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**Cloud – Aerosol LIDAR Infrared Pathfinder Satellite Observations
(CALIPSO)**

Data Management System

Data Products Catalog

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Reference Documents

The documents listed in this section contain information that was used to develop this document and/or information that provides additional reference material that may be useful for a complete understanding of the CALIPSO data products.

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Acronyms

AFWA	Air Force Weather Agency
ASDC	Atmospheric Science Data Center
ATBD	Algorithm Theoretical Basis Document
BATC	Ball Aerospace and Technologies Corporation
CALIOP	Cloud-Aerosol Lidar with Orthogonal Polarization
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations
CAPS	CALIPSO Automated Processing System
CCD	Charge Coupled Device
CCR	Configuration Change Request
CCSDS	Consultative Committee for Spacecraft Data Systems
CERES	Clouds and the Earth's Radiant Energy System
CNES	Centre National D'Etudes Spatiales
CRS	CERES Clouds and Radiative Swath Data Product
DPC	Data Products Catalog
DPREP	Data Pre-processing
DCR	Document Change Request
DEM	Digital Elevation Models
DMS	Data Management System
DMSP	Defense Meteorological Satellite Program
DRD	Data Requirements Description
ECI	Earth Centered Inertial
ECR	Earth Centered Rotation
ECS	EOSDIS Core System
EOS	Earth Observing Systems
EOSDIS	Earth Observing System Data and Information System
EROS	Earth Resources Observation System
GEWEX	Global Energy and Water cycle Experiment
GMAO	Global Modeling and Assimilation Office
GMT	Greenwich Mean Time
HDF	Hierarchical Data Format
HU	Hampton University
ICD	Interface Control Document
IFOV	Instantaneous Field of View
IGBP	International Geosphere Biosphere Programme
IIR	Imaging Infrared Radiometer
IPSL	Institut Pierre Simon Laplace
LaRC	Langley Research Center
LATIS	Langley TRMM and Terra Information System
LEM	Low Energy Shot Mitigation
LSWG	Lidar Science Working Group
MERRA-2	Modern-Era Retrospective analysis for Research and Applications, Version 2
MET	Meteorological Data

Acronyms

MOCC	Mission Operations Control Center
N/A	Not Applicable, Not Available
NISE	Near Real-Time Ice and Snow Extent
NSIDC	National Snow and Ice Data Center
ODCOD	Ocean Derived Column Optical Depth
PDDS	Payload Data Delivery System
PGE	Program Generation Executable
PIVB	Payload Instrumentation Verification Block
PM	Passive Microwave
PSC	Polar Stratospheric Cloud
SDP	Science Data Production
SDS	Scientific Data Set
SI	System International of Units
SSAI	Science Systems and Applications Inc.
SSM/I	Special Sensor Microwave/Imager
SSC	Swedish Space Corporation
TAI	International Atomic Time
TBD	To Be Determined
TRMM	Tropical Rainfall Measuring Mission
UNL	University of Nebraska-Lincoln
USGS	U.S. Geological Survey
USN	United Space Network, precursory to SSC
UTC	Universal Time Conversion
VFM	Vertical Feature Mask
WFC	Wide Field Camera

Symbols, SI Units

AU	astronomical unit
°, deg	degree
°C	degrees Celsius
hPa	hectopascal
J	joule
K	kelvin
km	kilometer
m	meter
mb	millibar
ms	millisecond
nm	nanometer
Pa	pascal
per, %	percent

Symbols, SI Units

s, sec	second
sr	steradian
V	volt
W	watt
μm	micron, micrometer

Data Type Abbreviations

Char	Character, 8 bits or 1 byte
Float_32	Floating point, 32 bits or 4 bytes
Float_64	Floating point, 64 bits or 8 bytes
Int_8	Integer, 8 bits or 1 byte
Int_16	Integer, 16 bits or 2 bytes
Int_32	Integer, 32 bits or 4 bytes
MB	Mbytes, megabytes, bytes/1024 ²
UInt_8	Unsigned integer, 8 bits or 1 byte
UInt_16	Unsigned integer, 16 bits or 2 bytes
UInt_32	Unsigned integer, 32 bits or 4 bytes

1.0 Introduction

The Cloud–Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) mission was a collaborative effort between the NASA Langley Research Center (LaRC) and the Centre National D’Etudes Spatiales (CNES) to study global radiative effects of aerosols and clouds on climate. CALIPSO was launched on April 28, 2006 and began science data acquisition on June 13, 2006 until by mutual agreement between NASA and CNES the science mission concluded on August 1, 2023. During this period of time CALIPSO provided nearly continuous measurements of the vertical structure and optical properties of clouds and aerosols to improve our understanding of their role in the Earth’s climate system and to improve the performance of a variety of models ranging from regional chemical transport to global circulation models used for climate prediction ([Winker et al., 2010](#)).

CALIPSO flew in the international A-Train constellation for coincident Earth observations from launch until September 13, 2018, when CALIPSO began lowering its orbit from 705 km to 688 km (428 miles) above the Earth to resume formation flying with CloudSat as part of the “C-Train”.

The CALIPSO payload consists of three co-aligned, near-nadir viewing instruments: a 2-wavelength polarization-sensitive lidar, an imaging infrared radiometer (IIR), and a high-resolution wide field camera (WFC). CALIOP is the name of the CALIPSO lidar and is an acronym for *Cloud-Aerosol Lidar with Orthogonal Polarization*. The lidar profiles provide information on the vertical distribution of aerosols and clouds, cloud particle phase, and classification of aerosol size. The CALIOP laser transmitter subsystem transmits laser light simultaneously at 532 nm and 1064 nm at a pulse repetition rate of 20.16 Hz. The CALIOP receiver subsystem measures backscatter intensity at 1064 nm and at two orthogonally polarized components of the 532 nm backscattered signal ([Hunt et al., 2009](#)).

The IIR provides medium spatial resolution nadir viewing images at 8.65, 10.6, and 12.05 μm , providing information on cirrus cloud particle size and infrared emissivity. The WFC digital camera collects daytime high spatial resolution imagery in the 620 - 670 nm wavelength range and is used to ascertain cloud homogeneity, aid in cloud clearing, and provide meteorological context.

The Data Management System (DMS) uses the CALIPSO Automated Processing System (CAPS) to convert the CALIPSO instrument data into scientific data products. A high level view of the CALIPSO DMS is illustrated in the Top Level Data Flow Diagram shown in Figure 1. The data flow diagram depicts the relationship between the data products and the subsystems that produce them. Circles in the diagram represent algorithm processes called subsystems. Subsystems are a logical collection of algorithms, which together convert input data products into output data products. Boxes with arrows entering a circle are input data sources for the subsystem, while boxes with arrows exiting the circles are output data products.

1.1 CALIPSO Data Products

Instrument data is transmitted from the satellite to the ground station once per day and transferred to the Level 0 processing facility to packetize, time order, archive, and transfer to the DMS at NASA Langley Research Center for autonomous processing. The DMS generates a wide variety of data products at varying levels of maturity and latency. The instrument data is combined with ancillary data sets such as meteorological, ephemeris, instrument status, and global reference products to enhance the quality and accuracy of the data products. Lidar Level 1 data values consist of geolocated profiles of calibrated lidar return signals. Level 1 IIR and WFC data consist of calibrated radiances. There are three types of Lidar

Level 2 products: layer products (cloud and aerosol), profile products (backscatter and extinction) and a vertical feature mask (cloud and aerosol locations and type). IIR Level 2 products are provided based on the IIR Swath (all pixels across swath) and IIR Track (coincident with lidar footprints). Level 3 products contain monthly-averaged parameters that are mapped onto a uniform spatial grid.

The CALIPSO data products are archived and publicly distributed by both the NASA Langley Atmospheric Science Data Center (ASDC), which is the NASA Distributed Active Archive Center (DAAC) of record for the CALIPSO project, and the AERIS/ICARE Data and Services Center in Lille, France. Relevant data documentation will be provided along-side the data at the ASDC, including detailed data quality summaries and description documentation, which will supplement the content contained in this DPC.

The CALIPSO Data Products Catalog (DPC) is intended to provide an overview of the data products that are used or produced by the Data Management System. The LaRC Atmospheric Science Data Center (ASDC) processes, archives, and disseminates the CALIPSO data products in Hierarchical Data Format (HDF) to the scientific community. The emphasis in this document is on the external interfaces with the LaRC ASDC for standard science data processing. Additional updates will be made as the product definitions mature.

Data are released by version. As each new version is released, quality summaries are written to provide detailed information on changes to the derivation and/or quality assessment of both existing and, when appropriate, new parameters. The CALIPSO DPC contains the definitive listing of all parameters contained in each of the publicly distributed CALIPSO data files. The quality summaries, along with the CALIPSO data users' guide, provide parameter documentation and suggestions for best practices in data usage.

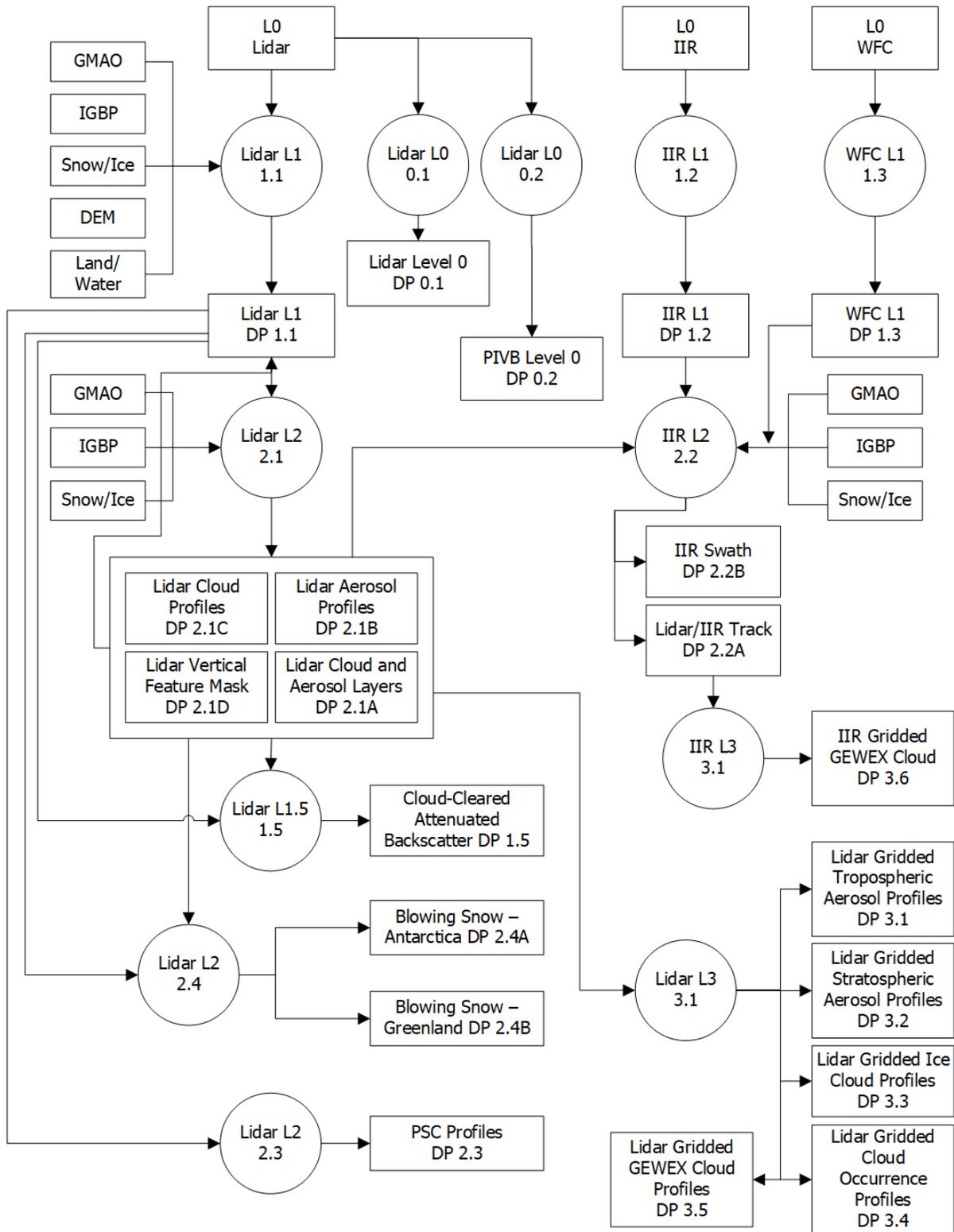


Figure 1: CALIPSO Top Level Data Flow Diagram

The CALIPSO data product naming convention is defined as:

[Investigation]_[Subsystem]_[Level]_[ProductID]-[ProductionStrategy]-[Version].[Instance].hdf

where:

Investigation = Mission Name (always CAL)
 Subsystem = LID, IIR, or WFC
 Level = Product Level; e.g., L0, L1, L15, L2 or L3
 ProductID = Product Identification
 ProductionStrategy = Identifier specifying the production strategy used to generate the product
 Version = Version information (e.g., V5.00)
 Instance = YYYY-MM-DDThh-mm-ssZ[D|N|A|B]

Table 1: CALIPSO Data Product Production Strategies

Test	Preliminary data products for which science algorithms, file contents and/or file structure are still under development; not publicly distributed.
Beta	Early release products for users to gain familiarity with data formats and parameters; not generally available for public download. Products designated as ‘beta’ should not be used as the basis for research findings or journal publications.
Quick Look	Very rapid processing to ensure earliest distribution at the expense of some degradation of data quality; calibration coefficients may be obtained from historical data; level 2 analyses use most recently available ancillary data.
Expedited	Rapid processing to ensure early availability at the expense of some degradation of data quality; calibration and level 2 analyses use most recently available ancillary data, which may represent conditions several days prior to the CALIPSO measurements.
Standard	Highest quality data; ancillary data is spatially and temporally matched to the CALIPSO measurements, thus guaranteeing the best possible calibration and most reliable level 2 retrievals.

For example, the file named CAL_LID_L1-Standard-V5-00.2007-05-01T01-20-09ZN.hdf would contain the following:

- Investigation: CAL (i.e., the CALIPSO mission),
- Subsystem: LID (i.e., Lidar)
- Level: L1 (i.e., Level 1)
- ProductID – none for level 1 data
- ProductionStrategy: Standard
- Version: V5-00
- Instance:
 - Date 1 May, 2007 (data measurement date), (2007-05-01)

- UTC time of first record: 1 hour, 20 minutes, 9 seconds (T01-20-09Z)
- Nighttime conditions (N)

The data product version information is defined using the X.YY format, where:

X – Major Release Number

- tracks a major software release.

YY – Minor Release Number

- tracks a minor software release, e.g., change in GMAO data version, code, or algorithm updates.

There are four categories of products, and they are listed in the tables below. These categories are described in the following summary.

Table 2: Science Archival Data Products: Output products, permanently stored by the LaRC ASDC, formatted in HDF, and available for distribution to the scientific community.

Table 3: Level 0 Products: Input payload products, permanently stored by the LaRC ASDC, and not available for distribution.

Table 4: Ancillary Products: Input products, permanently stored by the LaRC ASDC, needed to interpret the payload measurements, and not available for distribution.

These tables detail the products generated (output) or input/ancillary files used to process (input), the relevant algorithm (PGE), data product catalog tracking number (DP), version number (Ver), spatial and temporal resolutions, and estimated file sizes at differing time periods.

Table 2: CALIPSO Science Archival Data Product Summary - Monthly

PGE	DP	Product	Ver	Spatial Coverage	Temporal Coverage (hrs.)	File Size (MB)	Daily Size (MB)	Monthly Size (MB)
0.1	0.1	Table 5: Lidar Level 0 Record Summary	1.00	Profile	1.5	776.45	11,646.75	349,402.5
0.2	0.2	Table 8: Lidar Level 0 PIVB Record Summary	1.00	Profile	1.5	1.8	N/A	N/A
1.1	1.1	Lidar Level 1 - Day	5.00	Profile	0.83	497.427	7,461.405	223,842.15
1.1	1.1	Lidar Level 1 - Night	5.00	Profile	0.83	497.427	7,461.405	223,842.15
1.2	1.2A	IIR Level 1 - Day	3.00	Swath	0.83	50.02	750.3	22,509
1.2	1.2A	IIR Level 1 - Night	3.00	Swath	0.83	50.02	750.3	22,509
1.2	1.2B	IIR Level 1 Calibration	3.00	Swath	1.5	24.69	370.35	11,110.5
1.2	1.2C	IIR Level 1 Calibration Correction	3.00	Swath	1.5	1.66	24.9	747
1.3	1.3A	WFC Level 1 Registered – Day Only	4.00	Swath	0.83	44.90	673.5	20,205
1.3	1.3A	WFC Level 1 1 km Native – Day Only	4.00	Swath	0.83	45.29	679.35	20,380.5
1.3	1.3A	WFC Level 1 125m – Day Only	4.00	Swath	0.83	236.64	3,549.6	106,488
1.3	1.3B	WFC Level 1 Calibration – Night Only	4.00	Swath	0.83	0.23	3.45	103.5
1.3	1.3C	WFC Level 1 Assembler – Night Only	4.00	Swath	12.45	N/A	7.15	214.5
1.5	1.5	Lidar Level 1.5 – Day	1.00	Profile	0.83	32.46	486.9	14,607

PGE	DP	Product	Ver	Spatial Coverage	Temporal Coverage (hrs.)	File Size (MB)	Daily Size (MB)	Monthly Size (MB)
1.5	1.5	Lidar Level 1.5 – Night	1.00	Profile	0.83	32.46	486.9	14,607
2.1	2.1A	Lidar Level 2 1/3 km Merged Layer – Day	5.00	Profile	0.83	67.831	1,017.465	30,523.95
2.1	2.1A	Lidar Level 2 1/3 km Merged Layer – Night	5.00	Profile	0.83	67.831	1,017.465	30,523.95
2.1	2.1A	Lidar Level 2 1 km Cloud Layer – Day	5.00	Profile	0.83	42.385	635.775	19,073.25
2.1	2.1A	Lidar Level 2 1 km Cloud Layer – Night	5.00	Profile	0.83	42.385	635.775	19,073.25
2.1	2.1A	Lidar Level 2 5 km Cloud Layer – Day	5.00	Profile	0.83	97.507	1,462.605	43,878.15
2.1	2.1A	Lidar Level 2 5 km Cloud Layer – Night	5.00	Profile	0.83	97.507	1,462.605	43,878.15
2.1	2.1A	Lidar Level 2 5 km Aerosol Layer – Day	5.00	Profile	0.83	96.358	1,445.37	43,361.1
2.1	2.1A	Lidar Level 2 5 km Aerosol Layer – Night	5.00	Profile	0.83	96.358	1,445.37	43,361.1
2.1	2.1A	Lidar Level 2 5 km Merged Layer – Day	5.00	Profile	0.83	107.187	1,607.805	48,234.15
2.1	2.1A	Lidar Level 2 5 km Merged Layer – Night	5.00	Profile	0.83	107.187	1,607.805	48,234.15
2.1	2.1A	Lidar Level 2 5 km Merged Diag Layer – Day	5.00	Profile	0.83	165.109	2,476.635	74,299.05
2.1	2.1A	Lidar Level 2 5 km Merged Diag Layer – Night	5.00	Profile	0.83	165.109	2,476.635	74,299.05
2.1	2.1B	Lidar Level 2 Aerosol Profile – Day	5.00	Profile	0.83	160.48	2,407.2	72,216
2.1	2.1B	Lidar Level 2 Aerosol Profile – Night	5.00	Profile	0.83	160.48	2,407.2	72,216
2.1	2.1C	Lidar Level 2 Cloud Profile – Day	5.00	Profile	0.83	135.48	2,032.2	60,966
2.1	2.1C	Lidar Level 2 Cloud Profile – Night	5.00	Profile	0.83	135.48	2,032.2	60,966
2.1	2.1D	Lidar Level 2 Vertical Feature Mask – Day	5.00	Profile	0.83	88.71	1,330.65	39,919.5
2.1	2.1D	Lidar Level 2 Vertical Feature Mask – Night	5.00	Profile	0.83	88.71	1,330.65	39,919.5
2.2	2.2A	IIR/Lidar Level 2 Track – Day	5.00	Track	0.83	9.007	135.105	4,053.15
2.2	2.2A	IIR/Lidar Level 2 Track – Night	5.00	Track	0.83	9.007	135.105	4,053.15
2.2	2.2B	IIR Level 2 Swath – Day	5.00	Swath	0.83	151.457	2,271.855	68,155.65
2.2	2.2B	IIR Level 2 Swath – Night	5.00	Swath	0.83	151.457	2,271.855	68,155.65
2.3	2.3	Lidar Level 2 Polar Stratospheric Cloud – Night Only	3.00	Global	12.45	N/A	415.63	12,468.9
2.4	2.4A	Lidar Level 2 Blowing Snow Region, Antarctica - Monthly	2.00	Global	744.0	4,522.17	N/A	4,522.17
2.4	2.4B	Lidar Level 2 Blowing Snow Region, Greenland - Monthly	1.00	Global	744.0	4,522.17	N/A	4,522.17
3.1	3.1	Lidar Level 3 Tropospheric Aerosol, All Sky – Day	5.00	Global	744.0	258.523	N/A	258.523
3.1	3.1	Lidar Level 3 Tropospheric Aerosol, All Sky – Night	5.00	Global	744.0	258.523	N/A	258.523
3.1	3.1	Lidar Level 3 Tropospheric Aerosol, Cloud Free – Day	5.00	Global	744.0	258.523	N/A	258.523
3.1	3.1	Lidar Level 3 Tropospheric Aerosol, Cloud Free – Night	5.00	Global	744.0	258.523	N/A	258.523
3.1	3.1	Lidar Level 3 Tropospheric Aerosol, Cloudy Sky Transparent – Day	5.00	Global	744.0	258.523	N/A	258.523
3.1	3.1	Lidar Level 3 Tropospheric Aerosol, Cloudy Sky Transparent – Night	5.00	Global	744.0	258.523	N/A	258.523
3.1	3.1	Lidar Level 3 Tropospheric Aerosol, Cloudy Sky Opaque – Day	5.00	Global	744.0	258.523	N/A	258.523
3.1	3.1	Lidar Level 3 Tropospheric Aerosol, Cloudy Sky Opaque – Night	5.00	Global	744.0	258.523	N/A	258.523

PGE	DP	Product	Ver	Spatial Coverage	Temporal Coverage (hrs.)	File Size (MB)	Daily Size (MB)	Monthly Size (MB)
		Cloudy Sky Opaque – Night						
3.2	3.2	Lidar Level 3 Stratospheric Aerosol – Night Only	2.00	Global	744.0	5.489	N/A	5.489
3.3	3.3	Lidar Level 3 Ice Cloud – Day	2.00	Global	744.0	465.13	N/A	465.13
3.3	3.3	Lidar Level 3 Ice Cloud – Night	2.00	Global	744.0	465.13	N/A	465.13
3.3	3.3	Lidar Level 3 Ice Cloud – All	2.00	Global	744.0	465.13	N/A	465.13
3.4	3.4	Lidar Level 3 Cloud Occurrence – Day	2.00	Global	744.0	255.67	N/A	255.67
3.4	3.4	Lidar Level 3 Cloud Occurrence – Night	2.00	Global	744.0	255.67	N/A	255.67
3.4	3.4	Lidar Level 3 Cloud Occurrence – All	2.00	Global	744.0	255.67	N/A	255.67
3.5	3.5	Lidar Level 3 GEWEX Cloud – Day	2.00	Global	744.0	152.57	N/A	152.57
3.5	3.5	Lidar Level 3 GEWEX Cloud – Night	2.00	Global	744.0	152.57	N/A	152.57
3.5	3.5	Lidar Level 3 GEWEX Cloud – All	2.00	Global	744.0	152.57	N/A	152.57
3.6	3.6	IIR Level 3 GEWEX - Day	2.00	Global	744.0	111.316	N/A	111.316
3.6	3.6	IIR Level 3 GEWEX - Night	2.00	Global	744.0	111.316	N/A	111.316
3.6	3.6	IIR Level 3 GEWEX - All	2.00	Global	744.0	111.316	N/A	111.316

Table 3: CALIPSO Level 0 Input Data Product Summary

PGE	Product	Spatial Coverage	Temporal Coverage (hrs)	Product Size (MB)	Daily Size (MB)	Monthly Size (MB)
1.1	Lidar Level 0	Profile	1.65 (1 orbit)	157.85	2,295.94	68,878.32
1.2	IIR Level 0	Swath	1.65 (1 orbit)	66.15	962.12	28,863.69
1.3	WFC Level 0	Swath	1.65 (1 orbit)	15.36	223.39	6,701.75
Daily and Monthly Totals				239.36	3,481.45	104,443.76

Table 4: CALIPSO Ancillary Input Data Product Summary

PGE	Product	Spatial Coverage	Temporal Coverage	Product Size (MB)	Daily Size (MB)	Monthly Size (MB)
0.2	Ephemeris	N/A	Daily	0.50	0.50	15.00
0.1	LO Attitude	N/A	Daily	5.53	5.53	165.90
0.1	LO GPS	N/A	Daily	4.84	4.84	145.20
1.1 2.1 2.2	Daily MERRA-2	Global	Daily	883.00	7,061.00	218,855.00
2.2	IGBP Ecosystem	Global	Static	933.12	933.12	933.12
1.1 1.3	Digital Elevation Map	Global	Static	20,544	20,544	20,544.00
2.2	CERES Snow/Ice	Global	Daily	2.30	2.30	69.00
1.1 1.2 1.3	Land/Water Coverage	Global	Static	N/A	N/A	N/A

PGE	Product	Spatial Coverage	Temporal Coverage	Product Size (MB)	Daily Size (MB)	Monthly Size (MB)
	Daily and Monthly Totals			22,373.29	28,551.29	240,727.22

2.0 Archival Data Products

This section describes the CALIPSO data products, which are permanently archived at the Langley ASDC. Each data product is a single file in HDF format. Each subsection contains a brief overview of the purpose and content of the data product followed by one or more tables listing every parameter contained in the product. The following data attributes are described in the overview sections:

- Level – Data product levels are defined based on EOS definitions¹
- Type – Data type (Science Archival, Level 0, Ancillary, or Engineering)
- Frequency – How often the product is received or produced
- Time interval Covered
 - File – Time period covered within this file
- Spatial resolution
 - Record – Vertical and horizontal coverage
- File Name(s) – The name of the data product (Listed with Production Strategy, Version, and Instance)

Additional tables contain the following attributes for each parameter:

- Parameter Name – Name of parameter
- Data Type – Data type definition of the parameter value
- Units – Units of the parameter value
- Range – Range of values for the parameter (Note: For many parameters, “Range” indicates the nominal range physically meaningful values. Some small fraction of values may fall outside this range due to noise. Check the associated Uncertainty and QA parameters for guidance on data quality.)
- Elements/Record – elements per record for this parameter

The date and time parameters follow one of two formats. The format type is referenced within the DPC Archival Data Product Tables. One format follows the UTC CCSDS ASCII Time Code Format A and the other follows the International Atomic Time (TAI) time (see reference 6). Both formats are described below. The TAI time is based on the second of the International System of Units (SI), as realized at sea level, and is formed by the Bureau International de l’Heure (BIH) on the basis of clock data supplied by cooperating establishments. It is in the form of a continuous scale, e.g., in days, hours, minutes and seconds from the origin 1993 January 1.

The UTC CCSDS ASCII Time Code Format A is described as:

YYYY-MM-DDThh:mm:ss.ddZ

Where each character is an ASCII character using one octed with the following meanings:

- YYYY = Year in four-character subfield with values 0001-9999
- MM = Month in two-character subfield with values 01-12
- DD = Day of month in two-character subfield with values 01-28, -29, -30, or -31
- “T” = Calendar-Time separator
- hh = Hour in two-character subfield with values 00-23
- mm = Minute in two-character subfield with values 00-59
- ss = Second in two-character subfield with values 00-59 (-58 or -60 during leap seconds)
- dd = Decimal fraction of second in one- to n-character subfield where each d has values 0-9
- “Z” = Time code terminator (optional)

Note that the hyphen (-), colon (:), letter “T”, and period (.) are used as specific subfield separators, and that all subfields must include leading zeros. As many “d” characters to the right of the period as required may be used to obtain the required precision.

The International Atomic Time (TAI) is described as:

yymmdd.ffffff

Where each character is an ASCII character using one octet with the following meanings:

- yy = Last two digits of year where 07 represents 2007
- mm = Month in two-character subfield with values 01-12
- dd = Day of month in two-character subfield with values 01-28, -29, -30, or -31
- “.” = Period as a separator
- ffffff = Fractional part of day

Note that the period (.) is used as a specific subfield separator, and that all subfields must include leading zeros.

2.1 Lidar Level 0 Profiles DP 0.1

The Lidar Level 0 (L0) HDF data product translates a matched set of three 90-minute (full orbit) L0 binary files into a single HDF file containing the lidar measurements and health and status data from all three channels (i.e., 532 nm parallel, 532 nm perpendicular, and 1064 nm). These L0 do not contain the full range of data collected in the binary L0 and have been scrubbed to ensure that there is no proprietary information contained.

The major categories of the lidar level 0 product are:

- Lidar Profile Data

Level:	0
Version:	1.00
Type:	Archival
Frequency:	1/Orbit
Spatial Resolution Record:	Full resolution profile
Time Interval Covered:	Full Orbit (Day and Night)

Data File Name:

CAL_LID_L0-ProductionStrategy-Version.Instance.hdf

2.1.1 LIDAR Instrument Level 0 Data Product

Table 5: Lidar Level 0 Record Summary

Parameter	Reference Table	Individual Record Size	Elem/ Rec	Bytes
Core Metadata Record	Table 6	205	1	205
Level 0 Data Record	Table 7	7,301	108,900	795,078,900
Lidar Data Altitudes	Table 7	2,332	1	2,332
Region Boundaries	Table 7	68	1	68
Total Size (bytes)				795,081,505
Total Size (Mbytes)				776.45

2.1.2 LIDAR Instrument Level 0 Data Metadata

Table 6: Lidar Level 0 Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	L0_Lidar	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Initial_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	N/A	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	N/A	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Path_Number_at_Granule_Start	Int_16	N/A	1...233	1	2
Path_Number_at_Granule_End	Int_16	N/A	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Record Size (bytes)					205

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.1.3 LIDAR Instrument Level 0 Data Scientific Data Set

The table below summarizes the contents of each scientific data set (SDS) contained within the LIDAR Instrument Level 0 Data product. Each parameter is listed using the same SDS name that is used in the HDF file. Units are given for each parameter, as is the range of valid data values.

Table 7: Lidar Level 0 Data Record

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Lidar_Data_Altitudes ^A	Float_32	km	N/A	583	2,332

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Profile_Time	Float_64	s	4.203E8...9.623E8	1	8
Profile_UTC_Time ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Profile_ID	Int_32	NoUnits	N/A	1	4
Day_Night_Flag	Int_8	NoUnits	0...1	1	1
QC_Flag ^D	UInt_32	NoUnits	N/A	1	4
Off_Nadir_Angle	Float_32	°	N/A	1	4
Lidar_Mode ^D	Int_16	NoUnits	1...6	1	2
Lidar_Submode ^D	Int_16	NoUnits	1...25	1	2
Frame_Number	Int_16	NoUnits	1...11	1	2
Parallel_Amplifier_Gain_532	Float_32	V/V	N/A	1	4
Perpendicular_Amplifier_Gain_532	Float_32	V/V	N/A	1	4
Amplifier_Gain_1064_High	Float_32	V/V	N/A	1	4
Amplifier_Gain_1064_Low	Float_32	V/V	N/A	1	4
High_Gain_ADC_Offset_532_Par	UInt_16	NoUnits	N/A	1	4
Low_Gain_ADC_Offset_532_Par	UInt_16	NoUnits	N/A	1	4
High_Gain_ADC_Offset_532_Per	UInt_16	NoUnits	N/A	1	4
Low_Gain_ADC_Offset_532_Per	UInt_16	NoUnits	N/A	1	4
High_Gain_ADC_Offset_1064	UInt_16	NoUnits	N/A	1	4
Low_Gain_ADC_Offset_1064	UInt_16	NoUnits	N/A	1	4
Laser_Energy_Monitor_532	Float_32	J	N/A	1	4
Laser_Energy_Monitor_1064	Float_32	J	N/A	1	4
Parallel_Background_Monitor_532	Float_32	digitizer counts	N/A	1	4
Perpendicular_Background_Monitor_532	Float_32	digitizer counts	N/A	1	4
Quality_Flags_532_Par ^D	UInt_16	NoUnits	N/A	1	2
Quality_Flags_532_Per ^D	UInt_16	NoUnits	N/A	1	2
Quality_Flags_1064 ^D	UInt_16	NoUnits	N/A	1	2
Latitude	Float_32	°	-90.0...90.0	1	4
Longitude	Float_32	°	-180.0...180.0	1	4
Range_To_Mean_Sea_Level	Float_32	km	N/A	1	4
Backscatter_Start_Altitude	Float_32	km	N/A	1	4
Region_6_Low_Gain_Raw_Mean_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Raw_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Raw_Mean_1064	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Frame_RMS_Noise_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Frame_RMS_Noise_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Frame_RMS_Noise_1064	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Underflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Underflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Underflows_1064	UInt_16	NoUnits	N/A	1	2
Region_2_Low_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_2_Low_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_2_Low_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_1_Low_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_1_Low_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_1_Low_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_0_Low_Gain_Raw_Mean_532_Par	Float_32	digitizer counts	N/A	1	4
Region_0_Low_Gain_Raw_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_0_Low_Gain_Raw_Mean_1064	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Raw_Mean_532_Par	Float_32	digitizer counts	N/A	1	4

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Region_6_High_Gain_Raw_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Raw_Mean_1064	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Frame_RMS_Noise_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Frame_RMS_Noise_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Frame_RMS_Noise_1064	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Underflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Underflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Underflows_106	UInt_16	NoUnits	N/A	1	2
Region_3_High_Gain_Overflows_532_Par ^C	UInt_16	NoUnits	N/A	1	2
Region_3_High_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_3_High_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_2_High_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_2_High_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_2_High_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_6_Merged_Background_Mean_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Background_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Background_Mean_1064	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Shot_RMS_Noise_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Shot_RMS_Noise_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Shot_RMS_Noise_1064	Float_32	digitizer counts	N/A	1	4
Region_0_Merged_Background_Mean_532_Par	Float_32	digitizer counts	N/A	1	4
Region_0_Merged_Background_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_0_Merged_Background_Mean_1064	Float_32	digitizer counts	N/A	1	4
Gain_Coeff_A_532_Par	Float_32	NoUnits	N/A	1	4
Gain_Coeff_B_532_Par	Float_32	NoUnits	N/A	1	4
Gain_Coeff_C_532_Par	Float_32	NoUnits	N/A	1	4
Gain_Coeff_D_532_Par	Float_32	NoUnits	N/A	1	4
Gain_Coeff_A_532_Per	Float_32	NoUnits	N/A	1	4
Gain_Coeff_B_532_Per	Float_32	NoUnits	N/A	1	4
Gain_Coeff_C_532_Per	Float_32	NoUnits	N/A	1	4
Gain_Coeff_D_532_Per	Float_32	NoUnits	N/A	1	4
Gain_Coeff_A_1064	Float_32	NoUnits	N/A	1	4
Gain_Coeff_B_1064	Float_32	NoUnits	N/A	1	4
Gain_Coeff_C_1064	Float_32	NoUnits	N/A	1	4
Gain_Coeff_D_1064	Float_32	NoUnits	N/A	1	4
Backscatter_532_Parallel	Float_32	digitizer counts	N/A	583	2,332
Backscatter_532_Perpendicular	Float_32	digitizer counts	N/A	583	2,332
Backscatter_1064	Float_32	digitizer counts	N/A	583	2,332
Region_6_Altitude ^C	Float_32	km	N/A	2	8
Region_5_Altitude ^C	Float_32	km	N/A	2	8
Region_5_Altitude_Index ^C	UInt_16	NoUnits	N/A	2	4
Region_4_Altitude ^C	Float_32	km	N/A	2	8
Region_4_Altitude_Index ^C	UInt_16	NoUnits	N/A	2	4
Region_3_Altitude ^C	Float_32	km	N/A	2	8
Region_3_Altitude_Index ^C	UInt_16	NoUnits	N/A	2	4
Region_2_Altitude ^C	Float_32	km	N/A	2	8
Region_2_Altitude_Index ^C	UInt_16	NoUnits	N/A	2	4
Region_1_Altitude ^C	Float_32	km	N/A	2	8
Region_1_Altitude_Index ^C	UInt_16	NoUnits	N/A	2	4

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Record Size (bytes)					7,301

- A) [583] element array per file
- B) UTC CCSDS ASCII Time Code Format A
- C) Parameters contained in the Region_Boundaries Vgroup
- D) Detailed description provided in Appendix B

2.2 Lidar Level 0 Payload Instrumentation Verification Block DP 0.2

The CALIPSO payload flight software creates Raw and Post-Processed packets for data collected on each of the three lidar channels (532nm parallel, 532nm perpendicular, and 1064nm). These Payload Instrumentation Verification Block (PIVB) data are reported in the Lidar Level 0 PIVB data product.

This Lidar Level 0 PIVB reports raw backscatter signals from the high and low gain channel prior to being merged on-board into a single profile. PIVB data have been acquired episodically throughout the latter portion of the mission.

The major categories of the lidar level 0 PIVB product are:

- Lidar Profile Data

Level:	0
Version:	1.00
Type:	Archival
Frequency:	Intermittent
Temporal Range:	Intermittent, between August 23 rd , 2016, and June 17 th , 2023
Spatial Resolution Record:	Full resolution profile
Time Interval Covered:	15-shot data frame (Day or Night)

Data File Name:

CAL_LID_L0_PIVB-ProductionStrategy-Version.Instance.hdf

2.2.1 LIDAR Instrument Level 0 PIVB Data Product

Table 8: Lidar Level 0 PIVB Record Summary

Parameter	Reference Table	Individual Record Size	Elem/ Rec	Bytes
Core Metadata Record	Table 9	239	1	239
PIVB Level 0 Data Frame A	Table 10	212	1	212
PIVB Level 0 Data Frame B	Table 10	77	15	1,155
PIVB Level 0 Raw Lidar Data	Table 10	115,200	15	1,728,000
PIVB Level 0 Average 532 nm Lidar Data	Table 10	4,664	15	69,960
PIVB Level 0 Average 1064 nm Lidar Data	Table 10	1,620	15	24,300
Lidar Data Altitudes	Table 10	23,152	1	23,152
Region Boundaries	Table 10	192	1	192
Total Size (bytes)				1,847,210
Total Size (Mbytes)				1.80

2.2.2 LIDAR Instrument Level 0 PIVB Metadata

Table 9: Lidar Level 0 PIVB Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	LID_L0_PIVB	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	25	25
Total Bytes per Record					239

A) UTC CCSDS ASCII Time Code Format A

2.2.3 LIDAR Instrument Level 0 PIVB Data Scientific Data Set

The table below summarizes the contents of each scientific data set (SDS) contained within the LIDAR Instrument Level 0 PIVB Data product. Each parameter is listed using the same SDS name that is used in the HDF file. Units are given for each parameter, as is the range of valid data values. Each PIVB raw data record reports the height-resolved profiles of science digitizer measurements, in counts, for each of the three channels, along with packet identifiers that enable unambiguous matching of the raw and post-processed records. Each PIVB post-processed data record reports the height-resolved profiles of merged high and low gain digitizer counts, in counts, for each of the three channels. Also reported are profile quality assurance flags, several engineering parameters, and packet identifiers that enable unambiguous matching of the raw and post-processed records.

Table 10: Lidar PIVB Single Shot and Raw

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Profile.UTC_Time ^A	Float_64	yymmdd.fxxxxxx	N/A	1	8
Profile.TAI_Time	Float_64	s	N/A	1	8
Day_Night_Flag	Int_8	NoUnits	0...1	1	1
Lidar_Mode ^F	Int_16	NoUnits	1...6	1	2
Lidar_Submode ^F	Int_16	NoUnits	1...25	1	2
Frame_Number	Int_16	NoUnits	1...11	1	2
Parallel_Amplifier_High_Gain_532	Float_32	V/V	N/A	1	4
Perpendicular_Amplifier_High_Gain_532	Float_32	V/V	N/A	1	4
Amplifier_Gain_1064_High	Float_32	V/V	N/A	1	4
Amplifier_Gain_1064_Low	Float_32	V/V	N/A	1	4
Laser_Energy_Monitor_532	Float_32	J	N/A	1	4
Laser_Energy_Monitor_1064	Float_32	J	N/A	1	4
Parallel_Background_Monitor_532	Float_32	digitizer counts	N/A	1	4
Perpendicular_Background_Monitor_532	Float_32	digitizer counts	N/A	1	4
Quality_Flags_532_Par ^F	UInt_16	NoUnits	N/A	1	2
Quality_Flags_532_Per ^F	UInt_16	NoUnits	N/A	1	2
Quality_Flags_1064 ^F	UInt_16	NoUnits	N/A	1	2
Laser_Latitude	Float_32	°	-90.0...90.0	1	4
Laser_Longitude	Float_32	°	-180.0...180.0	1	4
Region_6_Low_Gain_Raw_Mean_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Raw_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Raw_Mean_1064	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Frame_RMS_Noise_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Frame_RMS_Noise_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Frame_RMS_Noise_1064	Float_32	digitizer counts	N/A	1	4
Region_6_Low_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Underflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Underflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_6_Low_Gain_Underflows_1064	UInt_16	NoUnits	N/A	1	2
Region_2_Low_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_2_Low_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_2_Low_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_1_Low_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_1_Low_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Region_1_Low_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_0_Low_Gain_Raw_Mean_532_Par	Float_32	digitizer counts	N/A	1	4
Region_0_Low_Gain_Raw_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_0_Low_Gain_Raw_Mean_1064	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Raw_Mean_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Raw_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Raw_Mean_1064	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Frame_RMS_Noise_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Frame_RMS_Noise_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Frame_RMS_Noise_1064	Float_32	digitizer counts	N/A	1	4
Region_6_High_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Overflows_532_1064	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Underflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Underflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_6_High_Gain_Underflows_1064	UInt_16	NoUnits	N/A	1	2
Region_3_High_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_3_High_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_3_High_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_2_High_Gain_Overflows_532_Par	UInt_16	NoUnits	N/A	1	2
Region_2_High_Gain_Overflows_532_Per	UInt_16	NoUnits	N/A	1	2
Region_2_High_Gain_Overflows_1064	UInt_16	NoUnits	N/A	1	2
Region_6_Merged_Background_Mean_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Background_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Background_Mean_1064	Float_32	digitizer counts	N/A	1	4
Region_0_Merged_Background_Mean_532_Par	Float_32	digitizer counts	N/A	1	4
Region_0_Merged_Background_Mean_532_Per	Float_32	digitizer counts	N/A	1	4
Region_0_Merged_Background_Mean_1064	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Shot_RMS_Noise_532_Par	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Shot_RMS_Noise_532_Per	Float_32	digitizer counts	N/A	1	4
Region_6_Merged_Shot_RMS_Noise_1064	Float_32	digitizer counts	N/A	1	4
Gain_Coeff_A_532_Par	Float_32	NoUnits	N/A	1	4
Gain_Coeff_B_532_Par	Float_32	NoUnits	N/A	1	4
Gain_Coeff_C_532_Par	Float_32	NoUnits	N/A	1	4
Gain_Coeff_D_532_Par	Float_32	NoUnits	N/A	1	4
Gain_Coeff_A_532_Per	Float_32	NoUnits	N/A	1	4
Gain_Coeff_B_532_Per	Float_32	NoUnits	N/A	1	4
Gain_Coeff_C_532_Per	Float_32	NoUnits	N/A	1	4
Gain_Coeff_D_532_Per	Float_32	NoUnits	N/A	1	4
Gain_Coeff_A_1064	Float_32	NoUnits	N/A	1	4
Gain_Coeff_B_1064	Float_32	NoUnits	N/A	1	4
Gain_Coeff_C_1064	Float_32	NoUnits	N/A	1	4
Gain_Coeff_D_1064	Float_32	NoUnits	N/A	1	4
Backscatter_532_Parallel_Averaged ^B	Float_32	digitizer counts	N/A	583	2,332
Backscatter_532_Perpendicular_Averaged ^B	Float_32	digitizer counts	N/A	583	2,332
Backscatter_1064_Averaged ^C	Float_32	digitizer counts	N/A	405	1,620
Altitude_532_Averaged ^B	Float_32	km	N/A	583	2,332
Altitude_1064_Averaged ^C	Float_32	km	N/A	405	1,620
Frame_Shot_Number	Int_32	NoUnits	N/A	1	4
Altitude_Raw_Data	Float_32	km	N/A	4,800	19,200
Raw_Data_532_Par_High_Gain ^D	Int_32	digitizer counts	N/A	4,800	19,200
Raw_Data_532_Par_Low_Gain ^D	Int_32	digitizer counts	N/A	4,800	19,200

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Raw_Data_532_Per_High_Gain ^D	Int_32	digitizer counts	N/A	4,800	19,200
Raw_Data_532_Per_Low_Gain ^D	Int_32	digitizer counts	N/A	4,800	19,200
Raw_Data_1064_High_Gain ^D	Int_32	digitizer counts	N/A	4,800	19,200
Raw_Data_1064_Low_Gain ^D	Int_32	digitizer counts	N/A	4,800	19,200
High_Offset_532_Par	Float_32	digitizer counts	N/A	1	4
High_Offset_532_Per	Float_32	digitizer counts	N/A	1	4
High_Offset_1064	Float_32	digitizer counts	N/A	1	4
Low_Offset_532_Par	Float_32	digitizer counts	N/A	1	4
Low_Offset_532_Per	Float_32	digitizer counts	N/A	1	4
Low_Offset_1064	Float_32	digitizer counts	N/A	1	4
Region_6_RawData_Altitude ^E	Float_32	km	N/A	2	8
Region_6_RawData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_5_RawData_Altitude ^E	Float_32	km	N/A	2	8
Region_5_RawData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_4_RawData_Altitude ^E	Float_32	km	N/A	2	8
Region_4_RawData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_3_RawData_Altitude ^E	Float_32	km	N/A	2	8
Region_3_RawData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_2_RawData_Altitude ^E	Float_32	km	N/A	2	8
Region_2_RawData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_1_RawData_Altitude ^E	Float_32	km	N/A	2	8
Region_1_RawData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_0_RawData_Altitude ^E	Float_32	km	N/A	2	8
Region_0_RawData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_5_532nmAvgData_Altitude ^E	Float_32	km	N/A	2	8
Region_5_532nmAvgData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_4_532nmAvgData_Altitude ^E	Float_32	km	N/A	2	8
Region_4_532nmAvgData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_3_532nmAvgData_Altitude ^E	Float_32	km	N/A	2	8
Region_3_532nmAvgData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_2_532nmAvgData_Altitude ^E	Float_32	km	N/A	2	8
Region_2_532nmAvgData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_1_532nmAvgData_Altitude ^E	Float_32	km	N/A	2	8
Region_1_532nmAvgData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_4_1064nmAvgData_Altitude ^E	Float_32	km	N/A	2	8
Region_4_1064nmAvgData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_3_1064nmAvgData_Altitude ^E	Float_32	km	N/A	2	8
Region_3_1064nmAvgData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_2_1064nmAvgData_Altitude ^E	Float_32	km	N/A	2	8
Region_2_1064nmAvgData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Region_1_1064nmAvgData_Altitude ^E	Float_32	km	N/A	2	8
Region_1_1064nmAvgData_Altitude_Index ^E	UInt_16	NoUnits	N/A	2	4
Record Size (bytes)					96,040

- A) UTC CCSDS ASCII Time Code Format A
- B) [583] element array per file
- C) [405] element array per file
- D) [4800] element array per file
- E) Parameters contained in the Region_Boundaries Vgroup
- F) Detailed description provided in Appendix B

2.3 Lidar Level 1B Profiles DP 1.1

The lidar Level 1B data product reports vertical profiles of calibrated and geolocated laser backscatter, including total attenuated backscatter coefficients at 532 nm and 1064 nm and 532 nm perpendicular channel attenuated backscatter coefficients. Due to the very different noise characteristics in CALIOP daytime and nighttime measurements, these files are partitioned into half orbit day–night segments (i.e., granules). Between altitudes of -0.5 km to 8.2 km above mean sea level (AMSL), CALIOP profile data are reported at single shot resolution. At higher altitudes, where data are averaged onboard the satellite, the averaged profiles are replicated as necessary to generate a pseudo-single shot data product. The L1B files report data from all nominal science mode measurements, but do not report measurements acquired when the lidar is configured in a diagnostic mode (e.g., boresighting).

The major categories of lidar Level 1B data are:

- Lidar Profile Data
- Position Data
- Viewing Geometry

Level:	1B
Version:	5.00
Type:	Archival
Frequency:	2/Orbit
Spatial Resolution Record:	Full resolution profile
Time Interval Covered:	Half Orbit (Day or Night)

Data File Name:
CAL_LID_L1-Standard-Version.Instance.hdf

2.3.1 LIDAR Level 1 Data Product

The maximum number of lidar 15-shot packets processed in one orbit approximately 8,000 (20.16 shots/sec).

