

Glacier Velocity Mapping

Geoinformatics Center - AIT

Overview

About Glacier Velocity

Glacier velocity is a vital part of glacier monitoring and understanding of the glacier system dynamics as well as providing valuable insights into changes in climate conditions.

Two methods are commonly used to derive the speed of the ice flow from the satellite data:

- 1) SAR interferometry;
- 2) feature/speckle tracking (optical/SAR data) between consecutive acquisitions.

In this tutorial we will use the second method applied to Sentinel-1 data.

Overview

Data and Software

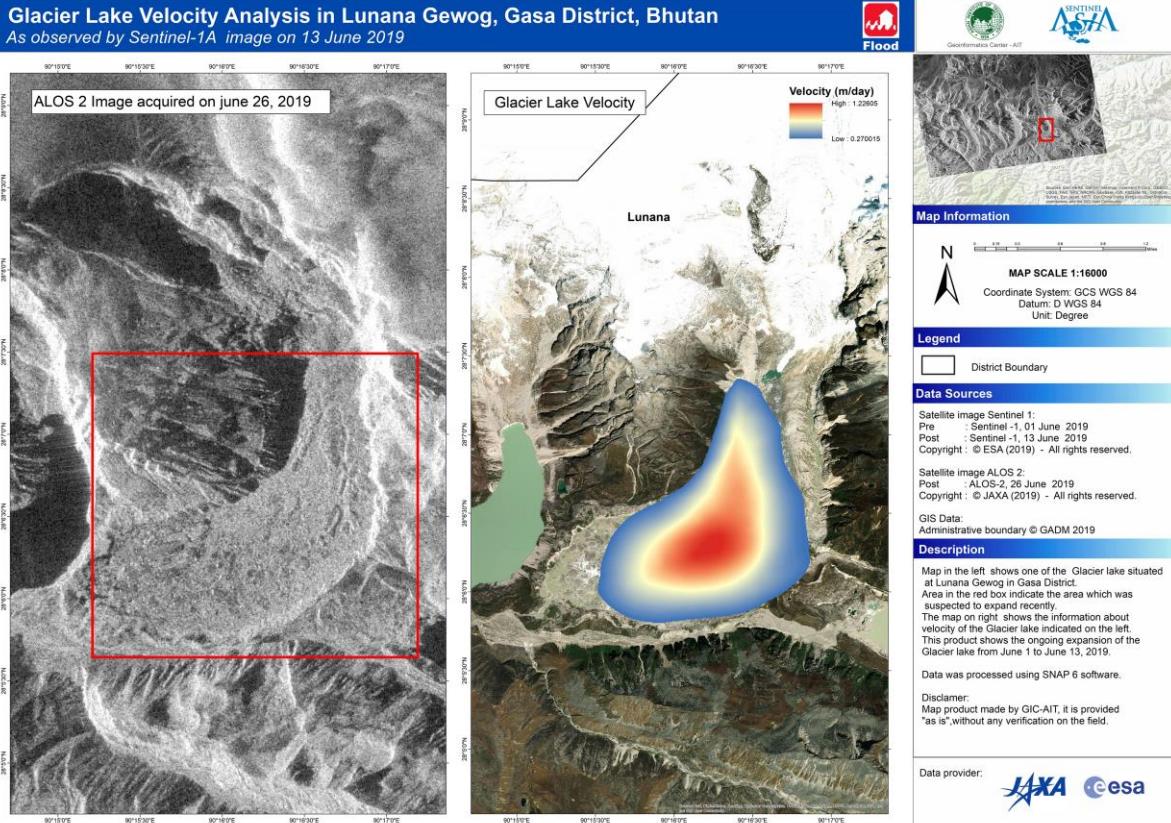
In this exercise, you will work with SNAP software to calculate glacier velocity in Thorthomi Tsho from a pair of Sentinel-1 data. QGIS will also be used to visualize the output.

Data:

- Sentinel-1 GRDH on 01 June 2019:
[`S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634.SAFE`](#)
- Sentinel-1 GRDH on 13 June 2019:
[`S1A_IW_GRDH_1SDV_20190613T120532_20190613T120557_027661_031F43_196F.SAFE`](#)

Overview

Sentinel Asia activation in Bhutan



Bhutan Glacier Lake Breach Flood

- **Occurrence Date (UTC):** 20 June 2019
- **SA activation Date(UTC):** 22 June 2019
- **Requester:** Ministry of Home and Cultural Affairs - Bhutan (MOHCA)
National Center for Hydrology and Meterology (NCHM)

Overview

SNAP software

☰ Q → Science Toolbox Exploitation Platform 

Note: the PROBA-V Toolbox is not compatible with SNAP version 10.

We offer three different installers for your convenience. Choose the one from the following table which suits your needs. During the installation process, each toolbox can be excluded from the installation. Toolboxes which are not initially installed via the installer can be later downloaded and installed using the plugin manager. Please note that SNAP and the individual Sentinel Toolboxes also support numerous sensors other than Sentinel.

If you previously used SNAP before, we recommend uninstalling the older SNAP version before installing the latest version.

Note: users running SNAP on Linux/Ubuntu version >= 16.04, please read the following instructions to avoid conflicts with the Ubuntu package manager "snap": [Update of SNAP default installation directory](#)

| | Windows 64-Bit | Mac OS X | Linux 64-bit |
|--------------------|--|--|--|
| Sentinel Toolboxes | These installers contain the Microwave and Optical Toolboxes, download size is close to 1GB. | | |
| | Main Download Mirror Download | Main Download Mirror Download | Main Download Mirror Download |
| SMOS Toolbox | These installers contain only the SMOS Toolbox , download size is close to 800MB. Download also the Format Conversion Tool (Earth Explorer to NetCDF) and the user manual . | | |
| | Main Download Mirror Download | Main Download Mirror Download | Main Download Mirror Download |
| All Toolboxes | These installers contain the Microwave , Optical and SMOS Toolbox , download size is close to 1GB. | | |
| | Main Download Mirror Download | Main Download Mirror Download | Main Download Mirror Download |

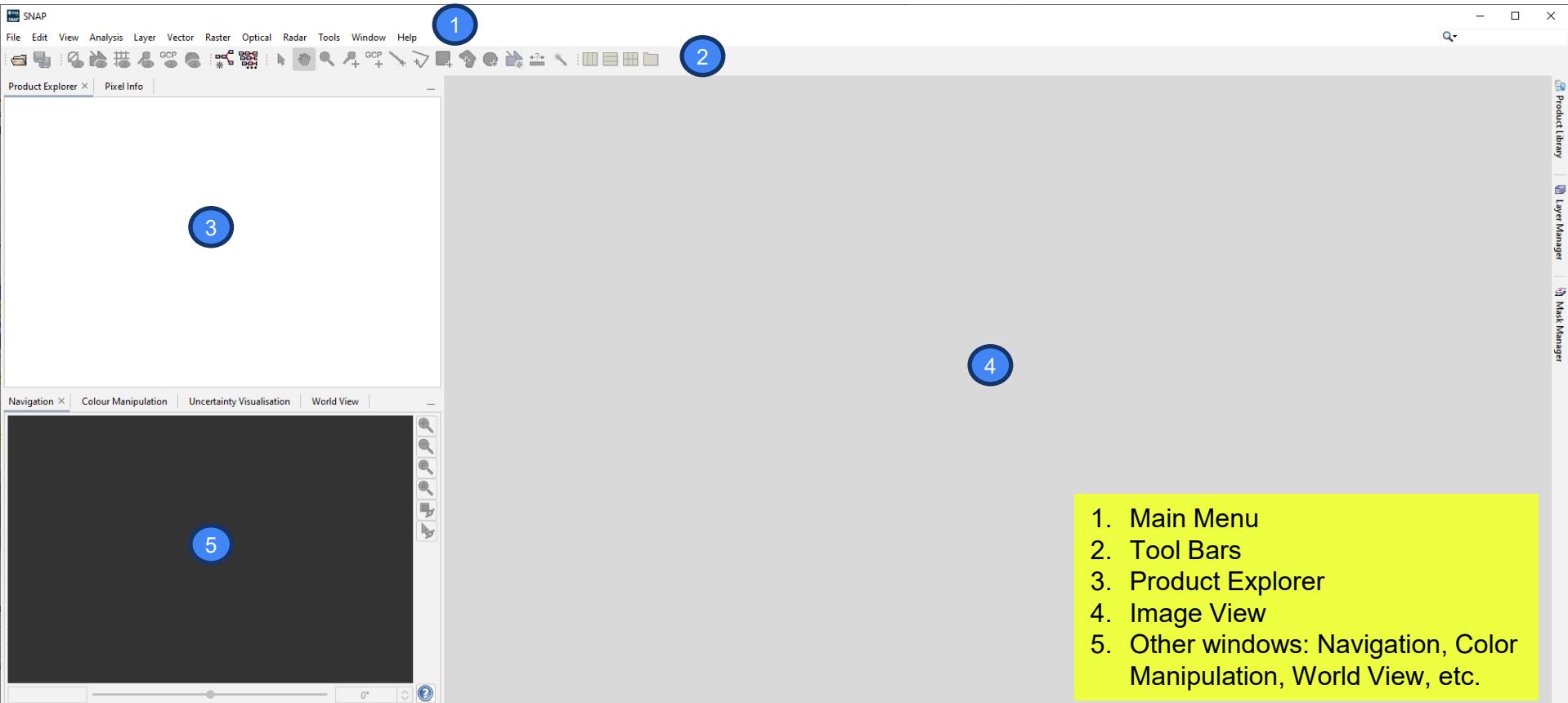
 Thanks to the open-source license, we create the SNAP installers with the [multi-](#)

<https://step.esa.int/main/download/snap-download/>

- The Sentinel Application Platform - or SNAP - in short is a collection of executable tools and Application Programming Interfaces (APIs) which have been developed to facilitate the utilisation, viewing and processing of a variety of remotely sensed data.
- Download the latest SNAP software from ESA. SNAP supports installers for Windows 64-bit, Mac OS X, and Linux 64-bit.
- Note:** We've downloaded the installer for Windows 64-bit in the training folder.
- Install the software. Use the default configuration.
- Once the installation is finished, update all suggested plugins.

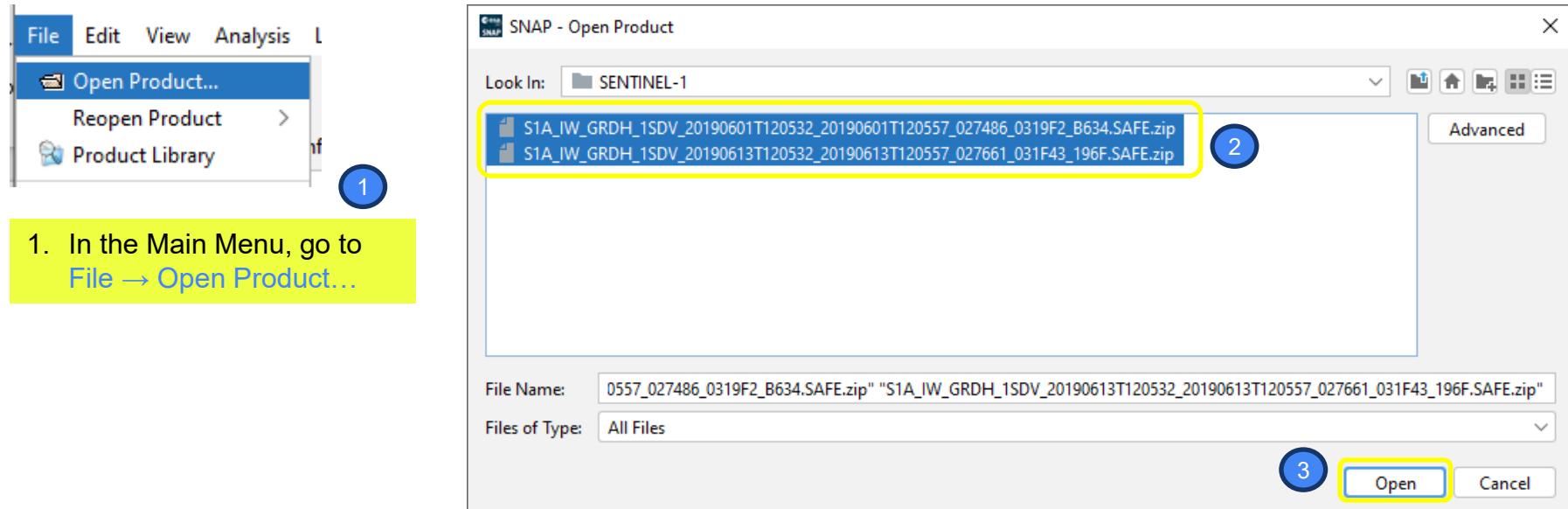
Data Preparation

Open SNAP software



Data Preparation

Open Sentinel-1 Data



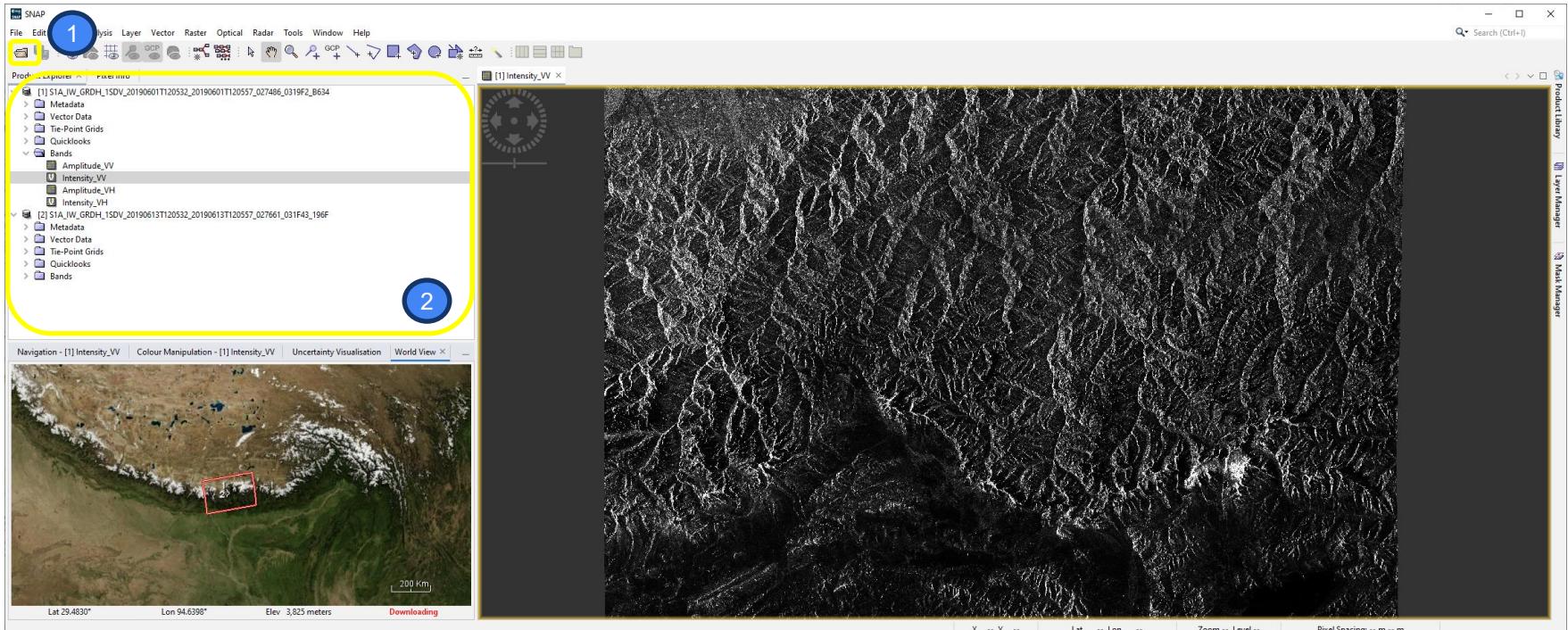
1. In the Main Menu, go to File → Open Product...

