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Cloud – Aerosol LIDAR Infrared Pathfinder Satellite Observations (CALIPSO)

Data Management System

Data Products Catalog

Document No: PC-SCI-503

Release 3.8

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Document Revision Record

The Document Revision Record below contains information pertaining to approved document changes. The table lists the date the change is issued, the Document Change Request (DCR) number, a short description of the revision, and the revised sections. The document authors are listed on the cover. The Head of the CALIPSO Data Management Team approves or disapproves the requested changes based on recommendations of the Configuration Management Board.

Table 0 - Document Revision Record

Issue Date	DCR2 Number	Description of Revision	Section Affected
03/13/2001		Initial draft document release for project review.	All
03/14/2003		Minor Updates to the Lidar Level 1B Data Product, to include several new parameters extracted from document DRD-14, Rev. A. Also moved the Lidar Housekeeping Record from the Lidar Level 1B Profile Product to the Lidar Calibration Product. Major updates to the Lidar Calibration Product based on input from the latest Lidar L1B ATBD and M. Osborne's Dec 2001 Calibration Data Product document. Major Updates to the Lidar Level 2 Data Products (DP 2.1A, DP 2.1B, DP 2.1C, and DP 2.1D) based on input from the CALIPSO Science Team. Updates to the IIR Level 1 Data Products to reflect new specifications provided in the latest CALIPSO Processing Requirements Document provided by CNES. Updates to the IIR Calibration Data Products to incorporate specific comments received from A. Lifermann. Also removed the Housekeeping Record until further requirements are defined. Updates to the IIR Level 2 Data Products based on input from A. Garnier. Updates to the WFC Level 1A and WFC Calibration Data Products based on the latest WFC ATBD and input from the CALIPSO Science Team. General revisions to include: 1) Changes to the daily and monthly product sizes in Table 1 and Table 2 due to extensive revisions to the Lidar Level 1 and Level 2 data products; 2) changes to the Level 0 Input Data Product Summary file sizes based on the most recent BATC DRD-14 document dated Aug. 29, 2002; 3) changes to the calibration product sizes due to a change in the time interval covered (from one orbit to 24 hours); and 4) the addition of underscores to all parameter names to be consistent with the appearance of the output from the CALIPSO Data Management software.	

Issue Date	DCR2 Number	Description of Revision	Section Affected
04/02/2003		Added A. Garnier to list of authors; updated date on IIR L2 Reference Document; added blind pixel image and note to the IIR L1 Calibration product; made extensive changes to the L4 Flux Science Record based on comments received from T. Charlock.	1.0, 2.10, 5.2
08/25/2004		Numerous formatting and organizational changes were made to improve the readability of the document; no DPC content changes were made.	All
08/31/2004	CCR #001	Meteorological profiles were added to the Lidar Level 1B Profile Products, and units were specified for all temporal and geophysical parameters.	1.0, 2.1
	CCR #002	The measurement altitudes were added to the metadata records associated with the Lidar Level 1B Profile Products, the Lidar Level 2 Aerosol Profile Products, and the Lidar Level 2 Cloud Profile Products.	1.0, 2.1, 2.5, 2.6
10/21/2004	CCR #003	The following fields were removed from the Lidar Level 2 Cloud and Aerosol Layer Products: • Column_Reflectance_1064 • Column_Reflectance_Uncertainty_1064 • Column_Reflectance_RMS_Variation_1064	2.0, 2.4
	CCR #004	The array size specified for the range resolved parameters included in the Lidar Level 2 Aerosol Profile Products was changed from 140 elements to 190 elements.	1.0, 2.5
12/08/2004	CCR #005	The following revisions were made to the Lidar Level 2 Cloud and Aerosol Layer Products: • the number of the tables describing the layer products was increased, and their structure slightly modified, in order to correctly reflect the CALIPSO data product distribution strategy (i.e., the layer products will be made available as four separate files) • the Viewing_Zenith_Angle and Viewing_Azimuth_Angle parameters were removed, and replaced with a single Off_Nadir_Angle parameter • units and ranges were specified for numerous parameters	1.0, 2.4
	CCR #006	The author list was updated, and several cosmetic repairs were made; no DPC content changes were made.	Pg ii, v
	CCR #007	The IIR Level 1B Radiances data product listing was updated consistent with changes made to the IIR Level 1 Requirements document.	1.0, 2.2, 2.8, 5.0, All
	CCR #008	The Wide Field Camera Level 1 Data Product was completely rewritten. All parameters previously reported as either pseudo-radiance or pseudo-reflectance are now being reported as, respectively, radiance and reflectance. In addition, the following tables were removed: • 1 km Registered Geolocation and Viewing Geometry • 125 m Native Geolocation and Viewing Geometry • 5 km Packet Record Several wide field camera raw data products were added to the Engineering Data Products section.	1.0, 2.3, 5.3, 5.4
	CCR #009	To make the DPC consistent with the specifications given in the SPIRS Input-Output Catalog, the IIR/Lidar Track Product was reorganized, and new content added as necessary.	1.0, 2.8, 2.9
	CCR #010	The longitude range in the WFC Level 1A 1 km Native Science Record was changed from –90°…90° to –180°…180°.	2.3
	CCR #011	Within the Lidar Level 2 Vertical Feature Mask Product (VFM), (a) revisions were made to the cloud types and stratospheric feature classifications reported, and (b) the number of feature subtype QA designations was reduced from 4 to 2. The latter change reduces the size of the VFM data product by approximately half.	1.0, 2.7
12/20/2004		Added updated Data flow Diagram; revised section numbering.	All

