SARscape's Basic module Tutorial

Version 5.7.0

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Index

Introduction

This document walks the reader through an example application of SARscape's Basic module . The reference software version used throughout the tutorial is SARscape version 5.3.0, running under ENVI 5.3.1 with a standard (GIS-like) interface, installed on Windows 7, 64bit. Sentinel-1A data are used as an example in the following, although the same steps apply to products from other sensors.

SARscape's Basic module contains basic SAR amplitude processing tools to extrapolate thematic information and perform temporal analysis of the evolution of the observed features.

In this tutorial, SARscape basic tools are explored with the help of examples. The goal is to extract features from a stack of geocoded filtered Sentinel-1 images starting from data download and going through all the required steps. In particular, this tutorial will go through all the main tools using data over Eastern Greece, affected by a flooding event in early 2015. In addition, two data types will be handled in this tutorial. The user can choose to use SLC or Ground Range data simply by reading the paragraphs that are color-coded (green for SLC and blue for Ground Range). Text in black is valid for both products. This processing can be done using the single panels as described in the first part of this tutorial or using the dedicated workflow as described in the second part.

Note: Before starting with this tutorial, please read the "SARscape Quick Start" chapter of the "Getting Started" tutorial, which can be found here: http://sarmap.ch/tutorials/tutorials.html.

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

This tutorial will use Sentinel data. How to download these data from Internet will be described. If this is not possible please use the data contained in the "Basic" folder on our FTP (ftp.sarmap.ch) and choose SLC or GR data. Please contact us at support@sarmap.ch to get login credentials.

This tutorial contains Copernicus Sentinel data [2015] and modified Copernicus Sentinel data [2015]. The Sentinel satellites are owned by the European Union, there are part of the Copernicus program. They have been developed and are operated by ESA (100% of the operations funding comes from the EU).

Data download and preparation

Data Download

Sentinel-1 data can be downloaded using the tool presented in the *Getting Started* tutorial that can be downloaded from: http://sarmap.ch/tutorials/tutorials.html. Please expand the time interval in order to get more images.

Note: If you are unable to download the files or you do not have an internet access when performing of this tutorial, please download the data in advance from our FTP site where you will find the acquisition used in this tutorial. Please contact us at support@sarmap.ch to get login credentials.

✍ Open the Sentinel MultiDownload panel found in data import in the toolbox.

✍ Inert a reference SAR image in the Input Files panel or upload an AOI in the Optional Files panel. Fill in the fields in the parameters tab as shown in Figure 1 for SLC and Figure 2 for GR. **Please note:** You receive a username and password after registering at the Sentinels Scientific Data Hub https://scihub.copernicus.eu/dhus/
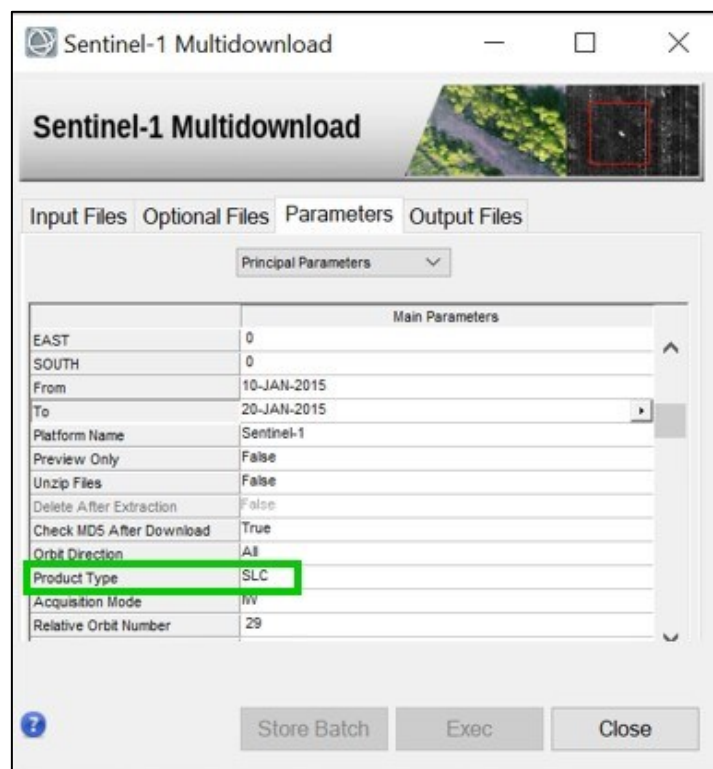

Figure 1: Principal Parameters for download of a stack of Sentinel IW SLC Data acquired over Eastern Greece from the 10th of January 2015 to 20th April 2015. The relative orbit number is 29.
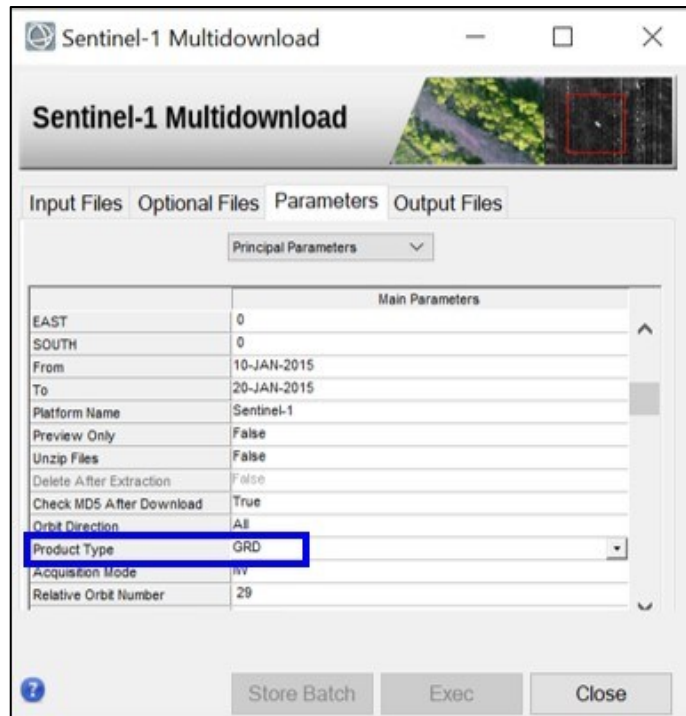
Figure 2: Principal Parameters for download of a stack of Sentinel IW GR Data acquired over Eastern Greece from the 10th of January 2015 to 20th April 2015. The relative orbit number is 29.

✍ Choose a convenient output directory for the progress file. The downloaded data will be saved in the same directory. **Please note:** make sure you have enough available free disk space in this folder. SLC dataset needs 65 GB, GR dataset needs 14 GB of space. Space needed for zip extraction and processing is not taken into account.

✍ Click Exec. The following window should appear (Figure 3). Please wait for the download to complete before continuing with the tutorial. During this time it is possible to use ENVI or SARscape and it is even possible to close ENVI. The window of Figure 3 will remain open.
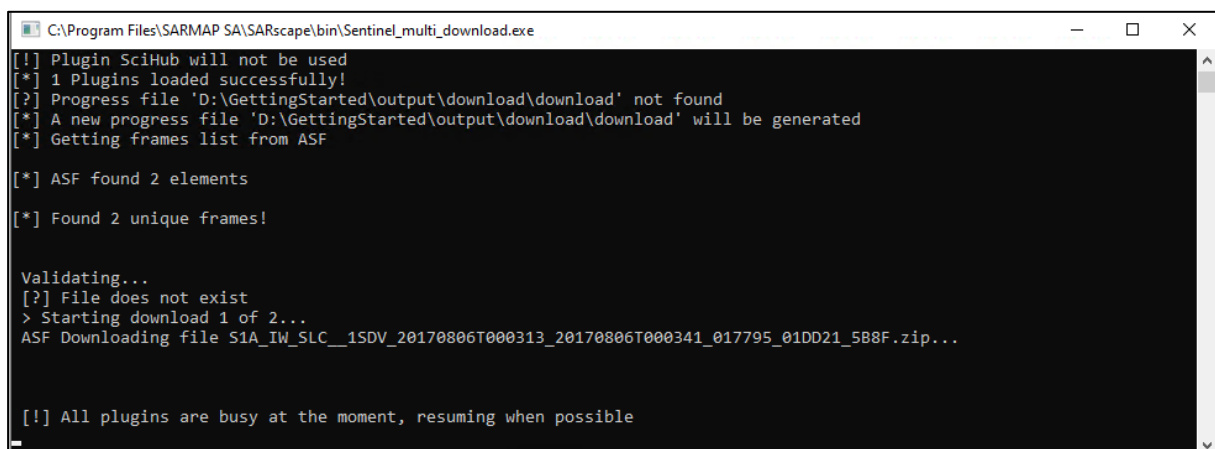

Figure 3: Download page for the files found by the Download Tool.

Setting Preferences

Before starting with the tutorial, it is advisable to set the correct SARscape and ENVI preferences as described in the "Getting Started" tutorial.

✎   Set ENVI and SARscape preferences as described in the "Getting Started" tutorial.

✎   In case of Sentinel-1 IW SLC data, please set the preferences to SENTINEL TOPSAR (Figure 4). There is no need to change the grid size as it is automatically changed to 15m.

✎   In case of GR data use the General parameters (Figure 5) and set the cartographic grid size to 15m (Figure 6).
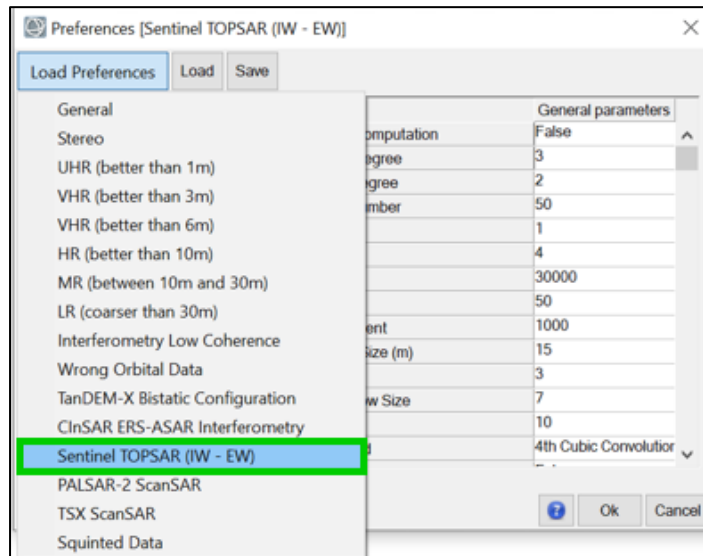

Figure 4: Load SENTINEL TOPSAR preferences before starting to work with Sentinel IW SLC data.
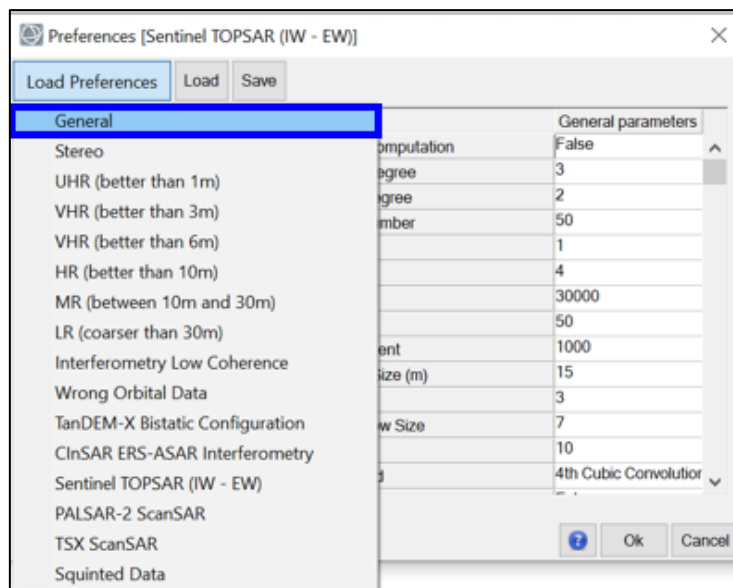

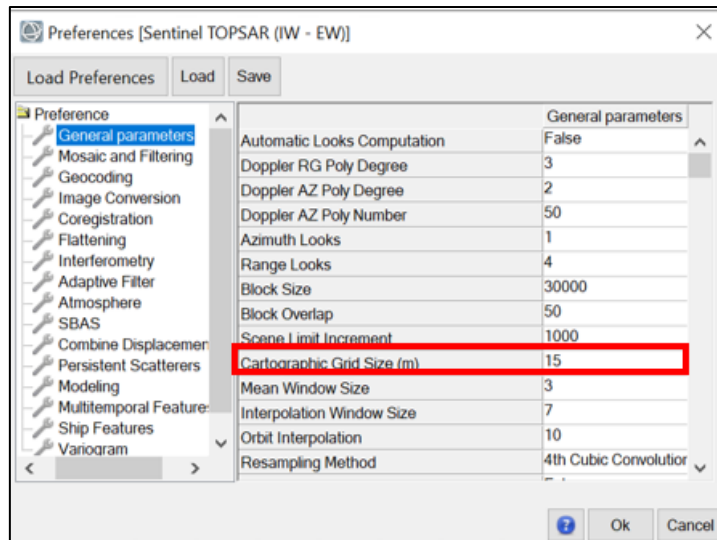Figure 5: Load General preferences before starting to work with Sentinel GR data.

Figure 6: Change the Cartographic Grid Size to 15m in the General parameters tab.

Data Import

As described in the Data Import chapter of the Getting Started tutorial, the purpose of the Data Import is to convert the data into SARscape's Data Format, generating the .sml and .hdr parameter files. In particular, during this step, we will import only the Co-polar polarization channel (VV for this dataset) and automatically rename the filename of the imported files using the provided metadata. For SLC files, a multi-looked _pwr image of the imported slc is automatically created if "Make Power QL" is set to True.

Note: In case of a considerable amount of data, it is possible to prevent the automatic loading of the imported files into ENVI (Figure 7). This will reduce the waiting time once the import processing has ended, but you will have to open the resulting images manually in order to check the results. The step described in this note is optional.
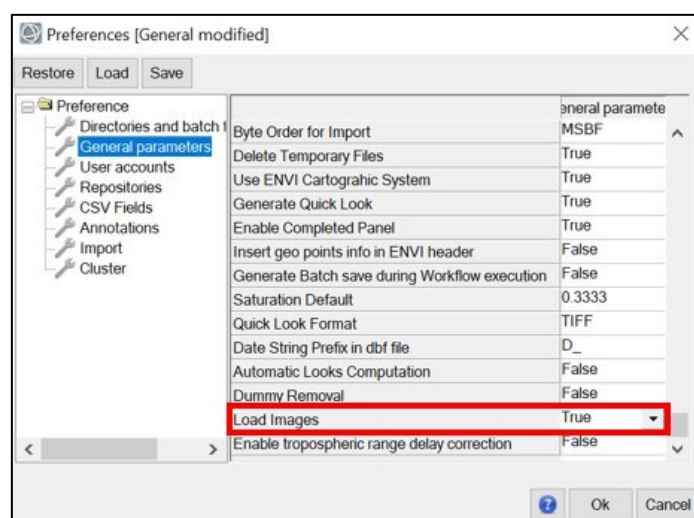

Figure 7: General parameters tab in SARscape Preferences panel. Set the "Display Output(s)" flag to FALSE if you do not want to open your output files in ENVI automatically after each process.

✎ Open the Import Sentinel panel found in "*Import Data*" → "*SAR Spaceborne*" → "*Single Sensor*" → "*Sentinel 1*". In SARscape folder found in ENVI's toolbox.

✎ SARscape allows to import the zipped file directly, therefore select the zipped folders as shown in Figure 8. Set "Rename the File Using Parameters" to TRUE. This will rename the output file name using the sensor name, the track number, the date and time of the acquisition and the polarization. **Note:** It is also possible to right click in the Input File List, choose "Add Folder" and select the directory containing all the unzipped files. All the manifest.safe files present in this directory (and sub-directories) will be inserted in the Input File List.

✎ Please also set the "Polarization" to "VV HH Only", this will let the software import only the co-polarized data (Figure 9).

