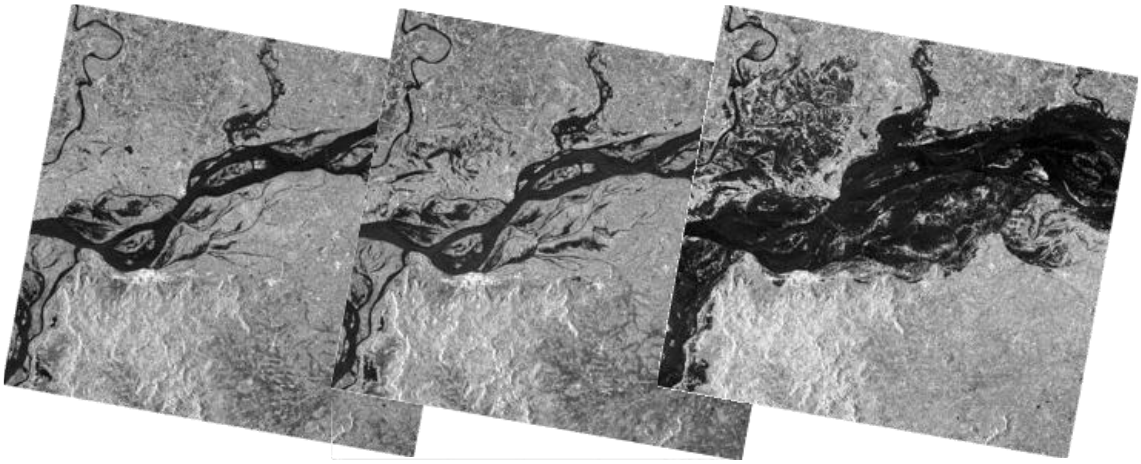
SARSCAPE TUTORIAL:
DATA PREPARATION



August 2026

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1. INTRODUCTION

The aim of this document is to guide users in preparation of satellite Synthetic Aperture Radar (SAR) data to perform the most common SARscape processings.

This specific exercise aims to walk to users through **Sentinel-1 data**[1] download from online repository using a pre-selected area of interest (AOI), import the data in the SARscape environment, crop the image to a selected extend and extract a Digital Elevation Model (DEM) that overlays the imported data terrain coverage (Figure 1).

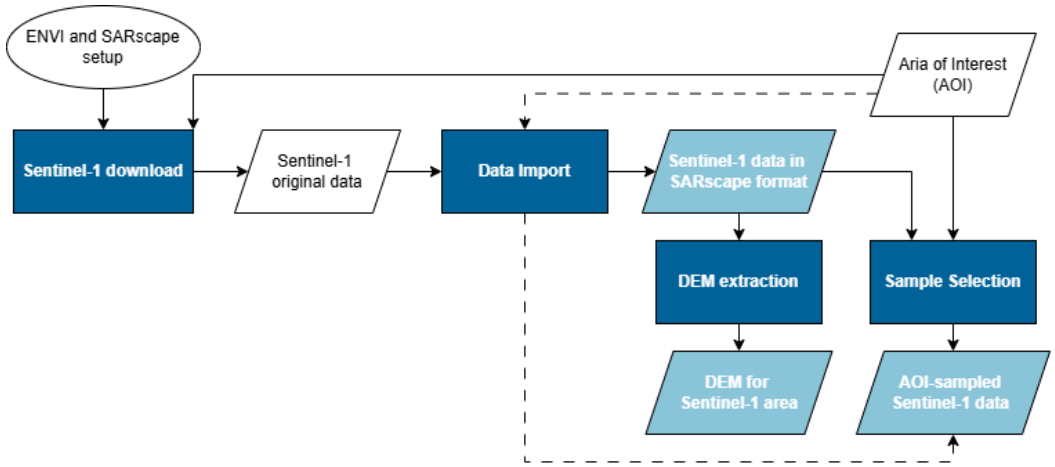

Figure 1. Data preparation scheme. The dashed line demonstrates the alternative approach for cutting the image along the AOI during the import step

This *Data preparation* tutorial is valid for the whole set of SARscape-supported sensors, except for the downloading step, which is specific for Sentinel data. For downloading Sentinel data, SARscape provides specific tools (*Sentinel-1 MultiDownload* and *Sentinel-2 Download*). Additionally, *NISAR data downloader* is also available.

If the download cannot be performed, please use the data in the *Data_Preparation* folder on our FTP (ftp.sarmap.ch). Please, contact support@sarmap.ch to get login credentials, providing the full name of the license owner, the name of your institution and the license number.

Note: SARscape contains dedicated tools for importing about 40 spaceborne SAR sensors and nearly 10 airborne sensors. Tools for importing generic SAR data, Sensor Independent Complex Data (SICD) and Import Sensor Independent Derived Data (SIDD) are also available.

The functionalities and example are referred to **SARscape version 6.3.1**, running under **ENVI 6.3.0** with a standard (GIS-like) interface installed on Windows 10, 64bit. For other software functionalities, such as interferometry or interferometric stacking, the Reader is referred to dedicated tutorials. The tutorials can be downloaded from https://www.sarmap.ch/index.php/software/sarscape/.

Paragraphs like this one, showing a hand on the left side, indicate a practical step that the user should perform to proceed with the tutorial.

The text written in gray corresponds to the information reported on the help page.

[1] The Sentinel satellites constellation is constructed and operated by the European Space Agency (ESA) in the framework of the Copernicus program.

2. ENVI PREFERENCES

To have an immediate quick access to the path in the dialog boxes of the SARscape tools, the *ENVI Preferences* should be set. The preferences are accessible from ***ENVI File -> Preferences***.

The paths must be set in *Directories* panel of *ENVI Preferences*:

Open the *ENVI Preferences,* navigate to *Directories* panel. Set the **Input Directory**, the **Output Directory** and the **Temporary Directory** (Figure 2).

ENVI Temporary Directory is used to keep intermediary files during SARscape workflow processes.

Important: **It is strongly recommended to do not choose USB or external drives as Input/Output or Temporary Directory, due to the large amount of data transfer. The User must have read/write privileges for the selected location.**

Note: **The intermediate files resulting from the processes run through the new SARscape workflows are stored in a subfolder in the Output Directory.**

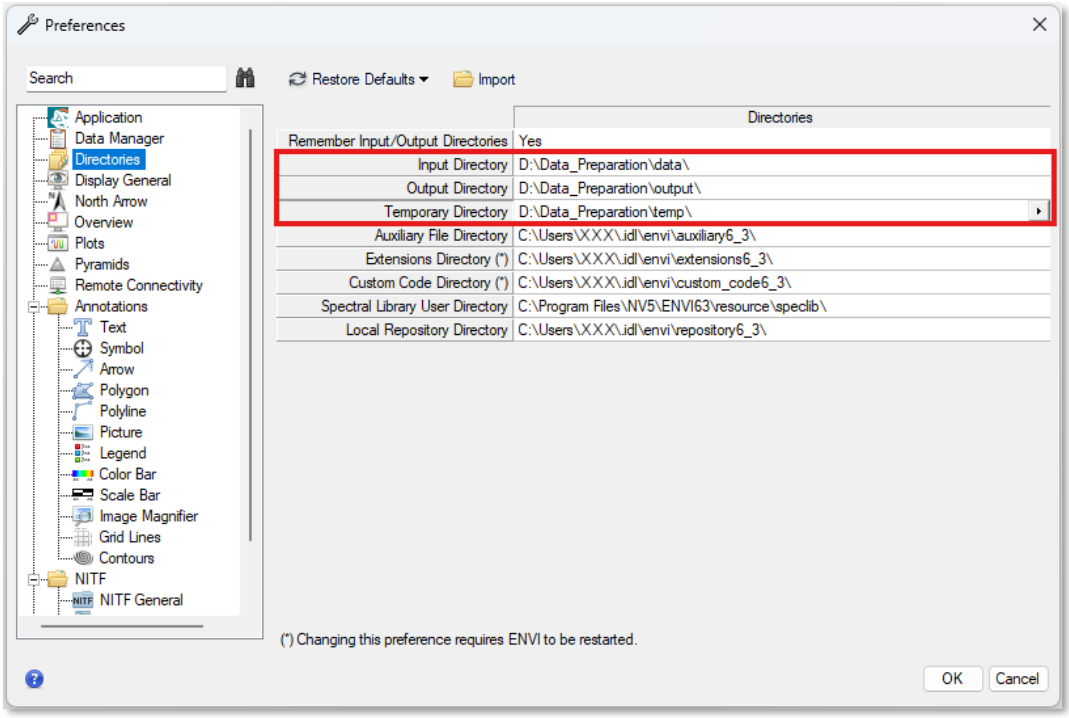

*Figure 2. Setting up the **Input, Output and Temporary Directories** in ENVI preferences, Directories panel*

3. SARSCAPE PREFERENCE COMMON

To correctly perform any processing, *SARscape Preferences* must be set accordingly before starting the processing. Preferences management is split into two modules *Preferences common* and *Preferences specific*. There located in *SARscape -> Preferences* folder.

The common preferences are used to specify general parameters in SARscape, such as *User accounts*, *Repositories, Annotations* and *Cluster* parameters, and others.

Note: If the preferences have been changed, these changes are not applied to the open tools. These tools must be closed and re-opened to let the changes take place.

3.1. WORKING DIRECTORY

The SARscape working directory stores working files, but also additional information about SARscape processes, such as ***Log*** and ***Trace*** files.

The other directories in the panel must be set if you have created a local (or local network) copy of DEM files or Orbit files.

- Open the *SARscape Preferences common*, navigate to *Directories and batch file name* panel. Set the ***Working Directory*** and ***Batch file name*** (Figure 3).
- Set a folder for the Sentinel-1 orbit files – ***Sentinel-1 auxiliary directory***.
  Note: this folder requires at least 17GB space.

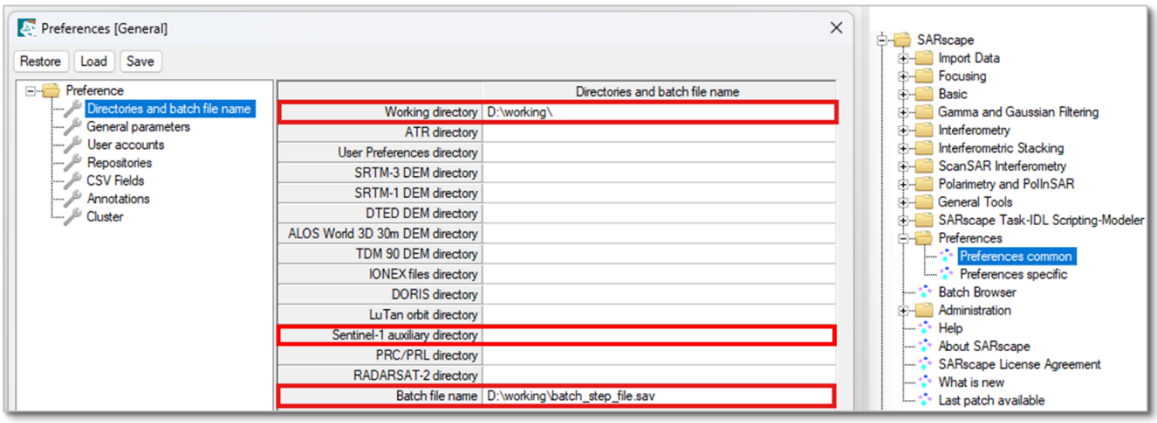

*Figure 3. Setting up the **Working directory, Sentinel-1 auxiliary directory, Batch file name** in SARscape Preferences common*

Important: **Please, make sure that you have read/write privileges for your selected directories.**

3.2. REPOSITORIES AND USER ACCOUNTS

In the panel *User accounts* the personal credentials for access to data repositories must be entered (Figure 4). The tool *Sentinel-1 MultiDownload* (Section 6.1) requires credentials for access to the European Space Agency (ESA) Data Scape platform or to Alaska Satellite Facility (ASF) platform. The URL addresses to the repositories are loaded automatically in the panel *Repositories*

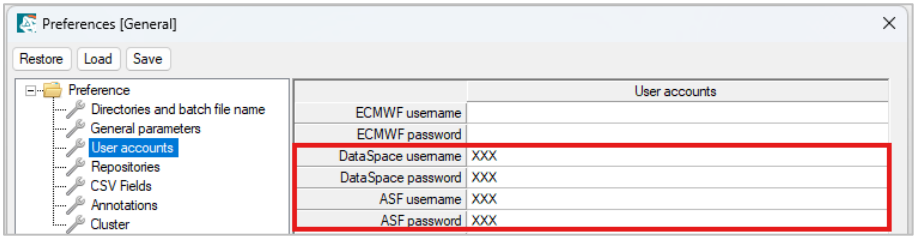

Figure 4. SARscape Preferences common – User accounts and Repositories panels

Note: The *Data Space* and *ASF* Sentinel-1 SAR data providers require at least one special character in the password. SARscape supports the following characters:

$ + @ & ! #

- In *User accounts* tab of *SARscape Preferences common* (Figure 4) add your credentials.

