SMAP L1A Radiometer Time-Ordered Parsed Telemetry, Version 2

USER GUIDE

How to Cite These Data

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

Piepmeier, J. R., E. J. Kim, P. Mohammed, J. Peng, and C. Ruf. 2015. *SMAP L1A Radiometer Time-Ordered Parsed Telemetry, Version 2*. [Indicate subset used]. Boulder, Colorado USA. NASA National Snow and Ice Data Center Distributed Active Archive Center. https://doi.org/10.5067/JGV8EY3FGAH1. [Date Accessed].

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

FOR CURRENT INFORMATION, VISIT https://nsidc.org/data/SPL1AP

National Snow and Ice Data Center

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1 DATA DESCRIPTION

1.1 Parameters

The Level-1A product includes scaled radiometer counts for the first four statistical moments of the vertically and horizontally polarized signals, as well as the complex cross-correlation between the polarizations. In subsequent processing, the first and second raw moments are used to compute a second central moment, which is the output of a conventional radiometer. The kurtosis is computed using all four raw moments, which is used in RFI detection and mitigation. The complex cross-correlation is used to compute the third and fourth Stokes parameters. All data have an effective 12 bits of resolution and are scaled to single-precision floating point numbers with consistent units.

Refer to the Appendix of this 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 five main groups, which contain additional groups and/or data sets. Files contain both fullband and subband data, referred to as moments data and high-resolution moments data, respectively. Fullband moments data are acquired over the entire 24 MHz radiometer bandwidth, and subband high resolution moments data are acquired for each of the 16 subbands within the 24 MHz bandwidth. Each subband has a 1.5 MHz bandwidth.

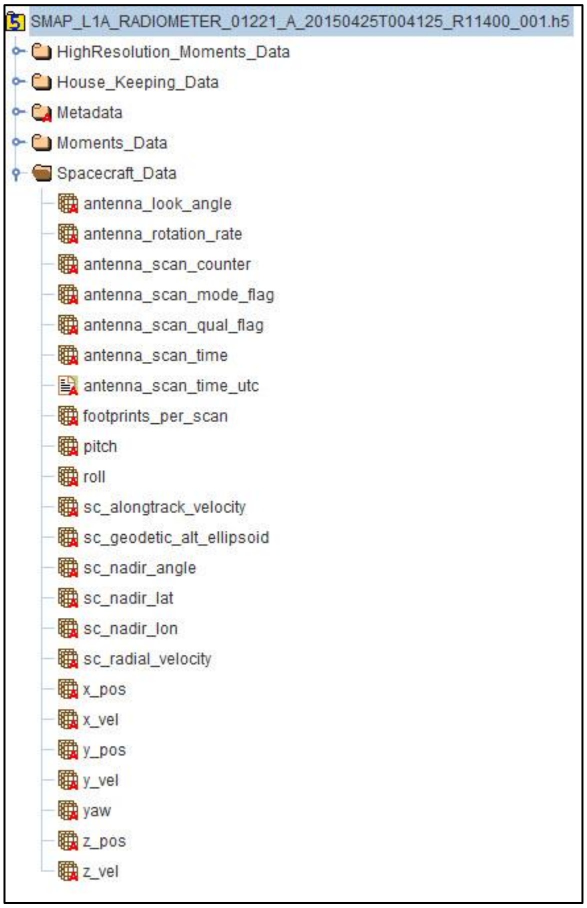

Figure 1. Subset of File Contents. For a complete list of file contents for the SMAP Level-1A telemetry product, refer to the Appendix.

The five main groups are summarized below. For a complete list and description of all data fields within these groups, refer to the Appendix of this document. Note that data array dimensions and sizes vary for this product.

High Resolution Moments Data

Includes the first four sample raw moments of the 16 subband signals parsed into five radiometric states. The moments are provided for both vertical (V) and horizontal (H) polarizations, and separately expressed in terms of the in-phase (real) and quadrature (imaginary) components of the signals. The complex cross-correlations of the two polarizations are also included for each of the 16 subbands.

HOUSEKEEPING DATA

Includes housekeeping telemetry or engineering data in both digital numbers and engineering units for each scan.

MOMENTS DATA

Includes the first four sample raw moments of the fullband signal parsed into five radiometric states. The moments are provided for both vertical and horizontal polarizations and separately expressed in terms of the in-phase (real) and quadrature (imaginary) components of the signals. Also included are the complex cross-correlations of the two polarizations.

SPACECRAFT DATA

Includes data for an entire antenna scan in the instrument swath, such as geometric and geographic information, spacecraft attitude, spacecraft nadir longitude and latitude, as well as representative time stamps.

1.2.3 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.

1.2.4 File Naming Convention

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

`SMAP_L1A_RADIOMETER_[Orbit#]_[A/D]_yyyymmddThhmmss_RLVvvv_NNN.[ext]`

For example:

`SMAP_L1A_RADIOMETER_00934_D_201510245T195920_R12242_001.h5`

Where:

Table 1. File Naming Conventions

Variable	**Description**
SMAP	Indicates SMAP mission data
L1A_RADIOMETER	Indicates specific product (L1A: Level-1A)
[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.
[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)

<table>
<tr><th>Variable</th><th>Description</th></tr>
<tr><td>yyyymmddThhmmss</td><td>Date/time in Universal Coordinated Time (UTC) of the first data element that appears in the product, where:
<table>
<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 minute, 2-digit second</td></tr>
</table></td></tr>
<tr><td>RLVvvv</td><td>Composite Release ID, where:
<table>
<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>
Example: R12242 indicates a standard data product with a version of 2.242. Refer to the SMAP Data Versions page for version information.</td></tr>
<tr><td>NNN</td><td>Number of times the file was generated under the same version for a particular date/time interval (002: 2nd time)</td></tr>
<tr><td>.[ext]</td><td>File extensions include:
<table>
<tr><td>.h5</td><td>HDF5 Data File</td></tr>
<tr><td>.qa</td><td>Quality Assessment File</td></tr>
<tr><td>.xml</td><td>XML Metadata File</td></tr>
</table></td></tr>
</table>

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. Fullband moments and cross-correlation data are collected globally. High resolution subband moments and cross-correlation data are collected over all land areas and two regions used for calibration—one in the South Pacific Ocean and one in Antarctica. If a portion of the radiometer scan covers land, the entire scan will contain high resolution data, resulting in some ocean coverage near coastal areas.

1.3.2 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.

