CloudSat Project

A NASA Earth System Science Pathfinder Mission

2B-GEOPROF-LIDAR Interface Control Document

Algorithm Version: 1.1 (12 December 2011)
2B-GEOPROF-LIDAR Product Version: 003 (26 November 2008)

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1. I/O Lists

1.1 Algorithm Inputs

	Source	Field
(1)	2B-GEOPROF 011	Seconds since the start of the granule.
(2)	2B-GEOPROF 011	Spacecraft Latitude
(3)	2B-GEOPROF 011	Spacecraft Longitude
(4)	2B-GEOPROF 011	Height of range bin in Reflectivity/Cloud Mask above reference surface (~ mean sea level).
(5)	2B-GEOPROF 011	Location of Surface Bin as determined by 1B CPR algorithm. The value here is shifted (as Height).
(6)	2B-GEOPROF 011	CPR Cloud Mask
(7)	LIDAR-VFM-AUX 001	
(8)	LIDAR-VFM-AUX 001	
(9)	LIDAR-VFM-AUX 001	
(10)	LIDAR-VFM-AUX 001	Spacecraft Position

1.2 Products

1.2.1 2B-GEOPROF-LIDAR 003 Fields

	Source	Field
(1)	2B-GEOPROF 011	Seconds since the start of the granule.
(2)	2B-GEOPROF 011	UTC seconds since 00:00 Z of the first profile
(3)	2B-GEOPROF 011	TAI time for the first profile.
(4)	2B-GEOPROF 011	Spacecraft Latitude
(5)	2B-GEOPROF 011	Spacecraft Longitude
(6)	2B-GEOPROF 011	Height of range bin in Reflectivity/Cloud Mask above reference surface (~ mean sea level).
(7)	2B-GEOPROF 011	Range to the CPR boresight intercept with the geoid
(8)	2B-GEOPROF 011	Digital Elevation Map
(9)	2B-GEOPROF 011	
(10)	2B-GEOPROF 011	Nominal satellite pitch angle offset from nadir
(11)	2B-GEOPROF 011	Nominal satellite roll angle offset from nadir
(12)	2B-GEOPROF 011	Data Quality
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(15)	2B-GEOPROF-LIDAR 003	Cloud Fraction
(16)	2B-GEOPROF-LIDAR 003	Quality of radar and lidar data
(17)	2B-GEOPROF-LIDAR 003	Number of hydrometeor layers
(18)	2B-GEOPROF-LIDAR 003	Height of Layer Base
(19)	2B-GEOPROF-LIDAR 003	Height of layer top

	Source	Field
(20)	2B-GEOPROF-LIDAR 003	Flag of layer base
(21)	2B-GEOPROF-LIDAR 003	Flag of layer top

2. Input Field Specifications

(1) Seconds since the start of the granule.

Name in file: Profile_time
Source: 2B-GEOPROF 011
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: nray
Units: seconds
Range: 0 to 6000
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0.139

Seconds since the start of the granule for each profile. The first profile is 0.

(2) Spacecraft Latitude

Name in file: Latitude
Source: 2B-GEOPROF 011
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: nray
Units: degrees
Range: -90 to 90
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0.139

Spacecraft Geodetic Latitude.

(3) Spacecraft Longitude

Name in file: Longitude
Source: 2B-GEOPROF 011
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: nray
Units: degrees
Range: -180 to 180
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0.139

Spacecraft geodetic longitude

(4) Height of range bin in Reflectivity/Cloud Mask above reference surface (~ mean sea level).

Name in file: Height
Source: 2B-GEOPROF 011
Field type (in file): INT(2)
Range: -5000 to 30000
Missing value: -9999
Missing value operator: ==

Field type (in algorithm): INT(2) **Factor:** 1
Dimensions: nbin,nray **Offset:** 0
Units: m **MB:** 8.674

Height of the radar range bins in meters above mean sea level.

(5) Location of Surface Bin as determined by 1B CPR algorithm. The value here is shifted (as Height).

