SAR Subsets for Selected Field Sites, 2007-2010

Revision date: January 11 2012

Summary:

This data set provides Synthetic Aperture Radar (SAR) images for 42 selected sites from various terrestrial ecology and meteorological monitoring networks including FLUXNET, Ameriflux, Long Term Ecological Research (LTER), and the Greenland Climate Network (GC-Net).

The data set contains at least one image for all 42 sites, and six sites have multiple images. See Table 1 for the sites and the temporal range of the available images. The scenes are in GeoTIFF format in Universal Transverse Mercator (UTM), WGS-84 projection, and 15-meter resolution.

The SAR images are subset scenes of approximately 60 km x 70 km that include an established site in one of the monitoring networks. The spatial resolution of all scenes is 15 meters. These scenes are distributed as GeoTIFF files with appropriate projection information defined within the file. The acquisition mode for all data is the Fine Beam Double Polarization or FBD with the HH/HV polarization. The HH and HV channels are distributed as 3 channels to allow for an intuitive image display. The HH band is displayed in the red and blue channels and the HV band is displayed in the green channel. For some images only single polarization is available; these images are distributed as grayscale images.

The source of the data is the PALSAR (Phased Array type L-band Synthetic Aperture Radar) sensor flying on the Advanced Land Observing Satellite (ALOS). The PALSAR data are in dual Polarization, HH+HV, mode. Bands HH (red and blue) and Band-HV (green) can be used to visualize land use patterns. The resulting images show vegetation in shades of green and barren land in shades of pink or purple.

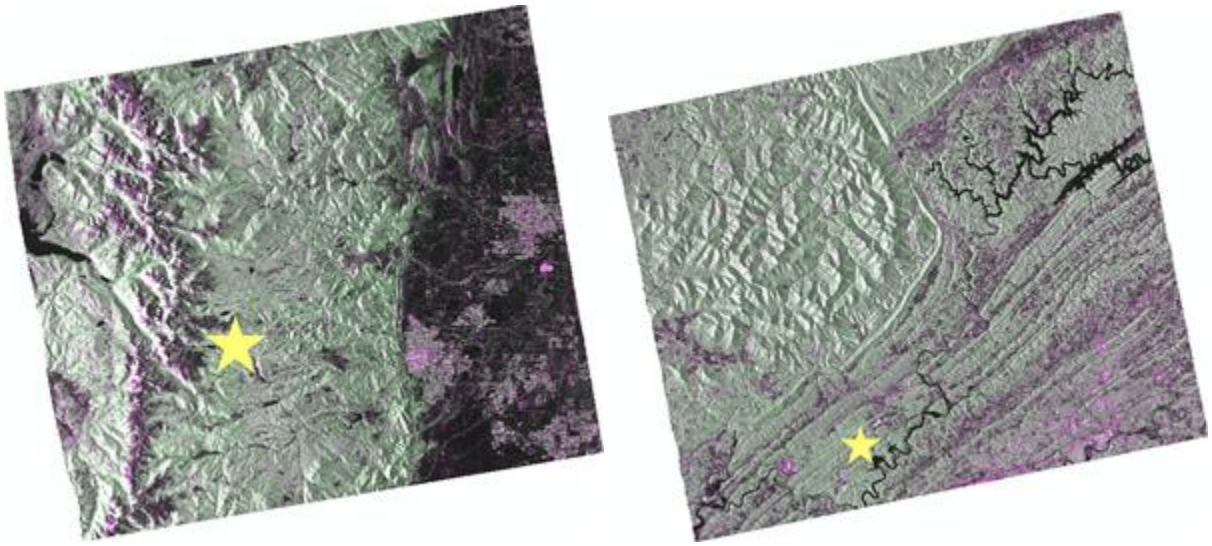

Figure 1. SAR images for (a) Niwot Ridge, Colorado and (b) Walker Branch Watershed, Tennessee sites. Visualizations for land use are generally set such that green is tree canopy, pink is crop or barren soil, black is water, and grays are low vegetation. The star icon indicates the location of the field site.

The data can be used for a number of purposes (1) to validate the SAR measurements using FLUX tower site characterization data; (2) to examine the impacts of vegetation dynamics on climate; (3) to understand human impacts on vegetation at a local scale; (3) to detect deforestation and forest degradation; (4) to map and differentiate growth stages and change; (5) to retrieve woody biomass and structural attributes; and (6) to characterize, map and monitor ecoregions such as mangroves and wetlands.

