Step-by-step tutorial

DefoEye: A Python-Based Software for Facilitated Time-Series InSAR Analysis of Sentinel-1 Remote Sensing Data

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The explanation of all parameters used in the TS-InSAR process is already provided in the main paper. Please refer to Section *2.2, Processing Workflow*, for more details.

It should be noted that the software is designed so that the user can start the process from different stages. For example, the user can begin directly from the unwrapping stage if they have already completed the earlier steps.

Once DefoEye is launched, the user is presented with the initial step of the interface, as shown in Figure 1. Here, the user can either choose to download the data or indicate that the data have already been downloaded and proceed with the process. If the data have already been downloaded, the user should select the second option ("Yes, proceed to analysis"), which is described starting from Figure 8 in this tutorial.

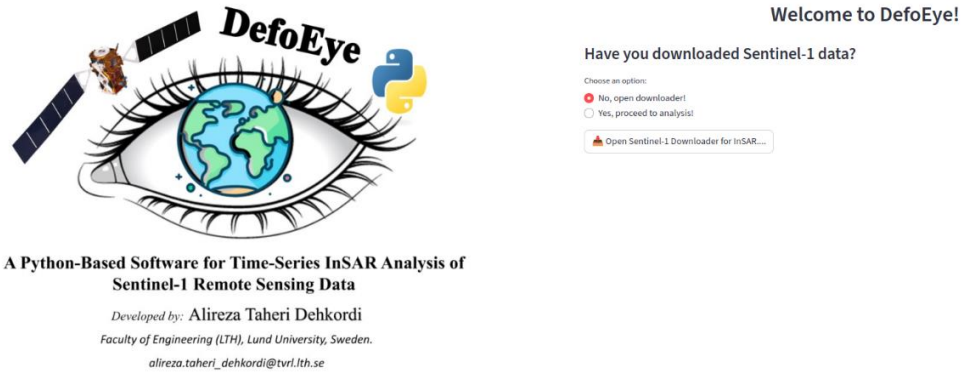

Figure 1. Initial step of the interface.

If the user chooses to download S1 data, the S1 Downloader module opens, as shown in Figure 2. The process begins at Step 1 (ROI), indicated in the top-left section of the interface.

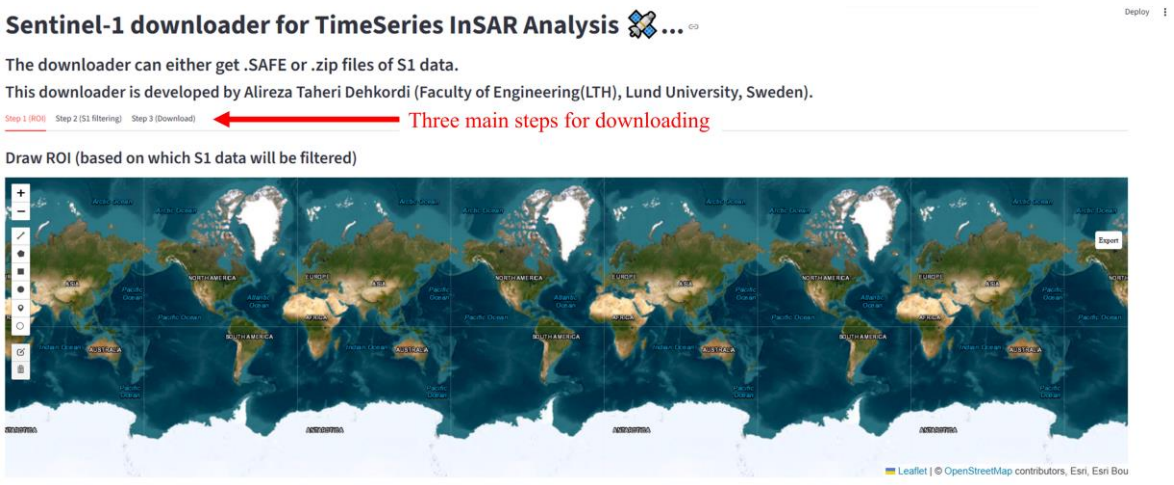

Figure 2. Sentinel-1 data downloader.

The user must draw the ROI (Region of Interest) using the drawing tools shown in Figure 3 and then export the ROI as a GeoJSON file.

