TROPICAL RAINFALL MEASURING MISSION SCIENCE DATA AND INFORMATION SYSTEM

Interface Control Specification Between the Tropical Rainfall Measuring Mission Science Data and Information System (TSDIS) and the TSDIS Science User (TSU)

TSDIS-P907

Volume 4: File Specifications for TRMM Products - Level 2 and Level 3

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Revision Number	Effective Date	CCR Number	Description of Changes
Version 1	7/31/95	N/A	Draft Release
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Version 3	6/28/96	Not Available	Update file specifications from Version 2 Algorithm
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Version 6	8/19/04	327, 328, 330	Update/correction text change to 2A25 Algorithm Fiqure 1.2.3-1 and other correction; Change made to Algorithm 2A21 "Path Attenuation - Changed Figure 1.2.2-1 and starting w/ pg. 1-11; Rain TypeFlag info changed. Changed specifications to 3B42 and 3B43 algorithm in Section 2.4; Modified Figure 1.2.3-1 Data Format Structure for 2A-25 PR Profile; Changes to section 1.3 TMI and PR. Figure 1.3.1-1 modifications; Changes to Figure 2.2.1-1 3A-25 PR Rainfall; Modifications to section 1; Changes to Algorithm 2A21, 2A23 and 2A25 file specifications; Changes to 2A12 file specifications (Rain Flag); Added Grid list specifications to the 3A25 algorithm description; Change to Algorithm 2A12 Rain flag, Confidence, Latent heating, water, ice and rain variables ; Changes made to label "Precipitation Water Parameter in 2A25 specifications; Change to Algorithm 2A23 Rain Type Flag specifications; Change to Algorithm 2A12 Latent Heating variable; Change to 3A25 file specifications - Removed lists on 2-27. Inserts on pg. 2-30, 2-31, Removed lists on pg.. 2-32; Made a correction to figure 1.1.1-1 on pg. 1-2. Removed "Structure Flag" on figure;

Version 6	8/19/04	(cont.)	Made a correction to section 1.3.1 “2B-31 TRMM combined; Made changes to 2A12 “Rain Flag” and “Confidence” specifications; Removed part of Figure 2.2.1-1 “Data Format Structure for 3A-25, PR rainfall

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This is the fourth volume of the TSDIS - TSU ICS. This volume specifies Level 2 and Level 3 file formats. It was written based on the TRMM Science Requirements, Version 1 and 2 algorithm descriptions and personal communications with the algorithm developers. It has been updated using communications with algorithm developers.

The sections that specify the metadata will change as the TSDIS metadata are defined. Currently, all Level 2 and 3 products use the Hierarchical Data Format (HDF) except 2A-52, which is in ASCII format. Level 2 satellite data products use the EOSDIS Swath Structure. Level 3 satellite data products use the EOSDIS Planetary Grid Structure. Level 2 and 3 Ground Validation (GV) radar data products use the TSDIS-defined Radar Grid Structure, except for 2A-52. The explanations of the HDF, Swath Structure, Planetary Grid Structures and Radar Grid Structure are given in Section 2 of Volume 3 of the TSDIS -TSU ICS, which is the Level 1 File Specifications. The formatting conventions, including values for missing data, are described in Section 3 of Volume 3 of the TSDIS -TSU ICS.

1. LEVEL 2 PRODUCTS

Level 2 products are instantaneous rainfall and surface cross section products retrieved from Level 1 data. There are 11 Level 2 TRMM products for satellite data and ground validation (GV) data. For satellite data, only the TRMM Microwave Imager (TMI) and Precipitation Radar (PR) have Level 2 data products; there is no Level 2 data product for the Visible and Infrared Scanner (VIRS). Ground validation data include GV radar data and data from rain gauges and disdrometers, which are located at the same sites as the GV radars.

1.1 TRMM MICROWAVE IMAGER (TMI)

There is only one Level 2A data product for TMI, 2A-12 — TMI Profiling (PI: Dr. Christian Kummerow). The granule size is one orbit plus 50 scan lines of pre-orbit overlap and 50 scan lines of post-orbit overlap. The following parameters are used in describing the formats:

nscan: the number of scans within one granule (See ICS Volume 3 Sections 3-5 and 3-6).

npixel: the number of high resolution pixels within one scan line (208).

nlayer: the number of profiling layers within one pixel (14).

ngeo: the number of geolocation data (2).

1.1.1 2A-12 - TMI Profiling

2A-12, "TMI Profiling", generates vertical hydrometeor profiles on a pixel by pixel basis. For each pixel, cloud liquid water, precipitation water, cloud ice water, precipitation ice, and latent heating are given at 14 vertical layers. The surface rainfall and the associated confidence indicator will also be computed. The format of this product is designed in consultation with the TMI algorithm scientists. Figure 1.1.1-1 shows the structure of the 2A-12 product in terms of the component objects and sizes.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

SwathStructure (Attribute, 5000-byte character):
SwathStructure gives the specification of the swath geometry. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

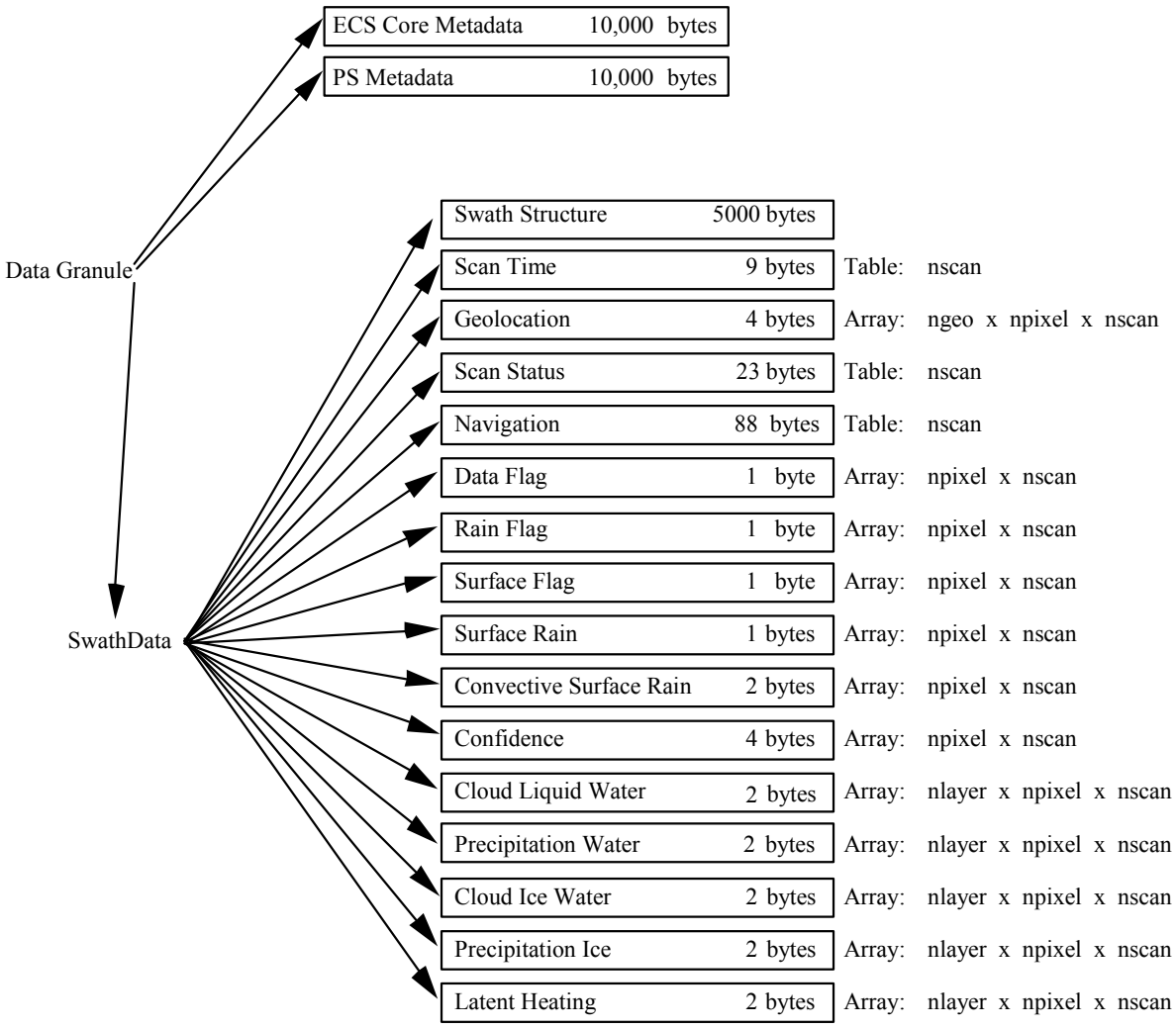

Figure 1.1.1-1
Data Format Structure for 2A-12, TMI Profiling

Scan Time (Vdata Table, record size 9 bytes, nscan records):
The Scan Time is the time associated with each scan. Table 1.1.1-1 gives the description of the content and format. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3.

Table 1.1.1-1
2A-12 Scan Time

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

Geolocation (SDS, array size ngeo x npixel x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are numbers of pixels and scans. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180° meridian is assigned to the western hemisphere.

Scan Status (Vdata, record size 21 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number. See the description of the 1B-11 Scan Status in the ICS Volume 3. All bytes in the Scan Status are copied from the 1B-11 Scan Status including the Missing byte. 2A-12 should reset the Missing byte if it determines data is missing or there is no-rain.

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Data Flag (SDS, array size npixel x nscan, 1-byte integer):
The Data Flag indicates the quality of data. Values greater than or equal to zero indicate good data quality. Values less than zero indicate bad data quality. Specific values are:

0	Good data quality
-9	Channel brightness temperature outside valid range
-15	The neighboring 5 x 5 pixel array is incomplete due to edge or bad data quality
-21	Surface type invalid
-23	Date time invalid
-25	Latitude or longitude invalid

Rain Flag (SDS, array size npixel x nscan, 1-byte integer):
The Rain Flag indicates if rain is possible. If Rain Flag is less than zero the pixel has been pre-screened as non-raining. If Rain Flag equals zero rain is possible and not ambiguous (rain may be zero or positive). If Rain Flag is greater than zero rain is possible, but ambiguous (rain may be zero or positive).

Surface Flag (SDS, array size npixel x nscan, 1-byte integer):
The Surface Flag indicates the type of surface and has the following values:

0: ocean;
1: land;
2: coast;
3: other.

Surface Rain (SDS, array size npixel x nscan, 4-byte float):
The Surface Rain is the instantaneous rain rate (mm h^{-1}) at the surface for each pixel. It ranges between 0.0 and 3000.0 mm/h. If only unambiguous data is desired, the Rain Flag must be checked.

Convective Surface Rain (SDS, array size npixel x nscan, 4-byte float):
The Convective Surface Rain is the instantaneous convective rain rate (mm h^{-1}) at the surface for each pixel. It ranges between 0.0 and 3000.0 mm/h. If only unambiguous data is desired, the Rain Flag must be checked.

Confidence (SDS, array size npixel x nscan, 4-byte float):
The Confidence is that associated with the surface rain. It reflects an rms deviation in temperatures and the number of good database profiles went into the retrieval. If only unambiguous data is desired, the Rain Flag must be checked.

The following four variables represent profiled quantities at 14 layers. The top of each layer is given at 0.5, 1.0, 1.5, 2.0, 2.5, 3.0, 3.5, 4.0, 5.0, 6.0, 8.0, 10.0, 14.0, and 18.0 km above the surface.

Cloud Liquid Water (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the cloud liquid water content for each pixel at 14 layers. It ranges from 0.00 to 10.00 g m^{-3} and is multiplied by 1000 and stored as a 2-byte integer. If only unambiguous data is desired, the Rain Flag must be checked.

Precipitation Water (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the precipitation water content for each pixel at 14 layers. It ranges from 0.00 to 10.00 g m^{-3} and is multiplied by 1000 and stored as a 2-byte integer. If only unambiguous data is desired, the Rain Flag must be checked.

Cloud Ice Water (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the cloud ice water content for each pixel at 14 layers. It ranges from 0.00 to 10.00 g m^{-3} and is multiplied by 1000 and stored as a 2-byte integer. If only unambiguous data is desired, the Rain Flag must be checked.

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Precipitation Ice (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the precipitation content for each pixel at 14 layers. It ranges from 0.00 to 10.00 g m^{-3} and is multiplied by 1000 and stored as a 2-byte integer. If only unambiguous data is desired, the Rain Flag must be checked.

Latent Heating (SDS, array size nlayer x npixel x nscan, 2-byte integer):
This is the heating (°C/hour) due to phase change and eddy heat flux (the heating may also be called $Q_1 - Q_R$) for each pixel at 14 levels. The 14 levels (different from the hydrometeor levels) are: 1 km, 2 km, 3 km, 4 km, 5 km, 6 km, 7 km, 8 km, 9 km, 10 km,12 km, 14 km, 16 km and 18 km. It is multiplied by 10 and stored as a 2-byte integer. Ranges are -256 °C/hour to 256 °C/hour. If only unambiguous data is desired, the Rain Flag must be checked.

1.2 PRECIPITATION RADAR (PR)

There are three level 2A products for PR, 2A-21 — Surface Cross Section (PI: Dr. Robert Meneghini), 2A-23 — PR Qualitative (PI: Dr. Jun Awaka), and 2A-25 — PR Profile (PI: Dr. Toshio Iguchi). The formats of these products are based on the Version 2 algorithm descriptions and consultation with PR algorithm scientists. The granule sizes for all Level 2 PR products are one orbit. The following parameters are used in describing the formats:

- nscan: the number of PR scans within one granule (See ICS Volume 3 Section 3-6).
- nray: the number of rays within one PR scan line (49).
- ngeo: the number of geolocation data (2).
- ncell1: the number of radar range cells at which the rain rate is estimated (80). The cells range from cell 0 to cell 79. Each cell is 250 m apart, with cell 79 at the earth ellipsoid.
- ncell2: the number of radar range cells at which the Z-R parameters are output (5).
- nmeth: the number of methods used (2).

1.2.1 2A-21 - Surface Cross Section

2A-21, "Surface Cross Section," computes the normalized surface cross section. If rain is present, it will also compute path attenuation and its associated reliability factor. Figure 1.2.1-1 shows the structure of the 2A-21 product in terms of the component objects and their sizes.

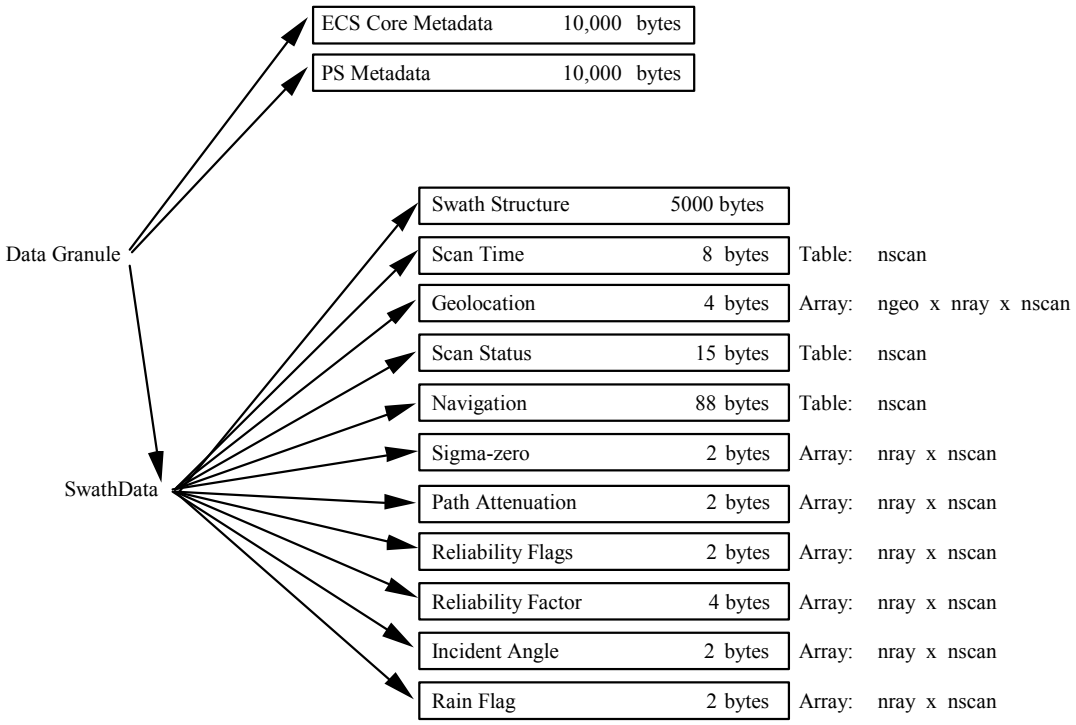

Figure 1.2.1-1
Data Format Structure for 2A-21, Surface Cross Section

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

SwathStructure (Attribute, 5000-byte character):
SwathStructure gives the specification of the swath geometry. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Scan Time (Vdata Table, record size 8 bytes, nscan records):
See the following Table 1.2.1-1.

Table 1.2.1-1

2A-21 Scan Time

Name	Format	Description
Scan Time	8-byte float	A time associated with the scan. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3. Scan Time is expressed as the UTC seconds of the day.

Geolocation (SDS, array size ngeo x nray x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are numbers of pixels and scans. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180° meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, record size 15 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number. See the description of the 1B-21 Scan Status in the ICS Volume 3. All bytes in Scan Status are copied from the 1B-21 Scan Status including the Missing byte. 2A-21 should reset the Missing byte if it determines data is missing or there is no-rain.

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Sigma-zero (SDS, array size nray x nscan, 2-byte integer):
The Sigma-zero is the normalized surface cross section. It ranges from -50.00 to 20.00 dB and is multiplied by 100 and stored as a 2-byte integer.

Path Attenuation (SDS, array size nray x nscan, 2-byte integer):
This is the estimate of positive 2-way integrated attenuation dB when rain is present. It ranges from 0.00 to 50.00 dB when reliable or marginally reliable. Multiplied by 100 and stored as a 2-byte integer.

Reliability Flags (SDS, array size nray x nscan, 2-byte integer):
Reliability Flags holds various information in the form of single digit integer flags. The 2-byte integer is expressed in the form vwxyz where v, w, x, y, and z are integers between 0 and 9 (v must be 0, 1, or 2). Each digit has the following definition:

v = 1 (no rain along path)
= 2 (rain along path)

w = 1 (PIA estimate is reliable)
= 2 (PIA estimate is marginally reliable)
= 3 (PIA estimate is unreliable)
= 4 (PIA estimate provides a lower bound to the path-attenuation)
= 9 (no-rain case)

x = 1 (spatial surface reference is used to estimate PIA)
= 2 (temporal surface reference is used to estimate PIA)
= 3 (neither exists - i.e. insufficient # of data points)
= 4 (unknown background type)
= 5 (no-rain case & low signal to noise ration - do not update temporal or spatial SRs)
= 9 (no-rain case)

y = 1 (surface tracker locked - central angle bin)
= 2 (surface tracker unlocked - central angle bin)
= 3 (peak surface return at normally-sampled gate - outside central swath)
= 4 (Peak surface return not at normally-sampled gate - outside central swath)

z = 0 (ocean)
= 1 (land)
= 2 (coast)
= 3 (OLC unknown or of a category other than those above or 'mixed' type)

Note: for missing data set reliabFlag = -9999

Reliability Factor (SDS array size nray x nscan, 4-byte float):
The Reliability Factor is the ratio of the estimated value of path attenuation to the standard deviation associated with the mean value of the reference estimate. This ratio ranges from 0 to 100 and is unitless.

Incident Angle (SDS, array size nray x nscan, 2-byte integer):
The Incident Angle is the angle, in degrees, between the PR nadir and the radar beam. It ranges from -30.0 to +30.0 degrees and is multiplied by 10 and stored as a 2-byte integer.

Rain Flag (SDS, array size nray x nscan, 2-byte integer):
The Rain Flag has the following values:

0: no rain;

1: rain present.

1.2.2 2A-23 - PR Qualitative

2A-23, "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. Figure 1.2.2-1 shows the structure of the 2A-23 product in terms of the component objects and their sizes.

Scan Time (Vdata Table, record size 8 bytes, nscan records):
See the following Table 1.2.2-1.

Table 1.2.2-1
2A-23 Scan Time

Name	Format	Description
Scan Time	8-byte float	A time associated with the scan. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3. Scan Time is expressed as the UTC seconds of the day.

Geolocation (SDS, array size ngeo x nray x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are numbers of pixels and scans. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180° meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, record size 15 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number. See the descriptin of the 1B-21 Scan Status in the ICS Volume 3. All bytes in Scan Status are copied from the 1B-21 Scan Status including the Missing byte. 2A-23 should reset the Missing byte if it determines data is missing or there is no-rain.

