SENTINEL-1 FOR AGRICULTURE MONITORING

Data: Sentinel-1A IW GRDH 1SDV (to download from Sentinel Data Hub: https://scihub.copernicus.eu/):

- S1A_IW_GRDH_1SDV_20160112T170742_20160112T170807_009464_00DB96_2299.zip

1. Open file
    1.1. File / Open Product
    1.2. Browse to
        S1A_IW_GRDH_1SDV_20160112T170742_20160112T170807_009464_00DB96_2299.zip

2. View metadata
    2.1. Select plus icons by filenames in "Product Explorer", expand "Metadata", double click on "Extracted Metadata". Here you can see the basic product information such as acquisition date, product type, acquisition mode, and geometry (antenna pointing, incidence angle, pass).

3. View world map
    3.1. View / Tool Windows / World Map
    3.2. Select magnifying glass icon to zoom to image footprint
    3.3. Use mouse wheel and left click to zoom and pan respectively

4. View image single bands
    4.1. Select "Bands" folder in "Product Explorer" window and view each band by double clicking on band name.

5. View multiple viewers
    5.1. Close metadata views, leaving only viewers with bands
    5.2. Synchronise views by selecting the relevant icons in the "Navigation" tab
    5.3. Select: Window / Tile Horizontally

6. Crop
    6.1. Select the image name in the "Product Explorer" window
    6.2. Raster / Subset…
    6.3. Select the "Geo Coordinates" tab, and input the following coordinates:
    North latitude bound: 51.117
    West longitude bound: 10.867
    South latitude bound: 51.067
    East longitude bound: 10.967
    6.4. Select "OK"

7. Save the newly created subset image
    7.1. Select image in "Product Explorer"
    7.2. Select: File / Save Product As… (e.g., S1A_IW_GRDH_1SDV_20160112T170742_20160112T170807_009464_00DB96_2299_subset)
    7.3. Select "Yes" to convert to BEAM DIMAP format (SNAP native file format)
    7.4. Select an output filename and location, and select "Save"

8. Calibrate
    8.1. Radar / Radiometric / Calibrate
    In the "I/O Parameters" select "S1A_IW_GRDH_1SDV_20160112T170742_20160112T170807_009464_00DB96_2299_subset". The target product will be automatically renamed with the ending "_Cal".
    8.2. Select the newly created subset image as source and specify an output directory and filename
    8.3. View the "Processing Parameters" tab (but leave all settings as default)
    8.4. Select "Run"

8.5. View the calibrated image

9. Filter speckle
   9.1. Radar / Speckle Filtering / Single Product Speckle Filter
   9.2. In the "I/O Parameters" select
      "S1A_IW_GRDH_1SDV_20160112T170742_20160112T170807_009464_00DB96_2299_subset_Cal
      ". The target product will be automatically renamed with the ending "_Spk".
   9.3. View the "Processing Parameters" tab (but leave all settings as default)
   9.4. In the "Filter" dropdown box, select "Lee"
   9.5. In "Filter Size X:" and "Filter Size Y:" select 3, and 3 respectively.
   9.6. Select "Run"

10. Convert to decibel (logarithmic scale)
    10.1. Expand the list of bands of the calibrated and speckle filtered image, right mouse click on the band
       "Sigma0_VH", select: "Linear to/from dB", then select "Yes" in the pop-up window.
    10.2. Repeat this also for the "Sigma0_VV" band.
    10.3. Right click on the newly created "Sigma0_VH_db" and "Sigma0_VV_db" bands and select "Convert
   Band", then: File / Save Product, to save the virtual bands to file.

