National Aeronautics and Space Administration

OPERA

Observational Products for End-Users from Remote Sensing Analysis

GIS Visualization Guide: OPERA Coregistered Single-Look Complex from Sentinel 1 A/B

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Observational Products for End-Users from Remote Sensing Analysis (OPERA) Project

Tutorial 101: How to visualize OPERA Level-2 Coregistered Single-Look Complex data from Sentinel-1 A/B using a GIS software

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For this tutorial, download the sample CSLC product here. The data can be viewed on a local machine using any GIS software (e.g., QGIS). We will visualize the phase and amplitude of the CSLC dataset acquired on May 01, 2022 over Los Angeles, California, USA.

1) Each OPERA L2_CSLC_S1 product is distributed as a HDF5 file following the CF-1.8 convention with separate groups containing the data raster layers, the low-resolution, correction layers, and relevant product metadata. Each h5 file has the following filename structure:

   OPERA_<LEVEL>_<PRODUCTTYPE>_<SENSOR>_<IMAGING_MODE>_<BURST_ID>_<POLARIZATION>_<DATETIME>_<PRODUCT_VERSION>_<PRODUCT_GENERATIONDATETIME>.ext

   e.g.
   OPERA_L2_CSLC_S1A_IW_064_135518_IW1_VV_20220501T015035_1.0_20230206T174400.h5

2) We load the Phase component of the OPERA L2_CSLC_S1 product first. To do this,
   a) Go to Layer tab -> select “Open Data Source Manager” in QGIS (Figure 1).

   b) Choose “Raster” from data type options presented, and enter the following text in the field for path to the Raster dataset:

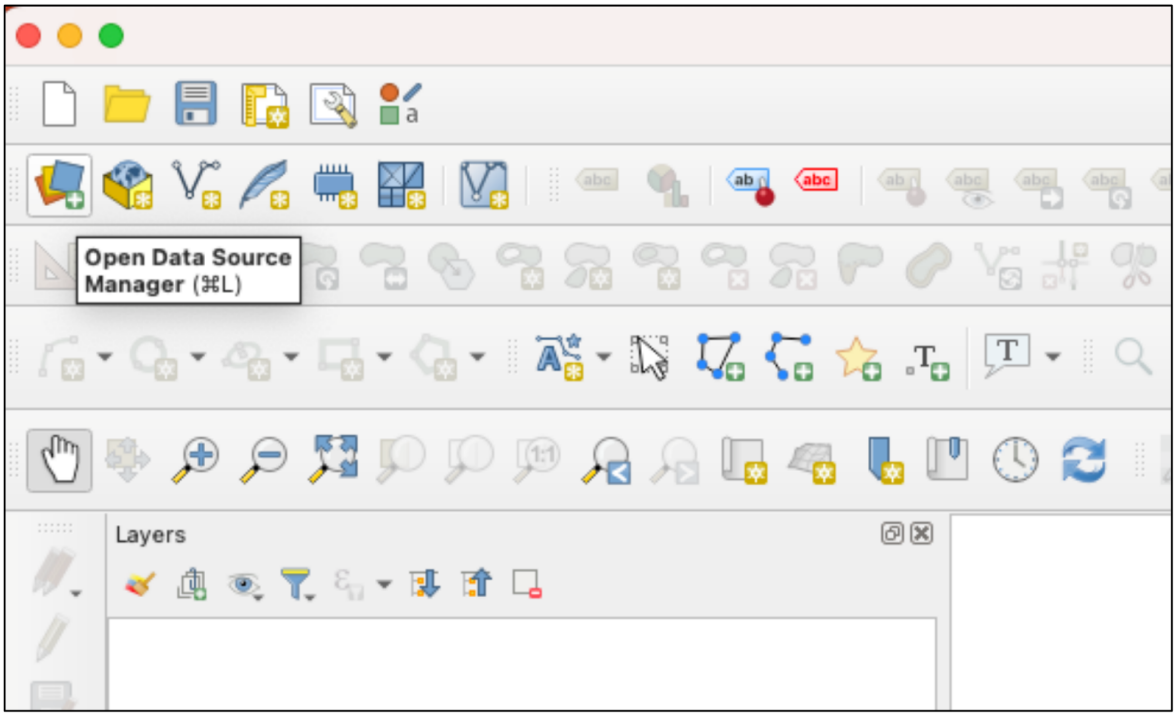
```
DERIVED_SUBDATASET:PHASE:NETCDF:"<path_to_file>":/science/SENTINEL1/CSLC/grids/VV
```

