



How to Acquire and Subset Sentinel-1 InSAR Data with Harmony and the GDAL Subsetter

ASF has pre-processed [Sentinel-1 Interferograms](#) (S1 InSAR) available for download. This recipe goes through the basic steps of constructing a Harmony request URL to find S1 InSAR data that falls within an area and time period of interest and perform variable and spatial subsetting on the data using the GDAL Subsetter.

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Background

Sentinel-1 InSAR Products (ARIA)

The Alaska Satellite Facility (ASF) has a targeted collection of pre-processed [Sentinel-1 Interferograms](#) (S1 InSAR) available for download. These products are generated by Jet Propulsion Laboratory's [ARIA Science Data](#) program, and can be downloaded from [ASF Data Search - Vertex](#) in their original netCDF format, or as individual GeoTIFF files. The individual products and netCDF layers include Unwrapped Phase, Coherence, Amplitude, and Connected Components.

In some cases, the spatial extent of these [Sentinel-1 InSAR](#) data products is larger than the user's area of interest, or the user may only be interested in a subset of the variables (data layers) included in the netCDF file. By subsetting the dataset spatially and extracting only the netCDF variables of interest before the product is downloaded, the size of the download can be significantly reduced.

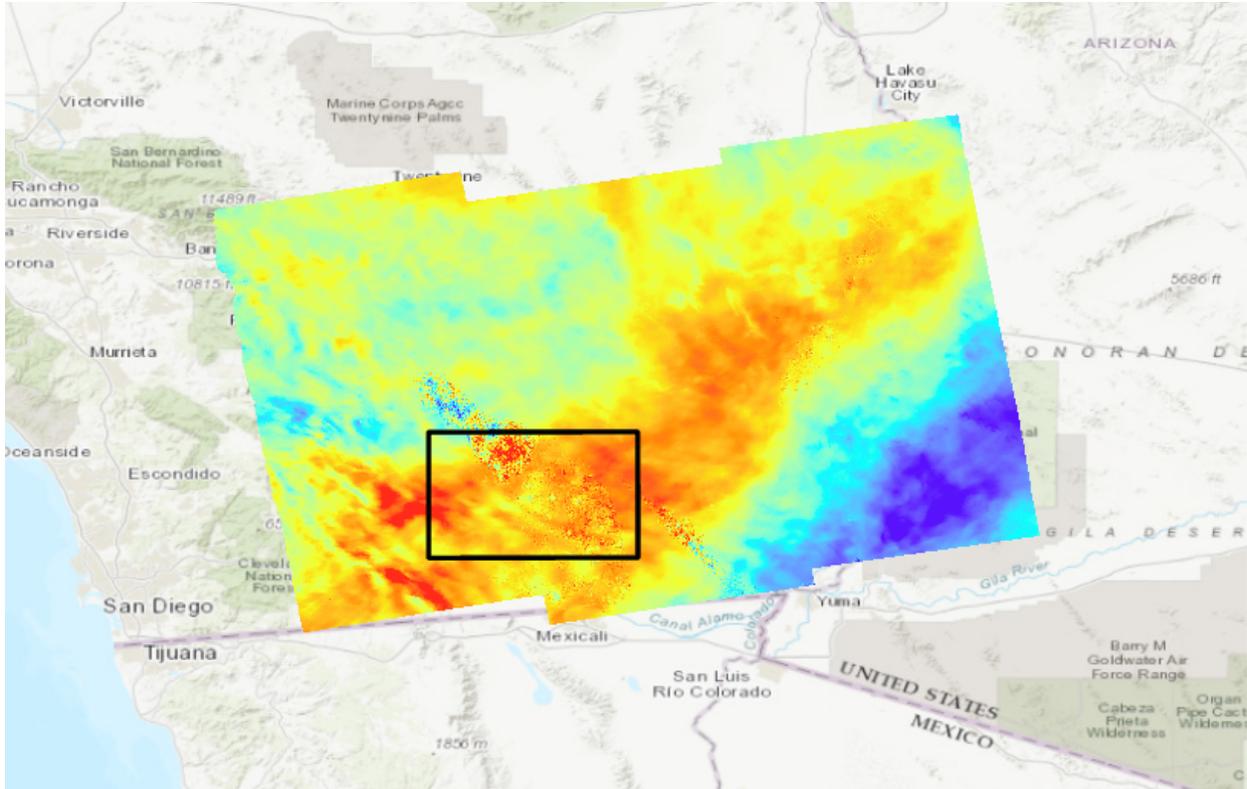
Harmony

Harmony is a cloud-based data transformation framework that can be leveraged by different NASA data providers to offer a streamlined user experience regardless of the data source. NASA's Earth Observing System Data and Information System (EOSDIS) supports 12 different Distributed Active Archive Centers (DAACs), each of which specializes in archiving and serving particular data types or topics. While datasets can differ significantly from one DAAC to another, some functionality can be consistently applied to a wide range of these datasets. Developing and sharing services in a common framework that can be used by all of the DAACs reduces duplication of effort and offers a more consistent experience for data consumers.

GDAL Subsetter

The GDAL Subsetter is a Harmony service developed by ASF that is currently configured for use with specific collections of S1 InSAR, UAVSAR and AVNIR-2 data with netCDF and GeoTIFF file formats. It allows users to extract spatial and/or variable subsets and to reproject the data if desired.

By accessing the GDAL Subsetter through Harmony, users can find S1 InSAR data that is within their area of interest and a temporal range, then generate products that are subsets of the variables and/or spatial extent of the original data products. Subset products are a fraction of the original data volume and can be downloaded more quickly and managed more easily. This recipe goes through the basic steps of constructing a Harmony request URL to find S1 InSAR data that falls within an area and time period of interest and perform variable and spatial subsetting on the data.