2. Browse to the location of the data. Then select both files of Sentinel-1 data. Each file refers to a different acquisition date.
3. Click Open

Data Preparation

Explore the Sentinel-1 Data

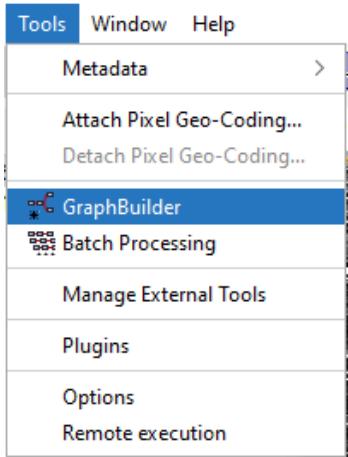
1. Click Open Product  and navigate to the data folder. Open both Sentinel-1 data.
2. The opened products will appear in the Product Explorer window. Click > to expand the contents of the product [1], then expand the Bands folder and double-click on the **Intensity_VV** band to visualize it.



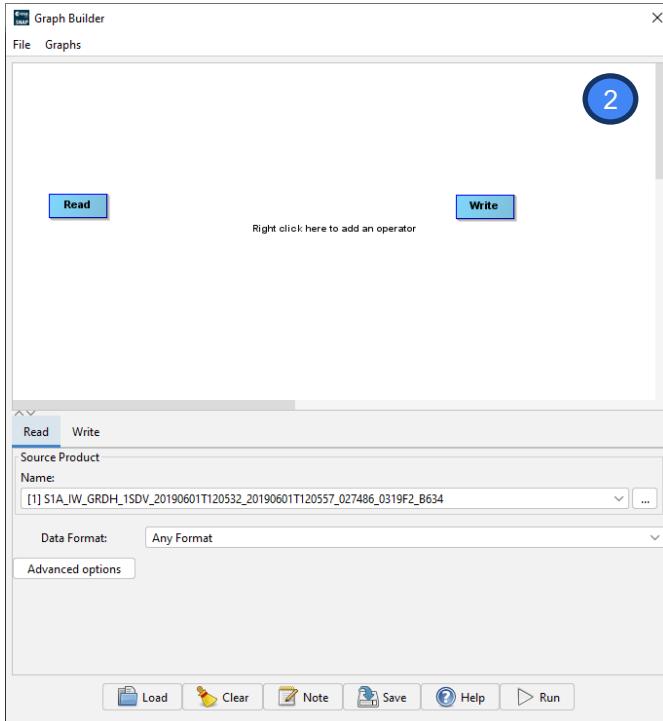
Data Pre-processing

Open Graph Builder

We will use the **Batch Processing** tool available in SNAP to apply all steps to both images in one go (this also saves disk space as only the final product is physically saved).



1. In the Main Menu, go to Tools → GraphBuilder



2. The **Graph Builder** window will show up.

In the beginning, the graph has only two operators: **Read** (to read the input) and **Write** (to write the output). We will create a step-by-step workflow to apply identical pre-processing steps to both of our scenes.

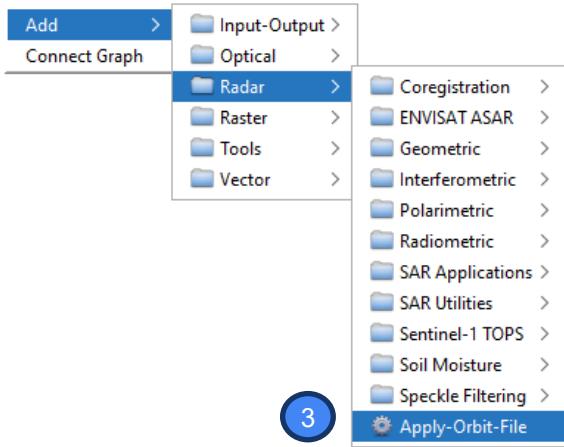
Data Pre-processing

Update the orbit metadata

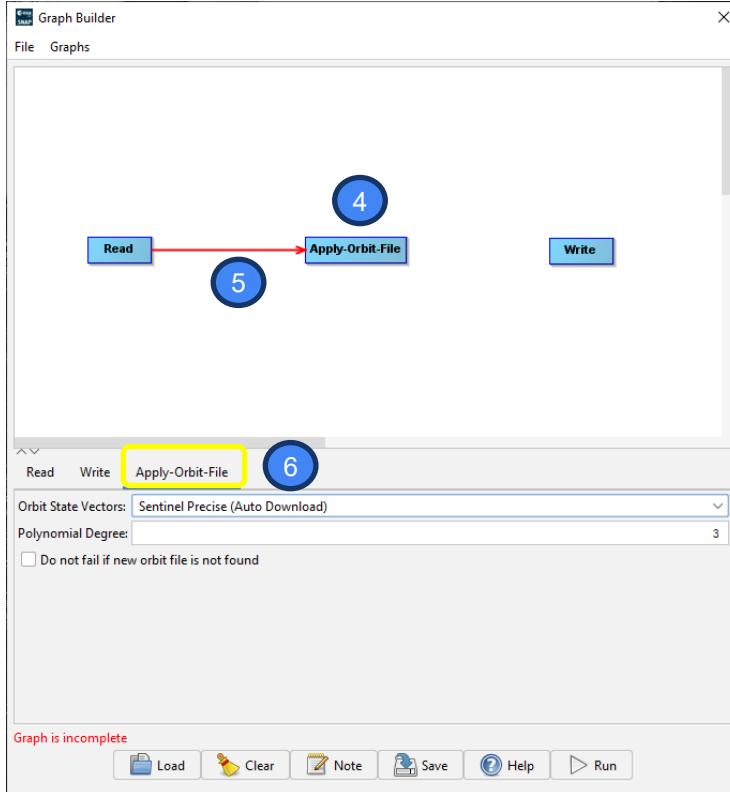
- The orbit state vectors provided in the metadata of a SAR product are generally not accurate and can be refined with the precise orbit files which are available days-to-weeks after the generation of the product.
- The orbit file provides accurate satellite position and velocity information. Based on this information, the orbit state vectors in the abstract metadata of the product are updated.

Data Pre-processing

Update the orbit metadata



3. To add the operator right-click the white space between the existing operators and go to **Add** → **Radar** → **Apply-Orbit-File**



4. A new operator rectangle appeared in our graph.
5. Now connect the new **Apply-Orbit-File** operator with the Read operator by clicking to the right side of the Read operator and dragging the red arrow towards the **Apply-Orbit-File** operator.
6. Notice that a new tab also appeared below the graph.

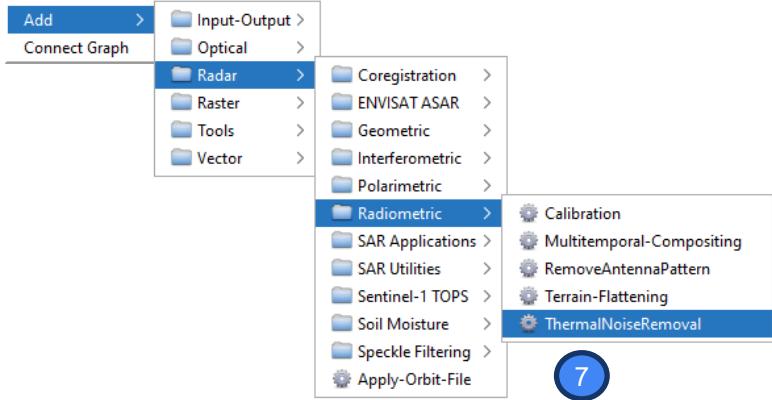
Data Pre-processing

Remove the thermal noise

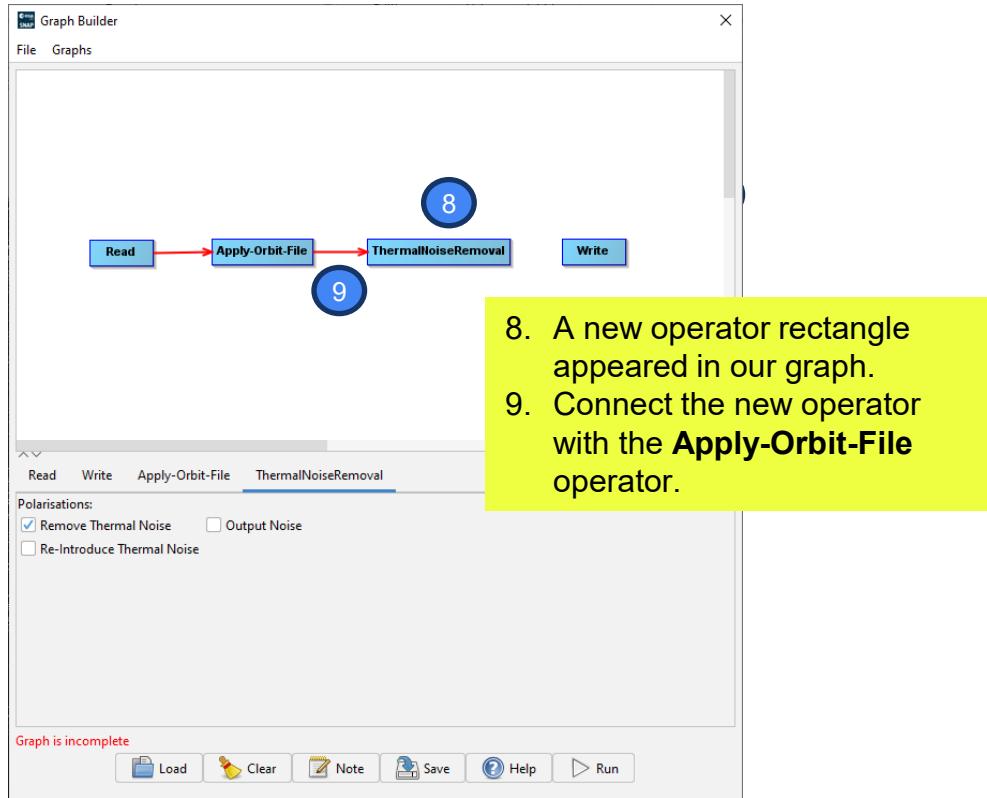
- Thermal noise in SAR imagery is the background energy that is generated by the receiver itself.
- It skews the radar reflectivity to towards higher values and hampers the precision of radar reflectivity estimates.
- Level-1 products provide a noise LUT for each measurement dataset, provided in linear power, which can be used to remove the noise from the product.

Data Pre-processing

Remove the thermal noise



7. Right-clicking the white space somewhere and go to to **Add** → **Radar** → **Radiometric** → **ThermalNoiseRemoval**



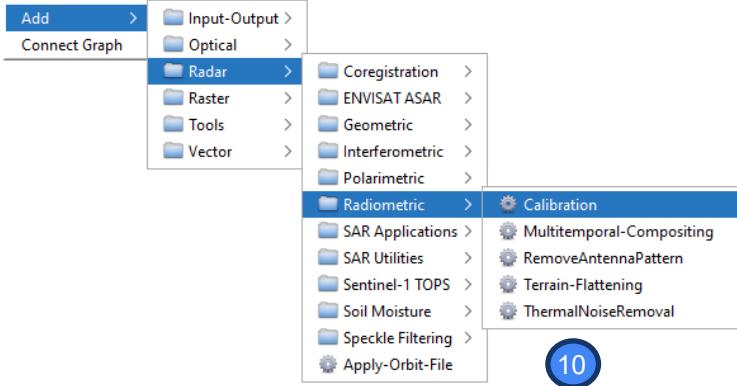
Data Pre-processing

Calibration

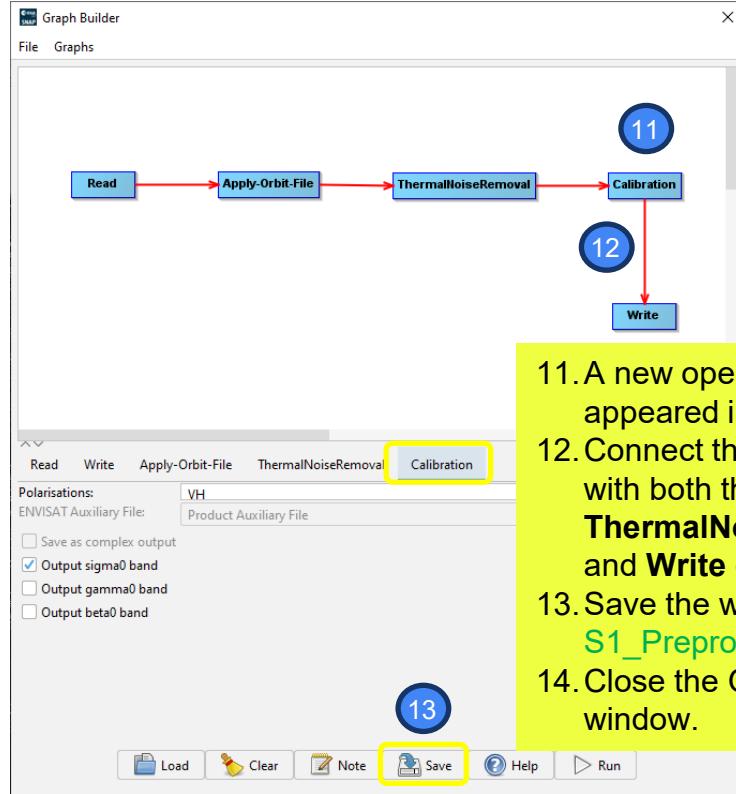
- Typical SAR data processing, which produces level-1 images, does not include radiometric corrections and significant radiometric bias remains.
- The radiometric correction is necessary for the pixel values to truly represent the radar backscatter of the reflecting surface and therefore for comparison of SAR images acquired with different sensors or acquired from the same sensor but at different times, in different modes, or processed by different processors.