Note: Setting the polarization flag to ALL will let the software import all available polarization channels (VV and VH in this case). If you want to use both polarizations, please remember to set the "Dual Pol" flag in the Filtering step.
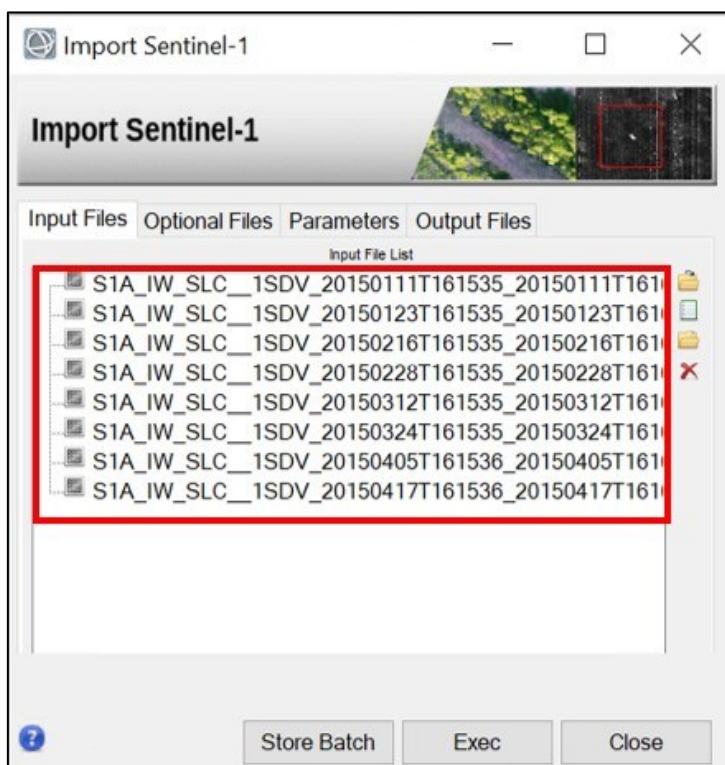

Figure 8: Sentinel-1 import panel showing the Input Files tab. The .zip folders are used as Input File for Sentinel Data whereas the Orbit Files are optional and are not required in this example.
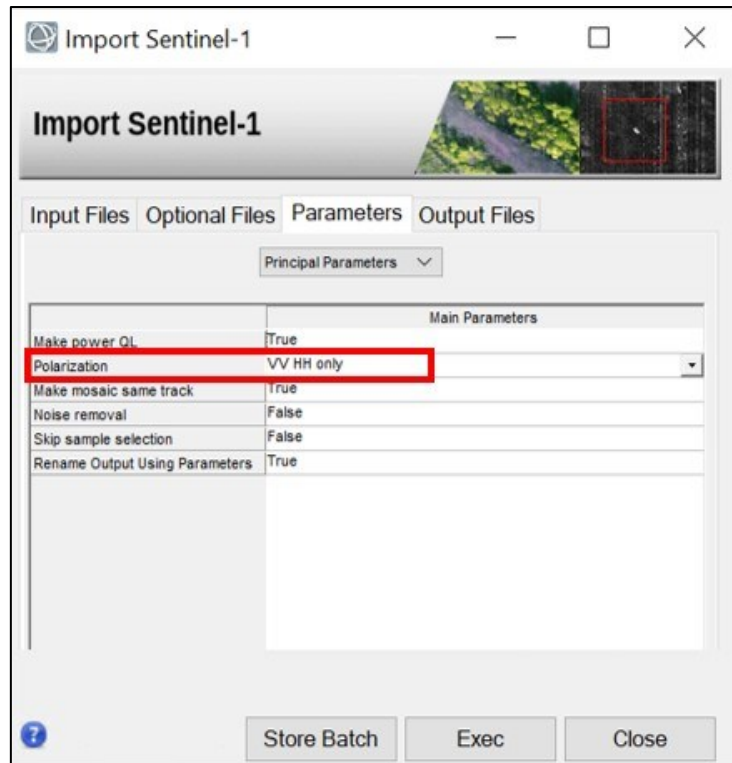
Figure 9: Principal parameters Tab of the Import Sentinel-1 panel. "Polarization" has to be set to "VV HH Only" in order to import only copolarization data (VV for this dataset).

✎ Make sure that in the Other Parameters "Make Power QL" is set to True (Figure 10). This will automatically create a multi-looked power image (_pwr) of the imported slc. Right click on the Output File List and change the output directory to a convenient one.

✎ Click Exec. Once the import has ended, in the output folder you will find 8 _slc_list files, 8 _pwr images and 8 folders, containing the _slc burst. The 8 _pwr are automatically loaded in ENVI's view (Figure 11).

✎ Click Exec. Once the import has ended, in the output folder you will find 8 _gr file (each one with his .hdr and .sml files), these files are automatically loaded in ENVI's view (Figure 12).
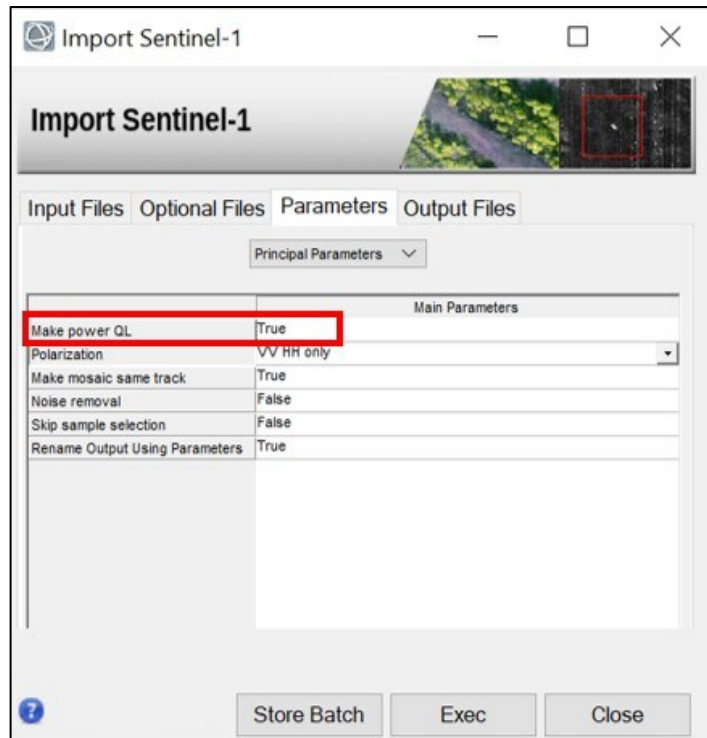
Figure 10: Principal Parameters Tab of the Import Sentinel-1 panel. Please make sure *"Make power QL"* is set to True.
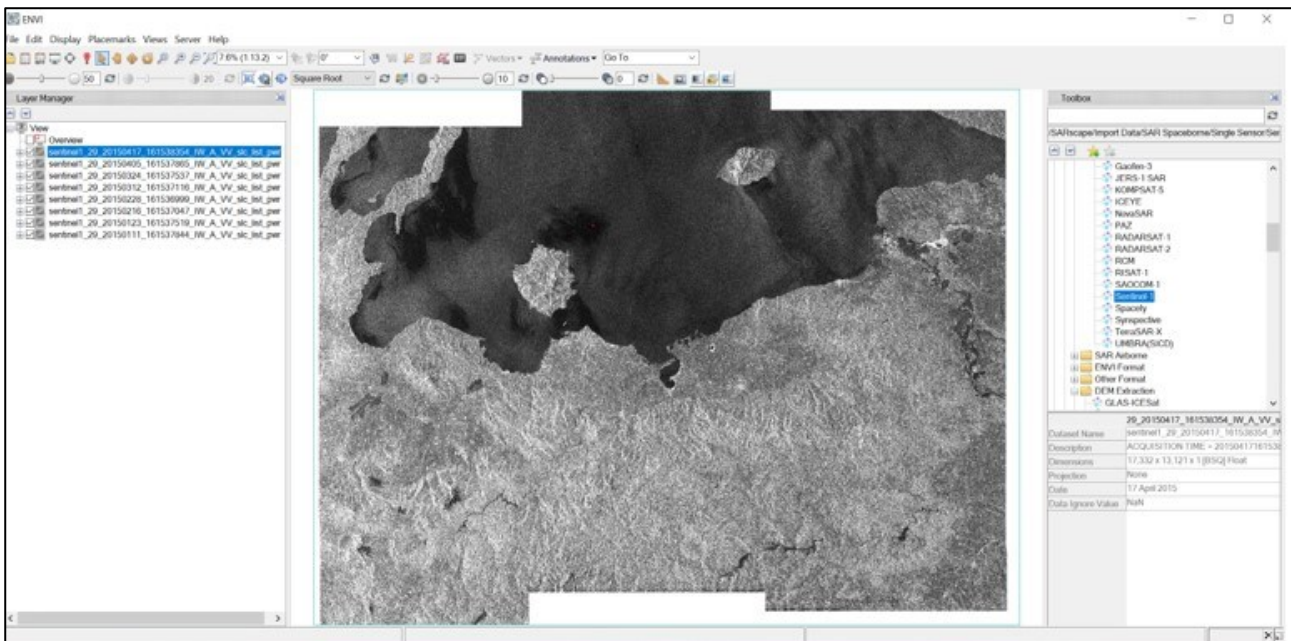

Figure 11: Multi-looked SLC (_pwr) data loaded in ENVI after the import. Note how the filename is automatically written using the information stored in the parameters (sensor, orbit, time, polarization).
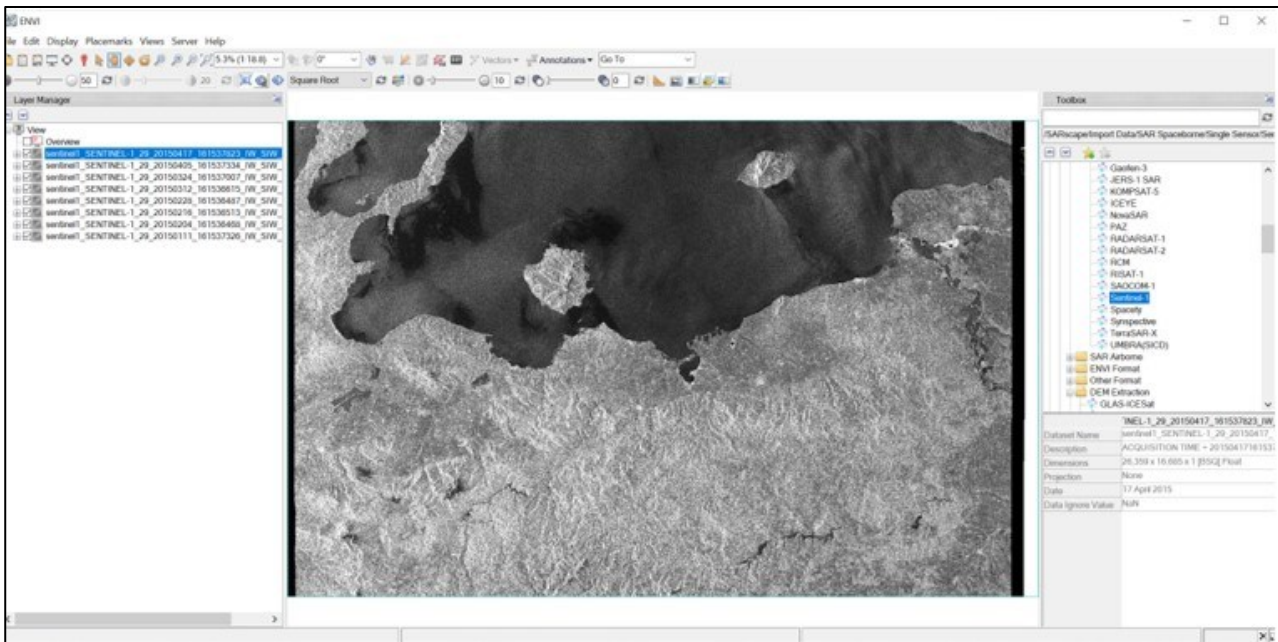
Figure 12: Ground Range data loaded in ENVI after the import. Note how the filename is automatically written using the information stored in the parameters (sensor, orbit, time, polarization).

Sample Selection

The Sample Selection is a SARscape tool that allows to crop an image (or a stack of images), reducing the file size and processing time of subsequent analyses. More details can be found in the "*Getting Started Tutorial*" in chapter "Sample Selection". Here the "Sample Selection SAR Geometry Data" tool will be used.

    ✑   Open a multilooked image (in our example the file named sentinel1_29_20150111_161537844_IW_SIW1_A_VV_slc_list_pwr) created in the previous step in the ENVI View. Create a shapefile at the bottom-left corner (Figure 13) as described in the Sample Selection Chapter of the "*Getting Started*" tutorial. The shape will not be perfectly rectangular. This can be solved using the "*Use Min and Max coordinates*" flag in the parameters (Figure 15 bottom-left).

    ✑   Open a Ground Range image (in our example the file named sentinel1_29_20150111_161537326_IW_SIW_A_VV_gr image) created in the previous step in the ENVI View. Create a shapefile at the bottom-left corner (Figure 14) as described in the Sample Selection Chapter of the "*Getting Started*" tutorial. The shape will not be perfectly rectangular. This can be solved using the "*Use Min and Max coordinates*" flag in the parameters (Figure 16 bottom-left).

Note: It is **not** possible to use the same shapefile to cut _slc_list files and _gr files because they have different image coordinates. The same shapefile can be used if it is created in geographic coordinates (for instance, using a geocoded image as reference). In this case, for more accurate results, it is suggested to specify a DEM among the Sample Selection optional files.

Tip: Setting "Make coregistration" to TRUE, will reduce the risk of wrongly located cuts, which can appear in case of shifted acquisition frames. This is however only a rough coregistration and does not replace the coregistration step described in the dedicated chapter.
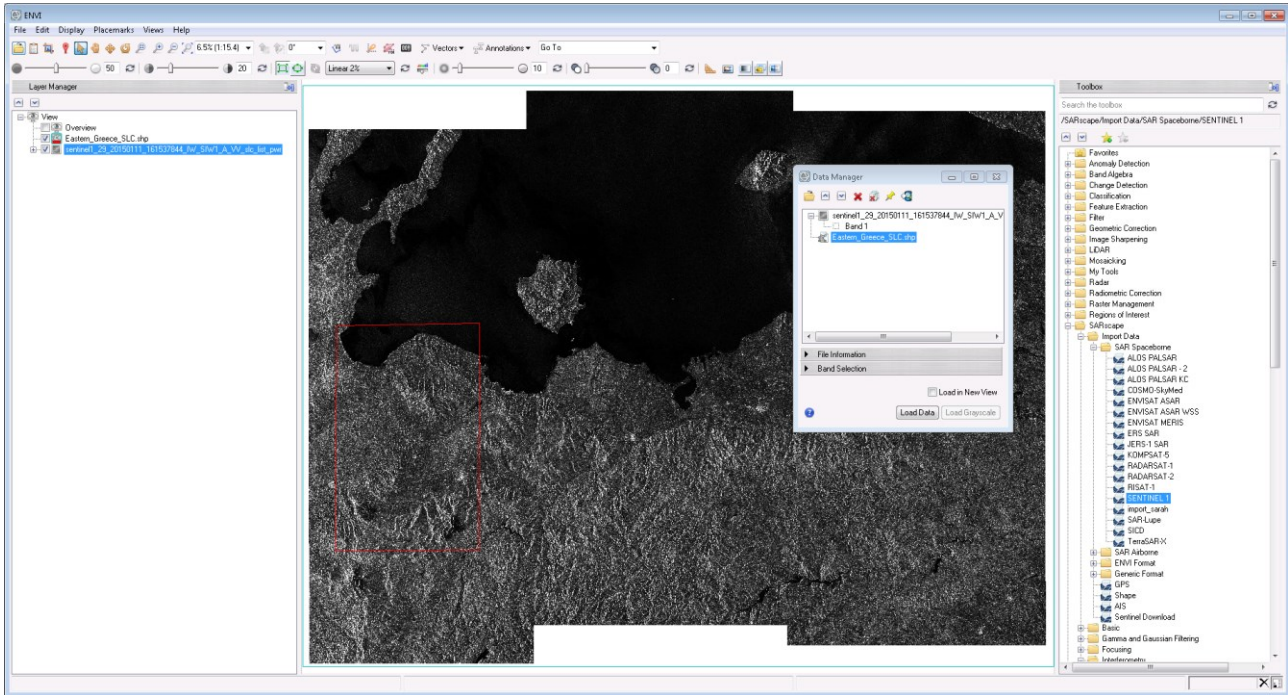

Figure 13: Polygon draw on sentinel1_29_20150111_161537844_IW_SIW1_A_VV_slc_list_pwr image. This is the area of interest that will be used to cut SLC images.
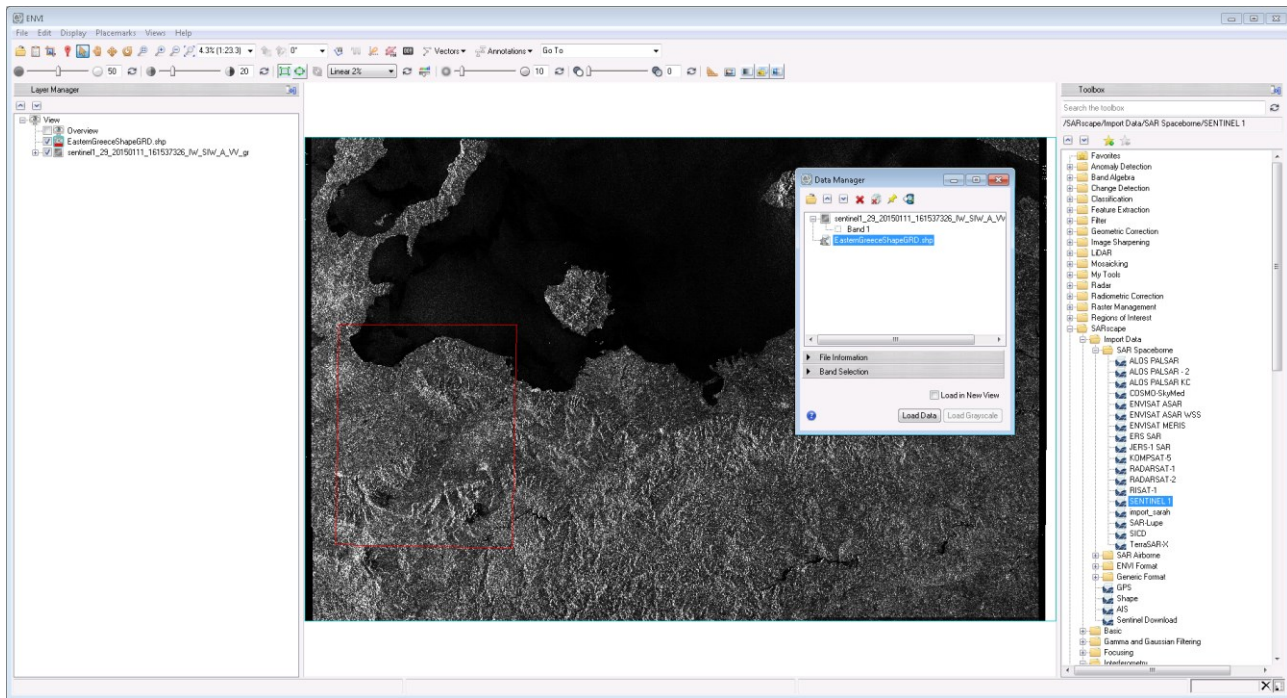
Figure 14: Polygon draw on sentinel1_29_20150111_161537326_IW_SIW_A_VV_gr image. This is the area of interest that will be used to cut GR images.

