TROPICAL RAINFALL MEASURING MISSION
PRECIPITATION PROCESSING SYSTEM

File Specification
1B21

Version 7

March 23, 2012

0.1 1B21 - PR Power

The PR Level-1B product, 1B21, ”PR Power,” is written as a Swath Structure. See Section 2 in HDF. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each scan.

Figure 1 through Figure 8 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 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.

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by PR algorithms only. See Metadata for TRMM Products for details.

pr_cal_coef (Group)

transCoef (4-byte float, array size: 1):
Transmission coefficient.

receptCoef (4-byte float, array size: 1):
Reception coefficient.

fcifIOchar (4-byte float, array size: 16):
FCIF I/O Characteristics.

ray_header (Group)

rayStart (2-byte integer, array size: nray):
Starting range bin number of Normal sample.

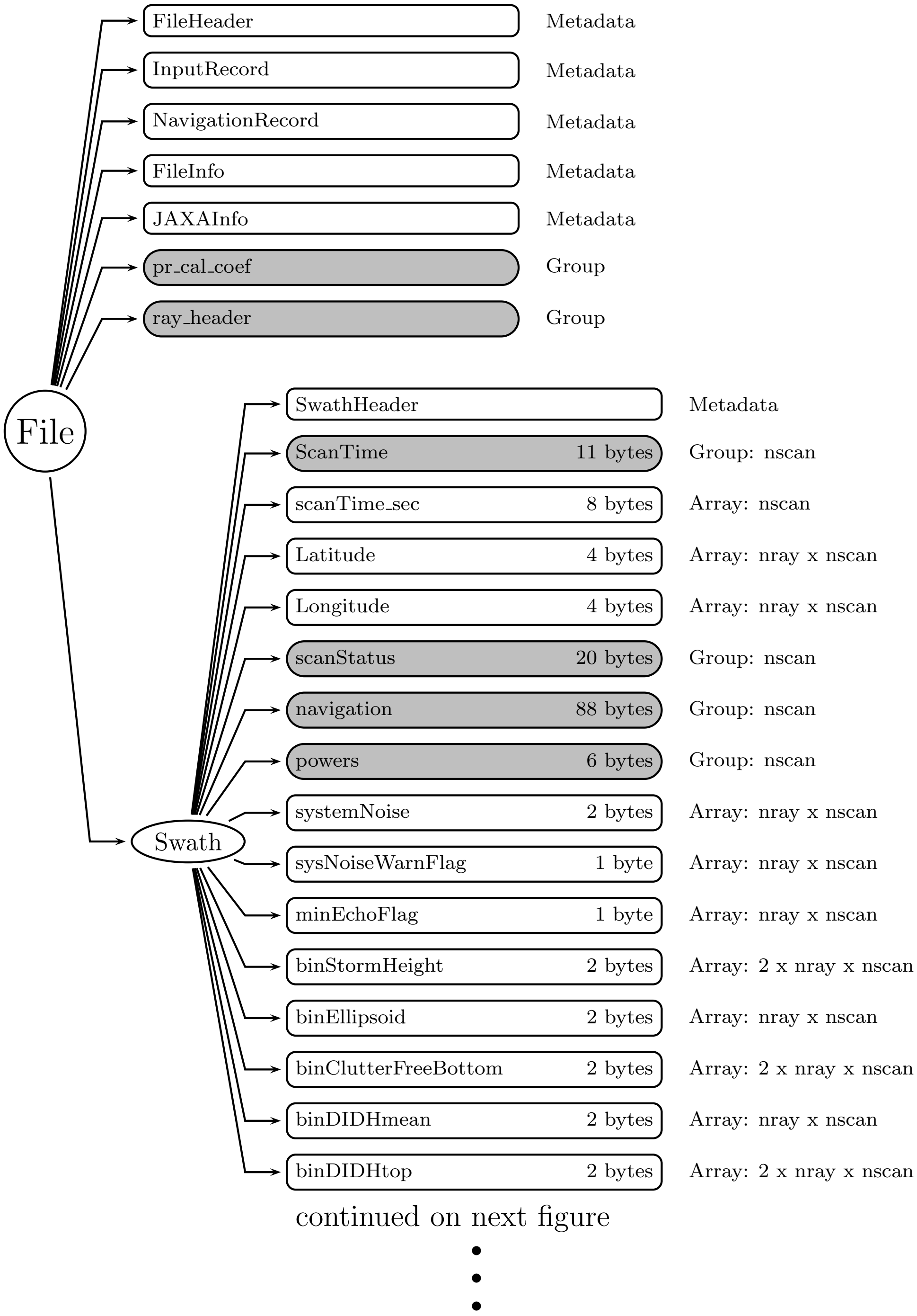


Figure 1: Data Format Structure for 1B21, PR Power

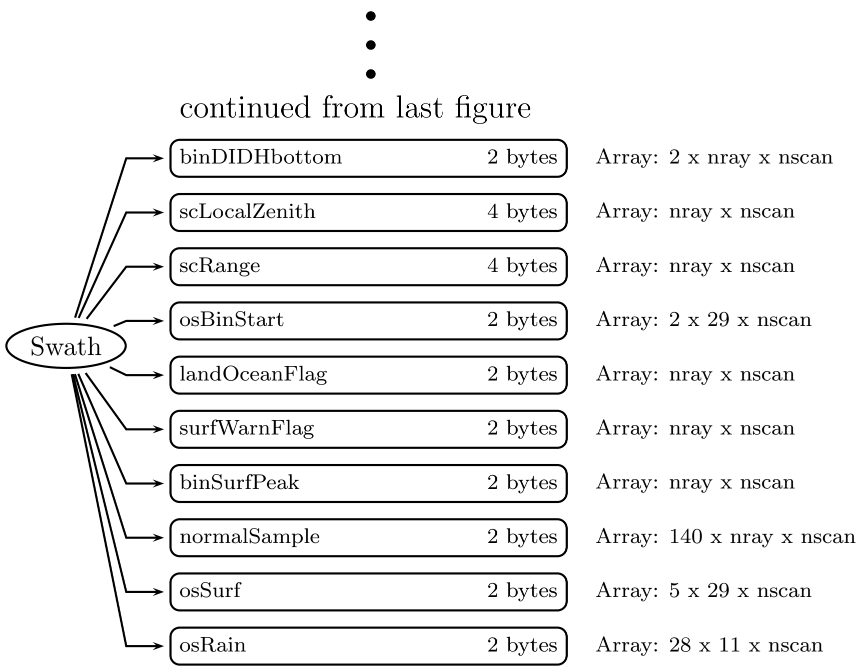

continued from last figure
Swath
binDIDHbottom 2 bytes Array: 2 x nray x nscan
scLocalZenith 4 bytes Array: nray x nscan
scRange 4 bytes Array: nray x nscan
osBinStart 2 bytes Array: 2 x 29 x nscan
landOceanFlag 2 bytes Array: nray x nscan
surfWarnFlag 2 bytes Array: nray x nscan
binSurfPeak 2 bytes Array: nray x nscan
normalSample 2 bytes Array: 140 x nray x nscan
osSurf 2 bytes Array: 5 x 29 x nscan
osRain 2 bytes Array: 28 x 11 x nscan

