GLOBAL PRECIPITATION MEASUREMENT
PRECIPITATION PROCESSING SYSTEM

File Specification
2AKu

Preliminary Version

November 6, 2016

0.1 2AKu - Ku precipitation

The Ku Level-2A product, 2AKu, "Ku precipitation," is written as a 1 swath structure. The swath is NS, normal scans. The following sections describe the structure and contents of the format.

Dimension definitions:

nscan	var	Number of scans in the granule.
nray	49	Number of angle bins in each NS scan.
nrayMS	25	Number of angle bins in each MS scan.
nrayHS	24	Number of angle bins in each HS scan.
nbin	176	Number of range bins in each NS and MS ray. Bin interval is 125 m. 0 is at the top. 175 is the bin of the earth ellipsoid.
nbinSZP	7	Number of range bins for sigmaZeroProfile.
nNP	4	Number of NP kinds.
nearFar	2	Near reference, Far reference.
foreBack	2	Foreward, Backward.
method	6	Number of SRT methods.
nNode	5	Number of binNode.
nDSD	2	Number of DSD parameters. Parameters are dBNw and Dm (mm).
LS	2	Liquid, solid.
nNUBF	3	Number of NUBF parameters.

Figure 1 through Figure 12 show the structure of this product. The text below describes the contents of objects in the structure, the C Structure Header File and the Fortran Structure Header File.