4. SARSCAPE PREFERENCE SPECIFIC

This tool gives possibility to load predefined processing parameters depending on the SAR images used in the process (Figure 5). These settings will be then automatically loaded in the tools and workflows which require this information. The default values of the parameters are recommended but also can be modified if needed for any of the processing in the list on the left side of the window. The changes can be *Saved* and *Loaded* from a *sml file for reuse. Alternatively, the parameters can be changed for one-time processing directly in the corresponding SARscape tools. This change will not be saved. In the next usage of the tool, the parameters will be automatically reloaded from *Preferences specific*.

The options for *Preferences specific* to be loaded are:

- General
- UHR (better than 1m) – ultra high resolution
- VHR (better than 3m) – very high resolution
- VHR (better than 6m) – very high resolution
- HR (better than 10 m) – high resolution
- MR (between 10m and 30m) - medium res.
- LR (coarser than 30m) – low resolution
- Interferometry Low Coherence
- Wrong Orbital Data
- TanDEM-X Bistatic Configuration
- CInSAR ERS-ASAR Interferometry
- Sentinel TOPSAR (IW-EW)
- PALSAR-2 ScanSAR
- TSX ScanSAR
- Umbra
- Squinted Data

Open the *SARscape Preferences specific* from *SARscape -> Preferences* and click the button **Load Preferences.** Choose **Sentinel TOPSAR (IW-EW)**. The parameters specific for processing of Sentinel-1 data will be loaded in all panels of the tool (Figure 5).

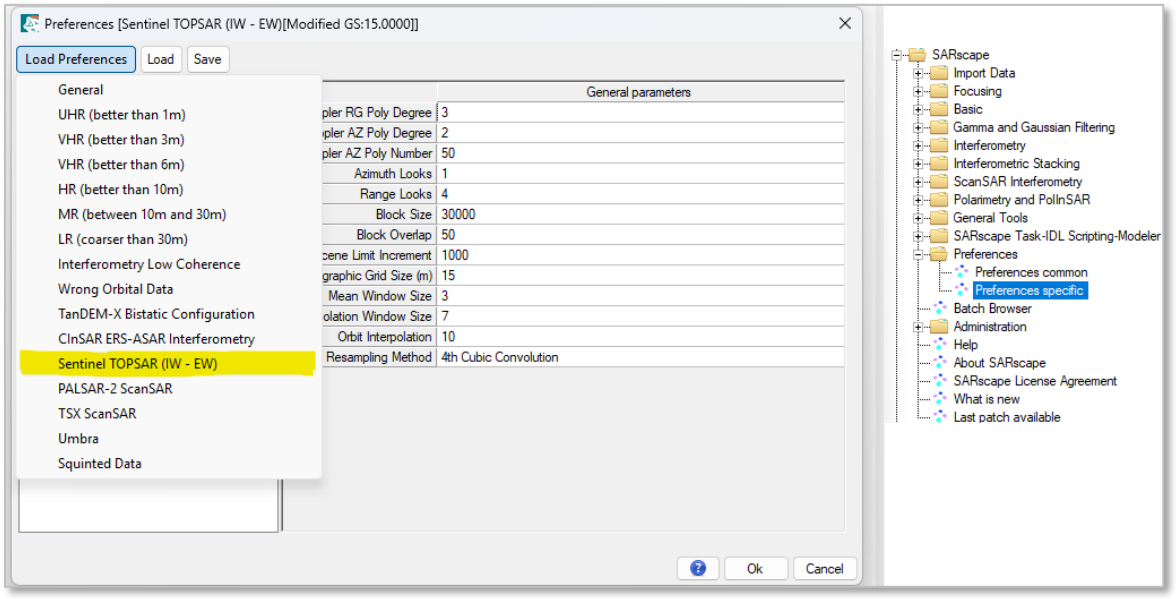

Figure 5. SARscape Preferences specific – loading the Sentinel TOPSAR (IW-EW) preferences

5. AREA OF INTEREST AND DATA DESCRIPTION

The current tutorial is based on a test AOI covering about 65 km sector from Ganges River in Eastern India, between the towns of Bhagalpur and Sahibganj (Figure 6).

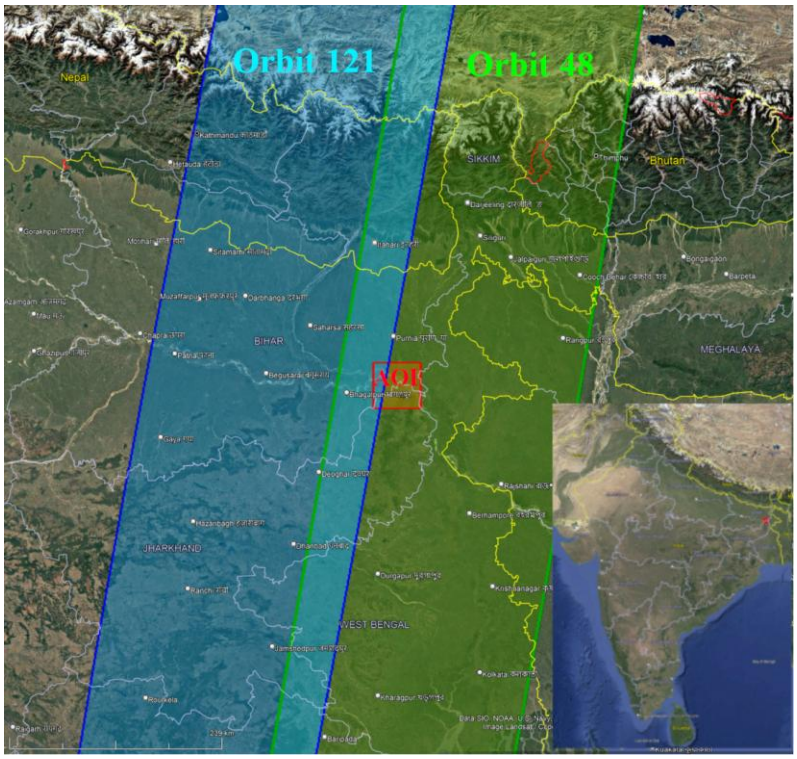

Figure 6. AOI marked with red rectangular is observed in the current tutorial. The area is covered by two Sentinel-1A descending orbits, No 48 in green and No 121 in blue

The AOI vector file in *.kml (Keyhole Markup Language) format is given in the **DataSetsTutorial_631** folder – *AOI_Data_Preparation.kml*. For a given time of interest (15th July to 20th August 2025), the AOI is covered by two Sentinel-1A tracks from descending relative orbits – No 48 and No 121 (Figure 6). For the purposes of this tutorial data only from relative orbit 48 will be used. Keep in mind that data from different orbits must be processed separately and the results can be merged afterwards.

Sentinel-1 satellite constellation is maintained by the ESA as a part of the Copernicus Sentinel series – a joint initiative between ESA and the European commission (EC). The constellation comprises two sun-synchronised near-polar orbiting satellites, separating the same orbital plane at 180°.

As of August 2026, the satellites Sentinel-1C (launched on December 5th, 2024) is operational since 26th March 2025, and Sentinel-1D (launched on November 4th, 2025), is collecting data since 17th April 2026. Since 24th June 2026 the two satellites are in full operational constellation with six-day repeat-pass orbits, providing observation in C-band with central frequency of 5.405 GHz)[2]. Archive imagery collected from Sentinel-1A (6th October 2014 – 29th June 2026) and Sentinel-1B (26th September 2016 – 23rd December 2021) are also accessible.

Sentinel-1 SAR data are available on a free, full and open basis governed by the Legal Notice on the use of Copernicus Sentinel Data and Service[3].

[2] https://sentiwiki.copernicus.eu/web/s1-mission
[3] https://sentinels.copernicus.eu/documents/247904/690755/Sentinel_Data_Legal_Notice

6. PROCESSING

6.1. SENTINEL-1 MULTIDOWNLOAD

SARscape package provides a tool for querying and download Sentinel-1 data, namely *Sentinel-1 MultiDownload* tool located in the module *Import data -> Download* (Figure 7).

Note: SARscape also provides tools for Sentinel-2 (optical) and NISAR data download, as well as Capella archive data download, located in the same toolbox. More details for these downloaders and these data can be found in the dedicated SARscape Help pages.

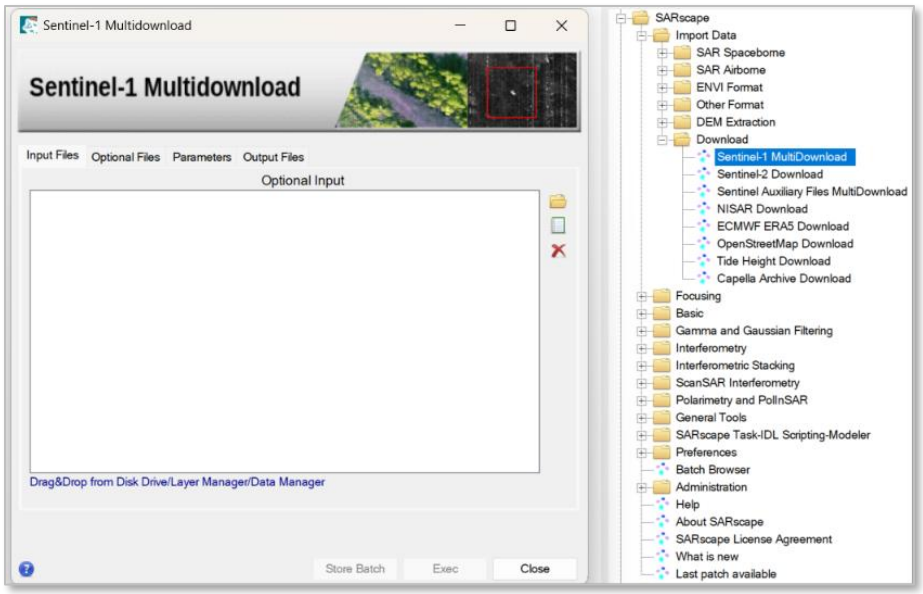

Figure 7. SARscape Sentinel-1 MultiDownload tool in Import Data module

Sentinel-1 data can be accessed through one of the two *Download services*:

- ESA Data Space: https://dataspace.copernicus.eu/browser/, or
- Alaska Satellite Facility (ASF): https://search.asf.alaska.edu.

An account with login credentials is required for both platforms (see Section 3.2). To take advantage of the ASF data portal, the login should be done at least once on the ASF web browser portal. The *Terms Of Service* for that account will also need to be accepted before using the *Sentinel-1 MultiDownload* tool. The User accounts must be specified in the *Preferences Common* at the *User Accounts* panel (Section 3.2). At least one account (ASF or DataSpace) is mandatory for this step.

Important: **Before opening the SARscape *Sentinel-1 MultiDownload* tool, the required preferences must be configured in *Preferences common* (*User accounts*, Section 3.2) and *Preferences Specific* (*Load Preferences -> Sentinel-1 TOPSAR (IW-EW)*, Section 4) so that they will automatically be populated with the correct parameters in the SARscape tools.**

If the user account credentials or specific preferences are changed in *Preferences* windows after Sentinel-1 MultiDownload tool has already been opened, the software will not update the parameters in the tool and will use those that were previously set. In this case, the tool must be closed and reopened for the new preferences to be applied correctly.

Note: A single image is around 4.5GB and the download depends on the connection speed.

Open the *Sentinel-1 MutiDownload* tool from *SARscape -> Import Data -> Download* (Figure 7).

6.1.1. Optional Files

A vector file (.shp) or a Google Earth file (.kml or .kmz) can be uploaded to specify a region of interest. The AOI file must have at least 4 vertices. All acquisitions inside or intersecting this polygon will be selected. The shapefile must be in Geographic Coordinate System (GEO-GLOBAL cartographic system, defining the coordinates by latitude and longitude).

In tab **Optional Files** load the file **AOI_Data_preparation.kml** into the **Geographical Region** field (Figure 8).

Figure 8. SARscape Sentinel-1 MultiDownload – loading AOI optional file

Alternatively, the coordinates of the area of interest can be set in the Parameters tab, in the fields WEST, NORTH, EAST, SOUTH – see Figure 9.

6.1.2. Parameters

At the tab *Parameters* the *Principal Parameters* are shown at first. Here the **service** for download can be selected between *ASF* and *ESA Data Space* platforms (Figure 9).

