



# SMAP Enhanced L3 Radiometer Global Daily 9 km 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:

O'Neill, P. E., S. Chan, E. G. Njoku, T. Jackson, and R. Bindlish. 2016. *SMAP Enhanced L3 Radiometer Global Daily 9 km 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/ZRO7EXJ8O3XI>. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT [NSIDC@NSIDC.ORG](mailto:NSIDC@NSIDC.ORG)

FOR CURRENT INFORMATION, VISIT [https://nsidc.org/data/SPL3SMP\\_E](https://nsidc.org/data/SPL3SMP_E)



National Snow and Ice Data Center

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# 1 DATA DESCRIPTION

## 1.1 Parameter Description

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Surface soil moisture (0-5 cm) in m<sup>3</sup>/m<sup>3</sup> derived from brightness temperatures (TBs) is output on a fixed global 9 km EASE-Grid 2.0. Also included are brightness temperatures in kelvin representing Level-1B brightness temperatures interpolated at a 9 km EASE-Grid 2.0 cell.

Refer to the [Product Specification Document](#) for details on all parameters.

## 1.2 Format

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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

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

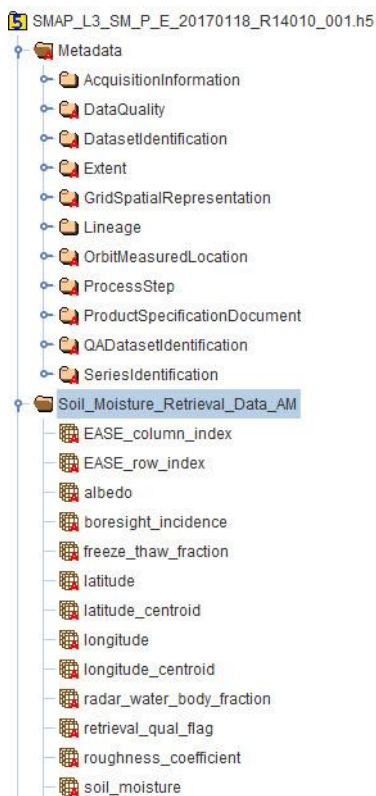


Figure 1. Subset of File Contents. For a complete list of file contents for the SMAP enhanced Level-3 radiometer soil moisture product, refer to the [Product Specification Document](#).

## 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](#).

### 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).

## 1.5 Metadata Fields

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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

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

SMAP\_L3\_SM\_P\_E\_yyyymmdd\_RLVvvv\_NNN.[ext]

For example:

SMAP\_L3\_SM\_P\_E\_20170117\_R14010\_001.h5

Table 1. File Naming Conventions

Variable	Description								
SMAP	Indicates SMAP mission data								
L3_SM_P_E	Indicates specific product (L3: Level-3; SM: Soil Moisture; P: Passive; E: Enhanced)								
yyymmdd	4-digit year, 2-digit month, 2-digit day of the first data element that appears in the product.								
RLVvvv	Composite Release ID (CRID), where: <table border="1" data-bbox="370 1062 1224 1335"> <tbody> <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 CRID Version Number</td> </tr> <tr> <td>vvv</td> <td>3-Digit Minor CRID Version Number</td> </tr> </tbody> </table> Refer to the <a href="#">SMAP Data Versions</a> page for version information.	R	Release	L	Launch Indicator (1: post-launch standard data)	V	1-Digit Major CRID Version Number	vvv	3-Digit Minor CRID Version Number
R	Release								
L	Launch Indicator (1: post-launch standard data)								
V	1-Digit Major CRID Version Number								
vvv	3-Digit Minor CRID Version Number								
NNN	Product Counter: Number of times the file was generated under the same version for a particular date/time interval (002: second time)								
.[ext]	File extensions include: <table border="1" data-bbox="370 1518 1438 1717"> <tbody> <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> </tbody> </table>	.h5	HDF5 data file	.qa	Quality Assurance file	.xml	XML Metadata file		
.h5	HDF5 data file								
.qa	Quality Assurance file								
.xml	XML Metadata file								

## 1.7 File Size

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Each file is approximately 271 MB.

## 1.8 Volume

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The daily data volume is approximately 271 MB.

## 1.9 Spatial Coverage

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Coverage spans from 180°W to 180°E, and from approximately 85.044°N and 85.044°S for the global EASE-Grid 2.0 projection. 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 approximately 1000 km, enabling nearly global coverage every three days.

### 1.9.1 Spatial Resolution

The native spatial resolution of the radiometer footprint is 36 km. Data are then interpolated using the Backus-Gilbert optimal interpolation algorithm into the global cylindrical EASE-Grid 2.0 projection with 9 km spacing.

## 1.10 Projection and Grid Description

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### 1.10.1 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 9 x 9 km<sup>2</sup> regardless of longitude and latitude. Using this projection, global data arrays have dimensions of 1624 rows and 3856 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](#).

