This project has received funding from the European Union's Seventh Programme for research, technological development and demonstration under grant agreement No [308417]".

# New Directions in Seismic Hazard Assessment through Focused Earth Observation in the Marmara Supersite

Grant Agreement Number: 308417
co-funded by the European Commission within the Seventh Framework Programme
THEME [ENV.2012.6.4-2]
[Long-term monitoring experiment in geologically active regions of Europe prone to natural hazards: the Supersite concept]

# D3.12

# Report on exploitation of independent sources for APS estimation and minimization

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|---|---|
| Project Start Date | 1 November 2012 |
| Project Duration | 36 months |
| Project Coordinator /Organization | Nurcan Meral Özel / KOERI |
| Work Package Number | 3 |
| Deliverable Name/ Number | Report on exploitation of independent sources for APS estimation and minimization / D3.12 |
| Due Date Of Deliverable | 31 October 2014 |
| Actual Submission Date | 3 November 2014 |
| Organization/Author (s) | SARMAP / Paolo PASQUALI |

| **Dissemination Level** | | |
|---|---|---|
| PU | Public | |
| PP | Restricted to other programme participants (including the Commission) | |
| RE | Restricted to a group specified by the consortium (including the Commission) | |
| CO | Confidential, only for members of the consortium (including the Commission) | |

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# 1. INTRODUCTION

This deliverable concerns the Task number 6: “Integrating a few independent atmospheric artifacts reduction into PSInsar and SBAS analysis”. The objective of this task is to provide a SARScape software license with the features required by the MARSite consortium.

SARscape has been updated with automatic data support for MERIS, MODIS and the ECMWF datasets and it is now capable of importing and processing stacks of geocoded atmospheric phase delays matching the SAR acquisition dates. Moreover, the SARScape stacking processing has been updated to exploit these new layers during the interferogram generation phase.

The goal is to extract the atmospheric path delay information from external and independent sources such as optical satellites (MODIS or MERIS), GPS, or global numerical weather forecasts (ECMWF). The atmospheric path delay is proportional to the water vapor column present during the SAR acquisition.

# 2. SOFTWARE DESCRIPTION AND SAMPLE RESULTS.

### 2.1 Extension of standard INSAR

The first update concerning the MARSite project is about the standard SARscape interferometry module. Users can now reduce atmospheric artifacts before the *phase to height* and *phase to displacement* steps. The correction is typically applied to the flattened and filtered interferogram, and the user can choose which sensor has the best performance among MERIS [1] , OSCAR [2] (obtained from the MODIS sensor) or ECMWF [3] . Figures 1 to 4 show the tool and one example exploiting the MERIS sensor as independent source of information, and the correction is carried out on an interferogram covering an earthquake in Iran.

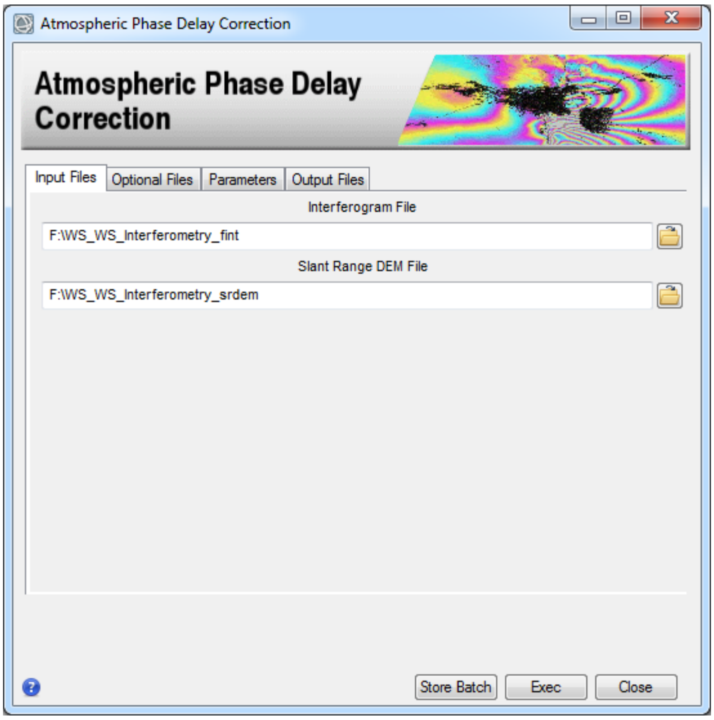


Figure 2: Atmospheric Phase Delay Correction tool to remove the atmospheric artefacts from a single interferogram. Input tab, with the corrupted interferogram.

