SMAP L3 Radiometer Global Daily 36 km EASE-Grid Soil Moisture, Version 6

USER GUIDE

How to Cite These Data

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

O'Neill, P. E., S. Chan, E. G. Njoku, T. Jackson, R. Bindlish, and J. Chaubell. 2019. *SMAP L3 Radiometer Global Daily 36 km EASE-Grid Soil Moisture, Version 6*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/EVYDQ32FNWTH. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SPL3SMP

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

Surface soil moisture (0-5 cm) in cm^3/cm^3 derived from brightness temperatures is output on a fixed 36 km EASE-Grid 2.0. Surface soil moisture (0-5 cm) in m^3/m^3 derived from brightness temperatures (TBs) is output on a fixed global 36 km EASE-Grid 2.0. Also included are brightness temperatures in kelvin representing the weighted average of Level-1B brightness temperatures whose boresights fall within a 36 km EASE-Grid 2.0 cell.

Refer to the Product Specification Document for details on all parameters.

1.2 Format

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

1.3 File Contents

As shown in Figure 1, each HDF5 file is organized into the following main groups, which contain additional groups and/or data sets:

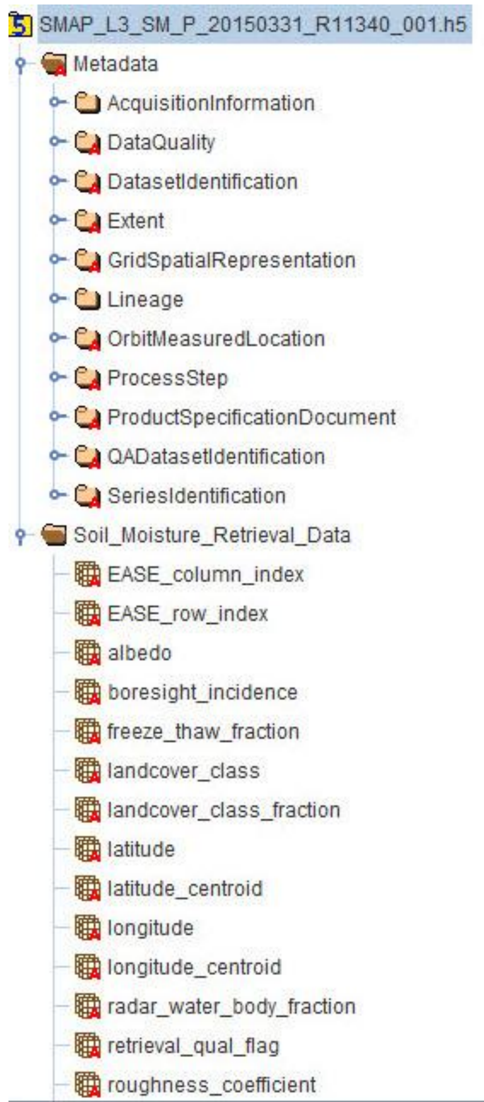

Figure 1. Subset of File Contents. For a complete list of file contents for the SMAP Level-3 radiometer soil moisture product, refer to the Product Specification Document.

The Metadata Fields group includes all the metadata that describe the full content of each file. For a description of all metadata fields for this product, refer to the Product Specification Document.

The Soil Moisture Retrieval Data AM group contains soil moisture data, ancillary data, and quality assessment flags for each descending half-orbit pass of the satellite (where the satellite moves from North to South and 6:00 a.m. is the Local Solar Time (LST) at the equator). The Soil Moisture Retrieval Data PM group contains soil moisture data, ancillary data, and quality assessment flags for each ascending half-orbit pass of the satellite (where the satellite moves from South to North and 6:00 p.m. is the LST at the equator). Corrected brightness temperatures are also provided for each AM and PM group.

1.4 File Naming Convention

Files are named according to the following convention, which is described in Table 1:

```
SMAP_L3_SM_P_yyyymmdd_RLVvvv_NNN.[ext]
```

For example:

```
SMAP_L3_SM_P_20150705_R13242_001.h5
```

Table 1. File Naming Conventions

<table>
<tr><th>Variable</th><th>Description</th></tr>
<tr><td>SMAP</td><td>Indicates SMAP mission data</td></tr>
<tr><td>L3_SM_P</td><td>Indicates specific product (L3: Level-3; SM: Soil Moisture; P: Passive)</td></tr>
<tr><td>yyyymmdd</td><td>4-digit year, 2-digit month, 2-digit day of the first data element that appears in the product.</td></tr>
<tr><td>RLVvvv</td><td>Composite Release ID, where:
<table>
<tr><td>R</td><td>Release</td></tr>
<tr><td>L</td><td>Launch Indicator (1: post-launch standard data)</td></tr>
<tr><td>V</td><td>1-Digit Major Version Number</td></tr>
<tr><td>vvv</td><td>3-Digit Minor Version Number</td></tr>
</table>
Example: R13242 indicates a standard data product with a version of 3.242.
Refer to the SMAP Data Versions page for version information.</td></tr>
<tr><td>NNN</td><td>Product Counter: Number of times the file was generated under the same version for a particular date/time interval (002: second time)</td></tr>
<tr><td>.[ext]</td><td>File extensions include:
<table>
<tr><td>.h5</td><td>HDF5 data file</td></tr>
<tr><td>.qa</td><td>Quality Assurance file</td></tr>
<tr><td>.xml</td><td>XML Metadata file</td></tr>
</table></td></tr>
</table>

1.5 File Size

Each file is approximately 25 - 30 MB.

