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SMAP/Sentinel-1 L2 Radiometer/Radar 30-Second Scene 3 km EASE-Grid Soil

Moisture, Version 2

This Level-2 (L2) soil moisture product provides estimates of land surface conditions retrieved by both the Soil Moisture Active Passive (SMAP) radiometer during 6:00 a.m. descending and 6:00 p.m. ascending half-orbit passes and the Sentinel-1A and -1B radar. SMAP L-band brightness temperatures and Copernicus Sentinel-1 C-band backscatter coefficients are used to derive soil moisture data, which are then resampled to an Earth-fixed, cylindrical 3 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.

This is the most recent version of these data.

Version Summary:

Changes to this version include:

- Implemented a new method of identifying and eliminating spurious sigma0 values in Sentinel-1A/B Level-1 sigma0 data using a hybrid approach that combines a median filter with thresholding. As a result, fewer spurious sigma0 values (mainly due to small man-made structures) bias the aggregated 1 km data.
- Replaced the previous 3 km resolution urban fraction map with a new 1 km map.
- Adjusted the thresholds used with the new 1 km urban fraction map to: 0.25 (no flag), 0.25 – 0.5 (flagged, retrieval performed), and 0.5 (masked, no retrieval). These are provided in bit 3 of the surface_flag data field.
- Adjusted the tau-omega parameters to be consistent with the values used in SPL2SMP/SPL2SMP_E algorithm.
- Implemented minor bug fix to the SMAP and Sentinel-1 overlap computation code.

Overview

Parameter(s):	MICROWAVE > BRIGHTNESS TEMPERATURE RADAR > SIGMA NAUGHT SOILS > SOIL MOISTURE/WATER CONTENT > SOIL MOISTURE	**Data Format(s):**	HDF5
Spatial Coverage:	N: 60, S: -60, E: 180, W: -180	**Platform(s):**	SENTINEL-1A, SENTINEL-1B, SMAP

Spatial Resolution:	3 km x 3 km	**Sensor(s):**	C-SAR, SMAP L-BAND RADIOMETER
Temporal Coverage:	31 March 2015 to present	**Version(s):**	V2
Temporal Resolution	30 second	**Metadata XML:**	View Metadata Record
Data Contributor(s):	Das, N., D. Entekhabi, R. S. Dunbar, S. Kim, S. Yueh, A. Colliander, P. E. O'Neill, T. Jackson, T. Jagdhuber, F. Chen, W. T. Crow, P. O'Neill, J. Walker, A. Berg, D. Bosch, T. Caldwell, and M. Cosh.		

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.

Das, N., D. Entekhabi, R. S. Dunbar, S. Kim, S. Yueh, A. Colliander, P. E. O'Neill, T. Jackson, T. Jagdhuber, F. Chen, W. T. Crow, P. O'Neill, J. Walker, A. Berg, D. Bosch, T. Caldwell, and M. Cosh. 2018. *SMAP/Sentinel-1 L2 Radiometer/Radar 30-Second Scene 3 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: https://doi.org/10.5067/KE1CSVXMI95Y. [Date Accessed].

Literature Citation

As a condition of using these data, we request that you acknowledge the author(s) of this data set by referencing the following peer-reviewed publication.

Das, N., D. Entekhabi, S. Dunbar, M. J. Chaubell, A. Colliander, S. Yueh, T. Jagdhuber, F. Chen, W. T. Crow, P. E. O'Neill, J. Walker, A. Berg, D. Bosch, T. Caldwell, M. Cosh, C. H. Collins, E. Lopez-Baeza, and M. Thibeault. 2019. The SMAP and Copernicus Sentinel 1A/B microwave active-passive high resolution surface soil moisture product, *Remote Sensing of Environment*. 233. 111380. https://doi.org/10.1016/j.rse.2019.111380

Documentation

Created:
2 January 2019
Last modified:
10 January 2020

Data Description

Parameters

Surface soil moisture (approximately 0-5 cm) in cm^3/cm^3 derived from brightness temperatures and sigma nought measurements is output on a fixed 3 km and 1 km* EASE-Grid 2.0.

Brightness temperatures (TBs) in kelvin are derived from native 36 km SMAP footprint using Backus-Gilbert interpolation on the 9 km EASE-Grid, and are then disaggregated to 3 km and 1 km grid cells by comparison with the background Sentinel-1 radar backscatter data to produce high-resolution soil moisture retrievals. Brightness temperature is a measure of the radiance of the microwave radiation welling upward from the top of the atmosphere to the satellite. The SMAP L-Band Radiometer measures four brightness temperature Stokes parameters: TH, TV, T3, and T4 at 1.41 GHz. TH and TV are the horizontally and vertically polarized brightness temperatures, respectively, and T3 and T4 are the third and fourth Stokes parameters, respectively.

Sigma nought (sigma0), or the backscatter coefficient, is a measure of the strength of radar signals reflected back to the instrument from a target, and is defined as per unit area on the ground. It is a normalized dimensionless number comparing the strength observed to that expected from a defined area, and is provided in natural units (not dB) in this product. The Copernicus Sentinel-1 C-band Synthetic Aperture Radar (C-SAR) measures dual polarization VV + VH in the Interferometric Wide Swath Mode (IW) over land with a center frequency of 5.405 GHz. Sigma0 measurements are derived using Synthetic-Aperture Radar (SAR) processing.

*1 km data are research quality, meaning they have not undergone validation.

Refer to the Appendix of this document for details on all parameters.

File Information

Format

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

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:

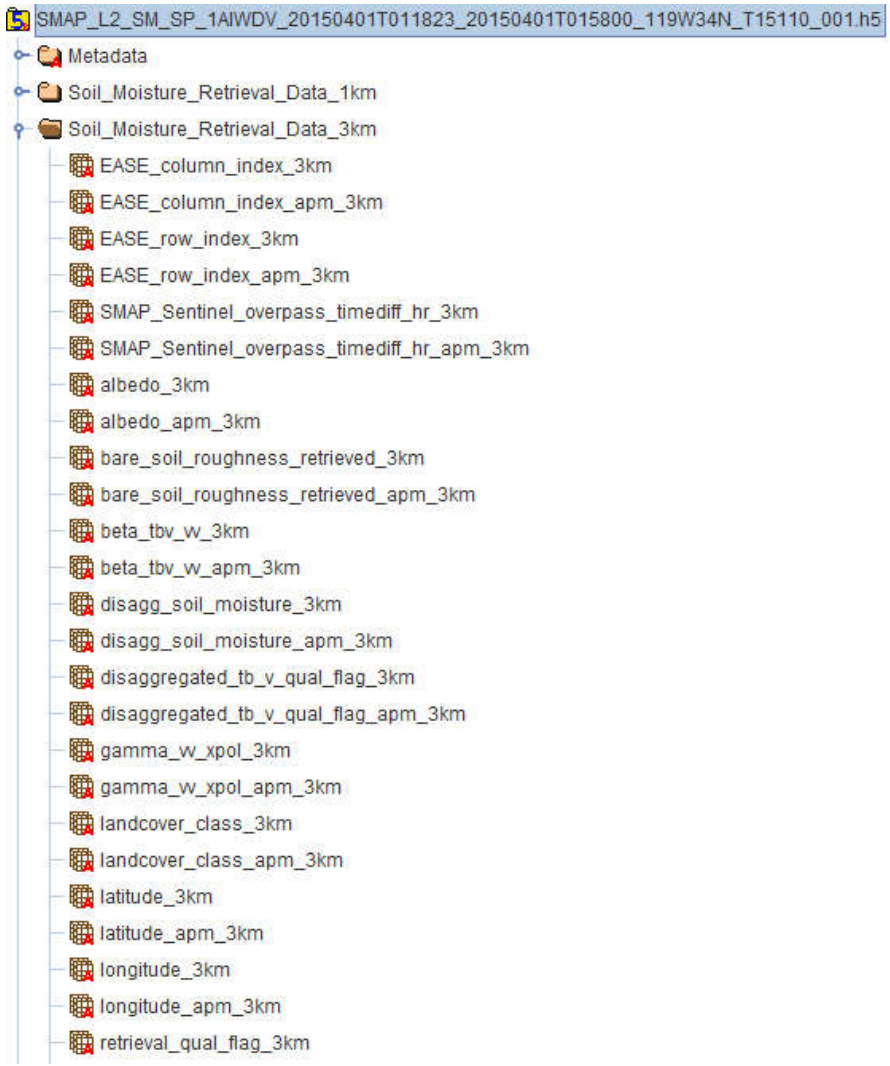

Figure 1. Subset of File Contents

For a complete list of file contents for the SMAP/Sentinel-1 Level-2 radar/radiometer soil moisture product, refer to the Appendix.

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 Appendix of this document.

All data arrays are two dimensional. Each two-dimensional data field (or element) represents a subset of the grid which contains the pixels of Sentinel-1 data along with the SMAP data that are overlaid on the grid within approximately 24 hours. The arrays in the 1 km data group have the same dimensions as the Sentinel-1 (L2_S0_S1) data. The dimensions of the arrays in the 3 km group are about one-third the size in each direction.

Soil Moisture Retrieval Data 3 km

Includes combined radar and radiometer soil moisture data at 3 km resolution, ancillary data, and quality assessment flags. Data are provided in two different sets of fields, including;

- **SMAP a.m.-only**—Only the closest SMAP a.m. data (from 6:00 a.m. descending half orbits) in time are used to spatially match up with the Sentinel-1 scene
- **SMAP a.m.-or-p.m.**—The closest SMAP a.m. or p.m. data (from 6:00 a.m. descending or 6 p.m. ascending half orbits) are used to spatially match up with the Sentinel-1 scene

Note: Data fields containing SMAP a.m.-or-p.m. data are named with *apm,* such as *disaggregated_tb_v_qual_flag_**apm**_3km.* Note that if the SMAP a.m. pass is the closest, the two arrays will have the same values.