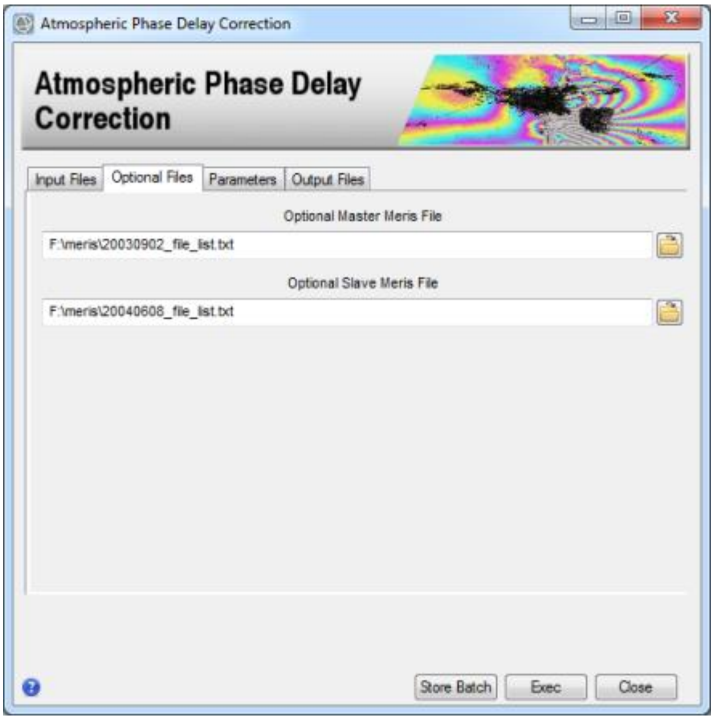


Figure 2: Atmospheric Phase Delay Correction tool to remove the atmospheric artefacts from a single interferogram. The input MERIS acquisitions relative to the master and slave acquisition times.

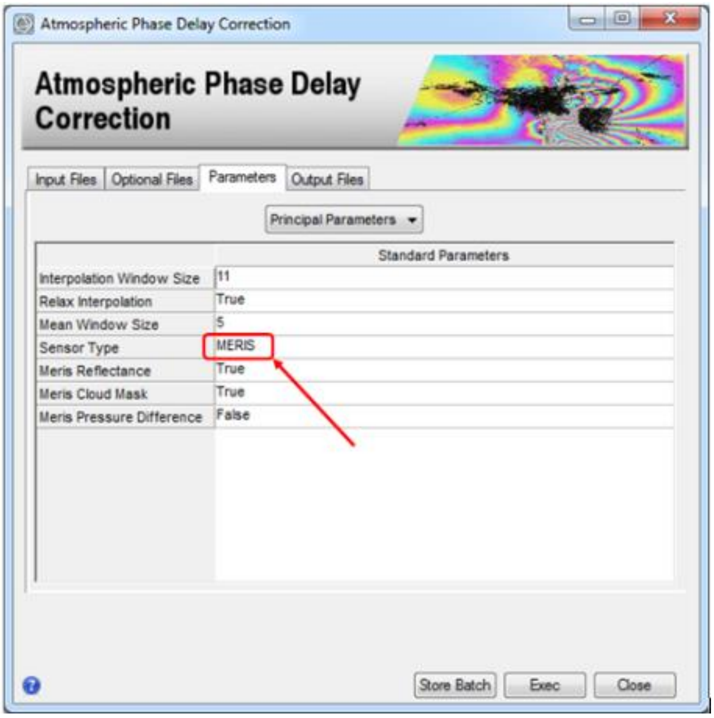


Figure 3: Atmospheric Phase Delay Correction tool to remove the atmospheric artefacts from a single interferogram. Sensor type selected in this case is MERIS.