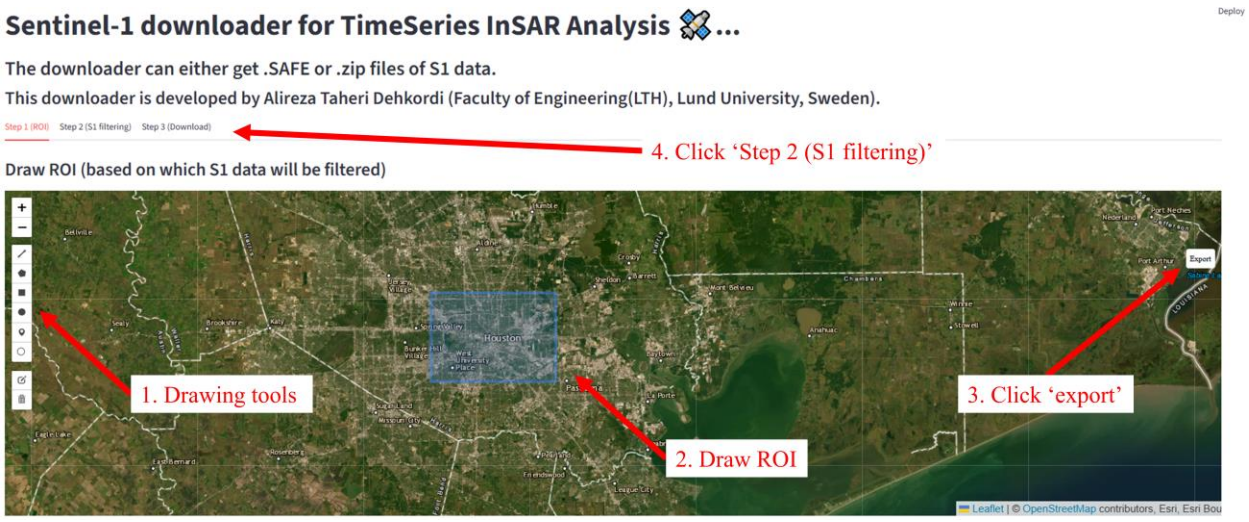

Figure 3. Drawing region of interest.

Then, the user proceeds to Step 2 (Figure 4). In this step, they can upload the GeoJSON file exported in Step 1, or alternatively, they can directly upload their own file without using the drawing tools in Step 1. If the uploaded GeoJSON file is in a valid format, the user can define a time range, choose between ascending or descending flight modes, and select the satellite platform (S1A or S1B).

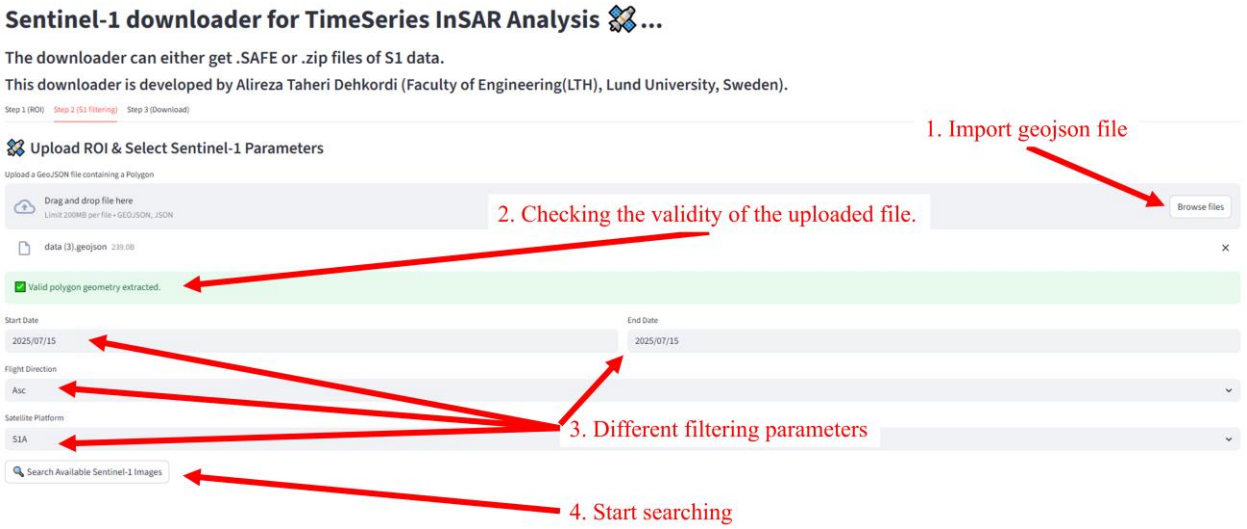

Figure 4. S1 data filtering.