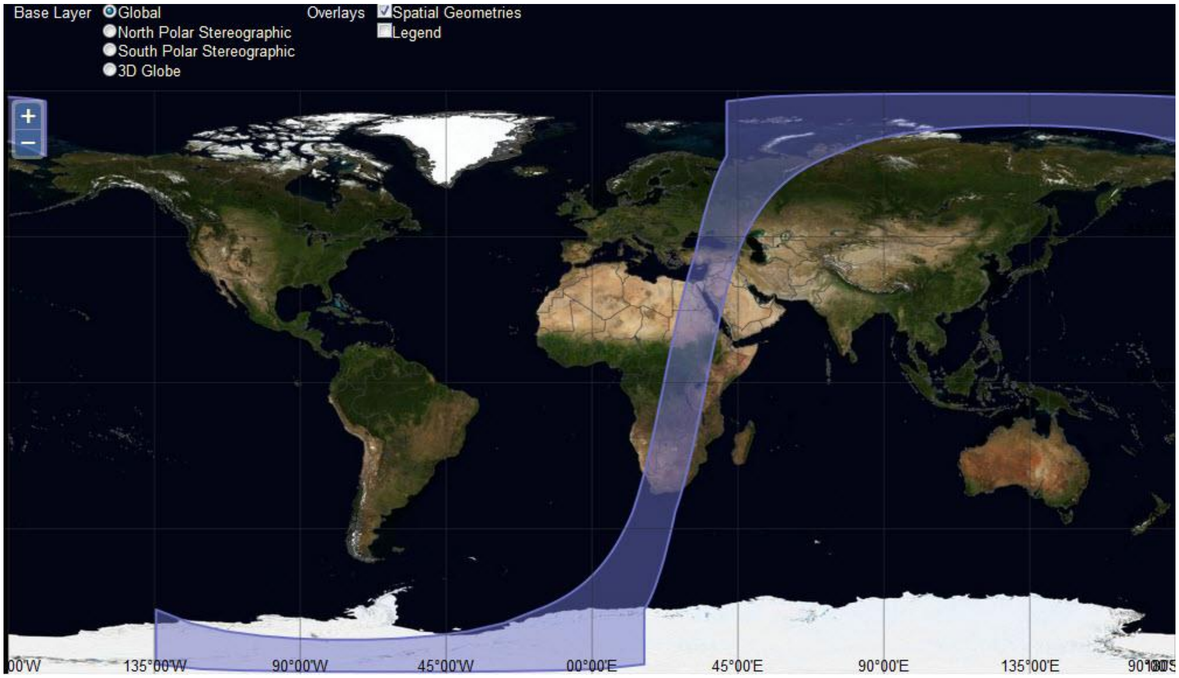

Figure 2. Spatial Coverage Map displaying one descending half orbit of the SMAP L-Band Radiometer. The map was created using Reverb | ECHO.

1.3.3 Resolution

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 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

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.

1.4.3 Latencies

FAQ: What are the latencies for SMAP radiometer data sets?

1.4.4 Resolution

Each half orbit spans approximately 49 minutes. The data sampling interval is approximately 350 µs for fullband moments data and 1.2 msec for subband high resolution moments data. The subband sampling interval represents a science packet, which covers four Pulse Repetition Intervals (PRIs).

2 DATA ACQUISITION AND PROCESSING

2.1 Instrumentation

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

2.2 Acquisition

SMAP Level-1A time-ordered instrument counts are processed from Level-0, Version 1 science packet data.

2.3 Processing

2.3.1 Overview

The SMAP Science Data System (SDS) at the Jet Propulsion Laboratory in Pasadena, California generates the Level-1A radiometer product from downlinked radiometer telemetry. Each Level-1A product contains a time-ordered series of instrument counts. These counts are extracted and scaled from instrument packets that conform to Consultative Committee on Space Data Systems (CCSDS) standards. The Level-1A sorts the packets based on the radiometric states, which are described below. Each data set associated with a specific packet of radiometer counts is labeled with a time stamp that records the instant of instrument acquisition. The Level-1A product also contains a set of housekeeping telemetry converted to engineering units for each scan.

The science telemetry includes the first four raw moments of the fullband (24-MHz wide) and 16 subband (each 1.5 MHz wide) signals, for both vertical and horizontal polarization. These data are separately expressed in terms of the in-phase and quadrature components of the signals. The instrument also outputs complex cross-correlation of the two polarizations for the fullband moments data as well as for the moments data that represent the 16 subband/high resolution moments data. Every science data packet therefore contains 360 elements of time-frequency data in high-rate mode and 72 elements of low-rate-mode time data. The subband data provide time and frequency diversity. These data improve detection and mitigation of RFI. Since RFI is expected mostly over land, the SMAP spacecraft downlinks high-rate-mode data over land and low-rate-mode data over oceans.

Radiometer data include science data packets that are generated once every four PRIs. For every PRI of the radar, the radiometer integrates approximately 300 μs within the receive window. The exact integration time varies based on the radar PRI length and blanking time length chosen by the instrument designers. Radiometer packets are made up of four PRIs. Each science data packet includes both fullband moments data and subband high resolution moments data for each of the four PRIs. The subband data are further integrated over each set of four PRIs yielding an integration time of approximately 1.2 ms. The radiometer timing diagram is shown in Figure 3.

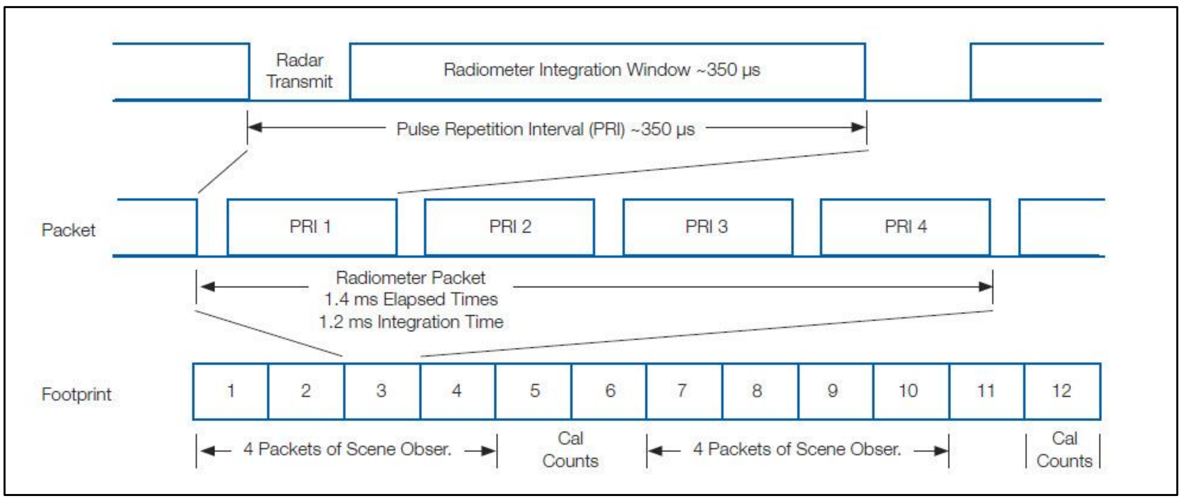

Figure 3. Radiometer Observation/Internal Calibration Timing (Entekhabi et al. 2014)

2.3.2 Radiometric States

The radiometer switching scheme indicates the radiometric state for each particular science data packet. A switch in state can occur once every packet or every four PRIs. The radiometer digital electronics control each instance when the instrument state changes during an antenna scan. The Level-1A processor employs the switching scheme to parse the raw science data. The switches that incorporate the use of the reference load and noise sources are necessary for calibration of science data. The calibration network can produce different combinations of switch and noise diode states. The default radiometer switching sequence produces five states, including:

- Antenna: Data acquired when the radiometer is switched to the antenna to observe the scene.
- Reference: Data acquired when the radiometer is switched to the reference load.
- Reference with Internal Noise Diode: Data acquired when the radiometer is switched to the reference load and the internal noise diode is turned on. The internal noise diode is coupled into both of the V and H channels.
- Antenna with External Noise Diode: Data acquired when an external noise diode is used to inject noise into the radio frequency path.
- Antenna with Internal Noise Diode: Data acquired when the radiometer is switched to the antenna to observe the scene and the internal noise diode is turned on.

2.4 Quality, Errors, and Limitations

2.4.1 Error Sources

L-band anthropogenic 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 SMAP L1B Radiometer Time-Ordered Brightness Temperatures, Version 3 to track and enable RFI detection and mitigation.

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

2.4.2 Quality Assessment

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 Appendix of this document and the Product Specification Document describe 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 the Level-1A 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.

