TRMM データ利用講習会

APPENDIX

PARAMETER DICIONARY

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宇宙開発事業団

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ECS (EOSDIS Core System) Metadata Elements [Core Metadata]

	Metadata Element	Defined Names of Parameters in the	Object Name in the HDF	Type	Estimated size	Description
1	Orbit Number	TK_ORBIT_NUMBER	OrbitNumber	int	17	The orbit number to be used in calculating the spatial extent of this data.
2	Beginning Date	TK_BEGIN_DATE *****.tkyear *****.tkmonth *****.tkday	RangeBeginningDate	date	25	The date when the granule coverage began. Granule coverage defined as the orbit for Level-1 and Level-2 satellite data, as the hour of the granule for Level-1 and Level-2 ground validation data, as the day of the granule for rain gauge and disdrometer data, and as the pentad or month of the granule for Level-3 data.
3	Beginning Time	TK_BEGIN_TIME *****.tkhour *****.tkminute *****.tksecond	RangeBeginningTime	time	23	The time when the granule coverage began. See beginning date.
4	Ending Date	TK_END_DATE *****.tkyear *****.tkmonth *****.tkday	RangeEndingDate	date	22	The date when the granule coverage ended. See beginning date.
5	Ending Time	TK_END_TIME *****.tkhour *****.tkminute *****.tksecond	RangeEndingTime	time	20	The time when the granule coverage ended. See beginning date.
6	Granule ID	TK_GRANULE_ID	GranulePointer	char	48	ID of granule. Same as input file name. (ex. 1B12.19990706.1039.1)
7	ID of ECS Data Object	TK_DATA_ID	ShortName	char	66	The unique identifier of an ECS collection to which this granule belongs. (i.e. “Total Power, Noise”, “PR Reflectivity”)
8	Size MB ECS Data Object	TK_FILE_SIZE	SizeMBECSDatatGranule	float	21	The size attribute will indicate the volume of data contained in the granule.
9	Longitude of Maximum Latitude	TK_LON_OF_MAX_LAT	LongitudeOfMaximumLatitude	char	50	Longitude of the northernmost extent of the satellite orbit. Decimal degrees with 6 figures precision after the decimal point. Positive east, negative west. A point on the 180th meridian is assigned to the western hemisphere.
10	Spatial Coverage Type	TK_SPAT_COV_TYPE	SpatialCoverageType	char	33	This attribute denotes whether the locality/coverage requires horizontal, vertical or both spatial domain and coordinate system definitions. "both"
11	Ellipsoid Name	TK_ELLIPSOID_NAME	EllipsoideName	char	50	Name of the ellipsoid. "World Geodetic System
12	Equatorial Radius	TK_EQ_RADIUS	EquatorialRadius	float	51	Equatorial radius of the earth ellipsoid (meters). "6378.137"
13	Denominator of Flattening	TK_FLATTENING_RATIO	DenominatorFlatteningRatio	float	51	The reciprocal of the flattening ratio, f, Ratio where f = 1 - b/a, a = Equatorial radius of the earth ellipsoid and b = Polar radius of the earth ellipsoid
14	Orbit Model Name	TK_ORBIT_MODEL_NAME	OrbitModelName	char	98	The reference name to the orbital model to be used to calculate the geolocation of this data to determine global spatial extent. "Definitive FDF Ephemeris"
15	Semi Major Axis	TK_KEP_SEMI_MAJOR_AXIS	SemiMajorAxis	float	19	Half of the long axis of the orbit ellipse (meters). Used Geometric metadata.
16	Mean Anomaly	TK_KEP_MEAN_ANOMALY	MeanAnomaly	float	18	Angle around the orbit at the Epoch Time about the Ellipse center from the ascending node (radians). Used Geometric metadata.
17	Right Ascension of Ascending Node	TK_KEP_RIGHT_ASCEN_NODE	RightAscensionNode	float	42	Right Ascension in Geocentric Inertial Coordinates of the north bound equator crossing (radians). Used Geometric metadata.
18	Argument of Perigee	TK_KEP_ARG_OF_PERIGEE	ArgumentOfPerigee	float	28	Angle from the ascending node to perigee (radians). Used Geometric metadata.
19	Eccentricity	TK_KEP_ECCENTRICITY	Eccentricity	float	21	Eccentricity of ellipse (meters). Used Geometric
20	Inclination	TK_KEP_INCLINATION	Inclination	float	20	Angle between Orbit plane and Earth Equatorial plane (radians).
21	Epoch date	TK_KEP_EPOCH_DATE	EpochDate	date	19	Reference date for orbital elements. Used Geometric metadata.
22	Epoch time	TK_KEP_EPOCH_TIME	EpochTime	time	19	Reference time for orbital elements. Used Geometric metadata
23	Epoch milliseconds	TK_KEP_EPOCH_MILLISEC	EpochMillisec	int	20	Reference milliseconds for orbital elements. Used Geometric metadata
24	West Bounding Coordinate	TK_WEST_BOUND_COORD	WestBoundingCoordinate	float	29	The degree value for the west longitude of boundary. "-180"
25	East Bounding	TK_EAST_BOUND_COOR	EastBoundingCoordinate	float	29	The degree value for the east longitude of boundary.
26	North Bounding Coordinate	TK_NORTH_BOUND_COORD	NorthBoundingCoordinate	float	30	The degree value for the north latitude of boundary. "40"
27	South Bounding Coordinate	TK_SOUTH_BOUND_COORD	SouthBoundingCoordinate	float	30	The degree value for the south latitude of boundary. "-40"
28	Center Point Latitude	TK_CENTER_POINT_LAT	CenterLatitude	float	52	Latitude of center point of product.
29	Center Point Longitude	TK_CENTER_POINT_LON	CenterLongitude	float	52	Longitude of center point of product.
30	Radius	TK_RADIUS	RadiusValue	float	15	Distance in km from Point "-9999.9"

	Metadata Element	Defined Names of Parameters in the	Object Name in the HDF	Type	Estimated size	Description
31	Latitude Resolution	TK_LATITUDE_RES	LatitudeResolution	float	27	The minimum diff erence between two adjacent latitude values expressed in Geographic
32	Longitude Resolution	TK_LONGITUDE_RES	LongitudeResolution	float	28	The minimum diff erence between two adjacent longitude values expressed in Geographic Coordinate units of measure. "-9999.9"
33	Geographic Coordinate Units	TK_GEO_COORD_UNITS	GeographicCoordinateUnits	char	112	Units of measure used for the latitude and longitude resolution values. "Decimal Degrees".
34	Temporal Range Type	TK_TEMPOR_RNG_TYPE	TemporalRangeType	char	50	This tells the system how temporal coverage is specified for the granule.
35	QA Parameter Name	TK_QA_PARAM_NAME	QualityAssuranceParameterName	char	98	Science Quality Flag
36	QA Parameter Value	TK_QA_PARAM_VALUE	QualityAssuranceParameterValue	char	99	A post processing indication of quality by the algorithm developer. The Quality Indicator takes the form of 4 possible ASCII strings: "NOT BEING INVESTIGATED", "BEING INVESTIGATED". "FAILED", or "PASSED".
37	Reprocessing Status	TK_REPRO_STAT	ReprocessingActual	char	40	This attribute identifies the intent of the product author to reprocess the data (i.e. data gaps, geolocation accuracy, scientist review quality flags).
38	Browse Package Reference	TK_BROUSE_NAME	BrowsePointer	char	105	This attribute will contain a system-resolvable reference to an HDF package containing a collection of browse granules. "NULL"
39	Contact Name	TK_CONTACT	ScienceContact	char	93	The name of the algorithm developer related to this granule. The contact name supplied here must exist in the ECS contact database. "NASDA Earth Observation Center".
40	Mean Motion	TK_NUM_ORBITS	MeanMotion	float	50	Number of orbits per day, including f r actions of orbits. Used Geometric metadata.
41	Orbit Adjust Flag	TK_ORBIT_ADJUST	OrbitAdjustFlag	int	50	Orbit Adjust Flag. Values are as follows: 0 = no orbit adjust activity during this orbit. 1 = orbit adjustment control modes occurred during this orbit.
42	Attitude Mode Flag	TK_ATTITUDE_MODE	AttitudeModeFlag	int	50	Attitude Mode Flag. Values are as follows: 0 = f o rward mode (+X f o rward) throughout this orbit 1 = backward mode (-X f o rward) throughout this orbit 2 = yaw maneuver during this orbit
43	Solar beta angle at beginning of granule	TK_BEGIN_SOLAR_BETA	SolarBetaAngleAtBeginningOfGranule	float	50	Elevation of sun in the orbit plane at the orbit start (degrees). Used Geometric metadata.
44	Solar beta angle at end of the granule	TK_END_SOLAR_BETA	SolarBetaAngleAtEndOfGranule	float	50	Elevation of sun in the orbit plane at the orbit start (degrees). Used Geometric metadata.
45	Sensor Alignment	TK_SENSOR_ALGN	SensorAlignment	char	100	Euler Sequence (3 integers) and Euler angles f o r rotation f r om spacecraft coordinates to sensor coordinates in degrees. (These are to be provided by the science team) "0.0, 0.0, 0.0, 1.2, 3"
46	Sensor Alignment Channel Offsets	TK_SENSOR_ALGN_CHAN_OFFSET	SensorAlignmentChannelO ff sets	char	50*number of channels	Euler Sequence (3 integers) and Euler angles f o r rotation f r om sensor coordinates to Channel coordinates with angles separately f o r each channel in degrees. (These are to be provided by the science team if needed, but they are not nominally used in TSDIS processing since geolocation is not done per channel) "0"
47	Scan Path Model	TK_SCAN_PATH_MODEL	ScanPathModel	char	100	Parameters describing the scan path as used f o r pixel geolocation. For a (nominal) conical scan model the following parameters are used: Axis of Scan (±1, 2, or 3). Ref e rence Axis f o r zero rotation angle (±1, 2 or 3), and Scan cone angular radius in degrees. Starting rotation angle relative to the scan axis in degrees, Total rotation angle spanned in degrees, Active scan duration time in seconds (between first and last pixel), and Time Off set between spacecraf t time of the sensor data packet and the f i rst pixel time, in seconds. "1.3, 90.0, -17.0, 34.0, 0.3, 0.0"
48	Scan Path Parameters Per Channel	TK_SCAN_PATH_PARAM	ScanPathModelParam	char	100	Parameters describing the scan path (These are to be provided by the science team if needed, but they are not nominally used in TSDIS processing since geolocation is not done per channel) "0" separately f o r each channel in degrees.
49	Ephemeris file descriptor	TK_EPHEM_FILENAME	EphemerisFileID	char	50	TSDIS granule ID f o r the ephemeris file. The f o rmat is EPHEM.YYMMDD.nn., where YY is year, MM is month, DD is day of the month, and nn is the version number.

PS (Product Specific) Metadata Elements [Archive Meta data]

	Metadata Element	Defined Names of Parameters in the	Object Name in the HDF	Type	Estimated size	Description
1	Data Gaps Duration	TK_DATA_GAP	DataGaps	float	50	The sum of the duration of the data gaps in seconds in the orbit (satellite data) or granule (GV data).
2	Number of Data Gaps	TK_NUM_DATA_GAP	NumberOfDataGaps	float	50	The number of data gaps in the data in the orbit (satellite data) or granule (GV data).
3	Algorithm Version	TK_ALGORITHM_VERSION	AlgorithmVersion	char	50	The version of the science algorithm is written as "M.m", where "M" is an integer corresponding to major revisions of the code. Major revisions are changes in the science algorithm which do affect the science, are delivered to TSDIS in an official delivery package, and require reprocessing. "m" is an integer corresponding to minor revisions or corrections. Minor revisions or corrections are made so the science algorithm will function properly in TSDIS, do not affect the science, are not delivered to TSDIS in an official delivery package, and do not require reprocessing. "M" is written without leading zeroes, with a range from 1 to 99. "m" is written with leading zeroes, with a range from 00 to 99. At launch, the version of all science algorithms is "1.00".
4	Product Version Number	TK_PRODUCT_VERSION	ProductVersion	int	50	A single integer indicating the version of the product. The first Product Version Number is 1. The Product Version Number is incremented every time the product is reprocessed due to the fact that the algorithm creating it changes or the algorithms creating the input to the algorithm change.
5	Toolkit Version	TK_TOOLKIT_VERSION	ToolkitVersion	char	50	Version of Toolkit used to create this granule.
6	Calibration Coefficient Version	TK_CAL_COEF_VERSION	CalibrationCoefficientVersion	int	50	Version of the calibration coefficients. (i.e. 1,2,3, etc.)
7	Missing Data	TK_MISSING_DATA	MissingData	int	50	Number of missing scans in the orbit (satellite data), missing rays (ground radar data) or missing observations (rain gauge or disdrometer data) express
8	Percentage of Bad or Missing Pixels	TK_PERCENT_BAD_MISS_PIXCEL	PercentOfBadOrMissingPixels	char	50	List by channel of the percentage of bad or missing pixels in the orbit (satellite data) or granule (GV data). "8.95%"
9	Maximum Valid Value of Channel	TK_MAX_VALID_CHANNEL	MaximumValidValueofChannel	char	50	List by channel of the maximum valid value (value specified by the instrument scientist). 1B: "-110", 1C: "20"
10	Minimum Valid Value of Channel	TK_MIN_VALID_CHANNEL	MinimumValidValueofChannel	char	50	List by channel of the minimum valid value (value specified by the instrument scientist).1B: "-20", 1C:
11	Min Max Unit	TK_MIN_MAX_UNITS	MinMaxUnit	char	50	Units of the Minimum and Maximum valid values. 1B: "dBm", 1C: "dBZ"
12	Orbit Size	TK_ORBIT_SIZE	OrbitSize	int	50	Numbers of scans in Orbit. If the granule is empty, Orbit Size = 0.
13	Radar Wavelength	TK_RADAR_WAVELENGT	RadarWavelength	float	50	Wavelength of the (meter). "0.02178"
14	Minimum Reflectivity Threshold	TK_MI_REF_THRESHOLD	MinimumReflectivityThreshold	float	50	The threshold (dBZ) below which ground based radar reflectivity data is set to the missing value. "-9999.9"
15	Algorithm ID	TK_ALGORITHM_ID	AlgorithmID	char	50	Name of the algorithm (i.e. 1B21, 1C21)
16	Data Accuracy	TK_DATA_ACCURACY	DataAccuracy	char	50	List by channel of the accuracy of the data.
17	Input IDs	TK_INPUT_FILES	InputFiles	char	300	List of input granule Ids. "NULL"
18	Data of Generation of Input Files	TK_GEN_DATE_INPUT_FILES	DataOfGenerationOfInputFiles	char	50	List of the generation dates of the input files. For ingested files, this is the date TSDIS received the file.
19	Data Center Source of Input	TK_DATA_CENTER_SRC	DataCenterSourceOfInputFiles	char	50	List of the centers generating the input files. Files e.g., TSDIS NMC.
20	Generation Date	TK_GEN_DATE	GenerationDate	int	50	Date the dataset was generated.
21	Day/Night	TK_DAY_NIGHT	DayNight	float	50	Percentage scans during the orbit in daytime mode. "-9999.9"
22	Solar Channel Gain	TK_SOLAR_GAIN	SolarChannelGains	float	50	Channel 1 Mirror Side A Channel 1 Mirror Side B Channel 2 Mirror Side A Channel 2 Mirror Side B

