# SMEX03 ENVISAT ASAR Data, Alabama, Georgia, Oklahoma, 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. *SMEX03 ENVISAT ASAR Data, Alabama, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/7ZGTHVZFAIDT. [Date Accessed].

Jackson, T., R. Bindlish, and R. Van der Velde. 2013. *SMEX03 ENVISAT ASAR Data, Georgia, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/M28ZA9EYPHQ5. [Date Accessed].

Jackson, T., R. Bindlish, and R. Van der Velde. 2013. *SMEX03 ENVISAT ASAR Data, Oklahoma, Version 1.* [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. doi: https://doi.org/10.5067/YXYV5M9B6I1J. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0357, https://nsidc.org/data/NSIDC-0576, https://nsidc.org/data/NSIDC-0577

National Snow and Ice Data Center

# TABLE OF CONTENTS

# 1 DETAILED DATA DESCRIPTION

## 1.1 Format

Browse images for each regional study area are provided as JPEG image files with corresponding JGW (JPEG World) georeference 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 one INI file is included for each study region. 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 BEST Home Page. With the exception of .HAN files, 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.

In addition to ASCII text and HAN files, each JPEG image in this data set has an associated JGW georeference file. Refer to Table 1 for clarification of JGW georeference file values, and to Figure 2 for the Sample Data Record. The JPEG image files in this data set vary in size and orientation, and range from approximately 2800 to 8200 pixels.

Table 1 Example of JGW File Values

| Sample JGW File Values (From al_ASAR_0701_IS2.jgw) | Description |
|---|---|
| 12.50000000000000 | Pixel size in the x-direction in map units (m) |
| 0.00000000000000 | Rotation about y-axis* |
| 0.00000000000000 | Rotation about x-axis* |
| -12.50000000000000 | Pixel size in the y-direction in map units (m)** |
| 576529.87500000000000 | X-coordinate of center of upper left pixel (Easting coordinate) |
| 3894594.75000000000000 | Y-coordinate of center of upper left pixel (Northing coordinate) |
| * Zero indicates the image did not require any rotation or rectification to be properly georeferenced.<br>** The pixel size in the y-direction in map units is negative to convert from image row numbering (increasing from the top down) to map coordinates (increasing from the bottom up). Thus, for a rectified image, this line must be equal to the pixel size in the x-direction in map units and of opposite sign. | |

## 1.2 File and Directory Structure

Data are available on the FTP site in the /soil_moisture/SMEX03/Alabama/satellite/ASAR/ directory. Located within the ASAR directory are three regional subdirectories (AL, GA, and OK) and the readme.txt file. Each regional subdirectory contains one INI file and one or more sets of JPG, JGW, ASCII text, and HAN files. Figure 1 shows the overall directory structure.

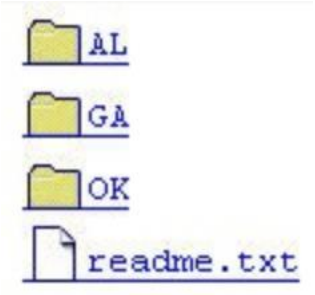


Figure 1. Directory Structure for SMEX03 ENVISAT ASAR Data

## 1.3 File Naming Convention

### 1.3.1 JPEG and JGW Files

JPEG and accompanying JGW georeference files for each regional study area are named according to the following convention and as described in Table 2:

```
rg_ASAR_mmdd_IS#_P.jpg
rg_ASAR_mmdd_IS#_P.jgw\
```

Where:

Table 2 Description of File Name Variables

| Variable | Description |
|---|---|
| rg | rg: Region (al: Alabama; ga: Georgia; ok: Oklahoma) |
| ASAR | Advanced Synthetic Aperture Radar (ASAR) |
| mmdd | mm: Two-digit month; dd: Two-digit day |
| IS# | IS: Image Swath; #: 1, 2, 3, 4, 5, 6, 7 |
| P | P: ENVISAT Pass (A: Ascending; D: Descending) |
| .jpg | Indicates that this is a JPEG file |
| .jgw | Indicates that this is a JGW (JPEG World) file |

**Examples:**

```
al_ASAR_0701_IS2_D.jpg
al_ASAR_0701_IS2_D.jgw
```

### 1.3.2 ASCII Text and HAN Files

ASCII text and Header Analysis (HAN) files for each regional study area are named according to the following convention and as described in Table 3:

```
rg_mmdd_P.txt
rg_mmdd_P.HAN
```

Where:

Table 3 Description of File Name Variables

| Variable | Description |
|---|---|
| rg | rg: Region (al: Alabama; ga: Georgia; ok: Oklahoma) |
| mmdd | mm: Two-digit month; dd: Two-digit day |
| P | P: ENVISAT Pass (A: Ascending; D: Descending) |
| .txt | Indicates that this is a text file |
| .HAN | Indicates that this is a HAN file |

**Examples:**

```
ok_0715_A.txt
ok_0715_A.HAN
```

### 1.3.3 INI Files

Also included for each regional study area is an INI file named rg_parameters.ini that contains the parameter information used to run BEST software when processing JPEG images for the region. As with all other files in this data set, rg in the INI file naming convention (rg_parameters.ini) indicates the particular study region. The INI file for Alabama, for example, is called al_parameters.ini.