Data Pre-processing

Calibration



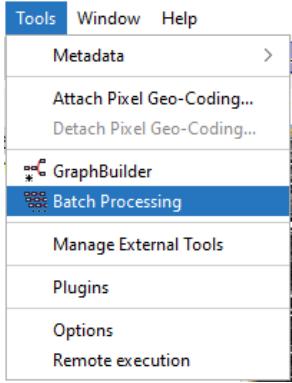
10. Right-clicking the white space somewhere and go to **Add** → **Radar** → **Radiometric** → **Calibration**



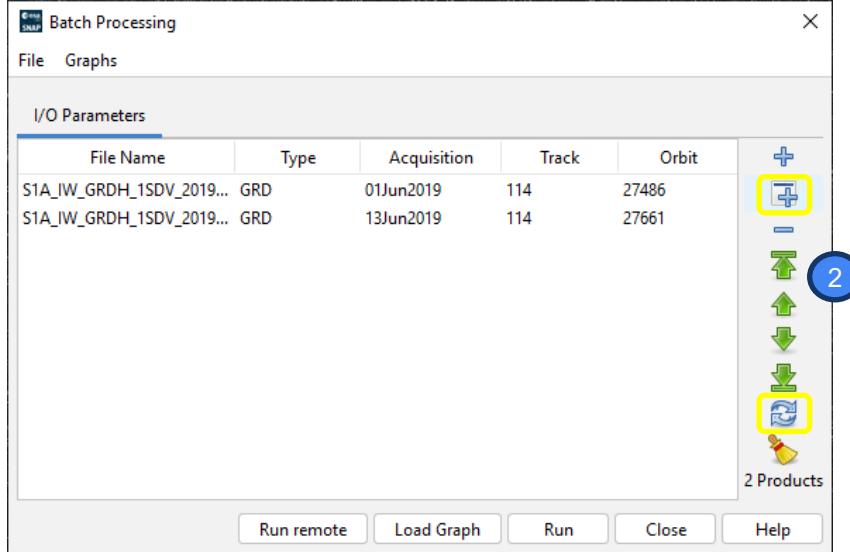
11. A new operator rectangle appeared in our graph.
12. Connect the new operator with both the **ThermalNoiseRemoval** and **Write** operators.
13. Save the workflow to **S1_Preprocessing.xml**
14. Close the Graph Builder window.

Data Pre-processing

Batch processing



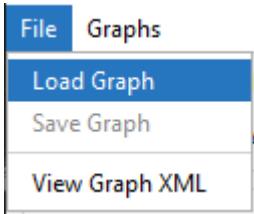
1. In the Product Explorer window, select (highlight) the product [1] (1 June 2019). Open the Batch Processing tool ([Tools](#) → [Batch Processing](#)).



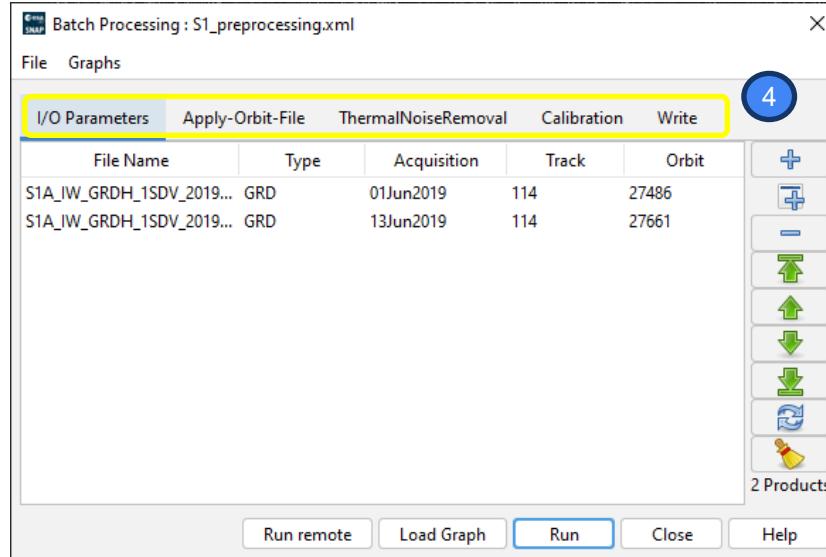
2. We will add both opened products by clicking **Add Opened** in the upper right (the second icon from the top) and then clicking **Refresh** (the second icon from the bottom).

Data Pre-processing

Batch processing



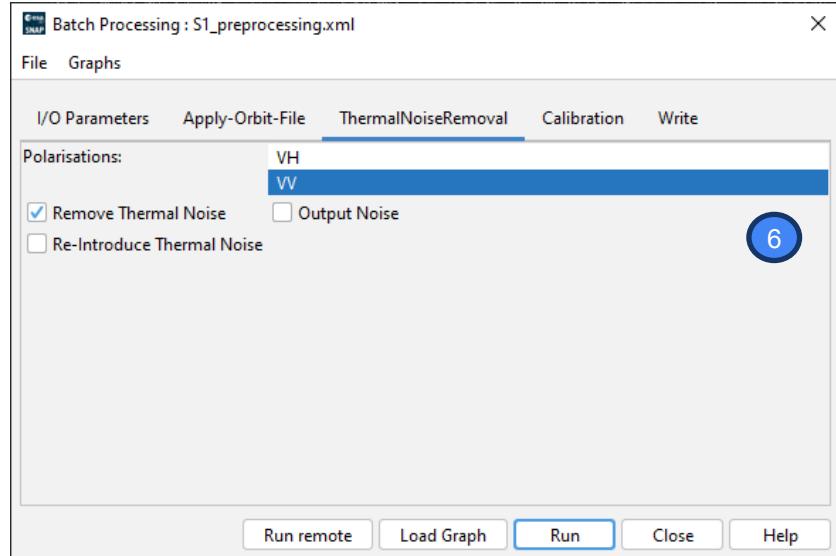
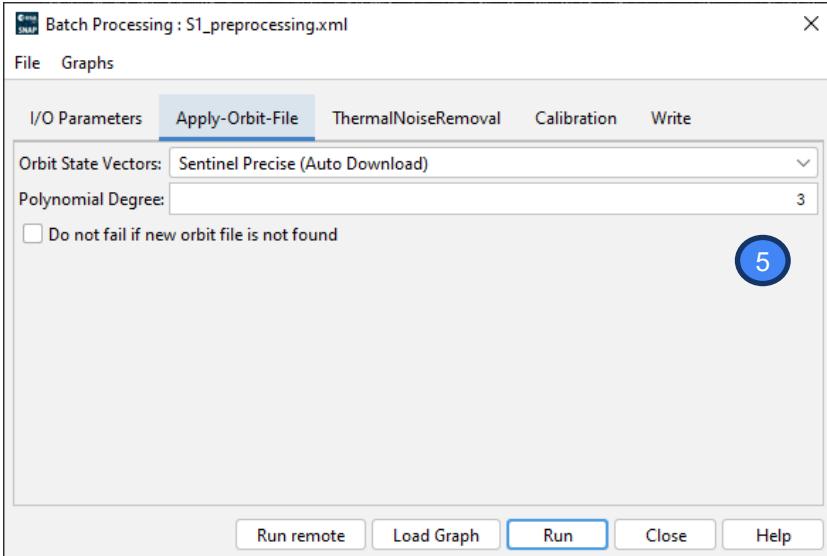
3. In the **Batch Processing** window, click [File → Load Graph](#) and navigate to our saved graph ([S1_Preprocessing.xml](#)) and open it.



4. We see that new tabs have appeared at the top of the **Batch Processing** window corresponding to our operators. We will change the parameter of each operator in the next steps.

Data Pre-processing

Batch processing

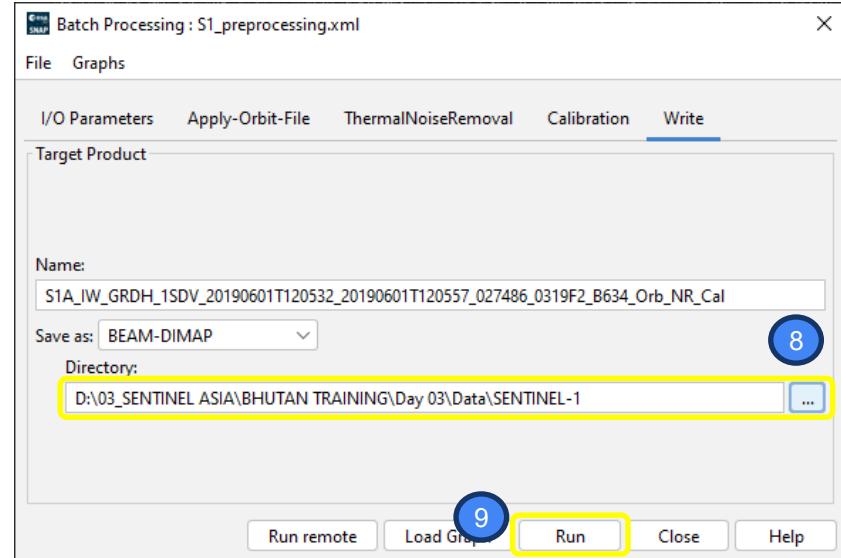
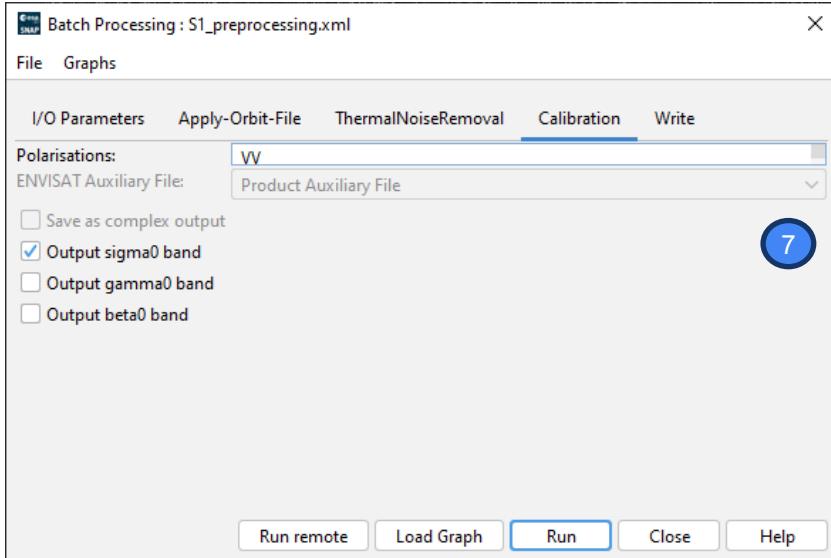


5. In the **Apply-Orbit-File** tab, accept the default settings.

6. In the **ThermalNoiseRemoval** tab select **VV** polarization and make sure that the “**Remove Thermal Noise**” option is selected.

Data Pre-processing

Batch processing

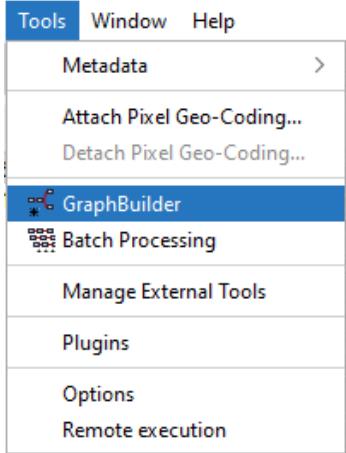


7. In the **Calibration** tab, accept all default settings.
8. In the **Write** tab, define your output directory.
9. Click **Run**. It will take a few seconds or minutes to complete the process.

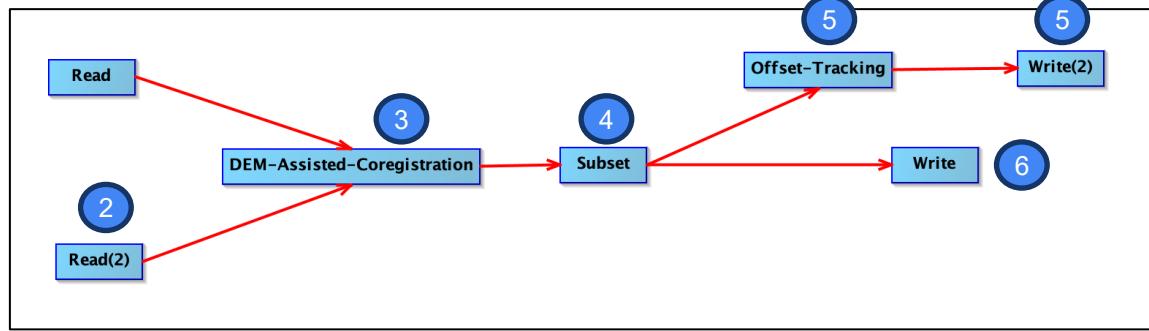
You should have 2 new products in the Product Explorer window. **Close** the Batch Processing window.