Then, by pressing the search button, a preliminary list of images that intersect with the ROI and meet the selected criteria is displayed (Figure 5). Since multiple scenes may cover the same ROI, a list of unique (path, frame) number combinations is presented for selection. The user should choose the combination that offers the best coverage of their region of interest. The optimal (path, frame) pair can be easily identified using the ASF Vertex API (https://search.asf.alaska.edu/#/).

After selection, the number of matching scenes is shown to the user and these can be downloaded in Step 3.

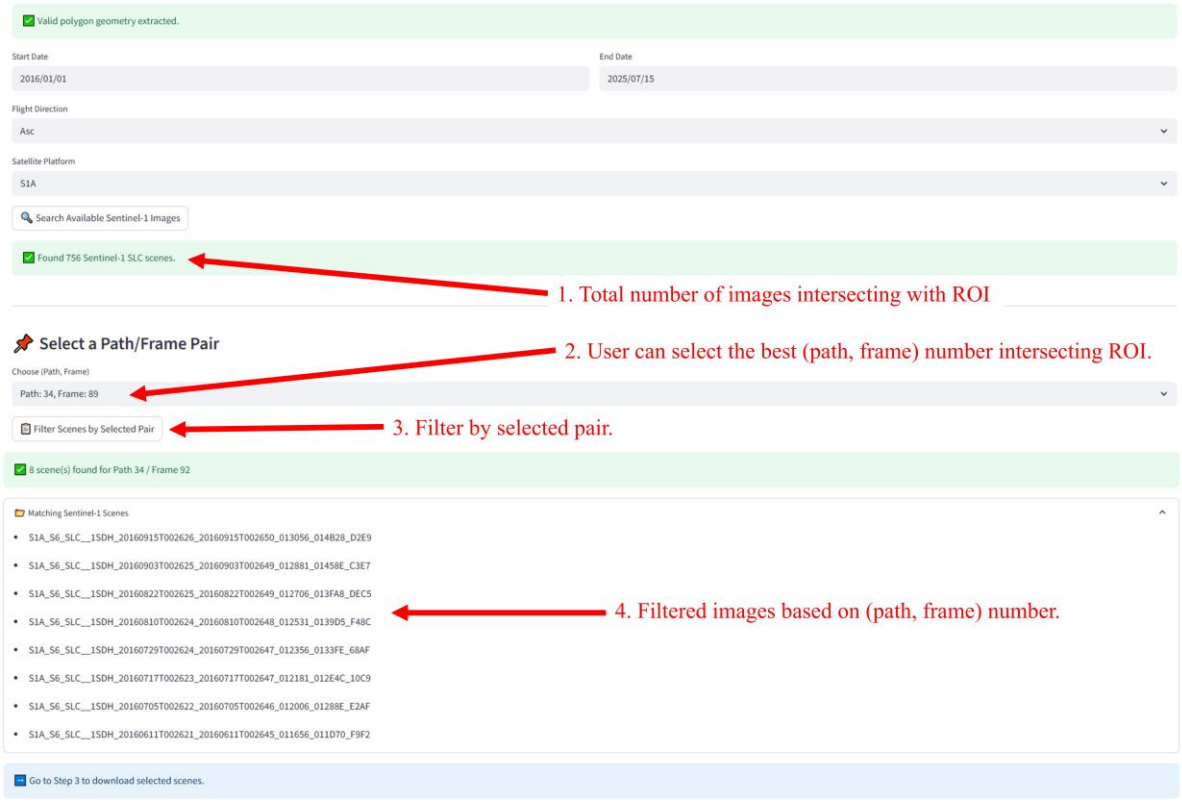

Figure 5. Filtering of S1 data based on Path/ Frame numbers.

In Step 3 (Figure 6), the user selects whether they want to download .SAFE files or .zip files. For .SAFE files (required by DefoEye), the user must specify the desired subswaths (iw1, iw2, iw3, or a combination) depending on the location of the ROI within the scene. After providing ASF credentials, the download process begins, and the selected data is saved to the specified directory. To obtain ASF credentials, users must register for an Earthdata Login profile.