The spatial extent of an Sentinel-1 InSAR granule (Unwrapped Phase shown in color) and the area of interest used in this exercise (black box). *Credit for color image: Sentinel-1 Interferogram (Unwrapped Phase). JPL ARIA 2020, contains modified Copernicus Sentinel data 2020, processed by ESA. Retrieved from ASF DAAC.*

Prerequisites

- Earthdata Login credentials (<https://urs.earthdata.nasa.gov/>)
- Access to the S1 InSAR collection by accepting the End User License Agreement for the GRFN BETA Products (Sentinel-1 interferograms). If you are signed in to Earthdata, the EULA can be accepted here: [EULA](#)
- A web browser configured to display json format
 - Chrome: Add the 'JSON Formatter' extension [JSON Formatter for Chrome](#)
 - Edge: Add the 'JSON Formatter for Edge' extension [JSON formatter for Edge](#)
 - Firefox: View defaults to JSON

URL Construction

Standard Components

The individual components of the Harmony request URL for the GDAL Subsetter are outlined below:

- The base URL for harmony is <https://harmony.earthdata.nasa.gov/>
- The short name for the S1 InSAR collection is [Sentinel-1 Interferograms](#). It is included in the next position of the URL and is followed by </ogc-api-coverages/1.0.0/collections/>.
- The S1 InSAR products have four variables, corresponding to the layers of the netCDF. Each of the variables is preceded by 'science/grids/data/' in the URL. The four variables are: amplitude; coherence; connectedComponents; and unwrappedPhase. Multiple variables can be subset by including a comma-separated list and will be output as individual bands in the product GeoTIFF.
Note: The '/' characters in the variable string need to be URL encoded to '%2F'. The URL encoding for a comma is '%2C'.
For example, a URL containing the two variables amplitude and coherence would be: [science%2Fgrids%2Fdata%2Famplitude%2Cscience%2Fgrids%2Fdata%2Fcoherence](#)
For this exercise, the unwrappedPhase variable is subset with: [science%2Fgrids%2Fdata%2FunwrappedPhase](#)
- The variable(s) in the URL is followed by </coverage/rangeset?>
- Spatial subset: The GDAL Subsetter currently allows users to perform spatial subsetting by including a bounding box in the form 'subset=lat(min:max)&subset=lon(min:max)', with latitude and longitude values applying to the WGS84 coordinate reference system. For this exercise, the subset bounding box is: [subset=lat\(32.85:33.3\)&subset=lon\(-116:-115.25\)](#)
- Temporal subset: (optional) Temporal filtering of the dataset is available to bound potentially large numbers of returns. Whether or not temporal filtering is used, results will be returned in chronological order according to the start date and time of data acquisition. A temporal range can be specified by including values according to the following format: subset=time("<begin>":"<end>") with <begin> and <end> being YYYY-MM-DDTHH:MM:SSZ
For this exercise, the temporal range is: [subset=time\("2020-03-01T00:00:00Z":"2020-03-02T00:00:00Z"\)](#)
- Whether or not temporal filtering is used, the number of results can be large. The optional 'maxResults' parameter can be used to limit the number of results, which are returned in chronological order of acquisition (oldest first). Results in this exercise will be limited to 4 by using [maxResults=4](#) .