Name in file: SurfaceHeightBin **Range:** 1 to 125
Source: 2B-GEOPROF 011 **Missing value:** -1
Field type (in file): INT(1) **Missing value operator:** ==
Field type (in algorithm): INT(1) **Factor:** 1
Dimensions: nray **Offset:** 0
Units: **MB:** 0.035

Location of Surface Bin as determined by 1B CPR algorithm. The value here is shifted (as is the Height matrix) so bins in neighboring rays are about the same height.

(6) CPR Cloud Mask

Name in file: CPR_Cloud_mask **Range:** 0 to 40
Source: 2B-GEOPROF 011 **Missing value:** -9
Field type (in file): INT(1) **Missing value operator:** ==
Field type (in algorithm): INT(1) **Factor:** 1
Dimensions: nbin,nray **Offset:** 0
Units: **MB:** 4.337

Each CPR resolution volume is assigned 1 bit mask value:

0 = No cloud detected
1 = likely bad data
5 = likely ground clutter
5-10 = week detection found using along track integration.
20 to 40 = Cloud detected .. increasing values represents clouds with lower chance of a being a false detection.

(7)

Name in file: Feature_Classification_Flags **Range:** to
Source: LIDAR-VFM-AUX 001 **Missing value:**
Field type (in file): UINT(2) **Missing value operator:**
Field type (in algorithm): UINT(2) **Factor:** 1
Dimensions: lidar_z,lidar_x **Offset:** 0
Units: **MB:** 44.432

(8)

Name in file: Latitude
Source: LIDAR-VFM-AUX 001
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: lidar_z_1d,lidar_x
Units: degrees
Range: -90 to 90
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0.016

(9)

Name in file: Longitude
Source: LIDAR-VFM-AUX 001
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: lidar_z_1d,lidar_x
Units: degrees
Range: -180 to 180
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0.016

(10) Spacecraft Position

Name in file: Spacecraft_Position
Source: LIDAR-VFM-AUX 001
Field type (in file): REAL(8)
Field type (in algorithm): REAL(8)
Dimensions: lidar_z_3,lidar_x
Units: km
Range: -8000 to 8000
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0.097

3. Product Field Specifications

3.1 2B-GEOPROF-LIDAR 003 Fields

(1) Seconds since the start of the granule.

Name in file: Profile_time
Source: 2B-GEOPROF 011
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: nray
Range: 0 to 6000
Missing value:
Missing value operator:
Factor: 1
Offset: 0

Units: seconds **MB:** 0.139

Seconds since the start of the granule for each profile. The first profile is 0.

(2) UTC seconds since 00:00 Z of the first profile

Name in file: UTC_start **Range:** 0 to 86400
Source: 2B-GEOPROF 011 **Missing value:**
Field type (in file): REAL(4) **Missing value operator:**
Field type (in algorithm): REAL(4) **Factor:** 1
Dimensions: <scalar> **Offset:** 0
Units: seconds **MB:** 0

The UTC seconds since 00:00 Z of the first profile in the data file.

(3) TAI time for the first profile.

Name in file: TAI_start **Range:** 0 to 6e+008
Source: 2B-GEOPROF 011 **Missing value:**
Field type (in file): REAL(8) **Missing value operator:**
Field type (in algorithm): REAL(8) **Factor:** 1
Dimensions: <scalar> **Offset:** 0
Units: seconds **MB:** 0

The TAI timestamp for the first profile in the data file. TAI is International Atomic Time: seconds since 00:00:00 Jan 1 1993.

(4) Spacecraft Latitude

Name in file: Latitude **Range:** -90 to 90
Source: 2B-GEOPROF 011 **Missing value:**
Field type (in file): REAL(4) **Missing value operator:**
Field type (in algorithm): REAL(4) **Factor:** 1
Dimensions: nray **Offset:** 0
Units: degrees **MB:** 0.139

Spacecraft Geodetic Latitude.

(5) Spacecraft Longitude

Name in file: Longitude **Range:** -180 to 180
Source: 2B-GEOPROF 011 **Missing value:**
Field type (in file): REAL(4) **Missing value operator:**
Field type (in algorithm): REAL(4) **Factor:** 1
Dimensions: nray **Offset:** 0
Units: degrees **MB:** 0.139

Spacecraft geodetic longitude

(6) Height of range bin in Reflectivity/Cloud Mask above reference surface (~ mean sea level).