Figure 2: Data Format Structure for 1B21, PR Power

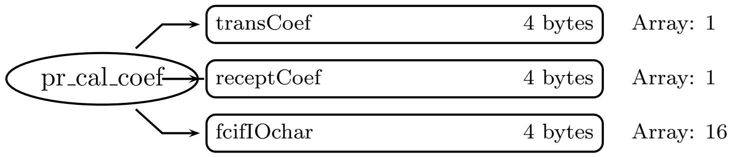
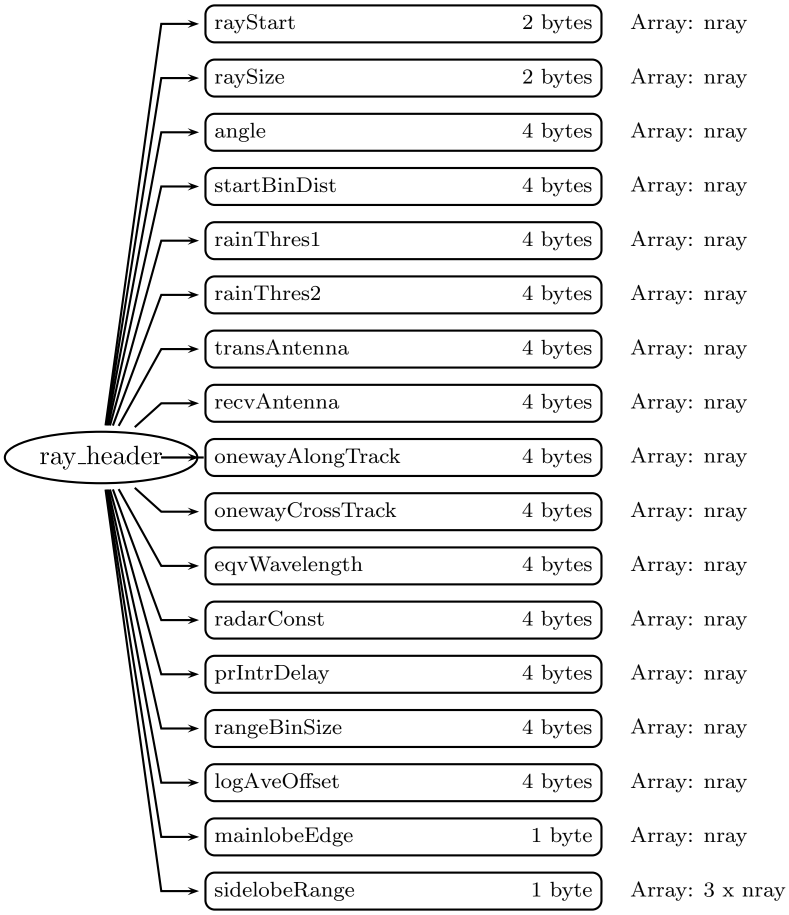
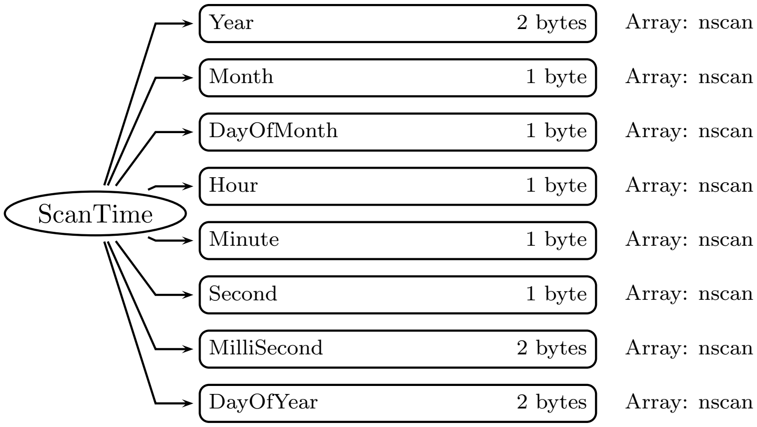

pr_cal_coef
transCoef 4 bytes Array: 1
receptCoef 4 bytes Array: 1
fcifIOchar 4 bytes Array: 16

Figure 3: Data Format Structure for 1B21, pr_cal_coef



ray_header		
rayStart	2 bytes	Array: nray
raySize	2 bytes	Array: nray
angle	4 bytes	Array: nray
startBinDist	4 bytes	Array: nray
rainThres1	4 bytes	Array: nray
rainThres2	4 bytes	Array: nray
transAntenna	4 bytes	Array: nray
recvAntenna	4 bytes	Array: nray
onewayAlongTrack	4 bytes	Array: nray
onewayCrossTrack	4 bytes	Array: nray
eqvWavelength	4 bytes	Array: nray
radarConst	4 bytes	Array: nray
prIntrDelay	4 bytes	Array: nray
rangeBinSize	4 bytes	Array: nray
logAveOffset	4 bytes	Array: nray
mainlobeEdge	1 byte	Array: nray
sidelobeRange	1 byte	Array: 3 x nray

