OPERA ArcGIS Pro Toolbox

Version 1.2

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Document Change Log

Revision	Cover Date	Sections Changed	Reason
V 1.0	12 April 2024	All Sections	First version of Document
V 1.1	27 May 2024	All Sections	Added Updated Version of OPERA Granule Download to the Toolbox
V 1.2	08 July 2024	All Sections	1) DIST-ALERT and RTC-SI product handling capabilities added to OPERA Granule Filter tool. 2) External dependency on MGRS shapefile (mgrs_region.shp) removed. 3) OPERA Zonal Statistics Tool introduced.

1.0 Introduction

1.1 Document Purpose

This document details the functionality of the OPERA ArcGIS Toolbox-Version1.2 (OPERA: Observational Products for End-users from Remote-sensing Analysis) developed to download, filter, mosaic and calculate statistics of the OPERA Level-3 Dynamic Surface Water Extent from Harmonized Landsat Sentinel-2 (DSWx-HLS) product, OPERA Level-3 Surface Disturbance Alert from Harmonized Landsat Sentinel-2 (DIST-ALERT) product, and OPERA Level-2 Radiometric Terrain Corrected SAR backscatter product from Sentinel-1 (RTC-S1). For details of the OPERA project please refer to the Product Specification Document.

1.2 Document Organization

Section 2 lists the prerequisites needed to use the toolbox.
Section 3 provides a detailed description of the geoprocessing tools in the toolbox.
Section 4 provides an illustrated walk-thorough of the tools' functionality.
Section 5 provides possible tool failure scenarios and troubleshooting support.
Section 6 provides details on acknowledgements and contact information for feedback on tools.
Appendix A provides an understanding of the minimum bounding geometry principle used in selection of granules in the OPERA Granule Download tool.
Appendix B explains the DSWx-HLS class prioritization process used to mosaic OPERA DSWx-HLS granules.

2.0 Prerequisites:

2.1 Earth Data Credentials

NASA Earth Data hosts NASA's Earth Science data collections. Therefore, an Earth Data account is required to access OPERA granules archived on PO.DAAC (Physical Oceanography Distributed Active Archive Center), LP DAAC (Land Processes Distributed Active Archive Center) and ASF DAAC (Alaska Satellite Facility Distributed Active Archive Center). An account can be created at https://urs.earthdata.nasa.gov/.

2.1 Software/License Requirements

This is an ArcGIS Pro toolbox developed for ArcGIS Pro software to download and manipulate OPERA products. The ArcGIS Spatial Extension must be activated to run all the tools.

3.0 The OPERA ArcGIS Pro Toolbox

3.1 Toolbox Overview

The toolbox contains four geoprocessing tools.

(a) OPERA Granule Download
(b) OPERA Granule Filter
(c) OPERA Granule Mosaic
(d) OPERA Zonal Statistics

These tools:

(a) Download OPERA DSWx-HLS granules from PO.DAAC.
Download OPERA DIST-ALERT granules from LP DAAC.
Download OPERA RTC-S1 granules from ASF DAAC.
(b) Filter OPERA DSWx-HLS granules from (a) a previously downloaded stack of granules based on a user-provided date range and Area of Interest (AOI) or (b) granules currently existing on the ArcGIS Pro contents pane.
(c) Composite and mosaic OPERA DSWx-HLS granules based on user-provided land cover priorities (The mosaic operator will choose the prioritized land cover class in areas where granules overlap).
(d) Calculate three different types of Zonal Statistics (i.e., number of pixels, area, percentage area) of each land cover class/product category class in granule(s) within a user-provided AOI.

Detailed descriptions of the tools are provided in section *3.2 Geoprocessing Tools in the Toolbox* and functionalities are demonstrated by way of image-walkthrough in section *4.0 Tool Functionality*.

The toolbox contains:

- Toolbox Documentation (Documentation_OPERAArcGISProToolbox_V1_2.pdf)
- The OPERA ArcGIS Pro Toolbox
- a ‘Dependency’ folder with a .RTX file that contains stretch parameters for the visualization of RTC-S1 product and color ramp files (colorramp_dswx.clr and colorramp_dist.clr) to preserve original OPERA DSWX-HLS and DIST-ALERT color ramp information during geoprocessing.

NOTE: The dependency folder is required to successfully run the tools. Please refrain from deleting/changing the folder path relative to its current location.

3.2 Geoprocessing Tools in the Toolbox

3.2.1 OPERA Granule Download

Tool Description:

Downloads OPERA DSWx-HLS, OPERA DIST-ALERT, and OPERA RTC-S1 granules from PO.DAAC, LP DAAC and ASF DAAC based on a user-provided date range and AOI.

Tool Parameters:

Parameter	**Parameter Description**	**Parameter Function/Notes**
Start Date[R]	Start Date for granule search	All OPERA granules from start date until the end date are queried. Start date is included in the query. The end date is NOT included in the query. Currently only the 'date' option in the radio buttons is supported. 'Date and Time' and 'Time' are not supported.
End Date[R]	End Date for granule search	
Area of Interest[R]	The Geographical Region for granule search.	This can either be (a) point(s), line(s) or polygon(s) shapefile, or (b) interactively drawn point(s), line(s) or polygon(s) on the ArcGIS Pro Map Frame. Images are queried based on a minimum bounding box principle using the point(s), line(s) or polygon(s) provided. Please see Appendix A for the details on the creation of the minimum bounding box.
Output Folder Location[R]	Folder where the granules will be downloaded into.	A new folder can be created using the browse icon or the dialog box for the Output Folder Location. The browse icon allows the user to set the location to an already existing folder, or to create a new folder. A folder name given in the parameter dialog box will create a folder in the current map geodatabase.
OPERA Product[R]	OPERA product to be downloaded.	The following products are enabled in the tool: OPERA DSWx-HLS (WTR layer), OPERA DIST-ALERT (VEG-DIST-STATUS layer) and OPERA RTC-S1 (VV layer). More details on these product types can be found at https://www.jpl.nasa.gov/go/opera/products
Cloud Cover Threshold[O]	Control for cloud cover of granules	Granules with cloud cover less than the user-defined threshold will be downloaded. Input value must be integer type.
Username[R]	NASA Earth data login credentials	The Username and Password are the user's Earth Data login credentials which are used to access OEPRA granules on PO.DAAC, LP DAAC and ASF DAAC.
Password[R]	NASA Earth data login credentials	

