TROPICAL RAINFALL MEASURING MISSION PRECIPITATION PROCESSING SYSTEM

File Specification
1B11

Version 7

March 22, 2012

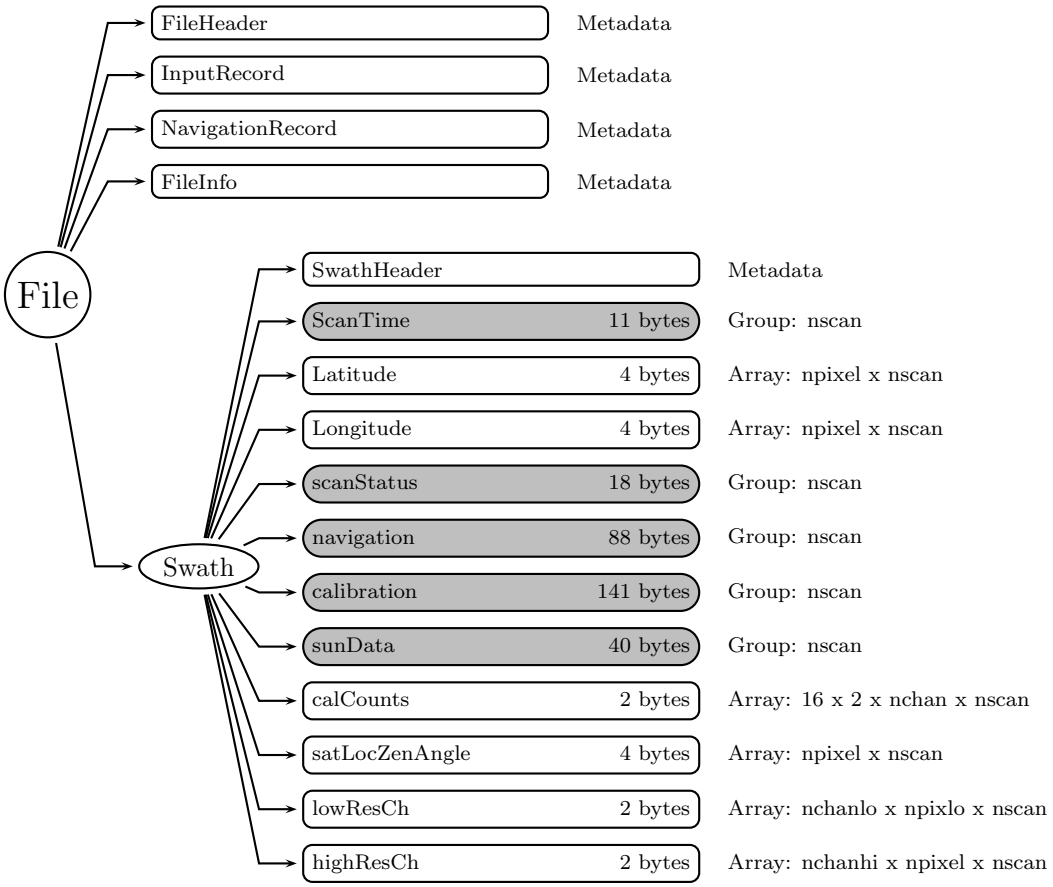


Figure 1: Data Format Structure for 1B11, TMI Brightness Temperatures

0.1 1B11 - TMI Brightness Temperatures

The TMI Level 1B Product, 1B11, "TMI Brightness Temperatures," is written as a Swath Structure. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nchan	9	Number of channels.
nchanlo	7	Number of channels.
nchanhi	2	Number of channels.
npixel	208	Number of high frequency pixels in each scan.
npixlo	104	Number of low frequency pixels in each scan.

