Case Study 2: Agriculture and Agri-Food Canada Crop Inventory

Carleton UNIVERSITY
Canada's Capital University

Natural Resources Canada
Ressources naturelles Canada

CSA ASC

Agriculture and Agri-Food Canada
Agriculture et Agroalimentaire Canada

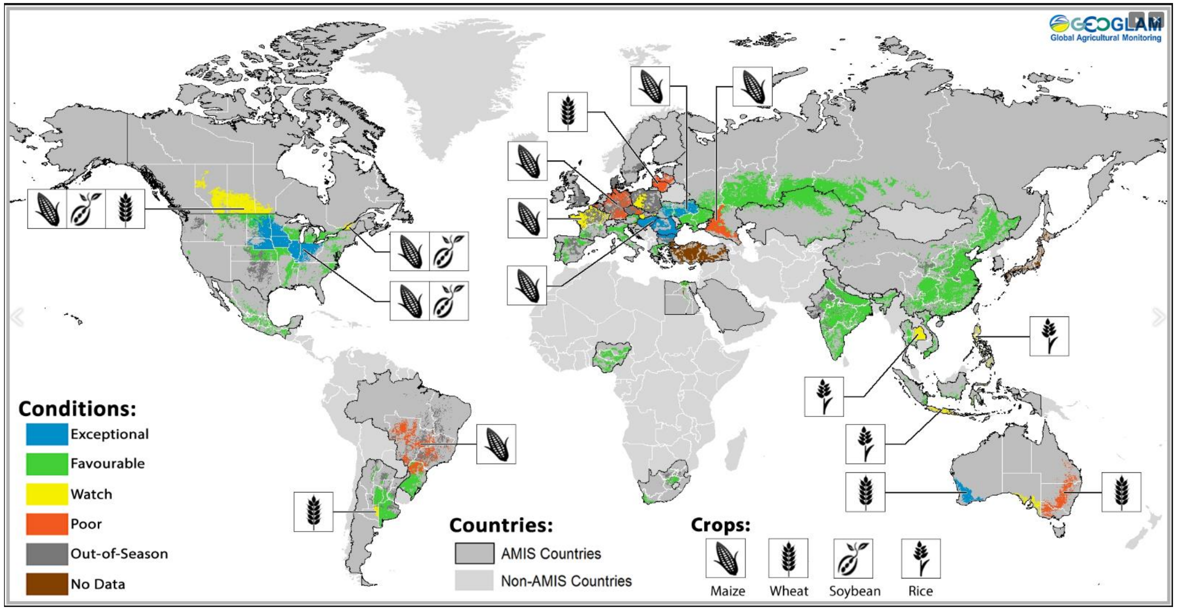
Agriculture in Canada and Globally

Canada's agricultural landscape is large and complex

- 230,000 farms
- *Total farm area: 67.6 million hectares*
- Land in crops: 35.9 million hectares
- 8.1% of total GDP
- 5th largest exporter of agricultural products
- Employs 2.2% of Canada's total population

National, regional and global challenges in food supply and demand

- World prices of wheat, rice, corn, and soybeans rose 226% from 2002 to 2008
- UN Food and Agriculture Organization (FAO) estimates that food production must double in the next 40 years to meet global needs
- Competing land uses and other uncertainties introduce risk



GEOGLAM Synthesis Map September 2018 Crop Growing Conditions for Maize, Wheat, Soybean and Rice

Image source: GEOGLAM.org

Need sound policies and risk management strategies based on accurate, timely and cost effective information

Earth Observation at AAFC

- AAFC has been conducting research on EO applications of space science for well over 30 years
    - World leader in agricultural monitoring and mapping, especially related to SAR applications.
    - Focus on research to support existing and future operations, followed by operational implementation
    - Sharing SAR methodology with scientists in other countries and international organizations to support agriculture monitoring
- Recent convergence of technologies (satellite imagery, software tools and hardware) allowed for operational solutions to support government policy development, program implementation and performance measurement
- AAFC can leverage Canadian space assets like RADARSAT-2 and the future RADARSAT Constellation Mission (RCM)
- Within a few years AAFC should be able to frequently image all of Canada's agricultural landscape with high temporal frequency at medium to high resolution and at low or no cost

Crops in Canada

Mandate

Earth Observation at AAFC produces Annual Crop Inventory

- Satellite-based land cover / land use maps
  - Initial focus on Prairie in 2009 and 2010
  - Expanded to entire agricultural extent of Canada in 2011
  - Utilizes multispectral and dual-polarization radar imagery
- Digitally-based and published on GoC Open Data Portal / AAFC Geospatial viewer
  - https://open.canada.ca/en/open-data
- Internally / externally used
  - Yield prediction, rotation patterns, crop acreages
  - Landscape fragmentation, habitat pressures
  - Crop marketing / business planning
  - Many additional uses, beyond agriculture

Landsat 8

Image source: GISGeography.com

RADARSAT-2

Image source: asc-csa.gc.ca

Current Operational Classifier

- STB-EOS Classification System (STB-EOS CS)
- Infrastructure built on series of scripts and GUIs
  - Decision Tree classifier (Breiman, 2001)
    - Permits integration of various data sources
      - In the current operational system, this is limited to set number of images
    - ~ 85% accuracy at national scale
  - Uses optical and SAR imagery
  - SAR includes a few images per season of dual polarization RADARSAT-2 data
  - Only intensity in VV and VH polarization

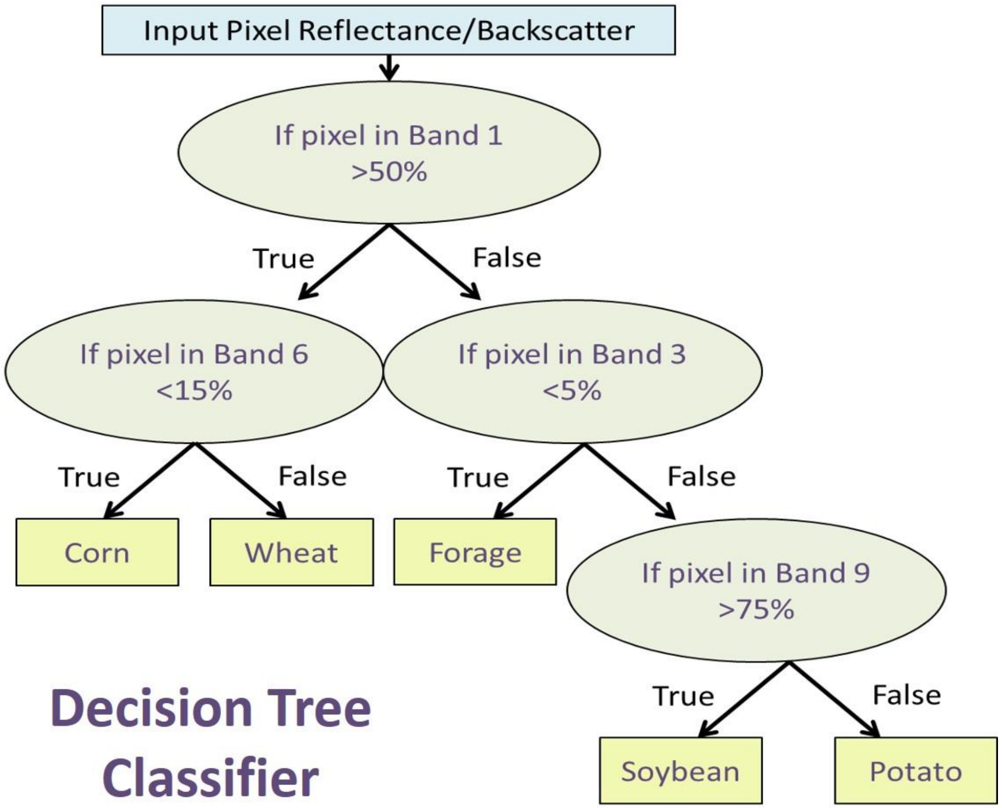


Image source: AAFC, Catherine Champagne

Importance of SAR Imagery for the Inventory

- Optical multi-spectral data (Landsat, DMC, AWiFS, Sentinel2) adequate to classify crops **if** data are available during critical periods of the growing season
- Accuracies greater than 85% have been achieved (overall and for individual crops), but can be significantly degraded by gaps in optical data collection
- Main issue is presence of clouds in multiple (or all) images
- The use of single-frequency, dual polarization (VV and VH) SAR imagery has been shown to increase the overall accuracies
- Current practice is use ~5-6 optical images and ~1-3 SAR images (non-optimal, due to system limitations)
- **Overall, integrating SAR data with an adequate national optical coverage improves the accuracy of AAFC's annual crop inventory**

Training and Validation Data Pre-processing - Collection

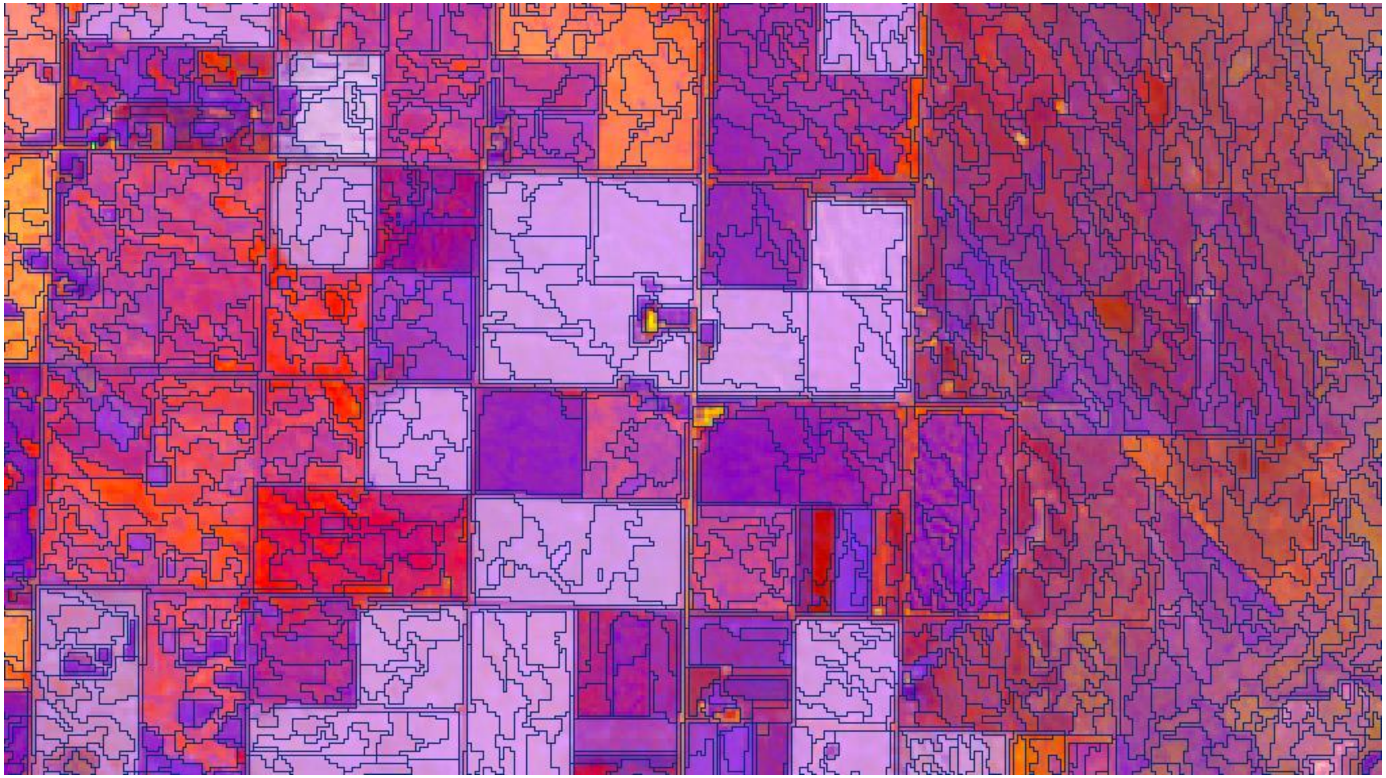
Southern Ontario Data Collection

- Locally provided insurance data (Prairie provinces and Quebec)
- Field data collection campaigns in summer by AAFC Staff in other provinces
- Coverage – well dispersed to cover areas of interest
- Large quantities of samples especially for rare and unusual crop types
- Classification success is highly dependent on quality of ground data inputs

Poor ground data = poor classification!

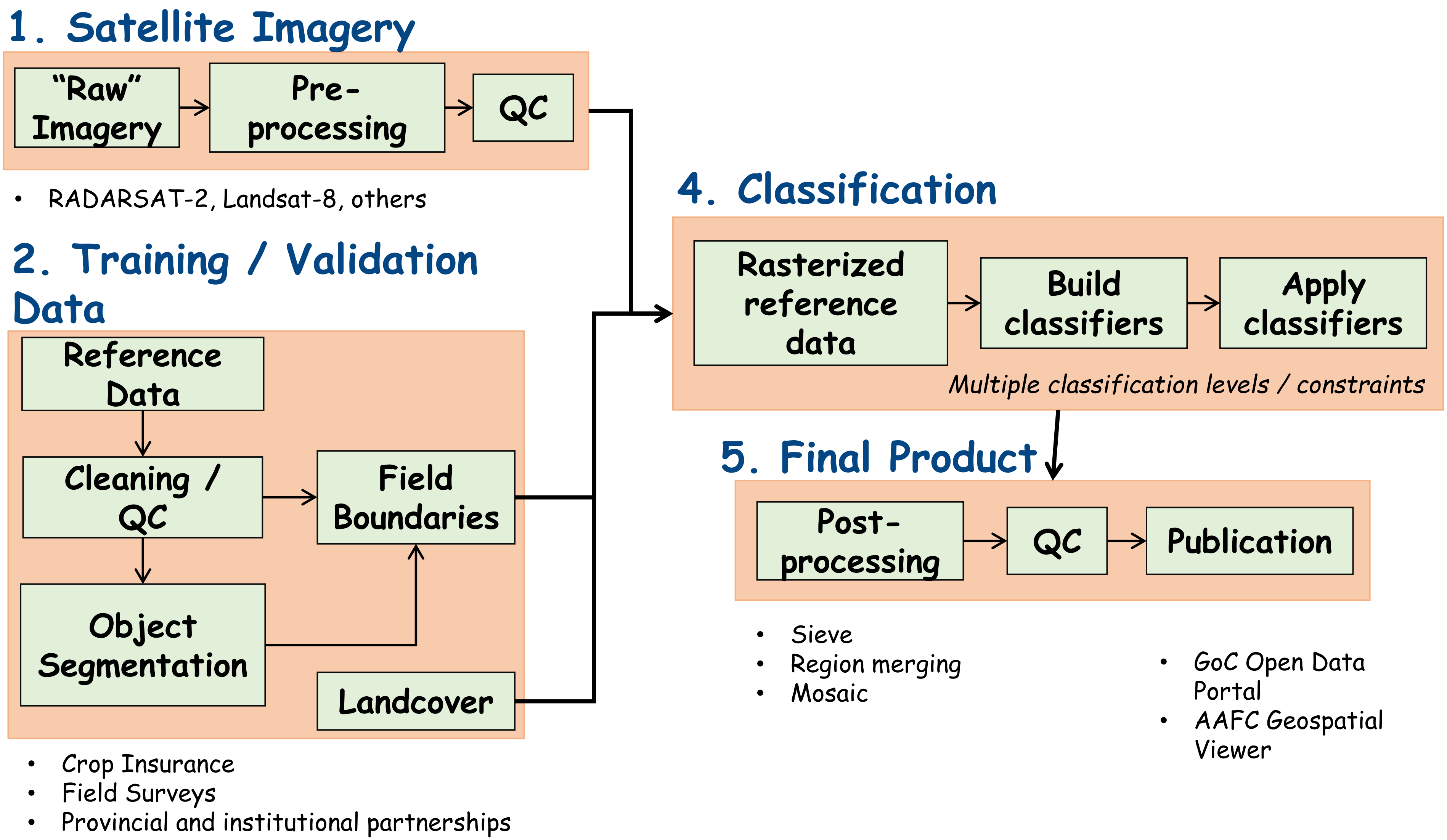
Training and Validation Data Pre-processing – In house Data Processing

- Match to AAFC legend
- Segmentation to simulate field boundaries
  - Not perfect but subsequently smoothed and quality controlled
- Converts field collected points to polygons
  - With a smaller dataset this step could be manually digitized



Object-based segmented current season Landsat image

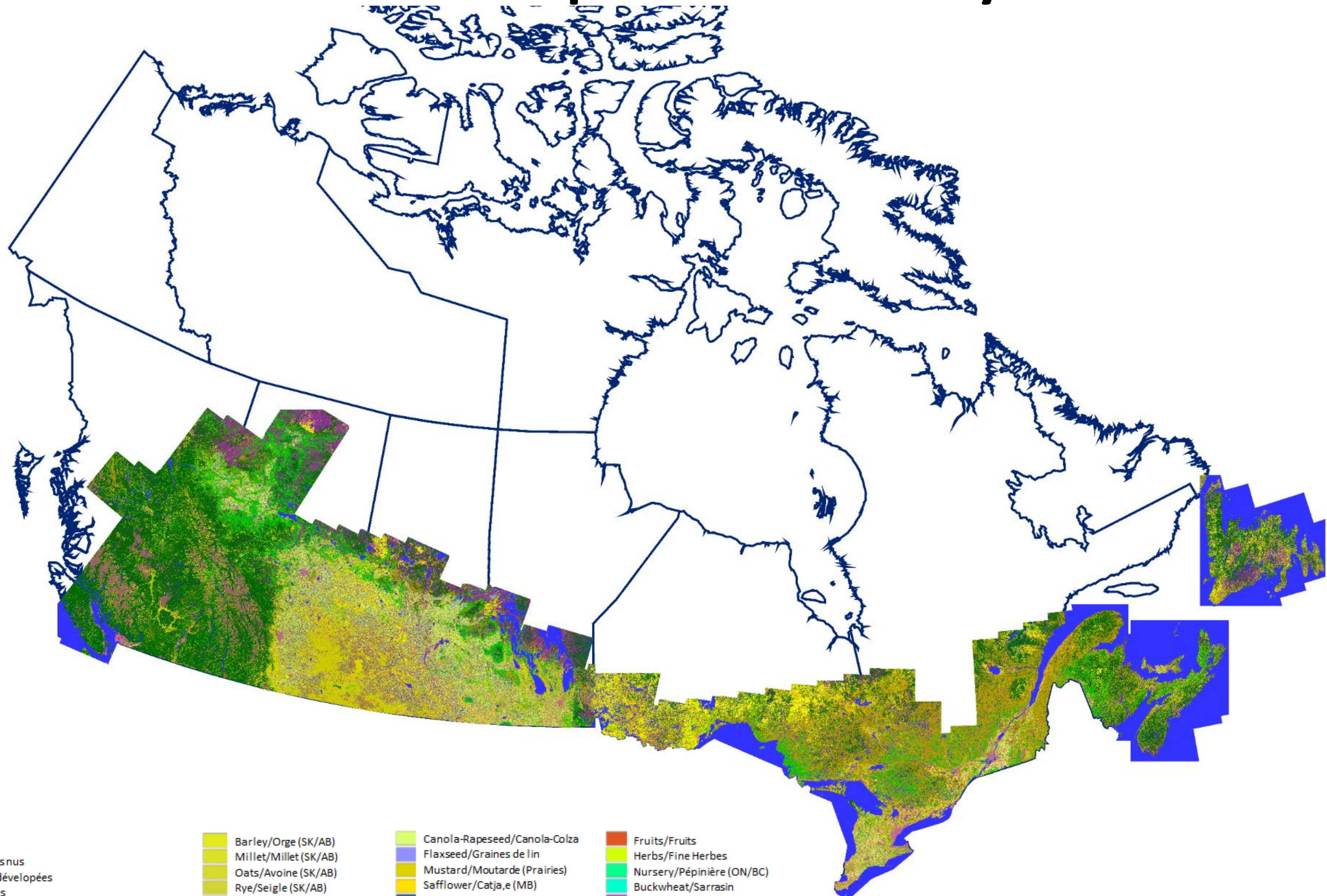
Current Overall Crop Inventory Operational Methodology



