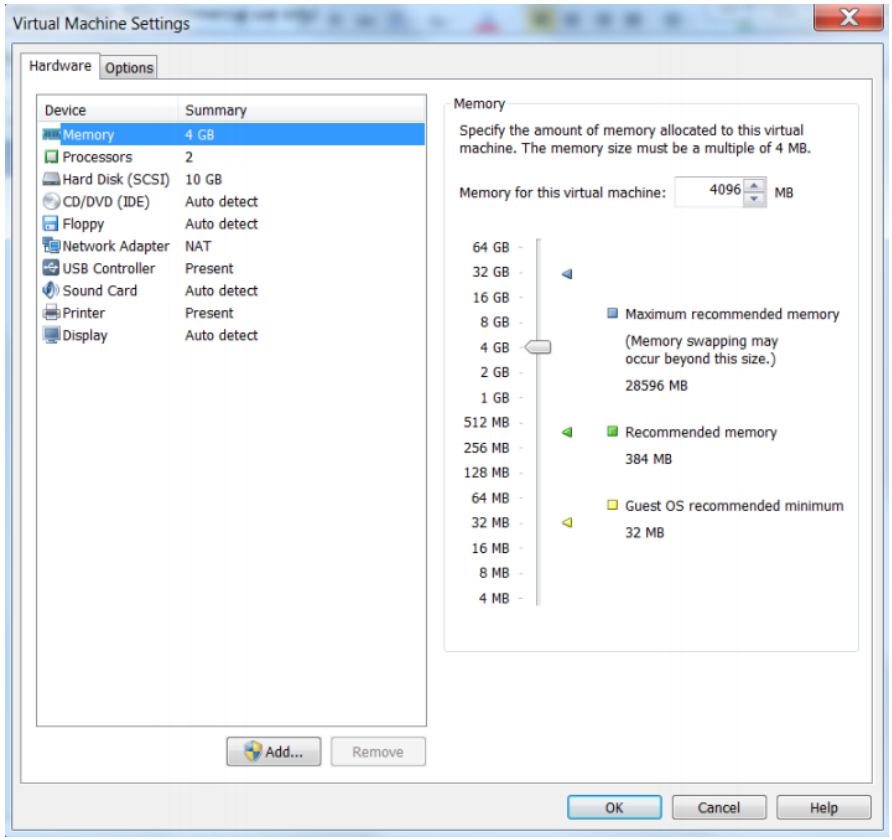
Open the VMware player and browse for the virtual machine.

Part seven: Unwrapping with SNAPHU

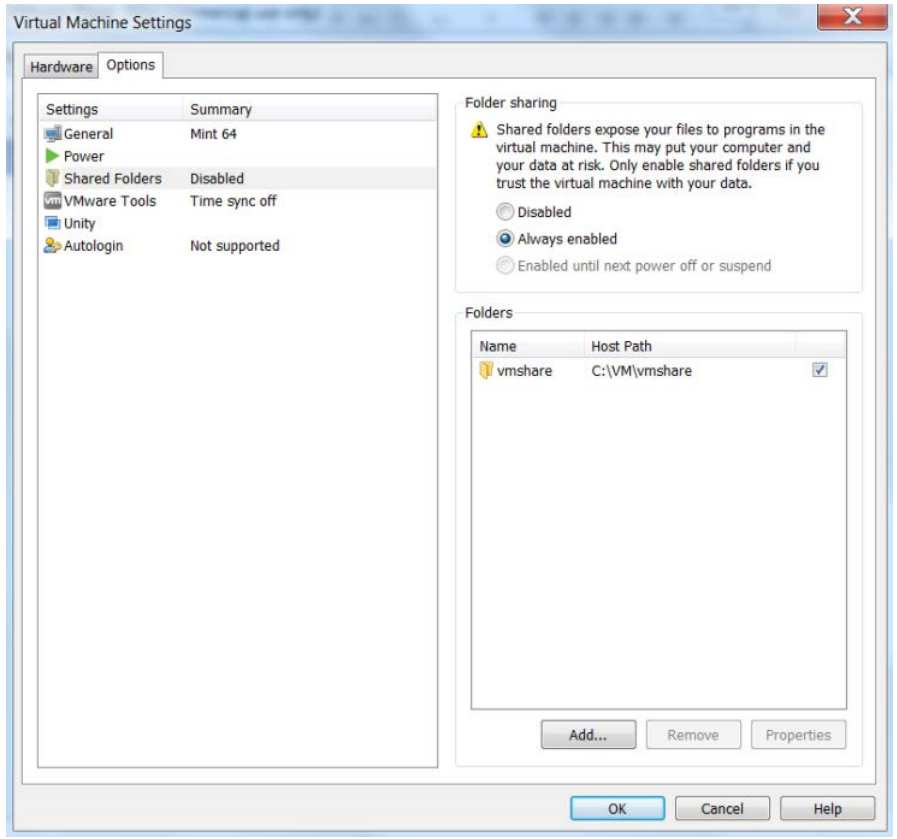
Edit Virtual Machine Settings

Part seven: Unwrapping with SNAP HU

Increase the memory to suit your computer. Depending on the size of your images, you may need at least 8GB. Under the options tabs, add a shared folder. Select 'Always Enable'.