Table 11: Lidar Instrument Record Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core and Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Metadata Record	Table 12	3,937	1	3,937
Spacecraft Position, Attitude, and Celestial Record	Table 13	124	63,630	7,890,120
Profile Geolocation and Viewing Geometry	Table 14	40	63,630	2,545,200
Lidar Data Altitudes	Table 14	2,332	1	2,332
Met Data Altitudes	Table 14	132	1	132
Lidar Profile Science Record	Table 15	7,841	63,630	498,922,830
Total Size (bytes)				509,365,454
Total Size (Mbytes)				497.427

2.3.2 LIDAR Level 1 Data Metadata

Table 12: Lidar Level 1 Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	L1_LIDAR_Science	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Number_of_Good_Profiles	Int_32	NoUnits	0...63,630	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	0...63,630	1	4
Initial_Subsatellite_Latitude	Float_32	degrees	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	degrees	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	degrees	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	degrees	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,426.0...261,231.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^D	Float_64	NoUnits	60,426.0...261,231.0	1	8
Ephemeris_Files_Used	Char	NoUnits	2 file names max	160	160
Attitude_Files_Used	Char	NoUnits	2 file names max	160	160
GMAO_Files_Used	Char	NoUnits	6 filenames max	480	480
Snow_Ice_Files_Used	Char	NoUnits	2 filenames max	160	160
GEOS_Version	Char	NoUnits	N/A	64	64
Percent_532-parallel_Bad	Float_32	%	0.0...100.0	1	4
Percent_532-perpendicular_Bad	Float_32	%	0.0...100.0	1	4
Percent_1064_Bad	Float_32	%	0.0...100.0	1	4
Percent_532-parallel_Missing	Float_32	%	0.0...100.0	1	4
Percent_532-perpendicular_Missing	Float_32	%	0.0...100.0	1	4
Percent_1064_Missing	Float_32	%	0.0...100.0	1	4

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Cal_Region_Top_Altitude_532	Float_32	km	0.0...40.0	1	4
Cal_Region_Base_Altitude_532	Float_32	km	0.0...40.0	1	4
Lidar_Data_Altitudes	Float_32	km	-2.0...40.0	583	2,332
Met_Data_Altitudes	Float_32	km	-2.0...40.0	33	132
Rayleigh_Extinction_Cross-section_532	Float_32	m ²	5.167E-31	1	4
Rayleigh_Extinction_Cross-section_1064	Float_32	m ²	3.127E-32	1	4
Rayleigh_Backscatter_Cross-section_532	Float_32	m ² /sr	5.930E-32	1	4
Rayleigh_Backscatter_Cross-section_1064	Float_32	m ² /sr	3.592E-33	1	4
Ozone_Absorption_Cross-section_532	Float_32	m ²	2.728461E-25	1	4
Ozone_Absorption_Cross-section_1064	Float_32	m ²	0.0	1	4
ScatteringRatioIn532NightCalibrationRegion	Float_32	NoUnits	1.01	1	4
ScatteringRatioIn532NightCalibrationRegionUncertainty	Float_32	NoUnits	0.01	1	4
MolecularModelUncertainty	Float_32	NoUnits	0.015	1	4
CirrusBackscatterColorRatio	Float_32	NoUnits	1.00	1	4
CirrusBackscatterColorRatioUncertainty	Float_32	NoUnits	0.25	1	4
AutocorrelationCoefficientFile	Char	NoUnits	1 filename max	160	160
Record Size (bytes)					3,937

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.3.3 LIDAR Level 1 Data Scientific Data Sets

The tables below summarize the contents of each scientific data set (SDS) contained within the LIDAR Instrument Level 1 Data products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 13: Lidar Level 1 Spacecraft Position, Attitude, and Celestial Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Spacecraft_Altitude	Float_32	km	700.0...740.0	1	4
Spacecraft_Position ^A	Float_64	km	-8,000.0...8,000.0	3	24
Spacecraft_Velocity ^A	Float_64	km/s	-10.0...10.0	3	24
Spacecraft_Attitude	Float_64	degrees	-180.0...180.0	3	24
Spacecraft_Attitude_Rate	Float_64	degrees /s	-10.0...10.0	3	24
Subsatellite_Latitude	Float_32	degrees	-90.0...90.0	1	4
Subsatellite_Longitude	Float_32	degrees	-180.0...180.0	1	4
Earth-Sun_Distance	Float_64	AU	0.98...1.02	1	8
Subsolar_Latitude	Float_32	degrees	-90.0...90.0	1	4
Subsolar_Longitude	Float_32	degrees	-180.0...180.0	1	4
Record Size (bytes)					124

A) ECR Coordinate System

Table 14: Lidar Level 1 Profile Geolocation and Viewing Geometry

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Data_Altitudes ^A	Float_32	km	-2.0...40.0	583	2,332
Met_Data_Altitudes ^B	Float_32	km	-2.0...40.0	33	132
Latitude	Float_32	degrees_north	-90.0...90.0	1	4
Longitude	Float_32	degrees_east	-180.0...180.0	1	4
Off_Nadir_Angle	Float_32	degrees	0.0...10.0	1	4
Viewing_Zenith_Angle	Float_32	degrees	0.0...90.0	1	4
Viewing_Azimuth_Angle	Float_32	degrees	-180.0...180.0	1	4
Solar_Zenith_Angle	Float_32	degrees	0.0...180.0	1	4
Solar_Azimuth_Angle	Float_32	degrees	-180.0...180.0	1	4
Scattering_Angle	Float_32	degrees	0.0...180.0	1	4
Surface_Altitude_Shift	Float_32	km	-0.15...0.15	1	4
Number_Bins_Shift	Int_32	NoUnits	-8...8	1	4
Record Size (bytes)					2,504

A) [583] element array per file

B) [33] element array per file

Table 15: Lidar Profile Science Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Profile_Time ^A	Float_64	TAI seconds	4.204E8...9.623E8	1	8
Profile_UTC_Time ^B	Float_64	yymmdd.ffffff	60,426.0...230,701.0	1	8
Profile_ID ^C	Int_32	NoUnits	1...228,630	1	4
Land_Water_Mask ^F	Int_8	NoUnits	0...7	1	1
IGBP_Surface_Type ^F	Int_8	NoUnits	1...18	1	1
Snow_Ice_Surface_Type ^F	UInt_8	NoUnits	0...255	1	1
Day_Night_Flag	Int_8	NoUnits	0...1	1	1
Frame_Number	Int_16	NoUnits	1...11	1	2
Lidar_Mode ^E	Int_16	NoUnits	1...6	1	2
Lidar_Submode ^E	Int_16	NoUnits	1...25	1	2
Surface_Elevation	Float_32	km	-1.0...9.0	1	4
GMAO_Surface_Elevation	Float_32	km	-1.0...9.0	1	4
Surface_Saturation_Flag_532Par	UInt_8	NoUnits	0...2	1	1
Surface_Saturation_Index_532Par	Int_16	NoUnits	-1...582	1	2
Negative_Signal_Anomaly_Index_532Par	Int_16	NoUnits	-1...582	1	2
Surface_Saturation_Flag_532Perp	UInt_8	NoUnits	0...2	1	1
Surface_Saturation_Index_532Perp	Int_16	NoUnits	-1...582	1	2
Negative_Signal_Anomaly_Index_532Perp	Int_16	NoUnits	-1...582	1	2
Surface_Saturation_Flag_1064	UInt_8	NoUnits	0...2	1	1
Surface_Saturation_Index_1064	Int_16	NoUnits	-1...582	1	2
Negative_Signal_Anomaly_Index_1064	Int_16	NoUnits	-1...582	1	2
Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Perpendicular_Amplifier_Gain_532	Float_32	V/V	26.0...178.0	1	4
Parallel_Amplifier_Gain_532	Float_32	V/V	26.0...178.0	1	4
Perpendicular_Background_Monitor_532	Float_32	count	120.0...6,000.0	1	4
Parallel_Background_Monitor_532	Float_32	count	6.0...6,000.0	1	4
Depolarization_Gain_Ratio_532	Float_32	NoUnits	0.0...2.5	1	4
Depolarization_Gain_Ratio_Uncertainty_532	Float_32	NoUnits	0.0...0.01	1	4
Calibration_Constant_532	Float_32	(km ³ · sr · count)/J	3.0E10...8.0E10	1	4
Calibration_Constant_Uncertainty_532	Float_32	(km ³ · sr · count)/J	2.0E8...1.6E9	1	4
Total_Attenuated_Backscatter_532	Float_32	1/(km · sr)	-0.1...3.3	583	2,332
Perpendicular_Attenuated_Backscatter_532	Float_32	1/(km · sr)	-0.08...1.7	583	2,332
Perpendicular_RMS_Baseline_532 ^D	Float_32	count	0.0...3,200.0	1	4
Parallel_RMS_Baseline_532 ^D	Float_32	count	0.0...3,200.0	1	4
Laser_Energy_1064	Float_32	J	0.038...0.12	1	4
Amplifier_Gain_1064	Float_32	V/V	102.0...195.0	1	4
Calibration_Constant_1064	Float_32	(km ³ · sr · count)/J	4.0E9...1.0E10	1	4
Calibration_Constant_Uncertainty_1064	Float_32	(km ³ · sr · count)/J	5.0E7...4.0E9	1	4
Attenuated_Backscatter_1064	Float_32	1/(km · sr)	-0.04...2.5	583	2,332
RMS_Baseline_1064 ^D	Float_32	count	200.0...1,800.0	1	4
Molecular_Number_Density	Float_32	molecules/m ³	4.8E22...4.8E25	33	132
Ozone_Number_Density	Float_32	molecules/m ³	9.0E16...1.0E19	33	132
Temperature	Float_32	degC	-120.0...60.0	33	132
Pressure	Float_32	hPa	1.0...1,086.0	33	132
Relative_Humidity	Float_32	%	0.0...150.0	33	132
Surface_Wind_Speeds_02m	Float_32	m/s	-80.0...80.0	2	8

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Surface_Wind_Speeds_10m	Float_32	m/s	-80.0...80.0	2	8
Tropopause_Height	Float_32	km	4.0...22.0	1	4
Tropopause_Temperature	Float_32	degC	-95.0...-20.0	1	4
Noise_Scale_Factor_532_Perpendicular	Float_32	count ^(1/2)	3.4...8.0	1	4
Noise_Scale_Factor_532_Parallel	Float_32	count ^(1/2)	4.0...8.0	1	4
Noise_Scale_Factor_1064	Float_32	count ^(1/2)	0.0	1	4
Perpendicular_Column_Reflectance_532	Float_32	NoUnits	0.0...1.0	1	4
Perpendicular_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Parallel_Column_Reflectance_532	Float_32	NoUnits	0.0...1.0	1	4
Parallel_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Reflectance_Calibration_Coefficient_532	Float_32	(W · 1/m ² · 1/sr) / counts	4.9E-5...7.5E-5	1	4
Reflectance_Calibration_Coefficient__Uncertainty_532	Float_32	(W · 1/m ² · 1/sr) / counts	2.2E-6...3.8E-6	1	4
QC_Flag ^E	UInt_32	NoUnits	0...16,777,215	1	4
QC_Flag_2 ^E	UInt_32	NoUnits	0...134,217,727	1	4
Record Size (bytes)					7,841

- A) International Atomic Time (TAI) seconds from Jan. 1, 1993
- B) TAI time converted to UTC time and stored in format: yymmdd.ffffff
- C) The minimum is the first profile, and the maximum is 90 + 99 minutes
- D) The ranges given include the nominal ranges with a little headroom. However, these are single-shot values, and it is fairly common to have individual shots that exceed these values, sometimes by a lot when we get a noise spike from radiation. Because the night and day gains are different, the lowest values occur toward the ends of the day segments, when the gain is low, and the background is low. For the 532 channels, the highest values occur at night in the South Atlantic Anomaly (SAA) when the gain is high, and the noise is fairly high. The highest 1064 values (except for noise spikes) occur in the daytime.
- E) Detailed description provided in Appendix B
- F) Detailed description provided in Section 4.0

2.4 IIR Level 1B Radiances DP 1.2A

The IIR Level 1B data product contains a half orbit of geolocated, calibrated radiances. Image data are registered to a 1 km grid centered on the lidar track.

The major categories for IIR Level 1B data are:

- IIR Earth View
- Position Data
- Viewing Geometry

Level:	1B
Version:	3.00
Type:	Archival
Frequency:	2/Orbit
Spatial Resolution Record:	1 km pixels x 70 km wide swath
Time Interval Covered:	Half Orbit (Day or Night)

Data File Name:
CAL_IIR_L1-Standard-Version.Instance.hdf

2.4.1 IIR Level 1 Data Product

The maximum number of IIR sequences processed in one orbit is 729, which equates to 1 sequence every 8.184 seconds. A sequence is a collection of 6 images; 3 Earth views and 3 calibration views (deep space or blackbody). Image data are registered to a 1 km grid centered on the lidar track. Each grid line occurs every 3 lidar shots, or 40,095 grid lines per orbit (20,048 per half orbit).

Table 16: IIR Record Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
IIR Metadata Record	Table 17	821	1	821
Spacecraft Position, Attitude, and Celestial Record	Table 18	360	384	138,240
Earth View Record	Table 19	2,548	20,048	51,082,304
Total Size (bytes)				51,222,268
Total Size (Mbytes)				50.02

2.4.2 IIR Level 1 Metadata

Table 17: IIR Level 1 Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	IIR_L1	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Number_of_IIR_Grid_Line_Records	UInt_16	NoUnits	0...20,048	1	2
Initial_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Ephemeris_Files_Used	Char	NoUnits	2 file names max.	160	160
Attitude_Files_Used	Char	NoUnits	2 file names max.	160	160
Level_0_Files_Used	Char	NoUnits	2 file names max.	160	160
Level_1_code_version_Used	Char	NoUnits	N/A	20	20
Input_parameter_version_number_used_Radiometry	UInt_16	NoUnits	N/A	1	2
Input_parameter_date_of_application_Radiometry	Int_8	NoUnits	4/2006 – 7/2023	27	27
Input_parameter_version_number_used_Geometry	UInt_16	NoUnits	N/A	1	2
Input_parameter_date_of_application_Geometry	Int_8	NoUnits	4/2006 – 7/2023	27	27
Percentage_of_8.65_Good_Pixels	Float_32	%	0.0...100.0	1	4
Percentage_of_12.05_Good_Pixels	Float_32	%	0.0...100.0	1	4
Percentage_of_10.6_Good_Pixels	Float_32	%	0.0...100.0	1	4
Percentage_of_Good_Pixels_3_Channels	Float_32	%	0.0...100.0	1	4
Percentage_of_Missing_Pixels	Float_32	%	0.0...100.0	1	4
Number_of_Images_Processed	Int_16	NoUnits	0...2,187	1	2
Percentage_of_Missing_Images	Float_32	%	0.0...100.0	1	4
Number_of_Equalization_mode	Int_16	NoUnits	0...TBD	1	2
Altitude_of_Projection	Float_32	km	0.0...40.0	1	4
Initial_Absolute_Sequence	Int_16	NoUnits	0...24,576	1	2
Final_Absolute_Sequence	Int_16	NoUnits	0...24,576	1	2
Grid_Line_Delta_Time	Float_32	s	0.0...0.2	1	4
Scale_Factor_for_Radiance	Float_32	NoUnits	1,000.0	1	4
Radiance_Offset	Float_32	NoUnits	0.0	1	4
Scale_Factor_for_Viewing_Angle	Float_32	NoUnits	100.0	1	4
Viewing_Angle_Offset	Float_32	NoUnits	0.0	1	4
Record Size (bytes)					821

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.4.3 IIR Level 1 Scientific Data Sets

The tables below summarize the contents of each scientific data set (SDS) contained within the IIR Level 1 products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 18: IIR Spacecraft Position, Attitude, and Celestial Record (1 per Earth view)

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Time_TAI_8.65 ^B	Float_64	s	4.203E8...9.623E8	1	8
Time_TAI_10.6 ^B	Float_64	s	4.203E8...9.623E8	1	8
Time_TAI_12.05 ^B	Float_64	s	4.203E8...9.623E8	1	8
Time_UTC_8.65 ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Time_UTC_10.6 ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Time_UTC_12.05 ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Spacecraft_Position_8.65 ^A	Float_64	km	-8,000.0...8,000.0	3	24
Spacecraft_Position_10.6 ^A	Float_64	km	-8,000.0...8,000.0	3	24
Spacecraft_Position_12.05 ^A	Float_64	km	-8,000.0...8,000.0	3	24
Spacecraft_Velocity_8.65 ^A	Float_64	km/sec	-8,000.0...8,000.0	3	24
Spacecraft_Velocity_10.6 ^A	Float_64	km/sec	-8,000.0...8,000.0	3	24
Spacecraft_Velocity_12.05 ^A	Float_64	km/sec	-8,000.0...8,000.0	3	24
Spacecraft_Attitude_8.65	Float_64	°	-180.0...180.0	3	24
Spacecraft_Attitude_10.6	Float_64	°	-180.0...180.0	3	24
Spacecraft_Attitude_12.05	Float_64	°	-180.0...180.0	3	24
Spacecraft_Attitude_Rate_8.65	Float_64	°/s	-10.0...10.0	3	24
Spacecraft_Attitude_Rate_10.6	Float_64	°/s ¹	-10.0...10.0	3	24
Spacecraft_Attitude_Rate_12.05	Float_64	°/s	-10.0...10.0	3	24
Subsatellite_Latitude_8.65	Float_32	°	-90.0...90.0	1	4
Subsatellite_Latitude_10.6	Float_32	°	-90.0...90.0	1	4
Subsatellite_Latitude_12.05	Float_32	°	-90.0...90.0	1	4
Subsatellite_Longitude_8.65	Float_32	°	-180.0...180.0	1	4
Subsatellite_Longitude_10.6	Float_32	°	-180.0...180.0	1	4
Subsatellite_Longitude_12.05	Float_32	°	-180.0...180.0	1	4
Record Size (bytes)					360

A) ECR Coordinate System

B) International Atomic Time (TAI) seconds from Jan. 1, 1993

C) TAI time converted to UTC time and stored in format: yymmdd.ffffff

Table 19: Earth View Record (1 per grid line)

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Lidar_Shot_Time ^A	Float_64	s	4.203E8...9.623E8	1	8
Lidar_Shot_UTC_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Latitude	Float_32	°	-90.0...90.0	69	276
Longitude	Float_32	°	-180.0...180.0	69	276
Image_Time_8.65 ^A	Float_64	s	4.203E8...9.623E8	1	8
Image_Time_10.6 ^A	Float_64	s	4.203E8...9.623E8	1	8
Image_Time_12.05 ^A	Float_64	s	4.203E8...9.623E8	1	8
Image_UTC_Time_8.65 ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Image_UTC_Time_10.6 ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Image_UTC_Time_12.05 ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Calibrated_Radiances_8.65	Int_16	Wm ⁻² .sr ⁻¹ .µm ⁻¹	0...32 ^D	69	138
Calibrated_Radiances_10.6	Int_16	Wm ⁻² .sr ⁻¹ .µm ⁻¹	0...32 ^D	69	138
Calibrated_Radiances_12.05	Int_16	Wm ⁻² .sr ⁻¹ .µm ⁻¹	0...32 ^D	69	138
Viewing_Zenith_Angle_8.65	Int_16	°	0.0...180.0	69	138
Viewing_Zenith_Angle_10.6	Int_16	°	0.0...180.0	69	138
Viewing_Zenith_Angle_12.05	Int_16	°	0.0...180.0	69	138
Viewing_Azimuth_Angle_8.65	Int_16	°	-180.0...180.0	69	138
Viewing_Azimuth_Angle_10.6	Int_16	°	-180.0...180.0	69	138
Viewing_Azimuth_Angle_12.05	Int_16	°	-180.0...180.0	69	138
Sequence_Number_8.65	Int_16	NoUnits	0...24,576	69	138
Sequence_Number_10.6	Int_16	NoUnits	0...24,576	69	138
Sequence_Number_12.05	Int_16	NoUnits	0...24,576	69	138
Pixel_Quality_Index ^C	UInt_32	NoUnits	0...15,745,287	69	276
Record Size (bytes)					2,548

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

C) Detailed description provided in Appendix C

D) Range after scale equation reported in HDF file

2.5 IIR Level 1B Calibration DP 1.2B

The IIR Level 1B Calibration data product contains the Space view and Blackbody images with the gains derived in each channel.

The major categories for IIR Level 1B Calibration data are:

- Space View Images
- Blackbody Images and Gains

Level: 1B
Version: 3.00
Type: Engineering/Archival
Frequency: Orbit
Spatial Resolution Record: 64 x 64 pixels
Time Interval Covered: Orbit

Data File Name:
CAL_IIR_L1_CAL-Standard-Version.Instance.hdf

2.5.1 IIR Level 1 Calibration Record Summary

The IIR acquisition is organized around cycles composed of 5 sequences with 1 sequence every 8.184 seconds. A sequence is a collection of 6 images composed of $64 \times 64 = 4096$ pixels: 1 Earth view and 1 calibration view for each of the 3 IIR channels. In each cycle, the calibration views are blackbody images in the first sequence and space view images in the four following sequences. The maximum number of sequences in one full orbit is 730.

Table 20: IIR Level 1 Calibration Record Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	874	1	874
IIR Calibration Metadata Record	Table 21	611	1	611
Space View Record	Table 22	24,664	584	14,403,776
Blackbody and Gain Record	Table 23	73,84073,840	146	10,780,640
Dead Pixel Image	Table 24	4,0964,096	1	4,096
Blind Pixel Image	Table 25	4,0964,096	1	4,096
Earth Averaging Record	Table 26	49,156	2	98,312
Total Size (bytes)				25,292,405
Total Size (Mbytes)				24.69

2.5.2 IIR Level 1 Calibration Metadata

Table 21: IIR Level 1 Calibration Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Product ID	Char	NoUnits	IIR L1 CAL	80	80
Date Time at Granule Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date Time at Granule End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date Time of Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Initial Subsatellite Latitude	Float 32	°	-90.0...90.0	1	4
Initial Subsatellite Longitude	Float 32	°	-180.0...180.0	1	4
Final Subsatellite Latitude	Float 32	°	-90.0...90.0	1	4
Final Subsatellite Longitude	Float 32	°	-180.0...180.0	1	4
Orbit Number at Granule Start	UInt 32	NoUnits	$1 \dots 2^{32}-1$	1	4
Orbit Number at Granule End	UInt 32	NoUnits	$1 \dots 2^{32}-1$	1	4
Orbit Number Change Time ^B	Float 64	NoUnits	60,428.0...230,701.0	1	8
Path Number at Granule Start	Int 16	NoUnits	1...233	1	2
Path Number at Granule End	Int 16	NoUnits	1...233	1	2
Path Number Change Time ^B	Float 64	NoUnits	60,428.0...230,701.0	1	8
Level 0 Files Used	Char	NoUnits	2 file names max.	160	160
Level 1 Code Version Used	Char	NoUnits	N/A	20	20
Input Parameter File Version Number Used Radiometry	UInt 16	NoUnits	N/A	1	2
Input Parameter Date of Application Radiometry ^A	Char	NoUnits	4/2006 – 7/2023	27	27

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Input Parameter File Version Number Used Geometry	UInt 16	NoUnits	N/A	1	2
Input parameter date of application Geometry ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Number Blackbody Records 8.65	Int 16	NoUnits	0...146	1	2
Number Blackbody Records 12.05	Int 16	NoUnits	0...146	1	2
Number Blackbody Records 10.6	Int 16	NoUnits	0...146	1	2
Number BB Images Interpolated Missing 8.65	Int 16	NoUnits	0...146	1	2
Number BB Images Interpolated Missing 12.05	Int 16	NoUnits	0...146	1	2
Number BB Images Interpolated Missing 10.6	Int 16	NoUnits	0...146	1	2
Number of Space Look Records 8.65	Int 16	NoUnits	0...584	1	2
Number of Space Look Records 12.05	Int 16	NoUnits	0...584	1	2
Number of Space Look Records 10.6	Int 16	NoUnits	0...584	1	2
Number CS Images Interpolated Missing 8.65	Int 16	NoUnits	0...584	1	2
Number CS Images Interpolated Missing 12.05	Int 16	NoUnits	0...584	1	2
Number CS Images Interpolated Missing 10.6	Int 16	NoUnits	0...584	1	2
Initial Sequence Number	Int 16	NoUnits	0...20,479	1	2
Final Sequence Number	Int 16	NoUnits	0...20,479	1	2
Percentage of Missing Cycles	Float 32	%	0.0...100.0	1	4
Percentage of Missing Sequences	Float 32	%	0.0...100.0	1	4
Percentage of Missing Single Images	Float 32	%	0.0...100.0	1	4
Number of Equalization Mode	Int 16	NoUnits	0...730	1	2
Blackbody Temperature Alert	Int 16	NoUnits	0...1	1	2
Cold Space Image Alert	Int 16	NoUnits	0...1	1	2
Blind Pixel Alert	Int 16	NoUnits	0...1	1	2
Dead Pixel Alert	Int 16	NoUnits	0...1	1	2
Moon Detect	Int 16	NoUnits	1...4,096	1	2
Scale Factor for Radiance	Float 32	NoUnits	1,000.0	1	4
Radiance Offset	Float 32	NoUnits	0.0	1	4
IIR L0 Filename Processed	Char	NoUnits	N/A	80	80
Number Single Packets Read	Int 32	NoUnits	0...4,380	1	4
Number Sequences Read	Int 32	NoUnits	0...730	1	4
Number Cycles Read	Int 32	NoUnits	0...147	1	4
File_Beginning_Time ^B	Float_64	yymmdd.f ffffff	60,428.0...230,701.0	1	8
File_End_Time ^B	Float_64	yymmdd.f ffffff	60,428.0...230,701.0	1	8
Record Size (bytes)					611

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.fffffff

2.5.3 IIR Level 1 Calibration Scientific Data Sets

The tables below summarize the contents of each scientific data set (SDS) contained within the IIR Calibration products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 22: Space View Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
SV_Cycle_Number	Int_16	NoUnits	0...4,095	1	2
SV_Sequence_Number	Int_16	NoUnits	1...20,479	1	2
SV_Image_Time_8.65 ^A	Float_64	s	4.203E8...9.623E8	1	8
SV_Image_UTC_Time_8.65 ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Space_View_Image_8.65	UInt_16	count	500.0...2,000.0	4,096	8,192
SV_Blackbody_Temp_8.65	Float_32	°C	-20.0...50.0	1	4
SV_Mean_of_All_Image_Pixels_8.65	Float_32	count	500.0...2,000.0	1	4
SV_Std_Dev_of_All_Image_Pixels_8.65	Float_32	count	15.0...25.0	1	4
SV_Image_Time_12.05 ^A	Float_64	s	4.203E8...9.623E8	1	8
SV_Image_UTC_Time_12.05 ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Space_View_Image_12.05	UInt_16	count	500.0...2,000.0	4,096	8,192
SV_Blackbody_Temp_12.05	Float_32	°C	-20.0...50.0	1	4
SV_Mean_of_All_Image_Pixels_12.05	Float_32	count	500.0...2,000.0	1	4
SV_Std_Dev_of_All_Image_Pixels_12.05	Float_32	count	15.0...25.0	1	4
SV_Image_Time_10.6 ^A	Float_64	s	4.203E8...9.623E8	1	8
SV_Image_UTC_Time_10.6 ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Space_View_Image_10.6	UInt_16	count	500.0...2,000.0	4,096	8,192
SV_Blackbody_Temp_10.6	Float_32	°C	-20.0...50.0	1	4
SV_Mean_of_all_Image_Pixels_10.6	Float_32	count	500.0...2,000.0	1	4
SV_Std_Dev_of_All_Image_Pixels_10.6	Float_32	count	15.0...25.0	1	4
Record Size (bytes)					24,664

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

Table 23: Blackbody and Gain Record

Parameter/Field	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
BB_Cycle_Number	Int_16	NoUnits	0...4,095	1	2
BB_Sequence_Number	Int_16	count	0...20,475	1	2
BB_Image_Time_8.65 ^A	Float_64	s	4.203E8...9.623E8	1	8
BB_Image_UTC_Time_8.65 ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Blackbody_Image_8.65	UInt_16	count	1,000...3,000	4,096	8,192
BB_Blackbody_Temp_8.65	Float_32	°C	-20.0...50.0	1	4
BB_Mean_of_all_Image_Pixels_8.65	Float_32	count	1,000.0...3,000.0	1	4
BB_Std_Dev_of_all_Image_Pixels_8.65	Float_32	count	10.0...30.0	1	4
Gain_Image_8.65	Float_32	count·(m ²)·sr·µm/W	100.0...160.0	4,096	16,384
Mean_of_all_Gain_Image_Pixels_8.65	Float_32	count·(m ²)·sr·µm/W	100.0...160.0	1	4
Std_Dev_of_all_Gain_Image_Pixels_8.65	Float_32	count·(m ²)·sr·µm/W	0.5...2.0	1	4
BB_Image_Time_12.05 ^A	Float_64	s	4.203E8...9.623E8	1	8
BB_Image_UTC_Time_12.05 ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Blackbody_Image_12.05	UInt_16	count	1,000...3,000	4,096	8,192
BB_Blackbody_Temp_12.05	Float_32	°C	-20.0...50.0	1	4
BB_Mean_of_all_Image_Pixels_12.05	Float_32	count	1,000.0...3,000.0	1	4
BB_Std_Dev_of_all_Image_Pixels_12.05	Float_32	count	10.0...30.0	1	4
Gain_Image_12.05	Float_32	count·(m ²)·sr·µm/W	80.0...125.0	4,096	16,384
Mean_of_all_Gain_Image_Pixels_12.05	Float_32	count·(m ²)·sr·µm/W	80.0...125	1	4
Std_Dev_of_all_Gain_Image_Pixels_12.05	Float_32	count·(m ²)·sr·µm/W	0.5...2.0	1	4
BB_Image_Time_10.6 ^A	Float_64	s	4.203E8...9.623E8	1	8
BB_Image_UTC_Time_10.6 ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Blackbody_Image_10.6	UInt_16	count	1,000...3,000	4,096	8,192
BB_Blackbody_Temp_10.6	Float_32	°C	-20.0...50.0	1	4
BB_Mean_of_all_Image_Pixels_10.6	Float_32	count	1,000.0...3,000.0	1	4
BB_Std_Dev_of_all_Image_Pixels_10.6	Float_32	count	10.0...30.0	1	4

Parameter/Field	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Gain_Image_10.6	Float_32	count·(m ²)·sr·μm/W	60.0...100.0	4,096	16,384
Mean_of_all_Gain_Image_Pixels_10.6	Float_32	count·(m ²)·sr·μm/W	60.0...100.0	1	4
Std_Dev_of_all_Gain_Image_Pixels_10.6	Float_32	count·(m ²)·sr·μm/W	0.5...2.0	1	4
Record Size (bytes)					73,840

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

Table 24: Dead Pixel Image

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Dead_Pixels	Int_8	NoUnits	0...1	4,096	4,096
Record Size (bytes)					4,096

Table 25: Blind Pixel Image

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Blind_Pixels	Int_8	NoUnits	0...1	4,096	4,096
Record Size (bytes)					4,096

Table 26: Earth Averaged Record (2/orbit)

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Earth_Average_First_Cycle_Number	Int_16	NoUnits	0...4,095	1	2
Earth_Average_Last_Cycle_Number	Int_16	NoUnits	0...4,095	1	2
Earth_Average_Image_8.65	Float_32	W/((m ²)·sr·μm)	0.0...30.0	4,096	16,384
Earth_Average_Image_12.05	Float_32	W/((m ²)·sr·μm)	0.0...30.0	4,096	16,384
Earth_Average_Image_10.6	Float_32	W/((m ²)·sr·μm)	0.0...30.0	4,096	16,384
Record Size (bytes)					49,156

2.6 IIR Level 1B Calibration Correction DP 1.2C

The IIR Level 1B Calibration Correction data product complements the IIR Level 1 Calibration data product and contains semi-empirical corrections that were applied to compute the earth view calibrated radiances reported in the Level 1B product.

The major categories for IIR Level 1B Calibration data are:

- Granule Information
- Calibration Correction

Level:	1B
Version:	3.00
Type:	Engineering/Archival
Frequency:	Orbit
Spatial Resolution Record:	64 x 64 pixels
Time Interval Covered:	Orbit

Data File Name:

CAL_IIR_L1_COR-Standard-Version.Instance.hdf

2.6.1 IIR Level 1 Calibration Correction Record Summary

The maximum number of IIR sequences processed in one full orbit is 730, which equates to 1 sequence every 8.184 seconds. A sequence is a collection of 6 images: 3 Earth views and 3 calibration views (blackbody or space view). The correction coefficients were determined vs. sequence number and for each of the 64 rows of the Earth view images. For a given sequence number, they are identical for each 64 columns of a given row.

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
IIR Correction Metadata Record	Table 27	205	1	205
Granule Record	Table 28	8,208	1	8,208
Calibration Correction Record	Table 29	2,316	730	1,690,680
Total Size (bytes)				1,699,996
Total Size (Mbytes)				1.66

2.6.2 IIR Level 1 Calibration Correction Metadata

Table 27: IIR Level 1 Calibration Correction Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	IIR_L1_COR	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Number_of_IIR_Grid_Line_Records	UInt_16	NoUnits	0...20,048	1	2
Initial_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Record Size (bytes)					205

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.fxxxxxx

2.6.3 IIR Level 1 Calibration Correction Scientific Data Sets

The tables below summarize the contents of each of the scientific data sets (SDS) contained within the IIR Level 1 Calibration Correction product. Each parameter listed is using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of the valid data values.

Table 28: Granule Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Orbit_Start_Time	Float_64	s	4.203E8...9.623E8	1	8
Row_Number	Int_8	NoUnits	0...63	4,096	4,096
Column_Number	Int_8	NoUnits	0...63	4,096	4,096
Initial_Correction_Table_Sequence_Number_Night	Int_16	NoUnits	0...729	1	2
Initial_Correction_Table_Sequence_Number_Day	Int_16	NoUnits	0...729	1	2
Initial_Image_Sequence_Number_Night	Int_16	NoUnits	0...20,479	1	2
Initial_Image_Sequence_Number_Day	Int_16	NoUnits	0...20,479	1	2
Record Size (bytes)					8,208

Table 29: Calibration Correction Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Image_Sequence_Number_8.65	Int_16	NoUnits	0...20,479	1	2
Correction_Table_Sequence_Number_8.65	Int_16	NoUnits	0...729	1	2
Row_Equalization_Tartan_Radiance_Correction_8.65	Float_32	NoUnits	0.9...1.1	64	256
Row_Bias_Radiance_Correction_8.65	Float_32	NoUnits	0.9...1.1	64	256
Row_Total_Radiance_Correction_8.65	Float_32	NoUnits	0.9...1.1	64	256
Image_Sequence_Number_12.05	Int_16	NoUnits	0...20,479	1	2
Correction_Table_Sequence_Number_12.05	Int_16	NoUnits	0...729	1	2
Row_Equalization_Tartan_Radiance_Correction_12.05	Float_32	NoUnits	0.9...1.1	64	256
Row_Bias_Radiance_Correction_12.05	Float_32	NoUnits	0.9...1.1	64	256
Row_Total_Radiance_Correction_12.05	Float_32	NoUnits	0.9...1.1	64	256
Image_Sequence_Number_10.6	Int_16	NoUnits	0...20,479	1	2
Correction_Table_Sequence_Number_10.6	Int_16	NoUnits	0...729	1	2
Row_Equalization_Tartan_Radiance_Correction_10.6	Float_32	NoUnits	0.9...1.1	64	256
Row_Bias_Radiance_Correction_10.6	Float_32	NoUnits	0.9...1.1	64	256
Row_Total_Radiance_Correction_10.6	Float_32	NoUnits	0.9...1.1	64	256
Record Size (bytes)					2,316

2.7 WFC Level 1B Scans DP 1.3A

The Wide Field Camera Level 1B data product contains geolocated radiance data.

The major categories of WFC Level 1B data are:

- WFC 125 m Earth View Data
- WFC 1 km Earth View Data
- WFC IIR Registered 1 km Data
- Position Data
- Viewing Geometry
- Housekeeping Data

Level: 1B
Version: 4.00
Type: Archival
Frequency: 1 Orbit
Spatial Resolution Record: 1 km pixels x 61 km wide swath
125 m pixels x 5 km wide swath
IIR 1 km pixels x 61 km wide swath
Time Interval Covered: Half Orbit (Day Only)

Data File Name:

CAL_WFC_L1_1Km-ProductionStrategy-Version.Instance.hdf
CAL_WFC_L1_125m-ProductionStrategy-Version.Instance.hdf
CAL_WFC_L1_IIR-ProductionStrategy-Version.Instance.hdf

2.7.1 Wide Field Camera Level 1 Data Product

The maximum number of 5 km WFC packets processed in one orbit is 3,288 (daytime only). For each orbit, 3 files are created to represent the WFC Level 1 data product. They are the “1 km IIR Registered Science Data”, the “1 km Native Science Data” and the “125 m Native Science Data”.

Table 30: WFC Record Summary - 1 km IIR Registered Science

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
WFC Metadata Record	Table 33	2,149	1	2,149
1 km IIR Registered Science Record	Table 34	2,704	17,005	45,981,520
Total Size (bytes)				45,984,572
Total Size (Mbytes)				44.90

Table 31: WFC Record Summary - 1 km Native Science

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
WFC Metadata Record	Table 33	2,149	1	2,149
1 km Native Science Record	Table 35	2,712	17,005	46,117,560
Reflectance Bin Record	Table 35	288	915	263,520
Total Size (bytes)				46,384,132
Total Size (Mbytes)				45.29

Table 32: WFC Record Summary - 125 m Native Science

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
WFC Metadata Record	Table 33	2,149	1	2,149
125 m Native Science Record	Table 36	1,780	136,040	242,151,200
Reflectance Bin Record	Table 36	288	600	172,800
Total Size (bytes)				242,327,052
Total Size (Mbytes)				236.64

2.7.2 WFC Level 1 data Metadata

Table 33: WFC Level 1 Metadata Record

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	WFC_Native_125m WFC_Native_1Km WFC_IIR_Registered_1km	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Number_of_Good_125m_Records	Int_32	NoUnits	0...160,320	1	4
Number_of_Bad_125m_Records	Int_32	NoUnits	0...160,320	1	4
Number_of_Good_1km_Records	Int_32	NoUnits	0...20,040	1	4
Number_of_Bad_1km_Records	Int_32	NoUnits	0...20,040	1	4
Initial_Subsatellite_Latitude	Float_32	degrees	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	degrees	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	degrees	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	degrees	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,426.0...261,231.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,426.0...261,231.0	1	8
Ephemeris_Files_Used	Char	NoUnits	2 file names max.	160	160
Attitude_Files_Used	Char	NoUnits	2 file names max.	160	160
Vicarious_Calibration_File_Used	Char	NoUnits	N/A	80	80
1km_Radiance_Calibration_Coefficients	Float_64	(Wm ⁻² .sr ⁻¹ .µm ⁻¹) (count ⁻¹)(ms)	N/A	61	488
125m_Radiance_Calibration_Coefficients	Float_64	(Wm ⁻² .sr ⁻¹ .µm ⁻¹) (count ⁻¹)(ms)	N/A	40	320
Column_Number_of_Center_Image_Pixel	Int_16	NoUnits	244...268	1	2
Row_Number_of_Center_Image_Pixel	Int_16	NoUnits	229...258	1	2
Frame_Time	Float_32	milliseconds	N/A	1	4
Integration_Time	Float_32	milliseconds	N/A	1	4
Total_Poss_Day_Packets	Int_32	NoUnits	0...4,000	1	4
Total_Proc_Day_Packets	Int_32	NoUnits	0...4,000	1	4
Total_Proc_Night_Packets	Int_32	NoUnits	0...4,000	1	4
Reflectance_Bins_Min	Float_32	NoUnits	0.0...1.4	72	288
Reflectance_Bins_Max	Float_32	NoUnits	0.0...9,999.0	72	288
Solar_Zenith_Bins_Min	Float_32	degrees	0.0...70.0	15	60
Solar_Zenith_Bins_Max	Float_32	degrees	5.0...75.0	15	60
Record Size (bytes)					2,149

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.7.3 WFC Level 1 Scientific Data Sets

The tables below summarize the contents of each scientific data set (SDS) contained within each of the WFC Level 1 data products. Parameters are listed using the same SDS names as in respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 34: 1 km IIR Registered Science Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Shot_Time ^A	Float_64	s	4.203E8...9.623E8	1	8
Lidar_Shot_UTC_Time ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Latitude	Float_64	degrees_north	-90.0...90.0	61	488
Longitude	Float_64	degrees_east	-180.0...180.0	61	488
Radiance	Float_32	Wm ⁻² .sr ⁻¹ .μm ⁻¹	0.0...2,000.0	61	244
Reflectance	Float_32	NoUnits	0.0...2.0	61	244
1km_Homogeneity	Float_32	NoUnits	0.0...2.0	1	4
Solar_Zenith	Float_32	degrees	0.0...90.0	61	244
Solar_Azimuth	Float_32	degrees	-180.0...180.0	61	244
Viewing_Zenith	Float_32	degrees	0.0...90.0	61	244
Viewing_Azimuth	Float_32	degrees	-180.0...180.0	61	244
Pixel_QC_Flag ^C	UInt_32	NoUnits	0...8	61	244
Record Size (bytes)					2,704

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

C) Detailed description provided in Appendix D

Table 35: 1 km Native Science Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Scan_Time ^A	Float_64	s	4.203E8...9.623E8	1	8
Scan_UTC_Time ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Latitude	Float_64	degrees_north	-90.0...90.0	61	488
Longitude	Float_64	degrees_east	-180.0...180.0	61	488
Radiance	Float_32	Wm ⁻² .sr ⁻¹ .μm ⁻¹	0.0...2,000.0	61	244
Reflectance	Float_32	NoUnits	0.0...2.0	61	244
1km_Homogeneity	Float_32	NoUnits	0.0...2.0	1	4
Solar_Zenith	Float_32	degrees	0.0...90.0	61	244
Solar_Azimuth	Float_32	degrees	-180.0...180.0	61	244
Viewing_Zenith	Float_32	degrees	0.0...90.0	61	244
Viewing_Azimuth	Float_32	degrees	-180.0...180.0	61	244
CCD_Temperature	Float_32	degC	-100.0...100.0	1	4
BasePlate_Temperature	Float_32	degC	-100.0...100.0	1	4
Reflectance_Bins ^C	Int_32	NoUnits	0...20,000	0	0
Pixel_QC_Flag ^D	UInt_32	NoUnits	0...8	61	244
Record Size (bytes)					2,712

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

C) For each pixel there are 72 reflectance bins within 15 solar zenith angle bins and are totaled for the entire orbit.

D) Detailed description provided in Appendix D

Table 36: 125 m Native Science Record

Parameter/Field	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Scan_Time ^A	Float_64	s	4.203E8...9.623E8	1	8
Scan_UTC_Time ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Latitude	Float_64	degrees_north	-90.0...90.0	40	320
Longitude	Float_64	degrees_east	-180.0...180.0	40	320
Radiance	Float_32	Wm ⁻² .sr ⁻¹ .μm ⁻¹	0.0...2,000.0	40	160
Reflectance	Float_32	NoUnits	0.0...2.0	40	160
125m_Homogeneity	Float_32	NoUnits	0.0...2.0	1	4
Reflectance_Bins_125 ^C	Int_32	NoUnits	0...160,000	0	0
Solar_Zenith	Float_32	degrees	0.0...90.0	40	160
Solar_Azimuth	Float_32	degrees	180.0...180.0	40	160
Viewing_Zenith	Float_32	degrees	0.0...90.0	40	160
Viewing_Azimuth	Float_32	degrees	180.0...180.0	40	160
Pixel_QC_Flag ^D	UInt_32	NoUnits	N/A	40	160
Record Size (bytes)					1,780

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

C) For each pixel there are 72 reflectance bins within 15 solar zenith angle bins and are totaled for the entire orbit.

D) Detailed description provided in Appendix D

2.8 WFC Level 1B Calibration DP 1.3B

The Wide Field Camera Level 1 Calibration data product contains geolocated nighttime digital count data. The calibration data is collected over a 25-second segment on the dark side of every orbit.

The major categories of WFC Level 1B Calibration data are:

- WFC 125 m Earth View Data
- WFC 1 km Earth View Data
- Position Data
- Housekeeping Data

Level: 1
Type: Archival
Frequency: 1 Orbit
Spatial Resolution Record: 1 km pixels x 61 km wide swath
125 m pixels x 5 km wide swath
Time Interval Covered: Orbit (All Nighttime)

Data File Name:

CAL_WFC_L1_Cal-ProductionStrategy-Version.Instance.hdf

2.8.1 Wide Field Camera Level 1 Calibration Data Product

The maximum number of 5 km WFC packets processed in one orbit is 3,288 (nighttime only).

Table 37: WFC Level 1 Calibration Record Summary

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
WFC Calibration Metadata Record	Table 38	1,437	1	1,437
WFC Calibration Data Record	Table 39	1,436	160	229,760
Total Size (bytes)				232,100
Total Size (Mbytes)				0.23

2.8.2 Wide Field Camera Level 1 Calibration data Metadata

Table 38: WFC Level 1 Calibration Metadata Record

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	WFC_L1	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 04/2020	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 04/2020	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Number_of_Good_125m_Records	Int_32	NoUnits	0...160,320	1	4
Number_of_Bad_125m_Records	Int_32	NoUnits	0...160,320	1	4
Number_of_Good_1km_Records	Int_32	NoUnits	0...20,040	1	4
Number_of_Bad_1km_Records	Int_32	NoUnits	0...20,040	1	4
Initial_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230701.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230701.0	1	8
Ephemeris_Files_Used	Char	NoUnits	2 file names max.	160	160
Attitude_Files_Used	Char	NoUnits	2 file names max.	160	160
Vicarious_Calibration_File_Used	Char	NoUnits	N/A	80	80
1km_Radiance_Calibration_Coefficients	Float_64	(Wm ⁻² .sr ⁻¹ .µm ⁻¹) (count ⁻¹)(ms)	N/A	61	488
125m_Radiance_Calibration_Coefficients	Float_64	(Wm ⁻² .sr ⁻¹ .µm ⁻¹) (count ⁻¹)(ms)	N/A	40	320
Total_Proc_Day_Packets	Int_32	NoUnits	0...4,000	1	4
Total_Proc_Night_Packets	Int_32	NoUnits	0...4,000	1	4

Parameter	Data Type	Units	Range	Elem/Rec	Bytes
Record Size (bytes)					1,437

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.8.3 Wide Field Camera Level 1 Calibration Data Record

The table below summarizes the contents of each scientific data set (SDS) contained within the WFC Level 1 calibration data product. Units are given for each parameter, as is the range of valid data values.

Table 39: Calibration Data Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
1Km_Row_Time ^A	Float_64	s	4.203E8...9.623E8	1	8
1Km_Row_UTC_Time ^B	Float_64	yymmdd.ffffff	60428.0...230701.0	1	8
125m_Row_Time ^A	Float_64	s	4.203E8...9.623E8	1	8
125m_Row_UTC_Time ^B	Float_64	yymmdd.ffffff	60428.0...230701.0	1	8
1Km_Latitude	Float_64	°	-90.0...90.0	61	488
1Km_Longitude	Float_64	°	-180.0...180.0	61	488
1Km_Pixel_Values	UInt_32	count	0...20,000	61	244
125m_Pixel_Values	UInt_32	count	0...20,000	40	160
Col_Number_of_Center_Image_Pixel	UInt_32	NoUnits	244...268	1	4
Row_Number_of_Center_Image_Pixel	UInt_32	NoUnits	229...258	1	4
CCD_Temperature	Float_32	°C	-100.0...100.0	1	4
BasePlate_Temperature	Float_32	°C	-100.0...100.0	1	4
Frame_Time	Float_32	ms	N/A	1	4
Integration_Time	Float_32	ms	N/A	1	4
Record Size (bytes)					1,436

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.9 WFC Level 1B Assembler DP 1.3C

The Wide Field Camera Level 1 Assembler data product contains geolocated nighttime daily digital count and daily statistical data which comes from the calibration product. The Assembler takes the calibration data and calculates the statistics for each pixel (mean, standard deviation, maximum, and minimum).

The major categories of WFC Level 1B Assembler data are:

- WFC 125 m Earth View Data
- WFC 1 km Earth View Data
- Position Data
- Housekeeping Data

Level: 1
Type: Archival
Frequency: 1 Day
Spatial Resolution Record: 1 km pixels x 61 km wide swath
125 m pixels x 5 km wide swath
Time Interval Covered: One Day (All Nighttime)

Data File Name:
CAL_WFC_L1_Asm-ProductionStrategy-Version.Instance.hdf

2.9.1 Wide Field Camera Level 1 Assembler Data Record

The maximum number of 5 km WFC packets that can be processed in one day is 49,320.