Current SAR Pre-processing Order of Operations

1. Download RADARSAT-2 (SLC) data with coverage over the entire agricultural extent of Canada
   - 2 or 3 images per season
   - Fills gaps for limited optical imagery areas
2. Convert data to Sigma naught (σ^0)
3. Speckle filter data with 7 x 7 Gamma Map filter
4. Rational Polynomial function model (ortho/terrain correction)
5. Feed corrected VV and VH images into the classifier with optical imagery and field data

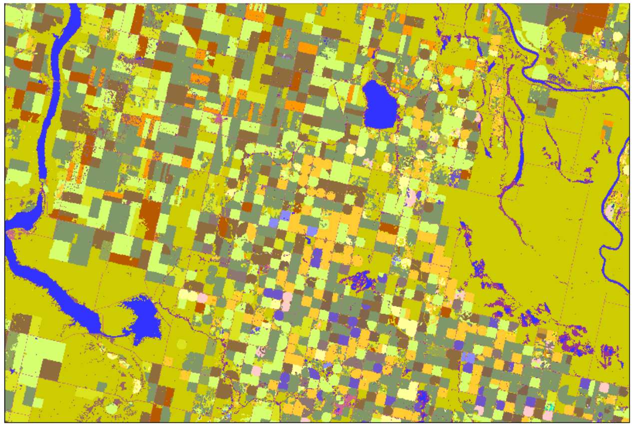
2017 Crop Inventory



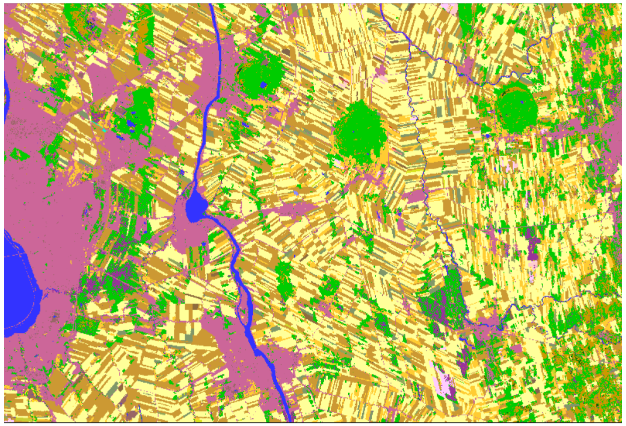
Legend/Légende

- Water/Eau
- Exposed Lands/Sols nus
- Developed/Zones dévelopées
- Shrubland/Arbustes
- Wetlands/Terres humides
- Grassland/Prairies
- Perennial Crops and Pastures/Cultures pérennes et pâturages
- Too Wet to be Seeded/Trop humide pour les semis
- Fallow/Jachère
- Cereals/Céreales
- Barley/Orge (SK/AB)
- Millet/Millet (SK/AB)
- Oats/Avoine (SK/AB)
- Rye/Seigle (SK/AB)
- Triticale/Triticale (SK/AB)
- Wheat/Blé (SK/AB)
- Corn/Maïs
- Oilseeds/Oléagineux
- Borage/Bourrache (SK)
- Camelina/Caméline (ON/AB)
- Canola-Rapeseed/Canola-Colza
- Flaxseed/Graines de lin
- Mustard/Moutarde (Prairies)
- Safflower/Catja,e (MB)
- Sunflower/Tournesols
- Soybean/Soja
- Peas/Pois
- Beans/Fèves
- Lentils/Lentilles (SK/AB)
- Vegetables/Légumes
- Fruits/Fruits
- Herbs/Fine Herbes
- Nursery/Pépinière (ON/BC)
- Buckwheat/Sarrasin
- Canary Seed/Alpiste des canaries (Prairies)
- Hemp/Chanvre (Prairies)
- Other Crops/Autres cultures
- Coniferous Forest/Forêt de conifères
- Deciduous Forest/Forêt de feuillus
- Mixed Forest/Forêt de feuillus

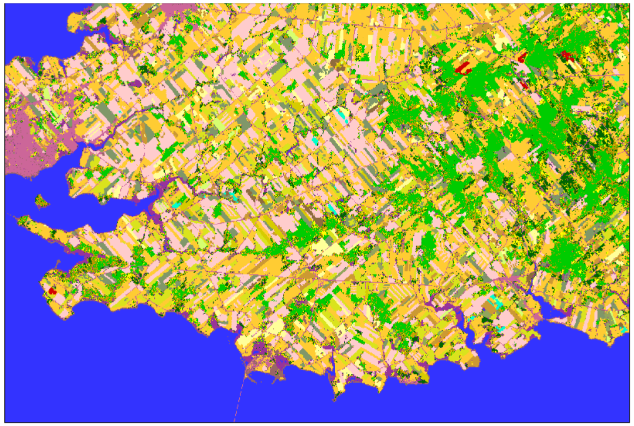
AAFC 2017 Annual Crop Inventory Local Examples



Between Brooks and Taber, Alberta



Richelieu River, Quebec



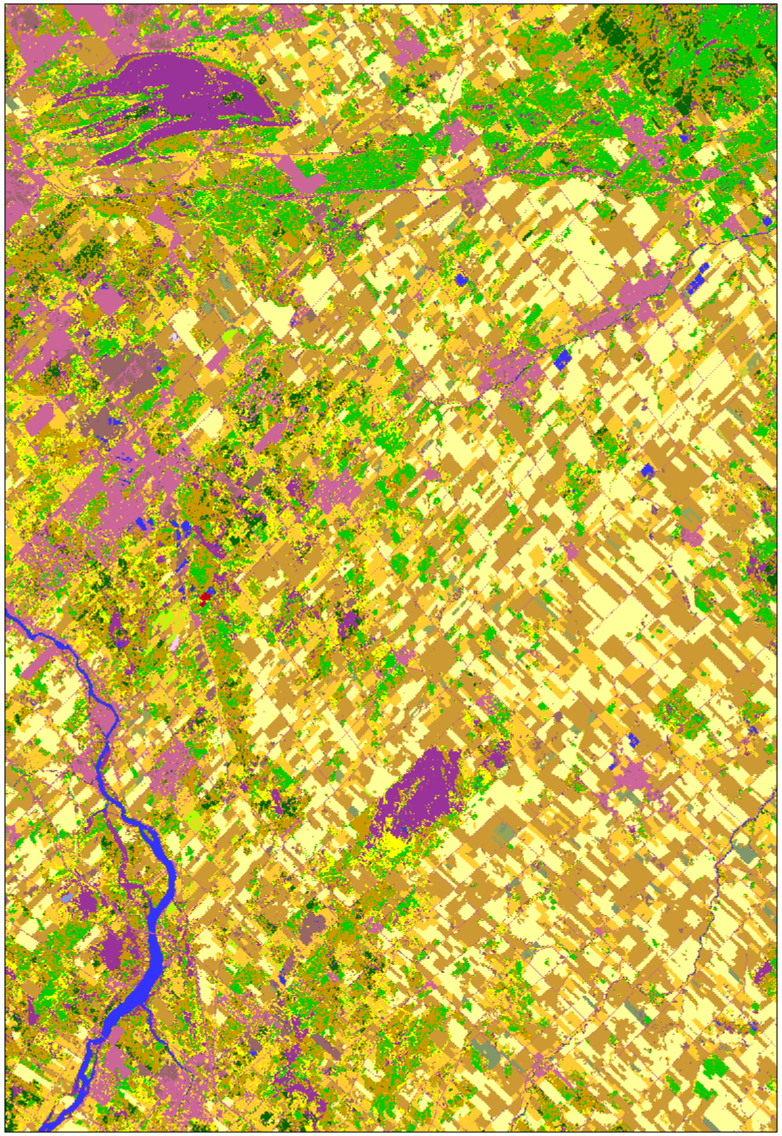
Central Prince Edward Island

Future SAR Pre-processing Order of Operations

1. Download RADARSAT(SLC/GRD) and Sentinel-1 (SLC/GRD) data with coverage over the entire agricultural extent of Canada
   - At least 1 SAR image per month of growing season (either RADARSAT-2, RCM or Sentinel-1)
   - Potential for polarimetric data from RCM (ongoing testing)
2. Convert data to Sigma naught (σ^0)
3. Speckle filter data with 7 x 7 Gamma Map filter
   - Testing changing to larger filter window size
4. Rational Polynomial function model (ortho/terrain correction)
   - Testing radiometric correction to incidence angle
5. Feed corrected VV and VH images into the classifier with optical imagery and field data
   - Potential for compact polarimetry variables and/or fully polarimetric decomposition variables
   - New classifier may be Random Forest classifier

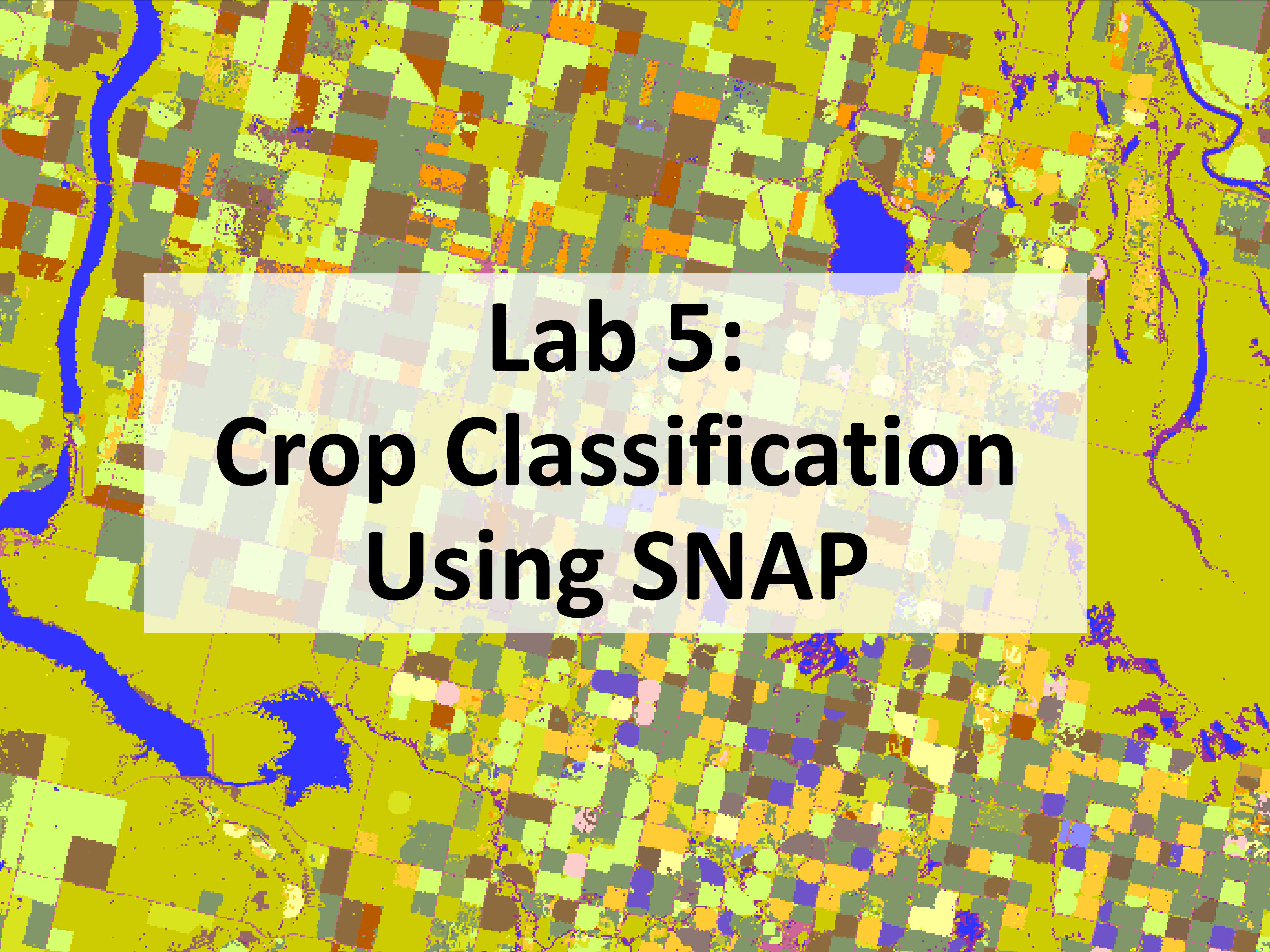
Summary

- AAFC is a leader in agriculture monitoring and mapping
- Operational Annual Crop Inventory products freely available since 2011 and used by a variety of internal and external users
- Crop Inventory requires a large amount of EO data, including optical and SAR imagery at key times in the growing season
- Crop Inventory stands to benefit from availability of additional SAR imagery in the future including Sentinels, RCM, SAOCOM, NISAR data, with possible improvements in accuracy, delivery time, etc.



Near Ottawa, Ontario
2017 Crop Inventory

Lab 5: Crop Classification Using SNAP



Crop Classification Using SNAP

Sentinel-1 GRD → Apply Orbit File → Speckle Filter → Geometric Correction (Includes normalization to local incidence angle and conversion to Sigma0) → Subset → Co-registration → Import Vectors → Random Forest Classifier

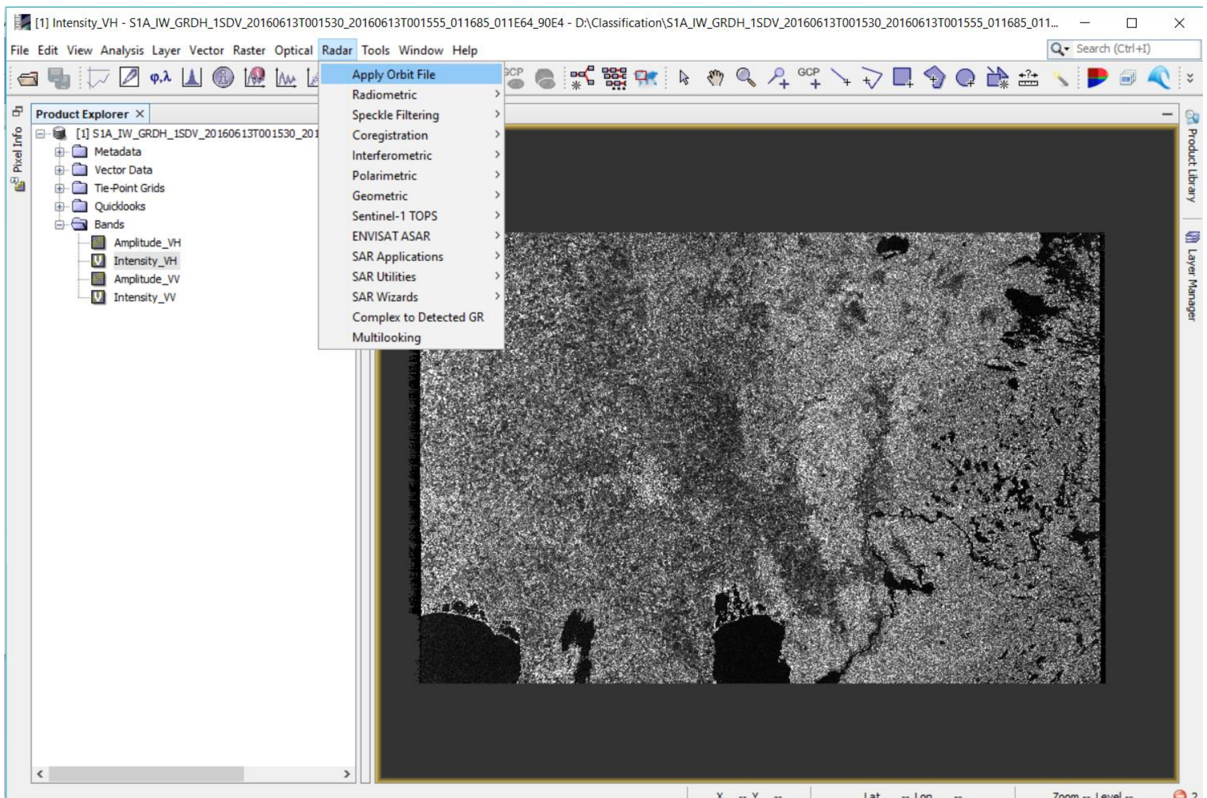
Co-registration → Export to .tif for use in other classifiers (in Python, R, etc.)

