SMAP L2 Radar/Radiometer Half-Orbit 9 km EASE-Grid Soil Moisture, Version 2

This Level-2 (L2) soil moisture product provides gridded estimates of global land surface conditions retrieved by both the Soil Moisture Active Passive (SMAP) radar and radiometer during 6:00 a.m. descending half-orbit passes. 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). A variety of ancillary data are also used as input, such as surface temperature, vegetation water content (VWC), and soil texture.

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	49 minutes
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

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 L2 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/LZIP2VM2GIA5. [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`
- `Soil_Moisture_Retrieval_Data_3km`

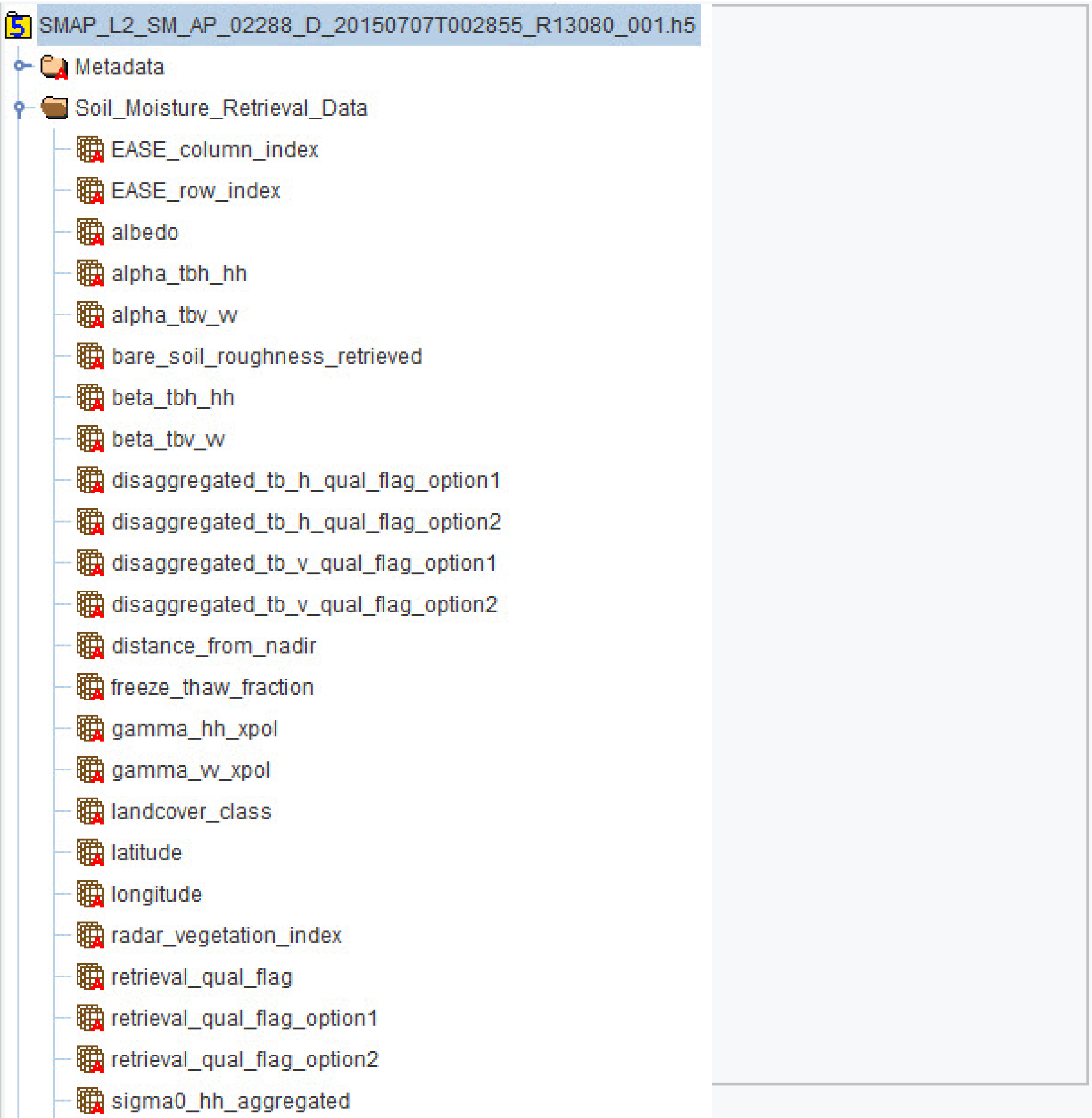

Figure 1. Partial Sample of the HDF5 File Structure

Data Fields Overview

Each Level-2 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 combined radar and radiometer soil moisture data, ancillary data, and quality assessment flags.