	Metadata Element	Defined Names of Parameters in the	Object Name in the HDF	Type	Estimated size	Description
23	SSM/I Adjustment Coefficients	TK_SSMI_ADJUST	SSMIAdjustCoef	float	300	List of the intercepts and slopes defining the following correction to the brightness temperatures for channel: deltaT={A_ch*(tb-250)/50}+B_ch The entries in the list are as follows: 10GHz Vertical adjustment intercept 10GHz Horizontal adjustment intercept 19GHz Vertical adjustment intercept 19GHz Horizontal adjustment intercept 21GHz Vertical adjustment intercept 37GHz Vertical adjustment intercept 37GHz Horizontal adjustment intercept 85GHz Vertical adjustment intercept 85GHz Horizontal adjustment intercept 10GHz Vertical adjustment slope 10GHz Horizontal adjustment slope 19GHz Vertical adjustment slope 19GHz Horizontal adjustment slope 21GHz Vertical adjustment slope 37GHz Vertical adjustment slope 37GHz Horizontal adjustment slope 85GHz Vertical adjustment slope 85GHz Horizontal adjustment slope
24	Orbit First Scan UTC Date	TK_FIRST_SCAN_UTC_DATE	OrbitFirstScanUTCDate	date	50	Orbit First Scan UTC Date. Date is a 10 character string with the following characters: YYYY/MM/DD, where YYYY = year, MM = month number, DD = day of month and "/" is a literal. If the granule is empty, the value is '0/0/0'. In 2A-52, UTC date is stored as "/" is replaced by "-". In 1B-11 and 2A-12, UTC date is stored in separate words for year, month and day of month.
25	Orbit First Scan UTC Time	TK_FIRST_SCAN_UTC_TIME	OrbitFirstScanUTCTime	time	50	Orbit First Scan UTC Time. Time is an 8 character string with the following characters: HH:MM:SS, where HH = hour, MM = minute, SS = second, and ":" is a literal. If the granule is empty, the value is '0:0:0'. In 1B-11 and 2A-12, UTC time is stored in separate words for hour, minute, and second.
26	Orbit First Scan UTC Milliseconds	TK_FIRST_SCAN_UTC_MILLISEC	OrbitFirstScanUTCMilliseconds	int	50	Orbit First Scan UTC Milliseconds. Milliseconds is a 3 character string with the following characters: MMM, where MMM = the number of milliseconds later than the last whole second.
27	Orbit First Scantime - Spacecraft Clock	TK_FIRSTSCAN_SC_SECS	OrbitFirstSCSecs	int	50	The seconds field of the spacecraft clock time of the first scan in the orbit.
28	Orbit First Scantime - Spacecraft Clock Subseconds	TK_FIRSTSCAN_SC_SUBSECS	OrbitFirstSCSubsecs	int	50	The subseconds field of the spacecraft clock time of the first scan in the orbit.
29	Orbit Last Scan UTC Date	TK_LAST_SCAN_UTC_DATE	OrbitLastScanUTCDate	date	50	Orbit Last Scan UTC Date. See Orbit First Scan UTC Date.
30	Orbit Last Scan UTC Time	TK_LAST_SCAN_UTC_TIME	OrbitLastScanUTCTime	time	50	Orbit Last Scan UTC Time. Decided by L1A file header. See Orbit First Scan UTC Time.
31	Orbit Last Scan UTC Milliseconds	TK_LAST_SCAN_UTC_MILLISEC	OrbitLastScanUTCmilliseconds	int	50	Orbit Last Scan UTC Milliseconds. See Orbit Last Scan UTC Milliseconds.
32	Orbit Last Scantime - Spacecraft Clock	TK_LAST_SCAN_SC_SECS	OrbitLastSCSecs	int	50	The seconds f i eld of the spacecraf t clock time of the last scan in the orbit.
33	Orbit Last Scantime - Spacecraft Clock Subseconds	TK_LAST_SCAN_SC_SUBSECS	OrbitLastSCSubsecs	int	50	The subseconds f i eld of the spacecraf t clock time of the last scan in the orbit.
34	UTCF Seconds	TK_UTCF_SECONDS	UTCFSeconds	int	50	The seconds f i eld of the UTCF f o r the granule.
35	UTCF Subseconds	TK_UTCF_SUBSECONDS	UTCFSubseconds	int	50	The subseconds f i eld of the UTCF f o r the granule.
36	UTCF Flag	TK_UTCF_FLAG	UTCFflag	int	50	Flag that indicates the origin of the UTCF. 0 = UTCF was derived f r om the first ACS packet in the orbit. 1 = a corrected UTFC was used. "0"
37	Leap Second flag	TK_LEAP_SECS_FLAG	LeapSecondsFlag	int	50	Flag that indicates if a leap second occurred within the granule. 0 = no; 1 = yes.
38	Radar site name	TK_RADAR_NAME	RadarSiteName	char	50	Name of the GV radar or radar site, whichever is applicable. "NULL".
39	Radar city	TK_RADAR_CITY	RadarCity	char	50	Nearest city to the radar site. "NULL".
40	Radar state	TK_RADAR_STATE	RadarState	char	50	State or province containing the radar site, if applicable. "NULL".
41	Radar country	TK_RADAR_COUNTRY	RadarCountry	char	50	Country containing the radar site. "NULL"
42	Number of VOS	TK_NUM_VOS	NumberOfVOS	int	50	The number of volume scans in this granule. "-9999"
43	Radar Grid Origin	TK_RADAR_ORIGIN_LAT	RadarGridOriginLatitude	int	50	Latitude (degrees) of the origin. "-9999.9"
44	Radar Grid Origin Longitude	TK_RADAR_ORIGIN_LON	RadarGridOriginLongitude	int	50	Longitude (degrees) of the origin. "-9999.9"
45	Radar Grid Origin	TK_RADAR_ORIGIN_ALT	RadarGridOriginAltitude	int	50	Altitude (km) of the origin. "-9999.9"

	Metadata Element	Defined Names of Parameters in the	Object Name in the HDF	Type	Estimated size	Description
46	Radar Grid Spacing x	TK_RADAR_SPACING_X	RadarGridSpacingX	float	50	The zonal interval (km) between grid points. "-9999.9"
47	Radar Grid Spacing y	TK_RADAR_SPACING_Y	RadarGridSpacingY	float	50	The meridional interval (km) between grid points. "-9999.9"
48	Radar Grid Spacing z	TK_RADAR_SPACING_Z	RadarGridSpacingZ	float	50	The vertical interval (km) between grid points. "-
49	Radar Grid Size x	TK_RADAR_GRID_SIZE_X	RadarGridSizeX	int	50	The number of grid points in the zonal grid direction. "-9999"
50	Radar Grid Size y	TK_RADAR_GRID_SIZE_Y	RadarGridSizeY	int	50	The number of grid points in the meridional grid direction. "-9999"
51	Radar Grid Size z	TK_RADAR_GRID_SIZE_Z	RadarGridSizeZ	int	50	The number of grid points in the vertical grid direction. "-9999"
52	DZ Cal	TK_GV_DZCAL	DZCal	float	50	Radar calibration offset (dBZ). "-9999.9"
53	GVL1C_Scale	TK_GV_L1C_SCALE	GVL1C_Scale	float	50	Scaling factor for 1C-51 mask (unitless) "-9999.9"
54	Alpha	TK_GV_ALPHA	Alpha	float	50	Correction for gaseous two-way attenuation (dB/km). "-9999.9"
55	Runtime Options	TK_GV_RUNTIME_OPT	RuntimeOptions	char	100	Runtime options for algorithm including QC parameters used. "NULL".
56	Anomaly Flag	TK_ANOMALY_FLAG	AnomalyFlag	char	100	This flag indicates if and why a granule is empty. The possible values are: "EMPTY: GENERATED AFTER SOFTWARE ERROR" * "EMPTY: NO DATA DUE TO NO RAIN" "EMPTY: NO DATA RECORDED" "EMPTY: DATA RECORDED BUT STILL MISSING" "EMPTY: REASON UNKNOWN" * "NOT EMPTY: POSSIBLE PROBLEM" "NOT EMPTY" * It is expected that satellite data would use only the three values followed by an asterisk. GV data is expected to use all seven values.
57	Software Version	TK_SOFTWARE_VERSION	SoftwareVersion	int	50	Version of the Software
58	Database Version	TK_DATABASE_VERSION	DatabaseVersion	int	50	Version of PR Database in the PR L1 software.
59	Total Quality Code	TK_TOTAL_QUALITY_CODE	TotalQualityCode	char	50	Total quality of the PR L1 product. Range is 'G', 'F', or 'P'.
60	Longitude on the Equator	TK_LON_ON_EQUATOR	LongitudeOnEquator	float	50	Longitude on the equator from the ascending node. Range is -180.000 to 179.999.
61	UTC Date on the Equator	TK_UTC_DATE_ON_EQUATOR	UTCDateOnEquator	date	50	UTC date on the equator. See Orbit First Scan UTC Date.
62	UTC Time on the Equator	TK_UTC_TIME_ON_EQUATOR	UTCTimeOnEquator	time	50	UTC time on the equator. See Orbit First Scan UTC time.
63	UTC milliseconds on the equator	TK_UTC_MILLISEC_ON_EQUATOR	UTCMillisecsOnEquator	int	50	UTC millisecond on the equator. See Orbit First Scan UTC Milliseconds.
64	Orbit center scan UTC date	TK_CENTER_SCAN_UTC_DATE	CenterScanUTCDate	date	50	UTC date at orbit center scan. See Orbit First Scan UTC Date.
65	Orbit center scan UTC time	TK_CENTER_SCAN_UTC_TIME	CenterScanUTCTime	time	50	UTC time at orbit center scan. See Orbit First Scan UTC Time.
66	Orbit center scan UTC	TK_CENTER_SCAN_UTC_MILLISEC	CenterScanUTCMillisec	int	50	UTC milliseconds at Orbit center scan. See milliseconds Orbit First Scan UTC Milliseconds.
67	Orbit first scan latitude	TK_FIRST_SCAN_LAT	FirstScanLat	float	50	Latitude of orbit first scan. Range is -40.000 to
68	Orbit first scan longitude	TK_FIRST_SCAN_LON	FirstScanLon	float	50	Longitude of orbit first scan. Range is -180.000 to
69	Orbit last scan latitude	TK_LAST_SCAN_LAT	LastScanLat	float	50	Latitude of orbit last scan. Range is -40.000 to 40.000.
70	Orbit last scan longitude	TK_LAST_SCAN_LON	LastScanLon	float	50	Longitude of orbit last scan. Range is -180.000 to
71	Number of Rain Scans	TK_NUM_OF_RAIN_SCAN	NumberOfRainScans	int	50	Number of rain scan whose Minimum Echo Flag is 1

VIRS Radiance 1B-01 Swath Data [L1B_01_SWATHDATA]

The following sizing parameter is used in describing these formats:
- nscan = the number of scans within one granule = 18026, on average
- the number of pixels within one scanline (261)

Scan Time (Vdata Table, record size 8 bytes, nscan records)

Name	Name in the TOOLKIT	Format	Description
Scan Time	scanTime	8-byte float	Scan Time is the center time of 1 scan (the time at center of the nadir beam transmitted pulse). It is expressed as the UTC seconds of the day.

Geolocation (SDS, array size 2 x npixel x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Geolocation	geolocation (2,261)	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 less than or equal to -9999.9. Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180th 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.

Name	Name in the TOOLKIT	Format	Description
Missing	scanStatus.missing	1-byte	Missing indicates whether information is contained in integer the scan data. The values are: 0: Scan data elements contain information 1: Scan was missing in the telemetry data 2: Scan data contains no elements with rain
Validity	scanStatus.validity	1-byte	Validity is a summary of status modes. If all status integer modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow: Bit Meaning if bit = 1 0: Spare (always 0) 1: Non-routine spacecraft orientation (2 or 3) 2: Non-routine ACS mode (other than 4) 3: Non-routine yaw update status (0 or 1) 4: Non-routine instrument status (other than 1) 5: Non-routine QAC (non-zero) 6: VIRS in non-mission mode (non-zero) 7: VIRS condition is abnormal (non-zero)
QAC	scanStatus.qac	1-byte	The Quality and Accounting Capsule of the Science integer packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	scanStatus.geoQuality	1-byte	Geolocation Quality is broken into 8 one-bit flags. A integer value of 0 indicates 'good' quality, and 1 indicates 'bad' quality. Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i)-1). Each flag is listed below. Note that ranges indicated will be refined in early-orbit check out. Bit Meaning if bit = 1

TMI Brightness Temperature 1B-11 Swath Data [L1B_11_SWATHDATA]

The following sizing parameter is used in describing these formats:
- nscan = the number of scans within one granule = 2991, on average
- npixel1: the number of high resolution pixels within one scan line (208).
- npixel2: the number of low resolution pixels within one scan line (104).

Scan Time (Vdata Table, record size 9 bytes, nscan records)

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

Geolocation (SDS, array size 2 x npixel1 x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Geolocation	geolocation(2,npixel1)	4-byte float	The earth location of the center of the IFOV of the high resolution (85 GHz) channels (channels 8 and 9) 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 less than or equal to -9999.9 Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180th meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, 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.

Name	Name in the TOOLKIT	Format	Description
Missing	scanStatus.missing	1-byte integer	Missing indicates whether information is contained in the scan data. The values are: 0: Scan data elements contain information 1: Scan was missing in the telemetry data 2: Scan data contains no elements with rain
Validity	scanStatus.validity	1-byte integer	Validity is a summary of status modes. If all statusmodes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1and other bits = 0, the unsigned integer value is 2**(8-i)-1). The non-routine situations follow: Bit Meaning if bit = 1 0: Spare (always 0) 1: Non-routine spacecraft orientation (2 or 3) 2: Non-routine ACS mode (other than 4) 3: Non-routine yaw update status (0 or 1) 4: Non-routine TMI status (Bit 0 = 0 or 1 = 0) 5: Non-routine QAC (non-zero) 6: Spare (always 0) 7: Spare (always 0)
QAC	scanStatus.qac	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	scanStatus.geoQuality	1-byte integer	Geolocation Quality is broken into 8 one-bit flags. Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) -1). A value of 0 indicates ‘good’ quality, and 1 indicates ‘bad’ quality. Each flag is listed below. Note that ranges indicated will be refined in early-orbit check out. Bit Meaning if bit = 1

PR Power 1B-21 Calibration Coefficients [L1B21_L1C21_HEADER]

Calibration coefficients consist of several parameters describing the PR electronic performance. They are controlled by NASDA based on the results of PR calibration data analysis.
These coefficients are applied in 1B21 (PR received power) calculations.

Calibration coefficients (Vdata Table, record size 4 bytes, 18 records)

Name	Name in the TOOLKIT	Format	Description
Transmitter gain correction factor	prCalCoef(nray).transCoef	4-byte float	Transmission gain correction factor for PR (unifless, 1record)
Receiver gain correction factor	prCalCoef(nray).receptCoef	4-byte float	Receiver gain correction factor for PR (unifless, 1record)
LOGAMP Input/Output	prCalCoef(nary).fcifIOchar(16)	16 x 4-byte float	LOGAMP Input/Output characteristics (unifless, 16record)

PR Power 1B-21 Ray Header [L1B21_L1C21_HEADER]

The Ray Header contains information that is constant in the granule, such as the parameters used in the radar equation, the parameters in the minimum echo test, and the sample start range bin number.
These parameters are provided for each angle bin.

Ray Header (Vdata Table, record size 60 bytes, 49 records)

Name	Name in the TOOLKIT	Format	Description
Ray Start	rayHdr(nray).rayStart	2-byte integer	Range bin number of starting normal sample, see Note (a)
Ray Size	rayHdr(nray).raySize	2-byte integer	Number of normal samples in 1 angle, see Note (a)
Scan Angle	rayHdr(nray).angle	4-byte float	unit deg, see Note (b)
Starting Bin Distance	rayHdr(nray).startBinDist	4-byte float	Distance (m) between the satellite and the starting bin sample. unit m, see Note (c)
Rain Threshold #1	rayHdr(nray).rainThres1	4-byte float	see Note (d)
Rain Threshold #2	rayHdr(nray).rainThres2	4-byte float	see Note (d)
Transmitter Antenna Gain	rayHdr(nray).transAntenna	4-byte float	unit dB
Receiver Antenna	rayHdr(nray).recvAntenn	4-byte float	unit dB
One-way 3dB Along-track	rayHdr(nray).onewayAlong Track	4-byte float	unit rad, see Note (e)
One-way 3dB Cross- track	rayHdr(nray).onewayCrossTrack	4-byte float	unit rad, see Note (e)
Equivalent wavelength	rayHdr(nray).eqvWavelength	4-byte float	unit m, see Note (f)
Rader Constant	rayHdr(nray).radarConst	4-byte float	unit dB, see Note (g)
PR Internal delayed	rayHdr(nray).printrDelay	4-byte float	set to 0
Range Bin Size	rayHdr(nray).rangeBinSi	4-byte float	unit m, see Note (a), (h)
Logarithmic Averaging Offset	rayHdr(nray).logAveOffset	4-byte float	unit dB, see Note (i)
Mainlobe Clutter Edge	rayHdr(nray).mainlobeEdge	1-byte integer	see Note (j)
Sidelobe Clutter Range [3]	rayHdr(nray).sidelobeRange(3)	3 x 1-byte integer	see Note (k)

Notes

a) The Precipitation Radar (PR) has 400 internal (logical) range bins (A/D sample points) and records “normal sample data” every other range bin from “Ray Start” in order to sample radar echoes from 0-km (the reference ellipsoid surface) to 15-km height. The number of recorded samples at an angle bin depends on the scan angle and is defined by “Ray Size.”
The Nth normal sample data can be converted to the internal logical range bin number as follows;
Logical range bin number at Nth normal sample
$$= RayStart + 2 \times (N-1)$$

b) Scan Angle is defined as the cross-track angle at the radar electric coordinates which are rotated by 4 degrees about the Y-axis (Pitch) of spacecraft coordinates.*1 The angle is positive when the antenna beam is rotated counter clockwise (CCW) from the nadir about the +X axis of the radar electric coordinates.

PR Reflectivity 1C-21 Calibration Coefficients [L1B21_L1C21_HEADER]

The 1C-21 product has the same format as 1B-21.

PR Reflectivity 1C-21 Ray Header [L1B21_L1C21_HEADER]

The 1C-21 product has the same format as 1B-21.

PR Reflectivity 1C-21 Swath Data [L1C_21_SWATHDATA]

The 1C-21 product has the same format as 1B-21. In 1C-21, the normal sample, surface orversample and rain oversample contain radar reflectivity factors (dBZ, mm^6/m^3) which are converted from the PR received powers in the corresponding places in 1B21 output. The radar equation used is

$$\Pr(range) = \frac{\pi^3 |K|^2}{2^{10} \ln 2} \frac{Pt \times Gt \times Gr \times along \times cross \times c \times pulse}{wavelength^2} \frac{1}{range^2} Zm$$

$$dBZm = 10 \log(10^{(Ps/10)} - 10^{(Pn/10)}) - C + 20 \log(range)$$

Ps: 1B21 received power
Pn: 1B21 noise level
range: Distance

$$C = Pt + Gt + Gr + 10 \log(along \times cross) + 10 \log(c \times pulse) - 10 \log(wavelength) + C0$$

Pt: transmitter power (in power)
pulse: transmitter pulse width (in power)
Gt: transmit antenna gain (in ray header)
Gr: receive antenna gain (in ray header)
along: Along-track beam width (in ray header)
cross: Cross-track beam width (in ray header)
c: speed of light
wavelength: wave length (in ray header)
C0: Radar Constant (in ray header)

If received power is below the noise level, the reflectivity is filled with a dummy value of -32700.

・Note that the radar reflectivity factors given in 1C-21 are apparent values and include rain or atomospheric attenuation.

Normal Sample (SDS, array size 140 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Normal Sample	normalSample(140,nray)	2-byte integer	The normal sampled PR radar refrectivity factors are recorded (unit: dBZ/100). The data is stored in the array of 49 angles * 140 elements. Since each angle has a different number of samples, the elements after the end of sample are filled with a value of -32767. If a scan is missing, the elements are filled with the value -32734. If received power is below the noise level, the reflectivity is filled with a dummy value of -32700. The range is -20 dBZ to 80 dBZ with an accuracy of 1.0 dBZ.

