

ESA SNAP Toolbox Introduction Detecting harvest from Sentinel-1 data

Magdalena Fitrzyk RSAC c/o ESA ESRIN

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Objectives



- Familiarizing with Sentinel-1 SLC products
- Calculation of backscatter intensity from Sentinel-1 SLC products
- Calculation of interferometric coherence
- >Analysis of coherence and intensity false colour composites

Introduction



Input data: set of two Sentinel-1 SLCs

S1A_IW_SLC__1SDV_20220308T044609_20220308T044636_042225_05083C_3949.zip S1A_IW_SLC__1SDV_20220320T044609_20220320T044636_042400_050E29_C715.zip

Output: coherence time series for harvest detection



Sentinel-1 data acquisition





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Sentinel-1 TOPS Data Handling and Processing

Bursted IW SLC



• **TOPSAR Split** to choose a subswath and bursts for the AOI

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Sentinel-1 TOPSAR Split



Radar/Sentinel-1 TOPS/S-1 TOPS Split

S-1 TOPS Split ×		
File Help	I/O Parameters Processing Parameters	
I/O Parameters Processing Parameters Source Product source: [1] S1A_IW_SLC1SDV_20190819T055015_20190819T055043_028634_033D5F_B955 ✓ … Target Product Name: S1A_IW_SLC1SDV_20190819T055015_20190819T055043_028634_033D5F_B955_split Save as: BEAM-DIMAP ✓ Directory: C:\LTC2019_demos\Output_cal_TC … Open in SNAP	Subswath: IW1 Polarisations: VH Bursts: 2 to 5 (max number of bursts: 9)	Selection of subswath Selection of polarization Selection of bursts
	Run Close	
Run Close		

TOPS Split applied to both S-1 SLCs



STEP 1 Interferometric Coherence



Applying orbit files



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 🛛 🕹 🗙	🙆 Apply Orbit File X	
File Help	POEORB - few weeks after a	acq.
	File Help	
I/O Parameters Processing Parameters	The second sec	
Source Product	I/O Parameters Processing Parameters	
source:	Orbit State Vectors: Sentinel Restituted (Auto Download)	
[1] S1B_IW_GRDH_1SDV_20190315T055747_20190315T055812_0 🗸	Polynomial Degree: Sentinel Precise (Auto Download) Sentinel Restituted (Auto Download) Hour net rain mew orbit me is not round	rs
Target Product		
Name:		
RDH_1SDV_20190315T055747_20190315T055812_015361_01CC2F_2DE0_Orb		
Save as: BEAM-DIMAP 🗸		
Directory:		
C:\LTC2019_demos\Output		
✓ Open in SNAP		
Run Close	Run Close	

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Coregistration





Co-registration of two S-1 SLC split products (master/reference and slave/secondary) of the same sub-swath using the orbits of the two products and a Digital Elevation Model (DEM).

[2] 20220308_20220320 🕀 📄 Metadata Vector Data Tie-Point Grids Bands i_IW2_VH_mst_08Mar2022 g_IW2_VH_mst_08Mar2022 Coregistered bands in one product Intensity IW2 VH mst 08Mar2022 i_IW2_VV_mst_08Mar2022 g_IW2_VV_mst_08Mar2022 Intensity_IW2_VV_mst_08Mar2022 i IW2 VH slv1 20Mar2022 g_IW2_VH_slv1_20Mar2022 Intensity_IW2_VH_slv1_20Mar2022 i_IW2_VV_slv1_20Mar2022 g_IW2_VV_slv1_20Mar2022 Intensity_IW2_VV_slv1_20Mar2022

Interferometric Coherence



COHERENCE

Measure of correlation between phase in two SAR complex images Ranging from 0 (no correlation) to 1

Coherence may be affected by:

- Local slope
- Properties of the surface
- Time lag between acquisitions
- > The perpendicular baseline
- Poor coregistration

Radar	Tools Window Help				
4	Apply Orbit File		₽ `+ +> 🗖 🗣 🖸		🗼 🏤 🔨 🔲 🗖 🖽 🗀
	Radiometric	>		_	
1	Speckle Filtering	>	IW3_VV_mst_19Aug2019 ×	[3	J] Intensity_IW3_VV_slv1_31Aug2019 ×
	Coregistration	>			
	Interferometric	>	Products	>	Interferogram Formation
	Polarimetric	>	Filtering	>	Coherence Estimation
	Geometric	>	Unwrapping	>	Topographic Phase Removal
1	Sentinel-1 TOPS	>	PSI\SBAS	>	Three-pass Differential InSAR
	ENVISAT ASAR	>	InSAR Stack Overview		Phase to Height
	SAR Applications	>			Phase to Displacement
	SAR Utilities	>			Phase to Displacement
	SAR Wizards	>			Phase to Elevation
	Complex to Detected GR				Integer Interferogram Combination
	Multilooking				