Support Acknowledgment

The National Aeronautics and Space Administration (NASA) funded this EOSDIS Tech Infusion project (2010) as a collaboration between the Alaska Satellite Facility (ASF), the National Snow and Ice Data Center (NSIDC), and the Oak Ridge National Laboratory Distributed Active Archive Center (ORNL DAAC) in 2010. The purpose of the project was to provide subsets of PALSAR data for selected field sites, such as flux tower locations, to increase terrestrial ecology users' understanding of SAR, to make the community more aware of SAR data, and to promote its overall use.

This project produced many scenes of SAR satellite imagery for use by terrestrial ecologists in their geo-spatial investigations. The PALSAR subsets are provided in non-proprietary, unrestricted, and user friendly GeoTIFF file format and are now publicly available at the ORNL DAAC Web site.

Data and Documentation Access:

Description and Links to Companion Files and Supplemental Information

SAR Documentation:

Alaska Satellite Facility, SAR Data Center (http://www.asf.alaska.edu/program/sdc)

Alaska Satellite Facility, SAR Data Center, PALSAR Summary (http://www.asf.alaska.edu/program/sdc/sensors#palsar)

Japan Aerospace Exploration Agency (JAXA), Advanced Land Observing Satellite "DAICHI" (ALOS) Site (http://www.jaxa.jp/projects/sat/alos/index_e.html)

ORNL DAAC Spatial Data Access Tool (SDAT) link:
http://webmap.ornl.gov/wcsdown/dataset.jsp?ds_id=993

Get Data: http://daac.ornl.gov/cgi-bin/dsviewer.pl?ds_id=993

Data Citation:

Cite this data set as follows:

Oak Ridge National Laboratory Distributed Active Archive Center, Alaska Satellite Facility Distributed Active Archive Center, and Japan Aerospace Exploration Agency. 2011. SAR Subsets for Selected Field Sites, 2007-2010. Data set. Available on-line [http://daac.ornl.gov] from ORNL DAAC, Oak Ridge, Tennessee, U.S.A. doi:10.3334/ORNLDAAC/993

Table of Contents

1. Data Set Overview:

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The data set contains at least one image for all 42 sites, and six sites have multiple images. See Table 1 for the sites and the temporal range of the available images. The scenes are in GeoTIFF format in Universal Transverse Mercator (UTM), WGS-84 projection, and 15-meter resolution.

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The data can be used for a number of purposes (1) to validate the SAR measurements using FLUX tower site characterization data; (2) to examine the impacts of vegetation dynamics on climate; (3) to understand human impacts on vegetation at a local scale; (3) to detect deforestation and forest degradation; (4) to map and differentiate growth stages and change; (5) to retrieve woody biomass and structural attributes; and (6) to characterize, map and monitor ecoregions such as mangroves and wetlands.

2. Data Description

This data set provides Synthetic Aperture Radar (SAR) images for 42 selected sites from various monitoring networks including FLUXNET, Ameriflux, LTER, and the Greenland Climate Network (GC-Net).

There is at least one image for all 42 sites, and six sites have multiple images. See Table 2 for the sites and the temporal range of the available images. The scenes are in GeoTIFF format in Universal Transverse Mercator (UTM) projection and 15-meter resolution.

Spatial Coverage

Sites: Selected field sites, such as carbon and heat flux tower locations, to increase terrestrial ecologist's understanding of SAR and to promote its use.

Figure 2. Locations of sites with SAR images.

Table 1. Selected environmental network sites and physical attributes.

Site Name	Land_unit	Latitude	Longitude	Site Type	Vegtype_igbpclss
Arctic LTER (ARC1)	North America	68.62833	-149.593331	LTER Site	Open shrublands
Baltimore Ecosystem Study (BES1)	North America	39.400281	-76.7702806	LTER Site	Urban and built-up
Bartlett Experimental Forest	North America	44.06464	-71.2880769	Flux Tower	Deciduous broad-leaf forest
BOREAS NSA - Old Black Spruce	North America	55.87962	-98.48081	Flux Tower	Evergreen needle-leaf forest
BOREAS SSA Young Aspen	North America	53.65601	-105.32314	Flux Tower	Mixed forest
British Columbia-Campbell River -	North America	49.87048	-125.29087	Flux Tower	Evergreen needle-leaf forest