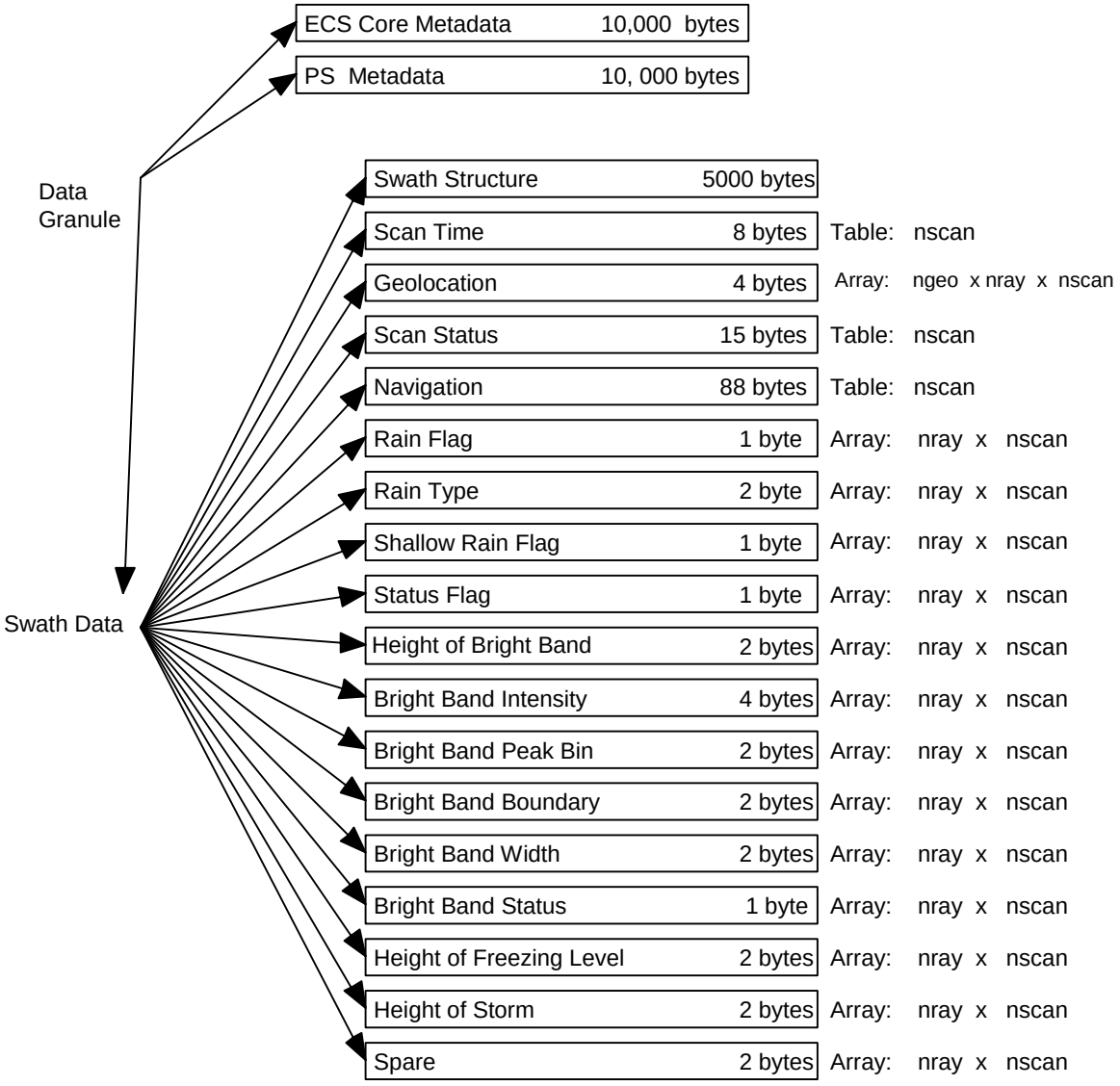

Figure 1.2.2-1
Data Format Structure for 2A-23, PR Qualitative

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Rain Flag (SDS, array size nray x nscan, 1-byte integer):
The Rain Flag is identical to the Minimum Echo Flag of 1C21:

0: no rain

10: rain possible

11: rain possible (echo greater than rain threshold #1 in clutter region)

12: rain possible (echo greater than rain threshold #2 in clutter region)

20: rain certain

Rain Type Flag (SDS, array size nray x nscan, 1-byte integer):
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.)

230: Probably convective. ---> this combination will not
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.

The above assignment of numbers has the following meaning:

(merged) rainType[i] / 100 = 1: stratiform,
2: convective.
3: others,

(merged) rainType[i] % 100 = Sub-category,

(merged) rainType[i] % 10 = 0: usual,
1: shallow isolated,

2: shallow non-isolated,
3: sidelobe clutter only (once shallow isolated
overwritten as sidelobe clutter only).
rainType[i]%10=3 occurs for type 313 only.

where rainType[i] % 10 means MOD(rainType[i],10) in FORTRAN.

Though rainType is changed to int16, no rain and missing values remain the same, that is

rainType[i] = -88 : no rain
-99 : missing

Shallow Rain Flag (SDS, array size nray x nscan, 1-byte integer):
The Shallow Rain Flag takes the following values:

shallowRain[i] = 10: maybe shallow, isolated,
= 11: shallow isolated (with confidence),
= 20: maybe shallow but not isolated,
= 21: shallow but not isolated (width confidence)
= 0: when not shallow.
< 0: when not rain certain or data missing.

Status Flag (SDS, array size nray x nscan, 1-byte integer):
The Status Flag indicates whether the data are obtained over sea or land and the confidence of 2A-23 product data. It is set as follows:

0:	good	(over ocean)
10:	BB detection may be good	(over ocean)
20:	R-type classification may be good (BB detection is good or BB does not exist)	(over ocean)
30:	Both BB detection and R-type classification may be good	(over ocean)
50:	not good (because of warnings)	(over ocean)
100:	bad (possible data corruption)	(over ocean)
1:	good	(over land)
11:	BB detection may be good	(over land)
21:	R-type classification may be good (BB detection is good or BB does not exist)	(over land)
31:	Both BB detection and R-type classification may be good	(over land)
51:	not good (because of warnings)	(over land)
101:	bad (possible data corruption)	(over land)
2:	good	(over coastline)

12:	BB detection may be good	(over coastline)
22:	R-type classification may be good (BB detection is good or BB does not exist)	(over coastline)
32:	Both BB detection and R-type classification may be good	(over coastline)
52:	not good (because of warnings)	(over coastline)
102:	bad (possible data corruption)	(over coastline)
4:	good	(over inland lake)
14:	BB detection may be good	(over inland lake)
24:	R-type classification may be good (BB detection is good or BB does not exist)	(over inland lake)
34:	Both BB detection and R-type classification may be good	(over inland lake)
54:	not good (because of warnings)	(over inland lake)
104:	bad (possible data corruption)	(over inland lake)
9:	may be good	(land/sea unknown)
19:	BB detection may be good	(land/sea unknown)
29:	R-type classification may be good (BB detection is good or BB does not exist)	(land/sea unknown)
39:	Both BB detection and R-type classification may be good	(land/sea unknown)
59:	not good (because of warnings)	(land/sea unknown)
109:	bad (possible data corruption)	(land/sea unknown)

When it is “no rain” or “data missing”, Status Flag contains the following values:

-88: no rain
-99: data missing

Assignment of the above numbers are based on the following rules:

When Status ≥ 0

Status/100	=	0: good, may be good, or not good
		1: doubtful
(Status/10) % 10	=	0: good, may be good when status <100, and not good when status ≥100
		1: BB detection not so confident
		2: R-type classification not so confident (but BB detection is good, or when BB does not exist)
		3: BB detection is not so confident and R-type classification not so confident
		5: Over-all quality of the processed data for the j-th scan angle is not good (but may not be too bad to be classified as bad data)
Status % 10	=	0: over ocean
		1: over land
		2: over coastline
		4: over inland lake

9: land/sea unknown

In other words, we can check the confidence level of 2A-23 by the following way:

	Status Flag ≥	100	:	bad (untrustworthy because of possible data corruption)
100>	Status Flag ≥	10	:	result not so confident (warning)
	Status Flag =	9	:	may be good
9>	Status Flag ≥	0	:	good

The last digit of Status Flag indicates over ocean, land, etc.

Height of Bright Band (SDS, array size nray x nscan, 2-byte integer):
A positive Height of Bright Band is defined in meters above mean sea level. Negative values are defined as follows:

-1111: No bright band
-8888: No rain
-9999: Data missing

Bright Band Intensity (SDS, array size nray x nscan, 4-byte float):
The maximum value of the bright band (dBZ) obtained from normal samples. The range is from 0.00 to 100.0 dBZ. Negative values are defined as:

-1111: No bright band
-8888: No rain
-9999: Data missing

Bright Band Peak Bin (SDS, array size nray x nscan, 2-byte integer):
A positive range bin number that corresponds to the peak of the bright band. This bin number is in the Level-1 bin numbering scheme (125m, see Level-1 PR description).
Negative values are defined as:

-1111: No bright band.
-8888: No rain.

Bright Band Boundary (SDS, array size 2 x nray x nscan, 2-byte integer):
Positive bin numbers of the boundary of the bright band.
The first index indicates the top of the bright band, the second index indicates the bottom. These bin numbers are in the Level-1 bin numbering scheme (125m, see Level-1 PR description).
Negative values are defined as:

-1111: No bright band.
-8888: No rain.

Bright Band Width (SDS, array size nray x nscan, 2-byte integer): The width of the bright band in meters.
Negative values are defined as:

-1111: No bright band.
-8888: No rain.

Bright Band Status (SDS, array size nray x nscan, 2-byte integer): Indicates the status of the bright band detection. This flag is a composite of three internal status flags:

```
BB_status[j] = BB_detection_status[j] * 16
             + BB_boundary_status[j] * 4
             + BB_width_status[j]
```

where each status on the right hand side takes the following values:

1: poor,
2: fair,
3: good.

These three internal flags would be computed from BB_status[j], for example, by something like as follows:

```
if (BB_status[j]>0) {
   BB_detection_status[j] = BB_status[j] / 16;
   BB_boundary_status[j] = (BB_status[j]%16) / 4;
   BB_width_status[j] = BB_status[j]%4;
 }
```

where % means MOD in FORTRAN;

BB_status[j]%4 <----> MOD(BB_status(j),4)

Height of Freezing Level (SDS, array size nray x nscan, 2-byte integer):
A positive Height of Freezing Level is the height of the 0°C isotherm above mean sea level in meters, estimated from climatological surface temperature data. Negative values are defined as:

-5555: When error occurred in the estimation of Height of Freezing Level
-8888: No rain
-9999: Data missing

Height of Storm (SDS, array size nray x nscan, 2-byte integer):
A positive Height of Storm is the height of the storm top above mean sea level in meters. 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]). Negative values are defined as:

-1111: Height of Storm not calculated because rain is not present with a high level of confidence in 1C21
-8888: No rain
-9999: Data missing

Spare (SDS, array size nray x nscan, 2-byte integer):
Contains developer output.

1.2.3 2A-25 - PR Profile

2A-25, "PR Profile", produces an estimate of vertical rainfall rate profile for each radar beam. The rainfall rate estimate is given at each resolution cell of the PR radar. To compare with ground-based radar data, the attenuation corrected Z profile is also given. The average rainfall rate between the two pre-defined altitudes is calculated for each beam position. Other output data include parameters of Z-R relationships, integrated rain rate of each beam, range bin numbers of rain layer boundaries, and many intermediate parameters. Figure 1.2.3-1 shows the structure of the 2A-25 product in terms of the component objects and their sizes.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

Figure 1.2.3-1 Data Format Structure for 2A-25, PR Profile (Following Page)

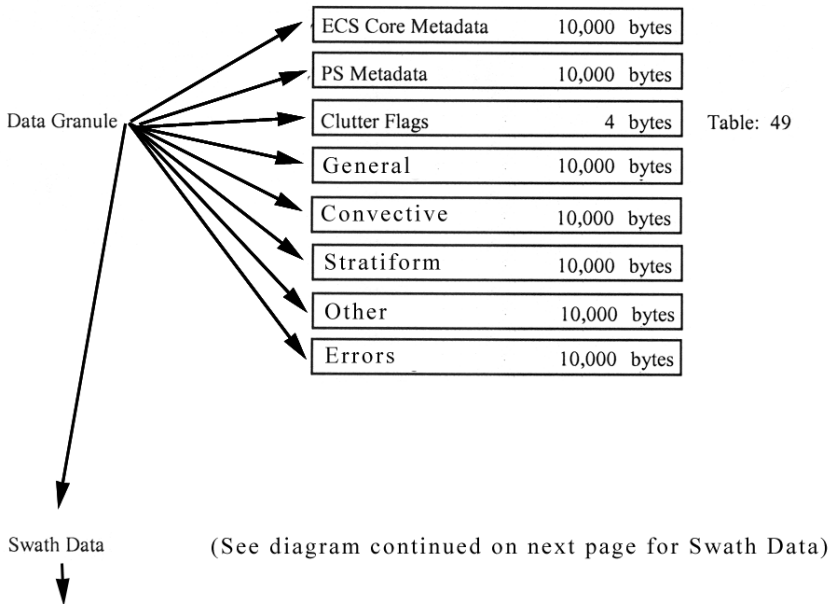

Figure 1.2.3-1 Data Format Structure for 2A-25, PR Profile (See next Page for Swath data)

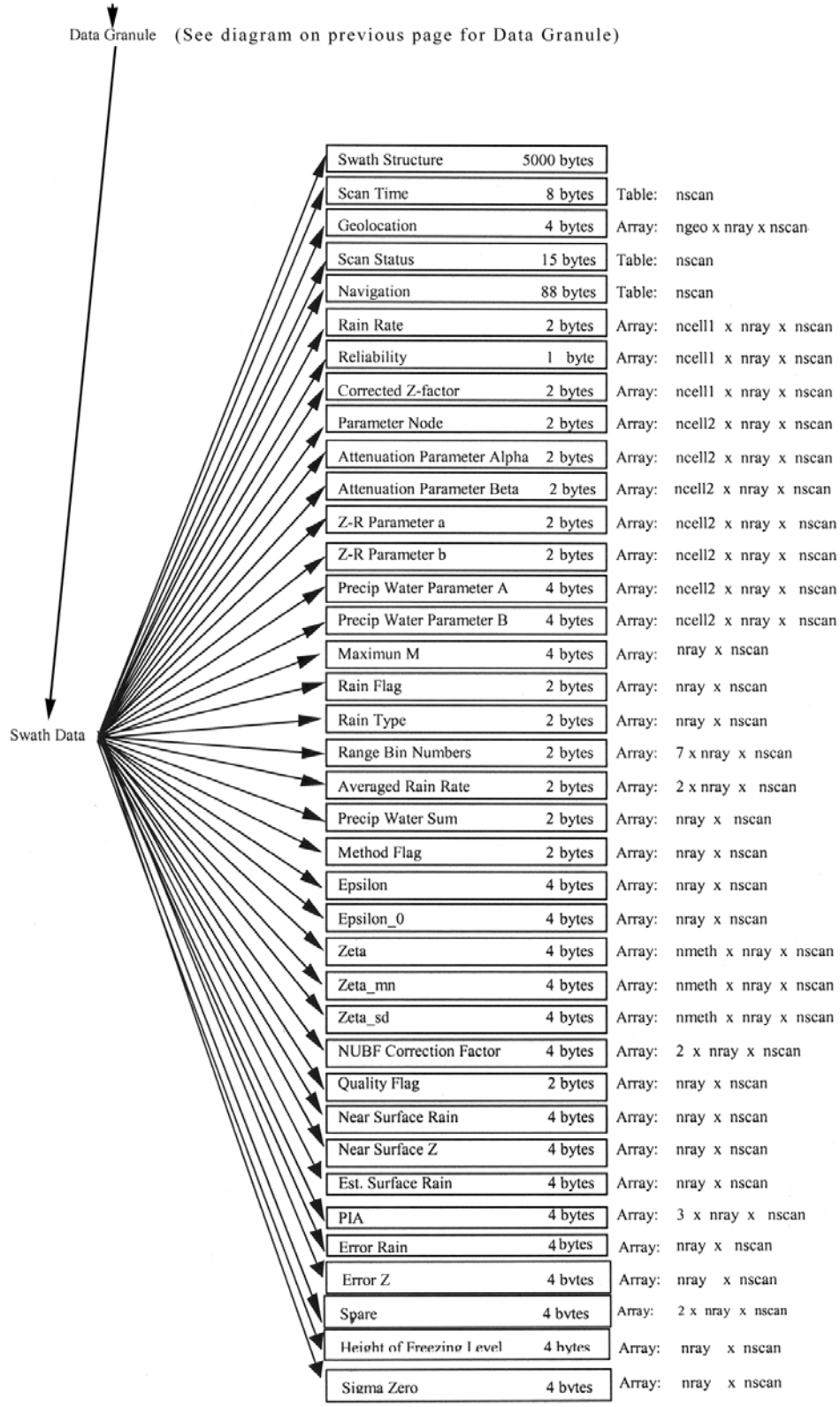

Figure 1.2.3-1 Data Format Structure for 2A-25, PR Profile (See previous page for Data granule)

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

The following five metadata fields are copies of the five parameter files used by the 2A-25 algorithm at runtime.

Parameters: General (Attribute, 10,000-byte character):
ASCII text of the general parameters used by 2A-25 at runtime.

Parameters: Convective (Attribute, 10,000-byte character):
ASCII text of the parameters for Convective rain used by 2A-25 at runtime.

Parameters: Stratiform (Attribute, 10,000-byte character):
ASCII text of the parameters for Stratiform rain used by 2A-25 at runtime.

Parameters: Other (Attribute, 10,000-byte character):
ASCII text of the parameters for Other rain used by 2A-25 at runtime.

Parameters: Errors (Attribute, 10,000-byte character):
ASCII text of the Error parameters used by 2A-25 at runtime.

Clutter Flags (Vdata Table, record size 4 bytes, 49 records):
The Clutter Flags are identical to the clutter information in 1B-21 in the Ray Header. See Table 1.2.3-1.

Table 1.2.3-1
2A-25 Clutter Flags

Name	Format	Description
Mainlobe Clutter Edge	1-byte integer	Absolute value of the difference in Range bin Numbers between the detected surface and the edge of the clutter from the mainlobe.
Sidelobe Clutter Range[3]	3 x 1-byte integer	Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter positon from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

SwathStructure (Attribute, 5000-byte character):
SwathStructure gives the specification of the swath geometry. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Scan Time (Vdata Table, record size 8 bytes, nscan records):
See the following Table 1.2.3-2.

Table 1.2.3-2
2A-25 Scan Time

Name	Format	Description
Scan Time	8-byte float	A time associated with the scan. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3. Scan Time is expressed as the UTC seconds of the day.

Geolocation (SDS, array size ngeo x nray x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are pixel and scan. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180° meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, record size 15 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number. See the description of the 1B-21 Scan Status in the ICS Volume 3.All bytes in the Scan Status are copied from the 1B-21 Scan Status including the Missing byte. 2A-25 should reset the Missing byte if it determines data is missing or there is no-rain.

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix B in Volume 3 of ICS, Level 1 File Specifications

Rain Rate (SDS, array size ncell1 x nray x nscan, 2-byte integer):
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 mmh^{-1} and is multiplied by 100 and stored as a 2-byte integer. A value of -88.88 mm/hr (stored as -889) means ground clutter.

Reliability (SDS, array size ncell1 x nray x nscan, 1-byte integer):
The Reliability is that for estimated rain rates at the radar range gates from 0 to 20 km. It ranges from 0 to 255. If data are missing, the reliability will be set as 10000000 in binary. The default value is 0 (measured signal below noise). 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 following meanings are assigned to each bit in the 8-bit integer if the bit = 1.

bit 0 rain possible
bit 1 rain certain
bit 2 bright band
bit 3 large attenuation
bit 4 weak return (Zm < 20 dBZ)
bit 5 estimated Z < 0 dBZ
bit 6 main-lobe clutter or below surface
bit 7 missing data

Corrected Z-factor (SDS, array size ncell1 x nray x nscan, 2-byte integer):
This is the attenuation corrected reflectivity factor (Z) at the radar range gates from 0 to 20 km along the slant range. It ranges from 0.0 to 80.0 dBZ and is multiplied by 100 and stored as a 2-byte integer. Values of reflectivity less than 0.0 dBZ are set to 0.0 dBZ. A value of -88.88 dB (stored as -8888) is a ground clutter flag.

Parameter Node (SDS, array size ncell2 x nray x nscan, 2-byte integer):
The Parameter Node gives the range bin numbers of the nodes at which the values of Attenuation and Z-R Parameters are given (see below). The values of the parameters between the nodes are linearly interpolated. This variable ranges from 0 and 79 and is unitless.

