SMAP-Derived 1-km Downscaled Surface Soil Moisture Product, Version 1

USER GUIDE

How to Cite These Data

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

Lakshmi, V. and B. Fang. 2023. *SMAP-Derived 1-km Downscaled Surface Soil Moisture Product, Version 1*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/U8QZ2AXE5V7B. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/NSIDC-0779

National Snow and Ice Data Center

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1 DATA DESCRIPTION

This data product contains global daily 1 km resolution surface soil moisture derived from the SMAP L-band radiometer. Specifically, MODIS land surface temperature data is used with the SMAP Enhanced L2radiometer Half-Orbit 9 km EASE-Grid Soil Moisture product in a downscaling algorithm to estimate soil moisture. The data set is validated by in situ soil moisture measurements from dense soil moisture networks representing different global land cover types.

1.1 Parameters

This product provides global daily 1 km resolution surface soil moisture (representing approximately the top 5 cm of the soil column on average). Daily data are separated into bands denoting the ascending and descending half-orbits of the SMAP L-band radiometer.

1.2 File Information

1.2.1 Format

Data files are provided in Geographic Tagged Image File Format (GeoTIFF).

1.2.2 File Contents

The data set includes a GeoTIFF file for each day with two soil moisture layers, one for the ascending and one for the descending SMAP L-band radiometer pass, as outlined in Table 1 and pictured in Figure 2.

Table 1. Layer Descriptions

Band	Description	Units
Band 1	SMAP 1 km downscaled soil moisture, measured on the descending overpass (6 AM)	m^3/m^3
Band 2	SMAP 1 km downscaled soil moisture, measured on the ascending overpass (6 PM)	m^3/m^3

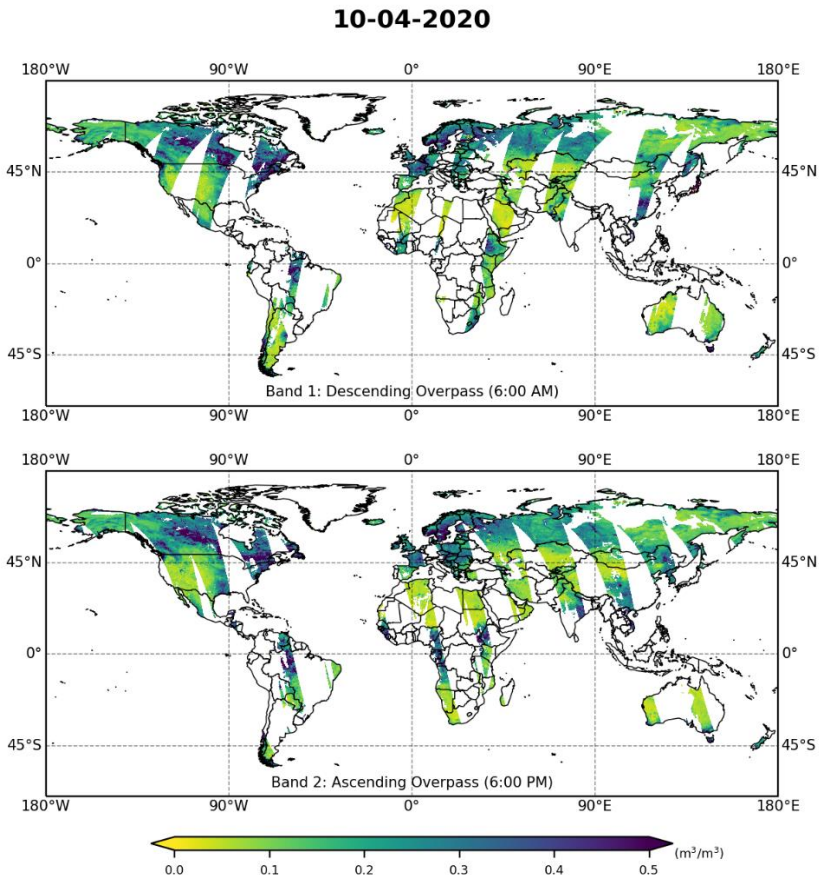

Figure 1. Example GeoTIFF

1.2.3 File Naming Convention

Files are named according to the following convention:

NSIDC-0779_EASE2_G1km_SMAP_SM_DS_yyyymmdd.tif

Table 2 describes the variables within each file name:

Table 2. File Naming Convention

Variable	Description
NSIDC-0779	NSIDC unique data set identifier
EASE2_G1km	The data use the global EASE-Grid 2.0 projection at 1 km resolution
SMAP	SMAP mission data
SM	Soil moisture data
DS	The data are downscaled
yyyymmdd	4 digit year, 2 digit month, 2 digit day of the first data element that appears in the product.
.tif	File extension

1.3 Spatial Information

1.3.1 Coverage

Coverage spans 180° W to 180° E, and from approximately 86° N to 86° S, as defined by EASE-Grid 2.0 coverage. The gap in coverage at both the North and South Pole, called a pole hole, has a radius of approximately 400 km. The swath width is 1000 km, enabling nearly global coverage every two to three days. Figure 2 shows the spatial coverage of the SMAP L-band radiometer for one descending half orbit, which comprises one band of this data set.

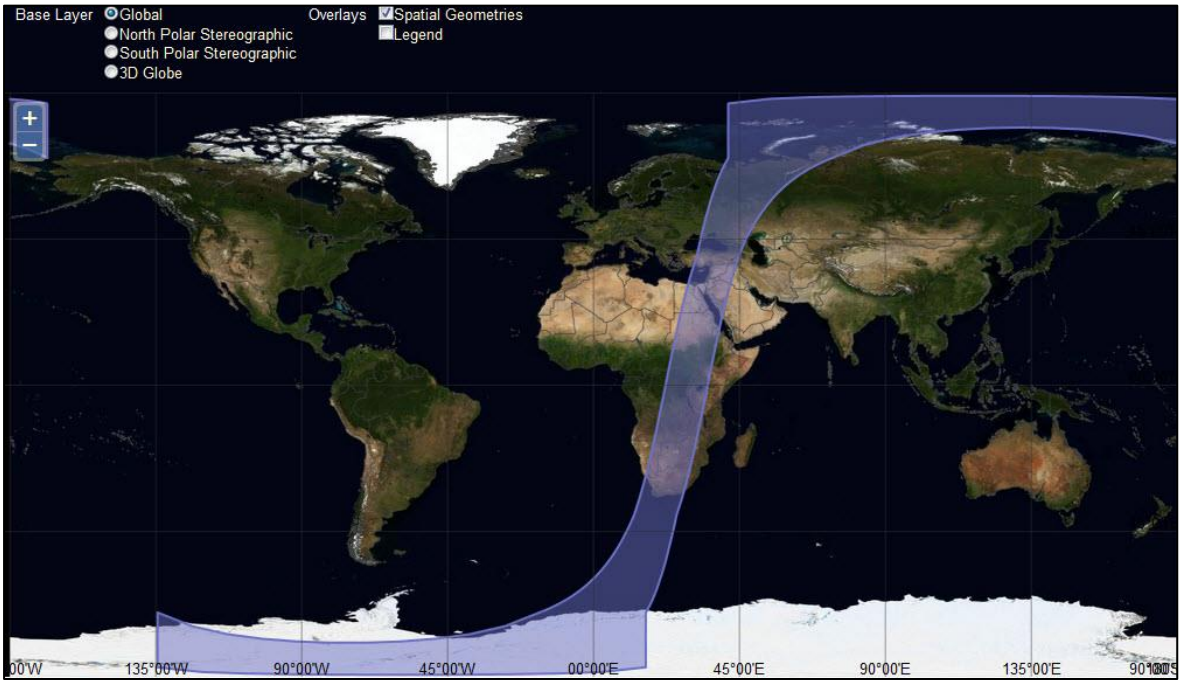

Figure 2. Spatial coverage map displaying one descending half orbit of the SMAP L-band radiometer.

1.3.2 Resolution

1 km

1.3.3 Geolocation

Data are gridded using the global cylindrical EASE-Grid 2.0 projection downscaled to 1 km. The following tables provide information for geolocating this data set. For more on EASE-Grid 2.0, refer to the EASE Grids website.