✎ Once the shapefile has been correctly created, the Sample Selection for SAR geometry data can be opened. It is located in "General Tools" → "Sample selections" → Sample Selection SAR Geometry data. For an SLC image insert all the _slc_list files in the input file list (Figure 15 top-left), insert the shape file in the vector file field and the _pwr image used as reference in the sample selection in the Input Reference File field (Figure 15 top-right), select "Geographical region" to false and "Use Min and Max coordinates" to true in the parameters tab (Figure 15 bottom-left) and select a convenient path for the outputs (Figure 15 bottom-right). For a GR image insert all the _gr files in the input file list (Figure 16 top-left), insert the shape file in the vector file field (Figure 16 top-right) no reference file is needed as the shapefile was drawn directly on _gr data, select "Geographical region" to false and "Use Min and Max coordinates" in the parameters tab (Figure 16 bottom-left) and select a convenient path for the outputs (Figure 16 bottom-right).

✎ "Geographical Region" must be set to False as the shape was drawn in slant geometry and the "Use Min and Max coordinates" flag has to be set to True so that the sample selection will then use a perfect rectangular shape that exploits the min and max coordinates of the previously draw shapefile. **Note:** the suffix "_cut" will automatically be added before the last extension name.

✎ Click Exec. Once the processing has ended, the resampled files are shown in ENVI view (Figure 17 for SLC and Figure 18 for GR). Please check that the files are correctly cut.
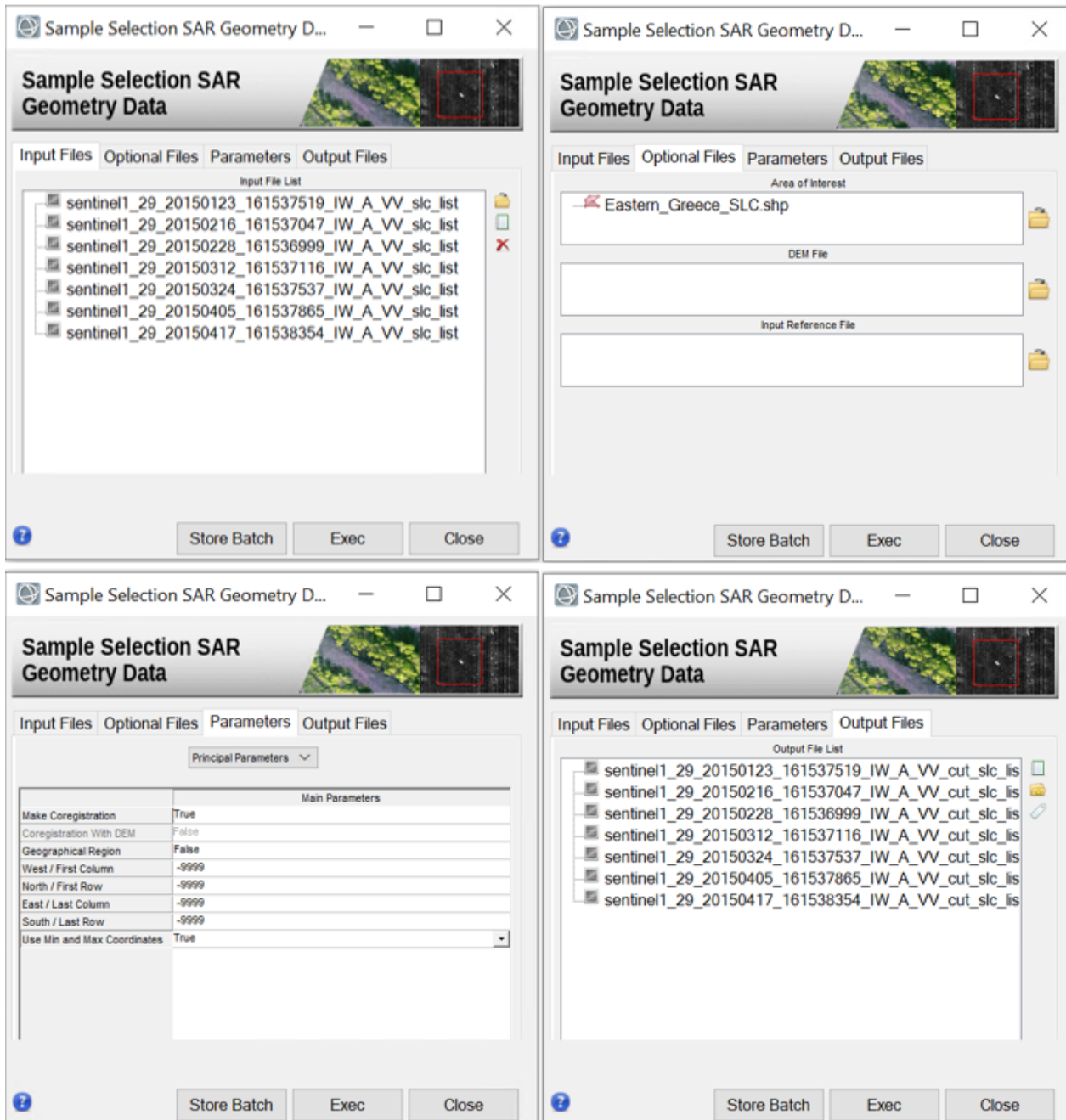
Figure 15: Sample Selection SAR geometry Data panel. Top left: Input file list, insert here all the _slc_list files (not the _pwr). Top right: optional files tab, here the previously created shape file has to be entered as well as the _pwr image used as a reference for drawing the shapefile. Bottom left: Parameters tab, set "Geographical region to False" (as the shapefile was drawn on an image in SAR geometry) and set "Use Min and Max Coordinates" to True. Bottom right, output file list.
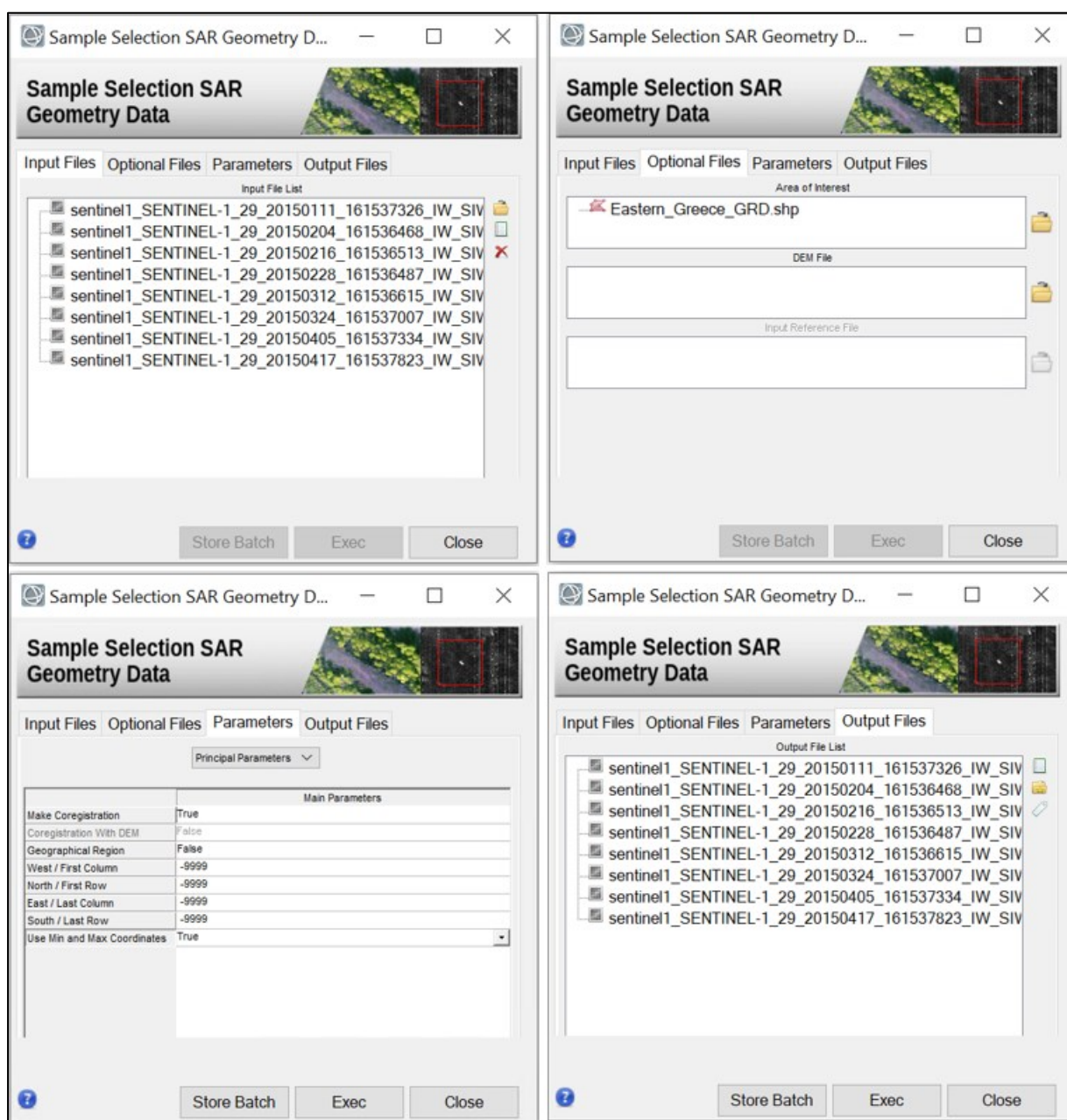
Figure 16: Sample Selection SAR geometry Data panel. Top left: Input file list. Top right: optional files tab, here the previously created shape file has to be entered. No reference file is needed as the shape file was drawn directly on the ground range images. Bottom left: Parameters tab, set "Geographical region to False" (as the shapefile was drawn on an image in SAR geometry) and set "Use Min and Max Coordinates" to True. Bottom right, output file list.
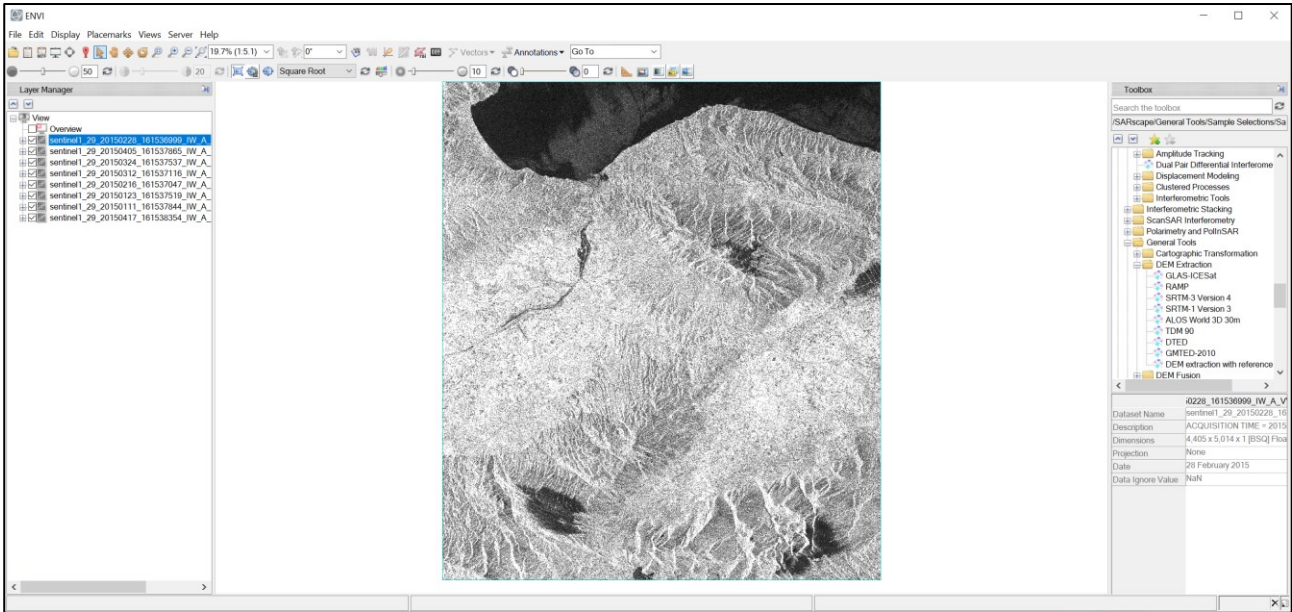
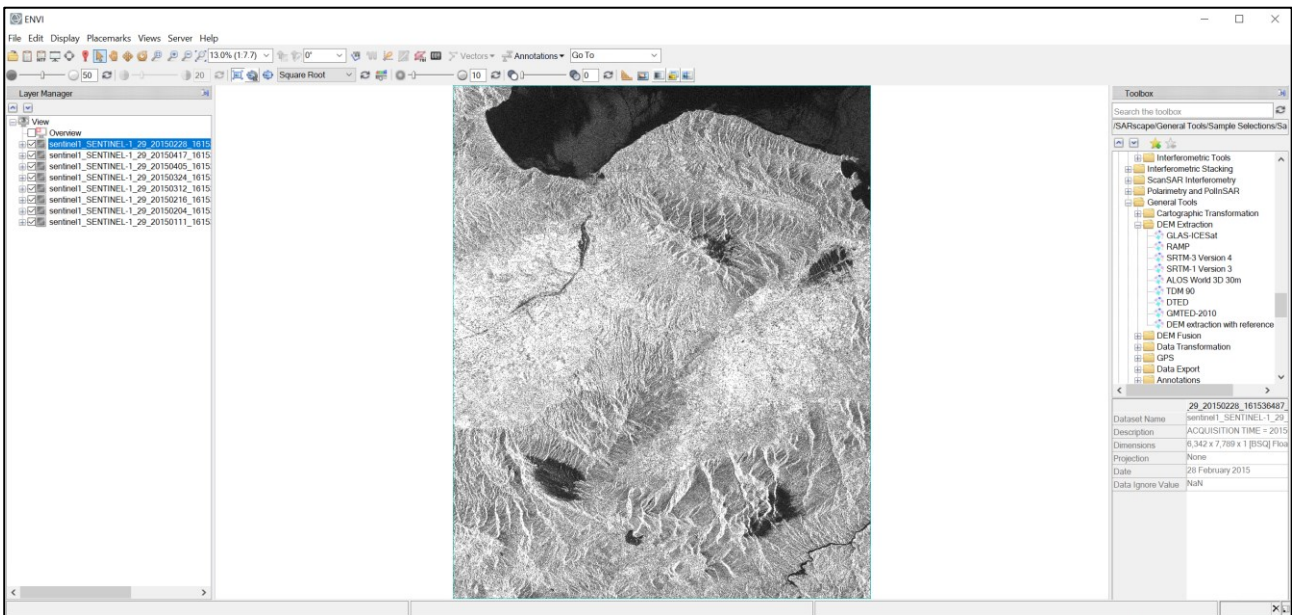Figure 17: Resampled _slc_list_pwr images opened in ENVI view after the Sample Selection processing has ended.