3 SOFTWARE AND TOOLS

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

4 VERSION HISTORY

Table 2. Summary of Version Changes

Version	Date	Version Changes
V1	July 2015	First public data release
V2	October 2015	Changes to this version include: • Transitioned to Validated-Stage 2 • Calibration parameters were adjusted to reduce calibration jumps and drift previously present in the Beta-release; as a result, calibration now meets its less than 0.4 K/month stability back to 31 March 2015 • Additional bit-error checking was performed on Level-0 instrument telemetry

5 RELATED DATA SETS

SMAP Data at NSIDC | Overview

SMAP Radar Data at the ASF DAAC

6 RELATED WEBSITES

SMAP at NASA JPL

7 CONTACTS AND ACKNOWLEDGMENTS

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NASA Goddard Space Flight Center

Greenbelt, MD

8 REFERENCES

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.

Mohammed-Tano, P. 2015. Soil Moisture Active Passive (SMAP) Project Level 1A Radiometer Product Specification Document. Pasadena, CA USA: SMAP Project, JPL D-92340, Jet Propulsion Laboratory. (D-92340-A_SMAP_Radiometer_Level1A_Product_Specification_Document_150720_with sigs.pdf, 979 KB)

Piepmeier, J. R., et al., (2021). SMAP Algorithm Theoretical Basis Document: L1B Radiometer Data Product: L1B_TB (Includes L1A and L1B), Rev.D. SMAP Project, NASA GSFC SMAP-006, NASA Goddard Space Flight Center, Greenbelt, MD. (See Technical References).

9 DOCUMENT INFORMATION

9.1 Publication Date

21 December 2018

9.2 Date Last Updated

17 June 2021

APPENDIX – DATA FIELDS

This Appendix provides a description of all data fields within the *SMAP L1A Radiometer Time-Ordered Parsed Telemetry* product. The data are grouped in the following main HDF5 groups:

- HighResolution_Moments_Data
- House_Keeping_Data
- Metadata
- Moments_Data
- Spacecraft_Data

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

HighResolution_Moments_Data

Table A1 describes the data fields within the HDF5 Group called *HighResolution_Moments_Data*, which are also referred to as the fullband moments data.

Fullband moments data provide the first four sample raw moments of the fullband signal parsed into five radiometric states. The moments are provided for both vertical and horizontal polarizations and separately expressed in terms of the in-phase (real) and quadrature (imaginary) components of the signals. The 3rd and 4th Stokes parameters of the two polarizations are also included for the fullband data.

As listed in Table A1, the data elements in the *HighResolution_Moments_Data* group have varying shapes depending on the radiometric state. Radiometer data stored in this group are at the Pulse Repetition Interval (PRI) resolution. For example, the *AntennaScan_AntPRI_Polarization_Array* shape describes a three-dimensional array. The slowest moving dimension represents a particular antenna scan. The second dimension represents the maximum number of packets when the instrument is operating in the antenna radiometric state. The fastest moving dimension represents one of four polarizations, stored real h, imaginary h, real v, imaginary v. Elements with different second dimensions are associated with different radiometric states, and thus different maximum array sizes.

Table A - 1. High Resolution Moments Data Fields

Data Field Name	Type	Shape	Valid_Min	Valid_Max	Units	Fill/Gap Value
ant_16_time_seconds	Float32	AntennaScan_AntPRI_Array	N/A	N/A	seconds	-9999.0
ant_nd_16_time_seconds	Float32	AntennaScan_AntNdPRI_Array	N/A	N/A	seconds	-9999.0
ant_xnd_16_time_seconds	Float32	AntennaScan_AntXndPRI_Array	N/A	N/A	seconds	-9999.0
highresolution_scan_index	Uint32	HighResolutionScan_Array	0	800	Counts	4294967294
m1_16_ant	Float32	AntennaScan_AntPRI_Polarization_Array	-1.71x108	1.71x108	Counts	-9999.0
m1_16_ant_nd	Float32	AntennaScan_AntNdPRI_Polarization_Array	-1.71x108	1.71x108	Counts	-9999.0
m1_16_ant_xnd	Float32	AntennaScan_AntXndPRI_Polarization_Array	-1.71x108	1.71x108	Counts	-9999.0
m1_16_ref	Float32	AntennaScan_RefPRI_Polarization_Array	-1.71x108	1.71x108	Counts	-9999.0
m1_16_ref_nd	Float32	AntennaScan_RefNdPRI_Polarization_Array	-1.71x108	1.71x108	Counts	-9999.0
m2_16_ant	Float32	AntennaScan_AntPRI_Polarization_Array	0	1.47x1018	Counts	-9999.0
m2_16_ant_nd	Float32	AntennaScan_AntNdPRI_Polarization_Array	0	1.47x1018	Counts	-9999.0
m2_16_ant_xnd	Float32	AntennaScan_AntXndPRI_Polarization_Array	0	1.47x1018	Counts	-9999.0
m2_16_ref	Float32	AntennaScan_RefPRI_Polarization_Array	0	1.47x1018	Counts	-9999.0
m2_16_ref_nd	Float32	AntennaScan_RefNdPRI_Polarization_Array	0	1.47x1018	Counts	-9999.0
m3_16_ant	Float32	AntennaScan_AntPRI_Polarization_Array	-7.36x1017	7.35x1017	Counts	-9999.0
m3_16_ant_nd	Float32	AntennaScan_AntNdPRI_Polarization_Array	-7.36x1017	7.35x1017	Counts	-9999.0
m3_16_ant_xnd	Float32	AntennaScan_AntXndPRI_Polarization_Array	-7.36x1017	7.35x1017	Counts	-9999.0
m3_16_ref	Float32	AntennaScan_RefPRI_Polarization_Array	-7.36x1017	7.35x1017	Counts	-9999.0
m3_16_ref_nd	Float32	AntennaScan_RefNdPRI_Polarization_Array	-7.36x1017	7.35x1017	Counts	-9999.0
m4_16_ant	Float32	AntennaScan_AntPRI_Polarization_Array	0	2.71x1037	counts	-9999.0
m4_16_ant_nd	Float32	AntennaScan_AntNdPRI_Polarization_Array	0	2.71x1037	counts	-9999.0
m4_16_ant_xnd	Float32	AntennaScan_AntXndPRI_Polarization_Array	0	2.71x1037	counts	-9999.0
m4_16_ref	Float32	AntennaScan_RefPRI_Polarization_Array	0	2.71x1037	counts	-9999.0
m4_16_ref_nd	Float32	AntennaScan_RefNdPRI_Polarization_Array	0	2.71x1037	counts	-9999.0
moments16_declination	Float32	HighResolutionScan_AntPacket_Array	90	-90	Degrees	-9999.0

Data Field Name	Type	Shape	Valid_Min	Valid_Max	Units	Fill/Gap Value
moments16_lat	Float32	AntennaScan_AntPRI_Array	-90	90	Degrees	-9999.0
moments16_lon	Float32	AntennaScan_AntPRI_Array	-180	180	Degrees	-9999.0
moments16_right_ascension	Float32	HighResolutionScan_AntPacket_Array	0	359.999	Degrees	-9999.0
ref_16_time_seconds	Float32	AntennaScan_RefPRI_Array	N/A	N/A	seconds	-9999.0
ref_nd_16_time_seconds	Float32	AntennaScan_RefNdPRI_Array	N/A	N/A	seconds	-9999.0
t3_16_ant	Float32	AntennaScan_AntPRI_Array	-7.36x1017	7.35x1017	counts	-9999.0
t3_16_ant_nd	Float32	AntennaScan_AntNdPRI_Array	-7.36x1017	7.35x1017	counts	-9999.0
t3_16_ant_xnd	Float32	AntennaScan_AntXndPRI_Array	-7.36x1017	7.35x1017	counts	-9999.0
t3_16_ref	Float32	AntennaScan_RefPRI_Array	-7.36x1017	7.35x1017	counts	-9999.0
t3_16_ref_nd	Float32	AntennaScan_RefNdPacket_Subband_Array	-7.36x1017	7.35x1017	counts	-9999.0
t4_16_ant	Float32	AntennaScan_AntPRI_Array	-7.36x1017	7.35x1017	counts	-9999.0
t4_16_ant_nd	Float32	AntennaScan_AntNdPRI_Array	-7.36x1017	7.35x1017	counts	-9999.0
t4_16_ant_xnd	Float32	AntennaScan_AntXndPRI_Array	-7.36x1017	7.35x1017	counts	-9999.0
t4_16_ref	Float32	AntennaScan_RefPRI_Array	-7.36x1017	7.35x1017	counts	-9999.0
t4_16_ref_nd	Float32	AntennaScan_RefNdPRI_Array	-7.36x1017	7.35x1017	counts	-9999.0

House_Keeping_Data

Table A2 lists the elements in the *House_Keeping_Data* group. The data elements have varying shapes depending on the type of engineering data being stored. For example, the *AntennaScan_HouseKeepingAnalog_Array* shape describes a two-dimensional array. The slower moving array index represents each Antenna Scan. The faster moving index represents either a specific temperature monitor point, voltage or current measure.