Clearcut Site					
British Columbia-Campbell River - Mature Forest Site	North America	49.86725	-125.3336	Flux Tower	Evergreen needle-leaf forest
Buffalo13 ESE- SDSU Antelope Research Station (Calving Pasture Site)	North America	45.516	-103.3017	Climate reference network station	Grasslands
Cascades/H.J. Andrews LTER- Oregon	North America	44.24885	-122.180347		Evergreen needle-leaf forest
Chamela Biological Station	North America	19.509281	-105.040175	Flux Tower	Deciduous broad-leaf forest
CP1	Europe	69.8819	-46.9736	GC-Net**	
Duke Forest Hardwoods	North America	35.973582	-79.1004304	Flux Tower	Mixed forest
Harvard Forest EMS Tower(HFR1)	North America	42.537756	-72.1714778	Flux Tower	Mixed forest
HJ Andrews Aeronet Sunphotometer (AND1)	North America	44.238889	-122.223889	LTER Site	Evergreen needle- leaf forest
Howland Forest (Main Tower)	North America	45.20407	-68.7402778	Flux Tower	Mixed forest
Humboldt Gl.	Europe	78.5266	-56.8305	GC-Net	
Juniper Woodland Site	North America	40.259322	-112.478125	Flux Tower	Grassland
KULU	Europe	65.7584	-39.6018	GC-Net	
Lost Creek	North America	46.08268	-89.97919	Flux Tower	Deciduous broad-leaf forest
Luquillo LTER (LUQ1)	North America	18.323889	-65.8175	LTER Site	Evergreen broadleaf forest
Metolius Eyerly Burn	North America	44.579442	-121.500076	Flux Tower	Evergreen needle-leaf forest
Metolius Intermediate Pine	North America	44.452432	-121.557166	Flux Tower	Evergreen needle-leaf forest
Missouri Ozark Site	North America	38.74411	-92.200009	Flux Tower	Deciduous broad-leaf forest
NASA-E	Europe	75	-29.9997	GC-Net	
NGRIP	Europe	75.0998	-42.3326	GC-Net	
Niwot Ridge (LTER NWT1)	North America	40.032878	-105.546403	Flux Tower	Evergreen needle-leaf forest
Park Falls	North America	45.945878	-90.2723042	Flux Tower	Deciduous broad-leaf forest
Phillips Creek Marsh (PHCK)	North America	37.46069	-75.8347115	LTER Site	Woody Savannas
Rond.- Faz. Nossa Senhora-Ji Parana-pasture	South America	-10.76181	-62.3572222	Flux Tower	Savannas
Rond.- Rebio Jaru Ji Parana- Tower B	South America	-10.07806	-61.9330972	Flux Tower	Evergreen broad-leaf forest
Santarem-Km77-Pasture	South America	-3.011896	-54.53652	Flux Tower	Cropland/natural vegetation mosaic
Sask - SSA Old Aspen	North America	53.62889	-106.19779	Flux Tower	Mixed forest

Sask- SSA Old Jack Pine	North America	53.91634	-104.69203	Flux Tower	Evergreen needle-leaf forest
Sioux Falls Portable	North America	43.2408	-96.902		Croplands
Sky Oaks	North America	33.384444	-116.640261	Flux Tower	Closed shrublands
Summit	Europe	72.5794	-38.5042	GC-Net	
Swiss Camp	Europe	69.5732	-49.5952	GC-Net	
Tablelands Juniper Savanna	North America	34.425489	-105.861545		Open shrublands
Tonzi Ranch	North America	38.4316	-120.965983	Flux Tower	Woody savannas
Valles Caldera Mixed Conifer	North America	35.888447	-106.532114		Woody savannas
Walker Branch Watershed	North America	35.958767	-84.2874333	Flux Tower	Deciduous broad-leaf forest
Western Peatland-LaBiche-Black Spruce/Larch Fen	North America	54.95384	-112.46698	Flux Tower	Mixed forest

** Greenland Climate Network (GC-Net) (http://cires.colorado.edu/science/groups/steffen/gcnet/)

Collection boundaries: (All latitude and longitude given in decimal degrees)

Westernmost Longitude	Easternmost Longitude	Northernmost Latitude	Southernmost Latitude
-156.6650	-29.9997	78.5266	-10.7618

Site Information

The purpose of the project was to provide subsets of PALSAR data for selected field sites from established monitoring networks for carbon and heat flux (AmeriFlux Tower locations), long-term ecological monitoring sites (LTER), Greenland Climate Network (GC-Net), and EOS Land Validation Sites to increase terrestrial ecology users' understanding of SAR data and promote its use. The PALSAR subsets are provided in non-proprietary, unrestricted, and user friendly GeoTIFF file format.

