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SNAP Tutorial

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Aim of the tutorial: is to generate Radiometrically Terrain Corrected (RTC) Images from Sentinel-1 GRD products

Plan for today:

SAR data processing with Snap :

i. Single-date processing

- Generating a Radiometrically Terrain Corrected (RTC) Image

ii. Multi-temp processing

- Generating a Radiometrically Terrain Corrected (RTC) Image for a multi-temporal data set
- Time series analysis of multi-temp dataset

Step by step - Generating a **Radiometrically Terrain Corrected (RTC)** Image of a single acquisition

1. Open data in SNAP- Display the data
2. Interpret the data (metadata, pixelinfo, image navigation tools etc.)
3. Take subset & apply orbit file
4. Apply radiometric calibration
5. Flatten terrain
6. Multi-Looking
7. Create Elevation Band (SRTM)
9. Range-Doppler Terrain Correction, Input: ML dataset
10. Convert gamma0 images from linear to dB
11. Compute difference image from gamma0 [dB]: VV – VH
12. Display data as RGB view
13. Statistical analyses: Scatterplots, Histogram Analysis, Profile Plot etc.

- Start SNAP by double-clicking the icon
- S1 Products can be opened directly from a zip

Open the S1 data

in the folder Single Image Analysis > input

Double click on the band to display

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Interpret data

Name	Value	Type	Unit	Description
Orbit_State_Vectors				
SRGR_Coefficients				
Doppler_Centroid_Coefficients				
Band_IW_VH				
Band_IW_VV				
PRODUCT	S1A_IW_GRDH_1SDV_20170103T164227_20170103T164252_0	ascii		Product name
PRODUCT_TYPE	GRD	ascii		Product type
SPH_DESCRIPTOR	Sentinel-1 IW Level-1 GRD Product	ascii		Description
MISSION	SENTINEL-1A	ascii		Satellite mission
ACQUISITION_MODE	IW	ascii		Acquisition mode
antenna_pointing	right	ascii		Right or left facing
BEAMS	-	ascii		Beams used
SWATH	-	ascii		Swath name
PROC_TIME	03-JAN-2017 19:12:40.495424	uint32	utc	Processed time
Processing_system_identifier	ESA Sentinel-1 IPF 002.72	ascii		Processing system identifier
orbit_cycle	98	int32		Cycle
REL_ORBIT	73	int32		Track
ABS_ORBIT	14670	int32		Orbit
STATE_VECTOR_TIME	03-JAN-2017 16:41:18.916021	uint32	utc	Time of orbit state vector
VECTOR_SOURCE	-	ascii		State vector source
incidence_near	30.321501549531447	float64	deg	
incidence_far	46.241142922950395	float64	deg	
slice_num	12	int32		Slice number
data_take_id	97742	int32		Data take identifier
first_line_time	03-JAN-2017 16:42:39.675737	uint32	utc	First zero doppler azimuth time
last_line_time	03-JAN-2017 16:42:48.567257	uint32	utc	Last zero doppler azimuth time
first_near_lat	47.97123425367955	float64	deg	
first_near_long	16.96502098766805	float64	deg	
first_far_lat	48.04479834917332	float64	deg	
first_far_long	17.602533324404394	float64	deg	
last_near_lat	48.50305414948575	float64	deg	
last_near_long	16.81592874334678	float64	deg	
last_far_lat	48.57669892952515	float64	deg	
last_far_long	17.460112385945408	float64	deg	
PASS	ASCENDING	ascii		ASCENDING or DESCENDING
SAMPLE_TYPE	DETECTED	ascii		DETECTED or COMPLEX
mds1_tx_rx_polar	VH	ascii		Polarization
mds2_tx_rx_polar	VV	ascii		Polarization
mds3_tx_rx_polar	-	ascii		Polarization
mds4_tx_rx_polar	-	ascii		Polarization
polsar_data	0	uint8	flag	Polarimetric Matrix
algorithm	-	ascii		Processing algorithm
azimuth_looks	1.0	float64		
range_looks	5.0	float64		
range_spacing	10.0	float64	m	Range sample spacing
azimuth_spacing	10.0	float64	m	Azimuth sample spacing

Check pixel info, navigation, worldview…

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Take subset

File Edit View Analysis Layer Vector Raster Optical Radar Tools Window Help
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
Product Explorer
Metadata
Vector Data
Tie-Point Grids
Quicklooks
Bands
Amplitude_VH
Intensity_VH
Amplitude_VV
Intensity_VV
[1] Amplitude_VH
Specify Product Subset
Spatial Subset
Band Subset
Tie-Point Grid Subset
Metadata Subset
Pixel Coordinates
Geo Coordinates
North latitude bound: 47.962
West longitude bound: 16.945
South latitude bound: 48.453
East longitude bound: 17.512
Scene step X: 1
Scene step Y: 1
Subset scene width: 5145.0
Subset scene height: 4595.0
Source scene width: 26516
Source scene height: 16679
Use Preview
Fix full width
Fix full height
Navigation - [1...
Colour Manipulat...
Uncertainty Visu...
World View
Time Series

Apply precise orbit files

Apply precise orbit files

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Radiometric Calibration

Why?