Figure 18: Resampled _gr images opened in ENVI view after the Sample Selection processing has ended.

Single Panels processing

This chapter shows the main tools of the SARscape Basic module performed step by step using the panels present in the toolbox.

Coregistration

Coregistration is required when multiple images cover the same region and a time-series of pixel values needs to be analyzed (e.g. for multi-temporal speckle filtering) or two images need to be compared, e.g. through, image ratio or similar operations. Coregistration is simply the process of resampling an image in slant- or ground-range coordinates to a reference acquisition geometry, also in slant- or ground-range coordinates. This process must not to be confused with geocoding, which is the process of resampling each pixel from slant- or ground-range coordinates to a cartographic reference system.

Note: If no DEM is inserted in the optional files, the coregistration with DEM will be discarded.

✎   Open the Coregistration panel, found in "*Basic*" → "*Intensity Processing*" → "*Coregistration*" and insert the _cut_pwr of the previously cut _slc_list (Figure 19 left) or the previously cut _cut_gr (Figure 20 left) in the "*Input File List*". Insert the first one as Reference File. The remaining images will be coregistered to (i.e. resampled to the geometry of) the first one.

✎   Choose a convenient output folder for the output files and click Exec (Figure 19 and Figure 20 right). There is no need to add optional files or to change the parameters.
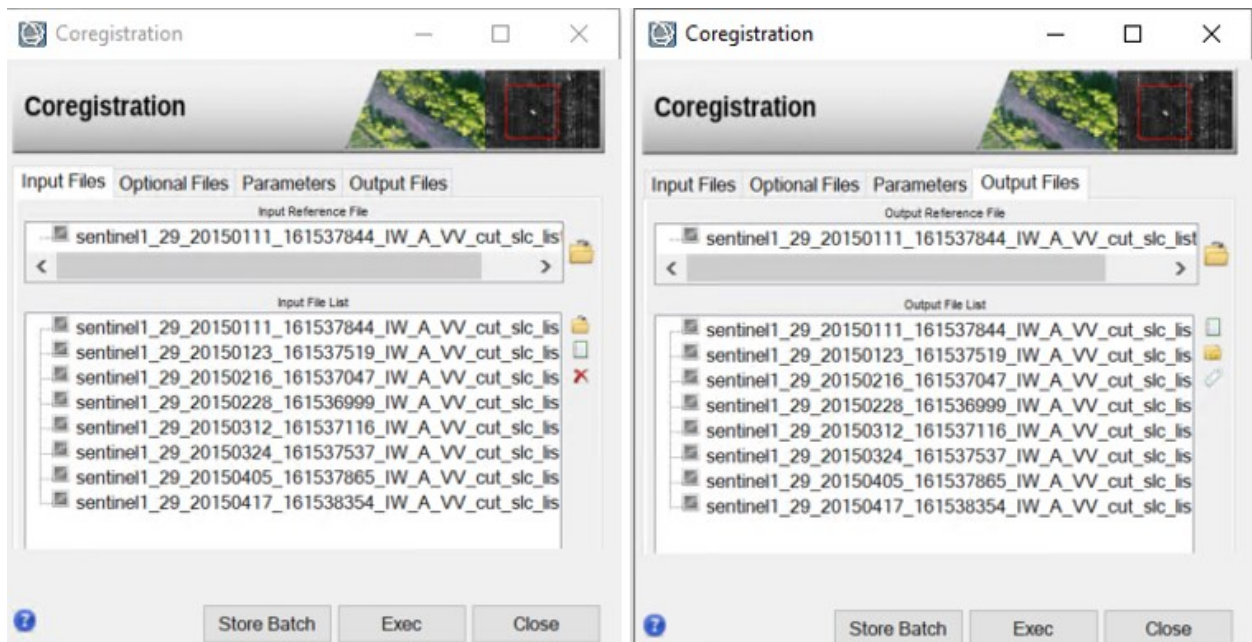

Figure 19: Coregistration Panel. Use the first image as a reference, the others will be coregistered to this reference image.
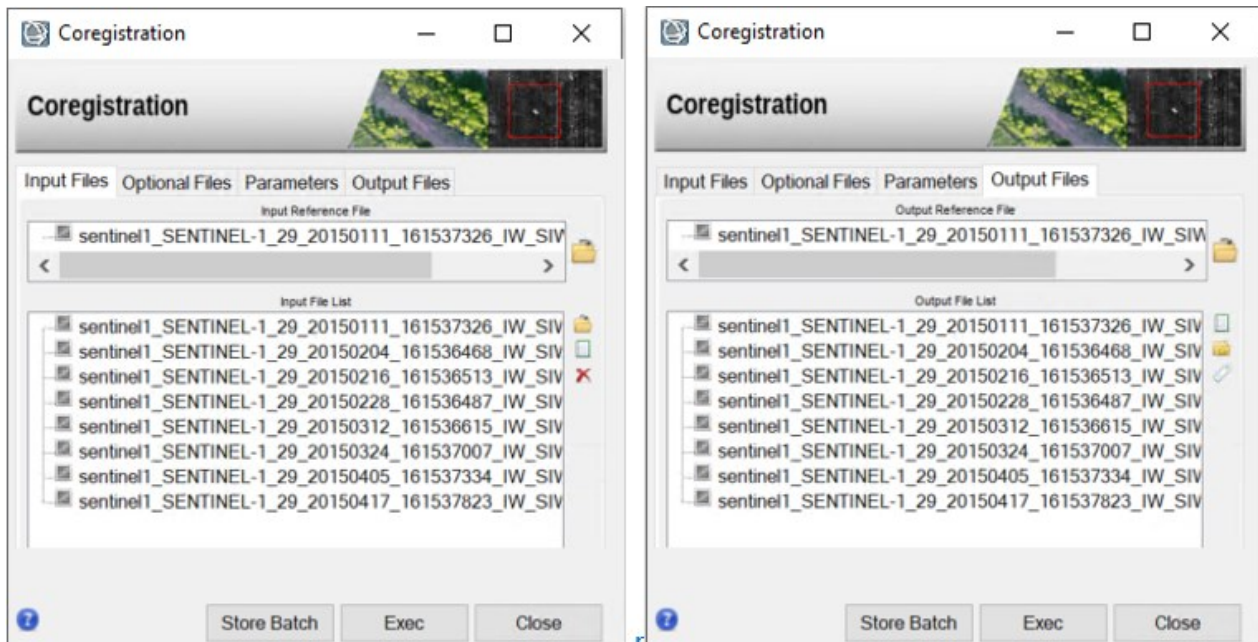
Figure 20: Coregistration Panel. Use the first image as a reference, the others will be coregistered to this reference image.

Filtering

Images obtained from coherent sensors such as SAR (or Laser) systems are characterized by speckle. This is a spatially random multiplicative noise due to coherent superposition of multiple backscatter sources within a SAR resolution element. In other words, speckle is a statistical fluctuation associated with the radar reflectivity of each pixel in a scene. A first step to reduce the speckle - at the expense of spatial resolution - is the so called multi-looking step, where range and/or azimuth resolution cells are averaged.

In our example, the De Grandi Spatio Temporal filtering will be used. It has to be pointed out that this multi-temporal filtering is based on the assumption that the same resolution element on the ground is illuminated by the radar beam in the same way, and corresponds to the same co-ordinates in the image plane in all images of the time series. The reflectivity can of course change from one time to the next due to a change in the dielectric and geometrical properties of the elementary scatters, but should not change due to a different position of the resolution element with respect to the radar. Therefore it is mandatory to co-register the SAR images in the time series to a common reference acquisition, before performing this kind of filtering. Input data must be in radar geometry; geocoded (_geo) data are not admitted.

The filter works in a combined time-space domain. Each element in homogeneous areas with developed speckle is averaged with corresponding uncorrelated elements in the time-series. The mean values of the probability distribution function of each instance in the averaged series is adjusted to keep track of changes in reflectivity. The adjustment is performed in space by estimation in a diagonal wavelet basis of the local mean backscatter values in each data set. Since the wavelet based estimator preserves structures in the image (such as edges and point targets), these structures (and changes thereof) are also preserved (and denoised) by the time domain averaging (Figure 24).

In the DualPol case, the number of channels used in the LMMSE filtering will be doubled with respect to the Single Pol version since both polarizations for each date will be used.

Note: It is suggested to always work with only one polarization type at once. It is however still possible to perform DualPol De Grandi filtering: the order of the files should be "co-pol" followed by "cross-pol" and the Data Type has to be set to "Dual pol".
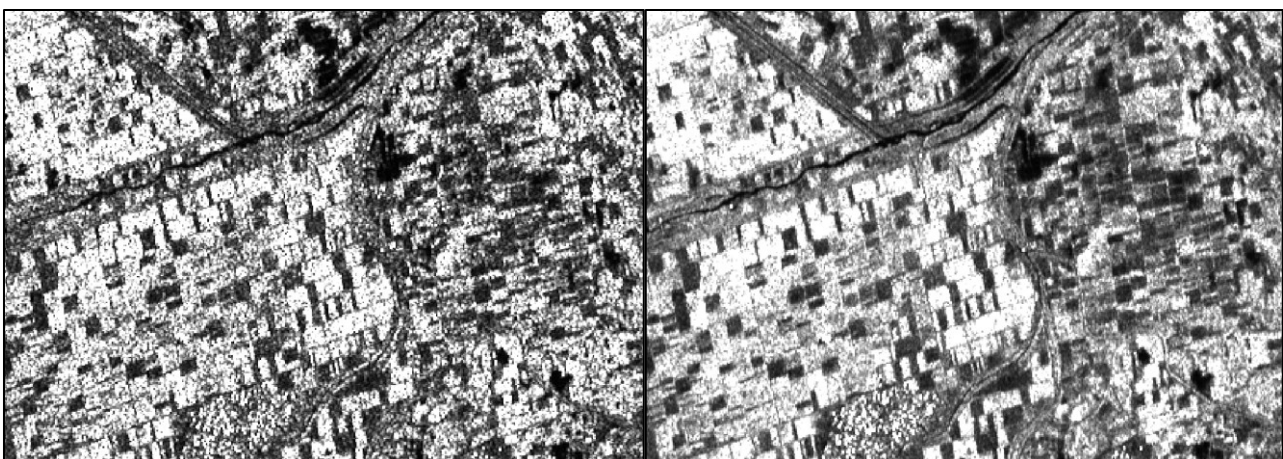

Figure 21: Unfiltered intensity image (left) and filtered intensity image (right) using the De Grandi filter. Note how the filtered image is less noisy but preserves (and enhance) the linear features

✎ Open the De Grandi Spatio Temporal Filtering panel, found in "*Basic*" → "*Intensity Processing*" → "*Filtering*" → "*De Grandi Spatio Temporal* Filtering" and insert the previously coregistered _rsp data (_cut_pwr_rsp or _cut_gr_rsp) in the "*Input File List*". (Figure 22 for data coming from SLC and Figure 24 for data coming from GR). **Note:** Use only VV polarized data.

✎ Leave all the preferences as default. Choose a convenient output folder and click Exec. The filtered results will be loaded automatically when the process ends (Figure 24 or Figure 25).
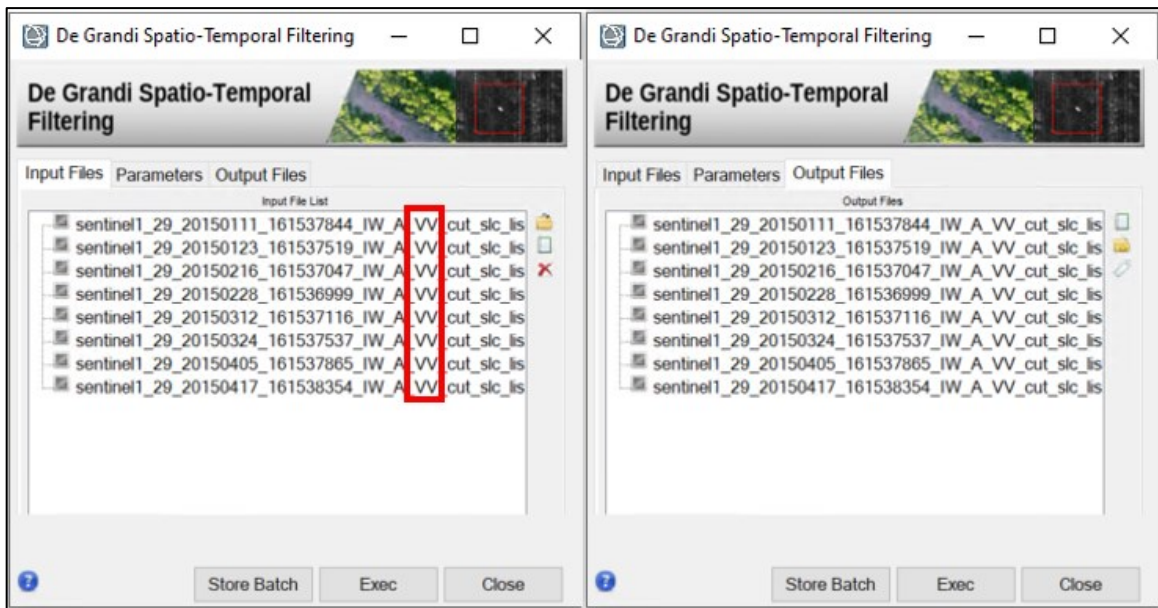
Figure 22: Input files for De Grandi Spatio-Temporal Filter for data coming from IW SLC data. VV polarization is used for this tutorial.
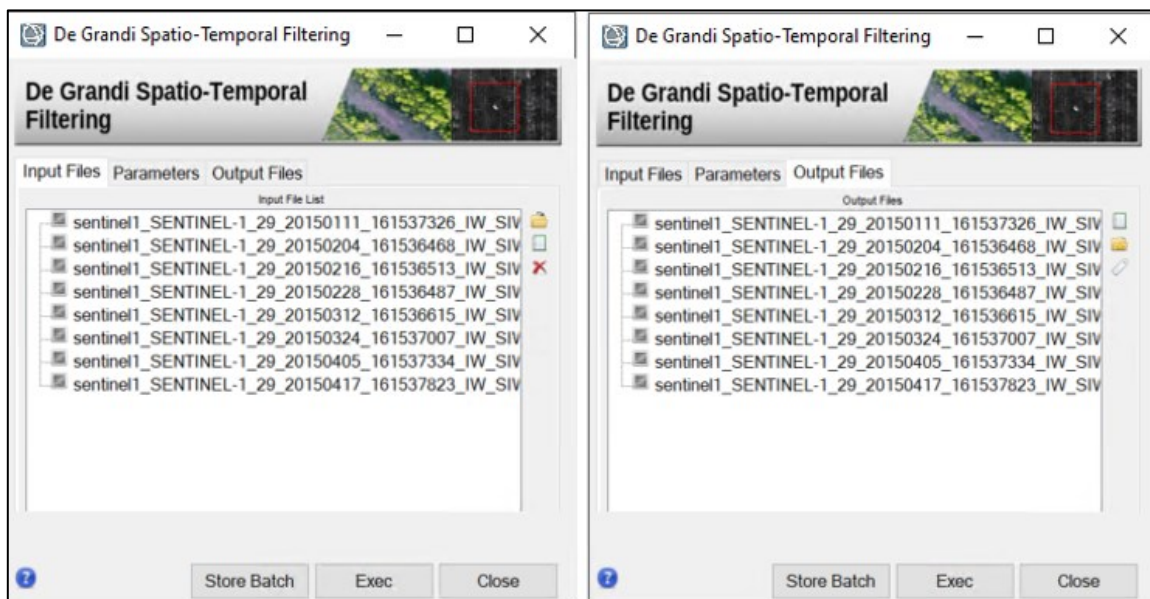
Figure 23: Input files for De Grandi Spatio-Temporal Filter for Ground-Range data. VV polarization is used for this tutorial.
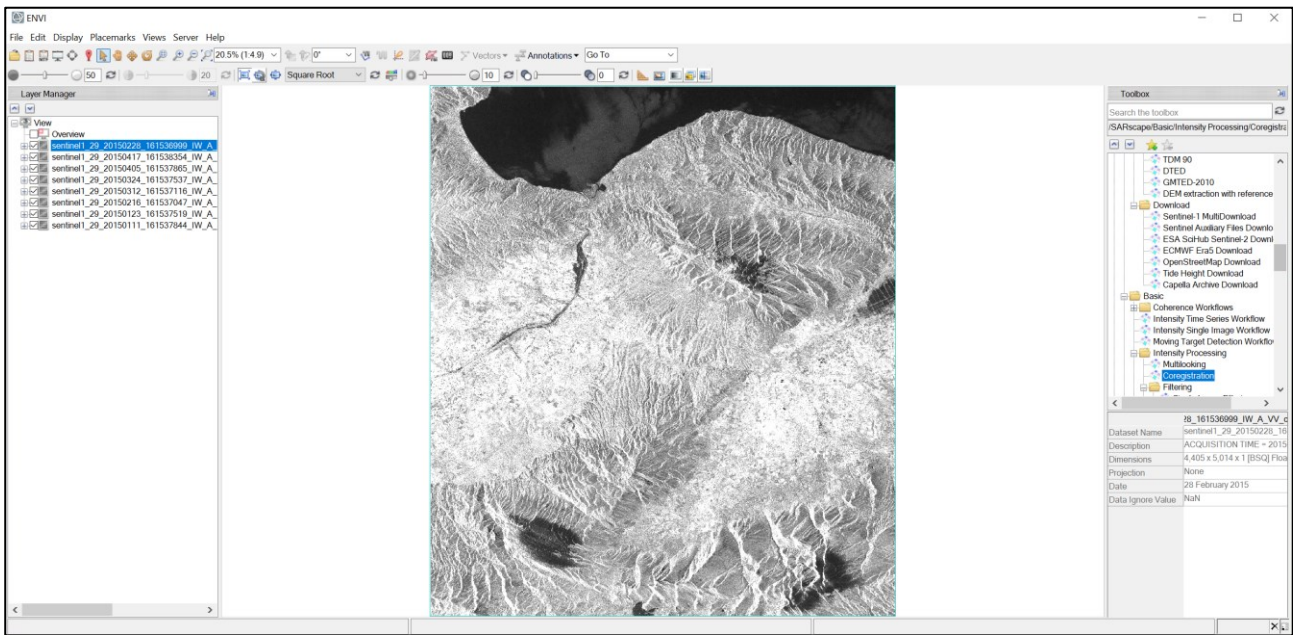
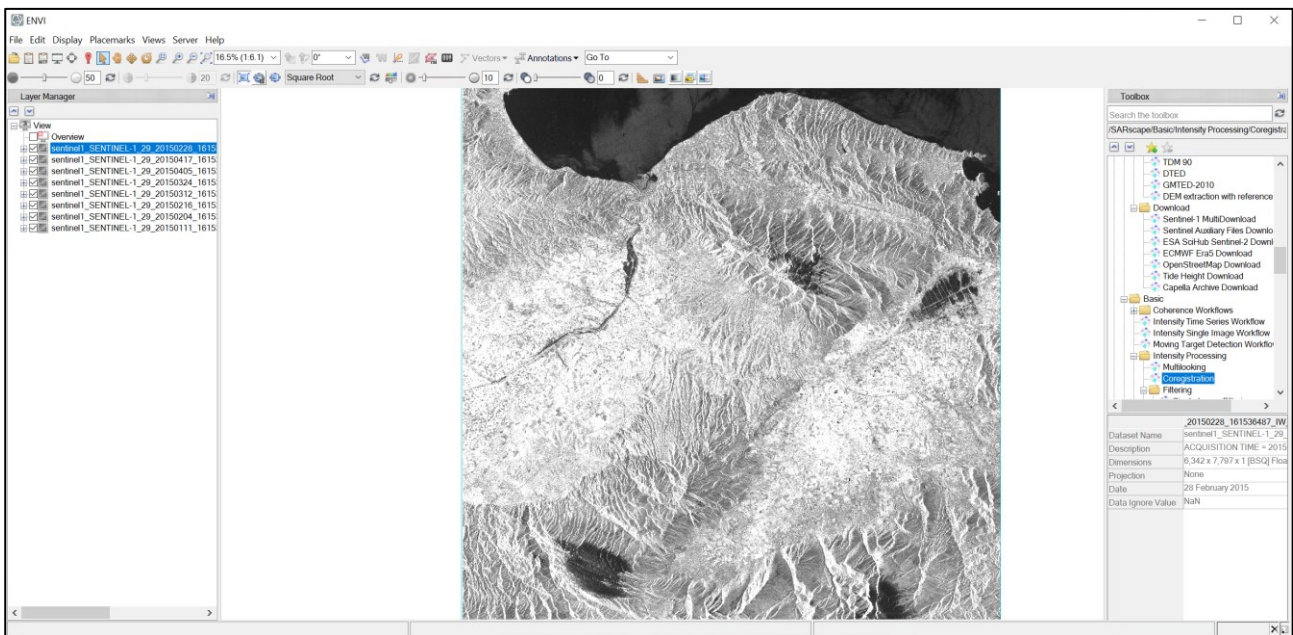Figure 24: Filtered pwr images opened after the De Grandi filtering Process.