Interferometric Coherence



Radar/Interferometric/Products/Coherence

ile Help	
I/O Parameters Processing Parameter	S
Subtract flat-earth phase	
Degree of "Flat Earth" polynomial	5 🗸
Number of "Flat Earth" estimation points	s 501 ~
Orbit interpolation degree	3 🗸
Subtract topographic phase	
Digital Elevation Model:	SRTM 3Sec (Auto Download) 🛛 🗸
Tile Extension [%]	100 🗸
Square Pixel	Independent Window Sizes
Coherence Range Window Size	10
Coherence Azimuth Window Size	2



Demarcation black-filled line between bursts

Close

Run

Interferometric Coherence





0 1

0 – no coherence, the area has changed (e.g. crop growth)

1 – high coherence, the area has not changed (e.g. buildings, asphalt)



S-1 TOPS Debursting



Radar/Sentinel-1 TOPS/S-1 TOPS Deburst

 S-1 TOPS Deburst Ie Help 	X
ie Help	~
/O Parameters Processing Parameters	
Source Product	
[5] S1A_IW_SLC1SDV_20190819T055015_20190819T055043_02 ~	
Target Product	
5015_20190819T055043_028634_033D5F_B955_split_Orb_Stack_coh_deb_	deb
Save as: BEAM-DIMAP	
C:\LTC2019 demos\Output SLC\backscatter TC	
☑ Open in SNAP	
Run C	lose

Input: Coherence



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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.

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Terrain Correction



Apply Orbit File	P		+?+	
Radiometric	>	· · · · · · · · ·	r —	
Speckle Filtering	> _V	/_19Aug2019_31Aug2019 ×	-	
Coregistration		A MARK AND		
nterferometric	>			
Polarimetric				And the second second second
Geometric	>	Terrain Correction	>	Range-Doppler Terrain Correction
Sentinel-1 TOPS	>	Ellipsoid Correction	>	SAR Simulation
NVISAT ASAR	>	SAR-Mosaic		SAR-Simulation Terrain Correction
AR Applications	>	ALOS Deskewing	8	
AR Utilities	>	Slant Range to Ground Range		
AR Wizards	>	Update Geo Reference		
Complex to Detected GR	80		Same and	Contraction of the second

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

+ Geocoding

📀 Range Doppler Terrain Correction	n X	
File Help		
I/O Parameters Processing Parameter	15	
Source Bands:	coh_IW3_VV_19Aug2019_31Aug2019	Select: > DEM
Digital Elevation Model:	SRTM 3Sec (Auto Download) v	 Pixel spacing
DEM Resampling Method:	BILINEAR_INTERPOLATION ~	
Image Resampling Method:	BILINEAR_INTERPOLATION ~	Projection
Source GR Pixel Spacings (az x rg):	13.86(m) x 3.37(m)	
Pixel Spacing (m):	13.86	
Pixel Spacing (deg):	1.2450649837896568E-4	
Map Projection:	WGS84(DD)	
Mask out areas without elevation	Output complex data	Pivol spacing
	DEM Latitude & Longitude	Fixer spacing
Incidence angle from ellipsoid	Local incidence angle Projected local incidence angle	20m
Apply radiometric normalization		
Save Sigma0 band	Use projected local incidence angle from DEM 🗸 🗸	
Save Gamma0 band	Use projected local incidence angle from DEM $\qquad \bigtriangledown$	
Save Beta0 band		
Auxiliary File (ASAR only):	Latest Auxiliary File 🗸 🗸	
	Run Close	

Processing of the coherence time series





Batch processing



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Batch Processing :	batch processin graph	xml			×) 🔏 📸 描 🤚 GCP 🙈 🐝 🞇
File Graphs I/O Parameters Cohe	rence TOPSAR-Deburst	Terrain-Correction	Write			
File Name	Туре	Acquisition	Track	Orbit	÷	Add vour data
Stack	SLC	08Mar2022	153	42225		
S1A_IW_SLC1SDV_2	0220 SLC	08Mar2022	153	42225		
S1A_IW_SLC1SDV_2	0220 SLC	20Mar2022	153	42400	-	
						
