UNIVERSITY COURSE APPLIED RADAR REMOTE SENSING

EXERCISE 6 – TUTORIAL

Crop Classification with S1 time series data using the SNAP software

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1 | Exercise outline

In this exercise, we will:

- Use radar Sentinel-1 data to classify and analyse time-series for different types of crop fields
- Data pre-processing will be perfomed, an then the crop types will be estimated by classification of the data, based on the Random Forest algorithm
- Land crops growth and health will be observed using RGB composites and backscatter values of different crop types using time series

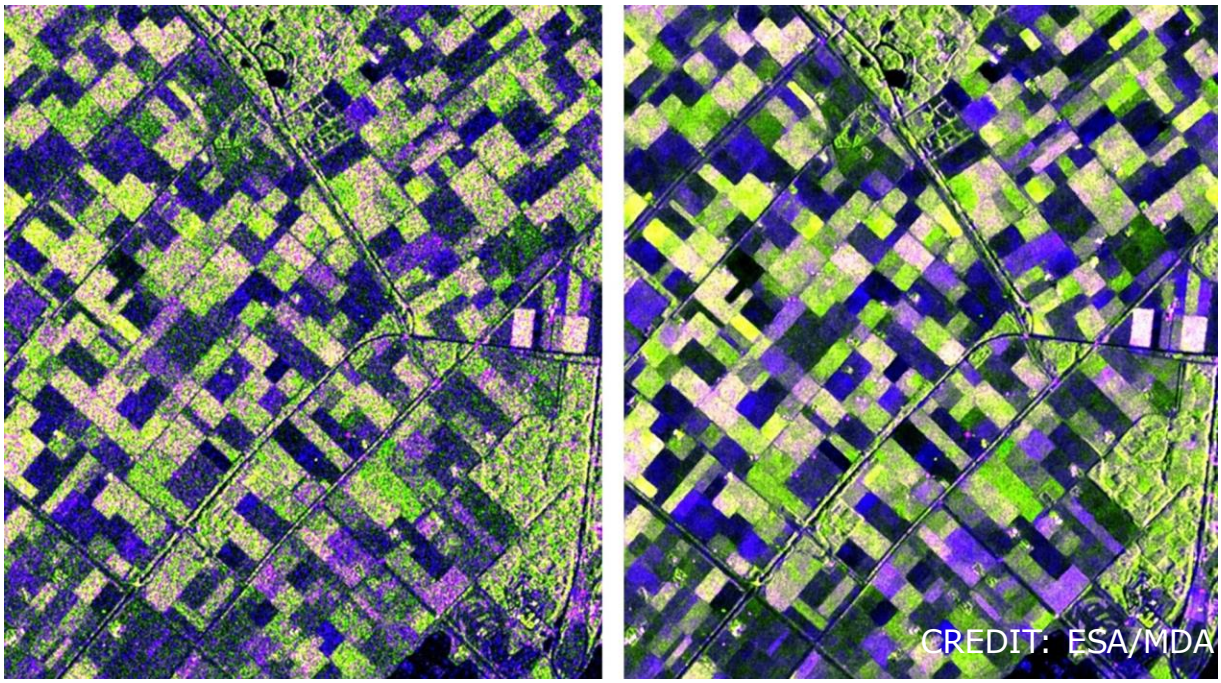
2 | Background

Crop classification using Sentinel-1 time-series

Crop classification using Sentinel-1 data involves the analysis of radar backscatter signals to differentiate between different types of crops based on their unique radar signatures.

Sentinel-1 data, with its frequent revisit times and all-weather capability, is particularly useful for crop classification as it provides consistent and reliable information regardless of weather conditions.

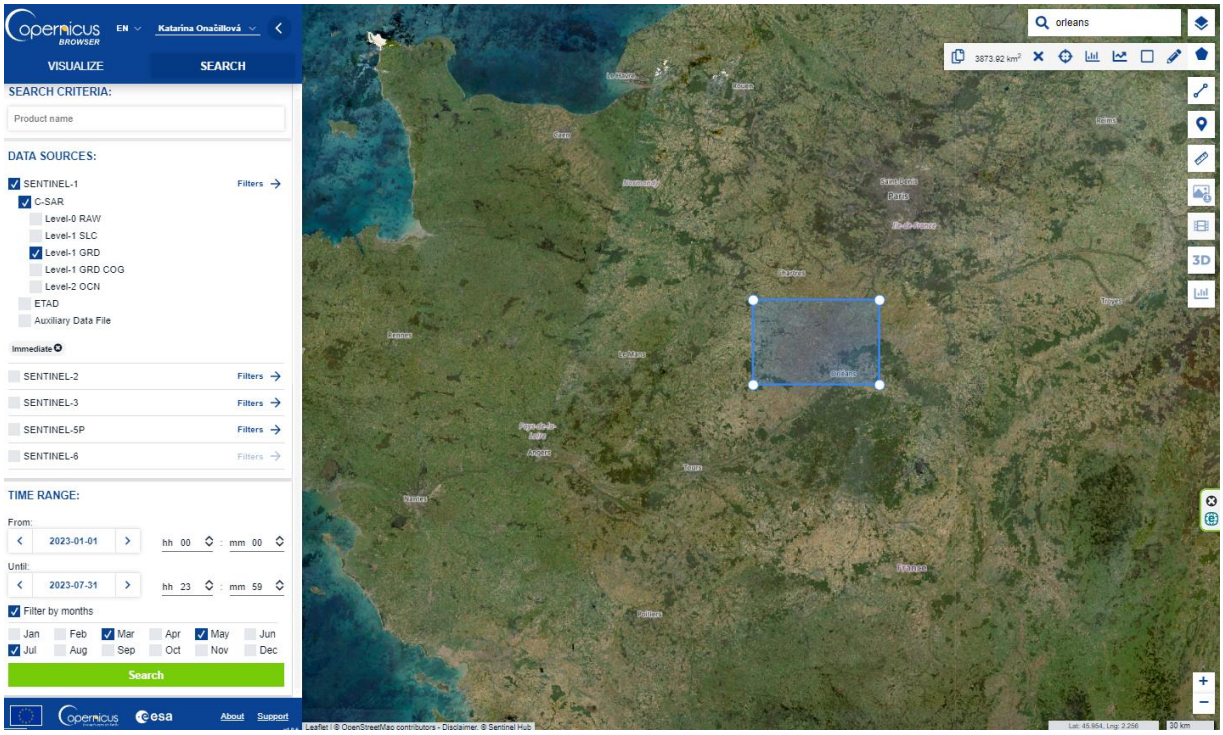
Crop classification using Sentinel-1 data relies on the radar backscatter signals obtained from the satellite. The backscatter intensity, polarization, and texture of the radar imagery are analyzed to distinguish between different crop types.



