SMAP Radar Twice-Daily SAR and SIR-Enhanced Scatterometer *EASE-Grid 2.0* Radar Backscatter, Version 1

USER GUIDE

How to Cite These Data

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

Long, D.G., J.Z. Miller, M.J. Brodzik, and M.A. Hardman. 2022. SMAP Radar Twice-Daily SAR and SIR-Enhanced Scatterometer EASE-Grid 2.0 Radar Backscatter, *Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/SCKWZSWQ7HPL. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0774

National Snow and Ice Data Center

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1 DATA DESCRIPTION

The NSIDC-0744 data set contains twice-daily synthetic aperture radar (SAR) and enhanced-resolution scatterometer radar backscatter data produced using two standard swath-based products from the Soil Moisture Active Passive (SMAP) mission: (1) the *SMAP L1C Radar Half-Orbit Sigma0, Version 1, data set* (SPL1CS0), and (2) the *SMAP L1B Radar Half-Orbit Time-Ordered Low Resolution* σ^0*, Version 1, data set* (SPL1BS0). The source SPL1CS0 data set were originally processed by the Jet Propulsion Laboratory (JPL) using an unfocused SAR algorithm (West, 2012), while the SPL1BS0 data provides lower resolution slice and footprint products. The new product processes the individual swath-based data from the input data sets into twice-daily images. The high-resolution SAR images are formed using a drop-in-the-bucket gridding (GRD) algorithm. Lower resolution slice and footprint data are used to generate GRD images and enhanced-resolution images using the Scatterometer Image Reconstruction (SIR) algorithm (Long and Miller, 2022) and the spatial measurement response function for each measurement type. A weighted average (AVE) algorithm creates a third image type for slice data. The SIR images provide global coverage that includes areas not observed in SAR data, most notably Antarctica, as well as information about the azimuth and incidence angle dependence. Note that the radiometer form of the SIR algorithm (rSIR) was used to derive brightness temperatures from SMAP radiometer data for the *SMAP Radiometer Twice-Daily rSIR-Enhanced EASE-Grid 2.0 Brightness Temperatures, Version 2, data set* (NSIDC-0738) and from the SMMR, AMSR-E, and SSM/I-SSMIS sensors for the *MEaSUREs Calibrated Enhanced-Resolution Passive Microwave Daily EASE-Grid 2.0 Brightness Temperature ESDR, Version 1, data set* (NSIDC-0630). Data are available as *EASE-Grid 2.0* polar projections for the Northern Hemisphere and Southern Hemisphere, and as *EASE-Grid 2.0* cylindrical projection for Temperate & Tropical (subset of Global) on 3.125-km and 25-km resolution grids.

1.1 Parameters

The main parameter for this data set is global normalized radar cross section (σ^0), termed radar backscatter or Sigma0. There are four 1.26 GHz SMAP radar GHz channels within this data set, which include like-polarization (horizontal transmit-horizontal receive [HH], vertical transmit-vertical receive [VV]) and cross-polarization (horizontal transmit-vertical receive [HV], and vertical transmit-horizontal receive [VH]). The valid range for σ^0 for all the channels is -60 dB to +10 dB.

Data files are produced for all dates. If no input data are available for a given date, data variables are stored as empty arrays.

Table 1 provides details regarding the key parameters available in all product files. Additional parameters that describe the incidence and azimuth dependence of the backscatter are available in

selected slice product files. See the product Algorithm Theoretical Basis Document (Long and Miller, 2022) for further details.

Table 1. Parameters

Parameter	Description	Units
crs	Coordinate reference system; EASE-Grid 2.0	For details, see Geolocation section of this document
Incidence_angle	Average incidence angle of the measurements used to derive σ^0	Degrees (°) measured clockwise from local North
Sigma0	Normalized radar cross section or backscatter (σ^0).	Unitless, see Algorithm Theoretical Basis Document (Long and Miller, 2022) for details
Sigma0_num_samples	Number of measurements used to derive σ^0	Count
Sigma0_std_dev	Standard deviation of the measurements used to derive σ^0	Unitless, in dB (as 10log_10)
Sigma0_time	SIR Time of Day	Minutes since 2015-05-31 00:00:00, see Algorithm Theoretical Basis Document (Long and Miller, 2022) for details
time	ANSI date	Days since 1972-01-01 00:00:00
x	projection_x_coordinate	Meters
y	projection_y_coordinate	Meters

1.2 File Information

1.2.1 Format

Data are provided in NetCDF (.nc) format using Climate and Forecast 1.6 and Attribute Conventions for Dataset 1.3 metadata conventions.