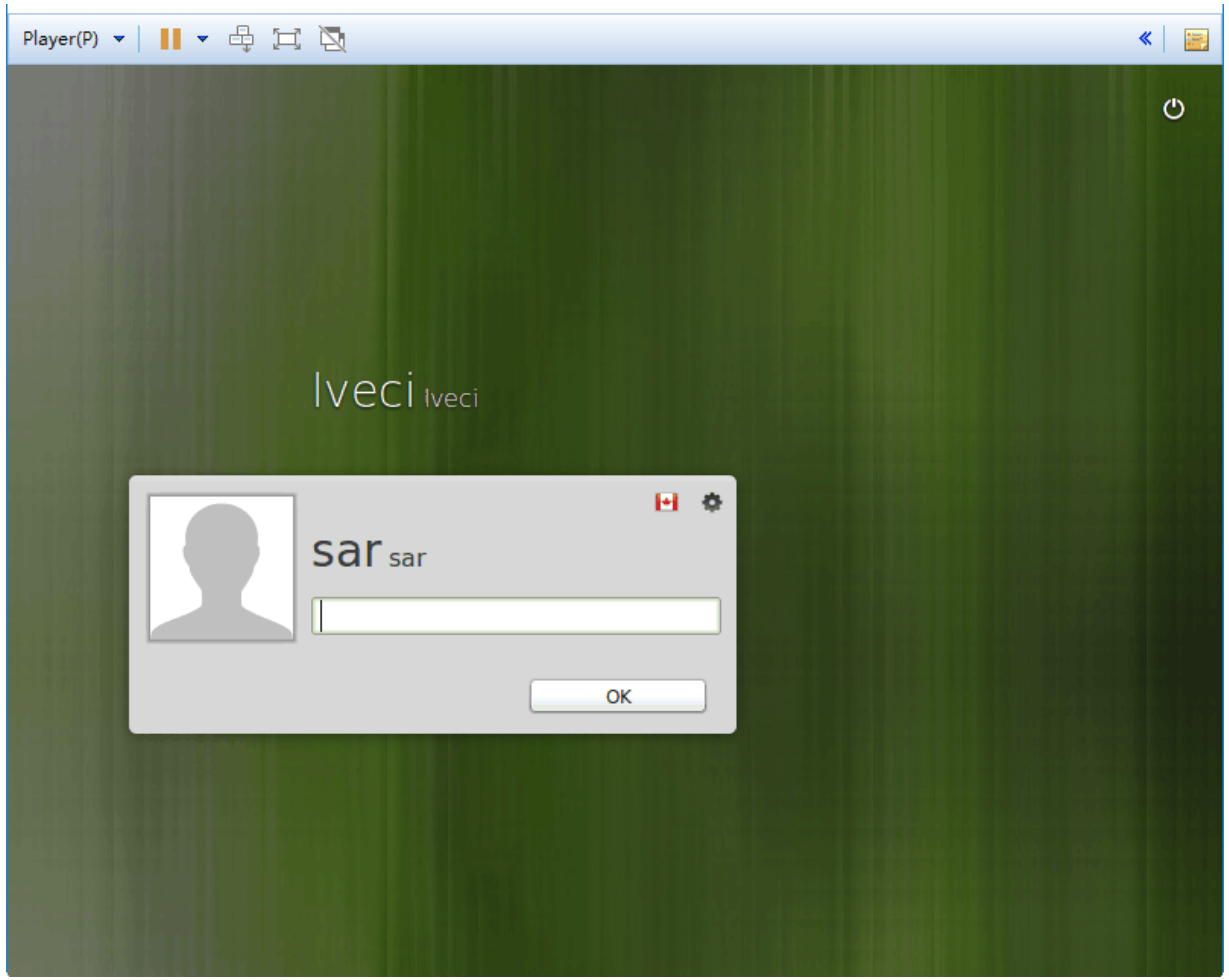


Increase Memory



Enable a Shared Folder

Part seven: Unwrapping with SNAPHU



Login: sar

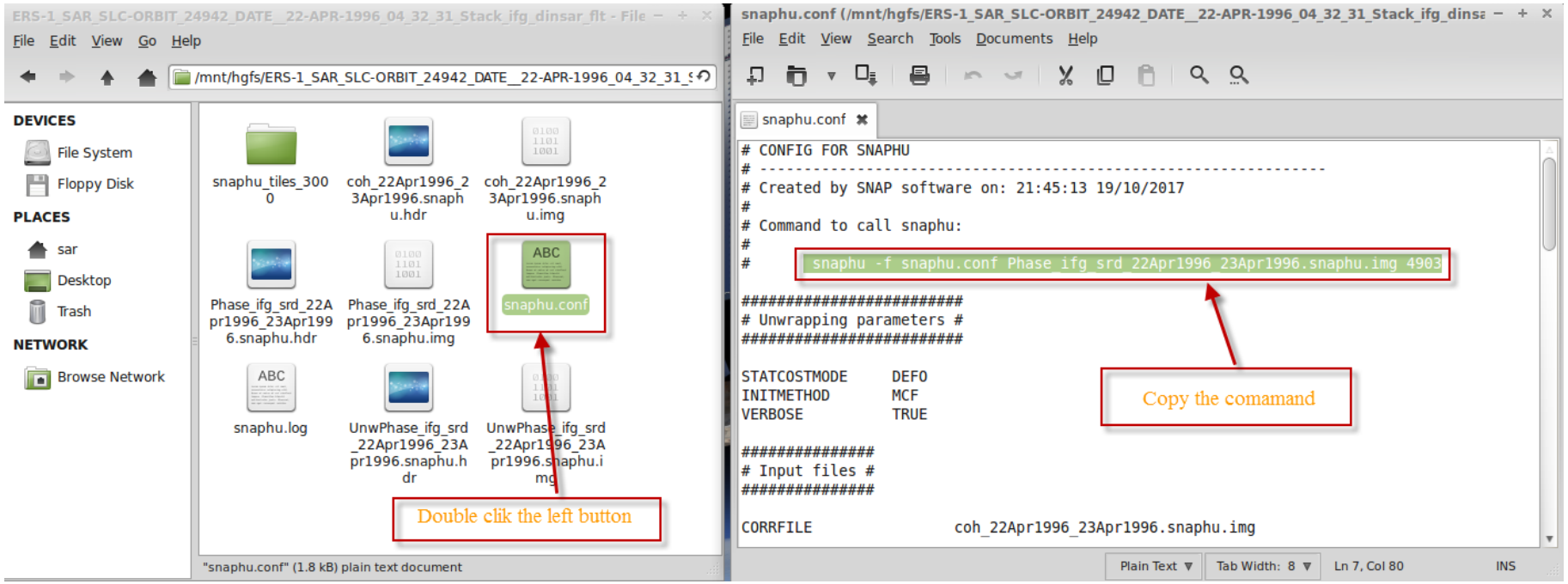
Password: sar01

Part seven: Unwrapping with SNAPHU

Go to the data folder in /mnt/hgfs/ and open the snaphu.conf file.