		An Earth Data account is required to access OPERA granules. Please see 2.0 Prerequisites section for URL to create an Earth Data account.
Visualize OPERA Granules[O]	Enables the visualization of downloaded granules in the contents pane with metadata enhancement.	Visualization of granules in the contents pane allows easy ingestion of granules into the "OPERA Granule Mosaic" or "OPERA Zonal Stats Calculator". Users can pick and choose granules (i.e., exclude high cloud cover granules, exclude granules that are marginally intersecting the AOI) during the creation of the mosaic or calculation of statistics. The visualized granules are metadata enhanced. For OPERA DSWx-HLS; class labels are added in place of underlying integer values for ease of interpretation. For DSWx-HLS; 0: Not Water 1: Open Surface Water 2: Partial Surface Water 252: HLS Snow/Ice 253: HLS Cloud/Cloud Cover For OPERA DIST-ALERT; 0: No disturbance 1: First <50% 2: Provisional <50% 3: Confirmed <50% 4: First ≥50% 5: Provisional ≥50% 6: Confirmed ≥50% 7: Confirmed <50% finished 8: Confirmed ≥50% finished For OPERA RTC-S1; Granules are stretched between 0.0 and 0.2 for better contrast. NOTE: The metadata enhancement only occurs for visualization purposes. The original OPERA granule pixel values are preserved within the downloaded granules.

[R]Required parameter. [O]Optional Parameter

3.2.2 OPERA Granule Filter

Tool Description:

This tool has two modes: Mode 1 filters OPERA DSWx-HLS, OPERA DIST-ALERT and OPERA RTC-S1 granules from an already exiting stack of granules based on a user-provided date range and AOI while Mode 2 filters granules from the ArcGIS Pro contents pane.

Tool Parameters:

Parameter	Parameter Description	Parameter Function/Notes
Filter Choice^{R}	User choice on how to filter the granules	Filters granules located in a local directory or granules already existing in the ArcGIS Pro contents pane.
Granules from Contents Pane^{R_CP}	Input Granules to be filtered.	Parameter appears only if Filter Choice is "FROM CONTENTS PANE". Granules can be dragged and dropped from Contents Pane or selected via drop-down option.
Folder path to OPERA Granules^{R_DF}	Folder where current OPERA granules exist.	Parameter appears only if Filter Choice is "FROM DIRECTORY". This is the location of the stack of OPERA Granules that need to be filtered. This is a folder. Geodatabases are not supported in this version of the tool.
Area of Interest^{R_DF}	The Geographical Region for granule search.	Parameter appears only if Filter Choice is "FROM DIRECTORY". As with the OPERA Granule Download (3.2.1), This can either be (a) point(s), line(s) or polygon(s) shapefile, or (b) interactively drawn point(s), line(s) or polygon(s) on the ArcGIS Pro Map Frame. Images are queried based on intersecting granules using user-provided point(s), line(s) or polygon(s). Intersection is

		NOT based on a minimum bounding geometry of the AOI.
Start Date[R_DF]	Start Date of granule search	Parameter appears only if Filter Choice is "FROM DIRECTORY". All OPERA granules from start date until end date are queried. Start date AND end date are included in the query.
End Date[R_DF]	End Date of granule search	
Visualize OPERA Granules[R_DF]	Enables the visualization of downloaded granules in the contents pane with metadata enhancement.	Parameter appears only if Filter Choice is "FROM DIRECTORY". Same as 3.3.1 OPERA Granule Download.
Output Folder Location[R]	Makes a copy of granules that meet the search criteria into a user-defined folder.	The original granules remain intact. Copies are placed in the designated folder. This must be an already existing directory.

[R]Required parameter; [R_DF] Required parameter in Directory-based filtering mode; [R_CP] Required parameter in Contents pane-based filtering mode.

Additional notes:

The number and types of tool parameters that are used for a successful tool run depends on the mode the tool is used in. The modes are governed by Filter Choice: Directory-based filtering and Contents Pane-based filtering.

1) Directory-based filtering

Directory-based filtering is envisioned to be used when a stack of OPERA granules of the SAME TYPE (e.g., DSWx-HLS) exist in a folder, and a few of them need to be selected based on a particular date range and an AOI. A successful run of this mode ensures that the selected (filtered) granules are placed in a separate folder of the user's choice for further geoprocessing.

2) Contents pane-based filtering

When you have a large number of granules on the ArcGIS Pro contents pane, and you want to handpick a few of these for further geoprocessing and want them copied to a separate folder, you do not have to go sift through the source directory of the granules and compare Granule ID's with the ones hand-picked on the contents pane; dragging and dropping the hand-picked granules to the "Contents Pane-based filtering mode" will automatically move a copy of these granules to a new directory. The granules do not have to be of the same type, nor do they have to reside in one source directory to be copied using mode (e.g., both DSWX-HLS and DIST-ALERT residing in two different folders can be filtered into one directory).

3.2.3 OPERA Granule Mosaic

Tool Description:

Mosaics OPERA DSWx-HLS granules based on user-provided land cover priorities (The mosaic operator will choose the prioritized land cover class in areas where granules overlap. Please see Annexure B for details on land cover prioritization).

Tool Parameters:

Parameter	Parameter Description	Parameter Function/Notes
Input Granules[R]	The OPERA granules to be mosaicked. Currently supports DSWx-HLS only.	These granules can be either (a) dragged and dropped from the contents pane, (b) selected from the drop-down buttons in the tool dialog box (if granules exist in the contents pane), or (c) bulk-selected by browsing to the folder containing the granules.
Land Cover Priority[R]	Prioritizes land cover classes in areas of overlap.	Annexure B explains the use of such a prioritization and how the prioritization is performed.
Convert HLS Snow/Ice to Open Surface Water[O]	Converts HLS labeled snow/ice pixels into open water pixels.	There exists a known error in the Harmonized Landsat Sentinel-2 (HLS) Imagery Mask Layer (the primary image input of the OPERA DSWx product) where sediment-laden or white (i.e. turbulent) Surface Water may be misclassified as Snow/Ice. Therefore, the user is given the option to convert HLS Snow/ice to Open Surface water if study date ranges and AOI suggest that is appropriate (e.g., if no snow/ice is expected)
Output Mosaic dataset[R]	The name and extension of the output mosaic raster to be created.	The extension is required, and the tool only supports .tif extensions, currently.
Spatial Reference of Mosaic Dataset[R]		Spatial reference can be defined either by using the drop-down tool and choosing an existing layer's spatial reference, or by explicitly navigating to the spatial

		reference directory using the ‘globe’ icon. If mosaicking large geographical regions across UTM zones, we recommend “WGS 84” if a Geographic Coordinate System is preferred, or “WGS 84 Web Mercator” if projected coordinates are preferred.

[R]Required parameter; [O]Optional Parameter

3.2.4 OPERA Zonal Statistics

Calculates three different statistics of OPERA DSWx-HLS and OPERA DIST-ALERT granules based on user-provided AOIs. The tool has the capability to process multiples granules (of the same type) at once. This tool is only meant to function on individual OPERA granules (i.e., DSWx-HLS or DIST-ALERT-HLS); not on mosaics created using these granules.

