SMEX04 ENVISAT ASAR Data: Arizona, Version 1

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Jackson, T., R. Bindlish, and R. Van der Velde. 2009. *SMEX04 ENVISAT ASAR Data: Arizona, Version 1* [Indicate subset used]. Boulder, Colorado USA. NSIDC: National Snow and Ice Data Center. https://doi.org/10.5067/T2HZFZ7BX0WX. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0417

National Snow and Ice Data Center

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1 DETAILED DATA DESCRIPTION

This data set is comprised of browse images acquired over the regional study area of Arizona, USA for the 2004 Soil Moisture Experiment (SMEX04).

1.1 Format

Browse images for each regional study area are provided as JPEG image files. The following types of header files are also provided:

- ASCII text (.txt extension): Output file generated by ESA's Basic ENVISAT SAR Toolbox (BEST); each ASCII text file contains an extensive annotation list for its corresponding image.
- HAN (.HAN extension): Internal BEST Header Analysis file
- INI (.ini extension): BEST configuration/initialization file generated by running the BEST Header Analysis module; contains the parameter information used to run BEST software.

One ASCII text file and one HAN file accompanies each JPEG image file in this data set, and a single INI file is included for the data set. For clarification of variables for all header files, refer to the BEST User Manual (PDF file, 1.53 MB) via the Documentation link on the Sample Record section of this document provides sample data records for each type of file in this data set. HAN files, however, are internal BEST Header Analysis files containing the full product header information used for running the Basic ENVISAT SAR Toolbox (BEST) applications. BEST is a suite of executable software tools designed to facilitate the use of ESA Synthetic Aperture Radar (SAR) data.

1.2 File and Directory Structure

Data are available on the HTTPS site in the https://daacdata.apps.nsidc.org/pub/DATASETS/AVDM/data/soil_moisture/SMEX04/Arizona/satellite/ASAR/ directory. The ASAR directory also contains the 00README.txt file, one INI file, and two sets each of JPEG, ASCII text, and HAN files.

1.3 File Naming Convention

1.3.1 JPEG and JGW Files

The JPEG image files are named according to the following conventions and as described in Table 1:

az_ASAR_mmdd_IS#_D.jpg

Example:

az_ASAR_0909_IS2_D.jpg

Where:

Table 1 Description of File Name Variables

Variable	Description
az	Arizona
ASAR	Advanced Synthetic Aperture Radar (ASAR)
mm	Two-digit month
dd	Two-digit day
IS#	Image Swath #: 1, 2, 3, 4, 5, 6, 7
D	Descending ENVISAT Pass
.jpg	Indicates that this is a JPEG file

1.3.2 ASCII Text and HAN Files

ASCII text and Header Analysis (HAN) files are named according to the following convention and as described in Table 2:

az_mmdd_D.txt

az_mmdd_D.HAN

Examples:

az_0909_D.txt

az_0909_D.HAN

Where:

Table 2 Description of File Name Variables

Variable	Description
az	Arizona
mm	Two-digit month
dd	Two-digit day
D	Descending ENVISAT Pass

.txt	Indicates that this is a text file
.HAN	Indicates that this is a HAN file

1.3.3 INI File

Also included for each regional study area is an INI file named az_parameters.ini that contains the parameter information used to run BEST software when processing JPEG images for the region.

1.4 Spatial Coverage

The approximate overall spatial coverage for each region is listed below. For a more detailed description, refer to Table 3.

Southernmost Latitude: 31.41° N
Northernmost Latitude: 32.57° N
Westernmost Longitude: 110.31° W
Easternmost Longitude: 109.01° W

Table 3 Specifications of SMEX04 Arizona ASAR Images

Study Area	Date (mm-dd-yyyy)	ENVISAT Pass	Image Swath	Spatial Coverage Coordinates: Upper Left Corner		Spatial Coverage Coordinates: Lower Right Corner	
				Latitude	Longitude	Latitude	Longitude
Arizona	09-09-2003	Descending	IS2	32.581	-110.310	31.412	-109.014
Arizona	14-10-2003	Descending	IS2	32.567	-110.312	31.413	-109.019

1.4.1 Spatial Resolution

The ASAR instrument's radar beam viewing angle can alternate between 15 and 45 degrees resulting in swaths ranging from 56 km to 105 km wide. Table 4 lists the specifications of the different image swaths the ASAR instrument is able to collect.

Table 4 ASAR Image Swath Specifications

ASAR Image Swath	Swath Width (km)	Incidence Angle Range (degrees)
IS1	105	15.0 - 22.9
IS2	105	19.2 - 26.7
IS3	82	26.0 - 31.4

ASAR Image Swath	Swath Width (km)	Incidence Angle Range (degrees)
IS4	88	31.0 - 36.4
IS5	64	35.8 - 39.4
IS6	70	39.1 - 42.8
IS7	56	42.5 - 45.2

Both SMEX04 ASAR images have 12.5 m pixel spacing and approximately 30 m resolution. Thus, each pixel represents a 12.5 x 12.5 m area on the ground, and it is possible to discern individual objects which are approximately 30 m wide or larger.

