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 nlay 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 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. 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
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	Value Meaning

		integer	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	navigate.scVelX navigate.scVelY	3 X 4-byte float	The velocity (ms^{-1}) of the spacecraft in Geocentric Inertial Coordinates at the Scan mid-Time. The order of

Velocity [3]	navigate.scVelZ		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(49)	2-byte integer	The Sigma-zero is the normalized surface cross section. It ranges from -50.00 to 20.00 dB and is multiplied by 100 and stored as a 2-byte integer.

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

Name	Name in the TOOLKIT	Format	Description
Path Attenuation	pathAtten(49)	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(49)	2-byte integer	Reliability Flags holds various information in the form of single digit integer flags. The 2-byte integer is expressed in the form vwxyz where v, w, x, y, and z are integers between 0 and 9 (v must be 0, 1, or 2). Each digit has the following definition: v = Miscellaneous information (e.g., land/sea/coast; whether a problem exists with the reference data set; missing data, etc.) Details are **TBD**. w = Path attenuation estimate is: 0 - unreliable 1 - marginally reliable 2 - reliable 3 - lower bound 9 - no-rain case x = Information about surface detection validity (including whether surface tracking is in the 'locked' or 'unlocked' state). Details are **TBD**. y = Indicator of which surface reference estimate has been chosen (temporal or spatial). Details are **TBD**. z = **TBD**

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

Name	Name in the TOOLKIT	Format	Description
Reliability Factor	reliabFactor(49)	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 will likely not exceed 5.0 and is unitless.

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

Name	Name in the TOOLKIT	Format	Description
Incident Angle	incAngle(49)	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(49)	2-byte integer	The Rain Flag has the following values: 0: no rain; 1: rain present.