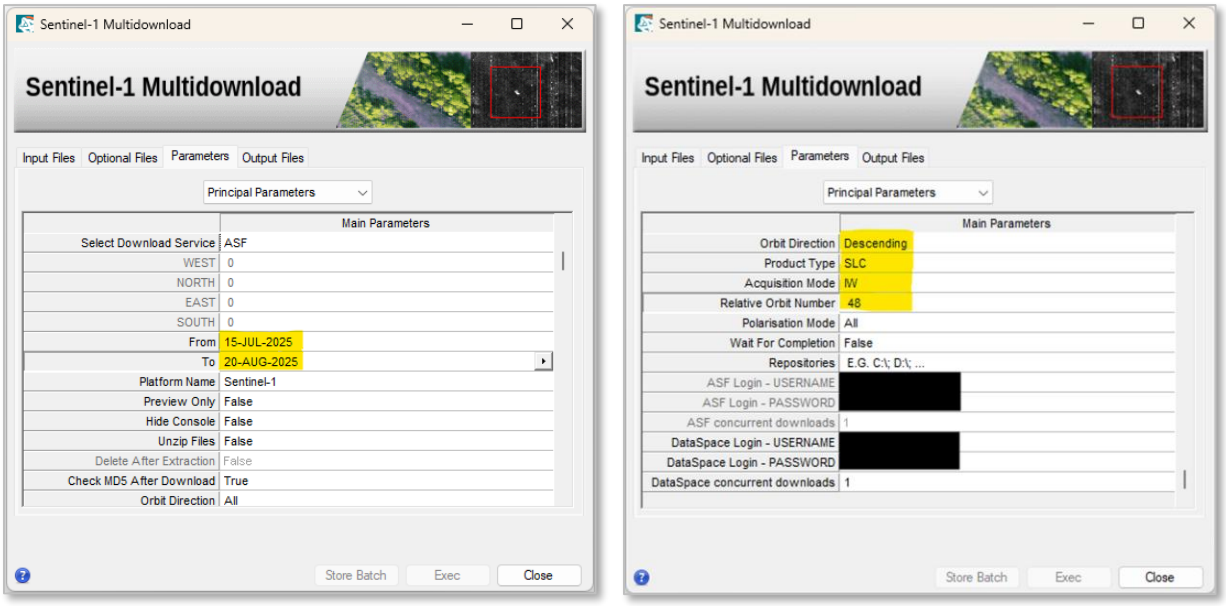

Figure 9. SARscape Sentinel-1 MultiDownload – setting the Principal Parameters

In tab **Parameters** (Figure 9) select **ASF** or **DataSpace** depending on the registration you have.

6.1.2.1. Time span

The **time span** for the Sentinel-1 query must be defined by setting the ***From*** and ***To*** dates in the provided fields, respecting the format of Day-Month-Year (e.g., 01-Jan-2018). These parameters are mandatory.

✍ Set the field **From** on **15th July 2025**, and the field **To** on **20th August 2025** (Figure 9, left).

6.1.2.2. Orbit Direction

The **Orbit Direction** field allows the selection between data acquired by *Ascending* or *Descending* Sentinel-1 satellite orbits, or to include both ("*All*" in Figure 9, left). This parameter is optional. By default, the data from both orbit passes will be downloaded.

✍ Set the field **Orbit Direction** to **Descending** (Figure 9, right).

6.1.2.3. Product Type

On this step a filter for the type of Sentinel-1 **product** can be applied. The available product types are:

- All – all available products will be downloaded.
- Level 1 Single Look Complex (**SLC**) – images in slant range in the imaging plane of the satellite data acquisition. Each image pixel contains amplitude and phase information[4].
- Level 1 Ground Range Detected (**GRD**) – focused SAR data that has been multi-looked and projected to ground range using the Earth ellipsoid model WGS84. Ground range coordinates are the slant range coordinates projected onto the ellipsoid. Pixel values represent detected amplitude, while the phase information is not kept.
- Level 0 – unprocessed (**RAW**) radar measurements, containing amplitude and phase information.
- Level 2 Ocean (**OCN**) – for oceanographic applications.

✍ Set the field **Product Type** to **SLC** (Figure 9, right).

6.1.2.4. Acquisition mode

The Sentinel-1 sensor acquires data in several **modes**, depending on the product resolution and ground coverage, namely:

- Interferometric Wide Swath (**IW**) – high resolution data, acquired in 250-km swath at approximately 5 m by 20 m spatial resolution (single look)[5]. Each swath consists of three sub-swaths (IW1, IW2 and IW3), which are further divided into 9 to 10 overlapping bursts (Figure 10). Data is generated with the Terrain Observation with Progressive Scans SAR (TOPSAR) system. This is the main acquisition mode over land.
- Extra-Wide Swath (**EW**) – medium resolution data generated with the TOPSAR system over a wider area (400-km swaths) using five sub-swaths at 20 m by 40 m spatial resolution. The EW mode is primarily used for sea ice, polar zones and specific maritime areas, oil spill monitoring and security services.

[4] https://documentation.dataspace.copernicus.eu/Data/SentinelMissions/Sentinel1.html
[5] https://sentiwiki.copernicus.eu/web/s1-mission

- Wave (**WV**) – acquires data in 20 by 20 km vignettes, at 5 m by 5 m spatial resolution, every 100 km along the orbit alternately from two different incidence angles. This is the default mode for acquiring data over open ocean.
- Stripmap (**SM**) – high resolution data, acquired in 80-km swath (six overlapping swaths that cover a range of 375 km in total) at nearly 5 m by 5 m spatial resolution (single look),

If *All* is selected, all available products for this query will be downloaded.

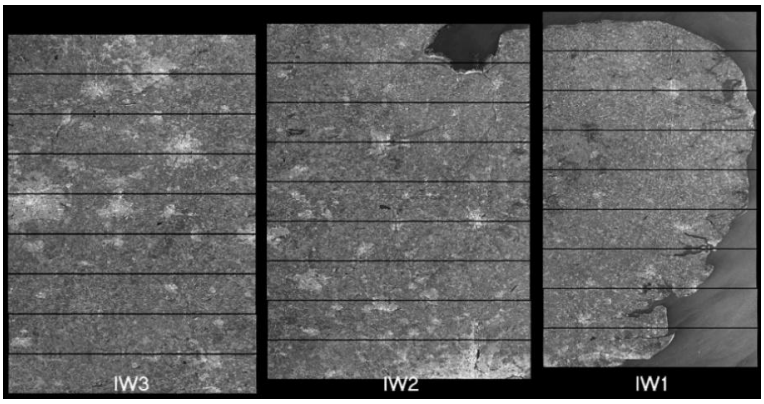

Figure 10. Example of Sentinel-1 IW SLC full image with three sub-swaths (IW1, IW2, and IW3) and their bursts (Source: ESA)

✍ Keep the default value **IW** for the **Acquisition Mode** (Figure 9, right).

6.1.2.5. Relative Orbit Number

The Relative orbit number is an identifier marking the position of each of the Sentinel-1 satellites within their 35-day repeat cycle, corresponding to 175-orbit repeat cycle, so the values are changing between 1 and 175. It indicates the acquisitions made over the same area (tracks) of the Earth's surface. The tracks have nearly the same viewing geometry.

✍ Set the value to **48** for the **Relative Orbit Number** (Figure 9, right).

6.1.2.6. Polarization mode

Sentinel-1 data are distributed in the following polarization schemes and stored in different image bands (Figure 23):

- VV – single co-polarization, vertical transmit/vertical received radar signal,
- Dual VV – partial dual co-polarization, vertical transmit/vertical received radar signal,
- HH – single co-polarization, horizontal transmit/horizontal received signal,
- Dual HH – partial dual co-polarization, horizontal transmit/horizontal received signal,
- VV + VH – dual-band cross-polarization, one vertical transmit/dual vertical-horizontal received,
- HH + HV – dual-band cross-polarization, one horizontal transmit/dual horizontal-vertical received,
- Dual HV – partial dual-band HV cross-polarization,
- Dual VH – partial dual-band VH cross-polarization.

The Polarization Mode parameter is optional. If the default option All is kept, all possible polarization modes will be downloaded.

✍ Keep the default value **ALL** for the **Polarization Mode** (Figure 9, right).

6.1.3. Output Files

To keep track of the downloaded data a *Progress filename* must be set in the *Output Files* tab (Figure 11). It contains a list of the found files that fulfil the user's query based on the provided parameters. It also performs a check if the files reported in this list are already included in the Progress File.

Note: If the requested data already exist in the downloading folder, the tool will recognise the files and will skip downloading them again which will save time.

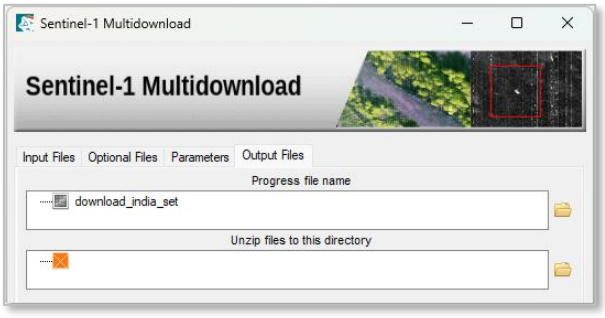

Figure 11. Setting the output files for Sentienl-1 Multidownload tool

The process will store the downloaded data in the folder where the progress file has been set and will unzip the downloaded compressed files if requested.

Note: SARscape does not require the downloaded Sentinel-1 files to be unzipped.

Once the Progress filename is set, click **Exec**.

6.1.4. Downloads

Once the download process is started a separate console is open (Figure 12) where the progress of the process is shown. It can be closed only once the download is completed, while meanwhile it is possible to use ENVI or SARscape.

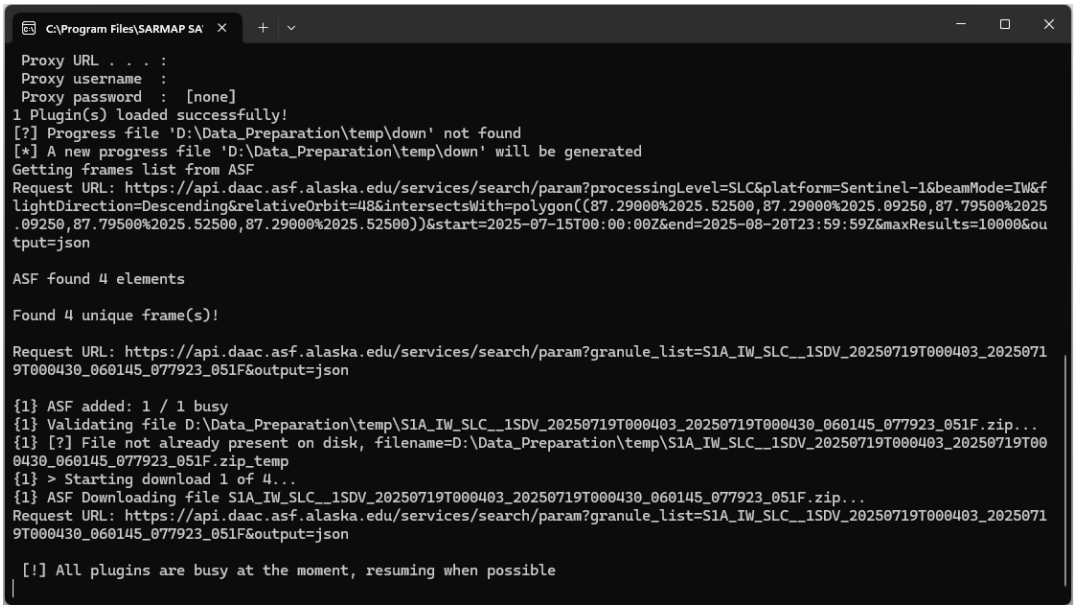

Figure 12. Sentinel-1 multidownload console window

Important: **Never use the same Progress File for two concurrent downloads.**

Note: Concurrent downloads: an account allows multiple downloads. Multiple different downloads can be launched with this tool, but it is imperative to use different progress files.

The given query finds 4 images from 3 dates from the descending relative orbit No 48 for the period of interest. This is a consequence of the different framing of the data within an orbit track. As it is seen in Figure 13 on the date of 31st July 2025 there are two images that cover the AOI. It must be noted that these are the bounding boxes of the image footprints, while it must be considered that the TOPSAR imaging system produces slightly shifted and overlapping interferometric swaths (IW) and bursts.