1.4.2 Projection and Grid Description

The projection used for this data set was the Universal Transverse Mercator (UTM) with the World Geodetic System 1984 (WGS 84) datum applied.

1.5 Temporal Coverage

Data were collected on 09 September 2003 and 14 October 2003.

1.5.1 Temporal Resolution

The ASAR images were acquired once during the pass of the ENVISAT satellite.

1.6 Parameter or Variable

1.6.1 Parameter Description

This data set consists of browse images and provides only a general quality assessment of the ASAR data used as part of the Soil Moisture Experiment 2004 (SMEX04). The measured parameter for the ASAR images was a relative radar returned signal strength, that is, the reflected radiance (measured by amplitude) for each pixel. From the measured amplitude values, the cross V-polarized (VV/VH) C-band radar backscatter coefficients were then derived. The images are a function of backscatter coefficients and are intended for browsing locations and general features. Thus, the images cannot be used to derive backscatter coefficient values; researchers interested in backscatter coefficient values must obtain the ASAR data.

1.6.2 Sample Data Record

With the exception of HAN files, Figures 1 through 3 show sample data records for each file type included in this data set. Figure 1 is a sample of the az_ASAR_0909_IS2_D.jpg file, a false-color C-band image.

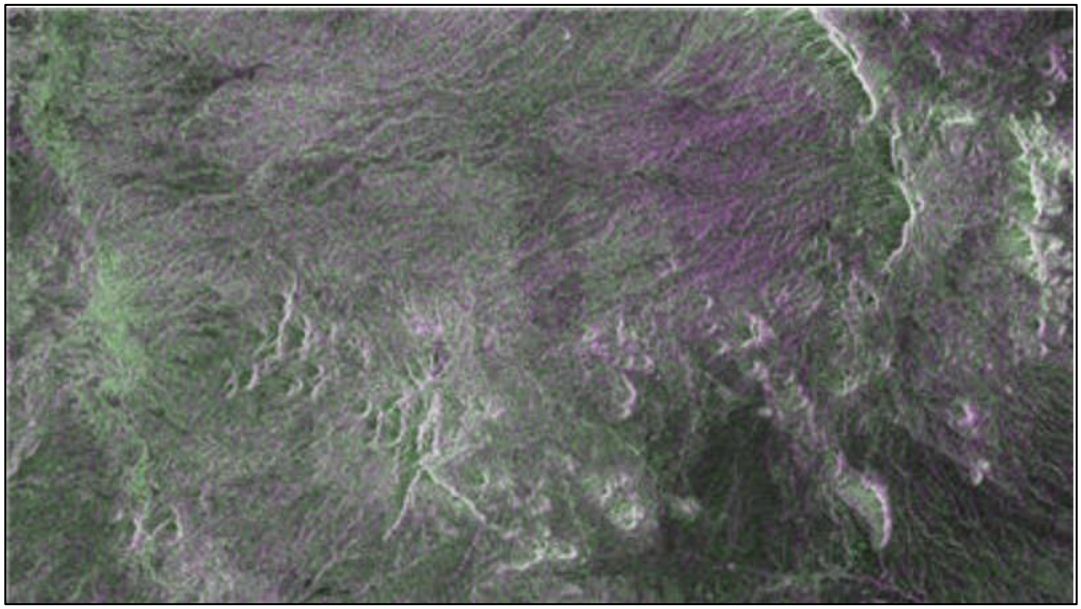

Figure 1 Sample False-Color C-band ASAR Browse Image

```
================================================================================
BEST - ESA / Telespazio - ANNOTATION LIST
================================================================================
Processing time.....: 21-Jan-2004 09:18:40.000
Product type........: gec
Sensor Mode.........: Alternating Polarization
Desired AP dataset..: 1
Source..............: ASAR
Data format.........: MPH-SPH
Facility id.........: esp
Format descriptor record...: C:\BEST\\cfg\gec3eespap
--------------------------------------------------------------------------------
File name...........: PDF - PRODUCT_DATA_FILE
Record name.........: Main Product Header Record
Pos Esa field name Value Units Tag
--------------------------------------------------------------------------------
1 dummy PRODUCT=" - -
--------------------------------------------------------------------------------
2 Product Tag ASA_APG_1PNUPA20030909_17 - product_name
2742_000000162019_00413_0
7982_0084.N1
--------------------------------------------------------------------------------
3 Product ID ASA_APG_1P - envisat_prod_id
--------------------------------------------------------------------------------
```

Figure 2 Partial Sample Data Record of az_0909_D.txt

```
[HEADER ANALYSIS]
Input Media Path = "d:\ASA_APG_1PNUPA20030909_172742_000000162019_00413_07982_0084.N1"
Input Media Type = "CDROM"
Sensor Id = "ASAR"
Sensor Mode = "Alternating Polarization"
AP Dataset = 1
Product Type = "GEC"
Data Format = "ENVISAT"
Source Id = "esp"
Number Of Volumes = 1
Output Dir = "C:\ASAR\AZ\"
Annotation File = "AZ_0909"
Header Analysis File = "AZ_0909"
Acknowledge Mount = 'Y'
```

Figure 3 Full Sample Data Record of az_parameters.ini

2 SOFTWARE AND TOOLS

Tools appropriate for viewing these data include any image viewing program that recognizes JPEG file format and any text editor or Web browser.

