TROPICAL RAINFALL MEASURING MISSION PRECIPITATION PROCESSING SYSTEM

File Specification
REAL TIME SYSTEM

Version 7P3

June 30, 2011

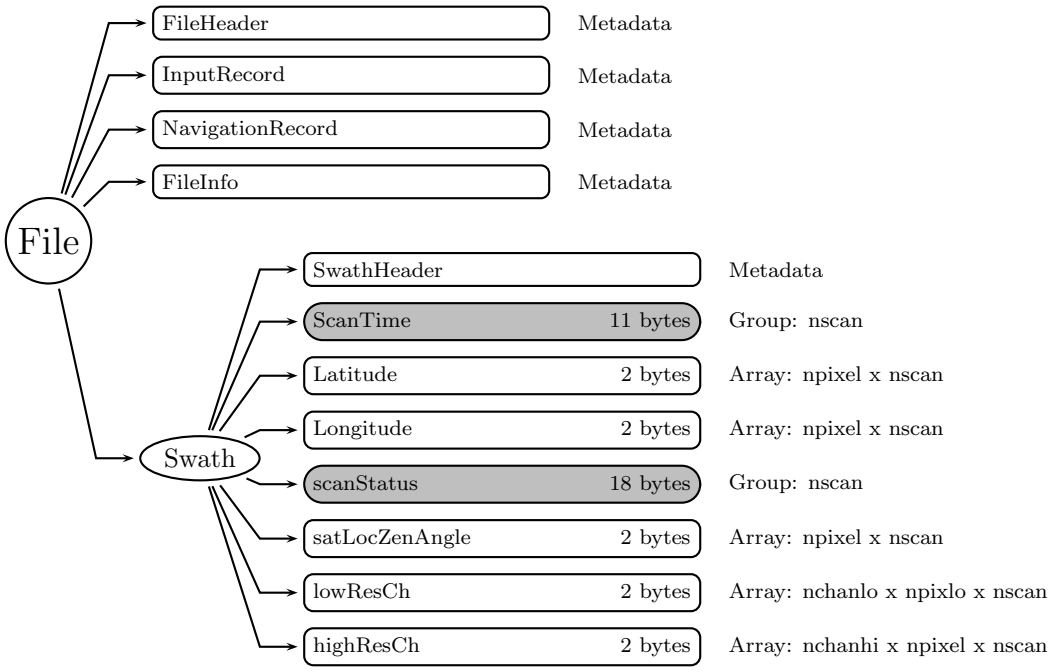

Figure 1: Data Format Structure for 1B11RT, TMI Brightness Temperatures

0.1 1B11RT - TMI Brightness Temperatures

The TMI Level 1B Product, 1B11RT, "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.
npixel	208	Number of high frequency pixels in each scan.
npixlo	104	Number of low frequency pixels in each scan.

Figure 1 through Figure 3 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 and Level 2 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

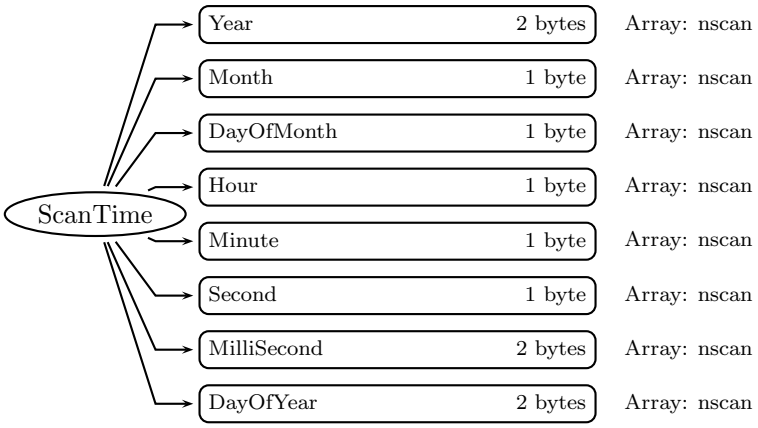

Figure 2: Data Format Structure for 1B11RT, ScanTime

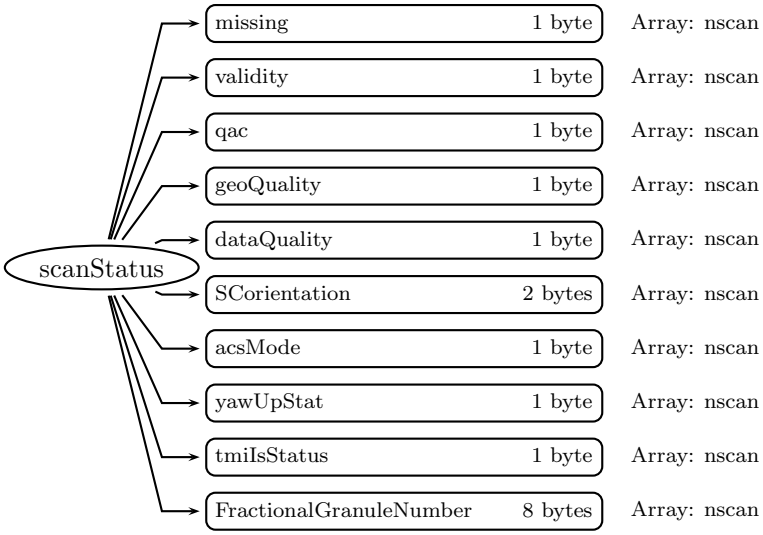

Figure 3: Data Format Structure for 1B11RT, scanStatus

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)

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 (2-byte integer, 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. Latitude in degrees is multiplied by 100 and stored as

a 2-byte integer. Latitude ranges from -90 to 90 degrees. Missing values are -9999 in the file.