cd /mnt/hgfs/vmshare/data/target_snaphu/

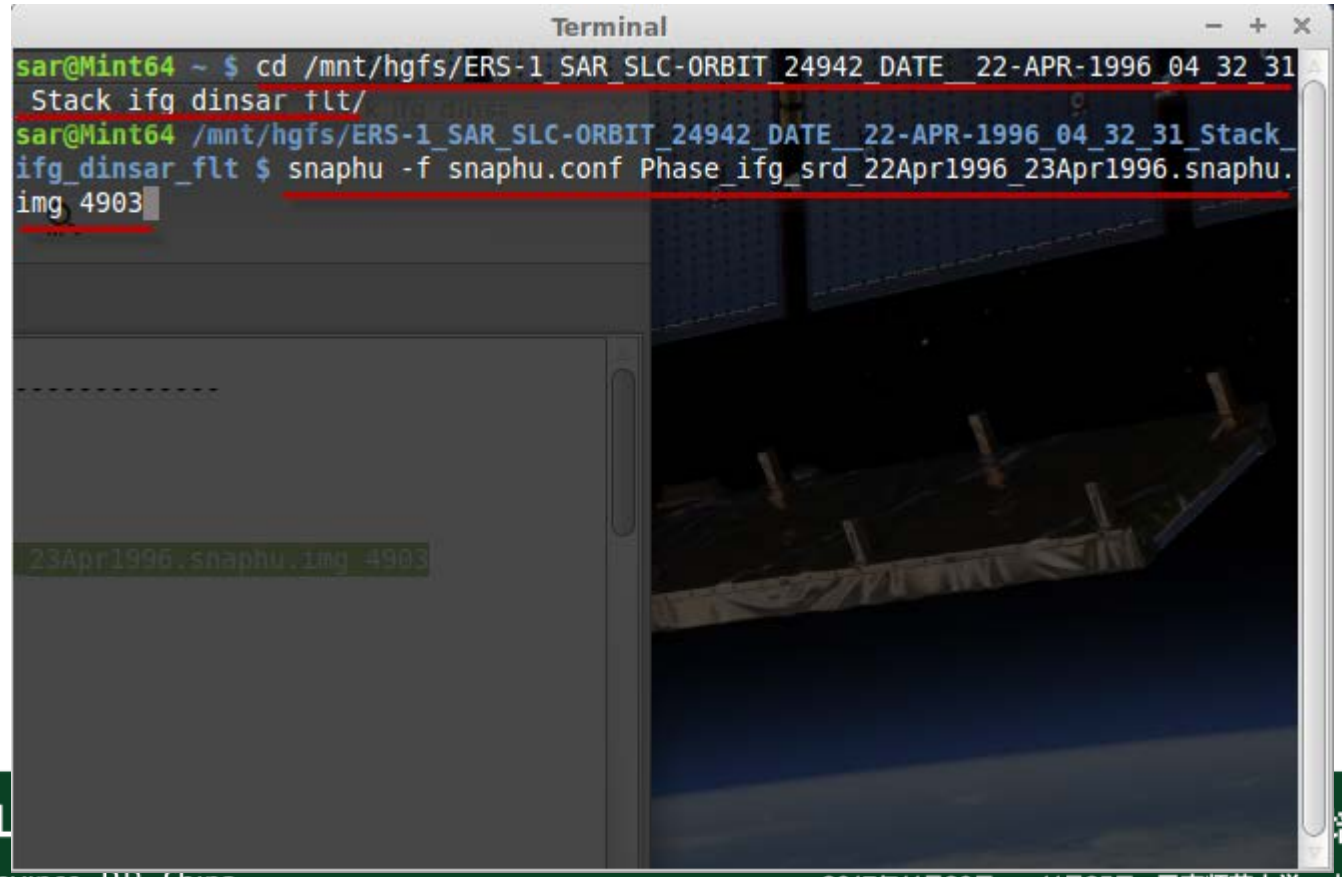
gedit snaphu.conf



Part seven: Unwrapping with SNAPHU

Copy the snaphu command and paste it into the command terminal and then run it.

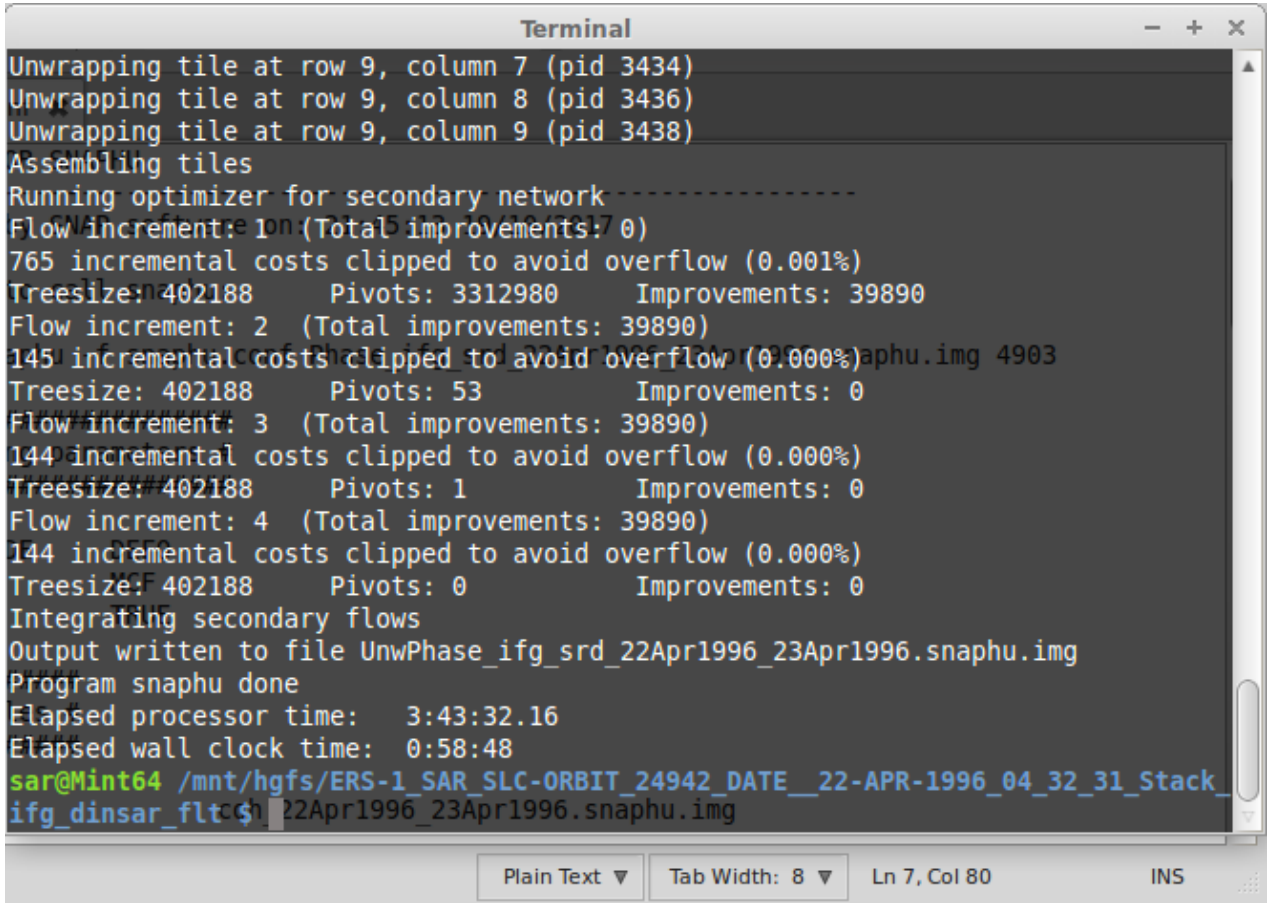
snaphu -f snaphu.conf Phase_ifg_srd_22Apr1996_23Apr1996.snaphu.img 4903



