SMAP/CYGNSS EASE-Grid Soil Moisture, Version 1

USER GUIDE

How to Cite These Data

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

Wernicke, L. J., C. C. Chew, E. E. Small. 2024. *SMAP/CYGNSS EASE-Grid Soil Moisture, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/8OODMTVR6RT9. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0797

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

The main parameter of this data set is surface soil moisture presented on the Global EASE-Grid 2.0 projection. Each data point represents the top 5 cm of the soil column and is derived by downscaling Soil Moisture Active Passive (SMAP) enhanced Level-3, 9 km brightness temperatures using Cyclone Global Navigation Satellite System (CYGNSS) reflectivity data. See the *Data Acquisition and Processing* section for more details.

1.1.1 Format

Data are in HDF5 format. For software and more information, including an HDF5 tutorial, visit the HDF Group's HDF5 website.

1.1.2 File Contents

As shown in Figure 1, each HDF5 file is organized into three main groups: `Metadata`, `SMAP_variables`, and `SMAPCYGNSS_variables`.

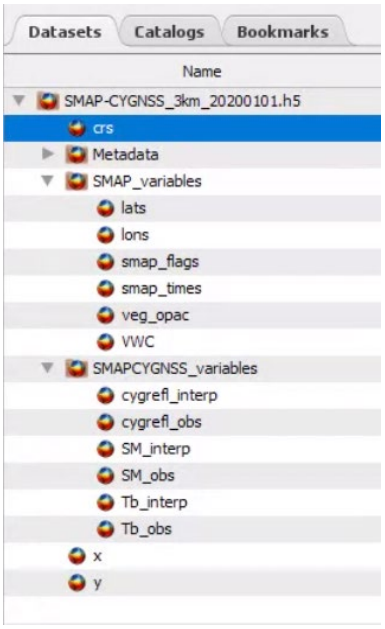

Figure 1. Subset of file contents.

The fields labeled crs, x, and y contain data related to the coordinate reference system.

The `SMAPCYGNSS_variables` group contains both spatially interpolated and observed (not interpolated) values for the following: CYGNSS reflectivity, soil moisture, and brightness

temperatures (each of which are labeled as: `cygrefl_interp` and `cygrefl_obs`; `SM_interp` and `SM_obs`; `Tb_interp` and `Tb_obs`, respectively).

The `SMAP_variables` group contains SMAP ancillary data regarding latitude (`lats`), longitude (`lons`), SMAP flags (`smap_flags`), SMAP time (`smap_times`), vegetation opacity (`veg_opac`), and vegetation water content (`VWC`). The SMAP flags are bit flags that record ambient surface conditions for the grid cell—from SMAP data attributes—interpolated to the latitude and longitude of the center of the 3 km EASE grid cell.

The `Metadata` group includes metadata that describe the full content of each file. This includes when the data were created; soil moisture data description; extent; and publications for further reading. For a description of all the fields for this product, refer to Wernicke et al. (2022).

1.1.3 Naming Convention

Files are named according to the following convention:

`NSIDC-0797_SMAP-CYGNSS_YYYYMMDD_V[n.n].h5`

For example:

`NSIDC-0797_SMAP-CYGNSS_20200101_V1.0.h5`

The variables within a file name are described in Table 1.

Table 1. Final naming convention

Variable	Description
`NSIDC-0797`	National Snow and Ice Data Center (NSIDC) data set authoritative identification
`SMAP-CYGNSS`	Indicates SMAP mission data used in conjunction with CYGNSS data
`yyyymmdd`	Acquisition date based on the interpolated SMAP/CYGNSS data, specified as the 4-digit year (yyyy), 2-digit month (mm), 2-digit day (dd)
`V[n.n]`	Indicates version number, in this case Version 1.0
`.h5`	File extension for an HDF5 data file

1.2 Spatial Information

1.2.1 Coverage

Global-grid coverage spans N:40, E: 180, S: -40, W: -180.

1.2.2 Resolution

3 km grid resolution

1.2.3 Geolocation

The data are provided on the Global 3 km EASE-Grid 2.0 projection. The following tables provide information for geolocating this data set. For more information on EASE-Grid 2.0, refer to the EASE Grids website.

Table 2. Geolocation Details for the Global 3 km EASE-Grid 2.0

Geographic coordinate system	WGS 1984
Projected coordinate system	EASE-Grid 2.0 Global
Longitude of true origin	0
Latitude of true origin	30
Scale factor at longitude of true origin	N/A
Datum	WGS 1984
Ellipsoid/spheroid	WGS 1984
Units	Meter
False easting	0
False northing	0
EPSG code	6933
PROJ4 string	+proj=cea +lat_ts=30 +lon_0=0 +x_0=0 +y_0=0 +datum=WGS84 +units=m +no_defs +type=crs
Reference	https://epsg.org/crs_6933/WGS-84-NSIDC-EASE-Grid-2-0-Global.html

Table 3. 3 km Resolution EASE Grid Details

Grid cell size (x, y pixel dimensions)	3,002.69 m (x) × 3,002.69 m (y)
Number of rows	4872
Number of columns	11568
Nominal gridded resolution	3 km by 3 km
Grid rotation	N/A
ulxmap – x-axis map coordinate of the center of the upper-left pixel (XLLCORNER for ASCII data)	-17367530.44
ulymap – y-axis map coordinate of the center of the upper-left pixel (YLLCORNER for ASCII data)	7314540.83

1.3 Temporal Information

1.3.1 Coverage

Coverage spans from 01 Apr 2017 to 31 Dec 2023.