   “PHASE” is highlighted above since it is the sub-dataset we wish to load. Here, <path_to_file> is replaced with the location of the downloaded data product For example:

```
DERIVED_SUBDATASET:PHASE:NETCDF:"/Users/karthikv/Desktop/cslc_data/OPERA_L2_CSLC_S1A_IW_064_135518_IW1_VV_20220501T015035_1.0_20230206T174400.h5":/science/SENTINEL1/CSLC/grids/VV
```

   c) Rename the newly added layer (Figure 2). To do this, right click on the added layer from the layers pane (named “VV” by default), select “Rename layer”, and type in “Phase”

1 **Select "Open Data Source" from the Data Source Manager Toolbar**



2 **Enter the provided string to load the phase data, changing the download path appropriately**

Figure 1. Loading the Phase component of the OPERA CSLC data.

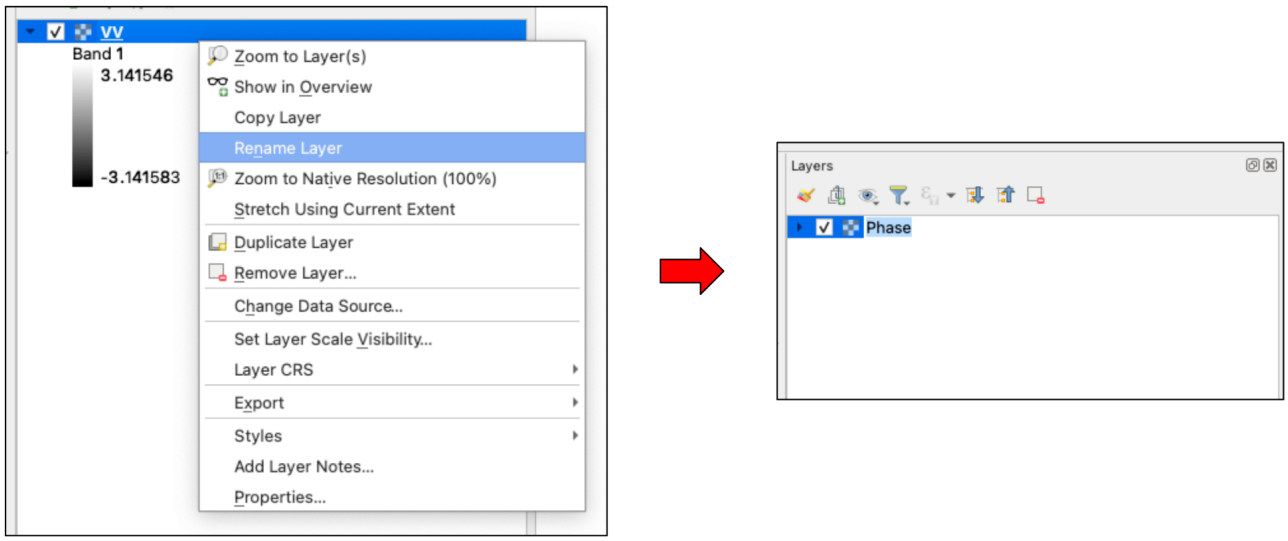


Figure 2. Renaming the layer.