Optional Components

Additional options for the request URL can be appended to the end in any order:

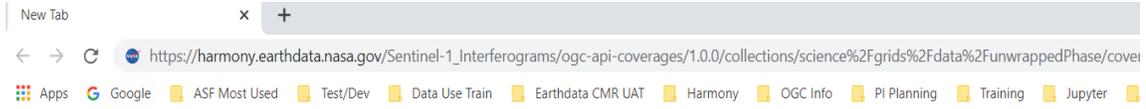
- Output format: Four output formats are available. For this exercise, the GeoTIFF output format will be used. The default format is NetCDF.
[&format=image%2Ftiff](#)
[&format=image%2Fpng](#)
[&format=image%2Fgif](#)
[&format=application/x-netcdf4](#)
- Output image pixel numbers in columns and rows: If only width or height is specified, the aspect ratio of the product is preserved.
[&width=<# columns>&height=<# rows>](#)
- Projected output: The GDAL Subsetter will project the output products to the projection of the input data file by default (WGS84 for S1 InSAR), but the user can specify a different output projection if desired. The output coordinate system can be defined using any of the following three input formats:
[&outputcrs=EPSG:<code>](#)
[&outputcrs=<proj4 string>](#)
[&outputcrs=<OGCWKT string>](#)
- Force asynchronous processing: If the Harmony request is such that only one product will be generated, the processing will be done synchronously. As a result, the job history and STAC catalog will not be generated and, rather than download links being generated, the product will automatically download. To force asynchronous processing when only one product will be generated, for example, when `maxResults=1` is used, use:
[&forceAsync=True](#)

Processing Steps

1. Assembly of the components described above yields the following Harmony request URL:

[https://harmony.earthdata.nasa.gov/Sentinel-1_Interferograms/ogc-api-coverages/1.0.0/collections/science%2Fgrids%2Fdata%2FunwrappedPhase/coverage/rangeset?subset=lat\(32.85:33.3\)&subset=lon\(-116:-115.25\)&subset=time\("2020-03-01T00:00:00":"2020-03-02T00:00:00"\)&format=image%2Ftiff&maxResults=4](https://harmony.earthdata.nasa.gov/Sentinel-1_Interferograms/ogc-api-coverages/1.0.0/collections/science%2Fgrids%2Fdata%2FunwrappedPhase/coverage/rangeset?subset=lat(32.85:33.3)&subset=lon(-116:-115.25)&subset=time()

