TMI Brightness Temperature 1B-11 Swath Data [L1B_11_SWATHDATA]

The following sizing parameter is used in describing these formats:

· nscan = the number of scans within one granule = 2991, on average

Scan Time (Vdata Table, record size 9 bytes, nscan records)

Name	Name in the TOOLKIT	Format	Description
Year	scanTime.year	2-byte integer	4-digit year, e.g., 1998.
Month	scanTime.month	1-byte integer	The month of the Year.
Day of Month	scanTime.dayOfMonth	1-byte integer	The day of Month.
Hour	scanTime.hour	1-byte integer	The hour (UTC) of the Day.
Minute	scanTime.minute	1-byte integer	The minute of the Hour.
Second	scanTime.second	1-byte integer	The second of the Minute.
Day of Year	scanTime.dayOfYear	2-byte integer	The day of the Year.

Geolocation (SDS, array size 2 x 208 x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Geolocation	geolocation(2,208)	4-byte float	The earth location of the center of the IFOV of the high resolution (85 GHz) channels (channels 8 and 9) at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are high resolution pixel and scan. Values are represented as floating point decimal degrees. Off-earth is represented as less than or equal to -9999.9 Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180th meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, record size 21 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number.

Name	Name in the TOOLKIT	Format	Description
Missing	scanStatus.missing	1-byte integer	Missing indicates whether information is contained in the scan data. The values are: 0: Scan data elements contain information 1: Scan was missing in the telemetry data 2: Scan data contains no elements with rain
Validity	scanStatus.validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation

			quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i)-1). The non-routine situations follow: Bit Meaning if bit = 1 0: Spare (always 0) 1: Non-routine spacecraft orientation (2 or 3) 2: Non-routine ACS mode (other than 4) 3: Non-routine yaw update status (0 or 1) 4: Non-routine TMI status (Bit 0 = 0 or 1 = 0) 5: Non-routine QAC (non-zero) 6: Spare (always 0) 7: Spare (always 0)
QAC	scanStatus.qac	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	scanStatus.geoQuality	1-byte integer	Geolocation Quality is broken into 8 one-bit flags. Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) -1). A value of 0 indicates 'good' quality, and 1 indicates 'bad' quality. Each flag is listed below. Note that ranges indicated will be refined in early-orbit check out. Bit Meaning if bit = 1 0: Grossly bad geolocation results: • Spacecraft position vector magnitude outside range 6720 to 6740 km. • Z component of midpoint of scan outside range -4100 to 4100 km. • Distance from S/C to midpoint of scan outside range 340 to 360 km. 1: Unexpectedly large scan to scan jumps in geolocated positions in along and cross track directions for first, middle, and last pixels in each scan. Allowed duration from nominal jump in along track motion = 0.06 km (first pixel), 0.04 km (middle pixel), and 0.06 km (last pixel). Allowed duration from nominal jump in cross track motion = 0.05 km (first pixel), 0.04 km (middle pixel), and 0.05 km (last pixel). Bit set in normal mode only. 2: Scan to scan jumps in yaw, pitch, and roll exceed maximum values. Values are : yaw = 0.0001 radians; pitch = 0.0001 radians; roll = 0.0001 radians. Bit set in

			normal control mode only. 3: In normal mode, yaw outside range (-0.003, 0.003) radians; pitch outside range (-0.007, 0.007) radians; roll outside range (-0.007, 0.007). 4: Satellite undergoing maneuvers during which geolocation will be less accurate. 5: Questionable ephemeris quality (including use of predicted Ephemeris for quicklook) or questionable UTCF quality. 6: Geolocation calculations failed (fill values inserted in the per pixel geolocation products, but not in metadata). 7: Missing attitude data. ACS data gap larger than 20 seconds.
Data Quality [9]	scanStatus.ch1 scanStatus.ch2 scanStatus.ch3 scanStatus.ch4 scanStatus.ch5 scanStatus.ch6 scanStatus.ch7 scanStatus.ch8 scanStatus.ch9	9 x 1-byte integer	The Quality of Channel Data for a given channel on a given scan line is the percentage of pixels whose values are within the acceptable range listed in the Metadata. Quality is given for each channel in the order of the channel number.
Current Spacecraft Orientation	scanStatus.scOrient	1-byte integer	Value Meaning 0: +x forward 1: -x forward 2: -y forward 3: Inertial - CERES Calibration 4: Unknown Orientation
Current ACS Mode	scanStatus.acsMode	1-byte integer	Value Meaning 0: Standby 1: Sun Acquire 2: Earth Acquire 3: Yaw Acquire 4: Nominal 5: Yaw Maneuver 6: Delta-H (Thruster) 7: Delta-V (Thruster) 8: CERES Calibration
Yaw Update Status	scanStatus.yawUpdateS	1-byte integer	Value Meaning 0: Inaccurate 1: Indeterminate 2: Accurate
TMI Instrument Status	scanStatus.tmiISstatus	1-byte integer	Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1). Bit Meaning 00 Receiver Status (1=ON, 0=OFF)