Soil Moisture Retrieval Data 1 km

Includes combined radar and radiometer soil moisture data at 1 km resolution, ancillary data, and quality assessment flags. As with the 3 km group, data are provided in two sets of fields:

- **SMAP a.m.-only**—Only the closest SMAP a.m. data (from 6:00 a.m. descending half orbits) in time are used to spatially match up with the Sentinel-1 scene
- **SMAP a.m.-or-p.m.**—The closest SMAP a.m. or p.m. data (from 6:00 a.m. descending or 6 p.m. ascending half orbits) are used to spatially match up with the Sentinel-1 scene

Note: 1 km data are research quality, meaning they have not undergone validation.

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.

File Naming Convention

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

```
SMAP_L2_SM_SP_[Sat/Mode/Pol]_[SMAP]yyyymmddThhmmss_[Sentinel-1]yyyymmddThhmmss_[Scene Center Location]_RLVvvv_NNN.[ext]
```

For example:

```
SMAP_L2_SM_SP_1AIWDV_20160901T061527_20160901T184245_007W06N_R15180_001.h5
```

Where:

Table 1. File Naming Conventions

Variable	Description
SMAP	Indicates SMAP mission data
L2_SM_SP	Indicates specific product [L2: Level-2; SM: Soil Moisture; S: Sentinel-1; P: Passive (refers to SMAP passive radiometer)]
[Sat/Mode/Pol]	Identifies specific Sentinel-1 satellite (1A or 1B), the SAR mode (IW: Interferometric Wide-swath), and the polarization mode (DV: Dual-polarization VV and VH)
[SMAP]yyyymmddThhmmss	Date/time in Universal Coordinated Time (UTC) of the **first** SMAP data element that appears in the product, where: yyyymmdd: 4-digit year, 2-digit month, 2-digit day T: Time (delineates the date from the time, i.e. yyyymmdd***T***hhmmss) hhmmss: 2-digit hour, 2-digit month, 2-digit second
[Sentinel-1]yyyymmddThhmmss	Date/time in Universal Coordinated Time (UTC) of the **first** Sentinel-1 data element that appears in the product, where: yyyymmdd: 4-digit year, 2-digit month, 2-digit day T: Time (delineates the date from the time, i.e. yyyymmdd***T***hhmmss) hhmmss: 2-digit hour, 2-digit month, 2-digit second

[Scene Center Location]	Approximate longitude (E or W) and latitude (N or S) of the center of the EASE-Grid area containing the Sentinel-1 radar scene. **Note:** This is useful for finding data over regional subsets.
RLVvvv	Composite Release ID, where: R: Release data L: Launch Indicator (1: post-launch standard data) V: 1-Digit Major CRID Version Number vvv: 3-Digit Minor CRID Version Number Refer to the SMAP Data Versions page for version information.
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 .xml: XML Metadata file

Spatial Information

Coverage

Coverage spans from 180°W to 180°E, and from approximately 60°N and 60°S. Latitude coverage for this product is constrained by the Shuttle Radar Topography Mission Digital Elevation Model (SRTM DEM) data used for terrain correction of the Sentinel-1A/1B radar data. In addition, Sentinel-1A/1B coverage is predominantly over land targets. Note that it takes 12 consecutive days of data to obtain global coverage.

Spatial Coverage Map

Figure 2 shows the spatial coverage of this product for one day.

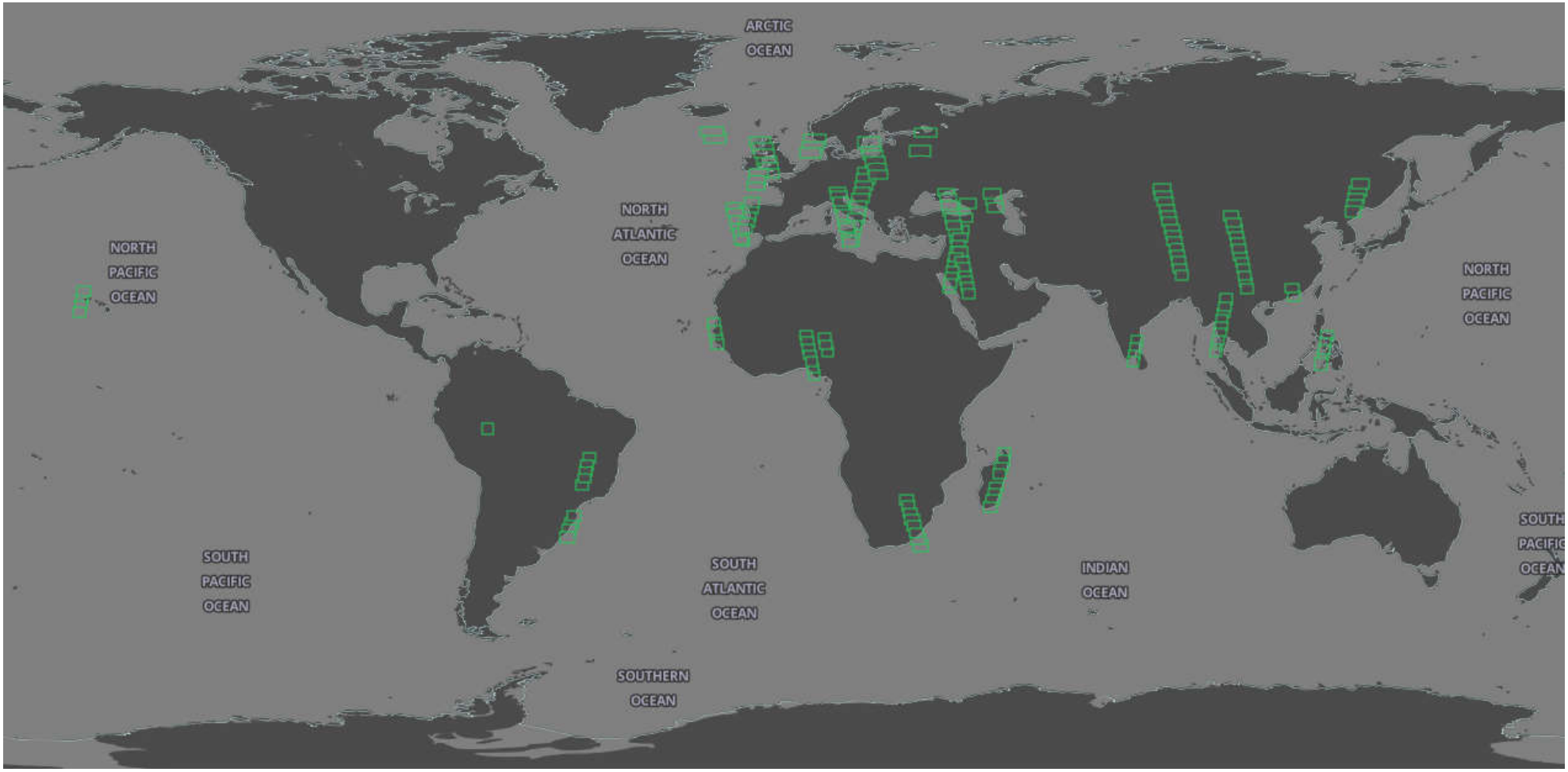

Figure 2. Spatial Coverage Map displaying SMAP/Sentinel-1A/1B match-up scenes for 01 November 2017. The map was created using the NASA Earthdata Search tool.

Resolution

SMAP 9 km radiometer brightness temperature data (SPL3SMP_E) and Sentinel-1 1 km SAR backscatter data (L2_S0_S1) are combined using the SMAP Active-Passive algorithm to derive soil moisture data that are gridded using the 3 km and 1 km EASE-Grid 2.0 projections. The gridded 9 km SMAP brightness temperatures are derived from the native 36 km* SMAP radiometer footprint by Backus-Gilbert interpolation directly to the 9 km EASE-Grid 2.0. The 1 km backscatter data from Sentinel-1 are aggregated and regridded on the 1 km EASE-Grid 2.0 starting from raw intensities at approximately 20 m native resolution.

* **Note:** The effective native resolution of the SMAP radiometer can range from approximately 25 km to 36 km depending on parameter extraction methods.

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 3 x 3 km^2 regardless of longitude and latitude. The SPL2SMAP_S data product is posted on both 3 km and 1 km EASE-Grids that are nested consistently with the 9 km brightness temperatures, and the 3 km and 1 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 3 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.

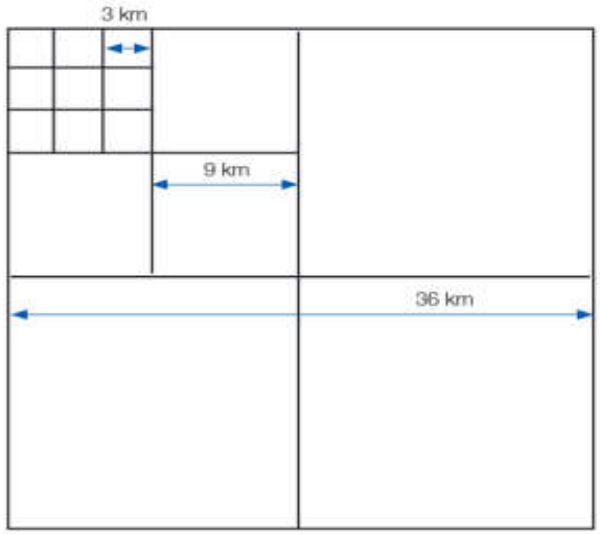

Figure 3. Perfect Nesting in EASE-Grid 2.0

Temporal Information

Coverage

Coverage spans from 31 March 2015 to present, but is not continuous. Please note the following gaps:

Ongoing Temporal Coverage Gaps

- The less frequent coverage of Sentinel-1 data results in more gaps for this match-up product than exist in the standard SMAP time series.
- In addition, the Sentinel-1 data stream varies considerably; data from many days/months prior may be received and/or downtimes may interrupt coverage, for example.
- SPL3SMP_E data from the previous, current, and next day are used to create this product, resulting in at least a day or two of standard latency.
- Small gaps in the SMAP time series will also occur due to instrument maneuvers, data downlink anomalies, data quality screening, and other factors. 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
- A significant gap in coverage occurred between 19 June and 23 July 2019 after the SMAP satellite went into Safe Mode. A brief description of the event and its impact on data quality is available in the SMAP Post-Recovery Notice.