Soil Moisture Retrieval Data 3 km

Includes combined radar and radiometer soil moisture data at 3km, 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_L2_SM_AP_[Orbit#]_D_yyyymmddThhmmss_RLVvvv_NNN.[ext]`

For example:

`SMAP_L2_SM_AP_00934_D_20141225T074951_R12130_002.h5`

Where:

Table 1. File Naming Conventions

Variable	Description
`SMAP`	Indicates SMAP mission data
`L2_SM_AP`	Indicates specific product (`L2`: Level-2; `SM`: Soil Moisture; `AP`: Active/Passive)
`[Orbit#]`	5-digit sequential number of the orbit flown by the SMAP spacecraft when data were acquired. Orbit 00000 began at launch. Orbit numbers increment each time the spacecraft flies over the southernmost point in the orbit path.
`D`	Descending half-orbit pass of the satellite (where satellite moves from North to South, and 6:00 a.m. is the local solar equator crossing time)
`yyyymmddThhmmss`	Date/time in Universal Coordinated Time (UTC) of the first 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
`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

Each half-orbit file is approximately 27 MB using HDF compression.

Volume

The daily data volume is approximately 500 MB.

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 Coverage Map

Figure 2 shows the spatial coverage of the SMAP L-Band Radar and Radiometer for one descending half orbit, which comprises one granule of this data set.

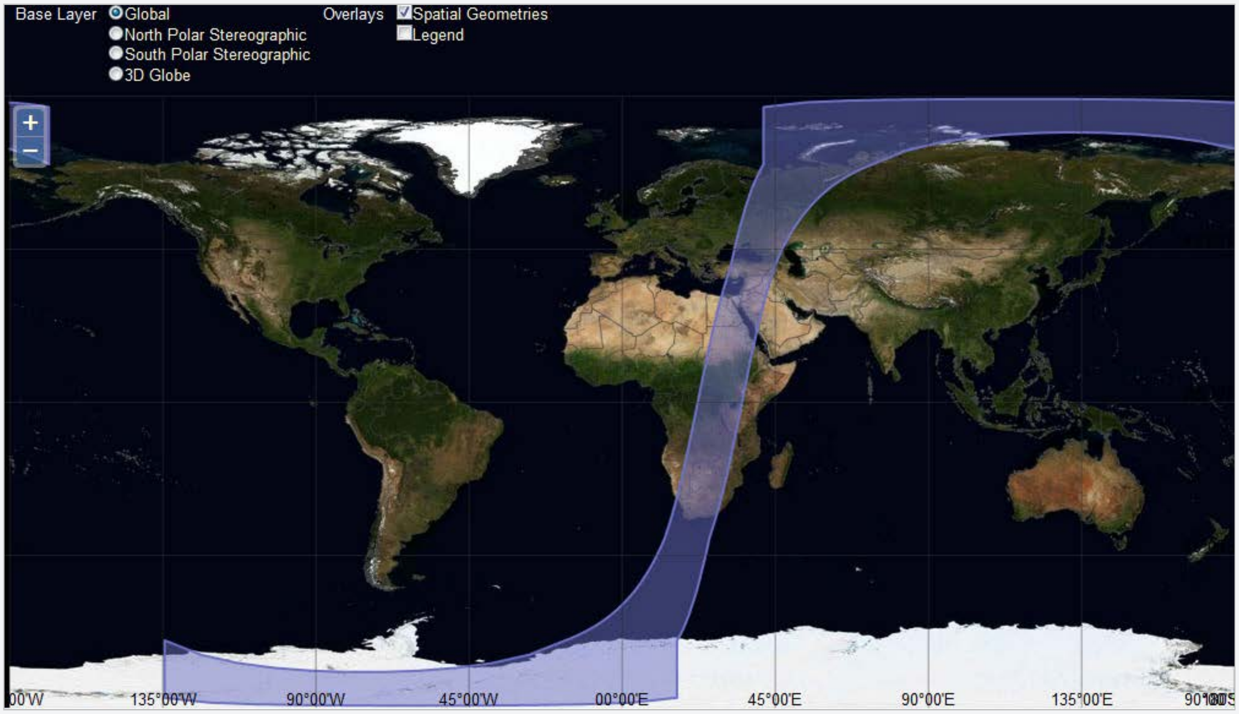

Figure 2. Spatial Coverage Map displaying one descending half orbit of the SMAP L-Band Radar and Radiometer. The map was created using the Reverb | ECHO tool.

