Cookbook

ESA SNAP Sentinel-1 Toolbox – Multi-temporal Analysis of Sentinel-1 SAR Backscattered Intensity

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Exercise objectives

- Familiarize with open source ESA SNAP Toolbox.
- Familiarize with Copernicus Sentinel-1 SAR products.
- Training on calculation and analysis of backscatter coefficient from Sentinel-1 detected products
- Inspection of manual as well as batch processing options of ESA SNAP Toolbox
- End-to-end showcase over the broader area of Bucharest (Hungary).

Useful Links

Information regarding Sentinel missions
https://sentinel.esa.int

Science Toolbox Exploitation Platform (STEP)
http://step.esa.int

Copernicus Open Access Hub (previously called “Sentinels Scientific Data Hub”)
https://scihub.copernicus.eu

French Access to the Sentinel Products (PEPS)
https://peps.cnes.fr

Alaska Satellite Facility
https://www.asf.alaska.edu

Sentinel-1 Quality Control Subsystem
https://qc.sentinel1.eo.esa.int

Datasets

Copernicus Sentinel-1 IW Ground Range Detected (GRD) core products:

Géosciences pour une Terre durable
brgm

S1A_IW_GRDH_1SDV_20170709T163414_20170709T163439_017397_01D0F4_1BC0
S1A_IW_GRDH_1SDV_20170721T163415_20170721T163440_017572_01D647_D282
S1A_IW_GRDH_1SDV_20170802T163415_20170802T163440_017747_01DBA1_F344

Data Processing Steps

Calculation of backscatter coefficients (sigma0) for a set of Sentinel-1 SLC products.

Manual Processing (OPTION A)
Should be repeated for every image.

A1. **Apply Orbit File**
GUI path: Radar → Apply Orbit File
Input: S1A_IW_GRDH_*
Output: S1A_IW_GRDH_*_Orb
Processing parameters:
Orbit State Vectors: Sentinel Restituted (Auto Downlaod)
Check "Do not fail if new orbit file is not found"

A2. **Calibrate**
GUI path: Radar → Radiometric → Calibrate
Input: S1A_IW_GRDH_*_Orb
Output: S1A_IW_GRDH_*_Orb_Cal
Processing parameters:
Check "Output Sigma0 band"

A3. **Multi-looking**
GUI: Radar → Multilooking
Input: S1A_IW_GRDH_*_Orb_Cal
Output: S1A_IW_GRDH_*_Orb_Cal_ML
Processing parameters:
Check "GR Square Pixel"
Number of Range Looks: 8
Number of Azimuth Looks: 2

A4. **Geocoding**
GUI: Radar → Geometric → Terrain Correction → Range-Doppler Terrain Correction
Input: S1A_IW_GRDH_*_Orb_Cal_ML
Output: S1A_IW_GRDH_*_Orb_Cal_ML_TC

Processing parameters:

Pixel Spacing (m): 20

Map Projection: WGS84(DD)

A5. **Subset**

GUI: Raster → Subset

Input: S1A_IW_GRDH_*_Orb_Cal_ML_TC

Output: S1A_IW_GRDH_*_Orb_Cal_ML_TC_subset

Processing parameters:

Geo Coordinates Menu:

North latitude bound: 47.577

West longitude bound: 18.775

South latitude bound: 47.359

East longitude bound: 19.088

Batch Processing (OPTION B)

B1. **Building Processing Chain**

GUI: Tools → Graph Builder

Input: Select any image of the data set for the READ operator in the graph.

Output: TOPSAR_Orb_Cal_ML_TC_subset.xml

Processing parameters:

- Add operators as defined in Manual Processing Steps (Option 1)
- Connect graph elements
- Keep default target name for WRITE operator
- Save processing graph (*.xml file)

B2. **Applying Processing Chain**

GUI: Tools → Batch Processing

Input: List of products to be processed & processing graph

Output: S1A_IW_GRDH_*_Orb_Cal_ML

Processing parameters:

- Load entire data set to I/O Parameters
- Load previously built processing graph
- Define output directory (should be different from input directory)

NOTE: Batch processing operator maintains names of input files without adding processing suffixes.