Resolution

Each match-up file spans approximately 30 seconds.

Note that although each Sentinel-1 scene is approximately 30 seconds, the resolution varies based on how closely SMAP half-orbit passes match up with Sentinel-1 scenes. While SMAP half-orbit passes acquire 49 minutes of data, it is the overlap of Sentinel-1 scenes that determines the temporal resolution of this product.

Data Acquisition and Processing

Background

The goal of SMAP mission is to combine the favorable attributes of 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, Dan et al. 2014, and Dan et al. 2016).

The SMAP Active-Passive algorithm is capable of incorporating other SAR measurements to obtain high-resolution brightness temperature and subsequently high-resolution soil moisture. The SMAP radar stopped functioning on 07 July 2015, and various radar data were explored to find suitable alternatives for SAR data. Sentinel-1 was found to be suitable to fulfill most of the requirements of the radar measurements as input to the SMAP Active-Passive algorithm. Few modifications needed to be made in the SMAP Active-Passive algorithm to accommodate the Sentinel-1 SAR measurements. Details of these modifications will be included in the forthcoming Algorithm Theoretical Basis Document (ATBD) for this product and are provided in the Beta Assessment Report (Das et al. 2017).

Acquisition

SMAP/Sentinel-1 Level-2 radiometer/radar soil moisture data (SPL2SMAP_S) are derived from the following:

- SMAP Enhanced L3 Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture, Version 2 (SPL3SMP_E)
- Copernicus Sentinel-1A C-SAR Data
- Copernicus Sentinel-1B C-SAR Data

Derivation Techniques and Algorithms

This section has been adapted from Entekhabi et al. 2012 and Das et al. 2014.

SPL2SMAP_S data are based on the merger of SMAP radiometer and Sentinel-1 radar data at two discrete grid resolutions: gridded 9 km and 1 km, respectively. The Equal-Area-Scalable-Earth Grid (EASE-Grid) cells of the radiometer and radar products nest perfectly; refer to the EASE-Grid 2.0 section of this document. Therefore, the SPL2SMAP_S 3 km soil moisture product has 16:1 and 1:9 correspondence with the radiometer and radar products. The grid definition used in the algorithm is illustrated in Figure 2 of the Algorithm Theoretical Basis Document (ATBD) of this product (Das et al. 2019), which is available as a technical reference. The SPL2SMAP_S baseline algorithm disaggregates the coarse resolution radiometer brightness temperature product based on the spatial variation in high-resolution radar backscatter. In addition, the algorithm requires static and dynamic ancillary data. These ancillary data are resampled to the same EASE-Grid prior to ingest in the SPL2SMAP_S processing. The dynamic ancillary data used to retrieve soil moisture for a particular 3 km or 1 km grid cell at a specific point in time are listed in the SPL2SMAP_S output files for the benefit of end users.

Baseline Algorithm

The SPL2SMAP_S algorithm is based on the disaggregation of the radiometer brightness temperatures using the radar backscatter spatial patterns within the radiometer footprint. The spatial patterns need to account for the different levels of radar backscatter cross-section sensitivity to soil moisture, vegetation cover, and soil surface roughness. For this reason, the radar measurements within the radiometer footprint are scaled by parameters that are derived from the spatially averaged radar and radiometer measurements over the scene. The co-variations at a coarse scale (radiometer grid scale) over specified periods of time (short relative to plant phenology) are mostly related to surface soil moisture changes rather than contributions of vegetation and surface roughness. These derived parameters from the radiometer and radar measurements address the high-resolution variability of soil moisture within the coarse radiometer grid cell. However, the high-resolution variability of vegetation and surface roughness with the coarse radiometer grid cell is addressed by the parameter derived using the high-resolution snapshot co-pol and x-pol radar measurements.

The basis for the brightness temperature disaggregation based on radar measurements begins with relating the radiometer measurements with the radar backscatter cross-section measurements in a simple conceptual framework outlined in the ATBD (refer to Section 2: Physics of the Problem). **Note**: The analysis provided therein is meant to simply demonstrate the dependencies and it is not directly (i.e. algebraically) part of the SPL2SMAP_S algorithm formulation.

Once the disaggregated brightness temperatures at 3 km and 1 km are produced, the Single Channel Algorithm (SCA)/Tau-Omega model is applied that uses high-resolution ancillary information at 3 km and 1 km to produce the SPL2SMAP_S product. Note that for this version of the SPL2SMAP_S product, the tau-omega parameters have been adjusted to be consistent with the values used in the SPL2SMP and SPL2SMP_E algorithms.

Formulation of the SPL2SMAP_S Baseline Algorithm

The SMAP L-band radiometer measures the natural microwave emission in the form of the brightness temperature (T_B) of the land surface, while the Sentinel-1 C-band radar measures the energy backscattered (sigma0, also referred to as S0 or σ_0) from the land surface after transmission of an electromagnetic pulse. On short time scales, an increase of surface soil moisture produces an increase in soil dielectric constant, which leads to a decrease in radiometer T_B and an increase in radar backscatter, and vice versa. Thus, variations in soil moisture cause T_B and sigma0 to be negatively correlated. This time period is generally shorter than the seasonal phenology of vegetation.

The land surface vegetation and surface roughness factors are expected to vary on time scales longer that those associated with soil moisture variability. However, over a short time periods the SMAP T_B and Sentinel-1 sigma0 are expected to have a linear functional relationship: $T_B = \alpha + \beta \times \sigma_0$. The unknown parameters α and β are dependent on the dominant vegetation and soil roughness characteristics. The T_B polarization can either be *v* or *h* and the σ polarization can be *vv, hh* (though *hh* is not used for this product), or *vh*. The parameter β can be derived in a snapshot approach based on pairs of SMAP radiometer T_B and spatially-averaged radar sigma0 from successive observations of the same Earth grid cell (Jagdhuber et al. 2017). The parameter β, which represents the sensitivity of backscatter to changes in brightness temperature, is highly dependent on vegetation characteristics.

The parameter β is unique for each location since it is a sensitivity parameter relating T_B and sigma0 and it is a function of surface characteristics like the local vegetation cover and soil roughness for a particular period of time. The parameter varies seasonally as well as geographically. To develop the satellite-based Active-Passive algorithm further, the relationship between T_B and sigma0 can also be conceptually evaluated at the 3 km scale within the radiometer footprint. At this scale brightness temperature is not available given the SMAP radiometer instrument resolution. In fact, determining T_B at this scale is the target of the algorithm and it is referred to as the disaggregated brightness temperature. The way to incorporate the effects of the variations of the parameter β at the 3 km and 1 km scale with respect to the coarser 9 km scale is to determine subgrid heterogeneity parameter Γ from high-resolution co- and cross-polarization. The methodology is described in Section 3.2 of the ATBD.

The performance of the brightness temperature disaggregation is heavily dependent on robust estimates of β and Γ parameters, which are specific for a given location and reflect the local roughness and vegetation cover conditions. The parameters vary seasonally as well as due to change in local surface conditions; therefore, it is optimal to derive these parameters for every SMAP and Sentinel-1 overlap instance.

Algorithm Process Flow

Figure 4 shows a simplified process flow diagram of the SPL2SMAP_S baseline algorithm.

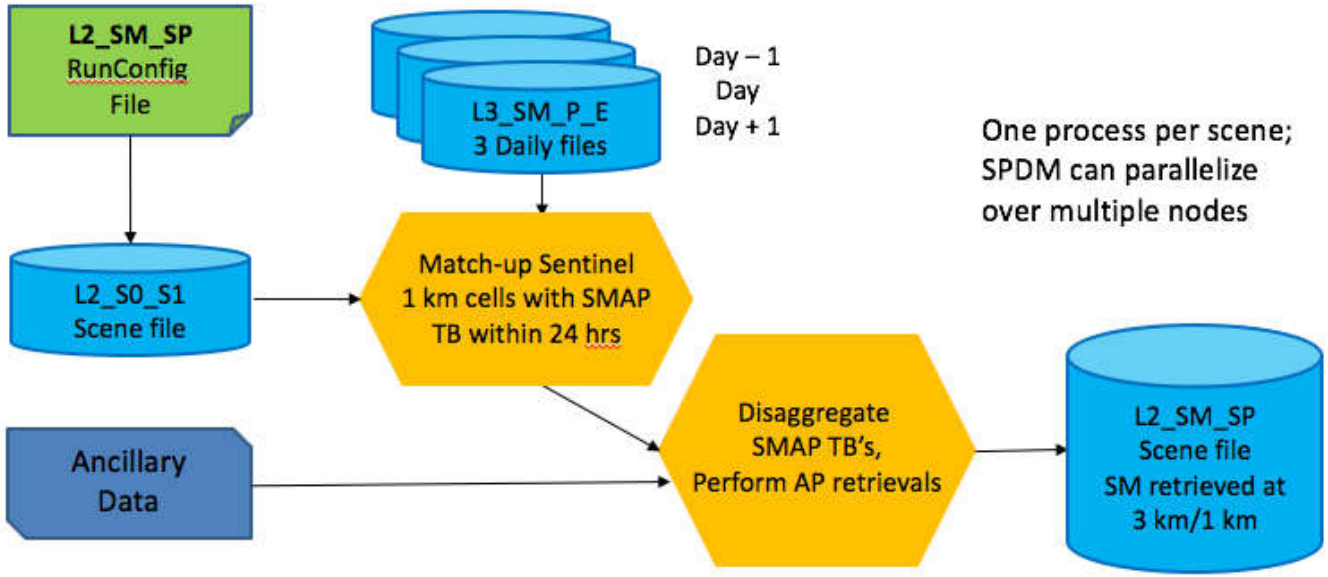

Figure 4. Process Flow Diagram of the SPL2SMAP_S Baseline Algorithm

Note: As shown in this figure and reflected in the file names, L2_SM_SP is an abbreviation for this product (also referred to as SPL2SMAP_S), SPDM refers to the Science Processing and Data Management system that can parallelize, or run many single-thread processes on multiple nodes, to process a scene.