1 **Right click on the 'Phase' layer, and select 'Properties'. Under 'Symbology', select 'Singleband pseudocolor' as the 'Render type'**

2 **Select 'RdBu' as the Color ramp. Note, this option might be under the 'All Color Ramps' menu**

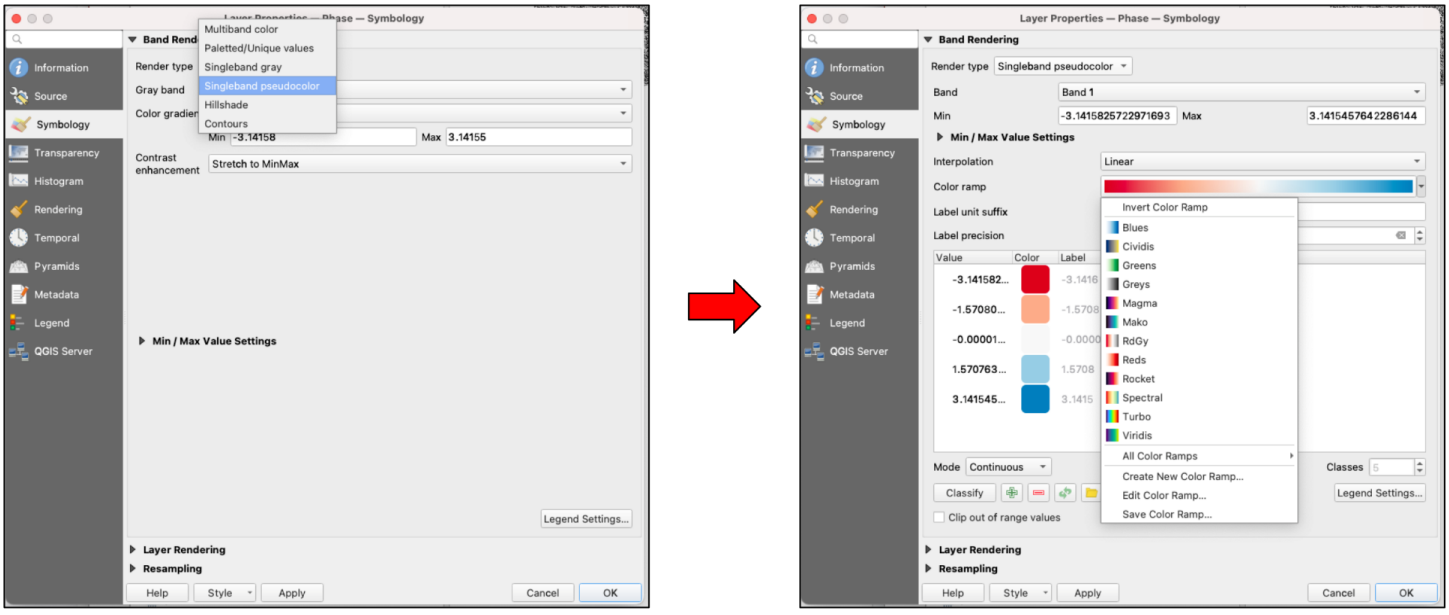


Figure 3. Changing the color ramp for the Phase layer

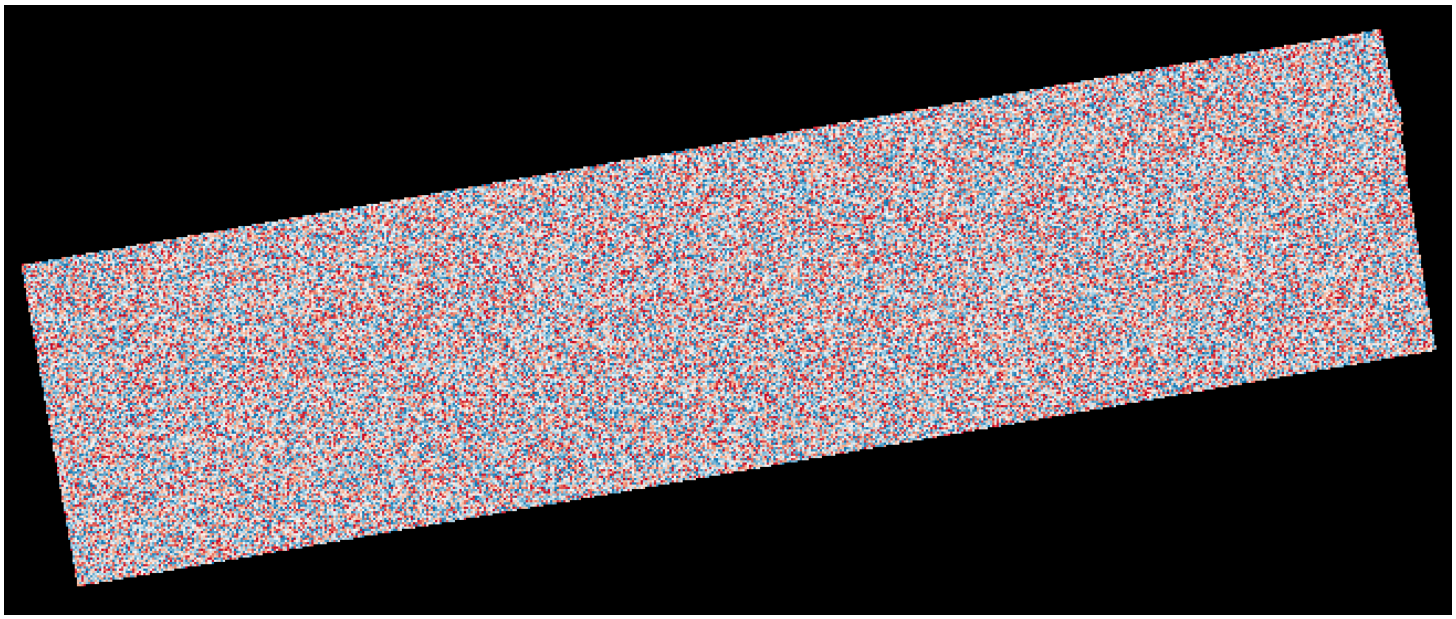


Figure 4. Phase component of the OPERA CSLC.

3) We can change the default colorbar for the Phase layer (Figure 3). To do this, right click on the layer and select properties. Under the “Symbology” tab, select “Singleband pseudocolor” as the render type. In the subsequent window, pick “RdBu” as the color ramp and press OK. Note, this color ramp may be under the “All color ramps” drop down menu. Your view should now match the one shown in Figure 4.

4) Load the Amplitude component. To do this,
   a. Go to Layer tab -> select “Open Data Source Manager” in QGIS (Figure 1).

   b. Choose “Raster” from data type options presented, and enter the following text in the field for path to the Raster dataset:

```
DERIVED_SUBDATASET:AMPLITUDE:NETCDF:"<path_to_file>":/science/SE
NTINEL1/CSLC/grids/VV
```

      where <path_to_file> is replaced with the location of the downloaded data product (Figure 1) For example:

```
DERIVED_SUBDATASET:AMPLITUDE:NETCDF:"/Users/karthikv/Desktop/csl
c_data/OPERA_L2_CSLC_S1A_IW_064_135518_IW1_VV_20220501T015035_1
.0_20230206T174400.h5":/science/SENTINEL1/CSLC/grids/VV
```

where <path_to_file> is replaced with the location of the downloaded data product. See Figure 1. for an example. Note that the derived sub-dataset type in the above line has changed from “PHASE” in Step 2, to “AMPLITUDE” now.

c. Rename the newly added layer as before. Similar to the instructions shown in Figure 2, right click on the layer from the layers pane (named “VV” by default), select “Rename layer”, and type “Amplitude”.