Part seven: Unwrapping with SNAPHU

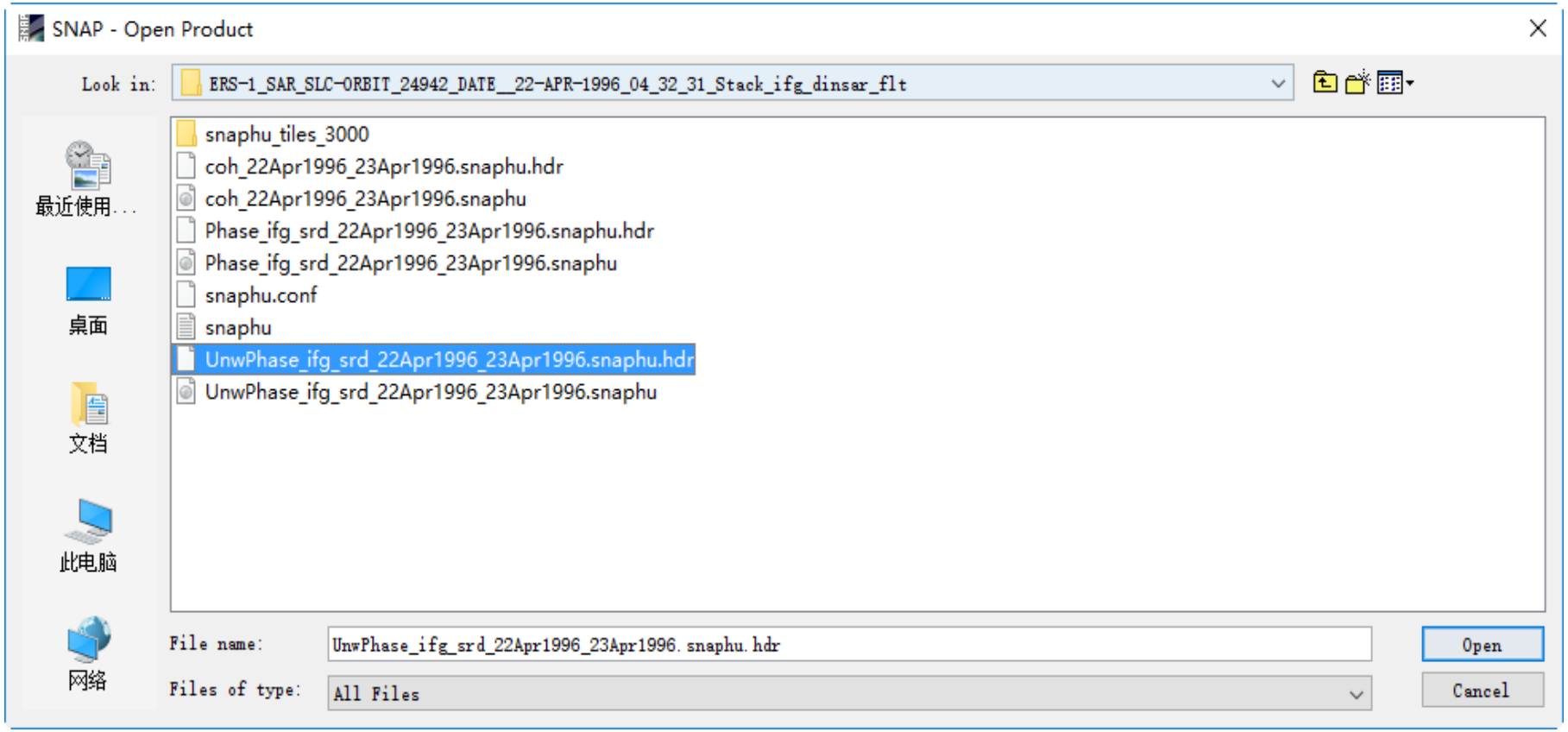
SNAPHU uses an iterative optimization procedure; its execution time depends on the difficulty of the interferogram.

Unwrapping can use a lot of memory. If the unwrapping fails due to there being not enough memory, you could create a subset of your area of interest and try with SNAPHU again.