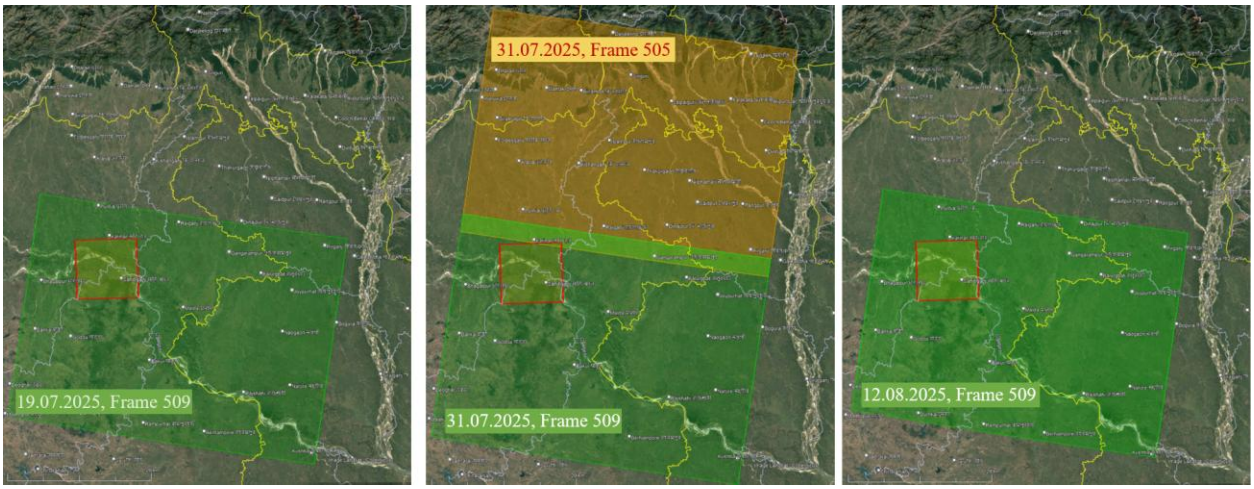

Figure 13. Sentinel-1 frames from orbit 48 that cover the AOI (red rectangular) for the period of interest

Even if it may seem that the image from frame 509 acquired on 31st July 2025 covers completely the AOI (Figure 13, middle), a detailed closer look over the TOPSAR bursts of these images (Figure 14) reveals that the northeastern corner of the AOI is not included in frame 505 from 31st July 2025 (Figure 14, left). For this reason, the searching algorithm includes also the neighbouring frame 505 (Figure 14, right). These files can be merged later during the import process (see section 6.3).

Figure 14. Detailed bursts coverage over the AOI on 31st July 2025, descending orbit 48 – frame 509 (left) and frame 505 (right)

Important: It is recommended to use the *SARscape Sentinel-1 Multidownload* tool instead of manual download since the tool take into consideration the real bursts coverage and not only the image bounding box.

6.2. SENTINEL AUXILIARY FILES

For the proper usage of Sentinel data, the availability of the Sentinel Auxiliary files is crucial. They are needed for accurate interferometric processing (Differential Interferometric Synthetic Aperture Radar – DInSAR, Persistent Scatterer Interferometry – PS, Small Baseline Subset Interferometry – SBAS). The set of Sentinel auxiliary files includes among all Precise Orbit Files (POEORB), Restituted Orbit Files (RESORB), Calibration Auxiliary Files, Instrument Auxiliary Files.

The information from these files is aligned to the downloaded Sentinel data during the *SARscape Import* step (section 6.3). The common approach is that during the Sentinel data import the needed auxiliary files are search on the Sentinel-1 Quality Control website[6] – the same credentials as for Sentinel-1 Multidownload are used for access. The *Import* tool downloads the auxiliary files temporary in the *SARscape Working directory*, apply the corrections to the Sentinel data and remove the auxiliary file from the local storage.

Alternatively, the files can be downloaded in advance if there is unstable internet connection or if the user would like to reuse them. In this case they should be stored locally on the processing machine. For this purpose, the preferred folder for storing the files should be set in advance in the *SARscape Preferences common* panel – in the field *Sentinel auxiliary directory* (Figure 15).

The *Sentinel Data Import* tool will check first if the auxiliary files are present in the directory set by the user. If the needed files are missing, it will download them from the repository and store the files temporary in the SARscape working directory as described above. In case the needed orbit files do not present locally and there is no access to the repository due to lack of internet access or missing credentials, a warning message will pop-up notifying the user that the images will not be corrected.

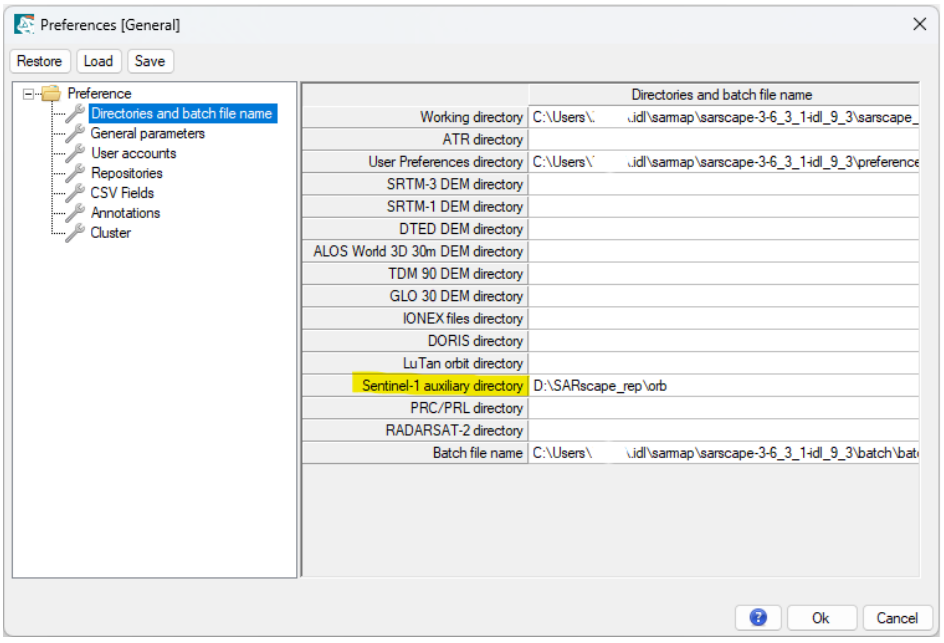

Figure 15. Setting in Preferences common a local directory for storing the Sentinel-1 auxiliary files

[6] Sentinel-1 Quality Control website – https://dataspace.copernicus.eu/browser/

SARscape alternatively provides a tool for downloading the auxiliary files. It is located in the *Import Data* module – in folder *Download* (Figure 16).

Download type parameter allows choosing the activity that must be performed:

- Incremental – All the files between the latest file already present in the local repository and the latest present on the online repository (https://dataspace.copernicus.eu/browser/) are downloaded.
- Full – A search in all pages of the online repository is performed. Data already downloaded will be checked and, if the dimension matches, skipped. Missing or corrupted files will be downloaded and stored, updating the local repository.

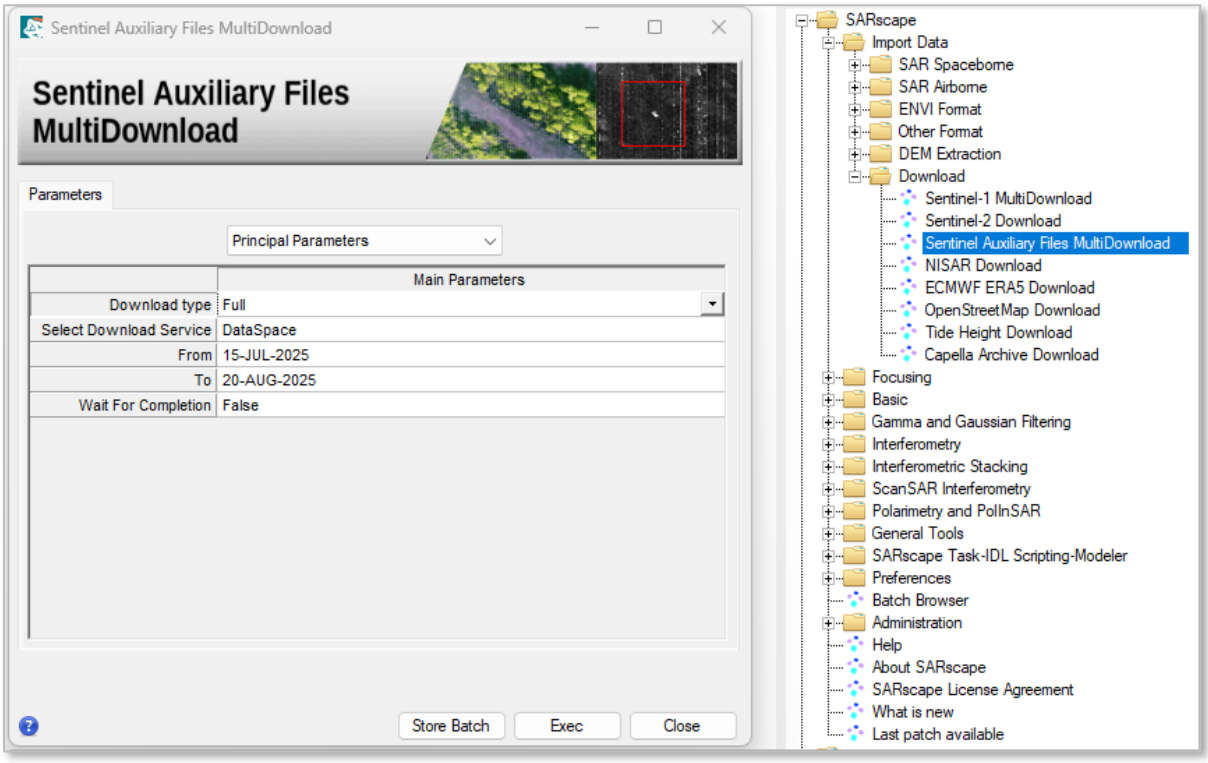

Figure 16. SARscape Sentinel Auxiliary Files MultiDownload tool

Tip: The downloaded orbit files can be kept for further processing with Sentinel-1 data. Just make sure to **update the repository** to cover the entire time span. **Please Note** that *Full* option must be set only the first time the tool is used, the *Incremental* mode can be set once the repository is populated.

Note: If you are unable to download the files or you do not have internet access while you are performing this tutorial, please use the previously downloaded files (*.EOF) that are included in the Tutorial Dataset.

It must be noted that the *Import* tool automatically downloads the relevant orbit for the input image. Therefore, it is not needed to first download the orbits in the local repository. This option is given in case of limited internet connection. To clarify, the *Sentinel Auxiliary Files Download* tool uses the same function as the *Import Sentinel-1* tool. However, the distinction lies in their functionalities: The *Sentinel Auxiliary Files Download* tool operates in background and downloads all Sentinel-1 orbits in the specified folder, while the *Import Sentinel-1* tool operates through its interface and it downloads only

orbits relevant to the input images. The *Sentinel Auxiliary Files Download* tool performs an unlimited number of connection attempts until the user manually closes the command prompt window, while the *Import Sentinel-1* tool performs a limited amount of connection attempts (3) and if it fails it imports the image without the relevant orbit applied. In this case a warning message will appear to notify the user. Running the *Sentinel Auxiliary Files Download* tool ensures a local repository, accessible during the import process even offline, while this is not valid for the *Import* tool since it applies the orbit file to the specific imported image.

In case the image has been imported without precise Sentinel-1 orbits (POE), and after a while they become available, SARscape provides possibility to update the corrections for the imported image by using the tools located in *General Tools* module, folder *Orbital Correction/Update to Precise Orbits* (Figure 17).