Figure 4: Data Format Structure for 1B21, ray_header



ScanTime		
Year	2 bytes	Array: nscan
Month	1 byte	Array: nscan
DayOfMonth	1 byte	Array: nscan
Hour	1 byte	Array: nscan
Minute	1 byte	Array: nscan
Second	1 byte	Array: nscan
MilliSecond	2 bytes	Array: nscan
DayOfYear	2 bytes	Array: nscan

Figure 5: Data Format Structure for 1B21, ScanTime

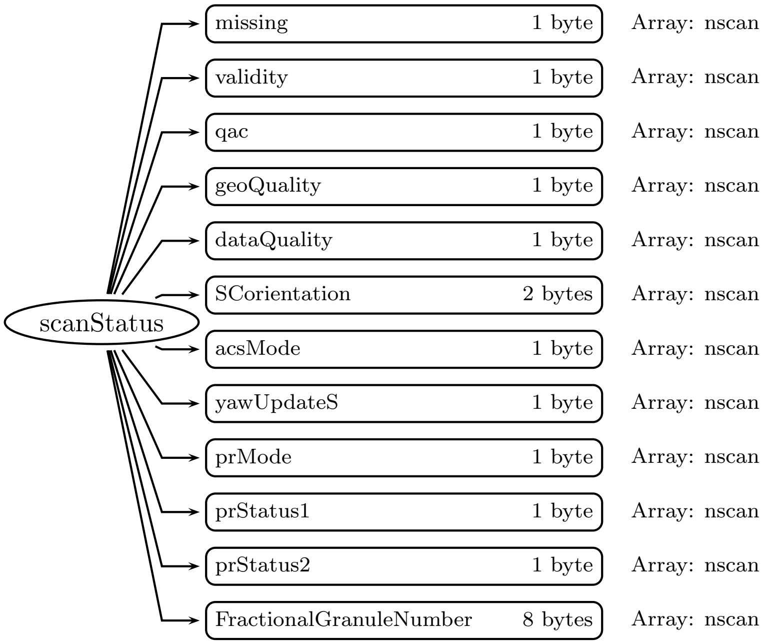

scanStatus
missing 1 byte Array: nscan
validity 1 byte Array: nscan
qac 1 byte Array: nscan
geoQuality 1 byte Array: nscan
dataQuality 1 byte Array: nscan
SCorientation 2 bytes Array: nscan
acsMode 1 byte Array: nscan
yawUpdateS 1 byte Array: nscan
prMode 1 byte Array: nscan
prStatus1 1 byte Array: nscan
prStatus2 1 byte Array: nscan
FractionalGranuleNumber 8 bytes Array: nscan