Part eight: Import Snaphu Umwrapped Phase

Step8-Open the Unwrapped phase hdr file

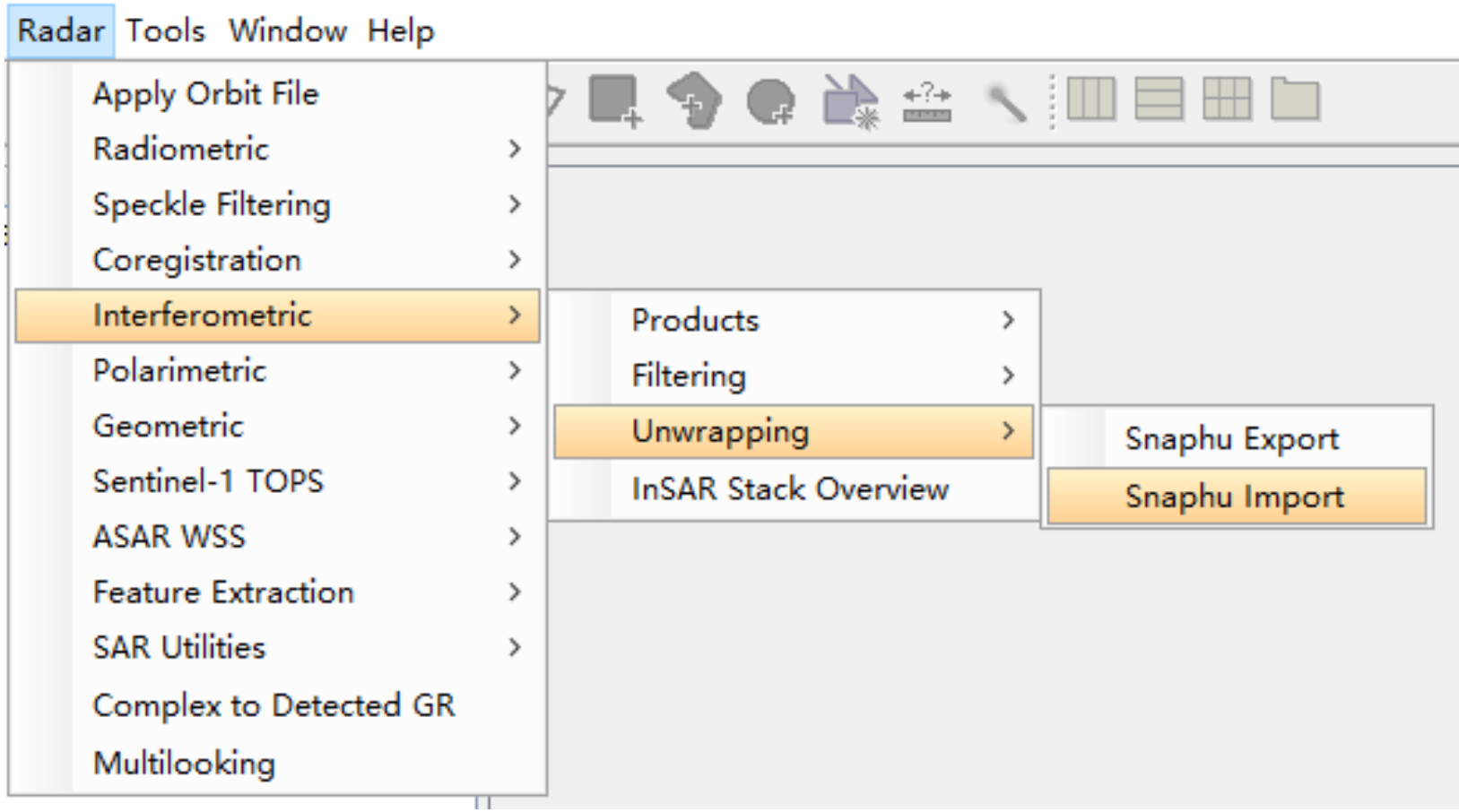


Open Unwrapped Phase Dialog

Part eight: Import Snaphu Umwrapped Phase

Step9-Import the Unwrapped phase:

Select Snaphu Import from the interferometric menu

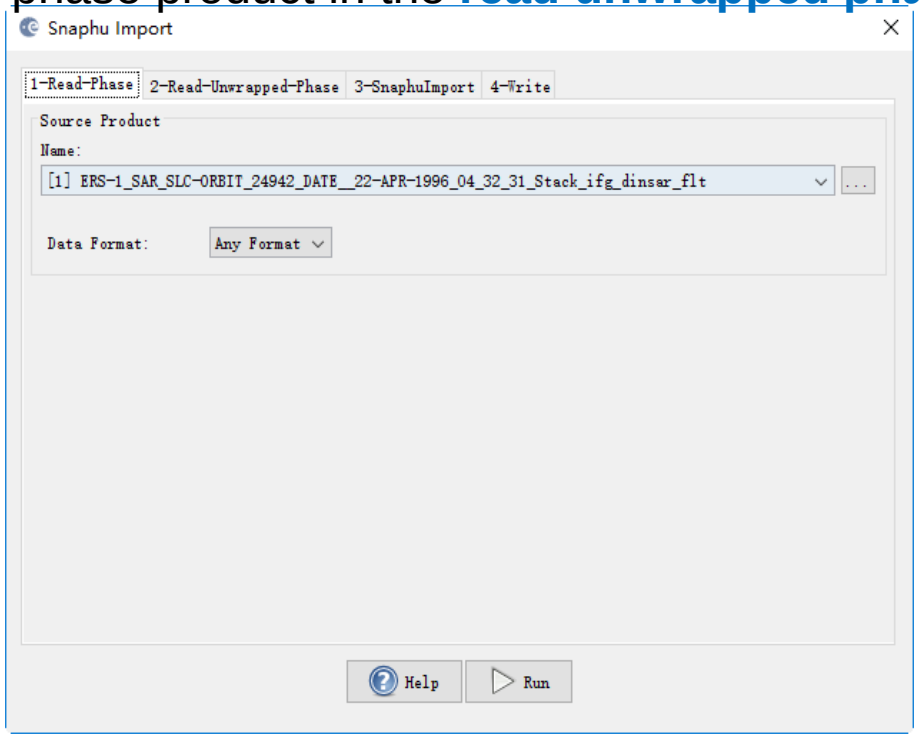


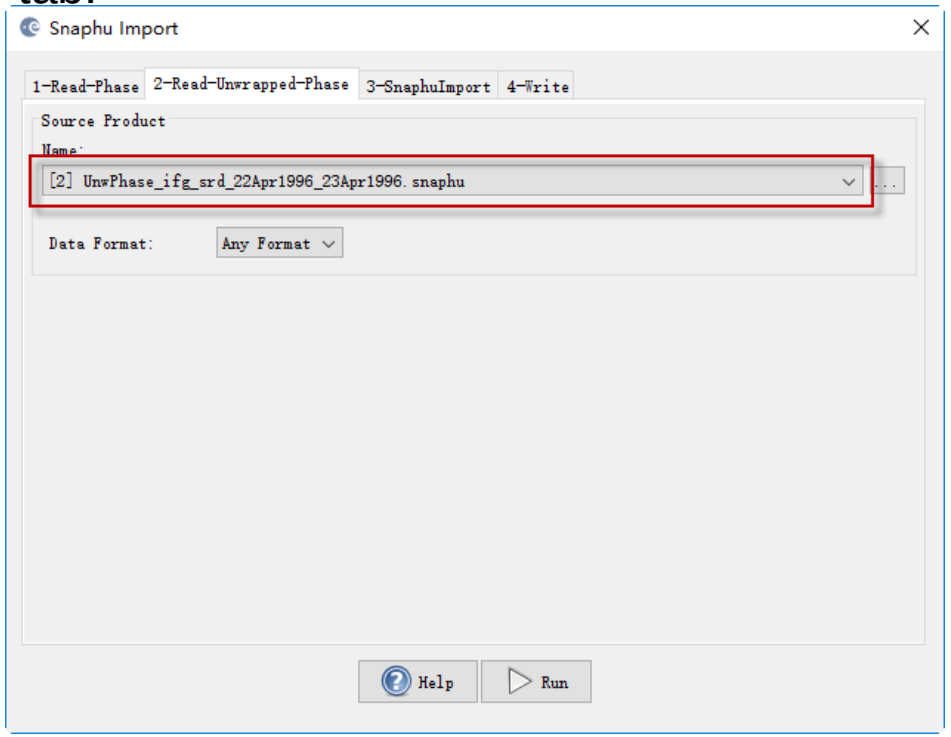
Import Unwrapped Phase Dialog

Part eight: Import Snaphu Umwrapped Phase

Select the wrapped phase in the **read phase** tab.