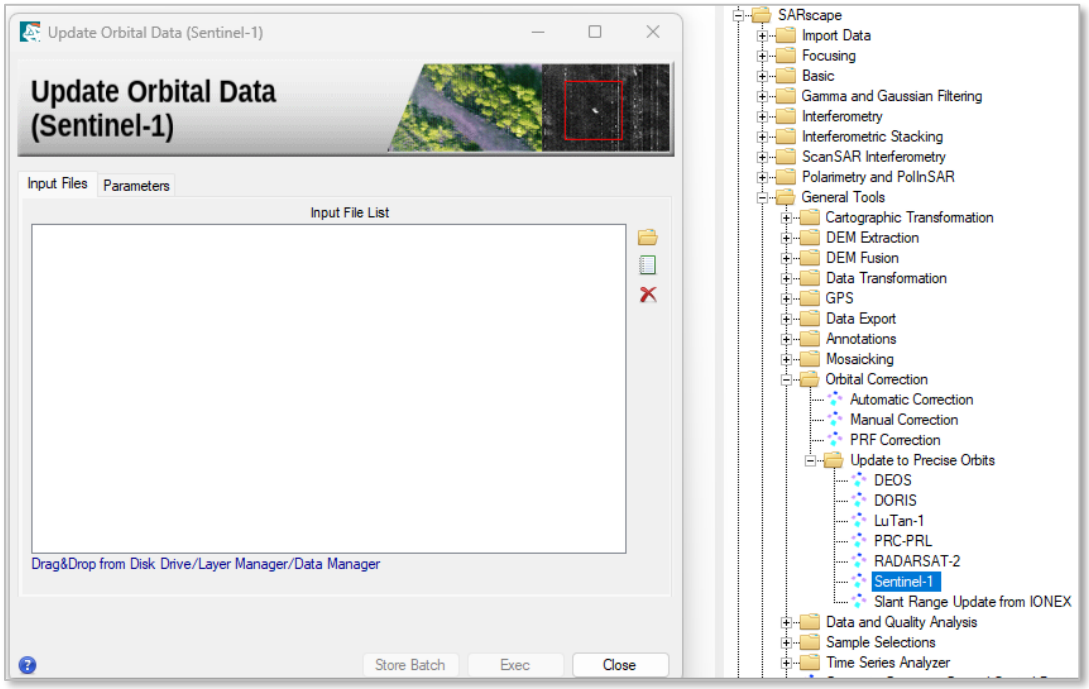

Figure 17. Possibility for update the auxiliary information of already imported image by Update to Precise Orbit tools in SARscape General Tools module

6.3. DATA IMPORT

The purpose of the Data Import is to convert the data into **SARscape Data Format.** It is important to point out that it is mandatory to use **the SARscape *Import Data* tools to process any data that was not created with SARscape.**

SARscape products consist of the following **data types**:

- **Binary data** (usually float, complex and byte) containing the data matrix (no extension is specified)
- Two ASCII header files containing ancillary information:
  - ***.sml** file, SARscape header file containing all relevant information needed for the data processing,
  - ***.hdr** file, corresponding to the ENVI header format, which enables the product compatibility within ENVI.

As already mentioned, the *SARscape Import Data* module provides support for import of about 40 types of data acquired from spaceborne sensors – a non-exhaustive list is shown on the right-hand side of Figure 18. These tools take into consideration specifications of these types of data, modes of acquisition, etc. In addition, the module contains a tool for *Generic SAR data* import, as well as for *SICD* and *SIDD*, imaging data formats used by U.S. government. In the current tutorial Sentinel-1 data are used and for this reason the dedicated tool is applied (Figure 18).

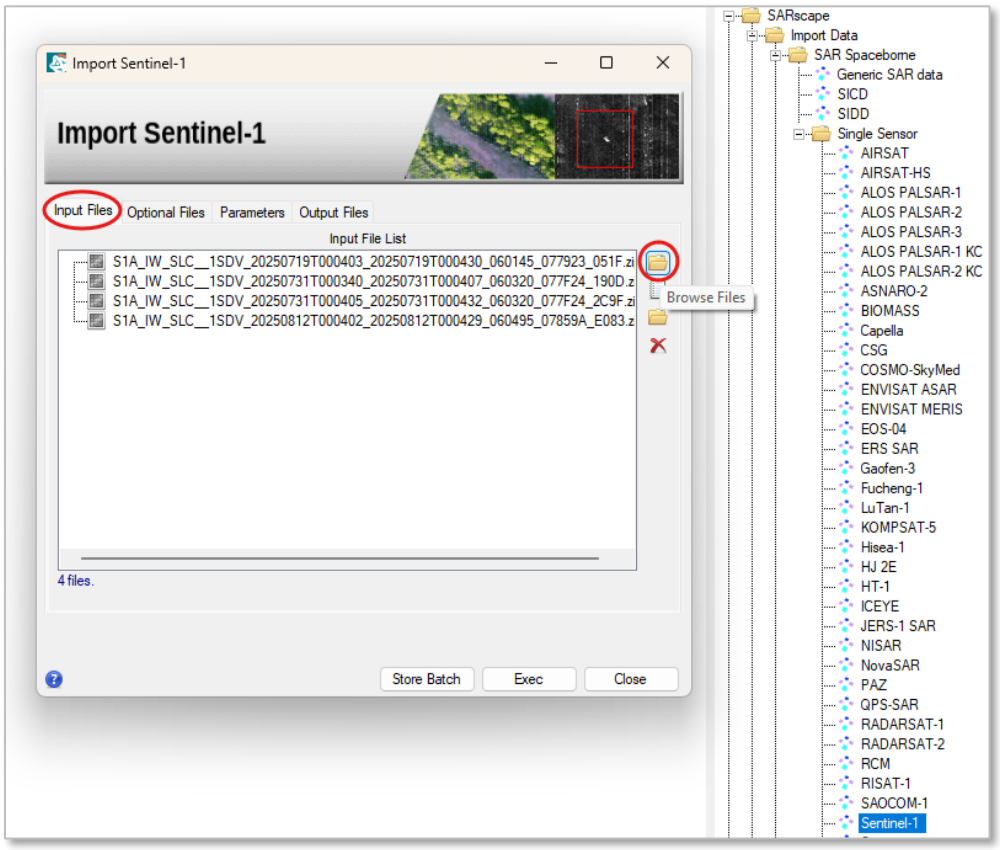

Figure 18. Import Sentinel-1 data tool within the Import Data SARscape module

- Open the tool **Sentinel-1** from *SARscape -> Import Data -> SAR Spaceborne -> Single Sensor.*
- In tab **Inpit Files** load the downloaded ***.zip** files with Sentinel-1 data from orbit 48 (Figure 18).

6.3.1. Optional Files (only for Sentinel-1 data and Generic SAR Data tools)

The original Sentinel-1 image can be cropped following the boundaries of a vector file (.shp) or a Google Earth file (.kml or .kmz). The AOI file must have at least 4 vertices. The shapefile must be in Geographic Coordinate System (GEO-GLOBAL cartographic system, defining the coordinates by latitude and longitude). The tool will select only the bursts that cover and intersect the AOI, will cut them and transform them into the SARscape format. Otherwise, the entire Sentinel-1 image with all the bursts will be imported (see section 6.4).

- In tab **Optional Files** load the file **AOI_Data_preparation.kml** into the **Area of Interest in Geographic Coordinates** field (Figure 19).

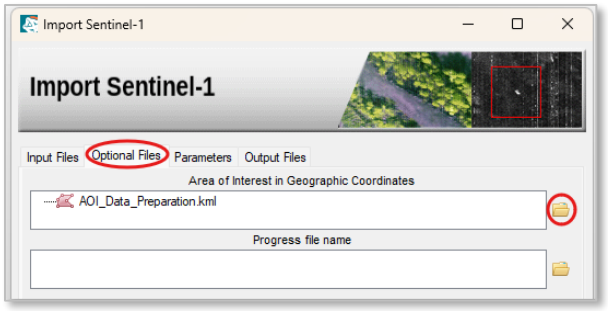

Figure 19. SARscape Sentinel-1 Data Import – loading AOI optional file

For all other type of data, and as an alternative for Sentinel-1 data, SARscape provides a dedicated tool for cropping the data after they are imported entirely – **Sample Selection for SAR Geometry Data** (see section 6.4).

6.3.2. Parameters

Depending on the imported data this tab has different fields for the different *Import* tools. In the case of Sentinel-1 importer the **Principal parameters** selection includes among the others (Figure 20):

- Make power QL – creates a multilooked power image, which is automatically loaded in ENVI the ENVI Layer Manager,
- Polarization – it allows choosing the polarization to be imported in case the original data contains more than 1 polarization,
- Make mosaic same track – if this option is set and all the files in the input file list are acquired in succession on the same track (relative orbit), the output will be one single _slc_list with only one _split_bursts folder (for each polarization),
- Skip Sample Selection – if this option is set to *True*, the entire bursts that intersect the AOI are imported and the sample selection (crop) is not performed. If this option is set to *False* (default) the imported bursts are also cropped (sampled) based on the AOI,
- Rename Output Using Parameters – if this option is not set, the output files will be placed in the output directory with the root name which appears in the Output File List. If this option is set to *True* (recommended), the output files will be placed in the output directory with an automatically generated root name, assigned based on the input file parameters. The name will contain the sensor name, the track number, the date and time of the acquisition, the geometry (Ascending/Descending) and the polarization.

Tip: In case the parameter *Make mosaic same track* is set to *False*, the *Sentinel-1 Mosaicking* tool from *SARscape General Tools module -> Mosaicking* folder can be used afterwards to join already imported Sentinel-1 images (also from different importing sessions). The merged images must be from the same orbit and the same viewing geometry. During this process an AOI can be added for cropping the mosaicked product.

Tip: For other than Sentinel-1 data the *Slant Range Mosaicking* tool can be applied – consult the SARscape Help pages for details.

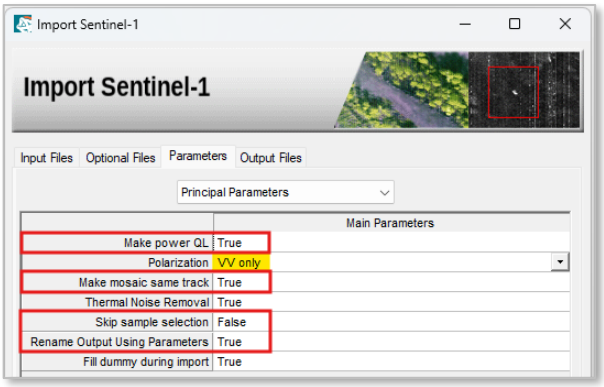

Figure 20. SARscape Sentinel-1 Data Import – Principal Parameters

Select **VV only** in **Polarization** field of **Principal Parameters**. Keep the rest by default (Figure 20).

6.3.3. Output Files

It is strongly recommended to not choose USB or external drives as Input/Output or Temporary Directory, due to the large amount of data transfer.

Set the Output directory at **Output Files** tab.

Click **Exec** and wait for the *Completed* message for end of the process.

6.3.4. Imported data

In the **Output folder** the imported images are stored as SARscape ***_slc_list** files. For each of them also the associated ***.hdr** and ***.sml** files (Figure 21) are saved.

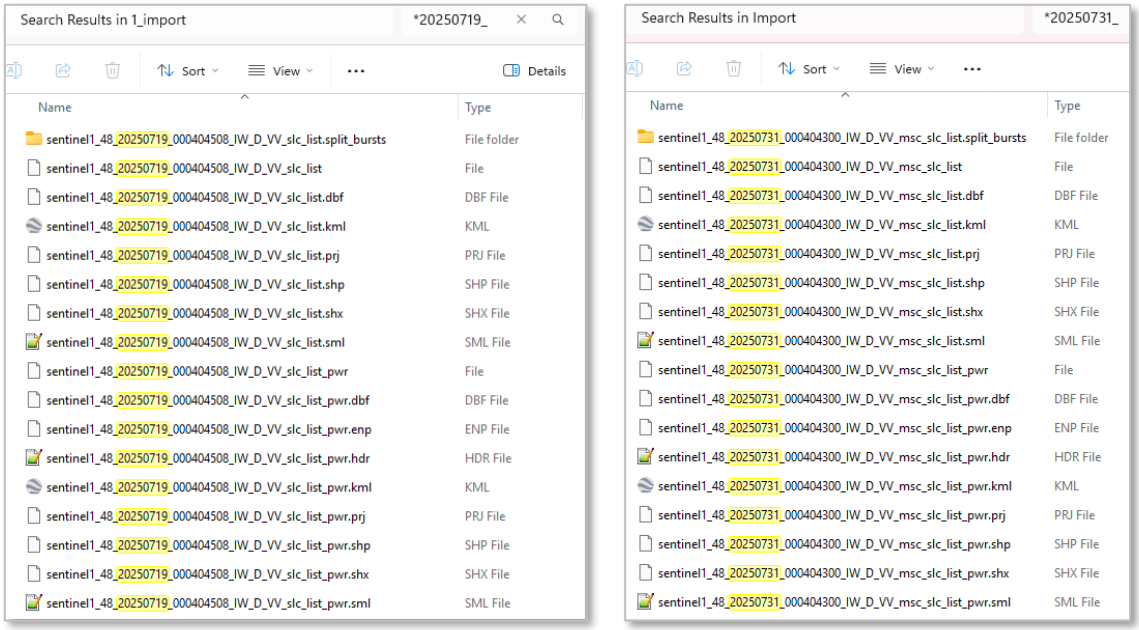

Figure 21. Examples for the output files from Import of a Sentinel-1 SCL images – from a single image (left), and from a mosaicked image (right)

The orbit track number is added to the output filename, which in the current case is **_48_**. The *Interferometric Wide Swath* acquisition mode, selected during the download (section 6.1.2.4), is

presented in the filename with the suffix **_IW_**. In the current training case, only files with **_VV_** polarization are imported according to the selection done in the *Import* tool (see Figure 20).

When the AOI is covered by several images that during the import are merged in a mosaic, like the images from 31.07.2025, the resulting imported image contains **_msc_** (from mosaic) in its filename (Figure 21, right).