1.2.2 File Contents

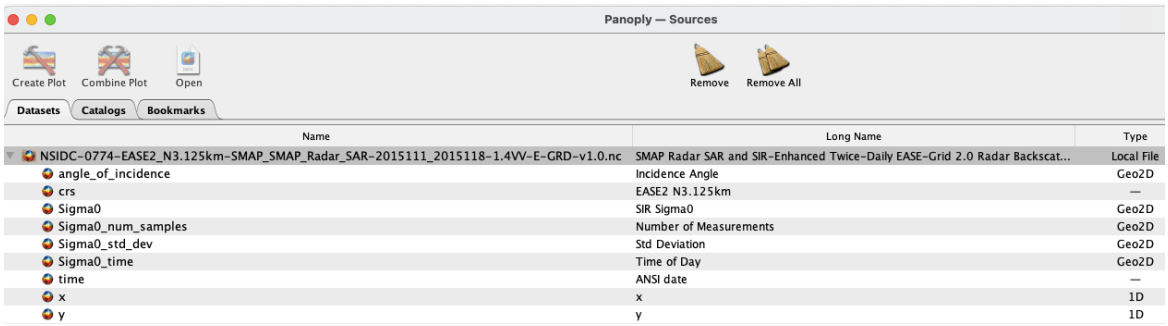

Figure 1. Sample of NetCDF file as seen in Panoply software. Parameters listed are explained in Section 1.1.

1.2.3 Naming Convention

Data files are named according to the following convention and as described in Table 2.

NSIDC-0774-EASE2_[G][###km]-SMAP_SMAP_Radar-[measurement]-yyyyddd-yyyyddd [1.2channel]-[pass]-[algorithm]-v1.0.nc

Table 2. File Naming Convention

Variable	Description
NSIDC-0074	NSIDC unique data set identifier
EASE2	Indicates the data are projected in EASE-Grid 2.0
G	Grid: N = Northern Polar S = Southern Polar T = Temperate & Tropical
####km	Gridding of the data, values are either 3.125 km or 25 km
SMAP_	SMAP mission
SMAP_Radar	Indicates the data are derived from the SMAP radar
measurement	The type of σ^0 measurement: SAR = after unfocused SAR algorithm applied (~1-3 km) Slice = (5 x 30 km) Foot = (29 x 36 km)
yyyyddd_yyyyddd	Start and stop dates of the imaging interval, Year (4-digit) and date (3-digit day of the year) for example, 2015110_2015110 = 1-day imaging interval 2015110_2015112 = 3-day imaging interval 2015110_2015117 = 8-day imaging interval
1.2channel	Frequency + channel (polarization), Possible frequency polarizations include: HH = horizontal transmit-horizontal receive VV = vertical transmit-vertical receive HV = horizontal transmit-vertical receive VH = vertical transmit-horizontal receive XX = cross-polarization (averaged VH and HV)
pass	The orbital direction (A, D) or imaging interval (M, E): A = Ascending (T grids only) D = Descending (T grids only) M = Morning (N or S grids only) E = Evening (N or S grids only)
algorithm	Specifies the algorithm used for the image reconstruction: GRD = drop-in-the-bucket gridding algorithm AVE = weighted average algorithm SIR = Scatterometer Image Reconstruction algorithm
v1.0	Data set version number

Sample File Names:

NSIDC-0774-EASE2_N3.125km-SMAP_SMAP_Radar_SAR-2015110_2015110-1.2HH-A-GRD-v1.0.nc

NSIDC-0774-EASE2_S25km-SMAP_SMAP_Radar_Slice-2015110_2015112-1.2VH-D-AVE-v1.0.nc

NSIDC-0774-EASE2_T3.125km-SMAP_SMAP_Radar_Foot-2015110_2015117-1.2XX-E-SIR-v1.0.nc

1.3 Spatial Information

1.3.1 Coverage

The spatial coverage for the entire data set is global. However, spatial coverage varies between data files. Data are available on the Northern Hemisphere, Southern Hemisphere, and Temperate & Tropical *EASE-Grid 2.0* projections.

1.3.2 Gridding

The gridding varies by data file. For *EASE-Grid 2.0* projections with the Northern Hemisphere, Southern Hemisphere, and Temperate & Tropical Hemispheres, resolutions are available at 3.125 km and 25 km. See the Algorithm Theoretical Basis Document (Long and Miller, 2022) for details.

1.3.3 Geolocation

The following tables provide information for geolocating this data set.

Table 3. Geolocation Details

Geographic coordinate system	WGS 84	WGS 84	WGS 84
Projected coordinate system	EASE-Grid 2.0 Global (Temperate & Tropical)	EASE-Grid 2.0 Northern Hemisphere	EASE-Grid 2.0 Southern Hemisphere
Longitude of true origin	0	0	0
Latitude of true origin	30	90	-90
Scale factor at longitude of true origin	N/A	N/A	N/A
Datum	WGS 1984	WGS 1984	WGS 1984

Ellipsoid/spheroid	WGS 1984	WGS 1984	WGS 1984
Units	Meter	Meter	Meter
False easting	0	0	0
False northing	0	0	0
EPSG code	6933	6931	6932
PROJ4 string	`+proj=cea +lat_ts=30 +lon_0=0 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs +type=crs`	`+proj=laea +lat_0=90 +lon_0=0 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs +type=crs`	`+proj=laea +lat_0=-90 +lon_0=0 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs +type=crs`
Reference	https://epsg.io/6933	https://epsg.io/6931	https://epsg.io/6932

1.4 Temporal Information

1.4.1 Coverage

13 April 2015 to 12 July 2015

While these dates suggest a continuous sequence of data, users should note that some empty data files exist where input data were not available. For files with no available inputs, file level metadata will show a zero for "number_of_input_files".