11. RGB image view
    11.1. Window / Open RGB Image Window
    11.2. Select the following bands: Red = Sigma0_VV_db, Green = Sigma0_VH_db, Blue = Sigma0_VV_db
    11.3. Contrast stretch the images: Colour Manipulation tab, move triangular sliders to either side of the
       histogram for each R, G and B channel.
    11.4. Repeat the process for the image prior to speckle filtering, and compare both speckle filtered and
       non-speckle filtered images: Window / Tile Horizontally, then link viewers in the "Navigation" tab
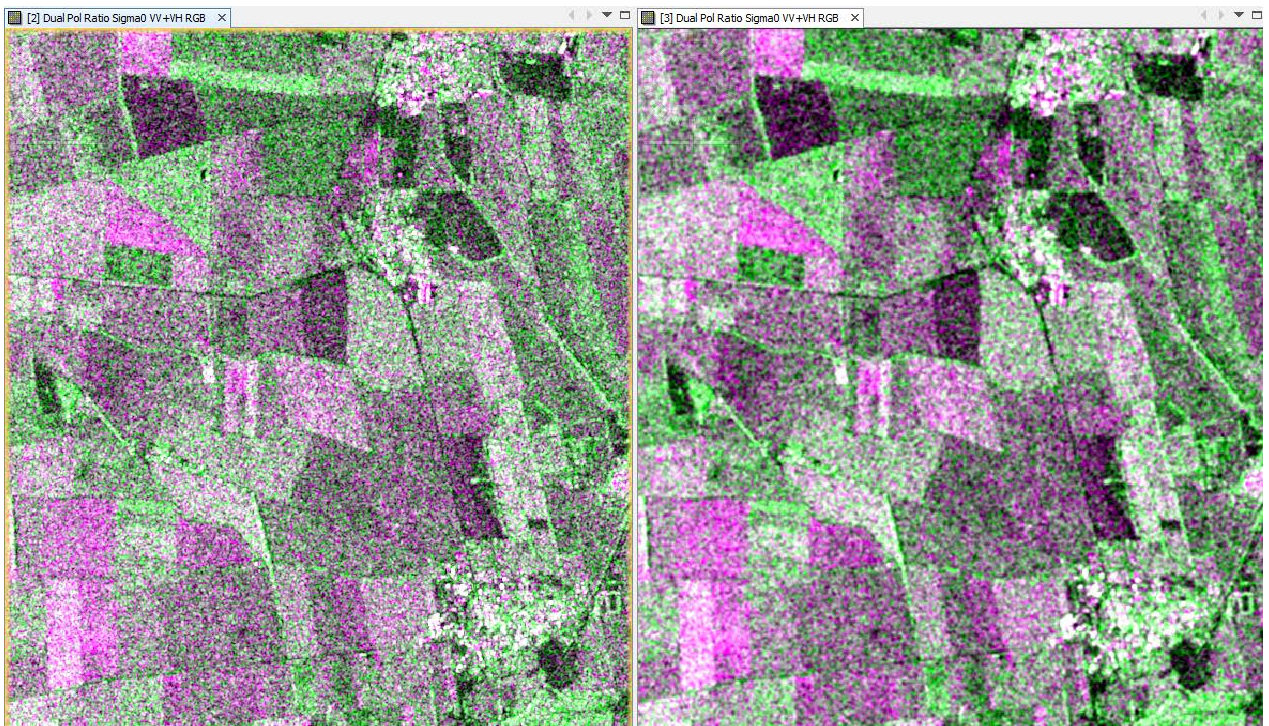
12. Geocoding / Terrain Correction
    12.1. Radar / Geometric / Terrain Correction / Range-Doppler Terrain Correction

12.2. In the "I/O Parameters" select
"S1A_IW_GRDH_1SDV_20160112T170742_20160112T170807_009464_00DB96_2299_subset_Cal
_Spk". The target product will be automatically renamed with the ending "_TC".
12.3. View the "Processing Parameters" tab (but leave all settings as default)
12.4. Select "Run"

13. Close all images in SNAP
13.1. Close all viewers
13.2. Right click on the name of one of the images in the "Product Explorer" window and select "Close
All Products"

Sentinel-1 Dual Pol Time Series Analysis

Data: Sentinel-1A IW GRDH 1SDV:

1. S1A_IW_GRDH_1SDV_20160112T170742_20160112T170807_009464_00DB96_2299_subset.dim
2. S1A_IW_GRDH_1SDV_20160124T170741_20160124T170806_009639_00E0BA_A936_subset.dim
3. S1A_IW_GRDH_1SDV_20160205T170741_20160205T170806_009814_00E5C0_8FAB_subset.dim
4. S1A_IW_GRDH_1SDV_20160217T170802_20160217T170827_009989_00EAE9_8994_subset.dim
5. S1A_IW_GRDH_1SDV_20160229T170741_20160229T170806_010164_00EFE2_E0E6_subset.dim
6. S1A_IW_GRDH_1SDV_20160312T170741_20160312T170806_010339_00F4FA_1381_subset.dim
7. S1A_IW_GRDH_1SDV_20160324T170742_20160324T170807_010514_00F9D6_82E4_subset.dim
8. S1A_IW_GRDH_1SDV_20160405T170742_20160405T170807_010689_00FEF3_BD55_subset.dim
9. S1A_IW_GRDH_1SDV_20160417T170743_20160417T170808_010864_01042F_A10C_subset.dim
10. S1A_IW_GRDH_1SDV_20160429T170743_20160429T170808_011039_0109A8_17CB_subset.dim
11. S1A_IW_GRDH_1SDV_20160511T170747_20160511T170812_011214_010F2F_6BEF_subset.dim
12. S1A_IW_GRDH_1SDV_20160523T170747_20160523T170812_011389_0114EB_2B14_subset.dim
13. S1A_IW_GRDH_1SDV_20160604T170753_20160604T170818_011564_011A8B_6206_subset.dim
14. S1A_IW_GRDH_1SDV_20160628T170755_20160628T170820_011914_01258C_8FC4_subset.dim
15. S1A_IW_GRDH_1SDV_20160722T170756_20160722T170821_012264_0130EC_0E23_subset.dim
16. S1A_IW_GRDH_1SDV_20160815T170757_20160815T170822_012614_013C81_EBC5_subset.dim
17. S1A_IW_GRDH_1SDV_20160908T170758_20160908T170823_012964_014825_5663_subset.dim
18. S1A_IW_GRDH_1SDV_20160920T170759_20160920T170824_013139_014DEE_6D15_subset.dim
19. S1A_IW_GRDH_1SDV_20161002T170759_20161002T170824_013314_015387_6F6F_subset.dim
20. S1A_IW_GRDH_1SDV_20161014T170759_20161014T170824_013489_015911_A4CD_subset.dim
21. S1A_IW_GRDH_1SDV_20161026T170759_20161026T170824_013664_015E7F_0237_subset.dim
22. S1A_IW_GRDH_1SDV_20161107T170759_20161107T170824_013839_0163F7_C9AC_subset.dim
23. S1A_IW_GRDH_1SDV_20161201T170758_20161201T170823_014189_016EC6_E2E8_subset.dim
24. S1A_IW_GRDH_1SDV_20161213T170758_20161213T170823_014364_01745F_7A42_subset.dim
25. S1A_IW_GRDH_1SDV_20161225T170758_20161225T170823_014539_0179C8_CF8C_subset.dim
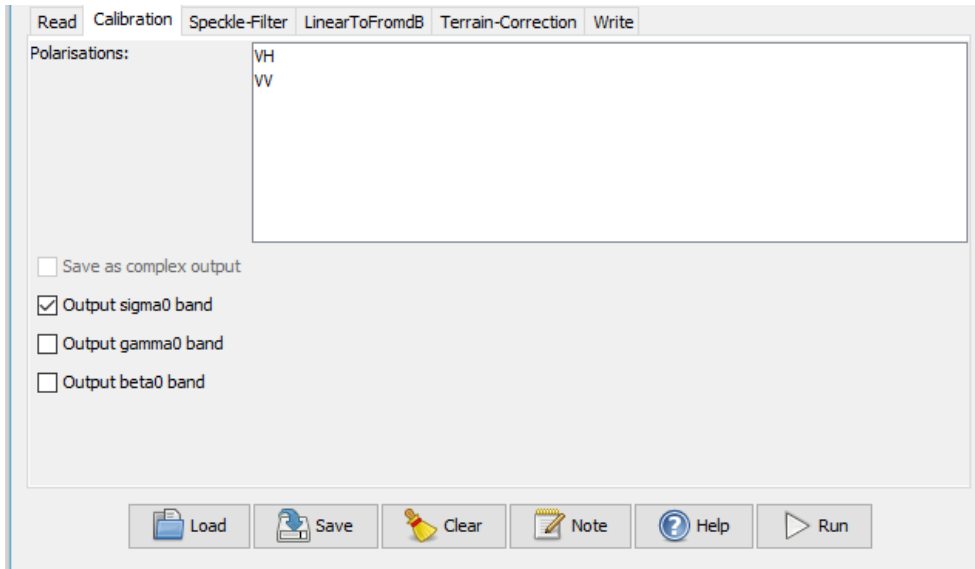
14. Open all files listed above
14.1. File / Open Product
14.2. Browse to data