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 SPL2SMAP 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 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.

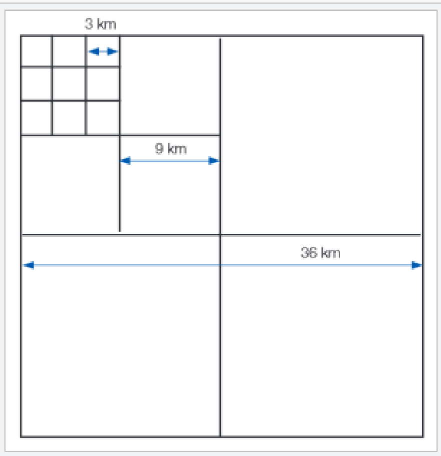

Figure 3. Perfect Nesting in EASE-Grid 2.0

Temporal Coverage

Level-2 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-2 half-orbit file spans approximately 49 minutes.

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 9 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 Reverb | ECHO, a NASA search and order tool for subsetting, reprojecting, and reformatting 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 Sources

SMAP Level-2 radar/radiometer soil moisture data (SPL2SMAP) are derived from the following:

- SMAP L2 Radar Half-Orbit 3 km EASE-Grid Soil Moisture, Version 2 (SPL2SMA)
- SMAP L2 Radiometer Half-Orbit 36 km EASE-Grid Soil Moisture, Version 2 (SPL2SMP)

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

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

SPL2SMAP data are based on the merger of SMAP radiometer and radar data at two discrete grid resolutions: 36 km and 3 km, respectively. The Equal-Area-Scalable-Earth Grid (EASE-Grid) cells of the radiometer and radar products nest perfectly; refer to the Projection and Grid Description section of this document. Therefore, the SPL2SMAP 9 km soil moisture product has 16:1 and 1:9 correspondence with the radiometer and radar products, respectively. The grid definition used in the algorithms is illustrated in Fig. 2 of the ATBD. The baseline and optional algorithms disaggregate the coarse resolution radiometer brightness temperature product based on the spatial variation in high resolution radar backscatter. In addition, the algorithms require static and dynamic ancillary data. These ancillary data are resampled to the same EASE-Grid prior to ingest in the SPL2SMAP processing. The dynamic ancillary data used to retrieve soil moisture for a particular 9 km grid cell at a specific point in time are listed in the SMAP SPL2SMAP and SPL3SMAP output files for the benefit of end users.

Refer to the Data Fields document for a description of all data fields.

Baseline Algorithm

The SPL2SMAP baseline 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 temporal fluctuations in the spatially averaged radar and radiometer measurements. The derivation of the parameters are physically possible because SMAP made coincident and constant look-angle radar and radiometer measurements; 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 radar and radiometer measurements addresses 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 Algorithm Theoretical Basis Document (ATBD) for this product (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 baseline SPL2SMAP algorithm formulation.

Once the disaggregated brightness temperatures at 9 km and 3 km are produced, the Single Channel Algorithm (SCA)/Tau-Omega model is applied that uses high-resolution ancillary information at 9 km and 3 km to produce the SPL2SMAP product.