Figure 1 through Figure 7 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

FileHeader (Metadata):
FileHeader contains general metadata. This group appears in all data products. See

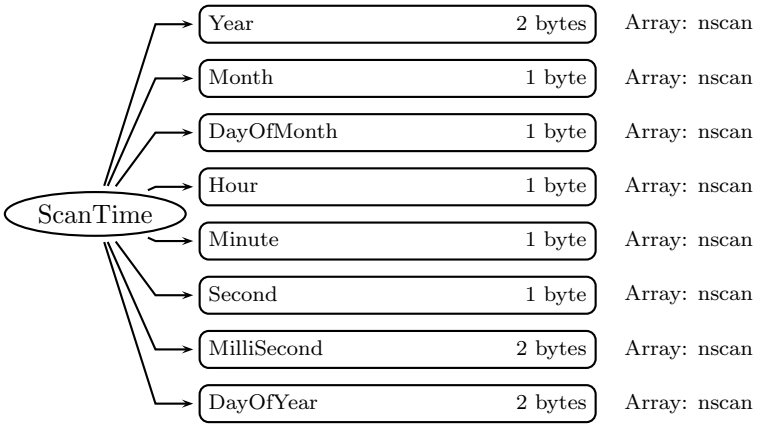


Figure 2: Data Format Structure for 1B11, ScanTime

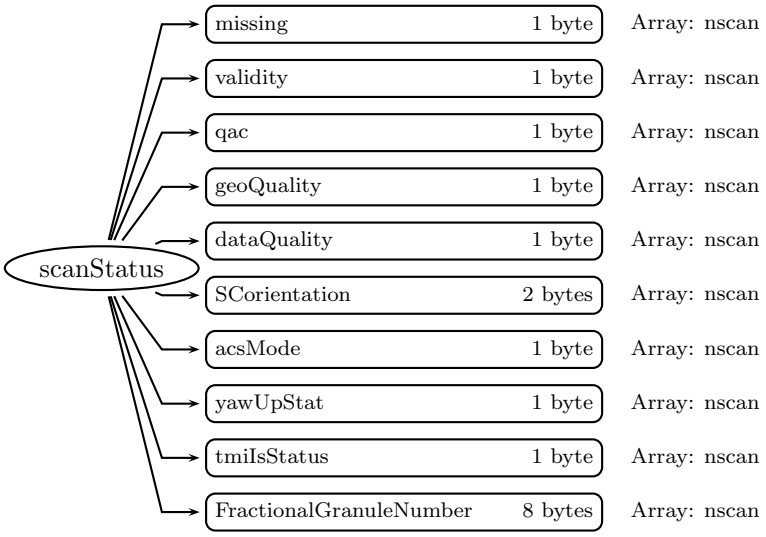


Figure 3: Data Format Structure for 1B11, scanStatus

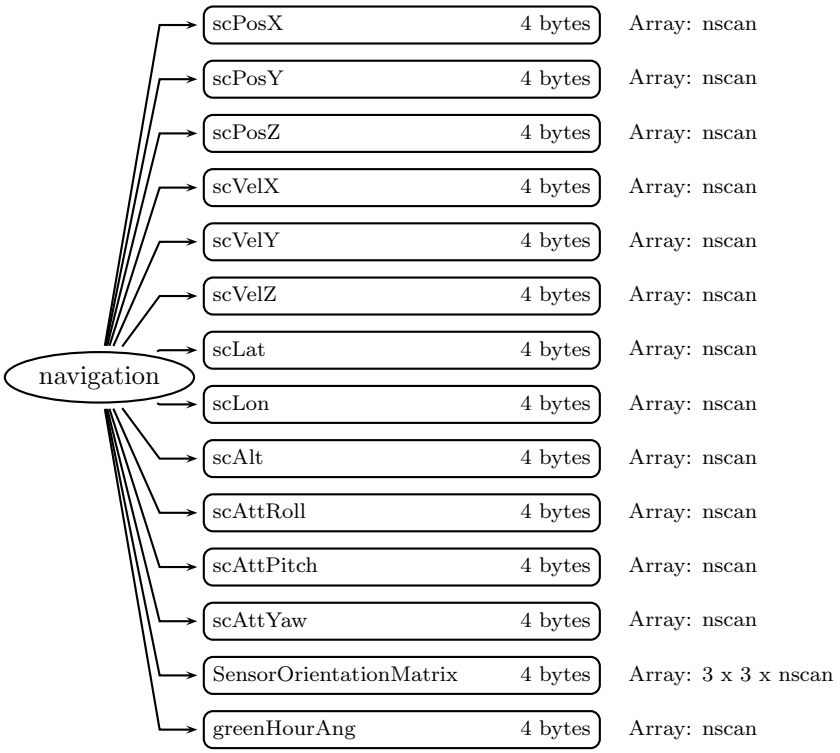


Figure 4: Data Format Structure for 1B11, navigation

Metadata for TRMM Products for details.