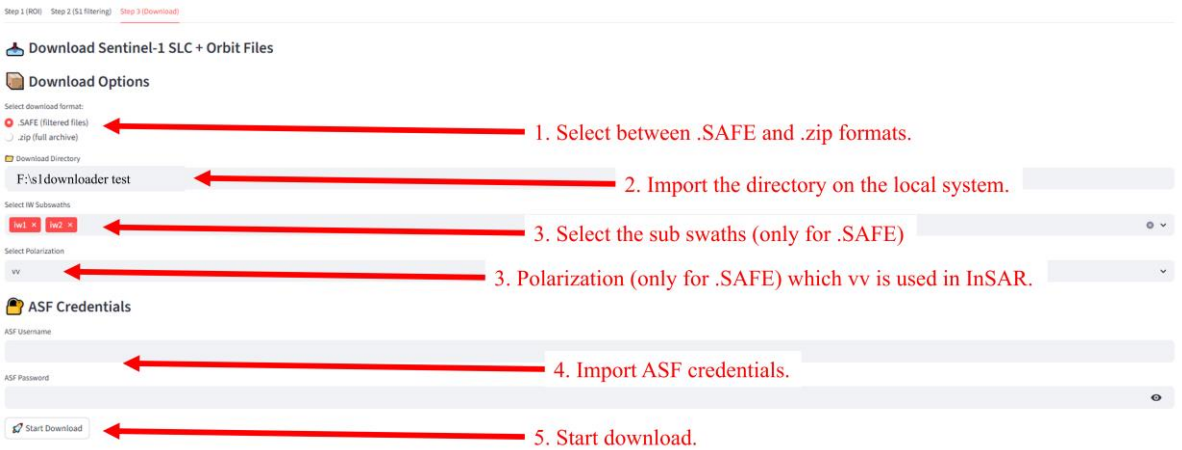

Figure 6. Final data download. The users must download .SAFE files for working with DefoEye.

Once the download is complete (or if the data have been downloaded using other methods), the base directory specified in DefoEye should contain both .SAFE and .EOF files (Figure 7).

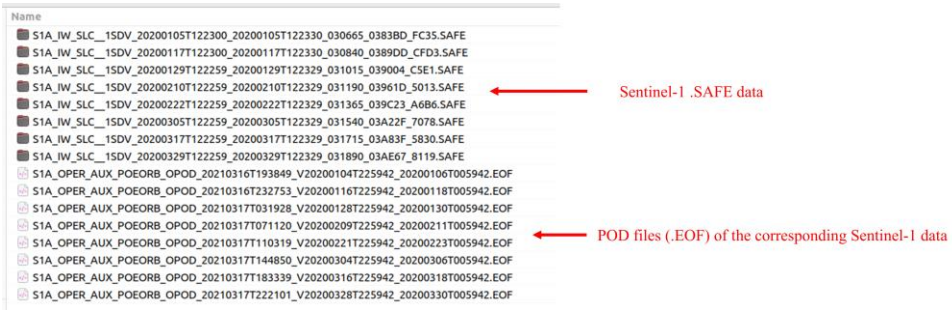

Figure 7. Base directory of Sentinel-1 data and corresponding orbit files.

Then, the user can return to the initial interface (Figure 1) and choose to start the processing (Figure 8).

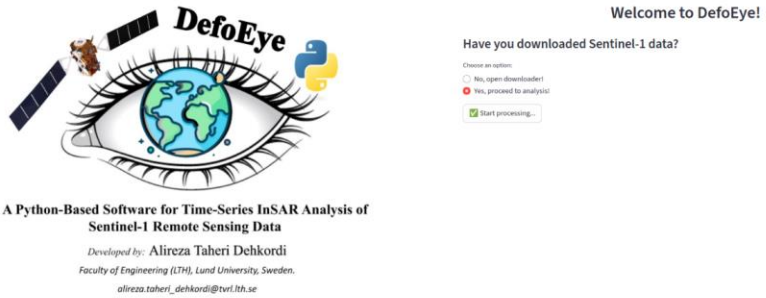

Figure 8. Starting TS-InSAR analysis.

By choosing to start the process, the user is directed to the introduction page, where the general workflow of DefoEye is shown (Figure 9).

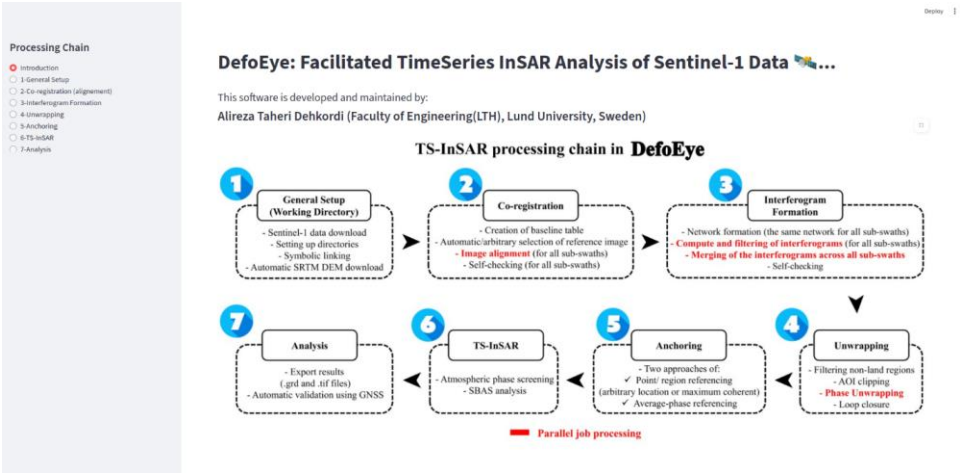

Figure 9. Introduction page of DefoEye.