1.6 Spatial Coverage

Coverage spans from 180°W to 180°E, and from approximately 85.044°N and 85.044°S. 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 three days.

1.7 Spatial Resolution

36 km

1.8 Geolocation

Data are gridded using the 36 km EASE-Grid 2.0 projection.The following tables provide information for geolocating this data set. For more on EASE-Grid 2.0, refer to the EASE Grids website.

Table 2. Geolocation Details for the Global EASE-Grid

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 3. Grid Details for the Global EASE-Grid

Grid cell size (x, y pixel dimensions)	36,032.22 projected meters (x) 36,032.22 projected meters (y)
Number of columns	964
Number of rows	406
Geolocated lower left point in grid	85.044° S, 180.000 ° W
Nominal gridded resolution	36 km by 36 km
Grid rotation	N/A
ulxmap – x-axis map coordinate of the outer edge of the upper-left pixel	-17367530.45 m
ulymap – y-axis map coordinate of the outer edge of the upper-left pixel	7314540.83 m

1.9 Temporal Information

1.9.1 Coverage

Coverage spans from 31 March 2015 to 27 August 2020.

1.9.2 Satellite and Processing Events

Due to instrument maneuvers, data downlink anomalies, data quality screening, and other factors, small gaps in the time series will occur. Refer to the SMAP On-Orbit Events List for Instrument Data Users page for details regarding these gaps.

1.9.3 Latencies

FAQ: What are the latencies for SMAP radiometer data sets?

1.9.4 Temporal Resolution

Each Level-3 file is a daily composite of half-orbit files/swaths.

2 DATA ACQUISITION AND PROCESSING

This section has been adapted from O'Neill et al. 2016 and O'Neill et al. 2018.

2.1 Background

The microwave portion of the electromagnetic spectrum, which includes wavelengths from a few centimeters to a meter, has long held the most promise for estimating surface soil moisture remotely. Passive microwave sensors measure the natural thermal emission emanating from the soil surface. The variation in the intensity of this radiation depends on the dielectric properties and temperature of the target medium, which for the near-surface soil layer is a function of the amount of moisture present. Low microwave frequencies, at L-band or approximately 1 GHz, offer the following additional advantages:

The atmosphere is almost completely transparent, providing all-weather sensing

Transmission of signals from the underlying soil is possible through sparse and moderate vegetation layers (up to at least 5 kg/m2 of vegetation water content)

Measurement is independent of solar illumination which allows for day and night observations

For an in-depth description of the theory of these measurements, refer to Passive Remote Sensing of Soil Moisture in the Algorithm Theoretical Basis Document (ATBD) for this product, O'Neill et al. 2018.

2.2 Acquisition

SMAP Level-3 radiometer soil moisture data (SPL3SMP) are composited from SMAP L2 Radiometer Half-Orbit 36 km EASE-Grid Soil Moisture, Version 5 (SPL2SMP).

2.3 Processing Steps

The SPL3SMP product is a daily global product. To generate the product, individual SPL2SMP half-orbit files acquired over one day are composited to produce a daily multi-orbit global map of retrieved soil moisture.

The SPL2SMP swaths overlap poleward of approximately +/- 65° latitude. Where overlap occurs, three options are considered for compositing multiple data points at a given grid cell:

1. Use the most recent (or last-in) data point
2. Take the average of all data points within the grid cell
3. Choose the data point observed closest to 6:00 a.m. Local Solar Time (LST)

The current approach for the SPL3SMP product is to use the nearest 6:00 a.m. LST criterion to perform Level-3 compositing for the descending passes. According to this criterion, for a given grid cell, an L2 data point acquired closest to 6:00 a.m. local solar time will make its way to the final Level-3 file; other late-coming L2 data points falling into the same grid cell will be ignored. For a given file whose time stamp (yyyy-mm-ddThh:mm:ss) is expressed in UTC, only the hh:mm:ss part is converted into local solar time. (O'Neill et al. 2015)

2.4 Quality, Errors, and Limitations

2.4.1 Error Sources

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 implements a combination of time and frequency diversity, kurtosis detection, and use of T4 thresholds to detect and, where possible, mitigate RFI.

Radiometer L3 data can contain bit errors caused by noise in communication links and memory storage devices. The CCSDS packets include error-detecting Cyclic Redundancy Checks (CRCs), which the L1A processor uses to flag errors.

More information about error sources is provided in Section 4.6: Algorithm Error Performance of the ATBD, O'Neill et al. 2018.