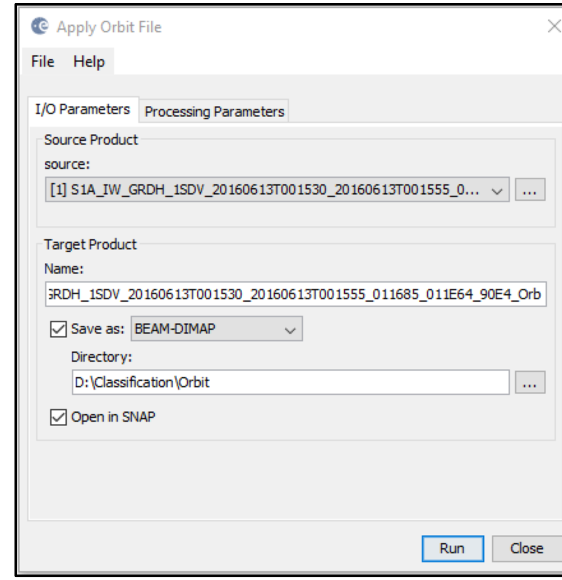
3 Sentinel-1 images over Carman, Manitoba

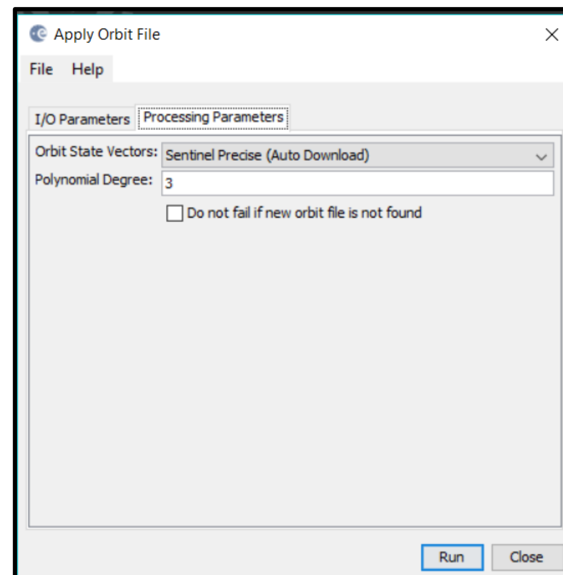
- June 13, 2016, July 7, 2016 & July 31, 2016
  - These images have been pre-processed to co-registration
- Field data in SNAP
  - 4 shape files: canola, corn, soybeans, wheat

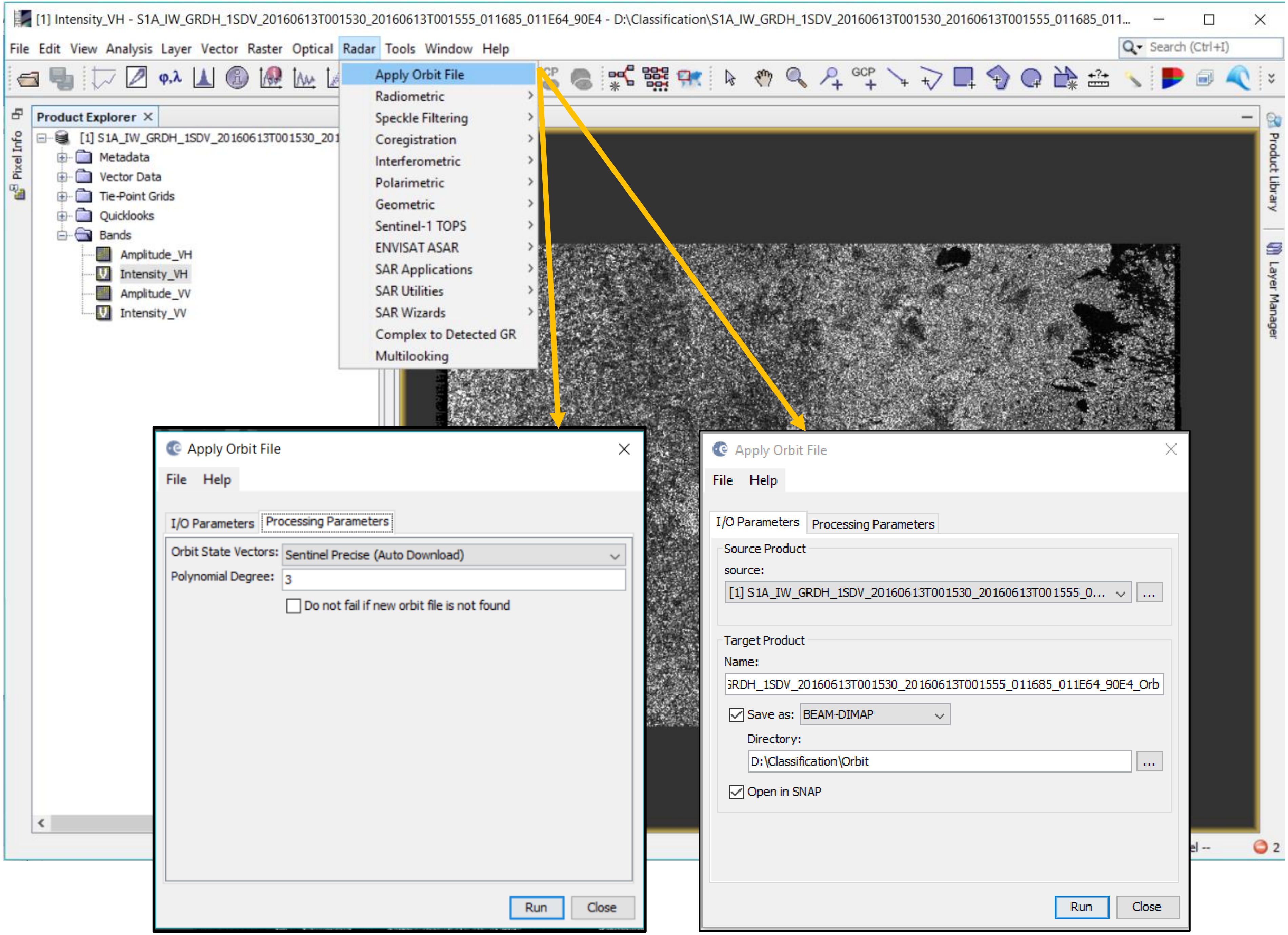
Pre-processing Steps – Apply Orbit File

1. Go to Radar Menu >> Apply Orbit File:
    a) I/O Parameters tab: source → raw image + Target product
    b) Processing Parameters tab: Orbit State Vectors→ Sentinel Precise Auto Download; Polynomial Degrees → 3
    c) Click Run and Close window when completed





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File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Product Explorer
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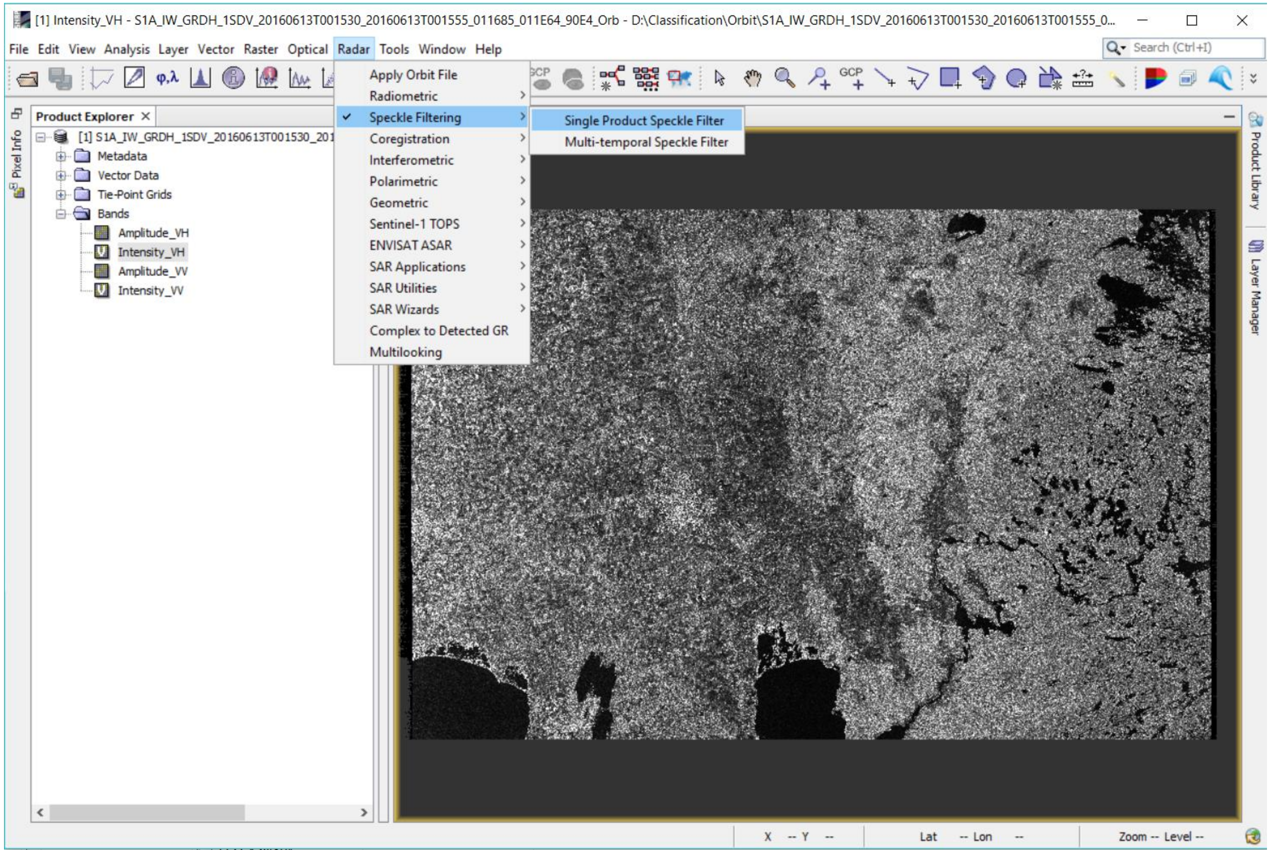
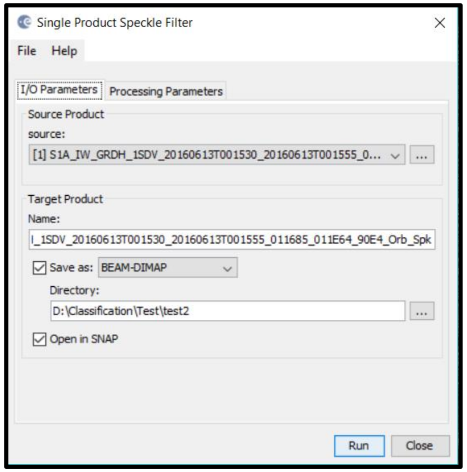
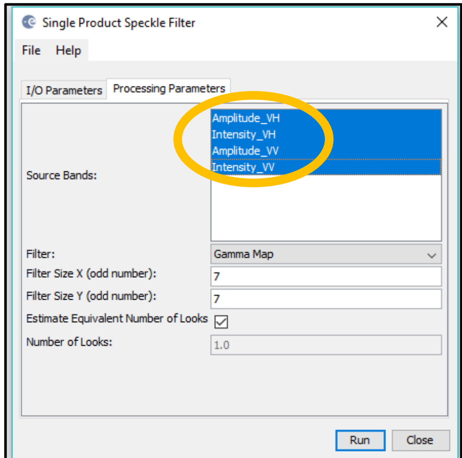
Vector Data
Tie-Point Grids
Quicklooks
Bands
Amplitude_VH
Intensity_VH
Amplitude_VV
Intensity_VV
Apply Orbit File
Radiometric
Speckle Filtering
Coregistration
Interferometric
Polarimetric
Geometric
Sentinel-1 TOPS
ENVISAT ASAR
SAR Applications
SAR Utilities
SAR Wizards
Complex to Detected GR
Multilooking
Pixel Info
Product Library
Layer Manager
Apply Orbit File
File Help
I/O Parameters
Processing Parameters
Orbit State Vectors: Sentinel Precise (Auto Download)
Polynomial Degree: 3
Do not fail if new orbit file is not found
Run
Close
Apply Orbit File
File Help
I/O Parameters
Processing Parameters
Source Product
source:
[1] S1A_IW_GRDH_1SDV_20160613T001530_20160613T001555_0...
Target Product
Name:
3RDH_1SDV_20160613T001530_20160613T001555_011685_011E64_90E4_Orb
Save as: BEAM-DIMAP
Directory:
D:\Classification\Orbit
Open in SNAP
Run
Close

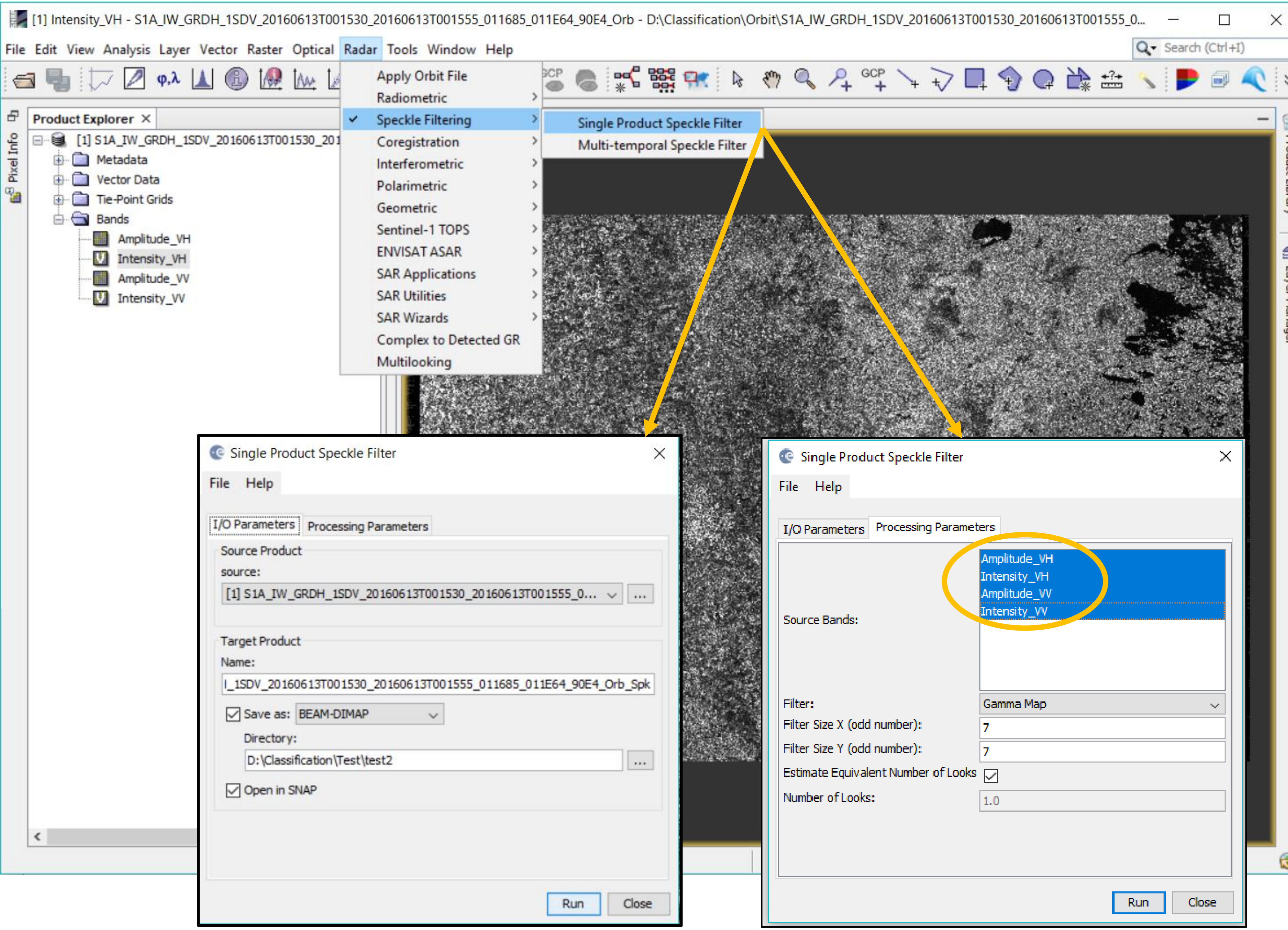
Pre-processing steps – Apply speckle filter (Gamma MAP 7 x 7)

1. Go to Radar Menu >> Speckle Filtering >> Single Product Speckle Filter:
   a) I/O Parameters tab: source → Apply Orbit Image + Target product
   b) Processing Parameters tab: Source Bands → Ensure all selected; Filter → Gamma Map → Window Size → 7 x7
   c) Click Run and Close window when completed





