SMAP L3 Radar/Radiometer Global Daily 9 km EASE-Grid Soil Moisture, Version 2

This Level-3 (L3) soil moisture product provides a daily composite of global land surface conditions retrieved by both the Soil Moisture Active Passive (SMAP) radar and radiometer. Input SMAP L-band backscatter and brightness temperature data used to derive soil moisture are resampled to an Earth-fixed, global, cylindrical 9 km Equal-Area Scalable Earth Grid, Version 2.0 (EASE-Grid 2.0).

Note: These data are Beta-release quality, meaning that they have not undergone full validation and may still contain significant errors.

Overview

Platform	SMAP Observatory
Sensors	SMAP L-Band Radar SMAP L-Band Radiometer
Spatial Coverage	Global, between 85.044°N and 85.044°S
Spatial Resolution	9 km
Temporal Coverage	13 April 2015 – 07 July 2015
Temporal Resolution	Daily
Parameters	Soil Moisture Sigma Nought Brightness Temperature
Data Format	Hierarchical Data Format, Version 5 (HDF5)
Metadata Access	View Metadata Record
Version	V2. Refer to the SMAP Data Versions page for version information. **Maturity State:** Beta **Note:** These data are Beta-release quality, meaning that they have not undergone full validation and may still contain significant errors.
Error Source	Radio Frequency Interference (RFI)
Get Data	FTP HTTPS Reverb | ECHO Worldview

Table of Contents

Citing These Data

As a condition of using these data, you must cite the use of this data set using the following citation. For more information, see our Use and Copyright Web page.

Entekhabi, D., N. Das, E. Njoku, J. Johnson, and J. Shi. 2015. *SMAP L3 Radar/Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture.*Version 2. [Indicate subset used]. Boulder, Colorado USA: NASA National Snow and Ice Data Center Distributed Active Archive Center. doi:http://dx.doi.org/10.5067/F88YVH7CVNXS. [Date accessed].