Longitude (2-byte integer, 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. Longitude in degrees is multiplied by 100 and stored as a 2-byte integer. Longitude ranges from -180 to 180 degrees. Missing values are -9999 in the file.

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

satLocZenAngle (2-byte integer, array size: npixel x nscan):
The angle, in degrees, between the local pixel geodetic zenith and the direction to the satellite. The angle is multiplied by 100 and stored as a 2-byte integer. Missing values are -9999 in the file.

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. Missing values are -9999 in the file. 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. Missing values are -9999 in the file. 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_1B11RT_H_
#define _TK_1B11RT_H_

#ifndef _L1B11RT_SCANSTATUS_
#define _L1B11RT_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;
} L1B11RT_SCANSTATUS;

#endif

#ifndef _L1B11RT_SCANTIME_
#define _L1B11RT_SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
} L1B11RT_SCANTIME;

#endif

#ifndef _L1B11RT_SWATH_
#define _L1B11RT_SWATH_

typedef struct {
    L1B11RT_SCANTIME ScanTime;
```

```
    float Latitude[208];
    float Longitude[208];
    L1B11RT_SCANSTATUS scanStatus;
    float satLocZenAngle[208];
    float lowResCh[104][7];
    float highResCh[208][2];
} L1B11RT_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L1B11RT_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 /L1B11RT_SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
END STRUCTURE

STRUCTURE /L1B11RT_SWATH/
    RECORD /L1B11RT_SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    RECORD /L1B11RT_SCANSTATUS/ scanStatus
```

```
    REAL*4 satLocZenAngle(208)
    REAL*4 lowResCh(7,104)
    REAL*4 highResCh(2,208)
END STRUCTURE
```

0.2 2A12RT - TMI Precipitation

The TMI Level 2A Product, 2A12RT, "TMI Precipitation," generates a surface precipitation rate and the probability of precipitation using the Goddard Profiling algorithm GPROF2008. For each pixel, surface precipitation and convective surface precipitation are given. Because the Bayesian algorithm retrieves small precipitation rates for almost all pixels, the probability of precipitation exceeding 50 percent can be used as a practical threshold for deciding if a specific pixel is likely to have precipitation or not. The format of this product was designed in consultation with the TMI algorithm scientists. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
npixel	208	Number of pixels in each scan.

Figure 4 through Figure 6 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 and Level 2 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.

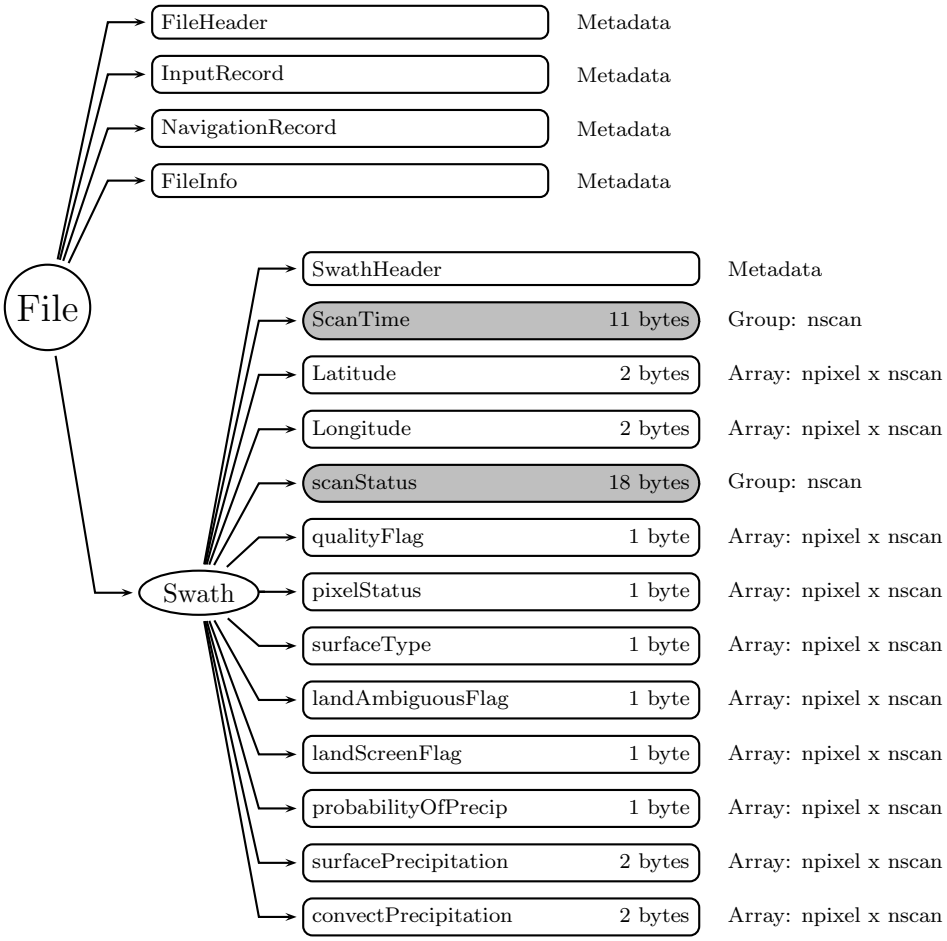

Figure 4: Data Format Structure for 2A12RT, TMI Precipitation

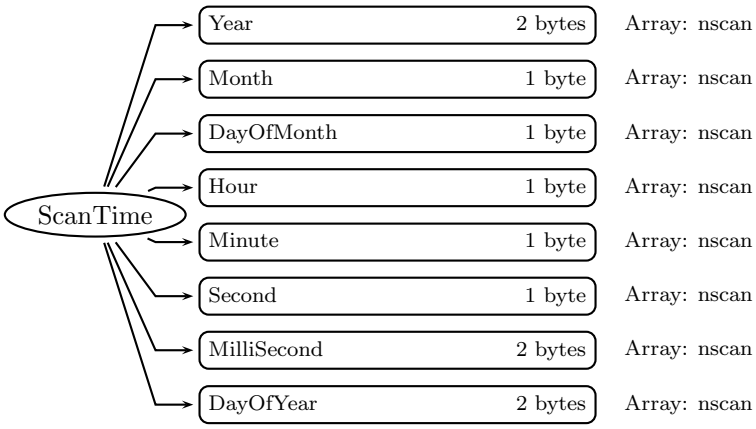

Figure 5: Data Format Structure for 2A12RT, ScanTime

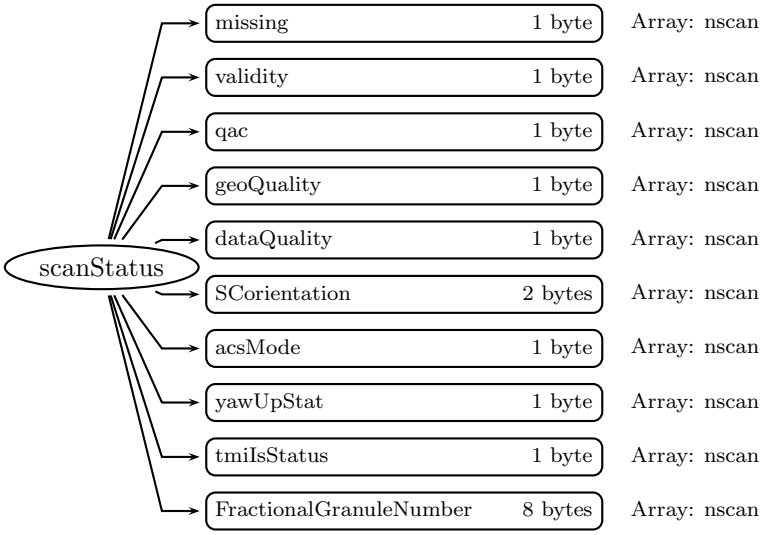

Figure 6: Data Format Structure for 2A12RT, scanStatus

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

Latitude (2-byte integer, 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. Latitude in degrees is multiplied by 100 and stored as a 2-byte integer. Latitude ranges from -90 to 90 degrees. Missing values are -9999 in the file.

Longitude (2-byte integer, 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. Longitude in degrees is multiplied by 100 and stored as a 2-byte integer. Longitude ranges from -180 to 180 degrees. Missing values are -9999 in the file.

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

qualityFlag (1-byte integer, array size: npixel x nscan):
qualityFlag indicates a generalized quality of the retrieved pixel (Range 0 - 99).