Parameter	Parameter Description	Parameter Function/Notes
Input Granules[R]	The OPERA granule(s) for which Zonal Statistics will be calculated.	These granule(s) can either be (a) dragged and dropped from the contents pane, (b) selected from the drop-down buttons in the tool dialog box (if granules exist in the contents pane), or (c) bulk-selected by browsing to the folder containing the granules.
Area of Interest[R]	The Geographical Region to which statistics calculations will be performed.	As with the OPERA Granule Download (3.2.1), This can either be a (a) point(s), line(s) or polygon(s) shapefile, or (b) interactively drawn point(s), line(s) or polygon(s) on the ArcGIS Pro Map Frame.
OPERA Product[R]	OPERA product type that will be subject to statistic calculation.	Currently, the tool supports statistics calculations for DSWx-HLS and DIST-ALERT products.
Statistic[R]	Type of areal statistic: Three different statistics can be calculated: 1) Pixels by class 2) Area by class 3) Percentage area by class	Statistics are calculated for the area covered by the user-provided AOI. *Number of Pixels:* Number of 30 m pixels within AOI. *Area by class:* Area of each product category class in square kilometers within AOI. *Percentage area by class:* percentage area of each product category class within AOI.
Create Graph[O]	Bar chart based on selected statistic.	Interactive Graph will be displayed in the Contents Pane.
Save Graph[O]	Local Directory to save graph.	Graph is saved as an .svg file.
Save Statistic Table[O]	Local Directory to save statistics table.	Table is saved as a .csv file*

[R]Required parameter. [O]Optional Parameter

*Abbreviations of the product category classes in the statistic table are as follows.

DSWx-HLS Product

Granule Pixel Value	Abbreviation	OPERA Product Class
0	NW	Not Water
1	OSW	Open Surface Water
2	PSW	Partial Surface Water
252	HLSSI	HLS Snow/Ice
253	HLSCLS	HLS Cloud/Cloud Shadow

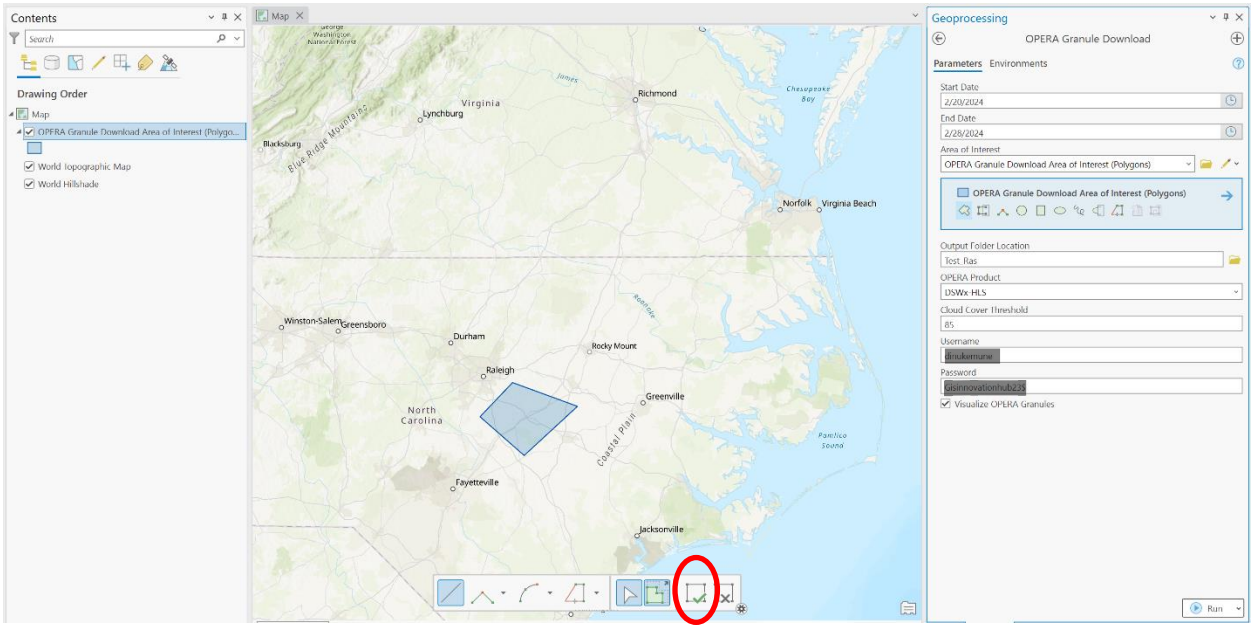
DIST-ALERT Product

Granule Pixel Value	Abbreviation	OPERA Product Class
0	ND	No disturbance
1	F_LT50	First <50%
2	P_LT50	Provisional <50%
3	C_LT50	Confirmed <50%
4	F_EGT50	First ≥50%
5	P_EG50	Provisional ≥50%
6	C_EGT50	Confirmed ≥50%
7	C_LT50F	Confirmed <50% finished
8	C_EGT50F	Confirmed ≥50% finished

4.0 Tool Functionality Demonstration

4.1. OPERA Granule Download

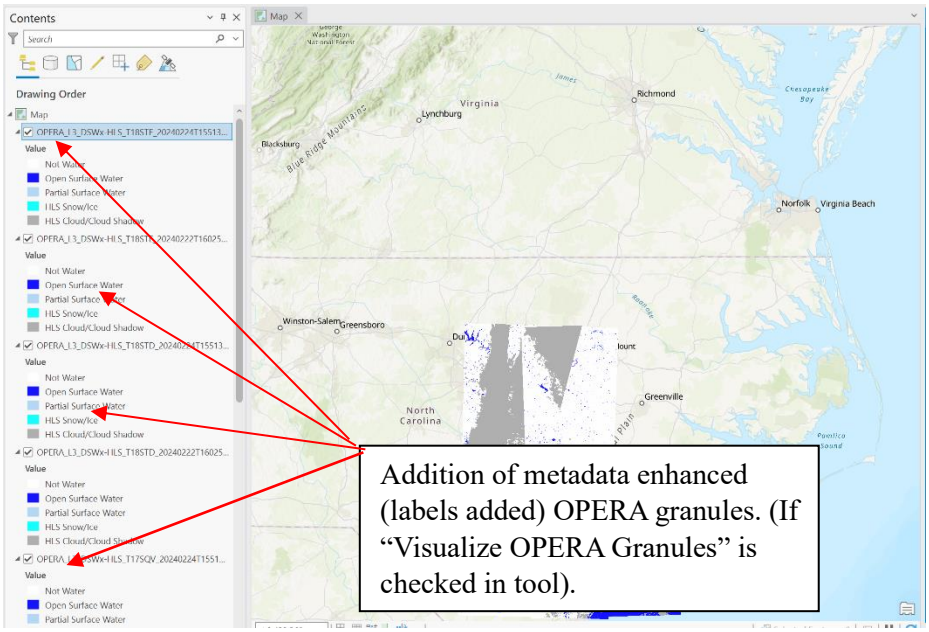
Setting up the tool



Make sure to apply uncommitted geometry sketches by clicking on the check mark (circled in red) after drawing the AOI.