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1, Level 2, and Level 3 orbital data products. Level 3 time averaged products have the same information separated into 3 groups since they have many inputs. See Metadata for TRMM Products for details.

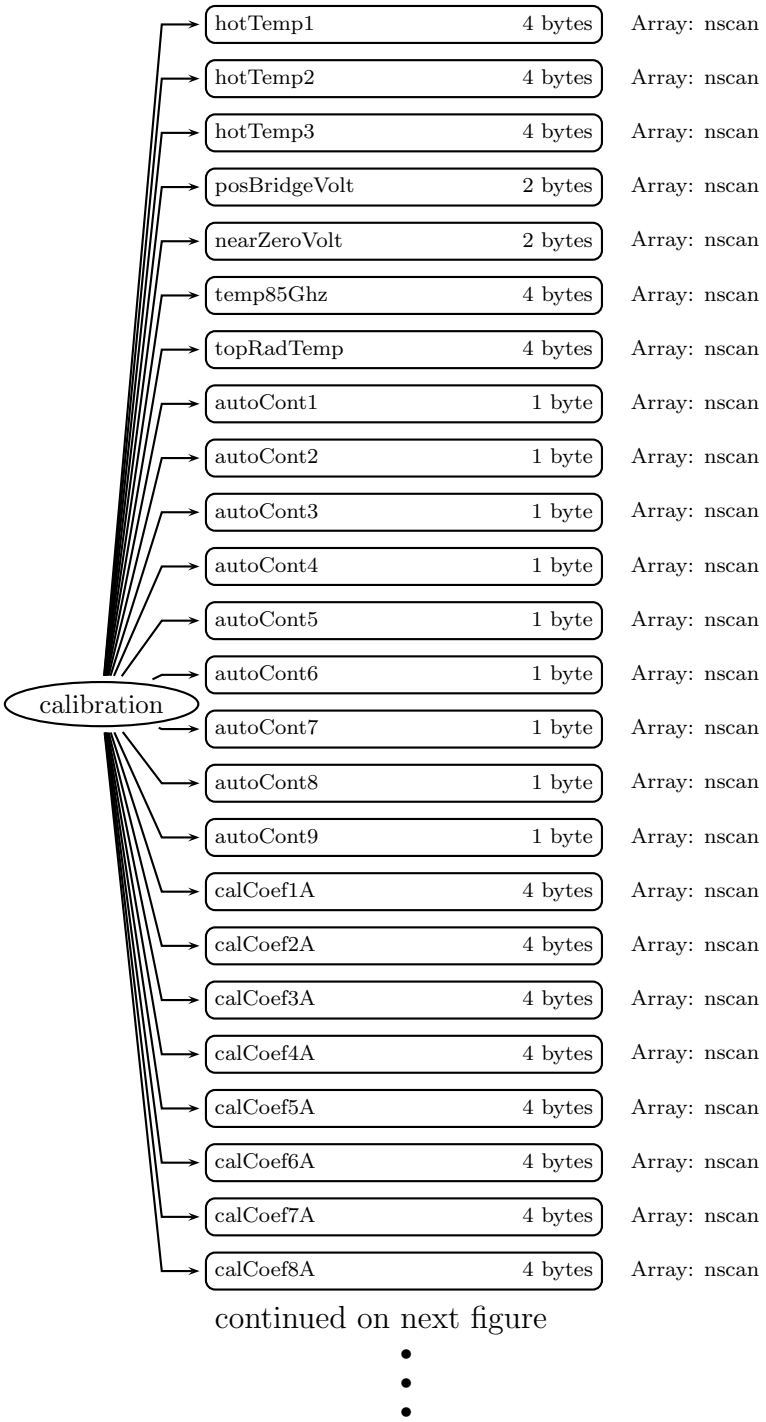
NavigationRecord (Metadata):
NavigationRecord contains navigation metadata for this granule. This group appears in Level 1 and Level 2 data products. See Metadata for TRMM Products for details.

FileInfo (Metadata):
FileInfo contains metadata used by the PPS I/O Toolkit (TKIO). This group appears in all data products. See Metadata for TRMM Products for details.

Swath (Swath)

SwathHeader (Metadata):
SwathHeader contains metadata for swaths. This group appears in Level 1 and Level 2 data products. See Metadata for TRMM Products for details.