Figure 25: Filtered gr images opened after the De Grandi filtering Process.

Geocoding

SAR systems measure the ratio between the power of the pulse transmitted and that of the echo received. This ratio (so-called backscatter) is projected into the slant range geometry. Geometric and radiometric calibration of the backscatter values are necessary for inter-comparison of radar images acquired with different sensors, or even of images obtained by the same sensor if acquired in different modes or processed with different processors. Further information can be found in the Geocoding chapter of the "*Getting started*" tutorial.

- ✍ Open the Geocoding panel, found in "*Basic*" → "*Intensity Processing*" → "*Geocoding*" → "*Geocoding and Radiometric Calibration*" and insert the previously filtered _pwr_rsp_fil or _gr_rsp_fil data in the "*Input File List*" (Figure 26 or Figure 27 top-left corner).

- ✍ In the DEM/Cartographic System tab (Figure 26 or Figure 27 top-right corner) you can either insert the DEM extracted for the *"Getting Started Tutorial"* or use the binocular button to call the DEM extractor tool (Figure 28). When the DEM is downloaded, the DEM extractor tool will automatically close and the path of the DEM will appear in the correct field in the Geocoding Panel.

- ✍ Check that the X and Y Gridsize is set to 15m and the Radiometric Calibration to True in the preferences (Figure 26 or Figure 27 bottom-left corner) and set the output file list to a convenient directory (Figure 26 or Figure 27 bottom-right corner). **Note:** the suffix "_geo" will automatically be added after the last extension name.

- ✍ Click Exec. The geocoded images will be loaded at the end of the processing.
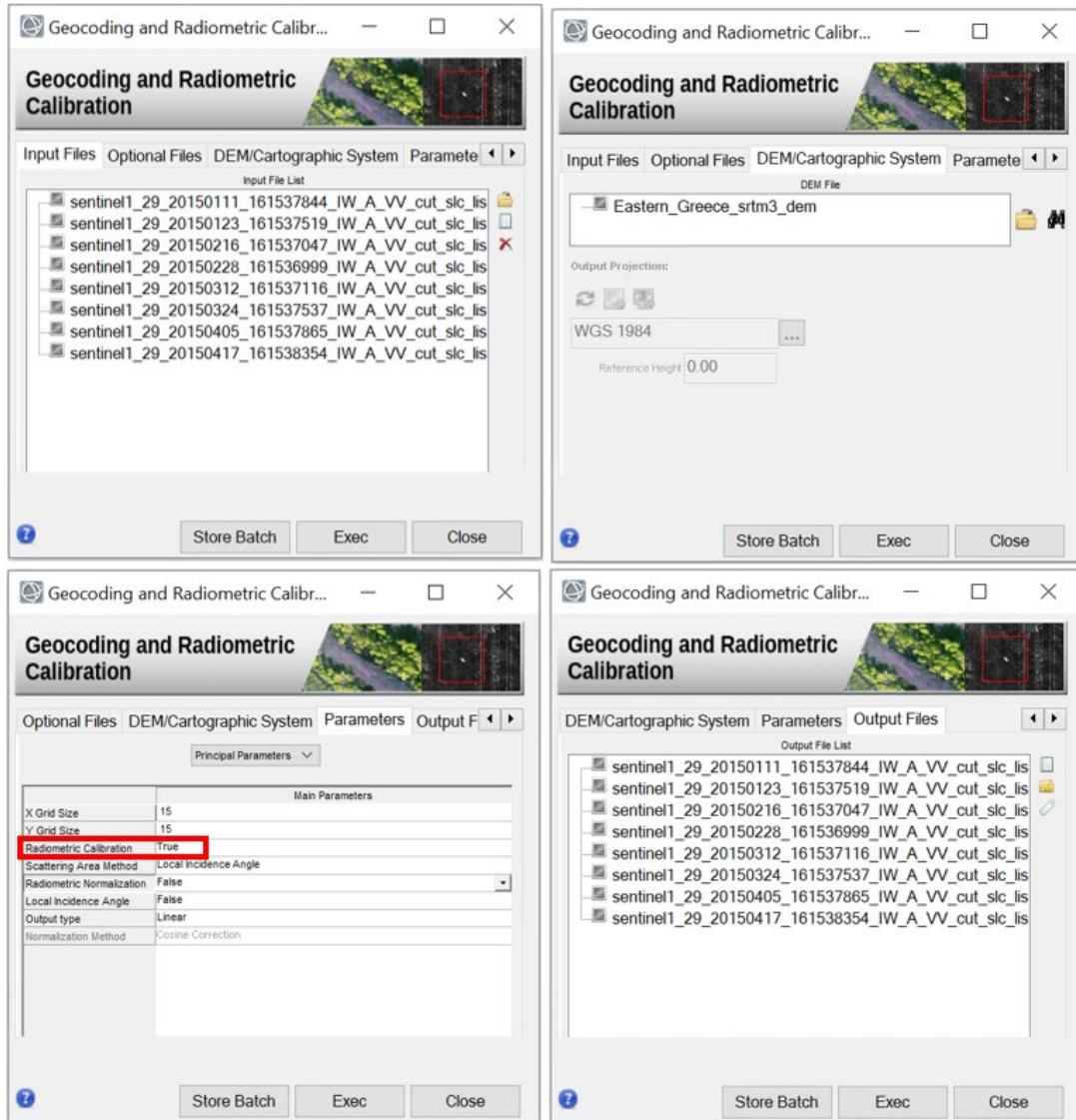
Figure 26: Geocoding panel. Top-left: input file list (filtered _pwr images), top right: DEM (download procedure in Figure 28), bottom left: parameters, set "Radiometric Calibration" to True, bottom right: Output file list.
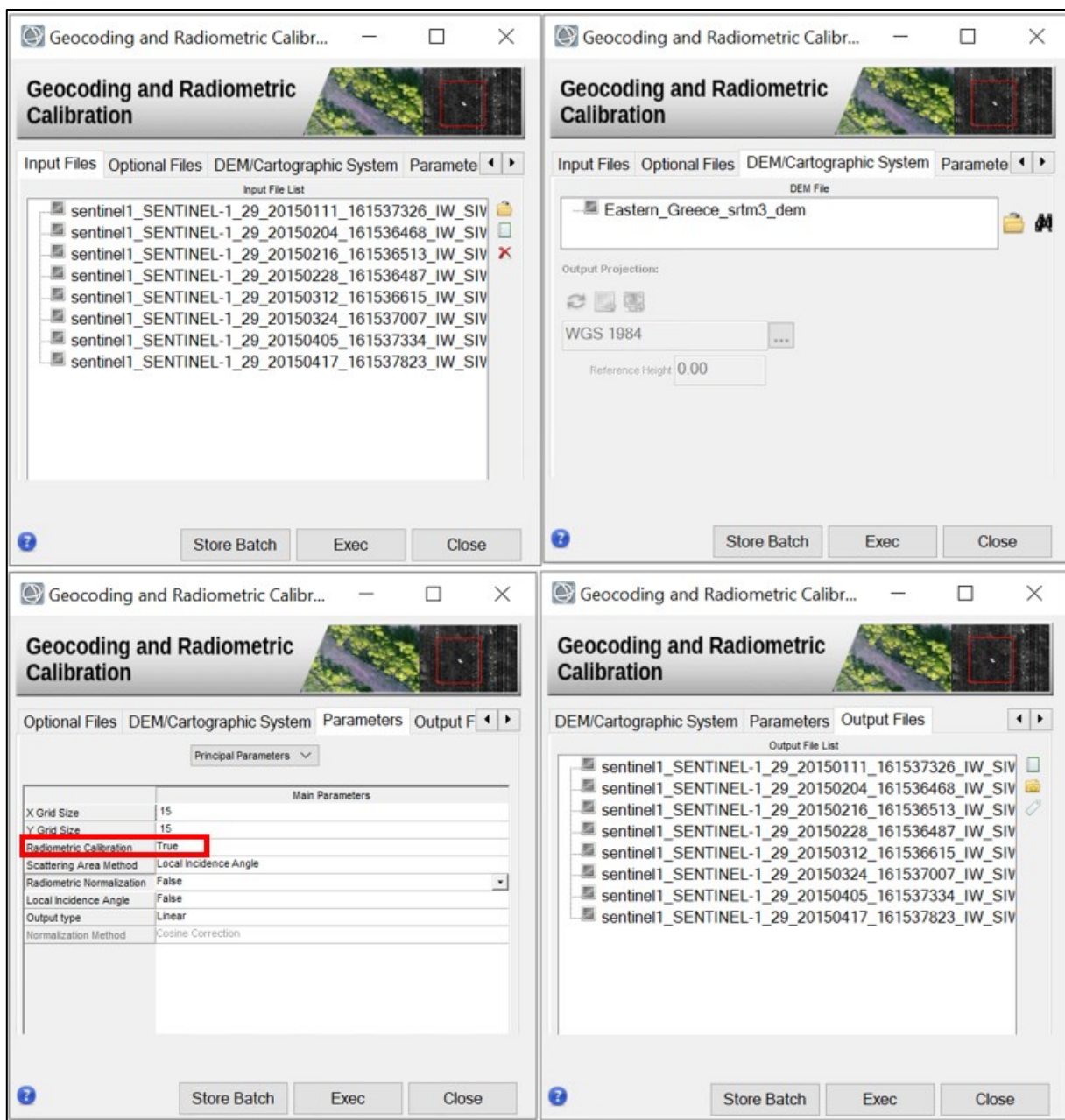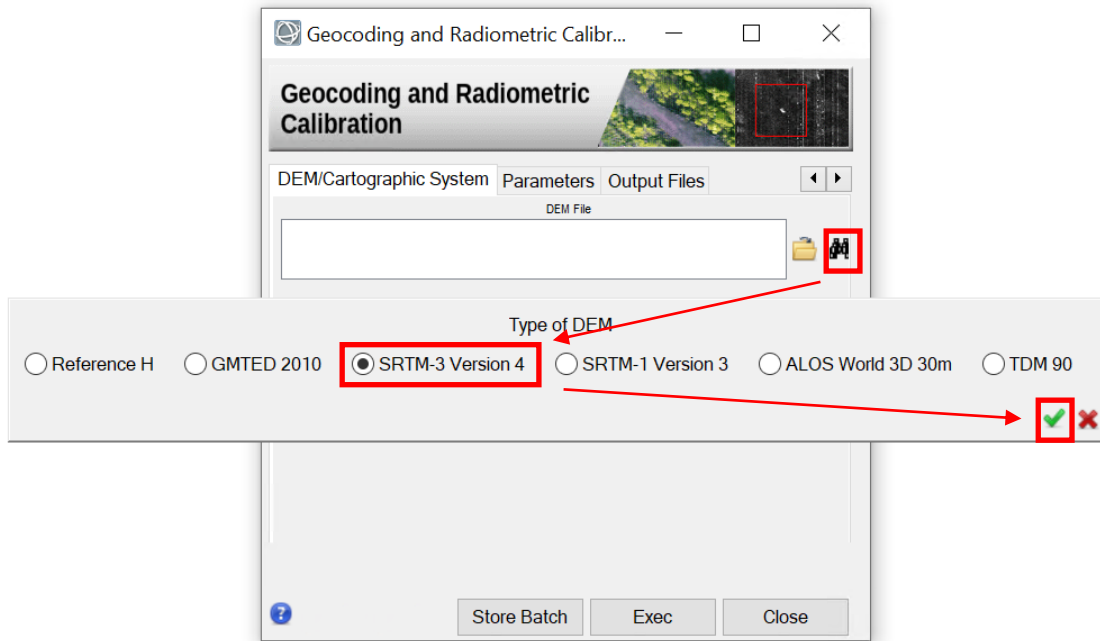
Figure 27: Geocoding panel. Top-left: input file list (filtered _gr images), top right: DEM (download procedure in Figure 28), bottom left: parameters, set "Radiometric Calibration" to True, bottom right: Output file list.