Issue Date	DCR2 Number	Description of Revision	Section Affected
01/06/2005	CCR #013	In section 2.3.1, the "WFC record summary" was expanded from a single table specifying a single WFC data product to three tables specifying three separate data products at different spatial resolutions.	1.0, 2.2, 2.8, 5.0, All
01/10/2005		Various formatting changes and improvements made throughout: acronyms and symbols tables updated.	All
03/03/2005	CCR #018	Remove remaining references to GLAS lidar ratio. Delete Table 39 and remove references to Table 39. Rename Table 37 to Best-estimate Lidar Ratio.	2.5
03/10/2005	CCR #020	Amend Tables 31 and 33 (5 km Column Descriptor Record: Clouds/Aerosols) to include feature-finder QC flag computed for each 5 km segment.	2.4
03/10/2005	CCR #021	Amend Tables 32 and 34 (5 km Layer Descriptor Records: Clouds/Aerosols) to include (a) the numerical result returned by the cloud-aerosol discrimination (CAD) algorithm, and (b) the extinction QC flag computed for each feature.	2.4
03/10/2005	CCR #022	Amend Table 32 (5 km Layer Descriptor Records: Clouds) to include the result returned by the cirrus cloud shape parameter algorithm.	2.4
05/18/2005	CCR #017	Amend Tables 10, 27, 29, and 31 (profile product and column descriptors) to include NSIDC map data.	2.1, 2.4
05/18/2005	CCR #023	Update the IGBP land cover description and legend.	4.6
05/20/2005	CCR #025	Updates to Lidar Tables 7 (remove unused calibration records), 9 (add off-nadir angle). Removed Table 63 (Lidar Daytime 1064 Calibration Record) and combined with Table 61 (Lidar 1064 Calibration Record (nighttime and daytime). Renumbered all Tables from 64 – 83, to 63 – 83. Updated the Lidar Calibration Product Tables (57 - 62) and Lidar Depolarization Gain Ratio Record Table (63).	2.1, 5.1 - 5.4, Appendix A
09/30/2005	CCR #026	Updated the references to coordinate and time formats throughout the entire catalog.	All
09/30/2005	CCR #027	Update the contents of the IIR level 1 data products. Major revisions included changing Int values to UInt, revising parameter names, and adding parameters. The tables revised include: Tables 67, 68, 69, 72, 73, and 74.	2.2, 5.2
09/30/2005	CCR #028	Updated WFC Tables 18, 19, and 21 to add total number of processes, and day/night packets; reflectance and solar zenith minimums and maximums (18), reordered parameters (19), added reflectance bins parameters (20 and 21). The summary Tables 15, 16, and 17 were updated to include changes above. Table 77, WFC Calibration Record, was reordered and 1 km and 125 m pixel value minimums and maximums were added. Table 75 was updated to include changes to Table 77.	2.3, 5.3
09/30/2005	CCR #029	Changed length of Date_Time_of_Production fields in Track and Swath products for consistency with other time fields (Tables 47, 50). Made editing changes to Tables 50 and 51.	2.8, 2.9
09/30/2005	CCR #030	Added Cal_Region_Top_Altitude_532 to Table 7. Added Spacecraft_Altitude to Table 8.	2.1
09/30/2005	CCR #031	Added aerosol data altitudes to "Lidar Aerosol Profile Metadata Record", Table 36. Update the number of elements per record for all atmospheric profile data (including altitude arrays) was changed from 190 elem/record to 199 elem/record. The numbers of bytes per record were updated to match the number of elements. Revised Tables 37 and 38.	2.5
09/30/2005	Edits only	Updated parameter names to match the production code. Revised Tables 26, 27, 28, 29, 30, 31, 32, 33, 34, and 43.	2.4, 2.7