ScanTime (Group)



continued on next figure

Figure 5: Data Format Structure for 1B11, calibration

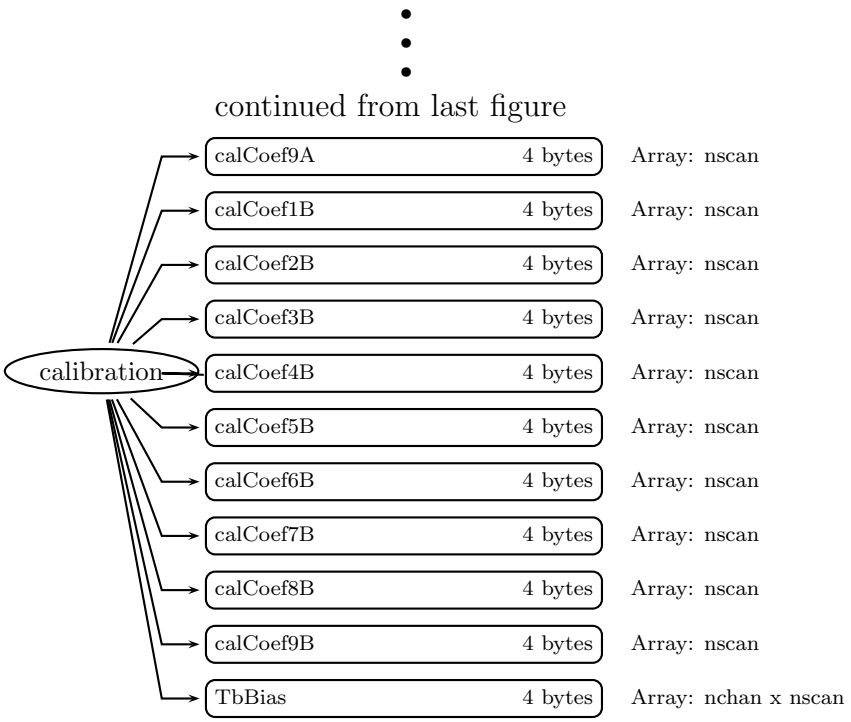


Figure 6: Data Format Structure for 1B11, calibration

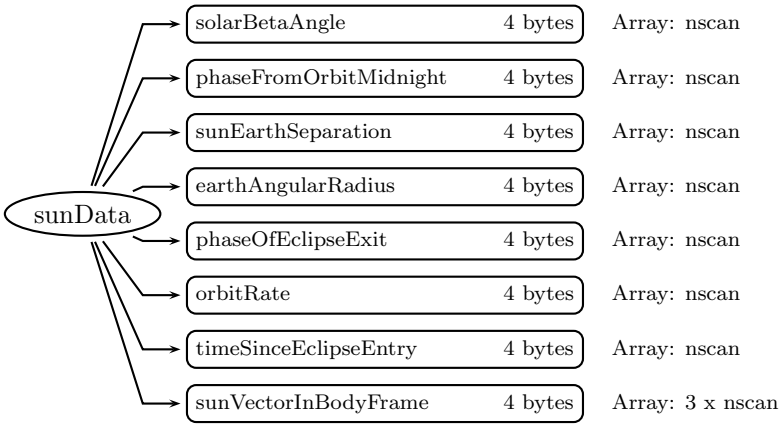


Figure 7: Data Format Structure for 1B11, sunData

Year (2-byte integer, array size: nscan):
4-digit year, e.g., 1998. Values range from 1950 to 2100 years. Special values are defined as:
-9999 Missing value

Month (1-byte integer, array size: nscan):
Month of the year. Values range from 1 to 12 months. Special values are defined as:
-99 Missing value

DayOfMonth (1-byte integer, array size: nscan):
Day of the month. Values range from 1 to 31 days. Special values are defined as:
-99 Missing value

Hour (1-byte integer, array size: nscan):
UTC hour of the day. Values range from 0 to 23 hours. Special values are defined as:
-99 Missing value

Minute (1-byte integer, array size: nscan):
Minute of the hour. Values range from 0 to 59 minutes. Special values are defined as:
-99 Missing value

Second (1-byte integer, array size: nscan):
Second of the minute. Values range from 0 to 60 s. Special values are defined as:
-99 Missing value

MilliSecond (2-byte integer, array size: nscan):
Thousandths of the second. Values range from 0 to 999 ms. Special values are defined as:
-9999 Missing value