1. Detailed Data Description

Format

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

File Structure

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

- `Metadata`
- `Soil_Moisture_Retrieval_Data`

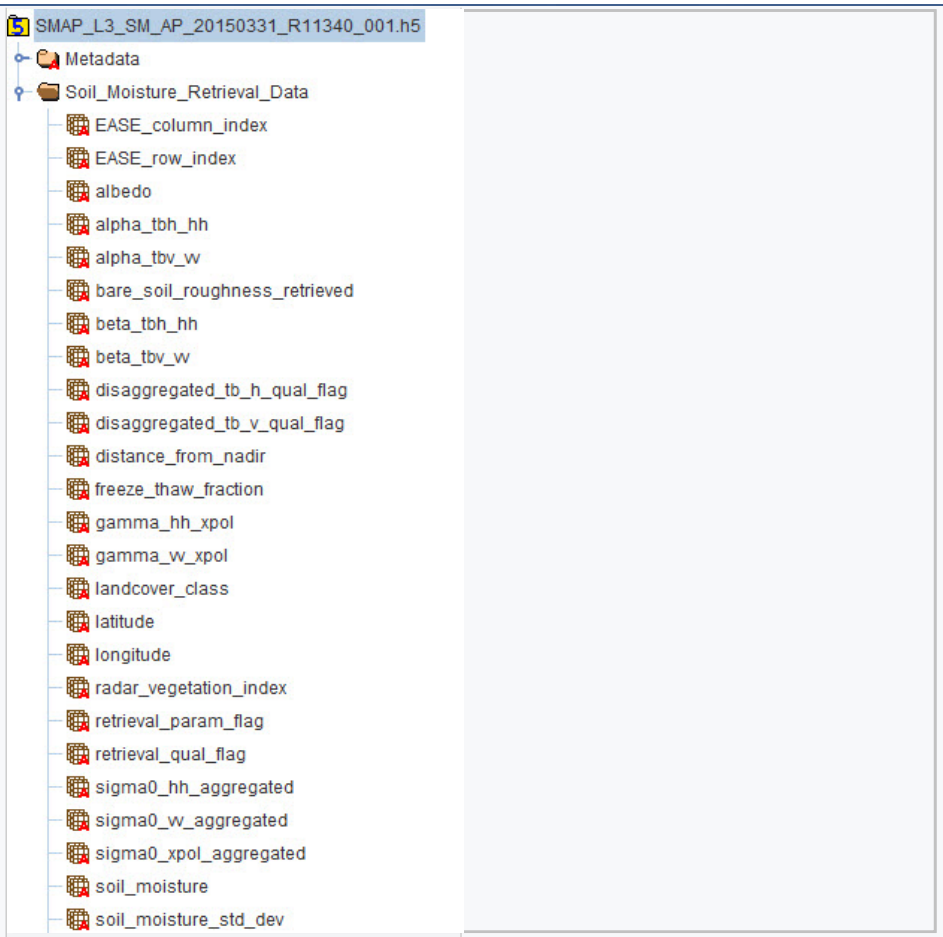

Figure 1. Partial Sample of the HDF5 File Structure

Data Fields Overview

Each Level-3 active/passive soil moisture file contains the following:

Metadata

Includes all metadata that describe the full content of each file. For a description of all metadata fields for this product, refer to the Metadata Fields document.

Soil Moisture Retrieval Data

Includes all combined radar and radiometer soil moisture data, ancillary data, and quality assessment flags.

Data Fields

For a complete list and description of all data fields, refer to the Data Fields document.

File Naming Convention

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

`SMAP_L3_SM_AP_yyyymmdd_RLVvvv_NNN.[ext]`

For example:

`SMAP_L3_SM_AP_20141225_R12130_002.h5`

Where:

Table 1. File Naming Conventions

Variable	Description
SMAP	Indicates SMAP mission data
L3_SM_AP	Indicates specific product (L3: Level-3; SM: Soil Moisture; AP: Active/Passive)
yyyymmdd	4-digit year, 2-digit month, 2-digit day; date/time in Universal Coordinated Time (UTC) of the first data element that appears in the product.
RLVvvv	Composite Release ID, where: R: Release L: Launch Indicator (1: Post-launch standard data) V: 1-Digit Major Version Number vvv: 3-Digit Minor Version Number **Example:** R12130 indicates a standard data product with a version of 2.130.
NNN	Number of times the file was generated under the same version for a particular date/time interval (002: 2nd time)
.[ext]	File extensions include: .h5: HDF5 data file .qa: Quality Assurance file .xml: XML Metadata file

File Size/Volume

The daily data volume is approximately 74 MB using HDF compression.

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.

Spatial Resolution

SMAP 3 km Synthetic Aperture Radar (SAR) backscatter data and 36 km radiometer brightness temperature data are combined using the SMAP Active-Passive algorithm to create soil moisture data that are then gridded using the 9 km EASE-Grid 2.0 projection.

Projection and Grid Description

EASE-Grid 2.0

These data are provided on the global cylindrical EASE-Grid 2.0 (Brodzik et al. 2012). The SPL3SMAP data product is posted on a 9 km EASE-Grid that is nested consistently with the 36 km brightness temperatures and 3 km radar backscatter cross-section data.

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.

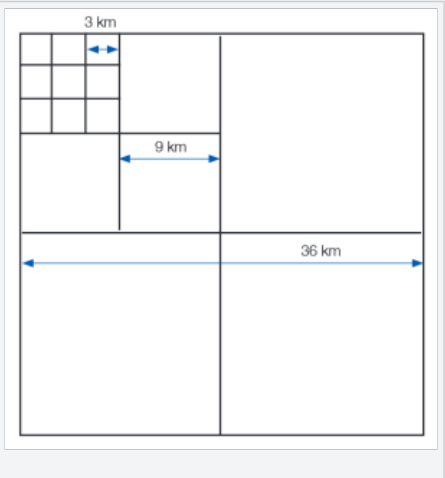

Figure 2. Perfect Nesting in EASE-Grid 2.0

Temporal Coverage

Level-3 combined radar and radiometer data are available from 13 April 2015 through 07 July 2015.

Note: Temporal coverage for this data set is limited due to the premature failure of the SMAP L-Band Radar. On 07 July 2015, the radar stopped transmitting due to an anomaly involving the instrument's high-power amplifier (HPA). For details, refer to the SMAP News Release issued 02 September 2015 by the Jet Propulsion Laboratory (JPL).