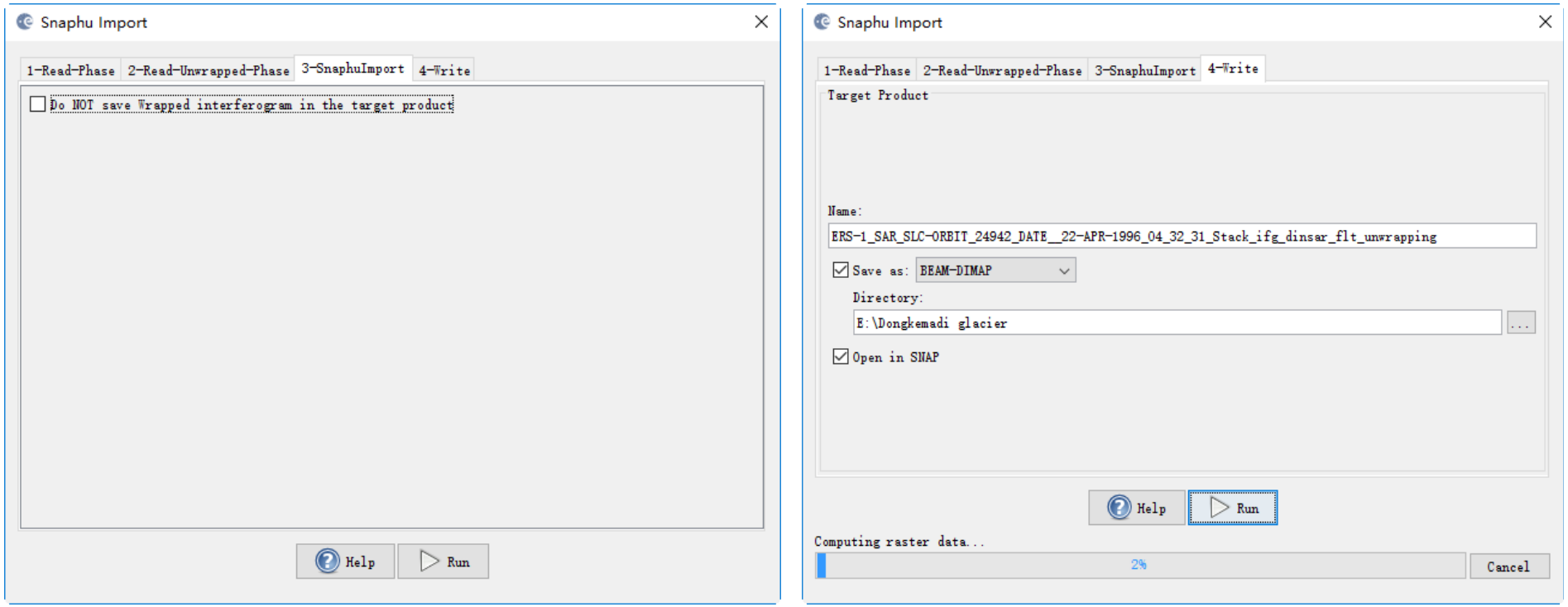
Select the unwrapped phase product in the **read unwrapped phase** tab.





Snaphu Import Dialog

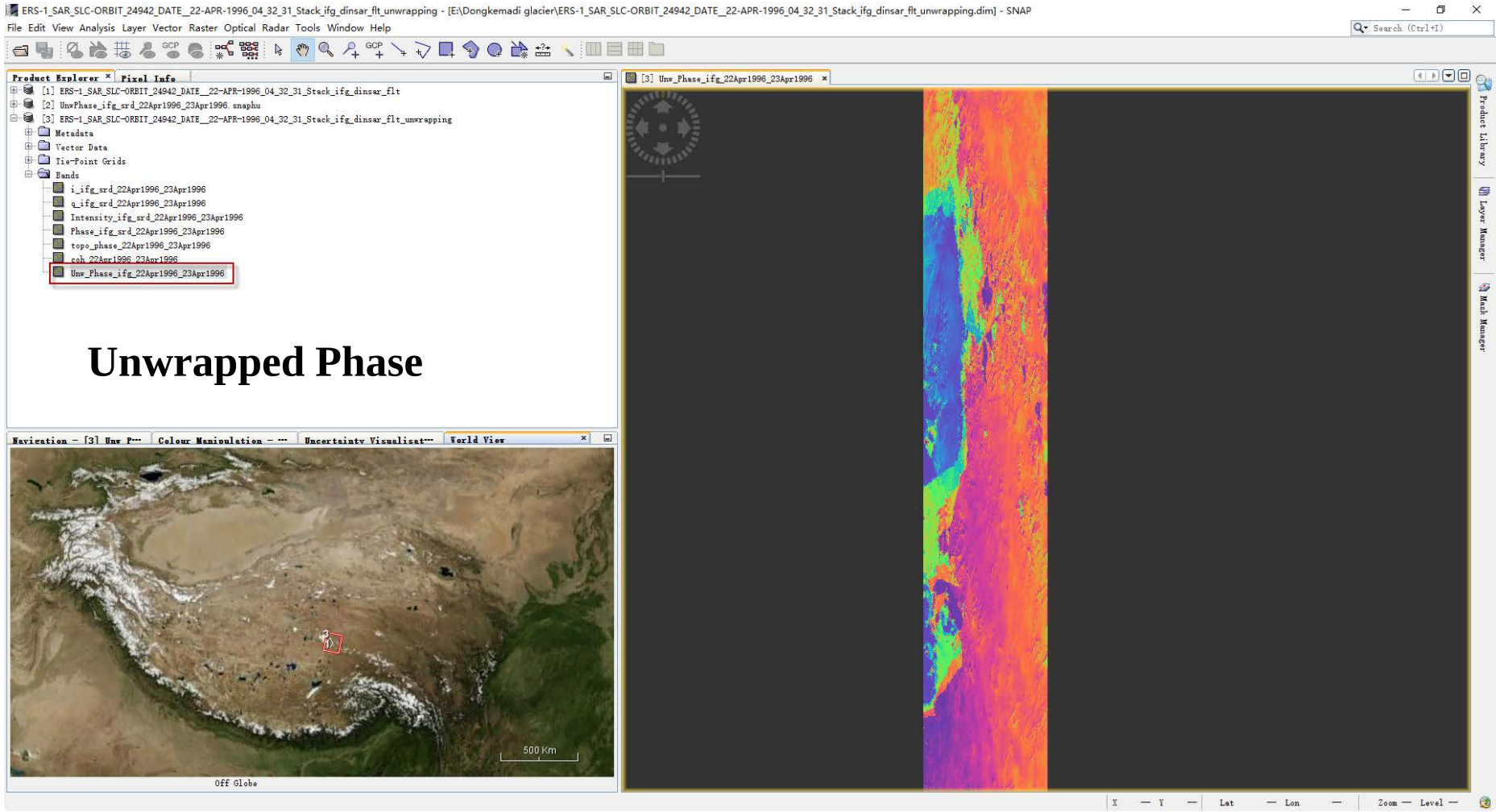
Part eight: Import Snaphu Umwrapped Phase