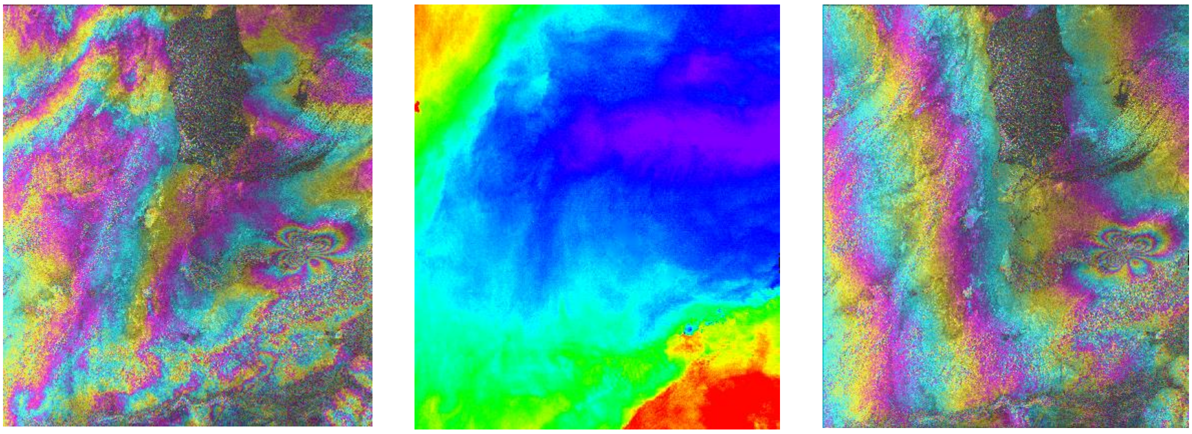

Figure 4: Flattened interferogram, standard case (left). Zenith Path Delay difference in slant range geometry (center). Flattened interferogram after the atmospheric correction (right).

The software almost completely removed the atmospheric distortion patters in the previous interferogram. What remains are some systematic fringes rising for orbit inaccuracy, but easily removable as a linear trend.

## 2.2 Extension of stacking processing

The second update for the MARSite project is the SARscape interferometric stacking module. A new tool for the geocoded Zenith Path Delay (ZPD) generation has been introduced, where the user can automatically create a stack of ZPDs that can be used in the SBAS or PS processing steps, as shown in Figures 5 and 6.

The ZPDs are extracted over one same area covered by the SAR acquisition at the same time. The user shall provide the list of SAR acquisitions and specify which sensor must be used for the ZPDs extraction. When the MERIS sensor is used, the data gathered through optical acquisitions matching the corresponding ASAR acquisitions must also be provided.

When OSCAR or ECMWF sensors are used, the software requires an internet connection to automatically download the necessary parameters and information from the Web. The result consists in a stack of raster files at different resolutions, depending on the selected sensor. The software will perform the download, the geocoding, the mosaicking of the water vapor, and eventually the conversion to ZPDs.