Copy the Harmony request URL in step 1, paste it into a browser, and hit Enter



2. Enter Earthdata credentials if not already logged in

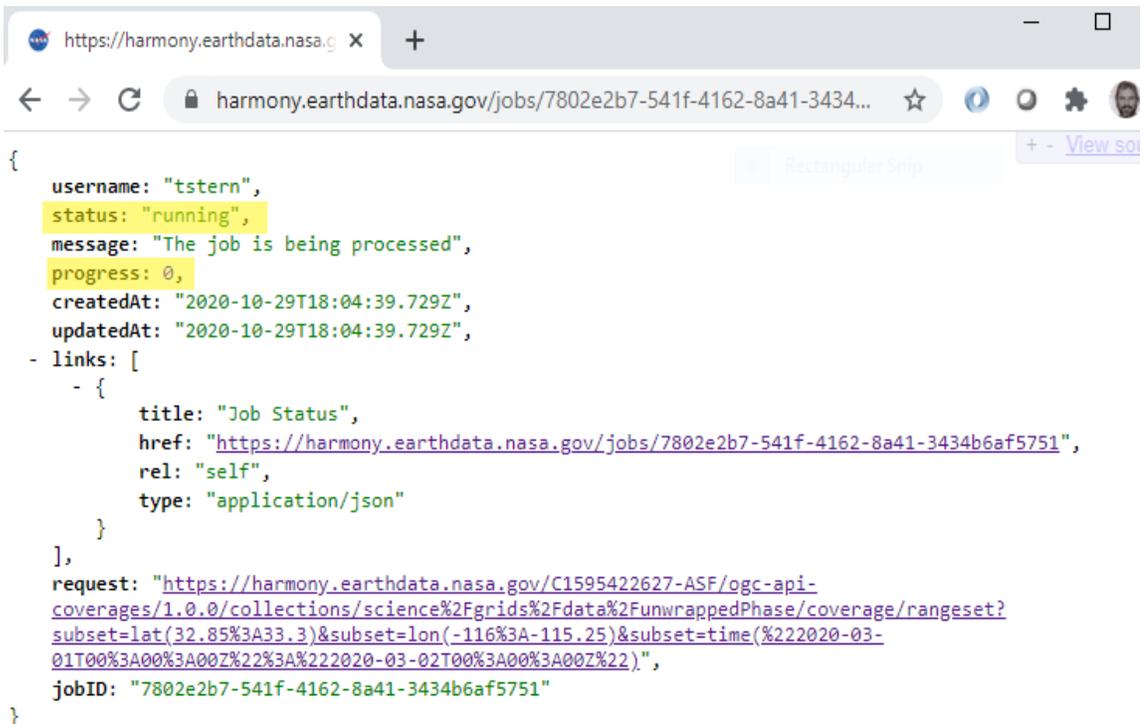
Sign in
https://urs.earthdata.nasa.gov

Username

Password

Sign in Cancel

3. Once logged in, the browser will start running the job. Refresh your browser as desired to monitor progress until the status is listed as “successful” and the progress value is 100 (see below).



4. Once the processing is complete, the browser window should include links to: 1) Job Status; 2)STAC Catalog; and 3) Products (see below). In this exercise, there should be four product links generated; the number of links generated will depend on the number of variables selected and the settings used for the temporal subset and maximum results when generating the URL.

```

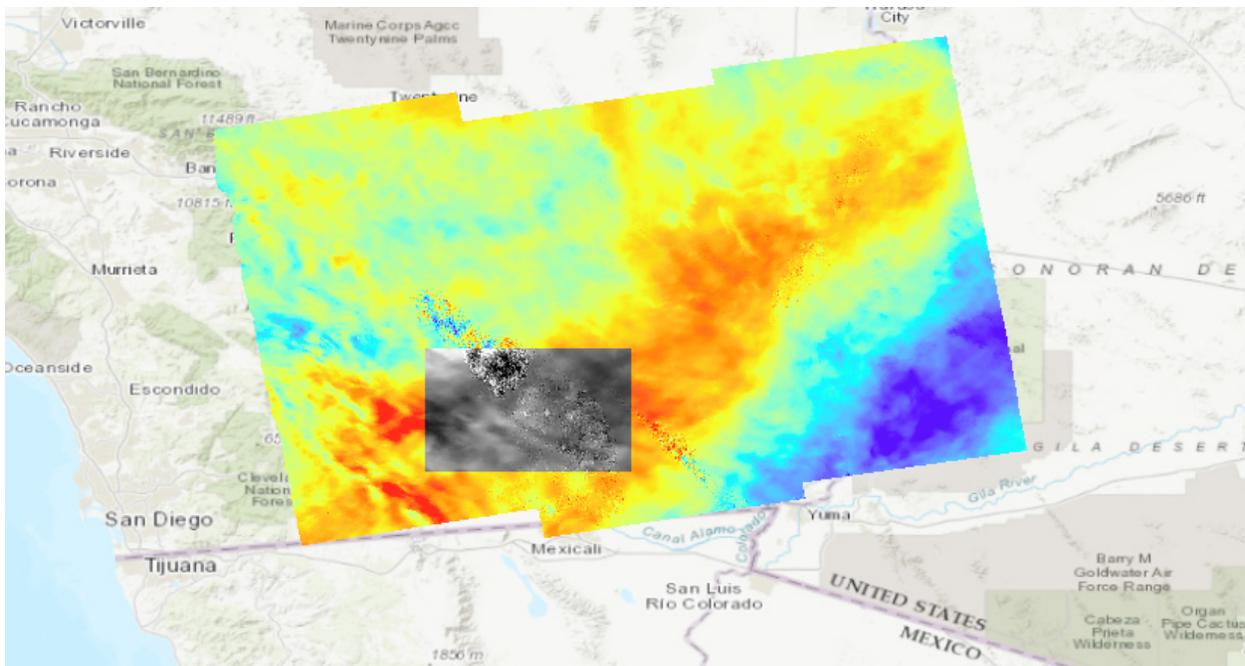
{
  username: "tstern",
  status: "successful",
  message: "The job has completed successfully",
  progress: 100,
  createdAt: "2020-10-29T18:04:39.729Z",
  updatedAt: "2020-10-29T18:05:09.674Z",
  - links: [
    - {
      title: "Job Status",
      href: "https://harmony.earthdata.nasa.gov/jobs/7802e2b7-541f-4162-8a41-3434b6af5751/",
      rel: "self",
      type: "application/json"
    },
    - {
      title: "STAC catalog",
      href: "https://harmony.earthdata.nasa.gov/stac/7802e2b7-541f-4162-8a41-3434b6af5751/",
      rel: "stac-catalog-json",
      type: "application/json"
    },
    - {
      href: "https://harmony.earthdata.nasa.gov/service-results/harmony-prod-
      staging/public/asfdataservices/gdal-subsetter/9b7d099f-1087-4948-adc0-464ebdaaf644/S1-GUNW-
      A-R-166-tops-20200301_20200206-014119-34455N_32574N-PP-7bf4-
      v2_0_2_science_grids_data_unwrappedPhase_subsetted.tif",
      title: "G1709857272-ASF",
      type: "image/tiff",
    }
  ]
}

