Cookbook

ESA SNAP – Sentinel-1 Toolbox
Multi-temporal Analysis of Sentinel-1 SAR Backscattered Intensity: Kunming (P.R. China)

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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 Kunming (P.R. China).

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_1SSV_20150908T111507_20150908T111532_007623_00A8F5_9A01
S1A_IW_GRDH_1SSV_20160902T111508_20160902T111533_012873_01453E_7A25
S1A_IW_GRDH_1SDV_20170909T111527_20170909T111552_018298_01EC66_6EC7
S1A_IW_GRDH_1SDV_20170909T111502_20170909T111527_018298_01EC66_BF80

Data Processing Steps

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

Manual Processing (OPTION A)

Processing steps need to be repeated for each image in the data set.

A0. **Sentinel-1 Slice Assembly** (step applied only to images acquired in 2017)
GUI path: Radar → Sentinel-1 TOPS → S-1 Slice Assembly
Input 1: S1A_IW_GRDH_20170909T111527_*_6EC7
Input 2: S1A_IW_GRDH_20170909T111502_*_BF80
Output: S1A_IW_GRDH_1SDV_20170909_Asm
Processing parameters:
Polarisations VV

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: 2
Number of Azimuth Looks: 2

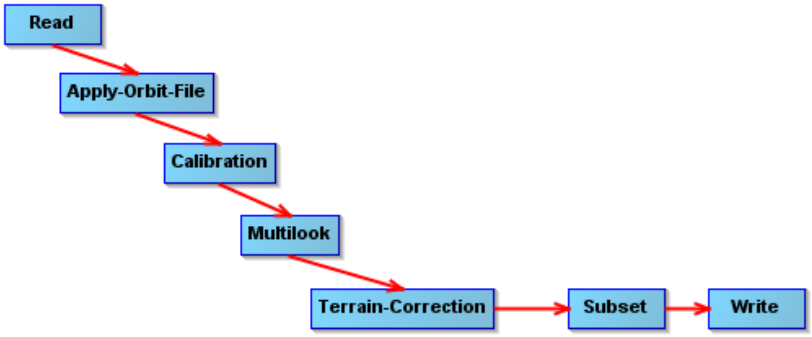
A4. **Terrain Correction Geocoding**
GUI: Radar → Geometric → Terrain Correction → Range-Doppler Terrain Correction
Input: S1A_IW_GRDH_*_Orb_Cal_ML
Output: S1A_IW_GRDH_*_Orb_Cal_ML_TC
Processing parameters:
Pixel Spacing (m): 20
Map Projection: WGS84(DD)

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: 25.492
West longitude bound: 102.234
South latitude bound: 24.508
East longitude bound: 103.288

Batch Processing (OPTION B)

Prepare of an automatic processing chain and apply it to entire data set.

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



B2. **Applying Processing Chain**

GUI: Tools → Batch Processing

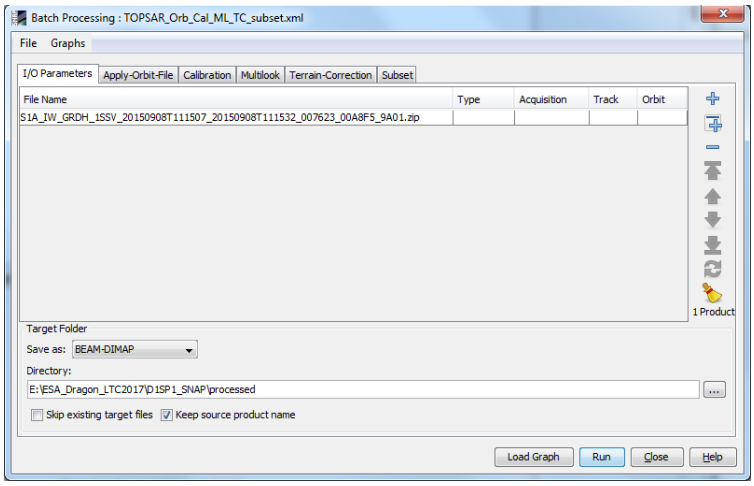
Input: List of products to be processed & processing graph

Output: -

Processing parameters:

- Load entire data set to I/O Parameters
- Load previously built processing graph (Load Graph option)
- 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 of previous processing steps (sigma0 terrain corrected images)

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_08Sep2015_db
   Green: Sigma0_VV_slv1_02Sep2015_db
   Blue: Sigma0_VV_slv2_09Sep2017_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
   Statistics Minimum (repeat)
   Statistics Maxmimum (repeat)

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