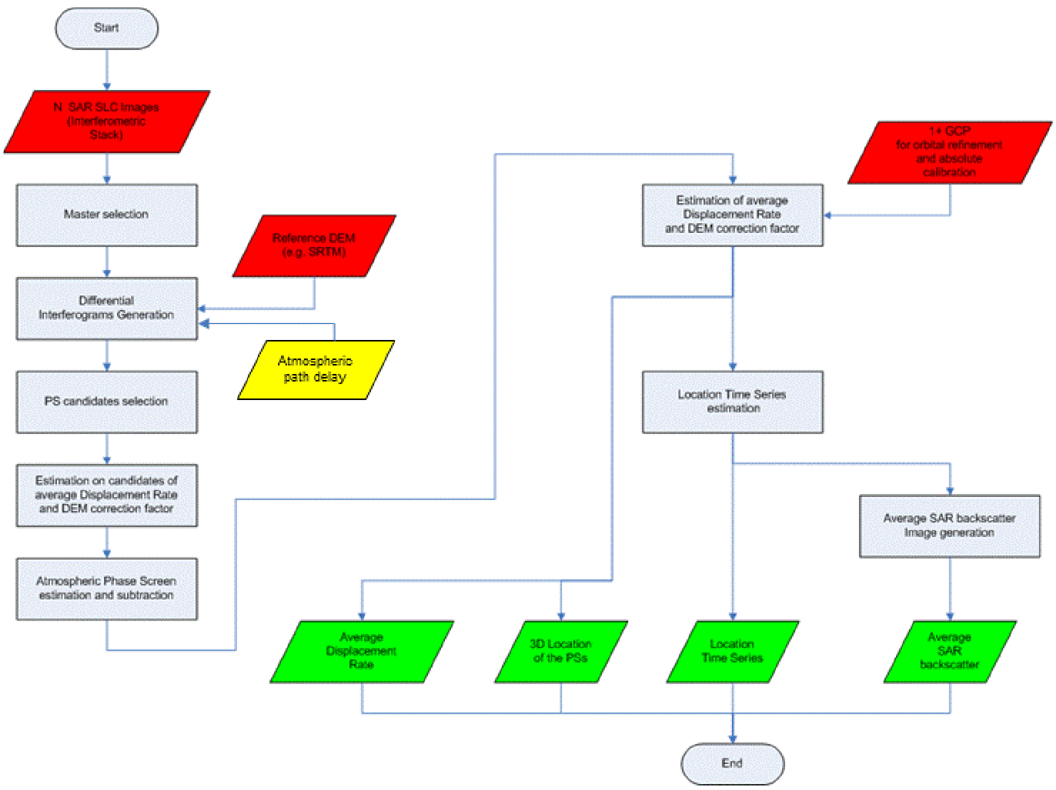

Figure 5: Logical workflow of SARscape PS module, including the exploitation of atmospheric path delay information (yellow block) obtained from external information.

