10TH ADVANCED TRAINING COURSE ON LAND REMOTE SENSING

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SNAP exercise: Forest monitoring using Sentinel-1Magdalena FitrzykRSAC c/o ESA

ESA UNCLASSIFIED – For ESA Official Use Only

Objectives



- Familiarizing with SNAP toolbox
- >Familiarizing with Sentinel-1 GRD prodcucts
- Calculation of backscatter intensity from Sentinel-1 detcted products
- >Analysis of temporal backscatter signatures for various land cover types
- Change detection over AOI (Beijing Daxing International Airport)



Introduction



Different penetration capability, depending on wavelength



Introduction





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Introduction



Input data: multitemporal stack of Sentinel-1 GRDH images over South America

- 10 September 2021
- S1B_IW_GRDH_1SDV_20210910T094944_20210910T095009_028634_036ADE_6409
- 1 September 2017
- S1A_IW_GRDH_1SDV_20170901T094957_20170901T095023_018180_01E8CD_9CB1

Output:

- temporal backscatter signatures for various land cover types
- change detection deforestration in Brazil

Data preparation



1. Opening the S1 data

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Close Product Close All Products Close Other Product	s									
Save Product Save Product As										
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 S1B_IW_GRDH_1SDV_20190219T055747_20190219T055812_015011_01C0C5_16E0.zip

 S1B_IW_GRDH_1SDV_20190315T055747_20190315T055812_015361_01CC2F_2DE0.zip

 S1B_IW_GRDH_1SDV_20190420T055748_20190420T055813_015886_01DD7D_B255.zip

 S1B_IW_GRDH_1SDV_20190514T055749_20190514T055814_016236_01E8EA_C0BC.zip

 S1B_IW_GRDH_1SDV_20190713T055752_20190713T055817_017111_020314_33F3.zip

 S1B_IW_GRDH_1SDV_20190818T055755_20190818T055820_017636_0212DC_C2D4.zip

For unzipped products

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measurer	ment		8/7/18 4:13 PM		
preview			8/7/18 4:13 PM		
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file <u>N</u> ame:	manifest.safe				



Updating orbits

- Remove Thermal Noise
- Radiometric calibration

Conversion of image intensity to sigma0 providing the radar backscatter

Speckle filtering

Filtering the inherent salt and pepper like texturing called speckles

> Terrain correction

Compensate for geometric distortions caused by topographical variations of a scene and the tilt of satellite sensor

- Creating a subset of S1 GRDH images Spatial subset depending on the AOI
- Creating a multitemporal stack Collocation spatially overlapping products (based on geolocation)
- Linear to dB conversion

Compensate for very high dynamic range in visualisation

Stack statistics and analysis of temporal backscatter signatures

Updating orbits



Radar / Apply orbit file

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File Help	File
I/O Parameters Processing Parameters	
Source Product	1/0
source:	Or
[1] S1B_IW_GRDH_1SDV_20190315T055747_20190315T055812_0 v	Po
Target Product	
Name:	
RDH_1SDV_20190315T055747_20190315T055812_015361_01CC2F_2DE0_Orb	
Directory:	
C:\LIC2013_demos\Output	
Open in SNAP	
Run Close	
	1

The orbit file provides accurate satellite position and velocity information. Based on this information, the orbit state vectors in the abstract metadata of the product are updated.

📀 Apply Orbit File	× POFORB - few weeks after acq.
File Help	
I/O Parameters Processing Parameters	
Orbit State Vectors: Sentinel Restituted (Auto Download) Polynomial Degree: Sentinel Precise (Auto Download) Sentinel Restituted (Auto Download) Do not rain mew orbit nie is not round	RESORB – within few hours
Run	Close

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Thermal Noise Removal



Radar/Radiometric/S-1 Thermal Noise Removal

Radar <u>T</u> ools <u>W</u> indow	v <u>H</u> elp
Apply Orbit File	
Radiometric	Calibrate
Speckle Filtering	Radiometric Terrain Flattening
Coregistration	Remove Antenna Pattern
Interferometric	S-1 Thermal Noise Removal
Polarimetric	Convert Sigma0 to Beta0
Geometric	Convert Sigma0 to Gamma0
Sentinel-1 TOPS	Create Calibration LUT TPG
ENVISAT ASAR	
SAR Applications	
SAR Utilities	
SAR Wizards	
Complex to Detected	GR SR
Multilooking	