Figure 28: Geocoding and Radiometric Calibration, DEM/Cartographic System tab. Use the binocular button to call automatically the DEM extractor tool.

Feature Extraction – Multi Temporal features

Single-date and multi-temporal features, based on first order statistics, can be derived from SAR intensity data. Depending on the targeted product, These features enable to detect and extract structures or temporal changes, which can be additionally used for segmentation and/or classification purposes. A graphical representation of some temporal descriptors is shown in Figure 29.
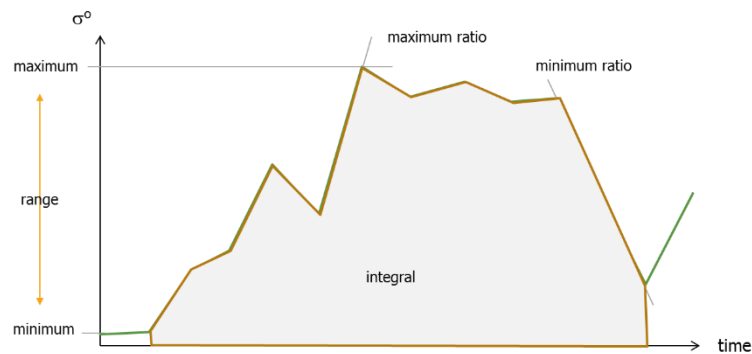

Figure 29: Temporal (intensity) Signature – Temporal descriptors. The selection of time range (seasonal, annual, etc.) is crucial.

Note: The feature extraction tool works with only one polarization at time. If several polarizations are available, the Multi Temporal Features tool has to be executed for each polarization.

✎ Open the Feature Extraction Tool, found in "*Basic*" → "*Intensity Processing*" → "*Feature Extraction*" → "*Multi Temporal Features*" and insert only the *VV* polarization of the previously geocoded _geo data in the "*Input File List*" (Figure 30 or Figure 32).

✎ In the parameters, set all the indexes to True, the software will then compute all indexes.

✎ In the output files, set the name of the root. The software will then add to this root a suffix according to the computed index. Click Exec.
You can now see the resulting images, one for each chosen index. The most important for us, in order to detect flooding, is the "RGB" index (Figure 33). The Coefficient of Variation index (STD/mean ratio) is assigned to the red channel, the Min index to the green channel and the Gradient (maximum absolute variation between consecutive acquisition dates) to the blue channel. Note the comparison with a Google Earth image, also partially showing a flood event (Figure 34).
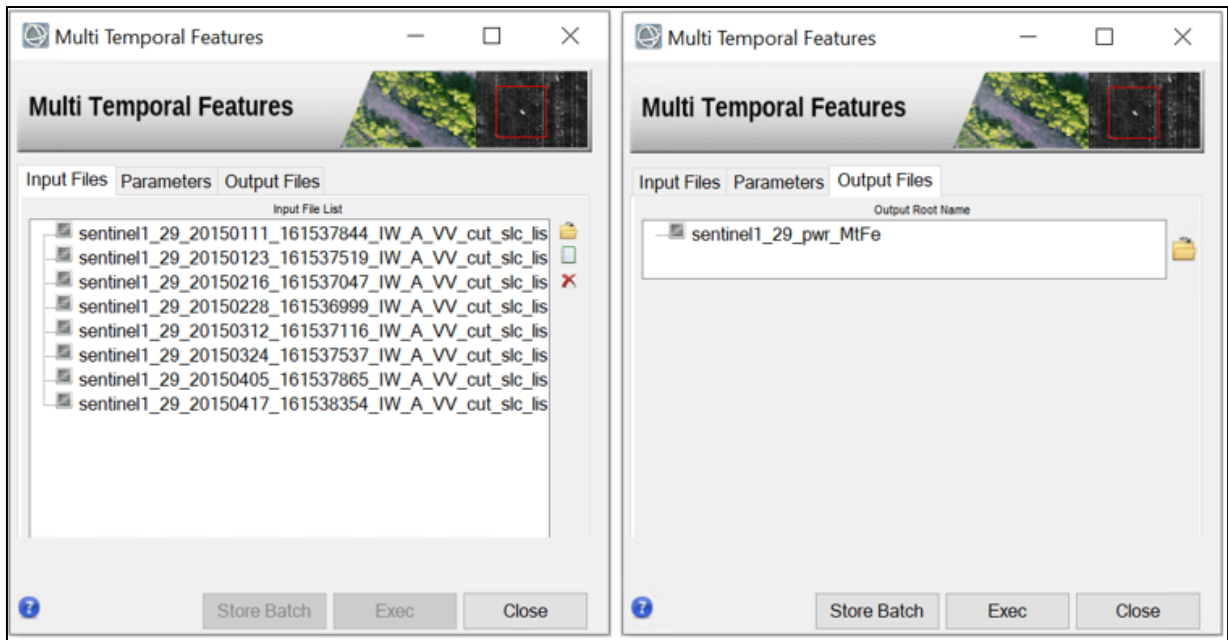
Figure 30: Multi Temporal Features panel for filtered multilooked SLC data in VV polarization.
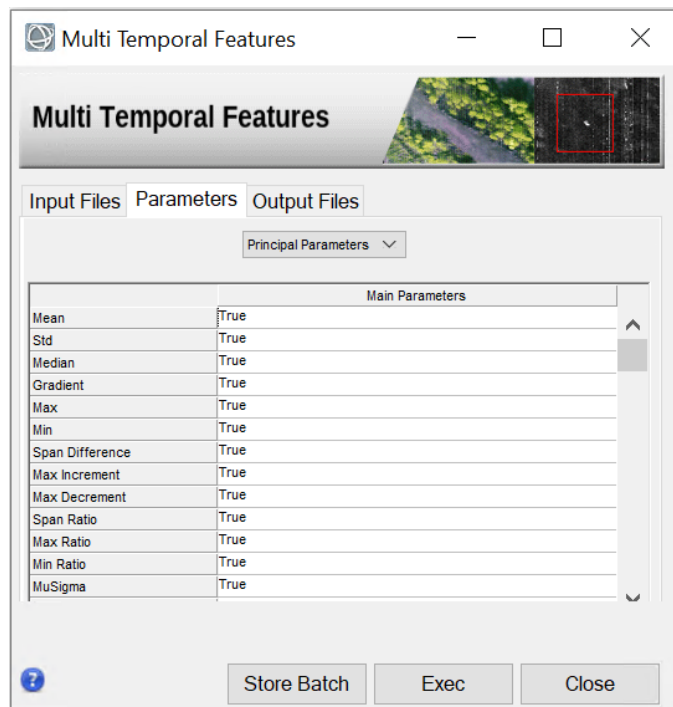

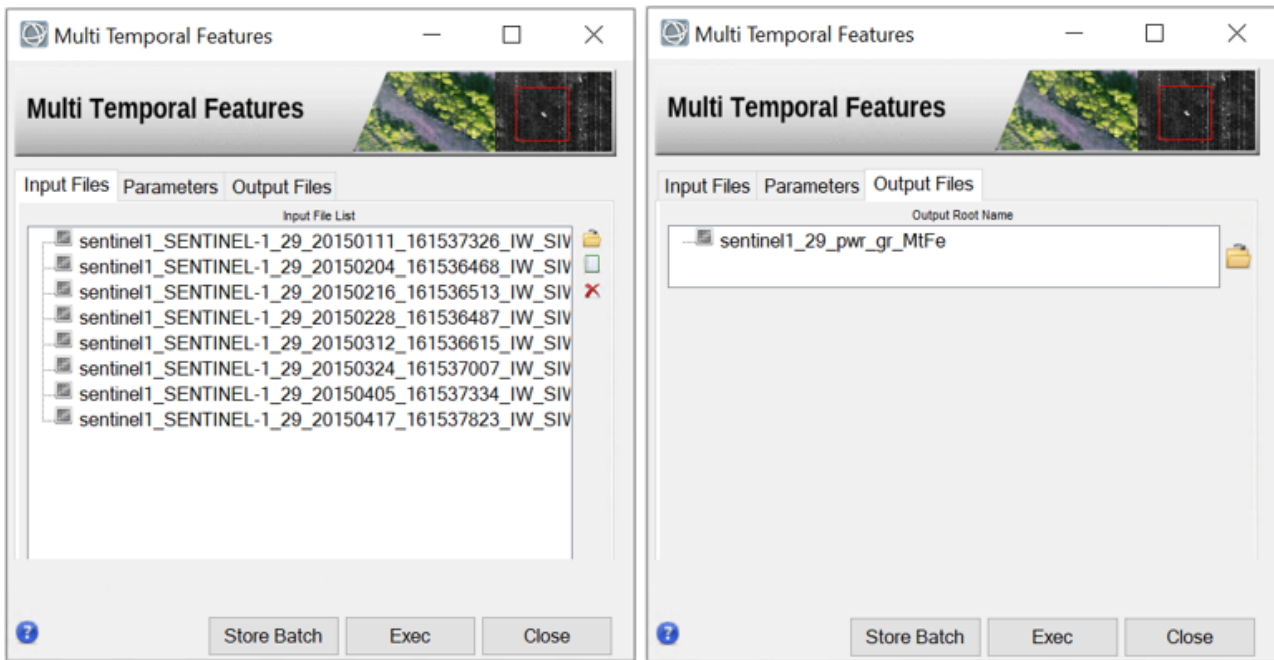Figure 31: Multi Temporal Features panel, parameters Tab. Set all the features to True.

Figure 32: Multi Temporal Features panel for filtered GR data in VV polarization.

RGB result

The RGB result (Figure 33) shows three different values on the same image, assigning each one to a different channel. The Coefficient of Variation index (STD/mean ratio) is assigned to the red channel, the Min index to the green channel and the Gradient (maximum absolute variation between consecutive acquisition dates) to the blue channel. Note how the flooded part has a strong purple color. A .kml is also created, allowing the user to overlay the result on google earth base map.
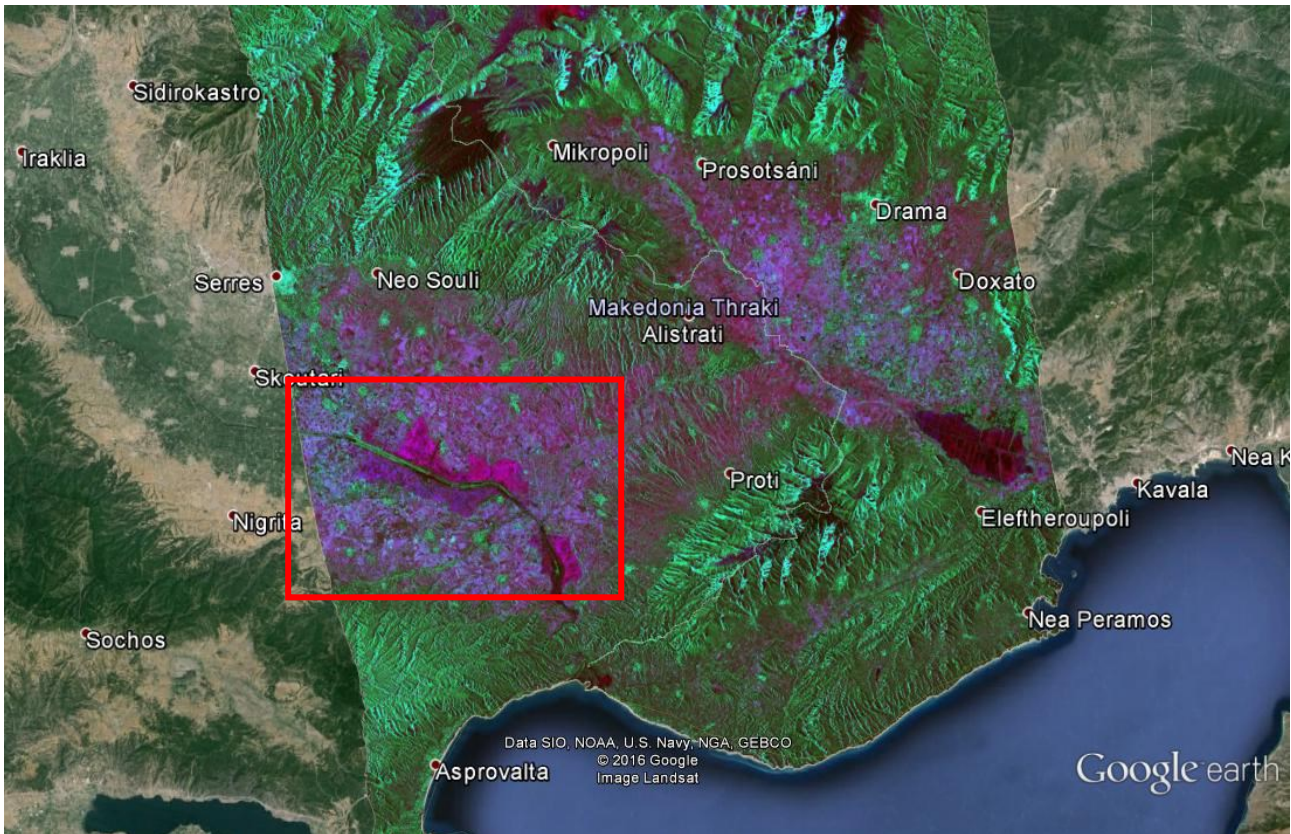
Figure 33: "RGB" result of the "Feature extraction tool. Note in the selected area the dark zone that refers to a low backscatter zone, caused by an overflowed river that flooded the floodplain.
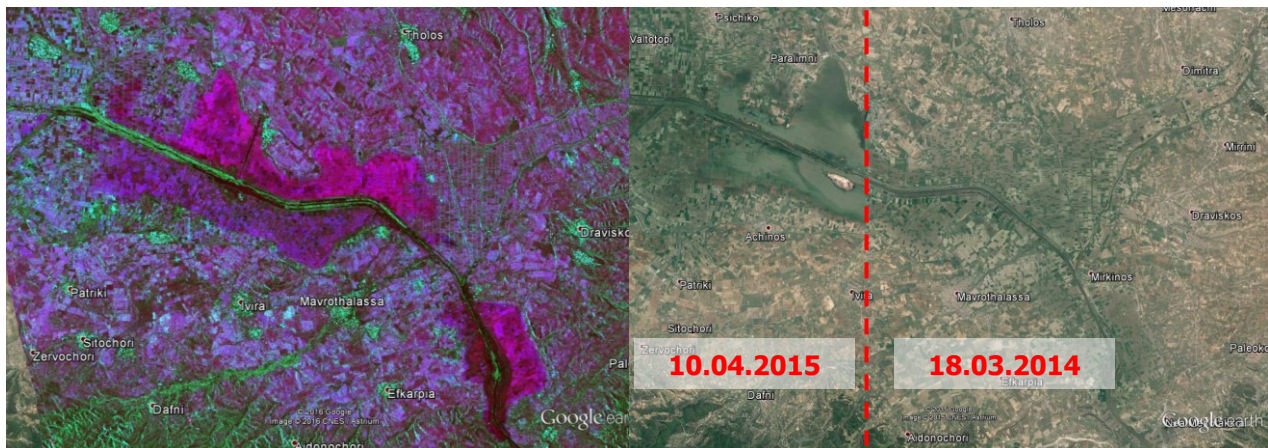

Figure 34: Comparison of the floodplain on the "RGB" result and google earth image. Left part of the Google Earth image was acquired on the 10th of April 2015 and the right part on the 18th of March 2014. Note how the flooded image in google earth matches the dark area in the "Min" result.

Multitemporal features

The other multitemporal features are located in the same output folder. In addition, a _meta file is created. This file contains all temporal descriptors selected in Figure 31 as well as all filtered geocoded images. This will show up in the ENVI Data manager as follows (Figure 35).