Surface Oversample (SDS, array size 5 x 29, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Surface	Oversample osSurf(5,29)	2-byte integer	The PR records the over-sampled data in five range bins around the surface peak detected on board (not Bin Surface Peak) in a total of 29 angle bins (nadir±14 angles) to examine the surface peak precisely. If the surface tracker status is lock-off, the data position is unknown. To use the oversample data, fill the five data starting at ìBin Start of Over Surfaceî in every other logical range bin, then merge with the interleaving normal sample data. The range is -20 dBZ to 80 dBZ with an accuracy of 1.0

Surface Oversample (SDS, array size 28 x 11, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Rain Oversample	osRain(28,11)	2-byte integer	The PR records the over-sampled data at 28 range bins in a total of 11 angle bins (nadir ±5 angles) to record the detailed vertical profile of the rain.The 125m interval dataset in heights from 0 km to 7.5 km can be generated by interleaving the Normal Samples with the Surface oversamples and rain oversamples. The data are merged in the same way as the Surface Oversample. The range is -20 dBZ to 80 dBZ with an accuracy of 1.0 dBZ.

TMI Profiling 2A-12 Swath Data [L2A_12_SWATHDATA]

The following parameters are used in describing the formats:
- nscan: the number of scans within one granule (2891+50 + 50 =2991, on average).
- npixel: the number of high resolution pixels within one scan line (208).
- nlayer: the number of profiling layers within one pixel (14).

Scan Time (Vdata Table, record size 9 bytes, nscan records):
The Scan Time is the time associated with each scan.

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

Geolocation (SDS, array size 2 x npixel x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Geolocation	geolocation (2,npixel)	4-byte float	The earth location of the center of the IFOV of the high resolution (85 GHz) channels (channels 8 and 9) 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 less than or equal to -9999.9 Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180th meridian is assigned to the western hemisphere.

Scan Status (Vdata Table, 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. 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.

Name	Name in the TOOLKIT	Format	Description
Missing	scanStatus.missing	1-byte integer	Missing indicates whether information is contained in the scan data. The values are: 0: Scan data elements contain information 1: Scan was missing in the telemetry data 2: Scan data contains no elements with rain
Validity	scanStatus.validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i)-1). The non-routine situations follow: Bit Meaning if bit = 1 0: Spare (always 0) 1: Non-routine spacecraft orientation (2 or 3) 2: Non-routine ACS mode (other than 4) 3: Non-routine yaw update status (0 or 1) 4: Non-routine TMI status (Bit 0 = 0 or 1 = 0) 5: Non-routine QAC (non-zero) 6: Spare (always 0) 7: Spare (always 0)
QAC	scanStatus.qac	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

PR Surface Cross Section 2A-21 Swath Data [L2A_21_SWATHDATA]

The following parameters are used in describing the formats:
− nscan: the number of PR scans within one granule (9150, on average).
− nray: the number of rays within one PR scan line (49).

Scan Time (Vdata Table, record size 8 bytes, nscan records)

Name	Name in the TOOLKIT	Format	Description
Scan Time	scanTime	8-byte float	Scan Time is the center time of 1 scan (the time at center of the nadir beam transmitted pulse). It is expressed as the UTC seconds of the day.

Geolocation (SDS, array size 2 x nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Geolocation	geolocation(2,nray)	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 pixels and scans. Values are represented as floating point decimal degrees. Off earth is represented as less than or equal to -9999.9 Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180º 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. 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.

Name	Name in the TOOLKIT	Format	Description
Missing	scanStatus.missing	1-byte integer	Missing indicates whether information is contained in the scan data. The values are: 0: Scan data elements contain information 1: Scan was missing in the telemetry data 2: Scan data contains no elements with rain
Validity	scanStatus.validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow: Bit Meaning if bit = 1 0 Spare (always 0) 1 Non-routine spacecraft orientation (2 or 3) 2 Non-routine ACS mode (other than 4) 3 Non-routine yaw update status (0 or 1) 4 Non-routine instrument status (other than 1) 5 Non-routine QAC (non-zero) 6 Spare (always 0) 7 Spare (always 0)
QAC	scanStatus.qac	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	scanStatus.geoQuality	1-byte integer	Geolocation quality is a summary of geolocation quality in the scan. A zero integer value indicates "good" geolocation. A non-zero value broken down into the following bit flags indicates: Bit Meaning if bit = 1 0: latitude limit error 1: geolocation discontinuity 2: attitude change rate limit error 3: attitude limit error 4: satellite undergoing maneuvers 5: using predictive orbit data 6: geolocation calculation error 7: not used

PR Qualitative 2A-23 Swath Data [L2A_23_SWATHDATA]

The following parameters are used in describing the formats:
- nscan: the number of PR scans within one granule (9150, on average).
- nray: the number of rays within one PR scan line (49).

Scan Time (Vdata Table, record size 8 bytes, nscan records)

Name	Name in the TOOLKIT	Format	Description
Scan Time	scanTime	8-byte float	Scan Time is the center time of 1 scan (the time at center of the nadir beam transmitted pulse). It is expressed as the UTC seconds of the day.

Geolocation (SDS, array size 2 x nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Geolocation	geolocation(2,49)	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 pixels and scans. Values are represented as floating point decimal degrees. Off earth is represented as less than or equal to -9999.9 Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180º 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. 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.

Name	Name in the TOOLKIT	Format	Description
Missing	scanStatus.missing	1-byte integer	Missing indicates whether information is contained in the scan data. The values are: 0: Scan data elements contain information 1: Scan was missing in the telemetry data 2: Scan data contains no elements with rain
Validity	scanStatus.validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow: Bit Meaning if bit = 1 0: Spare (always 0) 1: Non-routine spacecraft orientation (2 or 3) 2: Non-routine ACS mode (other than 4) 3: Non-routine yaw update status (0 or 1) 4: Non-routine instrument status (other than 1) 5: Non-routine QAC (non-zero) 6: Spare (always 0) 7: Spare (always 0)
QAC	scanStatus.qac	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	scanStatus.geoQuality	1-byte integer	Geolocation quality is a summary of geolocation quality in the scan. A zero integer value indicates ｷgood ｺ geolocation. A non-zero value broken down into the following bit flags indicates: Bit Meaning if bit = 1 0: latitude limit error 1: geolocation discontinuity 2: attitude change rate limit error 3: attitude limit error 4: satellite undergoing maneuvers 5: using predictive orbit data 6: geolocation calculation error 7: not used

PR Profile 2A-25 Clutter Flag [CLUTTER_FLAGS]

The Clutter Flags are identical to the clutter information in 1B-21 in the Ray Header.

Clutter Flag (Vdata Table, record size 4 bytes, 49 records)

Name	Name in the TOOLKIT	Format	Description
Mainlobe Clutter Edge	clutFlag(49).mainlobeEdge	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]	clutFlag(49).sidelobeRange(3)	3 x 1-byte integer	Absolute value of the difference in Range Bin Numbers between the detected surface and the clutter position from the sidelobe. A zero means no clutter indicated in this field since less than 3 bins contained significant clutter.

PR Profile 2A-25 Swath Data [L2A_25_SWATHDATA]

The following parameters are used in describing the formats:
- nscan: the number of PR scans within one granule (9150, on average).
- 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).
- ncell2: the number of radar range cells at which the Z-R parameters are output (5).
- nmeth: the number of methods used (2).

Scan Time (Vdata Table, record size 8 bytes, nscan records)

Name	Name in the TOOLKIT	Format	Description
Scan Time	scanTime	8-byte float	Scan Time is the center time of 1 scan (the time at center of the nadir beam transmitted pulse). It is expressed as the UTC seconds of the day.

Geolocation (SDS, array size 2 x nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Geolocation	geolocation(2,4nray)	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 pixels and scans. Values are represented as floating point decimal degrees. Off earth is represented as less than or equal to -9999.9 Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180º 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.

Name	Name in the TOOLKIT	Format	Description
Missing	scanStatus.missing	1-byte integer	Missing indicates whether information is contained in the scan data. The values are: 0: Scan data elements contain information 1: Scan was missing in the telemetry data 2: Scan data contains no elements with rain
Validity	scanStatus.validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow: Bit Meaning if bit = 1 0: Spare (always 0) 1: Non-routine spacecraft orientation (2 or 3) 2: Non-routine ACS mode (other than 4) 3: Non-routine yaw update status (0 or 1) 4: Non-routine instrument status (other than 1) 5: Non-routine QAC (non-zero) 6: Spare (always 0) 7: Spare (always 0)

TRMM Combined 2B-31 Swath Data [L2B_31_SWATHDATA]

The following parametersare used in describing the formats:
- nscan: the number of PR scans within one granule (9150, on average).
- nray: the number of rays within one PR scan line (49).
- Nradarrange: the number of radar range gates, up to about 20 km from the earth ellipsoid (80).

Scan Time (Vdata Table, record size 8 bytes, nscan records)

Name	Name in the TOOLKIT	Format	Description
Scan Time	scanTime	8-byte float	Scan Time is the center time of 1 scan (the time at center of the nadir beam transmitted pulse). It is expressed as the UTC seconds of the day.

Geolocation (SDS, array size 2 x nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Geolocation	geolocation(2,4nray)	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 pixels and scans. Values are represented as floating point decimal degrees. Off earth is represented as less than or equal to -9999.9 Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180º 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. All bytes in Scan Status are copied from the 1B-21 Scan Status including the Missing byte. 2B-reset the Missing byte if it determines data is missing or there is no-rain.

Name	Name in the TOOLKIT	Format	Description
Missing	scanStatus.missing	1-byte integer	Missing indicates whether information is contained in the scan data. The values are: 0: Scan data elements contain information 1: Scan was missing in the telemetry data 2: Scan data contains no elements with rain
Validity	scanStatus.validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow: Bit Meaning if bit = 1 0: Spare (always 0) 1: Non-routine spacecraft orientation (2 or 3) 2: Non-routine ACS mode (other than 4) 3: Non-routine yaw update status (0 or 1) 4: Non-routine instrument status (other than 1) 5: Non-routine QAC (non-zero) 6: Spare (always 0) 7: Spare (always 0)
QAC	scanStatus.qac	1-byte integer	integerThe Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.

TMI Emission 3A-11 Planetary Grid [L3A_11_PLANETGRID]

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).

Monthly Rainfall (SDS, array size nlat x nlon, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Monthly Rainfall	monthRain(nlat,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, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Number of Samples	noOfSamples(nlat,nlon)	2-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.

Chi Square Fit (SDS, array size nlat x nlon, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
Chi Square Fit	chiSqFit(nlat,nlon)	4-byte integer	The Chi Square Fit indicates how well the histogram of brightness emperatures 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):

Name	Name in the TOOLKIT	Format	Description
Freezing Level	freezLevel (nlat,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):

Name	Name in the TOOLKIT	Format	Description
T_0	T0(nlat,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):

Name	Name in the TOOLKIT	Format	Description
r_0	r0(nlat,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):

Name	Name in the TOOLKIT	Format	Description
Sigma_r	sigmaR(nlat,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):

Name	Name in the TOOLKIT	Format	Description
Probability of Rain	probRain(nlat,nlon)	2-byte integer	The Probability of Rain is that over oceans in 5° x 5° boxes for one onth. 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):

Name	Name in the TOOLKIT	Format	Description
Quality Indicator 1	qInd1(nlat,nlon)	2-byte integer	TBD.

PR Rainfall 3A-25 Planetary Grid 1 [L3A_25_GRID]

The following parameters are used in describing the formats:
- nlat: the number of 5º grid intervals of latitude from 40º N to 40º S (16).
- nlon: the number of 5º grid intervals of longitude from 180ºW to 180ºE (72).
- 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).
- 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, 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.

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):
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.

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 0º, 5º, 10º and 15º (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

PR Surface Rain 3A-26 Planetary Grid [L3A_26_GRID]

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

- 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

Total Counts (SDS, array size nlat x nlon, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
Total Counts	ttlCount(nlat,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):

Name	Name in the TOOLKIT	Format	Description
Rain Counts	rainCount(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
Zero Order pDf	zeroOrderpDf(nlat,nlon,ncat3,nh3,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, , 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):

Name	Name in the TOOLKIT	Format	Description
HB pDf	hbpDf(nlat,nlon,ncat3,nh3,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):

Name	Name in the TOOLKIT	Format	Description
pDf2A25	pDf2A25(nlat,nlon,ncat3,nh3,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 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):

Name	Name in the TOOLKIT	Format	Description
Zero Order Fit	zeroOrderFit(nlat,nlon,nh3,3,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):

Name	Name in the TOOLKIT	Format	Description
HB Fit	hbFit(nlat,nlon,nh3,3,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.

TMI and PR Combined 3B-31 Planetary Grid [L3B 31 GRID]

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).

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

Name	Name in the TOOLKIT	Format	Description
Surface rain	sfcrainTMI(nlat,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):

Name	Name in the TOOLKIT	Format	Description
Convective surface rain	convectRain(nlat,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):

Name	Name in the TOOLKIT	Format	Description
Monthly mean cloud water	cloudWater(nlat,nlon,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}.

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

Name	Name in the TOOLKIT	Format	Description
Monthly mean rain water	cloudWater(nlat,nlon,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}.

Cloud Ice (SDS, array size nlat x nlon x nlayer, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Cloud Ice	cloudIce(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
Graupel	graupel(nlat,nlon,nlayer)	4-byte float	The graupel is that at each vertical layer in each 5° x 5°box for one month. It ranges from 0.0 to 1000.0 g m^{-3} .

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

Name	Name in the TOOLKIT	Format	Description
Monthly mean latent heating	latentHeat(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
Surface rain	sfcrainCOMB(nlat,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):

Name	Name in the TOOLKIT	Format	Description
Rain water	rainWaterCOMB(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
Surface rain	sfcrainTMIoverlap(nlat,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):

Name	Name in the TOOLKIT	Format	Description
Convective surface rain	convectRainoverlap(nlat, 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):

Name	Name in the TOOLKIT	Format	Description
Surface rain	sfcrainCOMBoverlap(nlat,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.

TRMM and Others GPI Calibration 3B-42 Planetary Grid [L3B_42_PLANETGRID]

The following parameters are used in describing the formats:
- nlat: the number of 1° grid intervals of latitude from 40° N to 40° S (80).
- nlon: the number of 1° grid intervals of longitude 180°W to 180°E (360).

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

Name	Name in the TOOLKIT	Format	Description
Precipitation	precipitate(nlat,nlon)	4-byte float	This is the adjusted GPI precipitation estimate at each 1° x 1° box for 1day. It ranges from 0.0 to 3.5 mm/hr.

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

Name	Name in the TOOLKIT	Format	Description
Relative Error	relError(nlat,nlon)	4-byte float	This is the adjusted GPI relative error estimate at each 1° x 1° box for 1 day. It ranges from 0.0 to 3.5 mm/hr.

TRMM and Others Data Sources 3B-43 Planetary Grid [L3B_43_PLANETGRID]

The following parameters are used in describing the formats:
· nlat: the number of 1° grid intervals of latitude from 40° N to 40° S (80).
· nlon: the number of 1° grid intervals of longitude 180°W to 180°E (360).

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

Name	Name in the TOOLKIT	Format	Description
Precipitation	precipitate(nlat,nlon)	4-byte float	This is the satellite/gauge precipitation estimate at each 1° x 1° 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):

Name	Name in the TOOLKIT	Format	Description
Relative Error	relError(nlat,nlon)	4-byte float	This is the satellite/gauge relative error estimate at each 1° x 1° box for one month. It ranges from 0.0 to 3.5 mm/hr.

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

Name	Name in the TOOLKIT	Format	Description
The ratio	surfAdjRatio(nlat,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):

Name	Name in the TOOLKIT	Format	Description
The ratio	surfAdjRatioverlap(nlat,nlon)	4-byte float	The ratio of 2B31 to 2A12 surface rainfall, calculated from the swath overlap region for each 5° x 5° box.

fit2A25 (SDS array size nlat x nlon x nh3 x 3 x nthrsh, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
fit2A25	fit2A25(nlat,nlon,nh3,3,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):

Name	Name in the TOOLKIT	Format	Description
Reliability 0th Order Fit	reliabOrderFit(nlat,nlon,nh3,nthrsh)	4-byte float	Reliability parameter for the 0th order fit. Units and ranges are TBD.

Reliability HB Fit (SDS array size nlat x nlon x nh3 x nthrsh, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Reliability HB Fit	reliabHBfit(16,72,4,6)	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):

Name	Name in the TOOLKIT	Format	Description
Reliability 2A25 Fit	reliab2A25fit(nlat,nlon,nh3,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):

Name	Name in the TOOLKIT	Format	Description
rainMeanTH	rainMeanTH (nlat,nlon,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.

Rain Rate Mean 1 (SDS, array size nlat x nlon x nh1, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Rain Rate Mean 1	grid1.rainMean1 (nlat,nlon,nhl)	4-byte float	Rain Rate Mean 1 gives means of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Rain Rates Dev. 1	grid1.rainDev1 (nlat,nlon,nhl)	4-byte float	These are standard deviations of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Conv. Rain Rate Mean 1	grid1.convRainMean1 (16,72,6)	4-byte float	Conv. Rain Rate Mean 1 gives means of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Conv. Rain Rates Dev. 1	grid1.convRainDev1 (nlat,nlon,nhl)	4-byte float	Conv. Rain Rates Dev. 1 gives standard deviations of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Strat. Rain Rate Mean 1	grid1.stratRainDev1 (nlat,nlon,nhl)	4-byte float	Strat. Rain Rate Mean 1 gives means of nonzero 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.