```
Ocean Algorithm:
    High:    Good retrieval (uses only entries from TRMM apriori
             database)
    Medium:  Retrieval used extended database (created by lowering SST
             and Freezing level by 3K from TRMM observations)  and/or
             expanded search radius beyond 2K in SST and 3 mm in TPW
    Low:     Retrieval used excessive search radius to find matches in
             apriori database
Land/Coast Algorithm:
    High:    Good retrieval
    Medium:  Not currently used
    Low:     Pixel is ambiguous (Tb depression due to precipitation or
             surface effect)

Valid values include:
    0 : High quality (retrieval is good)
    1 : Medium quality (use with caution)
    2 : Low quality (recommended qualitative use only)
  -99 : Missing value
```

pixelStatus (1-byte integer, array size: npixel x nscan):
If there is no retrieval at a given pixel, pixelStatus explains the reason (Range 0 - 99).

```
0 : Valid pixel
1 : Boundary error in landmask
2 : Boundary error in sea-ice check
```

```
  3 : Boundary error in sea surface temperature
  4 : Invalid time
  5 : Invalid latitude/longitude
  6 : Invalid brightness temperature
  7 : Invalid sea surface temperature
  8 : No retrieval due to sea-ice over water
  9 : No retrieval due to sea-ice over coast
 10 : Land/coast screens not able to be applied
-99 : Missing value
```

surfaceType (1-byte integer, array size: npixel x nscan):
Indicates the type of surface (Range 0 - 99).

```
 10 : Ocean
 11 : Sea ice
 12 : Partial sea ice
 20 : Land
 30 : Coast
-99 : Missing value
```

landAmbiguousFlag (1-byte integer, array size: npixel x nscan):
Defines codes for uncertain/ambiguous retrievals over land (Range 0 - 99). Valid values are:

```
  0 : No information
 13 : Ambiguous T22V / 2 different scattering screens
 14 : Cannot discriminate precip from cold surface
 63 : Light precipitation
 64 : Cold surface
 65 : Grody light precipitation
 66 : Huffman ambiguous
-99 : Missing value
```

landScreenFlag (1-byte integer, array size: npixel x nscan):
Diagnostic codes for rainfall screens over land (Range 0 - 99). Valid values are:

```
  0 : No information
-31 : Land retrieval found ice likely
-41 : Land retrieval found large polarization
      difference due to ice or sand
-51 : Warm 85H and Low 22V, or clear ocean likely in coast retrieval
-61 : Probable coastline in coast retrieval
-99 : Missing value
```

probabilityOfPrecip (1-byte integer, array size: npixel x nscan):
A diagnostic variable, in percent, defining the fraction of raining vs. non-raining Dbase profiles that make up the final solution. Values range from 0 to 100 percent. Special values are defined as:
-99 Missing value

surfacePrecipitation (2-byte integer, array size: npixel x nscan):
The instantaneous precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Values are multiplied by 10 and stored as a 2-byte integer. Missing values are -9999 in the file.

convectPrecipitation (2-byte integer, array size: npixel x nscan):
The instantaneous convective precipitation rate at the surface for each pixel. Check pixelStatus for a valid retrieval. Values are in mm/hr. Values are multiplied by 10 and stored as a 2-byte integer. Missing values are -9999 in the file.

C Structure Header file:

```
#ifndef _TK_2A12RT_H_
#define _TK_2A12RT_H_

#ifndef _L2A12RT_SCANSTATUS_
#define _L2A12RT_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;
} L2A12RT_SCANSTATUS;

#endif

#ifndef _L2A12RT_SCANTIME_
#define _L2A12RT_SCANTIME_

typedef struct {
    short Year;
    signed char Month;
```

```
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
} L2A12RT_SCANTIME;

#endif

#ifndef _L2A12RT_SWATH_
#define _L2A12RT_SWATH_

typedef struct {
    L2A12RT_SCANTIME ScanTime;
    float Latitude[208];
    float Longitude[208];
    L2A12RT_SCANSTATUS scanStatus;
    signed char qualityFlag[208];
    signed char pixelStatus[208];
    signed char surfaceType[208];
    signed char landAmbiguousFlag[208];
    signed char landScreenFlag[208];
    signed char probabilityOfPrecip[208];
    float surfacePrecipitation[208];
    float convectPrecipitation[208];
} L2A12RT_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2A12RT_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 /L2A12RT_SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
END STRUCTURE

STRUCTURE /L2A12RT_SWATH/
    RECORD /L2A12RT_SCANTIME/ ScanTime
    REAL*4 Latitude(208)
    REAL*4 Longitude(208)
    RECORD /L2A12RT_SCANSTATUS/ scanStatus
    BYTE qualityFlag(208)
    BYTE pixelStatus(208)
    BYTE surfaceType(208)
    BYTE landAmbiguousFlag(208)
    BYTE landScreenFlag(208)
    BYTE probabilityOfPrecip(208)
    REAL*4 surfacePrecipitation(208)
    REAL*4 convectPrecipitation(208)
END STRUCTURE
```

0.3 2A23RT - PR Qualitative

2A23RT, "PR Qualitative", produces a Rain/No-rain flag. If rain is present, this algorithm will detect the bright band, determine the heights of the bright band and the storm, and classify rain types. 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 7 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.

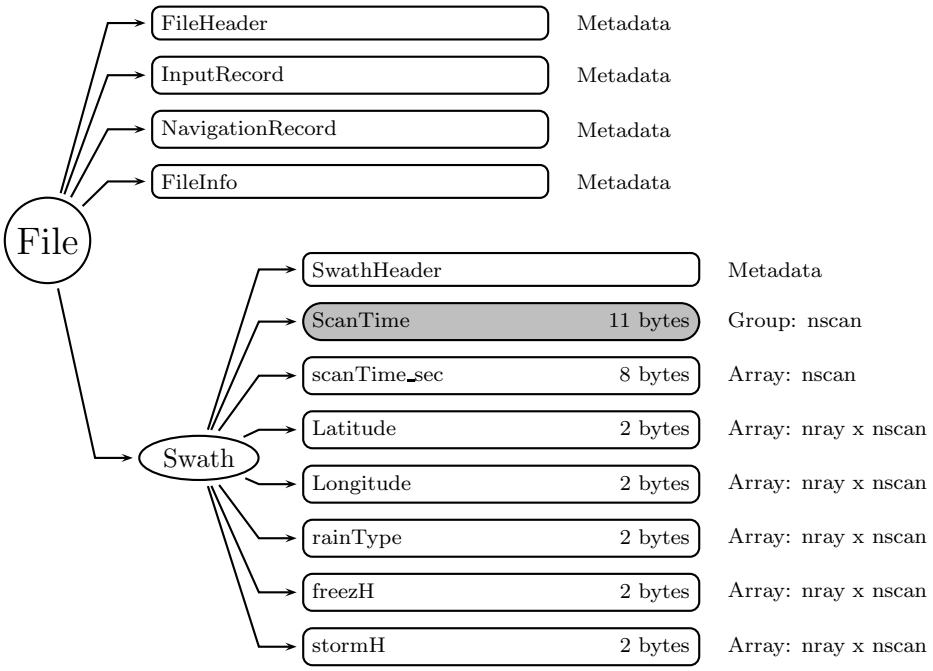

Figure 7: Data Format Structure for 2A23RT, PR Qualitative

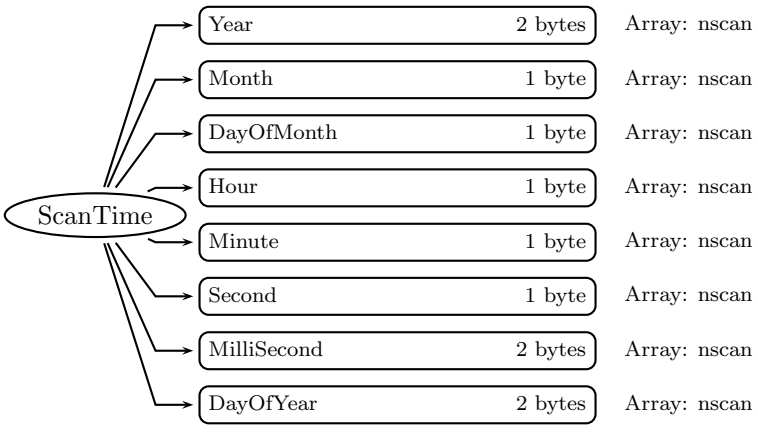

Figure 8: Data Format Structure for 2A23RT, ScanTime

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 and Level 2 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)

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 (2-byte integer, 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. Latitude in degrees is multiplied by 100 and stored as a 2-byte integer. Latitude ranges from -90 to 90 degrees. Missing values are -9999 in the file.

Longitude (2-byte integer, 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. Longitude in degrees is multiplied by 100 and stored as a 2-byte integer. Longitude ranges from -180 to 180 degrees. Missing values are -9999 in the file.

rainType (2-byte integer, array size: nray x nscan):
The Rain Type is set as follows:

```
100: Stratiform certain.
     When R\_type\_V(i) = T\_stra;    (BB exists)
     and  R\_type\_H(i) = T\_stra;

110: Stratiform certain.
     When R\_type\_V(i) = T\_stra;    (BB exists)
     and  R\_type\_H(i) = T\_others;

120: Probably stratiform.
     When R\_type\_V(i) = T\_others;(BB may exist but not detected)
     and  R\_type\_H(i) = T\_stra;
     BB not detected by V-profile method, but BB may exist.
     Radar echo not strong enough to be convective, and not
     noise (because H-pattern method classified this as
     stratiform but not noise (i.e., others)), hence the
     rain type in this case is most probably stratiform.

130: Maybe stratiform.
     When R\_type\_V(i) = T\_stra;   (BB detection certain)
```

```
     and  R\_type\_H(i) = T\_conv;
     Ambiguous, but rain type may be stratiform because
     the     bright band (BB) certainly detected, and radar
     echo below BB not so strong (because V-profile
     method classified this as stratiform).
     The H-pattern method classified this as convective
     not because the existence of very strong radar echo
     (if so, the V-profile method also would have
     classified this as convective despite of the
     existence of BB), but because it satisfied the
     stand-out condition for convective center against
     the background area with 11 km radius, which does
     not necessarily mean that radar echo is very strong.

140: Maybe stratiform or maybe transition or something else.
     When R\_type\_V(i) = T\_others; (BB hardly expected)
     and  R\_type\_H(i) = T\_stra;

152: Maybe stratiform:
     Shallow rain (non-isolated) is detected.
     When R\_type\_V(i) = T\_others;
          R\_type\_H(i) = T\_stra;
     and shallowRain(i) = 20 or 21;

160: Maybe stratiform, but rain hardly expected near surface.
     BB may exist but is not detected.
     When R\_type\_V(i) = T\_others;
     and  R\_type\_H(i) = T\_stra;

170: Maybe stratiform, but rain hardly expected near surface.
     BB hardly expected.  Maybe cloud only.
     Distinction between 170 and 300 is very small.
     When R\_type\_V(i) = T\_others;
     and  R\_type\_H(i) = T\_stra;

200: Convective certain.
     When R\_type\_V(i) = T\_conv;   (no BB)
     and  R\_type\_H(i) = T\_conv;

210: Convective certain.
     When R\_type\_V(i) = T\_others;
     and  R\_type\_H(i) = T\_conv;
     Since the criteria for convective by the V-profile
```

method is somewhat stringent, the V-profile method classified this as others, but actually it is convective because H-pattern method classified this as convective (probably by the stand-out condition for convective center against the background area). Though certain, the confidence level would be very slightly lower than that of the case designated by the number 20 (i.e. the case where both methods classified it as convective).

220: Convective certain.
When R_type_V(i) = T_conv;
and R_type_H(i) = T_others;
(or, on a very rare occasion, when only R_type_V(i) is available because of read scan error.)

appear in ver.6.11 and later.

When R_type_V(i) = T_conv; (BB exists)
and R_type_H(i) = T_conv;
Somewhat ambiguous because of the existence of the bright band (BB).
But the rain type is probably convective because radar echo below BB is so strong that even the V-profile method classified it as convective, and the H-pattern method also classified it as convective.

240: Maybe convective.
When R_type_V(i) = T_conv;
and R_type_H(i) = T_stra;
Though I tried to set the criteria for convective by the V-profile method as being somewhat more stringent than that of the H-pattern method, it is not always the case.
I expect that this combination would happen in two cases:

(1) When strong convective precipitation exists above Hebb-1km, below which is examined by the H-method, and echo below Hebb-1km is very weak due to strong ATT.

(2) But this combination also occurs when BB detection

```
        fails.
        (A very large Z at BB height would make the result of
        V-method as convective when the detection of BB fails.
        This may occur when BB is associated with strong
        precipitation: V-method has a chance to miss the
        BB, hence convective by V-method. A large ATT would
        make the echo below BB very weak, hence stratiform by
        H-method.)

    In practice, it is very difficult to distinguish the
    above (1) and (2).  In ver. 4.0, the above combination
    is classified as convective, because it is certain that
    the echo is strong so that it has a convective nature
    in both (1) and (2).  But, of course, a detailed study
    is needed in Day-2 improvement of the algorithm.