Issue Date	DCR2 Number	Description of Revision	Section Affected
09/30/2005	CCR #032	Remove Table 64 (Lidar Instrument Settings Record) and Table 65 (Lidar Housekeeping Record). All table numbers in the following sections were updated. Listed here are old table numbers. Section 5.2 "IIR Calibration" (Tables 66-74), Section 5.3 "WFC Calibration" (Tables 75-77), Section 5.4 "WFC Raw Data" (Tables 78-80), and Appendix A (Table 81).	5.1, 5.2, 5.3, 5.4
09/30/2005	N/A	CALIOP Data Products Catalog Version 2.1, includes CCRs through #032.	All
02/22/2006	CCR #033	Version 2.2. 1. Changed all N/A under the Units Table entries to NoUnits for all Lidar and WFC tables. 2. Updated Reference Publication page to include latest project documentation numbers and titles for ATBDs. 3. Revised acronyms and symbols tables (added CAPS, DPC, and CALIOP, added volts). 4. Changed shots per second to 20.16 (from 20.25 – 2 places in document). 5. Updated Section 1.0 Introduction including text, Figure 1, and Tables 1, 4, and 5 to add DPC reference Tables. 6. Revised the conversion from bytes to Mbytes. Old conversion equation: 7. Mbytes = bytes/1000000. New conversion equation: Mbytes = bytes/1048576. Affects Tables 1-6, 11,15-17, 22-25, 35, 39, 42, 46, 49, 52, 57, 64, 73, and 76. 8. Section 2.0 Archival Data Products: a. Added UTC CCSDS and TAI time parameter descriptions b. Corrected the description of columns in the DPC Tables c. Added the data file name category to data attributes (included data file name in every section) 9. Section 2.1 Lidar Level 1B Profiles DP 1.1: a. Revised Tables to match the HDF files. Revised Tables 7-10. 10. Section 2.4 Lidar Level 2 Cloud and Aerosol Layer Products DP 2.1A: a. Revised Tables to match the HDF files. Revised Tables 26, 28, 30, 31, 32, 33, 34. 11. Section 2.5 Lidar Level 2 Aerosol Profile Data Product DP 2.1B: a. Revised Tables to match the HDF files. Revised Tables 35, 36, 37, and 38. 12. Section 2.6 Lidar Level 2 Cloud Profile Data Product DP 2.1C: a. Revised Tables to match the HDF files. Revised Tables 40, 41, and 43. 13. Section 2.7 Lidar Level 2 Vertical Feature Mask Data Product DP 2.1D: a. Revised Tables to match the HDF files. Revised Table 44. 14. Section 5.1 Lidar Calibration: a. Revised Tables to match the HDF files. Removed parameters. Revised Tables 58-63. 15. Section 5.2.3 IIR Calibration Scientific Data Sets: a. Revised Table 72 to include a comma in the Bytes column data.	All
02/22/2006	CCR #034	1. Section 2.3.3 WFC Level 1 Scientific Data Sets: a. Added solar and viewing azimuth and zenith angle parameters, Table 20. 2. Section 5.3 WFC Calibration: a. Divided Table 75 into Table 75 and 76 for clarity of SDS parameters. This created a new Table 76. b. Renumbered old Tables 76 – 78. 3. Appendix A a. Renumbered Tables 79 and 80.	2.3.3, 5.3, Appendix A

