



# SMAP/CYGNSS EASE-Grid Soil Moisture, Version 1

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## 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](mailto: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

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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.

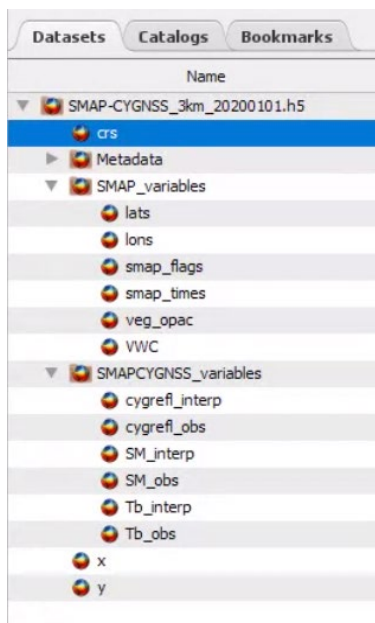


Figure 1. Subset of file contents.

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 describes the full content of each file; this includes when the data was created; soil moisture data description; extent; as well as 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 filename are described in Table 1.

Table 1. Final naming convention

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

## 1.2 Spatial Information

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### 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

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

Table 3. 3 km Resolution EASE Grid Details

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

## 1.3 Temporal Information

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### 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

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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

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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 on orbit.

For an assessment of algorithm performance, quality assessment using all SMAP 9 km core validation sites within  $\pm 38^\circ$  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 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

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November 2024

### 6.2 Date Last Updated

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November 2024