3 DATA ACQUISITION AND PROCESSING

3.1 Theory of Measurements

A Synthetic Aperture Radar (SAR) is an active microwave sensor that transmits a focused pulse of radar energy and receives reflected energy from the target (in this case, the Earth) in a form that can be converted into a high-resolution image. A SAR uses the sweep of a relatively small antenna through space to mimic the resolution attainable by a much larger stationary antenna. SAR images of a surface give a different view than visible/near infrared imagery due to the differences in interactions with surface materials in the microwave band. SAR images show the great variability in radar backscattering properties of a wet versus dry surface. In general, dry surfaces are very good radar absorbers, while wet surfaces are bright radar reflectors.

However, the interplay between a radar signal and the ground surface depends upon many factors, including vegetation cover, the density and dielectric properties of surface materials, surface roughness with regard to the signal's wavelength, the topography of a region, and the instrument's viewing angle and signal polarization. The resolution of a radar image is particularly affected by signal strength and bandwidth, chirp pulse length and the time between pulses, and the return signal integration time.

For more information, refer to the European Space Agency's (ESA) ASAR FAQ Web page.

3.2 Data Acquisition Methods

For the SMEX04 field campaign, ASAR acquired two radar images over the Arizona, USA study area. Table 3 lists these ASAR acquisitions with their spatial coverage and image swath.

3.2.1 Data Source

ENVISAT is a polar-orbiting, sun-synchronous advanced Earth observation satellite developed by the European Space Agency (ESA) to monitor environmental change. The ENVISAT platform flies at approximately 800 km altitude and has a repeat orbit cycle of 35 days. Its wide-swath instruments, such as ASAR, provide complete coverage of the globe within one to three days.

3.3 Derivation Techniques and Algorithms

The SMEX04 ASAR images were acquired in VV/VH mode for different image swaths. The ASAR images were then processed at various ESA stations to Level-1B products. Level-1B data consist of geocoded amplitude values. Geocoding is the transformation of the sensor-specific geometry of an image into a cartographic representation with well-defined scale and angular distortions. In this

case, the geocoded format is defined by the Universal Transverse Mercator projection. Backscatter coefficients can be derived from the amplitude values using equation 2.27 from the ASAR Product Handbook, which is formulated as follows:

$\sigma^o = \frac{A^2}{k} \sin(\alpha)$	(Equation 1)

Where σ is the backscatter coefficient (in power), A2 is the amplitude, k is the calibration coefficient from the product header, and α is the viewing angle.

3.3.1 Processing Steps

Images were acquired from the ASAR instrument and then processed as Level-1B data at ESA stations. Headers were generated using BEST software. Since ENVISAT/ASAR data is not public domain and needs to be acquired by individual research groups, images were converted to JPEG image files for browsing purposes. Refer to ESA's Specific Instrument Acquisition Web page for information regarding ESA data acquisition.

3.4 Sensor or Instrument Description

The Advanced Synthetic Aperture Radar (ASAR) instrument onboard the European Environmental Satellite (ENVISAT) is the first dual-polarized radar instrument mounted on a satellite platform. The ASAR antenna operates at 5.33 GHz in the microwave C-band. In its alternating polarization mode, ASAR can acquire backscatter coefficients in one of the following three polarization combinations: HH/VV (co-polarized mode), HH/HV (cross H-polarized mode) and VV/VH (cross V-polarized mode). All radar images used for SMEX04 were acquired in the cross V-polarized mode, or VV/VH. The spatial resolution of the sensor is approximately 30 meters, although the pixel spacing is 12.5 meters.

4 REFERENCES AND RELATED PUBLICATIONS

For more information, related resources for this data set are provided in Table 5.

Table 5 Related Documents

Document	Description	URL
USDA SMEX04 Web Site	More details on the SMEX04 field campaign	http://hydrolab.arsusda.gov/smex04/
European Space Agency (ESA) ENVISAT Web Site	Additional information regarding the ENVISAT platform	http://envisat.esa.int/
ASAR Product Handbook	The ASAR Product Handbook is an online resource available at the ESA Earthnet Online Web site. The handbook includes the ASAR Products User Guide, information regarding data formats and algorithms, details on the ASAR Instrument, Frequently Asked Questions (FAQs), a glossary, and additional resources.	http://envisat.esa.int/dataproducts/asar/CNTR.htm

4.1 Related Data Collections

AMSR-E/Aqua Data Web site: AMSR-E standard products available at NSIDC.

RADARSAT Data Web site: RADARSAT products available at NSIDC.

5 DOCUMENT INFORMATION

5.1 Publication Date

August 2009

5.2 Date Last Updated

29 March 2021