The process follows the same sequence as the flowchart shown in the introduction page. The first step is the general setup (Figure 10), in which the directory containing the downloaded S1 data (.SAFE) and .POD file (Figure 7), as well as the working directory where all DefoEye outputs are saved, must be specified. After that, the DEM is automatically downloaded to the working directory.

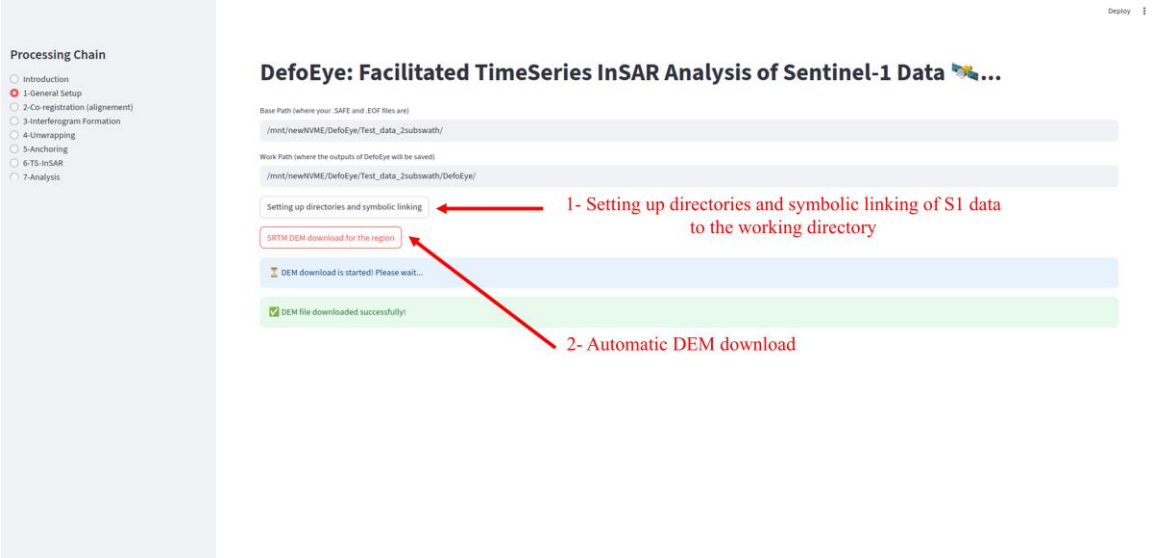

Figure 10. General Setup.

In the co-registration step (Figure 11), the user imports the reference image data (YYYYMMDD), and all other images are co-registered to the reference image. A self-checking procedure is also performed in this step to ensure the process is completed; otherwise, it reruns the process for any unsuccessful images.