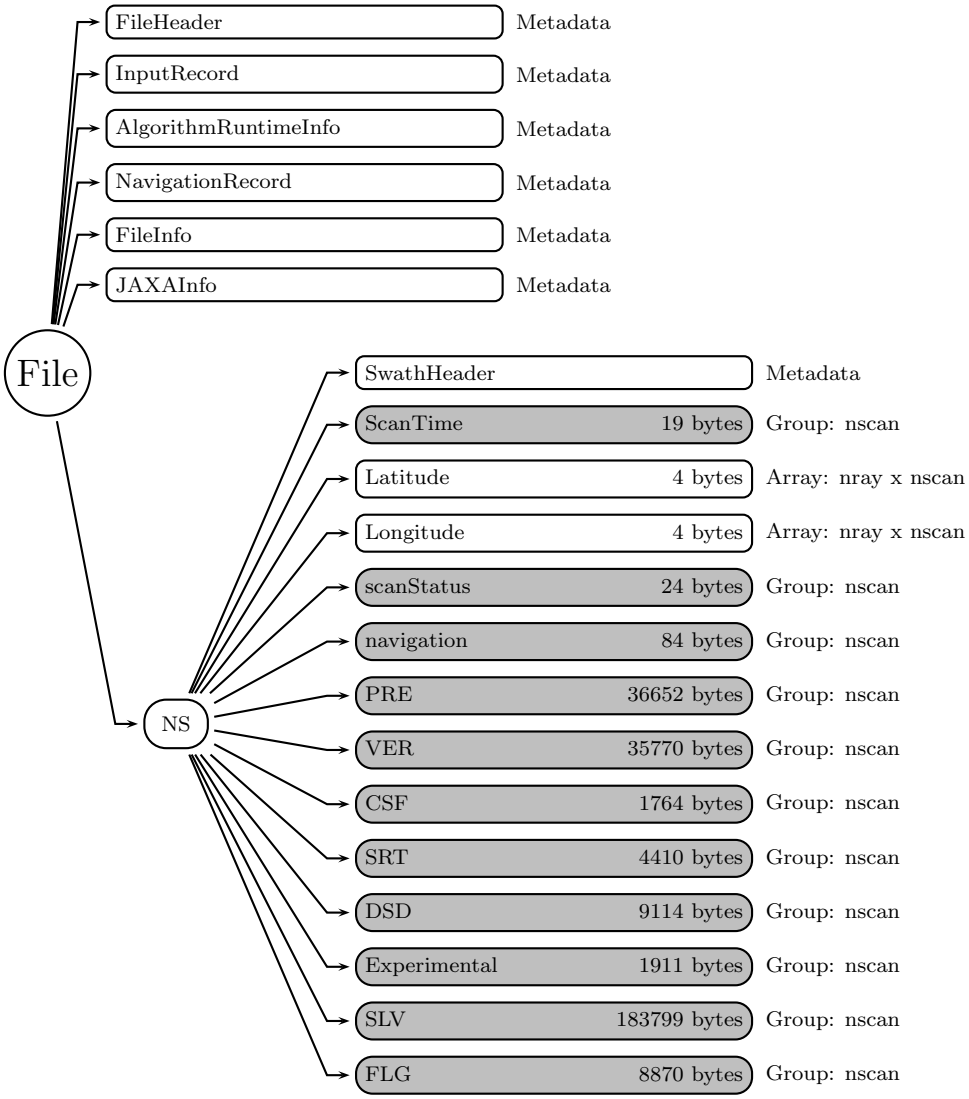

Figure 1: Data Format Structure for 2AKu, Ku precipitation

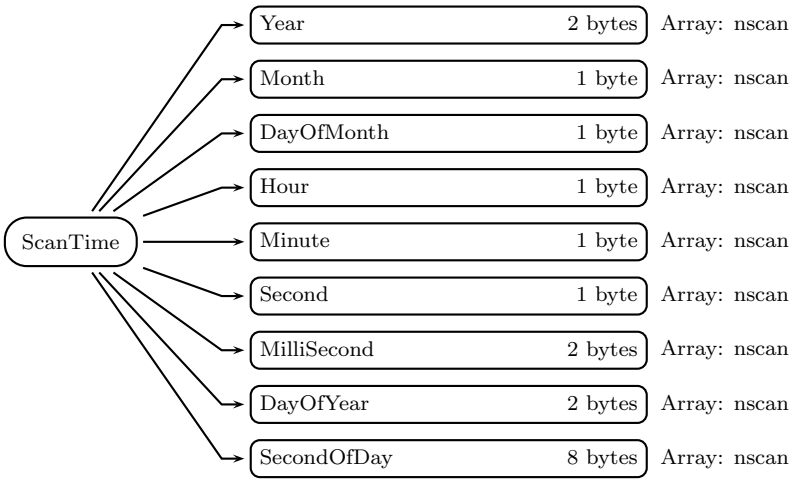

Figure 2: Data Format Structure for 2AKu, ScanTime

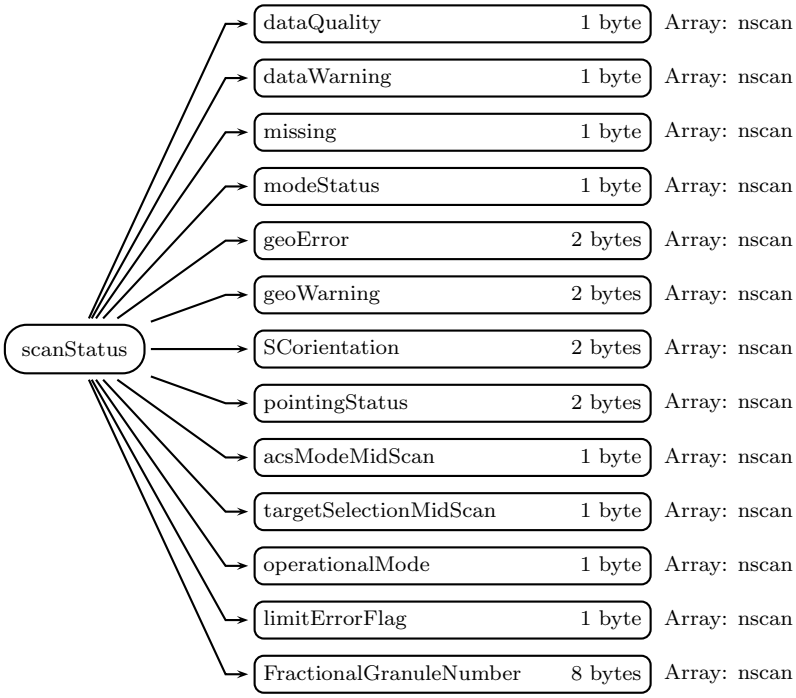

Figure 3: Data Format Structure for 2AKu, scanStatus

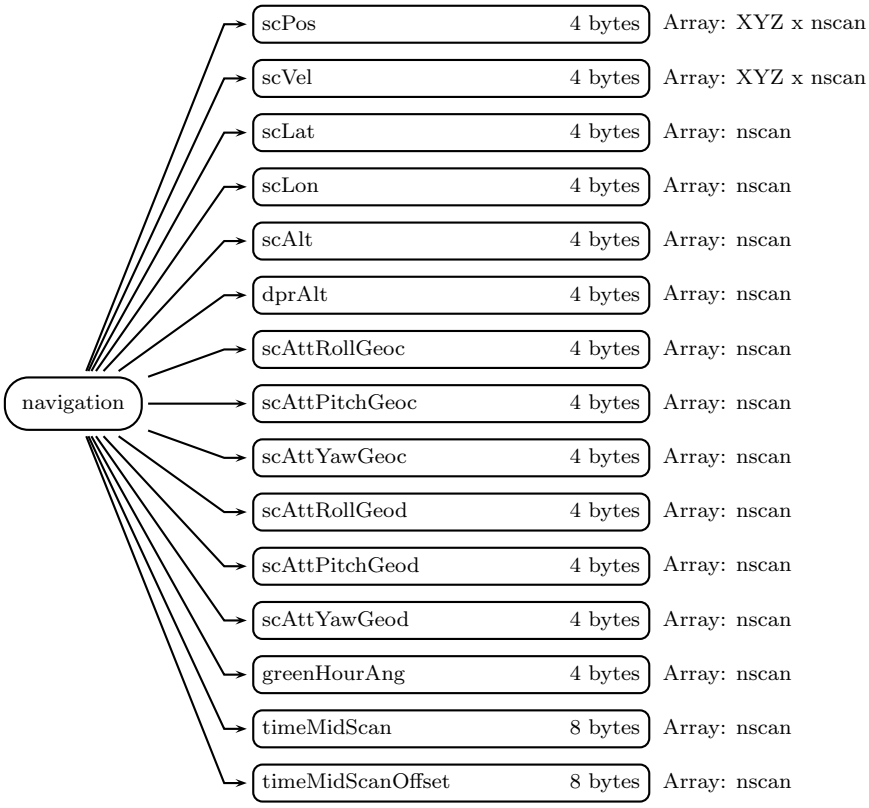

Figure 4: Data Format Structure for 2AKu, navigation

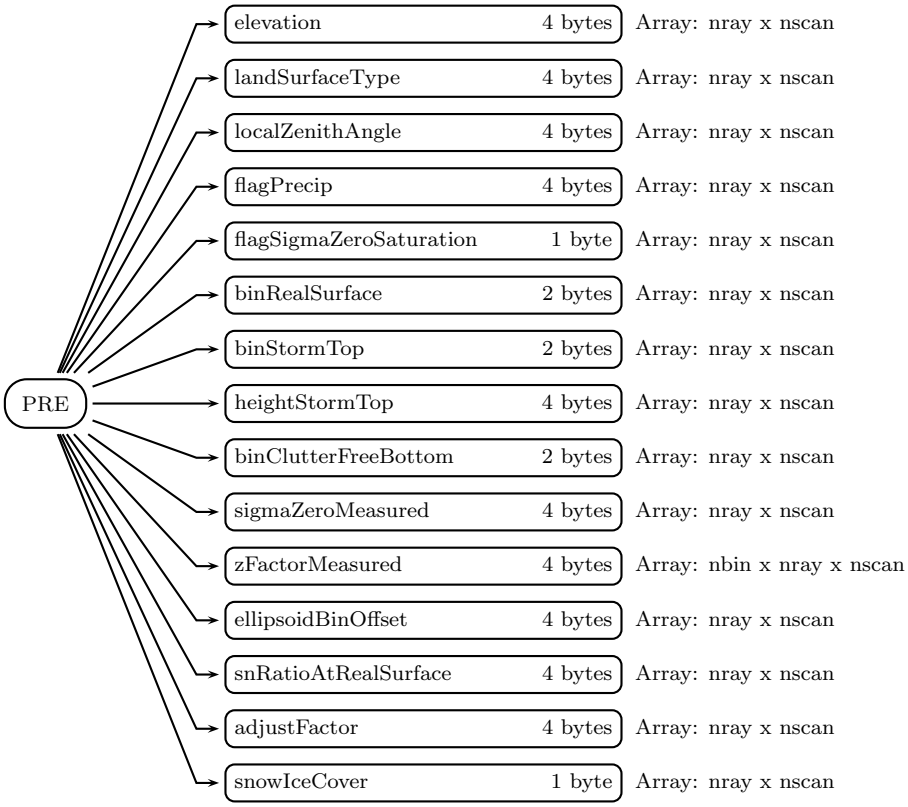

Figure 5: Data Format Structure for 2AKu, PRE

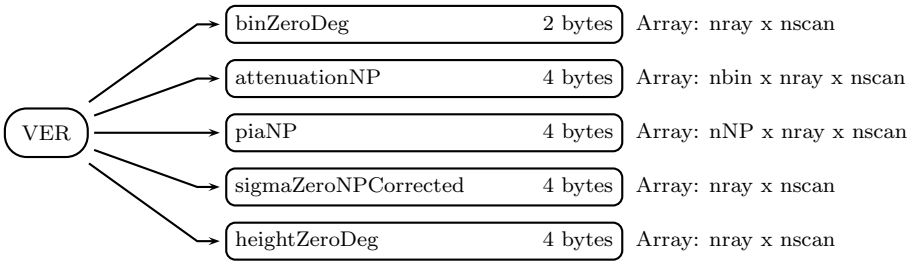

Figure 6: Data Format Structure for 2AKu, VER

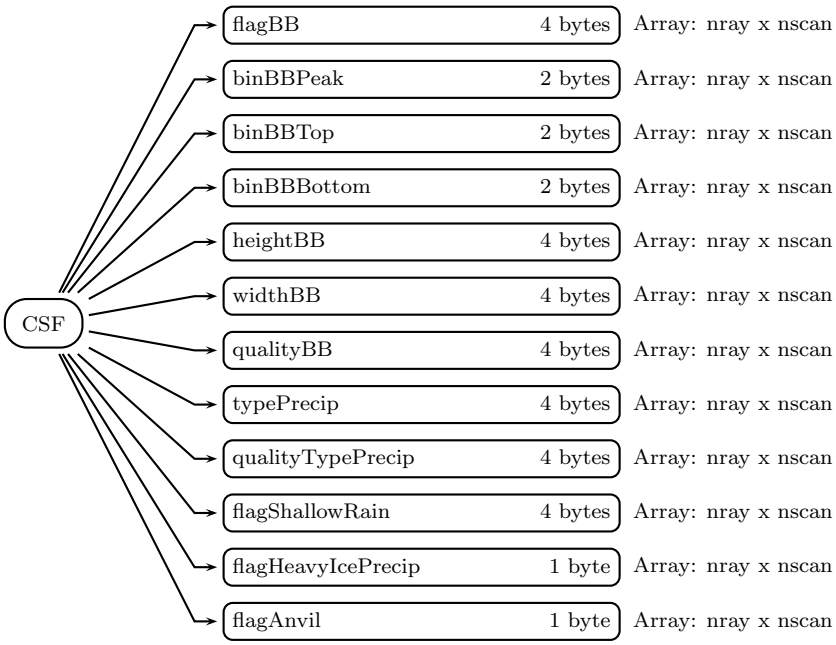

Figure 7: Data Format Structure for 2AKu, CSF

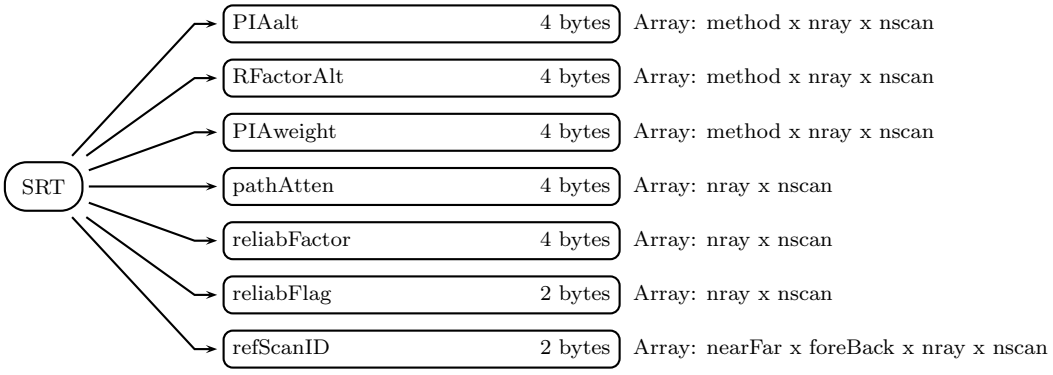

Figure 8: Data Format Structure for 2AKu, SRT

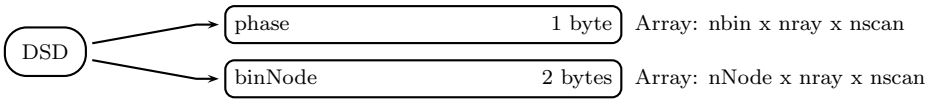

Figure 9: Data Format Structure for 2AKu, DSD

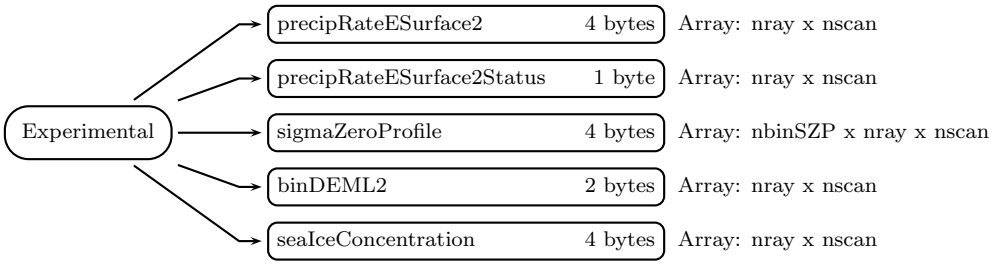

Figure 10: Data Format Structure for 2AKu, Experimental

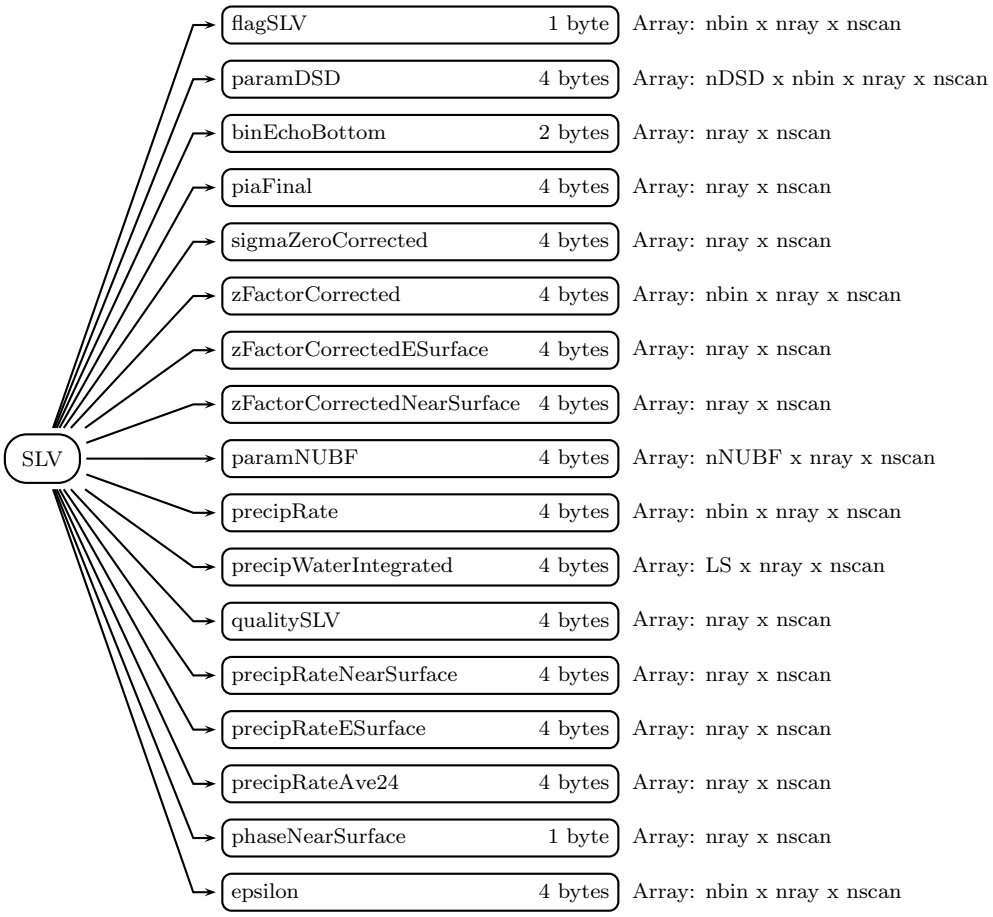

Figure 11: Data Format Structure for 2AKu, SLV

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

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

AlgorithmRuntimeInfo (Metadata):
AlgorithmRuntimeInfo contains text runtime information written by the algorithm. See Metadata for GPM Products for details.

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

FileInfo (Metadata):

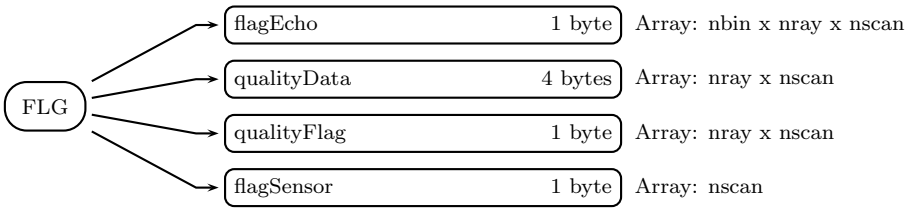

Figure 12: Data Format Structure for 2AKu, FLG

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

JAXAInfo (Metadata):
JAXAInfo contains metadata requested by JAXA. Used by DPR algorithms and GSMaP. See Metadata for GPM Products for details.

NS (Swath)

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

ScanTime (Group)

A UTC time associated with the scan.

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

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

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

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

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

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

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

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

SecondOfDay (8-byte float, array size: nscan):
A time associated with the scan. scanTime_sec is expressed as the UTC seconds of the day. Values range from 0 to 86400 s. Special values are defined as:
-9999.9 Missing value

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