Processing

This product is generated by the SMAP Science Data Processing System (SDS) at the Jet Propulsion Laboratory (JPL) in Pasadena, California USA. Prior to generating this product, Copernicus Sentinel-1A and -1B satellite imagery were acquired by the European Space Agency (ESA) and distributed through the Alaska Satellite Facility (ASF). To generate this product, the processing software:

1. Ingests one file containing a single scene of Sentinel-1 1 km L2_S0_S1 backscatter data from either Sentinel-1A or Sentinel-1B and three daily files of SMAP gridded 9 km SPL3SMP_E brightness temperature data. The SMAP files include SMAP data for the three days nearest the time of the Sentinel-1 data, along with the required static and dynamic ancillary data that cover those three days.

- The brightness temperatures available in SPL3SMP_E have been corrected for the presence of water bodies (up to 0.05 fraction) before being used in SPL2SMAP_S product generation. Beyond water body fraction of 0.05, no correction is conducted as it introduces high errors due to uncertainty present in the

water fraction information.
- The sigma0 measurements have been calibrated, terrain-corrected,* and aggregated onto 1 km EASE-Grid 2.0 pixels before being used in SPL2SMAP_S product generation. Level-2 sigma0 Sentinel-1 data (also referred to as L2_S0_S1) in the dual-polarization "SDV" mode (VV,VH) used exclusively for SMAP/Sentinel-1 SPL2SMAP_S processing.

* **Note:** For this version of the SPL2SMAP_S product, a new method of identifying and eliminating spurious sigma0 values in Sentinel-1A/B Level-1 S0 data has been implemented. This method, referred to as a hybrid filter, combines a median filter (i.e. replaces the value at each pixel with the median value of adjacent pixels) with thresholding to address spurious sigma0 values (mainly due to small man-made structures) which bias the aggregated 1 km data. To accommodate this change, a new 1 km urban fraction map from the Global Human Settlement project is used in place of the 3 km urban fraction map obtained from GRUMP data for the Version 1 SPL2SMAP_S product. In addition, the thresholds used to populate the *surface_flag* field have been adjusted to coincide with the use of the new 1 km urban fraction map; new threshold values are: < 0.25 (no flag), 0.25 – 0.5 (flagged, retrieval performed), and > 0.5 (masked, no retrieval).

2. The ingested data are then inspected for retrievability criteria according to input data quality, ancillary data availability, and land cover conditions. The nearest SMAP data in time at the location of the Sentinel-1 scene is determined, including:
- Data from SMAP a.m.-only (6:00 a.m. descending) orbits
- Data from SMAP a.m.-or-p.m. (6:00 a.m. descending or 6 p.m. ascending) orbits

Within each resolution data group (3 km and 1 km) there are two sets of outputs: SMAP a.m.-only and SMAP a.m.-or-p.m. One of the following four outcomes are possible:
- No match — Neither SMAP a.m. nor p.m. data match the Sentinel-1 scene, resulting in no output file.
- SMAP a.m.-only is closest — In this case the values of the SMAP a.m.-only and SMAP a.m.-or-p.m. elements are identical.
- SMAP a.m.-only and SMAP a.m.-or-p.m. are different — In general, the SMAP a.m.-or-p.m. data are the closest of all in time to the Sentinel-1 scene, but there are two different sets of retrievals due to SMAP data from different times.
- SMAP a.m.-only has fill values, SMAP a.m.-or-p.m. has valid data — This occurs when there are no SMAP a.m.-only matches, but a p.m. match can be found.

3. When retrievability criteria are met, the software invokes the brightness temperature disaggregation algorithm followed by the baseline retrieval algorithm to generate soil moisture. The brightness temperatures gridded at 9 km are converted to soil moisture using algorithms described in SPL2SMP_E and based on approximately 33 km resolution ancillary data. Note that the disaggregation is not performed if the coarse resolution brightness temperature does not meet the quality requirements, especially if large water bodies and RFI are present. Only cells that are covered by the actual swath for a given projection are written in the product.

Quality, Errors, and Limitations

Error Sources

Errors in SPL2SMAP_S data come from various sources with the most prominent potential error source being anthropogenic Radio Frequency Interference (RFI). Principally from ground-based surveillance radars and ancillary data, RFI can contaminate both radar and radiometer measurements at L-band. Early measurements

and results from European Space Agency's Soil Moisture and Ocean Salinity (SMOS) mission indicate RFI is a major source of concern because of high RFI present and detectable in many parts of the world. 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. Owing to such robust measures in the SMAP radiometer hardware and data processing, the SPL2SMAP_S product has lesser impact than SMOS measurements from anthropogenic RFI. The Sentinel-1 C-band radar data have no RFI indicators; the expectation is that the impact of RFI on the Sentinel-1 radar is reduced due to the radar frequency relative to the L-band SMAP radiometer. Other sources of error, such as disaggregation process errors and calibration and gridding errors, are quantified analytically for the disaggregated brightness temperatures and retrieved soil moisture at 3 km and 1 km. (Entekhabi et al. 2012 and Das et al. 2016)

More information about error sources is provided in Section 5.2 of the ATBD, *Error Budget of L2_SM_SP Algorithm*.

Quality Assessment

Science and application communities should take certain caveats into consideration before using the SPL2SMAP_S product. There is a tradeoff between adding spatial resolution with C-band SAR data and noise levels. The high resolution (3 km) of this product comes at a cost of degradation in temporal statistics of disaggregated brightness temperature and retrieved soil moisture. Whereas the more spatially-averaged SPL2SMP_E product may have less temporal noise and temporal uncertainty when compared to SPL2SMAP_S, the SPL2SMAP_S will have more spatial resolution in terms of resolving sharp and large-contrast features below the radiometer resolution. Therefore, users of SMAP data who require more frequent revisit and temporal accuracy can use the SPL2SMP_E product (posted at 9 km), and those users who need high resolution soil moisture patterns and details with slightly degraded accuracy and less frequent revisit can use SPL2SMSP_E data (posted at 3 km) for their science studies and geophysical applications. For in-depth details regarding the quality of these Version 2 Beta data, refer to the Beta Assessment Report (Das et al. 2017).

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 Appendix of this document and 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 HDF5 file-level metadata.

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.

Data Flags

Quality control (QC) is an integral part of the SPL2SMAP_S processing. The QC steps of SPL2SMAP_S processing are based on the flags that are provided with the

SMAP input data stream (SPL3SMP_E), different types of masks, flags, and fractional coverage of other variables provided by ancillary data. The SPL2SMAP_S will process all data that have favorable conditions for soil moisture retrieval (VWC <= 3 kg/m^2, no rain, no snow cover, no frozen ground, no RFI, sufficient distance from open water). However, soil moisture retrieval will also be conducted for regions with VWC > 3 kg/m^2, rain, RFI repaired data, and places closer to water bodies, but appropriate flags are added to these data points indicating their susceptibility to potentially high errors. In addition, due to differences in spatial resolution of the input data, the assignment of QC flags in SPL2SMAP_S may differ from the flags associated with the inputs. The thresholds of ancillary data that initiate flagging in the SPL2SMAP_S product are mentioned below. For example, TB data in SPL3SMP_E are corrected for the presence of water bodies. Studies are being conducted to assess the quality of corrected TB data that are acceptable and within the desired uncertainty level that could be used in SPL2SMAP_S processing. Preliminary assessment shows that 5% water body fraction within the 9 km grid cell of SPL3SMP_E has acceptable quality and low error level in kelvins. All the 3 km and 1 km nested grid cells of SPL2SMAP_S within the 9 km grid cell of SPL3SMP_E are flagged for suspected quality if the water body fraction is >5%. The water body fraction is reported for all land-based 3 km and 1 km grid cells in SPL2SMAP_S product file, and the water body flag bit is set in the retrieval quality field if the water body fraction is greater than a threshold value of 5%. In the case of VWC, SPL2SMAP_S retrieval is performed at all the grid cells irrespective of VWC but the QC flag is set only for a grid cell having VWC >3 kg/m^2. Retrievals are performed for SPL2SMAP_S grid cells that are associated with RFI and water body fraction above a particular threshold; however, appropriate QC flags are raised to inform the user about the suspected quality of disaggregated brightness temperature and retrieved soil moisture. No retrievals are performed over frozen ground, presence of snow, and 100% urban fraction. Thresholds from masks that will initiate flags and operational decisions to process the SPL2SMAP_S product are mentioned as follows:

Open Water Body Flag

Open water fraction is determined from Sentinel-1 high-resolution radar and/or *a priori* information on permanent open freshwater from the Moderate Resolution Imaging Spectroradiometer (MODIS) MOD44W database. The SPL2SMAP_S Version 2 product uses the MOD44W database due to the maturity of the SMAP radar open water algorithm and availability of radar measurements. This information is used to flag grid cells during soil moisture retrieval processing in the following way:

- Water fraction is 0.00–0.05: Retrieve soil moisture, do not flag.
- Water fraction is 0.05–0.10: Flag and retrieve soil moisture.
- Water fraction is 0.10–1.00: Flag but do not retrieve soil moisture.

RFI Flag

Presence of RFI in the SMAP brightness temperature data adversely affects the SMAP Active-Passive algorithm. Therefore specific logics are built into the SMAP Active-Passive processor to initiate a flag during soil moisture retrievals. The RFI flag is initiated as follows:

- No RFI detected in TB: Retrieve soil moisture, do not flag.
- RFI detected in TB and repaired: Flag and retrieve soil moisture.
- RFI detected in TB and not repaired: Flag and do not retrieve soil moisture.

Snow Flag

The ancillary data that provide a binary indicator for the presence of snow is used for flagging in the following way:

- Snow data indicates no snow is present in the cell: Retrieve soil moisture and do not flag.
- Snow data indicates any amount of snow is present in the cell: Flag and do not retrieve soil moisture.

Precipitation Flag

Presence of heavy rainfall during data acquisition may adversely affect the TB and sigma0 measurements. The precipitation data from Global Modeling and Assimilation Office (GMAO) is used to flag the 9 km and 3 km grid cells. SPL2SMAP_S retrievals will be performed irrespective of rainfall; however, the grid cell will be flagged in case of the presence of precipitation.