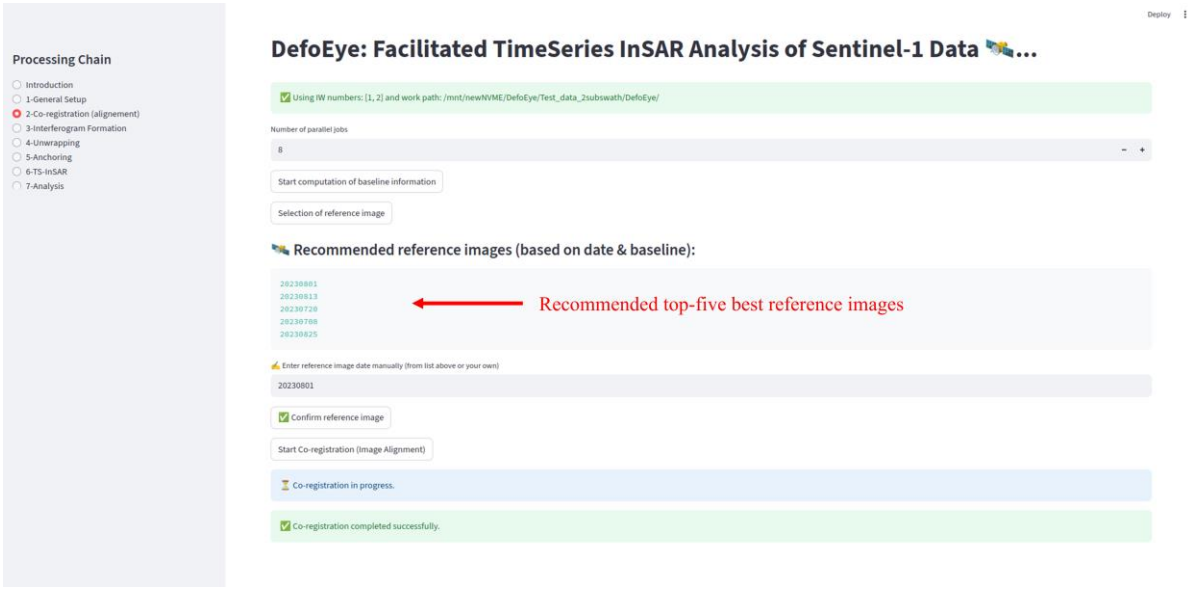

Figure 11. Co-registration.

The next step is interferogram formation (Figure 12). First, the interferogram network is created. Then, each interferogram for each subswath is computed and filtered, and the subswaths are merged into single files.