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Search (Ctrl+I)
Product Explorer
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Metadata
Vector Data
Tie-Point Grids
Bands
Amplitude_VH
Intensity_VH
Amplitude_VV
Intensity_VV
Pixel Info
Apply Orbit File
Radiometric
Speckle Filtering
Coregistration
Interferometric
Polarimetric
Geometric
Sentinel-1 TOPS
ENVISAT ASAR
SAR Applications
SAR Utilities
SAR Wizards
Complex to Detected GR
Multilooking
Single Product Speckle Filter
Multi-temporal Speckle Filter
Single Product Speckle Filter
File Help
I/O Parameters
Processing Parameters
Source Product
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Target Product
Name:
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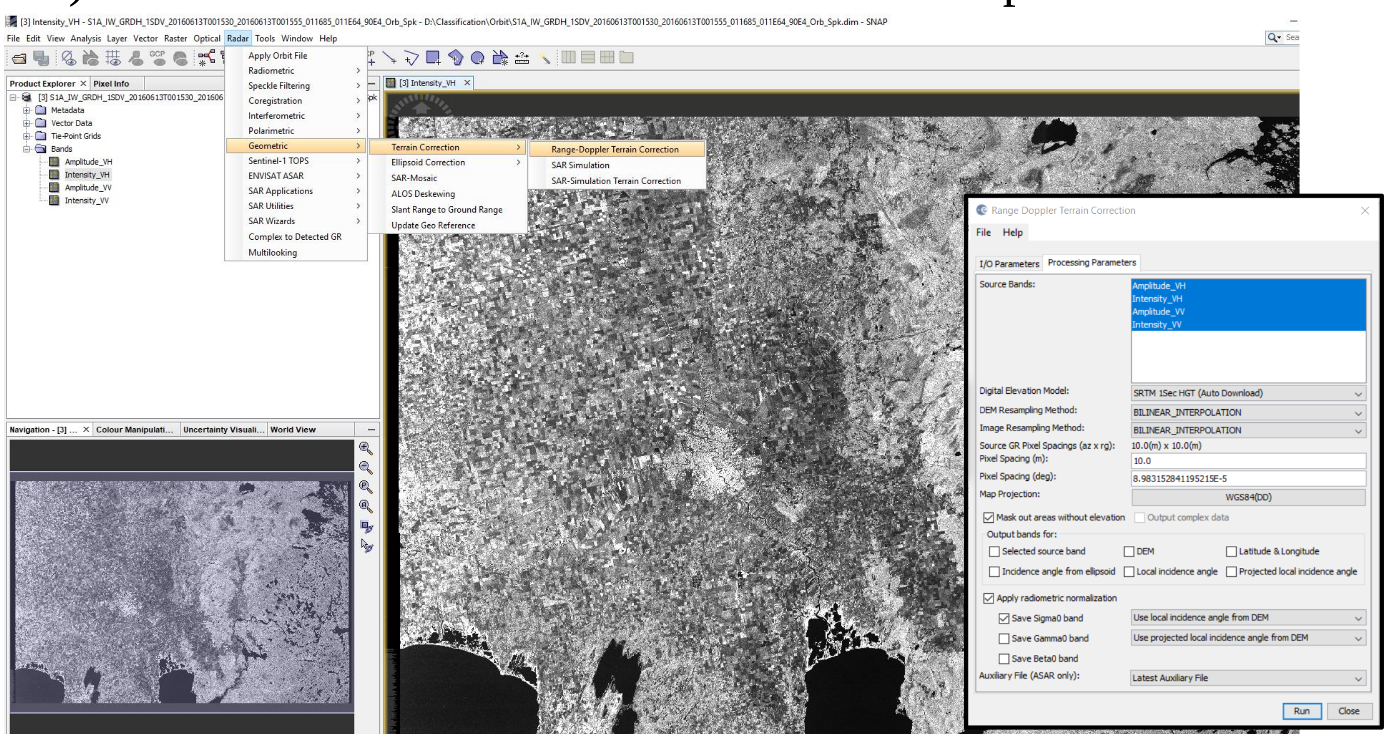
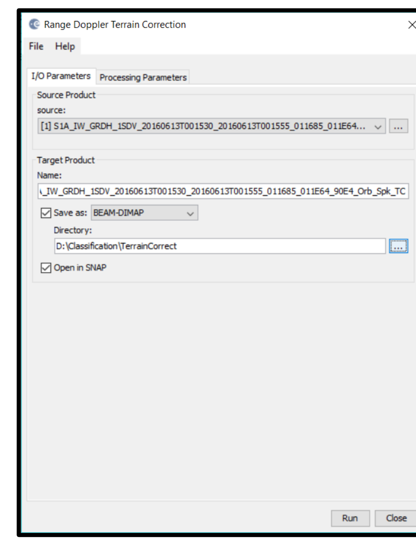
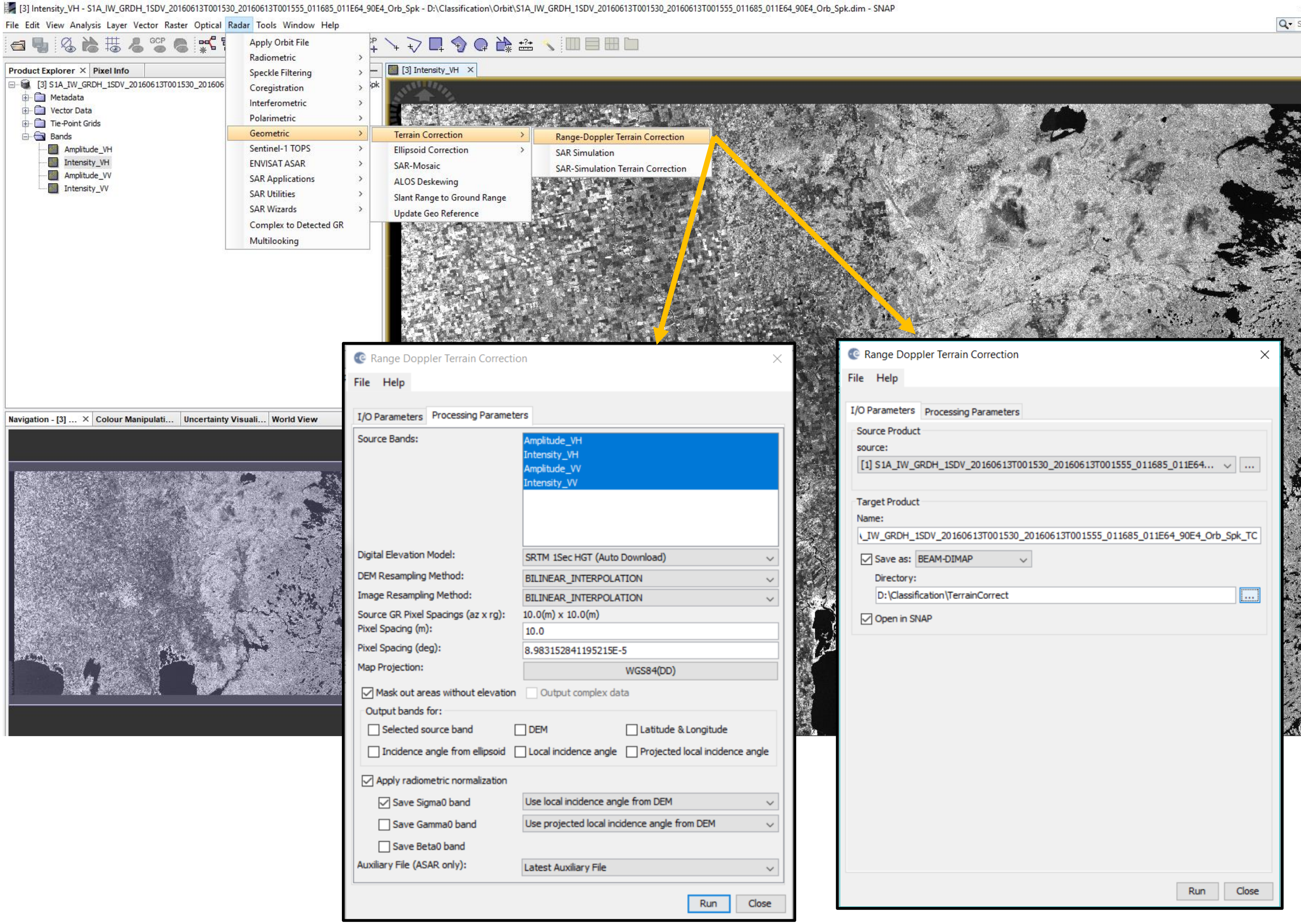
Save as: BEAM-DIMAP
Directory:
D:\Classification\Test\test2
Open in SNAP
Run
Close
Single Product Speckle Filter
File Help
I/O Parameters
Processing Parameters
Source Bands:
Amplitude_VH
Intensity_VH
Amplitude_VV
Intensity_VV
Filter:
Gamma Map
Filter Size X (odd number):
7
Filter Size Y (odd number):
7
Estimate Equivalent Number of Looks
Number of Looks:
1.0
Run
Close

Pre-processing steps - Terrain Correction

1. Go to Radar Menu >> Geometric >> Terrain Correction >> Range Doppler Terrain Correction:
   a) I/O Parameters tab: source → Speckle image + Target product
   b) Processing Parameters tab: Source Bands → Ensure all selected; Digital elevation model → SRTM 1Sec HGT (AutoDownload); Select Apply Radiometric Normalization → Save Sigma0 band → Use local incidence angle from DEM
   c) Click Run and Close window when completed



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File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Product Explorer
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Intensity_VH
Amplitude_VV
Intensity_VV
Apply Orbit File
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Ellipsoid Correction
SAR-Mosaic
ALOS Deskewing
Slant Range to Ground Range
Update Geo Reference
Range-Doppler Terrain Correction
SAR Simulation
SAR-Simulation Terrain Correction
[3] Intensity_VH
Navigation - [3] ...
Colour Manipulati...
Uncertainty Visuali...
World View
Range Doppler Terrain Correction
File Help
I/O Parameters
Processing Parameters
Source Bands:
Amplitude_VH
Intensity_VH
Amplitude_VV
Intensity_VV
Digital Elevation Model:
SRTM 1Sec HGT (Auto Download)
DEM Resampling Method:
BILINEAR_INTERPOLATION
Image Resampling Method:
BILINEAR_INTERPOLATION
Source GR Pixel Spacings (az x rg):
10.0(m) x 10.0(m)
Pixel Spacing (m):
10.0
Pixel Spacing (deg):
8.983152841195215E-5
Map Projection:
WGS84(DD)
Mask out areas without elevation
Output complex data
Output bands for:
Selected source band
DEM
Latitude & Longitude
Incidence angle from ellipsoid
Local incidence angle
Projected local incidence angle
Apply radiometric normalization
Save Sigma0 band
Use local incidence angle from DEM
Save Gamma0 band
Use projected local incidence angle from DEM
Save Beta0 band
Auxiliary File (ASAR only):
Latest Auxiliary File
Run
Close
Range Doppler Terrain Correction
File Help
I/O Parameters
Processing Parameters
Source Product
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Target Product
Name:
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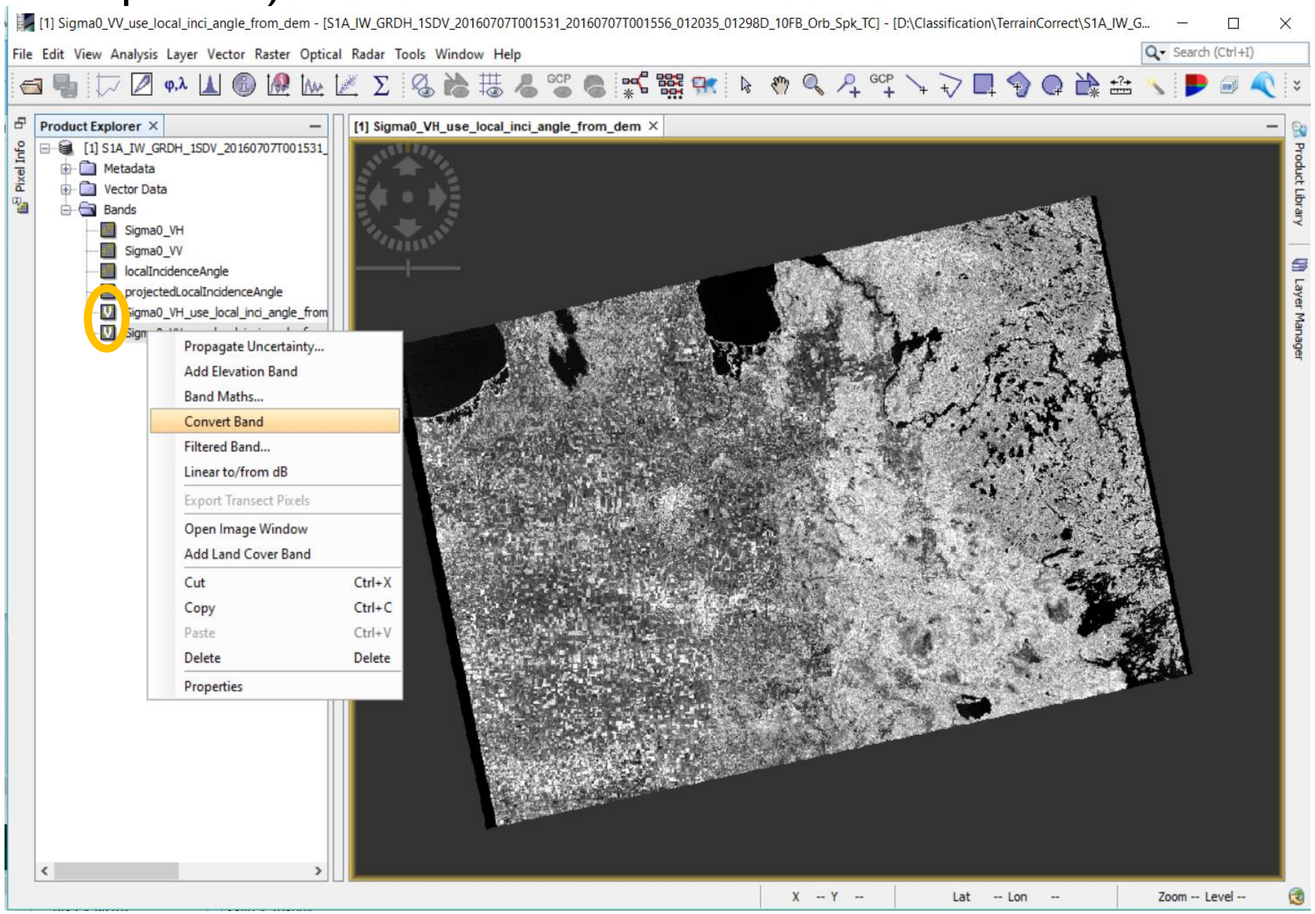
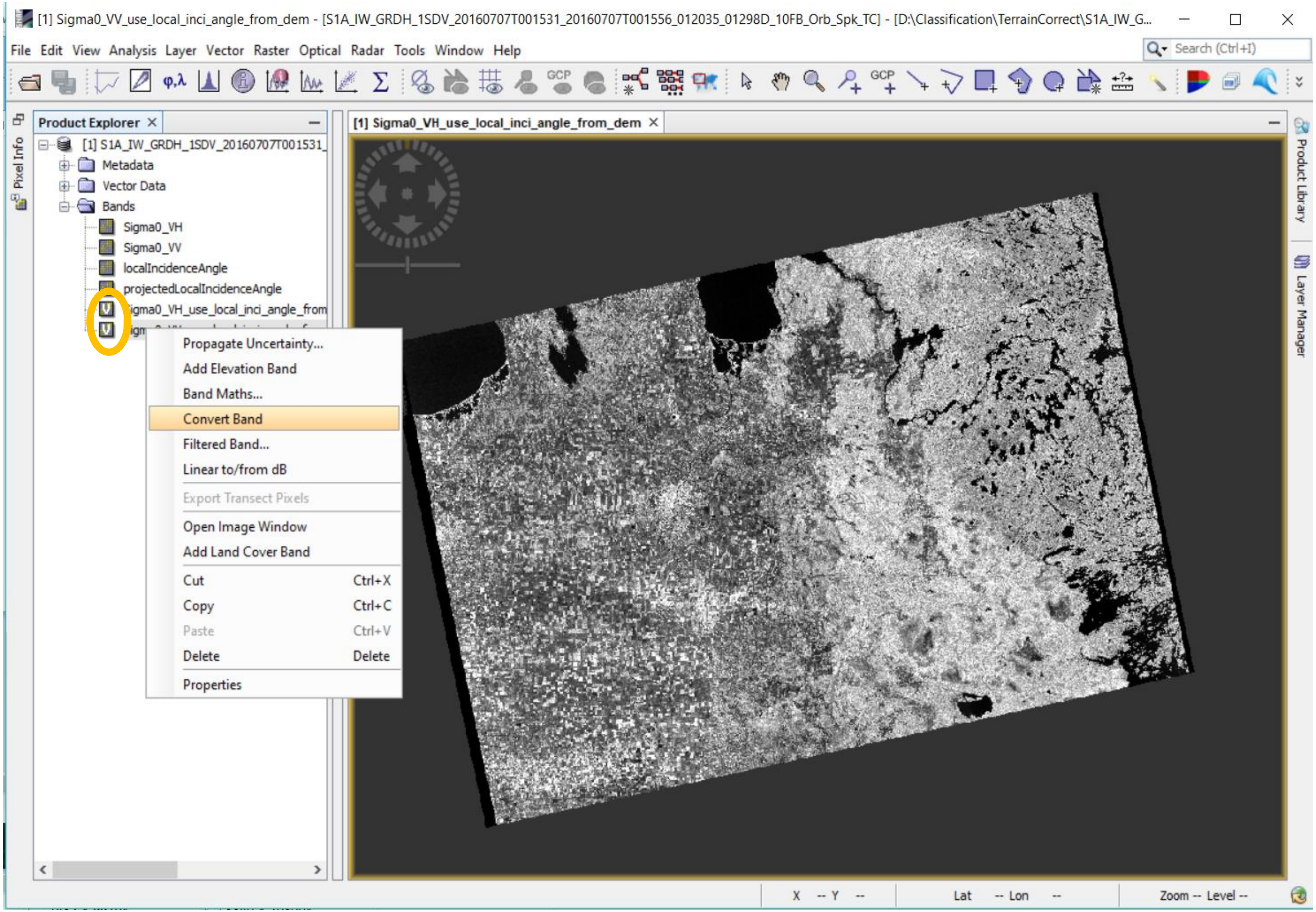
Save as:
BEAM-DIMAP
Directory:
D:\Classification\TerrainCorrect
Open in SNAP
Run
Close

Pre-processing Steps – Convert Virtual Bands

1) Right click on 'Virtual' band and select convert
2) Can then apply the Subset tool (without saving)
   a) Saving the converted bands at this point (entire image) takes a long time
   b) However if you do not save the file the converted band will not be saved but the virtual band (lookup table) will still be available

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File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
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Bands
Sigma0_VH
Sigma0_VV
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projectedLocalIncidenceAngle
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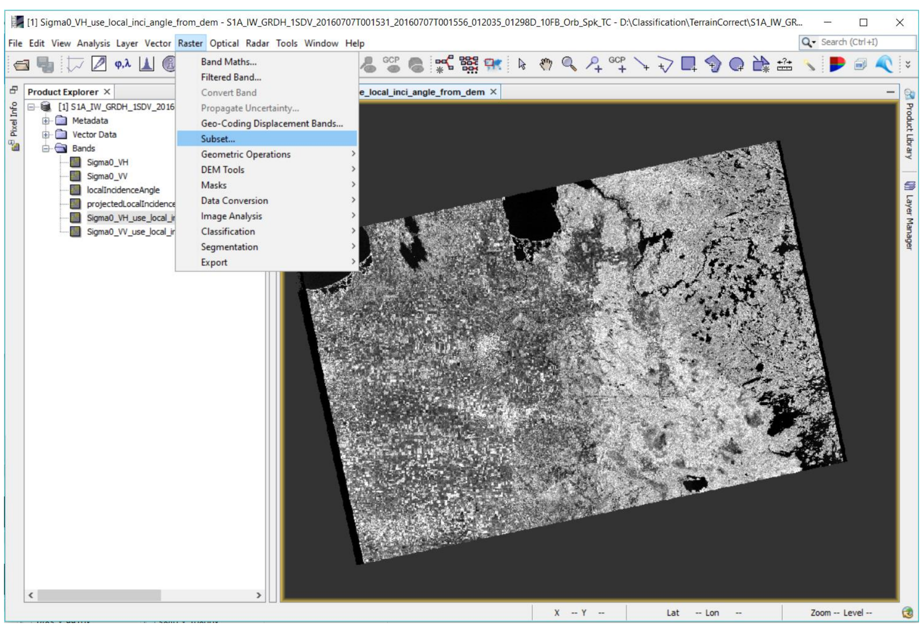
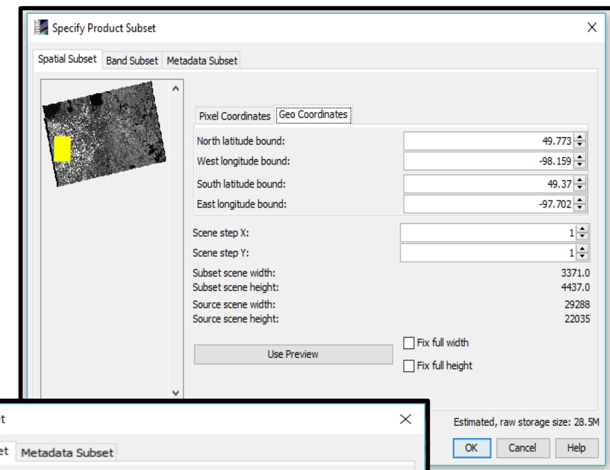
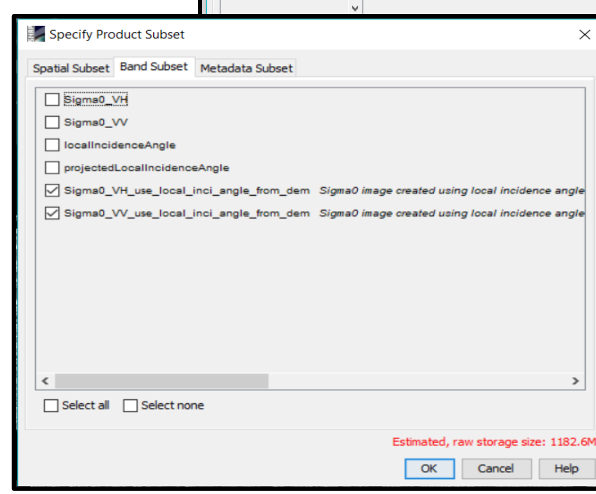
Propagate Uncertainty...
Add Elevation Band
Band Maths...
Convert Band
Filtered Band...
Linear to/from dB
Export Transect Pixels
Open Image Window
Add Land Cover Band
Cut Ctrl+X
Copy Ctrl+C
Paste Ctrl+V
Delete Delete
Properties
Pixel Info
Product Library
Layer Manager
X -- Y --
Lat -- Lon --
Zoom -- Level --