Attenuation Parameter Alpha (SDS, array size ncell2 x nray x nscan, 2-byte integer):
The attenuation parameter Alpha (α) relates the attenuation coefficient, k (dB/km) to the Z-factor: $k = \alpha Z^{\beta}$. α is computed at ncell2 radar range gates for each ray. It ranges from 0.000100 to 0.002000 and is multiplied by 10^6 and stored as a 2-byte integer.

Attenuation Parameter Beta (SDS, array size nray x nscan, 2-byte integer):
The Attenuation Parameter Beta (β) relates the attenuation coefficient, k (dB/km) to the Z-factor: $k = \alpha Z^{\beta}$. β is computed for each ray. It ranges from 0.500 to 2.000 and is multiplied by 10^3 and stored as a 2-byte integer.

Z-R Parameter a (SDS, array size ncell2 x nray x nscan, 2-byte integer):
Parameter a for Z-R relationship ($R=aZ^b$) is determined from the rain type and the height relative to the freezing level, the non-uniformity parameter (ξ) and the correction factor (ε) for the surface reference technique. a is computed at ncell2 radar range gates for each ray. It ranges from 0.0050 to 0.2000 and is multiplied by 10^4 and stored as a 2-byte integer.

Z-R Parameter b (SDS, array size ncell2 x nray x nscan, 2-byte integer):
Parameter b for Z-R relationship ($R=aZ^b$) is determined from the rain type and the height relative to the freezing level, the non-uniformity parameter (ξ) and the correction factor (ε) for the surface reference technique. b is computed at ncell2 radar range gates for each ray. It ranges from 0.500 to 1.000 and is multiplied by 10^3 and stored as a 2-byte integer.

Precipitation Water Parameter A (SDS, array size ncell2 x nray x nscan, 2-byte integer):
Parameter A in the M = AZ^B relationship. A is computed at each node (ncell2) for each ray. It ranges from ? to ?

Precipitation Water Parameter B (SDS, array size ncell2 x nray x nscan, 2-byte integer):
Parameter B in the M = AZ^B relationship. B is computed at each node (ncell2) for each ray. It ranges from ? to ?

Maximum Z (SDS, array size nray x nscan, 4-byte float):
This is the maximum value of measured reflectivity factor at each IFOV. It ranges from 0.0 to 100.0 dBZ.

Rain Flag (SDS, array size nray x nscan, 2-byte integer):
The Rain Flag indicates rain or no rain status and the rain type assumed in rain rate retrieval. The default value is 0 (no rain). 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 following meanings are assigned to each bit in the 16-bit integer if the bit = 1.

bit 0	rain possible
bit 1	rain certain
bit 2	zeta^beta > 0.5 [Path Integrated Attenuation (PIA) larger than 3 dB]
bit 3	large attenuation (PIA larger than 10 dB)
bit 4	stratiform
bit 5	convective
bit 6	bright band exists
bit 7	warm rain
bit 8	rain bottom above 2 km
bit 9	rain bottom above 4 km
bit 10	not used
bit 11	not used
bit 12	not used
bit 13	not used
bit 14	data missing between rain top and bottom
bit 15	not used

Rain Type (SDS, array nray x nscan, 2-byte integer):
This is a copy of the 2A23 Rain Type field, See 2A23 description.

Range Bin Numbers (SDS, array size 7 x nray x nscan, 2-byte integer):
This array gives the Range Bin Number of various quantities for each ray in every scan. The definitions are:

- top range bin number of the interval that is processed as meaningful data in 2A-25
- bottom range bin number of the interval that is processed as meaningful data in 2A-25
- actual surface range bin number
- range bin number of the bright band if it exits
- range bin number at which the path-integrated Z-factor first exceeds the given threshold
- range bin number at which the measured Z-factor is maximum
- range bin number of near surface bin

The Range Bin Numbers in this algorithm are different from the NASDA definition of Range Bin Number described in the ICS, Volume 3. The Range Bin Numbers in the algorithm range from 0 to 79 and have an interval of 250m. The earth ellipsoid is defined as range bin 79.

Averaged Rain Rate (SDS, array size 2 x nray x nscan, 2-byte integer):
There are two kinds of Average Rain Rate. The first one is the average rain rate for each ray between the two predefined heights of 2 and 4 km. It ranges from 0.0 to 3000.0 mm h^{-1} and is multiplied by 10 and stored as a 2-byte integer. The second one is the integral of rain rate from rain top to rain bottom. It ranges from 0.0 to 300 mm h^{-1} km and is multipled by 10 and stored as a 2-byte integer.

Precipitable Water Sum (SDS, array nray x nscan, 2-byte integer):The sum of precipitable water from the top range bin to the bottom range bin (see Range Bin Numbers above). Units are ? and it ranges from ? to ?

Method Flag (SDS, array size nray x nscan, 2-byte integer):
This flag indicates which method is used to derive the rain rate. The default value is 0 (including no rain case). 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 default value is 0 (including no rain case).

The following meanings are assigned to each bit in the 16-bit integer.

0: (bit 1)	no rain
if rain	
0: (bit 1)	over ocean
1: (bit 1)	over land
2: (bit 2)	over coast, river, etc.
3: (bit 2)	others (impossible)
+4: (bit 3)	PIA from constant-Z-near-surface assumption
+8: (bit 4)	spatial reference
+16: (bit 5)	temporal reference
+32: (bit 6)	global reference
+64: (bit 7)	hybrid reference
+128: (bit 8)	good to take statistics of epsilon.
+256: (bit 9)	HB method used, SRT totally ignored
+512: (bit 10)	very large pia_srt for given zeta
+1024: (bit 11)	very small pia_srt for given zeta
+2048: (bit 12)	no ZR adjustment by epsilon
+4096: (bit 13)	no NUBF correction because NSD unreliable
+8192: (bit 14)	surface attenuation > 60 dB
+16384: (bit 15)	data partly missing between rain top and bottom

Epsilon (SDS, array size nray x nscan, 4-byte float):
The Epsilon (ε) is the final correction factor applied to the assumed drop size distribution. Unitless and it ranges from 0.0 to 100.0.

Epsilon_0 (SDS, array nray x nscan , 4-byte float):
The adjustment parameter computed from the filtered surface reference PIA (2A21). Unitless and it ranges from 0.0 to 100.0.

Zeta (SDS, array size nmeth x nray x nscan, 4-byte float):
The Zeta (ζ) roughly represents the rain rate integrated along the ray using two different methods. It ranges from 0.0 to 100.0 and is unitless.

Zeta_mn (SDS, array size nmeth x nray x nscan, 4-byte float):
Zeta_mn (ζ_{mn}) is the average of zeta (ζ) in the vicinity of each beam position (average over three scans and three IFOVs). It is calculated using two methods. It ranges from 0.0 to 100.0 and is unitless.

Zeta_sd (SDS, array size nmeth x nray x nscan, 4-byte float):
Zeta_sd (ζ_{sd}) is the standard deviation of zeta (ζ) in the vicinity of each beam position (using three scans and three IFOVs). It is calculated using two methods. It ranges from 0.0 to 100.0 and is unitless.

Xi (SDS, array size nmeth x nray x nscan, 4-byte float):
The Xi is the normalized standard deviation defined as Zeta_sd/Zeta_mn. When Zeta_mn takes on small values (or zero) Xi is set to 99.0. It is calculated using two methods. Xi ranges from 0.0 to 99.0 and is unitless.

NUBF Correction Factor (SDS, array size 2 x nray x nscan, 4-byte float):
The Non-Uniform Beam Filling (NUBF) Correction Factor is used as a correction to reflectivity and attenuation calculations. The two NUBF Correction Factors are given for the k-Z and Z-R relations. The ranges are 1.0 to 3.0 and 0.8 to 1.0, respectively. Both are unitless quantities.

Quality Flag (SDS, array size nray x nscan, 2-byte integer):
This is a quality flag and ranges from 0 to 32767. The default value is 0 (normal). 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 following meanings are assigned to each bit in the 16-bit integer if the bit = 1.

0:	normal
+1:	unusual situation in rain average
+2:	NSD of zeta (xi) calculated from less than 6 points
+4:	NSD of PIA calculated from less than 6 points
+8:	NUBF for Z-R below lower bound
+16	NUBF for PIA above upper bound
+32:	epsilon not reliable, epsi_sig <= 0.0
+64:	2A21 input data not reliable

+128: 2A23 input data not reliable
+256: range bin error
+512: sidelobe clutter removal
+1024: probability=0 for all tau
+2048: pia_surf_ex <= 0.0
+4096: const Z is invalid
+8192: reliabFactor in 2A21 is NaN
+16384: data missing

15th bit (sign bit) is not used

Near Surface Rain (SDS, array size nray x nscan, 4-byte float):
Rainfall rate near the surface. The range is 0 to 3000 mm/hr. A value of –99.99 mm/hr. is a missing flag.

Near Surface Z (SDS, array size nray x nscan, 4-byte float):
Reflectivity near the surface. The range is 0.0 to 100.0 dBZ. A value of –99.99 dBZ is a missing flag.

Estimated Surface Rain (SDS, array nray x nscan, 4-byte float):
The rainfall estimate at the true (detected) surface bin. Units are mm/hr and ranges from 0 to 3000 mm/hr. A value of -99.99mm/hr is a missing flag.

PIA (SDS, array size 3 x nray x nscan, 4-byte float):

Path integrated attenuation (PIA) [two-way] estimates for three cases:
- The final adjusted PIA estimate
- The difference between the PIA at the surface and near surface range bins
- The PIA estimate from 2A21

Error Rain (SDS, array size nray x nscan, 4-byte float):
The error in Near Surface Rain Rate. The units are dB.

Error Z (SDS, array size nray x nscan, 4-byte float):
The error in Near Surface Z. The range is 0.0 to 100.0 dBZ.

Spare (SDS, array size 2 x nray x nscan, 4-byte float):
Contents and ranges are not public.

Height of Freezing Level (SDS, array size nray x nscan, 4-byte float):
A positive Height of Freezing Level is the height of the 0°C isotherm above mean sea level in meters, estimated from climatological surface temperature data. This field is copied from the 2A23 product. Negative values are defined as:

-5555: When error occurred in the estimation of Height of Freezing Level

-8888: No rain
-9999: Data missing

Sigma-zero (SDS, array size nray x nscan, 4-byte float):
The Sigma-zero is the normalized surface cross section. It ranges from -50.00 to 20.00 dB. This field is copied from the 2A21 product file.

1.3 TMI AND PR COMBINED

There is one combined algorithm for TMI and PR, 2B-31 — TRMM Combined (PI: Dr. Ziad Haddad). The format of the product is based on the TRMM Science Requirements and algorithm description. The granule size is one orbit and has a PR based geometry. The following parameters are used in describing the formats:

nscan:	the number of PR scans within one granule (See ICS Volume 3 Section 3-6).
nray:	the number of rays within one PR scan line (49).
ngeo:	the number of geolocation data (2).
Nradarrange:	the number of radar range gates, up to about 20 km from the earth ellipsoid (80). The gates range from gate 0 to gate 79. Each gate is 250 m apart, with gate 79 at the earth ellipsoid.
nlayer:	the number of layers of latent heating (13)

1.3.1 2B-31 - TRMM Combined

2B-31, "TRMM Combined", derives vertical hydrometeor profiles using data from PR radar and TMI. It also computes the correlation-corrected mass-weighted mean drop diameter and its standard deviation, and latent heating. Figure 1.3.1-1 shows the structure of the 2B-31 product in terms of the component objects and their sizes.

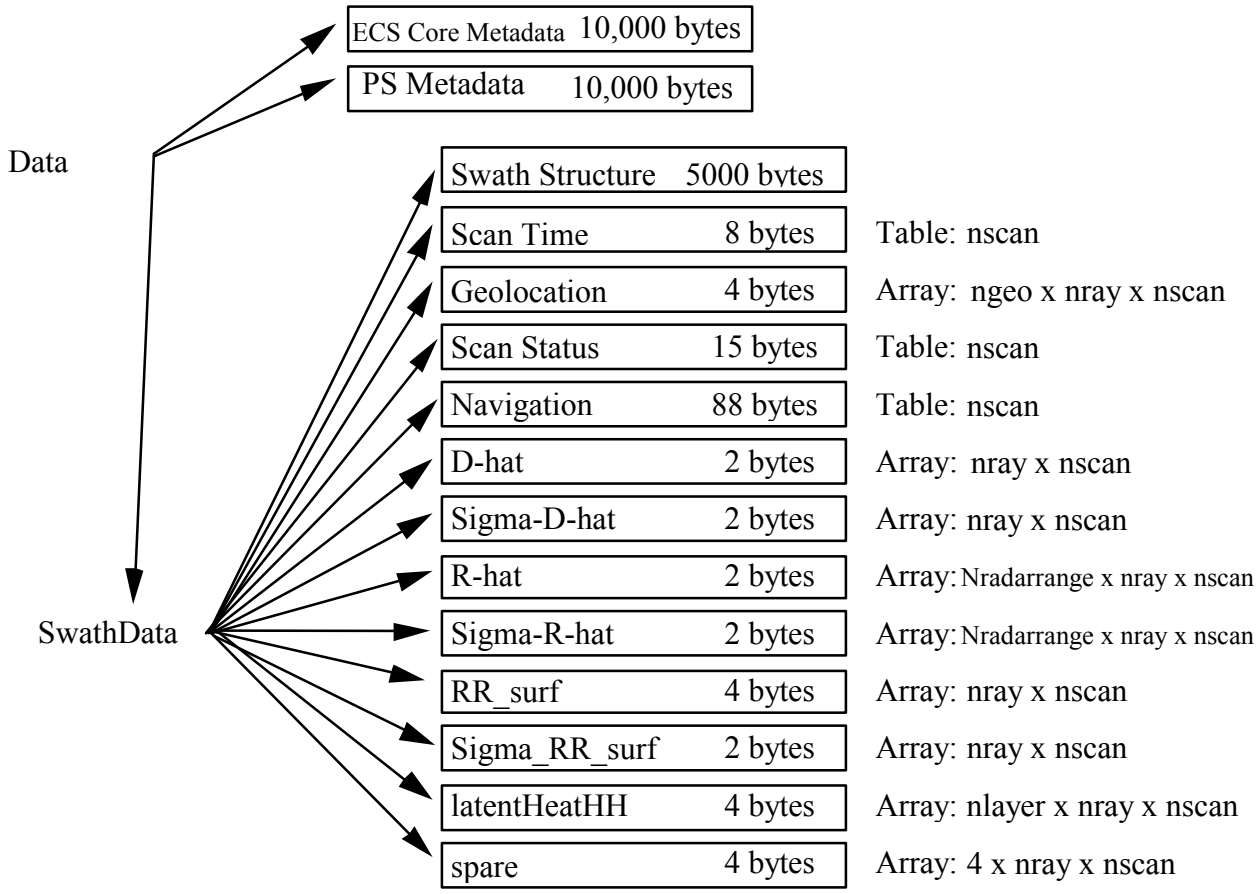

Figure 1.3.1-1
Data Format Structure for 2B-31, TRMM Combined

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

SwathStructure (Attribute, 5000-byte character):
SwathStructure gives the specification of the swath geometry. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Scan Time (Vdata Table, record size 8 bytes, nscan records):
See the following Table 1.3.1-1.

Table 1.3.1-1
2B-31 Scan Time

Name	Format	Description
Scan Time	8-byte float	A time associated with the scan. The exact relationship between the Scan Time and the time of each IFOV is described in ICS Volume 3, section 3. Scan Time is expressed as the UTC seconds of the day.

Geolocation (SDS, array size ngeo x nray x nscan, 4-byte float):
The earth location of the center of the IFOV at the altitude of the earth ellipsoid. The first dimension is latitude and longitude, in that order. The next dimensions are high resolution pixel and scan. Values are represented as floating point decimal degrees. Off-earth is represented as -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180° meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, record size 15 bytes, nscan records):
The status of each scan is represented in terms of quality, platform and instrument control data, and fractional orbit number. See the description of the 1B-21 Scan Status in the ICS Volume 3. All bytes in the Scan Status are copied from the 1B-21 Scan Status including the Missing byte. 2B-31 will reset the Missing byte if it determines data is missing or there is no-rain.

Navigation (Vdata Table, record size 88 bytes, nscan records):
See Appendix B in Volume 3 of ICS, Level 1 File Specifications

D-hat (SDS, array size nray x nscan, 2-byte integer):
D-hat is the correlation-corrected mass-weighted mean drop diameter. It is multiplied by 100 and stored as a two-byte integer. The accuracy is 0.01 "normalized"*mm. It ranges from 0.7 to 1.8 "normalized" mm (the value 0 indicates no rain or bad data). The accuracy is 0.01 "normalized" mm.

The parameters Λ, μ and N_0 of the corresponding drop size distribution $N(D)dD = N_0 D^{\mu} e^{-\Lambda D} dD$, giving the number per cubic-meter of drops of diameter between D and $D + dD$ *mm*, can be obtained from dHat and the rain rate rHat using the formulas:

$$\mu = -4 + 1/\left(0.1521\mathrm{dHat}^{0.23}\mathrm{rHat}^{0.074}\right)$$

$$\Lambda = 1/\left(0.1521\mathrm{dHat}^{1.33}\mathrm{rHat}^{0.23}\right)$$

$$N_0 = 55\ \mathrm{rHat}\ \Lambda^{\mu+4}/\left(\Gamma(\mu+4)\left(1-(1+0.53/\Lambda)^{-\mu-4}\right)\right)$$

Similarly, the rain rate rHat mm/hr can be converted into a liquid (+ ice) water M (g/m^3) using the formula:

$$\mathrm{M} = \frac{0.02878\mathrm{rHat}}{1-(1+\ 0.53/\Lambda)^{-\mu-4}}$$

The average value of dHat is around 1.1 "normalized" mm, a unit which comes from the fact that dHat is related to the true mass-weighted mean drop diameter D^* mm by the formula $\mathrm{dHat} = D^* \mathrm{rHat}^{-0.155}$ (with rHat in mm/hr).

Sigma-D-hat (SDS, array size nray x nscan, 2-byte integer):
Sigma-D-hat is the RMS uncertainty in D-Hat. It ranges from 0.00 to 2.00 "normalized"* mm and is multiplied by 100 and stored as a two-byte integer. The accuracy is 0.01 "normalized" mm.

R-hat (SDS, array size Nradarrange x nray x nscan, 2-byte integer):
R-hat is the instantaneous rain rate at the radar range gates. It ranges from 0.0 to 500.0 mm/hr and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1 mm/hr.

Sigma-R-hat (SDS, array size Nradarrange x nray x nscan, 2-byte integer):
Sigma-R-hat is the RMS uncertainty in the R-hat estimated at the radar range gates. It is multiplied by 10 and stored as a two-byte integer. It ranges from -125 to 125 mm/hr (the negative sign indicating estimates based on a “rain-possible” detection by the radar rather than the “rain-certain” associated with positive values). The values -125 and 125 are reserved for cases where the RMS uncertainty could not be accurately estimated. The accuracy is 0.5 mm/hr.

RR-Surf (SDS, array size nray x nscan, 4-byte float):
RR-Surf is the surface rainrate. It ranges from 0.0 to 500.0 mm/hr. The accuracy is 0.1 mm/hr.

Sigma-RR-Surf (SDS, array size nray x nscan, 2-byte integer):
Sigma-RR-Surf is the RMS uncertainty in RR-Surf. It is multiplied by 100 and stored as a two-byte integer. It ranges from -125 to 125 mm/hr (the negative sign indicating estimates based on a "rain-possible" detection by the radar rather than the "rain-certain" associated with positive values). The values -125 and 125 are reserved for cases where the RMS uncertainty could not be accurately estimated. The accuracy is 0.5mm/hr.

latentHeatHH (SDS, array size nlayer x nray x nscan, 4-byte float):
latentHeatHH is the "hydrometeor heating" in K/hr calculated from the vertical fluxes of the different hydrometeor species and using average archival temperature/pressure/humidity soundings which depend on longitude and latitude only. In version 6 all the precipitation is assumed to be liquid. Heating is listed for 13 layers. The first entry in the array is the heating in the layer between 18 km and 16 km above the earth ellipsoid. The layers have the following upper and lower boundaries defined in km above the earth ellipsoid:

First layer	18	16
Second layer	16	14
Third layer	14	12
Fourth layer	12	10
Fifth layer	10	8
Sixth layer	8	7
Seventh layer	7	6
Eighth layer	6	5
Ninth layer	5	4
Tenth layer	4	3
Eleventh layer	3	2
Twelvth layer	2	1
Thirteenth layer	1	0

spare (SDS, array size 4 x nray x nscan, 4-byte float):
Contents and ranges are not public.

* "normalized units" are defined as follows:
If a variable X, expressed in grams, is correlated with the rain rate R and a variable Y is defined where $Y = X * R^{0.37} R$, then the unit of Y is called "normalized grams".