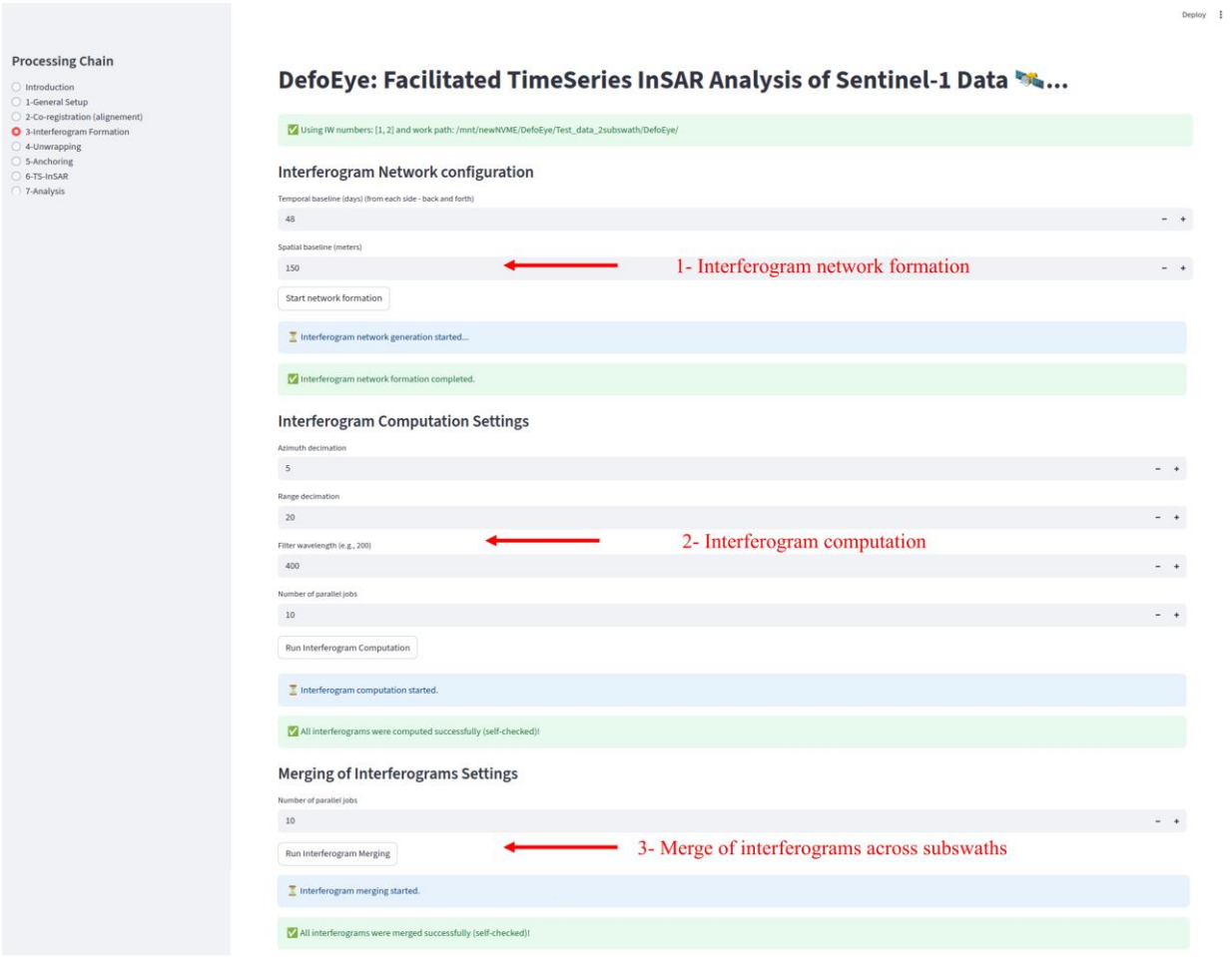

Figure 12. Interferogram Formation.

The next step is unwrapping (Figure 13), where water regions are first masked. Unwrapping is then performed within the selected AOI, and afterward, noisy interferograms are removed from the process using the triplet loop closure technique.

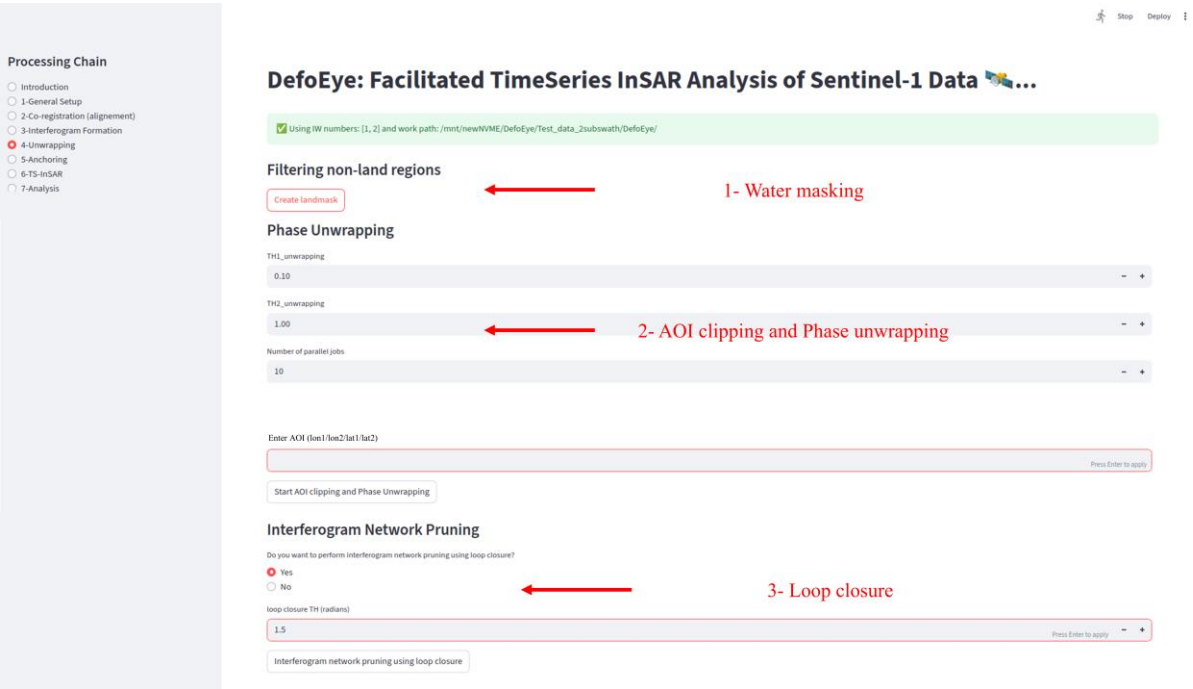

Figure 13. Unwrapping.

Then, the user can anchor the unwrapped interferograms by selecting a method (either point referencing or average-phase referencing) as shown in Figure 14.