Formulation of the Baseline SPL2SMAP 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 L-band radar measures the energy backscattered (σ0) 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, over short time periods variations soil moisture cause T_B and σ0 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 measured T_B and σ0 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 is either *vv* or *hh*. The parameter β can be statistically estimated based on a time-series regression of pairs of SMAP radiometer T_B and spatially-averaged radar data σ0 from successive observations of the same Earth grid cell. The parameter β, which represents the sensitivity of backscatter to changes in brightness temperature is highly dependent on vegetation characteristics. It is possible to categorize grid cells based on a radar vegetation index (RVI), which is directly proportional to the amount of vegetation on the land surface. RVI can be derived directly from SMAP radar measurements. Across low vegetation cover regions (low RVI), the changes in radiometer brightness temperature are also reflected in changes in radar backscatter, leading to large (negative) values of β. When the vegetation cover is dense and there is complete volume scattering from the vegetation canopy RVI reaches the upper limit of unity. For bare smooth surfaces, the cross-pol radar backscatter cross-section is insensitive to soil moisture and is much smaller than the co-pol values. This leads to a near-zero RVI.

The statistically-estimated parameter β is unique for each location since it is a sensitivity parameter relating T_B and σ0 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. Therefore the time-series pairs of T_B and σ0 are used for a location in the regression span a moving-window period over which vegetation phenology and surface characteristics can be considered constant. To develop the satellite-based active-passive algorithm further the relationship between T_B and σ0 can also be conceptually evaluated at the 9 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 regression parameters at the 9 km scale with respect to the coarser 36 km scale is to determine subgrid heterogeneity from high-resolution cross-polarization radar backscatter measurements. 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 statistically estimated parameters, which are specific for a given location and reflect the local roughness and vegetation cover conditions. The parameters vary seasonally; therefore, the time-series pairs of T_B and σ0 used for a location in the regression should be limited to a finite-length moving-window over which vegetation phenology can be considered constant. Depending on the dominant land cover vegetation, this may be as short as a few weeks for croplands and a few months for natural landscapes, especially those with evergreen (tropical or boreal) plant types. This translates to anywhere from two to about twenty or at most thirty pair of T_B and σ0 for the regression analysis. The issue is further complicated by the fact that robust estimation is possible only if there is adequate soil moisture variation within the window period (drydown or wetting event) to cause variations in both T_B and σ0. Estimates of β are based on the β-RVI relationships that are established over time. Observations from airborne field experiments show that RVI is indeed a unique and reliable estimator of β. More importantly, RVI isolates the impact of vegetation and separates the effect of surface roughness. From this point tau-omega (τ-ω) brightness temperature retrieval algorithms with considerable heritage can be used to retrieve surface soil moisture.

Algorithm Process Flow

Figure 4 is a simplified depiction of process flow for the current SPL2SMAP baseline algorithm. The process flow diagram captures important processes that involve input data streams and static and ancillary data used in the algorithm to generate the SPL2SMAP soil moisture product. The at 9 km are converted to soil moisture using algorithms described in SPL2SMP, but based on 9 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.

