



# **ALOS PALSAR**

# **Orthorectification Tutorial**

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# **ALOS PALSAR Orthorectification Tutorial**

In this tutorial you will calibrate, multilook, speckle filter, deskew, terrain correct an ALOS-1 PALSAR SAR data product.

# **Open a Product**

**Step 1 - Open a product:** Use the **Open Product** button in the top toolbar and browse for the location of an ALOS PALSAR product in CEOS data format.

For this part of the tutorial we will use the ALOS L1.1 data product over Mt. Fuji, Japan. The data set is available from as a demonstration InSAR dataset from JAXA.

Select the **Volume Descriptor** file and press **Open Product**. The volume descriptor may start with VOL or VDR.

If the product is zipped, it can also be opened by selecting the zip file directly.

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Recent Items	IMG-HH-ALPSRI	P083070690-H1.1_A P083070690-H1.1_A 070690-H1.1_A		
Desktop	VOL-ALPSRP083	070690-H1.1_A 070690-H1.1_A		
ly Documents				
Computer				
	File name: VOL-A	ALPSRP083070690-H1.1A		Open Product
Network	Files of type:			Cancel

#### **Open the Volume Descriptor**

In the **Products View** you will see the opened products. Each product consists of metadata and raster bands and may contain support information such as tie point grids or vector data.





**Products View** 

Double-click on the **Intensity\_HH** band to view the raster data.

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Intensity\_HH Band



The product is a ALOS PALSAR Level 1.1 Single Look Complex (SLC) data product. It is a slant range image containing complex data that has not been multilooked.

The image can appear stretched in the azimuth direction (y axis) and contains a lot of noise.

# Calibrating the Data

To properly work with the SAR data, the data should first be calibrated. This is especially true when preparing data for mosaicking where you could have several data products at different incidence angles and relative levels of brightness.

Calibration radiometrically corrects a SAR image so that the pixel values truly represent the radar backscatter of the reflecting surface.

The corrections that get applied during calibration are mission-specific, therefore the software will automatically determine what kind of input product you have and what corrections need to be applied based on the product's metadata. Calibration is essential for quantitative use of SAR data.

Rac	dar Tools Window Help		
	Apply Orbit File		
	Radiometric	-	Calibrate
	Speckle Filtering	►	Radiometric Terrain Flatten
	Coregistration	►	Remove Antenna Pattern
	Interferometric	•	S-1 Thermal Noise Removal
	Polarimetric	►	Convert Sigma0 to Beta0
	Geometric	•	Convert Sigma0 to Gamma0

Step 2 - Calibrate the product: From the Radar menu, go to Radiometric and select Calibrate.

#### Radar Menu

The source product should be your newly created subset. The target product will be the new file you will create. Also select the directory in which the target product will be saved to.

# ALOS PALSAR Orthorectification



I/O Parameters       Processing Parameters         Source Product	Calibration	Calibration X
	I/O Parameters       Processing Parameters         Source Product       source:         [1] ALOS·H1_1_A-ORBIT_ALPSRP083070690       •         Target Product       Name:         ALOS·H1_1_A-ORBIT_ALPSRP083070690_Calib       ✓         ✓ Save as:       BEAM-DIMAP         Directory:       e:/put/tmp         ✓ Open in RADARSAT2 TOOLBOX	I/O Parameters         Source Bands:       _HH         _LHH         _LHH         _LHH         _LHH         _LHH         _LHH         _LHH         _LHU         _LHU         _LHV         _LHV         _LHV         _LHV         _LHV         _LHV         _Save as complex output         _Save in dB         _Create gamma0 virtual band         _Create beta0 virtual band

#### **Calibration Dialog**

If you don't select any source bands, then the calibration operator will automatically select all real and imaginary (i, q) bands. Uncheck 'Save in complex' so that the calibration operator will produce a single Sigma0 band per real and imaginary pair.

After the calibration, a new product will be produced containing the calibrated Sigma0 bands.

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÷]	Identificatio	n		
÷ 🔒	Metadata			
÷- 🔒	Tie-point gri	ds		
÷- 🔒	Vectors			
ė- 🔒	Bands			
	Sigma0_	HH		
	- Sigma0_	HV		
				_

#### Sigma0 Bands

# Multilooking

Multilook processing can be used to produce a product with nominal image pixel size.

Multiple looks may be generated by averaging over range and/or azimuth resolution cells improving radiometric resolution but degrading spatial resolution.

As a result, the image will have less noise and approximate square pixel spacing after being converted from slant range to ground range.

Multilooking can be an optional step since it is not necessary when terrain correcting an image.

Single Look Complex

Range Looks: 1 Azimuth Looks: 1

Range Spacing: 7.8 m Azimuth Spacing: 4.0 m



# Multilooked

Range Looks: 4 Azimuth Looks: 20 🛌

Range Spacing: 31.2 m Azimuth Spacing: 80.0 m



Multilooking an SLC product

Step 3 - Multilook the Sigma0\_HH band: From the Radar menu, select Multilooking.

