



SMAP L1B Radiometer Half-Orbit Time-Ordered Brightness Temperatures, Version 3

USER GUIDE

How to Cite These Data

As a condition of using these data, you must include a citation:

Piepmeyer, J. R., P. Mohammed, J. Peng, E. J. Kim, G. De Amici, and C. Ruf. 2016. *SMAP L1B Radiometer Half-Orbit Time-Ordered Brightness Temperatures, Version 3*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. <https://doi.org/10.5067/YV5VOWY5V446>. [Date Accessed].

FOR QUESTIONS ABOUT THESE DATA, CONTACT NSIDC@NSIDC.ORG

FOR CURRENT INFORMATION, VISIT <https://nsidc.org/data/SPL1BTB>



National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

The SMAP L-Band Radiometer measures antenna temperatures referenced to the instrument feedhorn before and after RFI mitigation. SMAP antenna temperatures are then used to calculate the four Stokes parameters: TV, TH, T3, and T4 at 1.41 GHz. These parameters represent the vertically and horizontally polarized brightness temperatures, and the third and fourth cross-polarized brightness temperatures, respectively. The cross-polarized T3-channel measurement can be used to correct for possible Faraday rotation caused by charged particles in the upper atmosphere.

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

1.2 File Information

1.2.1 Format

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

1.2.2 File Contents

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

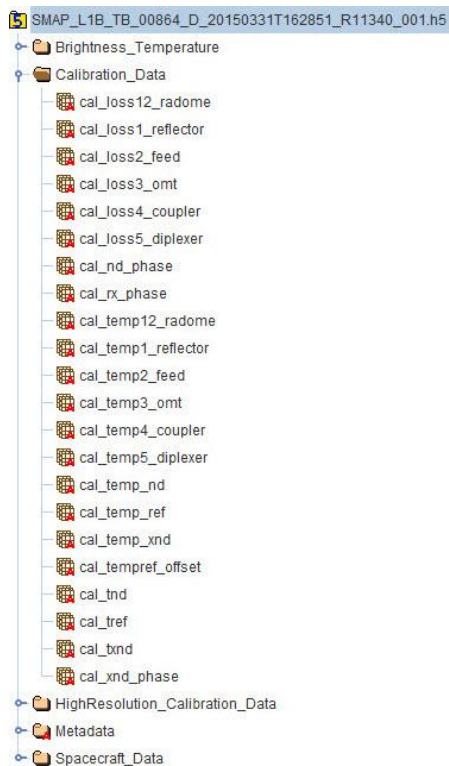


Figure 1. Subset of File Contents. For a complete list of file contents for the SMAP Level-1B brightness temperature product, refer to the Product Specification Document.

1.2.3 Data Fields

Each file contains the main data groups summarized in this section. For a complete list and description of all data fields within these groups, refer to the Product Specification Document. Note that data array dimensions and sizes vary for this product.

1.2.3.1 Brightness Temperature

Includes brightness temperatures (TBs) at each footprint referenced to the surface of the Earth with error sources removed. Undesirable radiometric sources (such as atmospheric effects and solar, lunar, and galactic emissions) are also removed. This group also includes antenna temperatures (TAs) referenced to the feedhorn before and after RFI mitigation, error source values, brightness temperature error, and Noise Equivalent Delta Temperature (NEDT). Many parameters are specifically designated for horizontal and vertical polarizations as well as the 3rd and 4th Stokes parameters.

1.2.3.2 Calibration Data

Includes fullband and subband calibration coefficients. Among these coefficients are instrument component losses, noise temperatures, physical temperatures, calibration gain and offset factors and phase values. The contents were corrected for detected RFI.

1.2.3.3 High Resolution Calibration Data

Includes subband calibration coefficients. Among these coefficients are instrument component losses, noise temperatures, physical temperatures, calibration gain and offset factors and phase values. The contents were corrected for detected RFI.

1.2.3.4 Spacecraft Data

Includes elements that specify either geometric or geographic information that are representative of each entire antenna scan of the instrument swath. Major elements include the spacecraft time, position, velocity, and attitude. Values in the spacecraft data group are representative of all brightness temperatures acquired during the corresponding antenna scan.

1.2.4 Metadata Fields

Includes all metadata that describe the full content of each file. For a description of all metadata fields for this product, refer to the [Product Specification Document](#).

1.2.5 Naming Convention

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

SMAP_L1B_TB_[Orbit#]_[A/D]_yyyymmddThhmmss_RLVvvv_NNN.[ext]

For example:

SMAP_L1B_TB_03891_D_20151024T155359_R13242_001.h5

Table 1. File Naming Conventions

Variable	Description
SMAP	Indicates SMAP mission data
L1B_TB	Indicates specific product (L1B: Level-1B; TB: Brightness Temperature)
[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.