DayOfYear (2-byte integer, array size: nscan):
Day of the year. Values range from 1 to 366 days. Special values are defined as:
-9999 Missing value

Latitude (4-byte float, array size: npixel x nscan):
The earth latitude of the center of the IFOV at the altitude of the earth ellipsiod. Latitude is positive north, negative south. Values range from -90 to 90 degrees. Special values are defined as:
-9999.9 Missing value

Longitude (4-byte float, array size: npixel x nscan):
The earth longitude of the center of the IFOV at the altitude of the earth ellipsiod. Longitude is positive east, negative west. A point on the 180th meridian has the value -180 degrees. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scanStatus (Group)

missing (1-byte integer, array size: nscan):
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
```

validity (1-byte integer, array size: nscan):
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**i). 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 instrument status (Bit 0 = 0 or bit 1 = 0)
5   Non-routine QAC (non-zero)

6   21 GHz Cold Count Flag (1 if Flag set)
7   Spare (always 0)
```

qac (1-byte integer, array size: nscan):
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.

geoQuality (1-byte integer, array size: nscan):
geoQuality is broken into 8 one-bit flags. Some flags represent problems but other flags are informational. Bits 0, 5, and 6 represent problems: 0 = 'good' quality and 1 = 'bad' quality. It is recommended not to use scans when any problem flag is 1. The informational flags have: 0 = routine conditions and 1 = non-routine conditions. Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(7-i). Note that good scans may have non-zero geoQuality. Each flag is listed below.

```
Bit Meaning if bit = 1
0   Grossly bad geolocation results:
    Spacecraft position vector magnitude outside range 6715 to 6790 km.
    Z component of midpoint of scan outside range -4100 to 4100 km.
    Distance from S/C to midpoint of scan outside range 500 to 750 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 deviation from nominal jump in along track motion = 3.0 km (first
    pixel), 3.0 km (middle pixel), and 3.0 km (last pixel).
```

```
    Allowed deviation from nominal jump in cross track motion = 3.0 km (first
    pixel), 3.0 km (middle pixel), and 3.0 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 = 0.005 radians; pitch = 0.005 radians; roll = 0.005 radians.
    Bit set in normal control mode only.
3   In normal mode, yaw outside range (-0.005, 0.005) radians; pitch outside
    range (-0.005, 0.005) radians; roll outside range (-0.005, 0.005) radians.
4   Satellite undergoing maneuvers during which geolocation will be less
    accurate.
5   Summary QA flag for dataQuality:  Set to 1 if bit 0 is 1 or bit 6 is 1,
    i.e. Grossly bad or failed geolocation calculations.
    Science data use not recommended.
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 1.0 seconds.
      Pitch, roll, and yaw are interpolated or extrapolated from nearby data.
```

dataQuality (1-byte integer, array size: nscan):
dataQuality is a flag for overall scan quality. Unless this is 0, the scan data is meaningless to higher science processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit  Meaning if bit = 1
0    missing
5    geoQuality indicates bad or missing values

6    validity bits 0-5 not all normal
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the TMI scan. If +X is forward, SCorientation is 0. If -X is forward, SCorientation is 180. If -Y is forward, SCorientation is 90. Values range from 0 to 360 degrees. Special values are defined as:

-8003	Inertial
-8004	Unknown
-9999	Missing value

acsMode (1-byte integer, array size: nscan):

```
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
```

yawUpStat (1-byte integer, array size: nscan):

```
Value Meaning
0     Inaccurate
1     Indeterminate
2     Accurate
```