Table 40: WFC Level 1 Assembler Record Summary

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
WFC Assembler Metadata Record	Table 41	169	1	169
WFC Assembler Data Record	Table 42	3,052	2,400	7,324,800
Total Size (bytes)				7,325,872
Total Size (Mbytes)				7.15

2.9.2 WFC Level 1 Assembler data Metadata

Table 41: WFC Level 1 Assembler Metadata Record

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	WFC_L1_Assembler	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 04/2020	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 04/2020	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Frame_Time	Float_32	ms	N/A	1	4
Integration_Time	Float_32	ms	N/A	1	4
Record Size (bytes)					169

A) UTC CCSDS ASCII Time Code Format A

2.9.3 WFC Level 1 Assembler Data Record

The table below summarizes the content of the data set (SDS) contained within the WFC Level 1 assembler data product. Parameters are listed using the same SDS names as in respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 42: WFC Level 1 Assembler Data Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
1Km_Row_Time ^A	Float_64	s	4.203E8...9.623E8	1	8
1Km_Row_UTC_Time ^B	Float_64	yymmdd.ffffff	60428.0...230701.0	1	8
125m_Row_Time ^A	Float_64	s	4.203E8...9.623E8	1	8
125m_Row_UTC_Time ^B	Float_64	yymmdd.ffffff	60428.0...230701.0	1	8
1Km_Latitude	Float_64	°	-90.0...90.0	61	488
1Km_Longitude	Float_64	°	-180.0...180.0	61	488

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
1Km_Pixel_Values	UInt_32	count	0...20,000	61	244
125m_Pixel_Values	UInt_32	count	0...20,000	40	160
Col_Number_of_Center_Image_Pixel	UInt_32	NoUnits	244...268	1	4
Row_Number_of_Center_Image_Pixel	UInt_32	NoUnits	229...258	1	4
CCD_Temperature	Float_32	°C	-100.0...100.0	1	8
BasePlate_Temperature	Float_32	°C	-100.0...100.0	1	8
1Km_Pixel_Values_Mean	Float_32	count	0.0...20000.0	61	244
125m_Pixel_Values_Mean	Float_32	count	0.0...20000.0	40	160
1Km_Pixel_Values_St_Dev	Float_32	count	0.0...20000.0	61	244
125m_Pixel_Values_St_Dev	Float_32	count	0.0...20000.0	40	160
1Km_Pixel_Values_Max	Float_32	count	0.0...20000.0	61	244
125m_Pixel_Values_Max	Float_32	count	0.0...20000.0	40	160
1Km_Pixel_Values_Min	Float_32	count	0.0...20000.0	61	244
125m_Pixel_Values_Min	Float_32	count	0.0...20000.0	40	160
Record Size (bytes)					3,052

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.10 Lidar Level 1.5 Standard Data Product DP 1.5

The lidar level 1.5 data product is a continuous segment of calibrated, geolocated, cloud-cleared, and spatially averaged profiles of lidar attenuated backscatter. These profiles are derived via a synthesis of the lidar level 1B profile and lidar level 2 aerosol profile products with the lidar level 2 vertical feature mask product. The lidar level 1.5 standard version 1.00 product uses standard version 4 level 1 and level 2 data as input. The level 1.5 data product is written in HDF.

Level:	1.5
Version:	1.00
Type:	Archival
Frequency:	2/Orbit
Record Spatial Resolution:	horizontal: 20 km
	vertical: 60 m vertical (-0.5 km to 20.2 km)
	180 m vertical (20.2 km to 30.1 km)

Data File Name:

CAL_LID_L15-Standard-Version.Instance.hdf

2.10.1 Lidar Level 1.5 Standard Data Product

Table 43: Lidar Level 1.5 Standard Instrument Record Summary

Record Name	Reference	Record Size	Recs/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar 1.5 Metadata Record	Table 44	22,373	1	22,373
Lidar Profile Science Record	Table 45	31,309	1,061	33,218,849
Total Size (bytes)				33,242,125
Total Size (Mbytes)				32.46

2.10.2 Lidar Level 1.5 Standard Data Metadata

Table 44: Lidar Level 1.5 Standard Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	L1.5 LIDAR Standard	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 12/2026	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 12/2026	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 12/2026	27	27
Initial_Subsatellite_Latitude	Float_32	deg	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	deg	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	deg	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	deg	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,426.0...261,231.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,426.0...160,601.0	1	8
GEOS_Version	Char	NoUnits	N/A	64	64
Level1_Filename	Char	NoUnits	N/A	160	160
Level2_VFM_Filename	Char	NoUnits	N/A	160	160
Level2_APro_Filename	Char	NoUnits	N/A	160	160
Lidar_Data_Altitudes	Float_32	km	-0.5... 30.1	400	1,600
Rayleigh_Extinction_Cross-section_532	Float_32	m ²	5.167E-31	1	4
Rayleigh_Extinction_Cross-section_1064	Float_32	m ²	3.127E-32	1	4
Rayleigh_Backscatter_Cross-section_532	Float_32	m ² .sr ⁻¹	5.930E-32	1	4
Rayleigh_Backscatter_Cross-section_1064	Float_32	m ² .sr ⁻¹	3.592E-33	1	4
Ozone_Absorption_Cross-section_532	Float_32	m ²	2.728461E-25	1	4
Ozone_Absorption_Cross-section_1064	Float_32	m ²	0.0	1	4
Production_Script	Char	NoUnits	N/A	20,000	20,000
Record Size (bytes)					22,373

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.10.3 Lidar Level 1.5 Standard Data Scientific Data Set

Table 176 summarize the contents of each scientific data set (SDS) contained within the lidar level 1.5 data product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 45: Lidar Profile Data

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Latitude (midpoint)	Float_32	deg	-90.0...90.0	1	4
Longitude (midpoint)	Float_32	deg	-180.0...180.0	1	4
Profile_Time (midpoint) ^A	Float_64	sec	4.204E8...1.072E9	1	8
Profile_UTC_Time (midpoint) ^B	Float_64	NoUnits	60,4260.0...26,1231.0	1	8
Profile_ID (first and last)	Int_32	NoUnits	1...228,630	2	8
Day_Night_Flag ^C	Int_8	NoUnits	0...2	1	1
Land_Water_Mask	Int_8	NoUnits	0...7	4	4
Surface_Elevation_Mean	Float_32	km	-1.0...9.0	1	4
Surface_Elevation_StDev	Float_32	km	-1.0...9.0	1	4
Samples_Averaged	UInt_16	NoUnits	0...360	400	800
Laser_Energy_Statistics_532 (min, max, mean, median)	Float_32	J	0.003...0.135	4	16
Laser_Energy_Statistics_1064 (min, max, mean, median)	Float_32	J	0.038...0.12	4	16
Minimum_Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Calibration_Constant_Parallel_532	Float_32	km ³ ·sr·J ⁻¹ ·count	3.0E10...8.0E10	1	4
Calibration_Constant_Parallel_Uncertainty_532	Float_32	km ³ ·sr·J ⁻¹ ·count	2.0E8...1.6E9	1	4
Total_Attenuated_Backscatter_532_Mean	Float_32	km ⁻¹ ·sr ⁻¹	-0.1...3.3	400	1,600
Total_Attenuated_Backscatter_532_Median	Float_32	km ⁻¹ ·sr ⁻¹	-0.1...3.3	400	1,600
Total_Attenuated_Backscatter_532_StDev	Float_32	km ⁻¹ ·sr ⁻¹	0.0...3.3	400	1,600
Total_Attenuated_Backscatter_Uncertainty_532	Float_32	km ⁻¹ ·sr ⁻¹	1.0E-5...1.0E-2	400	1,600
Calibration_Constant_Perpendicular_532	Float_32	km ³ ·sr·J ⁻¹ ·count	3.0E10...8.0E10	1	4
Calibration_Constant_Perpendicular_Uncertainty_532	Float_32	km ³ ·sr·J ⁻¹ ·count	2.0E9...1.6E9	1	4
Perpendicular_Attenuated_Backscatter_532_Mean	Float_32	km ⁻¹ ·sr ⁻¹	-0.08...1.7	400	1,600
Perpendicular_Attenuated_Backscatter_532_Median	Float_32	km ⁻¹ ·sr ⁻¹	-0.08...1.7	400	1,600
Perpendicular_Attenuated_Backscatter_532_StDev	Float_32	km ⁻¹ ·sr ⁻¹	0.0...3.3	400	1,600
Perpendicular_Attenuated_Backscatter_Uncertainty_532	Float_32	km ⁻¹ ·sr ⁻¹	1.0E-6...1.0E-3	400	1,600
Calibration_Constant_1064	Float_32	km ³ ·sr·J ⁻¹ ·count	4.0E9...1.0E10	1	4
Calibration_Constant_Uncertainty_1064	Float_32	km ³ ·sr·J ⁻¹ ·count	5.0E7...4.0E9	1	4
Attenuated_Backscatter_1064_Mean	Float_32	km ⁻¹ ·sr ⁻¹	-0.04...2.5	400	1,600
Attenuated_Backscatter_1064_Median	Float_32	km ⁻¹ ·sr ⁻¹	-0.04...2.5	400	1,600
Attenuated_Backscatter_1064_StDev	Float_32	km ⁻¹ ·sr ⁻¹	0.0...3.3	400	1,600
Attenuated_Backscatter_Uncertainty_1064	Float_32	km ⁻¹ ·sr ⁻¹	1.0E-5...1.0E-2	400	1,600
Molecular_Number_Density ^D	Float_32	m ⁻³	4.8E22...4.8E25	400	1,600
Ozone_Number_Density ^D	Float_32	m ⁻³	9.0E16...1.0E19	400	1,600
Molecular_Model_Attenuated_Backscatter_532 ^D	Float_32	km ⁻¹ ·sr ⁻¹	5.0E-4...2.0E-3	400	1,600
Molecular_Model_Attenuated_Backscatter_1064 ^D	Float_32	km ⁻¹ ·sr ⁻¹	5.0E-4...2.0E-3	400	1,600
Temperature ^D	Float_32	°C	-120.0...60.0	400	1,600

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Pressure ^D	Float_32	mb	1.0...1,086.0	400	1,600
Tropopause_Height_Mean ^D	Float_32	km	4.0...22.0	1	4
L2_Feature_Type	UInt_8	NoUnits	0... 29	400 x 4	1,600
Record Size (bytes)					31,309

- A) International Atomic Time (TAI) seconds from Jan. 1, 1993
 B) TAI time converted to UTC time stored in format: yymmdd.ffffff
 C) Reports the lighting conditions. For standard data products, 0 = day and 1 = night. However, expedited version of the lidar level 1.5 data product contains data recorded during both day and night since each granule spans 90 continuous minutes of the satellite orbit. Consequently, the day/night terminator can be crossed within the 20 km horizontal averaging interval. The Day_Night_Flag is assigned a value of 2 denoting day & night segments when the day/night terminator is crossed within a lidar level 1.5 expedited product profile.
 D) Based on GMAO data.

The L2_Feature_Type field is derived from the data reported in the level 2 vertical feature mask product and from cloud-clearing information in the level 2 aerosol profile product. With the exception of the Samples_Averaged SDS, all other fields in the lidar level 1.5 data product represent averages of data found in the lidar level 1B product at 532 nm and cloud-clearing information found in the lidar level 2 aerosol profile product.

For each altitude bin in the lidar level 1.5 product, the L2_Feature_Type field reports a 4-element array of 8-bit unsigned integers. These values describe the results of the CALIPSO layer detection and scene classification algorithms for tropospheric features. Each array element reports the classification results for a 5 km segment of the data that was considered for averaging when generating the 20-km horizontal resolution altitude bin. Values are as follows:

- 0 = invalid (bad or missing data)
- 1 = totally attenuated
- 2 = surface
- 3 = subsurface
- 4 = cloud
- 5 = clean marine
- 6 = dust
- 7 = polluted continental
- 8 = clean continental
- 9 = polluted dust
- 10 = smoke
- 11 = dusty marine
- 12 = PSC aerosol
- 13 = volcanic ash
- 14 = sulfate/other
- 15 = mixed aerosol
- 16 = cloud-cleared clean marine
- 17 = cloud-cleared dust
- 18 = cloud-cleared polluted continental
- 19 = cloud-cleared clean continental

20	=	cloud-cleared polluted dust
21	=	cloud-cleared smoke
22	=	cloud-cleared dusty marine
23	=	cloud-cleared PSC aerosol
24	=	cloud-cleared volcanic ash
25	=	cloud-cleared sulfate/other
26	=	cloud-cleared mixed aerosol
27	=	"clear air"
28	=	cloud-cleared "clear-air"
29	=	overcast

All range bins beneath the highest cloud in a profile are classified as ‘overcast’. The convention for defining clouds and overcast features with L2_Feature_Type is to classify the entire continuous vertical extent of the highest cloud in a profile as cloud (4) and then classify all range bins beneath that cloud as overcast (29) until the first totally attenuated, surface, or subsurface range bin.

“Cloud-cleared” aerosols refer to aerosols that have been detected after 1/3 km and/or 1 km horizontal resolution clouds have been cleared by the level 2 scene classification algorithms. Similarly, cloud-cleared “clear air” refers to segments of “clear air” where 1/3 km and/or 1 km resolution clouds have been cleared.

“Mixed aerosol” identifies 20 km x 60 m resolution elements containing more than one aerosol type. “Cloud-cleared mixed aerosol” identifies 20 km x 60 m resolution elements containing more than one aerosol subtype where at least one is cloud-cleared as defined above.

For level 1.5 standard version 1.00, stratospheric aerosol layers having the subtype PSC aerosol are screened just like clouds, whereas they retain their "PSC aerosol" L2_Feature_Type classification.

Important: Regions of data in the lidar level 1B and lidar level 2 aerosol profile products having L2_Feature_Type values of 0 through 4, 12, 23 and 29 are not included when computing the cloud-cleared averaged data that is recorded in the attenuated backscatter profiles.

2.11 Lidar Level 2 Cloud, Aerosol and Merged Layer Products DP 2.1A

The Lidar Level 2 cloud layer products are produced at 1 km and 5km horizontal resolutions. The Lidar Level 2 aerosol are only produced at a 5 km horizontal resolution. The merged layer products are produced at 1/3 km and 5 km horizontal resolution. The merged layer product is a combination of the aerosol and cloud layer products.

Within the Lidar Cloud, Aerosol and Merged Layer Products there are two general classes of data:

- Column Properties (including position data and viewing geometry)
- Layer Properties

Level: 2
Version: 5.00
Type: Archival
Frequency: 2/Orbit
Spatial Resolution Record: 1/3 km (full resolution)
1 km horizontal
5 km horizontal
Time Interval Covered: Half Orbit (Day or Night)

Data File Name:

CAL_LID_L2_333mMLay-Standard-Version.Instance.hdf
CAL_LID_L2_01kmCLay-Standard-Version.Instance.hdf
CAL_LID_L2_05kmCLay-Standard-Version.Instance.hdf
CAL_LID_L2_05kmALay-Standard-Version.Instance.hdf
CAL_LID_L2_05kmMLay-Standard-Version.Instance.hdf
CAL_LID_L2_05kmMLay-Diagnostic-Beta-Version.Instance.hdf

2.11.1 Lidar Level 2 Cloud and Aerosol Layers Record Summary

The tables below summarize the content and estimated size of each of the layer products. Six data files will be produced for each granule: a 1/3 km resolution merged product, 1 km resolution cloud product, a 5 km resolution cloud product, a 5 km resolution aerosol product, a 5 km resolution merged product, and a 5 km resolution merged diagnostic product.

The lidar layer products consist of a sequence of column descriptors, each one of which is associated with a variable number of layer descriptors. The column descriptors specify the temporal and geophysical location of the column of the atmosphere through which a given lidar pulse travels. Also included in the column descriptors are indicators of surface lighting conditions, information about the surface type, and the number of features (e.g., cloud and/or aerosol layers) identified within the column.

For each feature within a column, a set of layer descriptors is reported. The layer descriptors provide information about the spatial and optical characteristics of a feature, such as base and top altitudes, integrated attenuated backscatter, and optical depth.

The number of layers has a substantial impact on the data product sizes; therefore, for each set of column descriptors defined in this section, the maximum number of layer descriptors is specified in the element/record and byte fields. These values are meant to represent an upper bound on the number of layers that might be reasonably encountered in a real-world data set.

The 5 km resolution merged diagnostic product is similar with the 5 km merged diagnostic product but augmented with additional diagnostic information not included elsewhere.

Table 46: 1/3 km Lidar Merged Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Cloud & Aerosol Metadata Record	Table 52	43,006	1	43,006
Lidar Surface Detection Information	Table 53	68	4,010	272,680
Ocean Derived Column Optical Depth	Table 56	24	4,010	96,240
Lidar Data Altitudes	Table 63	583	1	2,332
1/3 km Column Descriptor Record: Merged	Table 63	133	60,143	7,999,019
1/3 km Layer Descriptor Record: Merged	Table 64	1,015	60,143	61,045,145
Total Size (bytes)				69,459,325
Total Size (Mbytes)				67.831

Table 47: 1 km Lidar Cloud Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Cloud & Aerosol Metadata Record	Table 52	43,006	1	43,006
Lidar Surface Detection Information	Table 53	72	4,010	288,720

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Ocean Derived Column Optical Depth	Table 56	24	4,010	96,240
Lidar Data Altitudes	Table 65	583	1	2,332
1 km Column Descriptor Record: Clouds	Table 65	126	21,210	2,672,460
1 km Layer Descriptor Record: Clouds	Table 66	1,900	21,210	40,299,000
Total Size (bytes)				43,402,661
Total Size (Mbytes)				42.385

Table 48: 5 km Lidar Cloud Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Cloud & Aerosol Metadata Record	Table 52	43,006	1	43,006
Lidar Surface Detection Information	Table 53	76	4,010	304,760
Ocean Derived Column Optical Depth	Table 56	24	4,010	96,240
Single Shot Parameters	Table 61	1,254	63,630	79,792,020
Single Shot Lidar Surface Detection Information	Table 54	68	63,630	4,326,840
Single Shot Ocean Derived Column Optical Depth	Table 58	24	63,630	1,527,120
Lidar Data Altitudes	Table 67	583	1	2,332
5 km Column Descriptor Record: Clouds	Table 67	318	4,010	1,275,180
5 km Layer Descriptor Record: Clouds	Table 68	3,112	4,010	12,479,120
Total Size (bytes)				99,847,521
Total Size (Mbytes)				97.507

Table 49: 5 km Lidar Aerosol Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Cloud & Aerosol Metadata Record	Table 52	43,006	1	43,006
Lidar Surface Detection Information	Table 53	76	4,010	304,760
Ocean Derived Column Optical Depth	Table 56	24	4,010	96,240
Single Shot Parameters	Table 61	1,249	63,630	79,473,870
Single Shot Lidar Surface Detection Information	Table 54	68	63,630	4,326,840
Single Shot Ocean Derived Column Optical Depth	Table 58	24	63,630	1,527,120
Lidar Data Altitudes	Table 69	583	1	2,332
5 km Column Descriptor Record: Aerosols	Table 69	320	4,010	1,283,200
5 km Layer Descriptor Record: Aerosols	Table 70	2,896	4,010	11,612,960

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Total Size (bytes)				98,671,231
Total Size (Mbytes)				96.358

Table 50: 5 km Lidar Merged Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Cloud & Aerosol Metadata Record	Table 52	43,006	1	43,006
Lidar Surface Detection Information	Table 53	76	4,010	304,760
Ocean Derived Column Optical Depth	Table 56	24	4,010	96,240
Single Shot Parameters	Table 61	1,254	63,630	79,982,910 79,792,020
Single Shot Lidar Surface Detection Information	Table 54	68	63,630	4,326,840
Single Shot Ocean Derived Column Optical Depth	Table 58	24	63,630	1,527,120
Lidar Data Altitudes	Table 71	583	1	2,332
5 km Column Descriptor Record: Merged	Table 71	322	4,010	1,291,220
5 km Layer Descriptor Record: Merged	Table 72	5,580	4,010	22,375,800
Total Size (bytes)				109,760,241
Total Size (Mbytes)				107.187

Table 51: 5 km Lidar Merged Diagnostic Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Cloud & Aerosol Metadata Record	Table 52	43,006	1	43,006
Lidar Surface Detection Information	Table 53	76	4,010	304,760
Ocean Derived Column Optical Depth - Diagnostic	Table 57	132	4,010	529,320
Single Shot Parameters	Table 61	1,257	63,630	79,982,910
Single Shot Lidar Surface Detection Information	Table 54	68	63,630	4,326,840
Single Shot Ocean Derived Column Optical Depth - Diagnostic	Table 59	132	63,630	8,399,160
01km Parameters	Table 62	2,243	21,210	47,574,030
01km Lidar Surface Detection Information	Table 55	68	21,210	1,442,280
01km Ocean Derived Column Optical Depth - Diagnostic	Table 60	132	21,210	2,799,720
Lidar Data Altitudes	Table 71	583	1	2,332
5 km Column Descriptor Record: Merged	Table 71	322	4,010	1,291,220
5 km Layer Descriptor Record: Merged	Table 72	5,580	4,010	22,375,800
Total Size (bytes)				169,072,281
Total Size (Mbytes)				165.109

2.11.2 Lidar Cloud, Aerosol and Merged Level 2 Metadata

Table 52: Lidar Cloud, Aerosol and Merged Level 2 Layer Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	L2_LIDAR	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Number_of_Good_Profiles	Int_32	NoUnits	0...63,630	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	0...63,630	1	4
Initial_Subsatellite_Latitude	Float_32	degrees	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	degrees	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	degrees	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	degrees	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Lidar_L1_Production_Date_Time	Char	NoUnits	4/2006 – 10/2025	27	27
Number_of_Single_Shot_Records_in_File	Int_32	NoUnits	0...63,630	1	4

Number_of_Average_Records_in_File	Int_32	NoUnits	0...21,210	1	4
Number_of_Features_Found	Int_32	NoUnits	0...616,606	1	4
Number_of_Cloud_Features_Found	Int_32	NoUnits	0...572,670	1	4
Number_of_Aerosol_Features_Found	Int_32	NoUnits	0...33,936	1	4
Number_of_Indeterminate_Features_Found	Int_32	NoUnits	0...572,640	1	4
MERRA2_Wind_Uncertainty	Float_32	m/s	N/A	1	8
AMSR_Wind_Correction_Uncertainty	Float_32	m/s	N/A	1	8
Lidar_Data_Altitudes	Float_32	km	-2.0...40.0	583	2,332
GEOS_Version	Char	NoUnits	N/A	64	64
GMAO_Files_Used	Char	NoUnits	4 file names max	320	320
Classifier_Coefficients_Version_Number	Char	NoUnits	0.0...99.9	1	4
Classifier_Coefficients_Version_Date	Char	NoUnits	4/2006 – 10/2025	1	6
Production_Script	Char	NoUnits	N/A	40,000	40,000
Record Size (bytes)					43,006

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.11.3 Lidar Cloud, Aerosol and Merged Level 2 Shared Parameter Information

The Lidar Cloud, Aerosol, and Merged Level 2 layer products contain a number of the same parameter information, as noted in the tables below.

Table 53: Lidar Surface Detection Information

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Surface_Top_Altitude_532	Float_32	km	-0.5...8.2	1	4
Surface_Base_Altitude_532	Float_32	km	-0.5...8.2	1	4
Surface_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
Surface_532_Integrated_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	1	4
Surface_532_Integrated_Attenuated_Color_Ratio	Float_32	NoUnits	0.0...2.0	1	4
Surface_Detection_Flags_532	UInt_16	NoUnits	0...8,192	1	2
Surface_Overlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
Surface_Scaled_RMS_Background_532	Float_32	1/(km · sr)	0.0...0.05	1	4
Surface_Peak_Signal_532	Float_32	1/(km · sr)	0.0...3.5	1	4
Surface_Detections_333m_532 ^{A C}	Int_16	NoUnits	0...15	1	2
Surface_Detections_1km_532 ^{B C}	Int_16	NoUnits	0...5	1	2
Surface_Top_Altitude_1064	Float_32	km	-0.5...8.2	1	4
Surface_Base_Altitude_1064	Float_32	km	-0.5...8.2	1	4
Surface_Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...2.0	1	4
Surface_1064_Integrated_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	1	4
Surface_1064_Integrated_Attenuated_Color_Ratio	Float_32	NoUnits	0.0...2.0	1	4
Surface_Detection_Flags_1064	UInt_16	NoUnits	0...16,384	1	2
Surface_Overlying_Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...2.0	1	4
Surface_Scaled_RMS_Background_1064	Float_32	1/(km · sr)	0.0...0.05	1	4
Surface_Peak_Signal_1064	Float_32	1/(km · sr)	0.0...3.5	1	4
Surface_Detections_333m_1064 ^{A C}	Int_16	NoUnits	0...15	1	2
Surface_Detections_1km_1064 ^{B C}	Int_16	NoUnits	0...5	1	2
Record Size (bytes)					76

A) included in the 1 km and 5 km resolution products only

B) included in the 5 km resolution products only

C) not included in the 333 m merged layer product

Table 54: Single Shot Lidar Surface Detection Information

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
ssSurface_Top_Altitude_532	Float_32	km	-0.5...8.2	1	4
ssSurface_Base_Altitude_532	Float_32	km	-0.5...8.2	1	4
ssSurface_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
ssSurface_532_Integrated_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	1	4
ssSurface_532_Integrated_Attenuated_Color_Ratio	Float_32	NoUnits	0.0...2.0	1	4
ssSurface_Detection_Flags_532	UInt_16	NoUnits	0...8,192	1	2
ssSurface_Overlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
ssSurface_Scaled_RMS_Background_532	Float_32	1/(km · sr)	0.0...0.05	1	4
ssSurface_Peak_Signal_532	Float_32	1/(km · sr)	0.0...3.5	1	4
ssSurface_Top_Altitude_1064	Float_32	km	-0.5...8.2	1	4
ssSurface_Base_Altitude_1064	Float_32	km	-0.5...8.2	1	4
ssSurface_Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...2.0	1	4
ssSurface_1064_Integrated_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	1	4
ssSurface_1064_Integrated_Attenuated_Color_Ratio	Float_32	NoUnits	0.0...2.0	1	4
ssSurface_Detection_Flags_1064	UInt_16	NoUnits	0...16,384	1	2
ssSurface_Overlying_Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...2.0	1	4
ssSurface_Scaled_RMS_Background_1064	Float_32	1/(km · sr)	0.0...0.05	1	4
ssSurface_Peak_Signal_1064	Float_32	1/(km · sr)	0.0...3.5	1	4
Record Size (bytes)					68

Table 55: 01km Shot Lidar Surface Detection Information - Diagnostic

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
01kmSurface_Top_Altitude_532	Float_32	km	-0.5...8.2	1	4
01kmSurface_Base_Altitude_532	Float_32	km	-0.5...8.2	1	4
01kmSurface_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
01kmSurface_532_Integrated_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	1	4
01kmSurface_532_Integrated_Attenuated_Color_Ratio	Float_32	NoUnits	0.0...2.0	1	4
01kmSurface_Detection_Flags_532	UInt_16	NoUnits	0...8,192	1	2
01kmSurface_Overlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
01kmSurface_Scaled_RMS_Background_532	Float_32	1/(km · sr)	0.0...0.05	1	4
01kmSurface_Peak_Signal_532	Float_32	1/(km · sr)	0.0...3.5	1	4
01kmSurface_Top_Altitude_1064	Float_32	km	-0.5...8.2	1	4
01kmSurface_Base_Altitude_1064	Float_32	km	-0.5...8.2	1	4
01kmSurface_Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...2.0	1	4
01kmSurface_1064_Integrated_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	1	4
01kmSurface_1064_Integrated_Attenuated_Color_Ratio	Float_32	NoUnits	0.0...2.0	1	4
01kmSurface_Detection_Flags_1064	UInt_16	NoUnits	0...16,384	1	2
01kmSurface_Overlying_Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...2.0	1	4
01kmSurface_Scaled_RMS_Background_1064	Float_32	1/(km · sr)	0.0...0.05	1	4
01kmSurface_Peak_Signal_1064	Float_32	1/(km · sr)	0.0...3.5	1	4
Record Size (bytes)					68

Table 56: Ocean Derived Column Optical Depth

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Ocean_Fresnel_Reflection_Coefficient_532 ^A	N/A	N/A	N/A		
ODCOD_Effective_Optical_Depth_532	Float_32	NoUnits	0.0...25.0	1	4
ODCOD_Effective_Optical_Depth_532_Uncertainty	Float_32	NoUnits	N/A	1	4
ODCOD_QC_Flag_532	UInt_32	NoUnits	0...4294967295	1	4
ODCOD_Surface_Wind_Speeds_10m	Float_32	m/s	-43.0...43.0	2	8
ODCOD_Surface_Wind_Speed_Correction	Float_32	m/s	-43.0...43.0	1	4
Record Size (bytes)					24

A) Coefficients will be put into the metadata and not into the Ocean_Derived_Column_Optical_Depth Vgroup

Table 57: Ocean Derived Column Optical Depth - Diagnostic

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Ocean_Fresnel_Reflection_Coefficient_532 ^A	N/A	N/A	N/A		
ODCOD_Two_Way_Transmittance_532	Float_32	NoUnits	0.0...1.0	1	4
ODCOD_Two_Way_Transmittance_532_Unc	Float_32	NoUnits	N/A	1	4
ODCOD_Two_Way_Transmittance_532_Unc_Wind	Float_32	NoUnits	N/A	1	4
ODCOD_Two_Way_Transmittance_532_Unc_Area	Float_32	NoUnits	N/A	1	4
ODCOD_Two_Way_Transmittance_532_Unc_T2MolO3	Float_32	NoUnits	N/A	1	4
ODCOD_T2_Product_Molecular_O3_532	Float_32	NoUnits	0.0...1.0	1	4
ODCOD_Two_Way_Transmittance_1064	Float_32	NoUnits	0.0...1.0	1	4
ODCOD_Two_Way_Transmittance_1064_Unc	Float_32	NoUnits	N/A	1	4
ODCOD_Two_Way_Transmittance_1064_Unc_Wind	Float_32	NoUnits	N/A	1	4
ODCOD_Two_Way_Transmittance_1064_Unc_Area	Float_32	NoUnits	N/A	1	4
ODCOD_Two_Way_Transmittance_1064_Unc_T2MolO3	Float_32	NoUnits	N/A	1	4
ODCOD_T2_Product_Molecular_O3_1064	Float_32	NoUnits	0.0...1.0	1	4
ODCOD_Ocean_Surface_Retro_Reflectance_532	Float_32	NoUnits	0.0...1.0	1	4
ODCOD_Ocean_Surface_Retro_Reflectance_1064	Float_32	NoUnits	0.0...1.0	1	4
ODCOD_Fundamental_Time_Delay_532	Float_32	microseconds	-0.05...0.15	1	4
ODCOD_Fundamental_Time_Delay_1064	Float_32	microseconds	-0.15...0.25	1	4
ODCOD_Scale_Factor_532	Float_32	NoUnits	0.0...5.0	1	4
ODCOD_Scale_Factor_1064	Float_32	NoUnits	0.0...5.0	1	4
ODCOD_First_Point_Index_532	Int_16	NoUnits	0...3	1	2
ODCOD_First_Point_Index_1064	Int_16	NoUnits	0...3	1	2
ODCOD_Surface_Points_532	Float_32	NoUnits	0.0...2.0	1	4
ODCOD_Surface_Points_1064	Float_32	NoUnits	0.0...2.0	1	4
ODCOD_IRF_Area_532	Float_32	NoUnits	0.0...0.962	1	4
ODCOD_IRF_Area_Uncertainty_532	Float_32	NoUnits	0.0...0.962	1	4
ODCOD_IRF_Area_1064	Float_32	NoUnits	0.0...0.962	1	4
ODCOD_IRF_Area_Uncertainty_1064	Float_32	NoUnits	0.0...0.962	1	4
ODCOD_Curve_Fit_Error_532	Float_32	NoUnits	N/A	1	4
ODCOD_Curve_Fit_Error_1064	Float_32	NoUnits	N/A	1	4
ODCOD_Effective_Optical_Depth_532	Float_32	NoUnits	0.0...25.0	1	4
ODCOD_Effective_Optical_Depth_532_Uncertainty	Float_32	NoUnits	N/A	1	4
ODCOD_QC_Flag_532	UInt_32	NoUnits	0...4294967295	1	4
ODCOD_Surface_Wind_Speeds_10m	Float_32	m/s	-43.0...43.0	2	8
ODCOD_Surface_Wind_Speed_Correction	Float_32	m/s	-43.0...43.0	1	4
Record Size (bytes)					132

A) Coefficients will be put into the metadata and not into the Ocean_Derived_Column_Optical_Depth V group

Table 58: Single Shot Ocean Derived Column Optical Depth

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
ssODCOD_Effective_Optical_Depth_532	Float_32	NoUnits	0.0...25.0	1	4
ssODCOD_Effective_Optical_Depth_532_Uncertainty	Float_32	NoUnits	N/A	1	4
ssODCOD_QC_Flag_532	UInt_32	NoUnits	0...4294967295	1	4
ssODCOD_Surface_Wind_Speeds_10m	Float_32	m/s	-43.0...43.0	2	8
ssODCOD_Surface_Wind_Speed_Correction	Float_32	m/s	-43.0...43.0	1	4
Record Size (bytes)					24

Table 59: Single Shot Ocean Derived Column Optical Depth - Diagnostic

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
ssODCOD_Two_Way_Transmittance_532	Float_32	NoUnits	0.0...1.0	1	4
ssODCOD_Two_Way_Transmittance_532_Unc	Float_32	NoUnits	N/A	1	4
ssODCOD_Two_Way_Transmittance_532_Unc_Wind	Float_32	NoUnits	N/A	1	4
ssODCOD_Two_Way_Transmittance_532_Unc_Area	Float_32	NoUnits	N/A	1	4
ssODCOD_Two_Way_Transmittance_532_Unc_T2MolO3	Float_32	NoUnits	N/A	1	4
ssODCOD_T2_Product_Molecular_O3_532	Float_32	NoUnits	0.0...1.0	1	4
ssODCOD_Two_Way_Transmittance_1064	Float_32	NoUnits	0.0...1.0	1	4
ssODCOD_Two_Way_Transmittance_1064_Unc	Float_32	NoUnits	N/A	1	4
ssODCOD_Two_Way_Transmittance_1064_Unc_Wind	Float_32	NoUnits	N/A	1	4
ssODCOD_Two_Way_Transmittance_1064_Unc_Area	Float_32	NoUnits	N/A	1	4
ssODCOD_Two_Way_Transmittance_1064_Unc_T2MolO3	Float_32	NoUnits	N/A	1	4
ssODCOD_T2_Product_Molecular_O3_1064	Float_32	NoUnits	0.0...1.0	1	4
ssODCOD_Ocean_Surface_Retro_Reflectance_532	Float_32	NoUnits	0.0...1.0	1	4
ssODCOD_Ocean_Surface_Retro_Reflectance_1064	Float_32	NoUnits	0.0...1.0	1	4
ssODCOD_Fundamental_Time_Delay_532	Float_32	microseconds	-0.05...0.15	1	4
ssODCOD_Fundamental_Time_Delay_1064	Float_32	microseconds	-0.15...0.25	1	4
ssODCOD_Scale_Factor_532	Float_32	NoUnits	0.0...5.0	1	4
ssODCOD_Scale_Factor_1064	Float_32	NoUnits	0.0...5.0	1	4
ssODCOD_First_Point_Index_532	Int_16	NoUnits	0...3	1	2
ssODCOD_First_Point_Index_1064	Int_16	NoUnits	0...3	1	2
ssODCOD_Surface_Points_532	Float_32	NoUnits	0.0...2.0	1	4
ssODCOD_Surface_Points_1064	Float_32	NoUnits	0.0...2.0	1	4
ssODCOD_IRF_Area_532	Float_32	NoUnits	0.0...0.962	1	4
ssODCOD_IRF_Area_Uncertainty_532	Float_32	NoUnits	0.0...0.962	1	4
ssODCOD_IRF_Area_1064	Float_32	NoUnits	0.0...0.962	1	4
ssODCOD_IRF_Area_Uncertainty_1064	Float_32	NoUnits	0.0...0.962	1	4
ssODCOD_Curve_Fit_Error_532	Float_32	NoUnits	N/A	1	4
ssODCOD_Curve_Fit_Error_1064	Float_32	NoUnits	N/A	1	4
ssODCOD_Effective_Optical_Depth_532	Float_32	NoUnits	0.0...25.0	1	4
ssODCOD_Effective_Optical_Depth_532_Uncertainty	Float_32	NoUnits	N/A	1	4
ssODCOD_QC_Flag_532	UInt_32	NoUnits	0...4294967295	1	4
ssODCOD_Surface_Wind_Speeds_10m	Float_32	m/s	-43.0...43.0	2	8
ssODCOD_Surface_Wind_Speed_Correction	Float_32	m/s	-43.0...43.0	1	4
Record Size (bytes)					132

Table 60: 01km Ocean Derived Column Optical Depth - Diagnostic

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
01kmODCOD_Two_Way_Transmittance_532	Float_32	NoUnits	0.0...1.0	1	4
01kmODCOD_Two_Way_Transmittance_532_Unc	Float_32	NoUnits	N/A	1	4
01kmODCOD_Two_Way_Transmittance_532_Unc_Wind	Float_32	NoUnits	N/A	1	4
01kmODCOD_Two_Way_Transmittance_532_Unc_Area	Float_32	NoUnits	N/A	1	4
01kmODCOD_Two_Way_Transmittance_532_Unc_T2Mol O3	Float_32	NoUnits	N/A	1	4
01kmODCOD_T2_Product_Molecular_O3_532	Float_32	NoUnits	0.0...1.0	1	4
01kmODCOD_Two_Way_Transmittance_1064	Float_32	NoUnits	0.0...1.0	1	4
01kmODCOD_Two_Way_Transmittance_1064_Unc	Float_32	NoUnits	N/A	1	4
01kmODCOD_Two_Way_Transmittance_1064_Unc_Wind	Float_32	NoUnits	N/A	1	4
01kmODCOD_Two_Way_Transmittance_1064_Unc_Area	Float_32	NoUnits	N/A	1	4
01kmODCOD_Two_Way_Transmittance_1064_Unc_T2M oLO3	Float_32	NoUnits	N/A	1	4
01kmODCOD_T2_Product_Molecular_O3_1064	Float_32	NoUnits	0.0...1.0	1	4
01kmODCOD_Ocean_Surface_Retro_Reflectance_532	Float_32	NoUnits	0.0...1.0	1	4
01kmODCOD_Ocean_Surface_Retro_Reflectance_1064	Float_32	NoUnits	0.0...1.0	1	4
01kmODCOD_Fundamental_Time_Delay_532	Float_32	microseconds	-0.05...0.15	1	4
01kmODCOD_Fundamental_Time_Delay_1064	Float_32	microseconds	-0.15...0.25	1	4
01kmODCOD_Scale_Factor_532	Float_32	NoUnits	0.0...5.0	1	4
01kmODCOD_Scale_Factor_1064	Float_32	NoUnits	0.0...5.0	1	4
01kmODCOD_First_Point_Index_532	Int_16	NoUnits	0...3	1	2
01kmODCOD_First_Point_Index_1064	Int_16	NoUnits	0...3	1	2
01kmODCOD_Surface_Points_532	Float_32	NoUnits	0.0...2.0	1	4
01kmODCOD_Surface_Points_1064	Float_32	NoUnits	0.0...2.0	1	4
01kmODCOD_IRF_Area_532	Float_32	NoUnits	0.0...0.962	1	4
01kmODCOD_IRF_Area_Uncertainty_532	Float_32	NoUnits	0.0...0.962	1	4
01kmODCOD_IRF_Area_1064	Float_32	NoUnits	0.0...0.962	1	4
01kmODCOD_IRF_Area_Uncertainty_1064	Float_32	NoUnits	0.0...0.962	1	4
01kmODCOD_Curve_Fit_Error_532	Float_32	NoUnits	N/A	1	4
01kmODCOD_Curve_Fit_Error_1064	Float_32	NoUnits	N/A	1	4
01kmODCOD_Effective_Optical_Depth_532	Float_32	NoUnits	0.0...25.0	1	4
01kmODCOD_Effective_Optical_Depth_532_Uncertainty	Float_32	NoUnits	N/A	1	4
01kmODCOD_QC_Flag_532	UInt_32	NoUnits	0...4294967295	1	4
01kmODCOD_Surface_Wind_Speeds_10m	Float_32	m/s	-43.0...43.0	2	8
01kmODCOD_Surface_Wind_Speed_Correction	Float_32	m/s	-43.0...43.0	1	4
Record Size (bytes)					132

Table 61: Lidar Cloud, Aerosol and Merged Level 2 Layer Single Shot Parameters

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Surface_Detection	Table	Info	Information	1	80
Ocean_Derived_Column_Optical_Depth	Table	Info	Information	1	80
ssProfile_ID	Int_32	NoUnits	1...228,630	1	4
ssLatitude	Float_32	degrees_north	-90.0...90.0	1	4
ssLongitude	Float_32	degrees_east	-180.0...180.0	1	4
ssProfile_Time ^A	Float_64	TAI seconds	4.204E8...9.623E8	1	8
ssProfile_UTC_Time ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
ssOff_Nadir_Angle ^D	Float_32	degrees	0.0...10.0	1	4
ssParallel_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
ssParallel_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
ssPerpendicular_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
ssPerpendicular_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
ssColumn_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
ssColumn_IAB_Cumulative_Probability	Float_32	NoUnits	0.0...1.0	1	4
ssDEM_Surface_Elevation	Float_32	km	-1.0...9.0	1	4
ssLaser_Energy_532	Float_32	J	0.003...0.135	1	4
ssLow_Energy_Mitigation_Column_QC_Flag	UInt_16	NoUnits	0...1983	1	2
ssScene_Flag	Int_32	NoUnits	N/A	1	4
ssNumber_Bins_Shift	Int_32	bins	-8...8	1	4
ssNumber_Layers_Found	Int_8	NoUnits	0...5	1	1
ssLayer_Top_Altitude	Float_32	km	-0.5...8.2	5	20
ssLayer_Base_Altitude	Float_32	km	-0.5...8.2	5	20
ssLayer_Top_Pressure	Float_32	hPa	1.0...1,086.0	5	20
ssMidlayer_Pressure	Float_32	hPa	1.0...1,086.0	5	20
ssLayer_Base_Pressure	Float_32	hPa	1.0...1,086.0	5	20
ssLayer_Top_Temperature	Float_32	degC	-110.0...60.0	5	20
ssLayer_Centroid_Temperature	Float_32	degC	-110.0...60.0	5	20
ssMidlayer_Temperature	Float_32	degC	-110.0...60.0	5	20
ssLayer_Base_Temperature	Float_32	degC	-110.0...60.0	5	20
ssOpacity_Flag	Int_8	NoUnits	0...1	5	5
ssColumn_Particate_Optical_Depth_Above_Opaque_Water_Cloud_532	Float_32	NoUnits	0.0...3.0	1	4
ssColumn_Particate_Optical_Depth_Above_Opaque_Water_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
ssAttenuated_Scattering_Ratio_Statistics_532	Float_32	NoUnits	N/A	30	120
ssAttenuated_Backscatter_Statistics_532	Float_32	1/(km · sr)	N/A	30	120
ssIntegrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...1.8	5	20
ssIntegrated_Attenuated_Backscatter_Uncertainty_532	Float_32	1/sr	0.0...0.5	5	20
ssAttenuated_Backscatter_Statistics_1064	Float_32	1/(km · sr)	N/A	30	120
ssIntegrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...1.8	5	20
ssIntegrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	1/sr	0.0...0.5	5	20
ssVolume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	30	120
ssIntegrated_Volume_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	5	20
ssIntegrated_Volume_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	0.0...2.0	5	20
ssAttenuated_Total_Color_Ratio_Statistics	Float_32	NoUnits	N/A	30	120
ssIntegrated_Attenuated_Total_Color_Ratio	Float_32	NoUnits	0.0...2.0	5	20
ssIntegrated_Attenuated_Total_Color_Ratio_Uncertainty	Float_32	NoUnits	0.0...3.0	5	20
ssOverlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	5	20
ssLayer_IAB_QA_Factor	Float_32	NoUnits	0.0...1.0	5	20
ssCAD_Score	Int_8	NoUnits	-101...110	5	5
ssInitial_CAD_Score ^C	Int_8	NoUnits	-101...119	5	5
ssFeature_Classification_Flags	UInt_16	NoUnits	1...49,146	5	10
ssWas_Cleared	Int_8	NoUnits	0...1	5	5
ssDecoupled_Layer_Type	Int_8	NoUnits	-1...9	5	5

Record Size (bytes)					1,254
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- A) International Atomic Time (TAI) seconds from Jan. 1, 1993
- B) TAI time converted to UTC time and stored in format: yymmdd.ffffff
- C) ssInitial_CAD_Score is excluded from the 5 km Aerosol Layer Product
- D) Parameter only in the 5km Merged Diagnostic Layer Product

Table 62: Lidar Merged Diagnostic Level 2 Layer 01km Shot Parameters

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Surface_Detection	Table	Info	Information	1	80
Ocean_Derived_Column_Optical_Depth	Table	Info	Information	1	80
1kmProfile_ID	Int_32	NoUnits	1...228,630	1	4
1kmLatitude	Float_32	degrees_north	-90.0...90.0	1	4
1kmLongitude	Float_32	degrees_east	-180.0...180.0	1	4
1kmProfile_Time ^A	Float_64	TAI seconds	4.204E8...9.623E8	1	8
1kmProfile_UTC_Time ^B	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
1kmOff_Nadir_Angle	Float_32	degrees	0.0...10.0	1	4
1kmParallel_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
1kmParallel_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
1kmPerpendicular_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
01kmPerpendicular_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
01kmColumn_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
01kmColumn_IAB_Cumulative_Probability	Float_32	NoUnits	0.0...1.0	1	4
01kmDEM_Surface_Elevation	Float_32	km	-1.0...9.0	1	4
01kmMinimum_Laser_Energy_532	Float_32	J	0.003...0.135	1	4
01kmNumber_Layers_Found	Int_8	NoUnits	0...10	1	1
01kmLayer_Top_Altitude	Float_32	km	-0.5...20.2	10	40
01kmLayer_Base_Altitude	Float_32	km	-0.5...10.2	10	40
01kmLayer_Top_Pressure	Float_32	hPa	1.0...1,086.0	10	40
01kmMidlayer_Pressure	Float_32	hPa	1.0...1,086.0	10	40
01kmLayer_Base_Pressure	Float_32	hPa	1.0...1,086.0	10	40
01kmLayer_Top_Temperature	Float_32	degC	-110.0...60.0	10	40
01kmLayer_Centroid_Temperature	Float_32	degC	-110.0...60.0	10	40
01kmMidlayer_Temperature	Float_32	degC	-110.0...60.0	10	40
01kmLayer_Base_Temperature	Float_32	degC	-110.0...60.0	10	40
01kmOpacity_Flag	Int_8	NoUnits	0...1	10	10
01kmColumn_Particiulate_Optical_Depth_Above_Opaque_Water_Cloud_532	Float_32	NoUnits	0.0...3.0	1	4
01kmColumn_Particiulate_Optical_Depth_Above_Opaque_Water_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
01kmAttenuated_Scattering_Ratio_Statistics_532	Float_32	NoUnits	N/A	60	240
01kmAttenuated_Backscatter_Statistics_532	Float_32	1/(km · sr)	N/A	60	240
01kmIntegrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...1.8	10	40
01kmIntegrated_Attenuated_Backscatter_Uncertainty_532	Float_32	1/sr	0.0...0.5	10	40
01kmAttenuated_Backscatter_Statistics_1064	Float_32	1/(km · sr)	N/A	60	240
01kmIntegrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...1.8	10	40
01kmIntegrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	1/sr	0.0...0.5	10	40
01kmVolume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
01kmIntegrated_Volume_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	10	40
01kmIntegrated_Volume_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	0.0...2.0	10	40
01kmAttenuated_Total_Color_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
01kmIntegrated_Attenuated_Total_Color_Ratio	Float_32	NoUnits	0.0...2.0	10	40
01kmIntegrated_Attenuated_Total_Color_Ratio_Uncertainty	Float_32	NoUnits	0.0...3.0	10	40
01kmOverlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	10	40
01kmLayer_IAB_QA_Factor	Float_32	NoUnits	0.0...1.0	10	40
01kmCAD_Score	Int_8	NoUnits	-101...110	10	10
01kmInitial_CAD_Score	Int_8	NoUnits	-101...119	10	10
01kmFeature_Classification_Flags	UInt_16	NoUnits	1...49,146	10	20
Record Size (bytes)					2,243

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.11.4 Lidar Cloud, Aerosol and Merged Level 2 Scientific Data Sets

The tables below summarize the content of each scientific data set (SDS) contained within the Lidar Level 2 layer products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 63: Lidar 1/3 km Column Descriptor Record: Merged

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Data_Altitudes ^A	Float_32	km	-2.0...40.0	583	2,332
Profile_ID	Int_32	NoUnits	1...228,630	1	4
Latitude	Float_32	degrees_north	-90.0...90.0	1	4
Longitude	Float_32	degrees_east	-180.0...180.0	1	4
Profile_Time ^B	Float_64	TAI seconds	4.204E8...9.623E8	1	8
Profile_UTC_Time ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Day_Night_Flag	Int_8	NoUnits	0...1	1	1
Off_Nadir_Angle	Float_32	degrees	0.0...10.0	1	4
Solar_Zenith_Angle	Float_32	degrees	0.0...180.0	1	4
Solar_Azimuth_Angle	Float_32	degrees	-180.0...180.0	1	4
Scattering_Angle	Float_32	degrees	0.0...180.0	1	4
Spacecraft_Position	Float_64	km	-8,000.0...8,000.0	3	24
Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Low_Energy_Mitigation_Column_QC_Flag	UInt_16	NoUnits	0...1983	1	2
Parallel_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Parallel_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Perpendicular_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Perpendicular_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
Column_IAB_Cumulative_Probability	Float_32	NoUnits	0.0...1.0	1	4
Column_Particulate_Optical_Depth_Above_Opaque_Water_Cloud_532	Float_32	NoUnits	0.0...3.0	1	4
Column_Particulate_Optical_Depth_Above_Opaque_Water_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Tropopause_Height	Float_32	km	4.0...22.0	1	4
Tropopause_Temperature	Float_32	degC	-95.0...-20.0	1	4
IGBP_Surface_Type ^D	Int_8	NoUnits	1...18	1	1
Snow_Ice_Surface_Type ^D	UInt_8	NoUnits	0...255	1	1
DEM_Surface_Elevation	Float_32	km	-1.0...9.0	1	4
Number_Layers_Found	Int_8	NoUnits	0...5	1	1
Scene_Flag	Int_32	NoUnits	N/A	1	4
Number_Bins_Shift	Int_32	NoUnits	-8...8	1	4
Record Size (bytes)					130

A) [583] element array per file

B) International Atomic Time (TAI) seconds from Jan. 1, 1993

C) TAI time converted to UTC time and stored in format: yymmdd.ffffff

D) Detailed description provided in Section 4.0

Table 64: Lidar 1/3 km Layer Descriptor Record: Merged

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Layer_Top_Altitude	Float_32	km	-0.5...8.2	5	20
Layer_Base_Altitude	Float_32	km	-0.5...8.2	5	20
Layer_Top_Pressure	Float_32	hPa	1.0...1,086.0	5	20
Midlayer_Pressure	Float_32	hPa	1.0...1,086.0	5	20
Layer_Base_Pressure	Float_32	hPa	1.0...1,086.0	5	20
Layer_Top_Temperature	Float_32	degC	-110.0...60.0	5	20
Layer_Centroid_Temperature	Float_32	degC	-110.0...60.0	5	20
Midlayer_Temperature	Float_32	degC	-110.0...60.0	5	20
Layer_Base_Temperature	Float_32	degC	-110.0...60.0	5	20
Opacity_Flag	Int_8	NoUnits	0...1	5	5
Attenuated_Scattering_Ratio_Statistics_532	Float_32	NoUnits	N/A	30	120
Attenuated_Backscatter_Statistics_532	Float_32	1/(km · sr)	N/A	30	120
Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...1.8	5	20
Integrated_Attenuated_Backscatter_Uncertainty_532	Float_32	1/sr	0.0...0.5	5	20
Attenuated_Backscatter_Statistics_1064	Float_32	1/(km · sr)	N/A	30	120
Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...1.8 ^A	5	20
Integrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	1/sr	0.0...0.5	5	20
Volume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	30	120
Integrated_Volume_Depolarization_Ratio ^B	Float_32	NoUnits	0.0...1.0	5	20
Integrated_Volume_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	0.0...2.0	5	20
Attenuated_Total_Color_Ratio_Statistics	Float_32	NoUnits	N/A	30	120
Integrated_Attenuated_Total_Color_Ratio ^B	Float_32	NoUnits	0.0...2.0	5	20
Integrated_Attenuated_Total_Color_Ratio_Uncertainty	Float_32	NoUnits	0.0...3.0	5	20
Overlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	5	20
Layer_IAB_QA_Factor	Float_32	NoUnits	0.0...1.0	5	20
Feature_Classification_Flags	UInt_16	NoUnits	1...49,146	5	10
CAD_Score	Int_8	NoUnits	-101...110	5	5
Initial_CAD_Score	Int_8	NoUnits	-101...119	5	5
Was_Cleared	Int_8	NoUnits	0...1	5	5
Decoupled_Layer_Type	Int_8	NoUnits	-1...9	5	5
Record Size (bytes)					1,015

A) While zero is the physically meaningful lower limit, small negative values may be encountered due to noise in weak signals.