Temporal Resolution

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

Parameter Description

Surface soil moisture (0-5 cm) in cm^3/cm^3 derived from the SMAP L-Band Radiometer and Radar is output on a fixed 36 km EASE-Grid 2.0.

Refer to the Data Fields document for details on all parameters.

2. Data Access and Tools

Get Data

Data are available via FTP and HTTPS.

Data are also available through the services listed in Table 2.

Table 2. Data Access Services

Service	Description
Reverb | ECHO	NASA search and order tool for subsetting, reprojecting, and reformatting data.
Worldview	NASA visualization tool for browsing full-resolution imagery and downloading the underlying data.

Software and Tools

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

3. Data Acquisition and Processing

Sensor or Instrument Description

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

Data Source

SMAP Level-3 radar/radiometer soil moisture data (SPL3SMAP) are derived from SMAP L2 Radar/Radiometer Global Daily 9 km EASE-Grid Soil Moisture, Version 2 (SPL2SMAP).

Theory of Measurements

The goal of SMAP mission is to combine the favorable attributes of SMAP L-Band Radar and Radiometer observations in terms of their spatial resolution and sensitivity to soil moisture, surface roughness, and vegetation in order to estimate soil moisture at a resolution of 10 km, and freeze-thaw state at a resolution of 1-3 km. Microwave radiometry and radar are well-established techniques for surface remote sensing. Combining passive and active sensors provides complementary information contained in the surface emissivity and backscatter signatures, which make it possible to obtain optimal accuracy of retrieved soil moisture at higher resolutions. Over land, it has been demonstrated that L-band radiometer and radar measurements both provide information to retrieve optimal soil moisture estimates (Das et al., 2011, 2014, and 2015).

Derivation Techniques and Algorithms

The SMAP Level-3 radar and radiometer soil moisture data set is a daily gridded composite of the SMAP L2 Radar/Radiometer Global Daily 9 km EASE-Grid Soil Moisture, Version 2 (SPL2SMAP) data set. The derivation of soil moisture from SMAP brightness temperatures occurs in the Level-2 processing of the separate radar and radiometer data sets.

Please refer to the Derivation Techniques section in the SPL2SMAP user guide for details on algorithms and ancillary data.

Processing Steps

This product is generated by the SMAP Science Data Processing System (SDS) at the Jet Propulsion Laboratory (JPL) in Pasadena, California USA. To generate the standard SPL3SMAP product, the processing software ingests one day's worth of SPL2SMAP granules and creates individual global composites as two-dimensional arrays for each output parameter defined in the SPL2SMAP product. Wherever data overlap occurs (typically at high latitudes), data acquired closest to the 6:00 a.m. local solar time are chosen. Because the input SPL2SMAP granules are available only for descending (6:00 a.m.) passes, the resulting SPL3SMAP granules are also available only for descending (6:00 a.m.) passes.

Error Sources

Anthropogenic Radio Frequency Interference (RFI), principally from ground-based surveillance radars, can contaminate both radar and radiometer measurements at L-band. Early measurements and results from ESA's Soil Moisture and Ocean Salinity (SMOS) mission indicate that in some regions RFI is present and detectable. The SMAP radar and radiometer electronics and algorithms include design features to mitigate the effects of RFI. The SMAP radar utilizes selective filters and an adjustable carrier frequency to tune to predetermined RFI-free portions of the spectrum while on orbit. 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.

For more information, refer to the Error Sources section of the SMAP L2 Radar/Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture, Version 2 (SPL2SMAP) user guide.

Quality Assessment

These Version 2 data are Beta-quality, which means they employ preliminary algorithms that are still being validated and are thus subject to uncertainties. For in-depth details regarding the quality of these Version 2 Beta data, refer to the Beta Assessment Report.

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 Data Fields 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 file/granule fails QA, the SDS does not send the granule to NSIDC until it is reprocessed. Products that fail QA are never delivered to NSIDC.

Data Flags

Ancillary data will sometimes also be employed to 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 SPL2SMAP user guide.

4. References and Related Publications

Bolten, J., V. Lakshmi, and E. Njoku. 2003. Soil Moisture Retrieval Using the Passive/Active L- and S-band Radar/Radiometer. *IEEE Trans. Geosci. Rem. Sens.*, 41:2792-2801.