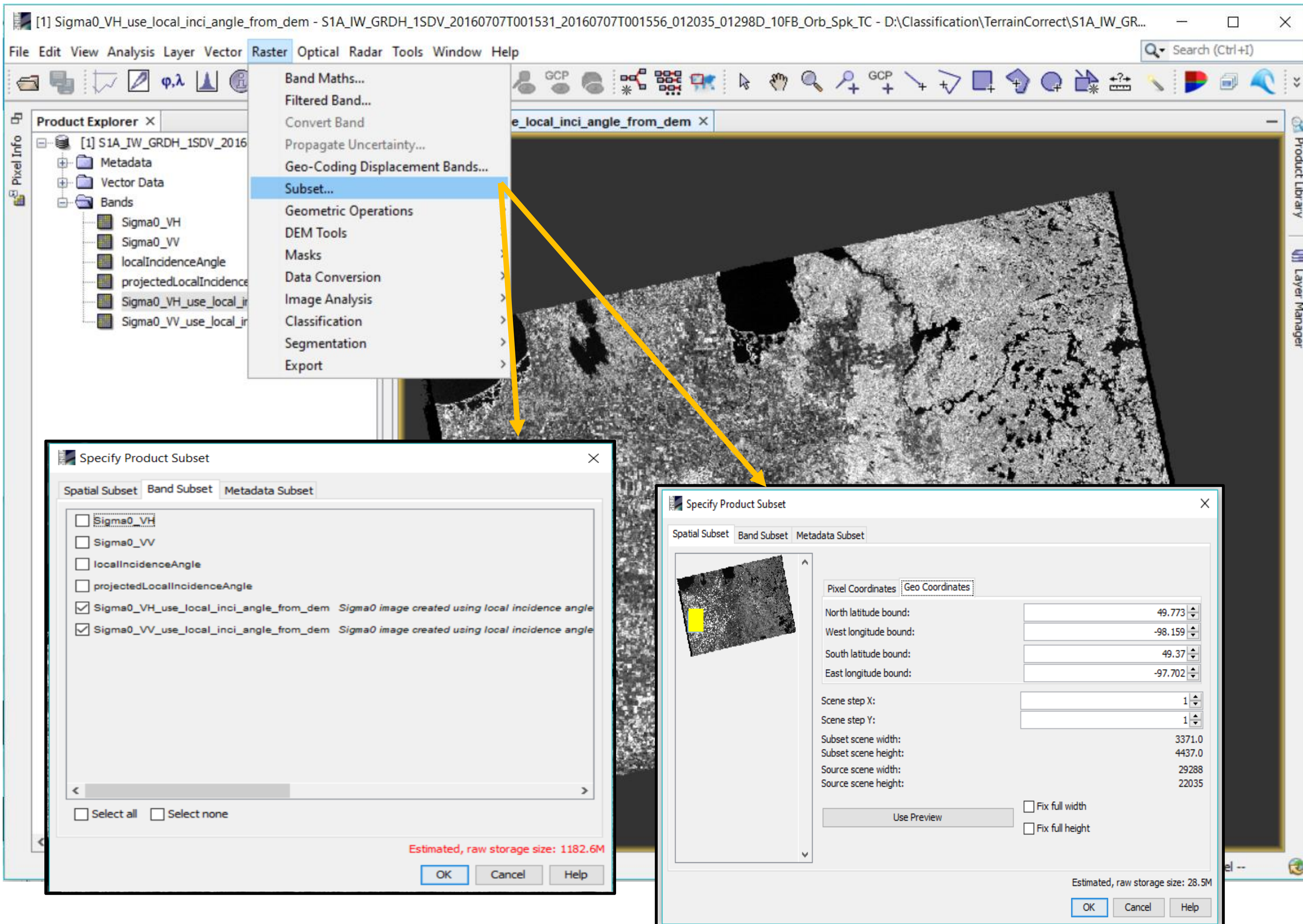
Pre-processing Steps – Subset Raster to AOI
(Per Image)

1) Go to Raster Menu >> Subset:
   a) Spatial Subset tab → enter the upper left and lower right coordinate under geo coordinates
   b) Band Subset → select bands you wish to subset "Sigma0_VH/VV_use_local_inci_angle_from_dem"
   c) Metadata Subset: leave as default
   d) Click Okay and Close window when completed
   e) You will need to "Save" the newly subset image





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File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Product Explorer
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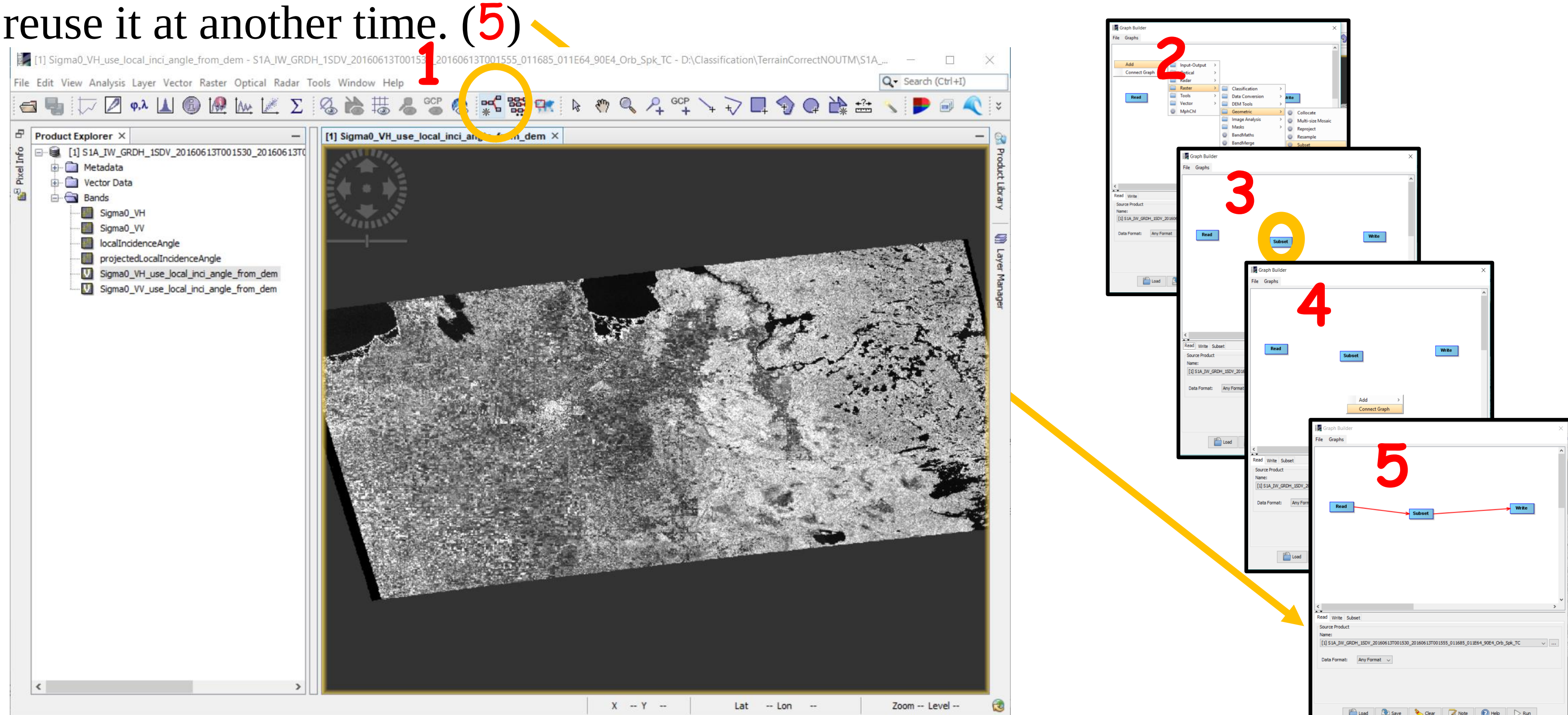
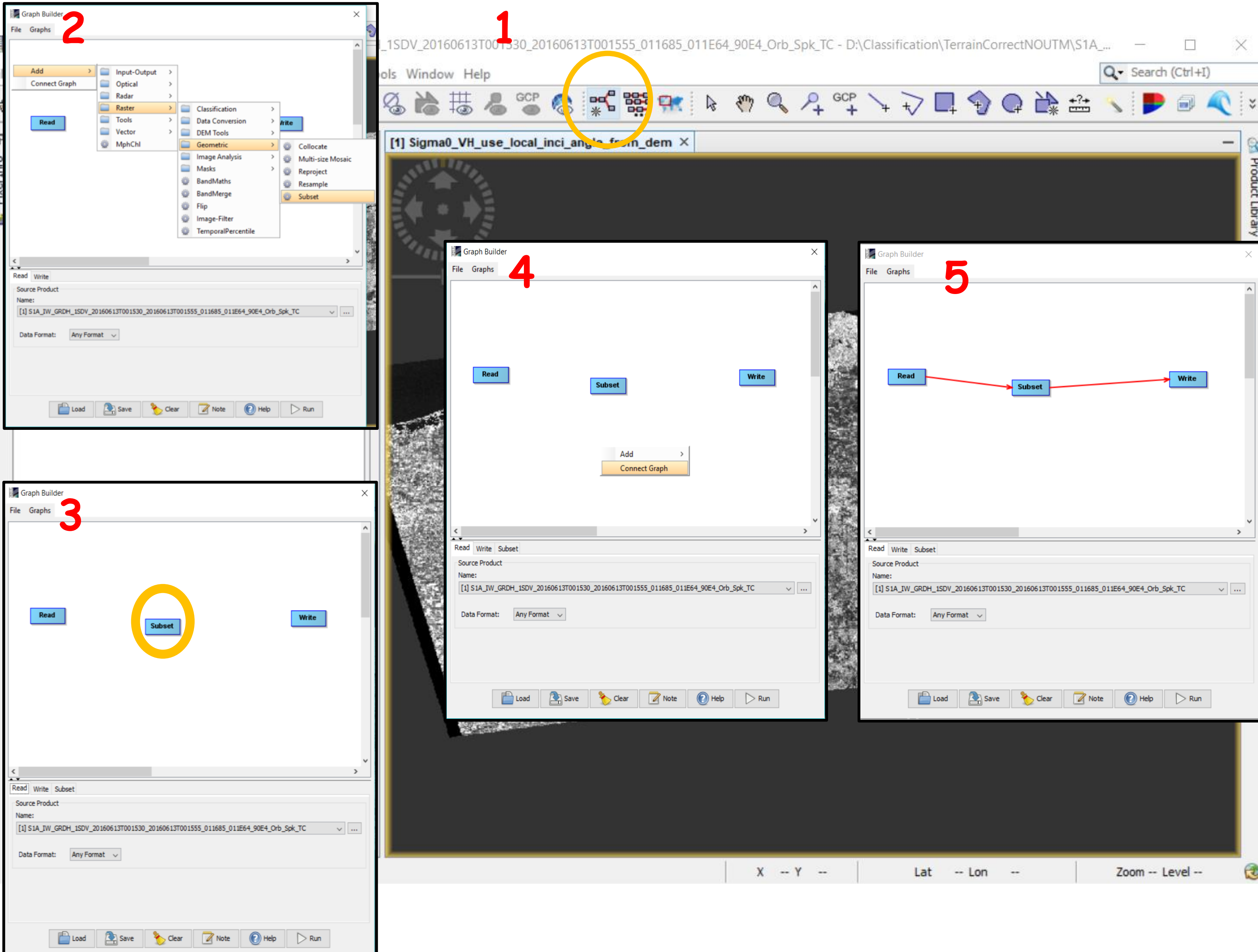
Metadata
Vector Data
Bands
Sigma0_VH
Sigma0_VV
localIncidenceAngle
projectedLocalIncidence
Sigma0_VH_use_local_i
Sigma0_VV_use_local_i
Band Maths...
Filtered Band...
Convert Band
Propagate Uncertainty...
Geo-Coding Displacement Bands...
Subset...
Geometric Operations
DEM Tools
Masks
Data Conversion
Image Analysis
Classification
Segmentation
Export
e_local_inci_angle_from_dem
Pixel Info
Product Library
Layer Manager
Specify Product Subset
Spatial Subset
Band Subset
Metadata Subset
Sigma0_VH
Sigma0_VV
localIncidenceAngle
projectedLocalIncidenceAngle
Sigma0_VH_use_local_inci_angle_from_dem Sigma0 image created using local incidence angle
Sigma0_VV_use_local_inci_angle_from_dem Sigma0 image created using local incidence angle
Select all
Select none
Estimated, raw storage size: 1182.6M
OK
Cancel
Help
Specify Product Subset
Spatial Subset
Band Subset
Metadata Subset
Pixel Coordinates
Geo Coordinates
North latitude bound: 49.773
West longitude bound: -98.159
South latitude bound: 49.37
East longitude bound: -97.702
Scene step X: 1
Scene step Y: 1
Subset scene width: 3371.0
Subset scene height: 4437.0
Source scene width: 29288
Source scene height: 22035
Use Preview
Fix full width
Fix full height
Estimated, raw storage size: 28.5M
OK
Cancel
Help

How to Build a Graph in SNAP

1) Go to Toolbar and select >> (1) Graph Builder:
   a) In blank space with ‘Read’ and ‘Write’ modules, right click and select ‘All’ – a list of the menus appears (2)
   b) Choose a function you need (e.g. “Subset”) (3)
   c) Once you have all modules you need, right click in blank space again and select “Connect Graph” (4)
   d) Red arrows appear and connect the modules of your process; Save your graph to reuse it at another time. (5)

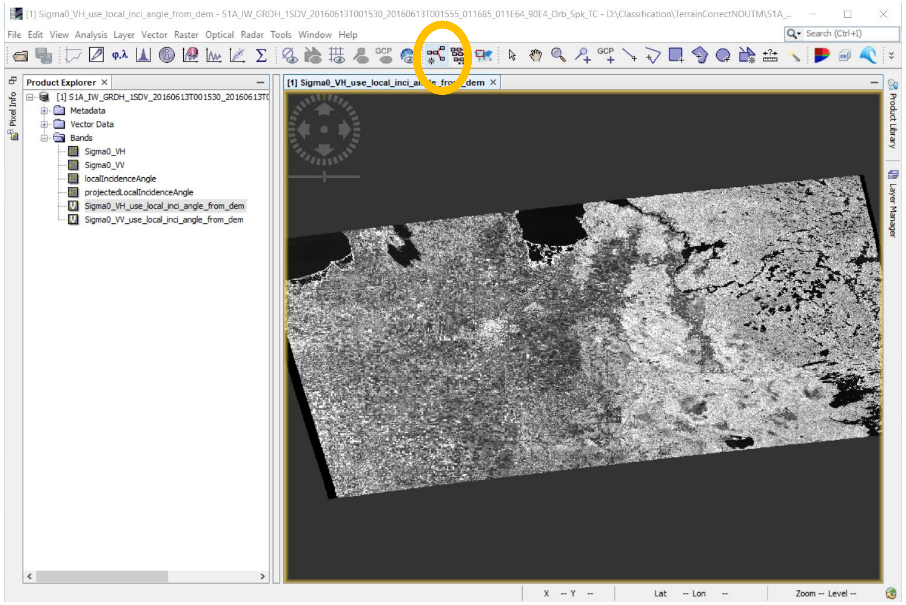


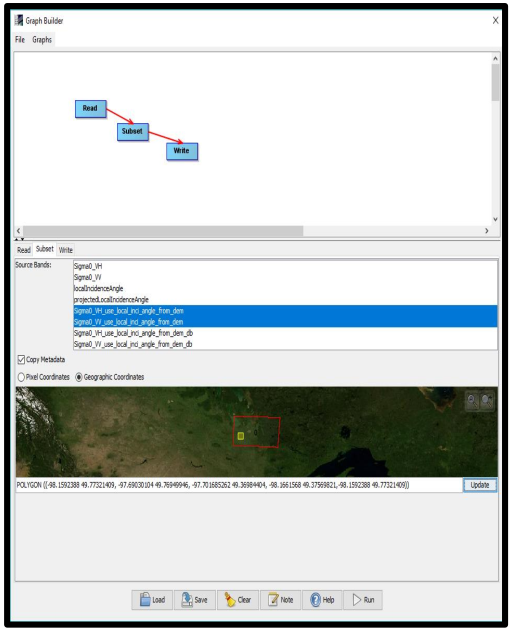

1
2
3
4
5
_1SDV_20160613T001530_20160613T001555_011685_011E64_90E4_Orb_Spk_TC - D:\Classification\TerrainCorrectNOUTM\S1A_...
ols Window Help
Search (Ctrl+I)
[1] Sigma0_VH_use_local_inci_angle_from_dem
Product Library
Graph Builder
File Graphs
Add
Connect Graph
Input-Output
Optical
Radar
Raster
Tools
Vector
MphChl
Classification
Data Conversion
DEM Tools
Geometric
Image Analysis
Masks
BandMaths
BandMerge
Flip
Image-Filter
TemporalPercentile
Collocate
Multi-size Mosaic
Reproject
Resample
Subset
Read
Subset
Write
Source Product
Name:
[1] S1A_IW_GRDH_1SDV_20160613T001530_20160613T001555_011685_011E64_90E4_Orb_Spk_TC
Data Format:
Any Format
Load
Save
Clear
Note
Help
Run
X -- Y --
Lat -- Lon --
Zoom -- Level --