Issue Date	DCR2 Number	Description of Revision	Section Affected
12/08/2006	CCR #035	Section 2.8 IIR/Lidar Track Product DP 2.2A Updated IIR Level 2 Tables 47, 48, 50, and 51 to include editing changes to Units and Range elements.	2.8
12/08/2006	CCR #036	Added UTC time to Tables 10, 13, 14, 19, 20, 21, 27, 29, 31, 33, 44, 59, 60, 61, 62, 63, 66, 67, 70, 71, 75, and 79.	2.1, 2.2, 2.3, 2.4, 2.7, 5.1, 5.2, 5.3
01/17/2007	CCR #037	Modified Lidar Level 2 data products to include an extinction QC flags at both 532 nm and 1064 nm	2.4
01/16/2007	CCR #038	Added Column Reflectances to the Lidar Level 1 Data Products	2.1
01/23/2007	CCR #039	Added relative humidity, surface wind speeds, and tropopause height and temperature to the Level 1 data products	2.1
01/16/2007	CCR #040	Added "Lidar Reflectance" (aka "lidar albedo") to the Lidar Level 2 Data Products	2.4
10/12/2007	CCR #041	Feature Finder Quality Flags, V02	2.4
10/04/2007	CCR #042	Data Products Catalog – updated document to make all sections consistent.	All
10/05/2007	CCR #043	Updated the contents of LIDAR Level 1B and calibration output files.	2.1
11/29/2007	CCR #044	Included GEOS-5 content into DPC with minor updates to document.	References, Acronyms, 4.3, Tables 7, 26, 36, 40, 43, 47, 50, 58
12/01/2007	CCR #045	Lidar Level 2 Data products additions for the Version 2.0 release.	Tables 26, and 37
12/01/2007	CCR #046	Added the Spacecraft_Position parameter allowing users to calculate the location of each sample when CALIPSO goes to a 3 degree pitch. This parameter was added to Tables: 27, 29, 31, 33, and 44.	2.4.3 and 2.7.3
		Data Products Catalog – Version 3.0	
10/01/2008	CCR #047	Added new Level 2 parameters, layer top pressure, layer base pressure, layer mid-point pressure, layer top temperature, and layer base temperature to Tables 28, 30, 32, and 34.	2.4.3
10/14/2008	CCR #048	Added new parameters to both the cloud (Tables 39 and 40) and aerosol (Tables 36 and 37) profile products. These include extinction QC flags, CAD scores, re-worked atmospheric volume description array, column optical depths for cloud, aerosol, and stratospheric layers, and intial lidar ratios for all cloud, aerosol, and stratospheric subtypes. Removed Table 38 "Lidar 40km Aerosol Profile Record, Fixed Lidar Ratio". Replaced Table 37 "Lidar 40 km Aerosol Profile Record, Best-estimage Lidar Ratio" with "Lidar 5 km Aerosol Profile Record, Best-estimage Lidar Ratio".	2.5 and 2.6
11/04/2008	CCR #049	Added the parameters, Orbit_Number_at_Granule_Start, Orbit_Number_at_Granule_End, Orbit_Number_Change_Time, Path_Number_at_Granule_Start, Path_Number_at_Granule_End, and Path_Number_Change_Time in file metadata record in Tables: 7, 12, 18, 26, 36, 39, 42, 46, 49, 52, 57, 64, 73, and 77.	2.1.2, 2.2.2, 2.3.2, 2.4.2, 2.5.2, 2.6.2, 2.7.2, 2.8.2, 2.9.2, 2.10, 5.1.2, 5.2.2, 5.3.2, and 5.4.2