Figure 6: Data Format Structure for 1B21, scanStatus

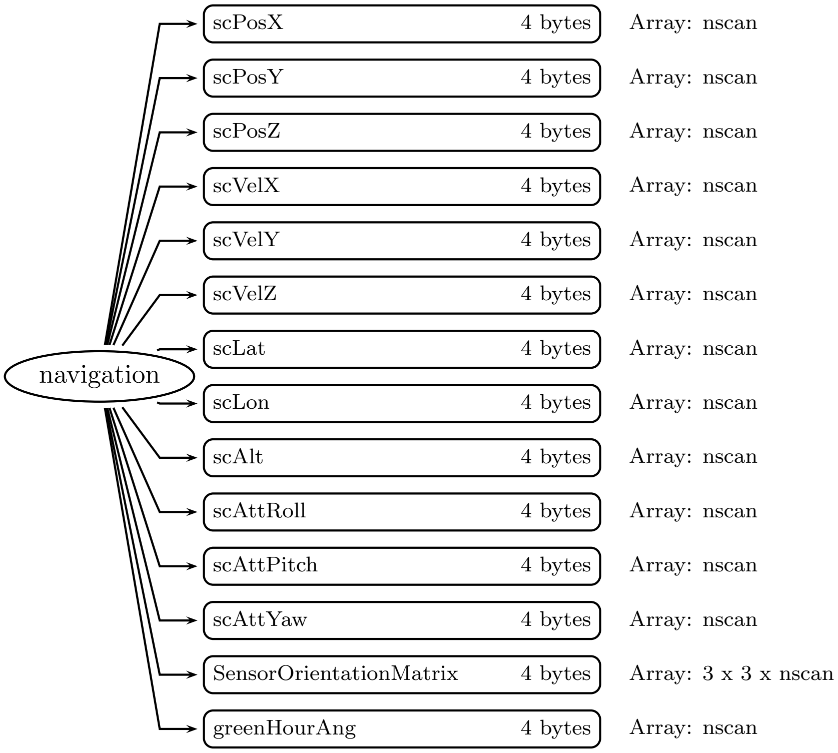

navigation
scPosX 4 bytes Array: nscan
scPosY 4 bytes Array: nscan
scPosZ 4 bytes Array: nscan
scVelX 4 bytes Array: nscan
scVelY 4 bytes Array: nscan
scVelZ 4 bytes Array: nscan
scLat 4 bytes Array: nscan
scLon 4 bytes Array: nscan
scAlt 4 bytes Array: nscan
scAttRoll 4 bytes Array: nscan
scAttPitch 4 bytes Array: nscan
scAttYaw 4 bytes Array: nscan
SensorOrientationMatrix 4 bytes Array: 3 x 3 x nscan
greenHourAng 4 bytes Array: nscan

Figure 7: Data Format Structure for 1B21, navigation

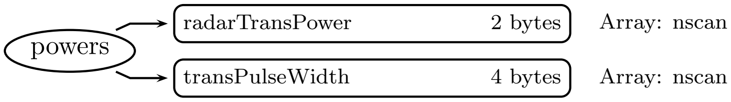


Figure 8: Data Format Structure for 1B21, powers

raySize (2-byte integer, array size: nray):
Number of Normal samples in the ray.

angle (4-byte float, array size: nray):
Angle (degrees) of the ray from nadir. The sign of the angle is consistent with the sensor y-axis, i.e., the angle is positive to the right of the direction of travel if the spacecraft is in normal mode.

startBinDist (4-byte float, array size: nray):
Distance (m) between the satellite and the starting bin number of the Normal sample for the ray.

rainThres1 (4-byte float, array size: nray):
Threshold used in minimum echo test (unitless). Value set by JAXA.

rainThres2 (4-byte float, array size: nray):
Threshold used in minimum echo test (unitless). Value set by JAXA.

transAntenna (4-byte float, array size: nray):
Transmitted radar antenna effectiveness (dB).

recvAntenna (4-byte float, array size: nray):
Received radar antenna effectiveness (dB).

onewayAlongTrack (4-byte float, array size: nray):
Radar beamwidth (radians) at the point transmitted power reaches one half of peak power in the along-track direction.

onewayCrossTrack (4-byte float, array size: nray):
Radar beamwidth (radians) at the point transmitted power reaches one half of peak power along the corss-track.

eqvWavelength (4-byte float, array size: nray):
Equivalent wavelength (m).

radarConst (4-byte float, array size: nray):
Radar constant dC (units are dB), which relates Received Power to Radar Reflectivity. dC depends on angle. ADD EQUATIONS.

prIntrDelay (4-byte float, array size: nray):
The time (seconds) between when echo returns at antenna and when echo is recorded in onboard processor.

rangeBinSize (4-byte float, array size: nray):
The vertical resolution of Normal sample bin (250 m).

logAveOffset (4-byte float, array size: nray):
The offset value (dB) between logarithmic average and normal average (+2.507dB).

mainlobeEdge (1-byte integer, array size: nray):
Absolute value of the difference in Range Bin Numbers between the detected surface and the edge of the clutter from the mainlobe.

sidelobeRange (1-byte integer, array size: 3 x nray):
Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter psition from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

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)

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

scanTime_sec (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:

-9999.9	Missing value

Latitude (4-byte float, array size: nray 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: nray 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
2 Scan data contains no elements with rain
```

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 (other than 1)
5   Non-routine QAC (non-zero)
6   Spare (always 0)
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):
Geolocation quality is a summary of geolocation quality in the scan. A zero integer value indicates 'good' geolocation. A non-zero value broken down into the following bit flags indicates the following, where 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	latitude limit error
1	geolocation
2	attitude change rate limit error
3	attitude limit error
4	satellite undergoing maneuvers
5	using predictive orbit data
6	geolocation calculation error
7	not used

dataQuality (1-byte integer, array size: nscan):
Data quality is a summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher 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	Geolocation Quality is not normal
6	Validity is not 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

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

Value	Meaning
0	Inaccurate
1	Indeterminate
2	Accurate

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

Value	Meaning
1	Observation Mode
2	Other Mode

prStatus1 (1-byte integer, array size: nscan):
This status is a warning for scan data. Unless this is 0, the scan data may include a little questionable value though it is not a problem (such as break of caution limit). This field is used only for NASDA's data analysis.

prStatus2 (1-byte integer, array size: nscan):
Initialization in Onboard Surface Search Algorithm.

Value	Meaning
0	Not initialized
1	Initialized

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.

powers (Group)

radarTransPower (2-byte integer, array size: nscan):
The total (sum) power of 128 SSPA elements corrected with SSPA temperature in orbit, based on temperature test data of SSPA transmission power. The units are dBm * 100. For this variable, the TSDIS Toolkit does not provide scaling.

transPulseWidth (4-byte float, array size: nscan):
Transmitted pulse width (s) corrected with FCIF temperature in orbit, based on temperature test data of FCIF.

systemNoise (2-byte integer, array size: nray x nscan):
System Noise (dBm) is an average of the 4 measured system noise values, multiplied by 100 and stored as a 2-byte integer. The range is -120 dBm to -20 dBm with an accuracy of 0.9 dBm. Missing data are given the value of -32,734.

sysNoiseWarnFlag (1-byte integer, array size: nray x nscan):
System Noise Warning Flag indicates possible contamination of lower window noise by high towers of rain. 1 means possible contamination; 0 means no possible contamination.

minEchoFlag (1-byte integer, array size: nray x nscan):
Flag to indicate the presence of rain in the ray (angle bin). The values of the flag are:

```
0  = no rain
10 = rain possible
11 = rain possible (Echo greater than rain threshold #1 in clutter range)
12 = rain possible (Echo greater than rain threshold #2 in clutter range)
13 = rain possible but probably sidelobe clutter
20 = rain certain
```

binStormHeight (2-byte integer, array size: 2 x nray x nscan):
Range Bin Number of the storm top. The first dimension is threshold, with values of possible rain threshold and certain rain threshold in that order. The Bin Storm Heights are generated in the procedure to determine the Minimum Echo Flag. The Bin Storm Height is the top range bin of the portion of consecutive range bins that flagged the ray as rain possible or rain certain. The range bin number is defined in this volume in the section on Precipitation Radar, Instrument and Scan Geometry.

binEllipsoid (2-byte integer, array size: nray x nscan):
The range bin number of the earth ellipsoid. The range bin number is defined in this volume in the section on Precipitation Radar, Instrument and Scan Geometry.

binClutterFreeBottom (2-byte integer, array size: 2 x nray x nscan):
The range bin number of the lowest clutter free bin. Clutter free bin numbers are given for clutter free certain and possible, respectively. The clutter free certain bin is always less than or equal to the clutter free possible bin number.

binDIDHmean (2-byte integer, array size: nray x nscan):
The mean range bin number of the DID surface elevation in a 5 km x 5 km box centered on the IFOV. The range bin number is defined in this volume in the section on Precipitation Radar, Instrument and Scan Geometry.

binDIDHtop (2-byte integer, array size: 2 x nray x nscan):
The range bin number of the maximum DID surface elevation in a box centered on the IFOV. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km. The range bin number is defined in this volume in the section on Precipitation Radar, Instrument and Scan Geometry.

binDIDHbottom (2-byte integer, array size: 2 x nray x nscan):
The range bin number of the minimum DID surface elevation in a box centered on the IFOV. The first dimension is the box size, with sizes of 5 km x 5 km and 11 km x 11km. The range bin number is defined in this volume in the section on Precipitation Radar, Instrument and Scan Geometry.

scLocalZenith (4-byte float, array size: nray x nscan):
The angle, in degrees, between the local zenith and the beam's center line. The local (geodetic) zenith at the intersection of the ray and the earth ellipsoid is used.

scRange (4-byte float, array size: nray x nscan):
Distance (m) between the spacecraft and the center of the footprint of the beam on the earth ellipsoid.

osBinStart (2-byte integer, array size: 2 x 29 x nscan):
The first dimension is the Bin Start of Oversample and Surface Tracker Status. The second dimension is the ray. The number of rays is 29 because this information only applies to the rays that have oversample data (rays 11 to 39). The third dimension is the scan. The Bin Start of Oversample is the starting range bin number of the oversample (either surface or rain) data, counting from the top down. The Surface Tracker Status has the value of 0 (Lock) or 1 (Unlock), where Lock means that (1) the on board surface detection detected the surface and (2) the surface detected later by processing on the ground fell within the oversample bins. Unlock means that Lock was not achieved. The range bin number is defined in this volume in the section on Precipitation Radar, Instrument and Scan Geometry.

landOceanFlag (2-byte integer, array size: nray x nscan):
Land or ocean information. The values of the flag are:

```
0 = Water
1 = Land
2 = Coast
3 = Water (w/ large attenuation)
4 = Land/Coast (w/ large attenuation)
```

surfWarnFlag (2-byte integer, array size: nray x nscan):
Definition TBD by JAXA.

binSurfPeak (2-byte integer, array size: nray x nscan):
The range bin number of the peak surface echo. This peak is determined by the post observation ground processing, not by the on board surface detection. The range bin number is defined in this volume in the section on Precipitation Radar, Instrument and Scan Geometry.

normalSample (2-byte integer, array size: 140 x nray x nscan):
Return power (dBm) of the normal sample, multiplied by 100 and stored as a 2-byte integer. Since each ray has a different size, the elements after the end of each ray are filled with a value of -32767. Other bins where data is not written due to a transmission,

calibration, or other problem, including an entire scan of missing bins, have the value of -32734. See Figure 6.1-2. The size of each ray is specified in Ray Header. The range is -120 dBm to -20 dBm.

osSurf (2-byte integer, array size: 5 x 29 x nscan):
Return power (dBm) of the surface echo oversample for the central 29 rays (rays number 11-39), multiplied by 100 and stored as a 2-byte integer. The range is -120 dBm to -20 dBm. Bins where data is not written due to a transmission, calibration, or other problem, including an entire scan of missing bins, have the value of -32734.

osRain (2-byte integer, array size: 28 x 11 x nscan):
Return power (dBm) of the rain echo oversample for the central 11 rays (rays number 20-30), multiplied by 100 and stored as a 2-byte integer. The range is -120 dBm to -20 dBm. Bins where data is not written due to a transmission, calibration, or other problem, including an entire scan of missing bins, have the value of -32734.

C Structure Header file:

```
#ifndef _TK_1B21_H_
#define _TK_1B21_H_

#ifndef _L1B21_POWERS_
#define _L1B21_POWERS_

typedef struct {
    short radarTransPower;
    float transPulseWidth;
} L1B21_POWERS;

#endif

#ifndef _L1B21_NAVIGATION_
#define _L1B21_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;
} L1B21_NAVIGATION;

#endif

#ifndef _L1B21_SCANSTATUS_
#define _L1B21_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 yawUpdateS;
    signed char prMode;
    signed char prStatus1;
    signed char prStatus2;
    double FractionalGranuleNumber;
} L1B21_SCANSTATUS;

#endif

#ifndef _L1B21_SCANTIME_
#define _L1B21_SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
} L1B21_SCANTIME;

#endif
```

```
#ifndef _L1B21_SWATH_
#define _L1B21_SWATH_

typedef struct {
    L1B21_SCANTIME ScanTime;
    double scanTime_sec;
    float Latitude[49];
    float Longitude[49];
    L1B21_SCANSTATUS scanStatus;
    L1B21_NAVIGATION navigation;
    L1B21_POWERS powers;
    float systemNoise[49];
    signed char sysNoiseWarnFlag[49];
    signed char minEchoFlag[49];
    short binStormHeight[49][2];
    short binEllipsoid[49];
    short binClutterFreeBottom[49][2];
    short binDIDHmean[49];
    short binDIDHtop[49][2];
    short binDIDHbottom[49][2];
    float scLocalZenith[49];
    float scRange[49];
    short osBinStart[29][2];
    short landOceanFlag[49];
    short surfWarnFlag[49];
    short binSurfPeak[49];
    float normalSample[49][140];
    float osSurf[29][5];
    float osRain[11][28];
} L1B21_SWATH;