These images show the same multi-temporal radar composite acquired over the Flevoland test site in the Netherlands. The grainy appearance of the left image is characteristic of radar images and often a limiting factor in using them at high resolution. The right image demonstrates how a new mathematical technique based on multiple images, which was improved in the campaign, can dramatically enhance the appearance of the image and data quality.

2.1 Study area and data used

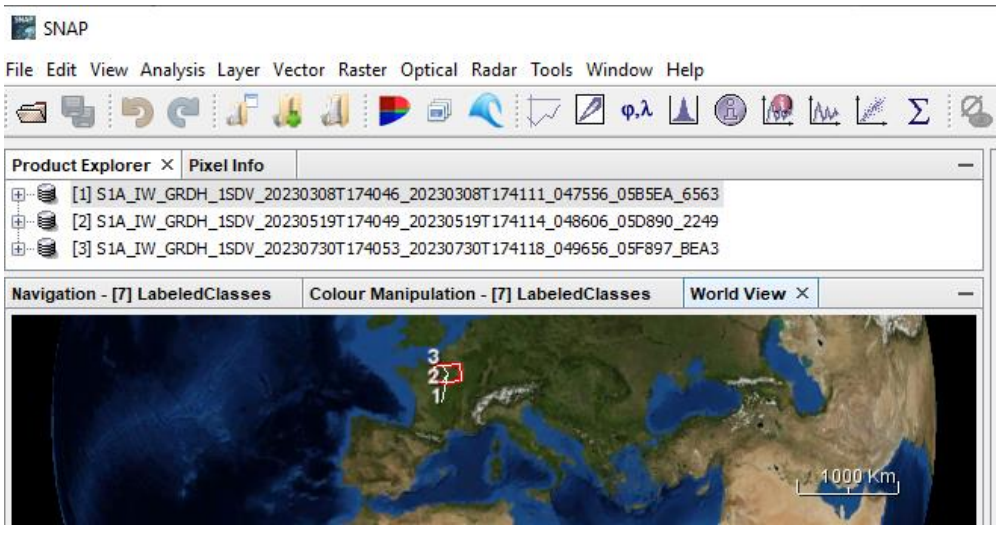
For this exercise, we will use three Sentinel-1 images to explore fields in Orleans, France, downloaded for year 2023 from the Dataspace Copernicus Open Access Hub [@https://dataspace.copernicus.eu/].



2.2. SNAP - Open and explore products

Open SNAP Desktop, click Open Product and open three Sentinel-1 GRDH downloaded products with HH and HV polarizations acquired on 11 July 2023 by double click on the zipped folders. The opened products will appear in Product Explorer window:

S1A_IW_GRDH_1SDV_20230308T174046_20230308T174111_047556_05B5EA_6563.SAFE
S1A_IW_GRDH_1SDV_20230519T174049_20230519T174114_048606_05D890_2249.SAFE
S1A_IW_GRDH_1SDV_20230730T174053_20230730T174118_049656_05F897_BEA3.SAFE



3. Pre-processing

3.1 Create subsets

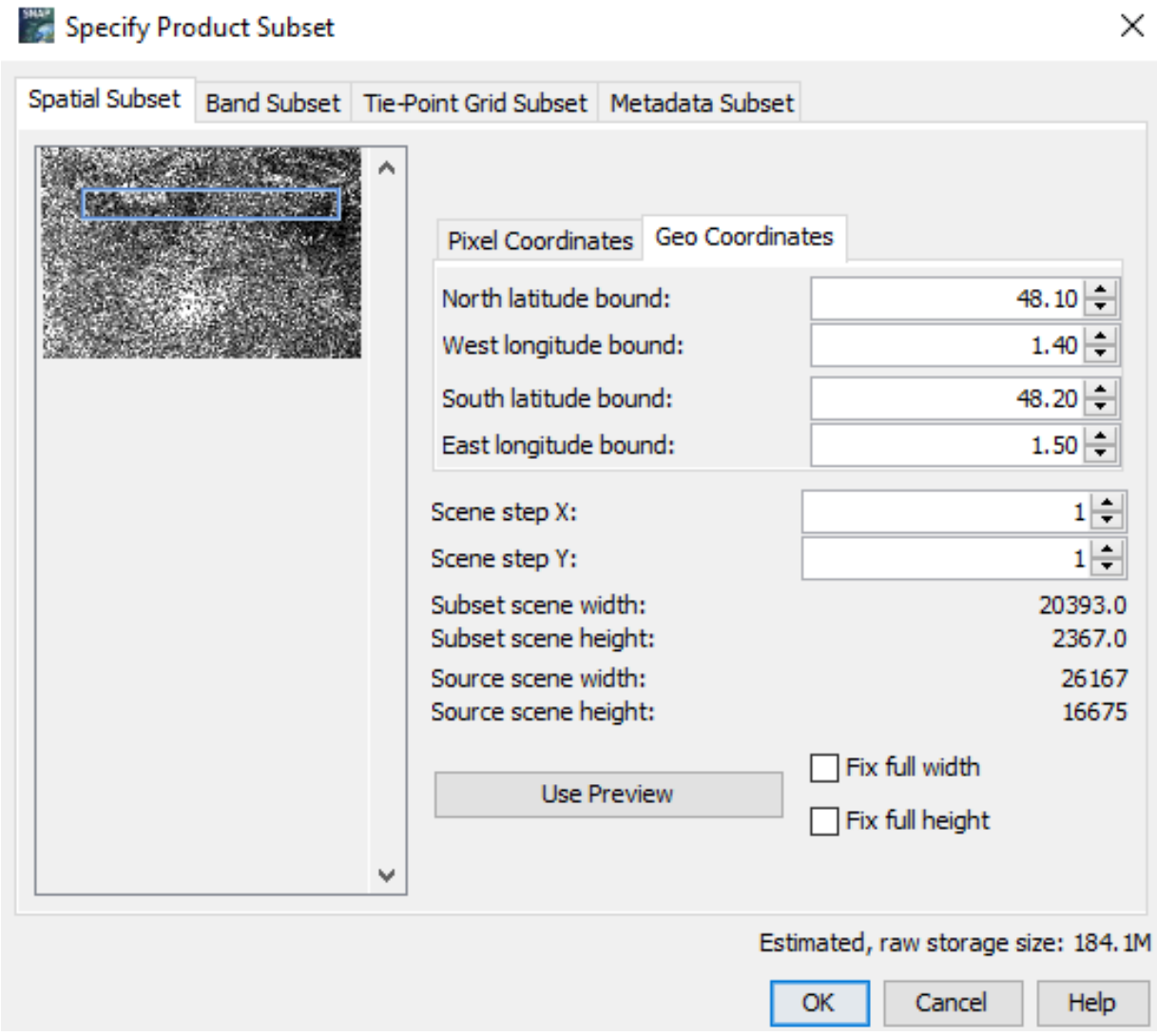
There is no need to process the whole image, instead, we can begin by narrowing down the scene to a more manageable size – creating subset. This approach will decrease processing time in subsequent stages, especially when the analysis is concentrated on a specific area rather than the entire scene.