NOTE: Tool run Illustrated using an interactively drawn “Polygon”. Interactive point(s), lines(s) and point(s), line(s) and polygon(s) shapefiles are also supported.

During tool Run



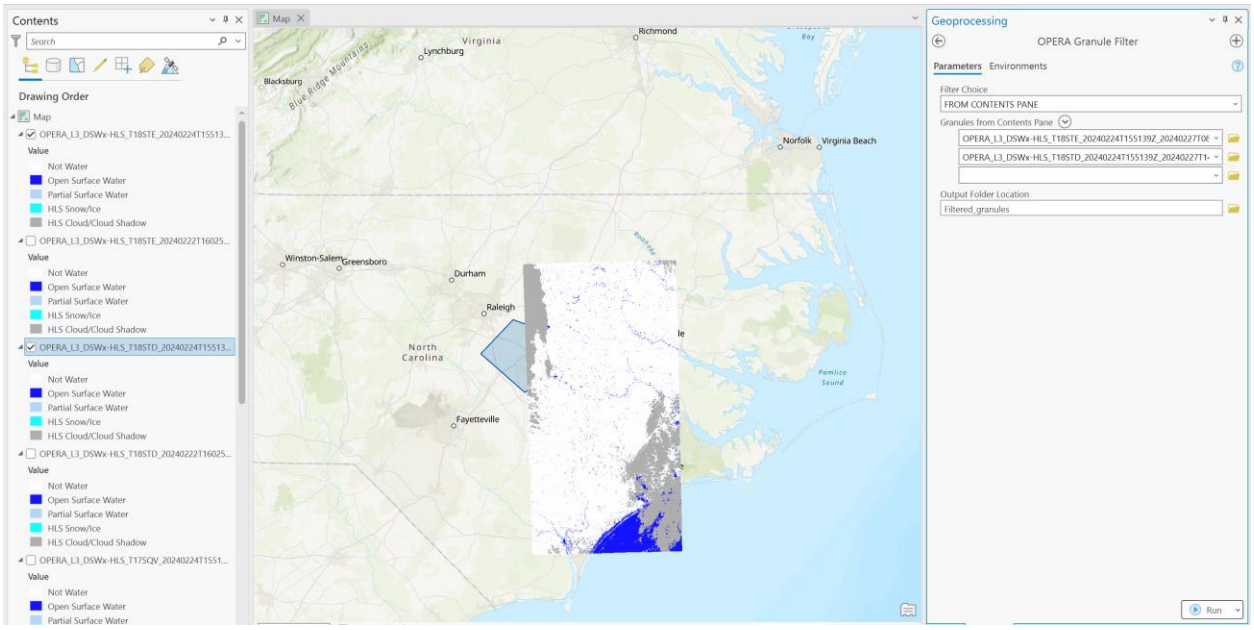
Successful tool Run

```
Start Time: Friday, July 12, 2024 5:52:21 PM
Coordinates of Minimum Bounding Box:
-78.54755399427631,35.81972843487253,-77.89200169449515,36.39398348763788

Status Code:
200

URLS of Downloaded DSWx-HLS Granules
['https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L3_DSWx-HLS_T18STF_20240222T160251Z_20240225T223600Z_S2A_30_v1.0_B01_WTR.tif',
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L3_DSWx-HLS_T17SQA_20240222T160251Z_20240225T223601Z_S2A_30_v1.0_B01_WTR.tif',
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L3_DSWx-HLS_T18STE_20240222T160251Z_20240225T200336Z_S2A_30_v1.0_B01_WTR.tif',
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L3_DSWx-HLS_T17SQV_20240222T160251Z_20240225T223551Z_S2A_30_v1.0_B01_WTR.tif',
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L3_DSWx-HLS_T18STF_20240224T155139Z_20240227T020629Z_S2B_30_v1.0_B01_WTR.tif',
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L3_DSWx-HLS_T17SQA_20240224T155139Z_20240227T153509Z_S2B_30_v1.0_B01_WTR.tif',
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L3_DSWx-HLS_T18STE_20240224T155139Z_20240227T082830Z_S2B_30_v1.0_B01_WTR.tif',
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L3_DSWx-HLS_T17SQV_20240224T155139Z_20240227T103846Z_S2B_30_v1.0_B01_WTR.tif']
Succeeded at Friday, July 12, 2024 5:53:05 PM (Elapsed Time: 43.65 seconds)
```

4.2 OPERA Granule Filter

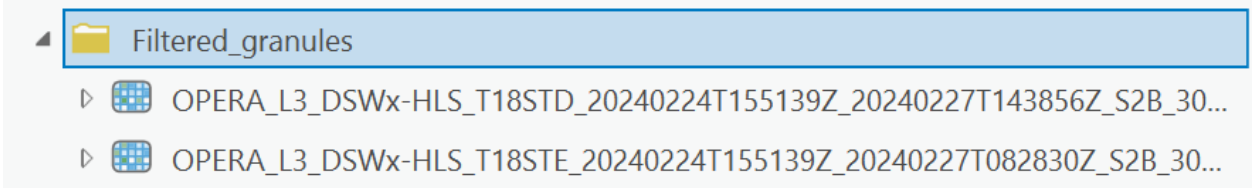
Setting up the tool: Mode 1 - Contents Pane-based filtering

Let's assume that we wanted to move selected granules from the contents pane into a separate folder from the above tool run in 4.1.