tmiIsStatus (1-byte integer, array size: nscan):
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  Spare
06  Spare Command 4 Status
07  Spare Command 5 Status
```

FractionalGranuleNumber (8-byte float, array size: nscan):
The floating point granule number. The granule begins at the Southern-most point of the spacecraft's trajectory. For example, FractionalGranuleNumber = 10.5 means the spacecraft is halfway through granule 10 and starting the descending half of the granule. Values range from 0 to 100000. Special values are defined as:
-9999.9 Missing value

navigation (Group)

scPosX (4-byte float, array size: nscan):
The x component of 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). 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.

scPosY (4-byte float, array size: nscan):
The y component of the position (m) of the spacecraft in Geocentric Inertial Coordinates. See scPosX.

scPosZ (4-byte float, array size: nscan):
The z component of the position (m) of the spacecraft in Geocentric Inertial Coordinates. See scPosX.

scVelX (4-byte float, array size: nscan):
The x component of the velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time.

scVelY (4-byte float, array size: nscan):
The y component of the velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time.

scVelZ (4-byte float, array size: nscan):
The z component of the velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time.

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time.

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time.

scAttRoll (4-byte float, array size: nscan):
The satellite attitude Euler roll angle (degrees) 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.

scAttPitch (4-byte float, array size: nscan):
The satellite attitude Euler pitch angle (degrees) 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.

scAttYaw (4-byte float, array size: nscan):
The satellite attitude Euler yaw angle (degrees) 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.

SensorOrientationMatrix (4-byte float, array size: 3 x 3 x nscan):
SensorOrientationMatrix is the rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time. It is unitless.

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

calibration (Group)

hotTemp1 (4-byte float, array size: nscan):
The physical temperatures, in degrees Kelvin, for the 3 temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotTemp2 (4-byte float, array size: nscan):
The physical temperatures, in degrees Kelvin, for the 3 temperature sensors attached to the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

hotTemp3 (4-byte float, array size: nscan):
The physical temperatures, in degrees Kelvin, for the 3 temperature sensors attached to

the hot load. Values range from 0 to 400 K. Special values are defined as:
-9999.9 Missing value

posBridgeVolt (2-byte integer, array size: nscan):
The positive bridge voltage of the hot load bridge reference. Values range from 0 to 4095 volts. Special values are defined as:
-9999 Missing value

nearZeroVolt (2-byte integer, array size: nscan):
The near zero voltage of the hot load bridge reference. Values range from 0 to 4095 volts. Special values are defined as:
-9999 Missing value

temp85Ghz (4-byte float, array size: nscan):
The receiver shelf temperature of the 85.5 GHz channel. Values range from -273.15 to 126.85 Celsius. Special values are defined as:
-9999.9 Missing value

topRadTemp (4-byte float, array size: nscan):
The temperature of the top of the radiator channel. Values range from -273.15 to 126.85 Celsius. Special values are defined as:
-9999.9 Missing value

autoCont1 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont2 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont3 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont4 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont5 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont6 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special

values are defined as:
-99 Missing value

autoCont7 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont8 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

autoCont9 (1-byte integer, array size: nscan):
Automatic gain control for the 9 channels in counts. Values range from 0 to 15. Special values are defined as:
-99 Missing value

calCoef1A (4-byte float, array size: nscan):
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, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef2A (4-byte float, array size: nscan):
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, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef3A (4-byte float, array size: nscan):
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, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef4A (4-byte float, array size: nscan):
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, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef5A (4-byte float, array size: nscan):
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, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef6A (4-byte float, array size: nscan):
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, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef7A (4-byte float, array size: nscan):
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, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef8A (4-byte float, array size: nscan):
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, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef9A (4-byte float, array size: nscan):
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, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef1B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef2B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef3B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef4B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef5B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for

each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef6B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef7B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef8B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

calCoef9B (4-byte float, array size: nscan):
Calibration coefficient B (degrees Kelvin / counts) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA: TA = A C + B Values are in K. Special values are defined as:
-9999.9 Missing value

TbBias (4-byte float, array size: nchan x nscan):
Bias in the brightness temperatures which is estimated due to instrument temperature fluctuations as a function of timeSinceEclipseEntry and solarBetaAngle. This bias is applied to reach the brightness temperature in this product. Values range from -10.0 to 10.0 K. In other words,