Strat. Rain Rates Dev. 1 (SDS, array size nlat x nlon x nh1, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Strat. Rain Rates Dev. 1	grid1.stratRainDev1(nlat ,nlon,nhl)	4-byte float	Strat. Rain Rates Dev. 1 gives standard deviations of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Zm Mean 1	grid1.zmMean1(nlat,nlo n,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Zm Dev.1	grid1.zmDev1(nlat,nlon, nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Conv. Zm Mean 1	grid1.convZmMean1(nla t,nlon,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Conv. Zm Dev. 1	grid1.convZmDev1(16,72,6)	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):

Name	Name in the TOOLKIT	Format	Description
Strat. Zm Mean 1	grid1.stratZmMean1(nlat,nlon,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Strat. Zm Dev. 1	grid1.stratZmDev1(nlat,nlon,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Zt Mean 1	grid1.ztMean1(nlat,nlon,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Zt Dev 1	grid1.ztDev1(nlat,nlon,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Conv. Zt Mean 1	grid1.convZtMean1(nlat,nlon,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Conv. Zt Dev 1	grid1.convZtDev1(nlat,nlon,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Strat. Zt Mean 1	grid1.stratZtMean1(nlat,nlon,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Strat. Zt Dev 1	grid1.stratZtDev1(nlat,nlon,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
PIA srt Mean	grid1.piaSrtMean(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
PIA srt Dev.	grid1.piaSrtDev(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
PIA hb Mean	grid1.piaHbMean(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
PIA hb Dev.	grid1.piaHbDev(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
PIA 0th Mean	grid1.pia0Mean(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
PIA 0th Dev.	grid1.pia0Dev(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
pia2a25Mean	grid.pia2a25Mean(nlat,nlon)	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):

Name	Name in the TOOLKIT	Format	Description
pia2a25Dev.	grid.pia2a25Mean(nlat,nlon,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.

Storm Height Mean (SDS, array size nlat x nlon x 3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Storm Height Mean	grid1.stormHtMean(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
Storm Height Dev.	grid1.stormHtDev(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
Xi Mean	grid1.xiMean(nlat,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):

Name	Name in the TOOLKIT	Format	Description
Xi Dev.	grid1.xiMean(nlat,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):

Name	Name in the TOOLKIT	Format	Description
NUBF Correction Factor Mean	grid1.nubfCorFacMean(nlat,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):

Name	Name in the TOOLKIT	Format	Description
NUBF Correction Factor Dev.	grid1.nubfCorFacDev(nlat,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):

Name	Name in the TOOLKIT	Format	Description
BB Height Mean	grid1.bbHtMean(nlat,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):

Name	Name in the TOOLKIT	Format	Description
BB Height Dev.	grid1.bbHtDev(nlat,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.

epsilonMean1 (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
epsilonMean1	grid1.epsilonMean1(16,72)	4-byte float	Mean of epsilon conditioned on use of SRT in 2A21 at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 3.0 (unitless).

epsilonDev1 (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
epsilonDev1	grid1.epsilonDev1(nlat,nlon)	4-byte float	Standard deviation of epsilon conditioned on use of SRT in 2A21 at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 3.0 (unitless).

surfRainMean1 (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
surfRainMean1	grid1.surfRainMean1(nlat,nlon)	4-byte float	Mean of 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):

Name	Name in the TOOLKIT	Format	Description
surfRainDev1	grid1.surfRainDev1(nlat,nlon)	4-byte float	Standard deviation of near-surface rain rate at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 3000.0 mm/h.

bbZmaxMean1 (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
bbZmaxMean1	grid1.bbZmaxMean1(nlat,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):

Name	Name in the TOOLKIT	Format	Description
bbZmaxDev1	grid1.bbZmaxDev1(nlat, 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.

bbwidthMean1 (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
bbwidthMean1	grid1.bbwidthMean1(nlat,nlon)	4-byte float	Mean of width of bright band at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 20,000.0 m.

bbwidthDev1 (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
bbwidthDev1	grid1.bbwidthDev1(nlat, nlon)	4-byte float	Standard deviation of width of bright band at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 20,000.0 m.

sdepthMean1 (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
sdepthMean1	grid1.sdepthMean1(nlat, 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):

Name	Name in the TOOLKIT	Format	Description
sdepthDev1	grid1.sdepthDev1(nlat,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.

surfRainAllMean1 (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
surfRainAllMean1	grid1.surfRainAllMean1(nlat,nlon)	4-byte float	Mean of near-surface rain rate using rain certain and rain possible at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 3,000.0 mm/h.

surfRainAllDev1 (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
surfRainAllDev1	grid1.surfRainAllDev1(nlat,nlon)	4-byte float	Standard deviation of near-surface rain rate using rain certain and rain possible at a horizontal resolution of 5° x 5°. It ranges from 0.0 to 3,000.0 mm/h.

Total Pixel Number 1 (SDS, array size nlat x nlon, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
Total Pixel Number 1	grid1.ttlPix1(nlat,nlon)	4-byte float	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):

Name	Name in the TOOLKIT	Format	Description
Bright Band Pixel Number 1	grid1.bbPix1(nlat,nlon)	4-byte float	The number of bright band counts over each 5 x 5 degree box for one month. The range is 0 to 2,000,000.

Rain Pixel Number 1 (SDS, array size nlat x nlon x nh1, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
Rain Pixel Number 1	grid1.rainPix1(nlat,nlon, nh1)	4-byte float	The Rain Pixel Number 1 is the number of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Conv. Rain Pixel Number 1	grid1.convRainPix1(nlat, nlon,nh1)	4-byte float	The Convective Rain Pixel Number 1 is the number of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Strat. Rain Pixel Number 1	grid1.stratRainPix1(nlat, nlon,nh1)	4-byte float	The Stratiform Rain Pixel Number 1 is the number of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Total Angle Pixel Number 1	grid1.ttlAnglePix1(nlat,nlon,nh1)	4-byte float	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):

Name	Name in the TOOLKIT	Format	Description
Rain Angle Pixel Number 1	grid1.rainAnglePix1(nlat,nlon,nh1)	4-byte float	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.

wrainPix1 (SDS, array size nlat x nlon, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
wrainPix1	grid1.wrainPix1(16,72)	4-byte float	Warm rain counts at a horizontal resolution of 5° x 5°. It ranges from 0 to 2,000,000.

surfRainPix1 (SDS, array size nlat x nlon, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
surfRainPix1	grid1.surfRainPix1(nlat, nlon)	4-byte float	Near-surface rain counts at a horizontal resolution of 5° x 5°. It ranges from 0 to 2,000,000.

epsilonPix1 (SDS, array size nlat x nlon, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
epsilonPix1	grid1.epsilonPix1(nlat,nlon)	4-byte float	Counts for epsilon when SRT value of PIA is used at a horizontal resolution of 5° x 5°. It ranges from 0 to 2,000,000.

surfRainAllPix1 (SDS, array size nlat x nlon, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
surfRainAllPix1	grid1.surfRainAllPix1(nlat,nlon)	4-byte float	Number of counts of non-zero near-surface rain rate using rain certain and rain possible at a horizontal resolution of 5° x 5°. It ranges from 0 to 2,000,000.

Storm Height Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Storm Height Hist.	grid1.stormHH(nlat,nlon, 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):

Name	Name in the TOOLKIT	Format	Description
Conv. Storm Height Hist.	grid1.convStormHH(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
Strat. Storm Height Hist.	grid1.stratStormHH(nlat, nlon,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):

Name	Name in the TOOLKIT	Format	Description
BB Height Hist.	grid1.BBHH(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
Snow-ice Layer Hist.	grid1.snowIceLH(nlat,nlon,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):

Name	Name in the TOOLKIT	Format	Description
Zm Hist.	grid1.zmH(nlat,nlon,ncat2,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Conv. Zm Hist.	grid1.convZmH(nlat,nlon,ncat2,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Strat. Zm Hist.	grid1.stratZmH(nlat,nlon,ncat2,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Zt Hist.	grid1.ztH(nlat,nlon,ncat2,nhl)	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 ategories 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):

Name	Name in the TOOLKIT	Format	Description
Conv. Zt Hist.	grid1.convZtH(nlat,nlon,ncat2,nhl)	2-byte	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):

Name	Name in the TOOLKIT	Format	Description
Strat. Zt Hist.	grid1.stratZtH(nlat,nlon,ncat2,nhl)	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):

Name	Name in the TOOLKIT	Format	Description
Rain Rate Hist.	grid1.rainH(nlat,nlon,ncat2,nhl)	2-byte integer	These are histograms of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Conv. Rain Rate Hist.	grid1.convRainH(nlat,nlon,ncat2,nhl)	2-byte integer	These are histograms of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Strat. Rain Rate	Hist. grid1.stratRainH(nlat,nlon,ncat2,nhl)	2-byte integer	These are histograms of nonzero 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

PIA srt Hist. (SDS, array size nlat x nlon x ncat2 x nang, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
PIA srt Hist.	grid1.piaSrtH(nlat,nlon,ncat2,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):

Name	Name in the TOOLKIT	Format	Description
PIA hb Hist.	grid1.piaHbH(nlat,nlon,ncat2,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):

Name	Name in the TOOLKIT	Format	Description
PIA 0th Hist.	grid1.pia0H(nlat,nlon,ncat2,nang)	2-byte integer	PIA 0th Hist. is the histogram of the 0th order path-integrated attenuation with a horizontal resolution of 5° x 5°. This histogram is calculated for 30 categories at 4 different incident angles (0°, 5°, 10° and 15°). It ranges from 0 to 32,767

pia2A25H (SDS, array size nlat x nlon x ncat2 x nang, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
pia2A25H	grid1.pia2A25H(nlat,nlon,ncat2,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.

Zm Gradient Hist. (SDS, array size nlat x nlon x ncat2 x nh2, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Zm Gradient Hist.	grid1.zmGradH(nlat,nlon,ncat2,nh2)	2-byte integer	These are histograms of the vertical gradient in measured reflectivity at 3 levels 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):

Name	Name in the TOOLKIT	Format	Description
Xi Hist.	grid1.xiH(nlat,nlon,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 size nlat x nlon x ncat2, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
NUBF Hist.	grid1.grid1.nubfH(nlat,nlon,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° x 5° grid boxes. It ranges from 0 to 32,767.

ZPZM Hist. (SDS, array size nlat x nlon x ncat2, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
ZPZM Hist.	grid1.zpzmH(nlat,nlon,ncat2)	2-byte integer	ZPZM Hist. is the histogram of the difference between the reflectivity at two heights: (Bright Band - Epsilon) and (Bright Band + Epsilon). This histogram is calculated for 30 different categories at each grid box of 5° x 5°. It ranges from 0 to 32,767.

bbZmaxH (SDS, array size nlat x nlon x ncat2, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
bbZmaxH	grid1.bbZmaxH(nlat,nlon,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.

epsilonH (SDS, array size nlat x nlon x ncat2, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
epsilonH	grid1.epsilonH(nlat,nlon, ncat2)	2-byte integer	Histogram of epsilon conditioned on use of SRT in 2A25 at a horizontal resolution of 5° x 5°. It ranges from 0 to 32,000.

surfRainH (SDS, array size nlat x nlon x ncat2, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
surfRainH	grid1.surfRainH(nlat,nlon,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.

integer

surfRainAllH (SDS, array size nlat x nlon x ncat2, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
surfRainAllH	grid1.surfRainAllH(nlat, nlon,ncat2)	2-byte integer	Histogram of near-surface rain rate using rain certain and rain possible 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):

Name	Name in the TOOLKIT	Format	Description
RR Corr. Coef.	grid1.rainCCoef(nlat,nlon,3)	4-byte float	These are correlation coefficients of nonzero 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. They are calculated under convective condition, stratiform condition or both. It ranges from -1.000 to 1.000.

Conv. RR Corr. Coef. (SDS, array size nlat x nlon x 3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Conv. RR Corr.	Coef.grid1.convRainCCoef(nlat,nlon,3)	4-byte float	These are correlation coefficients of nonzero 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):

Name	Name in the TOOLKIT	Format	Description
Strat. RR Corr.	Coef.grid1.stratRainCCoef(nlat,nlon,3)	4-byte float	These are correlation coefficients of nonzero 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.

Hgt. and Zm Corr. Coef. (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Hgt. and Zm Corr. Coef.	grid1.stormHtZmCCoef(nlat,nlon,3)	4-byte float	This is the correlation coefficient between the storm height and the maximum measured reflectivity factor along the path 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):

Name	Name in the TOOLKIT	Format	Description
PIAs Corr. Coef.	grid1.piaCCoef(16,72,4,3)	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.

Xi and Zm Corr. Coef. (SDS, array size nlat x nlon, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Xi and Zm Corr. Coef.	grid1.xiZmCCoef(nlat,nlon)	4-byte float	This is the correlation coefficient between the non-uniformity and the maximum measured reflectivity factor along the path for a 5° x 5°box for one month. It ranges from -1.000 to 1.000.

PR Rainfall 3A-25 Planetary Grid 2 [L3A_25_GRID]

The following parameters are used in describing the formats:
- 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).
- nh3: the number of fixed heights above the earth ellipsoid, at 2, 4, and 6 km plus one for path-average (4).

Rain Rate Mean 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Rain Rate Mean 2	grid2.rainMean2(nlath,nlonh,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 Rates Dev. 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Rain Rates Dev. 2	grid2.rainDev2(nlath,nlonh,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):

Name	Name in the TOOLKIT	Format	Description
Conv. Rain Rate Mean 2	grid2.convRainMean2(nlath,nlonh,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 Rates Dev. 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Conv. Rain Rates Dev. 2	grid2.convRainDev2(nlath,nlonh,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):

Name	Name in the TOOLKIT	Format	Description
Strat. Rain Rate Mean 2	grid2.stratRainDev2(nlath,nlonh,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 Rates Dev. 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Strat. Rain Rates Dev. 2	grid2.stratRainDev1(nlath,nlonh,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 size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Zm Mean 2	grid2.zmMean2(nlath,nlonh,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° x 0.5° grid boxes. It ranges from -20 to 80 dBZ.

Conv. Zm Mean 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Conv. Zm Mean 2	grid2.convZmMean2(148,720,4)	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° x 0.5° grid boxes. It ranges from -20 to 80 dBZ.

Strat. Zm Mean 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Strat. Zm Mean 2	grid2.stratZmMean2(nlath,nlonh,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° x 0.5° grid boxes. It ranges from -20 to 80 dBZ.

Zt Mean 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Zt Mean 2	grid2.ztMean2(nlath,nlonh,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° x 0.5° grid boxes. It ranges from 0.1 to 80 dBZ.

Conv. Zt Mean 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Conv. Zt Mean 2	grid2.convZtMean2(nlath,nlonh,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° x 0.5° grid boxes. It ranges from 0.1 to 80 dBZ.

Strat. Zt Mean 2 (SDS, array size nlath x nlonh x nh3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Strat. Zt Mean 2	grid2.stratZtMean2(nlath,nlonh,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° x 0.5°grid boxes. It ranges from 0.1 to 80 dBZ.

Storm Height Mean (SDS, array nlath x nlonh x 3, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Storm Height Mean	grid2.stormHeightMean(nlath,nlonh,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° x 0.5° 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):

Name	Name in the TOOLKIT	Format	Description
BB Height Mean	grid2.bbHeightMean(hlath,nlonh)	4-byte float	BB Height Mean gives the monthly means of bright-band height over grid boxes of 0.5° x 0.5°. It has units of meters and ranges from 0 to

surfRainMean2 (SDS, array size nlath x nlonh, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
surfRainMean2	grid2.surfRainMean2(nlath,nlonh)	4-byte float	Mean of 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):

Name	Name in the TOOLKIT	Format	Description
surfRainDev2	grid2.surfRainDev2(nlath,nlonh)	4-byte float	Standard Deviation of 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):

Name	Name in the TOOLKIT	Format	Description
bbZmaxMean2	grid2.bbZmaxMean2(nlath,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):

Name	Name in the TOOLKIT	Format	Description
bbZmaxDev2	grid2.bbZmaxDev2(148,720)	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):

Name	Name in the TOOLKIT	Format	Description
sdepthMean2	grid2.sdepthMean2(nlath,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):

Name	Name in the TOOLKIT	Format	Description
sdepthDev2	grid2.sdepthDev2(nlath,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):

Name	Name in the TOOLKIT	Format	Description
stormHeightDev2	grid2.stormHeightDev2(nlath,nlonh,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):

Name	Name in the TOOLKIT	Format	Description
bbHeightDev2	grid2.bbHeightDev2(nlath,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.

surfRainAllMean2 (SDS, array size nlath x nlonh, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
surfRainAllMean2	grid2.surfRainAllMean2(nlath,nlonh)	4-byte float	Mean of near-surface rain rate using rain certain and rain possible at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 3,000.0 mm/h.

surfRainAllDev2 (SDS, array size nlath x nlonh, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
surfRainAllDev2	grid2.surfRainAllDev2(nlath,nlonh)	4-byte float	Standard deviation of near-surface rain rate using rain certain and rain possible at a horizontal resolution of 0.5° x 0.5°. It ranges from 0.0 to 3,000.0 mm/h.

Total Pixel Number 2 (SDS, array size nlath x nlonh, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
Total Pixel Number2	grid2.ttlPix2(nlath,nlonh)	4-byte float	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):

Name	Name in the TOOLKIT	Format	Description
Bright Band Pixel Number 2	grid2.bbPixNum2(nlath, nlonh)	4-byte float	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.

wrainPix2 (SDS, array size nlath x nlonh, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
wrainPix2	grid2.wrainPix2(nlath,nlonh)	4-byte float	Warm rain counts at a horizontal resolution of 0.5° x 0.5°. It ranges from 0 to 2,000,000,000.

surfRainPix2 (SDS, array size nlath x nlonh, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
surfRainPix2	grid2.surfRainPix2(nlath,nlonh)	4-byte float	Near-surface rain counts at a horizontal resolution of 0.5° x 0.5°. It ranges from 0 to 2,000,000,000.

surfRainAllPix2 (SDS, array size nlath x nlonh, 4-byte integer):

Name	Name in the TOOLKIT	Format	Description
surfRainAllPix2	grid2.surfRainAllPix2(nlath,nlonh)	4-byte float	Near-surface rain counts using rain certain and rain possible 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):

Name	Name in the TOOLKIT	Format	Description
Rain Pixel Number 2	grid2.rainPix2(nlath,nlonh,nh3)	4-byte float	The Rain Pixel Number 2 is the monthly number of nonzero rain rate pixels for path-averaged rainfall and rainfall at the fixed heights of 2, 4, and 6 km 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):

Name	Name in the TOOLKIT	Format	Description
Conv. Rain Pixel Number 2	grid2.convRainPix2 (nlath,nlonh,nh3)	4-byte float	The Convective Rain Pixel Number 2 is the number of nonzero rain rate pixels for convective rain at the fixed heights of 2, 4, and 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):

Name	Name in the TOOLKIT	Format	Description
Strat. Rain Pixel Number 2	grid2.stratRainPix2 ((nlath,nlonh,nh3)	4-byte float	The Stratiform Rain Pixel Number 2 is the number of nonzero rain rate pixels for stratiform rain at the fixed heights of 2, 4, and 6 km, and path average over 0.5° x 0.5° boxes for one month. The range is 0 to 2,000,000.