Issue Date	DCR2 Number	Description of Revision	Section Affected
11/07/2008	CCR #050	Added “single shot cloud cleared fraction” to 5 km cloud and aerosol layer products to Tables 32 and 34.	2.4.3
11/06/2008	CCR #051	Added column optical depths to layer products to Tables 31 and 33.	2.4.3
11/14/2008	CCR #053	Added 1064 nm column optical depths to profile products to Tables 37 and 41.	2.5.3 and 2.7.1
11/07/2008	CCR #052	Deleted the “fixed lidar ratio” aerosol profile products from Table 38.	2.5.3
02/21/2009	CCR #056	The IGBP max value needed to be updated in Tables 10, 27, 29, 31, and 33. Updated link in section 4.6.	2.1.3, 2.4.3, and 4.6.
02/21/2009	CCR #054	Added an opacity flag to the 1/3 km and 1 km cloud layer products.	
04/20/2008	CCR #055	Removed fixed lidar ratio layer products in Table 33.	2.4.3
06/17/2009	Edits Only	Modified pages 6-7 such that the text in reflects the lidar level 1 version naming convention. Adjusted spacing for content to fit on one page.	2.0
08/04/2009	Edits Only	Corrected file name convention example. Activated Table of Contents to be linked to sections within the document.	1.0, TOC
		Data Products Catalog – Version 3.1	
09/17/2009	CCR #059	Added Rayleigh backscatter and extinction cross-sections and ozone absorption cross-sections to the lidar meta data included with the lidar data products to Tables 7, 36, and 39.	2.1.2, 2.5.2
04/08/2009	CCR #057	Updated Table 44 to indicate that the Ice/Water Phase type 3 (formerly “mixed phase”) now indicates “oriented ice crystals.”	2.7.3
10/28/2009	CCR #058	Replaced some of the TBDs and N/As in the range column for the following tables: 7 (Product_ID, Rayleigh_Extinction_Cross-section_532, Rayleigh_Extinction_Cross-section_1064, Rayleigh_Backscatter_Cross-section_532, Rayleigh_Backscatter_Cross-section_1064, Ozone_Absorption_Cross-section_532, and Ozone_Absorption_Cross-section_1064), 9 (Surface_Altitude_Shift, Number_Bins_Shift), 10 (Profile_ID, Land_Water_Mask, NSIDC_Surface_Type, Frame_Number, Lidar_Mode, Lidar_Submode, QC_Flag, QC_Flag_2), 12 (Product_ID), 18 (Product_ID), 26 (Product_ID), 36 (Product_ID, Rayleigh_Extinction_Cross-section_532, Rayleigh_Extinction_Cross-section_1064, Rayleigh_Backscatter_Cross-section_532, Rayleigh_Backscatter_Cross-section_1064, Ozone_Absorption_Cross-section_532, and Ozone_Absorption_Cross-section_1064), 39 (Product_ID, Rayleigh_Extinction_Cross-section_532, Rayleigh_Extinction_Cross-section_1064, Rayleigh_Backscatter_Cross-section_532, Rayleigh_Backscatter_Cross-section_1064, Ozone_Absorption_Cross-section_532, and Ozone_Absorption_Cross-section_1064), 42 (Product_ID), 46 (Product_ID), 49 (Product_ID), 57 (Product_ID), 64 (Product_ID), 77 (Product_ID), and 77 (Product_ID).	2.1.2, 2.1.3, 2.2.2, 2.3.2, 2.4.2, 2.5.2, 2.6.2, 2.7.2, 2.8.2, 2.9.2, 5.1.2, 5.2.2, 5.3.2, 5.4.2
11/10/2009	CCR #060	Added additional publications to the Reference section (item #19).	References
11/20/2009	CCR #061	Removed references subsystem 4.1. The entire section of 2.10 was removed from this version of the document. The CALIPSO team is not producing this product.	2.10
01/10/2010	CCR #062	Added ‘layer base extended’ information to the 5 km cloud and aerosol layer products.	2.4.3
01/10/2010	CCR #063	Added column optical depth uncertainties to all 5 km lidar level 2 data products.	2.4.3, 2.5.3, 2.6.3