```
V6 Tb - TbBias = V7 Tb
```

sunData (Group)

solarBetaAngle (4-byte float, array size: nscan):
Sun direction elevation from the orbit plane, positive toward orbit normal which is given by the cross product of the spacecraft position and velocity vectors. Values range from -59.0 to 59.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseFromOrbitMidnight (4-byte float, array size: nscan):
Phase angle of the Sun direction around the orbit plane, with zero phase in the direction of the Earth center from the spacecraft and positive toward the spacecraft velocity direction

so the phase increases with time. Zero phase occurs at local orbit midnight, 90 degrees occurs with the spacecraft over the Earth's dawn terminator, 180 degrees occurs at local orbit noon, and -90 degrees occurs with the spacecraft over the Earth's dusk terminator. Values range from -180.0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

sunEarthSeparation (4-byte float, array size: nscan):
The separation angle between the Sun and Earth directions from the spacecraft. Values range from 0 to 180.0 degrees. Special values are defined as:
-9999.9 Missing value

earthAngularRadius (4-byte float, array size: nscan):
The angle between the center of the Earth and the horizon edge. The sun is above the Earth horizon when the sunEarthSeparation is greater than the earthAngularRadius. Values range from 69.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

phaseOfEclipseExit (4-byte float, array size: nscan):
The estimated phaseFromOrbitMidnight where the spacecraft leaves the Earth shadow, based on the instantaneous solarBetaAngle and earthAngularRadius. Values range from 45.0 to 80.0 degrees. Special values are defined as:
-9999.9 Missing value

orbitRate (4-byte float, array size: nscan):
The instantaneous angular rate of the spacecraft around the orbit. Values range from 0.064 to 0.07 degrees/s. Special values are defined as:
-9999.9 Missing value

timeSinceEclipseEntry (4-byte float, array size: nscan):
The estimated duration in seconds since the last entry into the Earth's shadow. Values range from 0 to 5600.0 s. Special values are defined as:
-9999.9 Missing value

sunVectorInBodyFrame (4-byte float, array size: 3 x nscan):
The unit sun vector direction in the TMI instrument body coordinate frame, defined such that +Z is nominally toward the Earth and gives the instrument spin axis, and data is collected nominally centered about the +X direction. Values range from 0 to 1.0. Special values are defined as:
-9999.9 Missing value

calCounts (2-byte integer, array size: 16 x 2 x nchan x nscan):
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.

satLocZenAngle (4-byte float, array size: npixel x nscan):
The angle, in degrees, between the local pixel geodetic zenith and the direction to the

satellite.

lowResCh (2-byte integer, array size: nchanlo x npixlo x nscan):
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 following channels are included:

Channel	Frequency	Polarization	Minimum	Maximum
1	10 GHz	Vertica1	33	320
2	10 GHz	Horizontal	66	320
3	19 GHz	Vertical	133	320
4	19 GHz	Horizontal	80	320
5	21 GHz	Vertical	133	320
6	37 GHz	Vertical	133	320
7	37 GHz	Horizontal	112	320

highResCh (2-byte integer, array size: nchanhi x npixel x nscan):
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 following channels are included:

Channel	Frequency	Polarization	Minimum	Maximum
8	85 GHz	Vertical	70	320
9	85 GHz	Horizontal	70	320

C Structure Header file:

```
#ifndef _TK_1B11_H_
#define _TK_1B11_H_

#ifndef _L1B11_SUNDATA_
#define _L1B11_SUNDATA_

typedef struct {
    float solarBetaAngle;
    float phaseFromOrbitMidnight;
    float sunEarthSeparation;
```

```
    float earthAngularRadius;
    float phaseOfEclipseExit;
    float orbitRate;
    float timeSinceEclipseEntry;
    float sunVectorInBodyFrame[3];
} L1B11_SUNDATA;

#endif

#ifndef _L1B11_CALIBRATION_
#define _L1B11_CALIBRATION_

typedef struct {
    float hotTemp1;
    float hotTemp2;
    float hotTemp3;
    short posBridgeVolt;
    short nearZeroVolt;
    float temp85Ghz;
    float topRadTemp;
    signed char autoCont1;
    signed char autoCont2;
    signed char autoCont3;
    signed char autoCont4;
    signed char autoCont5;
    signed char autoCont6;
    signed char autoCont7;
    signed char autoCont8;
    signed char autoCont9;
    float calCoef1A;
    float calCoef2A;
    float calCoef3A;
    float calCoef4A;
    float calCoef5A;
    float calCoef6A;
    float calCoef7A;
    float calCoef8A;
    float calCoef9A;
    float calCoef1B;
    float calCoef2B;
    float calCoef3B;
    float calCoef4B;
    float calCoef5B;
```

```
    float calCoef6B;
    float calCoef7B;
    float calCoef8B;
    float calCoef9B;
    float TbBias[9];
} L1B11_CALIBRATION;