The _scl_list file in the main Output folder contains link to the TOPSAR bursts that cover the AOI. These bursts are stored in a separate sub-directory (**_split_bursts**) for each date additional to the main Output folder (see Figure 21, top rows). An example for bursts folder content is shown in Figure 22.

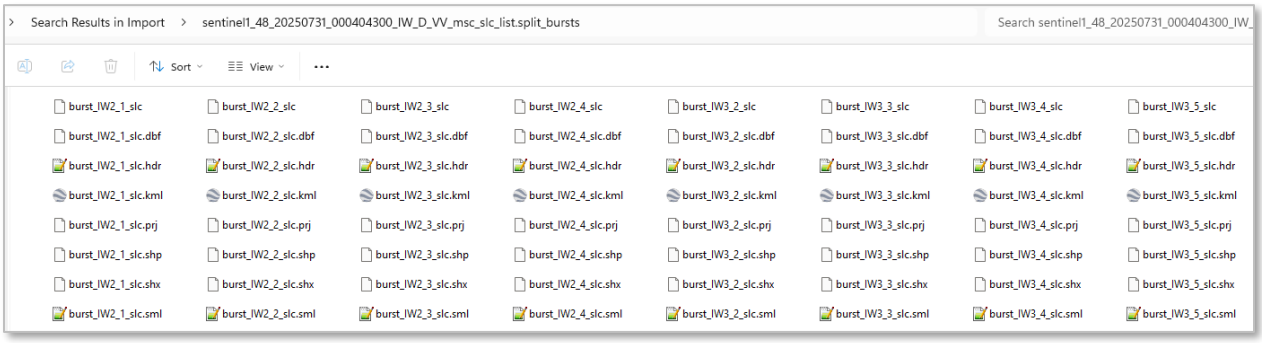

Figure 22. Example for a separate folder for selected Sentinel-1 image, containing separate burst data

In addition to the main SARscape files also shapefiles (***.shp**), together with the auxiliaries (*.dbf, *.prj, *.shx) are created, as well as Google Earth ***.kml** files. These files are created both for the bursts (in the subfolder – Figure 22) and for the _list files (in the main Output Directory – Figure 21). The files contain the boundary polygon of the image and can be used to visualise the footprint of the image or the separate bursts as in Figure 13 and Figure 14.

A multilooked power image (***_pwr** in Figure 21) is also created in the main Output Directory in case of Sentinel-1 SLC import and flag *Make power QL* set to *True*. The power image is not mandatory – it is useful for visualization. According to the parameters settings, the tool loads the power images in the ENVI Data and Layer Managers in the coordinate system of the SAR image, namely range and azimuth (Figure 23).

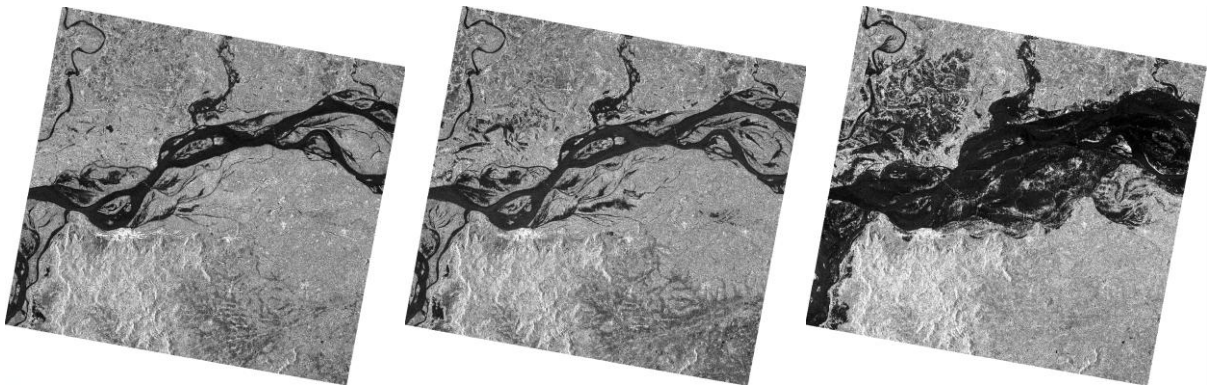

Figure 23. The imported and sampled Sentinel-1 images (descending orbit No 48) over the AOI acquired at the three dates – 19.07. 2025 (left), 31.07.2025 (middle, also mosaicked from two frames), 12.08.2025 (right)

The structure for imported Sentinel-1 data described above is similar to other data generated with ScanSAR mode, like PALSAR 2, and TSX. An example for TSX ScanSAR SARscape-imported image is given in Figure 24.

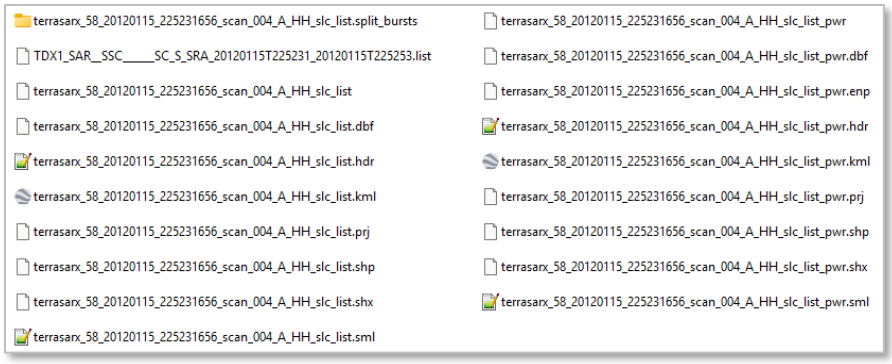

Figure 24. An example of the output from Import of a TerraSAR-X ScanSAR image

Important: The **structure** of the imported file must be kept together when moving the files. In particular, the ***_slc_list (together with all ancillary files) must be in the same directory as the *_split_bursts folder** (Figure 21 and Figure 24).

In case of sensors other than ScanSAR, no subfolders for bursts are created, and the ***_slc** files and the associated *.sml and *.hdr files are created in the selected Output Directory (Figure 25). These import tools do not automatically create power images, and the user can drag & drop the *_slc file directly into the ENVI View.

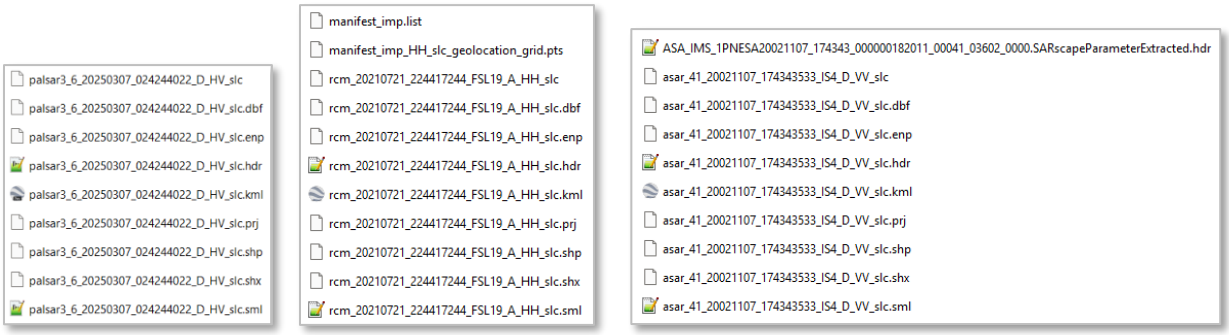

Figure 25. Examples of the output from Import of a PALSAR-3 Stripmap image (left), RCM Spotlight image (middle), ENVISAT ASAR image (right)

6.4. SAMPLE SELECTION

In the general case for SAR data imported with a tool from the *SARscape -> SAR Spaceborne -> Single Sensor toolbox*, other than *Sentinel-1* or *Generic SAR data*, a separate approach for sampling the data is available. The proposed tool is useful also if no AOI is added or the *Skip sample selection* is set to *True* for the *Sentinel-1* or *Generic SAR Data Import* processes. For all these cases SARscape **Sample Selection** tools are applicable. They allow creating a subset of an image (or a stack of images) to **reduce the image extent** based on an area of interest and consequentially to reduce the file size and processing time.

The region of interest can be selected by:

- giving coordinates (geographic or SAR),
- selecting a *.kml or *.kmz file (Google Earth or Map format),
- selecting a Shapefile (*.shp).

Depending on the data types, two Sample Selection tools are available in *SARscape -> General Tools*:

- **Sample Selection SAR Geometry Data:** This tool is used if the selection must be performed on data in **SAR geometry (_slc, _slc_list, _pwr, _gr**)
- **Sample Selection Geographic Data:** This tool must be used if the selection is to be performed on **geocoded data** (**_dem, _disp**, _geo, …).

Details about the usage of *Semple Selection Geographic Data* can be found in the SARscape Help pages. In this tutorial the *Sample Selection SAR Geometry Data* is demonstrated by repeating the *Import* without setting AOI but with additional *Sample selection* step. As said, this is the standard procedure for the rest of the data type from the *SARscape -> SAR Spaceborne -> Single Sensor* toolbox.

- Open the tool **Sentinel-1** from *SARscape -> Import Data -> SAR Spaceborne -> Single Sensor.*
- In tab **Inpit Files** load the downloaded ***.zip** files with Sentinel-1 data from orbit 48 (Section 6.1).
- Select **VV only** in **Polarization** field of **Principal Parameters**. Keep the rest by default.
- On the Output File List, click on the folder symbol to browse to the folder and change the output directory to a convenient one (different from the previously used) to store the imported data.
- Click **Exec** and wait for the *Completed* message for end of the process.

The entire power images, including the mosaicked one from 31st July 2025, are loaded in the Data and Layer Managers in the local coordinate system of the SAR image, **range** (along the flight direction) and **azimuth** (in line-of-sight or LOS direction) – see Figure 26. Be aware that the data are acquired in descending orbit which means that the first records are at the northeastern corner. When the image is open in the local range-azimuth coordinate system these records are read first from the upper left corner, so the image is flipped – a comparison is shown by the two pictures on the left in Figure 26.

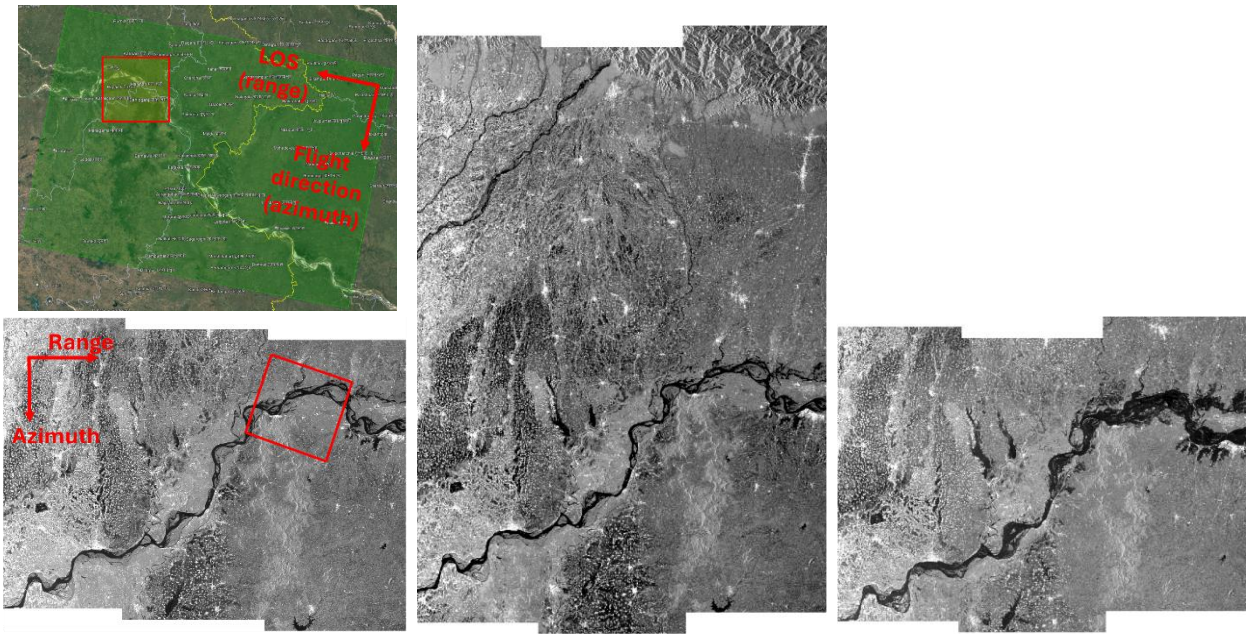

Figure 26. Entirely imported Sentinel-1 images (descending orbit No 48) over the AOI (red rectangle) acquired at the dates – 19.07. 2025 (left: up – footprint of the image in global geographic system, bottom – power image in local SAR coordinate system), 31.07.2025 (middle, mosaicked from two frames), 12.08.2025 (right)

As pointed out earlier, the images can be sampled by coordinates, with *.kml or *.kmz file, or with a shapefile. Apart from externally created shapefiles (from another geographic information system GIS), such a file can be created directly in ENVI. As a basemap a power image must be used.