Brodzik, M. J., B. Billingsley, T. Haran, B. Raup, and M. H. Savoie. 2012. EASE-Grid 2.0: Incremental but Significant Improvements for Earth-Gridded Data Sets. *ISPRS Int. J. Geo-Inf.* 1(1):32-45. http://dx.doi.org/10.3390/ijgi1010032.

Brodzik, M. J., B. Billingsley, T. Haran, B. Raup, and M. H. Savoie. 2014. Correction: Brodzik, M. J. et al. EASE-Grid 2.0: Incremental but Significant Improvements for Earth-Gridded Data Sets. *ISPRS Int. J. Geo-Inf 2012*. 1(1):32-45 *ISPRS Int. J. Geo-Inf.* 3(3):1154-1156. http://dx.doi.org/10.3390/ijgi3031154.

Das, N. N., D. Entekhabi, S. Dunbar, E. G. Njoku, and S. Yueh. 2015. Uncertainty Estimates in the SMAP Combined Active-Passive Downscaled Brightness Temperature. *IEEE-TGARS*. Accepted, in press.

Das, N. N., D. Entekhabi, E. G. Njoku, J. Johnston, J. C. Shi, and A. Colliander. 2014. Tests of the SMAP Combined Radar and Radiometer Brightness Temperature Disaggregation Algorithm Using Airborne Field Campaign Observations. *IEEE-TGARS*. 52:2018–2028.

Das, N. N., D. Entekhabi, and E. G. Njoku, 2011. An Algorithm for Merging SMAP Radiometer and Radar Data for High Resolution Soil Moisture Retrieval. *IEEE-TGARS*. 9: 1504-1512.

Das, N. N., and R. S. Dunbar. 2015. SMAP Level 3 Active/Passive Soil Moisture (L3_SM_AP) Product Specification Document. SMAP Project, JPL D-72552, Jet Propulsion Laboratory, Pasadena, CA. (http://nsidc.org/data/docs/daac/smap/sp_l3_smap/pdfs/SMAP L3_SM_AP PSD_10312015.pdf, 3 MB)

Das, N. N., et al. 2015. Soil Moisture Active Passive (SMAP) Project Calibration and Validation for the L2/3_SM_AP Beta-Release Data Products. SMAP Project, JPL D-93984. Jet Propulsion Laboratory, Pasadena, CA. (http://nsidc.org/data/docs/daac/smap/sp_l2_smap/pdfs/SMAP-AP_Assessment_Report_Final.pdf, 4 MB)

Entekhabi, D. et al. 2014. SMAP Handbook–Soil Moisture Active Passive: Mapping Soil Moisture and Freeze/Thaw from Space. Pasadena, CA USA: SMAP Project, JPL CL#14-2285, Jet Propulsion Laboratory.

Entekhabi, D., N. Das, E. Njoku, J. Johnson, and J. Shi. 2014.SMAP Algorithm Theoretical Basis Document: L2 & L3 Radar/Radiometer Soil Moisture (Active/Passive) Data Products. SMAP Project, JPL D-66481. Jet Propulsion Laboratory, Pasadena, CA. (http://nsidc.org/data/docs/daac/smap/sp_l2_smap/pdfs/277_L2_3_SM_AP_RevA_web.pdf, 16.6 MB)

5. Contacts and Acknowledgments

Investigators

Dara Entekhabi, Narendra Das, Eni Njoku
Jet Propulsion Laboratory
California Institute of Technology
Pasadena, CA 91109 USA

Joel Johnson
Ohio State University
Columbus, OH 43210 USA

Jiancheng Shi
University of California
Santa Barbara, CA

Technical Contact

NSIDC User Services
National Snow and Ice Data Center
CIRES, 449 UCB
University of Colorado
Boulder, CO 80309-0449 USA
phone: +1 303.492.6199
fax: +1 303.492.2468
form: Contact NSIDC User Services
e-mail: nsidc@nsidc.org

6. Document Information

Document Creation Date

October 2015

Document Revision Date

N/A

Document URL

`http://nsidc.org/data/docs/daac/smap/sp_l3_smap/index.html`