End of Successful Tool Run

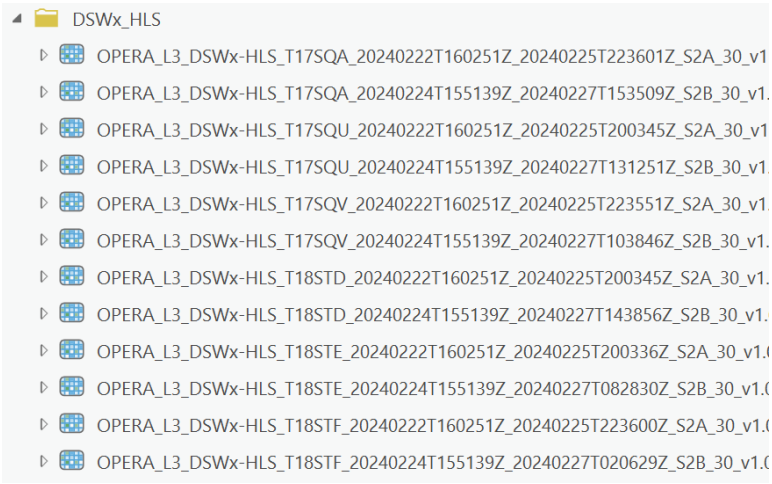
```
Start Time: Tuesday, July 9, 2024 5:57:56 PM
Number of filtered granules
2
Succeeded at Tuesday, July 9, 2024 5:57:58 PM (Elapsed Time: 1.50 seconds)
```



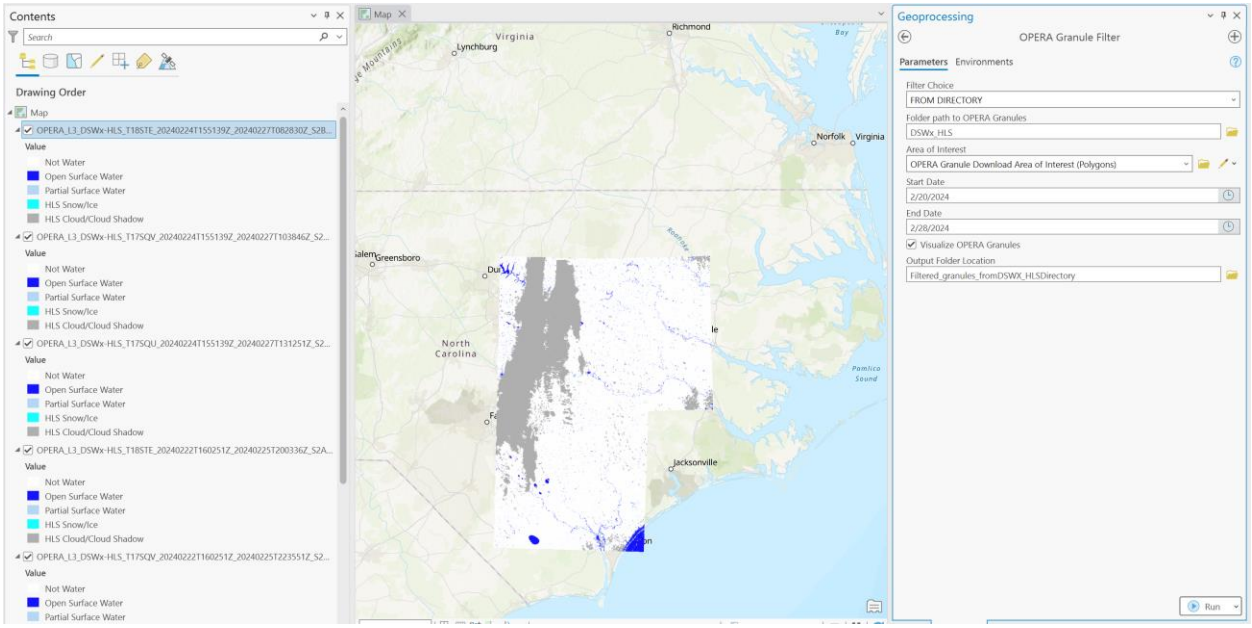
Setting up the tool: Mode 2 - Directory-based filtering

Let's assume that we wanted to select granules between the 20th and 28th February 2024 from DSWx-HLS granules in a directory that intersects the same geographical region as in 4.1.