Table A - 2. House Keeping Data Fields

Data Field Name	Type	Shape	Valid_ Min	Valid_ Max	Units	Fill/Gap Value
analog_dn	Uint16	AntennaScan_HouseKeepingAnalog_Array	0	65535	Counts	65534
analog_eu	Float32	AntennaScan_HouseKeepingAnalog_Array	N/A	N/A	Counts	-9999.0
digital_dn	Uint16	AntennaScan_HouseKeepingStatusDigital_Array	0	65535	Counts	65534
status_dn	Uint16	AntennaScan_HouseKeepingStatus_Array	0	65535	Counts	65534

Moments_Data

Table A3 describes the data fields within the HDF5 Group called *Moments_Data*, which are also referred to as subband moments data. The subband moments data provide the first four sample raw moments of the 16 subband signals parsed into five radiometric states. The moments are provided for both vertical and horizontal polarizations and separately expressed in terms of the in-phase (real) and quadrature (imaginary) components of the signals. The 3rd and 4th Stokes parameters of the two polarizations are also included for each of the 16 subbands. Radiometer data include science data packets that will be generated once every four PRIs. The data elements in the Moments Data group have varying shapes depending on the radiometric state. The switching scheme that indicates the radiometric state of a particular science data packet is pre-determined and used to parse the raw science data. For example, the *AntennaScan_Ant Packet_Subband_Polarization_Array* shape describes a four-dimensional array. The slowest moving dimension represents a particular antenna scan. The second dimension represents the maximum number of packets when the instrument is operating in the antenna radiometric state. The third dimension represents the 16 subbands. The fastest moving dimension represents one of four polarizations; the order of storage is real h, imaginary h, real v, imaginary v. Elements with different second dimensions are associated with different radiometric states, and thus different maximum array sizes.

Table A - 3. Moments Data Fields

Data Field Name	Type	Shape	Valid_Min	Valid_Max	Units	Fill/Gap Value
ant_nd_time_seconds	Float32	*AntennaScan_AntNdPacket_Array*	N/A	N/A	Seconds	-9999.0
ant_time_seconds	Float32	*AntennaScan_AntPacket_Array*	N/A	N/A	Seconds	-9999.0
ant_xnd_time_seconds	Float32	*AntennaScan_AntXndPacket_Array*	N/A	N/A	Seconds	-9999.0
m1_ant	Float32	*AntennaScan_AntPacket_Subband_Polarization_Array*	-6.85x108	6.85x108	Counts	-9999.0
m1_ant_nd	Float32	*AntennaScan_AntNdPacket_Subband_Polarization_Array*	-6.85x108	6.85x108	Counts	-9999.0
m1_ant_xnd	Float32	*AntennaScan_AntXndPacket_Subband_Polarization_Array*	-6.85x108	6.85x108	Counts	-9999.0
m1_ref	Float32	*AntennaScan_RefPacket_Subband_Polarization_Array*	-6.85x108	6.85x108	Counts	-9999.0
m1_ref_nd	Float32	*AntennaScan_RefNdPacket_Subband_Polarization_Array*	-6.85x108	6.85x108	Counts	-9999.0
m2_ant	Float32	*AntennaScan_AntPacket_Subband_Polarization_Array*	0	5.88x1018	Counts	-9999.0
m2_ant_nd	Float32	*AntennaScan_AntNdPacket_Subband_Polarization_Array*	0	5.88x1018	Counts	-9999.0
m2_ant_xnd	Float32	*AntennaScan_AntXndPacket_Subband_Polarization_Array*	0	5.88x1018	Counts	-9999.0
m2_ref	Float32	*AntennaScan_RefPacket_Subband_Polarization_Array*	0	5.88x1018	Counts	-9999.0
m2_ref_nd	Float32	*AntennaScan_RefNdPacket_Subband_Polarization_Array*	0	5.88x1018	Counts	-9999.0
m3_ant	Float32	*AntennaScan_AntPacket_Subband_Polarization_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
m3_ant_xnd	Float32	*AntennaScan_AntXndPacket_Subband_Polarization_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
m3_ant_nd	Float32	*AntennaScan_AntNdPacket_Subband_Polarization_Array*	-2.94x1018	2.94x1018	Counts	-9999.0

Data Field Name	Type	Shape	Valid_Min	Valid_Max	Units	Fill/Gap Value
m3_ref	Float32	*AntennaScan_RefPacket_Subband_Polarization_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
m3_ref_nd	Float32	*AntennaScan_RefNdPacket_Subband_Polarization_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
m4_ant	Float32	*AntennaScan_AntPacket_Subband_Polarization_Array*	0	1.09x1038	Counts	-9999.0
m4_ant_xnd	Float32	*AntennaScan_AntXndPacket_Subband_Polarization_Array*	0	1.09x1038	Counts	-9999.0
m4_ant_nd	Float32	*AntennaScan_AntNdPacket_Subband_Polarization_Array*	0	1.09x1038	Counts	-9999.0
m4_ref	Float32	*AntennaScan_RefPacket_Subband_Polarization_Array*	0	1.09x1038	Counts	-9999.0
m4_ref_nd	Float32	*AntennaScan_RefNdPacket_Subband_Polarization_Array*	0	1.09x1038	Counts	-9999.0
moments_declination	Float32	*AntennaScan_AntPRI_Array*	-90	90	Degrees	-9999.0
moments_lat	Float32	*AntennaScan_AntPacket_Array*	-90	90	Degrees	-9999.0
moments_lon	Float32	*AntennaScan_AntPacket_Array*	-180	180	Degrees	-9999.0
moments_right_ascension	Float32	*AntennaScan_AntPRI_Array*	0	359.999	Degrees	-9999.0
number_of_science_packets	Uint16	*AntennaScan_Array*	0	3624	n/a	65534
number_science_CRC_errors	Uint16	*AntennaScan_Array*	0	3624	n/a	65534
ref_nd_time_seconds	Float32	*AntennaScan_RefPacket_Array*	N/A	N/A	Seconds	-9999.0
ref_time_seconds	Float32	*AntennaScan_RefPacket_Array*	N/A	N/A	Seconds	-9999.0
science_packet_CRC_check	Char	*AntennaScan_SciencePacketCRC_Array*	N/A	N/A	N/A	N/A
t3_ant	Float32	*AntennaScan_AntPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
t3_ant_xnd	Float32	*AntennaScan_AntXndPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
t3_ant_nd	Float32	*AntennaScan_AntNdPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
t3_ref	Float32	*AntennaScan_RefPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0