#endif

#ifndef _L1B21_RAY_HEADER_
#define _L1B21_RAY_HEADER_

typedef struct {
    short rayStart[49];
    short raySize[49];
    float angle[49];
    float startBinDist[49];
    float rainThres1[49];
    float rainThres2[49];
    float transAntenna[49];
    float recvAntenna[49];
    float onewayAlongTrack[49];
    float onewayCrossTrack[49];
    float eqvWavelength[49];
    float radarConst[49];
    float prIntrDelay[49];
    float rangeBinSize[49];
    float logAveOffset[49];
    signed char mainlobeEdge[49];
    signed char sidelobeRange[49][3];
} L1B21_RAY_HEADER;

#endif

#ifndef _L1B21_PR_CAL_COEF_
#define _L1B21_PR_CAL_COEF_

typedef struct {
    float transCoef[1];
    float receptCoef[1];
    float fcifIOchar[16];
} L1B21_PR_CAL_COEF;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1B21_POWERS/
    INTEGER*2 radarTransPower
    REAL*4 transPulseWidth
END STRUCTURE

STRUCTURE /L1B21_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 /L1B21_SCANSTATUS/
    BYTE missing
    BYTE validity
    BYTE qac
    BYTE geoQuality
    BYTE dataQuality
    INTEGER*2 SCorientation
    BYTE acsMode
    BYTE yawUpdateS
    BYTE prMode
    BYTE prStatus1
    BYTE prStatus2
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /L1B21_SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
END STRUCTURE

STRUCTURE /L1B21_SWATH/
    RECORD /L1B21_SCANTIME/ ScanTime
    REAL*8 scanTime_sec
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    RECORD /L1B21_SCANSTATUS/ scanStatus
    RECORD /L1B21_NAVIGATION/ navigation
    RECORD /L1B21_POWERS/ powers
    REAL*4 systemNoise(49)
    BYTE sysNoiseWarnFlag(49)
    BYTE minEchoFlag(49)
    INTEGER*2 binStormHeight(2,49)
    INTEGER*2 binEllipsoid(49)
    INTEGER*2 binClutterFreeBottom(2,49)
    INTEGER*2 binDIDHmean(49)
    INTEGER*2 binDIDHtop(2,49)
    INTEGER*2 binDIDHbottom(2,49)
    REAL*4 scLocalZenith(49)
    REAL*4 scRange(49)
    INTEGER*2 osBinStart(2,29)
    INTEGER*2 landOceanFlag(49)
    INTEGER*2 surfWarnFlag(49)
    INTEGER*2 binSurfPeak(49)
    REAL*4 normalSample(140,49)
    REAL*4 osSurf(5,29)
    REAL*4 osRain(28,11)
END STRUCTURE

STRUCTURE /L1B21_RAY_HEADER/
    INTEGER*2 rayStart(49)
    INTEGER*2 raySize(49)
    REAL*4 angle(49)
    REAL*4 startBinDist(49)
    REAL*4 rainThres1(49)
    REAL*4 rainThres2(49)
    REAL*4 transAntenna(49)
    REAL*4 recvAntenna(49)
    REAL*4 onewayAlongTrack(49)
    REAL*4 onewayCrossTrack(49)
    REAL*4 eqvWavelength(49)
    REAL*4 radarConst(49)
    REAL*4 prIntrDelay(49)
    REAL*4 rangeBinSize(49)
    REAL*4 logAveOffset(49)
    BYTE mainlobeEdge(49)
    BYTE sidelobeRange(3,49)
END STRUCTURE

STRUCTURE /L1B21_PR_CAL_COEF/
    REAL*4 transCoef(1)
    REAL*4 receptCoef(1)
    REAL*4 fcifIOchar(16)
END STRUCTURE
```