Apply Orbit FileRadiometricSpeckle FilteringSpeckle FilteringCoregistrationInterferometricPolarimetricPolarimetricGeometricSentinel-1 TOPSASAR WSSFeature ExtractionBiomassSoil MoistureSAR Utilities	Rac	lar Tools Window Help	
RadiometricSpeckle FilteringCoregistrationInterferometricPolarimetricPolarimetricGeometricSentinel-1 TOPSASAR WSSFeature ExtractionBiomassSoil MoistureSAR Utilities		Apply Orbit File	
Speckle FilteringCoregistrationInterferometricPolarimetricGeometricSentinel-1 TOPSASAR WSSFeature ExtractionBiomassSoil MoistureSAR Utilities		Radiometric	
Coregistration		Speckle Filtering	
Interferometric  Polarimetric  Geometric  Sentinel-1 TOPS  ASAR WSS  Feature Extraction  Biomass  Soil Moisture  SAR Utilities		Coregistration	
Polarimetric       •         Geometric       •         Sentinel-1 TOPS       •         ASAR WSS       •         Feature Extraction       •         Biomass       •         Soil Moisture       •		Interferometric	•
Geometric  Sentinel-1 TOPS ASAR WSS Feature Extraction Biomass Soil Moisture SAR Utilities		Polarimetric	•
Sentinel-1 TOPS		Geometric	•
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Feature Extraction		ASAR WSS	
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Complex to Detected GR		Complex to Detected GR	
Multilooking		Multilooking	

# Select Multilooking

In the Multilook dialog, select the Sigma0\_HH band to only produce an output for this band.

Specify the number of range looks while the number of azimuth looks is computed based on the ground range spacing and the azimuth spacing.



Multilook	×
I/O Parameters Processir	ng Parameters
Source Bands:	Sigma0_HH Sigma0_HV
<ul> <li>GR Square Pixel</li> <li>Number of Range Looks:</li> <li>Number of Azimuth Looks:</li> <li>Mean GR Square Pixel:</li> <li>Output Intensity</li> </ul>	Independent Looks           1           5           15.416141
	Note: Detection for complex data is done without resampling.
	Run Close Help

# Select Sigma0\_HH band

Multilooking will produce a ground range square pixel using 1 look in range and 5 looks in azimuth. The resulting mean ground range pixel size will be 15.42 m.

Press Run to begin processing.

When complete, a new product will be created and will be available in the **Products View**.

In the new product, open the multilooked band.





# **Multilooked Band**

The image now looks more proportional; however, it remains with a lot of noise.

# **Speckle Reduction**

Speckle is caused by random constructive and destructive interference resulting in salt and pepper noise throughout the image.

Speckle filters can be applied to the data to reduce the amount of speckle at the cost of blurred features or reduced resolution.

**Step 4 - Speckle Filtering:** Select the multilooked product and then select **Speckle Filtering/Single Product** from the **Radar** menu.

Radar Tools Window Help		
Apply Orbit File		
Radiometric	•	
Speckle Filtering	+	Single Product Speckle Filter
Coregistration	•	Multi-temporal Speckle Filter

# Select Single Product Speckle Filtering

From the **Speckle Filter** dialog, select the **Refined Lee** speckle filter. The Refined Lee filter averages the image while preserving edges.

C Speckle filtering	x
I/O Parameters Processing Parameter	'S
Source Bands:	Sigma0_HH
Filter:	Refined Lee 🗸
Edge Threshold:	5000.0
	Run Close Help
_	

# Select Refined Lee

Press Run to process.

Open the newly created speckle filtered product.





# Speckle Filtered Result

The final processing which we will do to this product will be to terrain correct.

# **ALOS Deskewing**

For ALOS-1 L1.1 data, the annotated times are not zero Doppler times, i.e. the data is distributed in squinted geometry. Therefore, the data generally needs to be deskewed to transfer the data into a zero Doppler like geometry before applying standard SAR processing.

Note that for ALOS-2 deskewing is not needed.

**Step 5 - Deskewing:** Select the speckle filtered product and then select **ALOS Deskewing** from the **Geometry** menu.





# Select ALOS Deskewing

Deskew ALO	S product		22
I/O Parameters	Processing Parameters		
	Sigma0_HH		
Source Bands:			
		Run Close	Help

#### Press Run

The resulting product will have adjusted all the pixels to a more zero Doppler like geometry. Notice the gap along the top of the image.





#### **Dewskewed Image**

The product can now be terrain corrected.

# **Terrain Correction**

Terrain Correction will geocode the image by correcting SAR geometric distortions using a digital elevation model (DEM) and producing a map projected product.

Geocoding converts an image from Slant Range or Ground Range Geometry into a Map Coordinate System. Terrain Geocoding involves using a Digital Elevation Model (DEM) to correct for inherent SAR geometry effects such as **foreshortening**, **layover** and **shadow**.