1.4 GV RADAR

There are four Level 2A products for GV radar, 2A-52 — Existence (Contact: Dr. Michael Biggerstaff), 2A-53 — Radar Site Rain Map (Contact: Dr. Michael Biggerstaff), 2A-54 —Radar

Site Convective/Stratiform Map (Contact: Dr. Michael Biggerstaff), and 2A-55 — Radar Site 3-D Reflectivities (Contact: Dr. Michael Biggerstaff). The formats of these products are based on the Version 1 algorithm descriptions and consultation with GV radar algorithm scientists. The granule size is one hour for 2A-53, 2A-54, and 2A-55 but one month for 2A-52. The following parameters are used in describing the formats:

nvol: the number of volume scans within one granule (see Section 7 of Volume 3 of ICS for detailed explanation);

nx_prod: the number of points in the x-dimension of a 3-D Cartesian grid; 151 for single radar sites; 363 for the multiple radar site in Texas and 257 for the Florida multiple radar site;

ny_prod: the number of points in the y-dimension of a 3-D Cartesian grid; 151 for single radar sites; 285 for the multiple radar site in Texas and 353 for the Florida multiple radar site;

nz: the number of points in the z-dimension of a 3-D Cartesian grid; 13 for both single and multiple radar sites;

ncat: the number of categories for computing CFADs and vertical profiles. There are 12 categories (eg., stratiform precipitation, convective precipitation, water surface, and land, etc.) that are enumerated in each section where they apply;

nbin: the maximum number of reflectivity bins; this is 86 which will allow a reflectivity range of -15dBZ to 70 dBZ with increments of 1 dBZ.

1.4.1 2A-52 - Existence

2A-52, "Existence", is the fraction of the radar FOV which has measurable precipitation. The GV radar FOV is defined as a base scan (i.e., the lowest level sweep). The output will be ASCII files instead of HDF files. In addition to the ASCII product file there will be a detached SFDU header. The SFDU header is described in the **Interface Control Document Between EOSDIS Core System (ECS) and TRMM Science Data and Information System (TSDIS) for the ECS Project**. Each product file has the Existence data of one site (not one radar) for one month. Figure 1.4.1-1 shows an example of 2A-52 output.

Note: The column numbers at the bottom of the example do not appear in the 2A52 product, they exist in this example only to show the positions of each field.

```
Date of        Time of                Distance of Closest  Date of  Time of
  VOS            VOS     % Rain  Hit     Approach (CA)       CA       CA
-------------------------------------------------------------------------------
1998-01-01  14:55:52.000    3     0        -9999.900        NULL     NULL
1998-01-01  15:05:40.000    34    1        149.868       1998-01-01 15:06:11.946

12345678901234567890123456789012345678901234567890123456789012345678901234567890
         1         2         3         4         5         6         7         8
```

Figure 1.4.1-1

Example of 2A-52, Existence. (preceeding page)

The data is organized in seven columns separated by white space. All lines have 80 characters of data (including spaces). Each 80 character line is terminated with a line feed. The first two lines of the file are the column descriptors. The third line is a dashed line. Data start at the fourth line. The data fields and the lengths are as follows:

Date of VOS
The Date of VOS is the date of the beginning of the VOS. It has format of YYYY-MM-DD, where YYYY=year, MM=month, DD=day, and "-" is literal. Data for this field starts at column 1 (see Fig. 1.4.1-1).

Time of VOS
The Time of VOS is the time (UTC) of the beginning of the VOS. It has format of HH:MM:SS.sss, where HH=hour, MM=minute, SS=second, sss=millisecond, ":" and "." are literals. Data for this field starts at column 13 (see Fig. 1.4.1-1).

%Rain
%Rain is the percent of the raining area in the radar FOV. It is an integer value with a range of 0 to 100. Data for this field starts at column 29 (see Fig. 1.4.1-1).

Hit
The Hit field specifies which VOS was obtained when the satellite was the closest to the radar during coincidence. This will be a logical flag, 0(no hit) or 1(hit). There is a time limit of +/-30 minutes in seeking out the 'closest' volume scan (for example, for cases when the radar was down). Data for this field starts at column 35 (see Fig. 1.4.1-1).

Distance of Closest Approach (CA)
Distance of Closest Approach (CA) is the distance (km) from the radar to the sub-satellite point when a "Hit" occurred. It is a floating point value with 3 decimal point precision and a range from 0.000 to 750.000. If there was no hit, -9999.9 will be used. Data for this field starts at column 44 (see Fig. 1.4.1-1).

Date of CA
Date of CA (Date of Closest Approach) gives the date when the satellite is closest to the radar site. It has the same format as Date of VOS, while "NULL" will be used in the cases of "No Hit". Data for this field starts at column 58, if 'NULL' than column 61 (see Fig. 1.4.1-1).

Time of CA
Time of CA (Time of Closest Approach) gives the time (UTC) when the satellite is closest to the radar. It has the same format as Time of VOS, while "NULL" will be used in the cases of "No Hit". Data for this field starts at column 69, if 'NULL' than column 70 (see Fig. 1.4.1-1).

It should be noted that, in the case of a multiple radar site, %Rain is a combined result from all radars at that site, but Date of VOS, Time of VOS, Hit, Distance of Closest Approach, Date of CA and Time of CA apply to the primary radar only.

1.4.2 2A-53 - Radar Site Rain Map

2A-53, "Radar Site Rain Map", is an instantaneous surface rain rate map in Cartesian coordinates with a 2 km horizontal resolution. At single radar sites, the map covers an area of 300km x 300km. For the multiple radar site in Texas, the map covers a region of 724 km x 568 km, and in Florida 512 km x 704 km. Figure 1.4.2-1 shows the structure of the 2A-53 product in terms of the component objects and their sizes.

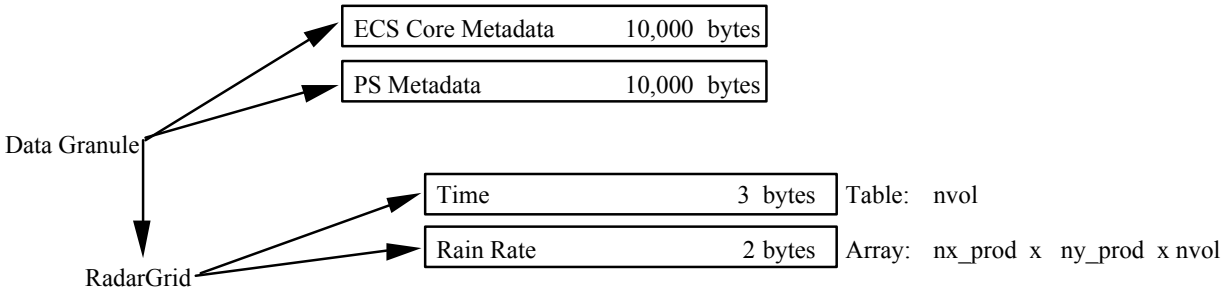

Figure 1.4.2-1
Data Format Structure for 2A-53, Radar Site Rain Map.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

Time (Vdata Table, record size 3 bytes, nvol records):
The time is the UTC hour-of-day, minute-of-hour and second-of-minute for the start of each VOS in the granule. See the following Table 1.4.2-1.

Table 1.4.2-1
2A-53 Time

Name	Format	Description
Hour	1-byte integer	the UTC hour-of-day for the start of one volume scan.
Minute	1-byte integer	the UTC minute-of-hour for the start of one volume scan.
Second	1-byte integer	the UTC second-of-minute for the start of one volume scan.

Rain Rate (SDS, array size: nx_prod x ny_prod x nvol, 2-byte integer):
This is the rain rate at the base scan. The rain rate ranges from 0.0 to 1000.0 mm h^{-1}. It is multiplied by 10 and stored as a 2-byte integer.

1.4.3 2A-54 - Radar Site Convective/Stratiform Map

2A-54, "Radar Site Convective/Stratiform Map", is an instantaneous map in Cartesian coordinates with a 2 km resolution. At single radar sites, the map covers an area of 300 km x 300 km. For the multiple radar site in Texas, the map covers a region of 724 km x 568 km, and in Florida 512 km x 704 km. The map identifies the surface precipitation as convective or stratiform. Figure 1.4.3-1 shows the structure of the 2A-54 product in terms of the component objects and their sizes.

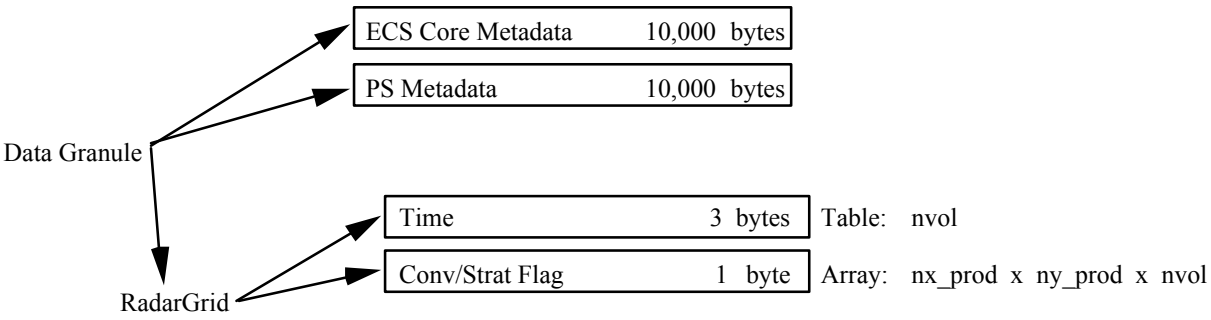

Figure 1.4.3-1
Data Format Structure for 2A-54, Radar Site Convective/Stratiform Map

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

Time (Vdata Table, record size 3 bytes, nvol records):
The time is the UTC hour-of-day, minute-of-hour and second-of-minute for the start of each VOS in the granule. See the following Table 1.4.3-1.

Table 1.4.3-1
2A-54 Time

Name	Format	Description
Hour	1-byte integer	the UTC hour-of-day for the start of one volume scan.
Minute	1-byte integer	the UTC minute-of-hour for the start of one volume scan.
Second	1-byte integer	the UTC second-of-minute for the start of one volume scan.

Conv/Strat Flag (SDS, array size: nx_prod x ny_prod x nvol, 1-byte integer):
The Convective/Stratiform flag is an instantaneous map in Cartesian coordinates. Each value represents the rain type of the entire vertical column. The following values are assigned for the Convective/Stratiform Flag:

0: no echo;
1: stratiform;
2: convective.
-99: missing data

1.4.4 2A-55 - Radar Site 3-D Reflectivities

2A-55, "Radar Site 3-D Reflectivities", is composed of 3 different fields. The first field has an array of 3-D reflectivities in Cartesian coordinates with a 2 km horizontal resolution over an area of 300 km x 300 km for single radar sites, and 724 km x 568 km for Texas multiple radar site, 512 km x 704 km for Florida multiple radar site. It has a vertical resolution of 1.5km and a height range up to 19.5 km. The second field has an array of vertical profiles based on the first field, and the third field has an array of the Contoured Frequency by Altitude Diagram (CFAD) data based on the first and second field. Figure 1.4.4-1 shows the structure of the 2A-55 product in terms of the component objects and their sizes.

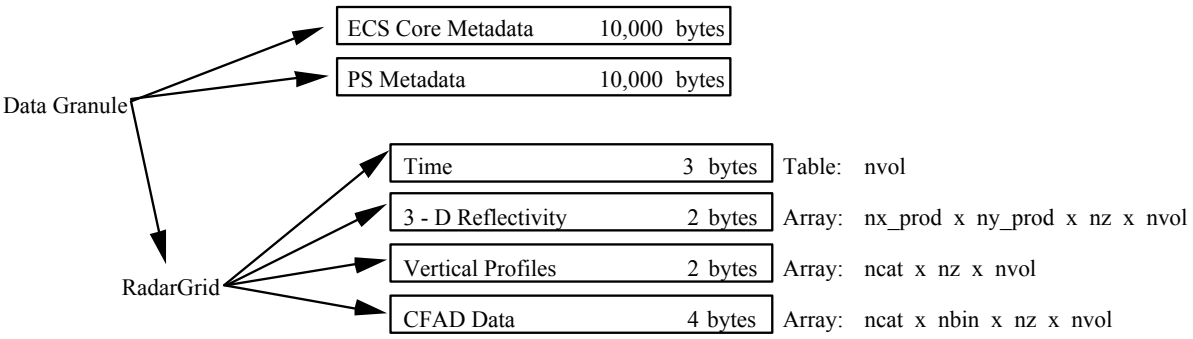

Figure 1.4.4-1
Data Format Structure for 2A-55, Radar Site 3-D Reflectivity

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

Time (Vdata Table, record size 3 bytes, nvol records):
The time is the UTC hour-of-day, minute-of-hour and second-of-minute for the start of each VOS in the granule. See the following Table 1.4.4-1.

Table 1.4.4-1
2A-55 Time

Name	Format	Description
Hour	1-byte integer	the UTC hour-of-day for the start of one volume scan.
Minute	1-byte integer	the UTC minute-of-hour for the start of one volume scan.
Second	1-byte integer	the UTC second-of-minute for the start of one volume scan.

3-D Reflectivity (SDS, array size nx_prod x ny_prod x nz x nvol, 2-byte integer):
The 3-D Reflectivity is the instantaneous reflectivity interpolated from volume scans onto a 3-D Cartesian coordinate system with a 1.5km vertical resolution to a height of 19.5km, and a 2 km horizontal resolution with varied covering ranges from single radar sites to multiple radar sites. For single radar sites, the horizontal area is 300 km x 300 km. At the multiple radar site in Texas, the area is 724 km x 568 km while in Florida it is 512 km x 704 km. Values range from -15.00 to 70.00 dBZ and are multiplied by 100 and stored as a 2-byte integer.

Vertical Profiles (SDS, array size ncat x nz x nvol, 2-byte integer):
The vertical profiles include reflectivities at each of the nz analysis levels for the following categories:

- total;
- total over land;
- total over sea;
- convective;
- convective over land;
- convective over sea;
- stratiform;
- stratiform over land;
- stratiform over sea;
- anvil (Anvil is defined as echo aloft with no contribution to surface rain.);
- anvil over land;
- anvil over sea.

Values range from -15.00 to 70.00 dBZ and are multiplied by 100 and stored as a 2-byte integer.

CFAD Data (SDS, array size ncat x nbin x nz x nvol, 4-byte integer):
The CFAD Data are the numbers of pixels counted in specified height-reflectivity bin pairs for the 12 categories listed below for each volume of radar data. nbin is the number of reflectivity bins and ranges from -15 dBZ to 70 dBZ. Values range from 0 to 22,801 (151 x 151) for single radar sites while from 0 to 103,455 (363 x 285) for Texas multiple radar site, and 0 to 90,721 (257 x 353) for Florida multiple radar site. The 12 categories are:

1) total;
2) total over land;
3) total over sea;
4) convective;
5) convective over land;
6) convective over sea;
7) stratiform;
8) stratiform over land;
9) stratiform over sea;
10) anvil (Anvil is defined as echo aloft with no contribution to surface rain.);
11) anvil over land;
12) anvil over sea.

2. LEVEL 3 PRODUCTS

Level 3 data products are either 5-day or monthly products calculated from Level 1 and Level 2 data. TSDIS will produce 9 Level 3 products from satellite data and ground validation data. Satellite data include TMI, VIRS, PR data from TRMM satellite, the SSM/I data from Defense Meteorological Satellite Program (DMSP) polar orbiting satellites, infrared data from the Geostationary Operational Environmental Satellite (GOES) which are available from Global Precipitation Climatology Project (GPCP) and the global rain gauge data from both the Global Precipitation Climatology Center (GPCC) and the Climate Assessment and Monitoring System (CAMS). Only GV radar data are included as input data for Level 3 GV products.

2.1 TRMM MICROWAVE IMAGER (TMI)

There is one level 3A data product for TMI, 3A-11 — TMI Emission (PI: Dr. Alfred Chang). The format of this product is designed in consultation with TMI algorithm scientists. The granule size is one month. The following parameters are used in describing the formats:

nlat: the number of 5° grid intervals of latitude from 40° N to 40° S (16).

nlon: the number of 5° grid intervals of longitude from 180°W to 180°E (72).

2.1.1 3A-11 - TMI Emission

3A-11, "TMI Emission", produces 5° x 5°monthly oceanic rainfall maps using TMI Level-1 data. Statistics of the monthly rainfall will also be calculated. Figure 2.1.1-1 shows the structure of the 3A-11 product in terms of the component objects and sizes.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications

Monthly Rainfall (SDS, array size nlat x nlon, 2-byte integer):
The Monthly Rainfall is the surface rainfall over oceans in 5° x 5° boxes from 40°N to 40°S. It ranges from 0.0 to 3000.0 mm and is multiplied by 10 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

Number of Samples (SDS, array size nlat x nlon, 4-byte integer):
The Number of Samples is that over oceans in 5° x 5° boxes for one month. It ranges from 0 to 500,000. Data on land areas are assigned the value -9999.

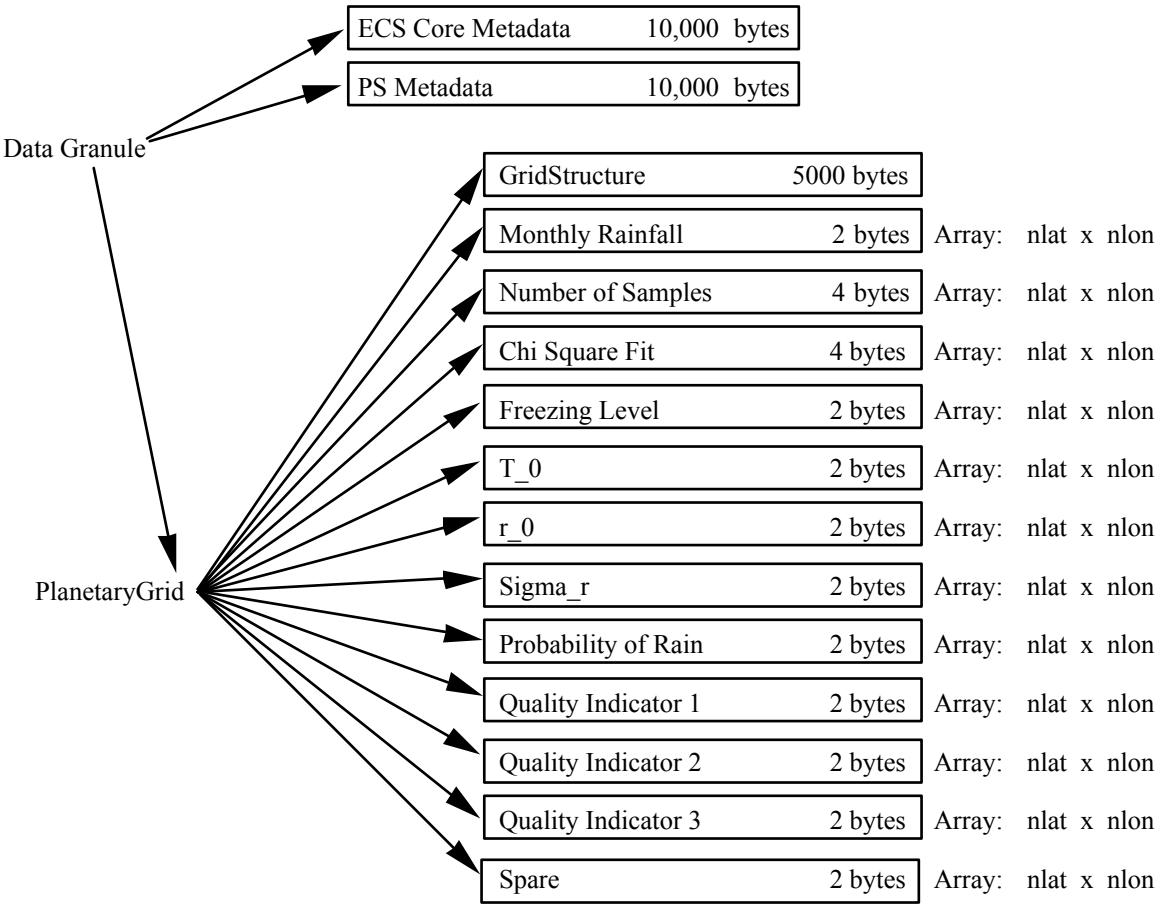

Figure 2.1.1-1
Data Format Structure for 3A-11, TMI Emission

Chi Square Fit (SDS, array size nlat x nlon, 4-byte integer):
The Chi Square Fit indicates how well the histogram of brightness temperatures fits the lognormal distribution function in 5° x 5° boxes for one month. It ranges from 1 to 1,000,000,000. Data on land areas are assigned the value -9999.