Data Field Name	Type	Shape	Valid_Min	Valid_Max	Units	Fill/Gap Value
t3_ref_nd	Float32	*AntennaScan_RefNdPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
t4_ref_nd	Float32	*AntennaScan_RefNdPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
t4_ant	Float32	*AntennaScan_AntPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
t4_ant_xnd	Float32	*AntennaScan_AntXndPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
t4_ant_nd	Float32	*AntennaScan_AntNdPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
t4_ref	Float32	*AntennaScan_RefPacket_Subband_Array*	-2.94x1018	2.94x1018	Counts	-9999.0
t4_ref_nd	Float32	*AntennaScan_RefNdPRI_Array*	-7.360E17	7.350E17	Counts	-9.999E20
telemetry_mode_flag	Uint16	*AntennaScan_Array*	N/A	N/A	N/A	65534
telemetry_qual_flag	Uint16	*AntennaScan_Array*	N/A	N/A	N/A	65534

Spacecraft_Data

Table A4 describes the data fields within the HDF5 Group called *Spacecraft_Data*. All the data sets in the Spacecraft Data group have *AntennaScan_Array* shape, which describes a one-dimensional array, where each array element represents a specific antenna scan in the instrument swath. Thus, array element *x_pos(6212)* lists the representative spacecraft position in the x dimension, array element *yaw(6212)* lists the representative spacecraft yaw, and array element *sc_geodetic_alt(6212)* lists the representative spacecraft altitude for the antenna scan that was acquired within a few seconds of the time specified in array element *antenna_scan_time_utc(6212*). The precise range of time covered by each antenna scan depends on the antenna rotation rate. The nominal antenna rotation rate is 13 revolutions per minute.

Table A - 4. Spacecraft Data Fields

Data Field Name	Type	Shape	Valid Min	Valid Max	Unit	Fill/Gap Value
antenna_look_angle	Float32	AntennaScan_Array	0	180	deg	-9999.0
antenna_rotation_rate	Float32	AntennaScan_Array	13	14.6	rpm	-9999.0
antenna_scan_counter	Uint32	AntennaScan_Array	0	4294967295	count	4294967294
antenna_scan_mode_flag	Uint16	AntennaScan_Array	0	65535	N/A	65534
antenna_scan_qual_flag	Uint16	AntennaScan_Array	0	65535	N/A	65534
antenna_scan_time	Float64	AntennaScan_Array	465156000	946000000	sec	-9999.0
antenna_scan_time_utc	Char24	AntennaScan_Array	2014-10-31T00:00:00.000Z	2030-12-31T23:59:60.999Z	N/A	N/A
	Uint16	AntennaScan_Array	0	65535	N/A	65534
footprints_per_scan	Float32	AntennaScan_Array	-90	90	deg	-9999.0
pitch	Float32	AntennaScan_Array	-90	90	deg	-9999.0
roll	Float32	AntennaScan_Array	-8000	8000	m/s	-9999.0
sc_alongtrack_velocity	Float32	AntennaScan_Array	650000	900000	meters	-9999.0

Data Field Name	Type	Shape	Valid Min	Valid Max	Unit	Fill/Gap Value
sc_geodetic_alt_ellipsoid	Float32	AntennaScan_Array	0	180	deg	-9999.0
sc_nadir_angle	Float32	AntennaScan_Array	-90	90	deg	-9999.0
sc_nadir_lat	Float32	AntennaScan_Array	-180	180	deg	-9999.0
sc_nadir_lon	Float32	AntennaScan_Array	-8000	8000	m/s	-9999.0
sc_radial_velocity	Float32	AntennaScan_Array	-999999	9999999	m	-9999.0
x_pos	Float32	AntennaScan_Array	-8000	8000	m/s	-9999.0
x_vel	Float32	AntennaScan_Array	-999999	9999999	m	-9999.0
y_pos	Float32	AntennaScan_Array	-8000	8000	m/s	-9999.0
y_vel	Float32	AntennaScan_Array	-180	180	deg	-9999.0
yaw	Float32	AntennaScan_Array	-999999	9999999	m	-9999.0
z_pos	Float32	AntennaScan_Array	-8000	8000	m/s	-9999.0

Data Field Definitions

ant_16_time_seconds

The number of SI-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each antenna look packet interpolated to antenna boresight azimuth of 0 degrees. The *ant_16_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the time of each of the antenna packets in the scan.

ant_nd_16_time_seconds

The number of SI-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each antenna plus internal noise diode look packet interpolated to antenna boresight azimuth of 0 degrees. The *ant_nd_16_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the times of each of the antenna plus internal noise diode packets in the scan.

ant_xnd_16_time_seconds

The number of SI-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each antenna plus external noise diode look packet interpolated to antenna boresight azimuth of 0 degrees. The *ant_xnd_16_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the times of each of the antenna plus external noise diode packets in the scan.

highresolution_scan_index

An array of indices of the high-resolution antenna scan rotations in the current granule. The value in this array references in the matching index in the Antenna Scan array. This array is also zero-based. highresolution_scan_index is a one-dimensional array. Each array index is representative of a specific antenna scan.

m1_16_ant

The first raw moment in each packet of subband radiometer data in the antenna state, which have been integrated to four pulse repetition intervals (PRIs) or approximately 1.2 ms. The *m1_16_ant* field is a four-dimensional array. The first dimension or the slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets with data in the antenna radiometric state in the antenna scan. The number of packets in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. As a result, a maximum value is set for this dimension. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m1_16_ant_nd

The first raw moment in each packet of the subband radiometer data in the antenna plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m1_16_ant_nd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna plus noise diode state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m1_16_ant_xnd

The first raw moment in each packet of subband radiometer data in the antenna plus external noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m1_16_ant_xnd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the external noise diode radiometric state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m1_16_ref

The first raw moment of subband radiometer data in the reference state, which have been integrated to four PRIs or approximately 1.2 ms. The *m1_16_ref* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m1_16_ref_nd

The first raw moment of subband radiometer data in the reference plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m1_16_ref_nd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference plus noise diode state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_16_ant

The second raw moment in each packet of subband radiometer data in the antenna state, which have been integrated to four PRIs or approximately 1.2 ms. The *m2_16_ant*field is a four-dimensional array. The first dimension or the slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets with data in the antenna radiometric state in the antenna scan. The number of packets in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. As a result, a maximum value is set for this dimension. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_16_ant_nd

The second raw moment in each packet of subband radiometer data in the antenna plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m2_16_ant_nd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna plus noise diode state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_16_ant_xnd

The second raw moment of subband radiometer data in the antenna plus external noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m2_16_ant_xnd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the external noise diode radiometric state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_16_ref

The second raw moment of subband radiometer data in the reference state, which have been integrated to four PRIs or approximately 1.2 ms. The *m2_16_ref* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_16_ref_nd

The second raw moment of subband radiometer data in the reference plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m2_16_ref_nd* is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference plus noise diode state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_16_ant

The third raw moment in each packet of subband radiometer data in the antenna state, which have been integrated to four PRIs or approximately 1.2 ms. The *m3_16_ant* field is a four-dimensional array. The first dimension or the slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets with data in the antenna radiometric state in the antenna scan. The number of packets in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. As a result, a maximum value is set for this dimension. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_16_ant_nd

The third raw moment of subband radiometer data in the antenna plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m3_16_ant_nd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna plus noise diode state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_16_ant_xnd

The third raw moment of subband radiometer data in the antenna plus external noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m3_16_ant_xnd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the external noise diode radiometric state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_16_ref

The third raw moment of subband radiometer data in the reference state, which have been integrated to four PRIs or approximately 1.2 ms. The *m3_16_ref* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_16_ref_nd

The third raw moment of subband radiometer data in the reference plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m3_16_ref_nd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference plus noise diode state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_16_ant