					-	
					٠	
					3 Products	
	R	Lun remote	d Graph	Run Close	Help	
		Load your	save	d graph		-

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Spatial Subset







Creating Stack of coherence



Radar Tools Window Help Input: all coherence subset images Apply Orbit File +7 Radiometric 1-ProductSet-Reader 2-CreateStack 3-Write VV_19Aug2019_31Aug2019 × Speckle Filtering File Name Type Acquisition Track Orbit Coregistration ÷ Coregistration 47 S1A_IW_SLC__1SDV_2015100... SLC 03Oct2015 7994 Interferometric S1 TOPS Coregistration 47 S1B_IW_SLC__1SDV_2017111... SLC 15Nov2017 8298 규 03Oct2015 47 7994 Polarimetric SLC_Stack_coh_deb_TC SLC > DEM-Assisted Coregistration Geometric 3 Stack Tools Create Stack Sentinel-1 TOPS Cross InSAR resampling Stack Averaging \$ ENVISAT ASAR Stack Split SAR Applications SAR Utilities 2-CreateStack 3-Write 1-ProductSet-Reader SAR Wizards S1A_IW_SLC__1SDV_20151003T222043_20171115_coregistered_coh_deb_ML_TC Master: Complex to Detected GR Resampling Type: NONE Multilooking Initial Offset Method: Product Geolocation Output Extents: Master Find Optimal Master 🕐 Help Run 19





Add the layer with shapefiles of crops

Draw your ROI . 1022 - [Stack] - [\\isilon-esrin.go.esa.int\folders\Data\SNAP_exercise_LTC22\coherence_stack\Stack.dim] - SNAP Vector Raster Optical Radar Tools Window Help L ⁽⁰⁾ L <u>Σ</u> ⁽⁰⁾ H δ H δ ⁽⁰⁾ C (0) H δ H δ ⁽⁰⁾ C (0) H δ H δ (0) H (0) H δ (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) H (0) New Vector Data Container - [] [1] coh_IW2_VV_08Mar2022_20Mar2022 × [] [1] coh_IW2_VH_08Mar2022_20Mar2022 ×

View/Tool Windows/Radar/Time series

022_13Apr2022_slv1_20Mar2022 022_13Apr2022_slv2_20Mar2022 022_25Apr2022_slv3_13Apr2022 022_25Apr2022_slv4_13Apr2022 022_07May2022_slv5_25Apr2022 022_07May2022_slv6_25Apr2022 022_19May2022_slv7_07May2022 :022_19May2022_slv8_07May2022 2022_31May2022_slv9_19May2022 :022_31May2022_slv10_19May2022 2022_12Jun2022_slv11_31May2022 :022_12Jun2022_slv12_31May2022 022_24Jun2022_slv13_12Jun2022 J22_24Jun2022_slv14_12Jun2022 022_06Jul2022_slv15_24Jun2022 J22_06Jul2022_slv16_24Jun2022 122 181ul2022 sly17 061ul2022

Geometry from WKT

WKT from Geometry Import Export







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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 the ground (distributed scatterer) in dB. A number comparing the strangth of the signal to that expected from and area of one square meter. It is defined with respect to the nominal horisontal plane and is varying with incidence angle, wavelength, polarisation and scattering surface itself

Backscatter Intensity product



MENU: Graph Builder + Batch processing tool



/O Parameters	Apply-Qrbit-	ile Calibration	1 IOPSAR-Deburst	Terrain-Corre	ction Write	
File Name		Туре	Acquisition	Track	Orbit	
1A_IW_SLC19	SDV_20151	SLC	03Oct2015	47	7994	
1B_IW_SLC1S	SDV_20171	SLC	15Nov2017	47	8298	
Target Folder						2 Produc
Target Folder	1-DTMΔP					2 Produc
Target Folder Save as: BEAM	1-DIMAP	~				2 Produce
Target Folder Save as: BEAM Directory:	1-DIMAP	~				2 Produc
Target Folder Save as: BEAM Directory: D:\DRAGON201	1-DIMAP 19\Final Datase	v et\SLC_process	ed\backscatter_inten	sity		2 Produc

Input: Two splitted SLCs



Sentinel-1 AWS-IW-VVVH - IW-DV-VV-DECIBEL-GAMMA0-RADIOMETRIC-TERRAIN-CORRECTED



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🛓 Export CSV

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VH/VV





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