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

scanStatus (Group)

dataQuality (1-byte integer, array size: nscan):
A summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher precipitation processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i).

```
Bit Meaning if bit = 1
0   missing
5   geoError is not zero
6   modeStatus is not zero
```

dataWarning (1-byte integer, array size: nscan):
Flag of data warning for each scan.

```
Bit Meaning if bit = 1
0   Beam matching is abnormal
1   VPRF table is abnormal
2   Surface table is abnormal
3   geoWarning is not zero
4   Operational mode is not observation mode
5   GPS status is abnormal
6   Spare (always 0)
7   Check sum of L1A is abnormal
```

missing (1-byte integer, array size: nscan):
Indicates whether information is contained in the scan data. The values are:

```
Bit Meaning if bit = 1
0   Scan is missing
1   Science telemetry packet missing
2   Science telemetry segment within packet missing
3   Science telemetry other missing
4   Housekeeping (HK) telemetry packet missing
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

modeStatus (1-byte integer, array size: nscan):
A summary of status modes. If all status modes are routine, all bits in modeStatus = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. modeStatus does not assess geolocation quality. modeStatus is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow:

```
Bit Meaning if bit = 1
0   Spare (always 0)
1   SCorientation not 0 or 180
2   pointingStatus not 0
3   Non-routine limitErrorFlag
4   Non-routine operationalMode (not 1 or 11)
5   Spare (always 0)
6   Spare (always 0)
7   Spare (always 0)
```

geoError (2-byte integer, array size: nscan):
A summary of geolocation errors in the scan. geoError is used to set a bit in dataQuality. A zero integer value of geoError indicates 'good' geolocation. A non-zero value broken

down into the bit flags below indicates the specified reason, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i).

Bits 0, 4, 5, 8 and 9 are per pixel error flags. If the number of bad pixels (for any of the reasons specified by these flags) is greater than the threshold then bit 7 = 1 and each of these flags is set to 1 if any pixel is bad for that reason. At launch this threshold is zero, so data is flagged if any pixel is bad. If the number of bad pixels is less than or equal to the threshold then bit 7 = 0 and all of these flags are also 0.