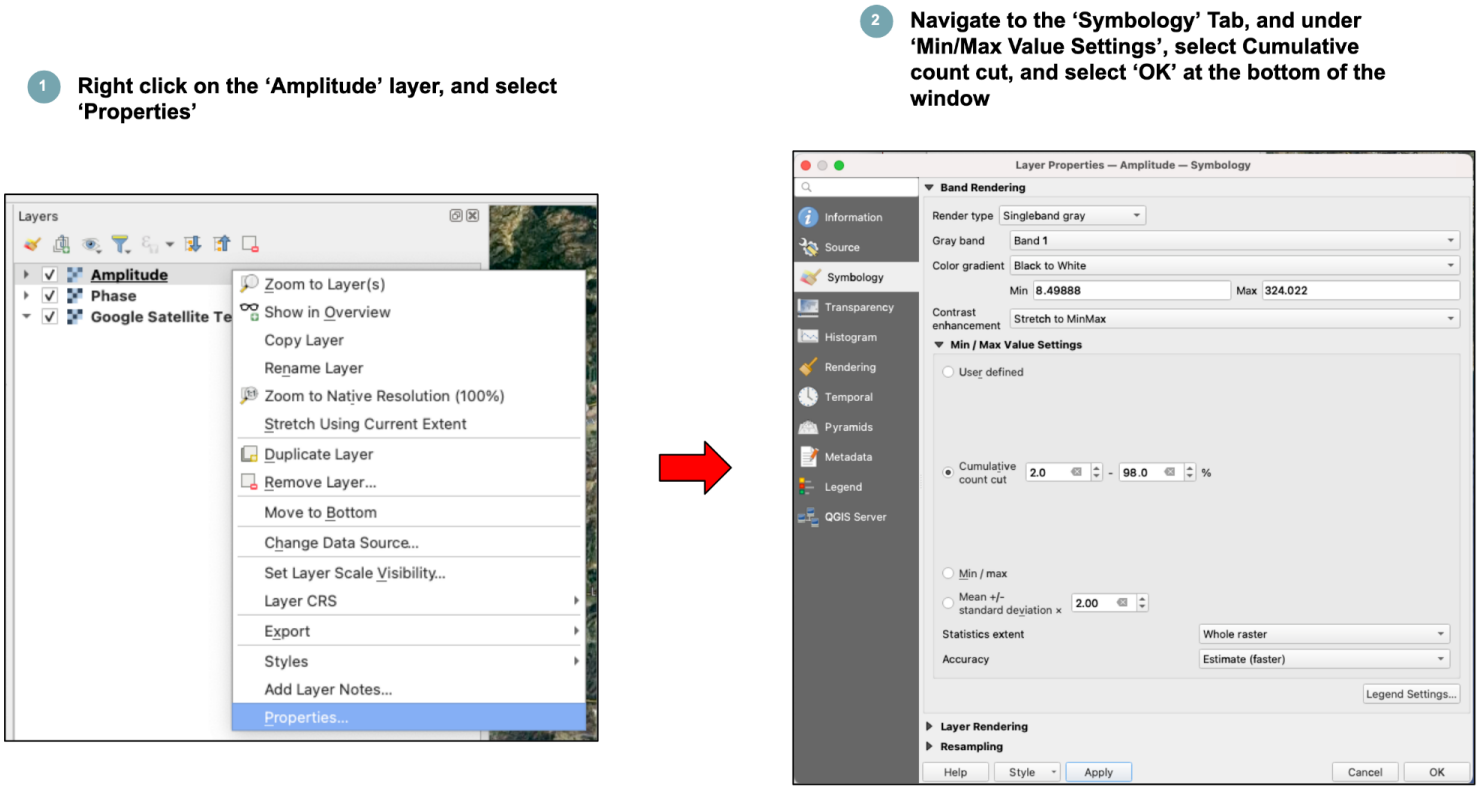


Figure 5. Changing display properties of the Amplitude layer.