- Load/turn on the power image of the first date in the ENVI Layer Manager: sentinel_48_**20250719**_000403565_IW_D_VV_slc_list_**pwr**
- In the ENVI menu select **File -> New -> Vector Layer**. In the new window give a **name** to the layer, e.g. AOI, and confirm the chose. The new layer appears in the Layer Manager (Figure 27).

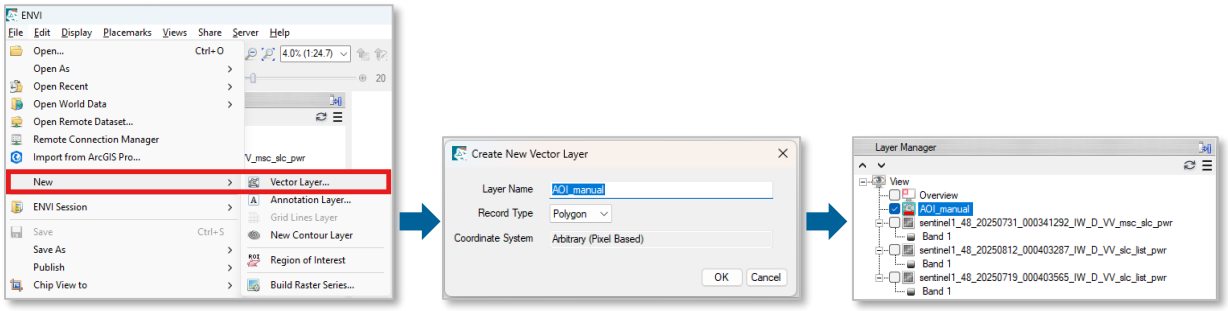

Figure 27. Steps for creating a new vector layer

- **Create vector** tool is activated in the task bar of ENVI (Figure 28).

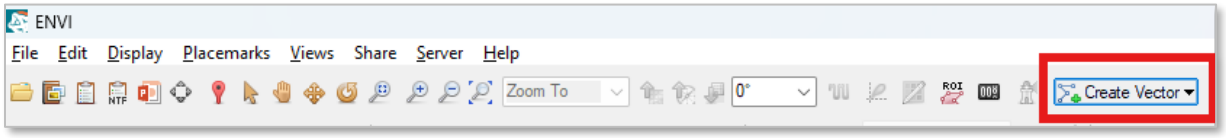

Figure 28. Create Vector tool is activated

At this point it is possible to draw a shapefile. It is suggested to use similar region as the one of the provided *AOI_Data_Preparation.kml*.

- Use the left mouse button to define the vertices of the AOI polygon in the ENVI View. Right click and ***Accept*** the inputs to complete the editing (Figure 29, left). Right click on the vector layer name to save the shapefile giving a proper name (Figure 29, right).

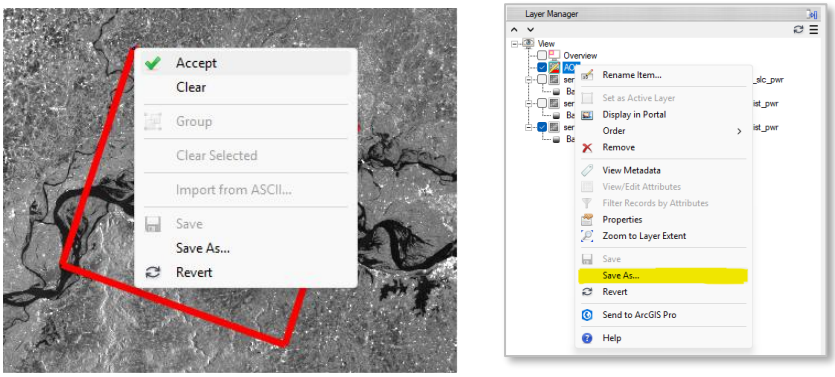

Figure 29. Creating a polygon (left) and saving the file (right)

Once the shapefile has been created, it can be used as an AOI extend for the Sample Selection tools.

- Open **SARscape ->** General Tools -> Sample Selection -> Sample selection SAR Geometry Data.
- Load the *_list files resulting from the entire Sentinel-1 data import (Figure 30).

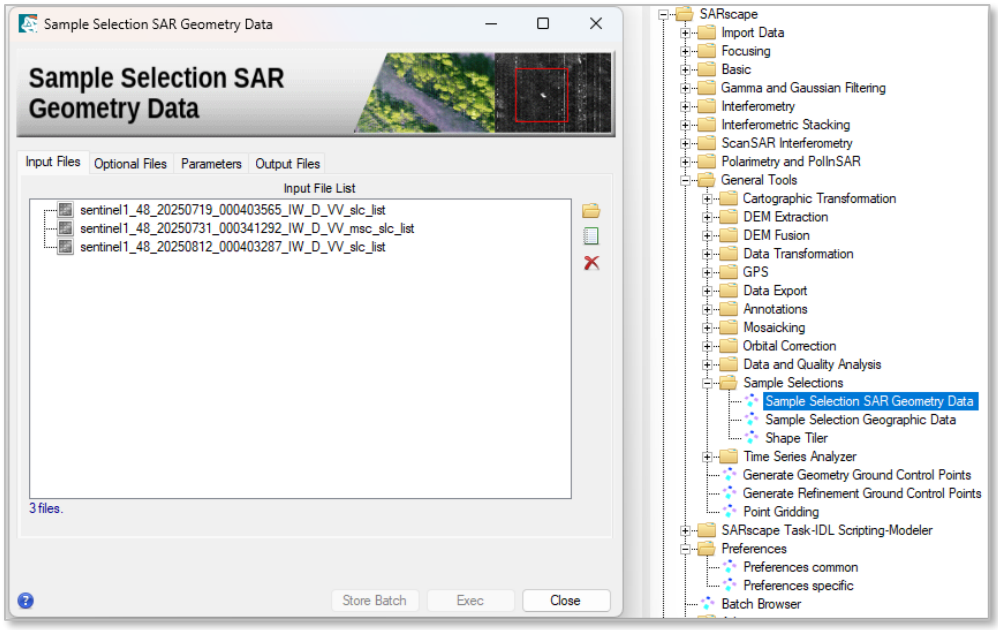

Figure 30. Sample Selection SAR Geometry Data tool and Import files

When the *Sample Selection* is performed on a stack of images using a shapefile in *SAR geometry*, the shapefile must be referred to the first image of the sampling stack. This image must be loaded in the relevant field of *Optional Fiels* tab (Figure 31).

Moreover, the **Principal Parameter Make Coregistration** must be set to **True** (Figure 32) when a set of images is sampled together.

- Load the newly created vector file in the field **Area of Interest** of the **Optional Files**.
- Load the first of the three imported images as an **Input Reference File** (Figure 31).

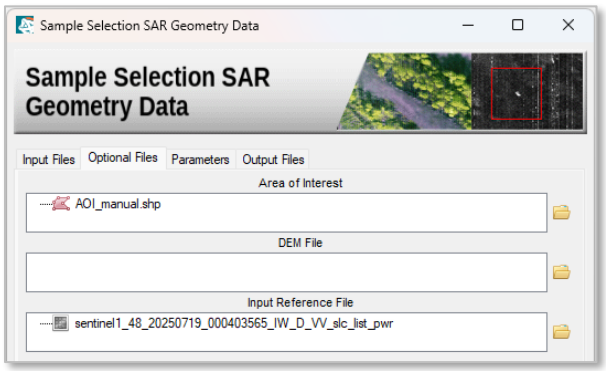

Figure 31. Optional Files for Sample Selection SAR Geometry Data tool

Since the shapefile was generated in slant geometry, the **Principle Parameter Geographical Region** must be set to **False** (Figure 32). In case the polygon is georeferenced (referred to an input DEM or Cartographic system) this flag must be set to *True*.

An AOI can be created also in Google Earth and saved in *kml format (e.g. the file from tutorial dataset AOI_Data_Preparation.kml). For this file the rules for a file in geographic coordinates apply.

Below the two set of settings, for an AOI in geographic and slant-range coordinates, are shown:

Optional files and parameters	Shapefile in geographic coordinates	Shapefile in slant-range coordinates
DEM file	Mandatory	Not needed
Reference file	Not needed	Mandatory (must be the PWR file used during the creation of the shapefile)
Make coregistration	False	True
Geographical region	True	False

Tip: When using a shapefile with approximate geographic coordinates setting to *True*, the *Use Min and Max coordinates* flag force the Sample Selection tool to uses a perfect rectangular shape that exploits the minimum and maximum coordinates of the previously draw shapefile.

Alternatively, the extend of interest can be defined by coordinates by setting the values for *West/First Column, North/First Row, East/Last Column, South/Last Row*. Switching between geographic and local SAR coordinates is manipulated by the flag for *Geographical Region* parameter (Figure 32).

In **Parameters** tab set **Make Coregistration** to **True**, **Geographical Region** to **False** (Figure 32).

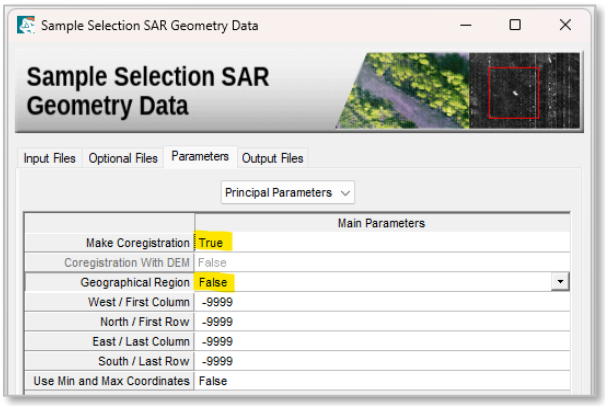

Figure 32. Principle Parameters for Sample Selection SAR Geometry Data tool

On Output File tab, click on the folder symbol to change the output directory – different from the one used in the Sentinel-1 data import (Figure 33).

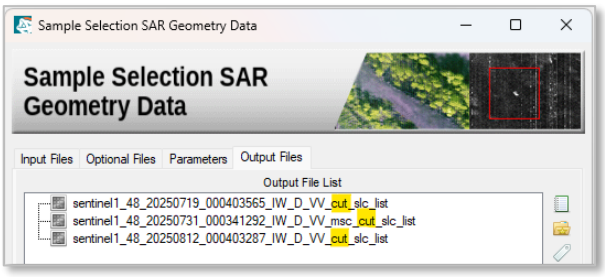

Figure 33. Sample Selection SAR Geometry Data tool – Output Files

Note: The suffix "_cut" is added in the output results filenames before the last suffix (Figure 33).

Click Exec. Once the processing has ended, the three cropped files are loaded in the ENVI view.

As a result, the previously imported entire Sentinel-1 images (Figure 34, left) are cropped to the selected AOI (Figure 34, right). The result is similar to the one achieved in section 6.3.4, Figure 23.

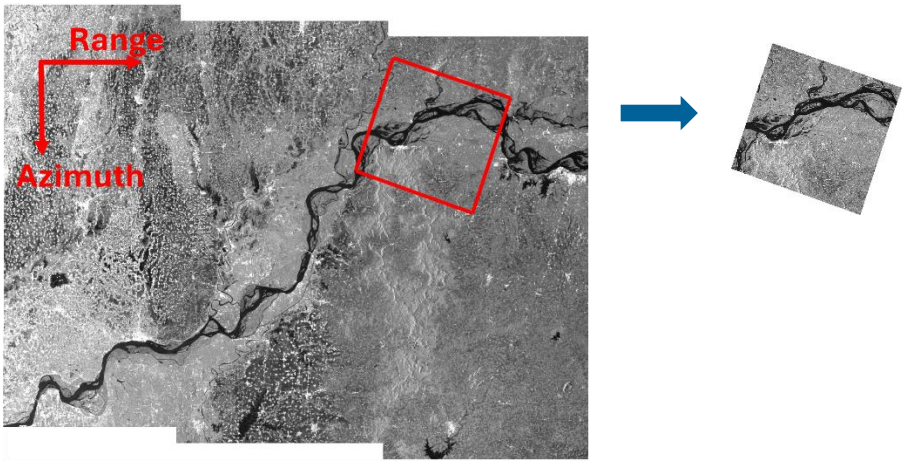

Figure 34. Sample Selection SAR Geometry Data tool – entire imported image to the left, together with the drawn shapefile of the AOI, result to the right. All in slant-range coordinates

6.5. DEM EXTRACTION AND IMPORT

For many processes, such as geocoding, coregistration, interferometric phase flattening, and the sample selection as mentioned above, an accurate reference Digital Elevation Model (DEM), containing heights above a reference ellipsoid is required. SARscape gives a possibility for automatic download from a list of available DEMs or to import external user DEM.