Go to the Subset tab and at "Geo Coordinates" set:

North latitude bound: 48.10
West longitude bound: 1.40
South latitude bound : 48.20
East longitude bound : 1.50

Note: There is no need to wait till thumbnail image will be created when entering coordinates.

Save the output subsets to your folder – we will need them for the next step.



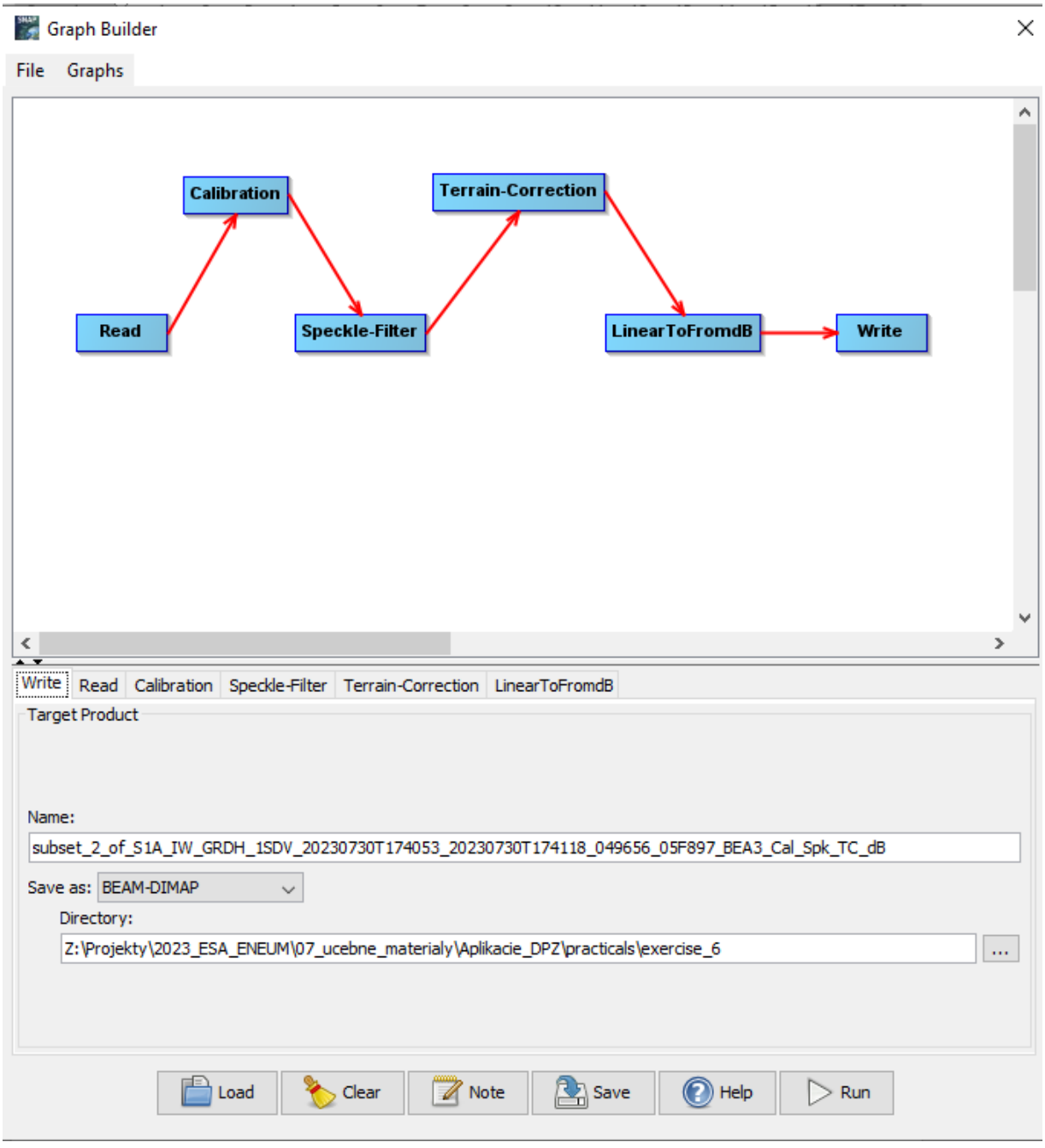
3.2 Build a pre-processing graph

Use the graph builder tool to create workflow for data processing:

Go to Tools > GraphBuilder
Right click and add, in the order below, each of the preprocessing steps:

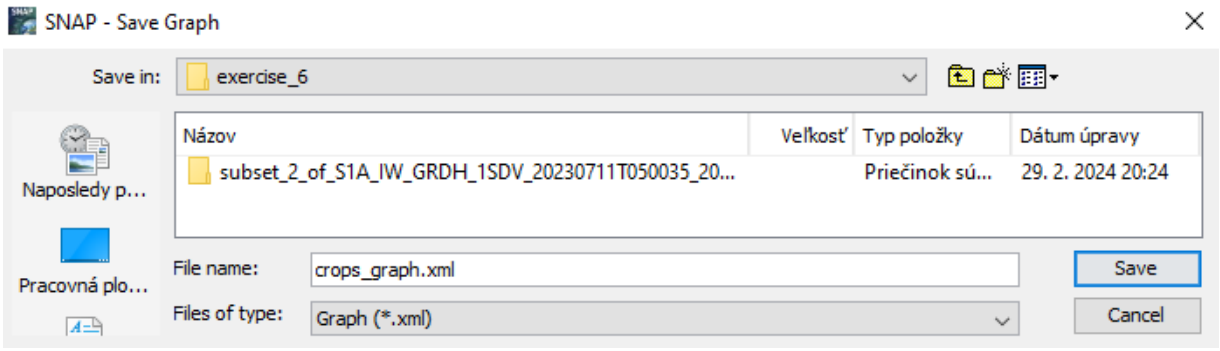
- The first tool is Read
- Add>Radar>Radiometric>Calibration
- Add>Radar>Speckle Filtering>Speckle-Filter
- Add>Radar>Geometric>Terrain Correction>Terrain Correction
- Add>Raster>Data Conversion>LinearToFromdB
- The last tool is Write

Click on each tool, and connect them by dragging the red arrows from one tool to the next, respecting the order above.



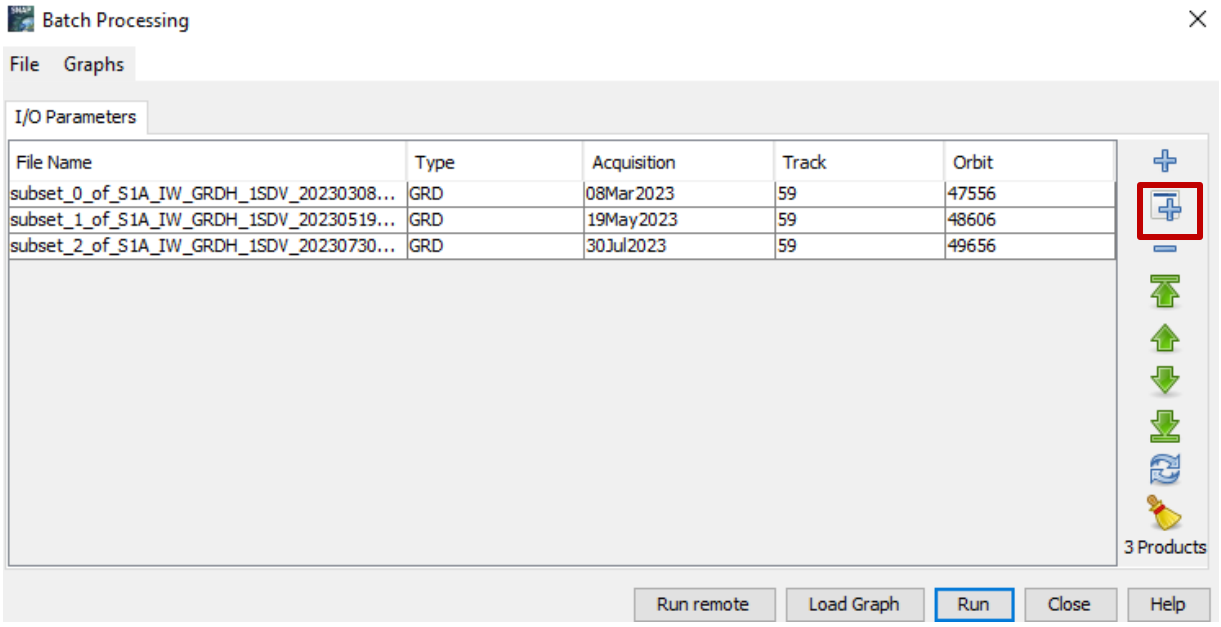
Leave the default parameters for individual tools, except Speckle-Filter:
- here, select Filter: Lee

Then got to File>Save Graph to save the workflow as a XML file „crops_graph".