```
Bit Meaning if bit = 1
0   Latitude limit exceeded for viewed pixel locations
1   Negative scan time, invalid input
2   Error getting spacecraft attitude at scan mid-time
3   Error getting spacecraft ephemeris at scan mid-time
4   Invalid input non-unit ray vector for any pixel
5   Ray misses Earth for any pixel with normal pointing
6   Nadir calculation error for subsatellite position
7   Pixel count with geolocation error over threshold
8   Error in getting spacecraft attitude for any pixel
9   Error in getting spacecraft ephemeris for any pixel
10  Spare (always 0)
11  Spare (always 0)
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

geoWarning (2-byte integer, array size: nscan):
A summary of geolocation warnings in the scan. geoWarning does not set a bit in dataQuality. Warnings indicate unusual conditions. These conditions do not indicate bad geolocation but are flagged as a warning that further review of the data may be useful. A zero integer value indicates usual geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i):

```
Bit Meaning if bit = 1
0   Ephemeris Gap Interpolated
1   Attitude Gap Interpolated
2   Attitude jump/discontinuity
3   Attitude out of range
4   Anomalous Time Step
5   GHA not calculated due to error
6   SunData (Group) not calculated due to error
```

```
7   Failure to calculate Sun in inertial coordinates
8   Fallback to GES ephemeris
9   Fallback to GEONS ephemeris
10  Fallback to PVT ephemeris
11  Fallback to OBP ephemeris
12  Spare (always 0)
13  Spare (always 0)
14  Spare (always 0)
15  Spare (always 0)
```

SCorientation (2-byte integer, array size: nscan):
The positive angle of the spacecraft vector (v) from the satellite forward direction of motion, measured clockwise facing down. We define v in the same direction as the spacecraft axis +X, which is also the center of the GMI scan. If SCorientation is not 0 or 180, a bit is set to 1 in modeStatus.

```
Value Meaning
0     +X forward (yaw 0)
180   -X forward (yaw 180)
-8000 Non-nominal pointing
-9999 Missing
```

pointingStatus (2-byte integer, array size: nscan):
pointingStatus is provided by the geo Toolkit. A value of zero means the pointing is good. Non-zero values indicate non-nominal pointing. If pointingStatus is non-zero, a bit in modeStatus is set to 1.

```
Value Meaning
0     Nominal pointing in Mission Science Mode
1     GPS point solution stale and PVT ephemeris used
2     GEONS solution stale and GEONS ephemeris used
-8000 Non-nominal mission science orientation
-9999 Missing
```

acsModeMidScan (1-byte integer, array size: nscan):
acsModeMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     LAUNCH
1     RATENULL
2     SUNPOINT
3     GSPM (Gyro-less Sun Point)
4     MSM (Mission Science Mode)
```

```
5     SLEW
6     DELTAH
7     DELTAV
-99   UNKNOWN -- ACS mode unavailable
```

targetSelectionMidScan (1-byte integer, array size: nscan):
targetSelectionMidScan is provided by the geo Toolkit as taken from Attitude Control System telemetry and is provided in this format for information only.

```
Value Meaning
0     S/C Z axis nadir, +X in flight direction
1     Flight Z axis nadir, +X in flight direction
2     S/C Z axis nadir, -X in flight direction
3     Flight Z axis nadir, -X in flight direction
4     +90 yaw for DPR antenna pattern calibration
5     -90 yaw for DPR antenna pattern calibration
-99   Missing
```

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

```
The operational mode of KuPR/KaPR stored in science telemetry.
operationalMode is used in modeStatus. The range is 1 to 20.

Value Meaning
1     Ku/Ka Observation
2     Ku/Ka External Calibration
3     Ku/Ka Internal Calibration
4     Ku/Ka SSPA Analysis
5     Ku/Ka LNA Analysis
6     Ku/Ka Health-Check
7     Ku/Ka Standby VPRF Table OUT
8     Ku/Ka Standby Phase Out
9     Ku/Ka Standby Dump Out
10    Ku/Ka Standby (No Science Data)
11    Ku/Ka Independent Observation
12    Ku/Ka Independent External Calibration
13    Ku/Ka Independent Internal Calibration
14    Ku/Ka Independent SSPA Analysis
15    Ku/Ka Independent LNA Analysis
16    Ku/Ka Independent Health-Check
17    Ku/Ka Independent Standby VPRF Table OUT
18    Ku/Ka Independent Standby Phase Out
19    Ku/Ka Independent Standby Dump Out
20    Ku/Ka Independent Standby (No Science Data)
```

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

```
Bit flags for every ray with information
about echo power limit checks.
limitErrorFlag may be used in modeStatus.
Detailed information is defined in
L1B Product Format edited by JAXA/EORC.
```

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

navigation (Group)

scPos (4-byte float, array size: XYZ x nscan):
The position vector(m) of the spacecraft in Earth-Centered Earth Fixed (ECEF) Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). Values range from -10000000 to 10000000 m. Special values are defined as:
-9999.9 Missing value

scVel (4-byte float, array size: XYZ x nscan):
The velocity vector (ms^{-1}) of the spacecraft in ECEF Coordinates at the Scan mid-Time. Values range from -10000000 to 10000000 m/s. Special values are defined as:
-9999.9 Missing value

scLat (4-byte float, array size: nscan):
The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -70 to 70 degrees. Special values are defined as:
-9999.9 Missing value

scLon (4-byte float, array size: nscan):
The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAlt (4-byte float, array size: nscan):
The altitude (m) of the spacecraft above the Earth Ellipsiod at the Scan mid-Time. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

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

DPR science telemetry. This is empty in non-DPR products. Values range from 350000 to 500000 m. Special values are defined as:
-9999.9 Missing value

scAttRollGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Orbital Coordinates to the spacecraft body coordinates. Orbital Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geocentric nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Note this is geocentric, not geodetic, referenced, so that pitch and roll will have twice orbital frequency components due to the onboard control system following the oblate geodetic Earth horizon. Note also that the yaw value will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeoc (4-byte float, array size: nscan):
The geocentric satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

scAttRollGeod (4-byte float, array size: nscan):
The geodetic satellite attitude Euler roll angle (degrees) at the Scan mid-Time. The order of the components in the file is roll, pitch, and yaw. However, the angles are computed using a 3-2-1 Euler rotation sequence representing the rotation order yaw, pitch, and roll for the rotation from Geodetic Coordinates to the spacecraft body coordinates. Geodetic Coordinates represent an orthogonal triad in Geocentric Inertial Coordinates where the Z-axis is toward the geodetic nadir, the Y-axis is perpendicular to the spacecraft velocity opposite the orbit normal direction, and the X-axis is approximately in the velocity direction for a near circular orbit. Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttPitchGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler pitch angle (degrees) at the Scan mid-Time. . Values range from -180 to 180 degrees. Special values are defined as:
-9999.9 Missing value

scAttYawGeod (4-byte float, array size: nscan):
The geodedic satellite attitude Euler yaw angle (degrees) at the Scan mid-Time. Values range from -135 to 225 degrees. Special values are defined as:
-9999.9 Missing value

greenHourAng (4-byte float, array size: nscan):
The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates. Values range from 0 to 360 degrees. Special values are defined as:
-9999.9 Missing value

timeMidScan (8-byte float, array size: nscan):
The Scan mid-Time in GPS Atomic time, namely the seconds since 0000 UTC,6 Jan 1980. timeMidScan is used as the reference time for the scPos and scVel values. Values range from 0 to 10000000000 s. Special values are defined as:
-9999.9 Missing value

timeMidScanOffset (8-byte float, array size: nscan):
Offset from the secondary header packet time to the timeMidScan. Values range from 0 to 100 s. Special values are defined as:
-9999.9 Missing value

PRE (Group)

elevation (4-byte float, array size: nray x nscan):
Elevation of the measurement point. It is a copy of DEMHmean of level 1B product. Values are in m. Special values are defined as:
-9999.9 Missing value

landSurfaceType (4-byte integer, array size: nray x nscan):

```
Land surface type.

0 - 99     Ocean
100 - 199  Land
200 - 299  Coast
300 - 399  Inland water
-9999      Missing value
```

localZenithAngle (4-byte float, array size: nray x nscan):
Local zenith angle of each ray. It is a copy of scLocalZenith of level 1B product. Values are in degree. Special values are defined as:
-9999.9 Missing value

flagPrecip (4-byte integer, array size: nray x nscan):

```
Precipitation or no precipitation.

For L2 Ku and L2 Ka

0       No precipitation
1       Precipitation
-9999   Missing value


For L2 DPR

0       No precipitation by both Ku and Ka
1       Precipitation by Ka, no rain by Ku
10      Precipitation by Ku, no rain by Ka
11      Precipitation by both Ku and Ka
-9999   Missing value
```

flagSigmaZeroSaturation (1-byte char, array size: nray x nscan):

```
A flag to show whether echoPower is under a saturated
level or not at a range bin with a calculation of
sigmaZeroMeasured.  Values are:

0  : normal (under saturated level)
1  : possible saturated level at real surface
2  : saturated level at real surface
99 : missing
```

binRealSurface (2-byte integer, array size: nray x nscan):
Range bin number for real surface. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

binStormTop (2-byte integer, array size: nray x nscan):
Range bin number for the storm top. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

heightStormTop (4-byte float, array size: nray x nscan):
Height of storm top. Values are in m. Special values are defined as:
-9999.9 Missing value

binClutterFreeBottom (2-byte integer, array size: nray x nscan):
Range bin number for clutter free bottom. Special values are defined as:
-9999 Missing value

sigmaZeroMeasured (4-byte float, array size: nray x nscan):
Surface backscattering cross section without attenuation correction (as measured). Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorMeasured (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor without attenuation correction (as measured). Values are in dBZ. Special values are defined as:
-9999.9 Missing value

ellipsoidBinOffset (4-byte float, array size: nray x nscan):
Distance between the ellipsoid and a center range bin of binEllipsoid defined by level 1B algorithm.