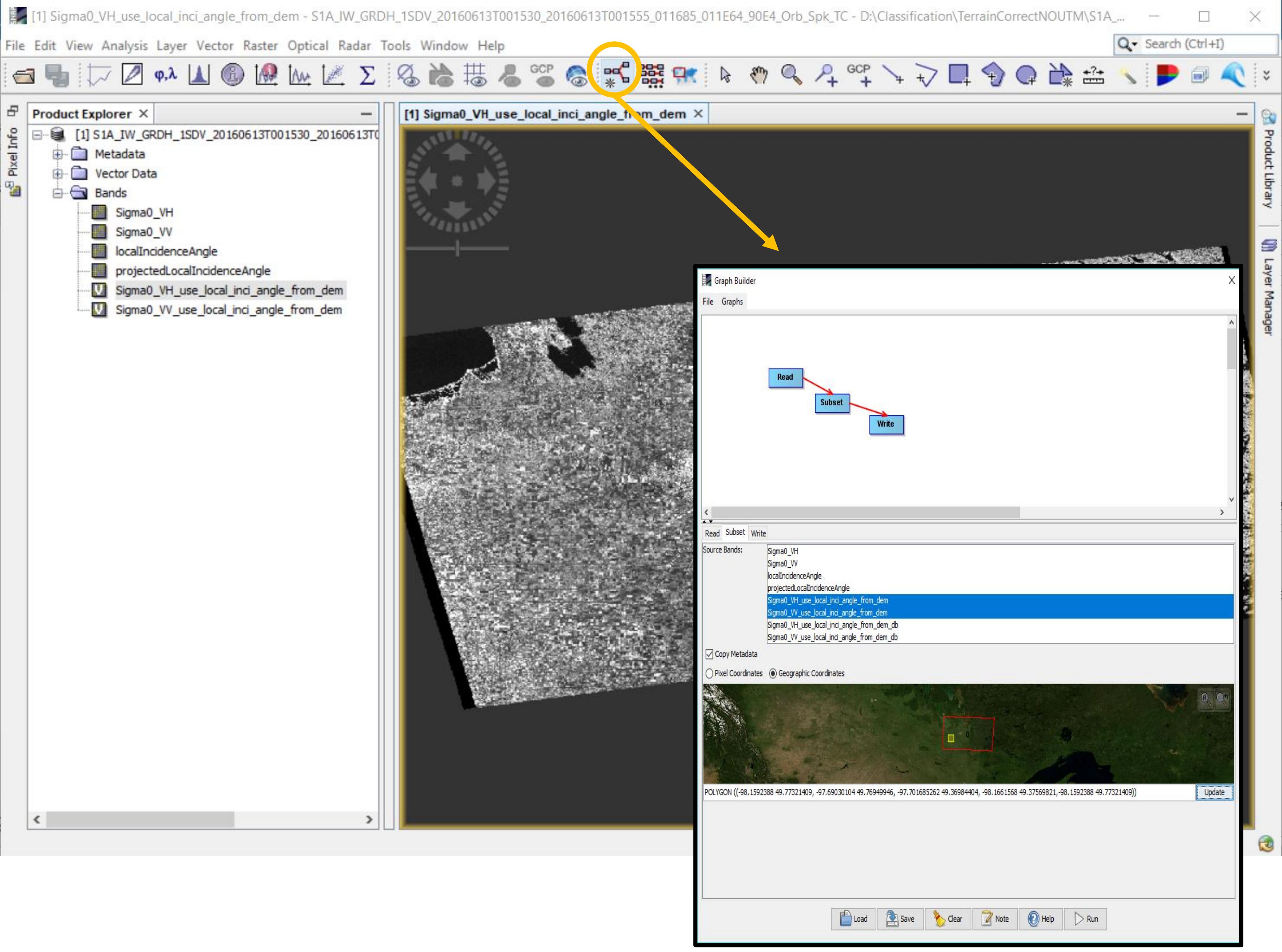
Pre-processing Steps – Subset Rasters to AOI (in Graph)

- Subset tool in a graph format is more precise
- Can write subset to new file immediately
- Can bulk process with created graph
- In either case, smaller files will have faster processing times*

1) Subset tab → select bands to be subset
2) Subset tab → click on Geographic Coordinates and add a well-known text polygon (5 coordinates, (last coordinate is same as first to close polygon))
3) Write Tab → Ensure new folder is selected for subset files to be saved to





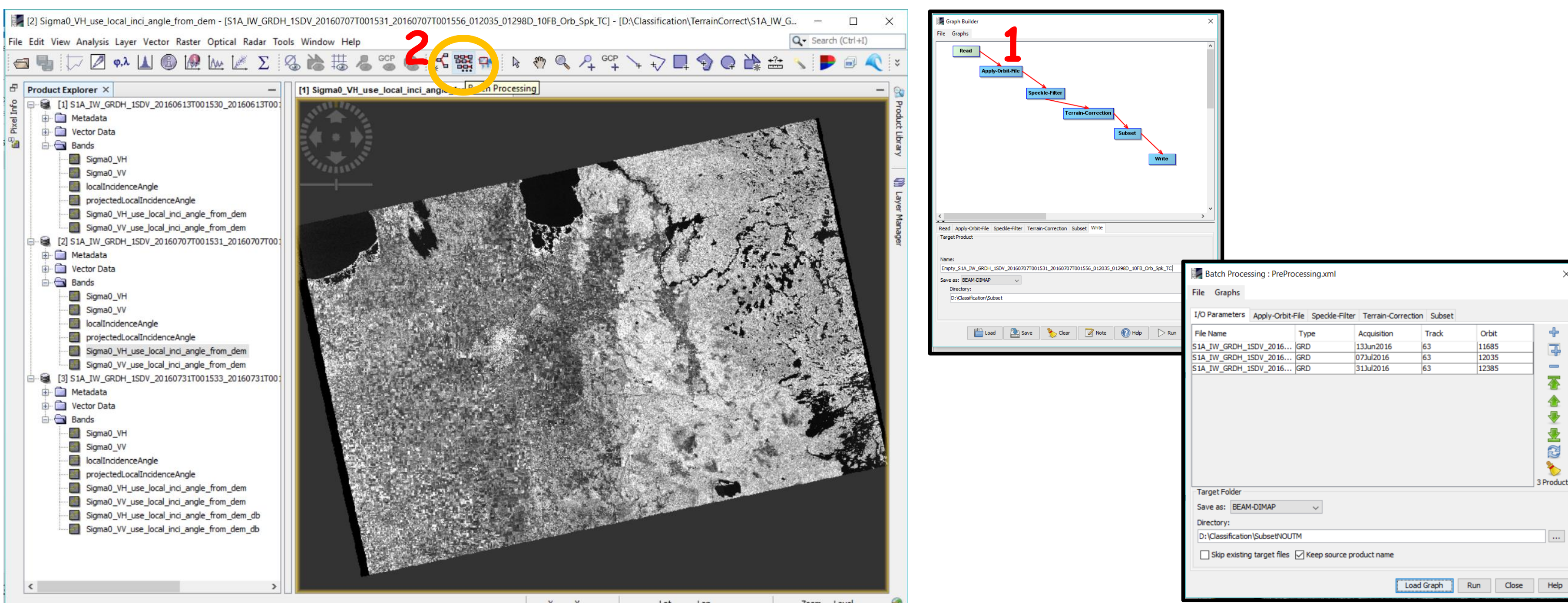


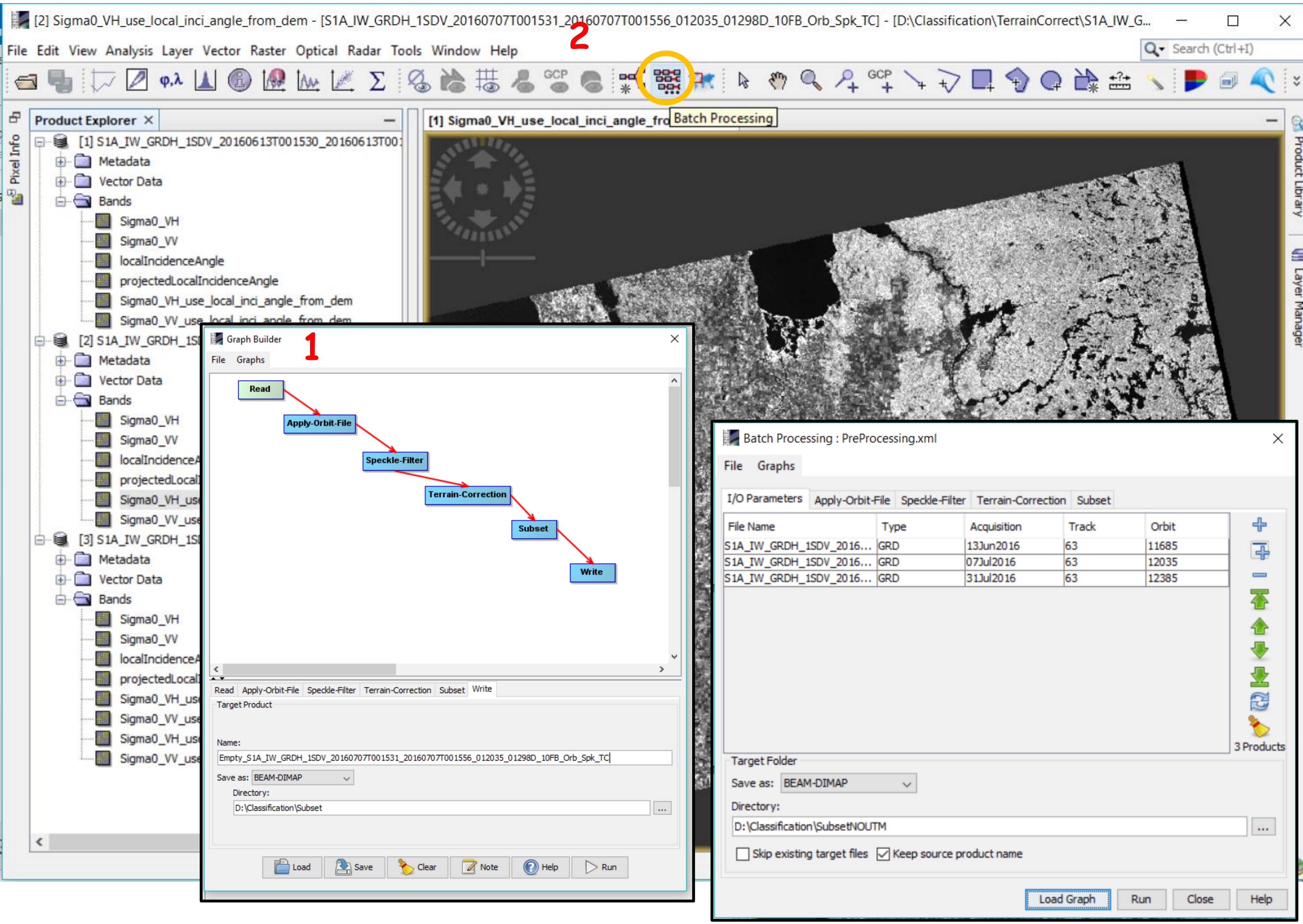
Product Explorer
Metadata
Vector Data
Bands
Sigma0_VH
Sigma0_VV
localIncidenceAngle
projectedLocalIncidenceAngle
Sigma0_VH_use_local_inci_angle_from_dem
Sigma0_VV_use_local_inci_angle_from_dem
Graph Builder
Read
Subset
Write
Source Bands:
Sigma0_VH_use_local_inci_angle_from_dem_db
Sigma0_VV_use_local_inci_angle_from_dem_db
Copy Metadata
Pixel Coordinates
Geographic Coordinates
Update
Load
Save
Clear
Note
Help
Run

Bulk processing – Create a graph and Pre-process All Images to Coregistration

- Can process multiple files (bulk processing) and run over night

1) Create a processing graph (this example contains all pre-processes to 'Subset') (1)
2) Batch Processing (2)
    - I/O Parameters tab: source → Click Plus sign with line over top adds all open imagery → Click Revolving Arrows refreshes metadata → Load Graph to load created processing graph
    - Once you load the graph, tabs of all processing modules will appear
    - Ensure you select all parameters under each tab

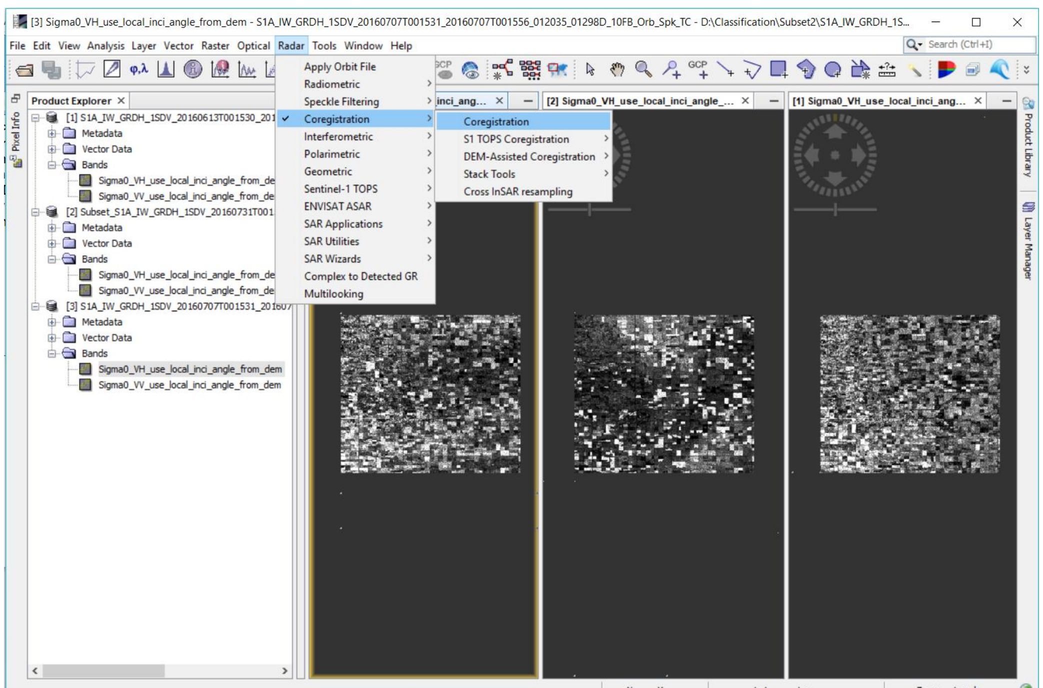


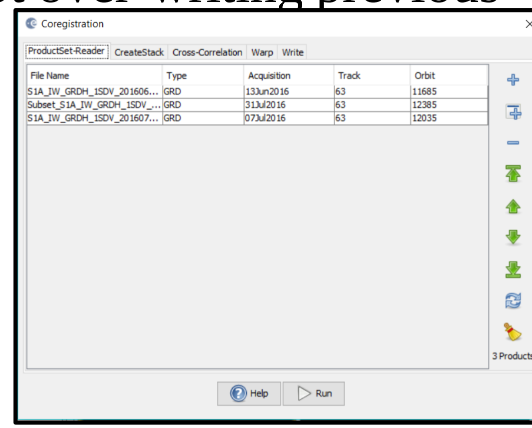

[2] Sigma0_VH_use_local_inci_angle_from_dem - [S1A_IW_GRDH_1SDV_20160707T001531_20160707T001556_012035_01298D_10FB_Orb_Spk_TC] - [D:\Classification\TerrainCorrect\S1A_IW_G...
2
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Batch Processing
Product Explorer
[1] S1A_IW_GRDH_1SDV_20160613T001530_20160613T001
Metadata
Vector Data
Bands
Sigma0_VH
Sigma0_VV
localIncidenceAngle
projectedLocalIncidenceAngle
Sigma0_VH_use_local_inci_angle_from_dem
Sigma0_VV_use_local_inci_angle_from_dem
[2] S1A_IW_GRDH_1S
[3] S1A_IW_GRDH_1S
[1] Sigma0_VH_use_local_inci_angle_fro
Pixel Info
Product Library
Layer Manager
Graph Builder
1
File Graphs
Read
Apply-Orbit-File
Speckle-Filter
Terrain-Correction
Subset
Write
Target Product
Name:
Empty_S1A_IW_GRDH_1SDV_20160707T001531_20160707T001556_012035_01298D_10FB_Orb_Spk_TC
Save as: BEAM-DIMAP
Directory:
D:\Classification\Subset
Load Save Clear Note Help Run
Batch Processing : PreProcessing.xml
File Graphs
I/O Parameters Apply-Orbit-File Speckle-Filter Terrain-Correction Subset
File Name Type Acquisition Track Orbit
S1A_IW_GRDH_1SDV_2016... GRD 13Jun2016 63 11685
S1A_IW_GRDH_1SDV_2016... GRD 07Jul2016 63 12035
S1A_IW_GRDH_1SDV_2016... GRD 31Jul2016 63 12385
3 Products
Target Folder
Save as: BEAM-DIMAP
Directory:
D:\Classification\SubsetNOUTM
Skip existing target files
Keep source product name
Load Graph Run Close Help