## 1.4 Spatial Coverage

The approximate overall spatial coverage for each region is listed below. For a more detailed description, refer to Table 4.

### 1.4.1 Alabama

Southernmost Latitude: 34.49° N
Northernmost Latitude: 35.59° N
Westernmost Longitude: 86.15° W
Easternmost Longitude: 85.02° W

### 1.4.2 Georgia

Southernmost Latitude: 30.79° N
Northernmost Latitude: 31.91° N
Westernmost Longitude: 83.98° W
Easternmost Longitude: 82.69° W

### 1.4.3 Oklahoma

Southernmost Latitude: 34.47° N
Northernmost Latitude: 35.61° N
Westernmost Longitude: 98.53° W
Easternmost Longitude: 97.31° W

Table 4 Specifications of ASAR Images Acquired During SMEX03

| Study Area | Date (mm-dd-yyyy) | ENVISAT Pass | Image Swath | Spatial Coverage Coordinates: Upper Left Corner | | Spatial Coverage Coordinates: Lower Right Corner | |
|---|---|---|---|---|---|---|---|
| Alabama | 07-01-2003 | Descending | IS4 | 35.59409 | -86.15519 | 34.494 | -85.0221 |
| Georgia | 06-25-2003 | Descending | IS4 | 32.02516 | -84.10617 | 30.93685 | -82.9342 |
| Georgia | 06-28-2003 | Ascending | IS2 | 31.93242 | -83.91968 | 30.81971 | -82.5910 |
| Georgia | 06-28-2003 | Descending | IS2 | 31.76725 | -83.91235 | 30.62544 | -82.5505 |
| Oklahoma | 03-26-2003 | Ascending | IS2 | 35.585 | -98.4742 | 34.39905 | -97.1028 |
| Oklahoma | 04-30-2003 | Ascending | IS2 | 35.21912 | -98.39458 | 34.0448 | -97.0302 |
| Oklahoma | 07-09-2003 | Ascending | IS2 | 35.58454 | -98.47263 | 34.41249 | -97.1047 |
| Oklahoma | 07-09-2003 | Descending | IS4 | 35.56303 | -98.37327 | 34.46375 | -97.2356 |
| Oklahoma | 07-12-2003 | Ascending | IS3 | 35.75946 | -98.8554 | 34.64989 | -97.7278 |
| Oklahoma | 07-15-2003 | Ascending | IS5 | 35.93128 | -98.59181 | 34.84973 | -97.6661 |

### 1.4.4 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 6 lists the specifications of the different image swaths the ASAR instrument is able to collect.

Table 5 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 |
| IS4 | 88 | 31.0 - 36.4 |
| IS5 | 64 | 35.8 - 39.4 |
| IS6 | 70 | 39.1 - 42.8 |
| IS7 | 56 | 42.5 - 45.2 |

All SMEX03 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.

### 1.4.5 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 between March and July 2003. Refer to Table 5 for precise temporal coverage and temporal resolution listed by region.

### 1.5.1 Temporal Resolution

Depending on the acquisition date, ASAR images over each study area were acquired once or twice during the pass of the ENVISAT satellite. Table 4 specifies whether the image was acquired during the ascending or descending pass, or both, over a given region.

## 1.6 Parameter or Variable

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 2003 (SMEX03). 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.

### 1.6.1 Sample Data Record

With the exception of HAN files, figures 2 through 5 show sample data records for each file type included in this data set. NOTE: Figure 4 is a partial sample data record of al_0715.txt due to the size of the file; each ASCII text file contains an extensive annotation list for its corresponding image and it is therefore not shown in its entirety.

```
                  12.50000000000000
                   0.00000000000000
                   0.00000000000000
                 -12.50000000000000
              576529.87500000000000
             3894594.75000000000000
```