Spatial Resolution

The SAR images are subset scenes of approximately 60 km x 70 km that includes an established site in one of the monitoring networks. The spatial resolution of all scenes is 15 meters.

Temporal Coverage

Temporal Resolution

SAR subsets were extracted for the dates shown in Table 2. The exact time of the image is included in the documentation.

Table 2. The selected sites, the name of their respective compressed image files, the date(s), and projections of the SAR subset image(s) provided.

Site Name	Image and Documentation Filename (compressed)	Image Date(s)	Image Projection
Arctic LTER (ARC1)	Arctic_LTER.zip	2010/07/11	WGS84, UTM, Zone 6N
Baltimore Ecosystem Study (BES1)	Baltimore_Ecosystem_Study.zip	2009/07/28	WGS84, UTM, Zone 18N
Bartlett Experimental Forest	Bartlett_Experimental_Forest.zip	2007/07/20 2007/09/04 2007/10/20 2008/06/06 2009/07/25 2009/10/25 2010/07/28 2010/09/12 2010/10/28	WGS84, UTM, Zone 19N
BOREAS NSA - Old Black Spruce	BOREAS_NSA_Old_Black_Spruce.zip	2010/09/24	WGS84, UTM, Zone 14N
BOREAS SSA Young Aspen	BOREAS_SSA_Young_Aspen.zip	2010/07/19	WGS84, UTM, Zone 13N
British Columbia-Campbell River - Clearcut Site	British_Columbia_Campbell_River_Clearcut_Site.zip	2010/06/05	WGS84, UTM, Zone 10N
British Columbia-Campbell River - Mature Forest Site	British_Columbia_Campbell_River_Mature_Forest_Site.zip	2010/06/05	WGS84, UTM, Zone 10N
Buffalo 13 ESE-SDSU Antelope Research Station (Calving Pasture Site)	Buffalo_13_ESE_SDSU_Antelope_Research_Station.zip	2010/10/02	WGS84, UTM, Zone 13N
Cascades/H.J. Andrews LTER-Oregon	Cascades_H_J__Andrews_LTER_Oregon.zip	2008/10/25	WGS84, UTM, Zone 10N
Chamela Biological	Chamela_Biological_Station.zip	2010/10/10	WGS84, UTM, Zone

Station			13N
CP1	CP1.zip	2009/11/10	WGS84, UTM, Zone 23N
Duke Forest Hardwoods	Duke_Forest_Hardwoods.zip	2010/09/25	WGS84, UTM, Zone 17N
Harvard Forest EMS Tower(HFR1)	Harvard_Forest_EMS_Tower.zip	2007/08/23 2010/08/31 2010/10/16	WGS84, UTM, Zone 18N
HJ Andrews Aeronet Sunphotometer (AND1)	HJ_Andrews_Aeronet_Sunphotometer.zip	2010/10/25	WGS84, UTM, Zone 10N
Howland Forest (Main Tower)	Howland_Forest.zip	2010/10/18	WGS84, UTM, Zone 19N
Humboldt Gl.	Humboldt_Gl.zip	2010/06/29	WGS84, UTM, Zone 21N
Juniper Woodland Site	Juniper_Woodland_Site.zip	2010/07/20	WGS84, UTM, Zone 12N
KULU	KULU.zip	2008/05/21 2008/07/06 2008/08/21	WGS84, UTM, Zone 24N
Lost Creek	Lost_Creek.zip	2010/10/08	WGS84, UTM, Zone 15N
Luquillo LTER (LUQ1)	Luquillo_LTER.zip	2010/10/11	WGS84, UTM, Zone 20N
Metolius Eyerly Burn	Metolius_Eyerly_Burn.zip	2010/06/29	WGS84, UTM, Zone 10N
Metolius Intermediate Pine	Metolius_Intermediate_Pine.zip	2010/06/29	WGS84, UTM, Zone 10N
Missouri Ozark Site	Missouri_Ozark_Site.zip	2010/08/04	WGS84, UTM, Zone 15N
NASA-E	NASA_E.zip	2009/12/23	WGS84, UTM, Zone 25N
NGRIP	NGRIP.zip	2010/06/29	WGS84, UTM, Zone 23N
Niwot Ridge (LTER NWT1)	Niwot_Ridge.zip	2007/06/05 2007/07/21 2007/10/21 2008/06/07	WGS84, UTM, Zone 13N