1.3.2 Resolution

Interpolated SMAP/CYGNSS brightness temperature (T_b) and soil moisture have a temporal resolution, or repeat period, of ~2-3 days. Observed (not interpolated) SMAP/CYGNSS T_b and soil moisture have a temporal resolution of ~10-15 days, on average.

2 DATA ACQUISITION AND PROCESSING

2.1 Acquisition

SMAP/CYGNSS 3 km EASE-Grid Soil Moisture are derived from SMAP Enhanced L3 Radiometer Global and Polar Grid Daily 9 km EASE-Grid Soil Moisture, Version 5 (SPL3SMP_E) and CYGNSS Level 1 Version 2.1 (CYGNSS_L1_V2.1). For December 2023 data, Version 6 of SMPL3SMP_E is used because the previous version was no longer being produced.

2.2 Processing

This product is derived by downscaling SMAP enhanced Level-3 (SPL3SMP_E) brightness temperatures (T_b) with a slightly modified version of the baseline SMAP active-passive T_b algorithm, the Single Channel Algorithm – Vertical polarization (SCA-V) in order to produce an even finer-scale product. The SCA-V was chosen since it outperforms other near soil surface moisture algorithms (Wernicke et al., 2022). The slightly modified SCA-V merges coarse-scale (33 km, gridded at 9 km) SMAP T_B measurements with fine-scale (3 km) CYGNSS reflectivity values to create fine-scale (3 km) SMAP/CYGNSS T_B data. Brightness temperature (T_B) measurements (K) were calculated using the SMAP/CYGNSS downscaling algorithm and 3 km interpolated CYGNSS reflectivity values (Wernicke et al., 2022).

For increased accuracy of derived near soil surface moisture only 6 a.m. SMAP enhanced T_b values (from descending orbits) were used.

For further discussion of the SCA-V algorithm, see O'Neill et al. (2021). For further discussion of using this algorithm to process spatially interpolated and observed (not interpolated) brightness temperature and soil moisture data, see Wernicke et al. (2022).

2.3 Quality, Errors, and Limitations

Anthropogenic radio frequency interference (RFI), principally from ground-based surveillance radars, can contaminate both radar and radiometer measurements at L-band. The SMAP radar and radiometer electronics and algorithms include design features to mitigate the effects of RFI. The SMAP radiometer utilizes selective filters and an adjustable carrier frequency to tune to predetermined RFI-free portions of the spectrum while in orbit.

For an assessment of algorithm performance, quality assessment using all SMAP 9 km core validation sites within ±38◦ latitude, and other sources of uncertainty, see Wernicke et al. (2024).

3 VERSION HISTORY

Table 4. Version History Summary

Version	Date Implemented	Impacted Temporal Coverage	Description of Changes
v01.0	Oct 2024	01 Apr 2017 to 31 Dec 2023	Initial release at the NASA NSIDC DAAC
v00.0	Jan 2024	01 Jan 2019 to 31 Oct 2021	Preliminary version published on Zenodo (DOI: 10.5281/zenodo.10402590)

4 RELATED DATA SETS

SMAP Enhanced L3 Radiometer Global and Polar Grid Daily 9 km EASE-Grid Soil Moisture, Version 5 (SPL3SMP_E)

CYGNSS Level 1 Version 2.1 (CYGNSS_L1_V2.1)

5 REFERENCES

O'Neill, P. E., S. Chan, E. G. Njoku, T. Jackson, R. Bindlish, J. Chaubell, and A. Colliander. (2021). *SMAP Enhanced L3 Radiometer Global and Polar Grid Daily 9 km EASE-Grid Soil Moisture, Version 5*. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/4DQ54OUIJ9DL

Wernicke, L. J., Chew, C. C., Small, E. E., & Das, N. N. (2022). Downscaling SMAP Brightness Temperatures to 3 km Using CYGNSS Reflectivity Observations: Factors That Affect Spatial Heterogeneity. In Remote Sensing (Vol. 14, Issue 20, p. 5262). MDPI AG. https://doi.org/10.3390/rs14205262

Wernicke, L. J., Chew, C. C., & Small, E. E. (2024). Spatially Interpolated CYGNSS Data Improve Downscaled 3 km SMAP/CYGNSS Soil Moisture. In Remote Sensing (Vol. 16, Issue 16, p. 2924). MDPI AG. https://doi.org/10.3390/rs16162924

6 DOCUMENT INFORMATION

6.1 Publication Date

November 2024

6.2 Date Last Updated

November 2024