2.4.2 Quality Assessment

For in-depth details regarding the quality of these data, refer to the Validated Assessment Report.

2.4.3 Quality Overview

SMAP products provide multiple means to assess quality. Each product contains bit flags, uncertainty measures, and file-level metadata that provide quality information. For information regarding the specific bit flags, uncertainty measures, and file-level metadata contained in this product, refer to the Product Specification Document.

Each HDF5 file contains metadata with Quality Assessment (QA) metadata flags that are set by the Science Data Processing System (SDS) at the JPL prior to delivery to NSIDC. A separate metadata file with an .xml file extension is also delivered to NSIDC with the HDF5 file; it contains the same information as the file-level metadata.

A separate QA file with a .qa file extension is also associated with each data file. QA files are ASCII text files that contain statistical information in order to help users better assess the quality of the associated data file.

If a product does not fail QA, it is ready to be used for higher-level processing, browse generation, active science QA, archive, and distribution. If a product fails QA, it is never delivered to NSIDC DAAC.

2.4.4 6:00 p.m. Ascending Half Orbits

Data from both 6:00 a.m. descending and 6:00 p.m. ascending half-orbit passes are used as input for soil moisture derivation in this Version 5 Validated product. However, the radiometer soil moisture algorithm assumes that the air, vegetation, and near-surface soil are in thermal equilibrium in the early morning hours; thus, retrievals from 6:00 p.m. ascending half-orbit passes may show a slight degradation in quality. Nonetheless, ubRMSE (unbiased root mean square error) and correlation of the p.m. and a.m. retrievals are relatively close.

2.4.5 Data Flags

Bit flags generated from input SMAP data and ancillary data are also employed to help determine the quality of the retrievals. Ancillary data help determine either specific aspects of the processing (such as corrections for transient water) or the quality of the retrievals (e.g. precipitation flag). These flags will provide information as to whether the ground is frozen, snow-covered, or flooded, or whether it is actively precipitating at the time of the satellite overpass. Other flags will indicate whether masks for steeply sloped topography, or for urban, heavily forested, or permanent snow/ice areas are in effect.

For a description of the data flag types and methods of flagging, refer to the Data Flags section in the SPL2SMP user guide. All flags in SPL2SMP are carried over into the SPL3SMP product.

3 INSTRUMENTATION

3.1 Description

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

4 SOFTWARE AND TOOLS

For tools that work with SMAP data, see the Tools web page.

5 VERSION HISTORY

Table 4. Summary of Version Changes

Version	Date	Description of Changes
V6	January 2021	Changes to this version include: Extended temporal coverage through 27 August 2020
V6	August 2019	Changes to this version include: The following data fields were added: *bulk_density, clay_fraction, bulk_density_pm, clay_fraction_pm*. The baseline algorithm (SCA-V) remains unchanged. Improved aggregation of values in input ancillary data, e.g. roughness, soil texture, NDVI. The fix has negligible impacts on retrievals estimated to be of recommended quality.
V5	June 2018	Changes to this version include: Level-1B water-corrected brightness temperatures are used in passive soil moisture retrieval. This procedure corrects for anomalous soil moisture values seen near coastlines in the previous version and should result in less rejected data due to waterbody contamination. Five new data fields accommodate this correction: *grid_surface_status, surface_water_fraction_mb_h, surface_water_fraction_mb_v, tb_h_uncorrected*, and *tb_v_uncorrected.* Improved depth correction for effective soil temperature used in passive soil moisture retrieval; new results are captured in the *surface_temperature* data field. This correction reduces the dry bias seen when comparing SMAP data to in situ data from the core validation sites. Frozen ground flag updated to reflect improved freeze/thaw detection algorithm, providing better accuracy; new results are captured in bit 7 of the surface_flag.
V4	December 2016	Changes to this version include: Added 6:00 p.m. ascending half orbits, which provide: More frequent regional/global coverage (critical in flood monitoring) Soil moisture diurnal variability information (useful in data assimilation systems) Consistency with other similar satellite-based soil moisture products Contains frozen ground flag (bit 7 of *surface_flag*) derived using Normalized Polarization Ration (NPR)-based SMAP passive freeze-thaw retrieval; replaces former SMAP radar-based freeze/thaw flag
V3	April 2016	Changes to this version include: Transitioned to Validated-Stage 2 Uses updated SPL2SMP V3 Validated data as input

Version	Date	Description of Changes
V2	October 2015	Changes to this version include: Uses SPL1CTB SPL2SMP V2 Beta data as input Corrects the retrieval quality flag error
V1	September 2015	First public release

6 RELATED DATA SETS

SMAP Data at NSIDC | Overview

SMAP Radar Data at the ASF DAAC

7 RELATED WEBSITES

SMAP at NASA JPL

8 CONTACTS AND ACKNOWLEDGMENTS

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10 DOCUMENT INFORMATION

10.1 Publication Date

7 January 2019

10.2 Date Last Updated

28 January 2021