15. Create processing chain
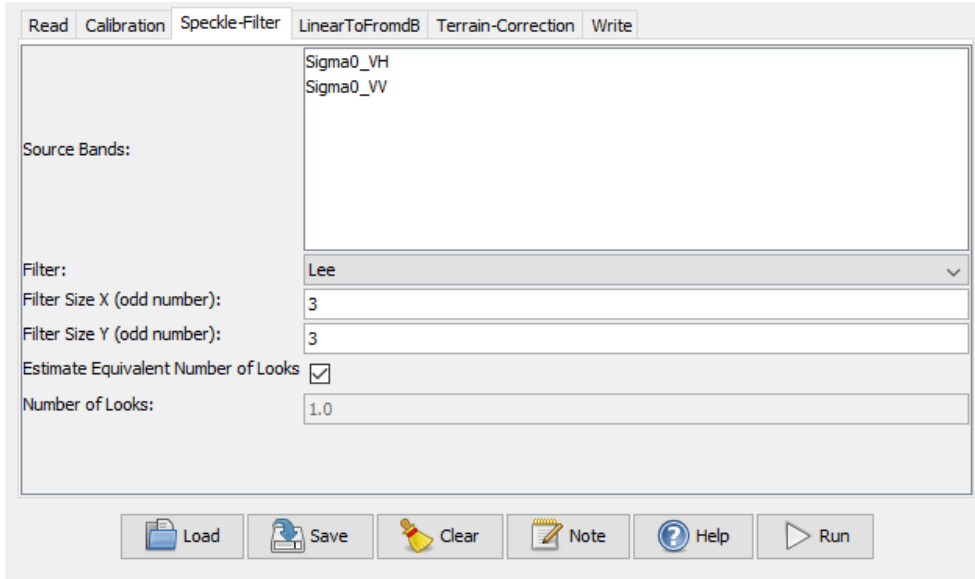15.1. Tools / GraphBuilder
15.2. Create the following graph by right mouse clicking and