B) Notes for depolarization and color ratio fields: Based solely on physical considerations, the expected range for the integrated volume depolarization ratio is between 0 and 1. The range for integrated attenuated total color ratio is less certain, but should fall between 0 and 2. However, because these quantities are computed as the ratio of two noisy numbers, the expected ranges might be exceeded for weakly scattering features or when the overlying attenuation is high.

Table 65: Lidar 1 km Column Descriptor Record: Clouds

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Lidar_Data_Altitudes	Float_532	km	-2.0...40.0	583	2,332
Profile_ID	Int_32	NoUnits	1...228,630	1	4
Latitude	Float_32	degrees_north	-90.0...90.0	1	4
Longitude	Float_32	degrees_east	-180.0...180.0	1	4
Profile_Time ^C	Float_64	TAI seconds	4.204E8...9.623E8	1	8
Profile_UTC_Time ^D	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Day_Night Flag	Int_8	NoUnits	0...1	1	1
Off_Nadir_Angle	Float_32	degrees	0.0...10.0	1	4
Solar_Zenith_Angle	Float_32	degrees	0.0...180.0	1	4
Solar_Azimuth_Angle	Float_32	degrees	-180.0...180.0	1	4
Scattering_Angle	Float_32	degrees	0.0...180.0	1	4
Spacecraft_Position	Float_64	km	-8,000.0...8,000.0	3	24
Parallel_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Parallel_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Perpendicular_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Perpendicular_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
Column_IAB_Cumulative_Probability	Float_32	NoUnits	0.0...1.0	1	4
Column_Particulate_Optical_Depth_Above_Opaque_Water_Cloud_532	Float_32	NoUnits	0.0...3.0	1	4
Column_Particulate_Optical_Depth_Above_Opaque_Water_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Tropopause_Height	Float_32	km	4.0...22.0	1	4
Tropopause_Temperature	Float_32	degC	-95.0...-20.0	1	4
IGBP_Surface_Type ^C	Int_8	NoUnits	1...18	1	1
Snow_Ice_Surface_Type ^C	UInt_8	NoUnits	0...255	1	1
DEM_Surface_Elevation	Float_32	km	-1.0...9.0	1	4
Minimum_Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Low_Energy_Mitigation_Column_QC_Flag	UInt_16	NoUnits	0...63	1	2
Number_Layers_Found	Int_8	NoUnits	0...10	1	1
Scene_Flag	Int_32	NoUnits	N/A	1	4
Record Size (bytes)					126

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

C) Detailed description provided in Section 4.0

Table 66: Lidar 1 km Layer Descriptor Record: Clouds

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Layer_Top_Altitude	Float_32	km	-0.5...20.2	10	40
Layer_Base_Altitude	Float_32	km	-0.5...20.2	10	40
Layer_Top_Pressure	Float_32	hPa	1.0...1,086.0	10	20
Midlayer_Pressure	Float_32	hPa	1.0...1,086.0	10	20
Layer_Base_Pressure	Float_32	hPa	1.0...1,086.0	10	20
Layer_Top_Temperature	Float_32	degC	-110.0...60.0	10	20
Layer_Centroid_Temperature	Float_32	degC	-110.0...60.0	10	20
Midlayer_Temperature	Float_32	degC	-110.0...60.0	10	40
Layer_Base_Temperature	Float_32	degC	-110.0...60.0	10	20
Opacity_Flag	Int_8	NoUnits	0...1	10	10
Attenuated_Scattering_Ratio_Statistics_532	Float_32	NoUnits	N/A	60	240
Attenuated_Backscatter_Statistics_532	Float_32	1/(km · sr)	N/A	60	240
Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...1.8	10	40
Integrated_Attenuated_Backscatter_Uncertainty_532	Float_32	1/sr	0.0...0.5	10	40
Attenuated_Backscatter_Statistics_1064	Float_32	1/(km · sr)	N/A	60	240
Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...1.8 ^A	10	40
Integrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	1/sr	0.0...0.5	10	40
Volume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
Integrated_Volume_Depolarization_Ratio ^B	Float_32	NoUnits	0.0...1.0	10	40
Integrated_Volume_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	0.0...2.0	10	40
Attenuated_Total_Color_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
Integrated_Attenuated_Total_Color_Ratio ^B	Float_32	NoUnits	0.0...2.0	10	40
Integrated_Attenuated_Total_Color_Ratio_Uncertainty	Float_32	NoUnits	0.0...3.0	10	40
Overlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	10	40
Layer_IAB_QA_Factor	Float_32	NoUnits	0.0...1.0	10	40
Feature_Classification_Flags	UInt_16	NoUnits	1...49,146	10	20
CAD_Score	Int_8	NoUnits	-101...110	10	10
Initial_CAD_Score	Int_8	NoUnits	-101...119	10	10
Low_Energy_Mitigation_Feature_QC_Flag	Int_8	NoUnits	0...1	10	10
Record Size (bytes)					1,900

A) While zero is the physically meaningful lower limit, small negative values may be encountered due to noise in weak signals.

B) Notes for depolarization and color ratio fields: Based solely on physical considerations, the expected range for the integrated volume depolarization ratio is between 0 and 1. The range for integrated attenuated total color ratio is less certain, but should fall between 0 and 2. However, because these quantities are computed as the ratio of two noisy numbers, the expected ranges might be exceeded for weakly scattering features or when the overlying attenuation is high.

Table 67: Lidar 5 km Column Descriptor Record: Clouds

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Data_Altitudes ^A	Float_32	km	-2.0...40.0	583	2,332
Profile_ID	Int_32	NoUnits	1...228,630	2	8
Latitude	Float_32	degrees_north	-90.0...90.0	3	12
Longitude	Float_32	degrees_east	-180.0...180.0	3	12
Profile_Time ^B	Float_64	TAI seconds	4.204E8...9.632E8	3	24
Profile_UTC_Time ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	3	24
Day_Night_Flag	Int_8	NoUnits	0...1	1	1
Off_Nadir_Angle	Float_32	degrees	0.0...10.0	1	4
Solar_Zenith_Angle	Float_32	degrees	0.0...180.0	1	4
Solar_Azimuth_Angle	Float_32	degrees	-180.0...180.0	1	4
Scattering_Angle	Float_32	degrees	0.0...180.0	1	4
Spacecraft_Position ^D	Float_64	km	-8,000.0...8,000.0	9	72
Parallel_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Parallel_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Parallel_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	N/A	1	4
Perpendicular_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Perpendicular_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Perpendicular_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	N/A	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
Column_IAB_Cumulative_Probability	Float_32	NoUnits	0.0...1.0	1	4
Column_Optical_Depth_Cloud_532	Float_32	NoUnits	0.0...25.0 ^E	1	4
Column_Optical_Depth_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Particiulate_Optical_Depth_Above_Opaque_Water_Cloud_532	Float_32	NoUnits	0.0...3.0	1	4
Column_Particiulate_Optical_Depth_Above_Opaque_Water_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Feature_Fraction	Float_32	NoUnits	0.0...1.0	1	4
Tropopause_Height	Float_32	km	4.0...22.0	1	4
Tropopause_Temperature	Float_32	degC	-95.0...-20.0	1	4
IGBP_Surface_Type ^F	Int_8	NoUnits	1...18	1	1
Snow_Ice_Surface_Type ^F	UInt_8	NoUnits	0...255	1	1
DEM_Surface_Elevation	Float_32	km	-1.0...9.0	4	16
Minimum_Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Low_Energy_Mitigation_Column_QC_Flag	UInt_16	NoUnits	0...63	1	2
Normalization_Constant_Uncertainty	Float_32	NoUnits	0.0...1.0	2	8
Calibration_Altitude_532	Float_32	km	0.0...40.0	2	8
FeatureFinderQC	UInt_16	NoUnits	0...32,767	1	2
High_Resolution_Layers_Cleared	UInt_16	NoUnits	0...32,767	1	2
Calibration_Altitude_532	Float_32	km	0.0...40.0	2	8

Number_Layers_Found	Int_8	NoUnits	0...10	1	1
Scene_Flag	Int_32	NoUnits	N/A	1	4
Record Size (bytes)					318

- A) [583] element array per file
- B) International Atomic Time (TAI) seconds from Jan. 1, 1993
- C) TAI time converted to UTC time and stored in format: yymmdd.ffffff
- D) Spacecraft_Position is a 3x3 array which includes the position for the three latitudes
- E) Column optical depths will occasionally exceed the maximum value cited here. Users are advised that these especially large values are numerical artifacts of the retrieval process, and do not represent realistic, physically meaningful retrievals.
- F) Detailed description provided in Section 4.0

Table 68: Lidar 5 km Layer Descriptor Record: Clouds

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Low_Energy_Mitigation_QC_Flag	Int_8	NoUnits	0...1	10	10
Layer_Top_Altitude	Float_32	km	-0.5...30.1	10	40
Layer_Base_Altitude	Float_32	km	-0.5...30.1	10	40
Layer_Base_Extended	UInt_16	NoUnits	0...49,146	10	20
Layer_Top_Pressure	Float_32	hPa	1.0...1,086.0	10	40
Midlayer_Pressure	Float_32	hPa	1.0...1,086.0	10	40
Layer_Base_Pressure	Float_32	hPa	1.0...1,086.0	10	40
Layer_Top_Temperature	Float_32	degC	-110.0...60.0	10	40
Layer_Centroid_Temperature	Float_32	degC	-110.0...60.0	10	40
Midlayer_Temperature	Float_32	degC	-110.0...60.0	10	40
Layer_Base_Temperature	Float_32	degC	-110.0...60.0	10	40
Opacity_Flag	Int_8	NoUnits	0...1	10	10
Horizontal_Averaging	Int_8	km	5...80	10	10
Attenuated_Scattering_Ratio_Statistics_532	Float_32	NoUnits	N/A	60	240
Attenuated_Backscatter_Statistics_532	Float_32	1/(km · sr)	N/A	60	240
Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...1.8	10	40
Integrated_Attenuated_Backscatter_Uncertainty_532	Float_32	1/sr	0.0...0.5	10	40
Attenuated_Backscatter_Statistics_1064	Float_32	1/(km · sr)	N/A	60	240
Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...1.8 ^A	10	40
Integrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	1/sr	0.0...0.5	10	40
Volume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
Integrated_Volume_Depolarization_Ratio ^B	Float_32	NoUnits	0.0...1.0	10	40
Integrated_Volume_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	0.0...2.0	10	40
Attenuated_Total_Color_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
Integrated_Attenuated_Total_Color_Ratio ^B	Float_32	NoUnits	0.0...2.0	10	40
Integrated_Attenuated_Total_Color_Ratio_Uncertainty	Float_32	NoUnits	0.0...3.0	10	40
Overlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	10	40
Layer_IAB_QA_Factor	Float_32	NoUnits	0.0...1.0	10	40
Feature_Classification_Flags	UInt_16	NoUnits	1...49,146	10	20
ExtinctionQC_532	UInt_16	NoUnits	0...32,768	10	32
CAD_Score	Int_8	NoUnits	-101...110	10	10
Initial_CAD_Score	Int_8	NoUnits	-101...119	10	10
Measured_Two_Way_Transmittance_532	Float_32	NoUnits	0.0...1.0	10	40
Measured_Two_Way_Transmittance_Uncertainty_532	Float_32	NoUnits	N/A	10	40
Two_Way_Transmittance_Measurement_Region	Float_32	km	0.0...30.0	20	80
Feature_Optical_Depth_532	Float_32	NoUnits	0.0...5.0	10	40
Feature_Optical_Depth_Uncertainty_532	Float_32	NoUnits	N/A	10	40
Overlying_Particate_Optical_Depth_532	Float_32	NoUnits	0.0...3.0	15	60
Overlying_Particate_Optical_Depth_Uncertainty_532	Float_32	NoUnits	N/A	15	60
Initial_532_Lidar_Ratio	Float_32	sr	19.0...25.0	10	40
Final_532_Lidar_Ratio	Float_32	sr	0.0...250.0	10	40
Final_532_Lidar_Ratio_Uncertainty	Float_32	sr	N/A	10	40
Lidar_Ratio_532_Selection_Method	Int_8	NoUnits	0...7	10	10
Layer_Effective_532_Multiple_Scattering_Factor	Float_32	NoUnits	0.01...1.0	10	40
Integrated_Particate_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	10	40
Integrated_Particate_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	N/A	10	40
Particate_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
Single_Shot_Cloud_Cleared_Fraction	Float_32	NoUnits	0.0...1.0	10	40
Ice_Water_Path	Float_32	g/m ²	0.0...200.0	10	40
Ice_Water_Path_Uncertainty	Float_32	g/m ²	N/A	10	40

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Decoupled_Layer_Type	Int_8	NoUnits	-1...9	10	10
Decoupled_Layer_Status	Int_8	NoUnits	-1...10	10	10
Unique_Layer_ID	Int_32	NoUnits	1...83,475	10	40
Record Size (bytes)					3,112

- A) While zero is the physically meaningful lower limit, small negative values may result due to noise in weak signals.
- B) Notes for depolarization and color ratio fields: Based solely on physical considerations, the expected range for the integrated volume depolarization ratio is between 0 and 1. The range for integrated attenuated total color ratio is less certain, but should fall between 0 and 2. However, because these quantities are computed as the ratio of two noisy numbers, the expected ranges might be exceeded for weakly scattering features or when the overlying attenuation is high.

Table 69: Lidar 5 km Column Descriptor Record: Aerosols

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Lidar_Data_Altitudes ^A	Float_32	km	-2.0...40.0	583	2,332
Profile_ID	Int_32	NoUnits	1...228,630	2	8
Latitude	Float_32	degrees_north	-90.0...90.0	3	12
Longitude	Float_32	degrees_east	-180.0...180.0	3	12
Profile_Time ^B	Float_64	TAI seconds	4.204E8...9.632E8	3	24
Profile_UTC_Time ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	3	24
Day_Night_Flag	Int_8	NoUnits	0...1	1	1
Off_Nadir_Angle	Float_32	degrees	0.0...10.0	1	4
Solar_Zenith_Angle	Float_32	degrees	0.0...180.0	1	4
Solar_Azimuth_Angle	Float_32	degrees	-180.0...180.0	1	4
Scattering_Angle	Float_32	degrees	0.0...180.0	1	4
Spacecraft_Position ^D	Float_64	km	-8,000.0...8,000.0	9	72
Parallel_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Parallel_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Parallel_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	N/A	1	4
Perpendicular_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Perpendicular_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Perpendicular_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	N/A	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
Column_IAB_Cumulative_Probability	Float_32	NoUnits	0.0...1.0	1	4
Column_Optical_Depth_Cloud_532	Float_32	NoUnits	0.0...25.0 ^E	1	4
Column_Optical_Depth_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Particulate_Optical_Depth_Above_Opaque_Water_Cloud_532	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Particulate_Optical_Depth_Above_Opaque_Water_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Feature_Fraction	Float_32	NoUnits	0.0...1.0	1	4
Tropopause_Height	Float_32	km	4.0...22.0	1	4
Tropopause_Temperature	Float_32	degC	-95.0...-20.0	1	4
IGBP_Surface_Type ^F	Int_8	NoUnits	1...18	1	1
Snow_Ice_Surface_Type ^F	UInt_8	NoUnits	0...255	1	1
DEM_Surface_Elevation	Float_32	km	-1.0...9.0	4	16
Minimum_Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Low_Energy_Mitigation_Column_QC_Flag	Float_32	NoUnits	0...63	1	4
Normalization_Constant_Uncertainty	Float_32	NoUnits	0.0...1.0	2	8
Calibration_Altitude_532	Float_32	km	0.0...40.0	2	8
FeatureFinderQC	UInt_16	NoUnits	0...32,767	1	2
High_Resolution_Layers_Cleared	UInt_16	NoUnits	0...32,767	1	2

Number_Layers_Found	Int_8	NoUnits	0...8	1	1
Surface_Wind_Speeds_02m	Float_32	m/s	-80.0...80.0	2	8
Scene_Flag	Int_32	NoUnits	N/A	1	4
Record Size (bytes)					320

- A) [583] element array per file
 B) International Atomic Time (TAI) seconds from Jan. 1, 1993
 C) TAI time converted to UTC time and stored in format: yymmdd.ffffff
 D) Spacecraft_Position is a 3x3 array which includes the position for the three latitudes
 E) Column optical depths will occasionally exceed the maximum value cited here. Users are advised that these especially large values are numerical artifacts of the retrieval process, and do not represent realistic, physically meaningful retrievals.
 F) Detailed description provided in Section 4.0

Table 70: Lidar 5 km Layer Descriptor Record: Aerosols

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Low_Energy_Mitigation_Feature_QC_Flag	Int_8	NoUnits	0...1	8	8
Layer_Top_Altitude	Float_32	km	-0.5...30.1	8	32
Layer_Base_Altitude	Float_32	km	-0.5...30.1	8	32
Layer_Base_Extended	UInt_16	NoUnits	0...49,146	8	16
Smoke_Layer_Base_Extended_QC_Flag	UInt_16	NoUnits	0...127	8	16
Layer_Top_Pressure	Float_32	hPa	1.0...1,086.0	8	32
Midlayer_Pressure	Float_32	hPa	1.0...1,086.0	8	32
Layer_Base_Pressure	Float_32	hPa	1.0...1,086.0	8	32
Layer_Top_Temperature	Float_32	degC	-110.0...60.0	8	32
Midlayer_Temperature	Float_32	degC	-110.0...60.0	8	32
Layer_Base_Temperature	Float_32	degC	-110.0...60.0	8	32
Opacity_Flag	Int_8	NoUnits	0...1	8	8
Horizontal_Averaging	Int_8	km	5...80	8	8
Attenuated_Scattering_Ratio_Statistics_532	Float_32	NoUnits	N/A	48	192
Attenuated_Backscatter_Statistics_532	Float_32	1/(km · sr)	N/A	48	192
Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...1.8 ^A	8	32
Integrated_Attenuated_Backscatter_Uncertainty_532	Float_32	1/sr	0.0...0.5	8	32
Attenuated_Backscatter_Statistics_1064	Float_32	1/(km · sr)	N/A	48	192
Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...1.8	8	32
Integrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	1/sr	0.0...0.5	8	32
Volume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	48	192
Integrated_Volume_Depolarization_Ratio ^B	Float_32	NoUnits	0.0...1.0	8	32
Integrated_Volume_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	0.0...2.0	8	32
Attenuated_Total_Color_Ratio_Statistics	Float_32	NoUnits	N/A	48	192
Integrated_Attenuated_Total_Color_Ratio ^B	Float_32	NoUnits	0.0...2.0	8	32
Integrated_Attenuated_Total_Color_Ratio_Uncertainty	Float_32	NoUnits	0.0...3.0	8	32
Overlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	8	32
Layer_IAB_QA_Factor	Float_32	NoUnits	0.0...1.0	8	32
Feature_Classification_Flags	UInt_16	NoUnits	1...49,146	8	16
Extinction_QC_Flag_532	UInt_16	NoUnits	0...32,768	8	32
Extinction_QC_Flag_1064	UInt_16	NoUnits	0...32,768	8	32
CAD_Score	Int_8	NoUnits	-101...110	8	8
Measured_Two_Way_Transmittance_532	Float_32	NoUnits	0.0...1.0 ^A	8	32
Measured_Two_Way_Transmittance_Uncertainty_532	Float_32	NoUnits	N/A	8	32
Two_Way_Transmittance_Measurement_Region	Float_32	km	0.0...30.0	16	64

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Feature_Optical_Depth_532	Float_32	NoUnits	0.0...3.0	8	32
Feature_Optical_Depth_Uncertainty_532	Float_32	NoUnits	N/A	8	32
Overlying_Particate_Optical_Depth_532	Float_32	NoUnits	0.0...3.0	8	32
Overlying_Particate_Optical_Depth_Uncertainty_532	Float_32	NoUnits	N/A	8	32
Initial_532_Lidar_Ratio	Float_32	sr	20.0...70.0	8	32
Final_532_Lidar_Ratio	Float_32	sr	0.0...250.0	8	32
Final_532_Lidar_Ratio_Uncertainty	Float_32	sr	N/A	8	32
Lidar_Ratio_532_Selection_Method	Int_8	NoUnits	0...7	8	8
Layer_Effective_532_Multiple_Scattering_Factor	Float_32	NoUnits	1.0	8	32
Integrated_Particate_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	8	32
Integrated_Particate_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	N/A	8	32
Particulate_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	48	192
Feature_Optical_Depth_1064	Float_32	NoUnits	0.0...3.0	8	32
Feature_Optical_Depth_Uncertainty_1064	Float_32	NoUnits	N/A	8	32
Initial_1064_Lidar_Ratio	Float_32	sr	30.0...55.0	8	32
Final_1064_Lidar_Ratio	Float_32	sr	0.0...250.0	8	32
Final_1064_Lidar_Ratio_Uncertainty	Float_32	sr	N/A	8	32
Lidar_Ratio_1064_Selection_Method	Int_8	NoUnits	0...7	8	8
Layer_Effective_1064_Multiple_Scattering_Factor	Float_32	NoUnits	1.0	8	32
Integrated_Particate_Color_Ratio	Float_32	NoUnits	0.0...4.0	8	32
Integrated_Particate_Color_Ratio_Uncertainty	Float_32	NoUnits	0.0...1.0	8	32
Particulate_Color_Ratio_Statistics	Float_32	NoUnits	N/A	48	192
Relative_Humidity	Float_32	NoUnits	0.0...1.5	8	32
Single_Shot_Cloud_Cleared_Fraction	Float_32	NoUnits	0.0...1.0	8	32
Decoupled_Layer_Type	Int_8	NoUnits	-1...9	8	8
Decoupled_Layer_Status	Int_8	NoUnits	-1...10	8	8
Unique_Layer_ID	Int_32	NoUnits	1...83,475	8	32
Record Size (bytes)					2,896

- A) While zero is the physically meaningful lower limit, small negative values may result due to noise in weak signals.
- B) Notes for depolarization and color ratio fields: Based solely on physical considerations, the expected range for the integrated volume depolarization ratio is between 0 and 1. The range for integrated attenuated total color ratio is less certain, but should fall between 0 and 2. However, because these quantities are computed as the ratio of two noisy numbers, the expected ranges might be exceeded for weakly scattering features or when the overlying attenuation is high.

Table 71: Lidar 5 km Column Descriptor Record: Merged

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Lidar_Data_Altitudes ^A	Float_32	km	-2.0...40.0	583	2,332
Profile_ID	Int_32	NoUnits	1...228,630	2	8
Latitude	Float_32	degrees_north	-90.0...90.0	3	12
Longitude	Float_32	degrees_east	-180.0...180.0	3	12
Profile_Time ^B	Float_64	TAI seconds	4.204E8...9.632E8	3	24
Profile_UTC_Time ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	3	24
Day_Night_Flag	Int_8	NoUnits	0...1	1	1
Off_Nadir_Angle	Float_32	degrees	0.0...10.0	1	4
Solar_Zenith_Angle	Float_32	degrees	0.0...180.0	1	4
Solar_Azimuth_Angle	Float_32	degrees	-180.0...180.0	1	4

Scattering_Angle	Float_32	degrees	0.0...180.0	1	4
Spacecraft_Position ^D	Float_64	km	-8,000.0...8,000.0	9	72
Parallel_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Parallel_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Parallel_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	N/A	1	4
Perpendicular_Column_Reflectance_532	Float_32	NoUnits	0.0...2.0	1	4
Perpendicular_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	0.0...0.45	1	4
Perpendicular_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	N/A	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
Column_IAB_Cumulative_Probability	Float_32	NoUnits	0.0...1.0	1	4
Column_Optical_Depth_Cloud_532	Float_32	NoUnits	0.0...25.0 ^E	1	4
Column_Optical_Depth_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Particulate_Optical_Depth_Above_Opaque_Water_Cloud_532	Float_32	NoUnits	0.0...3.0	1	4
Column_Particulate_Optical_Depth_Above_Opaque_Water_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^E	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Feature_Fraction	Float_32	NoUnits	0.0...1.0	1	4
Tropopause_Height	Float_32	km	4.0...22.0	1	4
Tropopause_Temperature	Float_32	degC	-95.0...-20.0	1	4
IGBP_Surface_Type ^F	Int_8	NoUnits	1...18	1	1
Snow_Ice_Surface_Type ^F	UInt_8	NoUnits	0...255	1	1
DEM_Surface_Elevation	Float_32	km	-1.0...9.0	4	16
Minimum_Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Low_Energy_Mitigation_Column_QC_Flag	UInt_16	NoUnits	0...63	1	2
Normalization_Constant_Uncertainty	Float_32	NoUnits	0.0...1.0	2	8
Calibration_Altitude_532	Float_32	km	0.0...40.0	2	8
FeatureFinderQC	UInt_16	NoUnits	0...32,767	1	2
High_Resolution_Layers_Cleared	UInt_16	NoUnits	0...32,767	1	2
Number_Layers_Found	Int_8	NoUnits	0...15	1	1
Surface_Wind_Speeds_02m	Float_32	m/s	-80.0...80.0	2	8
Scene_Flag	Int_32	NoUnits	N/A	1	8
Record Size (bytes)					322

A) [583] element array per file

B) International Atomic Time (TAI) seconds from Jan. 1, 1993

C) TAI time converted to UTC time and stored in format: yymmdd.ffffff

D) Spacecraft_Position is a 3x3 array which includes the position for the three latitudes

E) Column optical depths will occasionally exceed the maximum value cited here. Users are advised that these especially large values are numerical artifacts of the retrieval process, and do not represent realistic, physically meaningful retrievals.

F) Detailed description provided in Section 4.0

Table 72: Lidar 5 km Layer Descriptor Record: Merged

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Low_Energy_Mitigation_Feature_QC_Flag	Int_8	NoUnits	0...1	15	15
Layer_Top_Altitude	Float_32	km	-0.5...30.1	15	60
Layer_Base_Altitude	Float_32	km	-0.5...30.1	15	60
Layer_Base_Extended	UInt_16	NoUnits	0...49,146	15	30
Smoke_Layer_Base_Extended_QC_Flag	UInt_16	NoUnits	0...127	15	30
Layer_Top_Pressure	Float_32	hPa	1.0...1,086.0	15	60
Midlayer_Pressure	Float_32	hPa	1.0...1,086.0	15	60
Layer_Base_Pressure	Float_32	hPa	1.0...1,086.0	15	60
Layer_Top_Temperature	Float_32	degC	-110.0...60.0	15	60
Layer_Centroid_Temperature	Float_32	degC	-110.0...60.0	15	60
Midlayer_Temperature	Float_32	degC	-110.0...60.0	15	60
Layer_Base_Temperature	Float_32	degC	-110.0...60.0	15	60
Opacity_Flag	Int_8	NoUnits	0...1	15	15
Horizontal_Averaging	Int_8	km	5...80	15	15
Attenuated_Scattering_Ratio_Statistics_532	Float_32	NoUnits	N/A	90	360
Attenuated_Backscatter_Statistics_532	Float_32	1/(km · sr)	N/A	90	360
Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...1.8	15	60
Integrated_Attenuated_Backscatter_Uncertainty_532	Float_32	1/sr	0.0...0.5	15	60
Attenuated_Backscatter_Statistics_1064	Float_32	1/(km · sr)	N/A	90	360
Integrated_Attenuated_Backscatter_1064	Float_32	1/sr	0.0...1.8	15	60
Integrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	1/sr	0.0...0.5	15	60
Volume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	90	360
Integrated_Volume_Depolarization_Ratio ^A	Float_32	NoUnits	0.0...1.0	15	60
Integrated_Volume_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	0.0...2.0	15	60
Attenuated_Total_Color_Ratio_Statistics	Float_32	NoUnits	N/A	90	360
Integrated_Attenuated_Total_Color_Ratio ^A	Float_32	NoUnits	0.0...2.0	15	60
Integrated_Attenuated_Total_Color_Ratio_Uncertainty	Float_32	NoUnits	0.0...3.0	15	60
Overlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	15	60
Layer_IAB_QA_Factor	Float_32	NoUnits	0.0...1.0	15	60
Feature_Classification_Flags	UInt_16	NoUnits	1...49,146	15	30
Layer_Type	Int_8	NoUnits	2...4	15	15
Extinction_QC_Flag_532	UInt_16	NoUnits	0...32,768	15	30
Extinction_QC_Flag_1064	UInt_16	NoUnits	0...32,768	15	30
CAD_Score	Int_8	NoUnits	-101...110	15	15
Initial_CAD_Score	Int_8	NoUnits	-101...119	15	15
Measured_Two_Way_Transmittance_532	Float_32	NoUnits	0.0...1.0 ^B	15	60
Measured_Two_Way_Transmittance_Uncertainty_532	Float_32	NoUnits	N/A	15	60
Two_Way_Transmittance_Measurement_Region	Float_32	km	0.0...30.0	30	120
Feature_Optical_Depth_532	Float_32	NoUnits	0.0...3.0	15	60
Feature_Optical_Depth_Uncertainty_532	Float_32	NoUnits	N/A	15	60
Overlying_Particate_Optical_Depth_532	Float_32	NoUnits	0.0...3.0	15	60
Overlying_Particate_Optical_Depth_Uncertainty_532	Float_32	NoUnits	N/A	15	60
Initial_532_Lidar_Ratio	Float_32	sr	Aerosol: 20.0...70.0 Cloud: 19.0...25.0	15	60
Final_532_Lidar_Ratio	Float_32	sr	0.0...250.0	15	60
Final_532_Lidar_Ratio_Uncertainty	Float_32	sr	N/A	15	60
Lidar_Ratio_532_Selection_Method	Int_8	NoUnits	0...7	15	15
Layer_Effective_532_Multiple_Scattering_Factor	Float_32	NoUnits	Aerosol: 1.0 Cloud: 0.01...1.0	15	60
Integrated_Particate_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	15	60

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Integrated_Particate_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	N/A	15	60
Particulate_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	90	360
Feature_Optical_Depth_1064	Float_32	NoUnits	Aerosol: 0.0...3.0	15	60
Feature_Optical_Depth_Uncertainty_1064	Float_32	NoUnits	N/A	15	60
Initial_1064_Lidar_Ratio	Float_32	sr	Aerosol: 30.0...55.0	15	60
Final_1064_Lidar_Ratio	Float_32	sr	Aerosol: 0.0...250.0	15	60
Final_1064_Lidar_Ratio_Uncertainty	Float_32	sr	N/A	15	60
Lidar_Ratio_1064_Selection_Method	Int_8	NoUnits	Aerosol: 0...7	15	15
Layer_Effective_1064_Multiple_Scattering_Factor	Float_32	NoUnits	Aerosol: 1.0	15	60
Integrated_Particate_Color_Ratio	Float_32	NoUnits	Aerosol: 0.0...4.0	15	60
Integrated_Particate_Color_Ratio_Uncertainty	Float_32	NoUnits	Aerosol: 0.0...1.0	15	60
Particulate_Color_Ratio_Statistics	Float_32	NoUnits	N/A	90	360
Relative_Humidity	Float_32	NoUnits	0.0...1.5	15	60
Single_Shot_Cloud_Cleared_Fraction	Float_32	NoUnits	Aerosol: 0.0...1.0	15	60
Ice_Water_Path	Float_32	g/m ²	Cloud: 0.0...200.0	15	60
Ice_Water_Path_Uncertainty	Float_32	g/m ²	N/A	15	60
Decoupled_Layer_Type	Int_8	NoUnits	-1...9	15	15
Decoupled_Layer_Status	Int_8	NoUnits	-1...10	15	15
Unique_Layer_ID	Int_32	NoUnits	1...83475	15	60
Record Size (bytes)					5,580

- A) Notes for depolarization and color ratio fields: Based solely on physical considerations, the expected range for the integrated volume depolarization ratio is between 0 and 1. The range for integrated attenuated total color ratio is less certain, but should fall between 0 and 2. However, because these quantities are computed as the ratio of two noisy numbers, the expected ranges might be exceeded for weakly scattering features or when the overlying attenuation is high.
- B) While zero is the physically meaningful lower limit, small negative values may be encountered due to noise in weak signals.

2.12 Lidar Level 2 Aerosol Profile Data Product DP 2.1B

The Lidar Level 2 Aerosol Profile data products contain averaged aerosol profile data and ancillary data. There is no layer descriptors included in the lidar aerosol profile data products. The spatial distribution of the aerosol layers is instead completely characterized by the aerosol layer fraction and atmospheric volume description parameters.

The aerosol profile products are generated at a uniform horizontal resolution of 5 km. The aerosol backscatter and extinction coefficients are computed using a lidar ratio selected by the CALIPSO Lidar Ratio selection algorithm.

The major categories of the data product are:

- Backscatter Profile Data
- Depolarization Profile Data
- Extinction Profile
- Ancillary Profile Data

Level: 2
Version: 5.00
Type: Archival
Frequency: 2/Orbit
Spatial Resolution Record: 60 m vertical resolution x 5 km
Time Interval Covered: Half Orbit (Day or Night)

Data File Name:
CAL_LID_L2_5kmAPro-Standard-Version.Instance.hdf

2.12.1 Lidar Level 2 Aerosol Profile Data Summary

Table 73: Lidar Level 2 Aerosol Profile Data Record Summary

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Aerosol Metadata Record	Table 74	42,398	1	42,39842,398
Lidar Surface Detection Information	Table 53	76	4,010	304,760
Ocean Derived Column Properties	Table 56	24	4,010	96,240
Lidar Data Altitudes	Table 75	399	1	1,596
Lidar 5 km Aerosol Profile Record	Table 75	40,870	4,010	163,888,700
Total Size (bytes)				164,334,597
Total Size (Mbytes)				160.48

2.12.2 Lidar Level 2 Aerosol Profile Data Metadata

Table 74: Lidar Level 2 Aerosol Profile Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	L2_LIDAR	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Number_of_Good_Profiles	Int_32	NoUnits	0...4,242	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	0...4,242	1	4
Initial_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Rayleigh_Extinction_Cross-section_532	Float_32	m ²	5.167E-31	1	4
Rayleigh_Extinction_Cross-section_1064	Float_32	m ²	3.127E-32	1	4
Rayleigh_Backscatter_Cross-section_532	Float_32	m ² /sr	5.930E-32	1	4
Rayleigh_Backscatter_Cross-section_1064	Float_32	m ² /sr	3.592E-33	1	4
Ozone_Absorption_Cross-section_532	Float_32	m ²	2.728461E-25	1	4
Ozone_Absorption_Cross-section_1064	Float_32	m ²	0.0	1	4
Lidar_L1_Production_Date_Time ^A	Char	NoUnits	4/2006 – 10/2025	27	27
MERRA2_Wind_Uncertainty	Float_32	m/s	N/A	1	8
AMSR_Wind_Correction_Uncertainty	Float_32	m/s	N/A	1	8
Lidar_Data_Altitudes	Float_32	km	-0.5...30.0	399	1,596
Initial_Lidar_Ratio_Tropospheric_Aerosols_532	Float_32	sr	23.0...70.0	8	32
Initial_Lidar_Ratio_Stratospheric_Aerosols_532	Float_32	sr	50.0...70.0	8	32
Initial_Lidar_Ratio_Tropospheric_Aerosols_1064	Float_32	sr	23.0...48.0	8	32
Initial_Lidar_Ratio_Stratospheric_Aerosols_1064	Float_32	sr	25.0...50.0	8	32
GEOS_Version	Char	NoUnits	N/A	64	64
GMAO_Files_Used	Char	NoUnits	4 file names max	320	320
Classifier_Coefficients_Version_Number	Char	NoUnits	0.0...99.9	1	4
Classifier_Coefficients_Version_Date	Char	NoUnits	4/2006 – 10/2025	1	6
Production_Script	Char	NoUnits	N/A	40,000	40,000
Record Size (bytes)					42,398

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.fyyyyyy

2.12.3 Lidar Level 2 Aerosol Profile Data Scientific Data Sets

The table below summarizes the contents of each scientific data set (SDS) contained within the Lidar Aerosol Profile Data products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 75: Lidar Level 2 5 km Aerosol Profile Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Data_Altitudes ^A	Float_32	km	-2.0...30.0	399	1,596
Profile_ID	Int_32	NoUnits	1...228,630	2	8
Latitude	Float_32	degrees_north	-90.0...90.0	3	12
Longitude	Float_32	degrees_east	-180.0...180.0	3	12
Profile_Time ^B	Float_64	TAI seconds	4.204E8...9.632E8	3	24
Profile_UTC_Time ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	3	24
Day_Night_Flag	Int_8	NoUnits	0...1	1	1
Minimum_Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Low_Energy_Mitigation_Column_QC_Flag	UInt_16	NoUnits	0...63	1	2
Low_Energy_Mitigation_Feature_QC_Flag	Int_8	NoUnits	0...1	399x2	798
Column_Optical_Depth_Cloud_532	Float_32	NoUnits	0.0...25.0 ^D	1	4
Column_Optical_Depth_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^D	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^D	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^D	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^D	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Feature_Fraction	Float_32	NoUnits	0.0...1.0	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
Column_IAB_Cumulative_Probability	Float_32	NoUnits	0.0...1.0	1	4
Tropopause_Height	Float_32	km	4.0...22.0	1	4
Tropopause_Temperature	Float_32	degC	-95.0...-20.0	1	4
Temperature	Float_32	degC	-120.0...60.0	399	1,596
Pressure	Float_32	hPa	1.0...1,086.0	399	1,596
Molecular_Number_Density	Float_32	1/m ³	8E22...5E25	399	1,596
Ozone_Number_Density	Float_32	1/m ³	9E16...1E19	399	1,596
Relative_Humidity	Float_32	NoUnits	0.0...1.5	399	1,596
IGBP_Surface_Type ^E	Int_8	NoUnits	1...18	1	1
DEM_Surface_Elevation	Float_32	km	-1.0...9.0	4	16
Surface_Wind_Speeds_02m	Float_32	m/s	-80.0...80.0	2	8
Aerosol_Layer_Fraction	Int_8	NoUnits	0...30	399	399
Cloud_Layer_Fraction	Int_8	NoUnits	0...30	399	399

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Atmospheric_Volume_Description	UInt_16	NoUnits	1...57,338	399x2	1,596
Extinction_QC_Flag_532	UInt_16	NoUnits	0...32,768	399x2	1,596
Extinction_QC_Flag_1064	UInt_16	NoUnits	0...32,768	399x2	1,596
CAD_Score	Int_8	NoUnits	-101...110	399x2	798
Unique_Layer_ID	Int_32	NoUnits	1...83475	399x2	3,192
Total_Backscatter_Coefficient_532	Float_32	1/(km · sr)	0.0...0.05	399	1,596
Total_Backscatter_Coefficient_Uncertainty_532	Float_32	1/(km · sr)	N/A	399	1,596
Perpendicular_Backscatter_Coefficient_532	Float_32	1/(km · sr)	0.0...0.01	399	1,596
Perpendicular_Backscatter_Coefficient_Uncertainty_532	Float_32	1/(km · sr)	N/A	399	1,596
Particulate_Depolarization_Ratio_Profile_532	Float_32	NoUnits	0.0...1.0	399	1,596
Particulate_Depolarization_Ratio_Uncertainty_532	Float_32	NoUnits	N/A	399	1,596
Extinction_Coefficient_532	Float_32	1/km	0.0...1.25	399	1,596
Extinction_Coefficient_Uncertainty_532	Float_32	1/km	N/A	399	1,596
Aerosol_Multiple_Scattering_Profile_532	Float_32	NoUnits	0.0...1.0	399	1,596
Backscatter_Coefficient_1064	Float_32	1/(km · sr)	0.0...0.03	399	1,596
Backscatter_Coefficient_Uncertainty_1064	Float_32	1/(km · sr)	N/A	399	1,596
Extinction_Coefficient_1064	Float_32	1/km	0.0...1.0	399	1,596
Extinction_Coefficient_Uncertainty_1064	Float_32	1/km	N/A	399	1,596
Aerosol_Multiple_Scattering_Profile_1064	Float_32	NoUnits	0.0...1.0	399	1,596
Record Size (bytes)					40,870

- A) [399] element array per file
- B) International Atomic Time (TAI) seconds from Jan. 1, 1993
- C) TAI time converted to UTC time and stored in format: yymmdd.ffffff
- D) Column optical depths will occasionally exceed the maximum value cited here. Users are advised that these especially large values are numerical artifacts of the retrieval process, and do not represent realistic, physically meaningful retrievals.
- E) Detailed description provided in Section 4.0

2.13 Lidar Level 2 Cloud Profile Data Product DP 2.1C

The Lidar Level 2 Cloud Profile data products contain averaged cloud profile data and ancillary data. There is no layer descriptors included in the lidar cloud profile data products. The spatial distribution of the cloud layers is instead completely characterized by the cloud layer fraction and atmospheric volume description parameters. The cloud profile products are generated at a uniform horizontal resolution of 5 km. The 1064 calibration scheme assumes that both the extinction and the backscatter from clouds are spectrally independent. Consistent with this assumption, extinction and backscatter profiles will be reported for clouds only at 532 nm.

The major categories of the cloud profile data product are:

- Backscatter Profile Data
- Depolarization Profile Data
- Extinction Profile
- Ice Water Content
- Ancillary Profile Data

Level: 2
Version: 5.00
Type: Archival
Frequency: 2/Orbit
Spatial Resolution Record: 60 m vertical resolution
5 km Along Track
Time Interval Covered: Half Orbit (Day or Night)

Data File Name:

CAL_LID_L2_5kmCPro-Standard-Version.Instance.hdf

2.13.1 Lidar Level 2 Cloud Profile Data Record Summary

Table 76: Lidar Level 2 Cloud Profile Data Record Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Cloud Metadata Record	Table 77	42,278	1	42,278
Lidar Surface Detection Information	Table 53	76	4,010	304,760
Ocean Derived Column Properties	Table 56	24	4,010	96,240
Lidar Data Altitudes	Table 78	399	1	1,596
Lidar 5 km Cloud Profile Record	Table 78	34,486	4,010	138,288,860
Total Size (bytes)				138,734,637
Total Size (Mbytes)				135.48

2.13.2 Lidar Level 2 Cloud Profile Data Metadata

Table 77: Lidar Level 2 Cloud Profile Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	L2_LIDAR	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Number_of_Good_Profiles	Int_32	NoUnits	0...4,242	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	0...4,242	1	4
Initial_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Rayleigh_Extinction_Cross-section_532	Float_32	m ²	5.167E-31	1	4
Rayleigh_Extinction_Cross-section_1064	Float_32	m ²	3.127E-32	1	4
Rayleigh_Backscatter_Cross-section_532	Float_32	m ² /sr	5.930E-32	1	4
Rayleigh_Backscatter_Cross-section_1064	Float_32	m ² /sr	3.592E-33	1	4
Ozone_Absorption_Cross-section_532	Float_32	m ²	2.728461E-25	1	4
Ozone_Absorption_Cross-section_1064	Float_32	m ²	0.0	1	4
Lidar_L1_Production_Date_Time ^A	Char	NoUnits	4/2006 – 10/2025	27	27
MERRA2_Wind_Uncertainty	Float_32	m/s	N/A	1	8
AMSR_Wind_Correction_Uncertainty	Float_32	m/s	N/A	1	8
Lidar_Data_Altitudes	Float_32	km	-0.480...20.175	399	1,596
Initial_Lidar_Ratio_Clouds_532	Float_32	sr	19.0...25.0	2	8
GEOS_Version	Char	NoUnits	N/A	64	64
GMAO_Files_Used	Char	NoUnits	4 file names max	320	320
Classifier_Coefficients_Version_Number	Char	NoUnits	0.0...99.9	1	4
Classifier_Coefficients_Version_Date	Char	NoUnits	4/2006 – 10/2025	1	6
Production_Script	Char	NoUnits	N/A	40,000	40,000
Record Size (bytes)					42,278

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.13.3 Lidar Level 2 Cloud Profile Data Scientific Data Sets

The table below summarizes the contents of each scientific data set (SDS) contained within the Lidar Cloud Profile Data products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 78: Lidar Level 2 5 km Cloud Profile Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Data_Altitudes ^A	Float_32	km	-2.0...30.0	399	1,596
Profile_ID	Int_32	NoUnits	1...228,630	2	8
Latitude	Float_32	degrees_north	-90.0...90.0	3	12
Longitude	Float_32	degrees_east	-180.0...180.0	3	12
Profile_Time ^B	Float_64	TAI seconds	4.204E8...9.623E8	3	24
Profile_UTC_Time ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	3	24
Day_Night_Flag	Int_8	NoUnits	0...1	1	1
Minimum_Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Low_Energy_Mitigation_Column_QC_Flag	UInt_16	NoUnits	0...63	1	2
Low_Energy_Mitigation_Feature_QC_Flag	Int_8	NoUnits	0...1	399x2	798
Column_Optical_Depth_Cloud_532	Float_32	NoUnits	0.0...25.0 ^D	1	4
Column_Optical_Depth_Cloud_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^D	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_532	Float_32	NoUnits	0.0...3.0 ^D	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Tropospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^D	1	4
Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Optical_Depth_Stratospheric_Aerosols_1064	Float_32	NoUnits	0.0...3.0 ^D	1	4
Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_1064	Float_32	NoUnits	N/A	1	4
Column_Feature_Fraction	Float_32	NoUnits	0.0...1.0	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	0.0...2.0	1	4
Column_IAB_Cumulative_Probability	Float_32	NoUnits	0.0...1.0	1	4
Tropopause_Height	Float_32	km	4.0...22.0	1	4
Tropopause_Temperature	Float_32	degC	-95.0...-20.0	1	4
Temperature	Float_32	degC	-120.0...60.0	399	1,596
Pressure	Float_32	hPa	1.0...1,086.0	399	1,596
Molecular_Number_Density	Float_32	1/m ³	8.0E22...5.0E25	399	1,596
Ozone_Number_Density	Float_32	1/m ³	9.0E16...1.0E19	399	1,596
Relative_Humidity	Float_32	NoUnits	0.0...1.5	399	1,596
IGBP_Surface_Type ^E	Int_8	NoUnits	1...18	1	1
DEM_Surface_Elevation	Float_32	km	-1.0...9.0	4	16
Surface_Wind_Speeds_02m	Float_32	m/s	-80.0...80.0	2	8
Aerosol_Layer_Fraction	UInt_8	NoUnits	0...30	399	399
Cloud_Layer_Fraction	UInt_8	NoUnits	0...30	399	399

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Atmospheric_Volume_Description	UInt_16	NoUnits	1...57,338	399x2	1,596
Extinction_QC_Flag_532	UInt_16	NoUnits	0...32,768	399x2	1,596
CAD_Score	Int_8	NoUnits	-101...110	399x2	798
Unique_Layer_ID	Int_32	NoUnits	1...83,475	399x2	3,192
Total_Backscatter_Coefficient_532	Float_32	1/(km · sr)	0.0...1.5	399	1,596
Total_Backscatter_Coefficient_Uncertainty_532	Float_32	1/(km · sr)	N/A	399	1,596
Perpendicular_Backscatter_Coefficient_532	Float_32	1/(km · sr)	0.0...0.35	399	1,596
Perpendicular_Backscatter_Coefficient_Uncertainty_532	Float_32	1/(km · sr)	N/A	399	1,596
Particulate_Depolarization_Ratio_Profile_532	Float_32	NoUnits	0.0...1.0	399	1,596
Particulate_Depolarization_Ratio_Uncertainty_532	Float_32	NoUnits	N/A	399	1,596
Extinction_Coefficient_532	Float_32	1/km	0.0...12.0	399	1,596
Extinction_Coefficient_Uncertainty_532	Float_32	1/km	N/A	399	1,596
Cloud_Multiple_Scattering_Profile_532	Float_32	NoUnits	0.01...1.0	399	1,596
Ice_Water_Content_Profile	Float_32	g/(m ³)	0.0...0.54	399	1,596
Ice_Water_Content_Profile_Uncertainty	Float_32	g/(m ³)	N/A	399	1,596
Record Size (bytes)					34,486

- A) [399] element array per file
- B) International Atomic Time (TAI) seconds from Jan. 1, 1993
- C) TAI time converted to UTC time and stored in format: yymmdd.ffffff
- D) Column optical depths will occasionally exceed the maximum value cited here. Users are advised that these especially large values are numerical artifacts of the retrieval process, and do not represent realistic, physically meaningful retrievals.
- E) Detailed description provided in Section 4.0

2.14 Lidar Level 2 Vertical Feature Mask Data Product DP 2.1D

The Lidar Level 2 Vertical Feature Mask data product contains scene classification data and lidar lighting and land/water indicators.