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

Name	Name in the TOOLKIT	Format	Description
Quality Indicator 2	qInd2(nlat,nlon)	2-byte integer	TBD.

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

Name	Name in the TOOLKIT	Format	Description
Quality Indicator 3	qInd3(nlat,nlon)	2-byte integer	TBD.

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

Name	Name in the TOOLKIT	Format	Description
Spare	spare(nlat,nlon)	2-byte integer	TBD.

Geolocation Quality	scanStatus.geoQuality	1-byte integer	Geolocation quality is a summary of geolocation quality in the scan. A zero integer value indicates 'good' geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i): Bit Meaning if bit = 1 0 latitude limit error 1 geolocation discontinuity 2 attitude change rate limit error 3 attitude limit error 4 satellite undergoing maneuvers 5 using predictive orbit data 6 geolocation calculation error 7 not used
Data Quality	scanStatus.dataQuality	1-byte integer	Data quality is a summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). Bit Meaning if bit = 1 0: missing 5: Geolocation Quality is not normal 6: Validity is not normal
Current Spacecraft Orientation	scanStatus.scOrient	1-byte integer	Value Meaning 0: +x forward 1: -x forward 2: -y forward 3: Inertial - CERES Calibration 4: Unknown Orientation
Current ACS Mode	scanStatus.acsMode	1-byte integer	Value Meaning 0: Standby 1: Sun Acquire 2: Earth Acquire 3: Yaw Acquire 4: Nominal 5: Yaw Maneuver 6: Delta-H (Thruster) 7: Delta-V (Thruster) 8: CERES Calibration
Yaw Update Status	scanStatus.yawUpdateS	1-byte integer	Value Meaning 0: Inaccurate 1: Indeterminate 2: Accurate
PR Mode	scanStatus.prMode	1-byte integer	Value Meaning 0: Other Mode 1: Observation Mode
PR Status 1	scanStatus.prStatus1	1-byte integer	The flags listed here indicate warnings of PR conditions (noise level, echo power and echo position, and mode change). In data processing, users should be cautions with the following as a scan with non-zero status includes questionable range bins or angle bins. 0: LOGAMP noise limit error 1: Noise level limit error (The meaning of this warning is the same as the System Noize Warning Flag) 2: Out of PR dynamic range (Surface echo is so strong that it exceeds the PR receiver dynamic range. Calibration with the saturated echo may be questionable.) 3: Not reach surface position (If Surface echo is out of range window, Bin Surface Peak and related data become uncertain.) 7: FCIF mode change

PR Status 2	scanStatus.prStatus2	1-byte integerIn	In some cases, antenna sidelobes are directed to nadir receive surface echo positions. When the main beam is off nadir, the timing of such nadir-surface clutter can contaminate the rain echo. In ìPR STATUS2,î a warning flag is set ON (1) when the nadir surface echo (at the nadir angle bin #25) exceeds a predetermined threshold. When the flag is ON, please be careful about the echoes at all angle bins around the same logical range bin number as the Bin-surface-peak at nadir (angle bin number 25).
Fractional Orbit Number	scanStatus.fracOrbitN	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Scan Time - Orbit Start Time) / (Orbit End Time Orbit Start Time)

Navigation (Vdata, record size 88 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Geocentric Position [3]	navigate.scPosX navigate.scPosY navigate.scPosZ	3 X 4-byte float	The position (m) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). The order of components is: x, y, and z. Geocentric Inertial Coordinates are also commonly known as Earth Centered Inertial coordinates. These coordinates will be True of Date (rather than Epoch 2000 which are also commonly used), as interpolated from the data in the Flight Dynamics Facility ephemeris files generated for TRMM.
Spacecraft Geocentric Position [3]	navigate.scVelX navigate.scVelY navigate.scVelZ	3 X 4-byte float	The velocity (ms -1) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of components is: x, y, and z.
Spacecraft Geodetic Latitude	navigate.scLat	4-byte float	The geodetic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.
Spacecraft Geodetic Longitude	navigate.scLon	4-byte float	The geodetic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Range is -180 to 179.999999.
Spacecraft Geodetic Altitude	navigate.scAlt	4-byte float	The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time.
Spacecraft Attitude [3]	navigate.scAttRoll navigate.scAttPitch navigate.scAttYaw	3 X 4-byte float	The satellite attitude Euler angles 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.
Sensor Orientation Matrix [3 X 3]	navigate.att1 navigate.att2 navigate.att3 navigate.att4 navigate.att5 navigate.att6 navigate.att7 navigate.att8 navigate.att9	3 X 3 X 4-byte float	The rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time.
Greenwich Hour Angle	navigate.greenHourAng	4-byte float	The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

D-hat (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
D-hat	dHat(nray)	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. 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: $\mu = -4 + 1/(0.1521 dHat^{0.23} rHat^{0.074})$ $\Lambda = 1/ (0.1521 dHat^{1.33} rHat^{0.23})$ $N_0 = 55\ rHat \Lambda^{\mu+4} / (\Gamma(\mu+4)(1 - (1+ 0.53/\Lambda)^{-\mu-4})$ Similarly, the rain rate rHat mm/hr can be converted into a liquid (+ice) water M (g/m^3) using the formula: $M = 0.02878 rHat/(1 - (1+ 0.53/\Lambda)^{-\mu-4})$ 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 $dHat = D^* rHat^{-0.155}$ (with rHat in mm/hr).

Sigma-D-hat (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Sigma-D-hat	sigmaDhat(nray)	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.

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

Name	Name in the TOOLKIT	Format	Description
Epsilon	epsilon	2-byte integer	Epsilon is the correction made to the input path-integrated attenuation estimate. It ranges from -50.0 to 50.0 dB and is multiplied by 10 and stored as a two-bye integer. The accuracy is 0.1 dB.

Sigma-epsilon (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Sigma-epsilon	sigmaEpsilon	2-byte integer	Sigma-epsilon is the RMS uncertainty in the correction made to the input path-integrated attenuation estimate. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1dB.

R-hat (SDS, array size Nradarrange x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
R-hat	rHat(Nradarrange,nray)	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):

Name	Name in the TOOLKIT	Format	Description
Sigma-R-hat	sigmaRHat(Nradarrange, nray)	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.

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

Name	Name in the TOOLKIT	Format	Description
PIA	pia(nray)	2-byte integer	PIA is the PR + TMI estimate of the path-integrated one-way radar attenuation. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1 dB.

Sigma-PIA (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Sigma-PIA	sigmaPIA(nray)	2-byte integer	Sigma-PIA is the RMS uncertainty in PIA. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as an integer. The accuracy is 0.1 dB.

TMI-PIA (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
TMI-PIA	tmiPIA(nray)	2-byte integer	TMI-PIA is the TMI-based estimate of the one-way path-integrated radar attenuation. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1 dB.

Sigma-TMI-PIA (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Sigma-TMI-PIA	sigmaTMIpia(nray)	2-byte integer	Sigma-TMI-PIA is the RMS uncertainty in the TMI-PIA. It ranges from 0.0 to 50.0 dB and is multiplied by 10 and stored as a two-byte integer. The accuracy is 0.1 dB.

RR-Surf (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
RR-Surf	rrSurf(nray)	2-byte integer	The RR-Surf is the surface rainrate. 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-RR-Surf (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Sigma-RR-Surf	sigmaRRsurf(nray)	2-byte integer	The Sigma-RR-Surf is the RMS uncertainty in RR-Surf. 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 0.5mm/hr.

* "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”.

QAC	scanStatus.qac	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	scanStatus.geoQuality	1-byte integer	Geolocation quality is a summary of geolocation quality in the scan. A zero integer value indicates 'good' geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i): Bit Meaning if bit = 1 0 latitude limit error 1 geolocation discontinuity 2 attitude change rate limit error 3 attitude limit error 4 satellite undergoing maneuvers 5 using predictive orbit data 6 geolocation calculation error 7 not used
Data Quality	scanStatus.dataQuality	1-byte integer	Data quality is a summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). Bit Meaning if bit = 1 0: missing 5: Geolocation Quality is not normal 6: Validity is not normal
Current Spacecraft Orientation	scanStatus.scOrient	1-byte integer	Value Meaning 0: +x forward 1: -x forward 2: -y forward 3: Inertial - CERES Calibration 4: Unknown Orientation
Current ACS Mode	scanStatus.acsMode	1-byte integer	Value Meaning 0: Standby 1: Sun Acquire 2: Earth Acquire 3: Yaw Acquire 4: Nominal 5: Yaw Maneuver 6: Delta-H (Thruster) 7: Delta-V (Thruster) 8: CERES Calibration
Yaw Update Status	scanStatus.yawUpdateS	1-byte integer	Value Meaning 0: Inaccurate 1: Indeterminate 2: Accurate
PR Mode	scanStatus.prMode	1-byte integer	Value Meaning 0: Other Mode 1: Observation Mode
PR Status 1	scanStatus.prStatus1	1-byte integer	The flags listed here indicate warnings of PR conditions (noise level, echo power and echo position, and mode change). In data processing, users should be cautions with the following as a scan with non-zero status includes questionable range bins or angle bins. 0: LOGAMP noise limit error 1: Noise level limit error (The meaning of this warning is the same as the System Noize Warning Flag) 2: Out of PR dynamic range (Surface echo is so strong that it exceeds the PR receiver dynamic range. Calibration with the saturated echo may be questionable.) 3: Not reach surface position (If Surface echo is out of range window, Bin Surface Peak and related data become uncertain.) 7: FCIF mode change

PR Status 2	scanStatus.prStatus2	1-byte integer	In some cases, antenna sidelobes are directed to nadir receive surface echo positions. When the main beam is off nadir, the timing of such nadir-surface clutter can contaminate the rain echo. In "PR STATUS2," a warning flag is set ON (1) when the nadir surface echo (at the nadir angle bin #25) exceeds a predetermined threshold. When the flag is ON, please be careful about the echoes at all angle bins around the same logical range bin number as the Bin-surface-peak at nadir (angle bin number 25).
Fractional Orbit Number	scanStatus.fracOrbitN	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Scan Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata, record size 88 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Geocentric Position [3]	navigate.scPosX navigate.scPosY navigate.scPosZ	3 X 4-byte float	The position (m) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). The order of components is: x, y, and z. Geocentric Inertial Coordinates are also commonly known as Earth Centered Inertial coordinates. These coordinates will be True of Date (rather than Epoch 2000 which are also commonly used), as interpolated from the data in the Flight Dynamics Facility ephemeris files generated for TRMM.
Spacecraft Geodetic Velocity [3]	navigate.scVelX navigate.scVelY navigate.scVelZ	3 X 4-byte float	The velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of components is: x, y, and z.
Spacecraft Geodetic Latitude	navigate.scLat	4-byte float	The geodetic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.
Spacecraft Geodetic Longitude	navigate.scLon	4-byte float	The geodetic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Range is -180 to 179.999999.
Spacecraft Geodetic Altitude	navigate.scAlt	4-byte float	The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time.
Spacecraft Attitude [3]	navigate.scAttRoll navigate.scAttPitch navigate.scAttYaw	3 X 4-byte float	The satellite attitude Euler angles 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.
Sensor Orientation Matrix [3 X 3]	navigate.att1 navigate.att2 navigate.att3 navigate.att4 navigate.att5 navigate.att6 navigate.att7 navigate.att8 navigate.att9	3 X 3 X 4-byte float	The rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time.
Greenwich Hour Angle	navigate.greenHourAng	4-byte float	The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

Rain Rate (SDS, array size ncell x nray x nscan, 2-bytes integer):

Name	Name in the TOOLKIT	Format	Description
Rain Rate	rain(ncell1,nray)	2-byte integer	This is the estimate of rain rate at the radar range gates from 0 to 20 km. It ranges from 0.0 to 300.0 mm/h^{-1} and is multiplied by 10 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):

Name	Name in the TOOLKIT	Format	Description
Reliability	reliab(ncell1,nray)	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 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):

Name	Name in the TOOLKIT	Format	Description
Corrected Z-factor	correctZFactor(ncell1,nray)	2-byte integer	This is the attenuation corrected Z-factor at the radar range gates from 0 to 20 km. It ranges from 0.1 to 80.0 dB of mm 6 m -3 and is multiplied by 10 and stored as a 2-byte integer. A value of -88.88 dB (stored as -889) means ground clutter. A value of -77.77 dB (stored as -778) mans Z was less than 0 dBZ.

Attenuation Parameter Node (SDS, array size ncell2 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Attenuation Parameter Node	attenparmNode(ncell2,nray)	2-byte integer	The Attenuation Parameter Node gives the range bin numbers of the nodes at which the values of Attenuation Parameter Alpha are given (see below). The values of Alpha 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):

Name	Name in the TOOLKIT	Format	Description
Attenuation Parameter Alpha	attenParmAlpha(ncell2,nray)	2-byte integer	The attenuation parameter Alpha (α) relates the attenuation coefficient, k (dB/km) to the Z-factor: $k = \alpha Z^{\beta}$. a 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):

Name	Name in the TOOLKIT	Format	Description
Attenuation Parameter Beta	attenParmBeta(nray)	2-byte integer	The Attenuation Parameter Beta (β) relates the attenuation coefficient, k (dB/km) to the Z-factor: $k = \alpha Z^{\beta}$. b is computed at ncell2 radar range gates 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 Node (SDS, array size ncell2 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Z-R Parameter Node	ZRParmNode(ncell2,nray)	2-byte integer	The Z-R Parameter Node gives the range bin numbers of the nodes at which the Z-R parameters “a” and “b” are given (see below). The values of a and b between the nodes are linearly interpolated. This variable ranges from 0 and 79 and is unitless.

Z-R Parameter a (SDS, array size ncell2 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Z-R Parameter a	ZRParmA(ncell2,nray)	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 (ζ) and the correction factor (ε) for the surface reference technique. a is computed at 10 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):

Name	Name in the TOOLKIT	Format	Description
Z-R Parameter b	ZRParmB(ncell2,nray)	2-byte integer	Parameter b for Z-R relationship (R=aZ) is determined from the rain type and the height relative to the freezing level, the non-uniformity parameter (ζ) and the correction factor (ε) for the surface reference technique. b is computed at 10 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.

Maximum Z (SDS, array size nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Maximum Z	zmmax(nray)	4-byte float	This is the maximum value of measured reflectivity at each IFOV. It

Rain Flag (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Rain Flag	rainFlag(nray)	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 broad 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

Range Bin Number (SDS, array size 6 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Range Bin Number	rangeBinNum(6,nray)	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 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):

Name	Name in the TOOLKIT	Format	Description
Averaged Rain Rate	rainAve(2,nray)	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 3000 mm km h^{-1} and is multiplied by 10 and stored as a 2-byte integer.

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

Name	Name in the TOOLKIT	Format	Description
Weight	weightW(nray)	2-byte integer	The Weight is the weighting function of an estimate of the path-integrated attenuation and its reliability. It ranges from 0.000 to 1.000 and is multiplied by 10^3 and stored as a 2-byte integer.

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

Name	Name in the TOOLKIT	Format	Description
Method Flag	method	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). Bits 0 and 1 contain the following values: 0 - rain over ocean 1 - rain over land 2 - rain over coast 3 - rain over other surface (inland lake, etc.) The following meanings are assigned to the other bits in the 16-bit integer if the bit = 1. · bit 2 constant-Z-near-surface method · bit 3 rain less than 5 bins · bit 4 not enough (<5) successive rain data · bit 5 positive slope near surface · bit 6 zeta ≥ 1.0 · bit 7 quadratic weighting · bit 8 NUBF correction very large (> 2.0) · bit 9 No NUBF because NSD unreliable · bit 10 NUBF for Z-R below lower bound · bit 11 NUBF for PIA above upper bound · bit 12 NUBF for PIA below lower bound · bit 13 surface attenuation after NUBF correction > 60 dB · bit 14 data missing between rain top and bottom · bit 15 not used

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

Name	Name in the TOOLKIT	Format	Description
Epsilon	epsilon(nray)	4-byte float	The Epsilon (ε) is the correction factor for the surface reference. It ranges from 0.0 to 100.0.

Zeta (SDS, array size nmeth x nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Zeta	zeta(ngeo,nray)	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):

Name	Name in the TOOLKIT	Format	Description
Zeta_mn	zeta_mn(ngeo,nray)	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):

Name	Name in the TOOLKIT	Format	Description
Rain Oversample	zeta_sd(ngeo,nray)	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):

Name	Name in the TOOLKIT	Format	Description
Xi	xi(ngeo,nray)	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.

Thresholded PIZ Thickness (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Thresholded PIZ Thickness	thickThPIZ(nray)	2-byte integer	This is the number of range bins (250m resolution) between the highest range at which rain is certain and the range at which the Path-Integrated Z-factor (PIZ) first exceeds a threshold. This is a unitless quantity and it ranges from 0 to 79.

NUBF Correction Factor (SDS, array size 2 x nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
NUBF Correction Factor	nubfCorrectFactor(ngeo, nray)	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 2.0 and .9 to 1.0, respectively. Both are unitless quantities.