Snaphu Import Dialog

Part eight: Umwrapped Phase

Process and display the output unwrapped phase



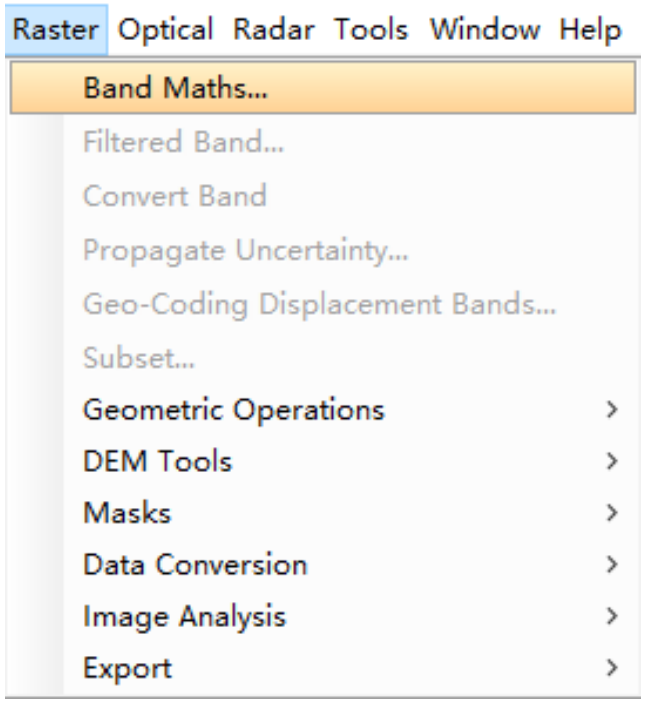
Part nine: Convert the Differential phase to glacier velocity

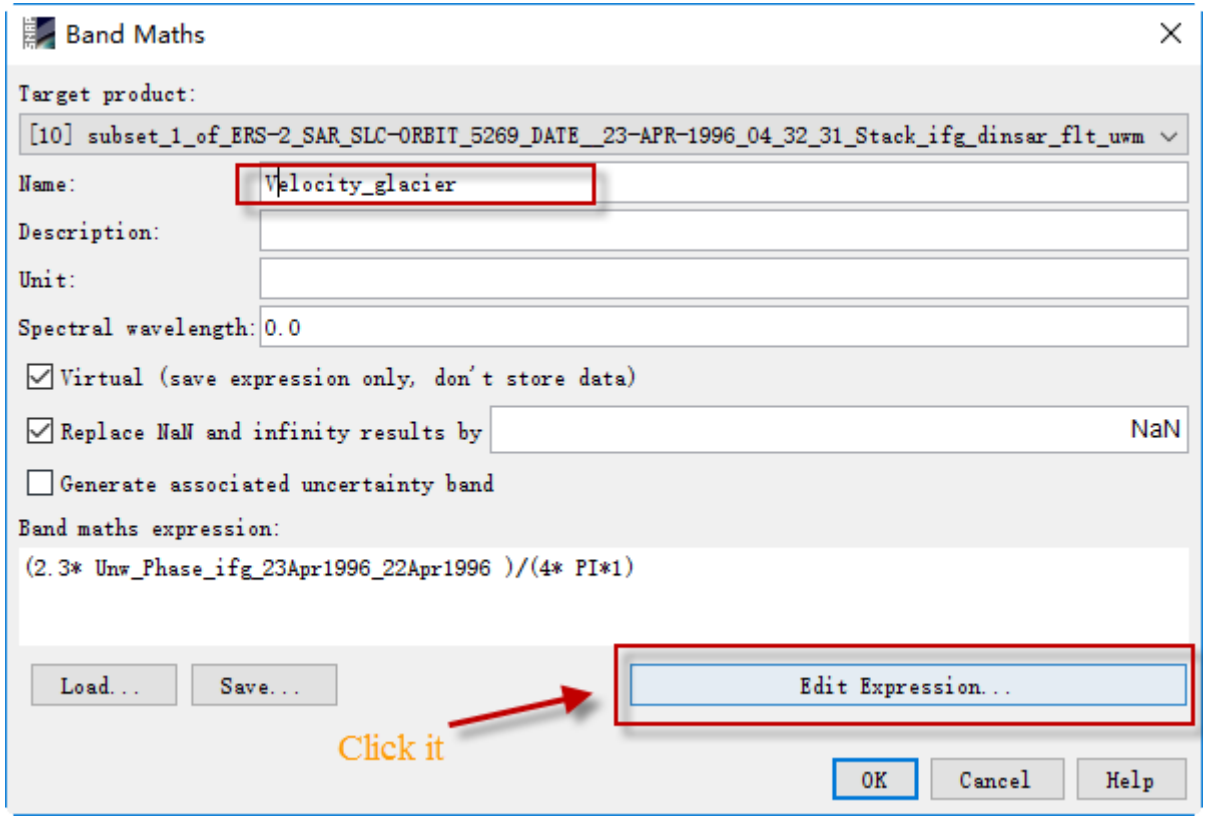
Using the ENVI bandmath tools to process

$$\Delta\phi_{disp} = -\frac{4\pi}{\lambda}\Delta r = -\frac{4\pi}{\lambda}v_l\Delta t$$