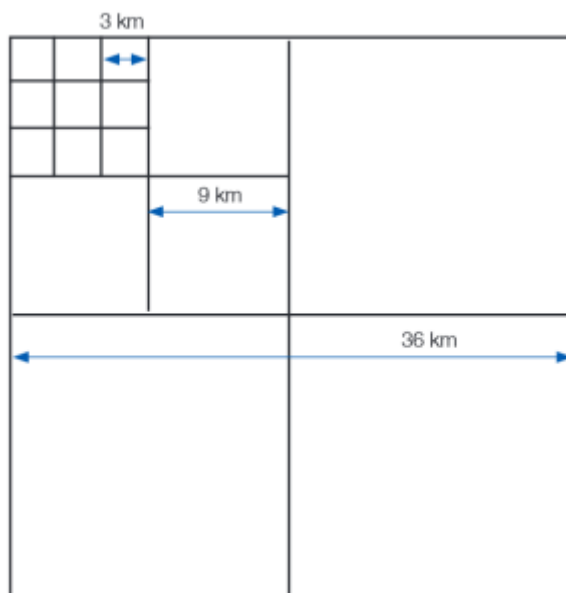


Figure 2. Perfect Nesting in EASE-Grid 2.0

## 1.11 Temporal Information

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### 1.11.1 Coverage

Coverage spans from 31 March 2015 to present.

### 1.11.2 Temporal Coverage Gaps

#### 1.11.2.1 Satellite and Processing Events

Due to instrument maneuvers, data downlink anomalies, data quality screening, and other factors, small gaps in the SMAP time series will occur. Details of these events are maintained on two master lists:

[SMAP On-Orbit Events List for Instrument Data Users](#)

[Master List of Bad and Missing Data](#)

### 1.11.3 Latencies

FAQ: [What are the latencies for SMAP radiometer data sets?](#)

## 1.12 Temporal Resolution

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Each enhanced 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. (2015).

### 3.1 Sensor or Instrument Description

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For a detailed description of the SMAP instrument, visit the [SMAP Instrument](#) page at the Jet Propulsion Laboratory (JPL) SMAP Web site.

### 3.2 Data Source

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SMAP enhanced Level-3 radiometer soil moisture data (SPL3SMP\_E) are composited from [SMAP Enhanced L2 Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture, Version 1 \(SPL3SMP\\_E\)](#).

### 3.3 Theory of Measurements

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The microwave portion of the electromagnetic spectrum, which includes wavelengths from a few centimeters to a meter, has long held 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, especially 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/m<sup>2</sup> of vegetation water content), and
- measurement is independent of solar illumination which allows for day and night observations. (O'Neill et al. 2016)

For an in-depth description of the theory of these measurements, refer to Section 2: Passive Remote Sensing of Soil Moisture in the Algorithm Theoretical Basis Document ([ATBD](#)) for the SMAP baseline Level-2 soil moisture product, SPL2SMP.



## 3.4 Derivation Techniques and Algorithms

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The SMAP enhanced Level-3 radiometer soil moisture product (SPL3SMP\_E) is a daily composite of the [SMAP Enhanced L2 Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture, Version 1 \(SPL2SMP\\_E\)](#). The derivation of soil moisture from SMAP brightness temperatures occurs in the Level-2 processing.

For information regarding the Backus-Gilbert optimal interpolation algorithm used to enhance these data, refer to the [SPL1CTB\\_E](#) user guide.

Please refer to the [Derivation Techniques](#) section in the SPL2SMP\_E user guide for details on algorithms and ancillary data.

## 3.5 Processing Steps

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

The SPL2SMP\_E swaths overlap poleward of approximately +/- 65° latitude. Where overlap occurs, three options were 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 points observed closest to 6:00 a.m. Local Solar Time (LST) for observations derived from SMAP descending passes and closest to 6:00 p.m. LST for observations derived from SMAP ascending passes

The current approach for the SPL3SMP\_E product is to use the nearest 6:00 a.m. LST and nearest 6:00 p.m. LST criteria to perform Level-3 compositing separately for descending and ascending passes, respectively. According to these criteria, for a given grid cell, an L2 data point acquired closest to 6:00 a.m. LST or closest to 6:00 p.m. LST will make its way to the final enhanced Level-3 file; other late-coming L2 data points falling into the same grid cell will be ignored. For a given L2 half-orbit granule whose time stamp (yyyymmddThhmmss) is expressed in UTC, only the hhmmss part is converted into local solar time. (O'Neill et al. 2016)

## 3.6 Error Sources

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Anthropogenic Radio Frequency Interference (RFI), principally from ground-based surveillance radars, can contaminate both radar and radiometer measurements at L-band. The SMAP 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 enhanced 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. 2016)

## 3.7 Quality Assessment

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For in-depth details regarding the quality of these Version 1 data, refer to the following reports:

[Validated Assessment Report](#)

[Beta Assessment Report](#)

### 3.7.1 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.

## 3.7.2 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\_E user guide. All flags in SPL2SMP\_E are carried over into the SPL3SMP\_E product.

# 4 CONTACTS AND ACKNOWLEDGMENTS

## Investigators

### **Peggy O'Neill**

NASA Goddard Space Flight Center  
Global Modeling and Assimilation Office  
Mail Code 610.1  
8800 Greenbelt Rd  
Greenbelt, MD 20771 USA

### **Steven Chan**

Jet Propulsion Laboratory  
4800 Oak Grove Drive  
Pasadena, CA 91109 USA

### **Rajat Bindlish**

NASA Goddard Space Flight Center  
Hydrological Sciences Laboratory  
Code 617, Bldg 33, G216  
Greenbelt, MD 20771 USA

### **Tom Jackson**

USDA/ARS Hydrology and Remote Sensing Laboratory  
104 Bldg. 007, BARC-West  
Beltsville, MD 20705 USA

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## 6 DOCUMENT INFORMATION

### 6.1 Publication Date

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## 6.2 Date Last Updated

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