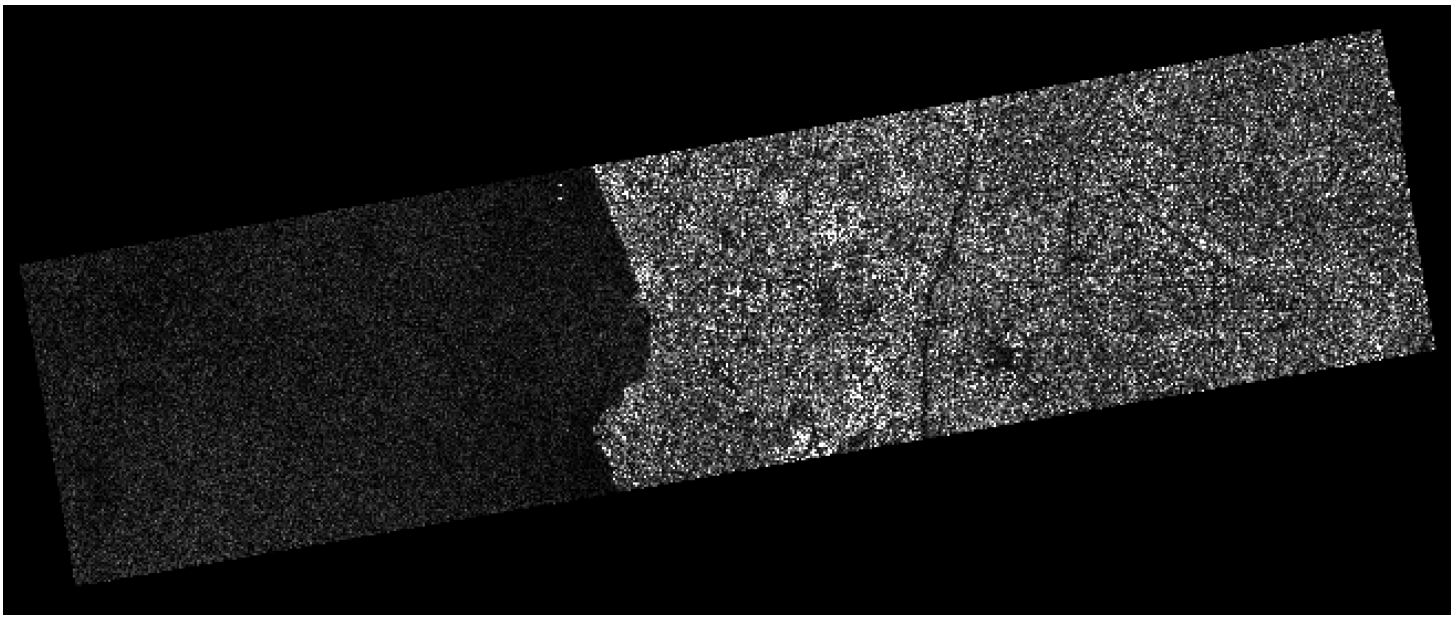


Figure 6. Amplitude component of the OPERA CSLC.

d. For better visual clarity, update the symbology for the “Amplitude” layer (Figure 5). To do this, right click on the layer and select properties. Under the “Symbology” tab, select the “Min/Max Value Settings” drop down, click on “Cumulative count cut” and press “Apply” then “OK”. Your view should now match Figure 6.

5) To add a basemap layer in QGIS, users can follow the instructions given in this link or follow the instructions in Figure 7. Alternatively, users can directly copy and paste the following URL into the ‘URL’ field under ‘Connection Details’:

```
https://mt1.google.com/vt/lyrs=y&x=%7Bx%7D&y=%7By%7D&z=%7Bz%7D
```

This should enable Google Satellite Terrain Hybrid base maps as a layer option under ‘XYZ Tiles’.

