



## 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:



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 ( $\sigma_0$ ) 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 Download)

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:** Comment 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