selecting a process, and left clicking on each
process to connect them with arrows.
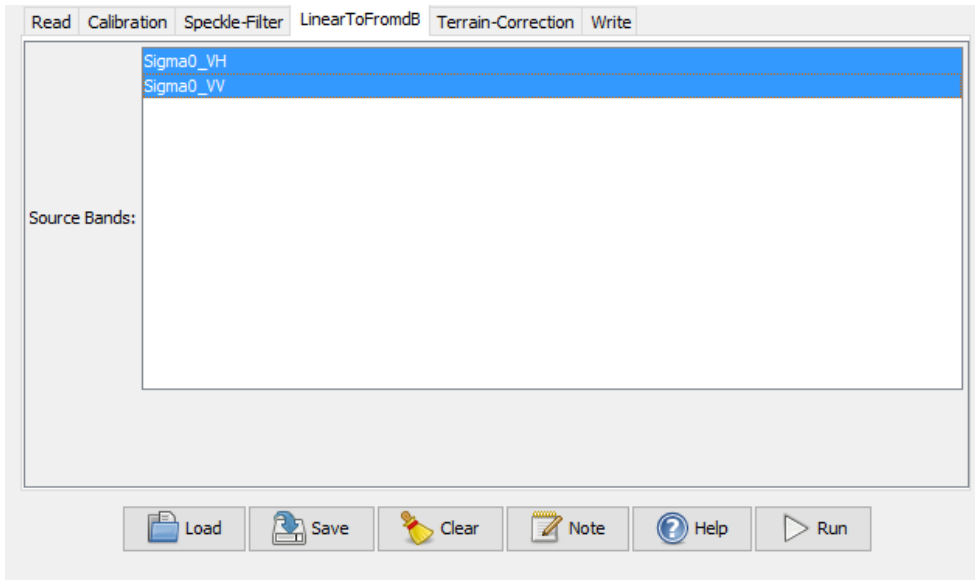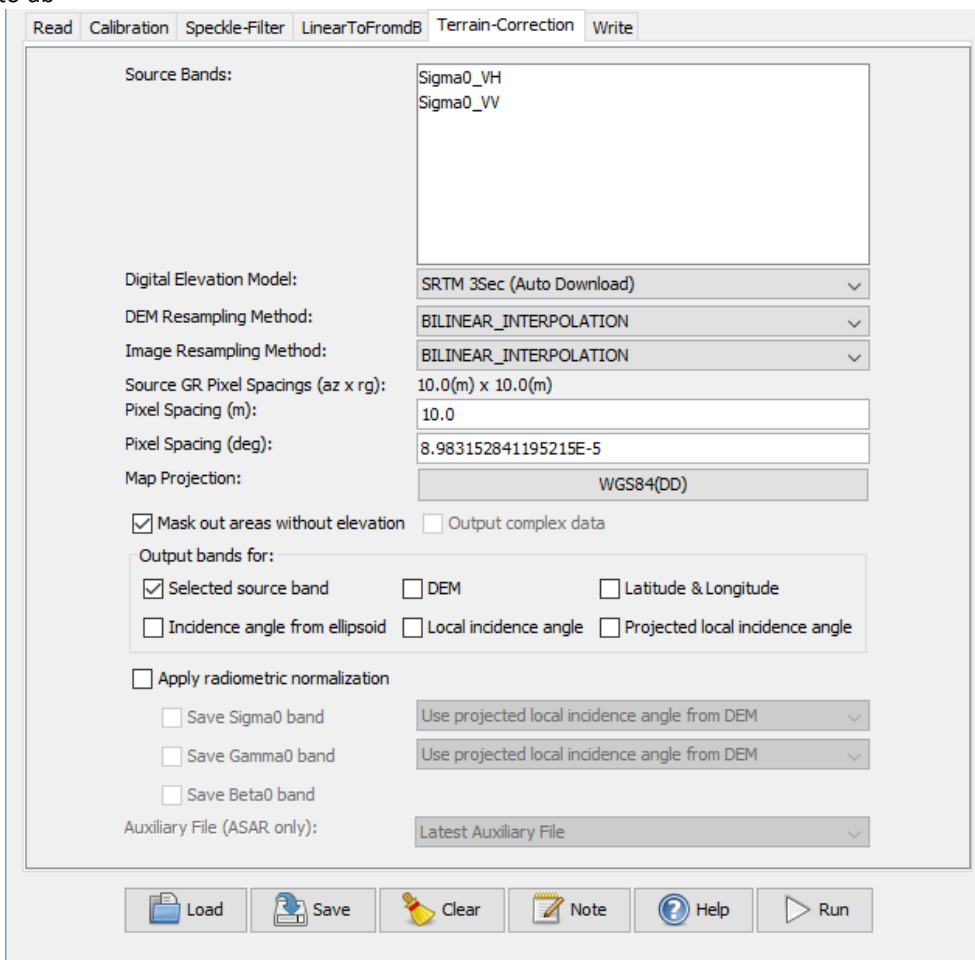15.3. Below