			01 Spin-up Status (1=ON, 0=OFF) 02 Spare Command 1 Status 03 Spare Command 2 Status 04 1 Hz Clock Select (1=A, 0=B) 05 21 GHz Cold Count Flag 06 Spare Command 4 Status 07 Spare Command 5 Status
Fractional Orbit Number	scanStatus.fracOrbitN	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata, record size 88 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Geocentric Position [3]	navigate.scPosX navigate.scPosY navigate.scPosZ	3 X 4-byte float	The position (m) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). The order of components is: x, y, and z. Geocentric Inertial Coordinates are also commonly known as Earth Centered Inertial coordinates. These coordinates will be True of Date (rather than Epoch 2000 which are also commonly used), as interpolated from the data in the Flight Dynamics Facility ephemeris files generated for TRMM.
Spacecraft Geocentric Velocity [3]	navigate.scVelX navigate.scVelY navigate.scVelZ	3 X 4-byte float	The velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of components is: x, y, and z.
Spacecraft Geodetic Latitude	navigate.scLat	4-byte float	The geodetic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.
Spacecraft Geodetic Longitude	navigate.scLon	4-byte float	The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Range is -180 to 179.999999.
Spacecraft Geodetic Altitude	navigate.scAlt	4-byte float	The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time.
Spacecraft Attitude [3]	navigate.scAttRoll navigate.scAttPitch navigate.scAttYaw	3 X 4-byte float	The satellite attitude Euler angles at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw

			value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates.
Sensor Orientation Matrix [3 X 3]	navigate.att1 navigate.att2 navigate.att3 navigate.att4 navigate.att5 navigate.att6 navigate.att7 navigate.att8 navigate.att9	3 X 3 X 4-byte float	The rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time.
Greenwich Hour Angle	navigate.greenHourAng	4-byte float	The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

Calibration (Vdata Table, record size 95 bytes, nscan records):

Name	**Name in the TOOLKIT**	**Format**	**Description**
Hot Load Temperature [3]	calib.hotTemp1 calib.hotTemp2 calib.hotTemp3	3 x 2-byte integer	The physical temperatures, in degrees Kelvin, for the 3 temperature sensors attached to the hot load. This temperature is reduced by 80K, multiplied by 100, and stored in the file as a 2-byte integer. Stored value = (T - 80K) * 100. Range: 0 to 400 K.
Hot Load Bridge Reference Positive Bridge Voltage	calib.posBridgeVolt	2-byte integer	The positive bridge voltage of the hot load bridge reference. Range: 0 to 4095.
Hot Load Bridge Reference Near Zero Voltage	calib.nearZeroVolt	2-byte integer	The near zero voltage of the hot load bridge reference. Range: 0 to 4095.
85.5 GHz Receiver Temperature	calib.temp85Ghz	2-byte integer	The receiver shelf temperature of the 85.5 GHz channel. This temperature is increased by 200, multiplied by 100, and stored in the file as a 2-byte integer. Range: -273.15 to 126.85 C
Top Radiator Temperature	calib.topRadTemp	2-byte integer	The temperature of the top of the radiator channel. This temperature is increased by 200, multiplied by 100, and stored in the file as a 2-byte integer. Range: -273.15 to 126.85 C
Automatic Gain Control [9]	calib.autoCont1 calib.autoCont2 calib.autoCont3 calib.autoCont4 calib.autoCont5 calib.autoCont6 calib.autoCont7 calib.autoCont8 calib.autoCont9	9 X 1-byte integer	Automatic gain control for the 9 channels in counts. Range: 0 to 15.
Calibration Coefficient A [9]	calib.calCoef1A calib.calCoef2A calib.calCoef3A calib.calCoef4A calib.calCoef5A calib.calCoef6A	9 X 4-byte float	Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, T_A: $T_A = A\ C + B$

	calib.calCoef7A calib.calCoef8A calib.calCoef9A		
Calibration Coefficient B [9]	calib.calCoef1B calib.calCoef2B calib.calCoef3B calib.calCoef4B calib.calCoef5B calib.calCoef6B calib.calCoef7B calib.calCoef8B calib.calCoef9B	9 X 4-byte float	Calibration coefficient B (degrees Kelvin) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, T_A: $T_A = A\ C + B$

Calibration Counts (SDS, array size 16 x 2 x 9 x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Calibration Counts	calCounts(16,2,9)	2-byte integer	Calibration measurements, in counts. The dimensions are: samples, load, channel, and scan. The sample dimension has a maximum of 16. The load dimension has first hot load and then cold sky. The low resolution channels (1-7) have 8 samples (the remaining 8 elements in the array are not used for each low resolution channel) and the high resolution channels (8 - 9) have 16 samples.

Satellite Local Zenith Angle (SDS, array size 12 x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Satellite Local Zenith Angle	satLocZenAngle(12)	4-byte float	The angle, in degrees, between the local pixel geodetic zenith and the direction to the satellite. This angle is given for every twentieth high resolution pixel along a scan: pixel 1,21,41, ... , 201, 208. For the pixel dimension, Offset = 0 and Increment = -20.

Low Resolution Channels (SDS, array size 7 x 104 x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Low Resolution Channels	lowResCh(7,104)	2-byte integer	Brightness temperature (K) reduced by 100 K, multiplied by 100, and stored as a 2-byte integer, i.e. Stored value = (T - 100 K) * 100 The dimensions are: channel, pixel, scan. The pixel dimension has Offset = 0 and Increment = -2. The data range is 100 K to 375 K. The following channels are included. Channel Frequency Polarization 1 10 GHz Vertical 2 10 GHz Horizontal 3 19 GHz Vertical 4 19 GHz Horizontal 5 21 GHz Vertical 6 37 GHz Vertical 7 37 GHz Horizontal

High Resolution Channels (SDS, array size 2 x 208 x nscan, 2-byte integer):First Echo

Name	Name in the TOOLKIT	Format	Description
High Resolution Channels	highResCh(2,208)	2-byte integer	Brightness temperature (K) reduced by 100 K, multiplied by 100, and stored as a 2-byte integer, i.e. Stored value = (T - 100 K) * 100 The dimensions are: channel, pixel, scan. The data range is 100 K to 375 K. The following channels are included: Channel Frequency Polarization 8 85 GHz Vertical 9 85 GHz Horizontal