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

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 261 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.

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: VIRS in non-mission mode (non-zero) 7: VIRS condition is abnormal (non-zero)
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. A 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 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, 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 [5]	scanStatus.ch1Quarity scanStatus.ch2Quarity scanStatus.ch3Quarity scanStatus.ch4Quarity scanStatus.ch5Quarity	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). Bit Value Meaning 0 0 normal 1 scan phase error

			1 0 normal 1 selftest error 2 0 normal 1 thermal data missing 3 0 normal 1 moon in space view 4 0 normal 1 H/K data drop-out suspected 5 0 not used 6 0 not used 7 0 not used

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 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 261 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 Maximum Accuracy 1 0 47 10% 2 0 7.23 10% 3 0 0.0986 2% 4 0 1.28 2% 5 0 1.15 2%