Post- Processing Steps

1. **Stack data**
   GUI: Radar → Coregistration → Stack Tools → Create Stack
   Inputs: Outputs from previous processing steps
   Output: S1A_Orb_Cal_ML_TC20_subset_Stack
   Processing parameters:
      Resampling Type: NONE
      Initial Offset Method: Product Geolocation

2. **Linear to dB scale**
   GUI: Raster → Data Conversion → Linear to/from dB
   Input: S1A_Orb_Cal_ML_TC20_subset_Stack
      (Select "Sigma0_*" bands within product and convert to virtual bands)
   Output: "Sigma0_*_db" bands
   Processing parameters: None

3. **Multi-temporal Filtering**
   GUI: Radar → Speckle Filtering Multi-temporal Speckle Filter
   Inputs: S1A_Orb_Cal_ML_TC20_subset_Stack (bands in linear scale)
   Output: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk
   Processing parameters:
      Filter Gamma Map
      Filter Size X (odd number): 3
      Filter Size Y (odd number): 3
      Check "Estimate Equivalent Number of Looks"

4. **Linear to dB scale**
   GUI: Raster → Data Conversion → Linear to/from dB
   Input: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk
      (Select "Sigma0_*" bands within product and convert to virtual bands)
   Output: "Sigma0_*_db" bands
   Processing parameters: None

   NOTE: Visualize differences before and after filtering and check improvement
   (common stretching of the histogram should be applied).

5. **Visualize Data Values in Scatter Plot**
   GUI: Analysis → Scatter Plot

Inputs: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk
Output: None
Processing parameters:

- Select Sigma0 (in dB) bands to be visualized in X- and Y-axis
- Apply "Refresh View" button
- Save chart as PNG image file

6. **Generate RGB Composite**
GUI: Raster → Band Math
Input: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk (should be selected)
Output: Virtual output in "Product View" space
Processing parameters:
Red: Sigma0_VV_mst_09Jul2017_db
Green: Sigma0_VV_slv1_21Jul2017_db
Blue: Sigma0_VV_slv2_02Aug2017_db

7. **Export RGB Composite as Image File**
GUI: File → Export → Other → View as Image
Input: Select RGB composite in "Product View" space
Output: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk_RGB
Processing parameters:
Select from available export formats (BMP, PGN, JPEG, TIFF, GeoTIFF)
Image Region: "Full scene"
Image Resolution: "Full resolution"

8. **Export RGB Composite as Google Earth file**
GUI: File → Export → Other → View as Google Earth KMZ
Input: Select RGB composite in "Product View" space
Output: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk_RGB.kmz
Processing parameters: None

NOTE: Commend on geolocation accuracy and the properties of the false colour composite

9. **Data Stack Averaging**
GUI: Radar → Coregistration → Stack Tools → Stack Averaging
Inputs: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk
Output: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk_avg
Processing parameters:
Statistics Mean Average

10. **Linear to dB scale**
    GUI: Raster → Data Conversion → Linear to/from dB
    Input: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk_avg
    (Select "Sigma0_*" band within product and convert to virtual band)
    Output: "Sigma0_*_db" band
    Processing parameters: None

11. **Histogram Stretching using predefined values**
    GUI: Colour Manipulation Menu (lower right corner)
    Input: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk_avg
    (band "class_indices" should be opened)
    Output: None
    Processing parameters:
    Button: Import Colour Palette from txt file (load "sigma0_dB.cpd" file)

12. **Calculate Image Statistics**
    GUI: Analysis → Statistics
    Input: S1A_Orb_Cal_ML_TC20_subset_Stack_Spk_avg
    Output: *.CSV file
    Processing parameters:
    - Select dB band of the input product
    - Apply "Refresh View" button
    - Export to CSV file