The spatial resolution for this product varies as a function of altitude, with the highest spatial resolutions occurring at the lowest altitudes. The table below provides a description of the data resolutions used in the vertical feature mask product.

Each 5 km horizontal segment of data contains one 16-bit integer for each lidar altitude resolution element. Each of these integers is a bit-mapped set of feature classification flags that provide a comprehensive overview of the CALIPSO measurements at the highest possible spatial resolution.

The major categories contained within the data product are:

- Day/Night Flag
- Land/Water Flag
- Scene Classification Data

Level:	2
Version:	5.00
Type:	Archival
Frequency:	2/Orbit
Spatial Resolution Record:	Single shot, full resolution
Time Interval Covered:	Half Orbit (Day or Night)

Data File Name:

CAL_LID_L2_VFM-ProductionStrategy-Version.Instance.hdf

2.14.1 Lidar Level 2 Vertical Feature Mask Data Record Summary

Table 79: Lidar Level 2 Vertical Feature Mask Data Record Summary

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903 903
Lidar Vertical Feature Mask Metadata Record	Table 80	42,966	1	42,966
Single Shot Parameters	Table 81	33	63,630	2,099,790
Lidar Data Altitudes	Table 82	545	1	2,180
Lidar 5 km Vertical Feature Mask Record	Table 82	22,119	4,010	88,697,190
Total Size (bytes)				90,843,029
Total Size (Mbytes)				88.71

2.14.2 Lidar Level 2 Vertical Feature Mask Metadata

Table 80: Lidar Level 2 Vertical Feature Mask Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Product_ID	Char	NoUnits	L2_LIDAR	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Lidar_L1_Production_Date_Time ^A	Char	NoUnits	4/2006...10/2025	27	27
Number_of_Good_Profiles	Int_32	NoUnits	0...4,242	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	0...4,242	1	4
Initial_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Initial_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Final_Subsatellite_Latitude	Float_32	°	-90.0...90.0	1	4
Final_Subsatellite_Longitude	Float_32	°	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,428.0...230,701.0	1	8
Lidar_Data_Altitudes	Float_32	km	-2.0...40.0	583	2,332
GEOS_Version	Char	NoUnits	N/A	64	64
GMAO_Files_Used	Char	NoUnits	4 file names max	320	320
Classifier_Coefficients_Version_Number	Char	NoUnits	0.0...99.9	1	4
Classifier_Coefficients_Version_Date	Char	NoUnits	4/2006...10/2025	1	6
Production_Script	Char	NoUnits	N/A	40,000	40,000
Record Size (bytes)					42,966

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.14.3 Lidar Level 2 Vertical Feature Mask Scientific Data Sets

The tables below summarize the contents of each scientific data set (SDS) contained within the Lidar Vertical Feature Mask products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 81: Lidar Level 2 Vertical Feature Mask Record – Single Shot Parameters

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
ssProfile_ID	Int_32	NoUnits	1...228,630	1	4
ssLatitude	Float_32	degrees_north	-90.0...90.0	1	4
ssLongitude	Float_32	degrees_east	-180.0...180.0	1	4
ssProfile_Time ^A	Float_64	TAI seconds	4.203E8...9.623E8	1	8
ssProfile_UTC_Time ^B	Float_64	yymmdd.ffffff	60,426.0...230,701.0	1	8
ssLand_Water_Mask	Int_8	NoUnits	0...7	1	1
ssLaser_Energy_532	Float_32	J	0.003...0.135	1	4
Record Size (bytes)					33

A) International Atomic Time (TAI) seconds from Jan. 1, 1993

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

Table 82: Lidar Level 2 Vertical Feature Mask Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Data_Altitudes ^A	Float_32	km	-0.5...30.0	545	2,180
Profile_ID	Int_32	NoUnits	1...228,630	1	4
Latitude	Float_32	degrees_north	-90.0...90.0	1	4
Longitude	Float_32	degrees_east	-180.0...180.0	1	4
Profile_Time ^B	Float_64	TAI seconds	4.203E8...9.623E8	1	8
Profile_UTC_Time ^C	Float_64	yymmdd.ffffff	60,428.0...230,701.0	1	8
Day_Night_Flag	UInt_16	NoUnits	0...1	1	2
Land_Water_Mask	Int_8	NoUnits	0...7	1	1
Minimum_Laser_Energy_532	Float_32	J	0.003...0.135	1	4
Spacecraft_Position ^D	Float_64	km	-8,000.0...8,000.0	3	24
Feature_Classification_Flags	UInt_16	NoUnits	1...49,146	5,515	11,030
VFM_Feature_Detection_Quality_Flag	UInt_16	NoUnits	1...32,767	5,515	11,030
Record Size (bytes)					22,119

A) [545] element array per file

B) International Atomic Time (TAI) seconds from Jan. 1, 1993

C) TAI time converted to UTC time and stored in format: yymmdd.ffffff

D) Spacecraft_Position is a 3x3 array which includes the position for the three latitudes

2.15 Lidar Level 2 Polar Stratospheric Clouds Product DP 2.3

The Lidar Level 2 Polar Stratospheric Clouds (PSC) data product ensemble describes the spatial distribution and optical properties of PSC layers observed by the CALIPSO lidar. The product contains profiles of PSC presence, composition, optical properties, and meteorological information along CALIPSO orbit tracks. Each file contains data from all nighttime orbit segments from a single day reported on a 5-km horizontal by 180-m vertical grid. PSC detection is limited to nighttime CALIOP observations because higher levels of background light during daytime significantly reduce the signal-to-noise and, hence, the PSC detection sensitivity. The files also include Aura Microwave Limb Sounder (MLS) measurements of the primary PSC condensable vapors HNO₃ and H₂O, and selected parameters from the Aura MLS v2 Derived Meteorological Products (DMPs), including equivalent latitude, vortex edge location, and dynamic tropopause altitude.

Level:	2
Type:	Archival
Version:	3.00
Frequency:	Daily
Spatial Resolution Record:	360° longitude (180°W to 180°E) 35° latitude (50° to 85°; winter hemisphere)
Time Interval Covered:	Nighttime Data Only Southern Hemisphere Months: May - October Northern Hemisphere Months: November - April

Data File Name:
CAL_LID_L2_PSCMask-ProductionStrategy-Version.Instance.hdf

2.15.1 Lidar Level 2 Polar Stratospheric Cloud Profile Data Record Summary

Table 83: Lidar Level 2 Polar Stratospheric Cloud Profile Data Record Summary

Record Name	Reference	Record Size	Records / File	File Size (bytes)
PSC Metadata Record	Table 84	1,205	1	1,205
PSC Record	Table 85	20,506	20,755	425,602,030
Total Size (bytes)				425,603,235
Total Size (Mbytes)				415.63

2.15.2 Lidar Level 2 Polar Stratospheric Cloud Data Metadata

Table 84: Lidar Level 2 Polar Stratospheric Cloud Profile Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Of_LIDAR_L1_Files	Int_16	NoUnits	1...15	1	2
Number_Altitudes	Int_32	NoUnits	1...121	1	4
Number_Profiles	Int_32	NoUnits	1...30,000	1	4
L1_Input_Filenames	String	NoUnits	N/A	1...15	315
L1_Input_Start_Times	Float_64	NoUnits	60,428.0...230,701.0	1...15	120
L1_Input_End_Times	Float_64	NoUnits	60,428.0...230,701.0	1...15	120
Number_HNO3_Pressure_Levels	Int_32	NoUnits	0...25	1	4
Number_H2O_Pressure_Levels	Int_32	NoUnits	0...25	1	4
Pressure_HNO3	Float_32	hPa	1.0...500.0	12	48
Pressure_H2O	Float_32	hPa	1.0...500.0	25	100
Altitude	Float_32	km	8.0...31.0	121	484
Record Size (bytes)					1,205

2.15.3 Lidar Level 2 Polar Stratospheric Cloud Scientific Data Sets

The table below summarizes the contents of each scientific data set (SDS) contained within the Lidar Polar Stratospheric Cloud Data products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 85: Lidar Level 2 Polar Stratospheric Cloud Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Profile_Time ^C	Float_64	sec	4.204E8...1.072E9	1	8
Profile_UTC_Time	Float_64	NoUnits	60,426.0...261,231.0	1	8
Latitude	Float_32	deg	-90.0...90.0	1	4
Longitude	Float_32	deg	-180.0...180.0	1	4
Orbit_Index	Int_16	NoUnits	0...15	1	2
Temperature	Float_32	K	150.0...350.0	121	484
Potential_Temperature	Float_32	K	200.0...1,200.0	121	484
Pressure	Float_32	hPa	1.0...1000.0	121	484
Vortex_Edge_Outer	Float_32	deg	-90.0...90.0	121	484
Vortex_Edge_Center	Float_32	deg	-90.0...90.0	121	484
Equivalent_Latitude	Float_32	deg	-90.0...90.0	121	484
Tropopause_Altitude_MERRA2	Float_32	km	3.0...25.0	1	4
Parallel_Attenuated_Backscatter_532_Initial	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.1	121	484
Perpendicular_Attenuated_Backscatter_532_Initial	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.05	121	484
Parallel_Attenuated_Backscatter_532	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.1	121	484
Parallel_Attenuated_Backscatter_532_Uncertainty	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.1	121	484
Perpendicular_Attenuated_Backscatter_532	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.05	121	484
Perpendicular_Attenuated_Backscatter_532_Uncertainty	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.05	121	484
Particulate_Depolarization_Ratio_532	Float_32	NoUnits	0.0...1.0	121	484
Particulate_Depolarization_Ratio_532_Uncertainty	Float_32	NoUnits	0.0...99.0	121	484
Total_Attenuated_Scattering_Ratio_532	Float_32	NoUnits	0.0...1.0	121	484
Total_Attenuated_Scattering_Ratio_532_Uncertainty	Float_32	NoUnits	0.0...99.0	121	484
Total_Attenuated_Backscatter_1064	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.1	121	484
Total_Attenuated_Backscatter_1064_Uncertainty	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.1	121	484
Molecular_Backscatter_532	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.1	121	484
Particulate_Backscatter_532	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.8	121	484
Particulate_Backscatter_532_Uncertainty	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.1	121	484
Total_Scattering_Ratio_532	Float_32	NoUnits	0.0...1.0	121	484
Total_Scattering_Ratio_532_Uncertainty	Float_32	NoUnits	0.0...1.0	121	484
Perpendicular_Scattering_Ratio_532	Float_32	NoUnits	0.0...1.0	121	484
Perpendicular_Scattering_Ratio_532_Uncertainty	Float_32	NoUnits	0.0...1.0	121	484
Perpendicular_Backscatter_532	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.5	121	484
Perpendicular_Backscatter_532_Uncertainty	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.1	121	484
Parallel_Backscatter_532	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.5	121	484
Parallel_Backscatter_532_Uncertainty	Float_32	km ⁻¹ ·sr ⁻¹	0.0...0.2	121	484
Particulate_Extinction	Float_32	km ⁻¹	0.0...10.0	121	484
Particulate_Surface_Area_Density_532	Float_32	μm ² cm ⁻³	0.0...350.0	121	484
Particulate_Volume_Density_532	Float_32	μm ³ cm ⁻³	0.0...350.0	121	484
Lidar_Ratio_532	Float_32	sr	0.0...250.0	121	484
Multiple_Scattering_Factor_532	Float_32	NoUnits	0.5...1.0	121	484
Retrieval_QC_Flag	Float_32	NoUnits	8.0...30.05	121	484

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
PSC_Feature_Mask	Int_16	NoUnits	-350...350	121	242
PSC_Composition	Int_16	NoUnits	-6...6	121	242
PSC_Composition_Confidence_Index_Non_Spherical	Float_32	NoUnits	-20.0...130.0	121	484
PSC_Composition_Confidence_Index_NAT_Ice	Float_32	NoUnits	-150.0...40.0	121	484
PSC_Composition_Confidence_Index_STS	Float_32	NoUnits	0.0...30.0	121	484
PSC_Ice_Mixture_Boundary	Float_32	NoUnits	-1.0...10.0	121	484
Total_Scattering_Ratio_532_Threshold	Float_32	NoUnits	0.0...5.0	121	484
Perpendicular_Attenuated_Backscatter_532_Threshold	Float_32	NoUnits	0.0E0...1.0E-4	121	484
HNO3_Mixing_Ratio	Float_32	NoUnits	0.0...2.0E-8	12	48
H2O_Mixing_Ratio	Float_32	NoUnits	0.0...8.0E-4	25	100
Record Size (bytes)					20,506

C) International Atomic Time (TAI) seconds from Jan. 1, 1993

2.16 Lidar Level 2 Blowing Snow Product DP 2.4A

The Lidar Level 2 Blowing Snow products report distribution of blowing snow properties based on backscatter retrievals for a specific region of the globe. These data products are distributed in hierarchical data format - HDF5 files, due to the size limitations of HDF4, which is the file format for all other CALIPSO data products.

The major categories of the blowing snow product are:

- Blowing Snow
- Backscatter

Level:	2
Type:	Archival
Version:	1.00 – Greenland 2.00 – Antarctica
Frequency:	1 file per month
Record Temporal Coverage:	all
Record Spatial Coverage:	horizontal: 360° longitude (180°W to 180°E) 180° latitude (90°N to 90°S) vertical: -1.82 km to 0.38 km
Record Spatial Resolution:	horizontal: 1° longitude by 1° latitude vertical: 30 m vertical resolution
Region:	Antarctica Greenland

Data File Name:

CAL_LID_L2_BlowingSnow_Region-ProductionStrategy-Version.Instance.hdf5

2.16.1 Lidar Level 2 Blowing Snow Data Record Summary

Table 86: Lidar Level 2 Blowing Snow Data Record Summary

Record Name	Reference	Record Size	Records / File	File Size (bytes)
Core & Archive Metadata	Appendix A – CALIPSO Metadata	875	1	875
Blowing Snow Metadata Record	Table 87	5,256	1	5,256
Ancillary Fields	Table 88	22	8,765,352	192,837,436
Geolocation Fields	Table 89	12	8,765,352	105,184,224
Snow Fields	Table 90	494	8,765,352	4,330,083,888
Observation Grid	Table 90	259,200	1	259,200
Blowing Snow Frequency Grid	Table 90	2,332,800	1	2,332,800
Total Size Bytes				4,630,703,679
Total Size Mbytes				4,522.17

2.16.2 Lidar Level 2 Blowing Snow Data Metadata

Table 87: Lidar Level 2 Blowing Snow Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Production_Time	Char	NoUnits	N/A	1	20
Lidar_Level_1_Files	Char	NoUnits	N/A	5,000	5,000
Region_Boundaries	Char	NoUnits	N/A	1	80
Number_of_Monthly_Ground_Returns	Int_32	count	0...40,000,000	1	4
Number_of_Monthly_Shots	Int_32	count	0...90,000,000	1	4
Ground_Return_Threshold	Float_32	1/sr	N/A	1	4
Blowing_Snow_Threshold	Float_32	1/sr	N/A	1	4
Wind_Speed_Threshold	Float_32	m/s	N/A	1	4
Lidar_Data_Altitudes	Float_32	km	-1.818...-0.382	34	136
Record Size (bytes)					5,256

2.16.3 Lidar Level 2 Blowing Snow Data Product Scientific Data Sets

The tables below summarize the contents of each scientific data set (SDS) contained within the Lidar Level 2 Blowing Snow Data product. Each parameter is listed using the same SDS name that is used in the respective HDF5 files. Units are given for each parameter, as is the range of valid data values.

Table 88: Lidar Level 2 Blowing Snow Data Record – Ancillary Fields

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Land_Water_Mask ^A	Int_16	NoUnits	0...7	1	2
Solar_Zenith_Angle	Float_32	°	0.0...180.0	1	4
Surface_Temperature	Float_32	°C	-95.0...13.0	1	4
Surface_Type_IGBP ^A	Int_16	NoUnits	1...18	1	2
Surface_Type_NSIDC	Int_16	NoUnits	0.0...255.0	1	2
Surface_Wind_Direction	Float_32	°	0.0...360.0	1	4
Surface_Wind_Speed	Float_32	m/s	0.0...33.0	1	4
Record Size (bytes)					22

Table 89: Lidar Level 2 Blowing Snow Data Record – Geolocation Fields

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Latitude	Float_32	°	-90.0...90.0	1	4
Longitude	Float_32	°	-180.0...180.0	1	4
Profile_UTC_Time	Float_32	NoUnits	60,426.0...261,231.0	1	4
Record Size (bytes)					12

A) Detailed description provided in Section 4.0

Table 90: Lidar Level 2 Blowing Snow Data Record – Snow Fields

Parameter	Data Type	Units	Nominal Range	Elem / Rec	Bytes
Blowing_Snow_Backscatter_Profile	Float_32	1/sr	N/A	34	136
Blowing_Snow_Color_Ratio_Profile	Float_32	NoUnits	0.0...2.0	34	136
Blowing_Snow_Depol_Profile	Float_32	NoUnits	0.0...1.0	34	136
Blowing_Snow_Layer_Average_Color_Ratio	Float_32	NoUnits	0.0...2.0	1	4
Blowing_Snow_Layer_Average_Depolarization	Float_32	NoUnits	0.0...1.0	1	4
Blowing_Snow_Layer_Confidence_Flag	Int_16	NoUnits	-2...7	1	2
Blowing_Snow_Layer_Depth	Float_32	m	0.0...600.0	1	4
Blowing_Snow_Layer_Optical_Depth	Float_32	NoUnits	0.0...18.0	1	4
Blowing_Snow_Layer_Strength	Float_32	NoUnits	0.0...96.19	1	4
Diamond_Dust_Flag	Int_16	NoUnits	0...1	1	2
Ground_Bin_Altitude_Index	Int_16	NoUnits	300...582	1	2
Ground_Signal_Backscatter	Float_32	1/sr	-0.84...22.15	4	32
Ground_Signal_Elevation	Float_32	km	-0.1568...4.124	1	4
Max_Blowing_Snow_Layer_Backscatter	Float_32	1/sr	-0.022...2.7644	1	4
Max_Blowing_Snow_Layer_Backscatter_Altitude	Float_32	m	0.0...570.0	1	4
Observation_Grid	Float_32	count	N/A	0	0
Blowing_Snow_Frequency_Grid	Float_32	count	N/A	0	0
Surface_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	-3.53E-4...1.037	1	4
Surface_Overlying_Integrated_Attenuated_Backscatter_532	Float_32	1/sr	-1.12 ... 3.2	1	4
Surface_Peak_Signal_532	Float_32	1/(km · sr)	-0.210...22.156	1	4
Surface_Top_Altitude_532	Float_32	km	-0.246...4.334	1	4
Record Size (bytes)					494

2.17 IIR/Lidar Level 2 Track Product DP 2.2A

The IIR/Lidar Level 2 Track data product contains IIR emissivity and cloud particle data related to pixels that have been co-located to the Lidar track.

The major categories of the data product are:

- Cloud Emissivity
- Cloud Properties
- Lidar Profile Data

Level: 2
Version: 5.00
Type: Archival
Frequency: 2/Orbit
Spatial Resolution Record: 1 km pixels at nadir
Time Interval Covered: Half Orbit (Day or Night)

Data File Name:
CAL_IIR_L2_Track-Standard-Version.Instance.hdf

2.17.1 IIR/Lidar Level 2 Track Product

Image data are registered to a 1 km grid centered on the lidar track. Each grid line occurs every 3 lidar shots, which results in a maximum of 40,095 grid lines per orbit (20,048 grid lines per half orbit).

Table 91: IIR/Lidar Level 2 Track Product Summary

Record Name	Reference	Record Size	Records/File	File Size (Bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
IIR Track Metadata Record	Table 92	377	1	9,222,080
IIR/Lidar Track Science Record	Table 93	460	20,048	9,222,080
Total Size (bytes)				9,223,360
Total Size (Mbytes)				9.007

2.17.2 IIR/Lidar Level 2 Track Metadata

Table 92: IIR/Lidar Level 2 Track Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Product_ID	Char	NoUnits	CAL_IIR_L2_Track	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	04/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	04/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	04/2006 – 7/2023	27	27
Initial_IIR_Scan_Center_Latitude	Float_32	degrees_north	-90.0...90.0	1	4
Initial_IIR_Scan_Center_Longitude	Float_32	degrees_east	-180.0...180.0	1	4
Ending_IIR_Scan_Center_Latitude	Float_32	degrees_north	-90.0...90.0	1	4
Ending_IIR_Scan_Center_Longitude	Float_32	degrees_east	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,426.0...230,701.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,426.0...230,701.0	1	8
Number_of_IIR_Records_in_File	Int_16	NoUnits	0...20,048	1	2
Number_of_Valid_08_65_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Valid_12_05_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Valid_10_60_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Invalid_08_65_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Invalid_12_05_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Invalid_10_60_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_08_65_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_12_05_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_10_60_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_08_65_Pixels_Location	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_12_05_Pixels_Location	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_10_60_Pixels_Location	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_08_65_Pixels_Radiance	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_12_05_Pixels_Radiance	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_10_60_Pixels_Radiance	Int_16	NoUnits	0...20,048	1	2
Mean_08_65_Radiance_All	Float_32	W/((m ²)·sr·μm)	0.0...40.0	1	4
Mean_12_05_Radiance_All	Float_32	W/((m ²)·sr·μm)	0.0...40.0	1	4
Mean_10_60_Radiance_All	Float_32	W/((m ²)·sr·μm)	0.0...40.0	1	4
Mean_08_65_Radiance_Selected_Cases	Float_32	W/((m ²)·sr·μm)	0.0...40.0	1	4
Mean_12_05_Radiance_Selected_Cases	Float_32	W/((m ²)·sr·μm)	0.0...40.0	1	4
Mean_10_60_Radiance_Selected_Cases	Float_32	W/((m ²)·sr·μm)	0.0...40.0	1	4
Mean_08_65_Brightness_Temp_All	Float_32	K	0.0...400.0	1	4
Mean_12_05_Brightness_Temp_All	Float_32	K	0.0...400.0	1	4
Mean_10_60_Brightness_Temp_All	Float_32	K	0.0...400.0	1	4
Mean_08_65_Brightness_Temp_Selected_Cases	Float_32	K	0.0...400.0	1	4
Mean_12_05_Brightness_Temp_Selected_Cases	Float_32	K	0.0...400.0	1	4
Mean_10_60_Brightness_Temp_Selected_Cases	Float_32	K	0.0...400.0	1	4
Number_of_Valid_LIDAR_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Invalid_LIDAR_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Rejected_LIDAR_Pixels	Int_16	NoUnits	0...20,048	1	2
Number_of_Selected_Cloud_Cases	Int_16	NoUnits	0...20,048	1	2

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Percent_of_Selected_Cloud_Cases	Float_32	%	0.0...100.0	1	4
Number_of_Selected_Aerosol_Cases	Int_16	NoUnits	0...20,048	1	2
Percent_of_Selected_Aerosol_Cases	Float_32	%	0.0...100.0	1	4
Number_of_Identified_Pixels_Clear_Sky	Int_16	NoUnits	0...20,048	1	2
Percent_of_Identified_Pixels_Clear_Sky	Float_32	%	0.0...100.0	1	4
Mean_Altitude_High_Cloud	Float_32	km	-0.5...30.1	1	4
GEOS_Version	Char	NoUnits	N/A	64	64
Record Size (bytes)					377

A) UTC CCSDS ASCII Time Code Format A

B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.17.3 IIR/Lidar Level 2 Track Scientific Data Sets

The table below summarizes the contents of each scientific data set (SDS) contained within the IIR/Lidar Track products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 93: IIR/Lidar Level 2 Track Science Record

Parameter	Data Type	Units	Range	Elem/Rec	Bytes
Latitude	Float_32	degrees_north	-90.0...90.0	1	4
Longitude	Float_32	degrees_east	-180.0...180.0	1	4
LIDAR_Shot_Time ^A	Float_64	TAI seconds	4.204E8...9.623E8	1	8
LIDAR_Profile_ID	Int_32	NoUnits	1...228,630	1	4
IIR_Image_Time_12_05 ^A	Float_64	TAI seconds	4.204E8...9.623E8	1	8
Brightness_Temperature_08_65	Float_32	K	0.0...400.0	1	4
Brightness_Temperature_12_05	Float_32	K	0.0...400.0	1	4
Brightness_Temperature_10_60	Float_32	K	0.0...400.0	1	4
Type_of_Scene ^B	Int_8	NoUnits	0...99	1	1
Was_Cleared_Flag_1km	Int_8	NoUnits	0...30	1	1
Multi_Layer_Flag ^B	Float_32	NoUnits	-8,030...8,030.0	1	4
Effective_Emissivity_08_65	Float_32	NoUnits	0.0...1.0	1	4
Effective_Emissivity_12_05	Float_32	NoUnits	0.0...1.0	1	4
Effective_Emissivity_10_60	Float_32	NoUnits	0.0...1.0	1	4
Effective_Emissivity_Uncertainty_08_65	Float_32	NoUnits	0.0...1.0	1	4
Effective_Emissivity_Uncertainty_12_05	Float_32	NoUnits	0.0...1.0	1	4
Effective_Emissivity_Uncertainty_10_60	Float_32	NoUnits	0.0...1.0	1	4
Effective_Emissivity_Uncertainty_Terms_08_65	Float_32	NoUnits	-1.0...1.0	3	12
Effective_Emissivity_Uncertainty_Terms_12_05	Float_32	NoUnits	-1.0...1.0	3	12
Effective_Emissivity_Uncertainty_Terms_10_60	Float_32	NoUnits	-1.0...1.0	3	12
Particle_Shape_Index ^B	Int_8	NoUnits	1...9	1	1
Particle_Shape_Index_Confidence ^B	Int_8	NoUnits	1...4	1	1
Effective_Particle_Size	Float_32	μm	0.0...200.0	1	4
Effective_Particle_Size_Uncertainty	Float_32	μm	0.0...200.0	1	4
Ice_Liquid_Water_Path	Float_32	g/(m ²)	0.0...1,300.0	1	4
Ice_Liquid_Water_Path_Confidence	Float_32	g/(m ²)	0.0...1,300.0	1	4
Reference_Brightness_Temperature ^B	Int_16	K	0.0...400.0	6	12
Blackbody_Brightness_Temperature ^B	Int_16	K	0.0...400.0	6	12
Computed_Brightness_Temperature_Surface ^B	Int_16	K	0.0...400.0	3	6
Optical_Depth_12_05	Float_32	NoUnits	0.0...10.0	1	4
Optical_Depth_12_05_Uncertainty	Float_32	NoUnits	0.0...10.0	1	4
Optical_Depth_0532_Upper_Level	Float_32	NoUnits	0.0...5.0	1	4
Depolarization_Upper_Level	Float_32	NoUnits	0.0...1.0	1	4
Integrated_Backscatter_Upper_Level	Float_32	sr ⁻¹	0.0...1.0	1	4
Layer_Top_Height_Upper_Level	Float_32	km	-0.5...30.1	1	4
Centroid_IAB_0532_Upper_Level	Float_32	km	-0.5...30.1	1	4
Layer_Bottom_Height_Upper_Level	Float_32	km	-0.5...30.1	1	4
Layer_Top_Temperature_Upper_Level	Float_32	K	160.0...340.0	1	4

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Temperature_Centroid_IAB_0532_Upper_Level	Float_32	K	160.0...340.0	1	4
Layer_Bottom_Temperature_Upper_Level	Float_32	K	160.0...340.0	1	4
Layer_Top_Pressure_Upper_Level	Float_32	hPa	1.0...1,086.0	1	4
Pressure_Centroid_IAB_0532_Upper_Level	Float_32	hPa	1.0...1,086.0	1	4
Layer_Bottom_Pressure_Upper_Level	Float_32	hPa	1.0...1,086.0	1	4
Ice_Water_Flag_Upper_Level	Int_8	NoUnits	1...9	1	1
Ice_Water_Flag_QA_Upper_Level	Float_32	NoUnits	0.0...100.1	1	4
Ice_Water_Path_CALIOP_Upper_Level	Float_32	g/(m ²)	0.0...500.0	1	4
Optical_Depth_0532_Lower_Level	Float_32	NoUnits	0.0...5.0	1	4
Depolarization_Lower_Level	Float_32	NoUnits	0.0...1.0	1	4
Integrated_Backscatter_Lower_Level	Float_32	sr ⁻¹	0.0...1.0	1	4
Layer_Top_Height_Lower_Level	Float_32	km	-0.5...30.1	1	4
Centroid_IAB_0532_Lower_Level	Float_32	km	-0.5...30.1	1	4
Layer_Bottom_Height_Lower_Level	Float_32	km	-0.5...30.1	1	4
Layer_Top_Temperature_Lower_Level	Float_32	K	160.0...340.0	1	4
Temperature_Centroid_IAB_0532_Lower_Level	Float_32	K	160.0...340.0	1	4
Layer_Bottom_Temperature_Lower_Level	Float_32	K	160.0...340.0	1	4
Layer_Top_Pressure_Lower_Level	Float_32	hPa	1.0...1,086.0	1	4
Pressure_Centroid_IAB_0532_Lower_Level	Float_32	hPa	1.0...1,086.0	1	4
Layer_Bottom_Pressure_Lower_Level	Float_32	hPa	1.0...1,086.0	1	4
Ice_Water_Flag_Lower_Level	Int_8	NoUnits	-9...9	1	1
Ice_Water_Flag_QA_Lower_Level	Float_32	NoUnits	0.0...100.1	1	4
Surface_Emissivity_08_65	Float_32	NoUnits	0.0...1.0	1	4
Surface_Emissivity_12_05	Float_32	NoUnits	0.0...1.0	1	4
Surface_Emissivity_10_60	Float_32	NoUnits	0.0...1.0	1	4
IGBP_Surface_Type ^C	Int_8	NoUnits	1...18	1	1
Snow_Ice_Surface_Type ^C	UInt_8	NoUnits	0...255	1	1
Surface_532_Integrated_Depolarization_Ratio	Float_32	NoUnits	0.0...1.0	1	4
TGeotype ^B	Int_16	NoUnits	100...1,800	1	2
Initial_Surface_Temperature	Float_32	K	160.0...340.0	1	4
Surface_Temperature	Float_32	K	160.0...340.0	1	4
IIR_Data_Quality_Flag	Int_8	NoUnits	0...15	1	1
Equalization_Flag	Int_8	NoUnits	0...7	1	1
LIDAR_Data_Quality_Flag	Int_8	NoUnits	0...3	1	1
Surrounding_Obs_Quality_Flag	Int_16	NoUnits	0...412	1	2
High_Cloud_vs_Background_Flag	Float_32	NoUnits	-93.0...412.0	1	4
Computed_vs_Observed_Background_Flag	Float_32	NoUnits	-10.0...10.0	3	12
Regional_Background_Std_Dev_Flag	Float_32	NoUnits	0.0...1.0	1	4
Microphysics	Float_32	NoUnits	0.0...2,002,009.0	10	40
Dust_Stratospheric_Aerosol_Flag	Int_8	NoUnits	0...8	1	1
Dust_Stratospheric_Aerosol_Flag_QA	Float_32	NoUnits	0.0...100.1	1	4
Reflectance	Float_32	NoUnits	0.0...2.0	1	4
Integrated_Water_Vapor_Path	Float_32	g/(cm ²)	0.0...10.0	1	4
Radiative_Temperature_Upper_Level	Float_32	K	160.0...340.0	1	4
Radiative_Height_Upper_Level	Float_32	km	-5.0...30.1	1	4
Radiative_Pressure_Upper_Level	Float_32	hPa	1.0...1086.0	1	4
Cloud_Optical_Depth	Float_32	NoUnits	0.0...20.0	1	4
Cloud_Optical_Depth_Uncertainty	Float_32	NoUnits	0.0...20.0	1	4

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Cirrus_IIR_Thickness	Float_32	km	0.0...30.6	1	4
Cirrus_Number_Concentration	Float_32	L ⁻¹	0.0... 1,000,000.0	1	4
Cirrus_Number_Concentration_Uncertainty	Float_32	L ⁻¹	0.0... 1,000,000.0	1	4
Cirrus_IIR_Extinction	Float_32	km ⁻¹	0.0...60.0	1	4
Cirrus_IIR_Extinction_Uncertainty	Float_32	km ⁻¹	0.0...60.0	1	4
Cirrus_Optical_Depth	Float_32	NoUnits	0.0...20.0	1	4
Cirrus_Optical_Depth_Uncertainty	Float_32	NoUnits	0.0...20.0	1	4
Cirrus_Effective_Diameter	Float_32	μm	0.0...150.0	1	4
Cirrus_Effective_Diameter_Uncertainty	Float_32	μm	0.0...150.0	1	4
Cirrus_Ice_Water_Content	Float_32	mg/(m ³)	0.0...3000.0	1	4
Cirrus_Ice_Water_Content_Uncertainty	Float_32	mg/(m ³)	0.0...3000.0	1	4
Cirrus_Ice_Water_Path	Float_32	g/(m ²)	0.0...1000.0	1	4
Cirrus_Ice_Water_Path_Uncertainty	Float_32	g/(m ²)	0.0...1000.0	1	4
Cirrus_Volume_Radius	Float_32	μm	0.0...100.0	1	4
Cirrus_Volume_Radius_Uncertainty	Float_32	μm	0.0...100.0	1	4
Low_Energy_Mitigation_Column_QC_Flag	UInt_16	NoUnits	0...63	1	2
Record Size (bytes)					460

- A) International Atomic Time (TAI) seconds from Jan 1, 1993
B) Range after scale equation reported in the HDF file
C) Detailed description provided in Section 4.0

2.18 IIR Level 2 Swath Product DP 2.2B

The IIR Level 2 Swath data product contains IIR emissivity and cloud particle data assigned to IIR pixels on a 1 km grid centered on the lidar track.

The major categories of the data product are:

- Cloud Emissivity
- Cloud Properties

Level:	2
Version:	5.00
Type:	Archival
Frequency:	2/Orbit
Spatial Resolution Record:	1 km pixels x 69 km swath
Time Interval Covered:	Half Orbit (Day or Night)

Data File Name:

CAL_IIR_L2_Swath-ProductionStrategy-Version.Instance.hdf

2.18.1 IIR Level 2 Swath Product

The maximum number of IIR sequences processed in one orbit is 729 (1 sequence every 8.15 seconds). Image data are registered to a 1 km grid centered on the lidar track. Each grid line occurs every 3rd lidar shot, or 40,095 grid lines per orbit (20,048 per half orbit).

Table 94: IIR Level 2 Swath Product Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Swath Metadata	Table 95	!Undefined Bookmark, IIR_SWATH 379	1	379
Swath Science Record	Table 96	7,736	20,048	155,091,328
Total Size (bytes)				155,092,610
Total Size (Mbytes)				151.457

2.18.2 IIR Level 2 Swath Metadata

Table 95: IIR Level 2 Swath Product Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Product_ID	Char	NoUnits	CAL_IIR_L2_Swath	80	80
Date_Time_at_Granule_Start ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_at_Granule_End ^A	Char	NoUnits	4/2006 – 7/2023	27	27
Date_Time_of_Production ^A	Char	NoUnits	4/2006 – 10/2025	27	27
Initial_IIR_Scan_Center_Latitude	Float_32	degrees_north	-90.0...90.0	1	4
Initial_IIR_Scan_Center_Longitude	Float_32	degrees_east	-180.0...180.0	1	4
Ending_IIR_Scan_Center_Latitude	Float_32	degrees_north	-90.0...90.0	1	4
Ending_IIR_Scan_Center_Longitude	Float_32	degrees_east	-180.0...180.0	1	4
Orbit_Number_at_Granule_Start	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_at_Granule_End	UInt_32	NoUnits	1...2 ³² -1	1	4
Orbit_Number_Change_Time ^B	Float_64	NoUnits	60,426.0...230,701.0	1	8
Path_Number_at_Granule_Start	Int_16	NoUnits	1...233	1	2
Path_Number_at_Granule_End	Int_16	NoUnits	1...233	1	2
Path_Number_Change_Time ^B	Float_64	NoUnits	60,426.0...230,701.0	1	8
Number_of_IIR_Records_in_File	Int_16	NoUnits	0...20,048	1	2
Number_of_Valid_08_65_Pixels	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Valid_12_05_Pixels	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Valid_10_60_Pixels	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Invalid_08_65_Pixels	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Invalid_12_05_Pixels	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Invalid_10_60_Pixels	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Rejected_08_65_Pixels	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Rejected_12_05_Pixels	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Rejected_10_60_Pixels	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Rejected_08_65_Pixels_Loc	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Rejected_12_05_Pixels_Loc	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Rejected_10_60_Pixels_Loc	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Rejected_08_65_Pixels_Rad	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Rejected_12_05_Pixels_Rad	Int_32	NoUnits	0...1,383,312	1	4
Number_of_Rejected_10_60_Pixels_Rad	Int_32	NoUnits	0...1,383,312	1	4
Mean_08_65_Radiance_All	Float_32	W/((m ²)·sr·µm)	0.0...40.0	1	4
Mean_12_05_Radiance_All	Float_32	W/((m ²)·sr·µm)	0.0...40.0	1	4
Mean_10_60_Radiance_All	Float_32	W/((m ²)·sr·µm)	0.0...40.0	1	4
Mean_08_65_Radiance_Selected_Cases	Float_32	W/((m ²)·sr·µm)	0.0...40.0	1	4
Mean_12_05_Radiance_Selected_Cases	Float_32	W/((m ²)·sr·µm)	0.0...40.0	1	4
Mean_10_60_Radiance_Selected_Cases	Float_32	W/((m ²)·sr·µm)	0.0...40.0	1	4
Mean_08_65_Brightness_Temp_All	Float_32	K	0.0...400.0	1	4
Mean_12_05_Brightness_Temp_All	Float_32	K	0.0...400.0	1	4
Mean_10_60_Brightness_Temp_All	Float_32	K	0.0...400.0	1	4
Mean_08_65_Brightness_Temp_Selected_Cases	Float_32	K	0.0...400.0	1	4
Mean_12_05_Brightness_Temp_Selected_Cases	Float_32	K	0.0...400.0	1	4
Mean_10_60_Brightness_Temp_Selected_Cases	Float_32	K	0.0...400.0	1	4
GEOS_Version	Char	NoUnits	N/A	64	64
Record Size (bytes)					379

- A) UTC CCSDS ASCII Time Code Format A
- B) TAI time converted to UTC time and stored in format: yymmdd.ffffff

2.18.3 IIR Level 2 Swath Scientific Data Sets

The table below summarizes the contents of each scientific data set (SDS) contained within the IIR Swath product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 96: IIR Level 2 Swath Product Science Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Latitude	Float_32	degrees_north	-90.0...90.0	69	276
Longitude	Float_32	degrees_east	-180.0...180.0	69	276
LIDAR_Shot_Time ^A	Float_64	TAI seconds	4.204E8...9.623E8	69	552
IIR_Track_Pixel_ID	Int_16	NoUnits	1...20,048	69	138
IIR_Image_Time_12_05 ^A	Float_64	s	4.204E8...9.623E8	1	8
LIDAR_DayNight_Flag	Int_8	NoUnits	0...1	69	69
Brightness_Temperature_08_65 ^B	Int_16	K	0...400.0	69	138
Brightness_Temperature_12_05 ^B	Int_16	K	0...400.0	69	138
Brightness_Temperature_10_60 ^B	Int_16	K	0...400.0	69	138
Calibrated_WFC_Reflectance ^B	Int_16	NoUnits	0.0...2.0	69	138
Surface_Emissivity_08_65 ^B	Int_16	NoUnits	0.0...1.0	69	138
Surface_Emissivity_12_05 ^B	Int_16	NoUnits	0.0...1.0	69	138
Surface_Emissivity_10_60 ^B	Int_16	NoUnits	0.0...1.0	69	138
Effective_Emissivity_08_65 ^B	Int_16	NoUnits	0.0...1.0	69	138
Effective_Emissivity_12_05 ^B	Int_16	NoUnits	0.0...1.0	69	138
Effective_Emissivity_10_60 ^B	Int_16	NoUnits	0.0...1.0	69	138
Effective_Emissivity_Uncertainty_08_65 ^B	Int_16	NoUnits	0.0...1.0	69	138
Effective_Emissivity_Uncertainty_12_05 ^B	Int_16	NoUnits	0.0...1.0	69	138
Effective_Emissivity_Uncertainty_10_60 ^B	Int_16	NoUnits	0.0...1.0	69	138
Homogeneity_Index_BT_08_65 ^B	Int_8	NoUnits	0.0...1.0	69	69
Homogeneity_Index_BT_12_05 ^B	Int_8	NoUnits	0.0...1.0	69	69
Homogeneity_Index_BT_10_60 ^B	Int_8	NoUnits	0.0...1.0	69	69
Homogeneity_Index_Surface_e_08_65 ^B	Int_8	NoUnits	0.0...1.0	69	69
Homogeneity_Index_Surface_e_12_05 ^B	Int_8	NoUnits	0.0...1.0	69	69
Homogeneity_Index_Surface_e_10_60 ^B	Int_8	NoUnits	0.0...1.0	69	69
Homogeneity_Index_Reflectance ^B	Int_8	NoUnits	0.0...1.0	69	69
Homogeneity_Index_Surface_Temperature ^B	Int_8	NoUnits	0.0...1.0	69	69
Homogeneity_Index_Humidity_Profile ^B	Int_8	NoUnits	0.0...1.0	69	69
Particle_Shape_Index	Int_8	NoUnits	1...9	69	69
Particle_Shape_Confidence	Int_8	NoUnits	1...4	69	69
Effective_Particle_Size ^B	Int_16	µm	0.0...200.0	69	138
Effective_Particle_Size_Uncertainty ^B	Int_16	µm	0.0...200.0	69	138
Optical_Depth_12_05 ^B	Int_16	NoUnits	0.0...10.0	69	138
Optical_Depth_12_05_Uncertainty ^B	Int_16	NoUnits	0.0...10.0	69	138
Ice_Liquid_Water_Path ^B	Int_16	g/(m ²)	0.0...1,300.0	69	138
Ice_Liquid_Water_Path_Confidence ^B	Int_16	g/(m ²)	0.0...1,300.0	69	138
Integrated_Water_Vapor_Path ^B	Int_16	g/(cm ²)	0.0...10.0	69	138
Scene_Flag ^B	Int_32	NoUnits	10,010...180,099	69	276
IIR_Data_Quality	Int_8	NoUnits	0...15	69	69
Equalization_Flag	Int_8	NoUnits	0...7	69	69

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Layer_Top_Height_Upper_Level	Int_16	km	-0.5...30.1	69	138
Centroid_IAB_0532_Upper_Level	Int_16	km	-0.5...30.1	69	138
Layer_Bottom_Height_Upper_Level	Int_16	km	-0.5...30.1	69	138
Layer_Top_Temperature_Upper_Level	Int_16	K	160.0...340.0	69	138
Temperature_Centroid_IAB_0532_Upper_Level	Int_16	K	160.0...340.0	69	138
Layer_Bottom_Temperature_Upper_Level	Int_16	K	160.0...340.0	69	138
Layer_Top_Pressure_Upper_Level	Int_16	hPa	1.0...1,086.0	69	138
Pressure_Centroid_IAB_0532_Upper_Level	Int_16	hPa	1.0...1,086.0	69	138
Layer_Bottom_Pressure_Upper_Level	Int_16	hPa	1.0...1,086.0	69	138
Layer_Top_Height_Lower_Level	Int_16	km	-0.5...30.1	69	138
Centroid_IAB_0532_Lower_Level	Int_16	km	-0.5...30.1	69	138
Layer_Bottom_Height_Lower_Level	Int_16	km	-0.5...30.1	69	138
Layer_Top_Temperature_Lower_Level	Int_16	K	160.0...340.0	69	138
Temperature_Centroid_IAB_0532_Lower_Level	Int_16	K	160.0...340.0	69	138
Layer_Bottom_Temperature_Lower_Level	Int_16	K	160.0...340.0	69	138
Layer_Top_Pressure_Lower_Level	Int_16	hPa	1.0...1,086.0	69	138
Pressure_Centroid_IAB_0532_Lower_Level	Int_16	hPa	1.0...1,086.0	69	138
Layer_Bottom_Pressure_Lower_Level	Int_16	hPa	1.0...1,086.0	69	138
Record Size (bytes)					7,736

A) International Atomic Time (TAI) seconds from Jan 1, 1993

B) Range after scale equation reported in the HDF file

2.19 Lidar Level 3 Tropospheric Aerosol Profile Product DP 3.1

The Lidar Level 3 tropospheric aerosol profile product reports mean profiles of aerosol optical properties on a uniform spatial grid. All level 3 parameters are derived from the CALIPSO level 2 5 km aerosol profile products.