Original Stack of Granules

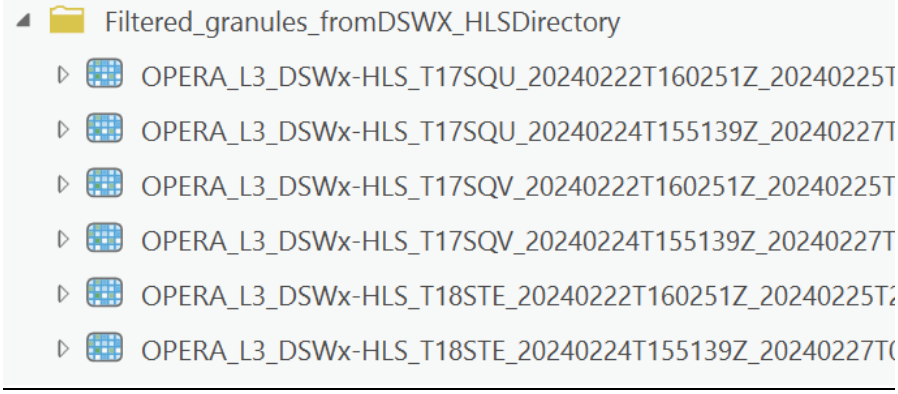


During Tool Run



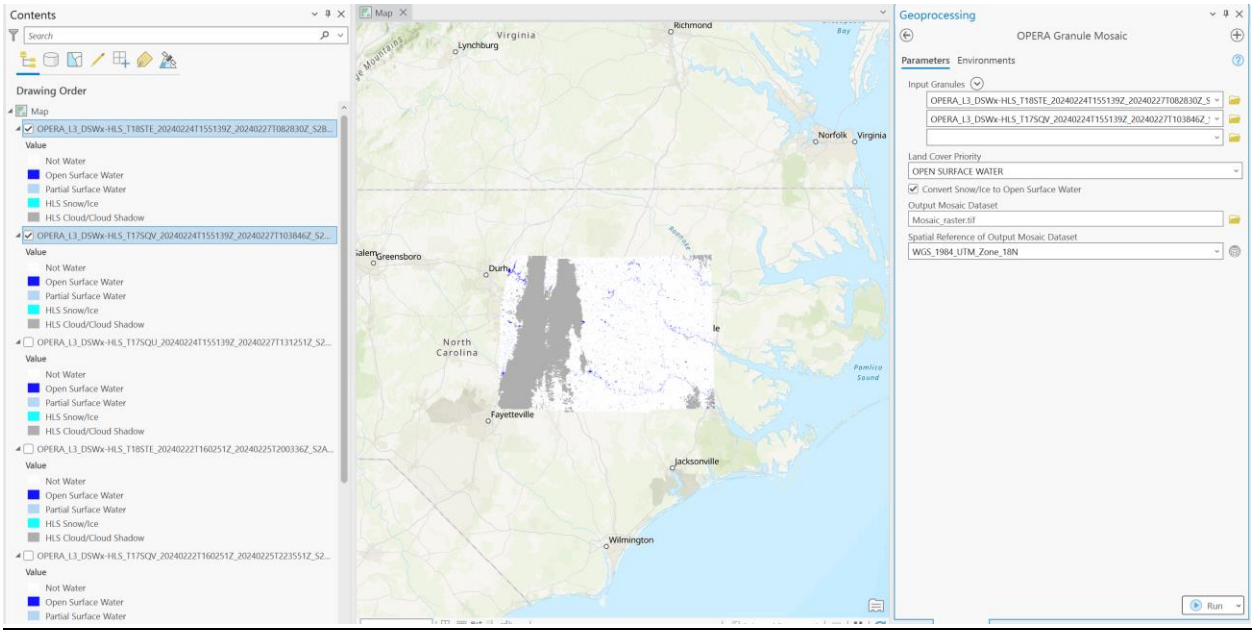
End of Successful Tool Run

All granules within the user-given date range and intersecting with the AOI

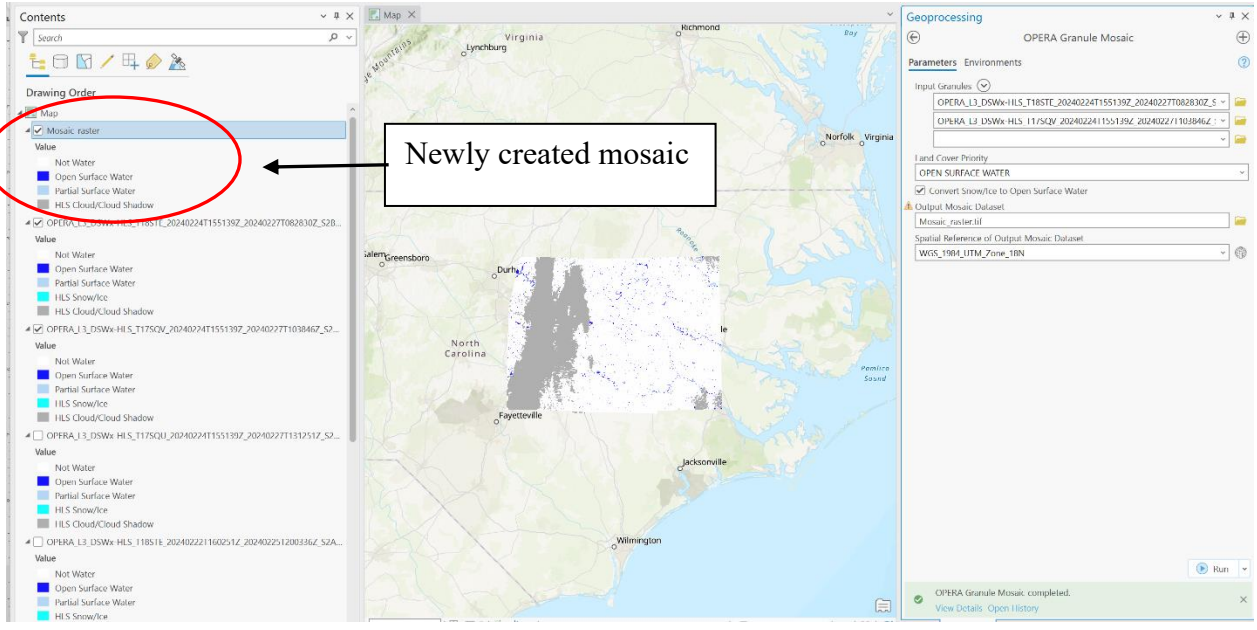


4.3 OPERA Granule Mosaic

Setting up the tool

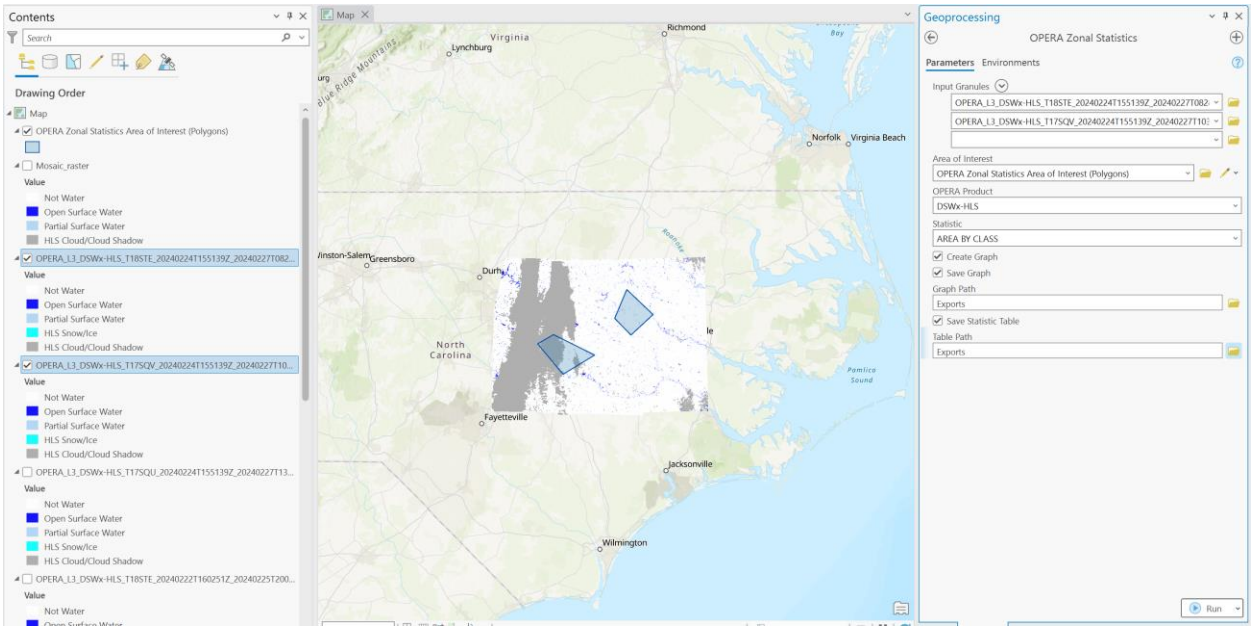


End of Successful Tool Run

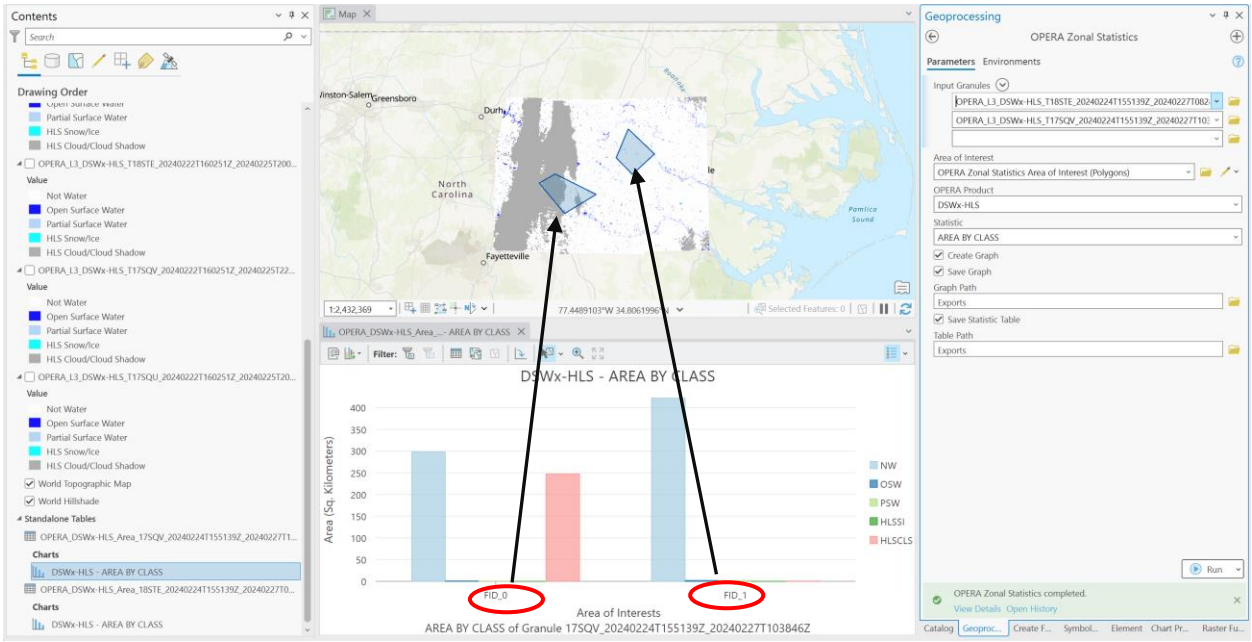


4.4. OPERA Zonal Statistics

Setting up the tool



End of Successful Tool Run



Descriptions of abbreviations of the product category classes in the statistic tables/charts can be found on page 13.

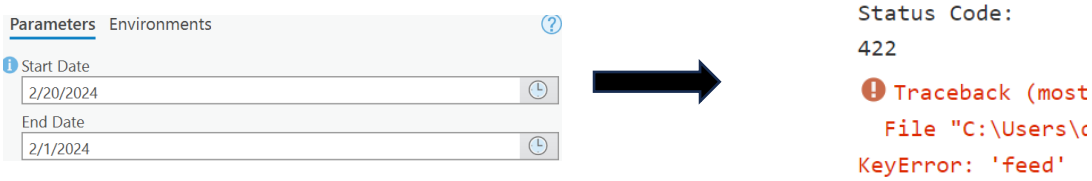
Outputs generated within user-defined folder:

2 csv files and 2 svg files of the charts (csv and chart1 each for a given DSWX-HLS granule)

5.0 Troubleshooting

5.1 OPERA Granule Download

Case 1: Dates not properly set. End date earlier than Start Date.



Case 2: Cloud Cover parameter not recognized in more recent OPERA granules.

```
KeyError: 'cloud_cover'
Failed script OPERA Granule Download...
Failed to execute (OPERAGranuleDownload).
```

Solution: (a) Carry out image download without using the cloud cover parameter or (b) set the image search date range to a few months back.

Case 3: Incorrect Username and/or Password

```
Coordinates of Minimum Bounding Box:
-78.54755399427631,35.81972843487253,-77.89200169449515,36.39398348763788

Status Code:
200

URLS of Downloaded DSWx-HLS Granules
['https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L