```
ellipsoidBinOffset =
    scRangeEllipsoid - { startBinRange + (binEllipsoid-1) x rangeBinSize}

scRangeEllipsoid : Distance between a sensor and the ellipsoid [m]
startBinRange : Distance between a sensor and a center
                of the highest observed range bin [m]
binEllipsoid : Range bin number of the Ellipsoid (1 - 260)
rangeBinSize : Range bin size [m]

-9999   Missing value
```

snRatioAtRealSurface (4-byte float, array size: nray x nscan):
Signal/Noise ratio at real surface range bin.

```
snRatioAtRealSurface =
    10.*log10(echoPowertrueV[mW]/noisePowertrueV[mW])

-9999   Missing value
```

adjustFactor (4-byte float, array size: nray x nscan):
Adjustment factor (dB) for zFactorMeasured (dBZm') and sigmaZeroMeasured (dBs0m'). dBZm' and dBs0m' are used and stored as follows:

```
dBZm' = dBZm - adjustFactor
dBs0m' = dBs0m - adjustFactor
The adjustment factor is the sum of 3 components:
base adjustment for instrument dependency,
angle-bin adjustment for angle-bin dependency, and
temporal adjustment for orbit number dependency.
```

snowIceCover (1-byte integer, array size: nray x nscan):
TBD. Special values are defined as:
-99 Missing value

VER (Group)

binZeroDeg (2-byte integer, array size: nray x nscan):

```
Range bin number with 0 degrees C level.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 88 at the Ellipsoid.
Special values are:
177: temperature at a surface is below 0 deg. C in Ku, KaMS, DPR(NS, MS).
89: temperature at a surface is below 0 deg. C in KaHS, DPR(HS).
```

attenuationNP (4-byte float, array size: nbin x nray x nscan):
Vertical profile of attenuation by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB/km. Special values are defined as:
-9999.9 Missing value

piaNP (4-byte float, array size: nNP x nray x nscan):
Path integrated attenuation caused by non-precipitation particles (cloud liquid water, cloud ice water, water vapor, and oxygen molecules). Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroNPCorrected (4-byte float, array size: nray x nscan):
Surface backscattering cross section with attenuation correction only for non-precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

heightZeroDeg (4-byte float, array size: nray x nscan):
Height of freezing level (0 degrees C level) Values are in m. Special values are defined as:
-9999.9 Missing value

CSF (Group)

flagBB (4-byte integer, array size: nray x nscan):
Bright band (BB) exists or not. The definition is different for L2 DPR on the one hand and L2 Ku and L2 Ka on the other.

```
L2 DPR:
0      no Bright Band
1      Bright Band detected by Ku and DFRm
2      Bright Band detected by Ku only
3      Bright Band detected by DFRm only
-1111  No rain value
-9999  Missing value

L2 Ku and L2 Ka:
0      BB not detected
1      BB detected
-1111  No rain value
-9999  Missing value
```

binBBPeak (2-byte integer, array size: nray x nscan):
Range bin number for the peak of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBTop (2-byte integer, array size: nray x nscan):
Range bin number for the top of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid.A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

binBBBottom (2-byte integer, array size: nray x nscan):
Range bin number for the bottom of bright band. For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. A value of -1111 denotes no precipitation is present. Special values are defined as:
-9999 Missing value

heightBB (4-byte float, array size: nray x nscan):
Height of bright band. A value of -1111.1 denotes no precipitation. Values are in m.

Special values are defined as:
-9999.9 Missing value

widthBB (4-byte float, array size: nray x nscan):
The width of bright band. A value of -1111.1 denotes no precipitation. Values are in m.
Special values are defined as:
-9999.9 Missing value

qualityBB (4-byte integer, array size: nray x nscan):

```
Quality of the bright band.
When the bright band is detected,
a larger positive number indicates lower
confidence in the detection.

The Ku detection is clear, but
the Ka and DPR detection is
somewhat doubtful.

The meaning of qualityBB has not
been finalized.

3      Smeared bright band
2      Not so clear bright band
1      Clear bright band
0      BB not detected in the case of rain
-1111  No rain value
-9999  Missing value
```

typePrecip (4-byte integer, array size: nray x nscan):
Precipitation type is expressed by an 8-digit number. The three major rain categories, stratiform, onvective, and other, can be obtained as follows:

```
When typePrecip is greater than zero,
Major rain type = typePrecip/10000000
     = 1    stratiform
     = 2    convective
     = 3    other

-1111  No rain value
-9999  Missing value

Let abcdefgh be the 8 digit number,
```

```
  abcdefgh

then
   a: Main rain type. (a=1,2,3),
   b: 0,
   c: 0,
   d: V rain type,
   e: H rain type,
   f: BB,
   g: Shallow rain,
   h: Small size cell.
-----------------------------------------------------
The following numbers appear as Ku and Ka (MS/HS) rain types:
   ---- stratiform
   1001H100
   10031000
   ---- convective
   2001H1xy (x>0 or y>0)
   2002Hbxy
   200310xy (x>0 or y>0)
   200320xy
   ---- other
   300330xy
where H is the rain type by H-method, and b depends on BB,
x on shallow rain and y on small size cell:
  H = 1: stratiform by H-method,
      2: convective by H-method,
      3: other by H-method.

  b = 0: BB not detected,
      1: BB detected.

  x = 0: No shallow rain,
      1: Shallow isolated,
      3: Shallow non-isolated.

  y = 0: No small size cell,
      1: Single cell,
      2: Small size cell consisting of two adjacent pixels.
============================================================
```

In the DPR product, rain type by the DFRm (measured dual frequency ratio) method is also included in typePrecip and can be obtained as follows:

```
DFRm rain type = (typePrecip%10000000)/1000000 in C
DFRm rain type = (MOD(typePrecip,10000000)/1000000 in FORTRAN

DFRm rain type
     = 1    stratiform
     = 2    convective
     = 4    transition
     = 9    DFRm method cannot be applicable (in this case
       the conventional method determines the major rain type)

-1111  No rain value
-9999  Missing value

 If dual frequency data is not available
 but Ku-only or Ka-olny is available,
 rain type is expressed by the following 8 digit number:
   10xxxxxx --- stratiform,
   20xxxxxx --- convective,
   30xxxxxx --- other,
 wihch is a copy of Ku-only module or Ka-only module.

 If dual frequency data is available, rain type is
 expressed by
   1qxxxxxx --- stratiform,
   2qxxxxxx --- convective,
   3qxxxxxx --- other,
 where q>0.
 Thus, by examining q, users can understand whether
 data is processed by dual frequency algorithm or
 single frequency algorithm.
 ======================================
 For MS and HS, DFRm method is used.
 ======================================
 DFRm decision classifies rain type into
    stratiform,
    convective,
 and
    transition.
 ------------------------------------------------------------
 The DPR numbering rule can be summarized as follows:
 Let opqrstuv be the 8 digit number, then
    o: Main rain type. (o=1,2,3),
    p: DFRm rain type. (p=0,1,2,4,9, with p=0 for single frequency data only),
```

```
   q: DFRm BB. (q=0,1),
   r: V rain type (by conventional V-method).
      Basically r=0 for inner swath and r>0 for outer swath.
      However, r>0 when only single frequency data is available,
   s: H rain type,
   t: = 0 for innner swath,
        1 when BB is detected in the outer swath.
   u: Shallow rain,
   v: Small size cell.
============================
============================
DFRm type can be obtained by examining p
============================
The meaning of p is as follows:
 p = 0: single frequency data only (dual frequncy data not available),
     1: stratiform by DFRm method,
     2: convective by DFRm method,
     4: transition by DFRm method,
     9: DFRm decision not available.
Note that p>0 always in DPR processing, which is different
from Ku-only or Ka-only result.
In Ku-only or Ka-only rain type numbering, p=0 always.
------------------------------------------------------------
================================================
The following numbers appear as DPR rain types:
================================================
*************************
*   For NS outer swath   *
*************************
  --- stratiform
  1901H100
  19031000
  --- convective
  2901H1xy (x>0 or y>0, see R\_type\_classification\_dpr2)
  2902Hwxy
  290310xy (x>0, y>0, see R\_type\_classification\_dpr2)
  290320xy
  --- other
  390330xy