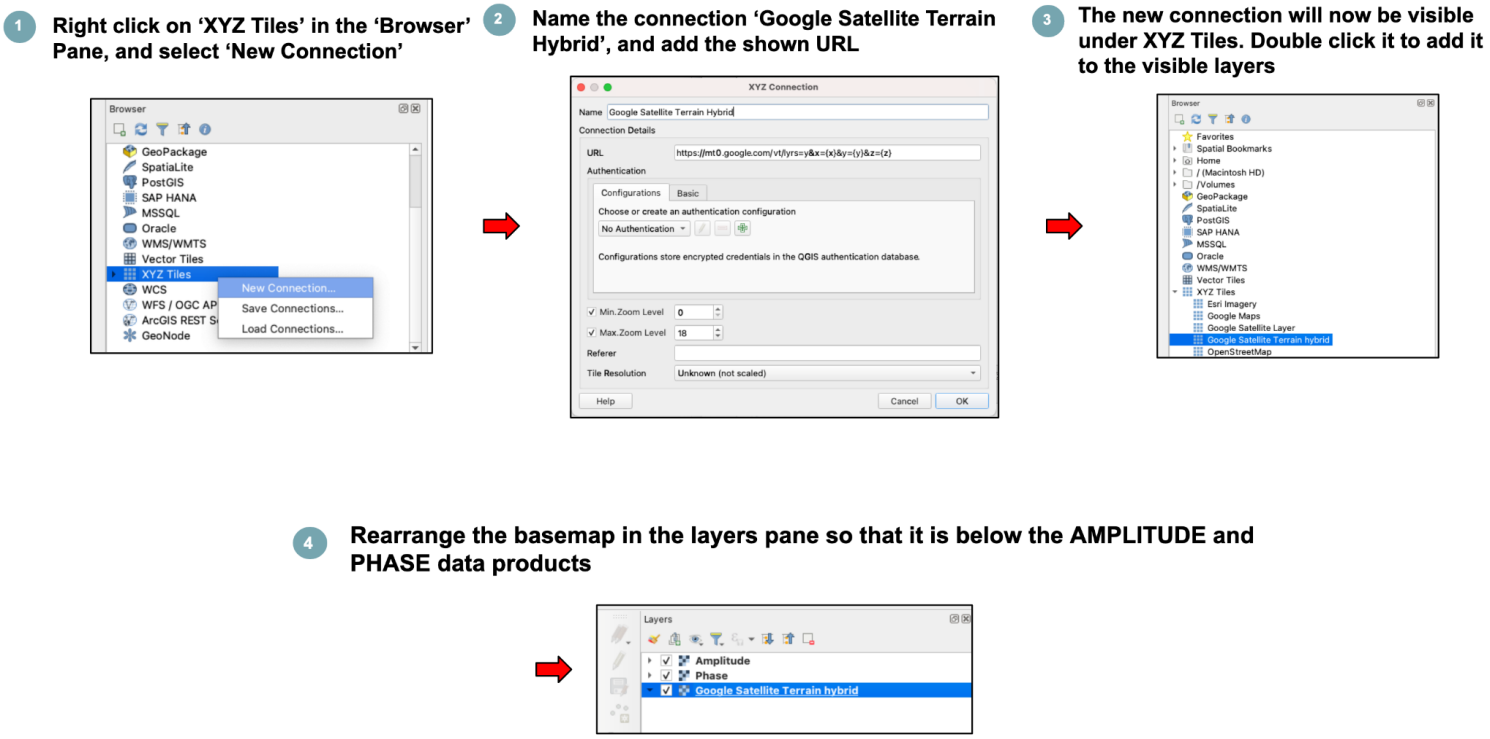


Figure 7. Adding a basemap to QGIS.

6) Reorganize the layers by dragging them in the "Layers" pane, such that Amplitude is on top, followed by Phase, and the Google Satellite Terrain Hybrid layer on the bottom. Your layers pane should match that shown in Figure 8.

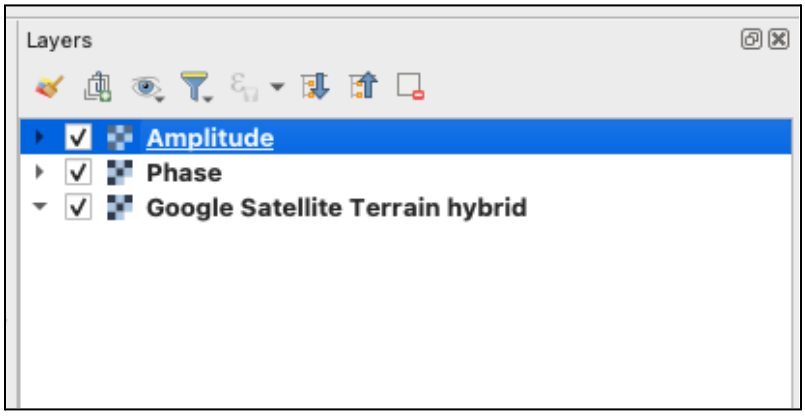


Figure 8. Final layer pane.