Freezing Level (SDS, array size nlat x nlon, 2-byte integer):
The Freezing Level is the estimated height of 0°C isotherm over oceans in 5° x 5° boxes for one month. It ranges from 0.00 to 6.00 km and is multiplied by 100 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

T_0 (SDS, array size nlat x nlon, 2-byte integer):
The T_0 is the mean of non-raining brightness temperatures over oceans in 5° x 5° boxes for one month. It ranges from 160.0 to 180.0 K and is multiplied by 10 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

r_0 (SDS, array size nlat x nlon, 2-byte integer):
The r_0 is the logarithmic mean rain rate over oceans in 5° x 5° boxes for one month. It ranges from 0.00 to 15.00 mm h^{-1} and is multiplied by 100 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

Sigma_r (SDS, array size nlat x nlon, 2-byte integer):
The Sigma_r(σ_r) is the standard deviation of logarithmic rain rates over oceans in 5° x 5° boxes for one month. It ranges from 0.00 to 1.00 mm h^{-1} and is multiplied by 100 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

Probability of Rain (SDS, array size nlat x nlon, 2-byte integer):
The Probability of Rain is that over oceans in 5° x 5° boxes for one month. It ranges from 0.000 to 1.000 and is multiplied by 1000 and stored as a 2-byte integer. Data on land areas are assigned the value -9999.

Quality Indicator 1 (SDS, array size nlat x nlon, 2-byte integer):
TBD

Quality Indicator 2 (SDS, array size nlat x nlon, 2-byte integer):
TBD

Quality Indicator 3 (SDS, array size nlat x nlon, 2-byte integer):
TBD

Spare (SDS, array size nlat x nlon, 2-byte integer):
TBD.

2.2 PRECIPITATION RADAR (PR)

There are two Level 3A products for the PR, 3A-25 — PR Rainfall (PI: Dr. Robert Meneghini), and 3A-26 — Surface Rain (PI: Dr. Robert Meneghini). The formats of these products are based on Version 2.2 algorithm descriptions given by PR algorithm scientist. The granule size is one month. The following parameters are used in describing the formats:

nlat: the number of 5° grid intervals of latitude from 40° N to 40° S (16).

nlon: the number of 5° grid intervals of longitude from 180°W to 180°E (72).

nlath: the number of 0.5° grid intervals of latitude from 37° N to 37° S (148).

nlonh: the number of 0.5° grid intervals of longitude 180°W to 180°E (720).

nh1: the number of fixed heights above the earth ellipsoid, at 2, 4, 6, 10, and 15 km plus one for path-average (6).

nh2: the number of fixed heights above the earth ellipsoid, at 2, 4, and 6 km (3).

nh3: the number of fixed heights above the earth ellipsoid, at 2, 4, and 6 km plus one for path-average (4).

ncat1: the first number of categories for histograms (25). ncat1 is currently not used.

ncat2: the second number of categories for histograms (30). Note that the number of thresholds is one greater than the number of categories. Thresholds are given below for several variables, others are **TBD.**

Reflectivity (dBZ) (bhz):

0.01, 12., 14., 16., 18., 20., 22., 24., 26., 28., 30., 32., 34., 36., 38., 40., 42., 44., 46., 48., 50., 52., 54., 56., 58., 60., 62., 64., 66., 68., 70.

Bright Band Height (km) (bhbb):

0.01, 0.25, 0.5, 0.75, 1., 1.25, 1.5, 1.75, 2., 2.25, 2.5, 2.75, 3., 3.25, 3.5, 3.75, 4., 4.25, 4.5, 4.75, 5., 5.25, 5.5, 5.75, 6., 6.25, 6.5, 6.75, 7., 7.5, 20.

Storm Height (km) (bhstorm):

0.01, 0.5, 1., 1.5, 2., 2.5, 3., 3.5, 4., 4.5, 5., 5.5, 6., 6.5, 7., 7.5, 8., 8.5, 9., 9.5, 10., 10.5, 11., 11.5, 12., 12.5, 13., 14., 15., 16., 20.

Snow Depth (km) (bhdepth):

0.01, 0.5, 0.75, 1., 1.25, 1.5, 1.75, 2., 2.25, 2.5, 2.75, 3., 3.25, 3.5, 3.75, 4., 4.25, 4.5, 4.75, 5., 5.25, 5.5, 5.75, 6., 6.25, 6.5, 6.75, 7., 7.25, 7.5, 20.

Zpzm (km) (bhzpzm):

0., 1., 2., 3., 4., 5., 6., 7., 8., 9., 10., 11., 12., 13., 14., 15., 16., 17., 18., 19., 20., 22., 24., 26., 28., 30., 32., 34., 36., 38., 50.

All PIA (dB) (bhpia):

0.01, 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.8, 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.5, 3.0, 3.5, 4.0, 4.5, 5.0, 5.5, 6.0, 6.5, 7.0, 7.5, 8.0, 8.5, 9.0, 9.5, 10., 100.

NUBF or Non-Uniform Beam Filling Factor (unitless) (bhnubf):

1., 1.05, 1.1, 1.15, 1.2, 1.25, 1.3, 1.35, 1.4, 1.45, 1.5, 1.55, 1.6, 1.65, 1.7, 1.75, 1.8, 1.85, 1.9, 1.95, 2., 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0

Xi or Horizontal Non-Uniformity Parameter (unitless) (bhxi):

0., 0.2, 0.4, 0.6, 0.8, 1., 1.2, 1.4, 1.6, 1.8, 2., 2.2, 2.4, 2.6, 2.8, 3., 3.2, 3.4, 3.6, 3.8, 4., 4.2, 4.4, 4.6, 4.8, 5., 10., 20., 30., 50., 10000.

Epsilon conditioned on use of SRT (unitless) (bhepsilon):

0., 0.1, 0.2, 0.3, 0.4, 0.5, 0.6, 0.7, 0.8, 0.9, 1., 1.1, 1.2, 1.3, 1.4, 1.5, 1.6, 1.7, 1.8, 1.9, 2., 2.1, 2.2, 2.3, 2.4, 2.5, 2.6, 2.7, 2.8, 2.9, 3.0

ncat3: the number of categories for probability distribution functions (25).

Rain rate thresholds (mm/hr) are:

12., 14., 16., 18., 20., 22., 24., 26., 28., 30., 32., 34., 36., 38., 40., 42., 44., 46., 48., 50., 52., 54., 56., 58., 60.

nang: the number of fixed incidence angles, at 0°, 5°, 10° and 15° (4).

nthrsh: the number of thresholds used for probability distribution functions (6).

Q-thresholds for Zero order:

0.1, 0.2, 0.3, 0.5, 0.75, 50.

Q-thresholds for HB:

0.1, 0.2, 0.3, 0.5, 0.75, 0.9999

pia-thresholds for SRT:

1.5, 1., 0.8, 0.6, 0.4, 0.1

2.2.1 3A-25 - PR Rainfall

3A-25, "PR Rainfall", computes monthly statistics of the PR measurements at both a low horizontal resolution (5° x 5° latitude/longitude) and a high horizontal resolution (0.5^o x 0.5^o latitude/longitude). The low resolution grids are in the Planetary Grid 1 structure and include 1) mean and standard deviation of the rain rate, reflectivity, path-integrated attenuation (PIA), storm height, Xi, bright band height and the NUBF (Non-Uniform Beam Filling) correction; 2) rain fractions; 3) histograms of the storm height, bright-band height, snow-ice layer, reflectivity, rain rate, path-attenuation and NUBF correction; 4) correlation coefficients. For the high resolution grids in the Planetary Grid 2 structure, mean rain rate along with standard deviation and rain fractions are computed. Figure 2.2.1-1 shows the structure of the 3A-25 product in terms of the component objects and their sizes. The Vgroups of PlanetaryGrid 1 and PlanetaryGrid 2 are Planetary Grid structure.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids in Planetary Grid 1. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Rain Rate Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Rain Rate Mean 1 gives means of non-zero rain rates over 5° x 5° boxes for one month. The rain rates are determined in 2A-25 and evaluated for the path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Rain Rates Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
These are standard deviations of non-zero rain rates over 5° x 5° boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Conv. Rain Rate Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Conv. Rain Rate Mean 1 gives means of non-zero rain rates for convective rain over 5° x 5° boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Conv. Rain Rates Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Conv. Rain Rates Dev. 1 gives standard deviations of non-zero rain rates for convective rain over 5° x 5° boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Strat. Rain Rate Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Strat. Rain Rate Mean 1 gives means of non-zero rain rates for stratiform rain over 5° x 5° boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

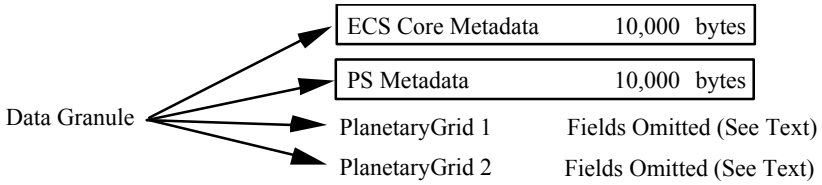

Figure 2.2.1-1 Data Format Structure for 3A-25, PR Rainfall

Strat. Rain Rates Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Strat. Rain Rates Dev. 1 gives standard deviations of non-zero rain rates for stratiform rain over 5° x 5° boxes for one month. The rain rates are determined in 2A-25 and evaluated for path-average and at the fixed heights of 2, 4, 6, 10 and 15 km. It ranges from 0.0 to 3000.0 mm/h.

Zm Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
The Zm Mean 1 gives means of measured radar reflectivity at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5° x 5° boxes for one month using data from 1C-21. It ranges from 0 to 100 dBZ.

Zm Dev.1 (SDS, array size nlat x nlon x nh1, 4-byte float):
The Zm Dev. 1 gives standard deviations of measured radar reflectivity at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5° x 5° boxes for one month using data from 1C-21. It ranges from 0 to 100 dBZ.

Conv. Zm Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Conv. Zm Mean 1 gives the monthly means of measured radar reflectivity for convective rain at a horizontal resolution of 5° x 5°. The path-averaged mean and means at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 1C-21. It ranges from 0 to 100 dBZ.

Conv. Zm Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Conv. Zm Dev. 1 gives the monthly standard deviations of measured radar reflectivity for convective rain at a horizontal resolution of 5° x 5°. The path-averaged standard deviation and those at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 1C-21. It ranges from 0 to 100 dBZ.

Strat. Zm Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Strat. Zm Mean 1 gives the monthly means of measured radar reflectivity for stratiform rain at a horizontal resolution of 5° x 5°. The path-averaged mean and means at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 1C-21. It ranges from 0 to 100 dBZ.

Strat. Zm Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Strat. Zm Dev. 1 gives the monthly standard deviations of measured radar reflectivity for stratiform rain at a horizontal resolution of 5° x 5°. The path-averaged standard deviation and those at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 1C-21. It ranges from 0 to 100 dBZ.

Zt Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
The Zt Mean 1 gives means of corrected radar reflectivity factors at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5° x 5° boxes for one month using data from 2A-25. It ranges from 0.1 to 80 dBZ.

Zt Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
The Zt Dev. 1 gives standard deviations of corrected radar reflectivity factors at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5° x 5° boxes for one month using data from 2A-25. It ranges from 0.0 to 80 dBZ.

Conv. Zt Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Conv. Zt Mean 1 gives the monthly means of corrected radar reflectivity for convective rain at a horizontal resolution of 5° x 5°. The path-averaged mean and means at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 2A-25. It ranges from 0.1 to 80 dBZ.

Conv. Zt Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Conv. Zt Dev. 1 gives the monthly standard deviations of corrected radar reflectivity for convective rain at a horizontal resolution of 5° x 5°. The path-averaged standard deviation and those at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 2A-25. It ranges from 0.0 to 80 dBZ.

Strat. Zt Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Strat. Zt Mean 1 gives the monthly means of measured radar reflectivity for stratiform rain at a horizontal resolution of 5° x 5°. The path-averaged mean and means at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 2A-25. It ranges from 0.1 to 80 dBZ.

Strat. Zt Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):
Strat. Zt Dev. 1 gives the monthly standard deviations of corrected radar reflectivity for stratiform rain at a horizontal resolution of 5° x 5°. The path-averaged standard deviation and those at the fixed heights of 2, 4, 6, 10 and 15 km are calculated using data from 2A-25. It ranges from 0.0 to 80.0 dBZ.

PIA srt Mean (SDS, array size nlat x nlon x nang, 4-byte float):
PIA srt Mean gives the monthly means of SRT (surface reference technique) path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5° x 5°. It has units of dB and a range from 0 dB to 100 dB.

PIA srt Dev. (SDS, array size nlat x nlon x nang, 4-byte float):
PIA srt Dev. gives the monthly standard deviation of SRT path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5° x 5°. It has units of dB and a range from 0 dB to 100 dB.

PIA hb Mean (SDS, array size nlat x nlon x nang, 4-byte float):
PIA hb Mean gives the monthly means of HB path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5° x 5°. It has units of dB and a range from 0 dB to 100 dB.

PIA hb Dev. (SDS, array size nlat x nlon x nang, 4-byte float):
PIA hb Dev. gives the monthly standard deviation of HB path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5° x 5°. It has units of and a range from 0 dB to 100 dB.

PIA 0th Mean (SDS, array size nlat x nlon x nang, 4-byte float):
PIA 0th Mean gives the monthly means of the 0th-order path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5° x 5°. It has units of and a range from 0 dB to 100 dB.

PIA 0th Dev. (SDS, array size nlat x nlon x nang, 4-byte float):
PIA 0th Dev. gives the monthly standard deviation of the 0th-order path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5° x 5°. It has units of dB and a range from 0 dB to 100 dB.

pia2a25Mean (SDS, array size nlat x nlon x nang, 4-byte float):
pia2a25Mean gives the monthly means of 2A25 path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5° x 5°. It has units of dB and a range from
0 dB to 100 dB.

pia2a25Dev. (SDS, array size nlat x nlon x nang, 4-byte float):
pia2a25Dev. gives the monthly standard deviation of 2A25 path-integrated attenuation calculated at four fixed incidence angles. It has a horizontal resolution of 5° x 5°. It has units of and a range from 0 dB to 100 dB.

PiaSrtssMean (SDS, array size nlat x nlon, 4-byte float):
Mean of PIA (path integrated attenuation, one-way) for SRT for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. Units are dB and it ranges from 0 to 100dB.

piaSrtssDev (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of PIA (path integrated attenuation, one-way) for SRT for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. Units are dB and it ranges from 0 to 100dB.

piaHbssMean (SDS, array size nlat x nlon, 4-byte float):
Mean of PIA (path integrated attenuation, one-way) for HB method for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. Units are dB and it ranges from 0 to 100dB.

piaHbssDev (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of PIA (path integrated attenuation, one-way) for HB method for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. Units are dB and it ranges from 0 to 100dB.

pia0ssMean (SDS, array size nlat x nlon, 4-byte float):
Mean of PIA (path integrated attenuation, one-way) for 0th-order method for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. Units are dB and it ranges from 0 to 100dB.

pia0ssDev (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of PIA (path integrated attenuation, one-way) for 0th-order method for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. Units are dB and it ranges from 0 to 100dB.

pia2a25ssMean (SDS, array size nlat x nlon, 4-byte float):
Mean of final PIA (path integrated attenuation, one-way) from 2A25 for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. Units are dB and it ranges from 0 to 100dB.

pia2a25ssDev (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of final PIA (path integrated attenuation, one-way) from 2A25 for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. Units are dB and it ranges from 0 to 100dB.

Storm Height Mean (SDS, array size nlat x nlon x 3, 4-byte float):
Storm Height Mean is the mean of the storm height for conditions of stratiform rain, convective rain and unconditional rain. It has units of meters and ranges from 0.0 to 20,000.

Storm Height Dev. (SDS, array size nlat x nlon x 3, 4-byte float):
Storm Height Dev. is the standard deviation of the storm height for conditions of stratiform rain, convective rain and unconditional rain. It has units of meters and ranges from 0.0 to 20,000.

Xi Mean (SDS, array size nlat x nlon, 4-byte float):
Xi Mean gives the monthly means of the horizontal non-uniformity parameter of the rain field within a ray at a horizontal resolution of 5° x 5°. It has no units and ranges from 0.0 to 99.0.

Xi Dev. (SDS, array size nlat x nlon, 4-byte float):
Xi Dev. gives the monthly standard deviation of the horizontal non-uniformity parameter of the rain field within a ray at a horizontal resolution of 5° x 5°. It has no units and ranges from 0.0 to 99.0.

NUBF Correction Factor Mean (SDS, array size nlat x nlon, 4-byte float):
The NUBF (Non-Uniform Beam Filling) Correction Factor Mean gives the monthly mean of NUBF correction for Z-factor and Rain Rate at a horizontal resolution of 5° x 5°. It has no units and a range of 0 to 2.0.

NUBF Correction Factor Dev. (SDS, array size nlat x nlon, 4-byte float):
The NUBF (Non-Uniform Beam Filling) Correction Factor Dev. gives the monthly standard deviation of the NUBF correction for Z-factor and Rain Rate at a horizontal resolution of 5° x 5°. It has no units and ranges from 0 to 2.0.

BB Height Mean (SDS, array size nlat x nlon, 4-byte float):
BB Height Mean gives the monthly means of the bright band height at a horizontal resolution of 5° x 5°. It has units of meters and ranges from 0 to 20,000.

BB Height Dev. (SDS, array size nlat x nlon, 4-byte float):
BB Height Dev. gives the monthly deviation of the bright band height at a horizontal resolution of 5° x 5°. It has units of meters and ranges from 0 to 20,000.

bbNadirHtMean1 (SDS, array size nlat x nlon, 4-byte float):
Height of bright band from nadir ray in meters for 5 x 5 deg. boxes. It ranges from 0 to 20,000 meters.

bbNadirHtDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of the bright band height from nadir ray in meters for 5 x 5 deg. boxes. It ranges from 0 to 20,000 meters.

bbNadirWidthMean1 (SDS, array size nlat x nlon, 4-byte float):
Width of bright band from nadir ray in meters for 5 x 5 deg. boxes. It ranges from 0 to 10,000 meters.

bbNadirWidthDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of the width of the bright band from nadir ray in meters for 5 x 5 deg. boxes. It ranges from 0 to 10,000
meters.

bbNadirZmaxMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of maximum Z in bright band from the nadir ray in dBZ for 5 x 5 deg. boxes. It ranges from 0 to 70dBZ.

bbNadirZmaxDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of maximum Z in bright band from the nadir ray in dBZ for 5 x 5 deg. boxes. It ranges from 0 to 70dBZ.

epsilonConvMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of epsilon conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0.0 to 5.0 (unitless).

epsilonConvDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of epsilon conditioned on convective rain and use of 2A21 SRT at a horizontal resolution
of 5 x 5deg. It ranges from 0.0 to 5.0 (unitless).

epsilonStratMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of epsilon conditioned stratiform rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0.0 to 5.0 (unitless).

epsilonStratDev1 (SDS, array size nlat x nlon, 4-byte float):
Mean of epsilon conditioned stratiform rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0.0 to 5.0 (unitless).

epsilon0ConvMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of epsilon0 conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0.0 to 5.0 (unitless).

epsilon0ConvDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of epsilon0 conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0.0 to 5.0 (unitless).

epsilon0StratMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of epsilon conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0.0 to 5.0 (unitless).

epsilon0StratDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of epsilon0 conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0.0 to 5.0 (unitless).

surfRainMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of non-zero near-surface rain rate at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 3000.0 mm/h.

surfRainDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of non-zero near-surface rain rate at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 3000.0 mm/h.

SurfRainConvMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of non-zero near-surface rain rate conditioned on convective rain in 5 x 5 deg. boxes. It ranges from 0.0 to 3000.0 mm/h.

SurfRainConvDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of non-zero near-surface rain rate conditioned on convective rain in 5 x 5 deg. boxes. It ranges from 0.0 to 3000.0 mm/h.

SurfRainStratMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of non-zero near-surface rain rate conditioned on stratiform rain in 5 x 5 deg. boxes. It ranges from 0.0 to 3000.0 mm/h.

SurfRainStratDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of non-zero near-surface rain rate conditioned on convective rain in 5 x 5 deg. boxes. It ranges from 0.0 to 3000.0 mm/h.

bbZmaxMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of maximum reflectivity in bright band at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 100.0 dBZ.

bbZmaxDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard Deviation of maximum reflectivity in bright band at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 100.0 dBZ.

sdepthMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of snow depth at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 20,000.0 m.

sdepthDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of snow depth at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 20,000.0 m.

e_surfRainMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) in mm/hr. Over 5 x 5 deg. boxes. It ranges from 0.0 to 400.0 mm/hr.

e_surfRainDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) in mm/hr. Over 5 x 5 deg. boxes. It ranges from 0.0 to 400.0 mm/hr.

e_surfRainConvMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) conditioned on convective rain in mm/hr. Over 5 x 5 deg. boxes. It ranges from 0.0 to 400.0 mm/hr.

e_surfRainConvDev1 (SDS, array size nlat x nlon, 4-byte float):

Standard deviation of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) conditioned on convective rain in mm/hr. It ranges from 0.0 to 400.0 mm/hr.

e_surfRainStratMean1 (SDS, array size nlat x nlon, 4-byte float):
Mean of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) conditioned on stratiform rain in mm/hr. Over 5 x 5 deg. boxes. It ranges from 0.0 to 400.0 mm/hr.

e_surfRainStratDev1 (SDS, array size nlat x nlon, 4-byte float):
Standard deviation of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) conditioned on stratiform rain in mm/hr. Over 5 x 5 deg. boxes. It ranges from 0.0 to 400.0 mm/hr.

rzA1 (SDS, array size nlat x nlon x 2, 4-byte float):
The A parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs. Computed for near-surface and 2km heights. Over 5 x 5 deg. boxes. It ranges from 0 to 1.0.

rzB1 (SDS, array size nlat x nlon x 2, 4-byte float):
The B parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs. Computed for near-surface and 2km heights. Over 5 x 5 deg. boxes. It ranges from 0 to 1.0.

rzConvA1 (SDS, array size nlat x nlon x 2, 4-byte float):
The A parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs conditioned on convective rain. Computed for near-surface and 2km heights. Over 5 x 5 deg. boxes. It ranges from 0 to 1.0.

rzConvB1 (SDS, array size nlat x nlon x 2, 4-byte float):
The B parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs conditioned on convective rain. Computed for near-surface and 2km heights. Over 5 x 5 deg. boxes. It ranges from 0 to 1.0.

rzStratA1 (SDS, array size nlat x nlon x 2, 4-byte float):
The A parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs conditioned on stratiform rain. Computed for near-surface and 2km heights. It ranges from 0 to 1.0.

rzStratB1(SDS, array size nlat x nlon x 2, 4-byte float):
The B parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs conditioned on stratiform rain. Computed for near-surface and 2km heights. Over 5 x 5 deg. boxes. It ranges from 0 to 1.0.

Total Pixel Number 1 (SDS, array size nlat x nlon, 4-byte integer):
The Total Pixel Number 1 is the number of total pixels over 5° x 5° boxes for one month. The range is 0 to 2,000,000.

Bright Band Pixel Number 1 (SDS, array size nlat x nlon, 4-byte integer):
The number of bright band counts over each 5° x 5° box for one month. The range is 0 to 2,000,000.

bbNadirPix1 (SDS, array size nlat x nlon, 4-byte integer):
The number of bright band nadir pixel counts. Over 5 x 5 deg. boxes. The range is 0 to 2,000,000.

Rain Pixel Number 1 (SDS, array size nlat x nlon x nh1, 4-byte integer):
The Rain Pixel Number 1 is the number of non-zero rain rate pixels at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5° x 5° boxes for one month. The range is 0 to 2,000,000.

Conv. Rain Pixel Number 1 (SDS, array size nlat x nlon x nh1, 4-byte integer):
The Convective Rain Pixel Number 1 is the number of non-zero rain rate pixels for convective rain at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5° x 5° boxes for one month. The range is 0 to 2,000,000.

Strat. Rain Pixel Number 1 (SDS, array size nlat x nlon x nh1, 4-byte integer):
The Stratiform Rain Pixel Number 1 is the number of non-zero rain rate pixels for stratiform rain at the fixed heights of 2, 4, 6, 10 and 15 km and for path-average over 5° x 5° boxes for one month. The range is 0 to 2,000,000.

Total Angle Pixel Number 1 (SDS, array size nlat x nlon x nang, 2-byte integer):
Total Angle Pixel Number 1 is the total number of pixels over each 5° x 5° latitude-longitude grid box for a month. This parameter is accumulated at four different angles (i.e., 0°, 5°, 10°, and 15°). The range is 0 to 30,000.

Rain Angle Pixel Number 1 (SDS, array size nlat x nlon x nang, 2-byte integer):
Rain Angle Pixel Number 1 is the total number of non-zero rain rate pixels over each 5° x 5° latitude-longitude grid box for a month. This parameter is accumulated at four different angles (i.e., 0°, 5°, 10°, and 15°). The range is 0 to 30,000.

surfRainPix1 (SDS, array size nlat x nlon, 4-byte integer):
Near-surface rain counts at a horizontal resolution of 5° x 5°. It ranges from 0 to 2,000,000.

SurfRainConvPix1 (SDS, array size nlat x nlon, 2-byte integer):
Counts of non-zero near-surface rain fall conditioned on convective rain in 5 x 5 deg. boxes. Ranges from 0 to 32,767.

SurfRainStratPix1 (SDS, array size nlat x nlon, 2-byte integer):
Counts of non-zero near-surface rainfall conditioned on convective rain in 5 x 5 deg. boxes. Ranges from 0 to 32,767.

e_surfRainPix1 (SDS, array size nlat x nlon, 4-byte integer):
The number of non-zero estimated surface rain pixel counts. Over 5 x 5 deg. boxes. The range is 0 to 2,000,000.

e_surfRainConvPix1 (SDS, array size nlat x nlon, 4-byte integer):
The number of non-zero estimated surface rain pixel counts conditioned on convective rain. Over 5 x 5 deg. boxes. The range is 0 to 2,000,000.

e_surfRainStratPix1 (SDS, array size nlat x nlon, 4-byte integer):
The number of non-zero estimated surface rain pixel counts conditioned on stratiform. Over 5 x 5 deg. boxes. The range is 0 to 2,000,000.

rzPix1 (SDS, array size nlat x nlon x 2, 4-byte integer):
The number of R-Z coefficient pixel counts for near-surface and 2km heights. Over 5 x 5 deg. boxes. The range is 0 to 2,000,000.

rzConvPix1 (SDS, array size nlat x nlon x 2, 4-byte integer):
The number of R-Z coefficient pixel counts for convective rain for near-surface and 2km heights. Over 5 x 5 deg. boxes. The range is 0 to 2,000,000.

rzStratPix1 (SDS, array size nlat x nlon x 2, 4-byte integer):
The number of R-Z coefficient pixel counts for stratiform rain for near-surface and 2km heights. Over 5 x 5 deg. boxes. The range is 0 to 2,000,000.

piaSrtssPix (SDS, array size nlat x nlon, 2-byte integer):
Counts of PIA using SRT method for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

piaHbssPix (SDS, array size nlat x nlon, 2-byte integer):
Counts of PIA using HB method for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

pia0ssPix (SDS, array size nlat x nlon, 2-byte integer):
Counts of PIA using 0th-order method for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

pia2a25ssPix (SDS, array size nlat x nlon, 2-byte integer):
Counts of final PIA from 2A25 for a sub-set of data where the 2A25 method flag has been set (see 2A25/3A25 algorithm users guide). Over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

rainCCoefPix (SDS, array size nlat x nlon x 3, 2-byte integer):
Counts for correlation coefficients of rain at the 3 heights. Over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

stratCCoefPix (SDS, array size nlat x nlon x 3, 2-byte integer):
Counts for correlation coefficients of rain conditioned on stratiform rain at the 3 heights. Over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

convCCoefPix (SDS, array size nlat x nlon x 3, 2-byte integer):
Counts for correlation coefficients of rain conditioned on convective rain at the 3 heights. Over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

piaCCoefPix (SDS, array size nlat x nlon x 5, 2-byte integer):
Counts for correlation coefficients of PIA for the 5 angle categories (0, 5, 10, 15 degrees and all 49 angle bins). It ranges from 0 to 32,767.

epsilonConvPix1 (SDS, array size nlat x nlon, 2-byte integer):
Counts of epsilon conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0 to 2,000,000.

epsilonStratPix1 (SDS, array size nlat x nlon, 2-byte integer):
Counts of epsilon conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0 to 2,000,000.

epsilon0ConvPix1 (SDS, array size nlat x nlon, 4-byte integer):
Counts of epsilon0 conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0 to 2,000,000.

epsilon0StratPix1 (SDS, array size nlat x nlon, 4-byte integer):
Counts of epsilon0 conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 5 x 5deg. It ranges from 0 to 2,000,000.

Storm Height Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the 'effective' storm heights for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Conv. Storm Height Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the 'effective' storm heights for convective rain for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Strat. Storm Height Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the 'effective' storm heights for stratiform rain for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

BB Height Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the bright-band heights for 30 categories over a 5° x 5° box for one month, given that the bright band is detected. It ranges from 0 to 32,767.

Snow-ice Layer Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
These are histograms of the depth of snow-ice layer for 30 categories over a 5° x 5° box for one month. The depth of snow-ice layer is defined as the difference between effective storm height and estimated height of 0°C isotherm. It ranges from 0 to 32,767.

Zm Hist. (SDS, array size nlat x nlon x ncat2 x nh1, 2-byte integer):
The Zm Histograms are histograms of measured reflectivities of rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Conv. Zm Hist. (SDS, array size nlat x nlon x ncat2 x nh1, 2-byte integer):
The Convective Zm Histograms are histograms of measured reflectivities of convective rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Strat. Zm Hist. (SDS, array size nlat x nlon x ncat2 x nh1, 2-byte integer):
The Stratiform Zm Histograms are histograms of measured reflectivities of stratiform rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Zt Hist. (SDS, array size nlat x nlon x ncat2 x nh1, 2-byte integer):
The Zt Histograms are histograms of corrected reflectivity factors for rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Conv. Zt Hist. (SDS, array size nlat x nlon x ncat2 x nh1, 2-byte integer):
The Convective Zt Histograms are histograms of corrected reflectivity factors for convective rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Strat. Zt Hist. (SDS, array size nlat x nlon x ncat2 x nh1, 2-byte integer):
The Stratiform Zt Histograms are histograms of corrected reflectivity factors for stratiform rain pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Rain Rate Hist. (SDS, array size nlat x nlon x ncat2 x nh1, 2-byte integer):
These are histograms of non-zero rain rate pixels at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Conv. Rain Rate Hist. (SDS, array size nlat x nlon x ncat2 x nh1, 2-byte integer):
These are histograms of non-zero rain rate pixels for convective rain at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767

Strat. Rain Rate Hist. (SDS, array size nlat x nlon x ncat2 x nh1, 2-byte integer):
These are histograms of non-zero rain rate pixels for stratiform rain at five heights (2, 4, 6, 10 and 15 km) and path-average for 20 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767

bbNadirHH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram in counts of bright band heights from nadir ray for 5 x 5 deg. boxes. There are 30 categories. It ranges from 0 to 32,767.

bbNadirWidthH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram in counts of bright band widths from nadir ray for 5 x 5 deg. boxes. There are 30 categories. It ranges from 0 to 32,767.

bbNadirZmaxH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram in counts of maximum Z in bright band from nadir ray for 5 x 5 deg. boxes. There are 30 categories. It ranges from 0 to 32,767.

e_surfRainH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram in counts of non-zero estimated surface rain for 5 x 5 deg. boxes. There are 30 categories. It ranges from 0 to 32,767.

e_surfRainConvH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram in counts of non-zero estimated surface rain conditioned on convective rain for 5 x 5 deg. boxes. There are 30 categories. It ranges from 0 to 32,767.

e_surfRainStratH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram in counts of non-zero estimated surface rain conditioned on stratiform rain for 5 x 5 deg. boxes. There are 30 categories. It ranges from 0 to 32,767.

SurfRainConvH (SDS, array size nlat x nlon x ncat2, 2-btye integer):
Histogram in counts of non-zero near-surface rainfall conditioned on convective rain in 5 x 5 deg. boxes. Binned into 20 categories. Ranges from 0 to 32,767.

SurfRainStratH (SDS, array size nlat x nlon x ncat2, 2-btye integer):
Histogram in counts of non-zero near-surface rainfall conditioned on stratiform rain in 5 x 5 deg. boxes. Binned into 20 categories. Ranges from 0 to 32,767.

piaSrtssH (SDS, array size nlat x nlon x ncat2, nang, 2-byte integer):
Histogram in counts of PIA from SRT subsetted by 2A25 method flag at 5 angles (0, 5, 10, 15 and all 49 angle bins) for 30 categories over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

piaHbssH (SDS, array size nlat x nlon x ncat2, nang, 2-byte integer):
Histogram in counts of PIA from HB method subsetted by 2A25 method flag at 5 angles (0, 5, 10, 15 and all 49 angle bins) for 30 categories over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

pia0ssH (SDS, array size nlat x nlon x ncat2, nang, 2-byte integer):
Histogram in counts of PIA from 0th-order method subsetted by 2A25 method flag at 5 angles (0, 5, 10, 15 and all 49 angle bins) for 30 categories over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

pia2a25ssH (SDS, array size nlat x nlon x ncat2, nang, 2-byte integer):
Histogram in counts of final PIA from 2A25 subsetted by 2A25 method flag at 5 angles (0, 5, 10, 15 and all 49 angle bins) for 30 categories over 5 x 5 deg. boxes. It ranges from 0 to 32,767.

PIA srt Hist. (SDS, array size nlat x nlon x ncat2 x nang, 2-byte integer):
PIA srt Hist. gives histograms of path-attenuation as determined by the surface reference technique (SRT) at 4 incidence angles (0, 5, 10 and 15°) for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

PIA hb Hist. (SDS, array size nlat x nlon x ncat2 x nang, 2-byte integer):
These are histograms of path-attenuation using an estimate derived from measured reflectivity (Z_m) and a k-Z relationship at 4 incidence angles (0, 5, 10 and 15°) for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

PIA 0th Hist. (SDS, array size nlat x nlon x ncat2 x nang, 2-byte integer):
PIA 0th Hist. is the histogram of the 0th order path-integrated attenuation with a horizontal resolution of 5^o x 5^o. This histogram is calculated for 30 categories at 4 different incident angles (0^o, 5^o, 10^o and 15^o). It ranges from 0 to 32,767

pia2A25H (SDS, array size nlat x nlon x ncat2 x nang, 2-byte integer):
These are histograms of path-attenuation as determined by 2A25 at 4 incidence angles (0, 5, 10 and 15°) for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

Xi Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):
The Xi Histograms is the histogram of non-uniformity parameter determined in 2A-25 for 30 categories over a 5° x 5° box for one month. It ranges from 0 to 32,767.

NUBF Hist. (SDS, array nlat x nlon x ncat2, 2-byte integer):
NUBF (Non-Uniform Beam Filling) Hist. gives the histogram of the NUBF correction for Z-factor and rain rate of 30 different categories over 5^o x 5^o grid boxes. It ranges from 0 to 32,767.

bbZmaxH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram of maximum Zt in bright band at a horizontal resolution of 5° x 5°. It ranges from 0 to 32,000.

epsilonConvH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram of epsilon conditioned convective rain and use of 2A21 SRT at a horizontal resolution of 5 x 5 deg. It ranges from 0 to 32,000.

epsilonStratH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram of epsilon conditioned stratiform rain and use of 2A21 SRT at a horizontal resolution of 5 x 5 deg. It ranges from 0 to 32,000.

epsilon0ConvH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram of epsilon0 conditioned convective rain and use of 2A21 SRT at a horizontal resolution of 5 x 5 deg. It ranges from 0 to 32,000.

epsilon0StratH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram of epsilon0 conditioned stratiform rain and use of 2A21 SRT at a horizontal resolution of 5 x 5 deg. It ranges from 0 to 32,000.

surfRainH (SDS, array size nlat x nlon x ncat2, 2-byte integer):
Histogram of near-surface rain rate at a horizontal resolution of 5° x 5°. It ranges from 0 to 32,000.

RR Corr. Coef. (SDS, array size nlat x nlon x 3, 4-byte float):
These are correlation coefficients of non-zero rain rates between 3 heights (i.e., correlation coefficient of rain rates at 2 km vs 4 km, 2 km vs 6 km, and 4 km vs 6 km) for a 5° x 5° box for one month.. It ranges from -1.000 to 1.000.

Conv. RR Corr. Coef. (SDS, array size nlat x nlon x 3, 4-byte float):
These are correlation coefficients of non-zero rain rates for convective rain between 3 heights (i.e., correlation coefficient of rain rates at 2 km vs 4 km, 2 km vs 6 km, and 4 km vs 6 km) for a 5° x 5° box for one month. It ranges from -1.000 to 1.000.

Strat. RR Corr. Coef. (SDS, array size nlat x nlon x 3, 4-byte float):
These are correlation coefficients of non-zero rain rates for stratiform rain between 3 heights (i.e., correlation coefficient of rain rates at 2 km vs 4 km, 2 km vs 6 km, and 4 km vs 6 km) for a 5° x 5° box for one month. It ranges from -1.000 to 1.000.

PIAs Corr. Coef. (SDS, array size nlat x nlon x nang x 3, 4-byte float):
This is the correlation coefficient of three path-integrated attenuations (SRT, HB, and 0th order PIAs) at angles of 0°, 5°, 10° and 15° for a 5° x 5° box for one month. It ranges from -1.000 to 1.000.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids in Planetary Grid 2. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

Rain Rate Mean 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):
Rain Rate Mean 2 gives means of non-zero rain rates over 0.5° x 0.5° boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2 km, 4 km, 6 km, and path average. It ranges from 0 to 3000.0 mm/h.

Rain Rate Dev. 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):
Rain Rate Dev. 2 gives standard deviations of non-zero rain rates over 0.5° x 0.5° boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2 km, 4 km, 6 km, and path average. It ranges from 0 to 3000.0 mm/h.

Conv. Rain Rate Mean 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):
Conv. Rain Rate Mean 2 gives means of non-zero rain rates for convective rain over 0.5° x 0.5° boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2 km, 4 km, 6 km, and path average. It ranges from 0 to 3000.0 mm/h.

Conv. Rain Rate Dev. 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):
Conv. Rain Rate Dev. 2 gives standard deviations of non-zero rain rates for convective rain over 0.5° x 0.5° boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2 km, 4 km, 6 km, and path average. It ranges from 0 to 3000.0 mm/h.

Strat. Rain Rate Mean 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):
Strat. Rain Rate Mean 2 gives means of non-zero rain rates for stratiform rain over 0.5° x 0.5° boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2 km, 4 km, 6 km, and path average. It ranges from 0 to 3000.0 mm/h.

Strat. Rain Rate Dev. 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):
Strat/ Rain Rate Dev. 2 gives standard deviations of non-zero rain rates for stratiform rain over 0.5° x 0.5° boxes for one month. The rain rates are determined in 2A-25 and evaluated at the fixed heights of 2 km, 4 km, 6 km, and path average. It ranges from 0 to 3000.0 mm/h.

Zm Mean 2 (SDS, array nlath x nlonh x nh3, 4-byte float):
Zm Mean 2 gives the monthly means of the measured reflectivity at the fixed height levels of 2 km, 4 km, 6 km, and path average over 0.5^o x 0.5^o grid boxes. It ranges from -20 to 80 dBZ.

Conv. Zm Mean 2 (SDS, array nlath x nlonh x nh3, 4-byte float):
Conv. Zm Mean 2 gives the monthly means of the measured reflectivity of convective rain at the fixed height levels of 2 km, 4 km, 6 km, and path average over 0.5^o x 0.5^o grid boxes. It ranges from -20 to 80 dBZ.

Strat. Zm Mean 2 (SDS, array nlath x nlonh x nh3, 4-byte float):
Strat. Zm Means gives the monthly means of the measured reflectivity of stratiform rain at the fixed heights of 2 km, 4 km, 6 km, and path average over 0.5^o x 0.5^o grid boxes. It ranges from -20 to 80 dBZ.

Zt Mean 2 (SDS, array nlath x nlonh x nh3, 4-byte float):
Zt Mean 2 gives the monthly means of the corrected reflectivity at the fixed heights of 2 km, 4 km, 6 km, and path average over 0.5^o x 0.5^o grid boxes. It ranges from 0.1 to 80 dBZ.

Conv. Zt Mean 2 (SDS, array nlath x nlonh x nh3, 4-byte float):
Conv. Zm Mean 2 gives the monthly means of the corrected reflectivity of convective rain at the fixed height levels of 2 km, 4 km, 6 km, and path average over 0.5^o x 0.5^o grid boxes. It ranges from 0.1 to 80 dBZ.

Strat. Zt Mean 2 (SDS, array nlath x nlonh x nh3, 4-byte float):
Strat. Zm Means gives the monthly means of the corrected reflectivity of stratiform rain at the fixed heights of 2 km, 4 km, 6 km, and path average over 0.5^o x 0.5^o grid boxes. It ranges from 0.1 to 80 dBZ.

Storm Height Mean (SDS, array nlath x nlonh x 3, 4-byte float):
Storm Height Mean gives the monthly means of the storm height, unconditioned and conditioned for stratiform and convective rain over 0.5^o x 0.5^o grid boxes. It has units of meters and ranges from 0 to 20,000.