- Aim: Pixel values that are directly related to radar backscatter.
- Level 1 product usually suffer from a certain radiometric bias.
- Radiometric calibration enables comparison of SAR images acquired with different sensors, or acquired from the same sensor but at different times, in different modes, or processed by different processors.

(SNAP Help: Calibration Operator)

Radiometric Calibration

- the backscatter coefficient provides a backscatter ratio estimate per given reference area. There are 3 conventional reference area:

  - **Beta^0** : in the slant range plane (radar brightness)
  - **Sigma^0** : ground area, that is locally tangent to an ellipsoidal model of the ground surface
  - **Gamma^0**: defined in the plane perpendicular to the LOS from sensor to ellipsoidal model of the ground surface

Fig. 2. Normalization areas for SAR backscatter.

- Small, David; 2011. 'Flattening Gamma: Radiometric Terrain Correction for SAR imagery'. IEEE Transactions on Geoscience and Remote Sensing, vol:49,no: 8, August, 2011

Radiometric calibration

Radiometric calibration

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Radiometric Terrain Flattening

Terrain variations affect not only the position of a target on the Earth's surface, but also the brightness of the radar return.

Radiometrically "flatten" the image → reducing terrain induced radiometric variations

"Terrain flattening operator in Snap removes the radiometric variability associated with topography using the terrain flattening method proposed by Small [2011] while leaving the radiometric variability associated with land cover."

(SNAP Help: Terrain Flattening Operator)

Radiometric Terrain Flattening

Radiometric Terrain Flattening

This process transforms Beta0 into Gamma0

Fig. 2. Normalization areas for SAR backscatter.

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What is multi-looking?

- Spatial averaging over multiple range/azimuth resolution cells

Why?

- Speckle reduction
- Creation of squared pixels (for Single-Look-Complex (SLC) images, the pixels are already square in the Ground Range Detected (GRD) images)

How?

- Goal: Choose a appropriate number of looks in range and azimuth
- In general you will need:
  - pixel spacing in azimuth
  - pixel spacing in slant range
  - look angle at scene center

Multi-looking

Multi-looking

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Create elevation band (SRTM)

Create elevation band (SRTM)

Do SAR simulation

Do SAR simulation

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Range-Doppler Terrain Correction

Due to topographical variations of a scene and the side looking geometry of the SAR sensor, distances can be distorted in the radar images.

Terrain corrections are intended to compensate for these distortions so that the geometric representation of the image will be as close as possible to the real world.

Terrain Correction allows geometric overlays of data from different sensors and/or geometries

(SNAP Help: Range-Doppler Terrain Correction Operator)

Range-Doppler Terrain Correction

Range-Doppler Terrain Correction

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1. Open data in SNAP- Display the data
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4. Apply radiometric calibration
5. Flatten terrain
6. Multi-Looking (5x5)
7. Create Elevation Band (SRTM)
9. Range-Doppler Terrain Correction, Input: ML dataset
10. Convert gamma0 images from linear to dB
11. Compute difference image from gamma0 [dB]: VV – VH
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Convert linear to dB

Convert linear to dB

Convert linear to dB

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Compute difference image from gamma0 [dB]: VV-VH

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Display difference image **VV-VH** in RGB

Display as RGB composite

Display as RGB composite

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Statistical analysis: Scatter Plot

Statistical analysis: Histogram

First select the band then press refresh button

Statistical analysis: Profile Plot

Select geometry

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Lesson learned

Import GRD SAR image

↓

Apply orbit file

↓

Radiometric calibration

↓

Terrain flattening

↓

Multi-looking

↓

Range Doppler terrain correction

↓

Display (linear to db & RGB)

GRD
(Ground Range Detected) image

→

Calibrated GRD

↓

Geocoded

←

RGB

Plan for today:

SAR data processing with Snap :

i. Single-date processing

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- Time series analysis of multi-temp dataset

Step by step - Generating a **Radiometrically Terrain Corrected (RTC)** Image of multi-temporal acquisitions

1. Generate a processing chain with graph builder
   i. Apply orbit files
   ii. Radiometric calibration
   iii. Terrain flattening
   iv. Range-Doppler terrain correction
2. Batch processing with the graph
3. Layer stacking
4. Display in RGB [dB]

Graph Builder

Graph Builder

Graph Builder

Step by step - Generating a **Radiometrically Terrain Corrected (RTC)** Image of multi-temporal acquisitions

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2. Batch processing with the graph
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4. Display in RGB [dB]

Batch Processing

Batch Processing

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2. Batch processing with the graph
3. Layer stacking
4. Display in RGB [dB]

Layer stacking

Layer stacking

Takes about 15 min to run

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2. Batch processing with the graph
3. Layer stacking
4. Display in RGB [dB]

RGB Composites of different acquisitions

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Time Series Analysis

Time Series Analysis

Time Series Analysis

Time Series Analysis

Pin Manager

X	Y	Lon	Lat	Color	Label
3380.500	2125.500	10.761533	52.513793		Pin 1
3299.500	2428.500	10.754256	52.486575		Pin 2
2969.500	1793.500	10.724612	52.543618		Pin 3

Thank you!!!!

https://eo-college.org/landingpage