VWC Flag

SPL2SMAP_S retrievals are conducted for all locations irrespective of VWC level. The grid cells are flagged for VWC greater than 3 kg/m^2.

Urban Area Flag

Presence of urban area adversely affects the L-band radiometric measurements. The presence of urban area within the SMAP measurement is likely to bias soil moisture retrievals. Currently the SPL2SMAP_S processor flags the regions having urban area as follows:

- Urban fraction is < 0.25: Retrieve soil moisture, do not flag.
- Urban fraction is 0.25 - 0.5: Flag and retrieve soil moisture.
- Urban fraction is > 0.5: Flag and do not retrieve soil moisture.

Mountain Area Flag

Statistics of mountainous regions are used to initiate flags and operational decisions during SPL2SMAP_S processing. The standard deviation of slope is used as a threshold to detect uneven terrain and mountainous regions. For QC related to mountainous regions, the SPL2SMAP_S processing is consistent with the SPL2SMP processing. Currently the SPL2SMAP_S processor flags any region where DEM slope standard deviation is more than three degrees. However, retrievals are performed for all locations.

For more information regarding data flags, refer to the Appendix of this document.

Instrumentation

Description

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

For information regarding the SAR satellites Sentinel-1A and -1B, refer to the European Space Agency (ESA) Copernicus Sentinel-1 website.

Software and Tools

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

Version History

Table 2. Summary of Version Changes

Version	Date	Version Changes
1	October 2017	First public data release
2	June 2018	Changes to this version include: • Implemented a new method of identifying and eliminating spurious sigma0 values in Sentinel-1A/B Level-1 sigma0 data using a hybrid approach that combines a median filter with thresholding. As a result, fewer spurious sigma0 values (mainly due to small man-made structures) bias the aggregated 1 km data. • Replaced the previous 3 km resolution urban fraction map with a new 1 km map. • Adjusted the thresholds used with the new 1 km urban fraction map to: 0.25 (no flag), 0.25 – 0.5 (flagged, retrieval performed), and 0.5 (masked, no retrieval). These are provided in bit 3 of the *surface_flag* data field. • Adjusted the tau-omega parameters to be consistent with the values used in SPL2SMP/SPL2SMP_E algorithm. • Implemented minor bug fix to the SMAP and Sentinel-1 overlap computation code.

Related Data Sets

SMAP Data at NSIDC | Overview

SMAP Radar Data at the ASF DAAC

Related Websites

SMAP at NASA JPL

Contacts and Acknowledgments

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Acknowledgments:

This data set contains modified Copernicus Sentinel-1 data (2015-present), acquired by the European Space Agency (ESA), distributed through the Alaska Satellite Facility (ASF), and processed by the SMAP Science Data System.

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Appendix - Data Fields

This appendix provides a description of all data fields within the *SMAP/Sentinel-1 L2 Radiometer/Radar 30-Second Scene 3 km EASE-Grid Soil Moisture* (SPL2SMAP_S) product. The data are grouped into three main HDF5 groups:

- Metadata
- Soil_Moisture_Retrieval_Data_1km

- Soil_Moisture_Retrieval_Data_3km

For a description of metadata fields for this product, refer to the Product Specification Document.

Soil_Moisture_Retrieval_Data_1km

Table A1 describes the data fields of a typical SPL2SMAP_S 1 km granule. Data in the 1 km group are research quality, meaning they have not undergone validation.

Note: Data fields containing SMAP a.m.-or-p.m. data are named with *apm,* such as *disaggregated_tb_v_qual_flag_**apm**_3km.* Note that if the SMAP a.m. pass is the closest, the two arrays will have the same values.

Table A1. Data Fields for *Soil_Moisture_Retrieval_Data_1km*

Data Field Name	Concept	Byte	Unit	Min	Max	Fill/Gap Value
EASE_column_index_1km	integer	2	count	0	65535	66534
EASE_column_index_apm_1km	integer	2	count	0	65535	66534
EASE_row_index_1km	integer	2	count	0	65535	66534
EASE_row_index_apm_1km	integer	2	count	0	65535	66534
SMAP_Sentinel-1_overpass_timediff_hr_1km	integer	2	count	-999999.9	999999.9	-9999.0
SMAP_Sentinel-1_overpass_timediff_hr_apm_1km	integer	2	count	-999999.9	999999.9	-9999.0
albedo_1km	real	4	normalized	0.0	1.0	-9999.0
albedo_apm_1km	real	4	normalized	0.0	1.0	-9999.0
bare_soil_roughness_retrieved_1km	real	4	meters	0.0	2.0	-9999.0

bare_soil_roughness_retrieved_apm_1km	real	4	meters	0.0	2.0	-9999.0
beta_tbv_vv_1km	real	4	kelvin	-35.0	0.0	-9999.0
beta_tbv_vv_apm_1km	real	4	kelvin	-35.0	0.0	-9999.0
disagg_soil_moisture_1km	real	4	cm^3/cm^3	0.0	0.75	-9999.0
disagg_soil_moisture_apm_1km	real	4	cm^3/cm^3	0.0	0.75	-9999.0
disaggregated_tb_v_qual_flag_1km	bit flag	2	N/A	N/A	N/A	66534
disaggregated_tb_v_qual_flag_apm_1km	bit flag	2	N/A	N/A	N/A	66534
gamma_vv_xpol_1km	bit flag	2	N/A	0.0	10.0	-9999.0
gamma_vv_xpol_apm_1km	bit flag	2	N/A	0.0	10.0	-9999.0
landcover_class_1km	enum	1	N/A	N/A	N/A	254
landcover_class_apm_1km	enum	1	N/A	N/A	N/A	254
latitude_1km	real	4	degrees_north	-90.0	90.0	-9999.0
latitude_apm_1km	real	4	degrees_north	-90.0	90.0	-9999.0
longitude_1km	real	4	degrees_east	-180.0	180.0	-9999.0

longitude_apm_1km	real	4	degrees_east	-180.0	179.999	-9999.0
retrieval_qual_flag_1km	bit flag	2	N/A	N/A	N/A	66534
retrieval_qual_flag_apm_1km	bit flag	2	N/A	N/A	N/A	66534
sigma0_incidence_angle_1km	bit flag	2	N/A	0.0	90.0	-9999.0
sigma0_incidence_angle_apm_1km	bit flag	2	N/A	0.0	90.0	-9999.0
sigma0_vh_aggregated_1km	real	4	normalized	-1.0	10.0	-9999.0
sigma0_vh_aggregated_apm_1km	real	4	normalized	-1.0	10.0	-9999.0
sigma0_vv_aggregated_1km	real	4	normalized	-1.0	10.0	-9999.0
sigma0_vv_aggregated_apm_1km	real	4	normalized	-1.0	10.0	-9999.0
soil_moisture_1km	real	4	cm^3/cm^3	0.0	0.75	-9999.0
soil_moisture_apm_1km	real	4	cm^3/cm^3	0.0	0.75	-9999.0
soil_moisture_std_dev_1km	real	4	cm^3/cm^3	0.0	0.5	-9999.0
soil_moisture_std_dev_apm_1km	real	4	cm^3/cm^3	0.0	0.5	-9999.0
spacecraft_overpass_time_seconds_1km	real	8	seconds	-99999999.9	9.4E8	-9999.0

spacecraft_overpass_time_seconds_apm_1km	real	8	seconds	-99999999.9	9.4E8	-9999.0
surface_flag_1km	bit flag	2	N/A	N/A	N/A	66534
surface_flag_apm_1km	bit flag	2	N/A	N/A	N/A	66534
surface_temperature_1km	real	4	kelvin	200.0	350.0	-9999.0
surface_temperature_apm_1km	real	4	kelvin	200.0	350.0	-9999.0
tb_v_disaggregated_1km	real	4	kelvin	0.0	330.0	-9999.0
tb_v_disaggregated_apm_1km	real	4	kelvin	0.0	330.0	-9999.0
tb_v_disaggregated_std_1km	real	4	kelvin	0.0	100.0	-9999.0
tb_v_disaggregated_std_apm_1km	real	4	kelvin	0.0	100.0	-9999.0
vegetation_opacity_1km	real	4	normalized	0.0	1.0	-9999.0
vegetation_opacity_apm_1km	real	4	normalized	0.0	1.0	-9999.0
vegetation_water_content_1km	real	4	kg/m^3	0.0	30.0	-9999.0
vegetation_water_content_apm_1km	real	4	kg/m^3	0.0	30.0	-9999.0
water_body_fraction_1km	real	4	normalized	0.0	1.0	-9999.0

water_body_fraction_apm_1km	real	4	normalized	0.0	1.0	-9999.0

Soil_Moisture_Retrieval_Data_3km

Table A2 describes the data fields of a typical SPL2SMAP_S 3 km granule.