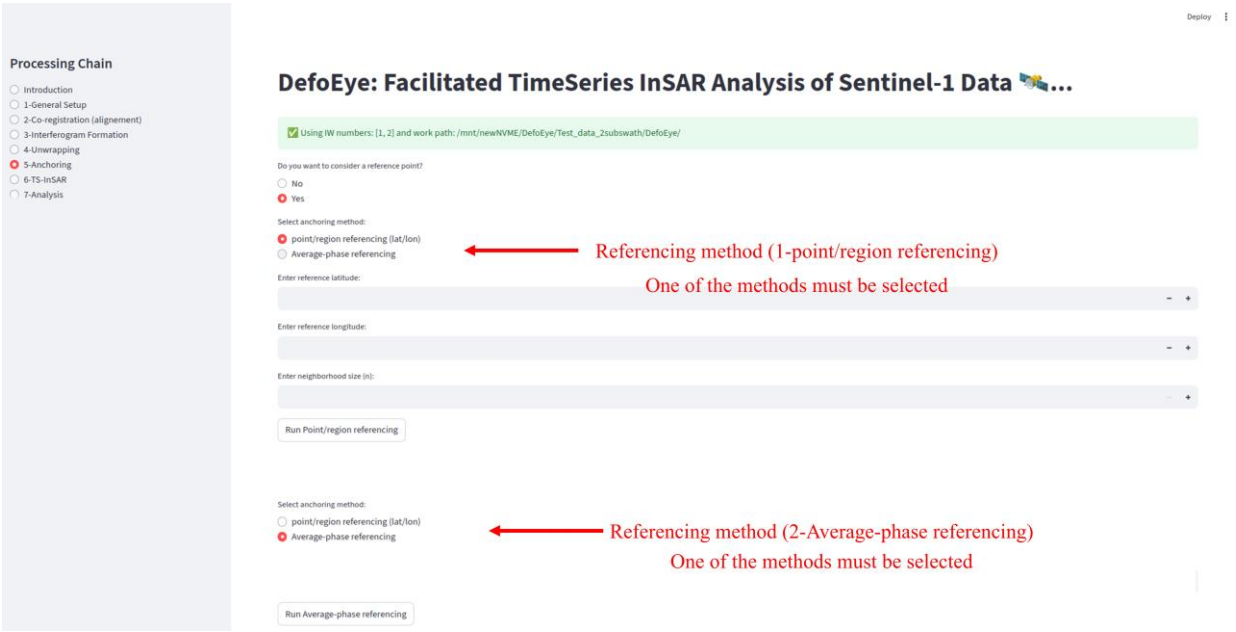

Figure 14. Referencing.

After anchoring, SBAS can be performed, as depicted in Figure 15.

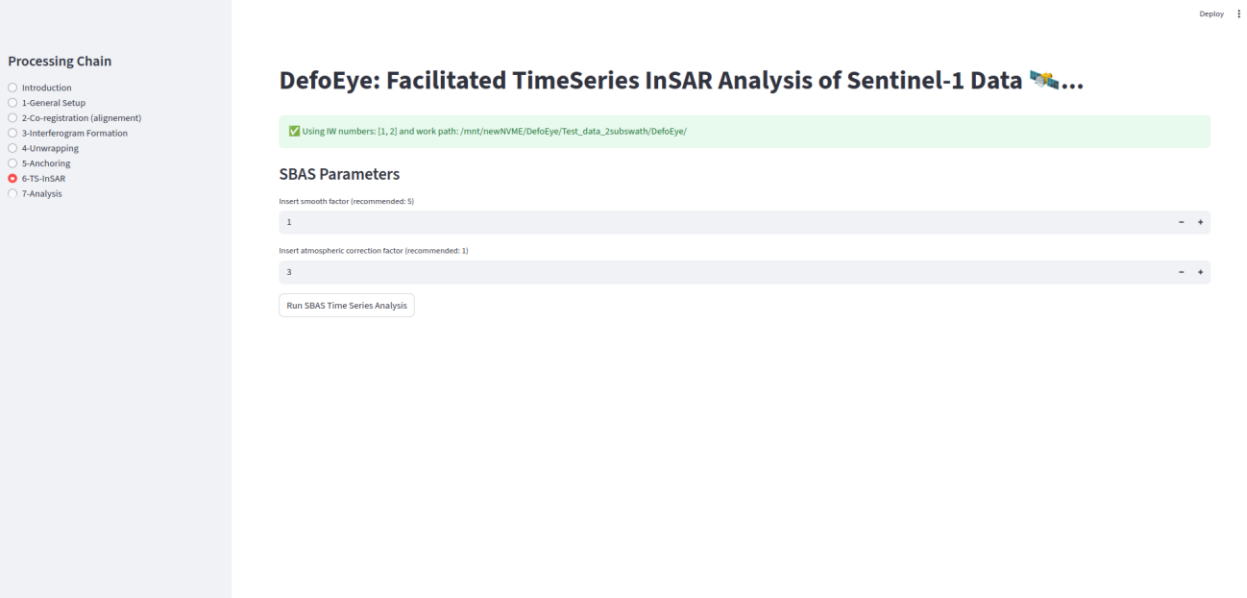

Figure 15. TS-InSAR

Finally, the export module and validation using GNSS data can be performed in Step 7 (Analysis).