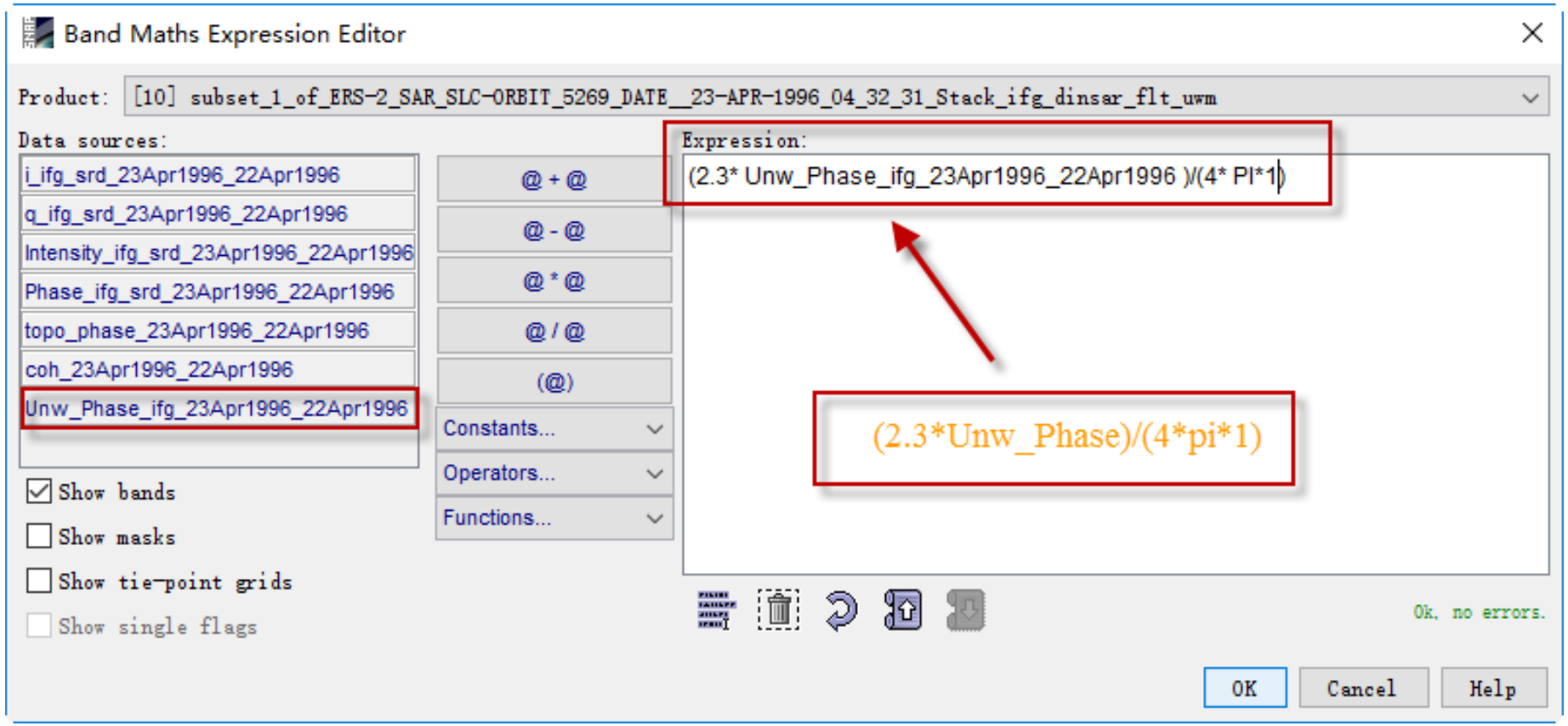
$$v_l = -\frac{\lambda\Delta\phi_{disp}}{4\pi\Delta t}$$

Part nine: Convert the Differential phase to glacier velocity



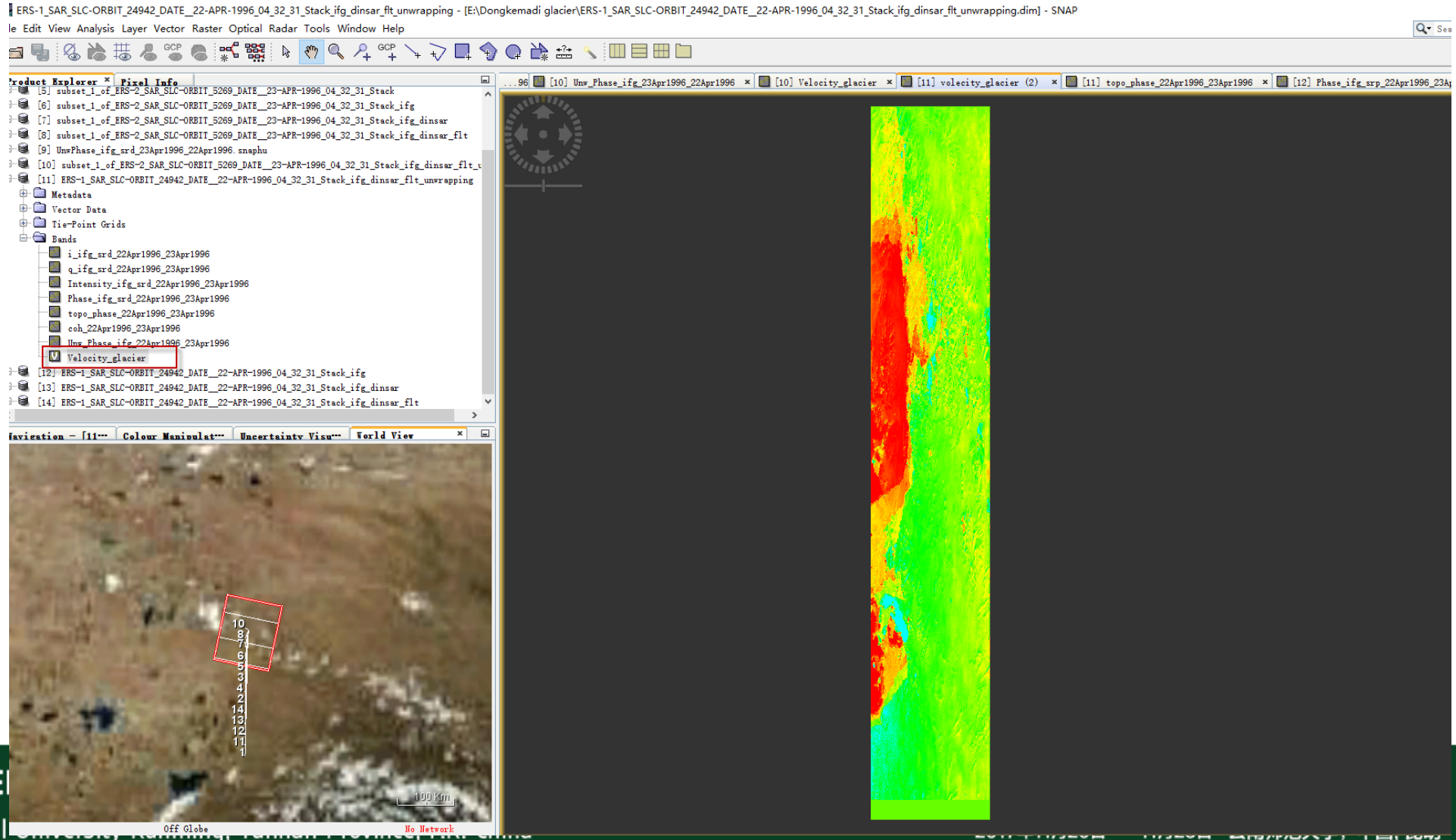


Part nine: Convert the Differential phase to glacier velocity



Band Maths Expression Editor Dialog

Part nine: Convert the Differential phase to glacier velocity



Glacier Velocity

THANKS