This particular file type allows the user to create RGB images "on the fly" by simply clicking on the white square at the left side of the image name to assign the band and the "load data" button at the bottom as described in Figure 35. This can be done using the single filtered geocoded images as in Figure 36 as well as using the temporal descriptors (Figure 37).
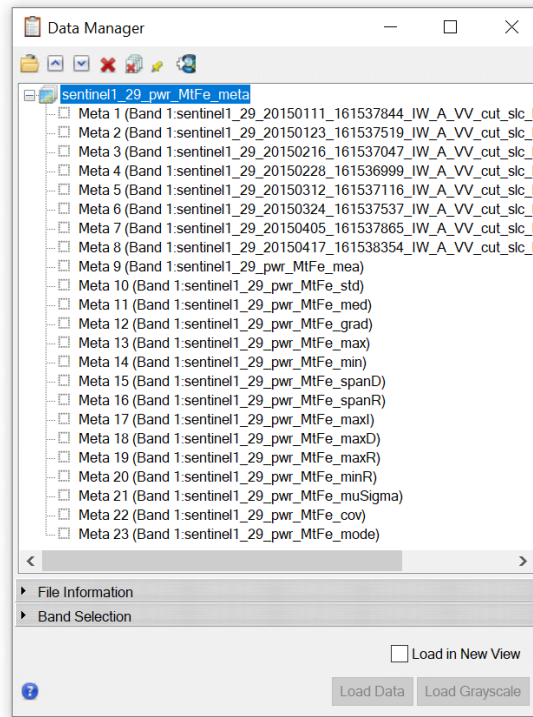

Figure 35: ENVI Data manager containing the _meta created in the Multi Temporal Features step. It shows all filtered geocoded acquisitions in the upper part and the temporal descriptors in the lower part.
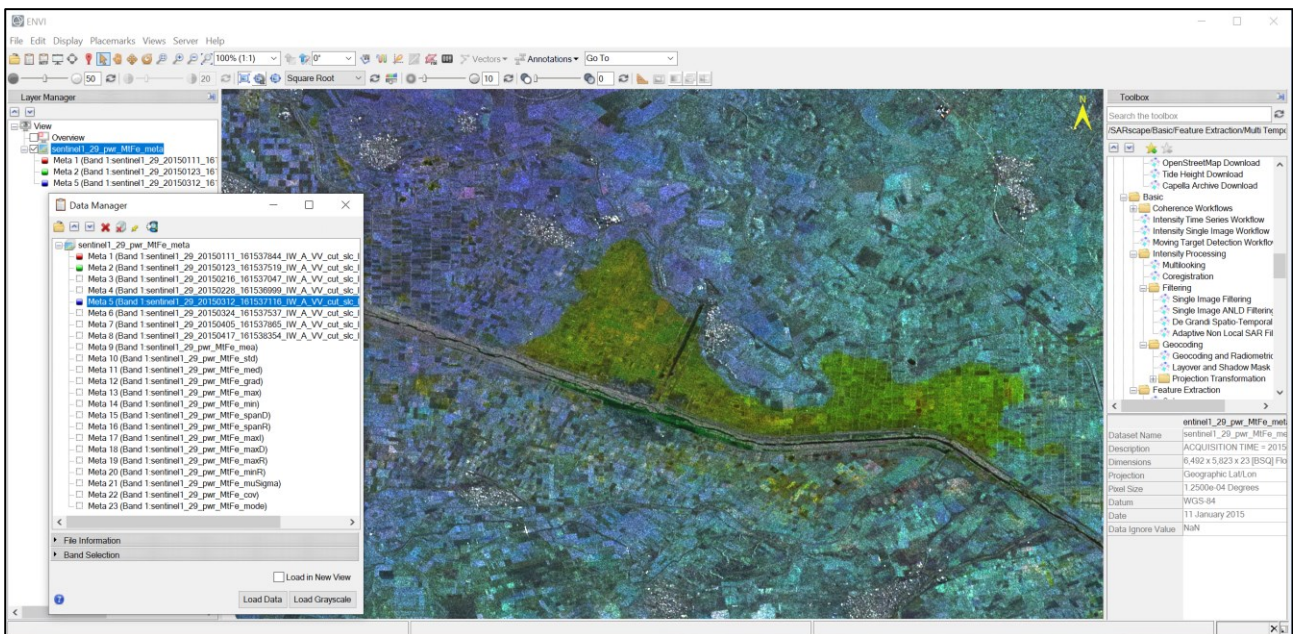

Figure 36: The three steps for the creation of an RGB using ENVI meta. 1: Select thee bands clicking on the white square on the left of the band name in the Data manager (the order has to be red followed by green

and blue). 2: Click on "Load Data" at the bottom of the Data manager panel. 3: The RGB composite is loaded into ENVI view and the three bands are shown In the Layer Manager.
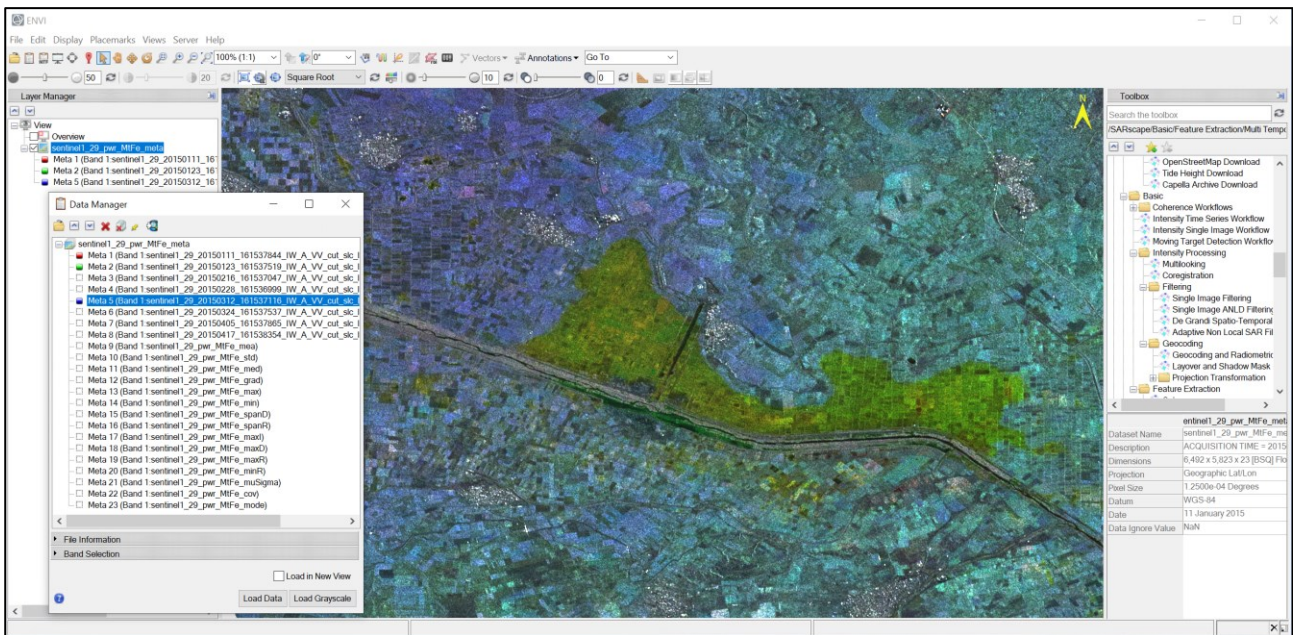

Figure 37: Another example of the three steps for the creation of an RGB using ENVI meta as in Figure 36 but using the temporal descriptors instead of the single acquisitions. This example uses the Minimum in the red channel, the Minimum ratio in the green channel and the Span Ratio in the blue channel.

Otherwise, if more complex RGB image have to be created, it is possible to use the SARscape tool found in "SARscape > General Tools > Data Export > Generate Color Composite". This tool allows to perform several different types of RGB operations and to adapt the scale, exponent and other parameters for each channel. Please refer to the Help for more information.

Workflow

This chapter will show how to use SARscape workflows in the Basic module. The first sub-chapter will concentrate on replicating the process performed in the Single Panels chapter using the Intensity Time Series Workflow and using the "next" buttons (which will cause a pause after each step). The second sub-section will show a usage example of the Coherence RGB workflow. In this case, the "Next >>>" button is used, which allows to perform all the steps with only one click. The operation of a SARscape workflow is explained in the *Getting Started* tutorial that can be downloaded from here: http://sarmap.ch/tutorials/tutorials.html.

Note: During the execution of workflows, it is not allowed to close the window or launch other processes.

Intensity time series workflow

For this tutorial, Sentinel-1 data will be used. The data can be downloaded using the tool presented in the Data Download section at page 4 of this tutorial. In this example, we will use only the resampled SLC files (_cut_slc_list) in VV polarization. This workflow can be performed with ground range too.

This workflow is found in SARscape>Basic>Intensity Time Series Workflow.

Tip: Use the resampled data as input in order to perform the workflow only on the area of interest defined in the Sample Selection chapter.

Note: With the workflow, it is not possible to ingest dual-pol data, as they have to be used separately for the multi temporal features analysis.

✎   Open the Intensity Time Series Workflow found in "*Basic*" and fill in the _cut_slc_list files in VV polarization (they have to be previously imported and resampled in SARscape as described in the relative section in the Data download and preparation chapter) as shown in Figure 38. Set up the DEM/Cartographic System tab as described in Figure 39 in order to automatically download an SRTM3v4 DEM and then set the gridsize to 15m (Figure 40).

✎   Click "Next >" This button allows to start downloading the DEM and then jump to the next step. **Note:** You will be asked to confirm the look-factor once the workflow has finished with the DEM download.
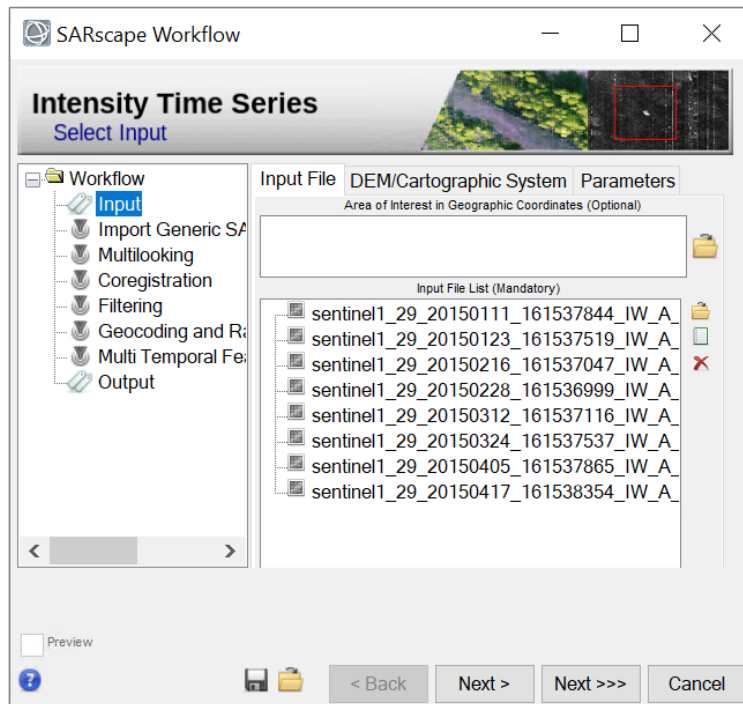
Figure 38: Input File Tab in Intensity Time Series Workflow.
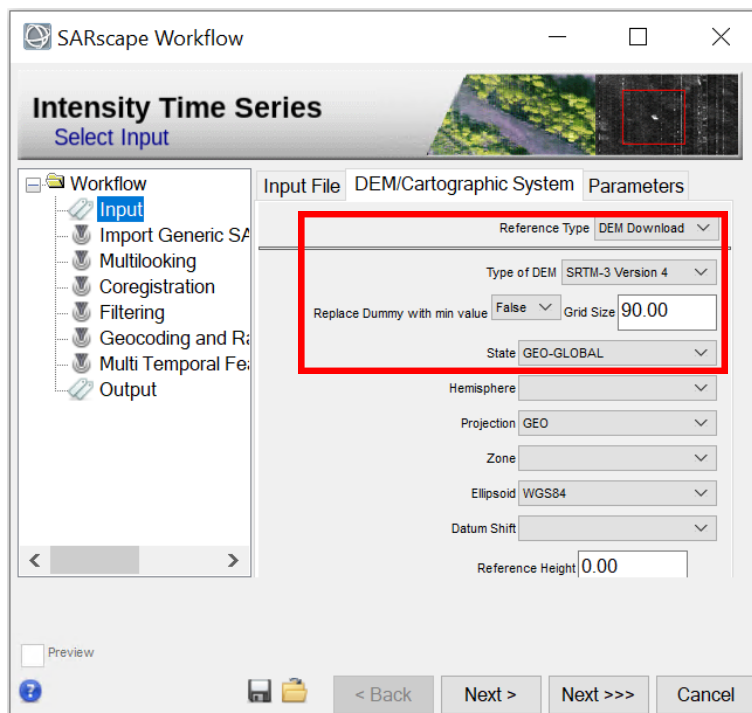

Figure 39: Dem/Cartographic System tab in Intensity Time Series Workflow. Use these settings to let the workflow automatically download the SRTM DEM that will be used from the Workflow. It is also possible to use a previously downloaded DEM.
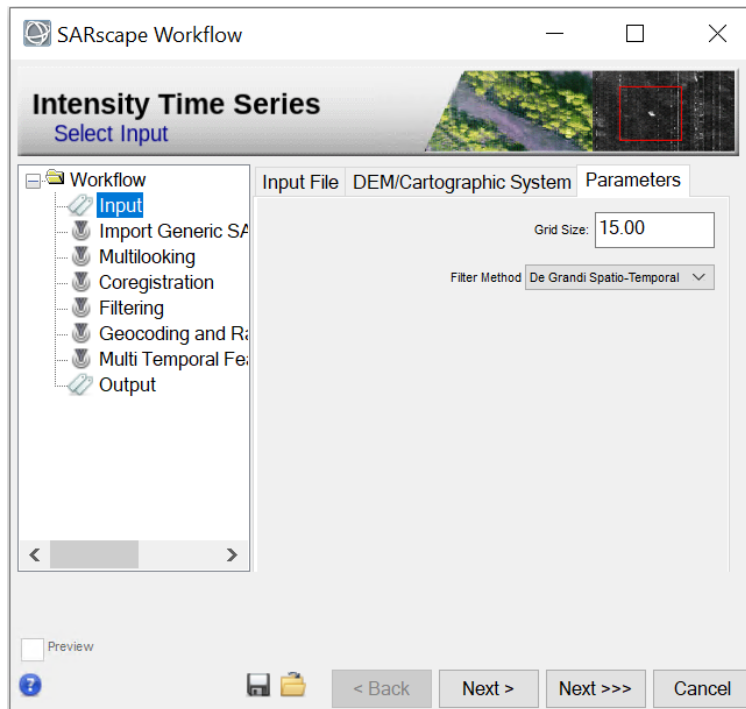
Figure 40: Parameters tab in Intensity Time Series Workflow.

✎ The workflow will run to the next step each time that you click "Next >".

✎ When you arrive to the Multi Temporal Features please select all the descriptors and then click "Next >" (Figure 41).

✎ At this point it is possible to select the output folder and root-name (Figure 42). All the output files will have the same root-name.