the graph, for each process, apply the settings as shown below:
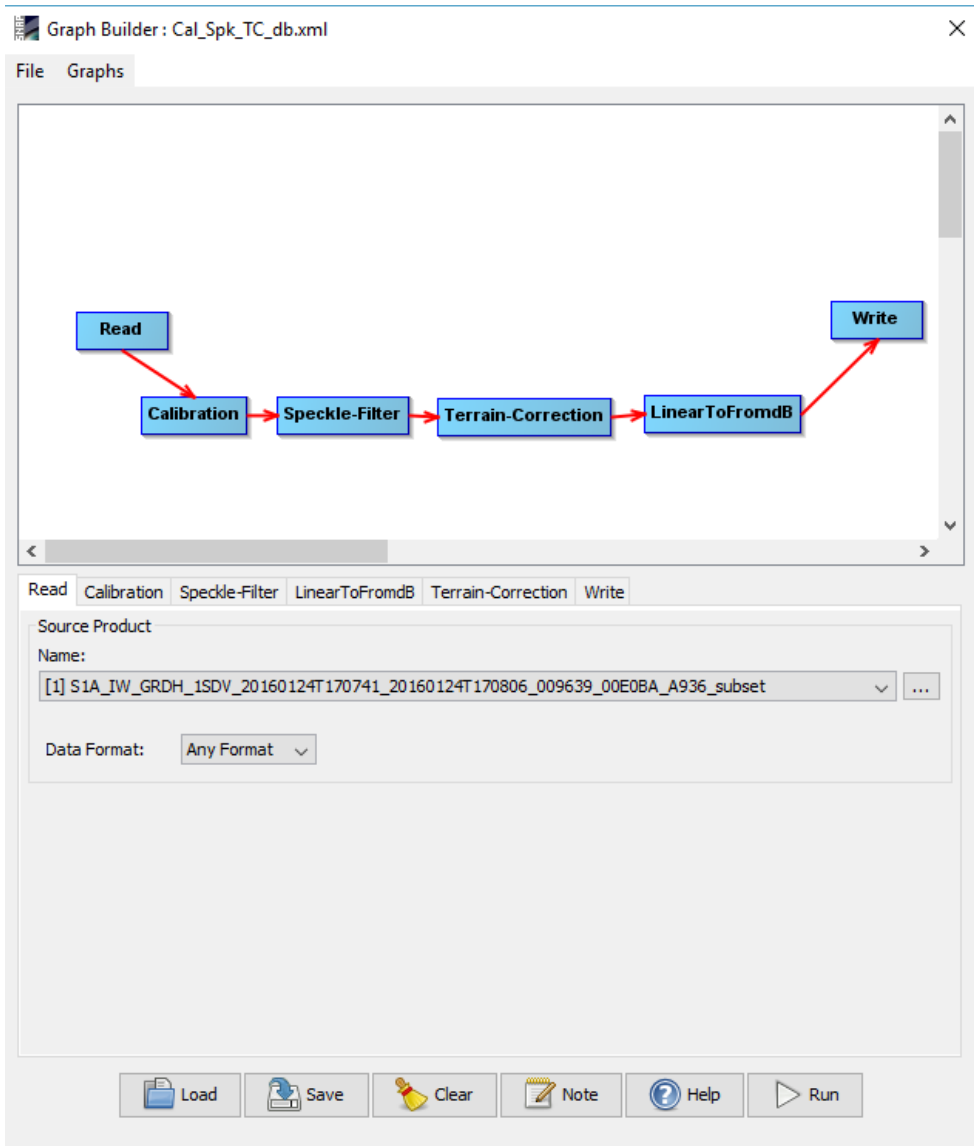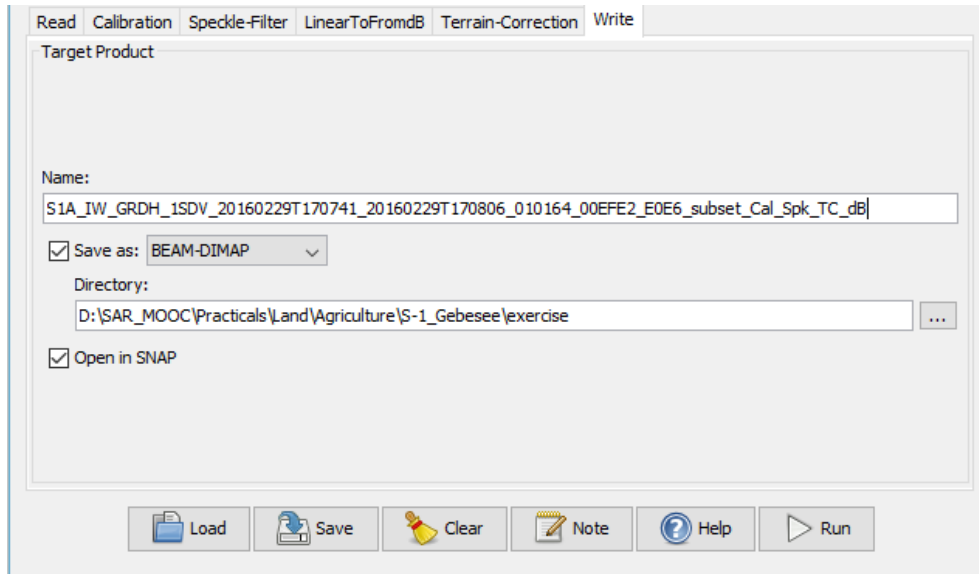
Read