251: Convective.
    Shallow isolated is detected.
    When R\_type\_V(i) = T\_conv,
         R\_type\_H(i) = T\_conv;
    and shallowRain(i) = 10 or 11;

252: Convective.
    Shallow rain (non-isolated) is detected.
    When R\_type\_V(i) = T\_conv,
         R\_type\_H(i) = T\_conv;
    and shallowRain(i) = 20 or 21;

261: Convective.
    Shallow isolated is detected.
    When R\_type\_V(i) = T\_conv,
         R\_type\_H(i) = T\_others;
    and shallowRain(i) = 10 or 11;

262: Convective.
    Shallow rain (non-isolated) is detected.
    When R\_type\_V(i) = T\_conv,
         R\_type\_H(i) = T\_others;
    and shallowRain(i) = 20 or 21;

271: Convective.
    Shallow isolated is detected.
    When R\_type\_V(i) = T\_others,
```

```
          R\_type\_H(i) = T\_conv;
     and shallowRain(i) = 10 or 11;

272: Convective.
     Shallow rain (non-isolated) is detected.
     When R\_type\_V(i) = T\_others,
          R\_type\_H(i) = T\_conv;
     and shallowRain(i) = 20 or 21;

281: Convective.
     Shallow isolated is detected.
     When R\_type\_V(i) = T\_conv,
          R\_type\_H(i) = T\_stra;
     and shallowRain(i) = 10 or 11;


282: Convective.
     Shallow rain (non-isolated) is detected.
     When R\_type\_V(i) = T\_conv,
          R\_type\_H(i) = T\_stra;
     and shallowRain(i) = 20 or 21;

291: Convective:
     Shallow isolated is detected.
     When R\_type\_V(i) = T\_others;
          R\_type\_H(i) = T\_stra;
     and shallowRain(i) = 10 or 11;

300: Others.
     When R\_type\_V(i) = T\_others;
     and  R\_type\_H(i) = T\_others;
     This category includes very weak echo (possibly noise)
     and/or cloud (very weak echo in the lower altitude but
     appreciable echo in the upper part, which was not
     detected as bright band).

312: Others.
     Shallow rain (non-isolated) is detected.
     When R\_type\_V(i) = T\_others,
          R\_type\_H(i) = T\_others;
     and shallowRain(i) = 20 or 21;-

313: Others.
```

```
        If sidelobe clutter were not rejected, shallow
        isolated would be detected.
        When R\_type\_V(i) = T\_others,
             R\_type\_H(i) = T\_others;
        where
        R\_type\_V: rain type classified by the V-profile method,
        R\_type\_H: rain type classified by the H-pattern method, which is
                  based on SHY95 developed by Prof. Houze and his group.

    -88: no rain

    -99: missing
```

freezH (2-byte integer, array size: nray x nscan):
A positive Height of Freezing Level is the height of the 0^{o}C isotherm above mean sea level, estimated from climatological surface temperature data. Values are in m. Special values are defined as:

-8888	No rain
-5555	When error occurred in the estimation of Height of Freezing Level
-9999	Missing value

stormH (2-byte integer, array size: nray x nscan):
A positive Height of Storm is the height of the storm top above mean sea level. A positive Height of Storm is given only when rain is present with a high degree of confidence in 1C21 (i.e., the Minimum Echo Flag in 1C21 has the value of 2 (rain certain)). Values range from 0 to 30000 m. Special values are defined as:

-8888	No rain
-1111	Rain is not present with a high level of confidence in 1C21
-9999	Missing value

C Structure Header file:

```
#ifndef _TK_2A23RT_H_
#define _TK_2A23RT_H_

#ifndef _L2A23RT_SCANTIME_
#define _L2A23RT_SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
```

```
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
} L2A23RT_SCANTIME;

#endif

#ifndef _L2A23RT_SWATH_
#define _L2A23RT_SWATH_

typedef struct {
    L2A23RT_SCANTIME ScanTime;
    double scanTime_sec;
    float Latitude[49];
    float Longitude[49];
    short rainType[49];
    short freezH[49];
    short stormH[49];
} L2A23RT_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2A23RT_SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
END STRUCTURE

STRUCTURE /L2A23RT_SWATH/
    RECORD /L2A23RT_SCANTIME/ ScanTime
    REAL*8 scanTime_sec
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
```

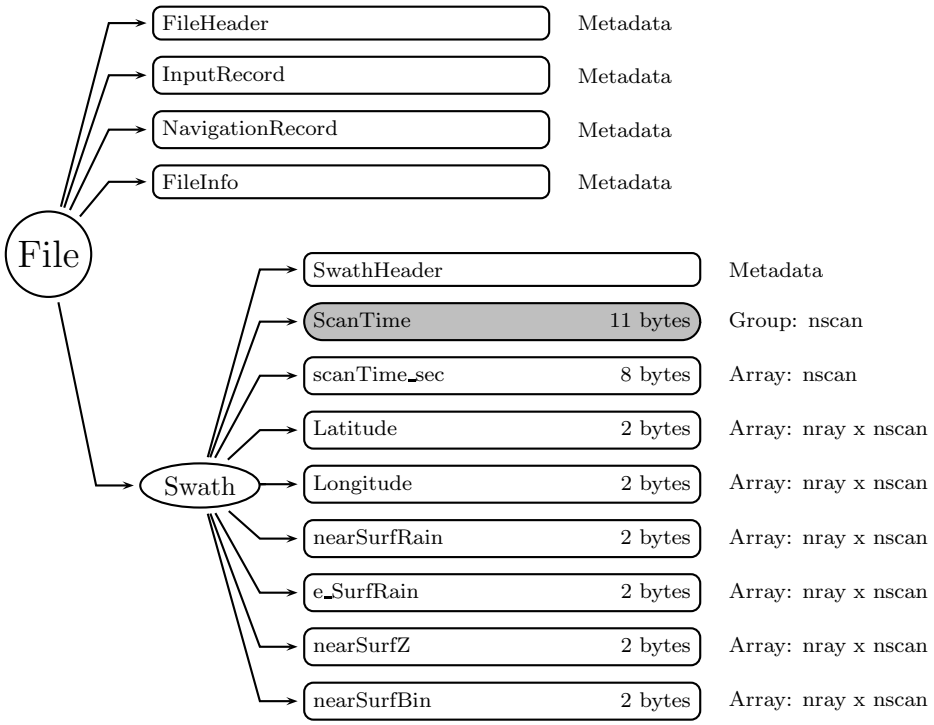

Figure 9: Data Format Structure for 2A25R1, PR Surface Rain