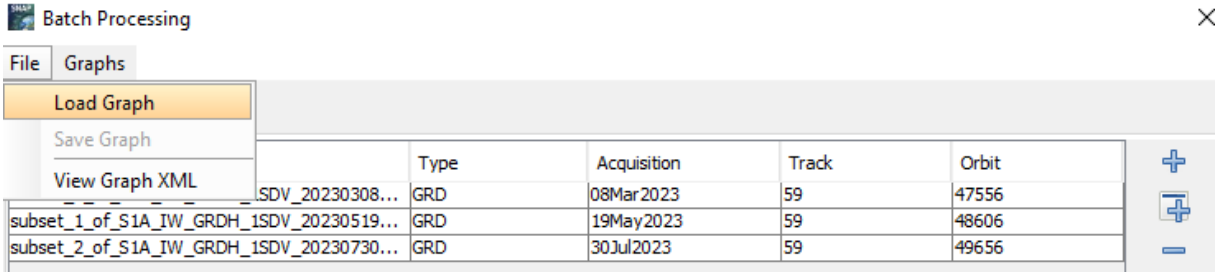


Batch processing

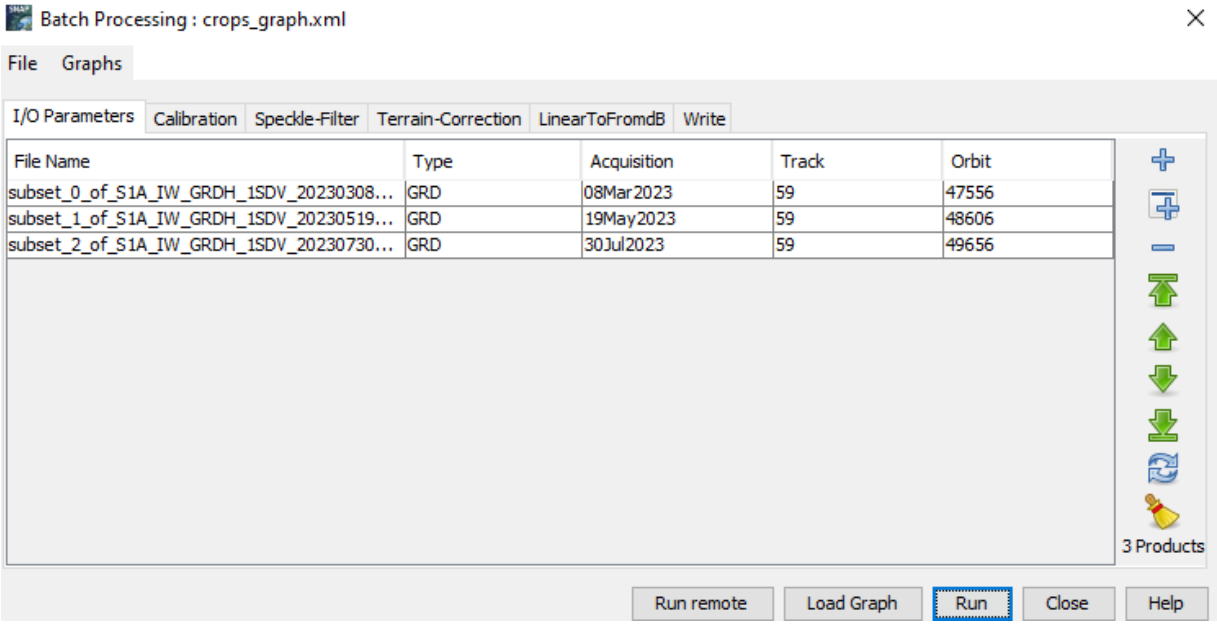
Navigate to Tools > Batch Processing:
Using the Add opened symbol select the files you want to process.



Using the Load Graph button, load the .xml-file you just saved

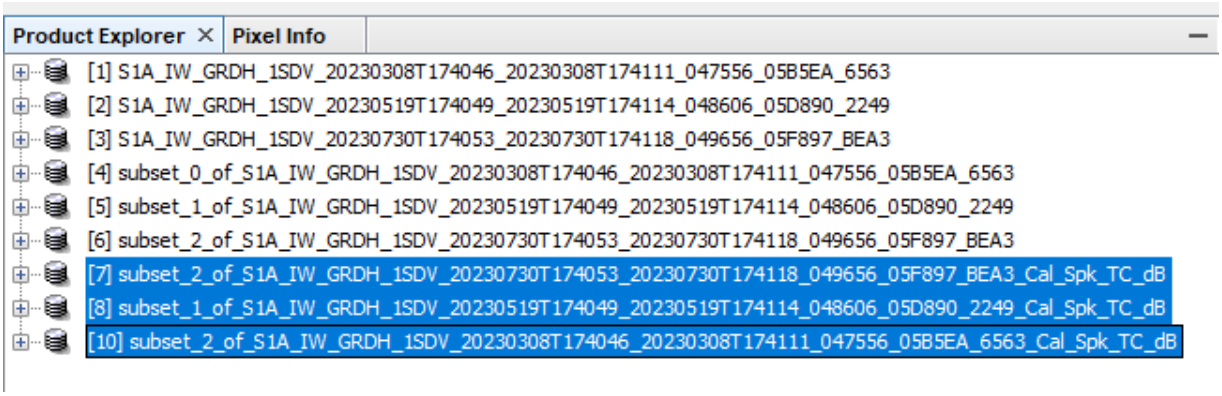


Adjust the output folder, click Run.



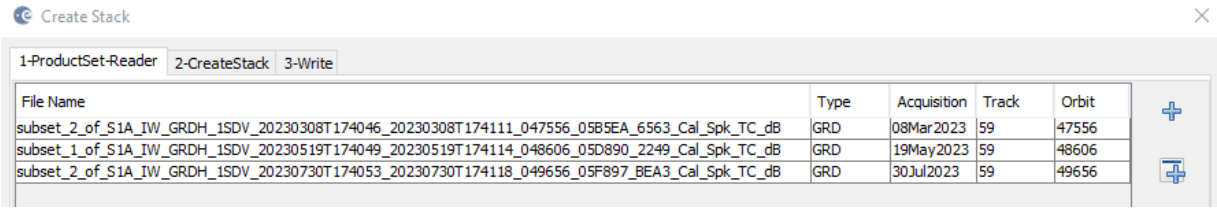
Note: this step might take several minutes to run.

When the process finishes it opens all of the output products in the Product Explorer window.

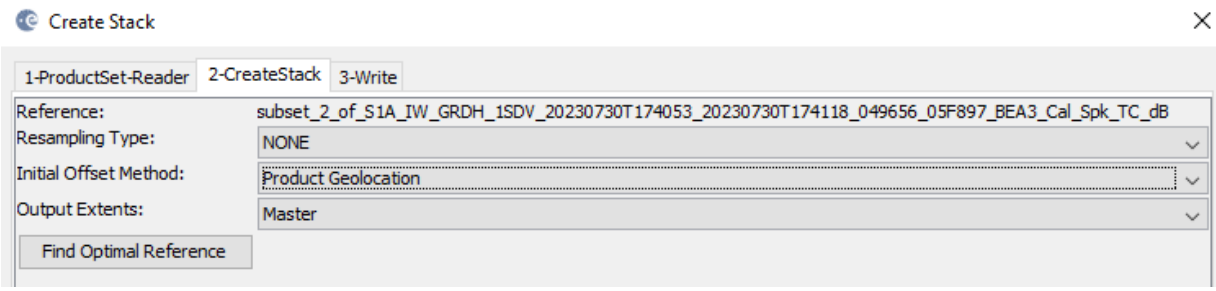


Create stack

Go to Radar > Coregistration > Stack Tools > Create Stack
In the Product-Set-Reader tab select the last three products from the previous step.