Table 3. Geolocation details for the downscaled EASE-Grid 2.0 projections used in this product

Geographic coordinate system	WGS 84
Projected coordinate system	EASE-Grid 2.0 Global
Longitude of true origin	0
Standard Parallel	30
Scale factor at longitude of true origin	N/A
Datum	WGS 84
Ellipsoid/spheroid	WGS 84
Units	meter
False easting	0
False northing	0
EPSG code	6933
PROJ4 string	+proj=cea +lon_0=0 +lat_ts=30 +x_0=0 +y_0=0 +ellps=WGS84 +towgs84=0,0,0,0,0,0,0 +units=m +no_defs
Reference	http://epsg.io/6933

Table 4. Grid details for the downscaled EASE-Grid 2.0 projections used in this product

Grid cell size (x, y pixel dimensions)	1,000.895 m (x) 1,000.895 m (y)
Number of columns	34704
Number of rows	14616
Geolocated lower left point in grid	86° S, 180.000° W
Nominal gridded resolution	1 km by 1 km
Grid rotation	N/A
ulxmap – x-axis map coordinate of the outer edge of the upper-left pixel	-17367530.04
ulymap – y-axis map coordinate of the outer edge of the upper-left pixel	7314540.66

1.4 Temporal Information

1.4.1 Coverage

This data set spans 1 April 2015 to 29 June 2024. 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 a comprehensive list of missing or bad data, please see the SMAP Master List of Bad and Missing Data.

The temporal coverage will be extended every 6-12 months.

1.4.2 Resolution

Daily

2 DATA ACQUISITION AND PROCESSING

2.1 Acquisition

SMAP Enhanced L1C Radiometer Half-Orbit 9 km EASE-Grid Brightness Temperatures, Version 3 (SPL1CTB_E) data were used to create the SMAP Enhanced L2 Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture (SPL2SMP_E) data that were downscaled to create this data set.

2.2 Processing

A soil moisture downscaling algorithm, based on thermal inertia theory, was used to downscale global 9 km SMAP soil moisture data, paired with Aqua MODIS data, to 1 km. The algorithm is based on the inverse relationship between land surface temperature differences from 1:30 AM to 1:30 PM Aqua MODIS overpasses and corresponding soil moisture from SMAP overpasses at 6 AM and 6 PM. This relationship was modeled using Global Land Data Assimilation System (GLDAS) Noah model output variables of surface skin temperature and global soil moisture and Land Long-Term Data Record (LTDR) normalized difference vegetation index (NDVI) data.

For more information, the downscaling algorithm is described in detail in Fang et al. (2022).

2.3 Quality, Errors, and Limitations

In situ soil moisture observations, from dense networks around the world, were used to validate the 1 km downscaled and 9 km data. The validation metrics indicated that both the 1 km and 9 km soil moisture data have overall overestimation trends. The in situ measurements used to validate the data were less spatially representative than the global SMAP soil moisture data. Comparing the downscaled data with in situ measurements indicated several data quality characteristics:

- The downscaling model performed better in the middle and low latitudes compared with high latitudes and in warm months compared with cold months.
- Regions with mountains, dense vegetation, and undulating surface terrain experienced poorer performance.
- Extremely wet and extremely dry months experienced poorer performance.

The downscaled SMAP data are missing in the global northernmost regions in winter months and certain subtropical and tropical regions in rainy seasons due to snow, ice, and cloud cover. The different data sources (GLDAS, SMAP, and MODIS) also sensed different soil depths.

Complete details on quality, error, and limitations can be found in Fang et al. (2022).

2.4 Instrumentation

For a detailed description of the SMAP instrument, visit the SMAP Instrument page at the Jet Propulsion Laboratory (JPL) SMAP website.

3 RELATED DATA SETS

SMAP Data at NSIDC | Overview

SMAP Radar Data at the ASF DAAC

SMAP Enhanced L2 Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture

4 REFERENCES

Fang, B., Lakshmi, V., Bindlish, R., Jackson, T.J. and Liu, P.W., 2020. Evaluation and validation of a high spatial resolution satellite soil moisture product over the Continental United States. *Journal of Hydrology*, *588*, p.125043. https://doi.org/10.1016/j.jhydrol.2020.125043.

Fang, B., Lakshmi, V., Cosh, M., Liu, P.W., Bindlish, R. and Jackson, T.J., 2022. A global 1-km downscaled SMAP soil moisture product based on thermal inertia theory. *Vadose Zone Journal*, *21*(2), p.e20182. https://doi.org/10.1002/vzj2.20182.

5 DOCUMENT INFORMATION

5.1 Publication Date

March 2023

5.2 Date Last Updated

September 2024