Quality Flag (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Quality Flag	qualityFlag(nray)	2-byte integer	This quality flag gives the overall error that affects the entire angle bin data, such as the error associated with the non-uniform beam filling effect and the surface reference reliability. It ranges from 0 to 255. If data are missing, the reliability will be set as 10000000 in binary. 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. · bit 0 unusual situation in rain average · bit 1 mean of zeta too small for NSD (xi) calculation · bit 2 NSD of zeta (xi) calculated from less than 6 points · bit 3 mean of PIA too small for NSD (PIA) calculation · bit 4 NSD of PIA calculated from less than 6 points · bit 5 epsilon not reliable (sigma0 marginally reliable) · bit 6 2A21 input data not reliable · bit 7 2A23 input data not reliable · bit 8 range bin error · bit 9 sidelobe clutter removal · 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

Near Surface Rain (SDS, array size nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Near Surface Rain	nearSurfRain(nray)	4-byte float	Rainfall rate near the surface. The range is 0 to 3000 mm/hr.

Near Surface Z (SDS, array size nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Near Surface Z	nearSurfZ(nray)	4-byte float	Reflectivity near the surface. The range is 0.0 to 100.0 dBZ.

PIA 2A25 (SDS, array size nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description

PIA 2A25	pia2a25(nray)	4-byte float	The Path Integrated Attenuation (PIA) estimated by 2A25 The range is 0.0 to 50.0 dB.

Error Rain (SDS, array size nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Error Rain	errorRain(nray)	4-byte float	The error in Near Surface Rain Rate. The range is 0 to 3000 mm/hr.

Error Z (SDS, array size nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Error Z	errorZ(nray)	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):

Name	Name in the TOOLKIT	Format	Description
Spare	spare(ngeo,nscan)	4-byte float	Contents and ranges are not public.

Data Quality	scanStatus.dataQuarity	1-byte	Data quality is a summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). Bit Meaning if bit = 1 0: missing 5: Geolocation Quality is not normal 6: Validity is not normal
Current Spacecraft Orientation	scanStatus.scOrient	1-byte integer	Value Meaning 0: +x forward 1: -x forward 2: -y forward 3: Inertial - CERES Calibration 4: Unknown Orientation
Current ACS Mode	scanStatus.acsMode	1-byte integer	Value Meaning 0: Standby 1: Sun Acquire 2: Earth Acquire 3: Yaw Acquire 4: Nominal 5: Yaw Maneuver 6: Delta-H (Thruster) 7: Delta-V (Thruster) 8: CERES Calibration
Yaw Update Status	scanStatus.yawUpdateS	1-byte integer	Value Meaning 0: Inaccurate 1: Indeterminate 2: Accurate
PR Mode	scanStatus.prMode	1-byte integer	Value Meaning 0: Other Mode 1: Observation Mode
PR Status 1	scanStatus.prStatus1	1-byte integer	The flags listed here indicate warnings of PR conditions (noise level, echo power and echo position, and mode change). In data processing, users should be cautions with the following as a scan with non-zero status includes questionable range bins or angle bins. 0: LOGAMP noise limit error 1: Noise level limit error (The meaning of this warning is the same as the System Noize Warning Flag) 2: Out of PR dynamic range (Surface echo is so strong that it exceeds the PR receiver dynamic range. Calibration with the saturated echo may be questionable.) 3: Not reach surface position (If Surface echo is out of range window, Bin Surface Peak and related data become uncertain.) 7: FCIF mode change
PR Status 2	scanStatus.prStatus2	1-byte integer	In some cases, antenna sidelobes are directed to nadir receive surface echo positions. When the main beam is off nadir, the timing of such nadir-surface clutter can contaminate the rain echo. In "PR STATUS2," a warning flag is set ON (1) when the nadir surface echo (at the nadir angle bin #25) exceeds a predetermined threshold. When the flag is ON, please be careful about the echoes at all angle bins around the same logical range bin number as the Bin-surface-peak at nadir (angle bin number 25).
Fractional Orbit Number	scanStatus.fracOrbitN	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Scan Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata, record size 88 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Geocentric Position [3]	navigate.scPosX navigate.scPosY navigate.scPosZ	3 X 4-byte float	The position (m) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). The order of components is: x, y, and z. Geocentric Inertial Coordinates are also commonly known as Earth Centered Inertial coordinates. These coordinates will be True of Date (rather than Epoch 2000 which are also commonly used), as interpolated from the data in the Flight Dynamics Facility ephemeris files generated for TRMM.
Spacecraft Geocentric Position [3] Velocity [3]	navigate.scVelX navigate.scVelY navigate.scVelZ	3 X 4-byte float	The velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of components is: x, y, and z.
Spacecraft Geodetic Latitude	navigate.scLat	4-byte float	The geodetic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.
Spacecraft Geodetic Longitude	navigate.scLon	4-byte float	The geodetic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Range is -180 to 179.999999.
Spacecraft Geodetic Altitude	navigate.scAlt	4-byte float	The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time.
Spacecraft Attitude [3]	navigate.scAttRoll navigate.scAttPitch navigate.scAttYaw	3 X 4-byte float	The satellite attitude Euler angles 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.
Sensor Orientation Matrix [3 X 3]	navigate.att1 navigate.att2 navigate.att3 navigate.att4 navigate.att5 navigate.att6 navigate.att7 navigate.att8 navigate.att9	3 X 3 X 4-byte float	The rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time.
Greenwich Hour Angle	navigate.greenHourAng	4-byte float	The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

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

Name	Name in the TOOLKIT	Format	Description
Rain Flag	rainFlag(nary)	1-byte integer	The Rain Flag is almost 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):

Name	Name in the TOOLKIT	Format	Description

Rain Type Flag	rainType(nray)	1-byte integer	The Rain Type Flag is set as follows:
			10: Stratiform certain.
			When R_type_V = T_stra; (BB exists)
			and R_type_H = T_stra;
			11: Stratiform certain.
			When R_type_V = T_stra; (BB exists)
			and R_type_H = T_others;
			12: Probably stratiform.
			When R_type_V = T_others;
			and R_type_H = T_stra;
			13: Maybe stratiform.
			When R_type_V = T_stra; (BB detection certain)
			and R_type_H = T_conv;
			14: Maybe stratiform or maybe transition or something else.
			When R_type_V = T_others; (BB hardly expected)
			and R_type_H = T_stra;
			15: Maybe stratiform.
			Shallow isolated (type of warm rain) is detected
			When R_type_V = T_others;
			R_type_H = T_stra;
			and warmRain > 0;
			20: Convective certain.
			When R_type_V = T_conv; (no BB)
			and R_type_H = T_conv;
			21: Convective certain.
			When R_type_V = T_others;
			and R_type_H = T_conv;
			22: Convective certain.
			When R_type_V = T_conv;
			and R_type_H = T_others;
			23: Probably convective.
			When R_type_V = T_conv; (BB exists)
			and R_type_H = T_conv;
			24: Maybe convective.
			When R_type_V = T_conv;
			and R_type_H = T_stra;
			25: Maybe convective.
			When R_type_V = T_stra; (BB detection not so confident)
			and R_type_H = T_conv;
			26: Convective.
			Shallow isolated (type of warm rain) is detected
			When R_type_V = T_conv;
			R_type_H = T_conv;
			and warmRain > 0;
			27: Convective.
			Shallow isolated (type of warm rain) is detected
			When R_type_V = T_conv;
			R_type_H = T_others;
			and warmRain > 0;

			28: Convective. Shallow isolated (type of warm rain) is detected When R_type_V = T_ others; R_type_H = T_ conv; and warmRain > 0; 29: Convective. Shallow isolated (type of warm rain) is detected When R_type_V = T_conv; R_type_H = T_stra; and warmRain > 0; 30: Others. When R_type_V = T_others; and R_type_H = T_others; 31: Others. Shallow isolated (type of warm rain) is detected. When R_type_V = T_others, R_type_H = T_others; and warmRain > 0; 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: Rain Type Flag / 10 = 1: stratiform, 2: convective, 3: others. Rain Type Flag % 10 = This indicates the level of confidence, which decreases as the number increases. where Rain Type Flag % 10 means MOD (Rain Type Flag, 10) in FORTRAN. When it is “no rain” or “data missing”, Rain Type Flag contains the following values: -88: no rain -99: data missing

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

Name	Name in the TOOLKIT	Format	Description
Warm Rain Flag	warmRain(nray)	1-byte integer	The Warm Rain Flag is set as follows: 0: warm rain is not detected; 1: there may be “warm” rain; 2: warm rain is detected (with high confidence). -88: no rain -99: data missing

Status Flag (SDS, array size nray x nscan, 1-byte integer):

Name	Name in the TOOLKIT	Format	Description
Status Flag	status(nray)	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 (over ocean) (BB detection is good or BB does not exist) 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 (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 (over coastline) (BB detection is good or BB does not exist) 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 (over inland lake) (BB detection is good or BB does not exist) 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 goodwhenstatus ³100 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 Status % 10 = 0: over ocean 1 : overland 2 : overcoastline 4 : overinlandlake 9 : land/seaun known 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.

Range Bin Number (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Range Bin Number	rangeBinNum(nray)	2-byte integer	A positive Range Bin Number corresponds to the height of bright band. Negative values are defined as follows: -1111: No bright band -8888: No rain

Height of Bright Band (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Height of Bright Band	HBB(nray)	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

Height of Freezing Level (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Height of Freezing Level	freezH(nray)	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):

Name	Name in the TOOLKIT	Format	Description
Height of Storm	stormH(nray)	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

Bright Band Intensity (SDS, array size nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Bright Band Intensity	BBintensity(nray)	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

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

Name	Name in the TOOLKIT	Format	Description
Spare	spare(nray)	4-byte float	Spare will characterize the width of the bright band. Since this characterization requires much research, the meaning is not disclosed.

Data Quality	scanStatus.dataQuarity	1-byte integer	Data quality is a summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). Bit Meaning if bit = 1 0: missing 5: Geolocation Quality is not normal 6: Validity is not normal
Current Spacecraft Orientation	scanStatus.scOrient	1-byte integer	Value Meaning 0: +x forward 1: -x forward 2: -y forward 3: Inertial - CERES Calibration 4: Unknown Orientation
Current ACS Mode	scanStatus.acsMode	1-byte integer	Value Meaning 0 Standby 1 Sun Acquire 2 Earth Acquire 3 Yaw Acquire 4 Nominal 5 Yaw Maneuver 6 Delta-H (Thruster) 7 Delta-V (Thruster) 8 CERES Calibration
Yaw Update Status	scanStatus.yawUpdateS	1-byte integer	Value Meaning 0 Inaccurate 1 Indeterminate 2 Accurate
PR Mode	scanStatus.prMode	1-byte integer	Value Meaning 0 Other Mode 1 Observation Mode
PR Status 1	scanStatus.prStatus1	1-byte integer	The flags listed here indicate warnings of PR conditions (noise level, echo power and echo position, and mode change). In data processing, users should be cautions with the following as a scan with non-zero status includes questionable range bins or angle bins. 0: LOGAMP noise limit error 1: Noise level limit error (The meaning of this warning is the same as the System Noize Warning Flag) 2: Out of PR dynamic range (Surface echo is so strong that it exceeds the PR receiver dynamic range. Calibration with the saturated echo may be questionable.) 3: Not reach surface position (If Surface echo is out of range window, Bin Surface Peak and related data become uncertain.) 7: FCIF mode change
PR Status 2	scanStatus.prStatus2	1-byte integer	In some cases, antenna sidelobes are directed to nadir receive surface echo positions. When the main beam is off nadir, the timing of such nadir-surface clutter can contaminate the rain echo. In “PR STATUS2,” a warning flag is set ON (1) when the nadir surface echo (at the nadir angle bin #25) exceeds a predetermined threshold. When the flag is ON, please be careful about the echoes at all angle bins around the same logical range bin number as the Bin-surface-peak at nadir (angle bin number 25).
Fractional Orbit Number	scanStatus.fracOrbitN	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Scan Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata, record size 88 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Geocentric Position [3]	navigate.scPosX navigate.scPosY navigate.scPosZ	3 X 4-byte float	The position (m) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). The order of components is: x, y, and z. Geocentric Inertial Coordinates are also commonly known as Earth Centered Inertial coordinates. These coordinates will be True of Date (rather than Epoch 2000 which are also commonly used), as interpolated from the data in the Flight Dynamics Facility ephemeris files generated for TRMM.
Spacecraft Geocentric Position [3]	navigate.scVelX navigate.scVelY navigate.scVelZ	3 X 4-byte float	The velocity (ms -1) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of components is: x, y, and z.
Spacecraft Geodetic Latitude	navigate.scLat	4-byte float	The geodetic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.
Spacecraft Geodetic Longitude	navigate.scLon	4-byte float	The geodetic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Range is -180 to 179.999999.
Spacecraft Geodetic Altitude	navigate.scAlt	4-byte float	The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time.
Spacecraft Attitude [3]	navigate.scAttRoll navigate.scAttPitch navigate.scAttYaw	3 X 4-byte float	The satellite attitude Euler angles 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.
Sensor Orientation Matrix [3 X 3]	navigate.att1 navigate.att2 navigate.att3 navigate.att4 navigate.att5 navigate.att6 navigate.att7 navigate.att8 navigate.att9	3 X 3 X 4-byte float	The rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time.
Greenwich Hour Angle	navigate.greenHourAng	4-byte float	The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

Sigma-zero (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Sigma-zero	sigmaZero(nray)	2-byte	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):

Name	Name in the TOOLKIT	Format	Description
Path Attenuation	pathAtten(nray)	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 and is multiplied by 100 and stored as a 2- byte integer.

Reliability Flags (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Reliability Flags	reliabFlag(nray)	2-byte integer	Reliability Flags holds various information in the form of single digit nteger 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 swa = 4 (Peak surface return not at normally-sampled gate - outside central swath) z = 0 (ocean) = 1 (land) = 2 (coast) = 3 (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):

Name	Name in the TOOLKIT	Format	Description
Reliability Factor	reliabFactor(nray)	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):

Name	Name in the TOOLKIT	Format	Description
Incident Angle	incAngle(nray)	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):

Name	Name in the TOOLKIT	Format	Description
Rain Flag	rainFlag(nary)	2-byte integer	The Rain Flag has the following values: 0: no rain; 1: rain present.

Geolocation Quality	scanStatus.geoQuality	1-byte integer	Geolocation Quality is broken into 8 one-bit flags. Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) -1). A value of 0 indicates 'good' quality, and 1 indicates 'bad' quality. Each flag is listed below. Note that ranges indicated will be refined in early-orbit check out. Bit Meaning if bit = 1 0: Grossly bad geolocation results: - Spacecraft position vector magnitude outside range 6720 to 6740 km. - Z component of midpoint of scan outside range -4100 to 4100 km. - Distance from S/C to midpoint of scan outside range 340 to 360 km. 1: Unexpectedly large scan to scan jumps in geolocated positions in along and cross track directions for first, middle, and last pixels in each scan. Allowed duration from nominal jump in along track motion = 0.06 km (first pixel), 0.04 km (middle pixel), and 0.06 km (last pixel). Allowed duration from nominal jump in cross track motion = 0.05 km (first pixel), 0.04 km (middle pixel), and 0.05 km (last pixel). Bit set in normal mode only. 2: Scan to scan jumps in yaw, pitch, and roll exceed maximum values. Values are : yaw = 0.0001 radians; pitch = 0.0001 radians; roll = 0.0001 radians. Bit set in normal control mode only. In normal mode, yaw outside range (-0.003, 0.003) radians; pitch outside range (-0.007, 0.007) radians; roll outside range (-0.007, 4: Satellite undergoing maneuvers during which geolocation will be less accurate. 5: Questionable ephemeris quality (including use of predicted Ephemeris for quicklook) or questionable UTCF quality. 6: Geolocation calculations failed (fill values inserted in the per pixel geolocation products, but not in metadata). 7: Missing attitude data. ACS data gap larger than 20 seconds.
Data Quality [9]	scanStatus.ch1 scanStatus.ch2 scanStatus.ch3 scanStatus.ch4 scanStatus.ch5 scanStatus.ch6 scanStatus.ch7 scanStatus.ch8 scanStatus.ch9	9 x 1-byte integer	The Quality of Channel Data for a given channel on a given scan line is the percentage of pixels whose values are within the acceptable range listed in the Metadata. Quality is given for each channel in the order of the channel number.
Current Spacecraft Orientation	scanStatus.scOrient	1-byte integer	Value Meaning 0: +x forward 1: -x forward 2: -y forward 3: Inertial - CERES Calibration 4: Unknown Orientation
Current ACS Mode	scanStatus.acsMode	1-byte integer	Value Meaning 0: Standby 1: Sun Acquire 2: Earth Acquire 3: Yaw Acquire 4: Nominal 5: Yaw Maneuver 6: Delta-H (Thruster) 7: Delta-V (Thruster) 8: CERES Calibration
Yaw Update Status	scanStatus.yawUpdateS	1-byte integer	Value Meaning 0: Inaccurate 1: Indeterminate 2: Accurate

TMI Instrument Status	scanStatus.tmiISstatus	1-byte integer	Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1). Bit Meaning 00 Receiver Status (1=ON, 0=OFF) 01 Spin-up Status (1=ON, 0=OFF) 02 Spare Command 1 Status 03 Spare Command 2 Status 04 1 Hz Clock Select (1=A, 0=B) 05 21 GHz Cold Count Flag 06 Spare Command 4 Status 07 Spare Command 5 Status
Fractional Orbit Number	scanStatus.fracOrbitN	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata, record size 88 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Geocentric Position [3]	navigate.scPosX navigate.scPosY navigate.scPosZ	3 X 4-byte float	The position (m) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). The order of components is: x, y, and z. Geocentric Inertial Coordinates are also commonly known as Earth Centered Inertial coordinates. These coordinates will be True of Date (rather than Epoch 2000 which are also commonly used), as interpolated from the data in the Flight Dynamics Facility ephemeris files generated for TRMM.
Spacecraft Geocentric Position [3]	navigate.scVelX navigate.scVelY navigate.scVelZ	3 X 4-byte float	The velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of components is: x, y, and z.
Spacecraft Geodetic Latitude	navigate.scLat	4-byte float	The geodetic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.
Spacecraft Geodetic Longitude	navigate.scLon	4-byte float	The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Range is -180 to 179.999999.
Spacecraft Geodetic Altitude	navigate.scAlt	4-byte float	The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time.
Spacecraft Attitude [3]	navigate.scAttRoll navigate.scAttPitch navigate.scAttYaw	3 X 4-byte float	The satellite attitude Euler angles 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.
Sensor Orientation Matrix [3 X 3]	navigate.att1 navigate.att2 navigate.att3 navigate.att4 navigate.att5 navigate.att6 navigate.att7 navigate.att8 navigate.att9	3 X 3 X 4-byte float	The rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time.
Greenwich Hour Angle	navigate.greenHourAng	4-byte float	The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

Data Flag (SDS, array size npixel x nscan, 1-bytes integer):

Name	Name in the TOOLKIT	Format	Description
Data Flag	dataFlag (npixel1)	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):

Name	Name in the TOOLKIT	Format	Description
Rain Flag	rainFlag (npixel)	1-byte integer	The Rain Flag indicates if rain is possible. If the value is greater than or equal to zero rain is possible. If the value is less than zero the pixel has been pre-screened as non-raining; the exact value is used to identify the screen itself.