Issue Date	DCR2 Number	Description of Revision	Section Affected
01/10/2010	CCR #064	Added classifier coefficients file information to metadata for all lidar level 2 data products.	2.4.2
17 01/11/2010	CCR #065	Modified the Primary Authors Page reflecting latest authors to this document.	Page ii
02/21/2010	CCR #066	Added the parameter, Day_Night_Flag to Tables 37 and 40.	2.5.3, 2.6.3
02/21/2010	CCR #067	Revised the reporting of Latitude, Longitude, TIA Time, and UTC Time in the Profile products.	2.6.3
02/16/2010	CCR #068	Added the CAD_Score parameter to the 1 km cloud layer product Table 30.	2.4.3
03/09/2010	CCR #069	Made major improvements to this document in support of the Lidar level 2 Version 3.01 data release.	All
		Data Products Catalog – Version 3.2	
08/09/2010	CCR #070	Corrected units for the parameters, Total_Attenuated_Backscatter_532, Perpendicular_Attenuated_Backscatter_532, and Attenuated_Backscatter_1064, in Table 10.	2.1.3
		Data Products Catalog – Version 3.3	
01/19/2011	CCR #071	Updated tables in support of the IIR Level 2 version 3.01 data release.	1, 2.8, 2.9
05/16/2011	CCR #072	Added section 6, “Special Purpose Data Products”. The first data product in this section is called Lidar Level 1.5 Expedited Data.	6, Appendix A
05/26/2011	CCR #073	Added a new Appendix B that provides the flag values for selected IIR Level 2 track and swath science parameters.	2.8.3, 2.9.3, Appendix B
05/15/2011	CCR #074	Corrected WFC table reference number in Table 4.	1.0
		Data Products Catalog – Version 3.4	
12/12/2011	CCR #075	Added a new section 2.10 supporting the new Lidar Level 3 Aerosol Profile Monthly Product.	1.0, 2.10
12/07/2011	CCR #076	Updated minor syntax within the document.	Page x, 1.0, Appendix B
12/21/2011	CCR #077	Updated the data production diagram to include the Lidar Level 3 product.	1.0
		Data Products Catalog – Version 3.5	
08/23/2012	CCR #078	In table 44, in the last row, change the word course to coarse.	2.7.3
01/08/2013	CCR #079	The entire document was updated reflecting the new expedited products that are produced for each instrument. The IIR section of the document was updated reflecting the order of the parameters as well as correcting information that matches the data files produced. Removed Section 5 – Engineering Data Products from the document.	All
		Data Products Catalog – Version 3.6	
07/26/2013	CCR #083	Update the DPC to include the AFWA file format/version change	1, 4.7
07/26/2013	CCR #084	Update the DPC to include GMAO file format/version change	1, 4.3
07/01/2013	CCR #085	Update the DPC to include AFWA and PSC Mask in the Production flow diagram – Figure 1	1
07/26/2013	CCR #086	Add New Polar Stratospheric Cloud Data Product into the DPC	2.8, remainder of DPC
07/26/2013	CCR #087	Modify DPC as needed (minor changes)	1