✎ After clicking on "Finish", ENVI will display the RGB and the _meta file, containing all the multitemporal descriptors

Tip: If you uncheck the "Delete Temporary Files", all the temporary files are kept in a folder located in the ENVI output directory with the name: SARsTmpDir_ddmmmyyy_hhmmss (the letters are referred to the date/time of the start of the workflow processing). Until the end of the process, the intermediary files are kept in the ENVI temporary directory.
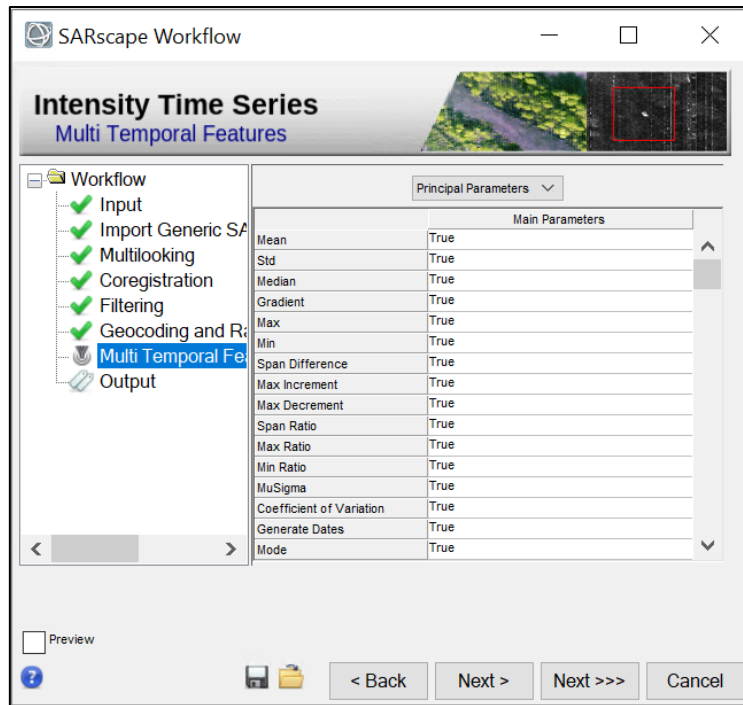
Figure 41: Multitemporal features step. Set all the flags to "true".
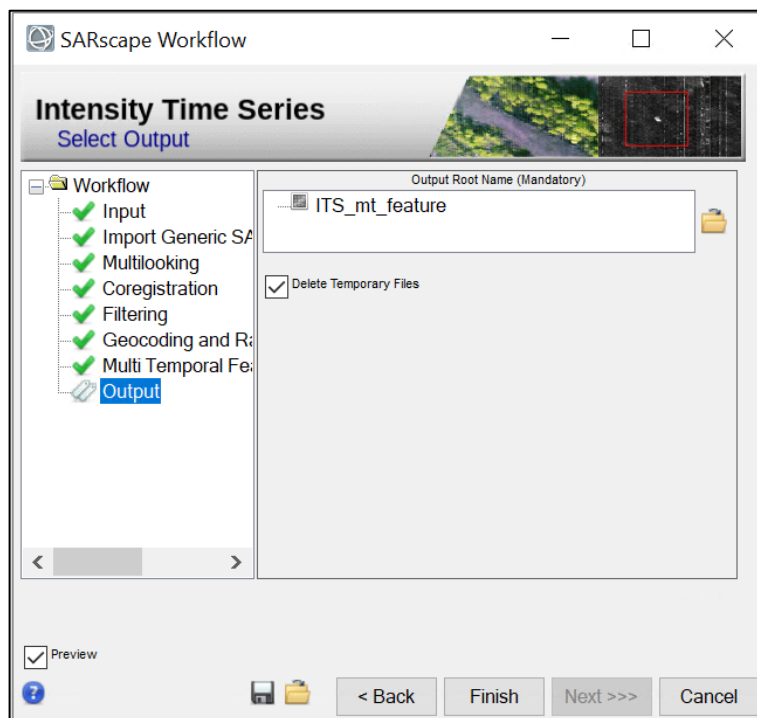

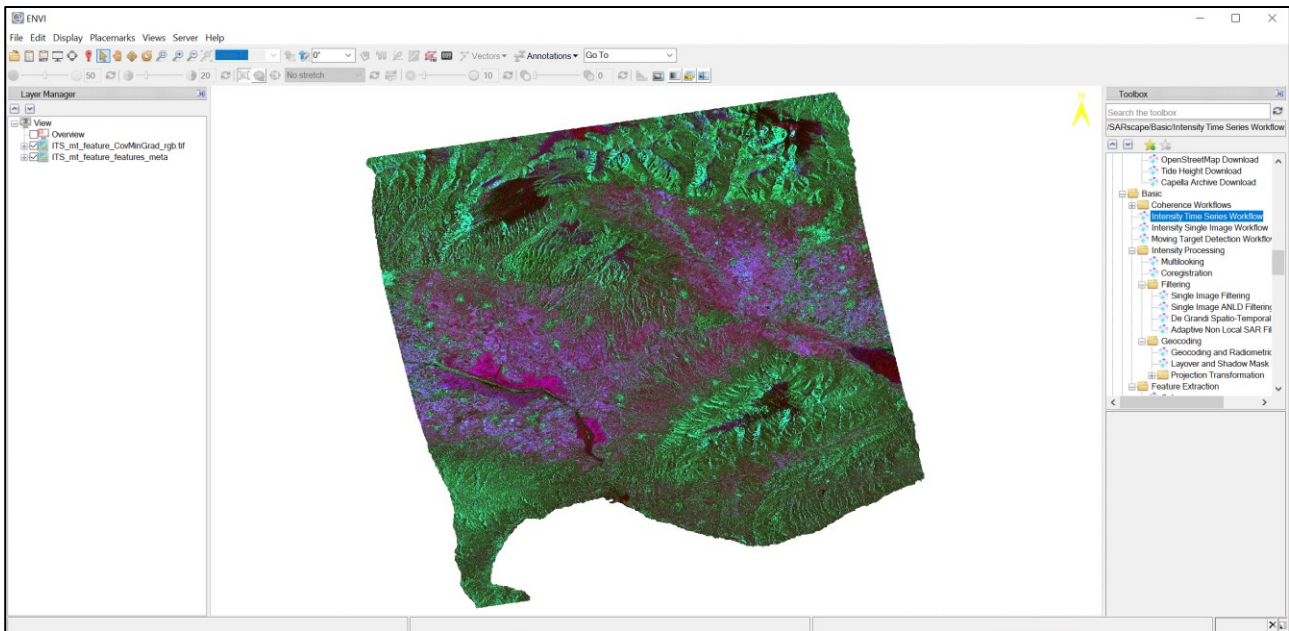Figure 42: Output Tab in the Intensity Time Series workflow.

Figure 43: RGB result of the Intensity Time Series Workflow. The RGB and the _meta file are both loaded and displayed in ENVI's Layer manager.

The result shown in Figure 43 is the same as the one shown in Figure 33 where The Coefficient of Variation index (STD/mean ratio) is assigned to the red channel, the Min index to the green channel and the Gradient (maximum absolute variation between consecutive acquisition dates) to the blue channel.

Coherence ILU-RGB Workflow

This *Basic* module workflow enables the execution, in a single iteration, of the following processing sequence, starting from an SLC pair: Coherence estimation, Multilooking, Coregistration, Power image and Coherence Geocoding and Color Composite Generation (Unsigned Coherence Combination, ILU).

The final purpose of this processing chain is to generate an RGB color composite for the visualization and identification of coherent temporal changes. The Red channel is the coherence; the Green channel is the mean Intensity; the Blue channel is the Intensity difference (2nd - 3rd).

- ✍ Make sure your SARscape preferences are set to Sentinel TOPSAR.

- ✍ Open the Coherence ILU-RGB Workflow found in "*Basic/Coherence Workflow*" and fill the master and slave fields with two _cut_slc_list (in this example we used the following dates: 20150123 and 20150216). As shown in Figure 44. **Tip:** As DEM you can use the one created in the Geocoding step at page 22. Change the gridsize to 15 m and then click the "Next >>>" button. This allows to run all the steps without interruptions until the output step.
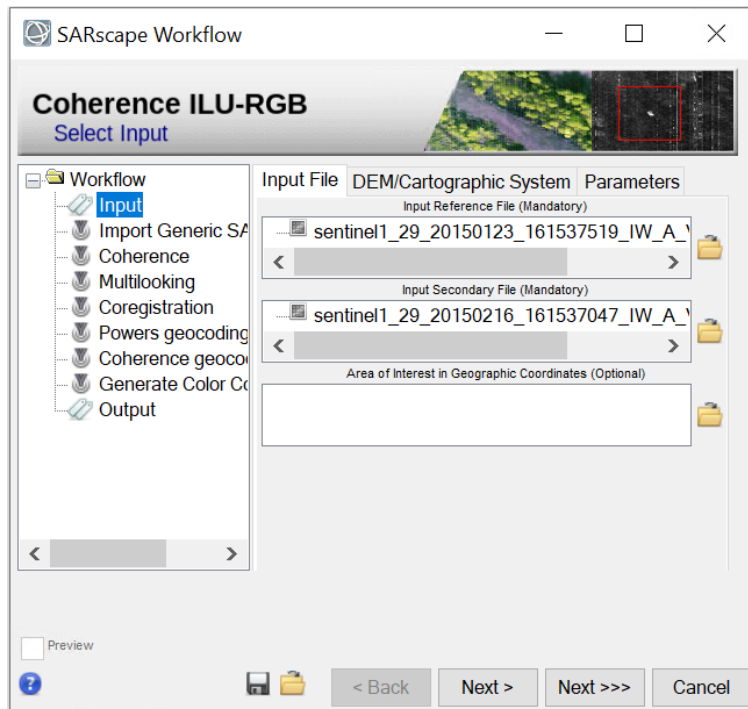
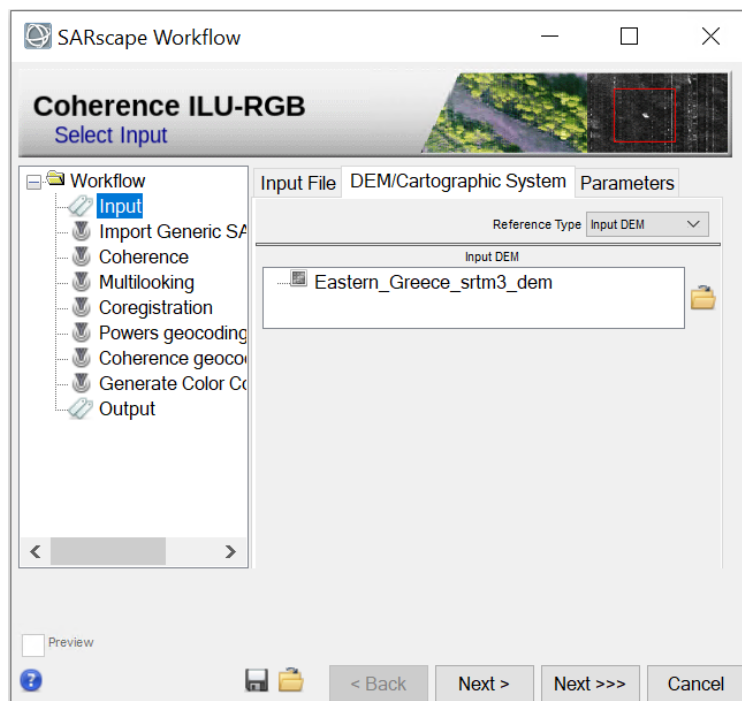Figure 44: Input files for the Coherence ILU-RGB workflow.

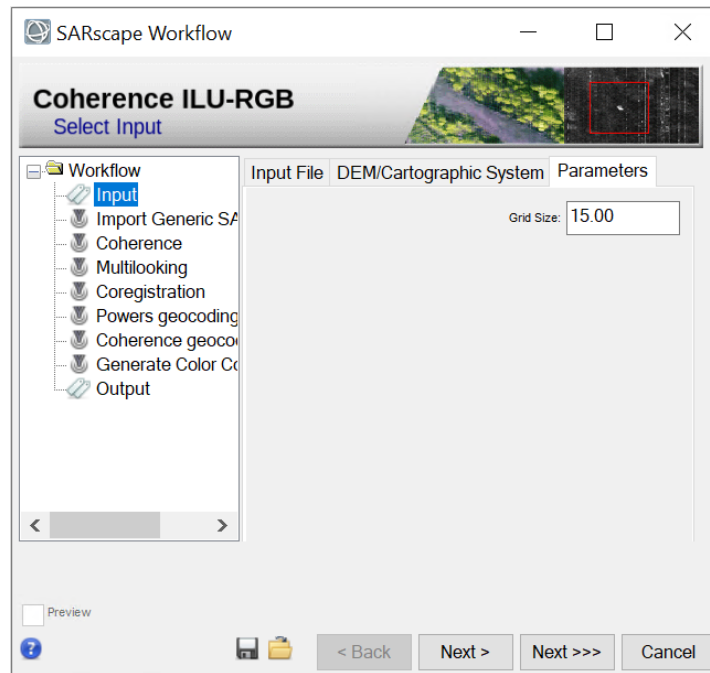Figure 45: Input DEM for the Coherence ILU-RGB workflow.

Figure 46: Parameters Tab. Check that the Grid Size is set to 15 m.

The software will then start to process all the steps one after another without interruptions until the output tab appears (Figure 47). As a result, an Unsigned Coherence Combination RGB color composite is shown in ENVI (Figure 48) as well as the geocoded multilooked master and slave acquisition and the geocoded coherence.
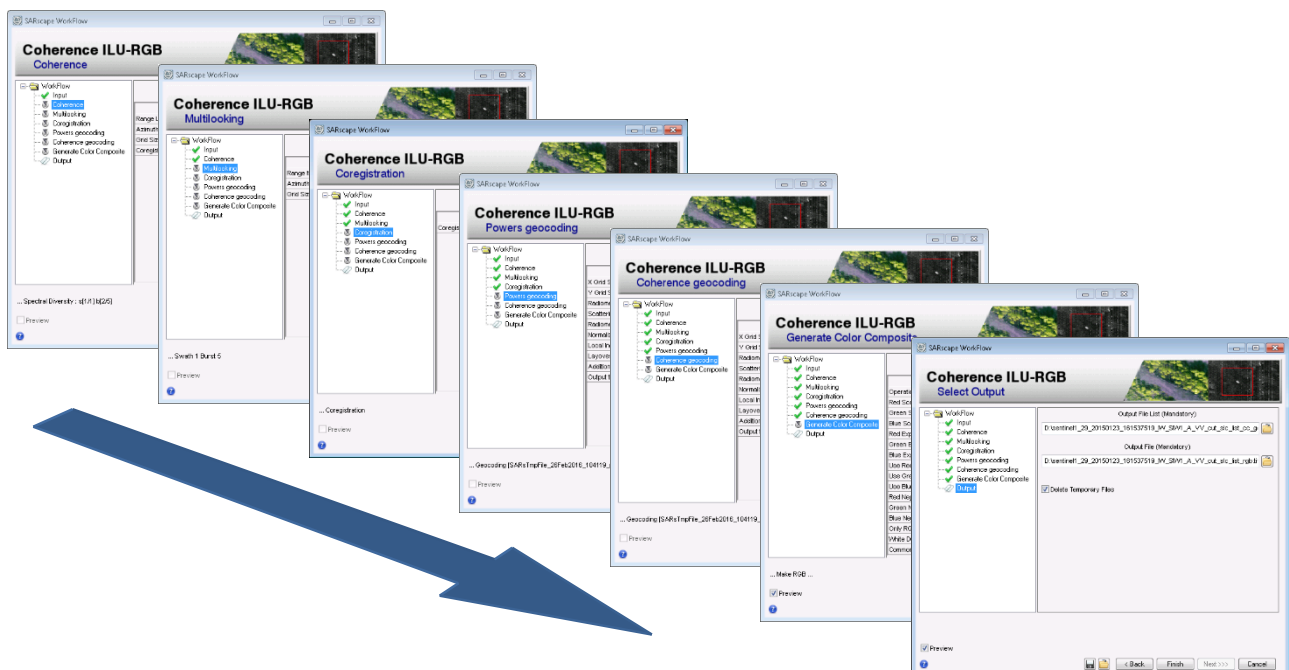

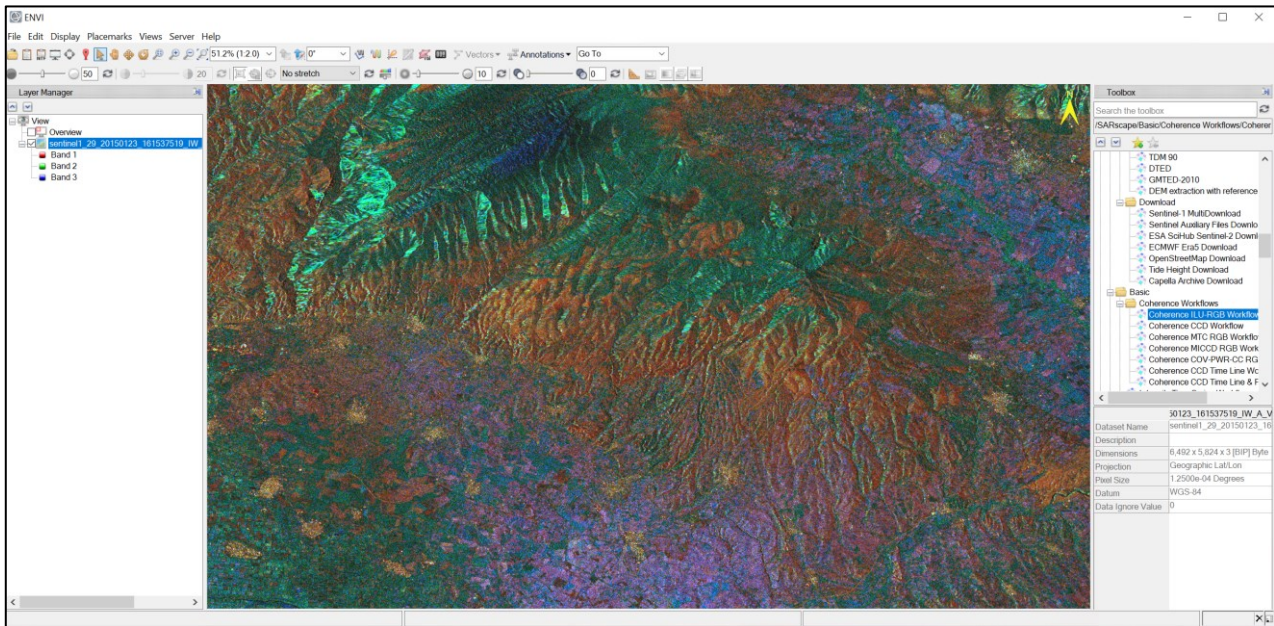Figure 47: All the steps of the workflow are performed in a row when the "Next >>>" button is used.

Figure 48: ILU RGB tiff result shown in ENVI. The Red channel is the coherence; the Green channel is the mean Intensity; the Blue channel is the Intensity difference (2nd - 3rd).