Data Processing

Open Graph Builder: Coregistration and Offset Tracking



1

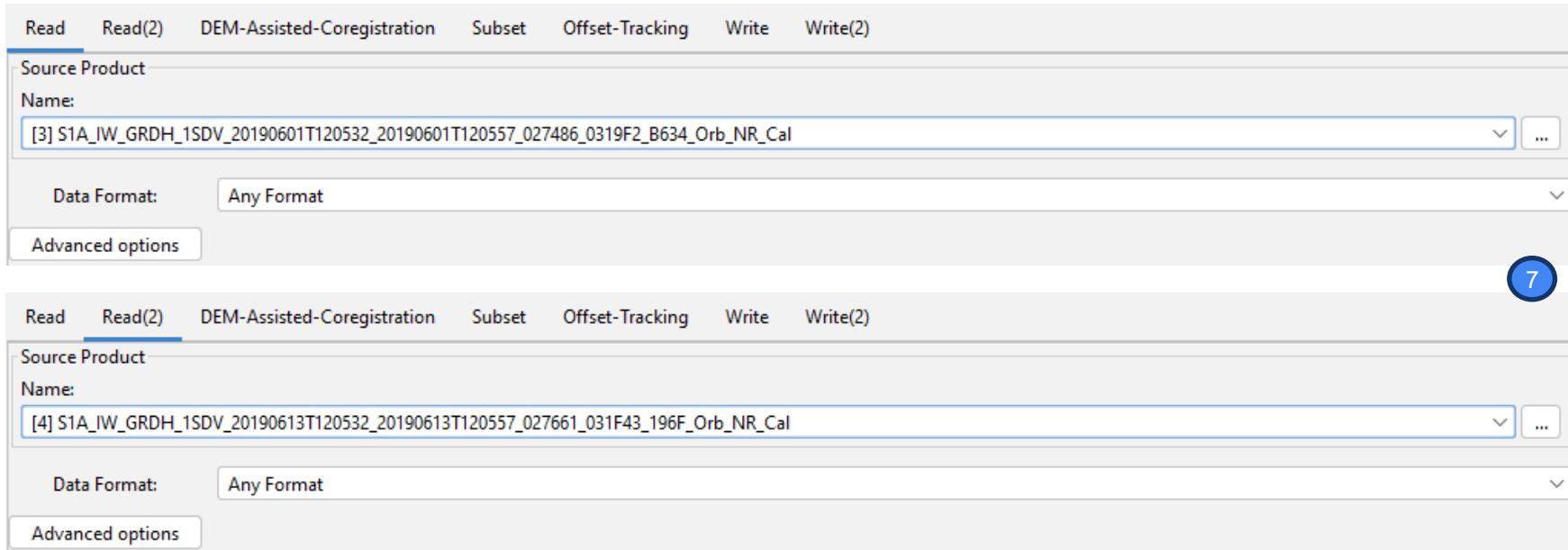


1. In the Main Menu, go to Tools → GraphBuilder

2. First, we need to delete the **Write** operator. Right click on it and select “Delete”. Then we need to add a second **Read** operator. Right-click in the white space and go to [Add](#) → [Input-Output](#) → [Read](#).
3. We will add the **DEM-Assisted Coregistration** operator by going to [Add](#) → [Radar](#) → [Coregistration](#) → [DEM-Assisted-Coregistration](#) and connect both **Read** operators to it.
4. Next, we will add the **Subset** operator ([Add](#) → [Raster](#) → [Geometric](#) → [Subset](#)) and connect the **DEM-Assisted-Coregistration** operator to it.
5. Since we want to continue to Offset Tracking and save this subset separately as well, we will add the **Offset-Tracking** operator ([Add](#) → [Radar](#) → [SAR Applications](#) → [Offset-Tracking](#)) and the **Write** operator ([Add](#) → [Input-Output](#) → [Write](#)). Connect the **Subset** operator to both **Offset-Tracking** and **Write** operator.
6. Lastly, we will add another **Write** operator ([Add](#) → [Input-Output](#) → [Write](#)) and connect the **Offset-Tracking** operator to it in order to save the final product

Data Processing

Read Data



Read Read(2) DEM-Assisted-Coregistration Subset Offset-Tracking Write Write(2)

Source Product

Name:

[3] S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634_Orb_NR_Cal

Data Format: Any Format

Advanced options

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Read Read(2) DEM-Assisted-Coregistration Subset Offset-Tracking Write Write(2)

Source Product

Name:

[4] S1A_IW_GRDH_1SDV_20190613T120532_20190613T120557_027661_031F43_196F_Orb_NR_Cal

Data Format: Any Format

Advanced options

7. First, let's go to the first **Read** tab and make sure that the pre-processed product [3] from 1-Jun 2019 is selected as the Source product. Then go to the **Read(2)** tab and set the pre-processed product [4] from 13 Jun 2019 as the Source product.

Data Processing

DEM-assisted coregistration

- Image coregistration is the process of geometrically aligning two or more images so that corresponding pixels represent identical area on earth surface.
- It is possible to coregister two or more products using only orbit state vectors, however for the purpose of offset tracking we need more precise coregistration.
- Therefore, we use additional information provided by digital elevation model (DEM).

Data Processing

DEM-assisted coregistration

Read Read(2) **DEM-Assisted-Coregistration** Subset Offset-Tracking Write Write(2)

Digital Elevation Model: SRTM 3Sec (Auto Download) ▾

DEM Resampling Method: BICUBIC_INTERPOLATION ▾

Resampling Type: BISINC_5_POINT_INTERPOLATION ▾

Tile Extension [%]: 50

Mask out areas with no elevation

8

8. Go to the **DEM-Assisted-Coregistration** tab and set “Digital Elevation Model”: **SRTM 3Sec (Auto Download)**

Data Processing

Subset image

Read Read(2) DEM-Assisted-Coregistration **Subset** Offset-Tracking Write Write(2)

Source Bands: Sigma0_VV_mst_01Jun2019
Sigma0_VV_slv1_13Jun2019

Copy Metadata

Pixel Coordinates Geographic Coordinates

Reference band: Sigma0_VV_mst_01Jun2019

X: 19200 Y: 11000
Width: 700 height: 600

Sub-sampling X: 1 Sub-sampling Y: 1

Since our Area of Interest (AOI) is quite small and there is no need to process the whole image, we start with sub-setting the scene to a more manageable size. This will reduce the processing time in further steps and is recommended when the analysis is focused only on a specific area and not on the complete scene.

9. Go to the **Subset** tab and at “Pixel Coordinates” set:

X = 19200 Y = 11000
Width = 700 Height = 600

Data Processing

Offset tracking

- Offset Tracking is used to estimate the motion of a feature between two acquisitions through cross-correlation on selected Ground Control Point (GCP) in coregistered images (master and slave) in both slant-range and azimuth direction.
- The movement velocity is then computed based on the offsets estimated by the cross-correlation.
- The velocities computed on the GCP grid are interpolated to create velocity map. It is a method frequently used for glacier motion estimation.

Data Processing

Offset tracking

The Offset Tracking is performed in the following sub-steps (ESA Snap):

- For each point in the user-specified GCP grid in the master image, compute the corresponding pixel position in slave image using normalized cross-correlation.
- If the computed offset between master and slave GCP positions exceeds the maximum offset (computed from user-specified maximum velocity), then the GCP point is marked as outlier.
- Perform local average for the offset on valid GCP points.
- Fill holes caused by the outliers. The offset at the missing point will be replaced by a new offset computed by local weighted average.
- Compute the velocities for all points on the GCP grid from their offsets.
- Finally, compute velocities for all pixels in the master image from the velocities on GCP grid by interpolation (the final product has same pixel size as the input data).

Data Processing

Offset tracking

Output Grid

Grid Azimuth Spacing (in pixels): 20

Grid Range Spacing (in pixels): 20

Grid Azimuth Spacing (in meters): 200.0

Grid Range Spacing (in meters): 200.0

Grid Azimuth Dimension: 30

Grid Range Dimension: 35

Total Grid Points: 1050

Registration

Registration Window Width: 128

Registration Window Height: 128

Registration Oversampling: 16

Cross-Correlation Threshold: 0.1

Average Box Size: 5

Max Velocity (m/day): 2.0

Radius for Hole Filling: 4

Resampling Type: BICUBIC_INTERPOLATION

Spatial Average

Fill Holes

10. In the **Offset-Tracking** tab, we need to set several parameters. First, we need to set the GCP grid spacing in pixels in range and azimuth directions (determines the resolution/level of detail of our velocity product).

Grid Azimuth Spacing (in pixels): 20
Grid Range Spacing (in pixels): 20

11. Next, we need to set the Registration Window dimensions; the size of the registration window depends on the maximum velocity of the glacier (from the literature of historical data) and the period between the data acquisitions.
Max Velocity (m/day): 2.0

Data Processing

Write output

12. In both the **Write** and **Write(2)** tabs, define your output directory.

Read Read(2) DEM-Assisted-Coregistration Subset Offset-Tracking **Write** Write(2)

Target Product

Name:

Save as:

Directory:

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Read Read(2) DEM-Assisted-Coregistration Subset Offset-Tracking Write **Write(2)**

Target Product

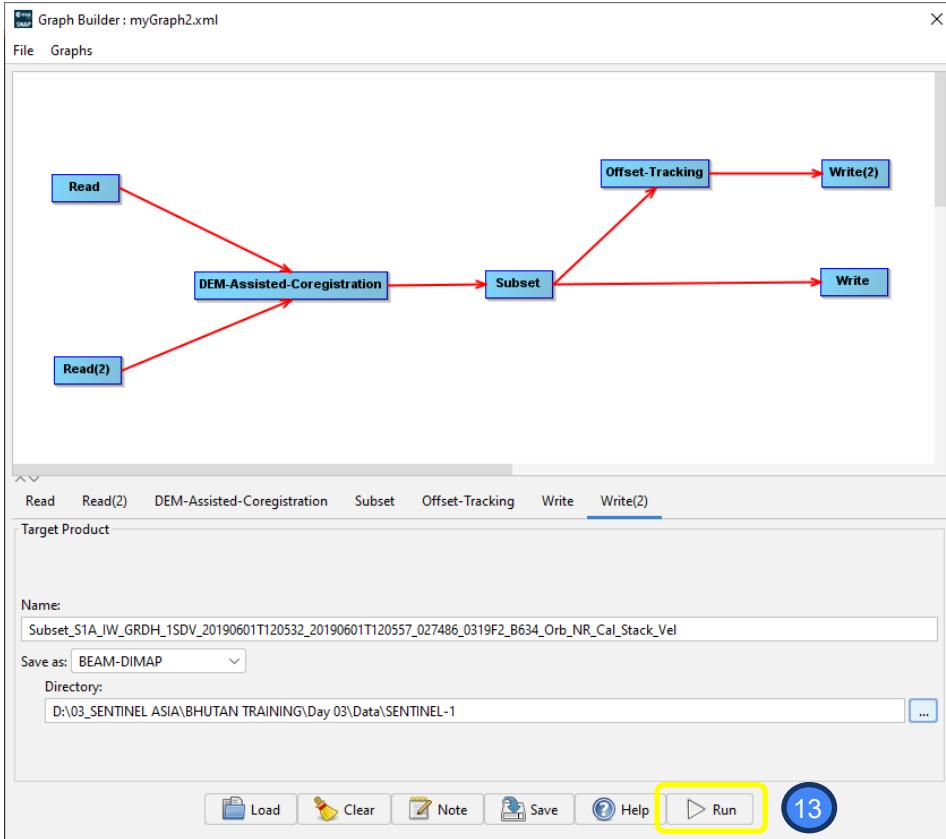
Name:

Save as:

Directory:

Data Processing

Run the Graph Builder



13. Now that all settings are completed. [Run](#) the Graph Builder.

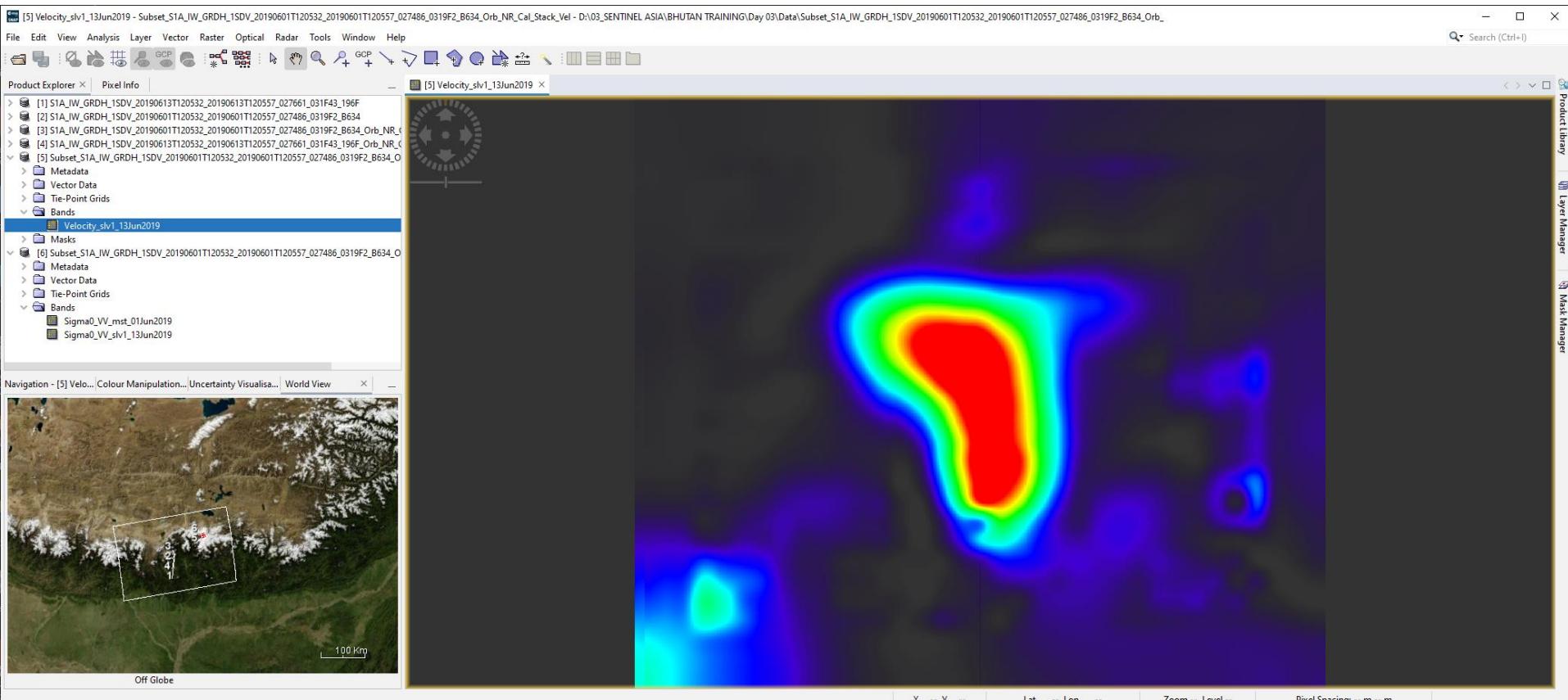
Note:

Depending on the version of SNAP that you have, there might be a recurring bug that prevents the Graph Builder from running. In such a case, we've prepared a [Graph_offsetTracking_backup.xml](#) file as a workaround.