The major categories of the aerosol data product are:

- Extinction Data
- Column Aerosol Optical Depth
- Ancillary Grid Data

Level: 3
Version: 5.00
Type: Archival
Frequency: Monthly
Record Temporal Coverage: daytime, nighttime.
Record Spatial Coverage: horizontal: 360° longitude (180°W to 180°E)
170° latitude (85°N to 85°S)
vertical: 12.5 km (-0.4 km to 12.1 km)
Record Spatial Resolution: horizontal: 5° longitude by 2° latitude
vertical: 60 m vertical resolution
Record Sky Conditions: all-sky, cloud-free, cloudy-sky transparent, cloudy-sky opaque

Data File Name:

CAL_LID_L3_Tropospheric_APro_AllSky-ProductionStrategy-Version.Instance.hdf
CAL_LID_L3_Tropospheric_APro_CloudFree-ProductionStrategy-Version.Instance.hdf
CAL_LID_L3_Tropospheric_APro_CloudySkyTransparent-ProductionStrategy-
Version.Instance.hdf
CAL_LID_L3_Tropospheric_APro_CloudySkyOpaque-ProductionStrategy-
Version.Instance.hdf

2.19.1 Lidar Level 3 Tropospheric Aerosol Data Summary DP 3.1

Table 97: Lidar Level 3 Tropospheric Aerosol Data Record

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Level 3 Aerosol Data Product Metadata	Table 98	35,568	1	35,568
Spatial Coordinates	Table 99	1,460	1	1,460
Meteorological Context	Table 100	5,014	6,120	30,685,680
Surface and Over-flight Parameters	Table 101	20	6,120	122,400
Static Lidar Parameters	Table 102	56	1	56
Aerosol Optical Properties: All Species	Table 103	12,908	6,120	78,996,960
Aerosol Optical Properties: Dust Only	Table 104	2,916	6,120	17,845,920
Aerosol Optical Properties: Elevated Smoke Only	Table 105	2,916	6,120	17,845,920
Aerosol Optical Properties: Polluted Dust Only	Table 106	2,916	6,120	17,845,920
Aerosol Optical Properties: Polluted Continental Only	Table 107	2,916	6,120	17,845,920
Aerosol Optical Properties: Marine Only	Table 108	2,916	6,120	17,845,920
Aerosol Optical Properties: Dusty Marine Only	Table 109	2,916	6,120	17,845,920
Aerosol Optical Properties: Clean Continental Only	Table 110	2,916	6,120	17,845,920
Aerosol Type Distribution: All Species	Table 111	2,928	6,120	17,919,360
Aerosol Spatial Distribution: All Species	Table 112	246	6,120	1,505,520
Aerosol Spatial Distribution: Dust Only	Table 113	246	6,120	1,505,520
Aerosol Spatial Distribution: Elevated Smoke Only	Table 114	246	6,120	1,505,520
Aerosol Spatial Distribution: Polluted Dust Only	Table 115	246	6,120	1,505,520
Aerosol Spatial Distribution: Polluted Continental Only	Table 116	246	6,120	1,505,520
Aerosol Spatial Distribution: Marine Only	Table 117	246	6,120	1,505,520
Aerosol Spatial Distribution: Dusty Marine Only	Table 118	246	6,120	1,505,520
Aerosol Spatial Distribution: Clean Continental Only	Table 119	246	6,120	1,505,520
Total Size (bytes)				264,727,987
Total Size (Mbytes)				258.523

2.19.2 Lidar Level 3 Tropospheric Aerosol Data Product Metadata

Table 98: Lidar Level 3 Tropospheric Aerosol Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	CAL_LID_L3_Tropospheric_APro_AllSky, CAL_LID_L3_Tropospheric_APro_CloudFree CAL_LID_L3_Tropospheric_APro_CloudySkyTransparent CAL_LID_L3_Tropospheric_APro_CloudySkyOpaque	80	80
Nominal_Year_Month	Char	NoUnits	N/A	6	6
Number_of_Level2_Files_Analyzed	UInt_16	NoUnits	0...900	1	2
Earliest_Input_Filename	Char	NoUnits	N/A	160	160
Latest_Input_Filename	Char	NoUnits	N/A	160	160
Data_Screening_Script_Filename	Char	NoUnits	N/A	160	160
Data_Screening_Script_File_Contents	Char	NoUnits	N/A	5,000	5,000
List_of_Input_Files	Char	NoUnits	N/A	30,000	30,000
Record Size (bytes)					335,568

2.19.3 Lidar Level 3 Tropospheric Aerosol Data Product Scientific Data Sets

Tables below summarize the contents of each scientific data set (SDS) contained within the CALIPSO Lidar Level 3 Tropospheric Aerosol Data Product. Each parameter is listed using the same (SDS) name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 99: Spatial Coordinates

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Longitude_Midpoint	Float_32	degrees_north	-180.0...180.0	72	288
Latitude_Midpoint	Float_32	degrees_east	-85.0...85.0	85	340
Altitude_Midpoint	Float_32	km	-0.5...12.1	208	832
Record Size (bytes)					1,460

Table 100: Meteorological Context

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Pressure_Mean	Float_32	hPa	1.0...1,086.0	208	832
Pressure_Standard_Deviation	Float_32	hPa	0.0...15.0	208	832
Temperature_Mean	Float_32	degC	-120.0...60.0	208	832
Temperature_Standard_Deviation	Float_32	degC	0.0...10.0	208	832
Relative_Humidity_Mean	Float_32	NoUnits	0.0...1.5	208	832
Relative_Humidity_Standard_Deviation	Float_32	NoUnits	0.0...0.4	208	832
Tropopause_Height_Minimum	Float_32	km	4.0...22.0	1	4
Tropopause_Height_Maximum	Float_32	km	4.0...22.0	1	4
Tropopause_Height_Median	Float_32	km	4.0...22.0	1	4
Tropopause_Height_Mean	Float_32	km	4.0...22.0	1	4
Tropopause_Height_Standard_Deviation	Float_32	km	0.0...5.0	1	4
Meteorological_Profiles_Averaged	Int_16	NoUnits	0...32,767	1	2
Record Size (bytes)					5,014

Table 101: Surface and Over-flight Parameters

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Surface_Elevation_Minimum	Float_32	km	-1.0...9.0	1	4
Surface_Elevation_Maximum	Float_32	km	-1.0...9.0	1	4
Surface_Elevation_Median	Float_32	km	-1.0...9.0	1	4
Land_Samples	Int_16	NoUnits	0...32,767	1	2
Water_Samples	Int_16	NoUnits	0...32,767	1	2

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Days_Of_Month_Observed	UInt_32	NoUnits	0...4,294,967,295	1	4
Record Size (bytes)					20

Table 102: Static Lidar Parameters

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Initial_Aerosol_Lidar_Ratio_532	Float_32	sr	20.0...70.0	7	28
Initial_Aerosol_Lidar_Ratio_Uncertainty_532	Float_32	sr	2.0...30.0	7	28
Record Size (bytes)					56

Table 103: Aerosol Optical Properties - All Species

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Mean	Float_32	km ⁻¹	0.0...4.0	208	832
Extinction_Coefficient_532_Standard_Deviation	Float_32	km ⁻¹	0.0...0.15	208	832
Extinction_Coefficient_532_Percentiles	Float_32	km ⁻¹	0.0...4.0	2,288	9,152
Samples_Searched	Int_16	NoUnits	0...32,767	208	416
Samples_Aerosol_Detected_Accepted	Int_16	NoUnits	0...32,767	208	416
Samples_Aerosol_Detected_Rejected	Int_16	NoUnits	0...32,767	208	416
Samples_Cloud_Detected	Int_16	NoUnits	0...32,767	208	416
Samples_Averaged	Int_16	NoUnits	0...32,767	208	416
AOD_Mean	Float_32	NoUnits	0.0...5.0	1	4
AOD_63_Percent_Below	Float_32	km	0.0...12.0	1	4
AOD_90_Percent_Below	Float_32	km	0.0...12.0	1	4
Record Size (bytes)					12,908

Table 104: Aerosol Optical Properties - Dust Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Mean_Dust	Float_32	km ⁻¹	0.0...4.0	208	832
Extinction_Coefficient_532_Standard_Deviation_Dust	Float_32	km ⁻¹	0.0...0.1	208	832
Samples_Aerosol_Detected_Accepted_Dust	Int_16	NoUnits	0...32,767	208	416
Samples_Aerosol_Detected_Rejected_Dust	Int_16	NoUnits	0...32,767	208	416
Samples_Averaged_Dust	Int_16	NoUnits	0...32,767	208	416

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
AOD_Mean_Dust	Float_32	NoUnits	0.0...5.0	1	4
Record Size (bytes)					2,916

Table 105: Aerosol Optical Properties – Elevated Smoke Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Mean_Elevated_Smoke	Float_32	km ⁻¹	0.0...4.0	208	832
Extinction_Coefficient_532_Standard_Deviation_Elevated_Smoke	Float_32	km ⁻¹	0.0...0.1	208	832
Samples_Aerosol_Detected_Accepted_Elevated_Smoke	Int_16	NoUnits	0...32,767	208	416
Samples_Aerosol_Detected_Rejected_Elevated_Smoke	Int_16	NoUnits	0...32,767	208	416
Samples_Averaged_Elevated_Smoke	Int_16	NoUnits	0...32,767	208	416
AOD_Mean_Elevated_Smoke	Float_32	NoUnits	0.0...5.0	1	4
Record Size (bytes)					2,916

Table 106: Aerosol Optical Properties – Polluted Dust Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Mean_Polluted_Dust	Float_32	km ⁻¹	0.0...4.0	208	832
Extinction_Coefficient_532_Standard_Deviation_Polluted_Dust	Float_32	km ⁻¹	0.0...0.1	208	832
Samples_Aerosol_Detected_Accepted_Polluted_Dust	Int_16	NoUnits	0...32,767	208	416
Samples_Aerosol_Detected_Rejected_Polluted_Dust	Int_16	NoUnits	0...32,767	208	416
Samples_Averaged_Polluted_Dust	Int_16	NoUnits	0...32,767	208	416
AOD_Mean_Polluted_Dust	Float_32	NoUnits	0.0...5.0	1	4
Record Size (bytes)					2,916

Table 107: Aerosol Optical Properties – Polluted Continental Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Mean_Polluted_Continental	Float_32	km ⁻¹	0.0...4.0	208	832
Extinction_Coefficient_532_Standard_Deviation_Polluted_Continental	Float_32	km ⁻¹	0.0...0.1	208	832

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Samples_Aerosol_Detected_Accepted_Polluted_Continental	Int_16	NoUnits	0...32,767	208	416
Samples_Aerosol_Detected_Rejected_Polluted_Continental	Int_16	NoUnits	0...32,767	208	416
Samples_Averaged_Polluted_Continental	Int_16	NoUnits	0...32,767	208	416
AOD_Mean_Polluted_Continental	Float_32	NoUnits	0.0...5.0	1	4
Record Size (bytes)					2,916

Table 108: Aerosol Optical Properties – Marine Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Mean_Marine	Float_32	km ⁻¹	0.0...4.0	208	832
Extinction_Coefficient_532_Standard_Deviation_Marine	Float_32	km ⁻¹	0.0...0.1	208	832
Samples_Aerosol_Detected_Accepted_Marine	Int_16	NoUnits	0...32,767	208	416
Samples_Aerosol_Detected_Rejected_Marine	Int_16	NoUnits	0...32,767	208	416
Samples_Averaged_Marine	Int_16	NoUnits	0...32,767	208	416
AOD_Mean_Marine	Float_32	NoUnits	0.0...5.0	1	4
Record Size (bytes)					2,916

Table 109: Aerosol Optical Properties – Dusty Marine Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Mean_Dusty_Marine	Float_32	km ⁻¹	0.0...4.0	208	832
Extinction_Coefficient_532_Standard_Deviation_Dusty_Marine	Float_32	km ⁻¹	0.0...0.1	208	832
Samples_Aerosol_Detected_Accepted_Dusty_Marine	Int_16	NoUnits	0...32,767	208	416
Samples_Aerosol_Detected_Rejected_Dusty_Marine	Int_16	NoUnits	0...32,767	208	416
Samples_Averaged_Dusty_Marine	Int_16	NoUnits	0...32,767	208	416
AOD_Mean_Dusty_Marine	Float_32	NoUnits	0.0...5.0	1	4
Record Size (bytes)					2,916

Table 110: Aerosol Optical Properties – Clean Continental Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Mean_Clean_Continental	Float_32	km ⁻¹	0.0...4.0	208	832
Extinction_Coefficient_532_Standard_Deviation_Clean_Continental	Float_32	km ⁻¹	0.0...0.1	208	832

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Samples_Aerosol_Detected_Accepted_Clean_Continental	Int_16	NoUnits	0...32,767	208	416
Samples_Aerosol_Detected_Rejected_Clean_Continental	Int_16	NoUnits	0...32,767	208	416
Samples_Averaged_Clean_Continental	Int_16	NoUnits	0...32,767	208	416
AOD_Mean_Clean_Continental	Float_32	NoUnits	0.0...5.0	1	4
Record Size (bytes)					2,916

Table 111: Aerosol Type Distribution

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Aerosol_Type	Int_16	NoUnits	0...32,767	1,456	2,912
Multiple_Aerosol_Type_Count	Int_16	NoUnits	0...32,767	8	16
Record Size (bytes)					2,928

Table 112: Aerosol Spatial Distribution - All Species

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column	Int_16	NoUnits	0...32,767	9	18
Highest_Aerosol_Layer_Detected	Float_32	km	0.0...20.0	11	44
Lowest_Aerosol_Layer_Detected	Float_32	km	0.0...20.0	11	44
Layer_Separation_Minimum	Float_32	km	0.0...20.0	7	28
Layer_Separation_Maximum	Float_32	km	0.0...20.0	7	28
Layer_Separation_Median	Float_32	km	0.0...20.0	7	28
Layer_Separation_Mean	Float_32	km	0.0...20.0	7	28
Layer_Separation_Standard_Deviation	Float_32	km	0.0...5.0	7	28
Record Size (bytes)					246

Table 113: Aerosol Spatial Distribution - Dust Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Dust	Int_16	NoUnits	0...32,767	9	18
Highest_Aerosol_Layer_Detected_Dust	Float_32	km	0.0...20.0	11	44
Lowest_Aerosol_Layer_Detected_Dust	Float_32	km	0.0...20.0	11	44
Layer_Separation_Minimum_Dust	Float_32	km	0.0...20.0	7	28
Layer_Separation_Maximum_Dust	Float_32	km	0.0...20.0	7	28
Layer_Separation_Median_Dust	Float_32	km	0.0...20.0	7	28
Layer_Separation_Mean_Dust	Float_32	km	0.0...20.0	7	28
Layer_Separation_Standard_Deviation_Dust	Float_32	km	0.0...5.0	7	28

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Record Size (bytes)					246

Table 114: Aerosol Spatial Distribution – Elevated Smoke Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Elevated_Smoke	Int_16	NoUnits	0...32,767	9	18
Highest_Aerosol_Layer_Detected_Elevated_Smoke	Float_32	km	0.0...20.0	11	44
Lowest_Aerosol_Layer_Detected_Elevated_Smoke	Float_32	km	0.0...20.0	11	44
Layer_Separation_Minimum_Elevated_Smoke	Float_32	km	0.0...20.0	7	28
Layer_Separation_Maximum_Elevated_Smoke	Float_32	km	0.0...20.0	7	28
Layer_Separation_Median_Elevated_Smoke	Float_32	km	0.0...20.0	7	28
Layer_Separation_Mean_Elevated_Smoke	Float_32	km	0.0...20.0	7	28
Layer_Separation_Standard_Deviation_Elevated_Smoke	Float_32	km	0.0...5.0	7	28
Record Size (bytes)					246

Table 115: Aerosol Spatial Distribution – Polluted Dust Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Polluted_Dust	Int_16	NoUnits	0...32,767	9	18
Highest_Aerosol_Layer_Detected_Polluted_Dust	Float_32	km	0.0...20.0	11	44
Lowest_Aerosol_Layer_Detected_Polluted_Dust	Float_32	km	0.0...20.0	11	44
Layer_Separation_Minimum_Polluted_Dust	Float_32	km	0.0...20.0	7	28
Layer_Separation_Maximum_Polluted_Dust	Float_32	km	0.0...20.0	7	28
Layer_Separation_Median_Polluted_Dust	Float_32	km	0.0...20.0	7	28
Layer_Separation_Mean_Polluted_Dust	Float_32	km	0.0...20.0	7	28
Layer_Separation_Standard_Deviation_Polluted_Dust	Float_32	km	0.0...5.0	7	28
Record Size (bytes)					246

Table 116: Aerosol Spatial Distribution – Polluted Continental Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Polluted_Continental	Int_16	NoUnits	0...32,767	9	18
Highest_Aerosol_Layer_Detected_Polluted_Continental	Float_32	km	0.0...20.0	11	44
Lowest_Aerosol_Layer_Detected_Polluted_Continental	Float_32	km	0.0...20.0	11	44
Layer_Separation_Minimum_Polluted_Continental	Float_32	km	0.0...20.0	7	28
Layer_Separation_Maximum_Polluted_Continental	Float_32	km	0.0...20.0	7	28
Layer_Separation_Median_Polluted_Continental	Float_32	km	0.0...20.0	7	28
Layer_Separation_Mean_Polluted_Continental	Float_32	km	0.0...20.0	7	28
Layer_Separation_Standard_Deviation_Polluted_Continental	Float_32	km	0.0...5.0	7	28
Record Size (bytes)					246

Table 117: Aerosol Spatial Distribution – Marine Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Marine	Int_16	NoUnits	0...32,767	9	18
Highest_Aerosol_Layer_Detected_Marine	Float_32	km	0.0...20.0	11	44
Lowest_Aerosol_Layer_Detected_Marine	Float_32	km	0.0...20.0	11	44
Layer_Separation_Minimum_Marine	Float_32	km	0.0...20.0	7	28
Layer_Separation_Maximum_Marine	Float_32	km	0.0...20.0	7	28
Layer_Separation_Median_Marine	Float_32	km	0.0...20.0	7	28
Layer_Separation_Mean_Marine	Float_32	km	0.0...20.0	7	28
Layer_Separation_Standard_Deviation_Marine	Float_32	km	0.0...5.0	7	28
Record Size (bytes)					246

Table 118: Aerosol Spatial Distribution – Dusty Marine Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Dusty_Marine	Int_16	NoUnits	0...32,767	9	18
Highest_Aerosol_Layer_Detected_Dusty_Marine	Float_32	km	0.0...20.0	11	44
Lowest_Aerosol_Layer_Detected_Dusty_Marine	Float_32	km	0.0...20.0	11	44
Layer_Separation_Minimum_Dusty_Marine	Float_32	km	0.0...20.0	7	28
Layer_Separation_Maximum_Dusty_Marine	Float_32	km	0.0...20.0	7	28
Layer_Separation_Median_Dusty_Marine	Float_32	km	0.0...20.0	7	28
Layer_Separation_Mean_Dusty_Marine	Float_32	km	0.0...20.0	7	28
Layer_Separation_Standard_Deviation_Dusty_Marine	Float_32	km	0.0...5.0	7	28
Record Size (bytes)					246

Table 119: Aerosol Spatial Distribution – Clean Continental Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Clean_Continental	Int_16	NoUnits	0...32,767	9	18
Highest_Aerosol_Layer_Detected_Clean_Continental	Float_32	km	0.0...20.0	11	44
Lowest_Aerosol_Layer_Detected_Clean_Continental	Float_32	km	0.0...20.0	11	44
Layer_Separation_Minimum_Clean_Continental	Float_32	km	0.0...20.0	7	28
Layer_Separation_Maximum_Clean_Continental	Float_32	km	0.0...20.0	7	28
Layer_Separation_Median_Clean_Continental	Float_32	km	0.0...20.0	7	28
Layer_Separation_Mean_Clean_Continental	Float_32	km	0.0...20.0	7	28
Layer_Separation_Standard_Deviation_Clean_Continental	Float_32	km	0.0...5.0	7	28
Record Size (bytes)					246

2.20 Lidar Level 3 Ice Cloud Product DP 3.3

The Lidar Level 3 ice cloud product reports global distributions of ice cloud extinction and ice water content histograms on a uniform spatial grid. All level 3 parameters are derived from the CALIPSO level 2 5-km cloud profile products, with a temporal averaging of one month. The level 3 data product is distributed in hierarchical data format (HDF) files.

The major categories of the ice cloud product are:

- Extinction Coefficient Histogram
- Ice Water Content Histogram
- Ancillary Grid Data

Level:	3
Version:	2.00
Type:	Archival
Frequency:	3 files per month
Record Temporal Coverage:	daytime, nighttime, all
Record Spatial Coverage:	horizontal: 360° longitude (180°W to 180°E) 170° latitude (85°N to 85°S) vertical: -0.5 km to 20.2 km
Record Spatial Resolution:	horizontal: 2.5° longitude by 2° latitude vertical: 120 m vertical resolution

Data File Name:

CAL_LID_L3_Ice_Cloud-ProductionStrategy-Version.Instance.hdf

2.20.1 Lidar Level 3 Ice Cloud Data Summary DP 3.3

Table 120: Lidar Level 3 Ice Cloud Data Record

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Level 3 Ice Cloud Data Product Metadata	Table 121	65,110	1	65,110
Spatial Coordinates	Table 122	1,604	1	1,604
Meteorological Context	Table 123	4,136	12,240	50,624,640
Surface and Over-flight Parameters	Table 124	20	12,240	244,800
Histogram Bin Boundaries	Table 125	1,056	1	1,056
Extinction Coefficient and Ice Water Content	Table 126	31,648	12,240	387,371,520
Sampling	Table 127	3,104	12,240	37,992,960
Total Size (bytes)				476,302,593
Total Size (Mbytes)				465.13

2.20.2 Lidar Level 3 Ice Cloud Data Product Metadata

Table 121: Lidar Level 3 Ice Cloud Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	CAL_LID_L3_Ice_Cloud	80	80
Date_Time_of_Production	Char	NoUnits	4/2006 – 10/2025	20	20
Nominal_Year_Month	Char	NoUnits	N/A	6	6
Program_Configuration	Char	NoUnits	N/A	5,000	5,000
Number_of_Level2_Files_Analyzed	UInt_16	NoUnits	0...900	1	2
Number_of_Bad_Profiles	UInt_16	NoUnits	0...65,535	1	2
List_of_Input_Files	Char	NoUnits	N/A	60,000	60,000
Record Size (bytes)					65,110

2.20.3 Lidar Level 3 Ice Cloud Data Product Scientific Data Sets

Tables below summarize the contents of each scientific data set (SDS) contained within the CALIPSO lidar level 3 ice cloud product. Each parameter is listed using the same (SDS) name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 122: Spatial Coordinates

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Longitude_Midpoint	Float_32	degrees_east	-180.0...180.0	144	576
Latitude_Midpoint	Float_32	degrees_north	-85.0...85.0	85	340
Altitude_Midpoint	Float_32	km	-0.5...20.2	172	688
Record Size (bytes)					1,604

Table 123: Meteorological Context

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Pressure_Mean ^A	Float_32	hPa	1.0...1,086.0	172	688
Pressure_Standard_Deviation ^A	Float_32	hPa	0.0...50.0	172	688
Temperature_Mean ^B	Float_32	degC	-120.0...60.0	172	688
Temperature_Standard_Deviation ^B	Float_32	degC	0.0...30.0	172	688
Relative_Humidity_Mean ^C	Float_32	NoUnits	0.0...1.5	172	688
Relative_Humidity_Standard_Deviation ^C	Float_32	NoUnits	0.0...0.80	172	688
Tropopause_Height_Mean ^D	Float_32	km	4.0...22.0	1	4
Tropopause_Height_Mean_Standard_Deviation ^D	Float_32	km	0.0...5.0	1	4
Record Size (bytes)					4,136

- A) Contained in the Pressure Vgroup
- B) Contained in the Temperature Vgroup
- C) Contained in the Relative_Humidity Vgroup
- D) Contained in the Tropopause_Height Vgroup

Table 124: Surface and Over-flight Parameters

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
DEM_Surface_Elevation_Minimum ^A	Float_32	km	-1.0...9.0	1	4
DEM_Surface_Elevation_Maximum ^A	Float_32	km	-1.0...9.0	1	4
DEM_Surface_Elevation_Median ^A	Float_32	km	-1.0...9.0	1	4
Land_Surface_Samples	Int_16	NoUnits	0...32,767	1	2
Water_Surface_Samples	Int_16	NoUnits	0...32,767	1	2
Days_Of_Month_Observed	UInt_32	NoUnits	0...4,294,967,295	1	4
Record Size (bytes)					20

- A) Contained in the DEM_Surface_Elevation Vgroup

Table 125: Histogram Bin Boundaries

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Bin_Boundaries	Float_32	km ⁻¹	-0.1...10.0	132	528
Ice_Water_Content_Bin_Boundaries	Float_32	g·m ⁻³	-0.01...1.0	132	528
Record Size (bytes)					1,056

Table 126: Extinction Coefficient and Ice Water Content

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_Coefficient_532_Histogram	Int_16	NoUnits	0...32,767	7,568	15,136
Ice_Water_Content_Histogram	Int_16	NoUnits	0...32,767	7,568	15,136
Extinction_Coefficient_532_Median	Float_32	km ⁻¹	-0.1...10.0	172	688
Ice_Water_Content_Median	Float_32	g·m ⁻³	-0.01...1.0	172	688
Record Size (bytes)					31,648

Table 127: Sampling

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Lidar_Surface_Subsurface_Samples	Int_16	NoUnits	0...32,767	172	344
Totally_Attenuated_Samples	Int_16	NoUnits	0...32,767	172	344
Cloud_Free_Samples	Int_16	NoUnits	0...32,767	172	344
Cloud_Samples	Int_16	NoUnits	0...32,767	172	344
Water_Cloud_Samples	Int_16	NoUnits	0...32,767	172	344
Unknown_Cloud_Samples	Int_16	NoUnits	0...32,767	172	344
Ice_Cloud_Samples	Int_16	NoUnits	0...32,767	172	344
Ice_Cloud_Rejected_Samples	Int_16	NoUnits	0...32,767	172	344
Ice_Cloud_Accepted_Samples	Int_16	NoUnits	0...32,767	172	344
Number_of_5km_Profiles_Evaluated	Int_32	NoUnits	0...4,294,967,295	1	4
Number_of_5km_Profiles_Excluded	Int_32	NoUnits	0...4,294,967,295	1	4
Record Size (bytes)					3,104

2.21 Lidar Level 3 Stratospheric Aerosol Profile Data Product DP 3.2

The Lidar Level 3 stratospheric aerosol profile product reports global distributions of 532 nm total attenuated backscatter, extinction, attenuated scattering ratios, and stratospheric aerosol optical depths on a uniform spatial grid. All level 3 parameters are derived from the CALIPSO version 4 level 1 and level 2 5 km merged layer and version 3 level 2 polar stratospheric cloud data products, with a temporal averaging of one month. The primary outputs are reported in terms of 1) background only and 2) all aerosols. For background only, all features identified by the level 2 algorithms have been removed. For all aerosol only aerosols layers are considered, while clouds and polar stratospheric clouds are removed. The level 3 data product is distributed in hierarchical data format (HDF) files.

The major categories of the stratospheric aerosol product are:

- 532 nm Total Attenuated Backscatter
- Extinction
- Aerosol Optical Depth
- Ancillary Grid Data

Level:	3
Version:	2.00
Type:	Archival
Frequency:	1 file per month
Record Temporal Coverage:	nighttime
Record Spatial Coverage:	horizontal: 360° longitude (180°W to 180°E) 170° latitude (85°N to 85°S)
	vertical: 8.2 km to 36.2 km
Record Spatial Resolution:	horizontal: 20 ° longitude by 5° latitude
	vertical: 900 m vertical resolution

Data File Name:

CAL_LID_L3_Stratospheric_APro-ProductionStrategy-Version.Instance.hdf

2.21.1 Lidar Level 3 Stratospheric Aerosol Profile Data Product Summary DP 3.2

Table 128: Lidar Level 3 Stratospheric Aerosol Profile Data Record

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Level 3 Stratospheric Aerosol Data Product Metadata	Table 129	61,300	1	61,300
Spatial Coordinates	Table 130	520	1	520
Meteorological Context	Table 131	316	612	193,392
Over-flight Parameters	Table 132	2	612	1,224
532 nm Calibration Coefficients	Table 133	12	612	7,344
532 nm Background Component	Table 134	4,376	612	2,678,112
532 nm All Aerosol Component	Table 135	4,376	612	2,678,112
Total Size (bytes)				5,620,907
Total Size (Mbytes)				5.489

2.21.2 Lidar Level 3 Stratospheric Aerosol Profile Data Product Metadata

Table 129: Lidar Level 3 Stratospheric Aerosol Profile Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	CAL_LID_L3_Stratospheric_APro	80	80
Date_Time_of_Production	Char	NoUnits	4/2006 – 10/2025	27	27
Nominal_Year_Month	Char	NoUnits	N/A	6	6
Number_of_Level_1_Files_Analyzed	UInt_16	NoUnits	0...451	1	2
List_of_Level_1_Input_Files	Char	NoUnits	N/A	29,575	29,575
List_of_Level_2_5kmMerged_Input_Files	Char	NoUnits	N/A	29,575	29,575
List_of_Level_2_PSC_Input_Files	Char	NoUnits	N/A	2,015	2,015
Initial_Aerosol_Lidar_Ratio_532	Float_32	NoUnits	N/A	1	4
Initial_Aerosol_Lidar_Ratio_Uncertainty_532	Float_32	NoUnits	N/A	1	4
Molecular_Backscatter_Cross_Section	Float_32	NoUnits	N/A	1	4
Molecular_Extinction_Cross_Section	Float_32	NoUnits	N/A	1	4
Ozone_Absorption_Cross_Section	Float_32	NoUnits	N/A	1	4
Record Size (bytes)					61,300

2.21.3 Lidar Level 3 Stratospheric Aerosol Profile Data Product Scientific Data Sets

Tables below summarize the contents of each scientific data set (SDS) contained within the CALIPSO lidar level 3 stratospheric aerosol profile product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 130: Spatial Coordinates

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Longitude_Midpoint	Float_32	degrees_east	-180.0...180.0	18	72
Latitude_Midpoint	Float_32	degrees_north	-85.0...85.0	34	136
Altitude_Midpoint	Float_32	km	8.2...36.2	78	312
Record Size (bytes)					520

Table 131: Meteorological Context

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Tropopause_Height_Mean	Float_32	km	5.0...18.0	1	4
Potential_Temperature_Mean	Float_32	K	300.0...1,250.0	78	312
Record Size (bytes)					316

Table 132: Over-flight Parameters

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_of_Granules	Int_16	NoUnits	0...451	1	2
Record Size (bytes)					2

Table 133: 532 nm Calibration Coefficients

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Calibration_Coefficient_Mean_532	Float_32	$\text{km}^3 \cdot \text{sr} \cdot \text{J}^{-1} \cdot \text{count}$	4.4E10...6.6E10	1	4
Calibration_Coefficient_Standard_Deviation_532	Float_32	$\text{km}^3 \cdot \text{sr} \cdot \text{J}^{-1} \cdot \text{count}$	0.0...5.7E8	1	4
Samples_Calibration_Coefficient_532	Int_32	NoUnits	0...8,000	1	4
Record Size (bytes)					12

Table 134: 532 nm Background Component

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Stratospheric_Optical_Depth_Background	Float_32	NoUnits	-0.05...0.06	1	4
Stratospheric_Optical_Depth_Uncertainty_Background	Float_32	NoUnits	0.0...0.02	1	4
Total_Attenuated_Backscatter_Background	Float_32	km ⁻¹ ·sr ⁻¹	0.0...5.3E-4	78	312
Total_Attenuated_Backscatter_Standard_Deviation_Background	Float_32	km ⁻¹ ·sr ⁻¹	0.0...2.1E-5	78	312
Samples_Accepted_Background	Int_32	NoUnits	0...8,000	78	312
Samples_Rejected_Background	Int_32	NoUnits	0...8,000	78	312
Molecular_Backscatter_Background	Float_32	km ⁻¹ ·sr ⁻¹	0.0...5.3E-4	78	312
Molecular_Backscatter_Standard_Deviation_Background	Float_32	km ⁻¹ ·sr ⁻¹	0.0...2.1E-5	78	312
Ozone_Absorption_Coefficient_Background	Float_32	km ⁻¹	0.0...1.9E-3	78	312
Ozone_Absorption_Coefficient_Standard_Deviation_Background	Float_32	km ⁻¹	0.0...8.0E-5	78	312
Attenuated_Scattering_Ratio_Background	Float_32	NoUnits	0.30...1.70	78	312
Attenuated_Scattering_Ratio_Uncertainty_Background	Float_32	NoUnits	0.03...0.35	78	312
Particulate_Backscatter_Background	Float_32	km ⁻¹ ·sr ⁻¹	-1.1E-4...1.3E-4	78	312
Particulate_Backscatter_Uncertainty_Background	Float_32	km ⁻¹ ·sr ⁻¹	0.0...4.5E-5	78	312
Extinction_Coefficient_Background	Float_32	km ⁻¹	-5.4E-3...6.5E-3	78	312
Extinction_Coefficient_Uncertainty_Background	Float_32	km ⁻¹	0.0...2.6E-3	78	312
Record Size (bytes)					4,376

Table 135: 532 nm All Aerosol Component

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Stratospheric_Optical_Depth	Float_32	NoUnits	-0.02...2.00	1	4
Stratospheric_Optical_Depth_Uncertainty	Float_32	NoUnits	2.4E-4...0.40	1	4
Total_Attenuated_Backscatter	Float_32	km ⁻¹ ·sr ⁻¹	0.0...6.3E-4	78	312
Total_Attenuated_Backscatter_Standard_Deviation	Float_32	km ⁻¹ ·sr ⁻¹	0.0...2.2E-4	78	312
Samples_Accepted	Int_32	NoUnits	0...8,000	78	312
Samples_Rejected	Int_32	NoUnits	0...8,000	78	312
Molecular_Backscatter	Float_32	km ⁻¹ ·sr ⁻¹	0.0...5.3E-4	78	312
Molecular_Backscatter_Standard_Deviation	Float_32	km ⁻¹ ·sr ⁻¹	0.0...2.1E-5	78	312
Ozone_Absorption_Coefficient	Float_32	km ⁻¹	0.0...1.9E-3	78	312
Ozone_Absorption_Coefficient_Standard_Deviation	Float_32	km ⁻¹	0.0...9.5E-5	78	312
Attenuated_Scattering_Ratio	Float_32	NoUnits	0.60...25.0	78	312
Attenuated_Scattering_Ratio_Uncertainty	Float_32	NoUnits	0.03...5.6	78	312
Particulate_Backscatter	Float_32	km ⁻¹ ·sr ⁻¹	-6.2E-5...0.15	78	312
Particulate_Backscatter_Uncertainty	Float_32	km ⁻¹ ·sr ⁻¹	0.0...2.1E-2	78	312
Extinction_Coefficient	Float_32	km ⁻¹	-3.2E-3...7.5	78	312
Extinction_Coefficient_Uncertainty	Float_32	km ⁻¹	0.0...1.56	78	312
Record Size (bytes)					4,376

2.22 Lidar Level 3 Cloud Occurrence Data Product DP 3.4

The Lidar Level 3 Cloud Occurrence product reports global distributions of cloud occurrence by counts on a uniform spatial grid. At each grid, the number of detected ice cloud samples is also reported as a histogram of ice cloud layer optical depth. All level 3 parameters are derived from the CALIPSO level 2 5 km cloud profile products, with a temporal averaging of one month. The level 3 data product is distributed in hierarchical data format (HDF) files.

The major categories of the cloud occurrence product are:

- Cloud counts partitioned by thermal phase and opacity
- Ice cloud count as a histogram of layer optical depth

Level:	3
Version:	2.00
Type:	Archival
Frequency:	3 files per month
Record Temporal Coverage:	daytime, nighttime, all
Record Spatial Coverage:	horizontal: 360° longitude (180°W to 180°E) 170° latitude (85°N to 85°S)
	vertical: -0.5 km to 20.2 km
Record Spatial Resolution:	horizontal: 2.5 ° longitude by 2° latitude
	vertical: 60 m vertical resolution

Data File Name:

CAL_LID_L3_Cloud_Occurrence-ProductionStrategy-Version.Instance.hdf

2.22.1 Lidar Level 3 Cloud Occurrence Data Product Summary DP 3.4

Table 136: Lidar Level 3 Cloud Occurrence Data Record Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Level 3 Cloud Occurrence Data Product Metadata	Table 137	10,110	1	10,110
Spatial Coordinates	Table 138	2,292	1	2,292
Meteorological Context	Table 139	8,264	12,240	101,151,360
Surface and Over-flight Parameters	Table 140	44	12,240	538,560
Sampling	Table 141	13,080	12,240	160,099,200
Total Size (bytes)				2,618,069,215
Total Size (Mbytes)				255.67

2.22.2 Lidar Level 3 Cloud Occurrence Data Product Metadata

Table 137: Lidar Level 3 Cloud Occurrence Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	CAL_LID_L3_Cloud_Occurrence	80	80
Date_Time_of_Production	Char	NoUnits	4/2006 – 10/2025	20	20
Nominal_Year_Month	Char	NoUnits	N/A	6	6
Program_Configuration	Char	NoUnits	N/A	5,000	5,000
Number_of_Level2_Files_Analyzed	UInt_16	NoUnits	0..900	1	2
Number_of_Bad_5km_Profiles	UInt_16	NoUnits	0..6,553	1	2
List_of_Input_MLay_Files	Char	NoUnits	N/A	5,000	5,000
Record Size (bytes)					10,110

2.22.3 Lidar Level 3 Cloud Occurrence Data Product Scientific Data Sets

Tables below summarize the contents of each scientific data set (SDS) contained within the CALIPSO lidar level 3 cloud occurrence product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

Table 138: Spatial Coordinates

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Longitude_Midpoint	Float_32	degrees_east	-180.0...180.0	144	576
Latitude_Midpoint	Float_32	degrees_north	-85.0...85.0	85	340
Altitude_Midpoint	Float_32	km	-0.5...20.2	344	1,376
Record Size (bytes)					2,292

Table 139: Meteorological Context

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Pressure_Mean ^A	Float_32	hPa	1.0...1,086.0	344	1,376
Pressure_Standard_Deviation ^A	Float_32	hPa	0.0...50.0	344	1,376
Temperature_Mean ^B	Float_32	degC	-120.0...60.0	344	1,376
Temperature_Standard_Deviation ^B	Float_32	degC	0.0...30.0	344	1,376
Relative_Humidity_Mean ^C	Float_32	NoUnits	0.0...1.5	344	1,376
Relative_Humidity_Standard_Deviation ^C	Float_32	NoUnits	0.0...0.80	344	1,376
Tropopause_Height_Mean ^D	Float_32	km	4.0...22.0	1	4
Tropopause_Height_Standard_Deviation ^D	Float_32	km	0.0...5.0	1	4
Record Size (bytes)					8,264

- A) Contained in the Pressure Vgroup
- B) Contained in the Temperature Vgroup
- C) Contained in the Relative_Humidity Vgroup
- D) Contained in the Tropopause_Height Vgroup

Table 140: Surface and Over-flight Parameters

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
DEM_Surface_Elevation_Minimum ^A	Float_32	km	-1.0...9.0	1	4
DEM_Surface_Elevation_Maximum ^A	Float_32	km	-1.0...9.0	1	4
DEM_Surface_Elevation_Median ^A	Float_32	km	-1.0...9.0	1	4
Snow_Ice_Surface_Mean ^B	Float_32	%	0.0...100.0	1	4
Snow_Ice_Surface_Standard_Deviation ^B	Float_32	%	0.0...100.0	1	4
Snow_Ice_Surface_Minimum ^B	Float_32	%	0.0...100.0	1	4
Snow_Ice_Surface_Maximum ^B	Float_32	%	0.0...100.0	1	4
Snow_Ice_Surface_Median ^B	Float_32	%	0.0...100.0	1	4
Land_Surface_Samples	Int_32	NoUnits	0...65,535	1	4
Water_Surface_Samples	Int_32	NoUnits	0...65,535	1	4

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Days_Of_Month_Observed	UInt_32	NoUnits	0...4,294,967,295	1	4
Record Size (bytes)					44

A) Contained in the DEM_Surface_Elevation Vgroup

B) Contained in the Snow_Ice_Surface Vgroup

Table 141: Sampling

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Lidar_Surface_Subsurface_Samples	Int_16	NoUnits	0...32,767	344	688
Totally_Attenuated_Samples	Int_16	NoUnits	0...32,767	344	688
Cloud_Free_Samples	Int_16	NoUnits	0...32,767	344	688
Cloud_Samples	Int_16	NoUnits	0...32,767	344	688
Cloud_Rejected_Samples	Int_16	NoUnits	0...32,767	344	688
Cloud_Accepted_Samples	Int_16	NoUnits	0...32,767	344	688
Unknown_Cloud_Transparent_Samples	Int_16	NoUnits	0...32,767	344	688
Unknown_Cloud_Opaque_Samples	Int_16	NoUnits	0...32,767	344	688
Water_Cloud_Transparent_Samples	Int_16	NoUnits	0...32,767	344	688
Water_Cloud_Opaque_Samples	Int_16	NoUnits	0...32,767	344	688
Ice_Cloud_Transparent_Samples	Int_16	NoUnits	0...32,767	344	688
Ice_Cloud_Opaque_Samples	Int_16	NoUnits	0...32,767	344	688
Ice_Cloud_Optical_Depth_Histogram ^A	Int_16	NoUnits	0...32,767	2,408	4,816
Number_Of_333m_Profiles_Evaluated	UInt_32	NoUnits	0...4,294,967,295	1	4
Number_Of_333m_Profiles_Excluded	UInt_32	NoUnits	0...4,294,967,295	1	4
Record Size (bytes)					13,080

A) Refer to Table 142 for a detailed description on the boundaries of this histogram

Table 142: Ice Cloud Optical Depth Histogram Boundaries

Bin	Optical Depth Range
0	Optical Depth < 0.01
1	$0.01 \leq$ Optical Depth < 0.03
2	$0.03 \leq$ Optical Depth < 0.10
3	$0.10 \leq$ Optical Depth < 0.30
4	$0.30 \leq$ Optical Depth < 1.00
5	Optical Depth \geq 1.00 & Transparent
6	Reserved

2.23 Lidar Level 3 GEWEX Cloud Data Product DP 3.5

The Lidar Level 3 (L3) CALIPSO Global Energy and Water cycle Experiment (GEWEX) Cloud product is a reformatted version of CALIPSO's contribution to the GEWEX cloud assessment of global cloud datasets from satellites. The data provided by CALIPSO for this project had to conform to a very specific format; yearly netCDF files organized by parameter. In order to be compatible with other publicly orderable Lidar L3 CALIPSO aerosol and cloud products, which are reported as monthly HDF files, this new Lidar L3 CALIPSO GEWEX cloud product was created. These files report global distributions of cloud amount and cloud top as averages and histograms on a uniform 2-dimensional (2D) spatial grid. All level 3 parameters are derived from the CALIPSO level 2 5-km cloud merged layer products, with a temporal averaging of one month.

The major categories of the cloud occurrence product are:

- Cloud amount average and histogram
- Cloud top temperature/pressure/altitude averages and histograms
- Ancillary grid data

Level:	3
Version:	2.00
Type:	Archival
Frequency:	3 files per month
Record Temporal Coverage:	daytime, nighttime, all
Record Spatial Coverage:	horizontal: 360° longitude (180°W to 180°E) 180° latitude (90°N to 90°S) vertical: -0.5 km to 20.2 km
Record Spatial Resolution:	horizontal: 1.0 ° longitude by 1.0° latitude vertical: low, middle and high altitudes

Data File Name:

CAL_LID_L3_GEWEX_Cloud-ProductionStrategy-Version.Instance.hdf

2.23.1 Lidar Level 3 GEWEX Cloud Data Product Summary DP 3.5

Table 143: Lidar Level 3 GEWEX Cloud Data Product Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
Lidar Level 3 GEWEX Data Product Metadata	Table 144	65,110	1	65,110
Spatial Coordinates	Table 145	2,160	1	2,160
Over-flight Parameter	Table 146	2	64,800	129,600
Histogram Bin Boundaries	Table 147	804	1	804
Cloud Amount	Table 148	368	64,800	23,846,400
Cloud top temperature, pressure and height	Table 149	2,040	64,800	132,192,000
Total Size (bytes)				156,236,977
Total Size (Mbytes)				152.57

2.23.2 Lidar Level 3 GEWEX Cloud Data Product Metadata

Table 144: Lidar Level 3 GEWEX Cloud Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	CAL_LID_L3_GEWEX_Cloud	80	80
Date_Time_of_Production	Char	NoUnits	4/2006 – 10/2025	20	20
Nominal_Year_Month	Char	NoUnits	N/A	6	6
Day_Night_Flag	Char	NoUnits	D = daytime N = nighttime A = all	2	2
Program_Configuration	Char	NoUnits	N/A	5,000	5,000
Number_of_Level2_Files_Analyzed	UInt_16	NoUnits	0...900	1	2
List_of_Input_Files	Char	NoUnits	N/A	60,000	60,000
Record Size (bytes)					65,110

2.23.3 Lidar Level 3 GEWEX Cloud Data Product Scientific Data Sets

Tables below summarize the contents of each scientific data set (SDS) contained within the CALIPSO lidar Level 3 GEWEX Cloud Product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values. Appendix G provides a detailed comparison between the variables in this product and the corresponding parameter names in the GEWEX Cloud Assessment Database.

Table 145: Spatial Coordinates

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Longitude_Midpoint	Float_32	degrees_east	-180.0...180.0	360	1,440
Latitude_Midpoint	Float_32	degrees_north	-90.0...90.0	180	720
Record Size (bytes)					2,160

Table 146: Over-flight Parameters

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Of_Orbit_Tracks	Int_16	NoUnits	0...32,767	1	2
Record Size (bytes)					2

Table 147: Histogram Bin Boundaries

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Cloud_Amount_Bin_Midpoint	Float_64	NoUnits	0.0...1.0	10	80
Cloud_Amount_Bin_Boundaries	Float_64	NoUnits	0.0...1.0	11	88
Cloud_Top_Temperature_Bin_Midpoint	Float_32	K	150.0...320.0	28	112
Cloud_Top_Temperature_Bin_Boundaries	Float_32	K	150.0...320.0	29	116
Cloud_Top_Pressure_Bin_Midpoint	Float_32	hPa	100.0...1,100.0	10	40
Cloud_Top_Pressure_Bin_Boundaries	Float_32	hPa	100.0...1,100.0	11	44
Cloud_Top_Altitude_Bin_Midpoint	Float_32	km	0.0...20.0	40	160
Cloud_Top_Altitude_Bin_Boundaries	Float_32	km	0.0...20.0	41	164
Record Size (bytes)					804

Table 148: Cloud Amount

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Cloud_Amount_Mean_TopLayer ^A	Float_32	NoUnits	0.0...1.0	1	4
Cloud_Amount_Histogram_TopLayer ^A	Int_32	NoUnits	0...2,147,483,647	10	40
High_Cloud_Amount_Mean_TopLayer ^A	Float_32	NoUnits	0.0...1.0	1	4
High_Cloud_Amount_Ratio_TopLayer ^A	Float_32	%	0.0...100.0	1	4
Middle_Cloud_Amount_Mean_TopLayer ^A	Float_32	NoUnits	0.0...1.0	1	4
Middle_Cloud_Amount_Ratio_TopLayer ^A	Float_32	%	0.0...100.0	1	4
Low_Cloud_Amount_Mean_TopLayer ^A	Float_32	NoUnits	0.0...1.0	1	4
Low_Cloud_Amount_Ratio_TopLayer ^A	Float_32	%	0.0...100.0	1	4
Ice_Cloud_Amount_Mean_TopLayer ^A	Float_32	NoUnits	0.0...1.0	1	4
Ice_Cloud_Amount_Ratio_TopLayer ^A	Float_32	%	0.0...100.0	1	4
Water_Cloud_Amount_Mean_TopLayer ^A	Float_32	NoUnits	0.0...1.0	1	4
Water_Cloud_Amount_Ratio_TopLayer ^A	Float_32	%	0.0...100.0	1	4
High_Ice_Cloud_Amount_Mean_TopLayer ^A	Float_32	NoUnits	0.0...1.0	1	4
High_Ice_Cloud_Amount_Ratio_TopLayer ^A	Float_32	%	0.0...100.0	1	4
Cloud_Amount_Mean_Passive ^B	Float_32	NoUnits	0.0...1.0	1	4
Cloud_Amount_Histogram_Passive ^B	Int_32	NoUnits	0...2,147,483,647	10	40
High_Cloud_Amount_Mean_Passive ^B	Float_32	NoUnits	0.0...1.0	1	4
High_Cloud_Amount_Ratio_Passive ^B	Float_32	%	0.0...100.0	1	4
Middle_Cloud_Amount_Mean_Passive ^B	Float_32	NoUnits	0.0...1.0	1	4
Middle_Cloud_Amount_Ratio_Passive ^B	Float_32	%	0.0...100.0	1	4
Low_Cloud_Amount_Mean_Passive ^B	Float_32	NoUnits	0.0...1.0	1	4
Low_Cloud_Amount_Ratio_Passive ^B	Float_32	%	0.0...100.0	1	4
Ice_Cloud_Amount_Mean_Passive ^B	Float_32	NoUnits	0.0...1.0	1	4
Ice_Cloud_Amount_Ratio_Passive ^B	Float_32	%	0.0...100.0	1	4
Water_Cloud_Amount_Mean_Passive ^B	Float_32	NoUnits	0.0...1.0	1	4
Water_Cloud_Amount_Ratio_Passive ^B	Float_32	%	0.0...100.0	1	4
High_Ice_Cloud_Amount_Mean_Passive ^B	Float_32	NoUnits	0.0...1.0	1	4
High_Ice_Cloud_Amount_Ratio_Passive ^B	Float_32	%	0.0...100.0	1	4
Cloud_Amount_Mean_Column ^C	Float_32	NoUnits	0.0...1.0	1	4
Cloud_Amount_Histogram_Column ^C	Int_32	NoUnits	0...2,147,483,647	10	40
High_Cloud_Amount_Mean_Column ^C	Float_32	NoUnits	0.0...1.0	1	4
High_Cloud_Amount_Ratio_Column ^C	Float_32	%	0.0...100.0	1	4
Middle_Cloud_Amount_Mean_Column ^C	Float_32	NoUnits	0.0...1.0	1	4
Middle_Cloud_Amount_Ratio_Column ^C	Float_32	%	0.0...100.0	1	4
Low_Cloud_Amount_Mean_Column ^C	Float_32	NoUnits	0.0...1.0	1	4
Low_Cloud_Amount_Ratio_Column ^C	Float_32	%	0.0...100.0	1	4
Ice_Cloud_Amount_Mean_Column ^C	Float_32	NoUnits	0.0...1.0	1	4
Ice_Cloud_Amount_Ratio_Column ^C	Float_32	%	0.0...100.0	1	4
Water_Cloud_Amount_Mean_Column ^C	Float_32	NoUnits	0.0...1.0	1	4
Water_Cloud_Amount_Ratio_Column ^C	Float_32	%	0.0...100.0	1	4
High_Ice_Cloud_Amount_Mean_Column ^C	Float_32	NoUnits	0.0...1.0	1	4
High_Ice_Cloud_Amount_Ratio_Column ^C	Float_32	%	0.0...100.0	1	4
Cloud_Amount_Mean_Opaque ^D	Float_32	NoUnits	0.0...1.0	1	4
Cloud_Amount_Histogram_Opaque ^D	Int_32	NoUnits	0...2,147,483,647	10	40
High_Cloud_Amount_Mean_Opaque ^D	Float_32	NoUnits	0.0...1.0	1	4
High_Cloud_Amount_Ratio_Opaque ^D	Float_32	%	0.0...100.0	1	4

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Middle_Cloud_Amount_Mean_Opaque ^D	Float_32	NoUnits	0.0...1.0	1	4
Middle_Cloud_Amount_Ratio_Opaque ^D	Float_32	%	0.0...100.0	1	4
Low_Cloud_Amount_Mean_Opaque ^D	Float_32	NoUnits	0.0...1.0	1	4
Low_Cloud_Amount_Ratio_Opaque ^D	Float_32	%	0.0...100.0	1	4
Ice_Cloud_Amount_Mean_Opaque ^D	Float_32	NoUnits	0.0...1.0	1	4
Ice_Cloud_Amount_Ratio_Opaque ^D	Float_32	%	0.0...100.0	1	4
Water_Cloud_Amount_Mean_Opaque ^D	Float_32	NoUnits	0.0...1.0	1	4
Water_Cloud_Amount_Ratio_Opaque ^D	Float_32	%	0.0...100.0	1	4
High_Ice_Cloud_Amount_Mean_Opaque ^D	Float_32	NoUnits	0.0...1.0	1	4
High_Ice_Cloud_Amount_Ratio_Opaque ^D	Float_32	%	0.0...100.0	1	4
Record Size (bytes)					368

- A) Contained in Cloud_Amount_Top_Layer Vgroup
- B) Contained in Cloud_Amount_Passive Vgroup
- C) Contained in Cloud_Amount_Column Vgroup
- D) Contained in Cloud_Amount_Opaque Vgroup

Table 149: Cloud Top Temperature, Pressure, and Height

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Cloud_Top_Temperature_Mean_TopLayer ^A	Float_32	K	150.0...320.0	1	4
Cloud_Top_Temperature_Histogram_TopLayer ^A	Int_32	NoUnits	0...2,147,483,647	28	112
High_Cloud_Top_Temperature_Mean_TopLayer ^A	Float_32	K	150.0...320.0	1	4
High_Cloud_Top_Temperature_Histogram_TopLayer ^A	Int_32	NoUnits	0...2,147,483,647	28	112
Middle_Cloud_Top_Temperature_Mean_TopLayer ^A	Float_32	K	150.0...320.0	1	4
Middle_Cloud_Top_Temperature_Histogram_TopLayer ^A	Int_32	NoUnits	0...2,147,483,647	28	112
Low_Cloud_Top_Temperature_Mean_TopLayer ^A	Float_32	K	150.0...320.0	1	4
Low_Cloud_Top_Temperature_Histogram_TopLayer ^A	Int_32	NoUnits	0...2,147,483,647	28	112
Ice_Cloud_Top_Temperature_Mean_TopLayer ^A	Float_32	K	150.0...320.0	1	4
Ice_Cloud_Top_Temperature_Histogram_TopLayer ^A	Int_32	NoUnits	0...2,147,483,647	28	112
Water_Cloud_Top_Temperature_Mean_TopLayer ^A	Float_32	K	150.0...320.0	1	4
Water_Cloud_Top_Temperature_Histogram_TopLayer ^A	Int_32	NoUnits	0...2,147,483,647	28	112
High_Ice_Cloud_Top_Temperature_Mean_TopLayer ^A	Float_32	K	150.0...320.0	1	4
High_Ice_Cloud_Top_Temperature_Histogram_TopLayer ^A	Int_32	NoUnits	0...2,147,483,647	28	112
Cloud_Top_Temperature_Mean_Passive ^B	Float_32	K	150.0...320.0	1	4
Cloud_Top_Temperature_Histogram_Passive ^B	Int_32	NoUnits	0...2,147,483,647	28	112
High_Cloud_Top_Temperature_Mean_Passive ^B	Float_32	K	150.0...320.0	1	4
High_Cloud_Top_Temperature_Histogram_Passive ^B	Int_32	NoUnits	0...2,147,483,647	28	112
Middle_Cloud_Top_Temperature_Mean_Passive ^B	Float_32	K	150.0...320.0	1	4
Middle_Cloud_Top_Temperature_Histogram_Passive ^B	Int_32	NoUnits	0...2,147,483,647	28	112
Low_Cloud_Top_Temperature_Mean_Passive ^B	Float_32	K	150.0...320.0	1	4
Low_Cloud_Top_Temperature_Histogram_Passive ^B	Int_32	NoUnits	0...2,147,483,647	28	112
Ice_Cloud_Top_Temperature_Mean_Passive ^B	Float_32	K	150.0...320.0	1	4
Ice_Cloud_Top_Temperature_Histogram_Passive ^B	Int_32	NoUnits	0...2,147,483,647	28	112
Water_Cloud_Top_Temperature_Mean_Passive ^B	Float_32	K	150.0...320.0	1	4
Water_Cloud_Top_Temperature_Histogram_Passive ^B	Int_32	NoUnits	0...2,147,483,647	28	112
High_Ice_Cloud_Top_Temperature_Mean_Passive ^B	Float_32	K	150.0...320.0	1	4
High_Ice_Cloud_Top_Temperature_Histogram_Passive ^B	Int_32	NoUnits	0...2,147,483,647	28	112
Cloud_Top_Pressure_Mean_TopLayer ^C	Float_32	hPa	100.0...1,100.0	1	4
Cloud_Top_Pressure_Histogram_TopLayer ^C	Int_32	NoUnits	0...2,147,483,647	10	40
Cloud_Top_Pressure_Mean_Passive ^D	Float_32	hPa	100.0...1,100.0	1	4
Cloud_Top_Pressure_Histogram_Passive ^D	Int_32	NoUnits	0...2,147,483,647	10	40
Cloud_Top_Altitude_Mean_TopLayer ^E	Float_32	km	0.0...20.0	1	4
Cloud_Top_Altitude_Histogram_TopLayer ^E	Int_32	NoUnits	0...2,147,483,647	40	160
Cloud_Top_Altitude_Mean_Passive ^F	Float_32	km	0.0...20.0	1	4
Cloud_Top_Altitude_Histogram_Passive ^F	Int_32	NoUnits	0...2,147,483,647	40	160
Record Size (bytes)					2,040

- A) Contained in Cloud_Top_Temperature_TopLayer Vgroup
- B) Contained in Cloud_Top_Temperature_Passive Vgroup
- C) Contained in Cloud_Top_Pressure_TopLayer Vgroup
- D) Contained in Cloud_Top_Pressure_Passive Vgroup
- E) Contained in Cloud_Top_Altitude_TopLayer Vgroup
- F) Contained in Cloud_Top_Altitude_Passive Vgroup

2.24 IIR Level 3 GEWEX Cloud Data Product DP 3.6

The IIR Level 3 (L3) Global Energy and Water cycle Experiment (GEWEX) Cloud Product reports global distributions of IIR cloud effective radius and water path averages and histograms on a uniform 2-dimensional (2D) spatial grid. This product is designed to follow the general guidance of the GEWEX Cloud Assessment. Cloud amount, radiative temperature, effective emissivity, and optical depth characterize the cloud samples for which IIR microphysical retrievals are reported. Cloud properties are reported for ice clouds, liquid water clouds, and for high ice clouds of layer pressure lower than 440 hPa. All level 3 parameters are derived from the IIR level 2 track products, with a temporal averaging of one month.