Variable	Description								
[A/D]	Half-orbit pass of the satellite, such as: A: Ascending (where satellite moves from South to North, and 6:00 p.m. is the local solar time) D: Descending (where satellite moves from North to South, and 6:00 a.m. is the local solar time)								
yyyymmdd Thhmmss	Date/time in Universal Coordinated Time (UTC) of the first data element that appears in the product, where: <table border="1" style="margin-left: 20px;"> <tr> <td>yyyymmdd</td> <td>4-digit year, 2-digit month, 2-digit day</td> </tr> <tr> <td>T</td> <td>Time (delineates the date from the time, i.e. yyyymmddThhmmss)</td> </tr> <tr> <td>hhmmss</td> <td>2-digit hour, 2-digit month, 2-digit second</td> </tr> </table>	yyyymmdd	4-digit year, 2-digit month, 2-digit day	T	Time (delineates the date from the time, i.e. yyyymmddThhmmss)	hhmmss	2-digit hour, 2-digit month, 2-digit second		
yyyymmdd	4-digit year, 2-digit month, 2-digit day								
T	Time (delineates the date from the time, i.e. yyyymmddThhmmss)								
hhmmss	2-digit hour, 2-digit month, 2-digit second								
RLVvvv	Composite Release ID, where: <table border="1" style="margin-left: 20px;"> <tr> <td>R</td> <td>Release</td> </tr> <tr> <td>L</td> <td>Launch Indicator (1: post-launch standard data)</td> </tr> <tr> <td>V</td> <td>1-Digit Major Version Number</td> </tr> <tr> <td>vvv</td> <td>3-Digit Minor Version Number</td> </tr> </table> <p>Example: R13242 indicates a post-launch data product with a version of 3.242.</p>	R	Release	L	Launch Indicator (1: post-launch standard data)	V	1-Digit Major Version Number	vvv	3-Digit Minor Version Number
R	Release								
L	Launch Indicator (1: post-launch standard data)								
V	1-Digit Major Version Number								
vvv	3-Digit Minor Version Number								
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: <table border="1" style="margin-left: 20px;"> <tr> <td>.h5</td> <td>HDF5 data file</td> </tr> <tr> <td>.qa</td> <td>Quality Assurance file</td> </tr> <tr> <td>.xml</td> <td>XML Metadata file</td> </tr> </table>	.h5	HDF5 data file	.qa	Quality Assurance file	.xml	XML Metadata file		
.h5	HDF5 data file								
.qa	Quality Assurance file								
.xml	XML Metadata file								

1.2.6 File Size

Each half-orbit file is approximately 46 MB.

1.2.7 Volume

The daily data volume is approximately 1.4 GB.

1.3 Spatial Information

1.3.1 Coverage

Coverage spans from 180°W to 180°E, and from approximately 86.4°N to 86.4°S. The gap in coverage at both the North and South Pole, called a pole hole, has a radius of approximately 400 km. The swath width is 1000 km, enabling nearly global coverage every three days.