You must load the .xml file in the Graph Builder and continue to work from there. You may still have to add some operators and modify the parameters as necessary.

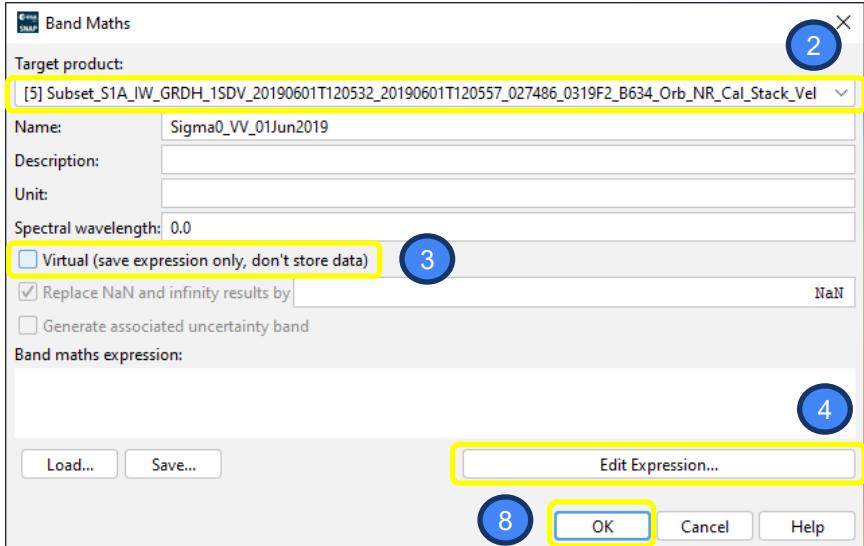
Data Processing

Visualize output: velocity

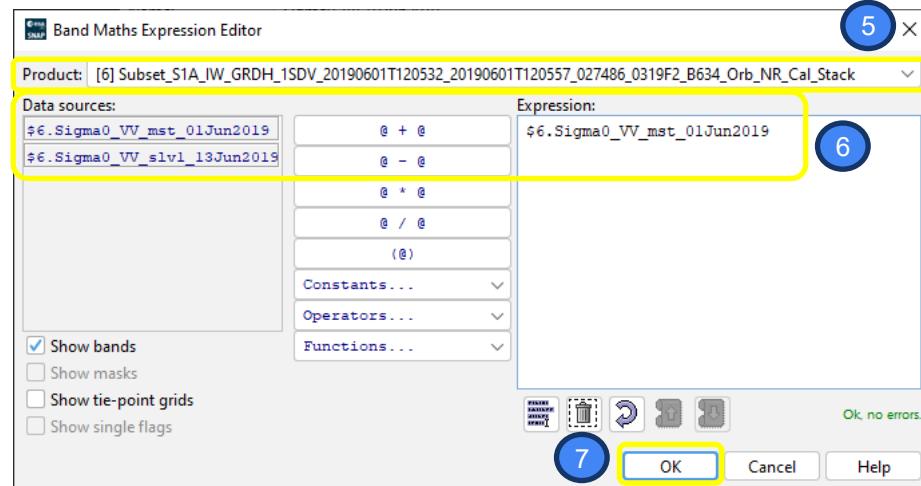


Data Processing

Stack the products



1. Right-click product [5] and open BandMath dialog.
2. Set "Name" to Sigma0_VV_01Jun2019
3. Deselect the Virtual (save expression only, don't store data) option because we want to store the data.



4. Click on the Edit Expression.
5. Set Product to: [6].
6. In Data Sources, click on \$6.Sigma0_VV_mst_01Jun2019 band.
7. Click OK in both windows. Repeat the process to add also the second band.

Data Processing

Stack the products (output)

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

Search (Ctrl+F)

Product Explorer | Pixel Info | [5] Velocity_slv1_13Jun2019 | [5] Sigma0_VV_01Jun2019 | [5] Sigma0_VV_13Jun2019

[5] Sigma0_VV_13Jun2019 - Subset_S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634_Orb_NR_Cal_Stack_Vel - D:\03_SENTINEL ASIA\BHUTAN TRAINING\Day 03\Data\Subset_S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634_Orb_NR_C

Product library | Layer Manager | Mask Manager

Product Explorer

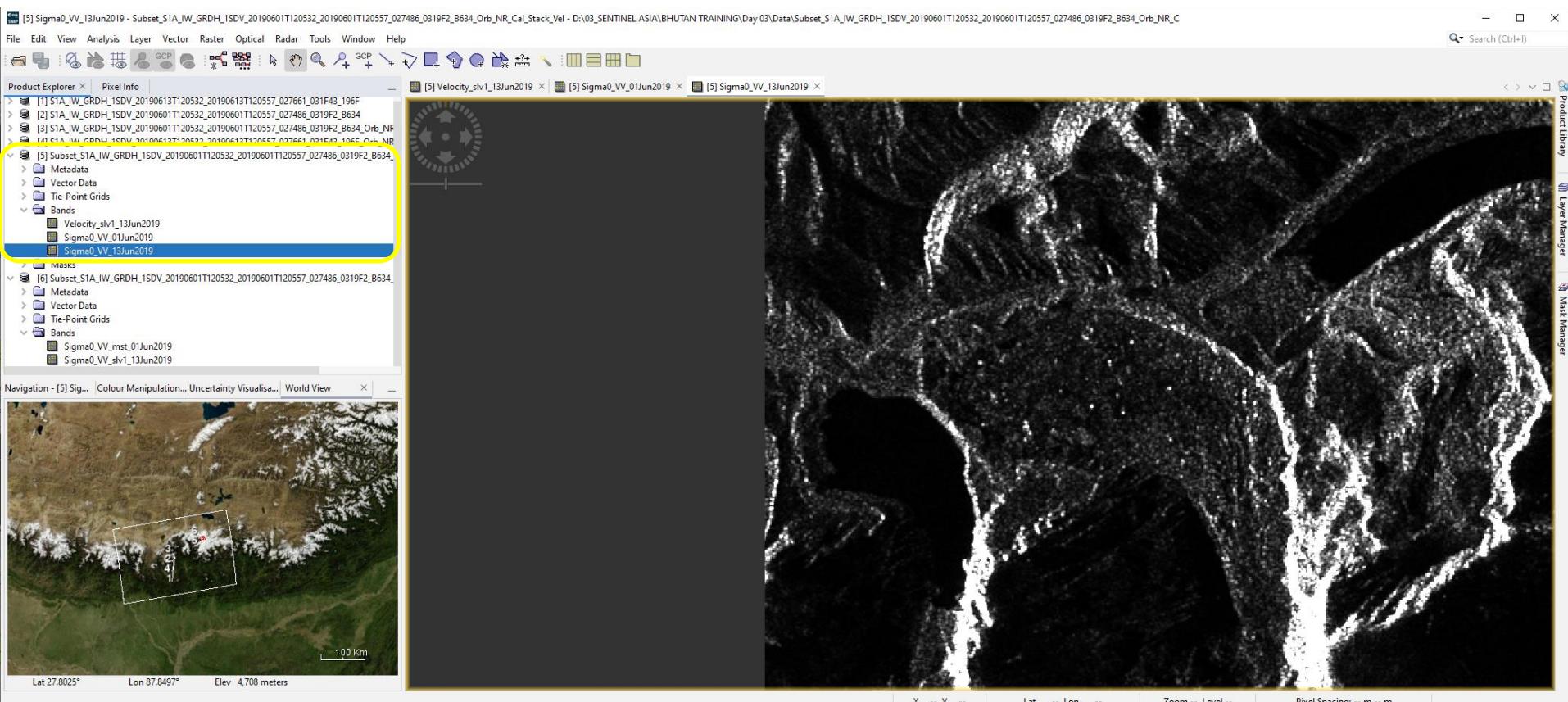
- [1] S1A_IW_GRDH_1SDV_20190613T120532_20190613T120557_027661_031F43_196F
- [2] S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634
- [3] S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634_Orb_NR
- [4] S1A_IW_GRDH_1SDV_20190613T120532_20190613T120557_027661_031F43_196F_Orb_NR
- [5] Subset_S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands**
 - Velocity_slv1_13Jun2019
 - Sigma0_VV_01Jun2019
 - Sigma0_VV_13Jun2019**
 - Masks
- [6] Subset_S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634
 - Metadata
 - Vector Data
 - Tie-Point Grids
 - Bands**
 - Sigma0_VV_mst_01Jun2019
 - Sigma0_VV_slv1_13Jun2019

Navigation - [5] Sig... | Colour Manipulation... | Uncertainty Visualisa... | World View

100 Km

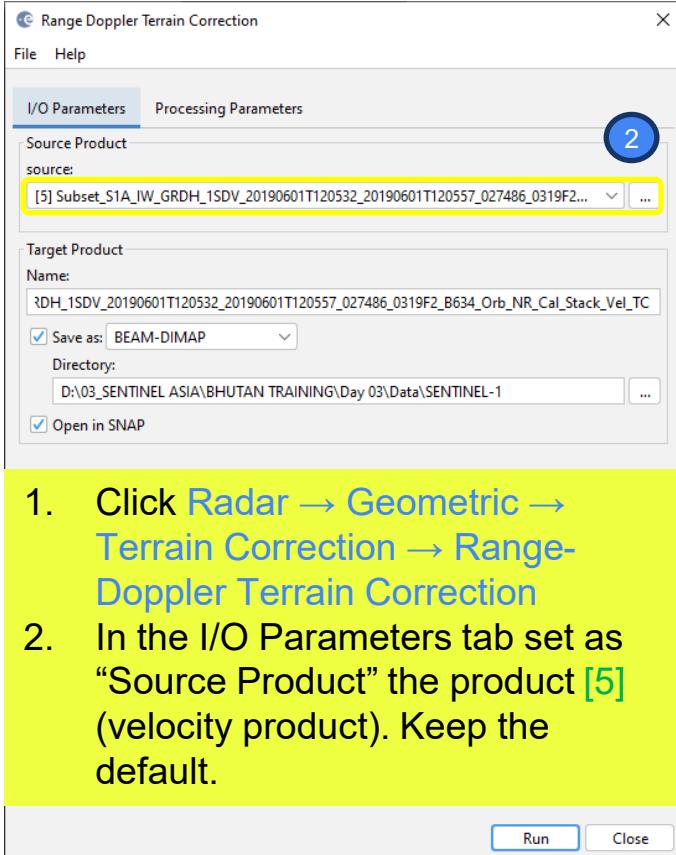
Lat 27.8025° Lon 87.8497° Elev 4,708 meters