6.5.1. DEM extraction

SARscape contains a set of tools for downloading DEMs from defined repositories. The tools are grouped in the folder *DEM extraction* part of the *Import Data* module (Figure 35) but also is present in the *General Tools* module. If the web server is online and no firewall blocks the internet connection, SARscape allows the user to download and mosaic the tiles covering an area of interest. Whilst downloading a DEM, a local repository is created in the directories linked to the *SARscape Preferences common – Directories and batch file name* (Figure 3). If a directory is not set, the downloaded tiles will be stored temporarily in the SARscape working directory and deleted after cropping the tiles and merging the parts. Only the sampled DEM will be kept in the folder defined in the output.

Alternatively, the user can set the folders to store SRTM-3, DTED, ALOS World 3D 30m, TDM90, GLO30 DEMs. In case the internet connection is not stable the user can download the tiles in advance and store them in the associated folders. As for the orbit data, the software will search for the needed DEM first in these directories. In this way the DEM tiles also can be reused.

To define the area of interest for selecting and cropping a DEM there are two options within the downloading tools – by a reference slant range image in tab *Input Files* (Figure 35) or by coordinates in tab *Parameters*.

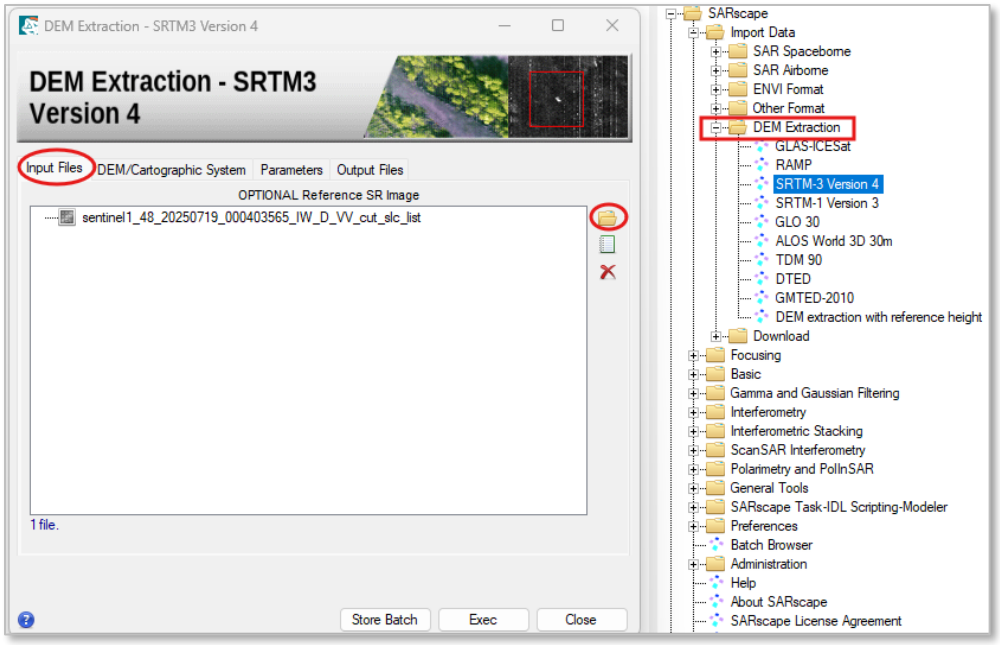

Figure 35. SRTM-3 Version 4 DEM extraction, Input Files tab and the available DEM extraction tools

- Open the **SRTM-3 Version 4** panel in *SARscape -> Import Data -> DEM extraction*.
- Insert the previously sampled image (***_slc_list**) from 19th July 2025 (or any of the previously cropped images) into the **Optional reference SR Image** field (Figure 35).

Note: If several images with different footprint and different geometries are loaded in the *Optional Reference SR* list, the tool will create a polygon around all of them and will download all needed tiles to cover this polygon.

Tip: A common DEM for all geometries (ascending and descending) and all sensors can be used in the processing.

- Keep the *Output Projection* in the *DEM/Cartographic System* tab by default to **Geographic WGS 1984**. Keep also the **Parameters** by default.

Note: Alternatively, the extend for the downloader can be defined by entering the coordinates at *Parameters* tab.

- In *Output Files* tab the filename for the downloaded DEM is given automatically as **Srtm-3_V4_dem**. Set the path for storing the DEM.
- Click **Exec**. Depending on your connection speed, the download can take up to several minutes. At the end of the processing the DEM is loaded in ENVI view in cartographic coordinates.

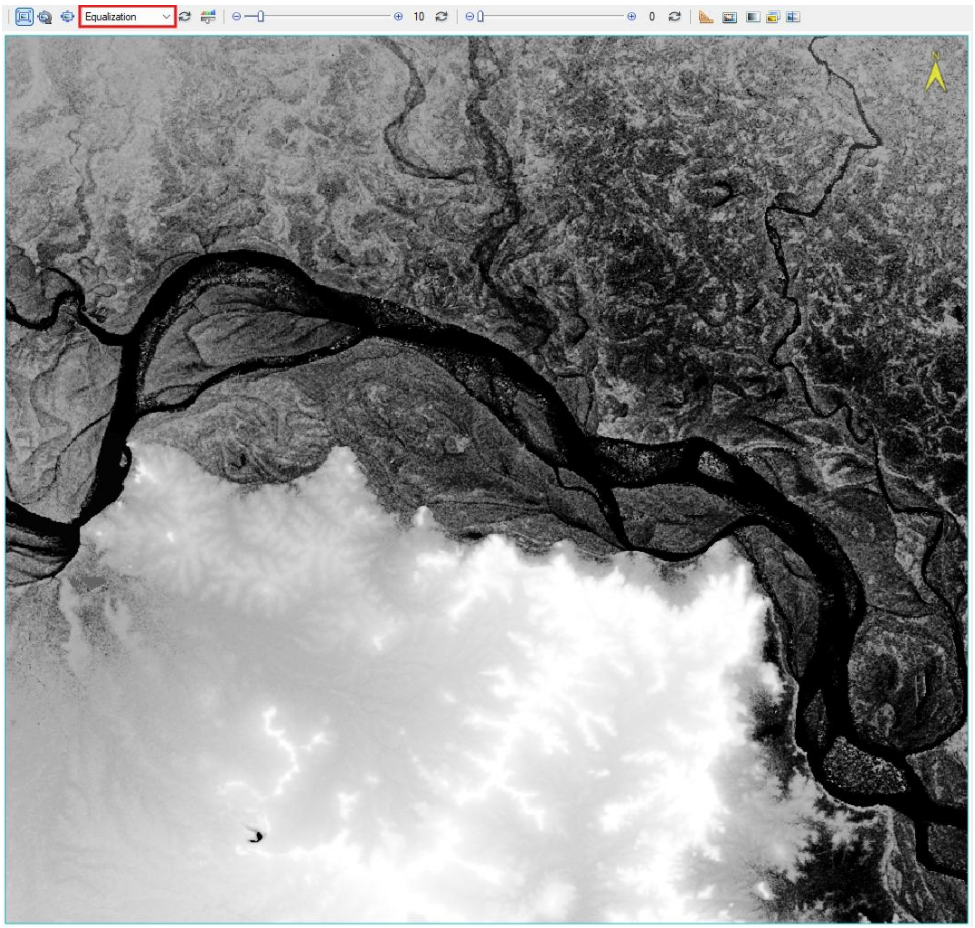

Figure 36. Downloaded SRTM-3 Version 4 DEM (in global coordinates) for the extend of the cropped data. Equalization stretch is applied (in the ENVI bar) to adjust pixel brightness

6.5.2. Import of an external DEM

An external DEM can be used in SARscape processing, but it must be referred to a reference ellipsoid (**DEM with ellipsoid heights**). For this purpose, the geoid component must be subtracted. SARscape provides a specific tool, namely *General Tools -> Cartographic Transformation -> Geoid Component*, which gives the possibility to subtract or to add a geoid height to a DEM. The available geoids are the WGS 84 Earth Gravitational Model 96 (EGM96), as well as the WGS 84 Earth Gravitational Model 2008 (EGM2008). The user can define alternative geoid by using the *User Geoids Management* tool located in the same toolbox.

Note: SRTM DEM is available only on land and between 60°N and 56°S of latitude and heights are above the EGM96 geoid. By default, the geoid component is subtracted during the DEM extraction, resulting in heights above the reference WGS-84 ellipsoid.

Depending on the imported user DEM the following tools can be applied:

- **TIFF format**: *Import Data -> Other Format -> Tiff* (choose the proper value for the *Data Units Parameter)*
- **ENVI Format**: *Import Data -> ENVI Format -> Original ENVI* (importing the DEM into ENVI first and saving it in ENVI format)
- **Original SARscape Format**: *Import Data -> ENVI Format -> Original SARscape*
- **Generic Binary format**: *Import Data -> Other Format -> Generic Binary -> Binary*.

7. BATCH PROCESSING

Each of the steps in this tutorial can be stored in batch file by clicking the **Store Batch** button in the corresponding processing window. In this way the user can perform checks, edit and run the entire or parts of the processing chain. The steps in the batch file which can be observed, modified and run through the *Batch Browser* are visible in Figure 37.

For more information of constructing a batch processing consult “Getting started” tutorial.

Keep in mind that new steps in the Batch file can be added only when the Batch Browser is closed.

Important: When the *Sentinel-1 Multidownload* (valid also for the other tools from this group) is run thought the Batch Browser it is important to set the parameter of the downloader *Wait for Completion* to *True*. Otherwise, the processing will be passed to the next step without waiting for downloading all requested images.

Note: In the case of *Sentienl-1 Multidownload* tool the output filenames are not known in advance so they cannot by directly loaded in the next step. The solutions are two – perform this step separately and then load the downloaded files in the file selector of the *Import* tool by their extension (*.zip) pointing to the download folder. Alternatively, create a file list manually once the file *download_found_list.txt* is created by the Sentinel-1 downloader. Note that the file list to be loaded in the *Import* tool must contain also the path to the files and the file extension (*.zip).

Important: When the sequence of steps is connected, as the output of one is the input for the next, it is recommended to uncheck the flag “*Ignore Errors and Continue Batch*”. Since the processes are depended on the previous one, if an error occurs at one step the process will stop before eventually passes corrupted results to the next step.

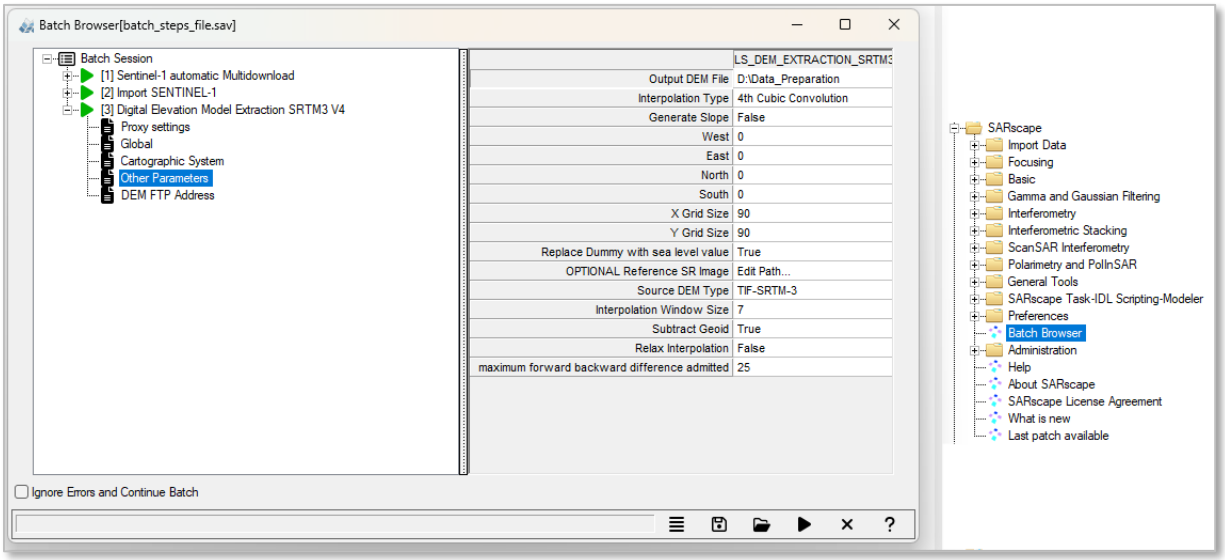

Figure 37. Batch Browser Content and location in SARscape Toolbox