		2009/07/26 2010/06/13 2010/07/29 2010/10/29 2010/12/14	
Park Falls	Park_Falls.zip	2010/10/08	WGS84, UTM, Zone 15N
Phillips Creek Marsh (PHCK)	Phillips_Creek_Marsh.zip	2010/10/31	WGS84, UTM, Zone 18N
Rond.- Faz. Nossa Senhora-Ji Parana-pasture	Rond_Faz_Nossa_Senhora_Ji_Parana_pasture.zip	2010/10/21	WGS84, UTM, Zone 20S
Rond.- Rebio Jaru Ji Parana-TowerB	Rond_Rebio_Jaru_Ji_Parana_Tower .zip	2010/07/17	WGS84, UTM, Zone 20S
Santarem-Km77-Pasture	Santarem_Km77-Pasture.zip	2007/06/12 2008/05/30 2009/06/18 2009/08/03 2010/06/21 2010/07/21 2010/08/06 2010/11/06	WGS84, UTM, Zone 21S
Sask- SSA Old Aspen	Sask_SSA_Old_Aspen.zip	2010/11/05	WGS84, UTM, Zone 13N
Sask- SSA Old Jack Pine	Sask_SSA_Old_Jack_Pine.zip	2010/10/31	WGS84, UTM, Zone 13N
Sioux Falls Portable	Sioux_Falls_Portable.zip	2010/03/20 2010/06/29 2010/07/16 2010/08/31 2010/10/16 2010/12/01	WGS84, UTM, Zone 14N
Sky Oaks	Sky_Oaks.zip	2009/11/18	WGS84, UTM, Zone 11N
Summit	Summit.zip	2010/01/23	WGS84, UTM, Zone 24N
Swiss Camp	Swiss_Camp.zip	2010/01/05	WGS84, UTM, Zone 22N
Tablelands Juniper Savanna	Tablelands_Juniper_Savanna.zip	2010/09/18	WGS84, UTM, Zone 13N
Tonzi Ranch	Tonzi_Ranch.zip	2010/09/17	WGS84, UTM, Zone

			10N
Valles Caldera Mixed Conifer	Valles_Caldera_Mixed_Conifer.zip	2010/10/05	WGS84, UTM, Zone 13N
Walker Branch Watershed	Walker_Branch_Watershed.zip	2010/10/27	WGS84, UTM, Zone 16N
Western Peatland-LaBiche-Black Spruce/Larch Fen	Western_Peatland_LaBiche_Black_Spruce.zip	2010/09/23	WGS84, UTM, Zone 12N

Data File Information

As show in Table 2, each site has a single compressed data file. Within the *.zip file is the GeoTIFF image file(s) with the image date appended to the file name. A *.pdf documentation file is also included and contains image-specific metadata, image analysts notes about channel assignments and colors, and a thumbnail of the SAR image as show in Figure 1. For sites with multiple images, only one thumbnail is included as images are quite similar in appearance.

Example Documentation File:

Site Name:Baltimore Ecosystem Study (BES1)
GeoTIFF: Baltimore_Ecosystem_Study_20090728.tif
Imagery Date: 28-Jul-2009, 03:32:51
Location: Maryland
The SAR image has greens, pinks, blacks and some gray colors. By assigning the HH to the red and blue channels
and the HV polarization to the green, we get these slightly more intuitive colors. Green is tree canopy. Black is water.
Polarization: FBD 34.3 HH+HV
Bands: HH (red & blue)
Bands: HV (green)

3. Data Application and Derivation:

PALSAR Terrestrial Biophysical Applications

The data can be used for a number of purposes (1) to validate the SAR measurements using FLUX tower site characterization data; (2) to examine the impacts of vegetation dynamics on climate; (3) to understand human impacts on vegetation at a local scale; (3) to detect deforestation and forest degradation; (4) to map and differentiate growth stages and change; (5) to retrieve woody biomass and structural attributes; and (6) to characterize, map and monitor ecoregions such as mangroves and wetlands.

Satellite radar can be important to Earth system monitoring because the properties of the signal return are better suited for certain vegetative biophysical estimates and are more accurate or not otherwise obtainable by passive remote sensing systems. A number of studies have shown a significant relationship between L-Band SAR backscatter coefficients and forest structure parameters including above ground

biomass and vegetative structural attributes. Other examples of terrestrial applications include wetland characterization, mapping, and monitoring and forest change analysis

The PALSAR subsets provided in this data set might be useful for visual interest and preliminary analysis of the field area. For in-depth analyses, such as biomass estimation, vegetation characterization, etc., users might have to download the lower level products from ASF.

Quantitatively Comparing Multi-Temporal Data

The data values in the image are Digital Numbers (DN) that can be used in the following equation to extract the Normalized Radar Cross Section (NRCS).