```
    INTEGER*2 rainType(49)
    INTEGER*2 freezH(49)
    INTEGER*2 stormH(49)
END STRUCTURE
```

0.4 2A25R1 - PR Surface Rain

2A25R1, "PR Surface Rain", produces an estimate of surface rainfall rate for each radar beam. To compare with ground-based radar, the attenuation corrected Z is also given. 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 9 through Figure 10 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.

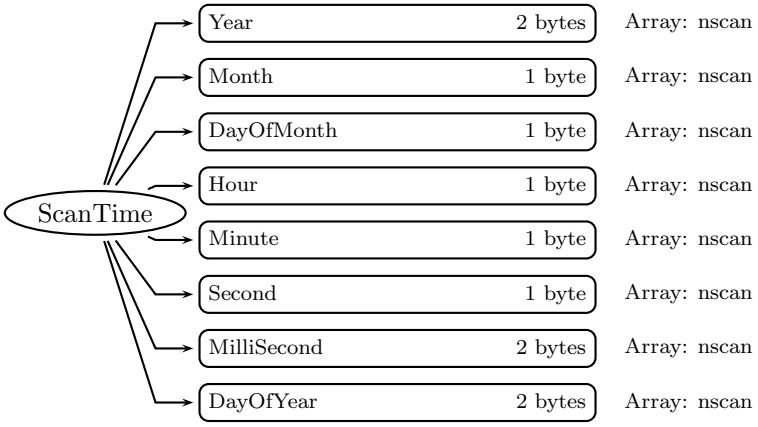

Figure 10: Data Format Structure for 2A25R1, ScanTime

InputRecord (Metadata):
InputRecord contains a record of input files for this granule. This group appears in Level 1 and Level 2 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)

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 (2-byte integer, 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. Latitude in degrees is multiplied by 100 and stored as a 2-byte integer. Latitude ranges from -90 to 90 degrees. Missing values are -9999 in the file.

Longitude (2-byte integer, 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. Longitude in degrees is multiplied by 100 and stored as a 2-byte integer. Longitude ranges from -180 to 180 degrees. Missing values are -9999 in the file.

nearSurfRain (2-byte integer, array size: nray x nscan):
Rainfall rate near the surface. The range is 0 to 3000 mm/hr. nearSurfRain is multiplied by 100 and stored as a 2-byte integer. Missing values are -9999 in the file.

e_SurfRain (2-byte integer, array size: nray x nscan):
The rainfall estimate at the true (detected) surface bin. The range is 0 to 3000 mm/hr. e_SurfRain is multiplied by 100 and stored as a 2-byte integer. Missing values are -9999 in the file.

nearSurfZ (2-byte integer, array size: nray x nscan):
Reflectivity near the surface. The range is 0.0 to 100.0 dBZ. nearSurfZ is multiplied by 100 and stored as a 2-byte integer. Missing values are -9999 in the file.

nearSurfBin (2-byte integer, array size: nray x nscan):
The Range Bin Number of the bottom of the interval that is processed as meaningful data by the operational 2A25 algorithm. Bin Numbers range from 0 to 79 and have an interval of 250 m. The earth ellipsiod is Bin Number 79. Bin Number 0 is 19750 m above the earth ellipsoid. The nearSurfRain and nearSurfZ are observed one bin less (250 m higher above the Earth ellipsoid) than the nearSurfBin. A value of -9999 is a missing flag.

C Structure Header file:

```
#ifndef _TK_2A25R1_H_
#define _TK_2A25R1_H_

#ifndef _L2A25R1_SCANTIME_
#define _L2A25R1_SCANTIME_

typedef struct {
    short Year;
    signed char Month;
    signed char DayOfMonth;
    signed char Hour;
    signed char Minute;
    signed char Second;
    short MilliSecond;
    short DayOfYear;
} L2A25R1_SCANTIME;

#endif

#ifndef _L2A25R1_SWATH_
#define _L2A25R1_SWATH_

typedef struct {
    L2A25R1_SCANTIME ScanTime;
    double scanTime_sec;
    float Latitude[49];
    float Longitude[49];
    float nearSurfRain[49];
    float e_SurfRain[49];
    float nearSurfZ[49];
    short nearSurfBin[49];
} L2A25R1_SWATH;

#endif
```

```
#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2A25R1_SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
END STRUCTURE