BB Height Mean (SDS, array nlath x nlonh, 4-byte float):
BB Height Mean gives the monthly means of bright-band height over grid boxes of 0.5^o x 0.5^o. It has units of meters and ranges from 0 to 20,000.

surfRainMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of non-zero near-surface rain rate at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 3000.0 mm/h.

surfRainDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard Deviation of non-zero near-surface rain rate at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 3000.0 mm/h.

bbZmaxMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of maximum reflectivity in bright band at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 100.0 dBZ.

bbZmaxDev2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of maximum reflectivity in bright band at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 100.0 dBZ.

sdepthMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of snow depth at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 20,000.0 m.

sdepthDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of snow depth at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 20,000.0 m.

stormHeightDev2 (SDS, array size nlath x nlonh x 3, 4-byte float):
Standard deviation of storm height at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 20,000.0 m.

bbHeightDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of bright band height at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 20,000.0 m.

epsilonConvMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of epsilon conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 5.0 (unitless).

epsilonConvDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of epsilon conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 5.0 (unitless).

epsilonStratMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of epsilon conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 5.0(unitless).

epsilonStratDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of epsilon conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 5.0 (unitless).

epsilon0ConvMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of epsilon0 conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 5.0 (unitless).

epsilon0ConvDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of epsilon0 conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 5.0 (unitless).

epsilon0StratMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of epsilon0 conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 5.0 (unitless).

epsilon0StratDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of epsilon0 conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 5.0 (unitless).

shallowIsoRainMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of shallow isolated rain at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 3000 mm/h.

shallowIsoRainDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of shallow isolated rain at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 3000 mm/h.

shallowRainMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of shallow rain at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 3000 mm/h.

shallowRainDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of shallow rain at a horizontal resolution of 0.5 x 0.5 deg. It ranges from 0.0 to 3000 mm/h.

e_surfRainMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0mm/h.

e_surfRainDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0 mm/h.

e_surfRainConvMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) conditioned on convective rain in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0 mm/h.

e_surfRainConvDev2 (SDS, array size nlath x nlonh, 4-byte float):

Standard deviation of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) conditioned on convective rain in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0 mm/h.

e_surfRainStratMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) conditioned on stratiform rain in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0 mm/h.

e_surfRainStratDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of non-zero estimated surface rain below clutter (See 2A25 algorithm user guide) conditioned on stratiform rain in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0 mm/h.

surfRainConvMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of non-zero near-surface rain conditioned on convective rain in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0 mm/h.

surfRainConvDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of non-zero near-surface rain conditioned on convective rain in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0 mm/h.

surfRainStratMean2 (SDS, array size nlath x nlonh, 4-byte float):
Mean of non-zero near-surface rain conditioned on stratiform rain in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0 mm/h.

surfRainStratDev2 (SDS, array size nlath x nlonh, 4-byte float):
Standard deviation of non-zero near-surface rain conditioned on stratiform rain in mm/h. Over 0.5 x 0.5 deg. boxes. It ranges from 0.0 to 400.0 mm/h.

rzA2 (SDS, array size nlath x nlonh x 2, 4-byte float):
The A parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs. Computed for near-surface and 2km heights. Over 0.5 x 0.5 deg. boxes. It ranges from 0 to 1.0.

rzB2 (SDS, array size nlath x nlonh x 2, 4-byte float):
The B parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs. Computed for near-surface and 2km heights. Over 0.5 x 0.5 deg. boxes. It ranges from 0 to 1.0.

rzConvA2 (SDS, array size nlath x nlonh x 2, 4-byte float):
The A parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs conditioned on convective rain. Computed for near-surface and 2km heights. Over 0.5 x 0.5 deg. boxes. It ranges from 0 to 1.0.

rzConvB2 (SDS, array size nlath x nlonh x 2, 4-byte float):
The B parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs conditioned on convective rain. Computed for near-surface and 2km heights. Over 0.5 x 0.5 deg. boxes. It ranges from 0 to 1.0.

rzStratA2 (SDS, array size nlath x nlonh x 2, 4-byte float):
The A parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs conditioned on stratiform rain. Computed for near-surface and 2km heights. Over 0.5 x 0.5 deg. boxes. It ranges from 0 to 1.0.

rzStratB2 (SDS, array size nlath x nlonh x 2, 4-byte float):
The B parameter in rainfall-reflectivity relation R = AZ^B from fitting of instantaneous R,Z pairs conditioned on stratiform rain. Computed for near-surface and 2km heights. Over 0.5 x 0.5 deg. boxes. It ranges from 0 to 1.0.

Total Pixel Number 2 (SDS, array size nlath x nlonh, 4-byte integer):
The Total Pixel Number 2 is the number of total pixels over 0.5° x 0.5° boxes for one month. The range is 0 to 2,000,000.

Bright Band Pixel Number 2 (SDS, array size nlath x nlonh, 4-byte integer):
The number of bright band counts over each 0.5° x 0.5° box for one month. The range is 0 to 2,000,000.

surfRainPix2 (SDS, array size nlath x nlonh, 4-byte integer):
Near-surface rain counts at a horizontal resolution of 0.5° x 0.5°. It ranges from 0 to 2,000,000,000.

Rain Pixel Number 2 (SDS, array size nlath x nlonh x nh3, 4-byte integer):
The Rain Pixel Number 2 is the monthly number of non-zero rain rate pixels for path-averaged rainfall and rainfall at the fixed heights of 2 km, 4 km, 6 km, and path average over 0.5° x 0.5° boxes. The range is 0 to 2,000,000.

Conv. Rain Pixel Number 2 (SDS, array size nlath x nlonh x nh3, 4-byte integer):
The Convective Rain Pixel Number 2 is the number of non-zero rain rate pixels for convective rain at the fixed heights of of 2 km, 4 km, 6 km, and path average over 0.5°x 0.5° boxes for one month. The range is 0 to 2,000,000.

Strat. Rain Pixel Number 2 (SDS, array size nlath x nlonh x nh3, 4-byte integer):
The Stratiform Rain Pixel Number 2 is the number of non-zero rain rate pixels for stratiform rain at the fixed heights of of 2 km, 4 km, 6 km, and path average over 0.5° x 0.5° boxes for one month. The range is 0 to 2,000,000.

epsilonConvPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of epsilon conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

epsilonStratPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of epsilon conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

epsilon0ConvPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of epsilon0 conditioned on convective rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

epsilon0StratPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of epsilon0 conditioned on stratiform rain and use of 2A21 SRT at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

shallowIsoRainPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of shallow isolated rain rain at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

shallowRainPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of shallow rain rain at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

e_surfRainPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of non-zero estimated surface rain at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

e_surfRainConvPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of non-zero estimated surface rain conditioned on convective rain at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

e_surfRainStratPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of non-zero estimated surface rain conditioned on statiform rain at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

surfRainConvPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of non-zero near-surface rain conditioned convective rain at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

surfRainStratPix2 (SDS, array size nlath x nlonh, 2-byte integer):
Counts of non-zero near-surface rain conditioned statiform rain at a horizontal resolution of 0.5 x 0.5deg. It ranges from 0 to 2,000,000.

rzPix2 (SDS, array size nlath x nlonh x 2, 2-byte integer):
The number of R-Z coefficent pixel counts for near-surface and 2km heights. Over 0.5 x 0.5 deg. boxes. It ranges from 0 to 2,000,000.

rzConvPix2 (SDS, array size nlath x nlonh x 2, 2-byte integer):
The number of R-Z coefficent pixel counts conditioned on convective rain for near-surface and 2km heights. Over 0.5 x 0.5 deg. boxes. It ranges from 0 to 2,000,000.

rzStratPix2 (SDS, array size nlath x nlonh x 2, 2-byte integer):
The number of R-Z coefficent pixel counts conditioned on stratiform rain for near-surface and 2km heights. Over 0.5 x 0.5 deg. boxes. It ranges from 0 to 2,000,000.

2.2.2 3A-26 - Surface Rain

3A-26, "Surface Rain", computes the distribution of rainfall on a 5° x 5°grid on a monthly basis. The output products are calculated at three fixed heights (2, 4, and 6 km) and for the path-averaged rain rates. 3A-26 will also compute fitting parameters for cumulative probability functions of rain rate as a function of 20 rain categories and 6 thresholds. Figure 2.2.2-1 shows the structure of the 3A-26 product in terms of the component objects and their sizes.

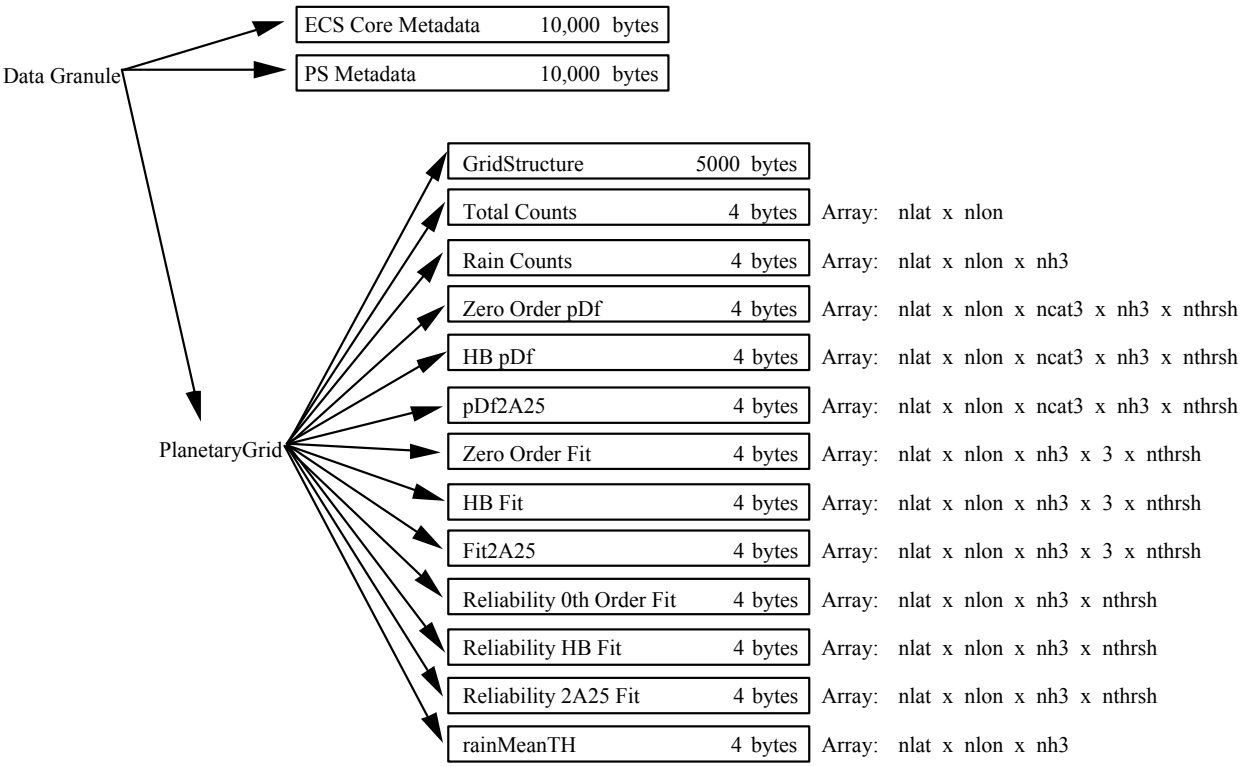

Figure 2.2.2-1
Data Format Structure for 3A-26, Surface Rainfall.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

Grid Structure (Vdata Table, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications

Total Counts (SDS, array size nlat x nlon, 4-byte integer):
This is the total number of counts (measurements) per month at each 5° x 5° box. Ranges are 0 to 2,147,483,647.

Rain Counts (SDS, array size nlat x nlon x nh3, 4-byte integer):
Total number of rain counts per month at each 5° x 5° box. This is computed at 2 km, 4 km, 6 km, and for the path-average. Ranges are 0 to 2,147,483,647.

Zero Order pDf (SDS, array size nlat x nlon x ncat3 x nh3 x nthrsh, 4-byte integer):
Probability distribution function (cumulative) in counts of the zeroth order rain rate estimate at each 5° x 5° box. The pDf is computed at 2 km, 4 km, 6 km, and for the path average. Ranges are 0 to 2,147,483,647.

HB pDf (SDS, array size nlat x nlon x ncat3 x nh3 x nthrsh, 4-byte integer):
Probability distribution function (cumulative) in counts of the Hitschfield-Bordan (HB) rain rate estimate at each 5° x 5° box. The pDf is computed at 2 km, 4 km, 6 km, and for the path average. Ranges are 0 to 2,147,483,647.

pDf2A25 (SDS, array size nlat x nlon x ncat3 x nh3 x nthrsh, 4-byte integer):
Probability distribution function (cumulative) in counts of the Surface Reference Technique (SRT) rain rate estimate at each 5° x 5° box. The pDf is computed computed at 2 km, 4 km, 6 km, and for the path average. Ranges are 0 to 2,147,483,647.

Zero Order Fit (SDS array size nlat x nlon x nh3 x 3 x nthrsh, 4-byte float):
The mean, variance and probability of rain parameters for the log-normal model obtained from the zeroth order pDf. Fitting parameters are given at 2 km, 4 km, 6 km, and for the path average. In addition, 5 thresholds are used. Ranges are **TBD**.

HB Fit (SDS array size nlat x nlon x nh3 x 3 x nthrsh, 4-byte float):
The 3 fitting parameters for the log-normal model obtained from the HB pDf. Fitting parameters are given at 2 km, 4 km, 6 km, and for the path average. In addition, 5 thresholds are used. Ranges are **TBD**.

fit2A25 (SDS array size nlat x nlon x nh3 x 3 x nthrsh, 4-byte float):
The 3 fitting parameters for the log-normal model obtained from the SRT pDf. Fitting parameters are given at 2 km, 4 km, 6 km, and for the path average and 5 thresholds. Ranges are **TBD**.

Reliability 0th Order Fit (SDS array size nlat x nlon x nh3 x nthrsh, 4-byte float):
Reliability parameter for the 0th order fit. Units and ranges are **TBD**.

Reliability HB Fit (SDS arraysize nlat x nlon x nh3 x nthrsh, 4-byte float):
Reliability parameter for the HB fit. Units and ranges are **TBD**.

Reliability 2A25 Fit (SDS array size nlat x nlon x nh3 x nthrsh, 4-byte float):
Reliability parameter for the SRT fit. Units and ranges are **TBD**.

rainMeanTH (SDS, array size nlat x nlon x nh3, 4-byte float):
The mean monthly unconditioned rain rate (mm/h) as determined from the threshold method (in particular, it is determined from the fitting parameters for the '0th-order method' using a single 'Q' threshold for each height level). Range is 0.0 to 3000.0 mm/h.

2.3 TMI AND PR COMBINED

There is one Level 3 combined algorithm for TMI and PR, 3B-31 — Rainfall Combined (PI: Dr. Christian Kummerow). The granule size is one month. The following parameters are used in describing the formats:

nlat: the number of 5° grid intervals of latitude from 40° N to 40° S (16).
nlon: the number of 5° grid intervals of longitude 180°W to 180°E (72).
nlayer: the number of profiling layers (14).

2.3.1 3B-31 - Rainfall Combined

3B-31, "Rainfall Combined", uses the high quality retrievals done for the narrow swath in 2B-31 to calibrate the wide swath retrievals generated in 2A-12. For each 5° x 5° latitude/longitude box and each vertical layer, an adjustment ratio will be calculated for the swath overlap region for one month. Figure 2.3.1-1 shows the structure of the 3B-31 product in terms of the component objects and their sizes.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications.

sfcrainTMI (SDS, array size nlat x nlon, 4-byte float):
Surface rain from 2A12 accumulated in each 5° x 5° box. It ranges from 0.0 to 3000.0 mm.

convect Rain (SDS, array size nlat x nlon, 4-byte float):
Convective surface rain from 2A12 accumulated in each 5° x 5° box. It ranges from 0.0 to 3000.0 mm.

cloudWater (SDS, array size nlat x nlon x nlayer, 4-byte float):
Monthly mean cloud water from 2A12 at each vertical layer in each 5° x 5° box. It ranges from 0.0 to 10.0 g m^{-3}.

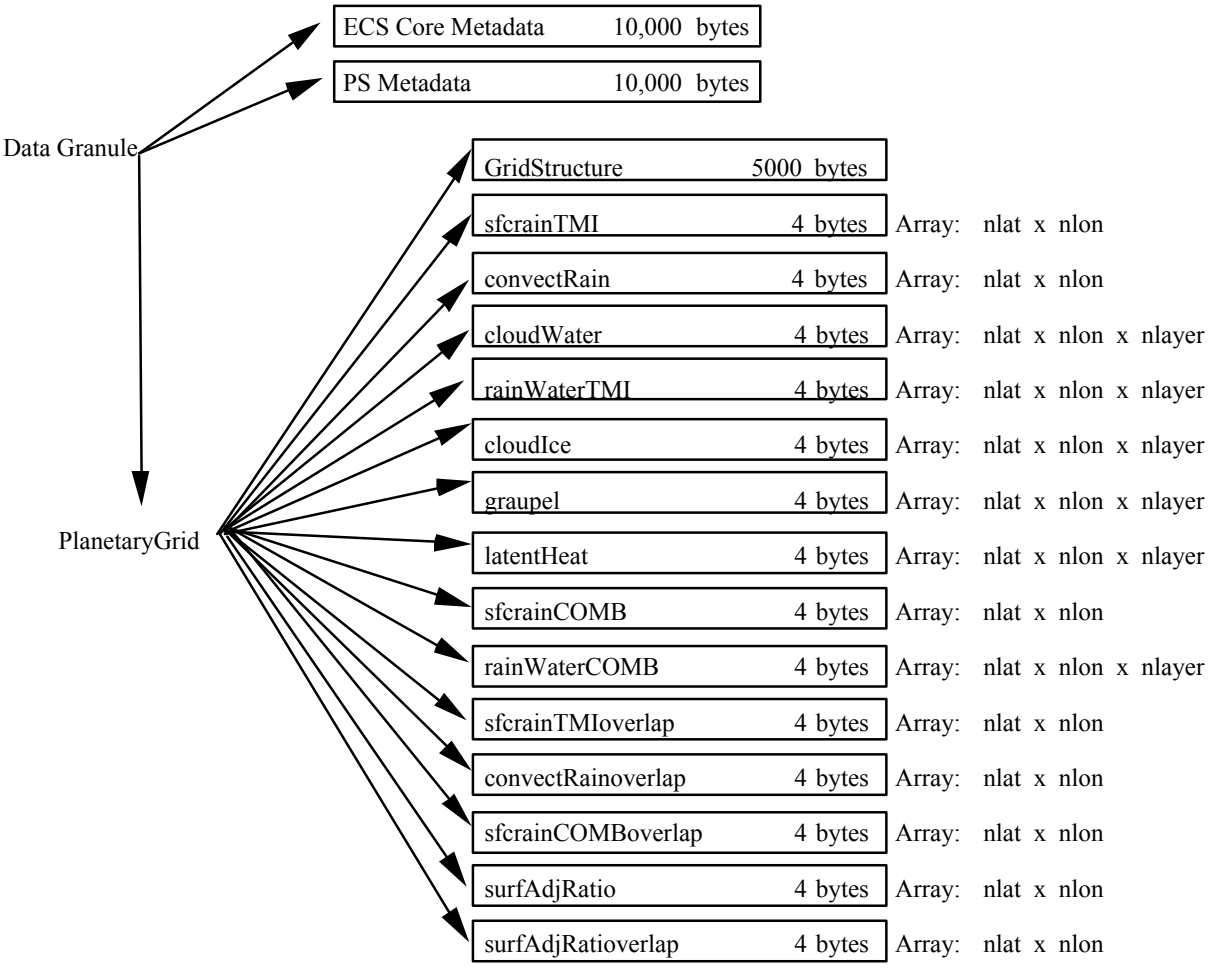

Figure 2.3.1-1
Data Format Structure for 3B-31, Rainfall Combined.

rainWaterTMI (SDS, array size nlat x nlon x nlayer, 4-byte float):
Monthly mean rain water from 2A12 at each vertical layer in each 5° x 5° box. It ranges from 0.0 to 10.0 g m^{-3}.

cloudIce (SDS, array size nlat x nlon x nlayer, 4-byte float):
Monthly mean cloud ice from 2A12 at each vertical layer in each 5° x 5° box. It ranges from 0.0 to 10.0 g m^{-3}.

graupel (SDS, array size nlat x nlon x nlayer, 4-byte float):
Monthly mean graupel from 2A12 at each vertical layer in each 5° x 5°. It ranges from 0.0 to 10.0 g m^{-3}.

latentHeat (SDS, array size nlat x nlon x nlayer, 4-byte float):
Monthly mean latent heating from 2A12 at each vertical layer in each 5° x 5° box. It ranges from -256 deg/hour to 256 deg/hour.

sfcrainCOMB (SDS, array size nlat x nlon, 4-byte float):
Surface rain from 2B31 accumulated in each 5° x 5° box. It ranges from 0.0 to 3000.0 mm.

rainWaterCOMB (SDS, array size nlat x nlon x nlayer, 4-byte float):
Rain water at each vertical layer from 2B31 accumulated in each 5° x 5° box. It ranges from 0.0 to 10.0 g m^{-3}.

sfcrainTMIoverlap (SDS, array size nlat x nlon, 4-byte float):
Surface rain from 2A12 where 2A12 and 2B31 overlap accumulated in each 5° x 5° box. It ranges from 0.0 to 3000.0 mm.

convectRainoverlap (SDS, array size nlat x nlon, 4-byte float):
Convective surface rain from 2A12 where 2A12 and 2B31 overlap accumulated in each 5° x 5° box. It ranges from 0.0 to 3000.0 mm.

sfcrainCOMBoverlap (SDS, array size nlat x nlon, 4-byte float):
Surface rain from 2B31 where 2A12 and 2B31 overlap accumulated in each 5° x 5° box. It ranges from 0.0 to 3000.0 mm.

surfAdjRatio (SDS, array size nlat x nlon, 4-byte float):
The ratio of 2B31 to 2A12 surface rainfall, calculated from the swath overlap region for each 5° x 5° box.

surfAdjRatioverlap (SDS, array size nlat x nlon, 4-byte float):
The ratio of 2B31 to 2A12 surface rainfall, calculated from the swath overlap region for each 5° x 5° box.