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Radiometric Calibration



From image pixel values or digital numbers (DNs) we can derive:

Beta Naught – radar brightness coefficient, reflectivity per unit area in slant range which is dimensionless

Sigma Naught – power returned to the antenna from ground (distributed scatterer) in dB. A number comparing the strength of the signal to that expected from an area of one square meter. It is defined with respect to the nominal horizontal plane and is varying with incidence angle, wavelength, polarisation and scattering surface itself



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Radiometric Calibration

Radar/Radiometric/Calibrate

Radar Tools Window	Help
Apply Orbit File	
Radiometric	Calibrate
Speckle Filtering	Radiometric Terrain Flattening
Coregistration	Remove Antenna Pattern
Interferometric	S-1 Thermal Noise Removal
Polarimetric	Convert Sigma0 to Beta0
Geometric	Convert Sigma0 to Gamma0
Sentinel-1 TOPS	Create Calibration LUT TPG
ENVISAT ASAR	
SAR Applications	
SAR Utilities	
SAR Wizards	•
Complex to Detected G	R Charles and Charles
Multilooking	r

Pixel values can be directly related

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ile Help		
I/O Parameters Pr	ocessing Parameters	
Polarisations:	VH VV	
 ☐ Save as complex o ☑ Output sigma0 bas ☑ Output gamma0 b 	nutput nd and	
Output beta0 band		
o the radar	· backscatter	Run Close

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Speckle filtering



Radar <u>T</u> ools <u>W</u> indow	Help
Apply Orbit File Radiometric	, φ,λ 🔝 🔞 🕼 Μ. Ι
Speckle Filtering	Single Product Speckle Filter
Coregistration	Multi-temporal Speckle Filter
Interferometric	· Carlo and and
Polarimetric	· · · · · · · · · · · · · · · · · · ·
Geometric	· · · · · · · · · · · · · · · · · · ·
Sentinel-1 TOPS	
ENVISAT ASAR	
SAR Applications	·
SAR Utilities	
SAR Wizards	
Complex to Detected GF	
Multilooking	1 Contraction

C Single Product Speckle Filter	C Single Product Speckle Filter	×
File Help	File Help	
I/O Parameters Processing Parameters	I/O Parameters Processing Parameters	
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Target Product Name:		
4_IW_GRDH_1SDV_20170901T094957_20170901T095023_018180_01E8CD_9CB1_Spk	Filter: Lee Sigma	~
Directory:	Number of Looks: 1	~
C:\Users\Magdalena Fitrzyk	Sigma:	~
Open in SNAP	Target Window Size: 3x3	~
Run Close	Run	Close

Spatial filtering with weighted average of selected filter across the image

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Speckle filtering







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Terrain correction & Geocoding





Point **B** with elevation **h** above the ellipsoid is imaged at position **B'** in SAR image, though its real position is **B''**. The offset Δr between **B'** and **B''** exhibits the effect of topographic distortions

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

Terrain correction & Geocoding



Radar / Geometric / Terrain Correction / Range Doppler Terrain Correction



Terrain correction & Geocoding



🚱 Range Doppler Terrain Correction 🛛 🕅	🚱 Range	Doppler Terrain Correction	R
File Help	File Help		
I/O Parameters Processing Parameters	I/O Parameters Processing Para	meters	
Source Product	Source Bands:	Sigma0_VH	
source: [2] S1B_IW_GRDH_1SDV_20180309T174910_20180309T174935_009958_0120AF_4CB V		Sigma0_VV	
Target Product			
S1B_IW_GRDH_1SDV_20180309T174910_20180309T174935_009958_0120AF_4CB8_Cal_TC			
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/application/workdir/LTC2018/subset_small_Cal_TC	Image Resampling Method:	BILINEAR_INTERPOLATION	
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	Incidence angle from ellipsoid	Local incidence angle	Masking areas
			without elevation
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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				
Γ	Subset				
T	DEM Tools		>		
	Geometric				
	Masks				
	Data Conversion >				
	Image Analysis >				
	Classification				
	Segmentatio	on	>		
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Use Preview	Fix full width	