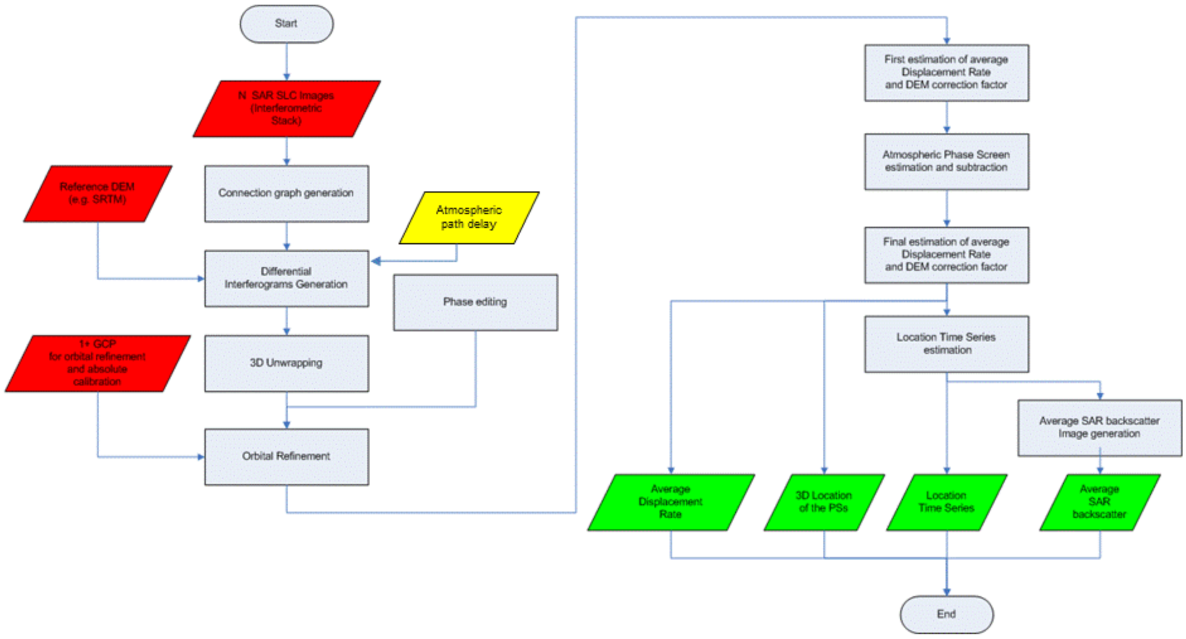


Figure 6: Logical workflow of SARscape SBAS module, including the exploitation of atmospheric path delay information (yellow block) obtained from external information.

Figure 7 to 9 depict the tool for the Atmospheric Layer extraction using a specific case study based on OSCAR data covering a desert area in the United Emirates. The processing is performed by using 30 ASAR acquisitions, but only 28 ZPDs have been downloaded: the two remaining ZPDs have been discarded because of the excessive cloud coverage.

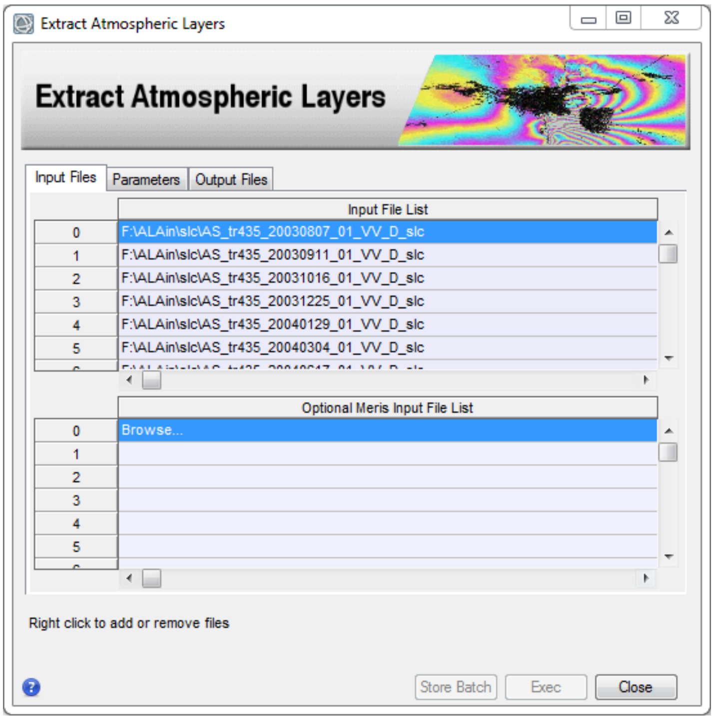


Figure 7: SARscape tool for the automatic Geocoded Zenith Path Delay generation. The user must specify the input SAR acquisition list.