X -- Y -- Lat -- Lon -- Zoom -- Level -- Pixel Spacing: -- m -- m

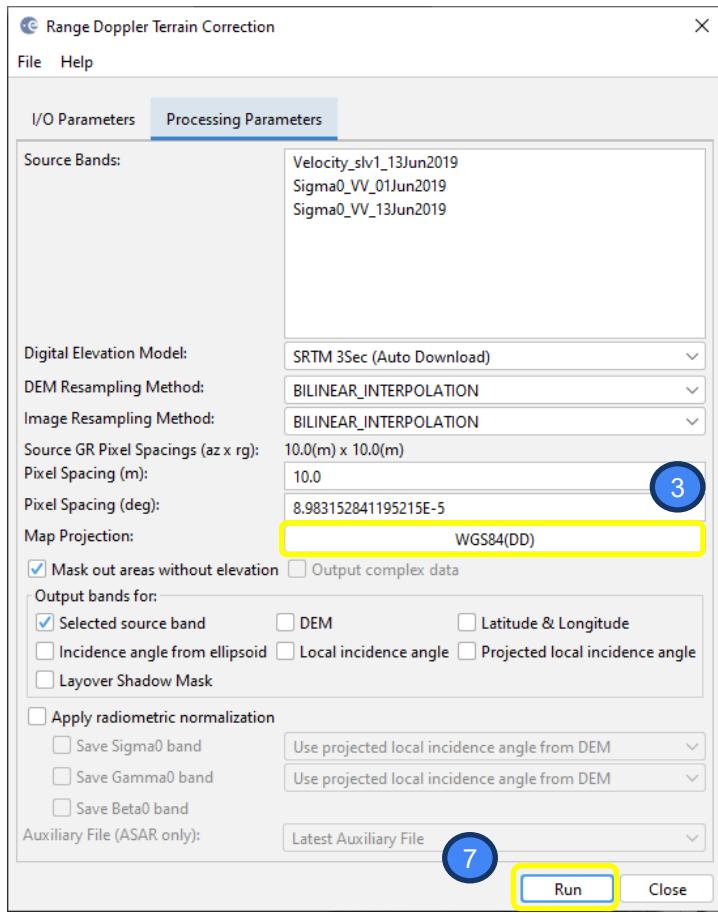


Data Processing

Terrain correction



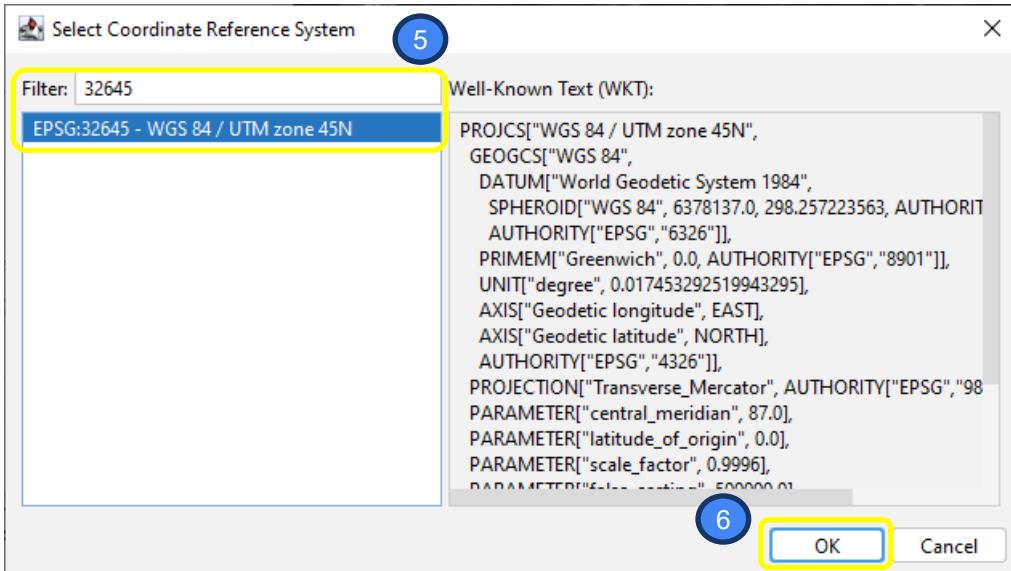
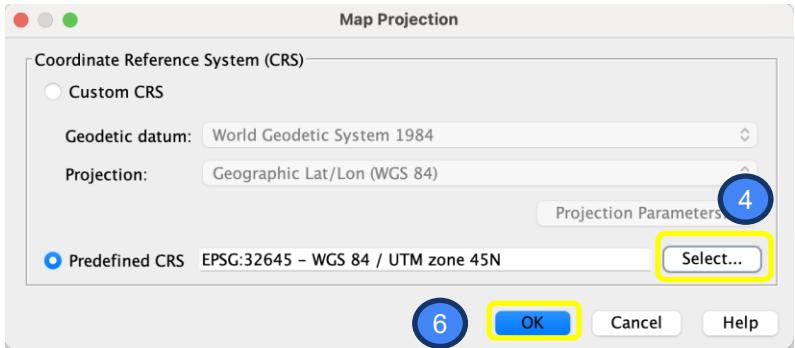
1. Click Radar → Geometric → Terrain Correction → Range-Doppler Terrain Correction
2. In the I/O Parameters tab set as “Source Product” the product [5] (velocity product). Keep the default.



3. In the Processing Parameters tab set: Click on Map Projection.

Data Processing

Terrain correction



4. In the Map Projection, choose Predefined CRS and click on “Select”.
5. In “Filter” search for 32645 (EPSG: 32645 – WGS84 / UTM Zone 45N)
6. Click OK to both windows.
7. Click Run in Range Doppler Terrain Correction window.

Data Processing

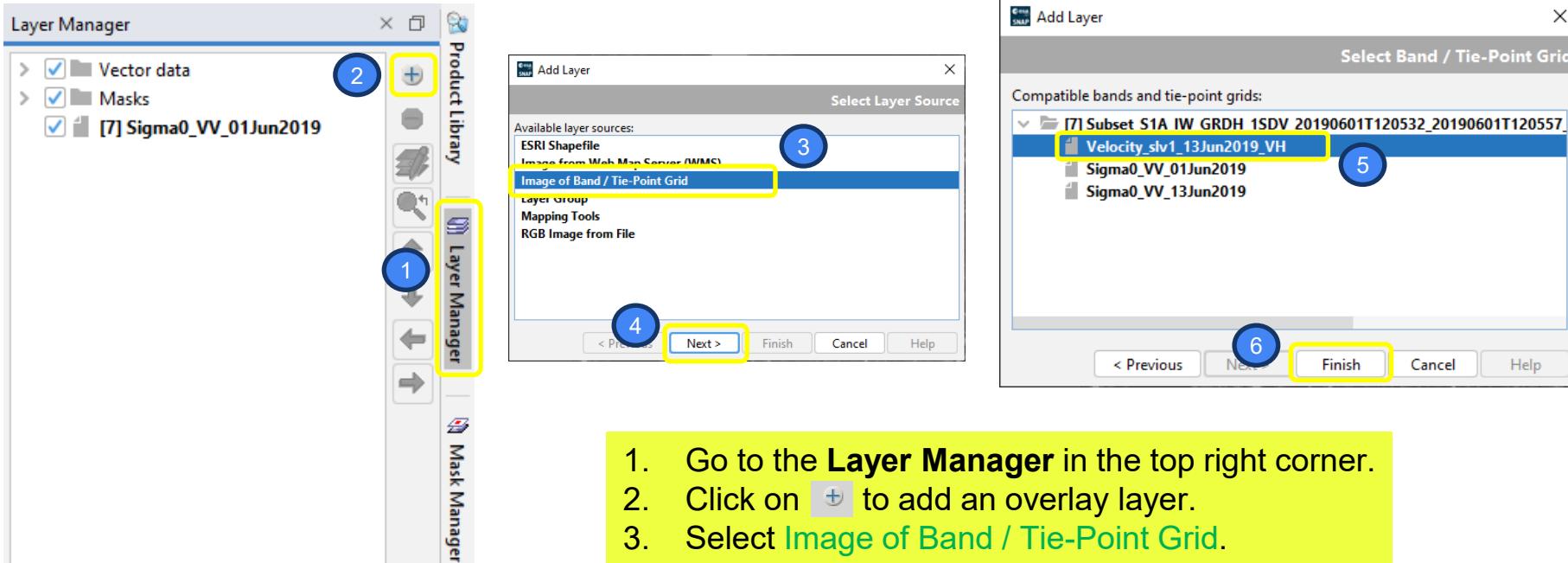
Visualize output: color manipulation

The screenshot shows the SNAP software interface. The top menu bar includes File, Edit, View, Analysis, Layer, Vector, Raster, Optical, Radar, Tools, Window, and Help. The Product Explorer panel on the left lists several processed bands, including Velocity, Sigma0_VV, and Sigma0_VH bands for different dates. A yellow box highlights the 'Sigma0_VV_01Jun2019' band in the list, with a blue circle labeled '1' on it. The main window displays a grayscale image of a forest area with significant texture. The bottom left shows a histogram for the selected band, with a blue circle labeled '2' on it. The histogram has a red text overlay: 'Name: Sigma0_VV_01Jun2019', 'Unit: null', 'Min: 0.001', 'Max: 21.631', and 'Rough statistics!'. The bottom right of the image shows a zoom control with 'Zoom -- Level --' and 'Pixel Spacing: -- m -- m'.

1. Open the **Sigma0_VV_01Jun2019** band in the View window.
2. To improve the visual, we can modify the histogram. In Colour Manipulation tab, select Sliders, then move the slider to the left).

Data Processing

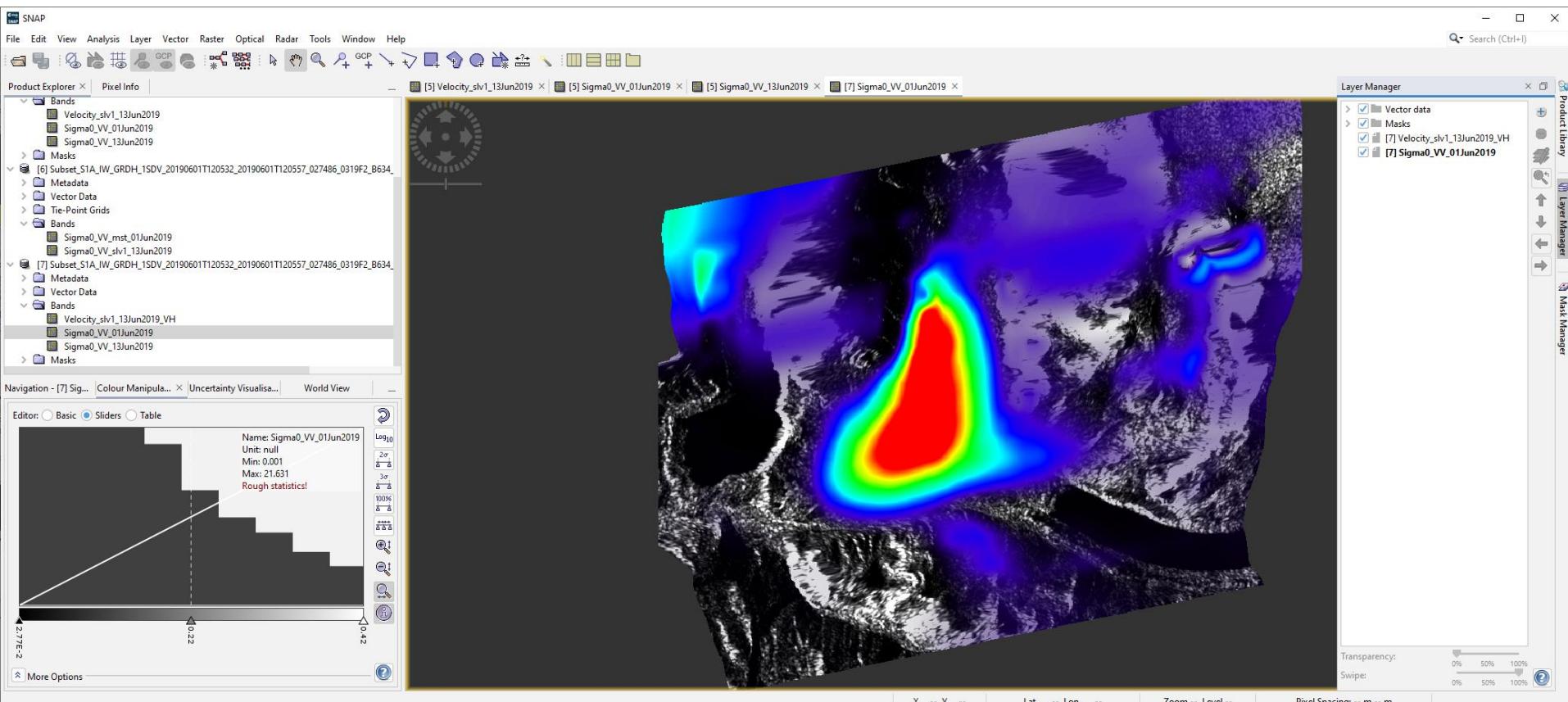
Visualize output: overlaying



1. Go to the **Layer Manager** in the top right corner.
2. Click on  to add an overlay layer.
3. Select **Image of Band / Tie-Point Grid**.
4. Click **Next**.
5. Select the **Velocity_slv1_13Jun2019_VH**.
6. Click **Finish**.

Data Processing

Visualize output: overlaying



Data Processing

Visualize output: table of velocity (vector data)

SNAP

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

Product Explorer | Pixel Info | [5] Velocity_slv1_13Jun2019 | [5] Sigma0_VV_01Jun2019 | [5] Sigma0_VV_13Jun2019 | [7] Sigma0_VV_01Jun2019 | [7] Velocity

1

Bands

- Velocity_slv1_13Jun2019
- Sigma0_VV_01Jun2019
- Sigma0_VV_13Jun2019

Masks

[6] Subset_S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634

Metadata

Vector Data

Tie-Point Grids

Bands

- Sigma0_VV_mst_01Jun2019
- Sigma0_VV_slv1_13Jun2019

[7] Subset_S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634

Metadata

Vector Data

- pins
- ground_control_points
- Velocity

Bands

Velocity_slv1_13Jun2019_VH

Navigation Colour Manipulation Uncertainty Visualisation World View

100 Km

Off Globe Downloading

The vector data of velocity contains the following information:

- coordinates of GCP point in the master image (1 June) and slave image (13 June),
- the distance travelled,
- velocity in m/day, heading in degrees (East from North),
- range shift and azimuth shift.