*******************************
*  For NS inner swath and MS  *
*******************************
```

```
  --- stratiform
  11B0H0xy
  14B01000
  19001000 --- H decision only
  19011000 --- MS rain >0 but no NS rain; MS V and H determine rain type
            or NS rain >0 but no MS rain; NS V and H determine rain type
  19013000 --- MS rain >0 but no NS rain; MS V and H determine rain type.
            or NS rain >0 but no MS rain; NS V and H determine rain type
  19031000 --- MS rain >0 but no NS rain; MS V and H determine rain type.
            or NS rain >0 but no MS rain; NS V and H determine rain type
  --- convective
  2100H0xy (x>0 or y>0)
  2110H00y (y>0)
  2200H0xy
  2210H00y
  2400H0xy
  2410H00y
  290010xy --- H decision only (x>0 or y>0)
  290020xy --- H decision only
  2901H0xy --- MS rain >0 but no NS rain; MS V and H determine rain type
            or NS rain >0 but no MS rain; NS V and H determine rain type
            (x>0 or y>0 for H=1,3)
  2902H0xy --- MS rain >0 but no NS rain; MS V and H determine rain type
            or NS rain >0 but no MS rain; NS V and H determine rain type
  290310xy --- MS rain >0 but no NS rain; MS V and H determine rain type
            (x>0 or y>0)
  290320xy --- MS rain >0 but no NS rain; MS V and H determine rain type
            or NS rain >0 but no MS rain; NS V and H determine rain type
  --- other
  340030xy
  390030xy --- H decision only
  390330xy --- MS rain >0 but no NS rain; MS V and H determine rain type
            or NS rain >0 but no MS rain; NS V and H determine rain type

**************
*   For HS   *
**************
  --- stratiform
  11B0H000
  14B01000
  19001000 --- H decision only
  --- convective
  21B0H0x0 (x>0)
```

```
  22B0H0x0
  240010x0 (x>0, 24B010x0 with B=0)
  240020x0
  241010x0 (x>0, 24B010x0 with B=1)
  290010x0 (x>0) --- H decision only
  290020x0 --- H decision only
  --- other
  340030x0
  390030x0 --- H decision only

 where w depends on BB by conventional V-method, B on BB
 by DFRm method, H on H-method, x on shallow rain
 and y on small size cell:
   w = 0: BB not detected by conventional V-method,
       1: BB detected by conventional V-methd.

   B = 0: BB not detected by DFRm method,
       1: BB detected by DFRm methd.

   H = 1: stratiform by H-method,
       2: convective by H-method,
       3: other by H-method.

   x = 0: No shallow rain,
       1: Shallow isolated,
       3: Shallow non-isolated.

   y = 0: No small size cell,
       1: Single cell,
       2: Small size cell consisting of two adjacent pixels.
 In the above, x>0 and y>0 are taken care of in the function
 R\_type\_classification\_dpr2().
 ============================================================
```

qualityTypePrecip (4-byte integer, array size: nray x nscan):

```
Quality of the precipitation type.

1      Good
-1111  No rain value
-9999  Missing value
```

flagShallowRain (4-byte integer, array size: nray x nscan):

```
Type of shallow rain
0      No shallow rain
10     Shallow isolated (maybe)
11     Shallow isolated (certain)
20     Shallow non-isolated (maybe)
21     Shallow non-isolated (certain)
-1111  No rain value
-9999  Missing value
```

flagHeavyIcePrecip (1-byte integer, array size: nray x nscan):
This flag denotes strong or severe precipitation accompanied by solid ice hydrometeors above the -10 degree C isotherm. Special values are defined as:
-99 Missing value

flagAnvil (1-byte integer, array size: nray x nscan):

```
flagAnvil is 1 when anvil is detected by the Ku-band radar,
0 when anvil is not detected, and
-99 when the data is missing.

Note that Ka-band decision is not made because of a lower
sensitivity of Ka-band radar (therefore, there does not
exist any Ka-band flagAnvil; only Ku-band flagAnvil
is available in Ku-only and DPR NS).
```

SRT (Group)

PIAalt (4-byte float, array size: method x nray x nscan):
The two-way path integrated attenuation (PIA) at from the each method estimate. The path-integrated attenuation from the jth method, where

PIAalt (j=1) = PIA_Ku from forward along-track spatial at kth angle bin
PIAalt (j=2) = PIA_Ku from backward along-track spatial at kth angle bin
PIAalt (j=3) = PIA_Ku from forward hybrid at kth angle bin
PIAalt (j=4) = PIA_Ku from backward hybrid at kth angle bin
PIAalt (j=5) = PIA_Ku from temporal reference at kth angle bin
PIAalt (j=6) = PIA_Ku from light-rain temporal reference at kth angle bin

Values are in dB. Special values are defined as:
-9999.9 Missing value

RFactorAlt (4-byte float, array size: method x nray x nscan):
The reliability factors associated with the individual PIA estimates corresponding to

PIAalt. Special values are defined as:
-9999.9 Missing value

PIAweight (4-byte float, array size: method x nray x nscan):
The weights of the individual PIA_Ku estimates used in deriving the effective path attenuation estimate, pathAtten. The sum of the weights should equal one. Where j is method and sigma_j is the standard deviation of reference data for method j.

PIAweight_j = 1/sigma_j^2 * (1/Sum_j(1/sigma_j^2))

Special values are defined as:
-9999.9 Missing value

pathAtten (4-byte float, array size: nray x nscan):
The effective 2-way path integrated attenuation. Values are in dB. Special values are defined as:
-9999.9 Missing value

reliabFactor (4-byte float, array size: nray x nscan):
Reliability Factor for the effective PIA estimate, pathAtten. Special values are defined as:
-9999.9 Missing value

reliabFlag (2-byte integer, array size: nray x nscan):
The reliability flag for the effective PIA estimate (pathAtten) based on the reliability factor (Rel_eff) in reliabFactor. Reliability Flag is:

= 1 if Rel_eff $>$ 3 ; PIAeff estimate is considered reliable
= 2 if 3 $\geq$ Rel_eff $>$ 1 ; PIAeff estimate is considered marginally reliable
= 3 if Rel_eff $\leq$ 1 ; PIAeff is unreliable
= 4 if SNR_at surface $<$ 2dB; provides a lower bound to the path-attenuation
= 9 (no-rain case)

Special values are defined as:
-9999 Missing value

refScanID (2-byte integer, array size: nearFar x foreBack x nray x nscan):
The number of scan lines between the current scan and the beginning (or end) of the along-track reference data at each angle bin. The values are computed by the equation: Current Scan Number - Reference Scan Number. The values are positive for the Forward estimates and negative for the Backward estimates. The Fortran indices for nearFar foreBack are:

```
1,1 - Forward - Near reference
2,1 - Forward - Far reference
1,2 - Backward - Near reference
2,2 - Backward - Far reference
```

Special values are defined as:
-9999 Missing value

DSD (Group)

phase (1-byte char, array size: nbin x nray x nscan):
Phase state of the precipitation. As an unsigned byte value this represents:

```
phase < 100 Temperature(C)=phase-100
phase > 200 Temperature(C)=phase-200
phase = 100 Top of the bright band
phase = 200 Bottom of the bright band
phase = 125 is used for the range bins between
                        the top and peak of bright band
phase = 175 is used for the range bins between
                        the peak and bottom of bright band

Integer values of phase/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

binNode (2-byte integer, array size: nNode x nray x nscan):

```
The bin number of the 5 nodes defined as:

0 - Bin number of storm top.
1 - Stratiform: 500m above center of bright band.
    Convective: 750m above 0deg C level.
2 - Stratiform: center of bright band.
    Convective: 0deg C level.
3 - Stratiform: 500m below center of bright band.
    Convective: 750m below 0deg C level.
4 - Bin number of real surface equal to
    binRealSurface in PRE group.
For NS and MS swaths,
bin numbers are 1-based ranging
from 1 at the top of the data window
with 176 at the Ellipsoid.
For HS swaths,
bin numbers are 1-based ranging
```

from 1 at the top of the data window
with 88 at the Ellipsoid.
-9999 - Missing

Experimental (Group)

precipRateESurface2 (4-byte float, array size: nray x nscan):
Estimates Surface Precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface2Status (1-byte char, array size: nray x nscan):
Status of the estimated surface precipitation using alternate method. For information on this experimental field contact the Joint DPR Team. Special values are defined as:
255 Missing value

sigmaZeroProfile (4-byte float, array size: nbinSZP x nray x nscan):
Surface backscattering cross section profile around the current ifov. For information on this experimental field contact the Joint DPR Team. Values are in dB. Special values are defined as:
-9999.9 Missing value

binDEML2 (2-byte integer, array size: nray x nscan):
Range bin number of the digital elevation model surface estimate. For information on this experimental field contact the Joint DPR Team. Special values are defined as:
-9999 Missing value

seaIceConcentration (4-byte float, array size: nray x nscan):
Sea ice concentration estimated by Ku. For information on this experimental field contact the Joint DPR Team. Values range from 30 to 100 percent. Special values are defined as:
-9999.9 Missing value