```

5. Download the individual products by clicking on the product links. GeoTIFF products can be opened in a GIS application like [ArcGIS](#) or [QGIS](#).
 - a. Open your GIS application
 - b. Add the GeoTIFF product(s) to the map using your preferred method, or use one of the following approaches:
 - i. QGIS: Click **Layer > Add Layer > Add Raster Layer** or use **Add Raster** icon, browse to directory containing subset image(s), select image(s) of interest and click OK.
 - ii. ArcMap: In the **File** menu, select **Add Data > Add Data** or click the Add Data icon, and browse to the directory containing the subset image(s). Add a folder connection if necessary. Select image(s) of interest and click Add.
 - iii. ArcGIS Pro: In the **Map** ribbon, click the **Add Data** button, browse to the directory containing subset image(s), select image(s) of interest and click OK.
 - c. If multiple variables were subset, individual bands can be displayed

- i. QGIS: Right click on the product in the table of contents > **Properties** > **Symbology**. On the symbology tab, for **Render Type** select **Singleband Grey** and from **Grey band** select the variable band to display.
- ii. ArcMap: Right click on the product in the table of contents > **Properties** > **Symbology** and select **Show** > **Stretched** and select the variable to display from the **Band** dropdown > **Apply** > **OK**
- iii. ArcGIS Pro: Right click on the product in the table of contents > **Symbology**. Under **Primary Symbology** select **Stretch**, then select the variable to display from the **Band** dropdown and close the Symbology window.

*Note: Using symbology to display individual bands of a multi-band subsetting product is not currently working as expected in some ArcGIS Pro versions. If you have difficulty visualizing bands other than the first one with the Stretch approach, you can use an RGB symbology and set all of the bands to the band you would like to visualize. Alternatively, select **Geoprocessing** from the View tab, and in the **Geoprocessing** pane select **Data Management Tools** > **Layers and Table Views** > **Make Raster Layer**. In the tool, for **Input raster**, navigate to the multi-band GeoTIFF, name the **Output raster layer**, and from the **Bands** dropdown select the band you want to display and click **Run**.*



Subsetting Unwrapped Phase Sentinel-1 InSAR product (black & white) layered on the original Sentinel-1 InSAR Unwrapped Phase product (color). *Credit for color image: Sentinel-1 Interferogram (Unwrapped Phase). JPL ARIA 2020, contains modified Copernicus Sentinel data 2020, processed by ESA. Retrieved from ASF DAAC.*

6. Users can revisit their job history and access previously processed products at <https://harmony.earthdata.nasa.gov/jobs/>
7. The [STAC](#) catalog can be accessed by clicking on the link in the job history. The catalog lists spatial and temporal information for the products that were generated.