Calibration

Speckle Filtering

Linear to db

Terrain-Correction

Write

15.4. Select "Save" and save the graph.
15.5. DO NOT select "Run", instead close the Graph Builder window.

16. Create batch directory
16.1. Create a new folder in which to save batch processed imagery

17. Batch processing
17.1. Tools / Batch Processing
17.2. Select "Add Opened"
17.3. Select "Load Graph" and browse to saved graph.
17.4. Under "Directory" browse to newly create batch directory
17.5. Select "Run"

18. Create stack
18.1. Close all images and reopen batch processed images in the batch folder
18.2. Radar / Coregistration / Stack Tools / Create Stack
18.3. Select "Add Opened"
18.4. In the "2-CreateStack" tab, select the following parameters: "Initial Offset Method": Product Geolocation
18.5. In the "Write" tab, select a filename and location
18.6. Select "Run"

19. Multitemporal, polarimetric analysis
19.1. View various temporal and polarimetric RGB composites of the speckled filtered stack in dB: Window / Open RGB Image Window
19.1.1. Example: Red = VV_dB, Green = VH_dB, Blue = VV_dB from the same date
19.1.2. Example: Red = VH_dB, Green = VH_dB, Blue = VH_dB from three different dates
19.2. Select "Export Product"

Sentinel-1 backscatter behaviour over different crop types

20. Overlay a shapefile of agricultural crop types from 2016
20.1. Open RGB Image Window (Step 18) (e.g., R=VV_db_17Feb_2016, Green=VV_db_22Jul2016, Blue=VV_db_07Nov2016

20.2. In Layer Manager click "Add Layer"

20.3. Select ESRI Shapefile, click "Next"

20.4. Browse to the shapefile "investigated_fields_2016_potato.shp, and select "Open".

20.5. Select "Finish"

20.6. Add another crop types (Spring wheat, sugar beat, winter barley, winter wheat) (same steps 19.1-19.4)

21. View temporal backscatter signature of different crops

21.1. View / Tool Windows / Radar / Time Series

21.2. Click Settings in "Time Series"-Box

21.3. In "Time Series Analysis Settings" click "Add Opened" and then "Apply" (note: open single pre-processed S1 data to create a time series plot; time series plot does not work with a stack)