SLV (Group)

flagSLV (1-byte integer, array size: nbin x nray x nscan):
Special values are defined as:
-99 Missing value

paramDSD (4-byte float, array size: nDSD x nbin x nray x nscan):
Parameters of the drop size distribution. The first index is dBNw; the second index is Dm in mm. Special values are defined as:
-9999.9 Missing value

binEchoBottom (2-byte integer, array size: nray x nscan):
For NS and MS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 176 at the Ellipsoid. For HS swaths, bin numbers are 1-based ranging from 1 at the top of the data window with 88 at the Ellipsoid. Special values are defined as:
-9999 Missing value

piaFinal (4-byte float, array size: nray x nscan):
The final estimates of path integrated attenuation caused by precipitation particles. Values are in dB. Special values are defined as:
-9999.9 Missing value

sigmaZeroCorrected (4-byte float, array size: nray x nscan):
Surface backscatter cross section with attenuation correction. Values are in dB. Special values are defined as:
-9999.9 Missing value

zFactorCorrected (4-byte float, array size: nbin x nray x nscan):
Vertical profile of reflectivity factor with attenuation correction. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedESurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at estimated surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

zFactorCorrectedNearSurface (4-byte float, array size: nray x nscan):
Reflectivity factor with attenuation correction at near surface. Values are in dBZ. Special values are defined as:
-9999.9 Missing value

paramNUBF (4-byte float, array size: nNUBF x nray x nscan):
TBD. Special values are defined as:
-9999.9 Missing value

precipRate (4-byte float, array size: nbin x nray x nscan):
Precipitation rate. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipWaterIntegrated (4-byte float, array size: LS x nray x nscan):
Precipitation water vertically integrated. Values are in g/m^2. Special values are defined as:
-9999.9 Missing value

qualitySLV (4-byte integer, array size: nray x nscan):
A flag to show methods in which precipRateNearSurface is retrieved. Special values are defined as:
-9999 Missing value

precipRateNearSurface (4-byte float, array size: nray x nscan):
Precipitation rate for the near surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateESurface (4-byte float, array size: nray x nscan):
Precipitation rate for the estimated surface. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

precipRateAve24 (4-byte float, array size: nray x nscan):
Average of precipitation rate for 2 to 4km height. Values are in mm/hr. Special values are defined as:
-9999.9 Missing value

phaseNearSurface (1-byte char, array size: nray x nscan):
Phase state of the precipitation at the Near-surface level. This is a copy of the phase in the DSD group at the Near-surface level. As an unsigned byte value this represents:

```
phaseNearSurface < 100 Temperature(C)=phaseNearSurface-100
phaseNearSurface > 200 Temperature(C)=phaseNearSurface-200
phaseNearSurface = 100 Top of the bright band
phaseNearSurface = 200 Bottom of the bright band
phaseNearSurface = 125 is used for the range bins between
                       the top and peak of bright band
phaseNearSurface = 175 is used for the range bins between
                       the peak and bottom of bright band

Integer values of phaseNearSurface/100 =

0 - solid
1 - mixed phase
2 - liquid
255 - Missing
```

epsilon (4-byte float, array size: nbin x nray x nscan):
Epsilon is the indication of the adjustment away from the initial drop size distribution, epsilon = 1 is no adjustment. Special values are defined as:
-9999.9 Missing value

FLG (Group)

flagEcho (1-byte integer, array size: nbin x nray x nscan):

```
Flag of precipitation and main/side lobe clutter
information of each range bin.

Bit  Meaning
0    For L2 Ku:  Precipitation judged by L2 Ku algorithm (copy of bit 2)
0    For L2 Ka:  Precipitation judged by L2 Ka algorithm (copy of bit 3)
0    For L2 DPR:  Precipitation judged by L2 DPR algorithm (copy of bit 1)
1    Precipitation judged by L2 DPR algorithm
2    Precipitation judged by L2 Ku algorithm
3    Precipitation judged by L2 Ka algorithm
4    Main lobe clutter judged by L2 Ku algorithm
5    Main lobe clutter judged by L2 Ka algorithm
6    Side lobe clutter judged by L2 Ku algorithm
7    Side lobe clutter judged by L2 Ka algorithm
```

qualityData (4-byte integer, array size: nray x nscan):
Normal data gives "0". Non-zero values mean the kinds of errors. Special values are defined as:
-9999 Missing value

```
Flag of quality data.  Bit range from 8 to 23
contains flags by each module.  Each module flag
has 2 bits of information.

The 2 bit flag for each module has values:
[higher bit    lower bit]
[0 0]  Good
[0 1]  Warning but usable
[1 0]  NG or error

The bits of qualityData are assigned as follows:

Bit      Meaning
0 - 7    Copy of dataQuality in level 1B product
8 - 9    Flag by input module
10 - 11  Flag by preparation module
12 - 13  Flag by vertical module
14 - 15  Flag by classification module
16 - 17  Flag by SRT module
18 - 19  Flag by DSD module
20 - 21  Flag by solver module
22 - 23  Flag by output module
24 - 31  Spare
```

qualityFlag (1-byte integer, array size: nray x nscan):

Flag derived from qualityData with the following values: Special values are defined as:
-99 Missing value

```
Value    Meaning
0        High quality.  No issues.
1        Low quality (DPR modules had warnings but still made a retrieval)
2        Bad (DPR modules had errors or dataQuality is bad and
         retrieval is missing)
```

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

```
Flag of input Ku/Ka data condition.

Value  Meaning
1      Valid
-99    Invalid (judged by dataQuality)
```