Surface Flag (SDS, array size npixel x nscan, 1-byte integer):

Name	Name in the TOOLKIT	Format	Description
Surface Flag	surfaceFlag (npixel)	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):

Name	Name in the TOOLKIT	Format	Description
Surface Rain	surfaceRain (npixel1)	4-byte float	The Surface Rain is the instantaneous rain rate (mm/h) at the surface for each pixel. It ranges between 0.0 and 3000.0 mm/h.

Convect Surface Rain (SDS, array size npixel1 x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Convect Surface Rain	convectRain (npixel)	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

Confidence (SDS, array size npixel x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Confidence	confidence (npixel)	4-byte float	The Confidence is that associated with the surface rain. It is measured as an rms deviation in temperatures with units in degrees (K). The data range is 0.0 to 300.0K

The following five 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):

Name	Name in the TOOLKIT	Format	Description
Cloud Liquid Water	cldWater (nlayer,npixel)	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.

Precipitation Water (SDS, array size nlayer x npixel x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Precipitation Water	precipWater (nlayer,npixel)	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.

Cloud Ice Water (SDS, array size nlayer x npixel x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Cloud Ice Water	cldIce (nlayer,npixel)	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.

Precipitation Ice (SDS, array size nlayer x npixel x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Precipitation Ice	precipIce (nlayer,npixel)	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.

Latent Heating (SDS, array size nlayer x npixel x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Latent Heating	latentHeat (nlayer,npixel)	2-byte integer	This is the latent heating release (°C/day) for each pixel at 14 layers. It is multiplied by 10 and stored as a 2-byte integer. Ranges are -256 deg/hour to 256 deg/hour.

Starting Bin Distance is determined by the sampling timing of the PR. The distance between the satellite and the center of the Nth normal sample bin is calculated as follows:

Distance = “Starting Bin Distance” + “Range Bin Size” × (N-1)

This distance is defined as the center of a radar resolution volume which extends ± 125 m .

d) Rain Thresholds are used in the minimum echo test.

e) Beam widths, both along track beam width and cross track beam width, are recorded based on the fact that the PR main beam is assumed to have a two-dimensional Gausian beam pattern.

f) “Equivalent Wavelength” $= 2c/(f_1 + f_2)$
where c is the speed of light, and f1 and f2 are PR’s two frequencies.

g) Radar Constant is defined as follows, and is used in the radar equation:

$$C0 = 10\log\left[\pi^3 \frac{|K|^2}{2^{10}\ln 2} 10^{-18}\right]$$

$$K = (\varepsilon - 1)/(\varepsilon + 2)$$

ε: *the relative dielectric constant of water*

$$|K|^2 = 0.2355$$

$|K|$ is the calculated value at 13.8 GHz and 0 degree C based on Ray (1972). With this constant, users can convert from PR receiving powers to rain reflectivity. (See the 1C products.)

h) Range Bin Size is the PR range resolution and is the width at which pulse electric power decreases 6dB (-6 dB width).

i) Logarithmic Averaging Offset is the offset value between the logarithmic average and the power-linear average. The PR outputs the data of 1 range bin which is the average of 64 LOGAMP outputs. “Received power” in the PR1B21 output is corrected for the bias error caused by the logarithmic average and is thus equal to normal average power.

j) Main Lobe Clutter Edge is a parameter previously used as the lowest range bin for the minimum echo test. This is the absolute value of the difference in range bin number between the surface peak and the edge of the clutter from the main lobe.

k) Absolute value of the difference in Range bin numbers between the bin number of the surface peak and the possible clutter position. A maximum of three range bins can be allocated as "possible" clutter locations. “Zero” indicates no clutter.

Note: Items j) and k) are not useful for detailed examination of radar echo range profile, especially over land.

*1 If there is no attitude error, +X (or sometimes –X, see Spacecraft Orientation in Scan Status) is along the spacecraft flight direction, +Z is along the local nadir, and +Y is defined so that the coordinates become a right-hand Cartesian system.

PR Power 1B-21 Swath Data [L1B 21 SWATHDATA]

The following sizing parameters are used in describing the format:
· nray = the number of rays = 49
· nscan = the number of scans within one granule = 9150, on average

Scan Time (Vdata Table, record size 8 bytes, nscan records)

Name	Name in the TOOLKIT	Format	Description
Scan Time	scanTime	8-byte float	Scan Time is the center time of 1 scan (the time at center of the nadir beam transmitted pulse). It is expressed as the UTC seconds of the day.

Geolocation (SDS, array size 2 x nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Geolocation	geolocation(2,4nray)	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 pixels and scans. Values are represented as floating point decimal degrees. Off earth is represented as less than or equal to -9999.9 Latitude is positive north, negative south. Longitude is positive east, negative west. A point on the 180º 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.

Name	Name in the TOOLKIT	Format	Description
Missing	scanStatus.missing	1-byte integer	Missing indicates whether information is contained in the scan data. The values are: 0: Scan data elements contain information 1: Scan was missing in the telemetry data 2: Scan data contains no elements with rain
Validity	scanStatus.validity	1-byte integer	Validity is a summary of status modes. If all status modes are routine, all bits in Validity = 0. Routine means that scan data has been measured in the normal operational situation as far as the status modes are concerned. Validity does not assess data or geolocation quality. Validity is broken into 8 bit flags. Each bit = 0 if the status is routine but the bit = 1 if the status is not routine. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). The non-routine situations follow: Bit Meaning if bit = 1 0 Spare (always 0) 1 Non-routine spacecraft orientation (2 or 3) 2 Non-routine ACS mode (other than 4) 3 Non-routine yaw update status (0 or 1) 4 Non-routine instrument status (other than 1) 5 Non-routine QAC (non-zero) 6 Spare (always 0) 7 Spare (always 0)
QAC	scanStatus.qac	1-byte integer	The Quality and Accounting Capsule of the Science packet as it appears in Level-0 data. If no QAC is given in Level-0, which means no decoding errors occurred, QAC in this format has a value of zero.
Geolocation Quality	scanStatus.geoQuality	1-byte integer	Geolocation quality is a summary of geolocation quality in the scan. A zero integer value indicates 'good' geolocation. A non-zero value broken down into the following bit flags indicates the following, where bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0 the unsigned integer value is 2**i): Bit Meaning if bit = 1 0 latitude limit error 1 geolocation discontinuity 2 attitude change rate limit error 3 attitude limit error 4 satellite undergoing maneuvers 5 using predictive orbit data 6 geolocation calculation error 7 not used

Data Quality	scanStatus.dataQuarity	1-byte integer	Data quality is a summary of data quality in the scan. Unless this is 0 (normal), the scan data is meaningless to higher processing. Bit 0 is the least significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**i). Bit Meaning if bit = 1 0 missing 5 Geolocation Quality is not normal 6 Validity is not normal
Current Spacecraft Orientation	scanStatus.scOrient	1-byte integer	Value Meaning 0 +x forward 1 -x forward 2 -y forward 3 Inertial - CERES Calibration 4 Unknown Orientation
Current ACS Mode	scanStatus.acsMode	1-byte integer	Value Meaning 0 Standby 1 Sun Acquire 2 Earth Acquire 3 Yaw Acquire 4 Nominal 5 Yaw Maneuver 6 Delta-H (Thruster) 7 Delta-V (Thruster) 8 CERES Calibration
Yaw Update Status	scanStatus.yawUpdateS	1-byte integer	Value Meaning 0 Inaccurate 1 Indeterminate 2 Accurate
PR Mode	scanStatus.prMode	1-byte integer	Value Meaning 0 Other Mode 1 Observation Mode
PR Status 1	scanStatus.prStatus1	1-byte integer	The flags listed here indicate warnings of PR conditions (noise level, echo power and echo position, and mode change). In data processing, users should be cautions with the following as a scan with non-zero status includes questionable range bins or angle bins. 0: LOGAMP noise limit error 1: Noise level limit error (The meaning of this warning is the same as the System Noize Warning Flag) 2: Out of PR dynamic range (Surface echo is so strong that it exceeds the PR receiver dynamic range. Calibration with the saturated echo may be questionable.) 3: Not reach surface position (If Surface echo is out of range window, Bin Surface Peak and related data become uncertain.) 7: FCIF mode change
PR Status 2	scanStatus.prStatus2	1-byte integer	In some cases, antenna sidelobes are directed to nadir receive surface echo positions. When the main beam is off nadir, the timing of such nadir-surface clutter can contaminate the rain echo. In “PR STATUS2,” a warning flag is set ON (1) when the nadir surface echo (at the nadir angle bin #25) exceeds a predetermined threshold. When the flag is ON, please be careful about the echoes at all angle bins around the same logical range bin number as the Bin-surface-peak at nadir (angle bin number 25).
Fractional Orbit Number	scanStatus.fracOrbitN	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Scan Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata, record size 88 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Geocentric Position [3]	navigate.scPosX navigate.scPosY navigate.scPosZ	3 X 4-byte float	The position (m) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). The order of components is: x, y, and z. Geocentric Inertial Coordinates are also commonly known as Earth Centered Inertial coordinates. These coordinates will be True of Date (rather than Epoch 2000 which are also commonly used), as interpolated from the data in the Flight Dynamics Facility ephemeris files generated for TRMM.
Spacecraft Geocentric Position [3]	navigate.scVelX navigate.scVelY navigate.scVelZ	3 X 4-byte float	The velocity (ms -1) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of components is: x, y, and z.
Spacecraft Geodetic Latitude	navigate.scLat	4-byte float	The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.
Spacecraft Geodetic Latitude	navigate.scLon	4-byte float	The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Range is -180 to 179.999999.
Spacecraft Geodetic Latitude	navigate.scAlt	4-byte float	The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time. The satellite attitude Euler angles at the Scan
Spacecraft Attitude [3]	navigate.scAttRoll navigate.scAttPitch navigate.scAttYaw	3 X 4-byte float	The satellite attitude Euler angles 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.
Sensor Orientation Matrix [3 X 3]	navigate.att1 navigate.att2 navigate.att3 navigate.att4 navigate.att5 navigate.att6 navigate.att7 navigate.att8 navigate.att9	3 X 3 X 4-byte float	The rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time.
Greenwich Hour Angle	navigate.greenHourAng	4-byte float	The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

Powers (Vdata Table, record size 6 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Radar Transmission Power	powers.radarTransPower	2-byte integer	The total (sum) power of 128 SSPA elements corrected with SSPA temperature in orbit, based on temperature test data of SSPA transmission power. The units are dBm * 100. For this variable, the TSDIS Toolkit does not provide scaling.
Transmitted Pulse Width	power.transPulseWidth	4-byte float	Transmitted pulse width (s) corrected with FCIF temperature in orbit, based on temperature test data of FCIF.

System Noise (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
System Noise	systemNoise(nray)	2-byte integer	System Noise (dBm) is an average of the 4 measured system noise values, multiplied by 100 and stored as a 2-byte integer. The system noise consists of external noise and PR internal noise, and is recorded as the total equivalent noise power at the PR antenna output.The range is -120 dBm to -20 dBm with an accuracy of 0.9 dBm. Missing data are given the value of -32,734.

System Noise Warning Flag (SDS, array size nray x nscan, 1-byte integer):

Name	Name in the TOOLKIT	Format	Description
System Noise Warning Flag	sysNoiseWarningFlag(nray)	1-byte integer	If the system noise level exceeds the noise level limit, the flag is set to 1. This will occur when (1) a radio interference is received, (2) system noise increases anomalously, or (3) noise level exceeds the limit due to the statistical variation of the noise. In cases (1) and (2), data should be used carefully. In case (3), this flag may be neglected.Received power levels in all range bins will increase in cases (1) and (2) as much as the increase of the system noise. PR may receive radio interference in the following areas. N3.1 E101.7 (in Malaysia) N33.8 W118.2 (around Los Angeles) S34.8 W68.4 (around Santiago) N10.5 W66.9 (in Chili) N4.7 E36.9 (around Ethiopia – Kenya border)

Minimum Echo Flag (SDS, array size nray x nscan, 1-byte integer):

Name	Name in the TOOLKIT	Format	Description
Minimum Echo Flag	minEchoFlag(nray)	1-byte integer	Five values are used in the Minimum Echo Flag: 0 : No rain. (Echoes are very weak.) 10: Rain possible but may be noise. (Some weak echoes above noise exist in clutter free ranges.) 20: Rain certain. (Some strong echoes above noise exist in clutter free ranges.) 11: Rain possible but may be noise or surface clutter. (Some weak echoes exist in possibly cluttered ranges.) 12: Rain possible but may be clutter. (Some strong echoes exist in possibly cluttered ranges.) Please be careful using the Minimum Echo Flag except when it is 0 or 20.

First Echo Height (SDS, array size 2 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
First Echo Height	binStormHeight(2,nray)	2-byte integer	The First Echo Height (storm height) is represented by the logical range bin number (1 to 400, 125-m interval). Two types of First Echo Height are estimated, depending on wheter the minimum echo flag = 10 or 20. (If the first echo is detected below the clutter-free bottom, the two types depend on whether the flag = 11 or 12.)

Range Bin Number of Ellipsoid (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Range Bin Number of Ellipsoid	binEllipsoid(nray)	2-byte integer	Ellipsoid Height is represented by the logical range bin number (1 to 400). This is calculated by the following equation. binEllipsoid[j] = Normal sample start range bin + (Spacecraft Range - Distance between satellite and the normal sample start range)/binsize ×2

Range Bin Number of Clutter-free Bottom (SDS, array size 2 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Range Bin Number of Clutter-free Bottom	binClutterFreeBottom(2,nray)	2-byte integer	This is the bottom range-bin number (logical range bin number) in clutter-free range bins estimated by the algorithm provided by Dr. Awaka (Hokkaido Tokai Univ. in Japan). binClutterFreeBottom(1,49): clutter free certain, binClutterFreeBottom(2,49): clutter free probable.

Range Bin Number of Bottom of DID (SDS, array size 2 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Range Bin Number of Mean DID	binDIDHmean(nray)	2-byte integer	binDIDHmean represents the range bin number corresponding to the mean height of all DID data samples available in a 5×5 km area that overlaps most with the footprint.

Range Bin Number of Top of DID (SDS, array size 2 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Range Bin Number of Top of DID	binDIDHtop(2,nray)	2-byte integer	binDIDHtop(1,46) represents the range bin number corresponding to the highest value (top) of all DID data samples in a 5´5 km box, and binDIDHtop(2,49), the range bin number corresponding to the highest value in a 11´11 km box.

Range Bin Number of Bottom of DID (SDS, array size 2 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Range Bin Number of Bottom of DID	binDIDHbottom(2,nray)	2-byte integer	The definition is the same as that of binDIDHtop(2,49) except that the value represents the lowest value (bottom) of all DID samples in a 5 × 5km or 11×11km box.

Satellite Local Zenith Angle (SDS, array size nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Satellite Local Zenith Angle	scLocalZenith(nray)	4-byte float	The angle, in degrees, between the local zenith and the beam's center line. The local (geodetic) zenith at the intersection of the ray and the earth ellipsoid is used.

Spacecraft Range (SDS, array size nray x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Range	spacecraftRange(nray)	4-byte float	Distance (m) between the spacecraft and the center of the footprint of the beam on the earth ellipsoid.

Bin start of Oversample (SDS, array size 2 x 29 x nscan, 2-byte integer):

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

Land/Ocean Flag (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Land/Ocean Flag	landOceanFlag(nray)	2-byte integer	Land or ocean information. The values of the flag are: 0: Water (ocean or inland water) 1: Land 2: Coast (not water or land)

Topographic Height (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Topographic Height	surWarningFlag(nray)	2-byte integer	The topographic mean height (m) of all DID samples in a 5 x 5 km.

Bin Number of Surface Peak (SDS, array size nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Bin Number of Surface Peak	binSurfPeak(49)	2-byte integer	The bin surface peak indicates the logical range bin number of the peak surface echo.If the surface is not detected, Bin Surface Peak is set to a value of -9999. Note that the echo peak may appear either in the normal sample data or in the over-sample data.

Normal Sample (SDS, array size 140 x nray x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Normal Sample	normalSample(140,nray)	2-byte integer	The normal sampled PR received powers are recorded (unit: dBm/100). The data is stored in the array of 49 angles * 140 elements.Since each angle has a different number of samples, the elements after the end of sample are filled with a value of -32767. If a scan is missing, the elements are filled with the value -32734. The range is -120 dBm to -20 dBm with an accuracy of 0.9 dBm.

Surface Oversample (SDS, array size 5 x 29, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Surface Oversample	osSurf(5,29)	2-byte integer	The PR records the over-sampled data in five range bins around the surface peak detected on board (not Bin Surface Peak) in a total of 29 angle bins (nadir ± 14 angles) to examine the surface peak precisely. If the surface tracker status is lock-off, the data position is unknown. To use the oversample data, fill the five data starting at “Bin Start of Over Surface” in every other logical range bin, then merge with the interleaving normal sample data. The range is -120 dBm to -20 dBm with an accuracy of 0.9 dBm.