1.4.2 Temporal Resolution

The temporal resolution is twice-daily.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

The SMAP radar was designed to attain vegetation roughness measurements as part of the primary SMAP mission objective to measure soil moisture from space. However, the global L-band σ^0 measurements have many applications beyond soil moisture. The various products with multiple effective resolutions and different noise levels allow users the flexibility of choosing the appropriate images for their research application, including low-noise (low-resolution) GRD images, fine resolution SAR images, and enhanced-resolution images. To facilitate comparisons, the data is provided in a similar format as the *SMAP Radiometer Twice-Daily rSIR-Enhanced EASE-Grid 2.0 Brightness Temperatures, Version 2, data set* (NSIDC-0738) and from the SMMR, AMSR-E, and SSM/I-SSMIS sensors for the *MEaSUREs Calibrated Enhanced-Resolution Passive Microwave Daily EASE-Grid 2.0 Brightness Temperature ESDR, Version 1, data set* (NSIDC-0630).

The inputs for this data set are the *SMAP L1C Radar Half-Orbit Sigma0, Version 1, data set* (SPL1CS0), and the *SMAP L1B Radar Half-Orbit Time-Ordered Low Resolution σ^0, Version 1, data set* (SPL1BS0).

2.2 Processing

The source SPL1CS0 data set was originally processed at JPL using an unfocused SAR algorithm (West 2012) on a swath (half orbit) basis. Also processed at JPL, the SPL1BS0 data set provides slice and footprint σ^0 measurements on a swath basis. The new NSIDC-0744 *Twice-Daily SAR and SIR-Enhanced Scatterometer EASE-Grid 2.0 Radar Backscatter, Version 1, data set* processes the swath-based data into twice-daily images. SAR images are formed using the GRD algorithm. Slice and footprint images are created two different ways. One uses the low-resolution GRD algorithm. The other uses the SIR algorithm to create enhanced-resolution images. The AVE algorithm creates a third image type for slice σ^0 measurements. SIR and AVE processing use the footprint and slice spatial measurement response function to combine overlapping σ^0 measurements. For further details, see the Algorithm Theoretical Basis Document (Long and Miller 2022).

2.3 Quality, Errors, and Limitations

Although SAR images provide the finest detail, these images are not available in all geographic locations, most notably Antarctica. SIR images should alternately be used. Depending on the algorithm and different statistical methods used for image reconstruction, the general rule is that GRD images have the coarsest detail since they have the greatest averaging. SIR images have the next level of fine detail, with SIR slice images having the smallest errors. Note, however, there is variability in measuring σ^0 at the various resolutions due to the sometimes-limited information on the incidence angle and azimuth angle for a given σ^0 measurement. For more detailed information, including corrections for backscatter based on local incidence and azimuth angles, and estimates of effective resolution, see the Algorithm Theoretical Basis Document (Long and Miller, 2022).

2.4 Instrumentation

For a detailed description of the SMAP instrument, visit the SMAP Instrument page at the JPL SMAP website.

3 VERSION HISTORY

The following table outlines version history for this data set.

Table 4. Version History Summary

Version	Release Date	Description of Changes
1.0	January 2023	Initial Release
1.1	January 2024	A subset of files processed using slice measurements with the SIR algorithm were updated to include missing incidence and azimuth angle information. The affected files can be identified by 'v1.1' in the filename.

4 RELATED DATA SETS

MEaSUREs Calibrated Enhanced-Resolution Passive Microwave Daily EASE-Grid 2.0 Brightness Temperature ESDR (NSIDC-0630)

SMAP Radiometer Twice-Daily rSIR-Enhanced EASE-Grid 2.0 Brightness Temperatures, Version 2 (NSIDC-0738)

SMAP Data at NSIDC | Overview

5 RELATED WEBSITES

SMAP at NASA JPL

6 REFERENCES

Long, D.G. and J.Z. Miller. 2022. SMAP Twice-Daily SAR and SIR-Enhanced Scatterometer EASE-Grid 2.0 Radar Backscatter: Algorithm Theoretical Basis Document. Version 1. (See PDF)

West, R. 2012. SMAP Level 1 Radar Data Products (L1B_S0, L1C_S0) Algorithm Theoretical Basis Document. Initial Release, Version 1. (See PDF)

7 DOCUMENT INFORMATION

7.1 Publication Date

December 2022

7.2 Date Last Updated

January 2024