C Structure Header file:

```
#ifndef _TK_2AKu_H_
#define _TK_2AKu_H_

#ifndef _L2AKu_FLG_
#define _L2AKu_FLG_

typedef struct {
    signed char flagEcho[49][176];
    int qualityData[49];
    signed char qualityFlag[49];
    signed char flagSensor;
} L2AKu_FLG;

#endif

#ifndef _L2AKu_SLV_
#define _L2AKu_SLV_

typedef struct {
    signed char flagSLV[49][176];
    float paramDSD[49][176][2];
    short binEchoBottom[49];
    float piaFinal[49];
```

```
    float sigmaZeroCorrected[49];
    float zFactorCorrected[49][176];
    float zFactorCorrectedESurface[49];
    float zFactorCorrectedNearSurface[49];
    float paramNUBF[49][3];
    float precipRate[49][176];
    float precipWaterIntegrated[49][2];
    int qualitySLV[49];
    float precipRateNearSurface[49];
    float precipRateESurface[49];
    float precipRateAve24[49];
    unsigned char phaseNearSurface[49];
    float epsilon[49][176];
} L2AKu_SLV;

#endif

#ifndef _L2AKu_EXPERIMENTAL_
#define _L2AKu_EXPERIMENTAL_

typedef struct {
    float precipRateESurface2[49];
    unsigned char precipRateESurface2Status[49];
    float sigmaZeroProfile[49][7];
    short binDEML2[49];
    float seaIceConcentration[49];
} L2AKu_EXPERIMENTAL;

#endif

#ifndef _L2AKu_DSD_
#define _L2AKu_DSD_

typedef struct {
    unsigned char phase[49][176];
    short binNode[49][5];
} L2AKu_DSD;

#endif

#ifndef _L2AKu_SRT_
#define _L2AKu_SRT_
```

```
typedef struct {
    float PIAalt[49][6];
    float RFactorAlt[49][6];
    float PIAweight[49][6];
    float pathAtten[49];
    float reliabFactor[49];
    short reliabFlag[49];
    short refScanID[49][2][2];
} L2AKu_SRT;

#endif

#ifndef _L2AKu_CSF_
#define _L2AKu_CSF_

typedef struct {
    int flagBB[49];
    short binBBPeak[49];
    short binBBTop[49];
    short binBBBottom[49];
    float heightBB[49];
    float widthBB[49];
    int qualityBB[49];
    int typePrecip[49];
    int qualityTypePrecip[49];
    int flagShallowRain[49];
    signed char flagHeavyIcePrecip[49];
    signed char flagAnvil[49];
} L2AKu_CSF;

#endif

#ifndef _L2AKu_VER_
#define _L2AKu_VER_

typedef struct {
    short binZeroDeg[49];
    float attenuationNP[49][176];
    float piaNP[49][4];
    float sigmaZeroNPCorrected[49];
    float heightZeroDeg[49];
} L2AKu_VER;
```

```
#endif

#ifndef _L2AKu_PRE_
#define _L2AKu_PRE_

typedef struct {
    float elevation[49];
    int landSurfaceType[49];
    float localZenithAngle[49];
    int flagPrecip[49];
    unsigned char flagSigmaZeroSaturation[49];
    short binRealSurface[49];
    short binStormTop[49];
    float heightStormTop[49];
    short binClutterFreeBottom[49];
    float sigmaZeroMeasured[49];
    float zFactorMeasured[49][176];
    float ellipsoidBinOffset[49];
    float snRatioAtRealSurface[49];
    float adjustFactor[49];
    signed char snowIceCover[49];
} L2AKu_PRE;

#endif

#ifndef _NAVIGATION_
#define _NAVIGATION_

typedef struct {
    float scPos[3];
    float scVel[3];
    float scLat;
    float scLon;
    float scAlt;
    float dprAlt;
    float scAttRollGeoc;
    float scAttPitchGeoc;
    float scAttYawGeoc;
    float scAttRollGeod;
    float scAttPitchGeod;
    float scAttYawGeod;
    float greenHourAng;
    double timeMidScan;
```

```
    double timeMidScanOffset;
} NAVIGATION;

#endif

#ifndef _L2AKu_SCANSTATUS_
#define _L2AKu_SCANSTATUS_

typedef struct {
    signed char dataQuality;
    signed char dataWarning;
    signed char missing;
    signed char modeStatus;
    short geoError;
    short geoWarning;
    short SCorientation;
    short pointingStatus;
    signed char acsModeMidScan;
    signed char targetSelectionMidScan;
    signed char operationalMode;
    signed char limitErrorFlag;
    double FractionalGranuleNumber;
} L2AKu_SCANSTATUS;

#endif

#ifndef _SCANTIME_
#define _SCANTIME_

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

#endif
```

```
#ifndef _L2AKu_NS_
#define _L2AKu_NS_

typedef struct {
    SCANTIME ScanTime;
    float Latitude[49];
    float Longitude[49];
    L2AKu_SCANSTATUS scanStatus;
    NAVIGATION navigation;
    L2AKu_PRE PRE;
    L2AKu_VER VER;
    L2AKu_CSF CSF;
    L2AKu_SRT SRT;
    L2AKu_DSD DSD;
    L2AKu_EXPERIMENTAL Experimental;
    L2AKu_SLV SLV;
    L2AKu_FLG FLG;
} L2AKu_NS;

#endif

#endif
```

Fortran Structure Header file:

```
STRUCTURE /L2AKu_FLG/
    BYTE flagEcho(176,49)
    INTEGER*4 qualityData(49)
    BYTE qualityFlag(49)
    BYTE flagSensor
END STRUCTURE

STRUCTURE /L2AKu_SLV/
    BYTE flagSLV(176,49)
    REAL*4 paramDSD(2,176,49)
    INTEGER*2 binEchoBottom(49)
    REAL*4 piaFinal(49)
    REAL*4 sigmaZeroCorrected(49)
    REAL*4 zFactorCorrected(176,49)
    REAL*4 zFactorCorrectedESurface(49)
    REAL*4 zFactorCorrectedNearSurface(49)
    REAL*4 paramNUBF(3,49)
    REAL*4 precipRate(176,49)
```

```
    REAL*4 precipWaterIntegrated(2,49)
    INTEGER*4 qualitySLV(49)
    REAL*4 precipRateNearSurface(49)
    REAL*4 precipRateESurface(49)
    REAL*4 precipRateAve24(49)
    CHARACTER phaseNearSurface(49)
    REAL*4 epsilon(176,49)
END STRUCTURE

STRUCTURE /L2AKu_EXPERIMENTAL/
    REAL*4 precipRateESurface2(49)
    CHARACTER precipRateESurface2Status(49)
    REAL*4 sigmaZeroProfile(7,49)
    INTEGER*2 binDEML2(49)
    REAL*4 seaIceConcentration(49)
END STRUCTURE

STRUCTURE /L2AKu_DSD/
    CHARACTER phase(176,49)
    INTEGER*2 binNode(5,49)
END STRUCTURE

STRUCTURE /L2AKu_SRT/
    REAL*4 PIAalt(6,49)
    REAL*4 RFactorAlt(6,49)
    REAL*4 PIAweight(6,49)
    REAL*4 pathAtten(49)
    REAL*4 reliabFactor(49)
    INTEGER*2 reliabFlag(49)
    INTEGER*2 refScanID(2,2,49)
END STRUCTURE

STRUCTURE /L2AKu_CSF/
    INTEGER*4 flagBB(49)
    INTEGER*2 binBBPeak(49)
    INTEGER*2 binBBTop(49)
    INTEGER*2 binBBBottom(49)
    REAL*4 heightBB(49)
    REAL*4 widthBB(49)
    INTEGER*4 qualityBB(49)
    INTEGER*4 typePrecip(49)
    INTEGER*4 qualityTypePrecip(49)
    INTEGER*4 flagShallowRain(49)
```

```
    BYTE flagHeavyIcePrecip(49)
    BYTE flagAnvil(49)
END STRUCTURE

STRUCTURE /L2AKu_VER/
    INTEGER*2 binZeroDeg(49)
    REAL*4 attenuationNP(176,49)
    REAL*4 piaNP(4,49)
    REAL*4 sigmaZeroNPCorrected(49)
    REAL*4 heightZeroDeg(49)
END STRUCTURE

STRUCTURE /L2AKu_PRE/
    REAL*4 elevation(49)
    INTEGER*4 landSurfaceType(49)
    REAL*4 localZenithAngle(49)
    INTEGER*4 flagPrecip(49)
    CHARACTER flagSigmaZeroSaturation(49)
    INTEGER*2 binRealSurface(49)
    INTEGER*2 binStormTop(49)
    REAL*4 heightStormTop(49)
    INTEGER*2 binClutterFreeBottom(49)
    REAL*4 sigmaZeroMeasured(49)
    REAL*4 zFactorMeasured(176,49)
    REAL*4 ellipsoidBinOffset(49)
    REAL*4 snRatioAtRealSurface(49)
    REAL*4 adjustFactor(49)
    BYTE snowIceCover(49)
END STRUCTURE

STRUCTURE /NAVIGATION/
    REAL*4 scPos(3)
    REAL*4 scVel(3)
    REAL*4 scLat
    REAL*4 scLon
    REAL*4 scAlt
    REAL*4 dprAlt
    REAL*4 scAttRollGeoc
    REAL*4 scAttPitchGeoc
    REAL*4 scAttYawGeoc
    REAL*4 scAttRollGeod
    REAL*4 scAttPitchGeod
    REAL*4 scAttYawGeod
```

```
    REAL*4 greenHourAng
    REAL*8 timeMidScan
    REAL*8 timeMidScanOffset
END STRUCTURE

STRUCTURE /L2AKu_SCANSTATUS/
    BYTE dataQuality
    BYTE dataWarning
    BYTE missing
    BYTE modeStatus
    INTEGER*2 geoError
    INTEGER*2 geoWarning
    INTEGER*2 SCorientation
    INTEGER*2 pointingStatus
    BYTE acsModeMidScan
    BYTE targetSelectionMidScan
    BYTE operationalMode
    BYTE limitErrorFlag
    REAL*8 FractionalGranuleNumber
END STRUCTURE

STRUCTURE /SCANTIME/
    INTEGER*2 Year
    BYTE Month
    BYTE DayOfMonth
    BYTE Hour
    BYTE Minute
    BYTE Second
    INTEGER*2 MilliSecond
    INTEGER*2 DayOfYear
    REAL*8 SecondOfDay
END STRUCTURE

STRUCTURE /L2AKu_NS/
    RECORD /SCANTIME/ ScanTime
    REAL*4 Latitude(49)
    REAL*4 Longitude(49)
    RECORD /L2AKu_SCANSTATUS/ scanStatus
    RECORD /NAVIGATION/ navigation
    RECORD /L2AKu_PRE/ PRE
    RECORD /L2AKu_VER/ VER
    RECORD /L2AKu_CSF/ CSF
    RECORD /L2AKu_SRT/ SRT
```

```
    RECORD /L2AKu_DSD/ DSD
    RECORD /L2AKu_EXPERIMENTAL/ Experimental
    RECORD /L2AKu_SLV/ SLV
    RECORD /L2AKu_FLG/ FLG
END STRUCTURE
```