Name in file: Height
Source: 2B-GEOPROF 011
Field type (in file): INT(2)
Field type (in algorithm): INT(2)
Dimensions: nbin,nray
Units: m
Range: -5000 to 30000
Missing value: -9999
Missing value operator: ==
Factor: 1
Offset: 0
MB: 8.674

Height of the radar range bins in meters above mean sea level.

(7) Range to the CPR boresight intercept with the geoid

Name in file: Range_to_intercept
Source: 2B-GEOPROF 011
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: nray
Units: km
Range: 600 to 800
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0.139

Range from the spacecraft to the CPR boresight intercept with the geoid.

(8) Digital Elevation Map

Name in file: DEM_elevation
Source: 2B-GEOPROF 011
Field type (in file): INT(2)
Field type (in algorithm): INT(2)
Dimensions: nray
Units: meters
Range: -9999 to 8850
Missing value: 9999
Missing value operator: ==
Factor: 1
Offset: 0
MB: 0.069

Elevation in meters above Mean Sea Level. A value of -9999 indicates ocean. A value of 9999 indicates an error in calculation of the elevation.

(9)

Name in file: Vertical_binsize
Source: 2B-GEOPROF 011
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: <scalar>
Units: m
Range: to
Missing value: -9999
Missing value operator: ==
Factor: 1
Offset: 0
MB: 0

effective vertical height of the radar range bin.

(10) Nominal satellite pitch angle offset from nadir

Name in file: Pitch_offset
Source: 2B-GEOPROF 011
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: <scalar>
Units: degrees
Range: -90 to 90
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0

The pitch angle offset from nadir during normal operations. Pitch up is positive (radar points along the flight track in the direction of motion), down is negative (radar points along the flight track opposite the direction of motion).

(11) Nominal satellite roll angle offset from nadir

Name in file: Roll_offset
Source: 2B-GEOPROF 011
Field type (in file): REAL(4)
Field type (in algorithm): REAL(4)
Dimensions: <scalar>
Units: degrees
Range: -90 to 90
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0

The roll angle offset from nadir during normal operations. Positive roll results in the radar pointing to the right of the flight track. Negative roll to the left.

(12) Data Quality

Name in file: Data_quality
Source: 2B-GEOPROF 011
Field type (in file): UINT(1)
Field type (in algorithm): INT(2)
Dimensions: nray
Units: --
Range: 0 to 127
Missing value:
Missing value operator:
Factor: 1
Offset: 0
MB: 0.035

Flags indicating data quality. If 0, then data is of good quality. Otherwise, treat as a bit field with 8 flags:

0: RayStatus_validity not normal.
1: GPS data not valid.
2: Temperatures not valid.
3: Radar telemetry data quality is not normal.
4: Peak power is not normal.
5: CPR calibration maneuver.
6: Missing frame.
7: Not used.

(13) Data status flags

Name in file: Data_status
Source: 2B-GEOPROF 011
Range: 0 to 127
Missing value:

Field type (in file): UINT(1)	**Missing value operator:**
Field type (in algorithm): UINT(1)	**Factor:** 1
Dimensions: nray	**Offset:** 0
Units: --	**MB:** 0.035

This is a bit field that contains data status flags:

Bit 0: missing frame (0=false, 1=true)
Bit 1: SOH missing (0=false, 1=true)
Bit 2: GPS data valid (0=false, 1=true)
Bit 3: 1 PPS lost (0=false, 1=true)
Bit 4: Star tracker 1 (0=off, 1=on)
Bit 5: Star tracker 2 (0=off, 1=on)
Bit 6: Coast (0=false, 1=true)
Bit 7: NISC (0=false, 1=true)

(14) CPR bus orientation (target ID)

Name in file: Data_targetID	**Range:** 0 to 81
Source: 2B-GEOPROF 011	**Missing value:**
Field type (in file): UINT(1)	**Missing value operator:**
Field type (in algorithm): INT(1)	**Factor:** 1
Dimensions: nray	**Offset:** 0
Units: --	**MB:** 0.035