In the CreateStack tab, select Product Geolocation as Initial Offset Method (Note: we did not use apply orbit file function, but the product geolocation is accurate enough for the purpose of our analysis)



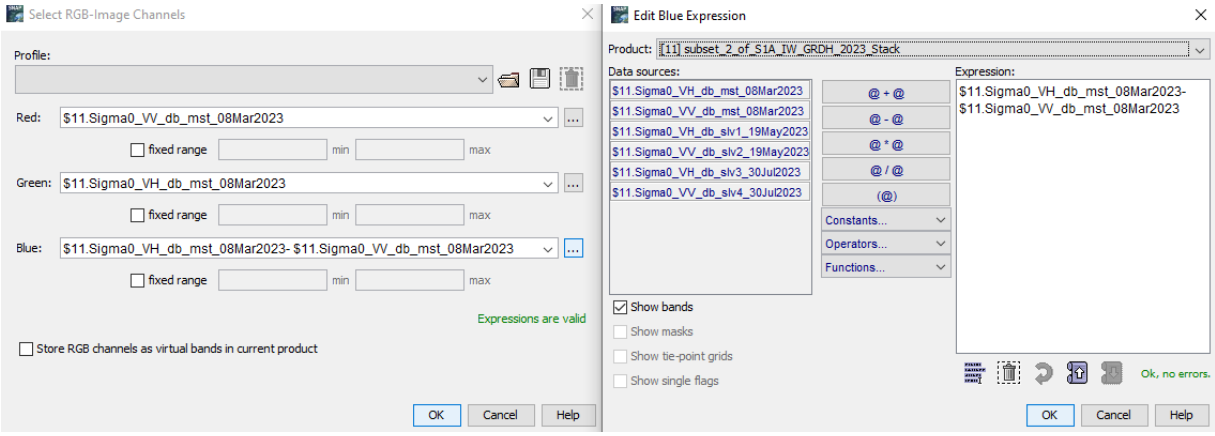
In the Write tab, adjust the stack name if needed, adjust the output folder and click Run. This step will might take few minutes.

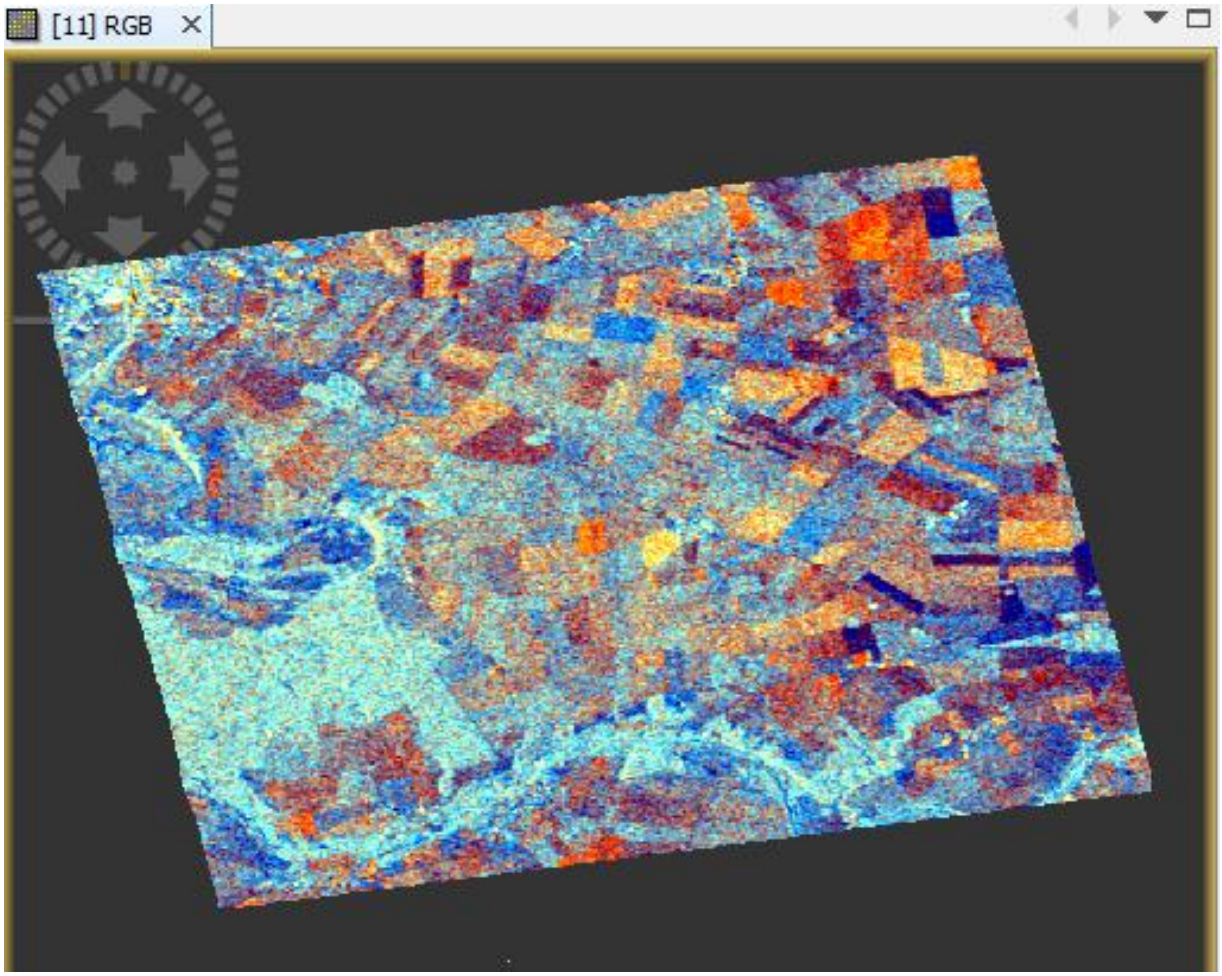
After the process is finished, we can see the new final „Stack" product in the Product Explorer window.