Figure 2 Full Sample of the Data Record of al_ASAR_0701_IS2_D.jgw

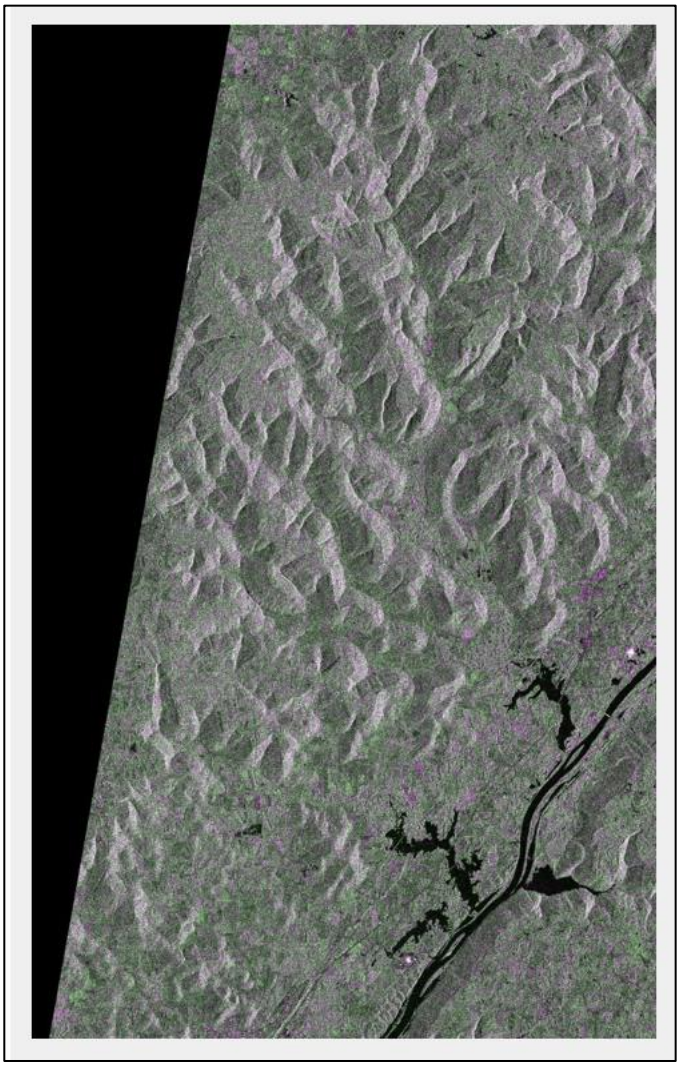

Figure 3 Sample ASAR Browse Image

Sample of the `al_ASAR_0701_IS2_D.jpg` file, a false-color C-band image.

```
================================================================================================================
BEST - ESA / Telespazio - ANNOTATION LIST
================================================================================================================
Processing time.............: 21-Jan-2004 09:06:11.000
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 Remark
----------------------------------------------------------------------------------------------------------------
1 dummy PRODUCT=" - - -
----------------------------------------------------------------------------------------------------------------
2 Product Tag ASA_APG_1PNUPA20030701_15 - product_name contains the string 'PRODUCT="
4612_000000162017_00412_0 '
6979_0036.N1
----------------------------------------------------------------------------------------------------------------
3 Product ID ASA_APG_1P - envisat_prod_id -
----------------------------------------------------------------------------------------------------------------
```

Figure 3 Partial Sample Data Record of ok_0715_A.txt

```
[HEADER ANALYSIS]
Input Media Path = "d:\ASA\APG\1P\ASA_APG_1PNUPA20030701_154612_000000162017_00412_06979_0036.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\AL\"
Annotation File = "al_0715"
Header Analysis File = "al_0715"
Acknowledge Mount = 'Y'
```

Figure 4 Full Sample Data Record of al_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

During the SMEX03 field campaign ASAR acquired one radar image over the Alabama study area, three images over Georgia, and six over the Oklahoma, USA study area. Table 4 lists these ASAR acquisitions with their spatial coverage and image swath.

## 3.3 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.

## 3.4 Derivation Techniques and Algorithms

### 3.4.1 Processing Steps

Images were acquired from the ASAR instrument 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.

## 3.5 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 the SMEX03 regional study areas 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

Table 7 Related Documents

| Document | Description | URL |
|---|---|---|
| USDA SMEX03 Web site | More details on the SMEX03 field campaign | http://www.wcc.nrcs.usda.gov/scan/ |
| European Space Agency (ESA) ENVISAT Web site | Additional information regarding the ENVISAT platform | http://envisat.esa.int/ |

| Document | Description | URL |
|---|---|---|
| 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 at NSIDC Web site: AMSR-E standard products available at NSIDC.
- RADARSAT Data Web site: RADARSAT products available at NSIDC.

# 5 CONTACTS AND ACKNOWLEDGMENTS

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# 6 DOCUMENT INFORMATION

## 6.1 Publication Date

January 2009

## 6.2 Date Last Updated

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