Rain Oversample (SDS, array size 28 x 11, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Rain Oversample	osRain(28,11)	2-byte integer	The PR records the over-sampled data at 28 range bins in a total of 11 angle bins (nadir ± 5 angles) to record the detailed vertical profile of the rain.The 125m interval dataset in heights from 0 km to 7.5 km can be generated by interleaving the Normal Samples with the Surface oversamples and rain oversamples. The data are merged in the same way as the Surface Oversample. The range is -120 dBm to -20 dBm with an accuracy of 0.9 dBm.

			0: Grossly bad geolocation results: - Spacecraft position vector magnitude outside range 6720 to 6740 km. - Z component of midpoint of scan outside range -4100 to 4100 km. - Distance from S/C to midpoint of scan outside range 340 to 360 km. 1: Unexpectedly large scan to scan jumps in geolocated positions in along and cross track directions for first, middle, and last pixels in each scan. Allowed duration from nominal jump in along track motion = 0.06 km (first pixel), 0.04 km (middle pixel), and 0.06 km (last pixel). Allowed duration from nominal jump in cross track motion = 0.05 km (first pixel), 0.04 km (middle pixel), and 0.05 km (last pixel). Bit set in normal mode only. 2: Scan to scan jumps in yaw, pitch, and roll exceed maximum values. Values are : yaw = 0.0001 radians; pitch = 0.0001 radians; roll = 0.0001 radians. Bit set in normal control mode only. 3: In normal mode, yaw outside range (-0.003, 0.003) radians; pitch outside range (-0.007, 0.007) radians; roll outside range (-0.007, 4: 0.007). Satellite undergoing maneuvers during which geolocation will be less 5: accurate. Questionable ephemeris quality (including use of predicted Ephemeris for quicklook) or questionable UTCF 6: quality. Geolocation calculations failed (fill values inserted in the per pixel 7: geolocation products, but not in metadata). Missing attitude data. ACS data gap larger than 20 seconds.
Data Quality [9]	scanStatus.ch1 scanStatus.ch2 scanStatus.ch3 scanStatus.ch4 scanStatus.ch5 scanStatus.ch6 scanStatus.ch7 scanStatus.ch8 scanStatus.ch9	9 x 1-byte integer	The Quality of Channel Data for a given channel on a given scan line is the percentage of pixels whose values are within the acceptable range listed in the Metadata. Quality is given for each channel in the order of the channel number.
Current Spacecraft Orientation	scanStatus.scOrient	1-byte integer	Value Meaning 0 +x forward 1 -x forward 2 -y forward 3 Inertial - CERES Calibration 4 Unknown Orientation
Current ACS Mode	scanStatus.acsMode	1-byte integer	Value Meaning 0 Standby 1 Sun Acquire 2 Earth Acquire 3 Yaw Acquire 4 Nominal 5 Yaw Maneuver 6 Delta-H (Thruster) 7 Delta-V (Thruster) 8 CERES Calibration
Yaw Update Status	scanStatus.yawUpdateS	1-byte integer	Value Meaning 0 Inaccurate 1 Indeterminate 2 Accurate

TMI Instrument Status	scanStatus.tmiISstatus	1-byte integer	Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1). Bit Meaning 00 Receiver Status (1=ON, 0=OFF) 01 Spin-up Status (1=ON, 0=OFF) 02 Spare Command 1 Status 03 Spare Command 2 Status 04 1 Hz Clock Select (1=A, 0=B) 05 21 GHz Cold Count Flag 06 Spare Command 4 Status 07 Spare Command 5 Status
Fractional Orbit Number	scanStatus.fracOrbitN	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)

Navigation (Vdata, record size 88 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Geocentric Position [3]	navigate.scPosX navigate.scPosY navigate.scPosZ	3 X 4-byte float	The position (m) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). The order of components is: x, y, and z. Geocentric Inertial Coordinates are also commonly known as Earth Centered Inertial coordinates. These coordinates will be True of Date (rather than Epoch 2000 which are also commonly used), as interpolated from the data in the Flight Dynamics Facility ephemeris files generated for TRMM.
Spacecraft Geocentric Velocity [3]	navigate.scVelX navigate.scVelY navigate.scVelZ	3 X 4-byte float	The velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of components is: x, y, and z.
Spacecraft Geodetic Latitude	navigate.scLat	4-byte float	The geodetic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.
Spacecraft Geodetic Longitude	navigate.scLon	4-byte float	The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Range is -180 to 179.999999.
Spacecraft Geodetic Altitude	navigate.scAlt	4-byte float	The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time.
Spacecraft Attitude [3]	navigate.scAttRoll navigate.scAttPitch navigate.scAttYaw	3 X 4-byte float	The satellite attitude Euler angles 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 yawvalue will show an orbital frequency component relative to the Earth fixed ground track due to the Earth rotation relative to inertial coordinates.
Sensor Orientation Matrix [3 X 3]	navigate.att1 navigate.att2 navigate.att3 navigate.att4 navigate.att5 navigate.att6 navigate.att7 navigate.att8 navigate.att9	3 X 3 X 4-byte float	The rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time.
Greenwich Hour Angle	navigate.greenHourAng	4-byte float	The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

Calibration (Vdata Table, record size 95 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Hot Load Temperature [3]	calib.hotTemp1 calib.hotTemp2 calib.hotTemp3	3 x 2-byte integer	The physical temperatures, in degrees Kelvin, for the 3 temperature sensors attached to the hot load. This temperature is reduced by 80K, multiplied by 100, and stored in the file as a 2-byte integer. Stored value = (T - 80K) * 100. Range: 0 to 400 K.
Hot Load Bridge Reference Positive Bridge Voltage	calib.posBridgeVolt	2-byte integer	The positive bridge voltage of the hot load bridge reference. Range: 0 to 4095.
Hot Load Bridge Reference Near Zero Voltage	calib.nearZeroVolt	2-byte integer	The near zero voltage of the hot load bridge reference. Range: 0 to 4095.
85.5 GHz Receiver Temperature	calib.temp85Ghz	2-byte integer	The receiver shelf temperature of the 85.5 GHz channel. This temperature is increased by 200, multiplied by 100, and stored in the file as a 2-byte integer. Range: -273.15 to 126.85 C
Top Radiator Temperature	calib.topRadTemp	2-byte integer	The temperature of the top of the radiator channel. This temperature is increased by 200, multiplied by 100, and stored in the file as a 2-byte integer. Range: -273.15 to 126.85 C
Automatic Gain Control [9]	calib.autoCont1 calib.autoCont2 calib.autoCont3 calib.autoCont4 calib.autoCont5 calib.autoCont6 calib.autoCont7 calib.autoCont8 calib.autoCont9	9 X 1-byte integer	Automatic gain control for the 9 channels in counts. Range: 0 to 15.
Calibration Coefficient A [9]	calib.calCoef1A calib.calCoef2A calib.calCoef3A calib.calCoef4A calib.calCoef5A calib.calCoef6A calib.calCoef7A calib.calCoef8A calib.calCoef9A	9 X 4-byte float	Calibration coefficient A (degrees Kelvin / counts) for the 9 channels. Coefficient A for each channel is used in the following equation to convert counts, C, to antenna temperature, TA : $T_A = A\ C + B$
Calibration Coefficient B [9]	calib.calCoef1B calib.calCoef2B calib.calCoef3B calib.calCoef4B calib.calCoef5B calib.calCoef6B calib.calCoef7B calib.calCoef8B calib.calCoef9B	9 X 4-byte float	Calibration coefficient B (degrees Kelvin) for the 9 channels. Coefficient B for each channel is used in the following equation to convert counts, C, to antenna temperature, TA : $T_A = A\ C + B$

Calibration Counts (SDS, array size 16 x 2 x 9 x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Calibration Counts	calCounts(16,2,9)	2-byte integer	Calibration measurements, in counts. The dimensions are: samples, load, channel, and scan. The sample dimension has a maximum of 16. The load dimension has first hot load and then cold sky. The low resolution channels (1-7) have 8 samples (the remaining 8 elements in the array are not used for each low resolution channel) and the high resolution channels (8 - 9) have 16 samples.

Satellite Local Local Zenith Angle (SDS, array size 12 x nscan, 4-byte float):

Name	Name in the TOOLKIT	Format	Description
Satellite Local Zenith Angle	satLocZenAngle(12)	4-byte float	The angle, in degrees, between the local pixel geodetic zenith and the direction to the satellite. This angle is given for every twentieth high resolution pixel along a scan: pixel 1,21,41, ... , 201, 208. For the pixel dimension, Offset = 0 and Increment = -20.

Low Resolution Channels (SDS, array size 7 x npixel2 x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Low Resolution Channels	lowResCh(7,npixel2)	2-byte integer	Brightness temperature (K) reduced by 100 K, multiplied by 100, and stored as a 2-byte integer, i.e. Stored value = (T - 100 K) * 100 The dimensions are: channel, pixel, scan. The pixel dimension has Offset = 0 and Increment = -2. The data range for each channel is listed in the two metadata elements: Minimum valid value of channel and Maximum valid value of channel. The data range is 100 K to 375 K. The following channels are included. Channel Frequency Polarization 1 10 GHz Vertical 2 10 GHz Horizontal 3 19 GHz Vertical 4 19 GHz Horizontal 5 21 GHz Vertical 6 37 GHz Vertical 7 37 GHz Horizontal

High Resolution Channels (SDS, array size 2 x npixel1 x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
High Resolution Channels	highResCh(2,npixel1)	2-byte integer	Brightness temperature (K) reduced by 100 K, multiplied by 100, and stored as a 2-byte integer, i.e. Stored value = (T - 100 K) * 100 The dimensions are: channel, pixel, scan. The data range for each channel is listed in the two metadata elements: Minimum valid value of channel and Maximum valid value of channel. The following channels are included: Channel Frequency Polarization 8 85 GHz Vertical 9 85 GHz Horizontal

			0: Grossly bad geolocation results: - Spacecraft position vector magnitude outside range 6720 to 6740 km. - Z component of midpoint of scan outside range -4100 to 4100 km. - Distance from S/C to midpoint of scan outside range 340 to 360 km. Unexpectedly large scan to scan jumps in geolocated positions in along 1: and cross track directions for first, middle, and last pixels in each scan. Allowed duration from nominal jump in along track motion = 0.06 km (first pixel), 0.04 km (middle pixel), and 0.06 km (last pixel). Allowed duration from nominal jump in cross track motion = 0.05 km (first pixel), 0.04 km (middle pixel), and 0.05 km (last pixel). Bit set in normal mode only. 2: Scan to scan jumps in yaw, pitch, and roll exceed maximum values. Values are: yaw = 0.0001 radians; pitch = 0.0001 radians; roll = 0.0001 radians. Bit set in normal control mode only. 3: In normal mode, yaw outside range (-0.003, 0.003) radians; pitch outside range (-0.007, 0.007) radians; roll outside range (-0.007, 4: 0.007). Satellite undergoing maneuvers during which geolocation will be less accurate. 5: Questionable ephemeris quality (including use of predicted Ephemeris for quicklook) or questionable UTCF quality. 6: Geolocation calculations failed (fill values inserted in the per pixel geolocation products, but not in metadata). 7: Missing attitude data. ACS data gap larger than 20 seconds.
Data Quality [5]	scanStatus.ch1Quality scanStatus.ch2Quality scanStatus.ch3Quality	5 x 1-byte integer	The Quality of Channel Data for a given channel on a given scan line is the percentage of pixels whose values are within the acceptable range listed in the Metadata. Quality is listed for each channel in order of the channel number.
Fractional Orbit Number	scanStatus.fracOrbitN	4-byte float	The orbit number and fractional part of the orbit at Scan Time. The orbit number will be counted from the beginning of the mission. The fractional part is calculated as: (Scan Time - Orbit Start Time) / (Orbit End Time - Orbit Start Time)
Current Spacecraft Orientation	scanStatus.scOrient	1-byte integer	Value Meaning 0 +x forward 1 -x forward 2 -y forward 3 Inertial - CERES Calibration 4 Unknown Orientation
Current ACS Mode	scanStatus.acsMode	1-byte integer	Value Meaning 0 Standby 1 Sun Acquire 2 Earth Acquire 3 Yaw Acquire 4 Nominal 5 Yaw Maneuver 6 Delta-H (Thruster) 7 Delta-V (Thruster) 8 CERES Calibration
Yaw Update Status	scanStatus.yawUpdateS	1-byte integer	Value Meaning 0 Inaccurate 1 Indeterminate 2 Accurate
VIRS Instrument Status	scanStatus.virsInstS	1-byte integer	Value Meaning 0 Day (no calibration occurring) 1 Night 2 Monitor Scan Stability 3 Day with Calibration
VIRS mode	scanStatus.	1-byte integer	Value Meaning 0 mission mode 1 safehold mode 2 outgas mode 3 activation mode

VIRS Abnormal Conditions	scanStatus.	1-byte integer	Bit 0 is the most significant bit (i.e., if bit i = 1 and other bits = 0, the unsigned integer value is 2**(8-i) - 1).

Navigation (Vdata, record size 88 bytes, nscan records):

Name	Name in the TOOLKIT	Format	Description
Spacecraft Geocentric Position [3]	navigate.scPosX navigate.scPosY navigate.scPosZ	3 X 4-byte float	The position (m) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time (i.e., time at the middle pixel/IFOV of the active scan period). The order of components is: x, y, and z. Geocentric Inertial Coordinates are also commonly known as Earth Centered Inertial coordinates. These coordinates will be True of Date (rather than Epoch 2000 which are also commonly used), as interpolated from the data in the Flight Dynamics Facility ephemeris files generated for TRMM.
Spacecraft Geocentric Position [3]	navigate.scVelX navigate.scVelY navigate.scVelZ	3 X 4-byte float	The velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of components is: x, y, and z.
Spacecraft Geodetic Latitude	navigate.scLat	4-byte float	The geodedic latitude (decimal degrees) of the spacecraft at the Scan mid-Time.
Spacecraft Geodetic Longitude	navigate.scLon	4-byte float	The geodedic longitude (decimal degrees) of the spacecraft at the Scan mid-Time. Range is -180 to 179.999999.
Spacecraft Geodetic Altitude	navigate.scAlt	4-byte float	The altitude (m) of the spacecraft above the Earth Ellipsoid at the Scan mid-Time.
Spacecraft Attitude [3]	navigate.scAttRoll navigate.scAttPitch navigate.scAttYaw	3 X 4-byte float	The satellite attitude Euler angles 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.
Sensor Orientation Matrix [3 X 3]	navigate.att1 navigate.att2 navigate.att3 navigate.att4 navigate.att5 navigate.att6 navigate.att7 navigate.att8 navigate.att9	3 X 3 X 4-byte float	The rotation matrix from the instrument coordinate frame to Geocentric Inertial Coordinates at the Scan mid-Time.
Greenwich Hour Angle	navigate.greenHourAng	4-byte float	The rotation angle (degrees) from Geocentric Inertial Coordinates to Earth Fixed Coordinates.

Solar Cal (Vdata, record size 32 bytes, nscan records):

The three components of the solar unit vector in Geocentric Inertial Coordinates, and the Sun-Earth distance in meters.

Name	Name in the TOOLKIT	Format	Description
Solar Position [3]	solarCal.sunVecX solarCal.sunVecY solarCal.sunVecZ	3 X 8-byte float	Sun Unit Vector (X-component) Sun Unit Vector (Y-component) Sun Unit Vector (Z-component) (Geocentric Inertial Coord)
Distance	solarCal.sunMag	8-byte float	Sun-Earth Distance (m)

Calibration Counts (SDS, array size 5 x 2 x 3 x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Calibration Counts	calCounts(5,2,3)	2-byte integer	Raw calibration counts are given in four dimensions. The first dimension is the channel number, the second dimension is the data word, the third dimension is blackbody, space view and solar diffuser, in that order, and the fourth dimension is the number of scans.

Temperature Counts (SDS, array size 6 x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Temperature Counts	tempCounts (6)	2-byte integer	Temperatures of the black body, primary and redundant, the radiant cooler temperatures, primary and redundant, the mirror temperature, and the electronics module temperature. All quantities have units of counts, and have minimum values of 0, and maximum values of 4095.

Local Direction (SDS, array size 2 x 2 x 27 x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Local Direction	localDirection (2,2,27)	2-byte integer	Angles (degrees) to the satellite and sun from the IFOV pixel position on the earth are given in 4 dimensions. The first dimension is zenith and azimuth angles, in that order. The zenith angle is measured between the local pixel geodetic zenith and the direction to the satellite. The azimuth angle is measured clockwise from the local North direction around toward the local East direction. The second dimension is the object to which the directions point, namely the satellite and the sun, in that order. The third dimension is the pixel number. Angles are given only for every tenth pixel along a scan: pixel 1, 11, 21, ..., and 261. For the pixel dimension, Offset = 0 and Increment = -10. The fourth dimension is the scan number. Angles are multiplied by 100 and stored as 2-byte integers.

Channels (SDS, array size 5 x npixel x nscan, 2-byte integer):

Name	Name in the TOOLKIT	Format	Description
Channels	channels (5,261)	2-byte integer	Scene data for the five channels, measured in Radiance (mW cm^{-2} μm^{-1} sr^{-1}) multiplied by a scale factor and stored as 2-byte integers. sr means steradian. The scale factors are 500, 1000, 100000, 10000, and 10000 for channels 1, 2, 3, 4, and 5, respectively. The three dimensions are channel, pixel, and scan. The range and accuracy for each channel is as follows. Channel / Minimum (mW cm^{-2} μm^{-1} sr^{-1}) / Maximum (mW cm^{-2} μm^{-1} sr^{-1}) / Accuracy 1 / 0 / 65.5 / 10% 2 / 0 / 32.7 / 10% 3 / 0 / 0.111 / 2% 4 / 0 / 1.371 / 2% 5 / 0 / 1.15 / 2%