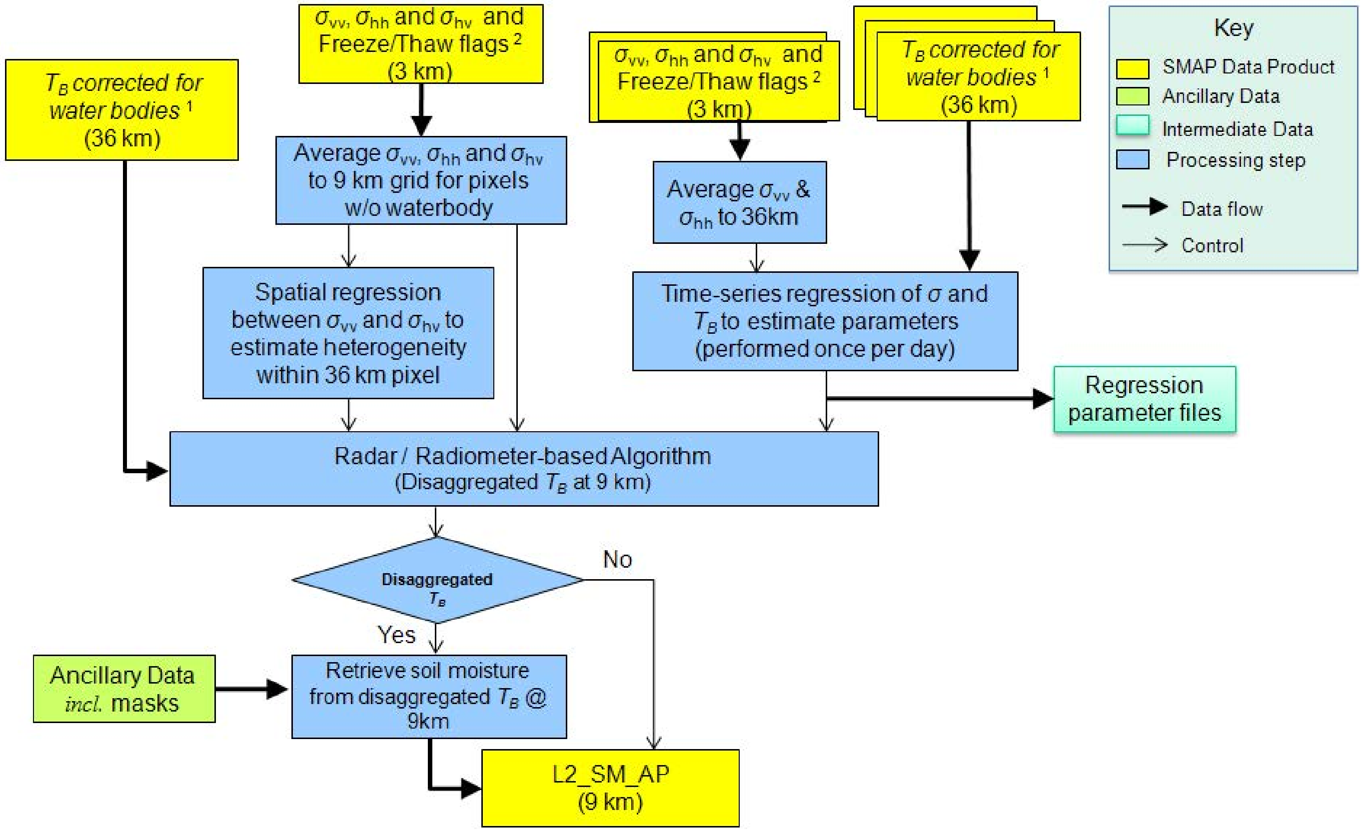

Figure 4. Process Flow Diagram of the Baseline SPL2SMAP Algorithm

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 this product, the processing software ingests the 6:00 a.m. descending half-orbit granules of the SMAP SPL2SMA and SPL2SMP products. The brightness temperature available in SPL2SMP is corrected from the presence of waterbodies (up to 0.05 fraction) and then used in SPL2SMAP product generation. Beyond waterbody fraction of 0.05, no correction is conducted as it introduces high errors due to uncertainty present in the water fraction information. The SPL2SMAP product generation process also uses the ancillary data, as well as the quality and surface flags from the SPL2SMA and SPL2SMP products. To generate the standard SPL2SMAP product, the processing software ingests the 6:00 a.m. descending half-orbit granules of the SPL2SMA and SPL2SMP data. The ingested data are then inspected for retrievability criteria according to input data quality, ancillary data availability, and land cover conditions. When retrievability criteria are met, the software invokes the baseline retrieval algorithm to generate soil moisture retrieval. Only cells that are covered by the swath are written in the product.

Error Sources

Errors in SPL2SMAP 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 radar and radiometer electronics and algorithms include design features to mitigate the effects of RFI. The SMAP radar utilized 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. Owing to such robust measures in the SMAP radiometer and radar hardware and data processing, the SPL2SMAP product has lesser impact from the anthropogenic RFI. Other sources of error are quantified analytically for the disaggregated brightness temperatures and retrieved soil moisture at 9 km and 3 km. (Entekhabi et al. 2012 and Das et al. 2015)

More information about error sources is provided in Section 4.3: Error Budget of Baseline Algorithm of the ATBD.

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 HDF5 file-level metadata.

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

If a product does not fail QA, it is ready to be used for higher-level processing, browse generation, active science QA, archive, and distribution. If a file/granule fails QA, the SDS does not send the granule to NSIDC until it is reprocessed. Level-2 products that fail QA are never delivered to NSIDC. Only a QA file is produced when there are no data that qualify for retrieval.