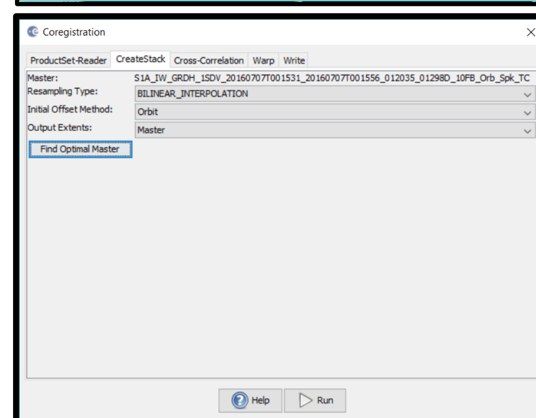
Pre-processing Steps - Co-registration

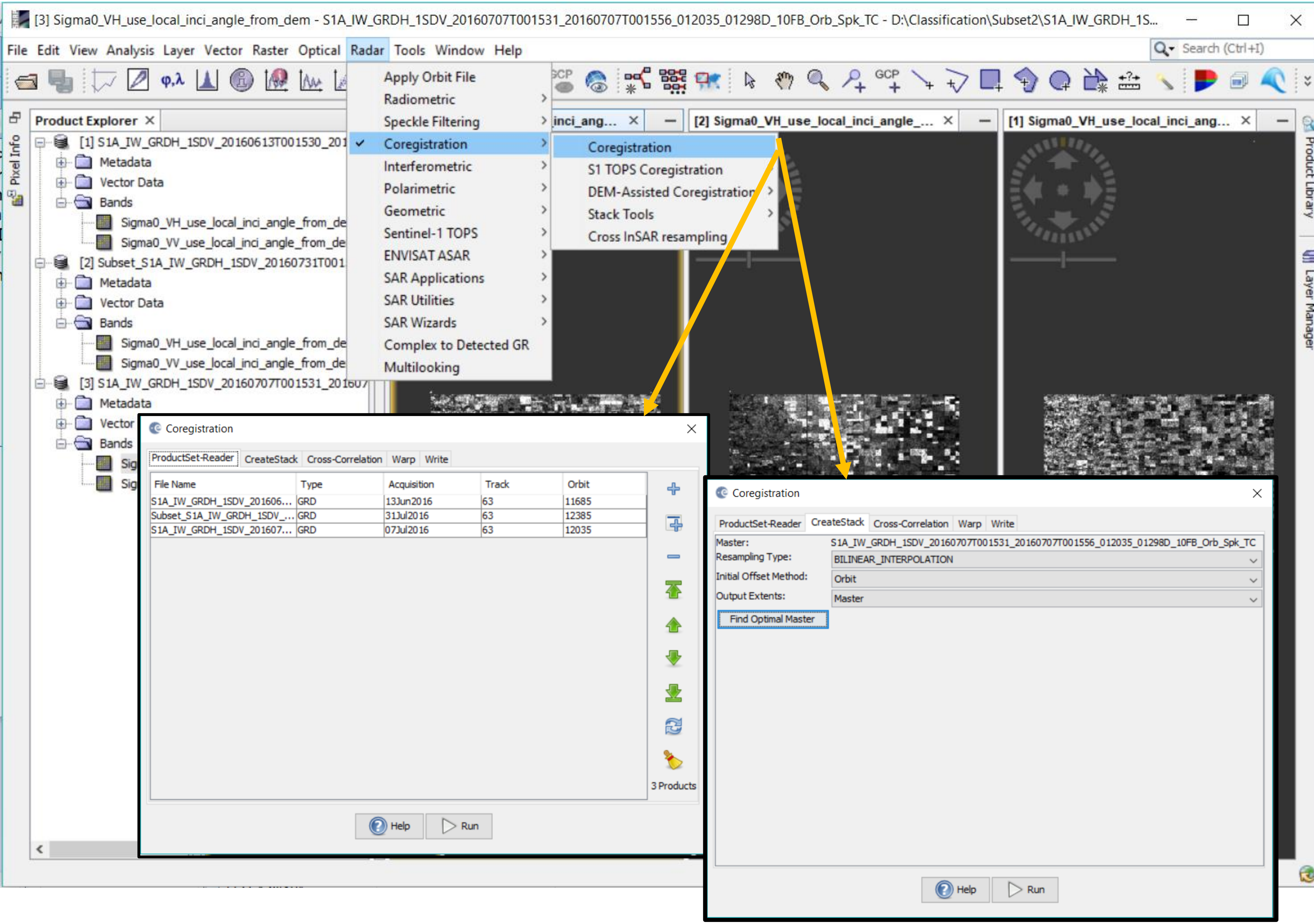
Spatial alignment of images acquired on June 13th, July 7th and July 31th, 2016

1. Go to Radar Menu >> Coregistration >> Coregistration:
   a) ProductSet-Reader: Click Plus sign with line over top adds all open imagery → Click Revolving Arrows refreshes metadata
   b) Create Stack: Resampling Type → Bilinear_Interpolation → Click Find Optimal Master
   c) Other tabs: leave as default; ensure Write folder is not over-writing previous files
   d) Click Run and Close window when completed





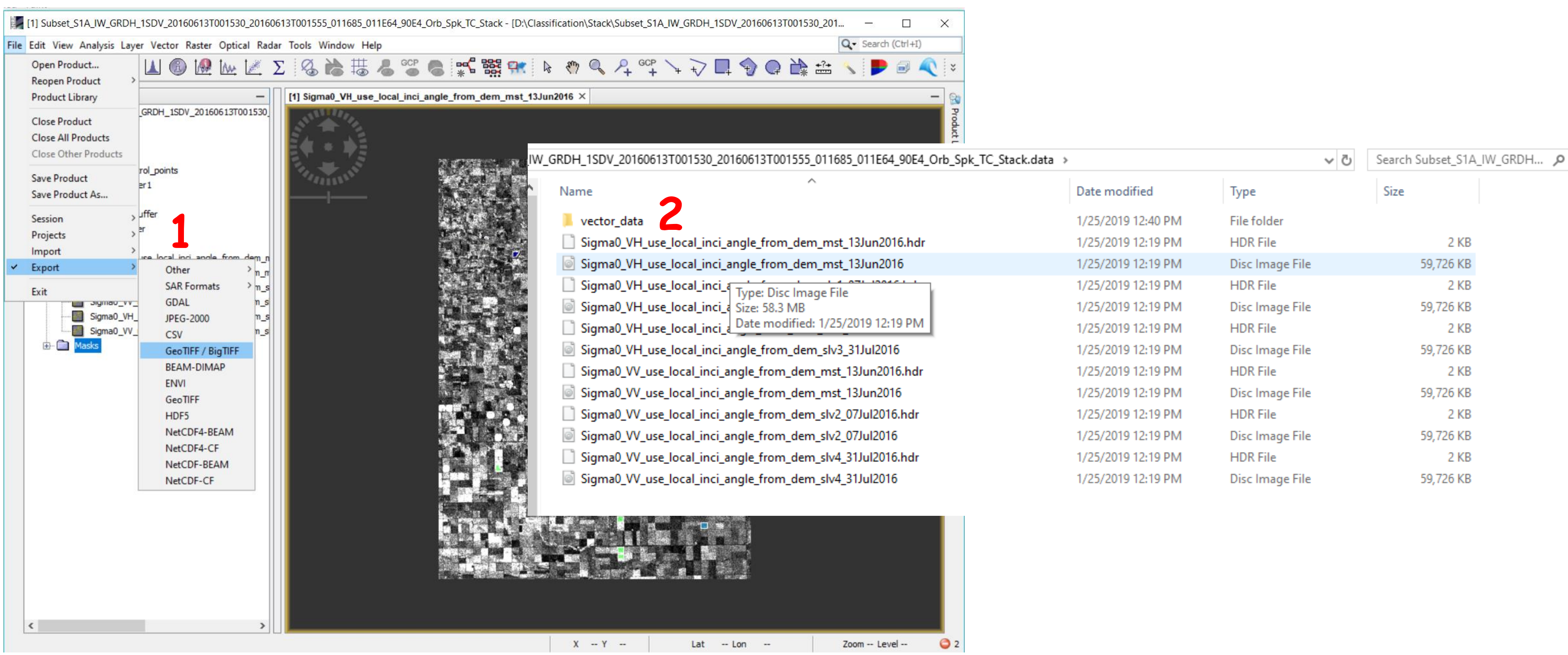


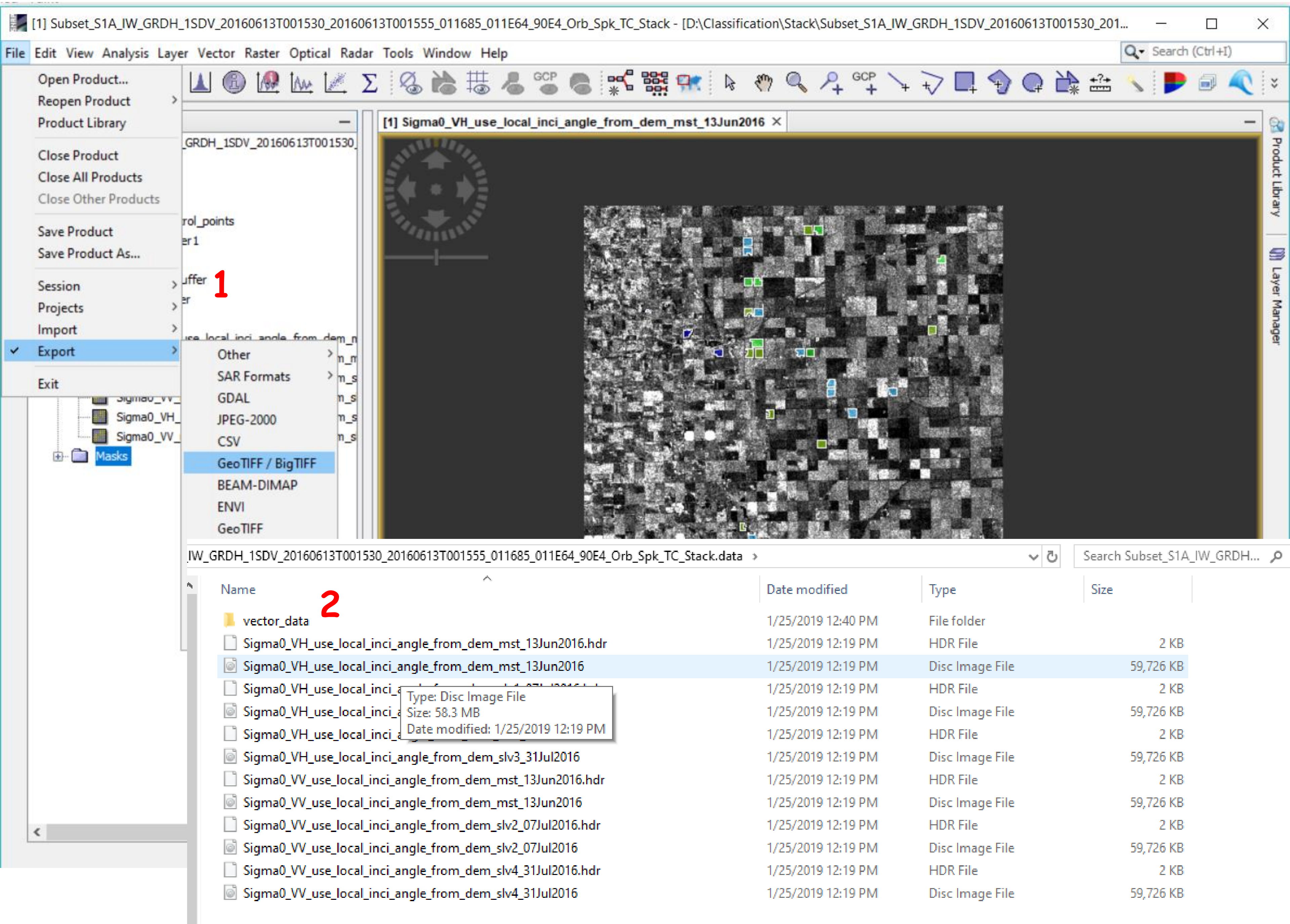


[3] Sigma0_VH_use_local_inci_angle_from_dem - S1A_IW_GRDH_1SDV_20160707T001531_20160707T001556_012035_01298D_10FB_Orb_Spk_TC - D:\Classification\Subset2\S1A_IW_GRDH_1S...
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Product Explorer
[1] S1A_IW_GRDH_1SDV_20160613T001530_201
Metadata
Vector Data
Bands
Sigma0_VH_use_local_inci_angle_from_de
Sigma0_VV_use_local_inci_angle_from_de
[2] Subset_S1A_IW_GRDH_1SDV_20160731T001
[3] S1A_IW_GRDH_1SDV_20160707T001531_201607
Apply Orbit File
Radiometric
Speckle Filtering
Coregistration
Interferometric
Polarimetric
Geometric
Sentinel-1 TOPS
ENVISAT ASAR
SAR Applications
SAR Utilities
SAR Wizards
Complex to Detected GR
Multilooking
Coregistration
S1 TOPS Coregistration
DEM-Assisted Coregistration
Stack Tools
Cross InSAR resampling
[2] Sigma0_VH_use_local_inci_angle_...
[1] Sigma0_VH_use_local_inci_ang...
Product Library
Layer Manager
Pixel Info
Coregistration
ProductSet-Reader CreateStack Cross-Correlation Warp Write
File Name Type Acquisition Track Orbit
S1A_IW_GRDH_1SDV_201606... GRD 13Jun2016 63 11685
Subset_S1A_IW_GRDH_1SDV_... GRD 31Jul2016 63 12385
S1A_IW_GRDH_1SDV_201607... GRD 07Jul2016 63 12035
3 Products
Help Run
Coregistration
ProductSet-Reader CreateStack Cross-Correlation Warp Write
Master: S1A_IW_GRDH_1SDV_20160707T001531_20160707T001556_012035_01298D_10FB_Orb_Spk_TC
Resampling Type: BILINEAR_INTERPOLATION
Initial Offset Method: Orbit
Output Extents: Master
Find Optimal Master
Help Run

Exporting Data Stacks Out of SNAP

- Limited functionality in SNAP; opportunity to customize classifiers
- Two ways to ‘export’
  - SNAP → File → Export (**1**)
  - Windows File Explorer → use the .img files in the associated BEAM DIMAP folder (**2**)
- Can use .tifs in R, Python etc. (RandomForest, R - https://cran.r-project.org/web/packages/randomForest/randomForest.pdf)