'https://archive.podaac.earthdata.nasa.gov/podaac-ops-cumulus-protected/OPERA_L3_DSWX-HLS_PROVISIONAL_V1/OPERA_L
Failed to download: OPERA_L3_DSWx-HLS_T18STF_20240222T160251Z_20240225T223600Z_S2A_30_v1.0_B01_WTR.tif
Failed to download: OPERA_L3_DSWx-HLS_T17SQA_20240222T160251Z_20240225T223601Z_S2A_30_v1.0_B01_WTR.tif
Failed to download: OPERA_L3_DSWx-HLS_T18STE_20240222T160251Z_20240225T200336Z_S2A_30_v1.0_B01_WTR.tif
Failed to download: OPERA_L3_DSWx-HLS_T17SQV_20240222T160251Z_20240225T223551Z_S2A_30_v1.0_B01_WTR.tif
```

Case 4: No imagery within search area/date range

```
Coordinates of Minimum Bounding Box:
-78.54755399427631,35.81972843487253,-77.89200169449515,36.39398348763788

Status Code:
200

URLS of Downloaded DSWx-HLS Granules
[]
No OPERA DSWx-HLS Granules found within given date range and/or AOI.
Please try again with different date range and/or AOI.
```

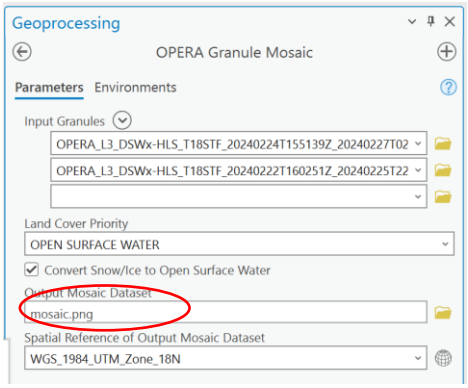
5.2 OPERA Granule Filter

Case 1: No OPERA granules within the given date range and/or AOI or Start Date later than End date in Directory-based filtering

```
No OPERA Granules to be filtered within given date range and/or AOI.
Please Try Again with different date range and/or AOI
Number of filtered granules
0
Failed script OPERA Granule Filter...
Failed to execute (OPERAGranuleFilter).
```

5.3 OPERA Granule Mosaic

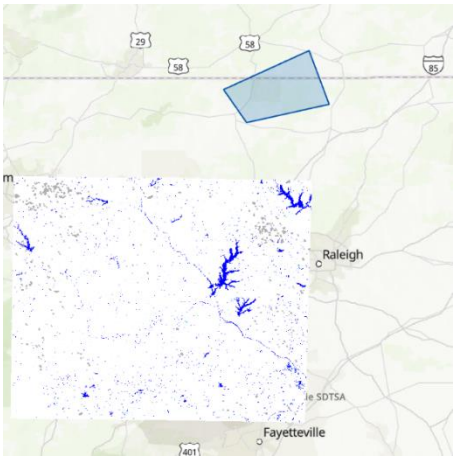
Case 1: Trying to save mosaic in a different format. Currently only .tif output raster formats are supported.