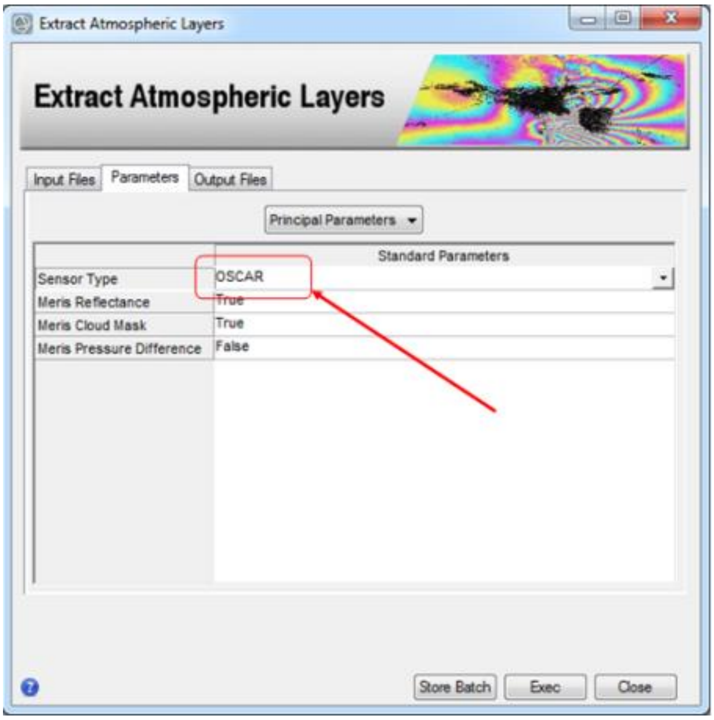


Figure 8: SARscape tool for the automatic Geocoded Zenith Path Delay generation. The atmospheric processing sensor type shall be selected among MERIS, OSCAR, and ECMWF.

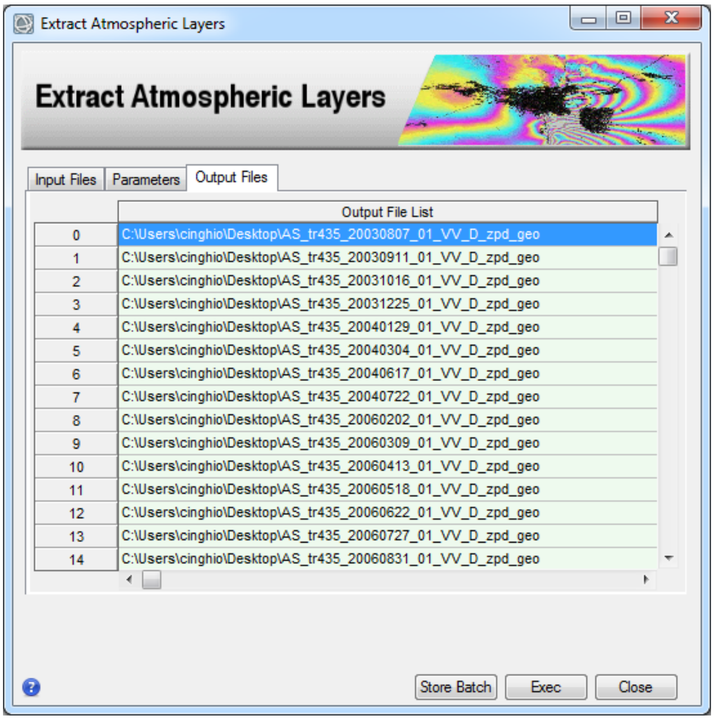


Figure 9: SARscape tool for the automatic Geocoded Zenith Path Delay generation. The output *_zpd_geo files list that will be generated by the tool.

Finally, Figures 10 to 12 show the impact of the refined processing on the stack of SBAS-processed images using the OSCAR sensor.

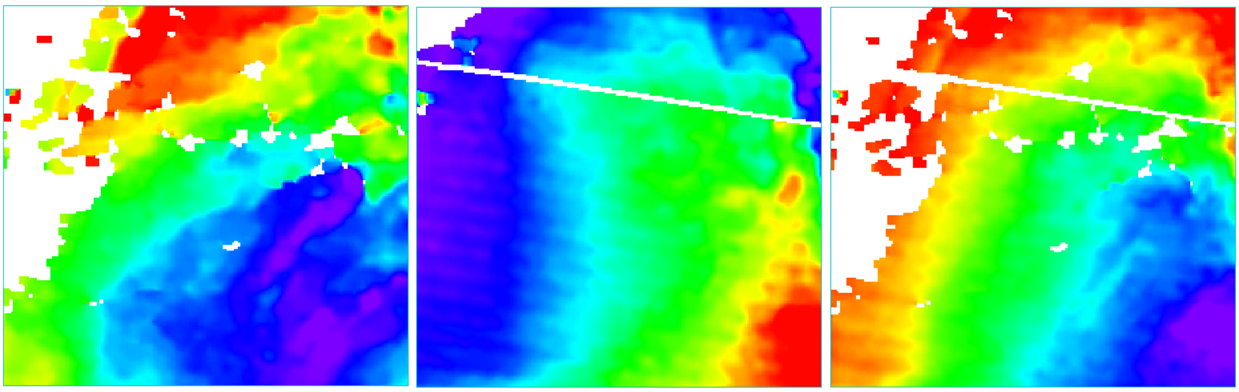

Figure 10: Geocoded Zenith Path Delay for two SAR acquisition date (left and center) and the geocoded Zenith Path Delay difference between the same two acquisitions (right).