#endif

#ifndef _L1B11_NAVIGATION_
#define _L1B11_NAVIGATION_

typedef struct {
    float scPosX;
    float scPosY;
    float scPosZ;
    float scVelX;
    float scVelY;
    float scVelZ;
    float scLat;
    float scLon;
    float scAlt;
    float scAttRoll;
    float scAttPitch;
    float scAttYaw;
    float SensorOrientationMatrix[3][3];
    float greenHourAng;
} L1B11_NAVIGATION;

#endif

#ifndef _L1B11_SCANSTATUS_
#define _L1B11_SCANSTATUS_

typedef struct {
    signed char missing;
    signed char validity;
    signed char qac;
    signed char geoQuality;
    signed char dataQuality;
    short SCorientation;
    signed char acsMode;
    signed char yawUpStat;
```

```
    signed char tmiIsStatus;
    double FractionalGranuleNumber;
} L1B11_SCANSTATUS;

#endif

#ifndef _L1B11_SCANTIME_
#define _L1B11_SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
} L1B11_SCANTIME;

#endif

#ifndef _L1B11_SWATH_
#define _L1B11_SWATH_

typedef struct {
    L1B11_SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    L1B11_SCANSTATUS scanStatus;
    L1B11_NAVIGATION navigation;
    L1B11_CALIBRATION calibration;
    L1B11_SUNDATA sunData;
    short calCounts[9][2][16];
    float satLocZenAngle[208];
    float lowResCh[104][7];
    float highResCh[208][2];
} L1B11_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1B11_SUNDATA/
    REAL*4 solarBetaAngle
    REAL*4 phaseFromOrbitMidnight
    REAL*4 sunEarthSeparation
    REAL*4 earthAngularRadius
    REAL*4 phaseOfEclipseExit
    REAL*4 orbitRate
    REAL*4 timeSinceEclipseEntry
    REAL*4 sunVectorInBodyFrame(3)
END STRUCTURE

STRUCTURE /L1B11_CALIBRATION/
    REAL*4 hotTemp1
    REAL*4 hotTemp2
    REAL*4 hotTemp3
    INTEGER*2 posBridgeVolt
    INTEGER*2 nearZeroVolt
    REAL*4 temp85Ghz
    REAL*4 topRadTemp
    BYTE autoCont1
    BYTE autoCont2
    BYTE autoCont3
    BYTE autoCont4
    BYTE autoCont5
    BYTE autoCont6
    BYTE autoCont7
    BYTE autoCont8
    BYTE autoCont9
    REAL*4 calCoef1A
    REAL*4 calCoef2A
    REAL*4 calCoef3A
    REAL*4 calCoef4A
    REAL*4 calCoef5A
    REAL*4 calCoef6A
    REAL*4 calCoef7A
    REAL*4 calCoef8A
    REAL*4 calCoef9A
    REAL*4 calCoef1B
    REAL*4 calCoef2B
    REAL*4 calCoef3B
    REAL*4 calCoef4B
    REAL*4 calCoef5B
```

```
    REAL*4 calCoef6B
    REAL*4 calCoef7B
    REAL*4 calCoef8B
    REAL*4 calCoef9B
    REAL*4 TbBias(9)
END STRUCTURE

STRUCTURE /L1B11_NAVIGATION/
    REAL*4 scPosX
    REAL*4 scPosY
    REAL*4 scPosZ
    REAL*4 scVelX
    REAL*4 scVelY
    REAL*4 scVelZ
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 scAttRoll
    REAL*4 scAttPitch
    REAL*4 scAttYaw
    REAL*4 SensorOrientationMatrix(3,3)
    REAL*4 greenHourAng
END STRUCTURE

STRUCTURE /L1B11_SCANSTATUS/
    BYTE missing
    BYTE validity
    BYTE qac
    BYTE geoQuality
    BYTE dataQuality
    INTEGER*2 SCorientation
    BYTE acsMode
    BYTE yawUpStat
    BYTE tmiIsStatus
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1B11_SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
```

```
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
END STRUCTURE

STRUCTURE /L1B11_SWATH/
    RECORD /L1B11_SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    RECORD /L1B11_SCANSTATUS/ scanStatus
    RECORD /L1B11_NAVIGATION/ navigation
    RECORD /L1B11_CALIBRATION/ calibration
    RECORD /L1B11_SUNDATA/ sunData
    INTEGER*2 calCounts(16,2,9)
    REAL*4 satLocZenAngle(208)
    REAL*4 lowResCh(7,104)
    REAL*4 highResCh(2,208)
END STRUCTURE
```