The fourth raw moment in each packet of subband radiometer data in the antenna state, which have been integrated to four PRIs or approximately 1.2 ms. The *m4_16_ant* field is a four-dimensional array. The first dimension or the slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets with data in the antenna radiometric state in the antenna scan. The number of packets in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. As a result, a maximum value is set for this dimension. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_16_ant_nd

The fourth raw moment of subband radiometer data in the antenna plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m4_16_ant_nd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna plus noise diode state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_16_ant_xnd

The fourth raw moment of subband radiometer data in the antenna plus external noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m4_16_ant_xnd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the external noise diode radiometric state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_16_ref

The fourth raw moment of subband radiometer data in the reference state, which have been integrated to four PRIs or approximately 1.2 ms. The *m4_16_ref* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_16_ref_nd

The fourth raw moment of subband radiometer data in the reference plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *m4_16_ref_nd* field is a four-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference plus noise diode state in the antenna scan. The third index represents the 16 subbands and the fourth index is the polarization. Both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

moments16_declination

The declination of the spacecraft boresight vector. The *moments16_declination* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the number of packets in the anten na state in the scan.

moments16_lat

The latitude of the antenna look packet on the surface of the Earth. The *moments16_lat* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the number of packets in the antenna state in the scan.

moments16_lon

The longitude of the antenna look packet on the surface of the Earth. The *moments16_long* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the number of packets in the antenna state in the scan.

moments16_right_ascension

The right ascension of the spacecraft boresight vector. The *moments16_right_ascension* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The fa ster moving dimension index represents the number of packets in the anten na state in the scan.

ref_16_time_seconds

The number of SI-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each reference look packet interpolated to antenna boresight azimuth of 0 degrees. The *ref_16_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the time of each of the reference packets in the scan.

ref_nd_16_time_seconds

The number of SI-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each reference plus internal noise diode look packet interpolated to antenna boresight azimuth of 0 degrees. The *ref_nd_16_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the time of each of the reference plus internal noise diode packets in the scan.

t3_16_ant

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the antenna state, which have been integrated to four PRIs or approximately 1.2 ms. The *t3_16_ant* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna radiometric state in the antenna scan. The number of packets in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. The third index represents the 16 subbands.

t3_16_ant_nd

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the antenna state plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *t3_16_ant_nd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna plus noise diode state in the antenna scan. The third index represents the 16 subbands.

t3_16_ant_xnd

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the antenna state plus external noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *t3_16_ant_xnd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna plus external noise diode state in the antenna scan. The third index represents the 16 subbands.

t3_16_ref

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the reference state, which have been integrated to four PRIs or approximately 1.2 ms. The *t3_16_ref* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference state in the antenna scan. The third index represents the 16 subbands.

t3_16_ref_nd

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the reference plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *t3_16_ref_nd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference plus noise diode state in the antenna scan. The third index represents the 16 subbands.

t4_16_ant

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the antenna state, which have been integrated to four PRIs or approximately 1.2 ms. The *t4_16_ant* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna state in the antenna scan. The number of packets in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. The third index represents the 16 subbands.

t4_16_ant_nd

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the antenna state plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *t4_16_ant_nd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna plus noise diode state in the antenna scan. The third index represents the 16 subbands.

t4_16_ant_xnd

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the antenna state plus external noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *t4_16_ant_xnd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the antenna plus external noise diode state in the antenna scan. The third index represents the 16 subbands.

t4_16_ref

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the reference state, which have been integrated to four PRIs or approximately 1.2 ms. The *t4_16_ref* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference state in the antenna scan. The third index represents the 16 subbands.

t4_16_ref_nd

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for subband radiometer data in the reference plus internal noise diode state, which have been integrated to four PRIs or approximately 1.2 ms. The *t4_16_ref_nd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of packets in the reference plus noise diode state in the antenna scan. The third index represents the 16 subbands.

analog_dn

The analog data from the engineering telemetry such as temperatures, voltages and current monitor points in digital numbers. The *analog_dn* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents all the analog data from the engineering telemetry packet for that particular scan. These data points can be found in words 74 to 233 of the engineering telemetry.

analog_eu

The analog data from the engineering telemetry such as temperatures, voltages and current monitor points in engineering units. The *analog_eu i*s a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents all the analog data from the engineering telemetry packet for that particular scan. These data points correspond to the words found in 74 to 233 of the engineering telemetry. These data points are converted to engineering units.

digital_dn

The digital data from the engineering telemetry in digital numbers. The *digital_dn* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents all the digital data from the engineering telemetry packet for that particular scan. These data points can be found in words 23 to 73 of the engineering telemetry.

status_dn

The status data from the engineering telemetry in digital numbers. The *status_dn* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents all the status data from the engineering telemetry packet for that particular scan. These data points can be found in words 1 to 22 of the engineering telemetry.

ant_nd_time_seconds

The number of SI-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each antenna plus internal noise diode look PRI interpolated to antenna boresight azimuth of 0 degrees. The *ant_nd_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the time for the antenna plus internal noise diode PRIs in the scan.

ant_time_seconds

The number of International System of Units (SI)-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each antenna look PRI interpolated to antenna boresight azimuth of 0 degrees. The *ant_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the time of the antenna PRIs in the scan.

ant_xnd_time_seconds

The number of SI-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each antenna plus external noise diode look PRI interpolated to antenna boresight azimuth of 0 degrees. The *ant_xnd_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the time of the antenna plus external noise diode PRIs in the scan.

m1_ant

The first raw moment in each packet of the fullband radiometer data in the antenna state, which have been integrated to approximately 300 μs or one PRI. The *m1_ant* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs acquired in the antenna radiometric state in the antenna scan. The number of PRIs in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. The third index is the polarization where both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m1_ant_nd

The first raw moment of fullband radiometer data in the antenna plus internal noise diode state, which have been integrated to approximately 300 μs or one PRI. The*m1_ant_nd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m1_ant_xnd

The first raw moment of fullband radiometer data in the antenna plus external noise diode state, which have been integrated to approximately 300 μs or one PRI. The*m1_ant_xnd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m1_ref

The first raw moment of fullband radiometer data in the reference state, which have been integrated to approximately 300 µs or one PRI. The *m1_ref* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m1_ref_nd

The first raw moment of fullband radiometer data in the reference plus internal noise diode state, which have been integrated to approximately 300 µs or one PRI. The m1_ref_nd field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference plus noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_ant

The second raw moment of fullband radiometer data in the antenna state, which have been integrated to approximately 300 µs or one PRI. The *m2_ant* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna state in the antenna scan. The number of PRIs in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. The third index is the polarization where both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_ant_nd

The second raw moment of fullband radiometer data in the antenna plus internal noise diode state, which have been integrated to approximately 300 µs or one PRI. The*m2_ant_nd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus noise diode in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_ant_xnd

The second raw moment of fullband radiometer data in the antenna plus external noise diode state, which have been integrated to approximately 300 µs or one PRI. The *m2_ant_xnd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus external noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_ref

The second raw moment of fullband radiometer data in the reference state, which have been integrated to approximately 300 μs or one PRI. The *m2_ref* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m2_ref_nd

The second raw moment of subband radiometer data in the reference plus internal noise diode state, which have been integrated to approximately 300 μs or one PRI. The*m2_ref_nd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference plus noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_ant

The third raw moment of fullband radiometer data in the antenna state, which have been integrated to approximately 300 μs or one PRI. The *m3_ant* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna state in the antenna scan. The number of PRIs in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. The third index is the polarization where both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_ant_nd