1.3.2 Spatial Coverage Map

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

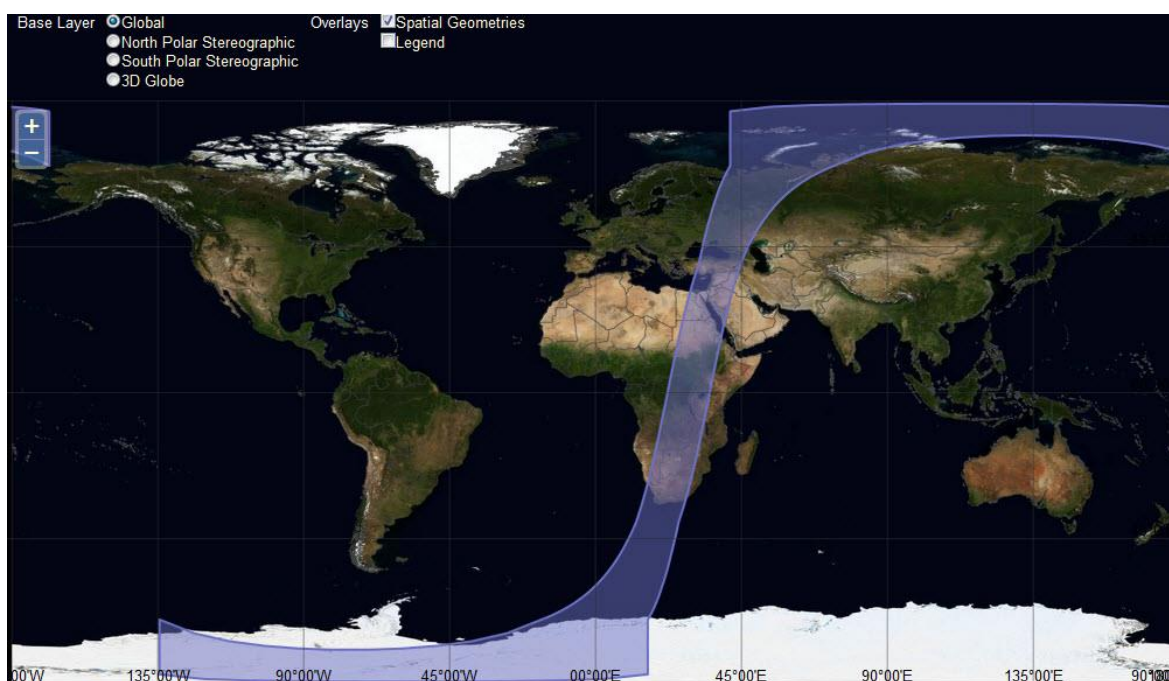


Figure 2. Spatial Coverage Map displaying one descending half orbit of the SMAP L-Band Radiometer. The map was created using the Reverb | ECHO tool.

1.3.3 Resolution

The instantaneous field of view of the radiometer footprint is approximately 36 x 47 km; the effective field of view of brightness temperatures in the Level-1B brightness temperature product is 39 x 47 km. The native spatial resolution of the radiometer footprint is approximately 40 km.

1.4 Temporal Information

1.4.1 Coverage

Coverage spans from 31 March 2015 to present.

1.4.2 Temporal Coverage Gaps

1.4.2.1 Satellite and Processing Events

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

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

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

1.4.2.2 Latencies

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

1.4.3 Resolution

Each Level-1B half-orbit file spans approximately 49 minutes.

2 DATA ACQUISITION AND PROCESSING

2.1 Background

This section has been adapted from Piepmeier et al. (2015). SMAP Level-1B radiometer brightness temperatures are processed from SMAP L1A Radiometer Time-Ordered Parsed Telemetry, Version 3 (SPL1AP). The Level-1A radiometer product contains parsed radiometer instrument telemetry.

2.2 Acquisition

2.2.1 Theory of Measurements

The objective of the Level-1B brightness temperature algorithm is to convert digital counts in the instrument telemetry into into time-ordered, geolocated brightness temperatures within the main

beam referenced to the Earth's surface. The algorithm theory is similar to what has been developed and implemented for decades for other satellite radiometers. SMAP includes two key features heretofore absent from satellite-borne radiometers: RFI detection and mitigation, and measurement of the third and fourth Stokes parameters using digital correlation.

This section contains a description of the sources contributing to the total apparent temperature seen at the input to the SMAP main reflector. The brightness temperature of a source (measured in kelvins) can be described in terms of the product of the physical temperature and the emissivity of the source. Emissivity is, in general, polarization-dependent, thus differentiating brightness temperature into TBV and TBH for the vertical and horizontal polarizations, respectively. These are the first two modified Stokes parameters. The real part of the complex correlation between these two components is measured by the third modified Stokes parameter, represented in brightness temperatures as T3. The fourth Stokes parameter, T4 measures the imaginary part of the correlation. For this document, a vector of modified Stokes parameters is shown by:

$$\bar{T}_B(\theta, \phi) = \begin{bmatrix} T_v \\ T_h \\ T_3 \\ T_4 \end{bmatrix} \quad \text{(Equation 1)}$$

where θ and Φ are the elevation and azimuth of a spherical coordinate system centered on the radiometer antenna boresight vector. Important sources of radiation at L-band are the Earth's land and sea, the cosmic background radiation, the sun, radiation sources outside our solar system, and the moon.

For an in-depth description of the theory of these measurements, refer to Section 4: Forward Model (TA to TB) of the [ATBD](#) for this product.

2.2.2 Derivation Technique and Algorithms

The raw radiometer instrument counts are converted to antenna temperatures and then to brightness temperatures to produce SMAP Level-1A and Level-1B products. The input data to the Level-1B brightness temperature algorithm are the [SMAP L1A Radiometer Time-Ordered Parsed Telemetry, Version 3](#) data. The Level-1A Science Processing Software produces the Level-1A product in accordance with the Earth Observing System (EOS) Data Product Levels definition, which states that Level-1A data products are reconstructed, unprocessed instrument data at full resolution, are time-referenced and annotated with ancillary information.