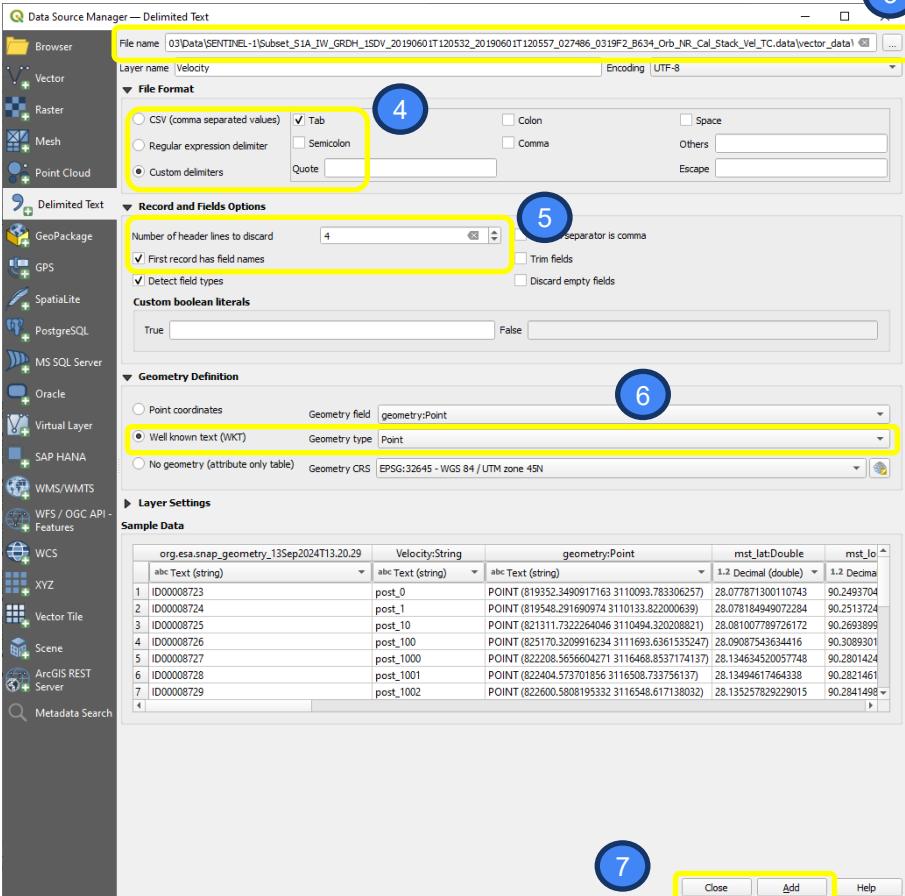
1. Expand the “Vector Data” folder of the product [7] and double-click on Velocity.

| Velocity | geometry | mst_lat | mst_lon | slv_lat | slv_lon | distance | velocity | heading | range_shift | azimuth_shift | style_css |
|-----------|---------------|---------|---------|---------|---------|----------|----------|---------|-------------|---------------|------------------|
| post_0 | POINT (819... | 28.078 | 90.249 | 28.078 | 90.249 | 0 | 0.047 | -1 | -0.479 | -0.301 | fill:#0000ff;... |
| post_1 | POINT (819... | 28.078 | 90.251 | 28.078 | 90.251 | 0 | 0.048 | -1 | -0.497 | -0.281 | fill:#0000ff;... |
| post_10 | POINT (821... | 28.081 | 90.269 | 28.081 | 90.269 | 0 | 0.032 | -1 | -0.335 | -0.177 | fill:#0000ff;... |
| post_100 | POINT (825... | 28.091 | 90.309 | 28.091 | 90.309 | 0 | 0.069 | -1 | -0.549 | 0.627 | fill:#0000ff;... |
| post_1000 | POINT (822... | 28.135 | 90.28 | 28.135 | 90.28 | 0 | 0.121 | -1 | -0.777 | 1.233 | fill:#0000ff;... |
| post_1001 | POINT (822... | 28.135 | 90.282 | 28.135 | 90.282 | 1.58 | 0.13 | 138.591 | -0.825 | 1.326 | fill:#0000ff;... |
| post_1002 | POINT (822... | 28.135 | 90.284 | 28.135 | 90.284 | 1.654 | 0.136 | 136.425 | -0.917 | 1.355 | fill:#0000ff;... |
| post_1003 | POINT (822... | 28.136 | 90.286 | 28.136 | 90.286 | 1.708 | 0.141 | 132.729 | -1.037 | 1.336 | fill:#0000ff;... |
| post_1004 | POINT (822... | 28.136 | 90.288 | 28.136 | 90.288 | 1.741 | 0.144 | 128.518 | -1.156 | 1.283 | fill:#0000ff;... |
| post_1005 | POINT (823... | 28.136 | 90.29 | 28.136 | 90.29 | 1.738 | 0.144 | 125.445 | -1.222 | 1.218 | fill:#0000ff;... |
| post_1006 | POINT (823... | 28.137 | 90.292 | 28.136 | 90.292 | 1.733 | 0.144 | 121.678 | -1.297 | 1.133 | fill:#0000ff;... |
| post_1007 | POINT (823... | 28.137 | 90.294 | 28.137 | 90.294 | 1.712 | 0.142 | 118.003 | -1.352 | 1.037 | fill:#0000ff;... |
| post_1008 | POINT (823... | 28.137 | 90.296 | 28.137 | 90.296 | 1.711 | 0.142 | 114.525 | -1.413 | 0.954 | fill:#0000ff;... |
| post_1009 | POINT (823... | 28.137 | 90.298 | 28.137 | 90.298 | 1.732 | 0.144 | 114.007 | -1.439 | 0.953 | fill:#0000ff;... |
| post_101 | POINT (825... | 28.091 | 90.311 | 28.091 | 90.311 | 0 | 0.071 | -1 | -0.476 | 0.701 | fill:#0000ff;... |
| post_1010 | POINT (824... | 28.138 | 90.3 | 28.138 | 90.3 | 1.791 | 0.149 | 115.717 | -1.457 | 1.028 | fill:#0000ff;... |
| post_1011 | POINT (824... | 28.138 | 90.302 | 28.138 | 90.302 | 1.797 | 0.149 | 118.865 | -1.403 | 1.109 | fill:#0000ff;... |
| post_1012 | POINT (824... | 28.138 | 90.304 | 28.138 | 90.304 | 1.779 | 0.147 | 122.298 | -1.319 | 1.177 | fill:#0000ff;... |
| post_1013 | POINT (824... | 28.139 | 90.306 | 28.139 | 90.306 | 1.695 | 0.14 | 125.566 | -1.189 | 1.19 | fill:#0000ff;... |
| post_1014 | POINT (824... | 28.139 | 90.308 | 28.139 | 90.308 | 1.622 | 0.134 | 127.647 | -1.095 | 1.179 | fill:#0000ff;... |
| post_1015 | POINT (818... | 28.13 | 90.24 | 28.13 | 90.24 | 4.983 | 0.41 | 326.009 | 2.031 | -4.478 | fill:#0000ff;... |
| post_1016 | POINT (818... | 28.13 | 90.242 | 28.131 | 90.242 | 4.582 | 0.377 | 326.943 | 1.799 | -4.147 | fill:#0000ff;... |
| post_1017 | POINT (818... | 28.131 | 90.244 | 28.131 | 90.244 | 4.191 | 0.344 | 328.111 | 1.567 | -3.825 | fill:#0000ff;... |
| post_1018 | POINT (818... | 28.131 | 90.246 | 28.131 | 90.246 | 3.83 | 0.315 | 329.383 | 1.353 | -3.526 | fill:#0000ff;... |
| post_1019 | POINT (819... | 28.131 | 90.248 | 28.131 | 90.248 | 3.501 | 0.288 | 330.532 | 1.171 | -3.247 | fill:#0000ff;... |
| post_102 | POINT (825... | 28.091 | 90.313 | 28.091 | 90.313 | 0 | 0.073 | -1 | -0.409 | 0.772 | fill:#0000ff;... |
| post_1020 | POINT (819... | 28.132 | 90.25 | 28.132 | 90.25 | 3.216 | 0.264 | 331.594 | 1.019 | -3.001 | fill:#0000ff;... |
| post_1021 | POINT (819... | 28.132 | 90.252 | 28.132 | 90.252 | 2.953 | 0.243 | 331.962 | 0.917 | -2.763 | fill:#0000ff;... |
| post_1022 | POINT (819... | 28.132 | 90.254 | 28.132 | 90.254 | 2.694 | 0.221 | 332.051 | 0.833 | -2.521 | fill:#0000ff;... |
| post_1023 | POINT (819... | 28.133 | 90.256 | 28.133 | 90.256 | 2.201 | 0.181 | 332.809 | 0.653 | -2.068 | fill:#0000ff;... |
| post_1024 | POINT (820... | 28.133 | 90.258 | 28.133 | 90.258 | 1.744 | 0.143 | 334.4 | 0.471 | -1.652 | fill:#0000ff;... |
| post_1025 | POINT (820... | 28.133 | 90.26 | 28.133 | 90.26 | 1.353 | 0.111 | 338.082 | 0.281 | -1.302 | fill:#0000ff;... |
| post_1026 | POINT (820... | 28.134 | 90.262 | 28.134 | 90.262 | 0 | 0.082 | -1 | 0.062 | -0.987 | fill:#0000ff;... |
| post_1027 | POINT (820... | 28.134 | 90.264 | 28.134 | 90.264 | 0 | 0.062 | -1 | -0.122 | -0.726 | fill:#0000ff;... |
| post_1028 | POINT (820... | 28.134 | 90.266 | 28.134 | 90.266 | 0 | 0.048 | -1 | -0.27 | -0.511 | fill:#0000ff;... |
| post_1029 | POINT (820... | 28.135 | 90.268 | 28.135 | 90.268 | 0 | 0.04 | -1 | -0.368 | -0.3 | fill:#0000ff;... |
| post_103 | POINT (825... | 28.092 | 90.315 | 28.092 | 90.315 | 0 | 0.075 | -1 | -0.35 | 0.835 | fill:#0000ff;... |
| post_1030 | POINT (821... | 28.135 | 90.27 | 28.135 | 90.27 | 0 | 0.039 | -1 | -0.462 | -0.076 | fill:#0000ff;... |

Data Visualization in QGIS

Open .csv file

1. Open **QGIS Desktop** software 
2. In the Menu Bar, click on **Layer** → **Add Layer** → **Add Delimited Text Layer**.
3. In Data Source, click on the **Browse**  button and navigate to the vector file
`...\\Subset_S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634_Orb_NR_Cal_Stack_Vel_TC.data\\vector_data\\Velocity.csv` in the data folder.
4. In File format, select **Custom delimiter**, checklist **Tab**, and uncheck all other delimiters.
5. In Record and Field options, set the Number of header lines to discard to “3” and make sure to checklist the “**First record has field names**” option.
6. In the Geometry definition, select “**Well known text (WKT)**” and set the Geometry type to “**Point**”.
7. With this file selected, click **Add**, then **Close**. The data you specified will now load.



File name: 03\\Data\\SENTINEL-1\\Subset_S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634_Orb_NR_Cal_Stack_Vel_TC.data\\vector_data\\Velocity.csv

Layer name: Velocity

File format

- CSV (comma separated values) Tab Colon Space
- Regular expression delimiter Semicolon Comma Others
- Custom delimiters Quote Escape

Record and Fields Options

- Number of header lines to discard: 4
- First record has field names
- Detect field types
- Custom boolean literals

Geometry Definition

- Point coordinates
- Well known text (WKT) Geometry type: Point
- No geometry (attribute only table) Geometry CRS: EPSG:32645 - WGS 84 / UTM zone 45N

Layer Settings

Sample Data

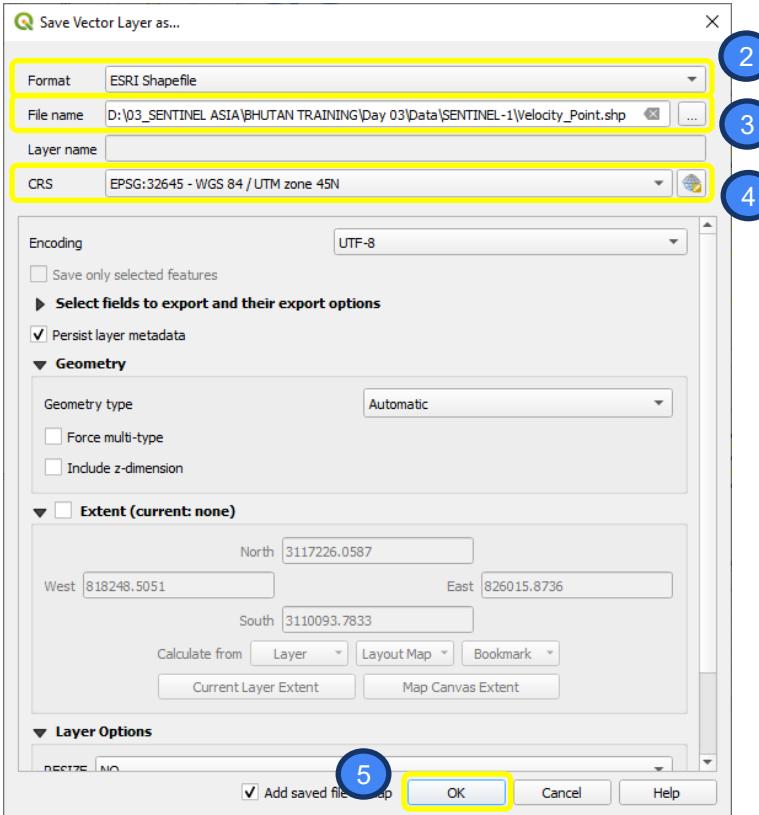
| org.esa.snap_geometry_13Sep2024T13.20.29 | Velocity:String | geometry:Point | mst_lat:Double | mst_lo: |
|--|-------------------|--|----------------------|-------------|
| abc_Text (string) | abc_Text (string) | abc_Text (string) | 1.2 Decimal (double) | 1.2 Decimal |
| 1 ID00008723 | post_0 | POINT (619352.349017163 3110093.783306257) | 28.0778171300110743 | 90.2493704 |
| 2 ID00008724 | post_1 | POINT (819548.291690974 3110133.822000639) | 28.07818497072284 | 90.2513724 |
| 3 ID00008725 | post_10 | POINT (821311.722264046 3110494.320208821) | 28.08107789726172 | 90.2693899 |
| 4 ID00008726 | post_100 | POINT (825170.3209916234 3111693.6361535247) | 28.0907543634416 | 90.3089301 |
| 5 ID00008727 | post_1000 | POINT (822208.565604271 3116468.8537174137) | 28.13463452057748 | 90.2801424 |
| 6 ID00008728 | post_1001 | POINT (822404.573701856 3116508.733756137) | 28.13494617464338 | 90.2821461 |
| 7 ID00008729 | post_1002 | POINT (822600.58095332 3116548.617130832) | 28.135257829229015 | 90.2841499 |