NRCS (dB) = 10*log10(<DN^2>) + CF

Where the Calibration Factor (CF) is a constant -83.

The cross section parameter is useful to quantitatively compare multi-temporal data.

4. Quality Assessment:

Because Radar emits its own signal, imaging can occur anytime of the day or night independent of sun angle. This is in contrast to passive imaging systems that require the Sun's illumination. Due to its longer wavelength than visible light, the microwaves used in Radar also have the advantage of not being impeded by cloud cover or other atmospheric contamination.

5. Data Acquisition Materials and Methods:

Imagery from synthetic aperture radar (SAR) satellites is not a familiar data set for most users of geographic information systems (GIS). There are several reasons why radar imagery is not commonly used, primarily because of the nature of the technology and its specialized applications. Another is that radar imagery is not optical, requiring more technical processing and specialized image interpretation skills.

Overview

The SAR satellite used to create these images is the Advanced Land Observing Satellite (ALOS). ASF is a downlink and archive for ALOS in the Americas. The SAR sensor is an L-Band phased array radar capable of imaging in several resolutions and polarizations. Because radar data is ranging data that measures the strength and scatter of the radar pulse, it is not like optical imagery which is visually intuitive. To make the SAR scenes more user friendly, the polarization data was classified as reds, greens, and blues in the image. Another aspect of radar remote sensing is that the ranging data must be terrain-corrected by a process that assigns the ranging values to geographic coordinates by utilizing a digital surface model (DSM). High resolution DSM data are not available for the entire planet and existing data at high latitudes is problematic, especially in areas of very little terrain relief, such as sheet glaciers. To use a consistent DSM for this project and all of the sites being investigated, the DSM data from the ASTER satellite was used for the terrain correction.

ALOS PALSAR

Launched on January 24th, 2006 aboard the Advanced Land Observing Satellite (ALOS), the Phased Array Type L-band Synthetic Aperture Radar (PALSAR) instrument has promising applications for natural resource and land applications including parameters applicable to terrestrial nutrient cycle estimates. Research has shown that SAR data by itself, or combined with other optical or active systems, can enhance land characterization with information not otherwise available from passive remote systems. Because Radar emits its own signal, imaging can occur anytime of the day or night independent of sun angle. This is in contrast to passive imaging systems that require the Sun's illumination. Due to its longer wavelength than visible light, the microwaves used in Radar also have the advantage of not being impeded by cloud cover or other atmospheric contamination. Some examples of PALSAR land applications include estimates and mapping of vegetation above ground biomass, deforestation mapping, wetland (including high latitude) characterization, and cropland monitoring.

Radar Imaging Basics

The PALSAR instrument is a type of Synthetic Aperture Radar (SAR) that emits energy in the long wavelength L-Band (1270 MHz) frequency. SAR radar systems are able to generate high-resolution imagery with a synthetic aperture (or virtual long antenna) by combining signals received by the physically short (real) antenna as it moves along its flight track.

As an imaging radar system moves along a flight path it emits and receives pulses in a single particular microwave wavelength and orientation (waves polarized in a single vertical (V) or horizontal (H) plane). The radar pulse interacts with the Earth's surface and is scattered in all directions, with some energy reflected back toward the radar's antenna. Known as backscatter, the returned signal is received by the antenna a fraction of a second later and in a specific polarization (H or V). The brightness, or amplitude, of the backscatter is measured and recorded and the data are used to derive an image. Radar waves interact differently with soil, vegetation, water, ice, and man-made objects such as buildings and roads because the backscatter is affected by the surface properties of objects. For a smooth surface such as water or a road, most of the incident energy is reflected away from the radar system resulting in a very low return signal. In contrast, rough surfaces will scatter the emitted energy in all directions and return a significant portion back to the antenna. In general, vegetation is usually moderately rough with most radar wavelengths.

6. Data Archive Access:

This data set is available through the Oak Ridge National Laboratory (ORNL) Distributed Active Archive Center (DAAC).

Data Archive:

Web Site: http://daac.ornl.gov

Contact for Data Center

E-mail: uso@daac.ornl.gov
Telephone: +1 (865) 241-3952

7. References:

Shimada, M.; Isoguchi, O.; Tadono, T.; Isono, K.; , "PALSAR Radiometric and Geometric Calibration," Geoscience and Remote Sensing, IEEE Transactions on , vol.47, no.12, pp.3915-3932, Dec. 2009 doi: 10.1109/TGRS.2009.2023909