#### Foreshortening

- The period of time a slope is illuminated by the transmitted pulse of the radar energy determines the length of the slope on radar imagery.
- This results in shortening of a terrain slope on radar imagery in all cases except when the local angle of incidence (θ) is equal to 90°.

Layover

- When the top of the terrain slope is closer to the radar platform than the bottom the former will be recorded sooner than the latter.
- The sequence at which the points along the terrain are imaged produces an image that appears inverted.



• Radar layover is dependant on the difference in slant range distance between the top and bottom of the feature.

#### Shadow

 The back-slope is obscured from the imaging beam causing no return area or radar shadow

The effects of these distortions can be seen below. The distance between 1 and 2 can appear shorter than it should and the return for 4 can occur before the return for 3 due to the elevation.



Even after deskewing, the product will have a significant positional error. For missions such as ALOS-1 and ERS where the product timing and orbit data are not accurate enough, it is recommended to use the SAR Simulation Terrain Correction.

The SAR Simulation Terrain Correction works the same as the Rangle Doppler Terrain Correction with the extra steps of simulating an image based on a DEM and then coregistering the simulated image with the input image. Once the DEM and the input product have been accurately matched, the terrain correction using the Range Doppler method can proceed.

**Step 6 - Terrain Correction:** Select the deskewed product and then select **SAR Simulation Terrain Correction** from the **Geometry/Terrain Correction** menu.



Ferrain Correction	•	Range-Doppler Terrain Correction
Ellipsoid Correction	•	5 11
Empsola concetion		SAR-Simulation Terrain Correction
Terrain Flattening	► ► _	SAR Simulation Tenam concetion
DENT 1		SAR Simulation

# Select SAR Simulation Terrain Correction

By default, the terrain correction will use the SRTM 3 sec DEM. The software will automatically determine the DEM tiles needed and download them automatically from internet servers.

SAR-Simulation Terrain Correction			
1-Read 2-Write 3-SAR-Simulation 4-0	GCP-Selection 5-SARSim-Terrain-Correction		
Source Bands:	Sigma0_HH Sigma0_HV		
Digital Elevation Model:	SRTM 3Sec (Auto Download)		
DEM Resampling Method:			
Save Layover-Shadow Mask as band			
	Process		

# SAR Simulation Terrain Correction Dialog

In the GCP Selection tab, you may need to select a large window depending on how far apart the georeferencing of the product is from the actual geographic position. For ALOS-1, a window size of 1024 may be needed for some products.



1-Read 2-Write 3-SAR-Simulation 4-GO	P-Selection 5-SARSim-Terrain-Correction
Number of GCPs:	еро
Coarse Registration Window Width:	1024 🗸
Coarse Registration Window Height:	1024 🗸
Row Interpolation Factor:	2
Column Interpolation Factor:	2
Max Iterations:	2
GCP Tolerance:	0.5
Apply Fine Registration	
Coherence Window Size:	
Coherence Threshold:	
Fine Registration Window Width:	32 👻
Fine Registration Window Height:	32 🗸
Ompute Coherence with Sliding Window	,
	Help     Process

# Select a Window Width and Height

In the Terrain Correction tab, the RMS threshold represents the cut off for the pixel accuracy of the coregistration. You may also select the output pixel spacing and the map projection.

As you have already calibrated this product, there is no need to apply radiometric normalization.



	-K 5-SADSim-Terrain-Correction
1-Read 2-Write 3-SAR-Simulation 4-GCP-Sele	
RMS Threshold:	0.5
WARP Polynomial Order:	1
Image Resampling Method:	BILINEAR_INTERPOLATION
Source GR Pixel Spacings (az x rg):	3.17(m) x 14.99(m)
Pixel Spacing (m):	14.99
Pixel Spacing (deg):	1.3465746108951625E-4
Map Projection:	WGS84(DD)
Save local incidence angle band	Save projected local incidence angle band
Save selected source band	Save DEM band
Apply radiometric normalization	
Save Sigma0 band	Use projected local incidence angle from DEM 👻
Save Gamma0 band	Use projected local incidence angle from DEM 👻
Save Beta0 band	
Auxiliary File (ASAR only):	Latest Auxiliary File 👻
Show Range and Azimuth Shifts	
He	Ip Process

# Select the RMS Threshold

Press **Run** to process.

Open the terrain corrected product.



#### **Terrain Corrected Image**

To view the image in decibel scaling, right-click on the terrain corrected **Sigma0\_HH** band and select **Linear to/from dB** convert the data using a virtual band.



# Select Linear to/from dB

A new virtual band will be created with the expression 10\*log10(Sigma0\_HH).





New Sigma0\_HH\_dB band

Double-click on the new Intensity\_VH\_dB band to open it.



Terrain Corrected Band in dB





For more tutorials visit the Sentinel Toolboxes website

http://step.esa.int/main/doc/tutorials/



Send comments to the SNAP Forum

http://forum.step.esa.int/