2.4 TRMM AND OTHERS COMBINED

There are two TRMM and Others Combined algorithms, 3B-42 — TRMM and Others-GPI Calibration (PI: Dr. Robert Adler and Dr. George Huffman), and 3B-43 — TRMM and Others Data Sources (PI: Dr. Robert Adler and Dr. George Huffman). The granule size is 3 hours for 3B-42 and one month for 3B-43. The following parameters are used in describing the formats:

nlat: the number of 0.25° grid intervals of latitude from 50° N to 50° S (400).

nlon: the number of 0.25° grid intervals of longitude 180°W to 180°E (1440).

2.4.1 3B-42 - TRMM and Others GPI Calibration

3B-42, "TRMM and Others GPI Calibration", provides precipitation estimates in the TRMM regions that have the (nearly-zero) bias of the "TRMM Combined Instrument" precipitation estimate and the dense sampling of geosynchronous IR imagery. Figure 2.4.1-1 shows the structure of the 3B-42 product in terms of the component objects and their sizes.

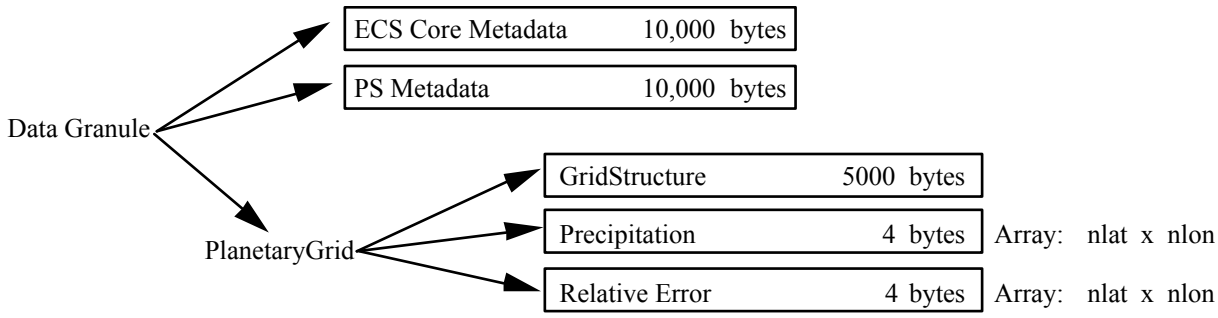

Figure 2.4.1-1
Data Format Structure for 3B-42, TRMM and Others GPI Calibration

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications

Precipitation (SDS, array size nlat x nlon, 4-byte float):
This is the adjusted GPI precipitation estimate at each 0.25° x 0.25° box. It ranges from 0.0 to 3.5 mm/hr.

Relative Error (SDS, array size nlat x nlon, 4-byte float):
This is the adjusted GPI relative error estimate at each 0.25° x 0.25° box. It ranges from 0.0 to 3.5 mm/hr.

2.4.2 3B-43 - TRMM and Others Data Sources

3B-43, "TRMM and Others Data Sources", provides a "best" precipitation estimate in the TRMM region from all global data sources, namely TRMM, geosynchronous IR, and rain gauges. Figure 2.4.2-1 shows the structure of the 3B-43 product in terms of the component objects and their sizes.

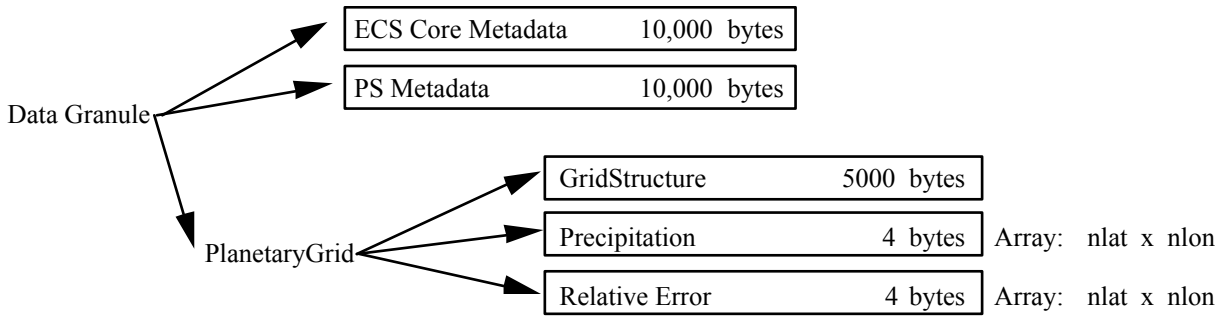

Figure 2.4.2-1
Data Format Structure for 3B-43, TRMM and Other Data Sources

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications

Precipitation (SDS, array size nlat x nlon, 4-byte float):
This is the satellite/gauge precipitation estimate at each 0.25° x 0.25° box for one month. It ranges from 0.0 to 3.5 mm/hr.

Relative Error (SDS, array size nlat x nlon, 4-byte float):
This is the satellite/gauge relative error estimate at each 0.25° x 0.25° box for one month. It ranges from 0.0 to 3.5 mm/hr.

2.5 GV RADAR

There are three Level 3A products for GV radar, 3A-53 — 5-Day Site Rainfall Map (Contact: Dr. Michael Biggerstaff), 3A-54 — Site Rainfall Map (Contact: Dr. Michael Biggerstaff) and 3A-55 — Monthly 3-D Structure (Contact: Dr. Michael Biggerstaff). The formats of these products are based on the Version 1 algorithm descriptions and consultation with GV radar algorithm scientists. The granule size is 5 days for 3A-53 and one month for 3A-54 and 3A-55. The following parameters are used in describing the format:

nx_prod: the number of points in the x-dimension of a 3-D Cartesian grid; 151 for single radar sites; 363 for the multiple radar site in Texas and 257 for Florida multiple radar site;

ny_prod: the number of points in the y-dimension of a 3-D Cartesian grid; 151 for single radar sites; 285 for the multiple radar site in Texas and 353 for Florida multiple radar site;

nz: the number of grid points in the z-dimension of a 3-D Cartesian grid; 13 for both single and multiple radar sites;

ncat: the number of categories for computing CFADs and vertical profiles. There are totally 12 categories (eg., stratiform precipitation, convective precipitation, water surface, and land, etc.) that are enumerated in each section where applicable;

nbin: the maximum number of reflectivity bins; this is 86 which will allow a reflectivity range of -15 to 70 dBZ incremented by 1 dBZ.

2.5.1 3A-53 - 5-Day Site Rain Map

3A-53, "5-Day Site Rain Map", is a map of 5-day surface rain totals derived from the instantaneous rain rate maps (2A-53). The map is in Cartesian coordinates with a 2 km horizontal resolution. It covers an area of 300km x 300km at single radar sites while the area differs for the multiple radar sites - 724 km x 568 km at the Texas site and 512 km x 704 km at Florida site. It should be noted that this is not a simple accumulation of the instantaneous maps as gaps in the data must be factored into the calculation. Figure 2.5.1-1 shows the structure of the 3A-53 product in terms of the component objects and their sizes.

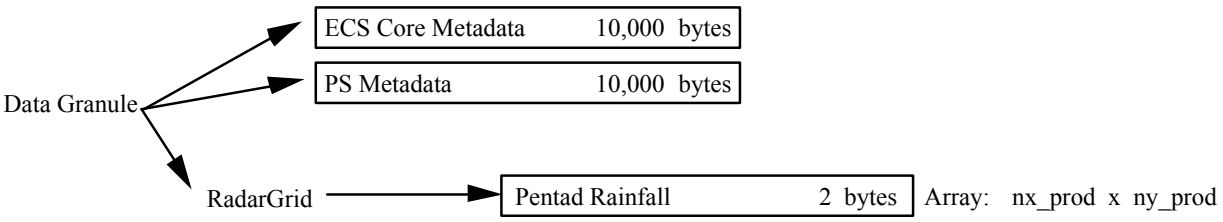

Figure 2.5.1-1
Data Format Structure for 3A-53, 5-Day Site Rain Map

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

Pentad Rainfall (SDS, array size nx_prod x ny_prod, 2-byte integer):
Pentad Rainfall is a map of the 5-day rainfall totals as derived from the instantaneous rain rate maps. The maps are in Cartesian coordinates with a 2 km horizontal resolution. They cover a region of 300km x 300km at single radar sites while the covered area differs for the multiple radar sites (i.e., 724 km x 568 km at Texas site and 512 km x 704 km at Florida site). As mentioned previously, this is not a simple accumulation of the instantaneous maps due to the presence of gaps in the data. The method used to handle the gaps is still **TBD**. The rainfall ranges from 0.0 to 5,000.0 mm. It is multiplied by 10 and stored as a 2-byte integer.

2.5.2 3A-54 - Site Rainfall Map

3A-54, "Site Rainfall Map", is a map of monthly surface rain totals derived from the instantaneous rain rate maps (2A-53). The map is in Cartesian coordinates with a 2 km horizontal resolution and covers an area of 300km x 300km at single radar sites while the covered area varies for multiple radar sites - 724 km x 568 km at Texas site and 512 km x 704 km at Florida site. This monthly rainfall map is not a simple accumulation of the instantaneous maps as gaps in the data must be factored into the calculation. Figure 2.5.2-1 shows the structure of the 3A-54 product in terms of the component objects and their sizes.

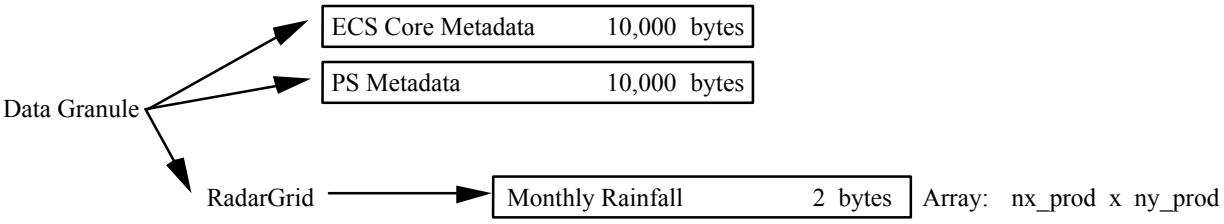

Figure 2.5.2-1
Data Format Structure for 3A-54, Site Rainfall Map.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

Monthly Rainfall (SDS, array size nx_prod x ny_prod, 2-byte integer):
Monthly Rainfall is a map of the monthly rainfall totals as derived from the instantaneous rain rate maps. The maps are in Cartesian coordinates with a 2 km horizontal resolution and cover an area of 300 km x 300 km at single radar sites, 724 km x 568 km at Texas multiple radar site and 512 km x 704 km at Florida multiple radar site. This monthly rainfall map is not a simple accumulation of the instantaneous maps due to the presence of gaps in the data. The method used to handle the gaps is still **TBD**. The rainfall ranges from 0 to 10,000 mm.

2.5.3 3A-55 - Monthly 3-D Structure

3A-55, "Monthly 3-D Structure", provides radar site monthly 3-D structure information obtained from 2A-55. Figure 2.5.3-1 shows the structure of the 3A-55 product in terms of the component objects and their sizes.

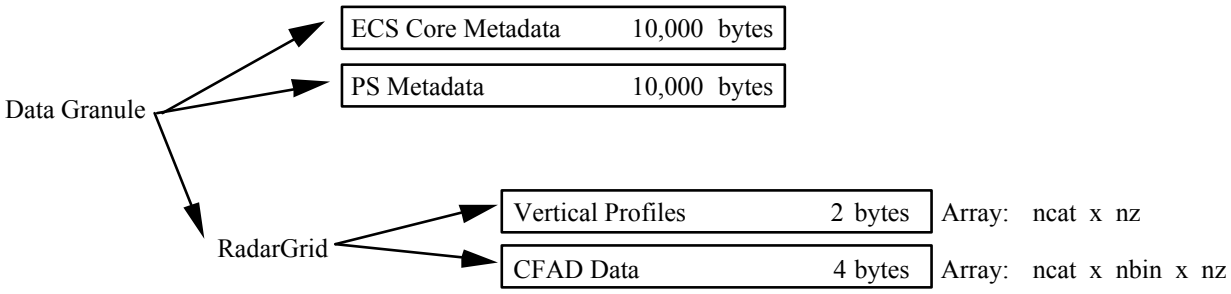

Figure 2.5.3-1
Data Format Structure for 3A-55, Monthly 3-D Structure.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

Vertical Profiles (SDS, array size ncat x nz, 2-byte integer):
The vertical profiles are computed at each analysis level for a month for the following categories:

1) total;
2) total over land;
3) total over sea;
4) convective;
5) convective over land;
6) convective over sea;
7) stratiform;
8) stratiform over land;
9) stratiform over sea;
10) "anvil" (Anvil is defined as echo aloft with no contribution to surface rain.);
11) "anvil" over land;
12) "anvil" over sea.

Values range from -15.00 to 70.00 dBZ and are multiplied by 100 and stored as 2-byte integers.

CFAD Data (SDS, array size ncat x nbin x nz, 4-byte integer):
The CFAD Data are the number of pixels counted in specified height-reflectivity bin pairs for the 12 categories listed below for a month of radar data. Values range from 0 to 68,403,000 (3,000 radar volumes/month x 151 x 151) for single radar sites and from 0 to 310,365,000 (3,000 x 363 x 285) for Texas multiple radar site, from 0 to 272,163,000 (3,000 x 257 x 353) for Florida multiple radar site. The 12 categories are:

1) total;
2) total over land;
3) total over sea;
4) convective;
5) convective over land;
6) convective over sea;
7) stratiform;
8) stratiform over land;
9) stratiform over sea;
10) "anvil" (Anvil is defined as echo aloft with no contribution to surface rain.);
11) "anvil" over land;
12) "anvil" over sea.

2.6 OTHER VALIDATION DATA

There are 4 other Level 3 validation data products. Of those, only 3A-46 — SSM/I Rain (PI: Dr. Robert Adler, Dr. George Huffman) will be used by TSDIS for data processing. The granule size is one month. The following parameters are used in describing the formats:

nlat: the number of 1.0° grid intervals of latitude from 90° N to 90° S (180).

nlon: the number of 1.0° grid intervals of longitude (360).

2.6.1 3A-46 - SSM/I Rain

3A-46, "SSM/I Rain", produces a 1.0° x 1.0° monthly rainfall map using SSM/I data. Figure 2.6.1-1 shows the structure of the 3A-46 product in terms of the component objects and sizes.

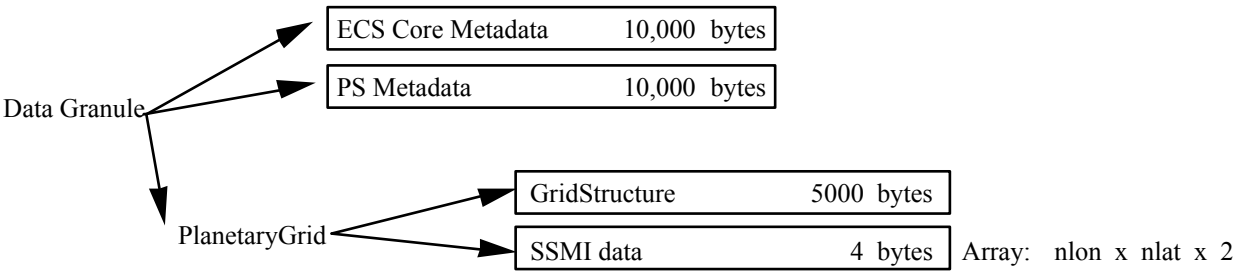

Figure 2.6.1-1
Data Format Structure for 3A-46, SSM/I Rain.

The contents of objects in the structure are as follows:

ECS Core Metadata (Attribute, 10,000-byte character):
ECS Core Metadata are metadata useful to most products stored at EOSDIS. See Section 1 in Volume 6 of ICS, Metadata for TRMM Products.

PS Metadata (Attribute, 10,000-byte character):
Product Specific Metadata are metadata defined by and specific to TSDIS. See Section 2 in Volume 6 of ICS, Metadata for TRMM Products.

GridStructure (Attribute, 5000-byte character):
GridStructure gives the specification of the geometry of the grids. See Section 2 in Volume 3 of ICS, Level 1 File Specifications. Exceptions to the values in Section 2 are noted in Table 2.6.1-1.

Table 2.6.1-1
3A-46 GridStructure Fields

Name	Value
Latitude Resolution	1
Longitude Resolution	1
North Bounding Coordinate	90
South Bounding Coordinate	-90
West Bounding Coordinate	0
East Bounding Coordinate	360
Origin	"NORTHWEST"

SSMIdata (SDS, array size nlon x nlat x 2, 4-byte float):
SSMI data averaged over 1° x 1° grid boxes and one month. The first variable is Precipitation Rate (mm/hr); the range is 0 to 100. The second variable is Number of Observations; the range is 0 to one billion. Note that the grids in SSMIdata are different than the standard TSDIS grids in the following ways:

1) The longitude dimension precedes the latitude dimension.
2) The longitude index begins at the Greenwich meridian.
3) The latitude index begins at the northernmost row.
4) The latitude range is -90 to +90.

3. ACRONYMS

C

CA	Closest Approach
CAMS	Climate Assessment and Monitoring System
CFAD	Contoured Frequency by Altitude Diagram

D

DMSP	Defense Meteorological Satellite Program

E

ECS	EOSDIS Core System
EOSDIS	Earth Observing System Data and Information System

F

FOV	Field of View

G

GOES	Geostationary Operational Environmental Satellite
GPCC	Global Precipitation Climatological Center
GPCP	Global Precipitation Climatological Project
GPI	GOES Precipitation Index
GV	Ground Validation

H

HB	Hitschfeld Bordan Technique

I

ICS	Interface Control Specification
IFOV	Instantaneous Field of View

N

NUBF	Non-Uniform Beam Filling

P

PI	Principal Investigator
PIA	Path Integrated Attenuation
PR	Precipitation Radar
PS	Product Specific

R

RR	Rain Rate

S

SDS	Science Data Set
SRT	Surface Reference Technique
SSM/I	Special Sensor Microwave/Imager

T

TBD	To Be Determined
TMI	TRMM Microwave Imager
TRMM	Tropical Rainfall Measuring Mission
TSDIS	TRMM Science Data and Information System
TSU	TSDIS Science Users

U

UTC	Universal Time Coordinated

V

VIRS	Visible and Infrared Scanner

4. GLOSSARY

Convective rain	Precipitation from a convective cloud with extensive vertical development.
Disdrometer	Equipment designed to measure and record the size distribution of raindrops.
Earth Ellipsoid	An imaginary surface of the earth in the shape of an ellipsoid that coincides with the Mean Sea Level.
Geoid	An imaginary surface of the earth that coincides with Mean Sea Level over oceans and is extended through continents.
Granule	The amount of information contained in one data file (e.g., one orbit for some satellite data or one hour for some ground validation data).
Graupel	Compact precipitating ice, smaller than hail.
Isotherm	A contour of equal or constant temperature.
Metadata	Information which describes a data set (e.g., date recorded, source, or purpose).
Nadir	The point on the earth directly below the satellite.
Planetary Grid Structure	An EOSDIS defined structure in HDF to store data organized in one of the planetary grids defined by EOSDIS.
Radar Grid Structure	A user defined structure in HDF to store data organized in a grid with constant distance spacing on the surface of the earth.
Radar Structure	A user defined structure in HDF to store data organized in original ground radar spherical geometry.
Scan	A single sweep of a sensor onboard a satellite
Stratiform rain	Precipitation from a stratiform cloud with extensive horizontal development.
Swath Structure	An EOSDIS defined structure in HDF to store data organized by scans.
Vdata	An HDF object that is a table of records.

Vgroup	An HDF group of objects or other Vgroups.
Z-R relationship	A relationship between radar reflectivity (Z in mm^6/m^3) and rain rate (R in mm/hr)