Table A2. Data Fields for *Soil_Moisture_Retrieval_Data_3km*

Data Field Name	Concept	Byte	Unit	Min	Max	Fill/Gap Value
EASE_column_index_3km	integer	2	count	0	65535	66534
EASE_column_index_apm_3km	integer	2	count	0	65535	66534
EASE_row_index_3km	integer	2	count	0	65535	66534
EASE_row_index_apm_3km	integer	2	count	0	65535	66534
SMAP_Sentinel-1_overpass_timediff_hr_3km	integer	2	count	-999999.9	999999.9	-9999.0
SMAP_Sentinel-1_overpass_timediff_hr_apm_3km	integer	2	count	-999999.9	999999.9	-9999.0
albedo_3km	real	4	normalized	0.0	1.0	-9999.0
albedo_apm_3km	real	4	normalized	0.0	1.0	-9999.0
bare_soil_roughness_retrieved_3km	real	4	meters	0.0	2.0	-9999.0
bare_soil_roughness_retrieved_apm_3km	real	4	meters	0.0	2.0	-9999.0

beta_tbv_vv_3km	real	4	kelvin	-35.0	0.0	-9999.0
beta_tbv_vv_apm_3km	real	4	kelvin	-35.0	0.0	-9999.0
disagg_soil_moisture_3km	real	4	cm^3/cm^3	0.0	0.75	-9999.0
disagg_soil_moisture_apm_3km	real	4	cm^3/cm^3	0.0	0.75	-9999.0
disaggregated_tb_v_qual_flag_3km	bit flag	2	N/A	N/A	N/A	66534
disaggregated_tb_v_qual_flag_apm_3km	bit flag	2	N/A	N/A	N/A	66534
gamma_vv_xpol_3km	bit flag	2	N/A	0.0	10.0	-9999.0
gamma_vv_xpol_apm_3km	bit flag	2	N/A	0.0	10.0	-9999.0
landcover_class_3km	enum	1	N/A	N/A	N/A	254
landcover_class_apm_3km	enum	1	N/A	N/A	N/A	254
latitude_3km	real	4	degrees_north	-90.0	90.0	-9999.0
latitude_apm_3km	real	4	degrees_north	-90.0	90.0	-9999.0
longitude_3km	real	4	degrees_east	-180.0	180.0	-9999.0
longitude_apm_3km	real	4	degrees_east	-180.0	179.999	-9999.0

retrieval_qual_flag_3km	bit flag	2	N/A	N/A	N/A	66534
retrieval_qual_flag_apm_3km	bit flag	2	N/A	N/A	N/A	66534
sigma0_incidence_angle_3km	bit flag	2	N/A	0.0	90.0	-9999.0
sigma0_incidence_angle_apm_3km	bit flag	2	N/A	0.0	90.0	-9999.0
sigma0_vh_aggregated_3km	real	4	normalized	-1.0	10.0	-9999.0
sigma0_vh_aggregated_apm_3km	real	4	normalized	-1.0	10.0	-9999.0
sigma0_vv_aggregated_3km	real	4	normalized	-1.0	10.0	-9999.0
sigma0_vv_aggregated_apm_3km	real	4	normalized	-1.0	10.0	-9999.0
soil_moisture_3km	real	4	cm^3/cm^3	0.0	0.75	-9999.0
soil_moisture_apm_3km	real	4	cm^3/cm^3	0.0	0.75	-9999.0
soil_moisture_std_dev_3km	real	4	cm^3/cm^3	0.0	0.5	-9999.0
soil_moisture_std_dev_apm_3km	real	4	cm^3/cm^3	0.0	0.5	-9999.0
spacecraft_overpass_time_seconds_3km	real	8	seconds	-99999999.9	9.4E8	-9999.0
spacecraft_overpass_time_seconds_apm_3km	real	8	seconds	-99999999.9	9.4E8	-9999.0

surface_flag_3km	bit flag	2	N/A	N/A	N/A	66534
surface_flag_apm_3km	bit flag	2	N/A	N/A	N/A	66534
surface_temperature_3km	real	4	kelvin	200.0	350.0	-9999.0
surface_temperature_apm_3km	real	4	kelvin	200.0	350.0	-9999.0
tb_v_disaggregated_3km	real	4	kelvin	0.0	330.0	-9999.0
tb_v_disaggregated_apm_3km	real	4	kelvin	0.0	330.0	-9999.0
tb_v_disaggregated_std_3km	real	4	kelvin	0.0	100.0	-9999.0
tb_v_disaggregated_std_apm_3km	real	4	kelvin	0.0	100.0	-9999.0
vegetation_opacity_3km	real	4	normalized	0.0	1.0	-9999.0
vegetation_opacity_apm_3km	real	4	normalized	0.0	1.0	-9999.0
vegetation_water_content_3km	real	4	kg/m^3	0.0	30.0	-9999.0
vegetation_water_content_apm_3km	real	4	kg/m^3	0.0	30.0	-9999.0
water_body_fraction_3km	real	4	normalized	0.0	1.0	-9999.0
water_body_fraction_apm_3km	real	4	normalized	0.0	1.0	-9999.0

Data Field Definitions

EASE_column_index_[1km/3km]

The column index of the 1 km (or 3 km) EASE-Grid 2.0 cell that contains the associated data. This field contains SMAP a.m.-only data.

EASE_column_index_apm_[1km/3km]

The column index of the 1 km (or 3 km) EASE-Grid 2.0 cell that contains the associated data. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

EASE_row_index_[1km/3km]

The row index of the 1 km (or 3 km) EASE-Grid 2.0 cell that contains the associated data. This field contains SMAP a.m.-only data.

EASE_row_index_apm_[1km/3km]

The row index of the 1 km (or 3 km) EASE-Grid 2.0 cell that contains the associated data. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

SMAP_Sentinel-1_overpass_timediff_hr_[1km/3km]

Number of hours difference between the SMAP overpass and the Sentinel-1 overpass. This field contains SMAP a.m.-only data.

SMAP_Sentinel-1_overpass_timediff_hr_apm_[1km/3km]

Number of hours difference between the SMAP overpass and the Sentinel-1 overpass. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

albedo_[1km/3km]

Diffuse reflecting power of the Earth's surface within the EASE-Grid 2.0 cell. This field contains SMAP a.m.-only data.

albedo_apm_[1km/3km]

Diffuse reflecting power of the Earth's surface within the EASE-Grid 2.0 cell. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

bare_soil_roughness_retrieved_[1km/3km]

Soil roughness provided by the MODIS International Geosphere-Biosphere Programme (IGBP) land cover map at 1 km (or 3 km) EASE-Grid 2.0 cell. The relative dominance of each land cover type is determined based on ranking among land cover classes using statistical mode. Table 4 provides a description of MODIS IGBP

classes and the precentage of each land type. This field contains SMAP a.m.-only data.

bare_soil_roughness_retrieved_apm_[1km/3km]

Soil roughness provided by the MODIS International Geosphere-Biosphere Programme (IGBP) land cover map at 1 km (or 3 km) EASE-Grid 2.0 cell. The relative dominance of each land cover type is determined based on ranking among land cover classes using statistical mode. Table 4 provides a description of MODIS IGBP classes and the precentage of each land type. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

beta_tbv_vv_[1km/3km]

Beta parameter used in the Active/Passive retrieval algorithm for the corresponding EASE-Grid 2.0 cell, derived using time series Tbv and sigma0_vv. This field contains SMAP a.m.-only data.

beta_tbv_vv_apm_[1km/3km]

Beta parameter used in the Active/Passive retrieval algorithm for the corresponding EASE-Grid 2.0 cell, derived using time series Tbv and sigma0_vv. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

disagg_soil_moisture_[1km/3km]

Representative soil moisture measurement for the 1 km EASE-Grid 2.0 cell obtained from disaggregating the coarse resolution soil moisture. This field contains SMAP a.m.-only data.

disagg_soil_moisture_apm_[1km/3km]

Representative soil moisture measurement for the 1 km EASE-Grid 2.0 cell obtained from disaggregating the coarse resolution soil moisture. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

disaggregated_tb_v_qual_flag_[1km/3km]

Bit flags that record the conditions and the quality of the disaggregated vertical polarization brightness temperature for the option 1 soil moisture algorithm generated for the EASE-Grid 2.0 cell. Refer to Table A3 for bit flag definitions. This field contains SMAP a.m.-only data.

Table A3. Quality Bit Flag Definitions

Name	Bit Position	Description of Values (0:off, 1:on)
Disaggregated brightness	0	0: Disaggregated vertical polarization brightness temperature has acceptable quality

temperature v-pol quality		
		1: Unable to disaggregate vertical polarization brightness temperatures into cells
Sigma0_vv quality flag	1	0: Soil moisture retrieval has recommended quality
		1: Soil moisture retrieval has uncertain quality
Sigma0_xpol quality flag	2	0: All vertical polarization sigma0 input that contributed to disaggregation of vertical polarization brightness temperatures were deemed as good quality
		1: Some vertical polarization sigma0 input that contributed to disaggregation of vertical polarization brightness temperatures was of questionable or poor quality
Brightness temperature v-pol quality flag	3	0: Vertical polarization brightness temperature input that was used for disaggregation was deemed as good quality
		1: Some vertical polarization brightness temperature input that was used for soil moisture retrieval was of questionable or poor quality
Brightness temperature v-pol RFI detected flag	4	0: Insignificant levels of RFI detected in the vertical polarization radiometer brightness temperature input
		1: Significant levels of RFI were detected in the vertical polarization radiometer brightness temperature input
Brightness temperature v-pol RFI corrected flag	5	0: The vertical polarization radiometer brightness temperature input is based on data that were repaired for the effects of RFI
		1: Unable to repair the vertical polarization radiometer brightness temperature input for the effects of RFI
Sigma0_vv RFI detected	6	0: Insignificant levels of RFI detected in the vertical polarization radar sigma0 input

flag		
		1: Significant levels of RFI were detected in the vertical polarization radar sigma0 input
Sigma0_vv RFI corrected flag	7	0: The input for retrieval is based on vertical polarization radar sigma0s that were repaired for the effects of RFI
		1: Unable to repair the vertical polarization radar sigma0 input for the effects of RFI
Sigma0_xpol RFI detected flag	8	0: Insignificant levels of RFI detected in the cross polarized radar sigma0 input
		1: Significant levels of RFI were detected in the cross polarized radar sigma0 input
Sigma0_xpol RFI corrected flag	9	0: The input for retrieval is based on cross polarized radar sigma0s that were repaired for the effects of RFI
		1: Unable to repair the cross polarized radar sigma0 input for the effects of RFI
Negative *sigma0_vv* flag	10	0: The input for retrieval is based on vertical polarization radar sigma0s that are greater than zero
		1: The input for retrieval is based on vertical polarization radar sigma0s that are less than or equal to zero
Negative *sigma0_xpol* flag	11	0: The input for retrieval is based on cross polarized radar sigma0s that are greater than zero
		1: The input for retrieval is based on cross polarized radar sigma0s that are less than or equal to zero
Water body correction flag	12	0: Waterbody correction successfully done and the percentage waterbody with 36 TB grid cell is <= 5%, TB deemed good quality
		1: Waterbody correction successfully done and the percentage waterbody with 36 TB grid cell is > 5%, TB quality is suspected

Undefined	13-15	0 (not used)

disaggregated_tb_v_qual_flag_apm_[1km/3km]

Bit flags that record the conditions and the quality of the disaggregated vertical polarization brightness temperature for the option 1 soil moisture algorithm generated for the EASE-Grid 2.0 cell. Refer to Table 3 for bit flag definitions. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

gamma_vv_xpol_[1km/3km]

Gamma parameter used in the Active/Passive retrieval algorithm for the corresponding EASE-Grid 2.0 cell, derived using high resolution sigma0_vv and sigma0_xpol. This field contains SMAP a.m.-only data.

gamma_vv_xpol_apm_[1km/3km]

Gamma parameter used in the Active/Passive retrieval algorithm for the corresponding EASE-Grid 2.0 cell, derived using high resolution sigma0_vv and sigma0_xpol. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

landcover_class_[1km/3km]

An enumerated type that specifies the predominant surface vegetation found in the EASE-Grid 2.0 cell at 1 km or 3 km. Refer to Table A4 for classification values. This field contains SMAP a.m.-only data.