The target id indicates the orientation of the spacecraft bus. For normal operations the target ID is 0. The complete ID table is listed below:

Control Frame 0
0: CPR to point in 300 seconds - Nominal science mode
1 - 15: Target ID for testing - not planned for operational use

Control Frame 0, CPR Calibration
16: CPR to point in 160 seconds
17: CPR 15º to the right
18: CPR 15º to the left
19: CPR 10º to the right -- default rotation
20: CPR 10º to the left -- default rotation
21: CPR 5º to the right
22: CPR 5º to the left
23 - 29: Target ID for testing - not planned for operational use
30 - 36: CPR rotation - not planned for operational use
37 - 39: Not planned for operational use

Control Frame 1, Four thruster closed-loop
40: Rotation into the OR orientation
41: Rotation into the x-track along the anti-ang momentum
42: Rotation into the x-track along ang momentum
43: Rotation into the orbit lower orientation

44: Rotation into alt. OR w/ CPR away from Sun
45 - 49: Not planned for operational use

Control Frame 2, One thruster open-loop
50: Rotation into the OR orientation
51: Rotation into the x-track along the anti-ang momentum
52: Rotation into the x-track along ang momentum
53: Rotation into the orbit lower orientation
54: Rotation into alt. OR w/ CPR away from Sun
55 - 59: Not planned for operational use

Control Frame 3, Two thruster open-loop
60: Rotation into the OR orientation
61: Rotation into the x-track along the anti-ang momentum
62: Rotation into the x-track along ang momentum
63: Rotation into the orbit lower orientation
64: Rotation into alt. OR w/ CPR away from Sun
65 - 69: Not planned for operational use

Control Frame 4, Four thruster open-loop
70: Rotation into the OR orientation
71: Rotation into the x-track along the anti-ang momentum
72: Rotation into the x-track along ang momentum
73: Rotation into the orbit lower orientation
74: Rotation into alt. OR w/ CPR away from Sun
75 - 80: Not planned for operational use

Control Frame 5
81: Body into the x-track along the anti-ang momentum
82 - 1023: Not planned for operational use

(15) Cloud Fraction

Name in file: CloudFraction	**Range:** 0 to 100
Source: 2B-GEOPROF-LIDAR 003	**Missing value:** -9
Field type (in file): INT(1)	**Missing value operator:** ==
Field type (in algorithm): INT(1)	**Factor:** 1
Dimensions: nbin,nray	**Offset:** 0
Units:	**MB:** 4.337

The CloudFraction reports the fraction of lidar volumes in a radar resolution volume that contains hydrometeors. It is recorded per ray and per bin as a 1-byte integer variable. It is a percentage from 0 to 100.

(16) Quality of radar and lidar data

Name in file: UncertaintyCF	**Range:** 0 to 100
Source: 2B-GEOPROF-LIDAR 003	**Missing value:** -9
Field type (in file): INT(1)	**Missing value operator:** ==
Field type (in algorithm): INT(1)	**Factor:** 1

Dimensions: nbin,nray **Offset:** 0
Units: **MB:** 4.337

The UncertaintyCF is a description of the quality of radar and lidar data. It is recorded per ray and per bin as 1-byte integer.

0 means that neither radar data nor lidar data was found.
1 indicates that only radar data has been found.
2 indicates that only lidar data has been found.
3 indicates that both radar data and lidar data were found.

(17) Number of hydrometeor layers

Name in file: CloudLayers **Range:** 0 to 5
Source: 2B-GEOPROF-LIDAR 003 **Missing value:** -9
Field type (in file): INT(1) **Missing value operator:** ==
Field type (in algorithm): INT(1) **Factor:** 1
Dimensions: nray **Offset:** 0
Units: **MB:** 0.035

CloudLayers is a description of the number of the observed hydrometeor layers in the vertical column of the radar footprint. It is recoded per ray as 1-byte integer. Its value is from 0 to 5. A maximum of 5 layers are recorded.