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Linear vs dB comparison





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Conversion from linear to dB





Automatic Processing with Graph





Automatic Processing with Graph – Calibration, Terrain Correction



Apply-Orbit-File	Calibration	Speckle-Filter	► Terrain-Correctio	n Write
				>
ply-Orbit-File Calibration	Speckle-Filter Terra	in-Correction		
DH_1SDV_20170901T0949	57_20170901T095023	_018180_01E8CD_9C	81	~
2	Apply-Orbit-File	Apply-Orbit-File Calibration	Apply-Orbit-File Calibration Speckle-Filter	Apply-Orbit-File Calibration Speckle-Filter Terrain-Correction

🛛 Note

Save

🕜 Help 🛛 🕞 Run

៉ Load 🛛 🔭 Clear

Apply Orbits: Sentinel Precise Calibration: Output Sigma0 Speckle filter: Lee Terrain Correction: pixel spacing 10m

The same settings like in manual processing!

save as GRD_Cal_TC.xml

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Batch processing

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Batch processing



File Graphs

I/O Parame	eters	Apply-Orbit-	File	Calibration	Terrain-Correction	Write		
File Name			Тур	e	Acquisition	Track	Orbit	4
Subset_S1/	WI_	GRDH_1SD	GRD		03Oct2015	47	7994	
Subset_S1/	_IW_	GRDH_1SD	GRD		11Jun2016	47	11669	
Subset_S1E	_IW_	GRDH_1SD	GRD		15Nov2017	47	8298	
Subset_S1E	_IW_	GRDH_1SD	GRD		10Nov2018	47	13548	
Subset_S1E	3_IW_	GRDH_1SD	GRD		30Sep2019	47	18273	
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Target Fo	der							5 Products
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				/	K in the second s			

File Graphs

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Subset_S1A_IW_	GRDH_1SD	GRD	03Oct2015	47	7994	
Subset_S1A_IW_	GRDH_1SD	GRD	11Jun2016	47	11669	
Subset_S1B_IW_	GRDH_1SD	GRD	15Nov2017	47	8298	
Subset_S1B_IW_	GRDH_1SD	GRD	10Nov2018	47	13548	
Subset_S1B_IW_	GRDH_1SD	GRD	30Sep2019	47	18273	
						2
						5 Products
Target Folder						
Save as: BEAM	1-DIMAP	~				
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D:\DRAGON20	19\Final Datase	et\GRD processe	ed			
Skip existing	g target files	Keep source	product name			
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Open previously saved graph GRD_Cal_TC.xml

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Creating multitemporal stack



0309T174910_20180309T174935_009958_0120AF_4CB8 - /applic	Create Stack	Create Stack
Radar <u>T</u> ools <u>W</u> indow <u>H</u> elp	1-ProductSet-Reader 2-CreateStack 3-Write	1-ProductSet-Reader 2-CreateStack 3-Write
Apply Orbit File Radiometric Speckle Filtering Coregistration Interferometric Polarimetric DEM-Assisted Coregistration Geometric Stack Tools Cross InSAR resampling Stack Averaging Stack Split SAR Applications SAR Wizards Complex to Detected GR Multilooking	File Name Type Acquisition Track Orbit S1B_IW_GRDH_1SDV_201	Master: S1B_W_GRDH_1SDV_20180309T174910_20180309T174935_009958_0120AF_4CB8 Resampling Type: NONE Initial Offset Method: Product Geolocation Output Extents: Master Find Optimal Master
Collocating spatially overlapping images	IProductSet-Reader 2-CreateStack 1-ProductSet-Reader 2-CreateStack Target Product Name: [518_W_GRDH_1SDV_20180309T174910_20180309T174935_009958_0120AF_4CB8_Stack Save as: BEAM-DIMAP Directory: //epplication/workdir/LTC2018	 Product geolocation (if terrain corrected) Orbits (if not terrain corrected)

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Collocation



Raster	Optical	Radar	Tools	Window	Help	
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Reference and secondary images to be collocated



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Visual inspection of the stack





RGB Composite





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RGB Composite