Table A4. MODIS IGBP Land Classification and Percentage of Land Cover

Class	Description	Percentage of Land Cover
0	Water	-
1	Evergreen Needleleaf Forest	3.96
2	Evergreen Broadleaf Forest	10.04
3	Deciduous Needleleaf Forest	0.63

Class	Description	Percentage of Land Cover
4	Deciduous Broadleaf Forest	1.59
5	Mixed Forests	4.69
6	Closed Shrublands	0.55
7	Open Shrublands	18.26
8	Woody Savannas	7.52
9	Savannas	6.97
10	Grasslands	9.27
11	Permanent Wetlands	0.22
12	Croplands	8.95
13	Urban and Built-Up	0.50
14	Cropland/Natural Vegetation Mosaic	2.10
15	Snow and Ice	11.04
16	Barren or Sparsely Vegetated	13.70

landcover_class_apm_[1km/3km]

An enumerated type that specifies the predominant surface vegetation found in the EASE-Grid 2.0 cell. Refer to Table A4 for classification values. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

latitude_[1km/3km]

Latitude of the center of the EASE-Grid 2.0 cell. This field contains SMAP a.m.-only data.

latitude_apm_[1km/3km]

Latitude of the center of the EASE-Grid 2.0 cell. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

longitude_[1km/3km]

Longitude of the center of the EASE-Grid 2.0 cell. This field contains SMAP a.m.-only data.

longitude_apm_[1km/3km]

Longitude of the center of the EASE-Grid 2.0 cell. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

retrieval_qual_flag_[1km/3km]

Bit flags that record the conditions and the quality of the retrieved baseline soil moisture. When translated to decimal representation, this parameter contains an integer indicating one of the following inversion outcomes. Refer to Table A5 for bit flag definitions. This field contains SMAP a.m.-only data.

Table A5. Retrieval Quality Flag Definition

Bit	Retrieval Information	Bit Value and Definition
0	Recommended quality*	0: Soil moisture retrieval has recommended quality
		1: Soil moisture retrieval has uncertain quality
1	Retrieval attempted*	0: Soil moisture retrieval was attempted
		1: Soil moisture retrieval was skipped

2	Retrieval successful*	0: Soil moisture retrieval was successful
		1: Soil moisture retrieval was not successful
3	Radar water body detection success flag**	0 (not used; carried over from flag definitions of other SMAP products)
4	Freeze/thaw retrieval success flag***	0: Freeze/thaw retrieval ran successfully
		1: Unable to ascertain freeze/thaw conditions
5	Radar vegetation index (RVI) retrieval success flag**	0 (not used; carried over from flag definitions of other SMAP products)
6	Disaggregated brightness temperature quality*	0: Disaggregated brightness temperature retrieval ran successfully
		1: Unable to disaggregate brightness temperatures into 1 km resolution cells
7	Anomalously high soil moisture retrieval*	0: Retrieved soil moisture is within normal range, between 0.02 and porosity, as determined by soil texture
		1: Retrieved soil moisture is beyond normal range, above porosity, as determined by soil texture

* In addition to 66534, **fill/gap values** appear in the data fields to indicate more specific failed retrieval cases. These additional fill/gap values include:

65: Used for bits 0 and 6 to indicate: Retrieval not recommended (bit 0) + TB disaggregation unsuccessful (bit 6)
129: Used for bits 0 and 7to indicate: Retrieval not recommended (bit 0) + retrieved soil moisture was anomalously high (bit 7)
133: Used for bits 0, 2, and 7 to indicate: Retrieval not recommended (bit 0) + retrieval failed (bit 2) + retrieved soil moisture was anomalously high (bit 7)
135: Used for bits 0, 1, 2, and 7 to indicate: Retrieval not recommended (bit 0) + retrieval not attempted (bit 1) + retrieval failed (bit 2) + retrieved soil moisture

was anomalously high (bit 7)
199: Used for bits 0, 1, 2, 6, and 7 to indicate: Retrieval not recommended (bit 0) + retrieval not attempted (bit 1) + retrieval failed (bit 2) + retrieved soil moisture was anomalously high (bit 7) + failed TB disaggregation (bit 6); **Note:** Due to not attempting the retrieval, bits 2 and 7 remained uncleared.

** Bits 3 and 5 are always clear; there is no radar-based water body detection algorithm applied and the RVI is not computed for this product.

*** Flag is set based on value of bit 8 of *surface_flag* (GMAO Tsurf).

retrieval_qual_flag_apm_[1km/3km]

Bit flags that record the conditions and the quality of the retrieved baseline soil moisture. When translated to decimal representation, this parameter contains an integer indicating one of the following inversion outcomes. Refer to Table A5 for bit flag definitions. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

sigma0_incidence_angle_[1km/3km]

The outcome of aggregating a set of 1 km (or 3 km) incidence angle of radar backscatter measurements into a 1 km (or 3 km) EASE-Grid 2.0 cell. This field contains SMAP a.m.-only data.

sigma0_incidence_angle_apm_[1km/3km]

The outcome of aggregating a set of 1 km (or 3 km) incidence angle of radar backscatter measurements into a 1 km (or 3 km) EASE-Grid 2.0 cell. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

sigma0_vh_aggregated_[1km/3km]

The outcome of aggregating a set of 1 km (or 3 km) cross-polarized radar backscatter measurements into a 1 km (or 3 km) EASE-Grid 2.0 cell. This field contains SMAP a.m.-only data.

sigma0_vh_aggregated_apm_[1km/3km]

The outcome of aggregating a set of 1 km (or 3 km) cross-polarized radar backscatter measurements into a 1 km (or 3 km) EASE-Grid 2.0 cell. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

sigma0_vv_aggregated_[1km/3km]

The outcome of aggregating a set of 1 km (or 3 km) vertical polarization radar backscatter measurements into a 1 km (or 3 km) EASE-Grid 2.0 cell. This field contains

SMAP a.m.-only data.

sigma0_vv_aggregated_apm_[1km/3km]

The outcome of aggregating a set of 1 km (or 3 km) vertical polarization radar backscatter measurements into a 1 km (or 3 km) EASE-Grid 2.0 cell. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

soil_moisture_[1km/3km]

Representative soil moisture measurement for the 1 km (or 3 km) EASE-Grid 2.0 cell for option 1. This field contains SMAP a.m.-only data.

Note: The *soil_moisture_3km* field contains data for the baseline algorithm.

soil_moisture_apm_[1km/3km]

Representative soil moisture measurement for the 1 km (or 3 km) EASE-Grid 2.0 cell for option 1. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

soil_moisture_std_dev_[1km/3km]

Standard deviation of soil moisture measure for the 1km EASE-Grid 2.0 cell. This field contains SMAP a.m.-only data.

soil_moisture_std_dev_apm_[1km/3km]

Standard deviation of soil moisture measure for the 1km EASE-Grid 2.0 cell. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

spacecraft_overpass_time_seconds_[1km/3km]

Number of seconds since a specified epoch that represents the spacecraft overpass relative to the 9 km EASE-Grid 2.0 cell that contains each 1 km (or 3 km) EASE-Grid 2.0 cell represented in this data product. This field contains SMAP a.m.-only data.

spacecraft_overpass_time_seconds_apm_[1km/3km]

Number of seconds since a specified epoch that represents the spacecraft overpass relative to the 9 km EASE-Grid 2.0 cell that contains each 1 km (or 3 km) EASE-Grid 2.0 cell represented in this data product. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

surface_flag_[1km/3km]

Bit flags that record ambient surface conditions for the EASE-Grid 2.0 cell. Refer to the *surface_flag_apm_[1km/3km]* description below for a detailed description of the *surface_flag* fields and bit flag definitions. This field contains SMAP a.m.-only data.

surface_flag_apm_[1km/3km]

A 16-bit integer field whose binary representation consists of bits that indicate the presence or absence of certain surface conditions at a grid cell. In Table A6, a '0' indicates the presence of a surface condition favorable to soil moisture retrieval. Each surface condition is numerically compared against two non-negative thresholds: T1 and T2, where T1 < T2. In most cases, when a surface condition is found to be below T1, retrieval is attempted and flagged for recommended quality. Between T1 and T2, retrieval is still attempted but flagged for uncertain quality. Above T2, retrieval is skipped. A summary of surface conditions and their thresholds are listed below. Table A6 lists surface condition bit flag definitions.

As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

Note: Bit position '0' refers to the least-significant bit. Final bit positions and definitions are subject to future revision and expansion as needed.