(18) Height of Layer Base

Name in file: LayerBase **Range:** 0 to 25000
Source: 2B-GEOPROF-LIDAR 003 **Missing value:** -99
Field type (in file): INT(2) **Missing value operator:** ==
Field type (in algorithm): REAL(4) **Factor:** 1
Dimensions: ncloud,nray **Offset:** 0
Units: m **MB:** 0.347

LayerBase is a description of the height of the observed hydrometeor layer base. It is recoded per ray as 4-byte float. Its value is from 0 to 25000. The units are meters.

(19) Height of layer top

Name in file: LayerTop **Range:** 0 to 25000
Source: 2B-GEOPROF-LIDAR 003 **Missing value:** -99
Field type (in file): INT(2) **Missing value operator:** ==
Field type (in algorithm): REAL(4) **Factor:** 1
Dimensions: ncloud,nray **Offset:** 0
Units: m **MB:** 0.347

LayerTop is a description of the height of the observed hydrometeor layer top. It is recoded per ray as 4-byte float. Its value is from 0 to 25000. The units are meters.

(20) Flag of layer base

Name in file: FlagBase	**Range:** 0 to 3
Source: 2B-GEOPROF-LIDAR 003	**Missing value:** -9
Field type (in file): INT(1)	**Missing value operator:** ==
Field type (in algorithm): INT(1)	**Factor:** 1
Dimensions: ncloud,nray	**Offset:** 0
Units:	**MB:** 0.173

FlagBase is the contribution flag for each layer base. It tells which instrument has been used to identify the base height. It is recorded per ray as 1-byte integer.

0 means that neither radar nor lidar finds a layer base.
1 indicates that only the radar has found the base.
2 indicates that only the lidar has found the base.
3 indicates that both radar and lidar have found the base.
-9 corresponds to missing data.

(21) Flag of layer top

Name in file: FlagTop	**Range:** 0 to 3
Source: 2B-GEOPROF-LIDAR 003	**Missing value:** -9
Field type (in file): INT(1)	**Missing value operator:** ==
Field type (in algorithm): INT(1)	**Factor:** 1
Dimensions: ncloud,nray	**Offset:** 0
Units:	**MB:** 0.173

FlagTop is the contribution flag for each layer top. It tells which instrument is finding the top height. It is recorded per ray as 1-byte integer.

0 means that neither radar nor lidar find a top.
1 indicates that only the radar has found the top.
2 indicates that only the lidar has found the top.
3 indicates that both radar and lidar have found the top.
-9 corresponds to missing data.

4. Changes Since the Last Product Version

4.1 2B-GEOPROF-LIDAR 003

General product changes
None.

Field changes
Profile_time (source: 2B-GEOPROF 011):

None.

UTC_start (source: 2B-GEOPROF 011):

None.

TAI_start (source: 2B-GEOPROF 011):

None.

Latitude (source: 2B-GEOPROF 011):

None.

Longitude (source: 2B-GEOPROF 011):

None.

Height (source: 2B-GEOPROF 011):

None.

Range_to_intercept (source: 2B-GEOPROF 011):

None.

DEM_elevation (source: 2B-GEOPROF 011):

None.

Vertical_binsize (source: 2B-GEOPROF 011):

None.

Pitch_offset (source: 2B-GEOPROF 011):

None.

Roll_offset (source: 2B-GEOPROF 011):

None.

Data_quality (source: 2B-GEOPROF 011):

None.

Data_status (source: 2B-GEOPROF 011):

None.

Data_targetID (source: 2B-GEOPROF 011):

None.

CloudFraction:

04/10/2008 09:36:35 - change document (Qiuqing Zhang)

UncertaintyCF:

04/10/2008 09:19:59 - Change the document. (Qiuqing Zhang)
04/10/2008 09:32:13 - change document (Qiuqing Zhang)
04/10/2008 09:43:59 - change document (Qiuqing Zhang)

CloudLayers:

04/10/2008 09:37:44 - change document (Qiuqing Zhang)

LayerBase:

04/10/2008 09:38:49 - change document (Qiuqing Zhang)

LayerTop:

04/10/2008 09:40:09 - change document (Qiuqing Zhang)

FlagBase:

04/10/2008 09:41:27 - change document (Qiuqing Zhang)

FlagTop:

04/10/2008 09:42:13 - change document (Qiuqing Zhang)