The third raw moment of fullband radiometer data in the antenna plus internal noise diode state, which have been integrated to approximately 300 μs or one PRI. The*m3_ant_nd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_ant_xnd

The third raw moment of fullband radiometer data in the antenna plus external noise diode state, which have been integrated to approximately 300 µs or one PRI. The*m3_ant_xnd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus external noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_ref

The third raw moment of subband radiometer data in the reference state, which have been integrated to approximately 300 µs or one PRI. The m3_ref field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m3_ref_nd

The third raw moment of fullband radiometer data in the reference plus internal noise diode state, which have been integrated to approximately 300 µs or one PRI.
The *m3_ref_nd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference plus noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_ant

The fourth raw moment of fullband radiometer data in the antenna state, which have been integrated to approximately 300 µs or one PRI. The *m4_ant* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna state in the antenna scan. The number of PRIs in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan. The third index is the polarization where both vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_ant_nd

The fourth raw moment of fullband radiometer data in the antenna plus internal noise diode state, which have been integrated to approximately 300 µs or one PRI. The
m4_ant_nd field is a three-dimensional array. The slowest moving dimension index represents the

antenna scan. The second dimension index represents the number of PRIs in the antenna plus noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_ant_xnd

The fourth raw moment of fullband radiometer data in the antenna plus external noise diode state, which have been integrated to approximately 300 µs or one PRI. The*m4_ant_xnd* field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus external noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_ref

The fourth raw moment of fullband radiometer data in the reference state, which have been integrated to approximately 300 µs or one PRI. The m4_16_ref field is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

m4_ref_nd

The fourth raw moment of fullband radiometer data in the reference plus internal noise diode state, which have been integrated to approximately 300 µs or one PRI.
m4_ref_nd is a three-dimensional array. The slowest moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference plus noise diode state in the antenna scan. The third index is the polarization where the vertical and horizontal polarizations are separated into their in-phase and quadrature components. The order of storage is real h, imaginary h, real v, imaginary v.

moments_declination

The declination of the spacecraft boresight vector. The *moments_declination* field is a two-dimensional array. The slower moving dime nsion index represents the antenna scan. The faster moving dimension index represents the number of PRIs in the antenna state in the scan.

moments_lat

The latitude of the antenna look PRI on the surface of the Earth. The *moments_lat* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the number of PRIs in the antenna state in the scan.

moments_lon

The longitude of the antenna look PRI on the surface of the Earth. The *moments_long* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the number of PRIs in the antenna state in the scan.

moments_right_ascension

The right ascension of the spacecraft boresight vector. The *moments_right_ascension* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the number of PRIs in the antenna state in the scan. The longitude of the antenna look PRI on the surface of the Earth. The *moments_long* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the number of PRIs in the antenna state in the scan.

number_of_science_packets

The number of science telemetry packets that appear in each antenna scan. Based on the instrument PRI and the spacecraft antenna rotation rate, the maximum number of science packets in a telemetry scan is 3624.

number_science_CRC_errors

The number of science telemetry packets with detected Cyclic Redundancy Check (CRC) errors within each antenna scan. The corresponding element in the array*number_of_science_packets* specifies the maximum number of CRC errors that might be flagged in the scan. The *number_science_CRC_errors* fieldis a one-dimensional array. Each array index is representative of a specific antenna scan.

ref_nd_time_seconds

The number of SI-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each reference plus internal noise diode look PRI interpolated to antenna boresight azimuth of 0 degrees. The *ref_nd_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the time for the reference plus internal noise diode PRIs in the scan.

ref_time_seconds

The number of SI-compatible seconds since 11:58:55.816 on 01 January 2000 UTC for each reference look PRI interpolated to antenna boresight azimuth of 0 degrees. The*ref_time_seconds* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the time for the reference PRIs in the scan.

science_packet_CRC_check

A bit packed string that indicates whether a CRC failed for any of the science telemetry packets within the current antenna scan. The string size is adjustable based on the number of bits required to represent all of the science telemetry packets in the largest antenna scan in the L1A Radiometer product. Based on the PRI and the spacecraft antenna rotation rate, the maximum number of scienc e telemetry packets in an antenna scan is 324. Thus, the maximum size of the bit packed string is 453 bytes or 3624 bits. Each bit in the *science_packet_CRC_check* field represents a science telemetry packet. The order of the bits in *science_packet_CRC_check* corresponds precisely with science packets in the telemetry. *Science_packet_CRC_check* is a two-dimensional array. The slower moving dimension index represents the antenna scan. The faster moving dimension index represents the number of bytes required to represent all of the science telemetry packets within each scan.

t3_ant

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the antenna state, which have been integrated to approximately 300 μs or one PRI. The *t3_ant* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna state in the antenna scan. The number of PRIs in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan.

t3_ant_nd

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the antenna state plus internal noise diode state, which have been integrated to approximately 300 μs or one pulse repetition interval (PRI). The *t3_ant_nd* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus noise diode state in the antenna scan.

t3_ant_xnd

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the antenna state plus external noise diode state, which have been integrated to approximately 300 μs or one pulse repetition interval (PRI). The *t3_ant_xnd* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus external noise diode state in the antenna scan.

t3_ref

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the reference state, which have been integrated to approximately 300 μs or one PRI. The *t3_ref* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference state in the antenna scan.

t3_ref_nd

The real portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the reference plus internal noise diode state, which have been integrated to approximately 300 µs or one PRI. The *t3_ref_nd* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference plus noise diode state in the antenna scan.

t4_ant

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the antenna state, which have been integrated to approximately 300 µs or one PRI. The *t4_ant* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna state in the scan. The number of PRIs in each antenna scan can vary depending on the exact integration time and the antenna rotation rate for that particular scan.

t4_ant_nd

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the antenna state plus internal noise diode state, which have been integrated to approximately 300 µs or one PRI. The *t4_ant_nd* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus noise diode state in the antenna scan.

t4_ant_xnd

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the antenna state plus external noise diode state, which have been integrated to approximately 300 µs or one PRI. The *t4_ant_xnd* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the antenna plus external noise diode state in the antenna scan.

t4_ref

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the reference state, which have been integrated to approximately 300 µs or one PRI. The *t4_ref* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference state in the antenna scan.

t4_ref_nd

The imaginary portion of the cross correlation of the two polarizations (vertical and horizontal) for fullband radiometer data in the reference plus internal noise diode state, which have been integrated to approximately 300 μs or one PRI. The *t4_ref_nd* field is a two-dimensional array. The slower moving dimension index represents the antenna scan. The second dimension index represents the number of PRIs in the reference plus noise diode state in the antenna scan.

telemetry_mode_flag

Bit flags that indicate operational conditions for each antenna scan. Table A5 specifies the meaning of individual bits in the *telemetry_mode_flag*. The *telemetry_mode_flag* is a one-dimensional array. Each array index is representative of an antenna scan.

Table A - 5. Description of *telemetry_mode_flag*

Bits	Interpretation	Value	Description
0	Telemetry Resolution Flag	0	fullband and subband data available
		1	Only fullband data are available
1-15	Undefined	N/A	N/A
		N/A	N/A

telemetry_qual_flag

Bit flags that indicate quality of each antenna scan. Table A6 specifies the meaning of individual bits in the *telemetry_qual_flag*. The *telemetry_qual_flag* is a one-dimensional array. Each array index is representative of a specific antenna scan.