Table A6. Surface Condition Bit Flag Definitions

Bit	Surface Condition	T1	T2	Bit Value and Interpretation
0	Static water	0.05	0.10	0: Water fraction less than T2: • Less than T1: Retrieval attempted and flagged for recommended quality • Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped
1	Radar-derived water body detection	0.05	0.10	0: Water fraction less than T2: • Less than T1: Retrieval attempted and flagged for recommended quality • Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped

2	Coastal proximity	N/A	1.0	0: Distance to nearby significant water bodies greater than T2 (number of 36-km grid cells): • Greater than T2: Retrieval attempted and flagged for recommended quality • Less than T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise:
3	Urban area	0.25	0.50	0: Urban fraction less than T2: • Less than T1: Retrieval attempted and flagged for recommended quality • Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped
4	Precipitation	0.05	0.10	0: Precipitation fraction less than T2: • Less than T1: Retrieval attempted and flagged for recommended quality • Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped

5	Snow or ice	0.05	0.10	0: Snow fraction less than T2: • Less than T1: Retrieval attempted and flagged for recommended quality • Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped
6	Permanent snow or ice	0.05	0.10	0: Ice fraction less than T2: • Less than T1: Retrieval attempted and flagged for recommended quality • Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped
7	Radar frozen ground* (from Sentinel-1 radar-derived F/T state)	0.00	0.90	0: Freeze/thaw fraction less than T2: • Less than T1: Retrieval attempted and flagged for recommended quality • Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped
8	Model frozen ground (from GMAO TSURF)	0.00	0.90	0: Freeze/thaw fraction less than T2: • Less than T1: Retrieval attempted and flagged for recommended quality

				• Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped
9	Mountainous terrain	3°	6°	0: Slope standard deviation less than T2: • Less than T1: Retrieval attempted and flagged for recommended quality • Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped
10	Dense vegetation	5.0	30.0	0: Vegetation Water Content (VWC) less than T2: • Less than T1 kg/m2: Retrieval attempted and flagged for recommended quality • Between T1 and T2: Retrieval attempted and flagged for uncertain quality
				1: Otherwise: • Above T2: Retrieval skipped
11	Scene edge	TBD	TBD	TBD

12	Anomalous sigma0	TBD	TBD	TBD
13-15	Undefined	N/A	N/A	0 (not used in SPL2SMP_E)

surface_temperature_[1km/3km]

Temperature at land surface based on GEOS5 GMAO; represents the effective soil temperature in radiative transfer modeling at L-band frequencies. This field contains SMAP a.m.-only data.

It has come to our attention that this parameter is often mistaken for the physical temperature of the top soil layer. The designation “effective” signifies an attempt to capture the soil integrated temperature and canopy temperature in a single parameter, as is widely reported in the literature. Depending on the actual emission sensing depth (which varies with soil moisture), this parameter usually does not coincide with a thermal physical temperature at a fixed depth (e.g. 5 cm or 10 cm).

surface_temperature_apm_[1km/3km]

Temperature at land surface based on GEOS5 GMAO; represents the effective soil temperature in radiative transfer modeling at L-band frequencies. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data. *Also as noted above, this parameter is an "effective" temperature and therefore does not usually coincide with a thermal physical temperature.*

tb_v_disaggregated_[1km/3km]

Vertical polarization brightness temperature adjusted for the presence of water bodies and disaggregated from the 9 km EASE-Grid 2.0 cells into 1 km (or 3 km) EASE-Grid 2.0 cells. This field contains SMAP a.m.-only data.

tb_v_disaggregated_apm_[1km/3km]

Vertical polarization brightness temperature adjusted for the presence of water bodies and disaggregated from the 9 km EASE-Grid 2.0 cells into 1 km (or 3 km) EASE-Grid 2.0 cells. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

tb_v_disaggregated_std_[1km/3km]

Standard deviation of the vertical polarization brightness temperature adjusted for the presence of water bodies and disaggregated from the 9 km EASE-Grid 2.0 cells into 1 km (or 3 km) EASE-Grid 2.0 cells. This field contains SMAP a.m.-only data.

tb_v_disaggregated_std_apm_[1km/3km]

Standard deviation of the vertical polarization brightness temperature adjusted for the presence of water bodies and disaggregated from the 9 km EASE-Grid 2.0 cells into 1 km (or 3 km) EASE-Grid 2.0 cells. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

vegetation_opacity_[1km/3km]

The measured opacity of the vegetation in the EASE-Grid 2.0 cell. Estimated vegetation opacity at 1 km 3 km spatial scale. Note that this parameter is the same 'tau' parameter normalized by the cosine of the incidence angle in the 'tau-omega' model, where:

$$\tau = \frac{b\,VWC}{\cos\theta}$$

The valid minimum and maximum below are subject to further analysis. This field contains SMAP a.m.-only data.

vegetation_opacity_apm_[1km/3km]

The measured opacity of the vegetation in the EASE-Grid 2.0 cell. The measured opacity of the vegetation in the EASE-Grid 2.0 cell. Estimated vegetation opacity at 1 km 3 km spatial scale. Note that this parameter is the same 'tau' parameter normalized by the cosine of the incidence angle in the 'tau-omega' model, where:

$$\tau = \frac{b\,VWC}{\cos\theta}$$

The valid minimum and maximum below are subject to further analysis. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

vegetation_water_content_[1km/3km]

Representative measure of water in the vegetation within the 1 km (or 3 km) EASE-Grid 2.0 cell. This field contains SMAP a.m.-only data.

vegetation_water_content_apm_[1km/3km]

Representative measure of water in the vegetation within the 1 km (or 3 km) EASE-Grid 2.0 cell. As noted by *apm* in the data field name, this field contains SMAP a.m.-or-p.m. data.

water_body_fraction_[1km/3km]

Fraction of the area of 1 km (or 3 km) EASE-Grid 2.0 cell that is a permanent or transient water body. Derived from the Digital Elevation Model (DEM) and radar processing. This field contains SMAP a.m.-only data.

water_body_fraction_apm_[1km/3km]

Fraction of the area of 1 km (or 3 km) EASE-Grid 2.0 cell that is a permanent or transient water body. Derived from the DEM and radar processing. As noted by *apm* in

the data field name, this field contains SMAP a.m.-or-p.m. data.

Fill/Gap Values

SMAP data products employ fill and gap values to indicate when no valid data appear in a particular data element. Fill values ensure that data elements retain the correct shape. Gap values locate portions of a data stream that do not appear in the output data file.

Fill values appear in the SPL2SMAP_S product when the SPL2SMAP_S SPS can process some, but not all, of the input data for a particular swath EASE-Grid 2.0 cell. Fill data may appear in the product in any of the following circumstances:

- One of Science Production Software (SPS) executables that generate the SPL2SMAP_S product is unable to calculate a particular science or engineering data value. The algorithm encounters an error. The error disables generation of valid output. The SPS reports a fill value instead.
- Some of the required science or engineering algorithmic input are missing. Data over the region that contributes to particular EASE-Grid 2.0 cell may appear in only some of the input data streams. Since data are valuable, the SPL2SMAP_S product records any outcome that can be calculated with the available input. Missing data appear as fill values.
- Non-essential information is missing from the input data stream. The lack of non-essential information does not impair the algorithm from generating needed output. The missing data appear as fill values.
- Fill values appear in the input SPL3SMP_E product. If only some of the input that contributes to a particular EASE-Grid 2.0 cell is fill data, the Level SPL2SMAP_S SPS will most likely be able to generate some output. However, some portion of the SPL2SMAP_S output for that EASE-Grid 2.0 cell may appear as fill values.

SMAP data products employ a specific set of data values to connote that an element is fill. The selected values that represent fill are dependent on the data type. No valid value in the SPL2SMAP_S product is equal to the values that represent fill. If any exceptions should exist in the future, the SPL2SMAP_S content will provide a means for users to discern between elements that contain fill and elements that contain genuine data values. This document will also contain a description of the method used to ascertain which elements are fill and which elements are genuine.

The SPL2SMAP_S product records gaps when entire frames within the time span of a particular data granule do not appear. Gaps can occur under one of two conditions:

- One or more complete frames of data are missing from all data streams.
- The subset of input data that is available for a particular frame is not sufficient to process any frame output.

The Level SPL2SMAP_S product records gaps in the product level metadata. The following conditions will indicate that no gaps appear in the data product:

- Only one instance of the attributes *Extent/rangeBeginningDateTime* and *Extent/rangeEndingDateTime* will appear in the product metadata.
- The character string stored in metadata element *Extent/rangeBeginningDateTime* will match the character string stored in metadata element *OrbitMeasuredLocation/halfOrbitStartDateTime*.
- The character string stored in metadata element *Extent/rangeEndingDateTime* will match the character string stored in metadata element *OrbitMeasuredLocation/halfOrbitStopDateTime*.

One of two conditions will indicate that gaps appear in the data product:

- The time period covered between *Extent/rangeBeginningDateTime* and *Extent/RangeEndingDateTime* does not cover the entire half orbit as specified in *OrbitMeasuredLocation/halfOrbitStartDateTime* and *OrbitMeasuredLocation/halfOrbitStartDateTime*.
- More than one pair of *Extent/rangeBeginningDateTime* and *Extent/rangeEndingDateTime* appears in the data product. Time periods within the time span of the half orbit that do not fall within the sets of *Extent/rangeBeginningDateTime* and *Extent/rangeEndingDateTime* constitute data gaps.

Notations

Table A7 lists the notations used in this document.

Table A7. Notation Definitions

Notation	Definition
Int8	8-bit (1-byte) signed integer
Int16	16-bit (2-byte) signed integer
Int32	32-bit (4-byte) signed integer
Uint8	8-bit (1-byte) unsigned integer
Uint16	16-bit (2-byte) unsigned integer
Float32	32-bit (4-byte) floating-point integer
Float64	64-bit (8-byte) floating-point integer
Char	8-bit character

H-pol	Horizontally polarized
V-pol	Vertically polarized

See Also

Support

How To

How do I search, order, and customize SMAP data using Earthdata Search?
In this step-by-step tutorial, we will demonstrate how to search, order, and customize NASA Soil Moisture Active Passive, or SMAP data using the NASA Earthdata Search application. NASA Earthdata search provides an interactive map-based search environment where you can filter your results based on... read more

Visualize NSIDC data as WMS layers with ArcGIS and Google Earth
NASA's Global Imagery Browse Services (GIBS) provides up to date, full resolution imagery for selected NSIDC DAAC data sets. ... read more

FAQ

What data subsetting, reformatting, and reprojection services are available for SMAP data?
The following table describes the data subsetting, reformatting, and reprojection services that are currently available for SMAP data via the NASA Earthdata Search tool and a Data Subscription... read more

Access complete Knowledge Base

Questions? Please contact:
NSIDC User Services
Phone: 1 303 492-6199
Email: nsidc@nsidc.org

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