Close Add Help

Data Visualization in QGIS

Convert .csv file to shapefile

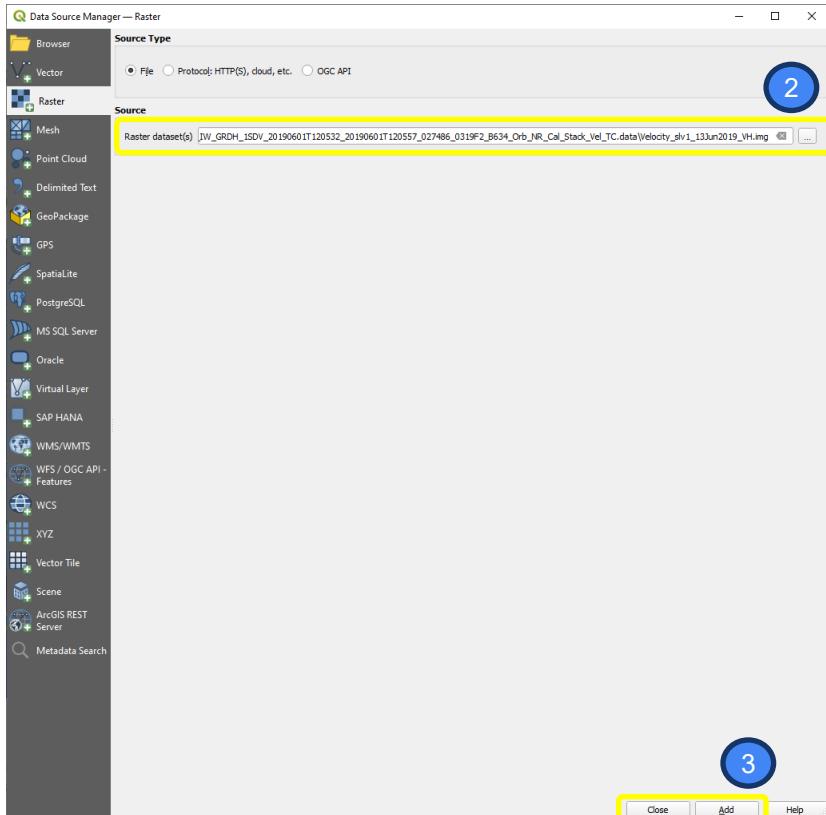
1. Right-click on the opened **Velocity** layer, then click **Save Vector Layer as**
2. In Format, select **ESRI Shapefile**.
3. Save the Vectorized result to **Velocity_Point.shp**
4. In CRS, make sure to select **EPSG: 32645 – WGS84 / UTM Zone 45N**.
5. Click **OK**.



Data Visualization in QGIS

Open velocity raster data

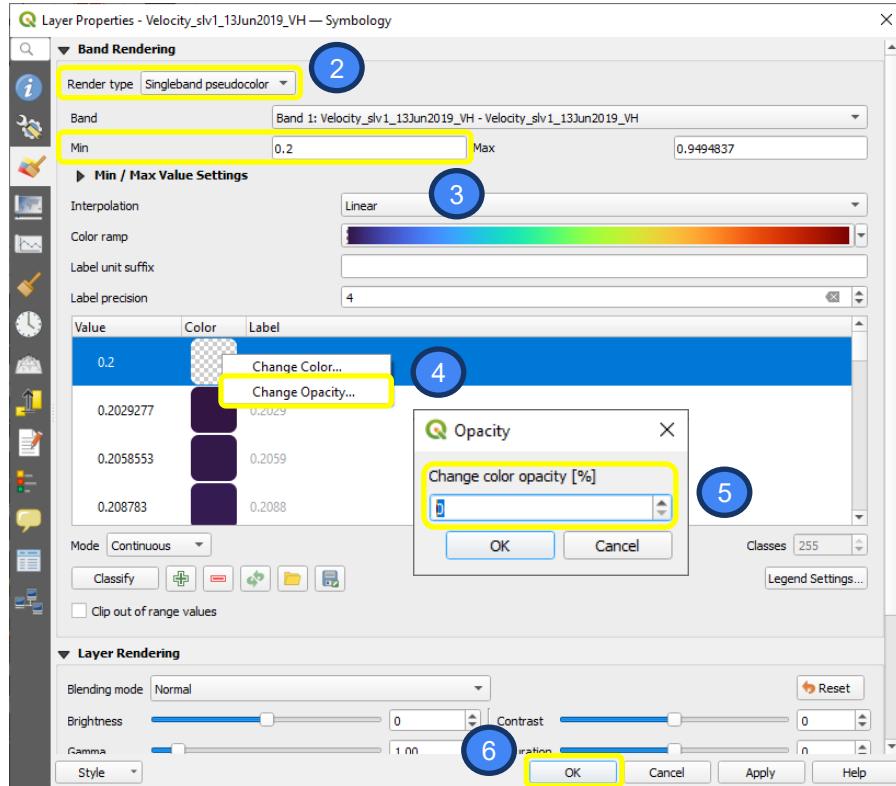
1. In the Menu Bar, click on **Layer** → **Add Layer** → **Add Raster Layer**.
2. In Data Source, click on the **Browse** button and navigate to the file **\Subset_S1A_IW_GRDH_1SDV_20190601T120532_20190601T120557_027486_0319F2_B634_Orb_NR_Cal_Stack_Vel_TC.data\Velocity_slv1_13Jun2019_VH.img** in the data folder.
3. With this file selected, click **Add**, then **Close**. The data you specified will now load.



Data Visualization in QGIS

Change the appearance of the velocity raster layer

1. Right-click on the opened [Velocity_slv1_13Jun2019_VH](#) raster layer, then click **Properties**.
2. In Render type, change to **Singleband pseudocolor**.
3. Let's change the Min value to **0.2**.
4. Right-click the Color for the Min value, then select **Change Opacity...**
5. To make it transparent, change the color opacity to **0**.
6. Click **OK**



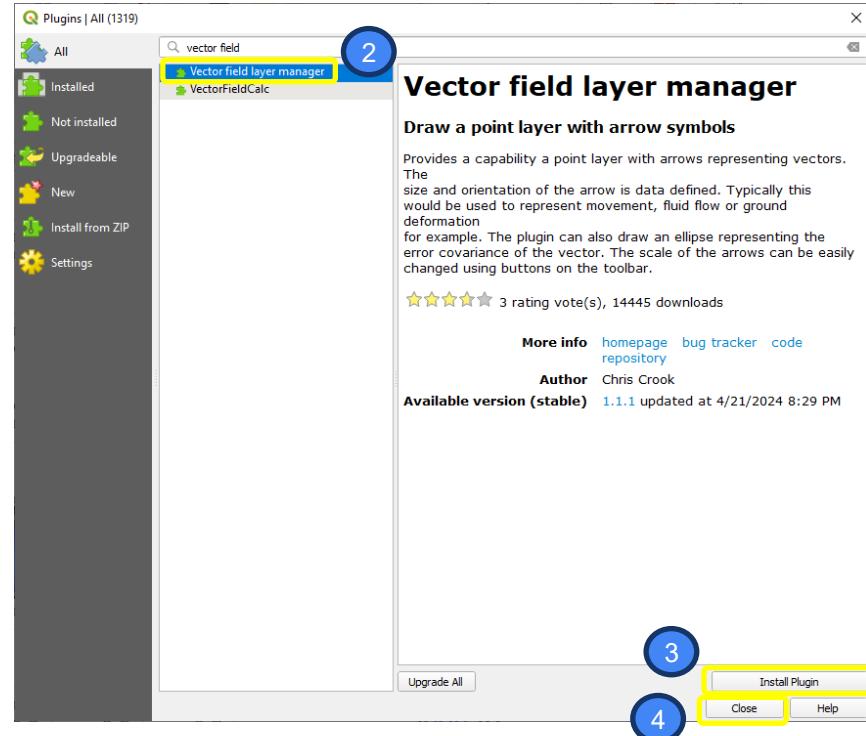
Data Visualization in QGIS

Install a plugin: Vector field layer manager

To visualize the velocity vector fields, we need to install the Vector field layer manager plug-in.

1. In the Menu Bar, click on [Plugins](#) → [Manage and Install Plugins](#).
2. In the dialog that opens, find the [Vector field layer manager](#) plugin.
3. Click [Install Plugin](#).
4. Click [Close](#).

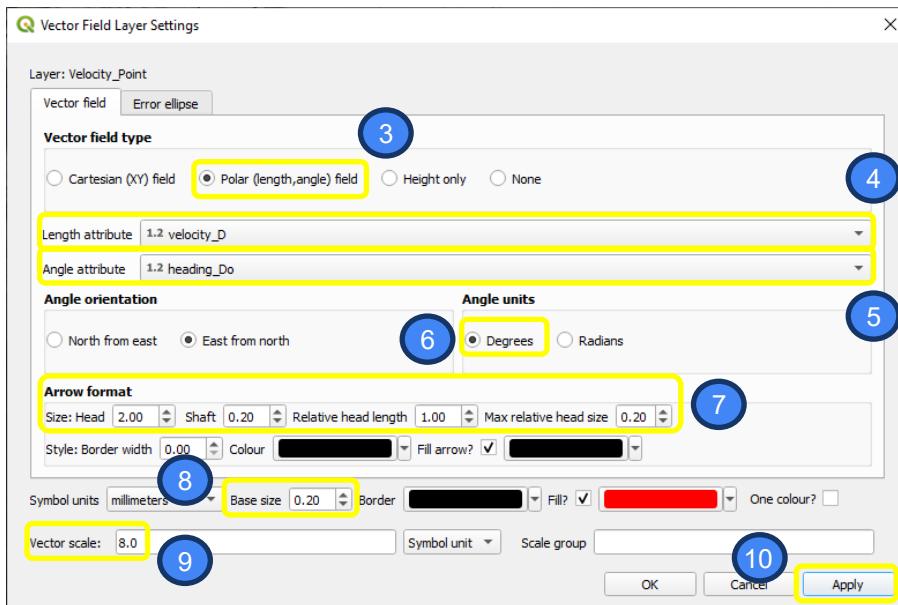
Your new plugin  is installed.



Data Visualization in QGIS

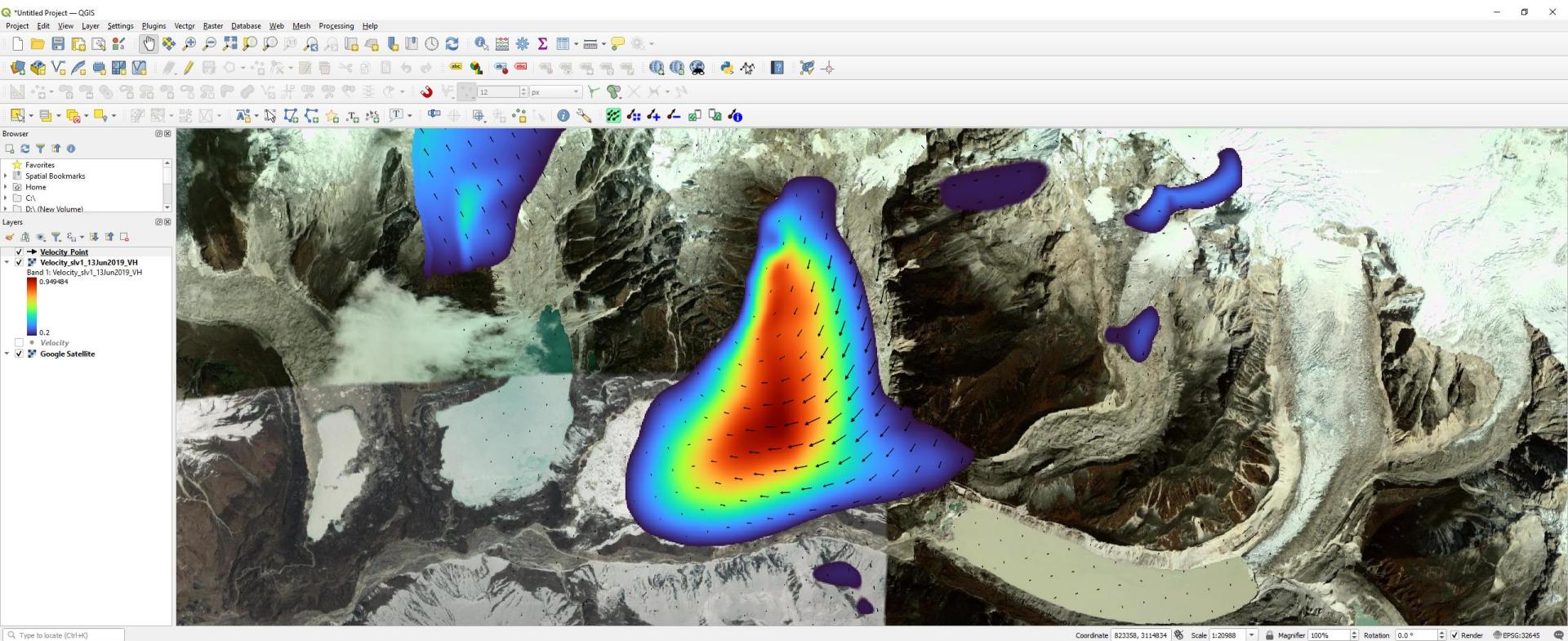
Setup the velocity vector field

1. In Layer List, select **Velocity_Point** layer to activate the Vector field layer manager plugin.
2. In Toolbar, click 
3. In the Vector field, select **Polar (length, angle) field**.
4. In the Length attribute, select **velocity_D**.
5. In the Angle attribute, select **Heading_Do**.
6. In the Angle units, change to **Degrees**.
7. In the Arrow format, set the following
 - Head: **2.00**
 - Shaft: **0.20**
 - Relative head length: **1.00**
 - Max relative head size: **0.20**
8. In the Base size, set to **0.20**
9. In the Vector scale, set to **8.0**
10. Click **Apply**.



Data Visualization in QGIS

Install a plugin: Vector field layer manager



Sources

- Serco Italia SPA (2018). Glacier Velocity with Sentinel-1 – Peterman Glacier, Greenland (version 1.2). Retrieved from RUS Lectures.
- How to Create Glacier Velocity Maps with Sentinel-1 Toolbox: <https://ASF.alaska.edu/how-to/data-recipes/how-to-create-glacier-velocity-maps-with-sentinel-1-toolbox/>

THANK YOU

Geoinformatics Center, Asian Institute of Technology