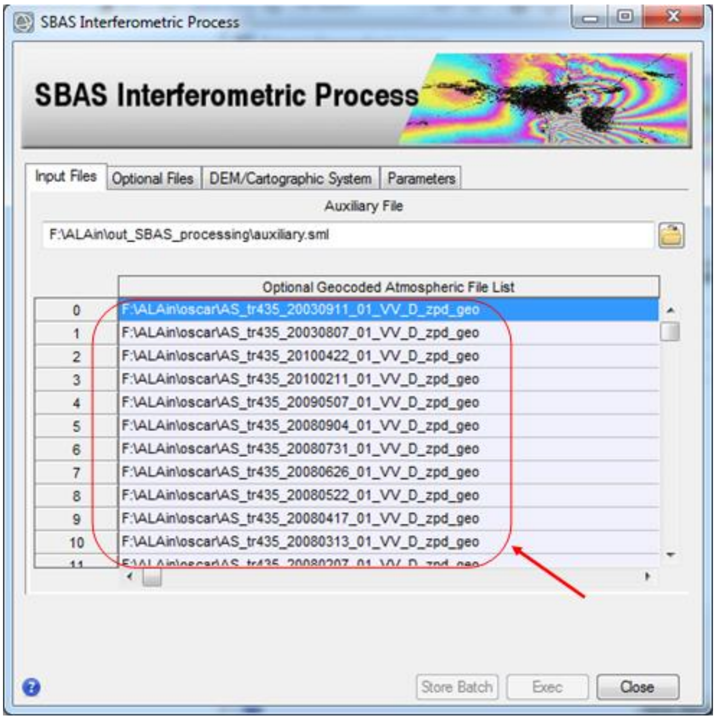


Figure 11: New SBAS Interferometric Process. Now the software accepts a geocoded Zenith Path Delay list of files as input and automatically subtracts them from the corresponding interferograms.

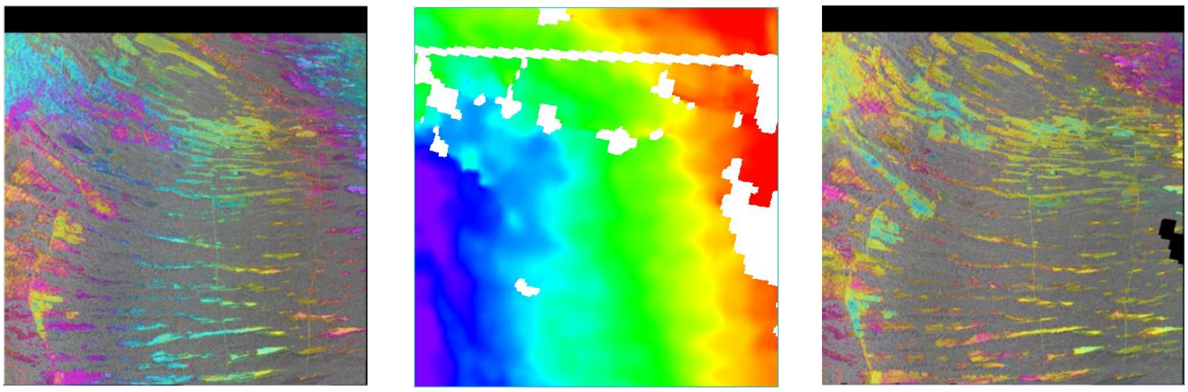

Figure 12: Flattened interferogram, standard case (left). Zenith Path Delay difference in slant range geometry (center). Flattened interferogram after the atmospheric correction (right).

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