7) Your view in QGIS should now match the view shown in Figure 9.

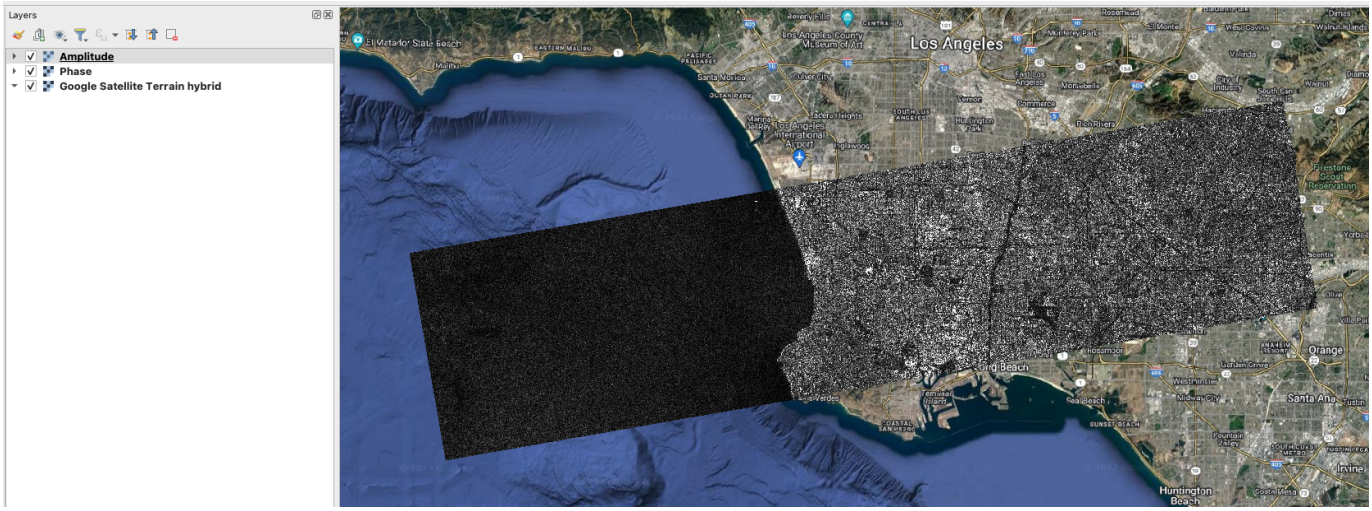


Figure 9. Amplitude component of the OPERA CSLC product overlaid on a Google Earth basemap.

Congratulations! You should have now produced a map in a GIS software showing the amplitude and phase components of an OPERA CSLC data. For additional details about the OPERA CSLC product and embedded layers, please refer to the **Product Specification** document. To learn more about OPERA and its products, please visit our website.

List of hyperlinks in this document

1. Provisional OPERA CSLC data product Los Angeles, CA is available at the following URL:
    a. May 01, 2022
    https://d2pn8kiwq2w21t.cloudfront.net/documents/OPERA_L2_CSLC_S1A_IW_064_135518_IW1_VV_20220501T015035_1.0_20230206T174400.h5

2. QGIS can be downloaded from the following link:
    https://www.qgis.org/en/site/forusers/download.html

3. Instructions on adding Google Satellite data as a basemap in QGIS can be found at this URL:
    https://www.geodose.com/2018/03/how-to-add-google-maps-layer-QGIS-3.html

4. Information about the OPERA CSLC products and layers can be found in the product specification document :
    https://tinyurl.com/CSLCspec

5. Additional information about OPERA and data products can be found at our project page:
    https://www.jpl.nasa.gov/go/opera/products