Display RGB time series

Now we can look at some RGB composites of this time series
Right-click on the last „Stack" product – Open RGB Image Window and select different band combinations to see the change of backscatter between one-day acquisition.

Firstly, we can look at polarimetric composite of the same day. For this, select:
Red: Sigma0_VV_db_mst_08Mar2023
Green: Sigma0_VH_db_mst_08Mar2023
Blue: Sigma0_VH_db_mst_08Mar2023-Sigma0_VV_db_mst_08Mar2023





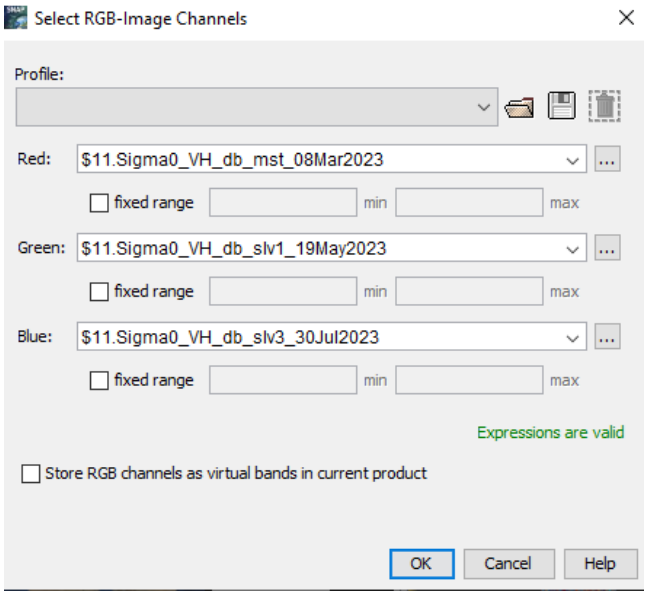
Another RGB composition we can generate is to look at images of the same polarisation but for different dates:

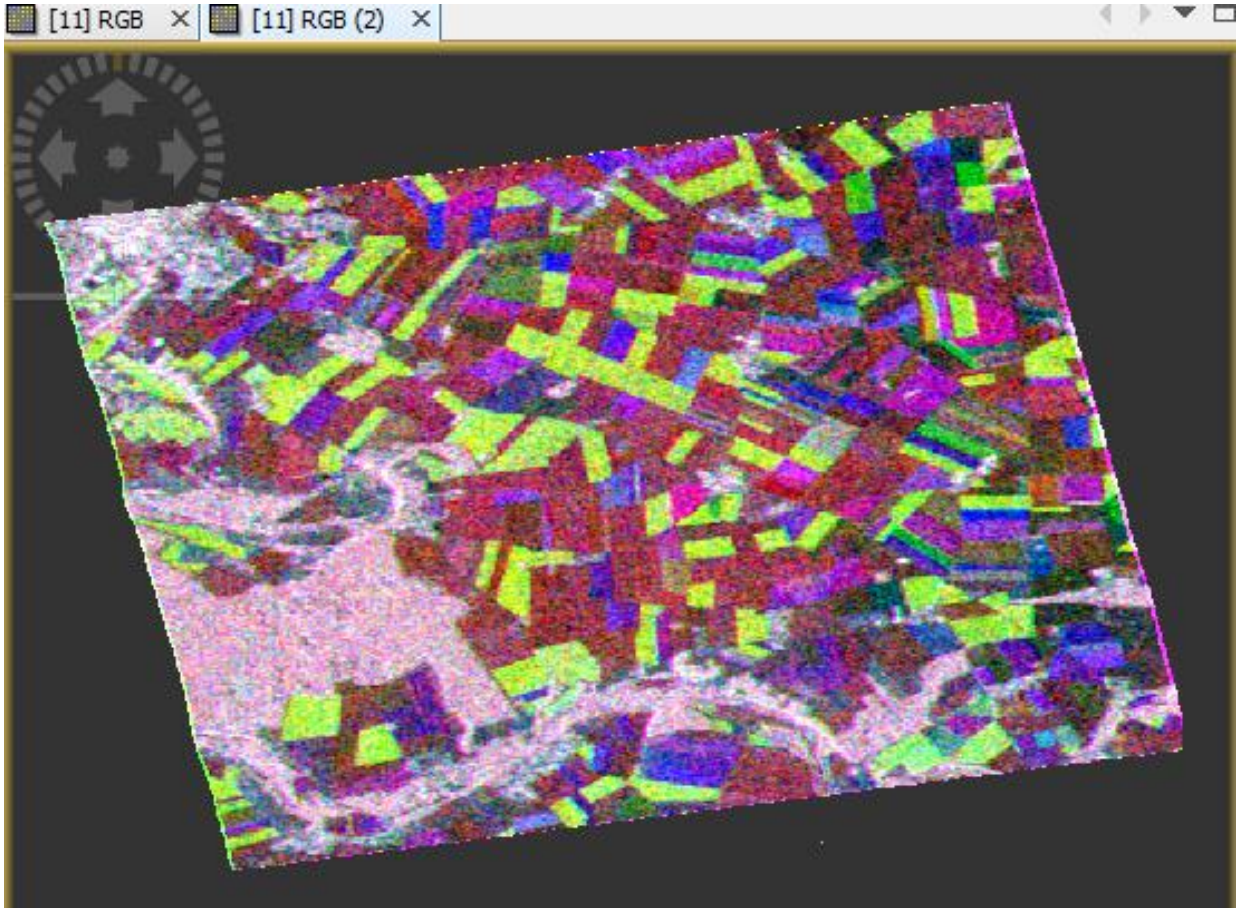
Right-click on the last „Stack" product – Open RGB Image Window and select different band combinations to see the change of backscatter for different acquisitions. For this, select:

Red:
Sigma0_VH_db_mst_08Mar2023

Green:
Sigma0_VH_db_slv_18May2023

Blue:
Sigma0_VH_db_slv_30Jul2023

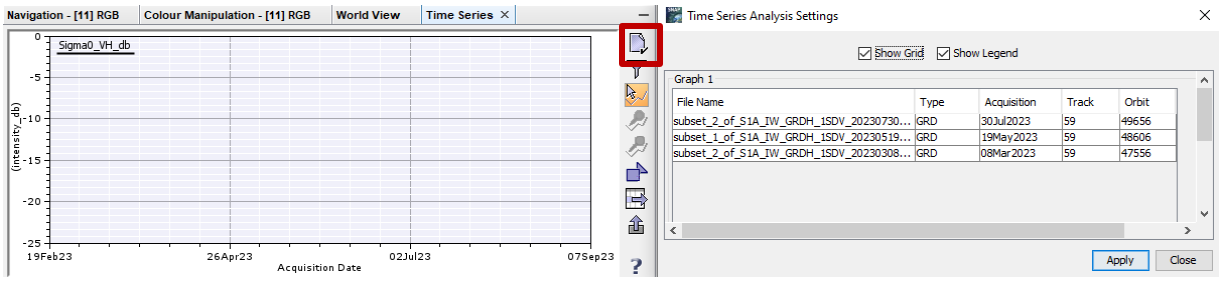




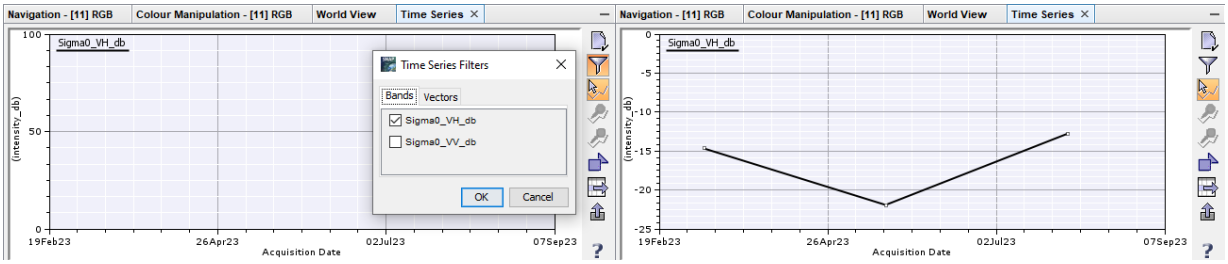
Time Series Analysis (using single scenes, not a stack)

Tool cannot use a stack, it needs single images instead

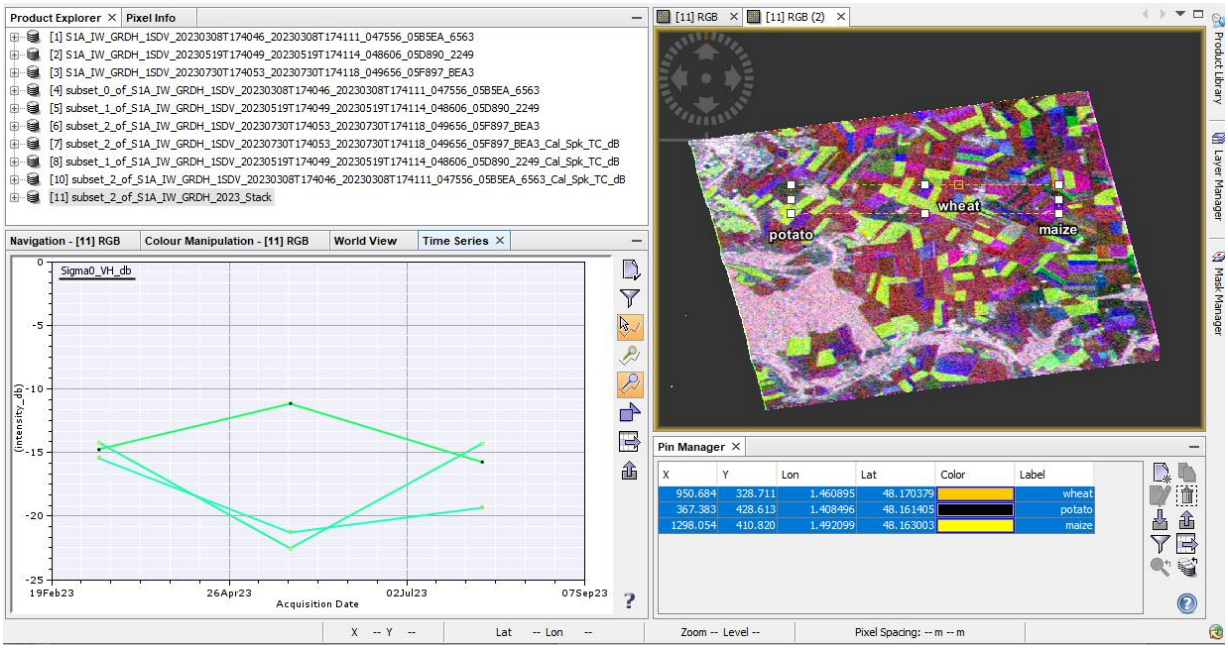
Navigate to View > Tool Windows > Radar > Time Series to open the Time Series tab at the bottom left of your SNAP window.
Click on Settings (top right of Time Series tab) and add individual (pre-processed) images. Click Apply.



Select also polarisation for which you want to explore time-series and click OK.



Using the time series tab, hover your mouse over the area to see the behaviour of single pixels over or use Pin Manager (View-Tool Windows-Pin Manager) to see the behaviour of the selected Pins.



Explore backscatter values of different crop types within the time range.

For more information, see the lecture: [6. SAR and optical remote sensing for precision agriculture 2]

THANK YOU FOR FOLLOWING THE EXERCISE!