Table A - 6. Description of *telemetry_qual_flag*

Bits	Interpretation	Value	Description
0	PN code check flag	0	PN code check successful. When successful, PN code is equal to Hex 35 2E F8 53
		1	PN code check failed
1-15	Undefined	N/A	N/A
		N/A	N/A

antenna_look_angle

The angle defined by the antenna boresight vector and the spacecraft nadir vector interpolated to an antenna scan angle of 0 degrees.

antenna_rotation_rate

The number of rotations the SMAP antenna assembly completes within a single minute.

antenna_scan_counter

The number of detected antenna scan rotations in each file.

antenna_scan_mode_flag

Bit flags that indicate operational conditions for each antenna scan. Each array index is representative of a specific cross track row in the swath grid. Table A7 specifies the meaning of individual bits in the *antenna_scan_mode_flag*.

Table A - 7. Description of *antenna_scan_mode_flag*

Bits	Description	Value	Description
0	Instrument Viewing Mode	0	Spacecraft antenna is positioned so that the SMAP instrument views locations on the Earth's surface.
		1	Spacecraft antenna is positioned so that the SMAP instrument does not view the Earth. SMAP spacecraft is either in maneuver, running a cold sky calibration for the radiometer or in transition state.
1	Ephemeris Usage Flag	0	Processing employed reconstructed ephemeris
		1	Processing employed predicted ephemeris
2	Data Resolution Flag	0	High resolution data contribute to this pixel
		1	Low resolution data contribute to this pixel
3	Orbit Maneuver Flag	0	Data acquired during normal operational mode
		1	Data acquired during an orbit maneuver
4-15	Undefined	N/A	N/A
		N/A	N/A

antenna_scan_qual_flag

Bit flags that indicate the quality of spacecraft position and orientation, or antenna pointing data for each antenna scan. Table A8 specifies the meaning of individual bits in the *antenna_scan_qual_flag*.

Table A - 8. Description of *antenna_scan_qual_flag*

Bits	Interpretation	Value	Description
0	Ephemeris Quality	0	Quality and frequency of the ephemeris data is within acceptable range.
		1	Quality or frequency of the ephemeris data may not be adequate to yield a sufficiently accurate measure of spacecraft location to meet mission geolocation requirements.
1	Attitude Quality	0	Quality and frequency of the attitude data is within acceptable range.

Bits	Interpretation	Value	Description
		1	Quality or frequency of the attitude data may not be adequate to interpolate a sufficiently accurate measure of spacecraft attitude to meet mission requirements.
2	Antenna Azimuth Quality	0	Quality and frequency of the antenna azimuth data is within acceptable range.
		1	Quality or frequency of the antenna pointing data may not be adequate to yield a sufficiently accurate measure to meet mission geolocation requirements.
3-15	Undefined	N/A	N/A
		N/A	N/A

antenna_scan_time

The time for each antenna rotation interpolated to antenna boresight azimuth of 0 degrees. Time values are counts of International System of Units (SI) seconds based on the J2000 epoch in Ephemeris Time (ET). The J2000 epoch starting point is 01 January 2000 at 12:00 ET, which translates to 01 January 2000 at 11:58:55.816 Universal Coordinated Time (UTC).

antenna_scan_time_utc

The UTC for each antenna rotation when antenna boresight azimuth is 0 degrees. For each antenna scan, the *antenna_scan_time_utc* records the same time instant as the*antenna_scan_time*. The *antenna_scan_time_utc* appears as an easily interpretable character string.

The format of the *antenna_scan_time_utc* is YYYY-MM-DDThh:mm:ss.dddZ, where YYYY represents the calendar year, MM represents the month of the year and DD represents the day of the month. The character T demarcates the date from the time. hh represents the hour in twenty-four hour time, mm represents the minutes, ss represents the seconds, and ddd represents thousandths of a second. The character Z designates Greenwich Mean Time. All numerical fields must occupy the allotted space. If any numerical value does not require the allotted space to represent the appropriate number, the field that specifies the number must contain leading zeroes.

footprints_per_scan

Number of brightness temperature footprints acquired in the current scan.

pitch

The angular rotation of the spacecraft body about the Y axis of the SMAP SRF. The Y axis of the SRF is normal to the spacecraft orbital plane. Pitch values are interpolated to the corresponding *antenna_scan_time*, which is equivalent to the instant when the antenna boresight azimuth is 0 degrees within the corresponding scan.

roll

The angular rotation of the spacecraft body about the X axis of the SMAP Science Orbit Reference Frame (SRF) coordinate system. The X axis of the SRF approximates the direction of spacecraft motion. Roll values are interpolated to the corresponding *antenna_scan_time*, which is equivalent to the instant when the antenna boresight azimuth is 0 degrees within the corresponding scan.

sc_alongtrack_velocity

The instantaneous velocity of the SMAP spacecraft that is tangent to the spacecraft path within the orbital plane interpolated to the time when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan. Interpolated to the time when the spacecraft nadir crosses the center line of the corresponding along track row in the 1 km swath grid.

sc_geodetic_alt_ellipsoid

The geodetic altitude of the spacecraft above the Earth's reference ellipsoid interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

sc_nadir_angle

The angle defined by the spacecraft geodetic nadir vector and the negative Z axis of the spacecraft coordinate system at each instance when the antenna scan angle is 0 degrees.

sc_nadir_lat

The geodetic latitude of the ground track position interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

sc_nadir_lon

The longitude of the ground track position interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

sc_radial_velocity

The velocity of the SMAP spacecraft in the direction of the vector that runs from the instantaneous spacecraft position to the center of the Earth interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

x_pos

The X component of spacecraft position in the Earth Centered Rotating (ECR) coordinate interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

x_vel

The X component of spacecraft velocity in the ECR coordinate system interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

y_pos

The Y component of spacecraft position in the ECR coordinate system interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

y_vel

The Y component of spacecraft velocity in the ECR coordinate system interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

yaw

The angular rotation of the spacecraft body about the Z axis of the SMAP SRF coordinate system. The Z axis of the SRF runs from the center of mass of the spacecraft toward geodetic nadir. Yaw values are interpolated to the corresponding *antenna_scan_time*, which is equivalent to the instant when the antenna boresight azimuth is 0 degrees within the corresponding scan.

z_pos

The Z component of spacecraft position in ECR coordinate system interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

z_vel

The Z component of spacecraft velocity in the ECR coordinate system interpolated to the instant when the antenna boresight azimuth is 0 degrees within the corresponding antenna scan.

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.

The total number of science packets or PRIs per scan varies depending on the antenna rotation rate and integration time of the instrument. Each science packet contains data in one of five radiometric states and the data are parsed and stored in this manner. To preserve the shape of the stored data elements, the size of certain dimensions is assigned a maximum value. Thus, fill values appear in this product when data in a particular radiometric state do not call for the maximum number of packets or PRIs per antenna rotation. Those elements with indices that do not contain recorded data contain fill values.

All 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. With a single exception, the Level-1A Radiometer product employs the same set of fill values as other SMAP data products. The other SMAP data products employ a null value of -9999.0 for floating point numbers. That value falls within range of a large number of telemetry elements in the radiometer telemetry. Thus, this product employs -9.999e20 as the null value for floating point numbers.

The Level-1A radiometer 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.

Acronyms and Abbreviations

Table A - 9. Acronyms and Abbreviations

Abbreviation	Definition
Char	8-bit character
Int8	8-bit (1-byte) signed integer
Int16	16-bit (2-byte) signed integer
Int32	32-bit (4-byte) signed integer
ECR	Earth Centered Rotating
ET	Ephemeris Time
Float32	32-bit (4-byte) floating-point integer
Float64	64-bit (8-byte) floating-point integer
H-pol	Horizontally polarized
N/A	Not Applicable
PRI	Pulse Repetition Interval
SI	International System of Units

Abbreviation	Definition
SRF	Science Orbit Reference Frame
Uint8	8-bit (1-byte) unsigned integer
Uint16	16-bit (2-byte) unsigned integer
UTC	Universal Coordinated Time
V-pol	Vertically polarized