Though the averages and histograms are the same as in the IIR CALIPSO-ST cloud product provided to the [GEWEX project](#), the data structure is slightly different. Instead of reporting each cloud property as yearly files, this product includes all cloud properties as monthly files. And the product is represented as Hierarchical Data Format (HDF) 4 format instead of Network Common Data Form (netCDF) 4 format. The changes are made to keep consistency with other current level 3 CALIPSO cloud and aerosol products.

The major categories of the IIR Level 3 GEWEX Cloud Product are:

- Cloud amount averages
- Cloud radiative temperature averages and histograms
- Cloud effective emissivity averages and histograms
- Cloud effective radius averages and histograms
- Cloud water path averages and histograms
- Cloud optical depth averages and histograms

Level:	3
Version:	2.00
Type:	Archival
Frequency:	3 files per month
Missing Value:	-9999.0
Record Temporal Coverage:	daytime, nighttime, all
Record Spatial Coverage:	horizontal: 360° longitude (180°W to 180°E) 180° latitude (90°N to 90°S)
Record Spatial Resolution:	horizontal: 1.0 ° longitude by 1.0° latitude

Data File Name:
Standard: CAL_IIR_L3_GEWEX_Cloud-ProductionStrategy-Version.Instance.hdf

2.24.1 IIR Level 3 GEWEX Cloud Data Product Summary DP 3.6

Table 150: IIR Level 3 GEWEX Cloud Data Product Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core & Archive Metadata Record	Appendix A – CALIPSO Metadata	903	1	903
IIR Level 3 GEWEX Cloud Data Product Metadata	Table 151	65,100	1	65,100
Spatial Coordinates	Table 152	2,160	1	2,160
Over-flight Parameter	Table 153	2	64,800	129,600
Histogram Bin Boundaries	Table 154	1,144	1	1,144
Cloud Amount	Table 155	20	64,800	1,296,000
Cloud Radiative Temperature	Table 156	348	64,800	22,550,400
Cloud Effective Emissivity	Table 157	72	64,800	4,665,600
Cloud Effective Radius	Table 158	340	64,800	22,032,000
Cloud Water Path	Table 159	276	64,800	17,884,800
Cloud Optical Depth	Table 160	700	64,800	45,360,000
Total Size (bytes)				113,987,707
Total Size (Mbytes)				111.316

2.24.2 IIR Level 3 GEWEX Cloud Data Product Metadata

Table 151: IIR Level 3 GEWEX Cloud Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	CAL_IIR_L3_GEWEX_Cloud	80	80
Date_Time_of_Production	Char	NoUnits	4/2006 – 10/2025	20	20
Nominal_Year_Month	Char	NoUnits	N/A	6	6
Day_Night_Flag	Char	NoUnits	D = daytime N = nighttime A = all	2	2
Program_Configuration	Char	NoUnits	N/A	5,000	5,000
Number_of_Level2_Files_Analyzed	UInt_16	NoUnits	0...900	1	2
List_of_Input_Files	Char	NoUnits	N/A	60,000	60,000
Total Size (bytes)					65,110

2.24.3 IIR Level 3 GEWEX Cloud Data Product Scientific Data Sets

Tables below summarize the contents of each scientific data set (SDS) contained within the CALIPSO IIR Level 3 GEWEX Cloud Product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values. provides a detailed comparison between the variables in this product and the corresponding parameter names in the GEWEX Cloud Assessment Database.

Table 152: Spatial Coordinates

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Longitude_Midpoint	Float_32	degrees_east	-180.0...180.0	360	1,440
Latitude_Midpoint	Float_32	degrees_north	-90.0...90.0	180	720
Total Size (bytes)					2,160

Table 153: Over-Flight Parameter

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Of_Orbit_Tracks	Int_16	NoUnits	0...900	1	2
Total Size Per Record (bytes)					2
Total Size (bytes)					129,600

Table 154: Histogram Bin Boundaries

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Cloud_Radiative_Temperature_Bin_Midpoint	Float_32	K	165.0...315.0	28	112
Cloud_Radiative_Temperature_Bin_Boundaries	Float_32	K	150.0...320.0	29	116
Cloud_Effective_Emissivity_12_05_Bin_Midpoint	Float_32	NoUnits	0.1...0.975	5	20
Cloud_Effective_Emissivity_12_05_Bin_Boundaries	Float_32	NoUnits	0.0...1.0	6	24
Ice_Cloud_Effective_Radius_Bin_Midpoint	Float_32	µm	1.0...175.0	31	124
Ice_Cloud_Effective_Radius_Bin_Boundaries	Float_32	µm	0.0...200.0	32	128
Water_Cloud_Effective_Radius_Bin_Midpoint	Float_32	µm	1.0...55.0	20	80
Water_Cloud_Effective_Radius_Bin_Boundaries	Float_32	µm	0.0...60.0	21	84
Cloud_Water_Path_Bin_Midpoint	Float_32	g/m ²	2.5...4000.0	22	88
Cloud_Water_Path_Bin_Boundaries	Float_32	g/m ²	0.0...5000.0	23	92
Cloud_Optical_Depth_Bin_Midpoint	Float_32	NoUnits	0.05...400.0	34	136
Cloud_Optical_Depth_Bin_Boundaries	Float_32	NoUnits	0.0...500.0	35	140
Total Size (bytes)					1,144

Table 155: Cloud Amount

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Of_Valid_Pixels_IIR	Int_16	NoUnits	0...32,767	1	2
Number_Of_LEM_Rejected_Pixels_IIR	Int_16	NoUnits	0...32,767	1	2
Number_Of_Candidate_Clouds_IIR	Int_16	NoUnits	0...32,767	1	2
Cloud_Amount_Mean_IIR	Float_32	NoUnits	0.0...1.0	1	4
Ice_Cloud_Amount_Mean_IIR	Float_32	NoUnits	0.0...1.0	1	4
Water_Cloud_Amount_Mean_IIR	Float_32	NoUnits	0.0...1.0	1	4
High_Ice_Cloud_Amount_Mean_IIR	Float_32	NoUnits	0.0...1.0	1	4
Total Size (bytes)					20

Table 156: Cloud Radiative Temperature

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Ice_Cloud_Radiative_Temperature_Mean_IIR	Float_32	K	150.0...320.0	1	4
Ice_Cloud_Radiative_Temperature_Histogram_IIR	Int_32	NoUnits	0...18,043,200	28	112
Water_Cloud_Radiative_Temperature_Mean_IIR	Float_32	K	150.0...320.0	1	4
Water_Cloud_Radiative_Temperature_Histogram_IIR	Int_32	NoUnits	0...18,043,200	28	112
High_Ice_Cloud_Radiative_Temperature_Mean_IIR	Float_32	K	150.0...320.0	1	4
High_Ice_Cloud_Radiative_Temperature_Histogram_IIR	Int_32	NoUnits	0...18,043,200	28	112
Total Size (bytes)					348

Table 157: Cloud Effective Emissivity

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Ice_Cloud_Effective_Emissivity_12_05_Mean_IIR	Float_32	NoUnits	0.0...1.0	1	4
Ice_Cloud_Effective_Emissivity_12_05_Histogram_IIR	Int_32	NoUnits	0...18,043,200	5	20
Water_Cloud_Effective_Emissivity_12_05_Mean_IIR	Float_32	NoUnits	0.0...1.0	1	4
Water_Cloud_Effective_Emissivity_12_05_Histogram_IIR	Int_32	NoUnits	0...18,043,200	5	20
High_Ice_Cloud_Effective_Emissivity_12_05_Mean_IIR	Float_32	NoUnits	0.0...1.0	1	4
High_Ice_Cloud_Effective_Emissivity_12_05_Histogram_IIR	Int_32	NoUnits	0...18,043,200	5	20
Total Size (bytes)					72

Table 158: Cloud Effective Radius

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Ice_Cloud_Effective_Radius_Mean_IIR	Float_32	μm	0.0...200.0	1	4
Ice_Cloud_Effective_Radius_Histogram_IIR	Int_32	NoUnits	0...18,043,200	31	124
Water_Cloud_Effective_Radius_Mean_IIR	Float_32	μm	0.0...60.0	1	4
Water_Cloud_Effective_Radius_Histogram_IIR	Int_32	NoUnits	0...18,043,200	20	80
High_Ice_Cloud_Effective_Radius_Mean_IIR	Float_32	μm	0.0...200.0	1	4
High_Ice_Cloud_Effective_Radius_Histogram_IIR	Int_32	NoUnits	0...18,043,200	31	124
Total Size (bytes)					340

Table 159: Cloud Water Path

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Ice_Water_Path_Mean_IIR	Float_32	g/m ²	0.0...3000.0	1	4
Ice_Water_Path_Histogram_IIR	Int_32	NoUnits	0...18,043,200	22	88
Liquid_Water_Path_Mean_IIR	Float_32	g/m ²	0.0...3000.0	1	4
Liquid_Water_Path_Histogram_IIR	Int_32	NoUnits	0...18,043,200	22	88
High_Ice_Water_Path_Mean_IIR	Float_32	g/m ²	0.0...3000.0	1	4
High_Ice_Water_Path_Histogram_IIR	Int_32	NoUnits	0...18,043,200	22	88
Total Size (bytes)					276

Table 160: Cloud Optical Depth

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Ice_Cloud_Optical_Depth_Mean_IIR	Float_32	NoUnits	0.0...400.0	1	4
Ice_Cloud_Optical_Depth_Histogram_IIR	Int_32	NoUnits	0...18,043,200	34	136
Water_Cloud_Optical_Depth_Mean_IIR	Float_32	NoUnits	0.0...400.0	1	4
Water_Cloud_Optical_Depth_Histogram_IIR	Int_32	NoUnits	0...18,043,200	34	136
High_Ice_Cloud_Optical_Depth_Mean_IIR	Float_32	NoUnits	0.0...400.0	1	4
High_Ice_Cloud_Optical_Depth_Histogram_IIR	Int_32	NoUnits	0...18,043,200	34	136
Ice_Cloud_Optical_Depth_Mean_LIDAR	Float_32	NoUnits	0.0...400.0	1	4
Ice_Cloud_Optical_Depth_Histogram_LIDAR	Int_32	NoUnits	0...18,043,200	34	136
High_Ice_Cloud_Optical_Depth_Mean_LIDAR	Float_32	NoUnits	0.0...400.0	1	4
High_Ice_Cloud_Optical_Depth_Histogram_LIDAR	Int_32	NoUnits	0...18,043,200	34	136
Total Size (bytes)					700

3.0 Level 0 Input Data Products

This section briefly summarizes the level 0 input data products used to generate the data products noted in this products catalog. Figure 2 lists all of the level 0 data provided to NASA LaRC ASDC from the Swedish Space Corporation (SSC), previously United Space Network (USN), by way of the Payload Data Delivery System (PDDS). Raw data (data transmitted from satellite to ground system in CCSDS format) is downlinked from the CALIPSO spacecraft, and the PDDS generates level 0 files reconstructed from the raw data. Frames of raw data are error checked, time ordered and segregated into differing level 0 files based on the content. These level 0 files are then provided to NASA LaRC ASDC via secure transfer and picked up by the CALIPSO data processing.

Figure 2 lists all of the potential level 0 files that are provided by the PDDS, with only a subset used by routine science generation. The APIDPktID column corresponds to the packet ID set aside for each product as defined in DRD-14.

These level 0 data products are not publicly orderable, but as described in other sections there is a public version of the Lidar Level 0 product and the Lidar Level 0 PIVB product.

Description	APIDPktID	File Descriptor
Lidar IHSD	APID1001	CALIPSO/Lidar_01_LZ
Lidar 532P Normal mode	APID1002	CALIPSO/Lidar_02_LZ
Lidar 532S Normal mode	APID1003	CALIPSO/Lidar_03_LZ
Lidar 1064 Normal mode	APID1004	CALIPSO/Lidar_04_LZ
Lidar 532P Atmospheric mode	APID1005	CALIPSO/Lidar_05_LZ
Lidar 532S Atmospheric mode	APID1006	CALIPSO/Lidar_06_LZ
Lidar 1064 Atmospheric mode	APID1007	CALIPSO/Lidar_07_LZ
Lidar 532P PIVB Raw Shot Data	APID1008	CALIPSO/Lidar_08_LZ
Lidar 532S PIVB Raw Shot Data	APID1009	CALIPSO/Lidar_09_LZ
Lidar 1064 PIVB Raw Shot Data	APID1010	CALIPSO/Lidar_10_LZ
Lidar 532P PIVB Post-Processed Data – Normal	APID1011	CALIPSO/Lidar_11_LZ
Lidar 532S PIVB Post-Processed Data – Normal	APID1012	CALIPSO/Lidar_12_LZ
Lidar 1064 PIVB Post-Processed Data – Normal	APID1013	CALIPSO/Lidar_13_LZ
Lidar 532P PIVB Post-Processed Data – Atmospheric Test	APID1014	CALIPSO/Lidar_14_LZ
Lidar 532S PIVB Post-Processed Data – Atmospheric Test	APID1015	CALIPSO/Lidar_15_LZ
Lidar 1064 PIVB Post-Processed Data – Atmospheric Test	APID1016	CALIPSO/Lidar_16_LZ
Lidar Report Config	APID1017	CALIPSO/Lidar_17_LZ
Lidar LTS Passthrough Response	APID1018	CALIPSO/Lidar_18_LZ
Lidar LRE Passthrough Response	APID1019	CALIPSO/Lidar_19_LZ
Geode User State Telemetry	APID1103	CALIPSO/Geode_03_LZ
Geode Covariance Telemetry	APID1104	CALIPSO/Geode_04_LZ
Geode Residuals Telemetry	APID1105	CALIPSO/Geode_05_LZ
Geode Location Solution Telemetry	APID1106	CALIPSO/Geode_06_LZ
Geode Real-time Telemetry	APID1107	CALIPSO/Geode_07_LZ
WFC Normal	APID1201	CALIPSO/WFC_01_LZ
WFC PIVB Raw Data	APID1202	CALIPSO/WFC_02_LZ
WFC PIVB Post Processed	APID1203	CALIPSO/WFC_03_LZ
WFC Raw Data	APID1204	CALIPSO/WFC_04_LZ
IIR Normal	APID1301	CALIPSO/IIR_01_LZ
Ancillary Time Bulletin	APID1801	CALIPSO/AttEph01_LZ
Ancillary GPS Bulletin	APID1802	CALIPSO/AttEph02_LZ
Ancillary Attitude Bulletin	APID1803	CALIPSO/AttEph03_LZ
PHSD Operate Image Packet	APID2402	CALIPSO/HouseKpg_LZ
Payload Event Packet	APID2501	CALIPSO/HouseK02_LZ
Payload Event Packet	APID2501	CALIPSO/HouseK03_LZ
POST_PROCESSED_EPHEMERIS	EPH>APID1802	CALIPSO/POST_PROCESSED_EPHEMERIS

Figure 2: Overview of CALIPSO Level 0 data files.

3.1 Lidar Level 0 Data

The Lidar Level 0 data set contains profiles for the 532 nm parallel, 532 nm perpendicular, and 1064 nm channels, along with selected instrument health and status information. To reduce the telemetry data rate, the lidar instrument performs significant processing prior to data downlink. On-orbit, the instrument performs profile vertical and horizontal averaging, as well as altitude registration to a fixed grid above local mean sea level. Current profile averaging parameters and spatial resolutions are based on a laser pulse repetition frequency of 20.16 Hz. Averaging parameters are not expected to change during normal on-orbit operations. The lidar frame consists of data averaged from 15 lidar shots with the instantaneous field of view for each shot occurring every 333 m along track.

Table 161: On-orbit Lidar Profile Horizontal and Vertical Averaging for 532 nm

Level	Altitude (km)	Shots Aver.	Horiz Res (km)	Vert Res (m)	Samples per Profile	Profiles per Frame	Samples per Frame
Upper Stratosphere	30.1 - 40.0	15	5.0	300	33	1	33
Lower Stratosphere	20.2 - 30.1	5	1.667	180	55	3	165
Upper Troposphere	8.2 - 20.2	3	1	60	200	5	1,000
Lower Troposphere	-0.5 - 8.2	1	0.333	30	290	15	4,350
Subsurface	-2.0 - -0.5	1	0.333	300	5	15	75
Total					583		5,623

Table 162: On-orbit Lidar Profile Horizontal and Vertical Averaging for 1064 nm

Level	Altitude (km)	Shots Aver.	Horiz Res (km)	Vert Res (m)	Samples per Profile	Profiles per Frame	Samples per Frame
Upper Stratosphere	30.1 - 40.0	N/A	N/A	N/A	N/A	N/A	N/A
Lower Stratosphere	20.2 - 30.1	5	1.667	180	55	3	165
Upper Troposphere	8.2 - 20.2	3	1	60	200	5	1,000
Lower Troposphere	-0.5 - 8.2	1	0.333	60	145	15	2,175
Subsurface	-2.0 - -0.5	1	0.333	300	5	15	75
Total					405		3,415

3.2 Imaging Infrared Radiometer Level 0 Data

The Imaging Infrared Radiometer (IIR) Level 0 data set provides radiance counts at 8.65 μm , 10.6 μm and 12.05 μm . The IIR samples 64 km x 64 km images for each channel, every 8.15 seconds. Each IFOV is approximately 1 km x 1 km at the Earth's surface. On-orbit calibration is performed using the black body and deep space references. Each sequence contains three Earth images (one per channel) followed by either three black body or cold space images.

3.3 Wide Field Camera Level 0 Data

The Wide Field Camera (WFC) Level 0 data set consists of high spatial resolution imagery data used to ascertain cloud homogeneity over the footprint of the Lidar/IIR, aid cloud clearing, and provide overall meteorological context. The WFC is a digital camera that collects imagery in the 620 nm to 670 nm wavelength range during daylight segments of the orbit. The WFC views a 61 km wide swath centered on the lidar boresight. The IFOV of each pixel is approximately 125 m at the Earth's surface. The WFC acquires data at a rate of 0.28 frames per second. On-board processing bins pixels outside the central 5 km cross track swath to give an IFOV of 1 km, thus reducing the downlinked data rate.

4.0 Ancillary Input Data Products

This section describes a number of ancillary data products required by the CALIPSO science processing algorithms.

4.1 Ephemeris Data

CNES was the primary source of post-processed ephemeris data used in geolocation. The post-processed ephemeris data are received from the CALIPSO Mission Operations Control Center (MOCC) via an ASDC ingest system.

The CALIPSO project relies on the EOSDIS Core System (ECS) Toolkit to run geolocation routines and libraries.

Appendix L of the Toolkit Users Guides (ECS 333-CD-500-001) specifies the require spacecraft ephemeris data contents and structures. Appendix L also specifies time standards, reference coordinate systems for both ephemeris and orbital elements, and orbit numbering.

The Terra Spacecraft Ephemeris and Attitude Data Preprocessing (184-TP-001-002) shows an example, used by CALIPSO, to reformat the Terra spacecraft ephemeris data into a compatible Toolkit format.

The DMS data subsystem DPREP 0.2 converts the CNES provided ephemeris into the compatible Toolkit format. The DPREP 0.2 algorithm was built specifically to handle the CNES data.

4.2 Attitude Data

SSC was the primary source of the attitude data used in geolocation.

Appendix L of the Toolkit Users Guide (ECS 333-CD-500-001) specifies the EOSDIS spacecraft attitude data contents and structure. Appendix L specifies time standards, reference coordinate systems for both ephemeris and orbital elements, and orbit numbering.

The Terra Spacecraft Ephemeris and Attitude Data Preprocessing (184-TP-001-002) shows an example, used by CALIPSO, to reformat the Terra spacecraft attitude data into a compatible Toolkit format.

The DMS data subsystem DPREP 0.1 converts the PDDS provided attitude data into the compatible Toolkit format. The DPREP 0.1 algorithm was based on DPREP code developed for the CERES project.

4.3 Meteorological Parameters

NASA's Global Modeling and Assimilation Office (GMAO) was the primary source of meteorological data used for the CALIPSO data processing.

Older versions of the CALIPSO data products relied on spatially subsetted versions of the GEOS 5 FP-IT (Forward Processing for Instrument Teams) data products, which were built specifically for the CALIPSO project and pushed to NASA LaRC ASDC.

- DFPITI3NXASMCAL was a global, gridded product providing 2D assimilated fields.
- DFPITI3NVASMCAL was a global, gridded product providing 3D assimilated fields.

All final versions of the CALIPSO data products use MERRA-2 (Modern-Era Retrospective analysis for Research and Applications) data products ([Gelaro et al., 2017](#)). The choice of replacing FP-IT with MERRA-2 was to make use of the MERRA-2 assimilation of temperature measurements from the Microwave Limb Sensor (MLS) on the NASA Aura satellite, yielding improved calibration coefficients.

These are publicly orderable data products that were pulled by the NASA LaRC ASDC.

- inst1_2d_asm_Nx was a global, gridded product providing 2D assimilated fields.
- inst3_3d_asm_Nv is a global, gridded product providing 3D assimilated fields.

4.4 Digital Elevation Model

CALIPSO data products rely on a digital elevation model (DEM) built and provided by the CloudSat team (Tanelli et al., 2014). Previous versions, since the start of the CALIPSO mission, relied on the GTOPO30 DEM. It had been shown that GTOPO30 contained a number of inaccuracies in elevation over mountainous areas and Greenland that were corrected by using the CloudSat DEM. Use of this new DEM not only improved these noted differences but complemented improvements to the surface detection techniques carried out over the course of the mission and also allowed both missions to have a common surface reference.

4.5 Surface Typing

The U.S. Geological Survey's (USGS) Earth Resources Observation System (EROS) Data Center, the University of Nebraska-Lincoln (UNL), and the Joint Research Centre of the European Commission generated a 1 km resolution global land cover characteristics data base for use in a wide range of environmental research and modeling applications ([Loveland et al., 2000](#)). The land cover characterization effort was part of the International Geosphere-Biosphere Programme-Data and Information System activity. From this effort, a global 1 km resolution Surface Type map was produced by the IGBP. The data set is derived from 1 km Advanced Very High Resolution Radiometer (AVHRR) data spanning a 12 month period (April 1992 - March 1993). See the paper, "International Geosphere Biosphere Programme Land Cover Classification" (Belward, 1996) for more information.

The static map used by CALIPSO was provided by the CERES Surface and Atmospheric Radiation Budget (SARB) working group at NASA LaRC. The map was built using the 1 km IGBP scene types supplied by the USGS and is provided as a 10' equal angle map (1080 x 2160 elements). An 18th scene type (tundra) is added to distinguish the rocky/barren scene of northern climes vs. that of other deserts. Interpretation of each of the surface type values are seen in Table 163. Interpretation of the land/water mask, as seen in Table 164, is derived from the IGBP and DEM.

Table 163: Interpretation of the IGBP Surface Type Values

Value	Surface Type
1	Evergreen-Needleleaf-Forest
2	Evergreen-Broadleaf-Forest
3	Deciduous-Needleleaf-Forest
4	Deciduous-Broadleaf-Forest
5	Mixed-Forest

Value	Surface Type
6	Closed-Shrubland
7	Open-Shrubland (Desert)
8	Woody-Savanna
9	Savanna
10	Grassland
11	Wetland
12	Cropland
13	Urban
14	Crop-Mosaic
15	Permanent-Snow
16	Barren/Desert
17	Water
18	Tundra

Table 164: Interpretation of Land Water Mask

Value	Surface Type
0	shallow ocean
1	Land
2	Coastlines
3	shallow inland water
4	intermittent water
5	deep inland water
6	continental water
7	deep ocean

4.6 Snow and Ice Map

The Air Force Weather Agency's (AFWA) snow depth analysis model (SNODEP) is responsible for generating daily global snow depth and snow age analyses. The operational SNODEP model uses snow depth reports from synoptic observations combined with Defense Meteorological Satellite Program (DMSP) Special Sensor Microwave/Imager (SSM/I) Passive Microwave (PM) data and climatology to generate a global analysis of snow depth and snow age. Snow extent and sea ice concentration maps are provided on a 25km azimuthal, equal-area projection. The AFWA product is available within approximately one to two days of the satellite overpass. The CERES Data Processing Team re-maps the data onto a 10-minute equal-area grid into separate snow (CERES_ESNOW) and ice (CERES_EICE) data sets, which are then merged by CALIPSO into the Snow_Ice_Surface_Type SDS.

Values between 0 and 100 represent the percentage of ice within a pixel having a nominal resolution of 25 km². Pixels with permanent ice are assigned a value of 101. A value of 103 indicates pixels containing snow. 255 indicates mixed type/uncertain type pixels at coastlines. Earlier versions of the CALIPSO data products used information obtained from the [National Snow and Ice Data Center \(NSIDC\)](#).

Appendix A – CALIPSO Metadata

This section describes the metadata that are written to all CALIPSO HDF products. The table below describes the Core metadata record that is written to both the HDF and the ASCII file for the ASDC to be used to identify output science data products. The table lists the item number, parameter names, the units, range or allowable values, the data type and the maximum number of elem/record. The parameter data type is a string of x characters. Archive metadata adds an additional 4 bytes (903 bytes).

Table 165: Core Metadata Record Vdata

Item	Parameter Name	Data Type	Unit	Nominal Range	Max Number of Elements	Number of records	Bytes
1	GRANULEID	Char	NoUnits	N/A	80	1	80
2	GRANULENAME	Char	NoUnits	N/A	80	1	80
3	GRANULEVERSION	Char	NoUnits	N/A	80	1	80
4	DAYNIGHT	Char	NoUnits	“D”, “N”, or “B”	1	1	1
5	BROWSE	Char	NoUnits	“Y” or “N”	1	1	1
6	GRINGTYPE	Char	NoUnits	“R” or “S”	1	1	1
7	METADATANAME	Char	NoUnits	N/A	80	1	80
8	PRODUCTIONDATETIME	Char	NoUnits	4/2006 – 10/2025	20	1	20
9	START_DATE	Char	NoUnits	4/2006 – 7/2023	27	1	27
10	STOP_DATE	Char	NoUnits	4/2006 – 7/2023	27	1	27
11	QAFLAG	Char	NoUnits	“Passed” or “Failed”	6	1	6
12	QAEXPLANATION	Char	NoUnits	N/A	80	1	80
13	MINLAT	Float_32	deg	-90.0...90.0	4	1	16
14	MINLON	Float_32	deg	-180.0...180.0	4	1	16
15	MAXLAT	Float_32	deg	-90.0...90.0	4	1	16
16	MAXLON	Float_32	deg	-180.0...180.0	4	1	16
17	GRINGLATITUDE	Float_64	deg	-90.0...90.0	21	1	162
18	GRINGLONGITUDE	Float_64	deg	-180.0...180.0	21	1	162
19	STARTORBITNUMBER	UInt_32	NoUnits	1...2 ³² -1	1	1	4
20	STOPORBITNUMBER	UInt_32	NoUnits	1...2 ³² -1	1	1	4
21	ORBITCHANGETIME	Float_64	NoUnits	60,426.0...261,231.0	1	1	8
22	STARTPATHNUMBER	Int_16	NoUnits	1...233	1	1	2
23	STOPPATHNUMBER	Int_16	NoUnits	1...233	1	1	2
24	PATHCHANGETIME	Float_64	NoUnits	60,426.0...261,231.0	1	1	8
	Total Bytes per Record						899

Appendix B – Lidar Instrument and Level 1 Quality

Table 166: Interpretation of the lidar operations mode values

Value	Operations Modes
1	Safe
2	Standby
3	Autonomous Data Collection (DAQ) – nominal science operation
4	Built In Test System (BITS)
5	Special Operations (SO)
6	Diagnostic

Table 167: Interpretation of the lidar operations submode values

Value	Operations Submode
1	safe
2	warm-up
3	standby
4	Normal – nominal science operation
5	BITS profile #1, no background
6	BITS profile #2, no background
7	BITS profile #3, no background
8	BITS profile #4, no background
9	BITS profile #1, with background
10	BITS profile #2, with background
11	BITS profile #3, with background
12	BITS profile #4, with background
13	no baseline removal
14	baseline measurement
15	polarization calibration
16	extended background measurement
17	boresight alignment
18	manual boresight operation
19	boresight search
20	build on-board baseline profiles
21	baseline corrected high gain channel
22	baseline corrected low gain channel
23	uncorrected high gain channel
24	uncorrected low gain channel
25	diagnostic
26-32	Spare

Table 168: Channel Quality Assurance Flags for 532 nm and 1064 nm

Bit	Interpretation
15	Configuration Suspect
14	Shutter Position Unconfirmed
13	High Gain Upper FIFO Empty
12	High Gain Lower FIFO Empty
11	Low Gain Upper FIFO Empty
10	Low Gain Lower FIFO Empty
9	Remove Baseline Algorithm Failed
8	Dynamic Gain Used

Bit	Interpretation
7	Gain Calculation Status
6	Suspect Filter Wait Time
5	Suspect Old Table Data
4	Suspect GPS Data Points Ignored
3	Suspect Filter Performance
2	Suspect Old GPS Data
1	Suspect No Geolocation Solution
0	Suspect Attitude

Two sets of unsigned 32-bit Quality Check (QC) flags, at single shot resolution, are contained in several of the data products. The first QC flag (Table 169) provides laser energy, geo-location, and calibration status, while the second QC flag (Table 170) summarizes observed error conditions.

Table 169: Bit Assignments for the first QC Flag (1)

Bits	Description
1	532 nm parallel channel missing
2	532 nm perpendicular channel missing
3	1064 nm channel missing
4	Not geo-located
5	Single shot 532 laser energy below calibration threshold (near zero energy)
6	Single shot 1064 laser energy below calibration threshold (near zero energy)
7	Historical value used for the depolarization gain ratio
8	Historical calibration constant used, 532 nm parallel channel
9	Historical calibration constant used, 532 nm perpendicular channel
10	Historical calibration constant used, 1064 nm channel
11	Averaged calibration constant used, 532 nm parallel channel
12	Averaged calibration constant used, 532 nm perpendicular channel
13	Single shot 532 laser energy below data quality threshold (low energy)
14	Single shot 1064 laser energy below data quality threshold (low energy)
15	Near zero 532 nm laser energy profile included in region 3 average
16	Near zero 1064 nm laser energy profile included in region 3 average
17	Near zero 532 nm laser energy profile included in region 4 average
18	Near zero 1064 nm laser energy profile included in region 4 average
19	Near zero 532 nm laser energy profile included in region 5 average
20	Low 532 nm laser energy profile included in region 3 average
21	Low 1064 nm laser energy profile included in region 3 average
22	Low 532 nm laser energy profile included in region 4 average
23	Low 1064 nm laser energy profile included in region 4 average
24	Low 532 nm laser energy profile included in region 5 average
25-32	Spare

Table 170: Bit Assignments for the second QC Flag (2)

Bits	Description
1	Reserve
2	Excessive underflows, 532 nm parallel channel in region 6
3	Excessive underflows, 532 nm perpendicular parallel channel, region 6
4	Excessive underflows, 1064 nm channel, region 6

Bits	Description
5	Excessive overflows, 532 nm parallel channel, region 6
6	Excessive overflows, 532 nm perpendicular parallel channel, region 6
7	Excessive overflows, 1064 nm channel, region 6
8	Excessive overflows, 532 nm parallel channel, region 2
9	Excessive overflows, 532 nm perpendicular parallel channel, region 2
10	Excessive overflows, 1064 nm channel, region 2
11	LRE Flags in SAD packet indicate bad data, 532 nm parallel channel
12	LRE Flags in SAD packet indicate bad data, 532 nm perpendicular channel
13	LRE Flags in SAD packet indicate bad data, 1064 nm channel
14	Quality Flags in SAD packet indicates bad data, 532 nm parallel channel
15	Quality Flags in SAD packet indicates bad data, 532 nm perpendicular channel
16	Quality Flags in SAD packet indicates bad data, 1064 nm channel
17	Suspicious offset calculation, 532 nm parallel channel
18	Suspicious offset calculation, 532 nm perpendicular channel
19	Suspicious offset calculation, 1064 nm channel
20	Suspicious mean signal value, 532 nm parallel channel (any/all regions)
21	Suspicious mean signal value, 532 nm perpendicular channel (any/all regions)
22	Suspicious mean signal value, 1064 nm channel (any/all regions)
23	RMS noise out of range, 532 nm parallel channel
24	RMS noise out of range, 532 nm perpendicular parallel channel
25	RMS noise out of range, 1064 nm channel
26	Near surface meteorological parameters were remapped to DEM surface altitude
27	1064 nm calibration coefficients suspect due to low temperatures associated with power up
28-32	Spare

Appendix C – IIR Level 1

This section details the bit assignments for the Pixel_Quality_Index included in the IIR Level 1 Scientific Data Sets. Bits 1-3 give the overall quality of the pixel for scientific analysis. Bits 4-21 include more detailed information and bits 22-24 indicate if an equalization correction has been applied.

Table 171: Bit Assignment for Pixel Quality Index

Bits	Description
1	Pixel quality channel 12.05: 0=Good; 1=Bad
2	Pixel quality channel 10.60: 0=Good; 1=Bad
3	Pixel quality channel 08.65: 0=Good; 1=Bad
4-8	If bit 9=0: Number of interpolated pixels in IIR matrix used in Level 1 bi-cubic interpolation (from 0 to 16), channel 12.05 If bit 9=1, then 1: Saturated pixel; 2: Missing pixel
9	Bad pixel, channel 12.05
10-14	If bit 15=0: Number of interpolated pixels in IIR matrix used in Level 1 bi-cubic interpolation (from 0 to 16), channel 10.6 If bit 15=1, then 1: Saturated pixel; 2: Missing pixel
15	Bad pixel, channel 10.6
16-20	If bit 21=0: Number of interpolated pixels in IIR matrix used in Level 1 bi-cubic interpolation (from 0 to 16), channel 08.65 If bit 21=1, then 1: Saturated pixel; 2: Missing pixel
21	Bad pixel, channel 08.65
22	Equalization correction applied, channel 12.05: 0=No; 1=Yes (spare in Version 1.x)
23	Equalization correction applied, channel 10.60: 0=No; 1=Yes (spare in Version 1.x)
24	Equalization correction applied, channel 08.65: 0=No; 1=Yes (spare in Version 1.x)
25-32	Spare

Appendix D – WFC Level 1

This section details the bit assignments for the Pixel QC Flag included in the WFC Level 1 Scientific Data Sets.

Table 172: Interpretation of the pixel QC flag

Bit	Definition
1	Center pixel not defined in the WFC Level 0 data
2	Radiance exceeds maximum count...saturated pixel
3	Cannot geolocate
4	Negative radiance
5	Negative reflectance

Appendix E – Lidar Level 2

This section provides several interpretative tables for the primary Lidar Level 2 science parameter flag values. For more detailed information refer to Lidar Level 2 data description and quality summaries.

For each layer detected in the CALIPSO backscatter data, a set of feature classification flags is assembled to provide a high-level description of feature type. These feature classification flags are stored as bit-mapped 16-bit integers, with bit 0 being the least significant bit. For each granule processed by the level 2 data analyses, the VFM data product maps these flags onto a 2D matrix of 16-bit integers recorded at CALIOP’s altitude-dependent data downlink resolution between 30.1 km and –0.5 km and extending along the full granule ground track. The interpretation of the bit fields in the feature classification flags are given in Table 173.

Table 173: Feature_Classification_Flag Definition

Bit(s)	Field Description	Bit Interpretation
0-2	Feature Type	0 = rejected by LEM 1 = “clear air” 2 = cloud 3 = tropospheric aerosol 4 = stratospheric aerosol 5 = surface 6 = subsurface 7 = no signal (totally attenuated)
3-4	Feature Type QA	0 = none 1 = low 2 = medium 3 = high
5-6	Ice/Water Phase	0 = unknown/not determined 1 = ice 2 = water 3 = oriented ice crystals
7-8	Ice/Water Phase QA	0 = none 1 = low 2 = medium 3 = high
9-11	Feature Sub-type	
	If feature type = aerosol, bits 10-12 will specify the tropospheric aerosol type.	0 = not determined 1 = marine 2 = desert dust 3 = polluted continental/smoke 4 = clean continental 5 = polluted dust 6 = elevated smoke 7 = dusty marine

Bit(s)	Field Description	Bit Interpretation
	If feature type = cloud, bits 10-12 will specify the cloud type.	0 = low overcast, transparent 1 = low overcast, opaque 2 = transition stratocumulus 3 = low, broken cumulus 4 = altocumulus (transparent) 5 = altostratus (opaque) 6 = cirrus (transparent) 7 = deep convective (opaque)
	If feature type = Stratospheric Aerosol, bits 10-12 will specify the stratospheric aerosol type.	0 = invalid 1 = polar stratospheric aerosol 2 = volcanic ash 3 = sulfate 4 = elevated smoke 5 = unclassified 6 = spare 7 = spare
	If feature type = clear-air, bits 10-12 will specify horizontal averages not searched for features due to low energy mitigation	0 = not applicable 1 = not searched at 80 km 2 = not searched at 20 and 80 km
12	Feature Subtype QA	0 = not confident 1 = confident
13-15	Horizontal Averaging Required	0 = not applicable 1 = 1/3 km 2 = 1 km 3 = 5 km 4 = 20 km 5 = 80 km

Table 174: Interpretation for the Feature Type QA bits in the CALIOP feature classification flag

Feature Type	QA Interpretation
0 = LEM-rejected	N/A (always 0)
1 = clear air	N/A (always 0)
2 = cloud	0 = no confidence = $ \text{CAD score} < 20$
3 = tropospheric aerosol	1 = low confidence = $20 \leq \text{CAD score} < 50$
4 = stratospheric aerosol	2 = medium confidence = $50 \leq \text{CAD score} < 70$ 3 = high confidence = $ \text{CAD score} \geq 70$
5 = surface	N/A (always 3)
6 = subsurface	N/A (always 0)
7 = no signal	N/A (always 0)

The Atmospheric Volume Description is a profile descriptive flag containing the Feature Classification Flags associated with each 5 km x 60 m (or 5 km x 180 m) range bin in the Profile Products. This parameters maps to the Feature Classification flag, except that the interpretation of final three bits (i.e., the averaging required for detection) is slightly different from the interpretation that would be used for the feature classification flags, as noted in Table 175.

Table 175: Atmospheric_Volume_Description Definition of the Horizontal Averaging

Bit(s)	Field Description	Bit Interpretation
13-15	Horizontal averaging required for detection (provides a coarse measure of feature backscatter intensity)	0 = not applicable 1 = 5 km 2 = 20 km 3 = 80 km 4 = 5 km w/ subgrid feature detected at 1/3 km 5 = 20 km w/ subgrid feature detected at 1/3 km 6 = 80 km w/ subgrid feature detected at 1/3 km 7 = spare

Table 176 and Table 177 contain quality assurance parameters used to report the output of a revised boundary layer cloud clearing algorithm (BLaCC) first used in the V4.51 data release. Table 176 identifies the specific path within the algorithm that determines the mechanism for partitioning clouds and aerosols within the boundary layer features. Table 177 assigns a BLaCC classification to each layer.

Table 176: Decoupled Layer Type SDS

Type	Decoupled Layer Type Definition
-1	Not applicable (fill value)
0	Layer is not in the boundary layer (not used in V5.00)
1	Is mother layer; not partitioned
2	Is truncated mother layer; top altitude revised downward (lower)
3	Fused cloud separated from a mother layer; layer type determined by the BLaCC ^A criteria
4	Severed cloud separated from a mother layer; layer type determined by the BLaCC ^A criteria
5	Severed aerosol separated from a mother layer; layer type determined by the BLaCC ^A criteria
6	Severed layer separated from a mother layer; layer type determined by the CALIOP CAD algorithm
7	Severed layer: clouds detected in all single shot profiles
8	Unused
9	BLaCC ^A algorithm error

A) Boundary Layer Cloud Clearing algorithm

Table 177: Decoupled Layer Status SDS

Status	Decoupled Layer Status Definition
-1	Not applicable (fill value)
0	Detected mother layer is not in the boundary layer
1	Fused layer top too close to mother layer top; delete fused layer, retain original mother layer
2	Severed layer is not recognized as a legitimate feature; retain fused layer, delete mother layer and severed layer
3	Severed layer is base is above PBL; retain fused and severed layers, delete mother layer
4	No clouds detected at single shot resolution with a severed layer; retain fused and severed layers, delete mother layer
5	Severed layer classified as cloud after removing clouds detected at single shot resolution; retain fused and severed layers, delete mother layer

Status	Decoupled Layer Status Definition
6	Severed layer classified as aerosol; single shot detections within severed aerosol layer are not confidently classified as clouds; redefine all single shot detections as aerosols; retain fused and severed layers, delete mother layer
7	Severed layer classified as aerosol; single shot detections within severed aerosol layer are confidently classified as clouds; delete fused and severed layers, retain mother layer
8	Detected mother layer is not the uppermost mother layer in the boundary layer
9	BLaCC ^A algorithm completed with errors
10	BLaCC ^A algorithm failed

A) Boundary Layer Cloud Clearing algorithm

Table 178 indicates the detection, at any averaging resolution, of specific atmospheric feature types within each 5 km column.

Table 178: Scene Classification Flag SDS

Bit	Interpretation
0	Tropospheric aerosol, subtype = marine
1	Tropospheric aerosol, subtype = dust
2	Tropospheric aerosol, subtype = polluted continental/smoke
3	Tropospheric aerosol, subtype = clean continental
4	Tropospheric aerosol, subtype = polluted dust
5	Tropospheric aerosol, subtype = elevated smoke
6	Tropospheric aerosol, subtype = dusty marine
7	Stratospheric aerosol, subtype = polar stratospheric aerosol
8	Stratospheric aerosol, subtype = volcanic ash
9	Stratospheric aerosol, subtype = sulfate
10	Stratospheric aerosol, subtype = elevated smoke
11	Stratospheric aerosol, subtype = unclassified
12	Column has ROI phase clouds at any resolution
13	Column has HOI phase clouds at any resolution
14	Column has water phase clouds at any resolution
15	Column has unknown phase clouds at any resolution

Table 179 specifies the internal procedure used to select the initial lidar ratio for each layer at either 532 nm or 1064 nm.

Table 179: 532 nm and 1064 nm Lidar Ratio Selection Method SDS

Value	Lidar Ratio Selection Method
0	Not Determined
1	Transmittance Method, constrained retrieval; selected only for those layers with a measurable two-way transmittance lying between 0 and 1; also known as a constrained retrieval
2	Opaque Layer Method; selected for all opaque layers

Value	Lidar Ratio Selection Method
3	Cirrus Temperature Method; selected for transparent ice clouds that are not suitable for solution via constrained retrieval; i.e., clouds for which the two-way transmittance either cannot be measured or falls outside the bounds of 0 to 1
4	Unknown Cloud Phase; selected for unknown phase transparent clouds having centroid temperatures between -37.0 and 0.0 °C that are not suitable for solution via constrained retrieval
5	Fixed Layer Method; selected for transparent water clouds and aerosols that are not suitable for solution via constrained retrieval (e.g., surface-attached aerosols)
6	Solution at 532 nm Method; selected for 1064 nm solutions in transparent clouds. Because spectral independence is assumed for clouds, the 1064 nm solution is initiated using the 532 nm multiple scattering factor and the 532 nm final lidar ratio.
7	MAC Table Interpolation; lidar ratio assigned via interpolation of the 'Maps of Aerosol lidar ratios for CALIPSO'(MAC) lookup table; applies only to transparent marine and dusty marine aerosol types that are not suitable for solution via constrained retrieval

Table 180 contains the 532 nm and 1064 nm extinction quality control flags, reported for each layer for which an extinction retrieval was attempted. Aerosol extinction is computed for both wavelengths, while cloud extinction is only reported at 532 nm.