STRUCTURE /L2A25R1_SWATH/
    RECORD /L2A25R1_SCANTIME/ ScanTime
    REAL*8 scanTime_sec
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 nearSurfRain(49)
    REAL*4 e_SurfRain(49)
    REAL*4 nearSurfZ(49)
    INTEGER*2 nearSurfBin(49)
END STRUCTURE
```

0.5 2A25R2 - PR PR Profile

2A25R2, "PR Profile", produces an estimate of vertical rainfall rate for each radar beam. 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.
ncell1	20	Number of radar range cells at which the rain rate is estimated. The cells range from 0 to 19. Each cell is 500m apart, with cell 0 at 10000 m above and cell 19 at 500 m above the earth ellipsiod.

Figure 11 through Figure 12 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.

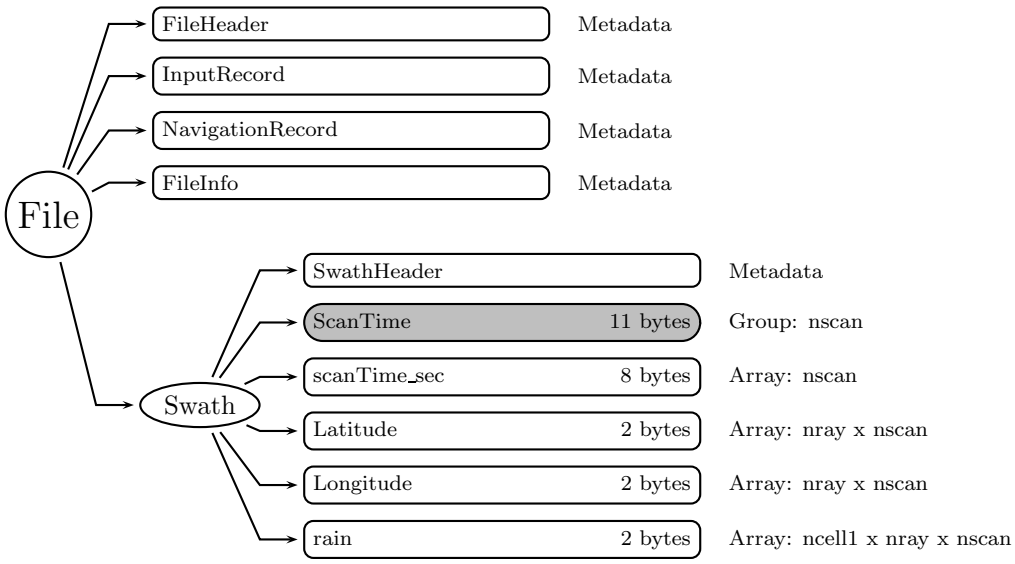

Figure 11: Data Format Structure for 2A25R2, PR PR Profile

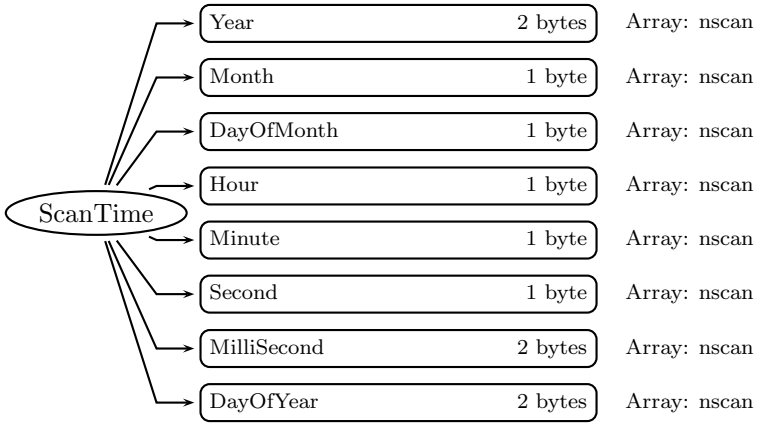

Figure 12: Data Format Structure for 2A25R2, ScanTime

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 and Level 2 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)

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 (2-byte integer, 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. Latitude in degrees is multiplied by 100 and stored as a 2-byte integer. Latitude ranges from -90 to 90 degrees. Missing values are -9999 in the file.

Longitude (2-byte integer, 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. Longitude in degrees is multiplied by 100 and stored as a 2-byte integer. Longitude ranges from -180 to 180 degrees. Missing values are -9999 in the file.

rain (2-byte integer, array size: ncell1 x nray x nscan):
This is the estimate of rain rate at the radar range gates from 0 to 20 km along the slant range. It ranges from 0.0 to 300.0 mm/hr and is multiplied by 100 and stored as a 2-byte integer. A value of -8888 means ground clutter. Missing values are -9999 in the file.

C Structure Header file:

```
#ifndef _TK_2A25R2_H_
#define _TK_2A25R2_H_

#ifndef _L2A25R2_SCANTIME_
#define _L2A25R2_SCANTIME_

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

```
} L2A25R2_SCANTIME;

#endif

#ifndef _L2A25R2_SWATH_
#define _L2A25R2_SWATH_

typedef struct {
    L2A25R2_SCANTIME ScanTime;
    double scanTime_sec;
    float Latitude[49];
    float Longitude[49];
    float rain[49][20];
} L2A25R2_SWATH;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2A25R2_SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
END STRUCTURE

STRUCTURE /L2A25R2_SWATH/
    RECORD /L2A25R2_SCANTIME/ ScanTime
    REAL*8 scanTime_sec
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    REAL*4 rain(20,49)
END STRUCTURE
```