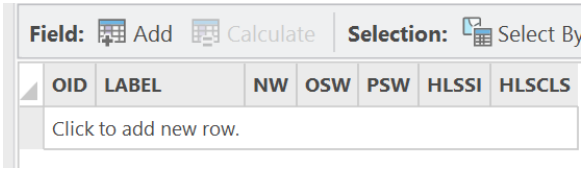



```
RuntimeError: ERROR 010093: Output raster format UNKNOWN is unsupported.
Failed script OPERA Granule Mosaic...
Failed to execute (OPERAGranuleMosaic).
```

5.4 OPERA Zonal Statistics

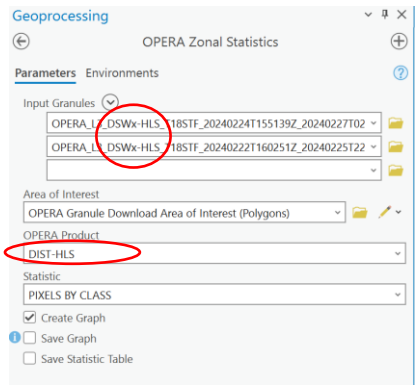
Case 1: If Area of Interest is outside the Input Granules.

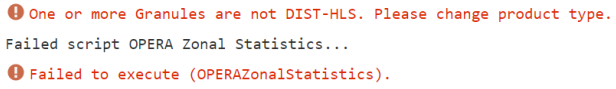




[empty data table]

Case 2: If Product type does not match the input granules (i.e., if product type is set to DSWx-HLS when trying to calculate statistics for DIST-ALERT input granules).





6.0 Feedback and Citation

We are eager to hear your feedback! Please let us know of any technical difficulties that you might encounter via our github page.

We would also appreciate it if users of this toolbox considered acknowledging our work in the following manner.

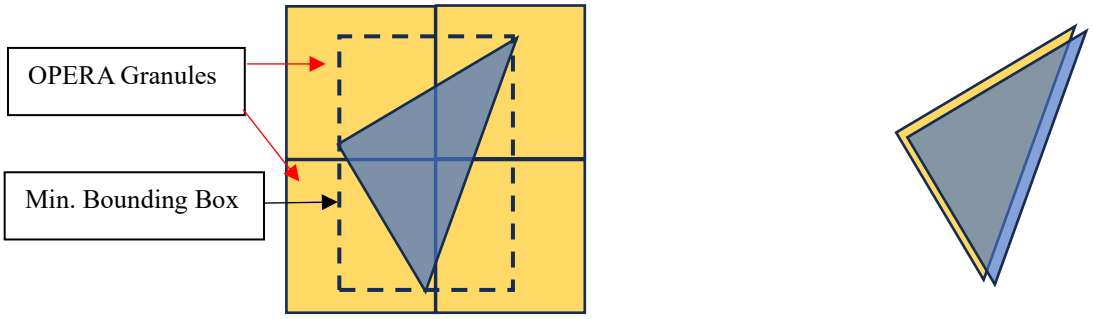
Munasinghe, D., Bonnema, M., Frasson, R.P.M., Handwerger, A.L., Chan, S., Bekaert, D. OPERA ArcGIS Pro Toolbox_V1(2023). Jet Propulsion Lab, California Institute of Technology, CA, USA.

APPENDIX A: The Minimum Bounding Geometry of the AOI

The AOI is a required input for the "OPERA Granule Download". This specifies the geographical regions for which the OPERA granule search should be carried out. There are two ways of inputting the AOI. This would be either as;

(a) Point(s), line(s) or polygon(s) shapefile, or
(b) Point(s), line(s) or polygon(s) drawn interactively on the ArcGIS Pro Map Frame.

Once an AOI is specified, the latitude and longitude of the minimum bounding box of the AOI provided by the user is used to identify intersecting OPERA granules. The main reason why a bounding box approach is used is to give users the opportunity to be able to download OPERA granules based on a much bounding box rather than the AOI itself. A bounding box allows for neighboring regions also to be captured providing the users an increased amount of information content about the AOI. (See comparison between AOI based approach and bounding box-based approach in Figure 1). The bounding box approach also allows shapes other than polygons to be used for image search. For example, an interactively drawn line or line shapefile may be used as an AOI to obtain OPERA granules intersecting the line. If the user chooses to do so, a clip operation can be subsequently performed using the OPERA file Mosaic tool to extract the exact region bounded by the edges of a user provided AOI.



Intersect minimum bounding geometry with OPERA Granules *Clip Granules to AOI*

Figure 1: Comparison between intersecting with bounding box and clip to AOI.

As mentioned before the AOI can be a point/multiple points, line/lines or polygon/polygons if drawn interactively, or a point/multiple points, line/multiple lines, polygon/multi-polygon shapefile. Different shapes of bounding boxes can be created in ArcGIS Pro. Please refer to ArcGIS Pro documentation for further details. Only a 'rectangle by area' type is activated in the OPERA Granule Download.

APPENDIX B:

Land cover prioritization in the OPERA Granule Mosaic tool.

An OPERA DSWx-HLS granule is classified into a maximum of 5 land cover classes (i.e., 0: Not Water, 1: Open Surface Water, 2: Partial Surface Water, 252: HLS Snow/Ice, and 253: HLS Cloud/Cloud Shadow). During the creation of the mosaic, determination of land cover priority is required in overlapping granule areas. This determination is based on the user's end goal. For example, if the user needs a mosaicked raster that shows the maximum extent of open surface water area, the user would prioritize 'Open Surface Water'. When this prioritization is made, for a given pixel in the overlapping area of the stack of rasters used in the mosaicking process, the Open Surface Water Pixel is selected to be included in the mosaic. If no Open Surface Water pixels are found in the stack for that particular pixel, Partial Surface Water >> Not Water >> HLS Cloud/Cloud Shadow>> HLS Snow/Ice is picked in that order (See red rectangle in table 1 for the prioritization when "Open Surface Water" is selected). Table 1 also provides the ranking of prioritizations under each user-selected land cover class.

The order of prioritizations under each selection is given below.

Priority Rank	User Selection				
	Open Surface Water (OSW)	Partial Surface Water (PSW)	Not Water (NW)	HLS Snow/Ice (HLS-S/I)	HLC Cloud/Cloud Cover (HLS-C/CS)
1	OSW	PSW	NW	HLS-S/I	HLS-C/CS
2	PSW	OSW	OSW	OSW	OSW
3	NW	NW	PSW	PSW	PSW
4	HLS-C/CS	HLS-C/CS	HLS-C/CS	NW	NW
5	HLS-S/I	HLS-S/I	HLS-S/I	HLS-C/CS	HLS-S/I