SMAP L3 Radiometer Global Daily 36 km EASE-Grid Soil Moisture, Version 5

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, and R. Bindlish. 2018. *SMAP L3 Radiometer Global Daily 36 km EASE-Grid Soil Moisture, Version 5*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/ZX7YX2Y2LHEB. [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:

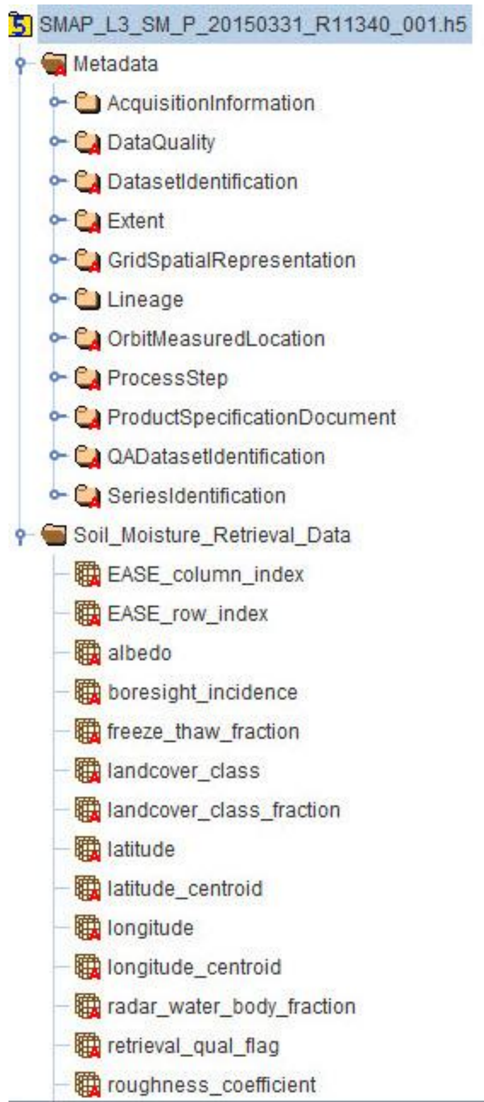

Figure 1. Subset of File Contents. For a complete list of file contents for the SMAP Level-3 radiometer soil moisture product, refer to the Product Specification Document.

1.4 Data Fields

Each file contains the main data groups summarized in this section. For a complete list and description of all data fields within these groups, refer to the Product Specification Document.

All data element arrays are one-dimensional with a size of *N*, with the exception of *landcover_class* and *landcover_class_fraction,* which are two-dimensional arrays with a size of *N* x 3; where *N* is the number of valid cells covered by the radiometer swath on the grid.

1.4.1 SOIL MOISTURE RETRIEVAL DATA_AM

Includes 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].

1.4.2 SOIL MOISTURE RETRIEVAL DATA PM

Includes 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. For these brightness temperatures (such as *tb_3_corrected*), an additional procedure has been applied to correct for anomalous water and land values. Further details are provided in the Water/Land Contamination Correction section of the SPL2SMP user guide. (SPL2SMP data are used as input for this product).

1.5 Metadata Fields

Includes all 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.

1.6 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

Variable	Description
SMAP	Indicates SMAP mission data
L3_SM_P	Indicates specific product (L3: Level-3; SM: Soil Moisture; P: Passive)
yyyymmdd	4-digit year, 2-digit month, 2-digit day of the first data element that appears in the product.

<table>
<tr><th>Variable</th><th>Description</th></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>

1.7 File Size

Each file is approximately 24 MB.

1.8 Volume

The daily data volume is approximately 24 MB.

1.9 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.

1.10 Spatial Resolution

The native spatial resolution of the radiometer footprint is approximately 40 km. Data are then gridded using the 36 km EASE-Grid 2.0 global projection.

1.11 Projection and Grid Description

1.11.1 EASE-Grid 2.0

These data are provided on the global cylindrical EASE-Grid 2.0 (Brodzik et al. 2012). Each grid cell has a nominal area of approximately 36 x 36 km2 regardless of longitude and latitude. Using this projection, all global data arrays have dimensions of 406 rows and 964 columns.

EASE-Grid 2.0 has a flexible formulation. By adjusting a single scaling parameter, a family of multi-resolution grids that nest within one another can be generated. The nesting can be adjusted so that smaller grid cells can be tessellated to form larger grid cells. Figure 2 shows a schematic of the nesting.

This feature of perfect nesting provides SMAP data products with a convenient common projection for both high-resolution radar observations and low-resolution radiometer observations, as well as for their derived geophysical products. For more on EASE-Grid 2.0, refer to the EASE-Grid 2.0 Format Description.

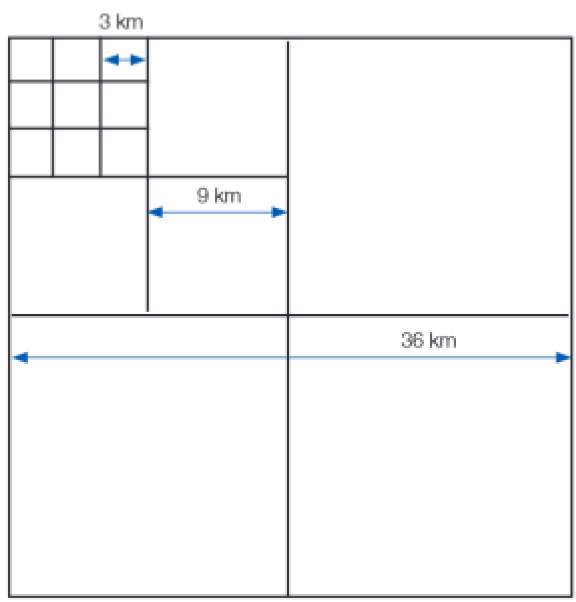

Figure 2. Perfect Nesting in EASE-Grid 2.0

1.12 Temporal Coverage

Coverage spans from 31 March 2015 to 12 August 2019.

1.12.1 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.

1.12.2 Latencies

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

1.12.3 Temporal Resolution

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

2 SOFTWARE AND TOOLS

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

3 DATA ACQUISITION AND PROCESSING

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

3.1 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.

3.2 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).

3.3 Derivation Techniques and Algorithms

The SMAP Level-3 radiometer soil moisture is a daily gridded composite of the SMAP L2 Radiometer Half-Orbit 36 km EASE-Grid Soil Moisture, Version 3 (SPL2SMP). The derivation of soil moisture from SMAP brightness temperatures occurs in the Level-2 processing.

Please refer to the Derivation Techniques section in the SPL2SMP user guide for details on algorithms and ancillary data.

3.4 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)

3.5 Quality, Errors, and Limitations

3.5.1 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.

3.5.2 Quality Assessment

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

3.5.3 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.

3.5.4 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.

3.5.5 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.

4 INSTRUMENTATION

4.1 Description

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

5 SOFTWARE AND TOOLS

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

6 CONTACTS AND ACKNOWLEDGMENTS

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8 DOCUMENT INFORMATION

8.1 Publication Date

7 January 2019

8.2 Date Last Updated

13 November 2019