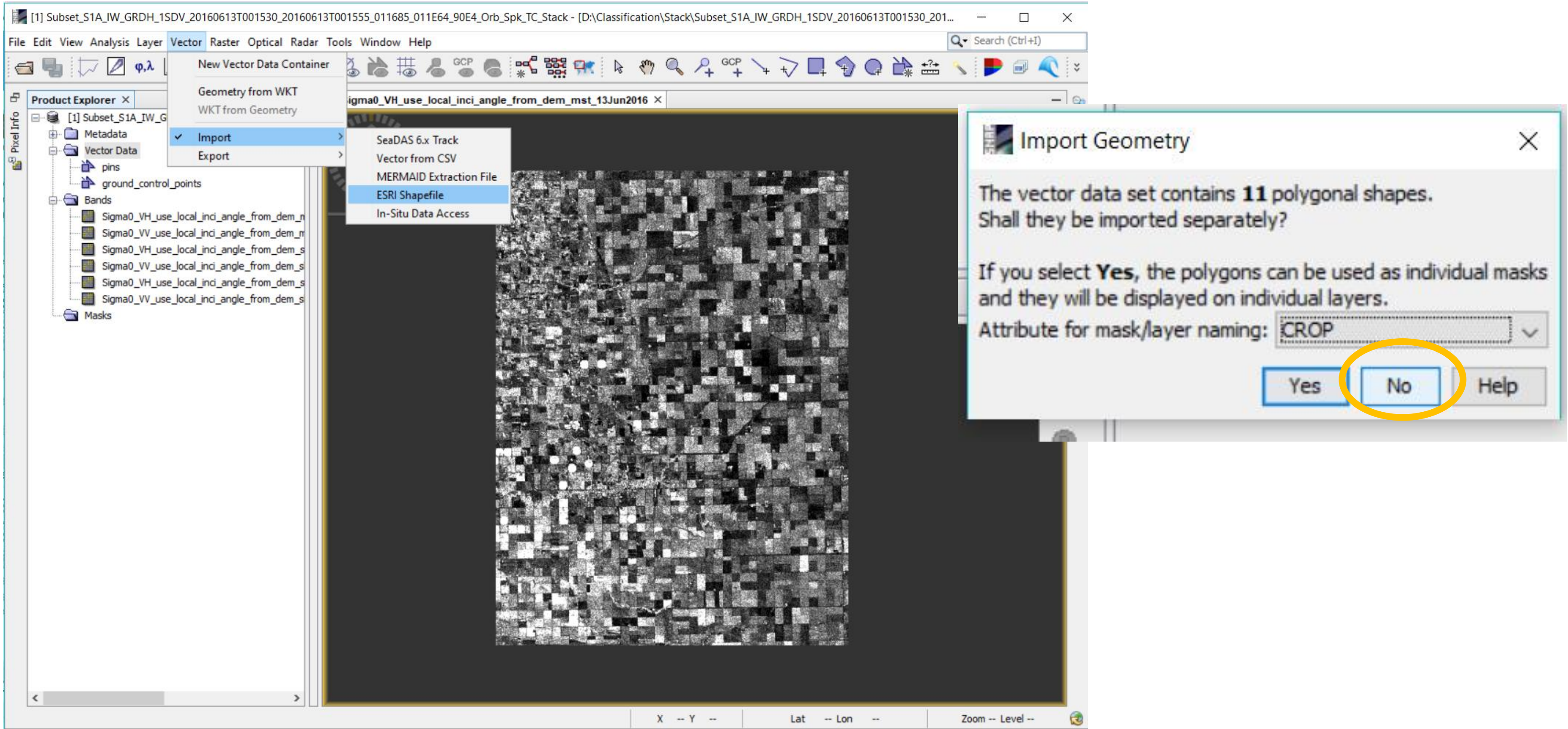


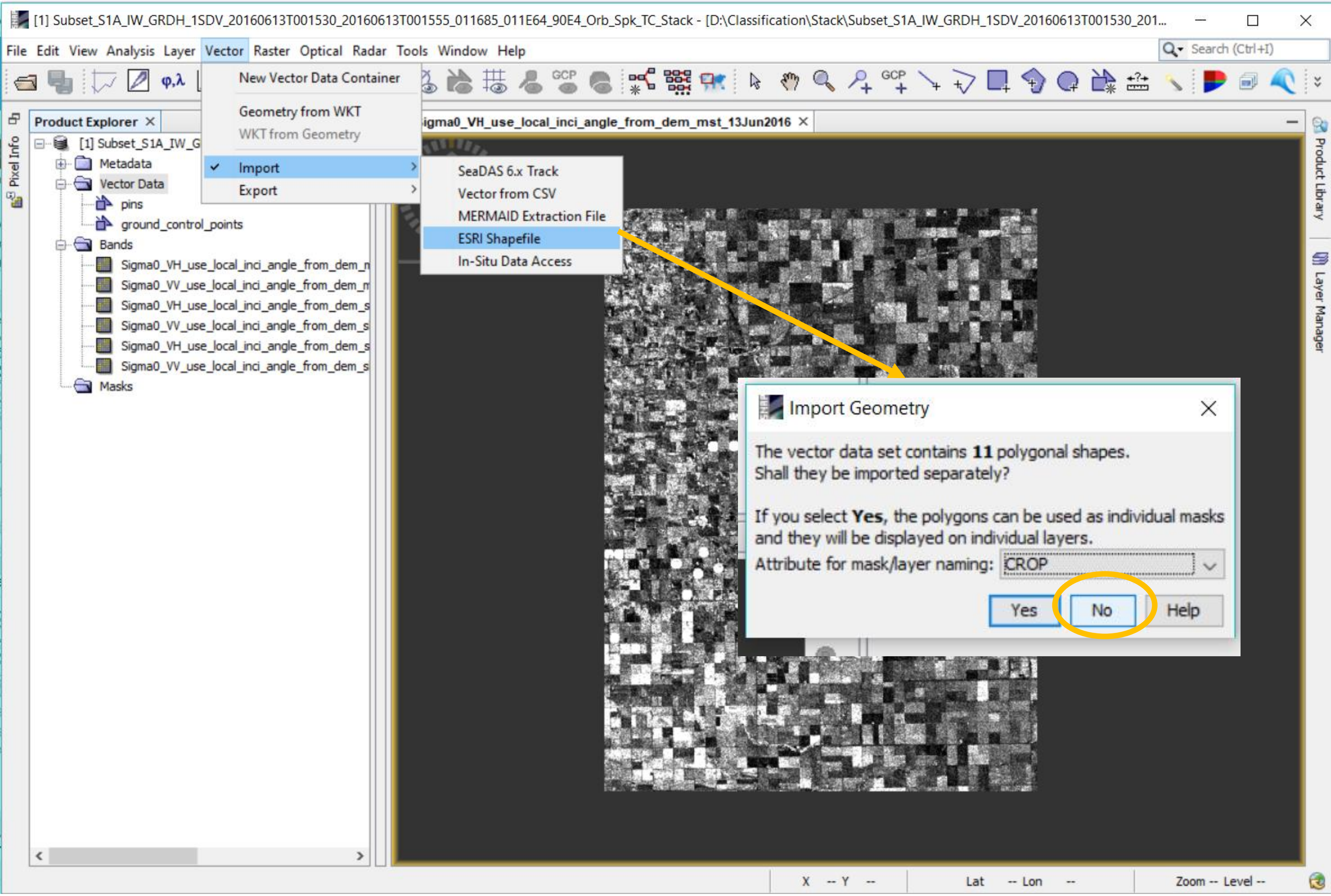

[1] Subset_S1A_IW_GRDH_1SDV_20160613T001530_20160613T001555_011685_011E64_90E4_Orb_Spk_TC_Stack - [D:\Classification\Stack\Subset_S1A_IW_GRDH_1SDV_20160613T001530_201...
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
Open Product...
Reopen Product
Product Library
Close Product
Close All Products
Close Other Products
Save Product
Save Product As...
Session
Projects
Import
Export
Exit
Other
SAR Formats
GDAL
JPEG-2000
CSV
GeoTIFF / BigTIFF
BEAM-DIMAP
ENVI
GeoTIFF
1
Sigma0_VH_
Sigma0_VV_
Masks
[1] Sigma0_VH_use_local_inci_angle_from_dem_mst_13Jun2016
Product Library
Layer Manager
IW_GRDH_1SDV_20160613T001530_20160613T001555_011685_011E64_90E4_Orb_Spk_TC_Stack.data
Search Subset_S1A_IW_GRDH...
2
Name
Date modified
Type
Size
vector_data 1/25/2019 12:40 PM File folder
Sigma0_VH_use_local_inci_angle_from_dem_mst_13Jun2016.hdr 1/25/2019 12:19 PM HDR File 2 KB
Sigma0_VH_use_local_inci_angle_from_dem_mst_13Jun2016 1/25/2019 12:19 PM Disc Image File 59,726 KB
Sigma0_VH_use_local_inci_a 1/25/2019 12:19 PM HDR File 2 KB
Sigma0_VH_use_local_inci_a 1/25/2019 12:19 PM Disc Image File 59,726 KB
Sigma0_VH_use_local_inci_a 1/25/2019 12:19 PM HDR File 2 KB
Type: Disc Image File
Size: 58.3 MB
Date modified: 1/25/2019 12:19 PM
Sigma0_VH_use_local_inci_angle_from_dem_slv3_31Jul2016 1/25/2019 12:19 PM Disc Image File 59,726 KB
Sigma0_VV_use_local_inci_angle_from_dem_mst_13Jun2016.hdr 1/25/2019 12:19 PM HDR File 2 KB
Sigma0_VV_use_local_inci_angle_from_dem_mst_13Jun2016 1/25/2019 12:19 PM Disc Image File 59,726 KB
Sigma0_VV_use_local_inci_angle_from_dem_slv2_07Jul2016.hdr 1/25/2019 12:19 PM HDR File 2 KB
Sigma0_VV_use_local_inci_angle_from_dem_slv2_07Jul2016 1/25/2019 12:19 PM Disc Image File 59,726 KB
Sigma0_VV_use_local_inci_angle_from_dem_slv4_31Jul2016.hdr 1/25/2019 12:19 PM HDR File 2 KB
Sigma0_VV_use_local_inci_angle_from_dem_slv4_31Jul2016 1/25/2019 12:19 PM Disc Image File 59,726 KB

Adding Field Data in SNAP

- Must import each crop type individually

1) Go to Vector Menu >> Import >> Esri Shapefile:
   a) Import Geometry: Choose attribute for mask/layer naming→
   b) When asked to import as individual masks - **NO**
   c) Complete for each crop type you are using




[1] Subset_S1A_IW_GRDH_1SDV_20160613T001530_20160613T001555_011685_011E64_90E4_Orb_Spk_TC_Stack - [D:\Classification\Stack\Subset_S1A_IW_GRDH_1SDV_20160613T001530_201...
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Search (Ctrl+I)
New Vector Data Container
Geometry from WKT
WKT from Geometry
Import
Export
SeaDAS 6.x Track
Vector from CSV
MERMAID Extraction File
ESRI Shapefile
In-Situ Data Access
Product Explorer
[1] Subset_S1A_IW_G
Metadata
Vector Data
pins
ground_control_points
Bands
Sigma0_VH_use_local_inci_angle_from_dem_m
Sigma0_VV_use_local_inci_angle_from_dem_m
Sigma0_VH_use_local_inci_angle_from_dem_s
Sigma0_VV_use_local_inci_angle_from_dem_s
Sigma0_VH_use_local_inci_angle_from_dem_s
Sigma0_VV_use_local_inci_angle_from_dem_s
Masks
Pixel Info
igma0_VH_use_local_inci_angle_from_dem_mst_13Jun2016
Product Library
Layer Manager
Import Geometry
The vector data set contains 11 polygonal shapes.
Shall they be imported separately?
If you select Yes, the polygons can be used as individual masks
and they will be displayed on individual layers.
Attribute for mask/layer naming: CROP
Yes
No
Help
X -- Y --
Lat -- Lon --
Zoom -- Level --

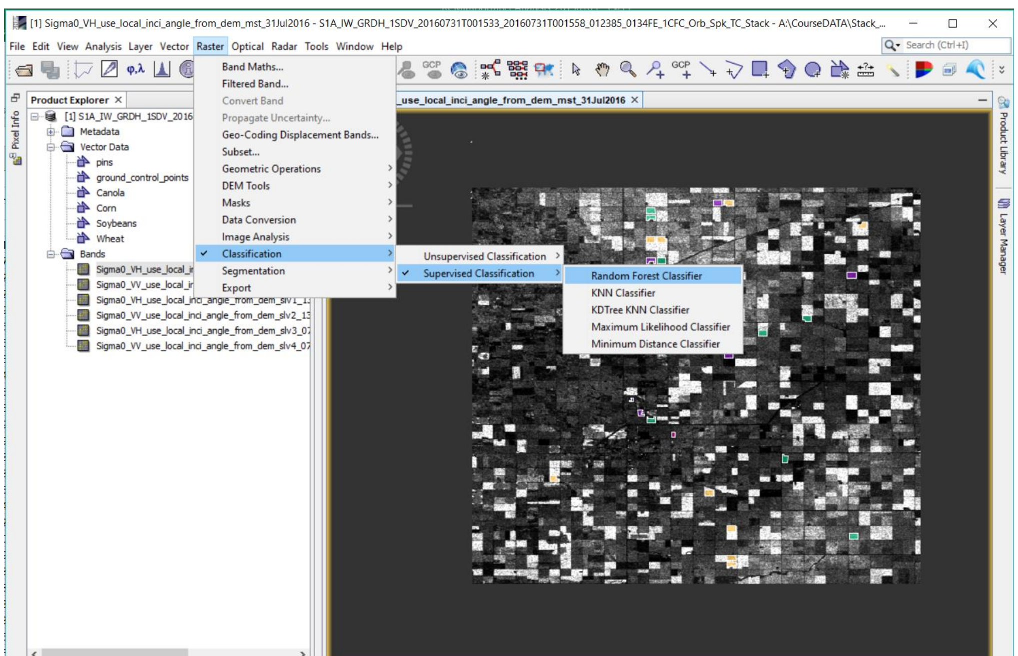
Classification in SNAP

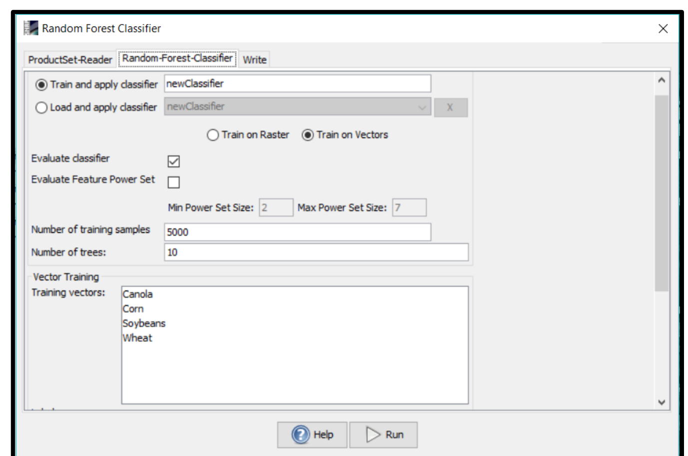
- Using the stack of EO data along with added vectors of field data to classify data using Random Forest

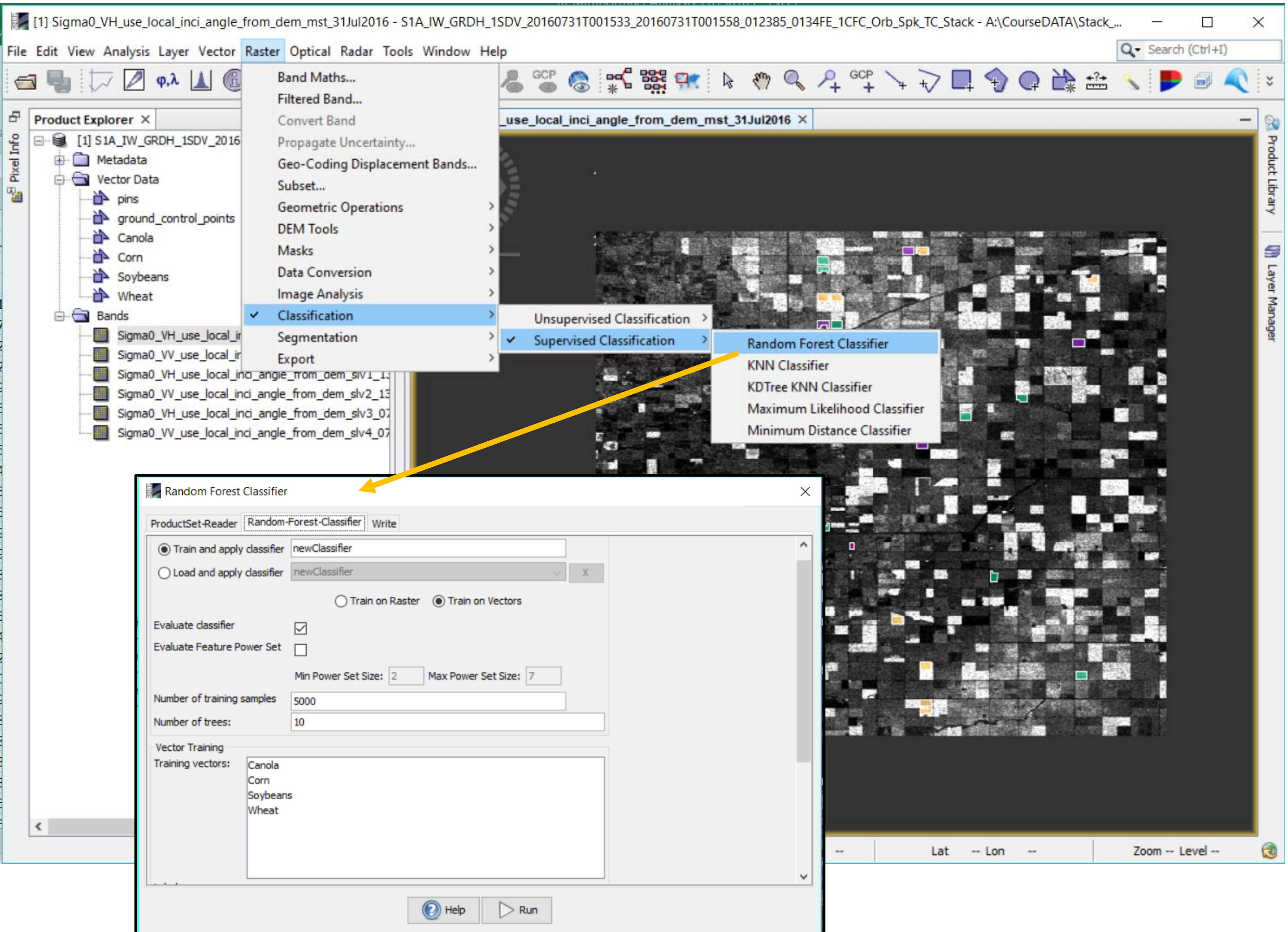
1) Go to Raster Menu >> Classification >> Supervised Classification >> Random Forest Classifier:
   a) Random Forest Classifier: Can leave all as default
   b) During research you can assess how changing the parameters changes results

2) Number of training samples are number of training pixels to include from class masks

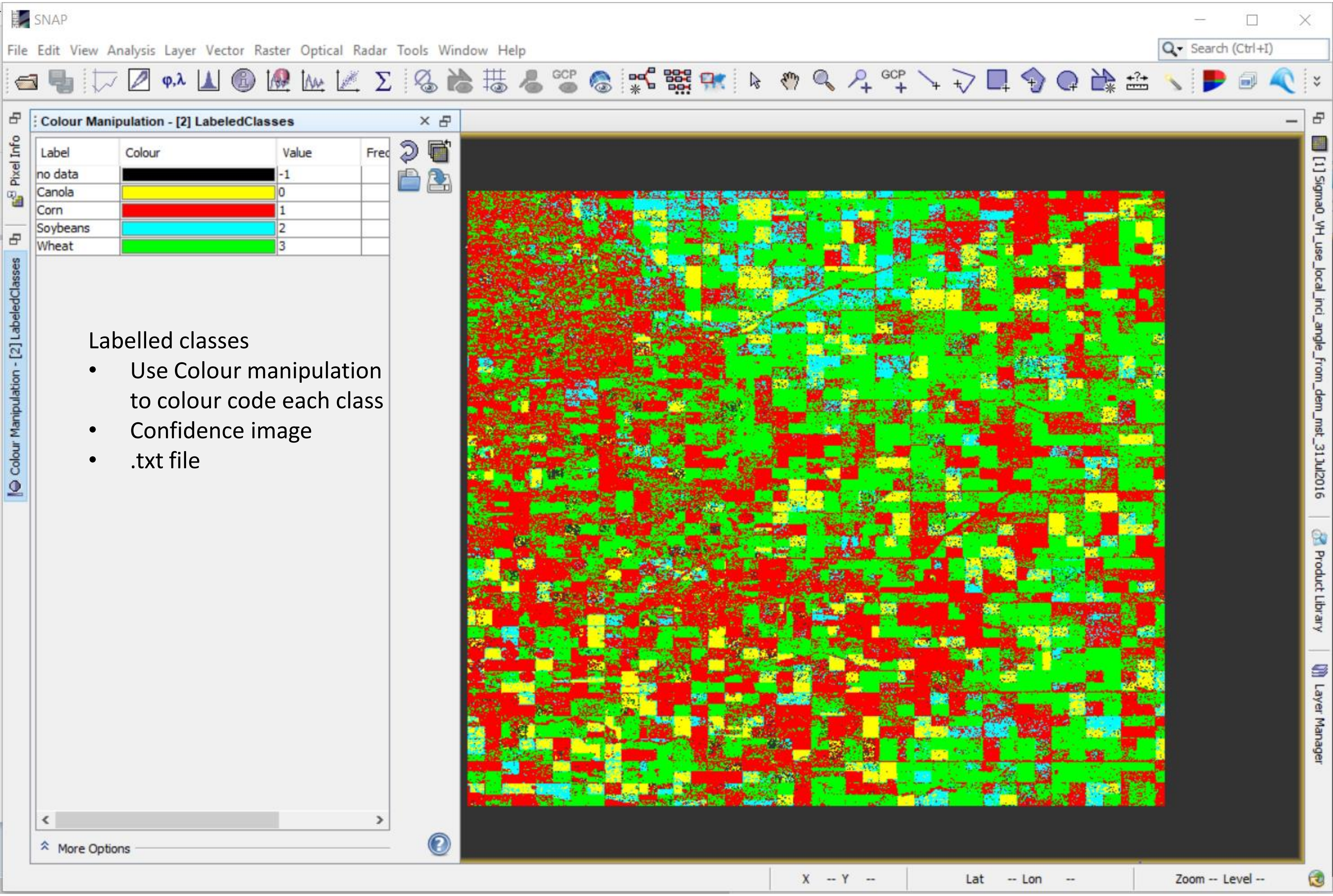
3) Number of trees are the number of trees to be grown with each individual tree similar to Decision Tree classifier






[1] Sigma0_VH_use_local_inci_angle_from_dem_mst_31Jul2016 - S1A_IW_GRDH_1SDV_20160731T001533_20160731T001558_012385_0134FE_1CFC_Orb_Spk_TC_Stack - A:\CourseDATA\Stack_...
File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
Product Explorer
[1] S1A_IW_GRDH_1SDV_2016
Metadata
Vector Data
pins
ground_control_points
Canola
Corn
Soybeans
Wheat
Bands
Band Maths...
Filtered Band...
Convert Band
Propagate Uncertainty...
Geo-Coding Displacement Bands...
Subset...
Geometric Operations
DEM Tools
Masks
Data Conversion
Image Analysis
Classification
Segmentation
Export
Unsupervised Classification
Supervised Classification
Random Forest Classifier
KNN Classifier
KDTree KNN Classifier
Maximum Likelihood Classifier
Minimum Distance Classifier
Random Forest Classifier
ProductSet-Reader
Random-Forest-Classifier
Write
Train and apply classifier
newClassifier
Load and apply classifier
Train on Raster
Train on Vectors
Evaluate classifier
Evaluate Feature Power Set
Min Power Set Size: 2
Max Power Set Size: 7
Number of training samples 5000
Number of trees: 10
Vector Training
Training vectors:
Canola
Corn
Soybeans
Wheat
Help
Run
Lat -- Lon --
Zoom -- Level --

Classification in SNAP – Random Forest Outputs



Labelled classes

- Use Colour manipulation to colour code each class
- Confidence image
- .txt file

Classification in SNAP – Random Forest Output – Confidence Image