Quality Flags

Quality control (QC) is an integral part of the SPL2SMAP processing. The QC steps of SPL2SMAP processing are based on the flags that are provided with the input data streams (SPL2SMP, and SPL2SMA), different types of masks, flags, and fractional coverage of other variables provided by ancillary data. The SPL2SMAP will process all data that have favorable conditions for soil moisture retrieval (VWC <= 5 kg/m2, 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 > 5, 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. The product specification table provided in Section 6 of the ATBD elaborates the fields for QC bit flags. A flow diagram in Fig. 39 of the ATBD illustrates the decision tree to perform SPL2SMAP retrieval. As shown in Fig. 39, the SPL2SMAP processing involves merging of two data stream i.e., SPL2SMP and SPL2SMA. Therefore, the QC of SPL2SMAP output is influenced by these input data streams. In other words, the QC flags of SPL2SMAP output are the union of QC flags from SPL2SMP and SPL2SMA data streams. However, due to differences in spatial resolution of the (SPL2SMAP), the assignment of QC flags in SPL2SMAP may differ from the flags associated with the inputs. The thresholds of ancillary data that initiate flagging in the SPL2SMAP product are mentioned below. For example, T_B data in SPL2SMP are corrected for the presence of water bodies. Studies are being conducted to assess the quality of corrected T_B data that are acceptable and within the desired uncertainty level that could be used in SPL2SMAP processing. Preliminary assessment shows that 5% waterbodies fraction within the 36 km grid cell of SPL2SMP has acceptable quality and have low error level in degree Kelvins. All the 9 km nested grid cells of SPL2SMAP within the 36 km grid cell of SPL2SMP are flag for suspected quality if the waterbodies fraction is >5%. The water body fraction is reported for all land-based 9 km grid cells in SPL2SMAP 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 retrieval is performed at all the grid cells irrespective of VWC but QC flag set only for grid cell having VWC >5 kg/m2. Retrievals are performed for SPL2SMAP 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 SPL2SMAP product are mentioned as follows:

Open Water Body Flag

Open water fraction is determined from SMAP high-resolution radar and/or *a priori* information on permanent open freshwater from the Moderate Resolution Imaging Spectroradiometer (MODIS) MOD44W database. The SPL2SMAP Version 2 Beta 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 and radar backscatter data adversely affects the SMAP Active-Passive algorithm. Therefore specific logics are built into the SMAP Active-Passive processor to initiate flag during soil moisture retrievals. The RFI flag is initiates as follows:

- No RFI detected in T_B and σ0: Retrieve soil moisture, do not flag.
- RFI detected in T_B and repaired: Flag and retrieve soil moisture.
- RFI detected in σ0 and repaired: Flag and retrieve soil moisture.
- RFI detected in T_B and not repaired: Flag and do not retrieve soil moisture.
- RFI detected in σ0 and not repaired: Flag and do not retrieve soil moisture.

Snow Flag

The ancillary data that provide a binary indicator for 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, do not retrieve soil moisture.

Precipitation Flag

Presence of heavy rainfall during SMAP data acquisition may adversely affect the T_B and σ0 measurements. The precipitation data from Global Modeling and Assimilation Office (GMAO) is used to flag the 9 km and 3 km grid cells. SPL2SMAP retrievals will be performed irrespective of rainfall; however, the grid cell will be flagged in case of the presence of precipitation.

VWC Flag

SPL2SMAP retrievals are conducted for all the locations irrespective of VWC level. The grid cells are flagged for VWC greater than 5 kg/m2.

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 processor flag the regions having urban area as follows:

- Urban fraction is 0.00–0.25: Retrieve soil moisture, do not flag.
- Urban fraction is 0.25 - < 1.0: Flag and retrieve soil moisture.
- Urban fraction is = 1.0: Flag but do not retrieve soil moisture.

Mountain Area Flag

Statistics of mountainous regions are used to initiate flags and operational decisions during SPL2SMAP processing. The standard deviation of slope is used as a threshold to detected uneven terrain and mountainous regions. For QC related to mountainous regions, the SPL2SMAP processing is consistent with the SPL2SMP and SPL2SMA processing. Currently the SPL2SMAP 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 Data Fields document.

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., and R. S. Dunbar. 2015. SMAP Level 2 Active/Passive Soil Moisture (L2_SM_AP) Product Specification Document. SMAP Project, JPL D-72548, Jet Propulsion Laboratory, Pasadena, CA. (http://nsidc.org/data/docs/daac/smap/sp_l2_smap/pdfs/SMAP L2_SM_AP PSD_10312015.pdf, 3 MB)

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., 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

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