The Level-1B radiometer brightness temperature Science Processing Software geolocates and radiometrically calibrates the Level-1A data to obtain antenna temperatures (TA). Subsequent processing performs algorithms that detect and flag pixels for RFI. The data are then time and frequency averaged near the antenna's angular Nyquist rate. Finally, the Level-1B algorithm compensates for sources of error or sources of radiometric energy not associated with emissivity of the Earth's surface. Those sources include Faraday rotation, energy detected by antenna sidelobes and spillover, atmospheric effects, solar radiation, lunar radiation, cosmic microwave background, and galactic emission.

For more details regarding the algorithm used to generate this product, refer to Section 5: Calibration Algorithm of the [ATBD](#) for this product.

2.3 Processing

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 both descending and ascending half-orbit files of the Level-1A brightness temperature data. The descending half orbits contain data acquired at very nearly 6:00 a.m. local solar time. The ascending half orbits contain data acquired at very nearly 6:00 p.m. local solar time.

The total number of radiometer science packets per antenna scan varies depending on the antenna rotation rate and integration time of the instrument. The resulting number of antenna footprints per scan is therefore variable. To preserve the shape of stored data elements, the size of certain dimensions is assigned a maximum value. Thus, fill values appear in the SMAP Level-1B brightness temperature product when a particular scan does not contain the maximum possible number of footprints.

Antenna Temperatures (TAs) are processed by RFI detection and mitigation algorithms (see Error Sources) where the pixels for a footprint that are flagged for RFI are removed and the remaining clean pixels are averaged to form an RFI-free antenna footprint. If all pixels for a particular footprint are flagged for RFI then the footprint antenna temperature is assigned the null value. The corresponding footprint brightness temperature (TB) value will also be assigned the null value since the RFI-free antenna footprint antenna temperatures are used to produce the time-ordered brightness temperature product. Subsequently, after pixels with RFI are flagged and dropped, the remaining clean pixels are used to compute the NEDT for that footprint. If all pixels are removed, the null value is assigned to the NEDT for that footprint. For a more details, refer to Section C. RFI Detection and Mitigation (p. 33) of the [SMAP Handbook](#).

2.4 Quality, Errors, and Limitations

2.4.1 Quality Assessment

For in-depth details regarding the quality of these Version 2 Validated data, refer to the following reports:

[Validated Assessment Report](#)

[Beta Assessment Report](#)

SMAP data sets provide multiple means to assess quality. Each data set contains bit flags, uncertainty measures, and file-level metadata that provide quality information. The Product Specification Document describes the specific bit flags, uncertainty measures, and file-level metadata contained in this data set.

Each SMAP HDF5 data file contains metadata with Quality Assessment (QA) metadata flags. These QA metadata flags are calculated and set by the SDS at JPL prior to delivery to the National Snow and Ice Data Center Distributed Active Archive Center (NSIDC DAAC). A separate, ISO 19115-compliant metadata file with an .xml file extension is also delivered to NSIDC DAAC with the HDF5 data file; it contains the same information as the file-level metadata.

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

In addition, various levels of QA are conducted with Level-1B data. If a file passes QA, the SDS applies that file for higher-level processing, browse generation, active science QA, and data archive and distribution. If a product fails QA, it is never delivered to NSIDC DAAC.

2.4.2 Errors

L-Band anthropogenic Radio Frequency Interference (RFI), principally from ground-based surveillance radars, can contaminate radiometer measurements. Early measurements and results from the European Space Agency Soil Moisture and Ocean Salinity (SMOS) mission indicate that, in some regions, RFI is present and detectable. The SMAP radiometer electronics and algorithms have been designed to include features to mitigate the effects of RFI. The SMAP radiometer implements a combination of time and frequency diversity, kurtosis detection, and the use of 3rd and 4th Stokes parameter thresholds to detect and where possible mitigate RFI. Data elements associated with subbands are included in the Level-1B radiometer product to track and enable RFI detection and mitigation.

The input Level-1A radiometer data can also contain bit errors caused by noise in communication links and memory storage devices. The packets produced by the Consultative Committee on Space Data Systems (CCSDS) include error-detecting Cyclic Redundancy Checks (CRCs), which the Level-1A processor uses to flag errors.

2.5 Instrumentation

2.5.1 Description

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

3 SOFTWARE AND TOOLS

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

4 CONTACTS AND ACKNOWLEDGMENTS

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6 DOCUMENT INFORMATION

6.1 Publication Date

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6.2 Date Last Updated

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