21.4. In "Time Series"-Box click "Filter bands" and select e.g. all Bands in VH polarization (or check "select all")

21.5. In "Time Series"-Box click "Show at cursor position"

21.6. Navigate with the cursor to different crop types

22. Temporal backscatter signature with Pin Tool

22.1. Activate "Tools" (View / Toolbars / Tools)

22.2. Click "Pin Placing Tool"

22.3. Click on specific crop type

22.4. In Pin Manager (View / Toolbars Tool / Window) you can edit and remove your pins

22.5. Put at least one pin to every crop type
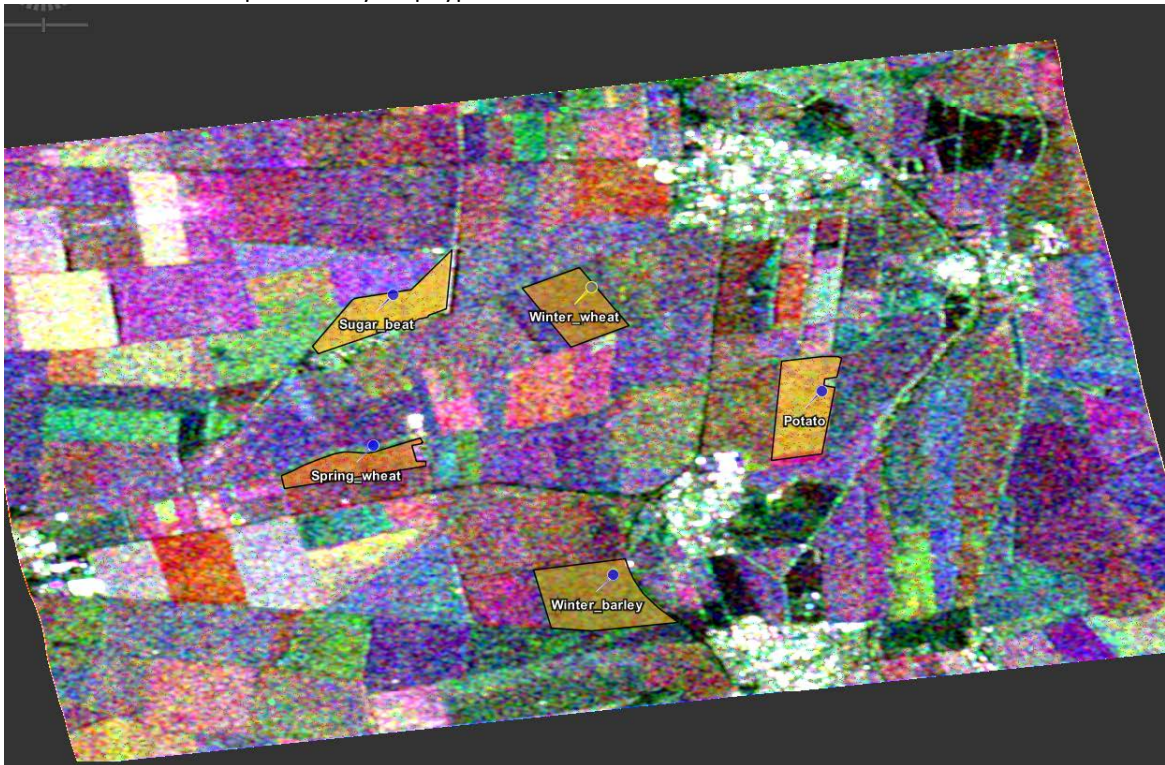
22.6. In "Time Series"-Box deactivate "Show at cursor position" but activate "Show for all pins"

22.7. You can export temporal backscatter signature as csv data ("Export graph to text file") or an image ("Export graph to image file")