Table 180: 532 nm and 1064 nm Extinction QC SDS

Bit	Value	Interpretation
0	0	unconstrained retrieval; initial lidar ratio unchanged during solution process
	1	constrained retrieval
1	2	Initial lidar ratio reduced to achieve successful full-column solutions
2	4	Suspicious retrieval due to layer or overlying integrated attenuated backscatter being too high or excessive lidar ratio reductions
3	8	Initial lidar ratio has been reduced and has converged, but backscatter uncertainty solution does not exist
4	16	Layer being analyzed has been identified by the feature finder as being totally attenuating (i.e., opaque)
5	32	Estimated optical depth error exceeds the maximum allowable value
6	64	Negative signal anomaly detected
7	128	Retrieval terminated at maximum iterations for a constrained retrieval
8	256	No solution possible within allowable lidar ratio bounds
9	512	Two-way particulate transmittance has converged but constrained retrieval still not achieved
10	1024	Backscatter coefficients not converging and maximum lidar ratio correction iterations reached
11	2048	Uncertainties not converging and maximum lidar ratio correction iterations achieved
12	4096	Lidar ratio converged but retrieval still not converging
13	8192	Range bin contains two different feature types that may have different lidar ratios
14	16384	Complex retrieval failure
15	32768	Fill value or no solution attempted

Table 181: Smoke Layer Base Extended QC Flag SDS

Bit	Interpretation
0	Candidate for smoke layer extension
1	Success, smoke layer extended
2	Failed, smoke layer base already in contact with a cloud layer
3	Failed, no cloud layer is found below the smoke layer
4	Failed, gap distance between smoke and cloud layer exceeds limit
5	Failed, 1064 nm scattering ratio test is below threshold
6	Failed, cloud color ratio test is below threshold

In the mid-2016 the CALIOP laser began intermittently emitting low energy pulses, with occurrence frequency of these pulses slowly increasing with as the mission progressed. CALIOP's low energy mitigation (LEM; [Tackett et al., 2023b](#)) algorithm was developed, which identifies level 1 backscatter data resulting from low energy pulses and, when appropriate, works to exclude from level 2 analysis and data processing. Table 182, Table 183, and Table 184 contain LEM flags designated for each column. Table 185 contain LEM flags reported for each layer detected.

Table 182: Low Energy Mitigation Column QC Flag SDS – Profile Data products

Bit(s)	Interpretation
0	Column contains LEM affected data (data has been rejected or contains low energy shots that LEM accepts)
1	Column belongs to a 5 km resolution frame that has been rejected due to too many unusable profiles
2	Column belongs to a 5 km resolution frame that has been rejected due to too many rejected subregions in altitude region 3
3	Column belongs to a 5 km resolution frame that has been rejected due to too many rejected subregions in altitude region 4
4	Feature detection at 20 km resolution not performed in this column due to an insufficient fraction of usable 5 km resolution frames
5	Feature detection at 80 km resolution not performed in this column due to an insufficient fraction of usable 5 km resolution frames
6-15	unused

Table 183: Low Energy Mitigation Column QC Flag SDS - Layer Data products

Bit(s)	Interpretation
0	Column contains LEM affected data (data has been rejected or low energy shots that LEM accepts)
1	Column belongs to a 5 km resolution frame that has been rejected due to too many unusable profiles
2	Column belongs to a 5 km resolution frame that has been rejected due to too many rejected subregions in altitude region 3 (8.2 – 20.2 km)
3	Column belongs to a 5 km resolution frame that has been rejected due to too many rejected subregions in altitude region 4 (20.2 – 30.1 km)
4	Feature detection at 20 km resolution not performed in this column due to insufficient fraction of usable 5 km resolution frames
5	Feature detection at 80 km resolution not performed in this column due to insufficient fraction of usable 5 km resolution frames

Bit(s)	Interpretation
6	unused
7	Column has data rejected in altitude regions 1 & 2 (-0.2 – 8.2 km) (333 m only)
8	Column has data rejected in altitude region 3 (8.2 – 20.2 km) (333 m only)
9	Column has data rejected in altitude region 4 (20.2 – 30.1 km) (333 m only)
10	Column does not have low energy, but data is rejected in altitude regions 1 & 2 due to rejected data in altitude region 3 (333 m only)
11-15	unused

Table 184: Low Energy Mitigation Internal Column QC Flag SDS – Layer Diagnostic

Bit(s)	Interpretation
0	Single shot columns have data rejected in regions 1 & 2 but the 5 km resolution column was not rejected by LEM
1	Column has data rejected in region 3 but the 5 km resolution column was not rejected by LEM
2	Column has data rejected in region 4 but the 5 km resolution column was not rejected by LEM
3	Full column is rejected by LEM
4	Column rejected due to region 3
5	Frame rejected due to too many low energy shots
6	Frame rejected due to too many rejected subregions in region 3
7	Frame rejected due to too many rejected subregions in region 4
8	Feature detection was not attempted at 20 km resolution due to too many LEM-rejected columns
9	Feature detection was not attempted at 80 km resolution due to too many LEM-rejected columns
10	Feature detection was not attempted at resolution 6 due to too many LEM-rejected columns
11	Column contains LEM affected data in region 3
12	Column contains LEM affected data in region 4
13-15	unused

Table 185: Low Energy Mitigation Feature QC Flag SDS

Value	Interpretation
0	No low energy shots affecting the layer
1	Some portion of the layer contains low energy shots and/or data rejected by the LEM algorithm

Table 186 reports the quality assurance flags that describe the wavelength-specific outcomes of the respective surface searches.

Table 186: 532 nm and 1064 nm Surface Detection Flags SDS

Bit(s)	Interpretation
0	Surface detected? 0 = no 1 = yes

Bit(s)	Interpretation
1	Surface detection method 0 = derivative test 1 = multi-shot averaged data test 2 = single shot surface detection fraction test 3 = unused
2	532 nm parallel channel saturated
3	532 nm perpendicular channel saturated
4	1064 nm channel saturated
5	532 nm parallel channel negative signal anomaly
6	532 nm perpendicular channel negative signal anomaly
7	1064 nm channel negative signal anomaly
8	Derivative method failure: $Z(\text{min gradient}) < Z(\text{max gradient})$
9	Derivative method failure: vertical extent exceeds limit
10	Derivative method failure: peak signal below threshold
11	Failure: vertical separation between 532 and 1064 surface top altitudes exceeds allowable limit
12	Failure: surface detected at 1064 nm only, but overlying atmospheric total attenuated backscatter color ratio is below a threshold value. This test is disabled in the V5.00 release.
13	Unused
14-15	Surface detected? 0 = no 1 = yes

Table 187 reports the ocean derived column optical depth (ODCOD) quality control flags, describing the output of the ODCOD 532 nm retrievals.

Table 187: ODCOD Quality Control Flags SDS

Bit(s)	Interpretation
0	The fundamental time delay was shifted from the first point
1	Lidar surface data too many data points for a valid surface spike
2	Range bin above recorded lidar surface data added
3	Range bin below recorded lidar surface data added
4	The surface point ratio indicated that the first point of the surface spike is missing
5	To find the time delay, the surface spike index range had to be shifted down
6	The retrieval inputs fall outside of confidence ranges indicating a confident retrieval
7-9	Unused
10	No Lidar surface was found
11	The surface is not ocean
12	The surface is ice
13	The wind speed is outside the valid range (0.025 to 43 m/s)
14	The fundamental time delay found was too low; insufficient data samples to conduct a second search
15	Too few data points to solve
16	The CALIOP response model curve area was too large
17	The CALIOP response model curve scale factor could not be found
18	Lidar surface saturated

Bit(s)	Interpretation
19	Lidar surface has negative signal anomaly
20	Lidar surface data is not valid
21	Flags bad input/ancillary data
22	No Lidar surface was detected via derivative method at greater than single shot resolutions
23-31	Unused

The CALIOP clouds-aerosol discrimination (CAD) score provides a numerical confidence level for the classification of layers, ranging between -100 and 100. The sign of the CAD indicates feature type: positive values indicate a cloud, while negative values indicate aerosols. The absolute value provides a confidence, where the larger the magnitude the higher the confidence that the classification is correct.

Table 188 reports special CAD scores that are outside of the standard range.

Table 188: Special CAD Scores

Value	Interpretation
-111	Data quality degraded due to low laser energy
-101	Negative mean attenuated backscatter encountered
101	Not used after the V3.x release
102	Not used after the V3.x release
103	Layer integrated attenuated backscatter at 532 nm is suspiciously high
104	Boundary layer clouds that were found to be opaque at the initial 5 km horizontal averaging resolution used by the layer detection algorithm
105	Layer detected at one of the coarser averaging resolutions (20 km or 80 km) for which the initial estimates of measured properties have been negatively impacted
106	A cirrus cloud ‘fringe’ that was initially classified as an aerosol by the CAD algorithm and subsequently reclassified via spatial proximity analysis as a randomly oriented ice cloud (see Liu et al., 2019)
107	Classification made by the single-shot cloud-clearing algorithm; layer detected at 5 km resolution is irrevocably classified as a high confidence cloud prior to any attenuation corrections for overlying layers (see Tackett et al., 2023)
108	Classification made by the single-shot cloud-clearing algorithm; layer detected at 5 km is irrevocably classified as an aerosol prior to any attenuation corrections for overlying layers
109	Classification made by the single-shot cloud-clearing algorithm; single shot cloud is reclassified as an aerosol
110	Classification made by the single-shot cloud-clearing algorithm; indeterminate layer reclassified as a cloud

Appendix F – IIR Level 2 Science Parameter Flag Values

This section provides several interpretative tables for the primary IIR Level 2 Track and Swath science parameter flag values. For more detailed information refer to IIR Level 2 Track and Swath data description and quality summaries.

Table 189 records the number of aerosol layers in the atmospheric column classified by CALIOP.

Table 189: Dust_Stratospheric_Aerosol_Flag (track)

Record #	Interpretation: number of layers
1	Tropospheric Dust
2	Tropospheric Polluted dust
3	Tropospheric Dusty marine
4	Stratospheric PSC aerosol
5	Stratospheric volcanic ash
6	Stratospheric sulfate
7	Stratospheric elevated smoke

Table 190 records the QA scores assigned to the seven aerosol subtypes reported in Dust_Stratospheric_Aerosol_Flag.

Table 190: Dust_Stratospheric_Aerosol_Flag_QA (track)

	Interpretation
<i>Decimal part</i>	Mean Aerosol/PSC Type score (0.100: confident; 0.000: not confident)
<i>Integer part</i>	Mean Feature Type score (100: high; 50: medium; 25: low; 0: none)

Table 191 indicates whether an equalization correction has been applied.

Table 191: Equalization_Flag (track and swath)

Bit(s)	Value	Interpretation: equalization correction
1	0	Channel 12.05: no
	1	Channel 12.05: yes
2	0	Channel 10.60: no
	1	Channel 10.60: yes
3	0	Channel 08.65: no
	1	Channel 08.65: yes
4-8	0	N/A

Table 192 provides the main characteristics of the background radiances used to retrieve the effective emissivity of the current pixel.

Table 192: High_Cloud_vs_Background_Flag (track)

Digits	Value	Digit interpretation
<i>Units</i>	0	Background reference computed
	1	Background reference measured at a distance <= 10 km
	2	Background reference measured, 10 km < distance <= 50 km

	3	Background reference measured, 50 km < distance <= 100 km
<i>Tens</i>	0	Background reference computed
	1	Measured background reference effective emissivity between -0.1 and 1.1
	2	Measured background reference effective emissivity < -0.1
	3	Measured background reference effective emissivity > 1.1
	-9	Measured background reference is clear sky
<i>Hundreds</i>	0	Background reference: clear sky (10)
	1	Background reference: low opaque cloud (20)
	2	Background reference: high opaque cloud (40)
	3	Background reference: low semi-transparent non depolarizing aerosols (52)
	4	Background reference: low opaque aerosols (56)

Table 193 reports a parameter built from the Ice/Water Phase reported by the Feature Classification Flag in the CALIOP Level 2 Cloud layer product for each layer in the lower level.

Table 193: Ice_Water_Flag_Lower_Level (track)

Value	Interpretation
1	Randomly oriented ice crystals (ROI)
2	Liquid water
3	Horizontally oriented ice crystals (HOI)
9	Unknown/not determined phase
5	Lower level is an aerosol layer
-9	Background reference is a surface, or retrievals not attempted
-99	Type of Scene not defined

Table 194 reports a parameter built from the Feature Type QA and Ice/Water Phase QA reported by the Feature Classification Flag in the CALIOP Level 2 Cloud layer product for each layer in the lower level.

Table 194: Ice_Water_Flag_QA_Lower_Level (track)

Digits	Interpretation
<i>Decimal part</i>	Ice/Water Phase score (0.100: high; 0.050: medium; 0.025: low; 0.000: none)
<i>Integer part</i>	Feature Type score (100: high; 50: medium; 25: low; 0: none)

Table 195 reports a parameter built from the Ice/Water Phase reported by the Feature Classification Flag in the CALIOP Level 2 Cloud layer product for each layer in the upper level.

Table 195: Ice_Water_Flag_Upper_Level (track)

Value	Interpretation
1	Randomly oriented ice crystals (ROI)
2	Liquid water
3	Horizontally oriented ice crystals (HOI)
4	Ice crystals only, both ROI and HOI
6	Ice (ROI and/or HOI) and liquid water
9	At least one layer has unknown/not determined phase
-99	No cloud layer in the upper level or retrievals not attempted

Table 196 reports a parameter built from the Feature Type QA and Ice/Water Phase QA reported by the Feature Classification Flag in the CALIOP Level 2 Cloud layer product for each layer in the upper level.

Table 196: Ice_Water_Flag_QA_Upper_Level (track)

Digits	Interpretation
<i>Decimal part</i>	Mean Ice/Water Phase score (0.100: high; 0.050: medium; 0.025: low; 0.000: none)
<i>Integer part</i>	Mean Feature Type score (100: high; 50: medium; 25: low; 0: none)

Table 197 indicates the IIR calibrated radiance quality extracted from the Pixel_Quality_Index of the IIR Level 1B product.

Table 197: IIR_Data_Quality (swath) and IIR_Data_Quality_Flag (track)

Bit(s)	Value	Interpretation
1	0	IIR calibrated radiances in the 3 channels are of nominal quality
	1	At least one of the channels has poor quality or is missing
2	0	Channels 08.65 and 10.60 derived from the same sequence of acquisition
	1	Channels 08.65 and 10.60 not derived from the same sequence of acquisition
3	0	Channels 08.65 and 12.05 derived from the same sequence of acquisition
	1	Channels 08.65 and 12.05 not derived from the same sequence of acquisition
4	0	Channels 10.6 and 12.05 derived from the same sequence of acquisition
	1	Channels 10.6 and 12.05 not derived from the same sequence of acquisition
5-8	0	N/A

Table 198 reports the Feature Type QA derived from the Feature_Classification_Flag parameter reported in the CALIOP lidar level 2 layer product for the uppermost layer in the upper level.

Table 198: Lidar_Quality_Flag (track)

Value	Interpretation: Feature QA from Feature_Classification_Flag
0	None
1	Low
1	Medium
2	High

Table 199 provides the whole set of $D_{e12/10}$ and $D_{e12/08}$ diameters inferred from the $\beta_{eff12/10}$ and $\beta_{eff12/08}$ microphysical indices.

Table 199: Microphysics (track)

Digits	Digit Interpretation
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<i>Units</i>	Records 1 to 3: particle shape index used in V3 Records 4 to 6: particle shape index Records 7 to 10: set to 0
<i>Thousands-Hundreds-Tens</i>	Effective diameter $D_{e12/08}$ in microns Records 1 to 3: V3. Records 4 to 6: V4; set to zero if $\beta_{eff12/08}$ is not valid and $\beta_{eff12/10}$ is valid. Records 7 to 10: set to 0.
<i>Millions-Hundred thousands-Ten thousands</i>	Effective diameter $D_{e12/10}$ in microns Records 1 to 3: V3. Records 4 to 6: V4, set to zero if $\beta_{eff12/10}$ is not valid and $\beta_{eff12/08}$ is valid. Records 7 to 10: SPARTICUS $N(D)_1$ unmodified, TC4 $N(D)_1$ unmodified, SPARTICUS $N(D)_1 = 0$, TC4 $N(D)_1 = 0$.

Table 200 provides the number of layers included in the upper level, as well as the difference in km between the base altitude of the uppermost layer and the top altitude of the lowermost layer.

Table 200: Multi_Layer_Flag (track)

Digits	Interpretation
<i>Tens-Units-Decimals</i>	Difference between the bottom altitude of the uppermost layer and the top altitude of the lowermost layer within the upper level. Multi_Layer_Flag takes the sign of this quantity. This quantity is set to zero for mono-layer cases.
<i>Hundreds</i>	0
<i>Ten thousands-Thousands</i>	Number of layers in the upper level.

Table 201 identifies the model that was used to retrieve the Effective_Particle_Size.

Table 201: Particle_Shape_Index (track and swath)

Value	Interpretation
1	Water
7	Severely rough 8-element column aggregate
9	Severely rough single hexagonal column

Table 202 reflects the agreement between the retrieved ($\beta_{eff12/10}$, $\beta_{eff12/08}$) pair of microphysical indices and the selected model.

Table 202: Particle_Shape_Index_Confidence (track and swath)

Value	Interpretation
1	Good
2	Medium
3	Best guess model
4	None

Table 203 reports a composite of three different pieces of information: (1) the units digit indicates if the studied pixel is isolated or part of a structure with consecutive IIR pixels of same Type_of_Scene. It is not computed for scenes containing only aerosols, for type of scene 20, or when no IIR retrievals are attempted. (2) the tens digit is a mineral aerosols index based on IIR inter-channels brightness temperature differences (BTD). Mineral aerosols layers are identified (tens digit=1) when the 08_65 minus 12_05 BTD is $< -2\text{K}$ and the 10_60 minus 12_05 BTD is $< -0.5\text{K}$, (3) the hundreds digit is an index describing the difference between observed and computed brightness temperatures for specific types of scenes: scenes identified as clear sky (10) or containing low aerosols (52, 53) and scenes containing opaque clouds (20, 40). This index is designed to identify cloud-free and opaque cloud pixels where measured and computed brightness temperatures are exhibiting large differences, and which may require further analysis.

Table 203: Surrounding_Obs_Quality_Flag (track)

Digits	Value	Interpretation
<i>Units</i>	0	3 or more consecutive pixels with the same Type_of_Scene
	1	2 consecutive pixels with the same Type_of_Scene
	2	Not computed
<i>Tens IIR aerosols index</i>	0	No mineral aerosols detected
	1	Mineral aerosols detected
<i>Hundreds Obs-Computed</i>	0	Not computed or satisfactory for computed cases: Mean (Observed - Computed) Brightness Temperatures between -2K and $+2\text{K}$
	1	Low Mean (Observed - Computed) Brightness Temperatures between -5K and -2K
	2	High Mean (Observed - Computed) Brightness Temperatures between $+2\text{K}$ and $+5\text{K}$
	3	Very low Mean (Observed - Computed) Brightness Temperatures $< -5\text{K}$
	4	Very high Mean (Observed - Computed) Brightness Temperatures $> 5\text{K}$

Table 204 contains a Parameter derived from IGBP_Surface_Type and uses Surface_532_Integrated_Depolarization_Ratio, if available, and Snow_Ice_Surface_Type to identify pixels covered with sea ice or snow and to refine the classification around coastlines.

Table 204: TGeotype (track)

Category	TGeotype	Interpretation
Water	1700	IGBP water (17) and surface depolarization ratio < 0.15 or snow ice surface type = 0
	1705	Surface depolarization not available and $0 < \text{snow ice surface type} < 50$
	1750	Coastline land (IGBP $\neq 17$) pixel changed to water because surface depolarization ratio < 0.15
Water/sea ice transition	1710	IGBP water (17) $0.15 \leq \text{surface depolarization ratio} \leq 0.6$
Sea Ice	1510	IGBP water (17) Surface depolarization > 0.6 or snow ice surface type ≥ 50
Snow	1560	Land (IGBP $\neq 17$) Surface depolarization > 0.6 or snow ice surface type ≥ 50

Snow-free land	IGBP x 100	Land (IGBP ≠17) Surface depolarization < 0.6 or snow ice surface type = 0
	1730	Coastline water (IGBP =17) pixel changed to snow-free land because $0.15 \leq$ surface depolarization ratio ≤ 0.6

Table 205 contains the scene classification derived from the CALIOP Level 2 Cloud and Aerosol 5-km layer data products, designed to select the scenes to be further analyzed in term of effective emissivity and in the meantime to be possibly compared with existing clouds classifications.

Table 205: Type of Scene (track)

Value	Description
CLEAR SKY, Was Cleared_Flag_1km=0	
10	Clear sky (no aerosols detected by lidar)
AEROSOLS ONLY, Was Cleared_Flag_1km=0	
51	1 to 4 high ST aerosols
52	1 to 4 low ST aerosols, vol_depolarization_ratio_mean < 6%
53	1 to 4 low ST aerosols, vol_depolarization_ratio_mean > 6%
54	1 to 4 high ST aerosols and 1 to 3 low ST aerosols
55	1 high opaque aerosol
56	1 low opaque aerosol
64	1 to 4 high ST aerosols/ 1 low opaque aerosol
57	Any other aerosols only
CLOUDS	
20	Low opaque cloud, no aerosol, vol_depolarization_ratio_max >40%
70	Low opaque cloud, no aerosol, vol_depolarization_ratio_max < 40%
40	High opaque cloud, no aerosol, vol_depolarization_ratio_max >40%
80	High opaque cloud, no aerosol, vol_depolarization_ratio_max < 40%
81	1 high ST cloud and 1 high opaque cloud, centroid altitudes difference < 1km
85	1 high ST aerosol and 1 high opaque cloud, centroid altitudes difference < 1km
21	1 high ST cloud only (no aerosol)
22	2 high ST clouds, no high ST aerosol
23	1 high ST cloud and 1 low ST cloud, no high ST aerosol
24	1 low ST cloud, attenuated_backscatter_max > 0.02 sr ⁻¹ or vol_depolarization_ratio_max > 6%, no high ST aerosol
59	1 low ST cloud, attenuated_backscatter_max < 0.02 sr ⁻¹ and vol_depolarization_ratio_max < 6%, no high ST aerosol
25	2 low ST clouds only (no aerosol)
26	3 high ST clouds
27	2 high ST clouds and 1 low ST cloud
67	3-4 high ST clouds and 1 low ST cloud
28	1 high ST cloud and 2 low ST clouds
68	2-3 high ST clouds and 2 low ST clouds or 3 high ST clouds and 3 low ST clouds
29	3 to 7 low ST clouds only (no aerosol)
31	1 high ST cloud / 1 low opaque cloud, no high ST aerosol
32	2 to 6 high ST clouds/ 1 opaque cloud
62	3 to 6 ST clouds (at least 1 high ST and 1 low ST)/ 1 opaque cloud
33	1 high ST cloud and 1 low ST cloud/ 1 opaque cloud
34	1 low ST cloud/ 1 opaque cloud
39	2 to 4 low ST clouds/ 1 low opaque cloud
41	1 high ST cloud/ 1 high opaque cloud, centroid altitudes difference > 1km
42	2 high ST clouds/ 1 high opaque cloud
MIXED AEROSOLS/CLOUDS	

30	1 high ST cloud / 1 to 4 low ST aerosols
66	1 high ST aerosol above 1 high ST cloud and 1 low ST cloud
63	1 to 4 low aerosols above 1 low ST cloud
35	1 to 4 high ST aerosols/ 1 low opaque cloud
36	1 to 4 low ST aerosols/ 1 low opaque cloud
37	1 high ST cloud/ 1 low opaque aerosol
38	1 low ST cloud/ 1 low opaque aerosol
65	1 to 4 high ST aerosols / 1 high opaque cloud; if 1 high ST aerosol, centroid altitudes difference > 1km
OTHERS	
50	Clear sky (no aerosol), Was_Cleared_Flag_1km > 0
91	1 to 4 high ST aerosols, Was_Cleared_Flag_1km > 0
92	1 to 4 low ST aerosols, vol_depolarization_ratio_mean < 6%, Was_Cleared_Flag_1km > 0
93	1 to 4 low ST aerosols, vol_depolarization_ratio_mean > 6%, Was_Cleared_Flag_1km > 0
94	1 to 4 high ST aerosols and 1 to 3 low ST aerosols, Was_Cleared_Flag_1km > 0
95	1 high opaque aerosol, Was_Cleared_Flag_1km > 0
96	1 low opaque aerosol, Was_Cleared_Flag_1km > 0
97	Any other aerosols only, Was_Cleared_Flag_1km > 0
98	1 to 4 high ST aerosols/ 1 low opaque aerosol, Was_Cleared_Flag_1km > 0
99	No classification or 5 km column rejected by the CALIOP LEM algorithm

Appendix G – CALIPSO/GEWEX Lidar Level 3 Parameters

This section explicitly compares the SDS parameters contained in the two differing formats of CALIPSO derived data; yearly netCDF files sent to GEWEX for the multi-satellite cloud assessment and the monthly HDF format consistent with other publicly released Lidar L3 CALIPSO products. Both versions of these data products are produced from identical input data and algorithms, however the file structure and parameter naming contained in the files substantially differ.

Table 206 provides a translation between these two formats, as the left most column are the SDS parameters contained the CALIPSO publicly released monthly HDF files and the right most column is the yearly netCDF file available from the GEWEX Cloud Assessment Database,

Table 206: CALIPSO/GEWEX Lidar Level 3 SDS Parameter Comparison

CALIPSO Parameter	Description	GEWEX Parameter
Longitude_Midpoint	Longitude at the grid cell midpoint	longitude
Latitude_Midpoint	Latitude at the grid cell midpoint	latitude
Number_Of_Orbit_Tracks	Number of CALIPSO orbital tracks at each grid cell	n_tot
Cloud_Amount_Bin_Midpoint	Cloud amount at the midpoint of each bin	bin, CA
Cloud_Amount_Bin_Boundaries	Cloud amount at bin boundaries	bin_bounds, CA
Cloud_Top_Temperature_Bin_Midpoint	Cloud top temperature at the midpoint of each bin	bin, CT
Cloud_Top_Temperature_Bin_Boundaries	Cloud top temperature at bin boundaries	bin_bounds, CT
Cloud_Top_Pressure_Bin_Midpoint	Cloud top pressure at the midpoint of each bin	bin, CP
Cloud_Top_Pressure_Bin_Boundaries	Cloud top pressure at bin boundaries	bin_bounds, CP
Cloud_Top_Altitude_Bin_Midpoint	Cloud top altitude at the midpoint of each bin	bin, CZ
Cloud_Top_Altitude_Bin_Boundaries	Cloud top altitude at bin boundaries	bin_bounds, CZ
Cloud_Amount_Mean_TopLayer	Mean of cloud amount of top layer flavor reported within the latitude/longitude grid cell	a_CA, topLayer
Cloud_Amount_Histogram_TopLayer	Histogram of cloud amount of top layer flavor reported within the latitude/longitude grid cell	h_CA, topLayer
High_Cloud_Amount_Mean_TopLayer	Mean of cloud amount of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAH, topLayer
High_Cloud_Amount_Ratio_TopLayer	Percentage of cloud amount of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAHR, topLayer

Middle_Cloud_Amount_Mean_TopLayer	Mean of cloud amount of top layer flavor at middle-level altitude region reported within the latitude/longitude grid cell	a_CAM, topLayer
Middle_Cloud_Amount_Ratio_TopLayer	Percentage of cloud amount of top layer flavor at middle-level altitude region reported within the latitude/longitude grid cell	a_CAMR, topLayer
Low_Cloud_Amount_Mean_TopLayer	Mean of cloud amount of top layer flavor reported at low-level altitude region within the latitude/longitude grid cell	a_CAL, topLayer
Low_Cloud_Amount_Ratio_TopLayer	Percentage of cloud amount of top layer flavor at low-level altitude region reported within the latitude/longitude grid cell	a_CALR, topLayer
Ice_Cloud_Amount_Mean_TopLayer	Mean of ice cloud amount of top layer flavor reported within the latitude/longitude grid cell	a_CAI, topLayer
Ice_Cloud_Amount_Ratio_TopLayer	Percentage of ice cloud amount of top layer flavor reported within the latitude/longitude grid cell	a_CAIR, topLayer
Water_Cloud_Amount_Mean_TopLayer	Mean of water cloud amount of top layer flavor reported within the latitude/longitude grid cell	a_CAW, topLayer
Water_Cloud_Amount_Ratio_TopLayer	Percentage of water cloud amount of top layer flavor reported within the latitude/longitude grid cell	a_CAWR, topLayer
High_Ice_Cloud_Amount_Mean_TopLayer	Mean of ice cloud amount of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAIH, topLayer
High_Ice_Cloud_Amount_Ratio_TopLayer	Percentage of ice cloud amount of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAIHR, topLayer
Cloud_Amount_Mean_Passive	Mean of cloud amount of passive flavor reported within the latitude/longitude grid cell	a_CA, passive
Cloud_Amount_Histogram_Passive	Histogram of cloud amount of passive flavor reported within the latitude/longitude grid cell	h_CA, passive
High_Cloud_Amount_Mean_Passive	Mean of cloud amount of passive flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAH, passive
High_Cloud_Amount_Ratio_Passive	Percentage of cloud amount of passive flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAHR, passive

Middle_Cloud_Amount_Mean_Passive	Mean of cloud amount of passive flavor at middle-level altitude region reported within the latitude/longitude grid cell	a_CAM, passive
Middle_Cloud_Amount_Ratio_Passive	Percentage of cloud amount of passive flavor at middle-level altitude region reported within the latitude/longitude grid cell	a_CAMR, passive
Low_Cloud_Amount_Mean_Passive	Mean of cloud amount of passive flavor reported at low-level altitude region within the latitude/longitude grid cell	a_CAL, passive
Low_Cloud_Amount_Ratio_Passive	Percentage of cloud amount of passive flavor at low-level altitude region reported within the latitude/longitude grid cell	a_CALR, passive
Ice_Cloud_Amount_Mean_Passive	Mean of ice cloud amount of passive flavor reported within the latitude/longitude grid cell	a_CAI, passive
Ice_Cloud_Amount_Ratio_Passive	Percentage of ice cloud amount of passive flavor reported within the latitude/longitude grid cell	a_CAIR, passive
Water_Cloud_Amount_Mean_Passive	Mean of water cloud amount of passive flavor reported within the latitude/longitude grid cell	a_CAW, passive
Water_Cloud_Amount_Ratio_Passive	Percentage of water cloud amount of passive flavor reported within the latitude/longitude grid cell	a_CAWR, passive
High_Ice_Cloud_Amount_Mean_Passive	Mean of ice cloud amount of passive flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAIH, passive
High_Ice_Cloud_Amount_Ratio_Passive	Percentage of ice cloud amount of passive flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAIHR, passive
Cloud_Amount_Mean_Column	Mean of cloud amount of column flavor reported within the latitude/longitude grid cell	a_CA, column
Cloud_Amount_Histogram_Column	Histogram of cloud amount of column flavor reported within the latitude/longitude grid cell	h_CA, column
High_Cloud_Amount_Mean_Column	Mean of cloud amount of column flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAH, column
High_Cloud_Amount_Ratio_Column	Percentage of cloud amount of column flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAHR, column

Middle_Cloud_Amount_Mean_Column	Mean of cloud amount of column flavor at middle-level altitude region reported within the latitude/longitude grid cell	a_CAM, column
Middle_Cloud_Amount_Ratio_Column	Percentage of cloud amount of column flavor at middle-level altitude region reported within the latitude/longitude grid cell	a_CAMR, column
Low_Cloud_Amount_Mean_Column	Mean of cloud amount of column flavor reported at low-level altitude region within the latitude/longitude grid cell	a_CAL, column
Low_Cloud_Amount_Ratio_Column	Percentage of cloud amount of column flavor at low-level altitude region reported within the latitude/longitude grid cell	a_CALR, column
Ice_Cloud_Amount_Mean_Column	Mean of ice cloud amount of column flavor reported within the latitude/longitude grid cell	a_CAI, column
Ice_Cloud_Amount_Ratio_Column	Percentage of ice cloud amount of column flavor reported within the latitude/longitude grid cell	a_CAIR, column
Water_Cloud_Amount_Mean_Column	Mean of water cloud amount of column flavor reported within the latitude/longitude grid cell	a_CAW, column
Water_Cloud_Amount_Ratio_Column	Percentage of water cloud amount of column flavor reported within the latitude/longitude grid cell	a_CAWR, column
High_Ice_Cloud_Amount_Mean_Column	Mean of ice cloud amount of column flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAIH, column
High_Ice_Cloud_Amount_Ratio_Column	Percentage of ice cloud amount of column flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAIHR, column
Cloud_Amount_Mean_Opaque	Mean of cloud amount of opaque flavor reported within the latitude/longitude grid cell	a_CA, opaque
Cloud_Amount_Histogram_Opaque	Histogram of cloud amount of opaque flavor reported within the latitude/longitude grid cell	h_CA, opaque
High_Cloud_Amount_Mean_Opaque	Mean of cloud amount of opaque flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAH, opaque
High_Cloud_Amount_Ratio_Opaque	Percentage of cloud amount of opaque layer flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAHR, opaque

Middle_Cloud_Amount_Mean_Opaque	Mean of cloud amount of opaque flavor at middle-level altitude region reported within the latitude/longitude grid cell	a_CAM, opaque
Middle_Cloud_Amount_Ratio_Opaque	Percentage of cloud amount of opaque layer flavor at middle-level altitude region reported within the latitude/longitude grid cell	a_CAMR, opaque
Low_Cloud_Amount_Mean_Opaque	Mean of cloud amount of opaque flavor reported at low-level altitude region within the latitude/longitude grid cell	a_CAL, opaque
Low_Cloud_Amount_Ratio_Opaque	Percentage of cloud amount of top layer flavor at low-level altitude region reported within the latitude/longitude grid cell	a_CALR, opaque
Ice_Cloud_Amount_Mean_Opaque	Mean of ice cloud amount of opaque flavor reported within the latitude/longitude grid cell	a_CAI, opaque
Ice_Cloud_Amount_Ratio_Opaque	Percentage of ice cloud amount of opaque flavor reported within the latitude/longitude grid cell	a_CAIR, opaque
Water_Cloud_Amount_Mean_Opaque	Mean of water cloud amount of opaque flavor reported within the latitude/longitude grid cell	a_CAW, opaque
Water_Cloud_Amount_Ratio_Opaque	Percentage of water cloud amount of opaque layer flavor reported within the latitude/longitude grid cell	a_CAWR, opaque
High_Ice_Cloud_Amount_Mean_Opaque	Mean of ice cloud amount of opaque flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAIH, opaque
High_Ice_Cloud_Amount_Ratio_Opaque	Percentage of ice cloud amount of opaque layer flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CAIHR, opaque
Cloud_Top_Temperature_Mean_TopLayer	Mean of cloud top temperature of top layer flavor reported within the latitude/longitude grid cell	a_CT, topLayer
Cloud_Top_Temperature_Histogram_TopLayer	Histogram of cloud top temperature of top layer flavor reported within the latitude/longitude grid cell	h_CT, topLayer
High_Cloud_Top_Temperature_Mean_TopLayer	Mean of cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CTH, topLayer
High_Cloud_Top_Temperature_Histogram_TopLayer	Histogram of cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell	h_CTH, topLayer
Middle_Cloud_Top_Temperature_Mean_TopLayer	Mean of cloud top temperature of top layer flavor at middle-level altitude region	a_CTM, topLayer

	reported within the latitude/longitude grid cell	
Middle_Cloud_Top_Temperature_Histogram_Top Layer	Histogram of cloud top temperature of top layer flavor at low-level altitude region reported within the latitude/longitude grid cell	h_CTM, topLayer
Low_Cloud_Top_Temperature_Mean_TopLayer	Mean of cloud top temperature of top layer flavor reported at low-level altitude region within the latitude/longitude grid cell	a_CTL, topLayer
Low_Cloud_Top_Temperature_Histogram_TopLayer	Histogram of cloud top temperature of top layer flavor at low-level altitude region reported within the latitude/longitude grid cell	h_CTL, topLayer
Ice_Cloud_Top_Temperature_Mean_TopLayer	Mean of ice cloud top temperature of top layer flavor reported within the latitude/longitude grid cell	a_CTI, topLayer
Ice_Cloud_Top_Temperature_Histogram_TopLayer	Histogram of ice cloud top temperature of top layer flavor reported within the latitude/longitude grid cell	h_CTI, topLayer
Water_Cloud_Top_Temperature_Mean_TopLayer	Mean of water cloud top temperature of top layer flavor reported within the latitude/longitude grid cell	a_CTW, topLayer
Water_Cloud_Top_Temperature_Histogram_TopLayer	Histogram of water cloud top temperature of top layer flavor reported within the latitude/longitude grid cell	h_CTW, topLayer
High_Ice_Cloud_Top_Temperature_Mean_TopLayer	Mean of ice cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CTIH, topLayer
High_Ice_Cloud_Top_Temperature_Histogram_TopLayer	Histogram of ice cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell	h_CTIH, topLayer
Cloud_Top_Pressure_Mean_TopLayer	Mean of cloud top pressure of top layer flavor reported within the latitude/longitude grid cell	a_CP, topLayer
Cloud_Top_Pressure_Histogram_TopLayer	Histogram of cloud top pressure of top layer flavor reported within the latitude/longitude grid cell	h_CP, topLayer
Cloud_Top_Altitude_Mean_TopLayer	Mean of cloud top altitude of top layer flavor reported within the latitude/longitude grid cell	a_CZ, topLayer
Cloud_Top_Altitude_Histogram_TopLayer	Histogram of cloud top altitude of top layer flavor reported within the latitude/longitude grid cell	h_CZ, topLayer

Cloud_Top_Temperature_Mean_Passive	Mean of cloud top temperature of passive flavor reported within the latitude/longitude grid cell	a_CT, passive
Cloud_Top_Temperature_Histogram_Passive	Histogram of cloud top temperature of passive flavor reported within the latitude/longitude grid cell	h_CT, passive
High_Cloud_Top_Temperature_Mean_Passive	Mean of cloud top temperature of passive flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CTH, passive
High_Cloud_Top_Temperature_Histogram_Passive	Histogram of cloud top temperature of passive flavor at high-level altitude region reported within the latitude/longitude grid cell	h_CT, passive
Middle_Cloud_Top_Temperature_Mean_Passive	Mean of cloud top temperature of passive flavor at middle-level altitude region reported within the latitude/longitude grid cell	a_CTM, passive
Middle_Cloud_Top_Temperature_Histogram_Passive	Histogram of cloud top temperature of passive flavor at low-level altitude region reported within the latitude/longitude grid cell	h_CTM, passive
Low_Cloud_Top_Temperature_Mean_Passive	Mean of cloud top temperature of passive flavor at low-level altitude region reported within the latitude/longitude grid cell	a_CTL, passive
Low_Cloud_Top_Temperature_Histogram_Passive	Histogram of cloud top temperature of passive flavor at low-level altitude region reported within the latitude/longitude grid cell	h_CTL, passive
Ice_Cloud_Top_Temperature_Mean_Passive	Mean of ice cloud top temperature of passive flavor reported within the latitude/longitude grid cell	a_CTI, passive
Ice_Cloud_Top_Temperature_Histogram_Passive	Histogram of ice cloud top temperature of passive flavor reported within the latitude/longitude grid cell	h_CTI, passive
Water_Cloud_Top_Temperature_Mean_Passive	Mean of water cloud top temperature of passive flavor reported within the latitude/longitude grid cell	a_CTW, passive
Water_Cloud_Top_Temperature_Histogram_Passive	Histogram of water cloud top temperature of passive flavor reported within the latitude/longitude grid cell	h_CTW, passive
High_Ice_Cloud_Top_Temperature_Mean_Passive	Mean of ice cloud top temperature of passive flavor at high-level altitude region reported within the latitude/longitude grid cell	a_CTIH, passive
High_Ice_Cloud_Top_Temperature_Histogram_Passive	Histogram of ice cloud top temperature of passive flavor at high-level altitude region reported within the latitude/longitude grid cell	h_CTIH, passive

Cloud_Top_Pressure_Mean_Passive	Mean of cloud top pressure of passive flavor reported within the latitude/longitude grid cell	a_CP, passive
Cloud_Top_Pressure_Histogram_Passive	Histogram of cloud top pressure of passive flavor reported within the latitude/longitude grid cell	h_CP, passive
Cloud_Top_Altitude_Mean_Passive	Mean of cloud top altitude of passive flavor reported within the latitude/longitude grid cell	a_CZ, passive
Cloud_Top_Altitude_Histogram_Passive	Histogram of cloud top altitude of passive flavor reported within the latitude/longitude grid cell	h_CZ, passive

Appendix H – CALIPSO/GEWEX IIR Level 3 Parameters

This section explicitly compares the SDS parameters contained in the two differing formats of CALIPSO derived data; yearly netCDF files sent to GEWEX for the multi-satellite cloud assessment and the monthly HDF format consistent with other publicly released L3 CALIPSO products. Both versions of these data products are produced from identical input data and algorithms. Daytime (D), nighttime (N), and all time (A) statistics are reported in GEWEX files with observational time in filenames set to ‘0130PM’, ‘0130AM’, and ‘0130AMPM’, respectively. However, the file structure and parameter naming contained in the files substantially differ.

Table 207 provides a translation between these two formats, as the left most column lists the SDS parameters contained in the CALIPSO monthly HDF files and the right most column gives the corresponding GEWEX parameters in *italic* and the relevant yearly netCDF file(s) available from the GEWEX Cloud Assessment Database.

Table 207: CALIPSO/GEWEX IIR Level 3 SDS Parameter Comparison

CALIPSO Parameter	Description	<i>GEWEX Parameter</i> GEWEX File(s)
Longitude_Midpoint	Longitude at grid cell midpoint	<i>longitude</i> Any file
Latitude_Midpoint	Latitude at grid cell midpoint	<i>latitude</i> Any file
Number_Of_Orbit_Tracks	Number of CALIPSO orbital tracks in grid cell	<i>n_tot</i> Any file
Cloud_Radiative_Temperature_Bin_Midpoint	Temperature at the midpoint of each bin of the cloud radiative temperature histograms.	<i>bins</i> CTI_IIR, CTW_IIR, CTIH_IIR
Cloud_Radiative_Temperature_Bin_Boundaries	Temperature at bin boundaries of the cloud radiative temperature histograms.	<i>bin_bounds</i> CTI_IIR, CTW_IIR, CTIH_IIR
Cloud_Effective_Emissivity_12_05_Bin_Midpoint	Effective emissivity at the midpoint of each bin of the cloud effective emissivity histograms.	<i>bins</i> CEMI_IIR, CEMW_IIR, CEMIH_IIR
Cloud_Effective_Emissivity_12_05_Bin_Boundaries	Effective emissivity at bin boundaries of the cloud effective emissivity histograms.	<i>bin_bounds</i> CEMI_IIR, CEMW_IIR, CEMIH_IIR
Ice_Cloud_Effective_Radius_Bin_Midpoint	Effective radius at the midpoint of each bin of the ice and high ice clouds effective radius histograms.	<i>bins</i> CREI_IIR, CREIH_IIR
Ice_Cloud_Effective_Radius_Bin_Boundaries	Effective radius at bin boundaries of the ice and high ice clouds effective radius histograms.	<i>bin_bounds</i> CREI_IIR, CREIH_IIR

Water_Cloud_Effective_Radius_Bin_Midpoint	Effective radius at the midpoint of each bin of the liquid water clouds effective radius histograms.	bins CREW_IIR
Water_Cloud_Effective_Radius_Bin_Boundaries	Effective radius at bin boundaries of the liquid water clouds effective radius histograms.	bin_bounds CREW_IIR
Cloud_Water_Path_Bin_Midpoint	Water path at the midpoint of each bin of the water path histograms for ice, high ice and liquid water clouds.	bins CIWP_IIR, CLWP_IIR, CIWPH_IIR
Cloud_Water_Path_Bin_Boundaries	Water path at bin boundaries of the water path histograms for ice, high ice and liquid water clouds.	bin_bounds CIWP_IIR, CLWP_IIR, CIWPH_IIR
Cloud_Optical_Depth_Bin_Midpoint	Optical depth at the midpoint of each bin of the cloud optical depth histograms.	bins CODI_IIR, CODW_IIR, CODIH_IIR, CODI_IIR- LIDAR, CODIH_IIR- LIDAR
Cloud_Optical_Depth_Bin_Boundaries	Optical depth at bin boundaries of the cloud optical depth histograms.	bin_bounds CODI_IIR, CODW_IIR, CODIH_IIR, CODI_IIR- LIDAR, CODIH_IIR- LIDAR
Number_Of_Valid_Pixels_IIR	Number of valid IIR pixels in the grid cell.	None
Number_Of_LEM_Rejected_Pixels_IIR	Number of IIR pixels in the grid cell rejected by the CALIOP Low Energy Mitigation algorithm.	None
Number_Of_Candidate_Clouds_IIR	Number of IIR cloudy pixels in the grid cell accepted as a pre-requisite for meaningful microphysical retrievals, before microphysics and thermodynamic phase quality filters are applied.	None
Cloud_Amount_Mean_IIR	Mean amount of candidate cloudy pixels with only ice or only liquid water clouds in the atmospheric column, regardless of the thermodynamic phase quality filters, and where IIR has confident microphysical retrievals. The mean amount in the grid cell is the average of the amounts in the individual CALIPSO orbital tracks.	None
Ice_Cloud_Amount_Mean_IIR	Mean amount of pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. The mean amount in the grid cell is the average of the amounts in the individual CALIPSO orbital tracks.	a_CAI CAI_IIR

Water_Cloud_Amount_Mean_IIR	Mean amount of pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. The mean amount in the grid cell is the average of the amounts in the individual CALIPSO orbital tracks.	a_CAW CAW_IIR
High_Ice_Cloud_Amount_Mean_IIR	Mean amount of pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. The mean amount in the grid cell is the average of the amounts in the individual CALIPSO orbital tracks.	a_CAIH CAIH_IIR
Ice_Cloud_Radiative_Temperature_Mean_IIR	Mean cloud radiative temperature at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CTI CTI_IIR
Ice_Cloud_Radiative_Temperature_Histogram_IIR	Cloud radiative temperature histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CTI CTI_IIR
Water_Cloud_Radiative_Temperature_Mean_IIR	Mean cloud radiative temperature at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CTW CTW_IIR
Water_Cloud_Radiative_Temperature_Histogram_IIR	Cloud radiative temperature histogram at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CTW CTW_IIR
High_Ice_Cloud_Radiative_Temperature_Mean_IIR	Mean cloud radiative temperature at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CTIH CTIH_IIR
High_Ice_Cloud_Radiative_Temperature_Histogram_IIR	Cloud radiative temperature histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CTIH CTIH_IIR
Ice_Cloud_Effective_Emissivity_12_05_Mean_IIR	Mean cloud effective emissivity at 12.05 microns at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CEMI CEMI_IIR

Ice_Cloud_Effective_Emissivity_12_05_Histogram_IIR	Cloud effective emissivity at 12.05 microns histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CEMI CEMI_IIR
Water_Cloud_Effective_Emissivity_12_05_Mean_IIR	Mean cloud effective emissivity at 12.05 microns at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CEMW CEMW_IIR
Water_Cloud_Effective_Emissivity_12_05_Histogram_IIR	Cloud effective emissivity at 12.05 microns histogram at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CEMW CEMW_IIR
High_Ice_Cloud_Effective_Emissivity_12_05_Mean_IIR	Mean cloud effective emissivity at 12.05 microns at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CEMIH CEMIH_IIR
High_Ice_Cloud_Effective_Emissivity_12_05_Histogram_IIR	Cloud effective emissivity at 12.05 microns histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CEMIH CEMIH_IIR
Ice_Cloud_Effective_Radius_Mean_IIR	Mean effective radius at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CREI CREI_IIR
Ice_Cloud_Effective_Radius_Histogram_IIR	Effective radius histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CREI CREI_IIR
Water_Cloud_Effective_Radius_Mean_IIR	Mean effective radius at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CREW CREW_IIR
Water_Cloud_Effective_Radius_Histogram_IIR	Effective radius histogram at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CREW CREW_IIR
High_Ice_Cloud_Effective_Radius_Mean_IIR	Mean effective radius at grid cell in pixels with only candidate high ice clouds	a_CREIH

	passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	CREIH_IIR
High_Ice_Cloud_Effective_Radius_Histogram_IIR	Effective radius histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CREIH CREIH_IIR
Ice_Water_Path_Mean_IIR	Mean ice water path at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CIWP CIWP_IIR
Ice_Water_Path_Histogram_IIR	Ice water path histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CIWP CIWP_IIR
Liquid_Water_Path_Mean_IIR	Mean liquid water path at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CLWP CLWP_IIR
Liquid_Water_Path_Histogram_IIR	Liquid water path histogram at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CLWP CLWP_IIR
High_Ice_Water_Path_Mean_IIR	Mean ice water path at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CIWPH CIWPH_IIR
High_Ice_Water_Path_Histogram_IIR	Ice water path histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CIWPH CIWPH_IIR
Ice_Cloud_Optical_Depth_Mean_IIR	Mean IIR-derived visible cloud optical depth at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CODI CODI_IIR
Ice_Cloud_Optical_Depth_Histogram_IIR	IIR-derived visible cloud optical depth histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CODI CODI_IIR

Water_Cloud_Optical_Depth_Mean_IIR	Mean IIR-derived visible cloud optical depth at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CODW CODW_IIR
Water_Cloud_Optical_Depth_Histogram_IIR	IIR-derived visible cloud optical depth histogram at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CODW CODW_IIR
High_Ice_Cloud_Optical_Depth_Mean_IIR	Mean IIR-derived visible cloud optical depth at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CODIH CODIH_IIR
High_Ice_Cloud_Optical_Depth_Histogram_IIR	IIR-derived visible cloud optical depth histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CODIH CODIH_IIR
Ice_Cloud_Optical_Depth_Mean_LIDAR	Mean CALIOP-derived visible cloud optical depth at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CODI CODI_IIR-LIDAR
Ice_Cloud_Optical_Depth_Histogram_LIDAR	CALIOP-derived visible cloud optical depth histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CODI CODI_IIR-LIDAR
High_Ice_Cloud_Optical_Depth_Mean_LIDAR	Mean CALIOP-derived visible cloud optical depth at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	a_CODIH CODIH_IIR-LIDAR
High_Ice_Cloud_Optical_Depth_Histogram_LIDAR	CALIOP-derived visible cloud optical depth histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals.	h_CODIH CODIH_IIR-LIDAR