Issue Date	DCR2 Number	Description of Revision	Section Affected
07/26/2013	CCR #092	Updated Figure 1 to correct the production flow for the Lidar Level 1.5 data product	1
08/28/2013	CCR #089	Updated the Core Metadata Table to match produced data	Appenidx A
		Data Products Catalog – Version 3.7	
05/16/2013	CCR #080	Add additional parameters in the Lidar Level 1 Metadata Record. They are: GMAO_Files_Used and Snow_Ice_Files_Used.	2.1.2
05/16/2013	CCR #081	Add additional parameters in the Lidar Level 1 Metadata Record. They are: ScatteringRatioIn532NightCalibrationRegion, ScatteringRatioIn532NightCalibrationRegionUncertainty, MolecularModelUncertainty, CirrusBackscatterColorRatio, and CirrusBackscatterColorRatioUncertainty	2.1.2
02/12/2013	CCR #082	Add 'surface saturation flag', 'surface saturation index' and 'negative signal anomaly index' to the lidar level 1b data product	2.1.3
08/27/2013	CCR #090	Replace Product_ID for Lidar Level 1 in table 7. Applies for Version 4.	2.1.2
08/29/2013	CCR #091	Change parameter name in table 10 NSIDC_Surface_Type to Snow_Ice_Surface_Type. Applies in Version 4.	2.1.3
08/29/2013	CCR #093	Update file sizes because of changes in CCRs #80, #81, and #82. The file sizes were modified in tables 1, 7, and 10.	1.1, 2.1.2, 2.1.3
09/12/2013	CCR #094	Change nominal range for TAI and UTC times for Lidar Level 1 data version 4.0.	2.1.2, 2.1.3, Appendix A
11/19/2013	CCR #095	Update the nominal ranges in the tables in section 2.1 in support of the Version 4 release.	2.1.3
11/18/2013	CCR #088	Add wording describing Version 4.0 Lidar Level 1.	1.1, 2.1
12/13/2013	CCR #096	Replace data manager name on the signature page (iii).	iii
01/30/2014	CCR #097	Add GMAO surface altitudes to lidar level 1B data product.	2.1.3
02/18/2014	CCR #098	Lidar Level 1 Quality Check Flags added as an appendix	Appendix B, Appendix C
03/03/2014	CCR #099	Update Data Quality Check Flag 2 account for 1064 nm transient response to temperature	2.1.3, Appendix B
06/18/2014	CCR #100	Update the DPC signature page and author page.	ii, iii, iv
07/11/2014	CCR #101	Update the WFC File Sizes due to SES Angle Collect change.	2.3.1
07/11/2014	CCR #102	Add additional WFC data products file sizes to Table 1.	1.1
		Data Products Catalog – Version 3.8	
08/25/2015	CCR #103	Update Lidar Level 3 Aerosol Profile product content generated for the Version 3 release.	1.1, 2.11
08/24/2015	CCR #104	Update the out of date link to the IGBP Land Cover Legend.	4.6

DOCUMENT REVISION RECORD V
REFERENCE DOCUMENTS XIX
ACRONYMS XXII
SYMBOLS, SI UNITS XXIII
DATA TYPE ABBREVIATIONS XXIV
1.0 INTRODUCTION 1
1.1 CALIPSO DATA PRODUCTS 1
2.0 ARCHIVAL DATA PRODUCTS 11
2.1 LIDAR LEVEL 1B PROFILES DP 1.1 13
2.1.1 LIDAR INSTRUMENT LEVEL 1 DATA PRODUCT 14
2.1.2 LIDAR INSTRUMENT LEVEL 1 DATA METADATA 15
2.1.3 LIDAR INSTRUMENT LEVEL 1 DATA SCIENTIFIC DATA SETS 17
2.2 IIR LEVEL 1B RADIANCES DP 1.2 20
2.2.1 INFRARED IMAGING RADIOMETER LEVEL 1 DATA PRODUCT 21
2.2.2 IIR LEVEL 1 METADATA 22
2.2.3 IIR LEVEL 1 SCIENTIFIC DATA SETS 23
2.3 WFC LEVEL 1B SCANS DP 1.3 25
2.3.1 WIDE FIELD CAMERA LEVEL 1 DATA PRODUCT 26
2.3.2 WFC LEVEL 1 DATA METADATA 28
2.3.3 WFC LEVEL 1 SCIENTIFIC DATA SETS 29
2.4 LIDAR LEVEL 2 CLOUD AND AEROSOL LAYER PRODUCTS DP 2.1A 31
2.4.1 LIDAR LEVEL 2 CLOUD AND AEROSOL LAYERS RECORD SUMMARY 33
2.4.2 LIDAR CLOUD & AEROSOL LEVEL 2 METADATA 35
2.4.3 LIDAR CLOUD & AEROSOL LEVEL 2 SCIENTIFIC DATA SETS 36
2.5 LIDAR LEVEL 2 AEROSOL PROFILE DATA PRODUCT DP 2.1B 45
2.5.1 LIDAR LEVEL 2 AEROSOL PROFILE DATA SUMMARY 46
2.5.2 LIDAR AEROSOL PROFILE DATA METADATA 47
2.5.3 LIDAR AEROSOL PROFILE DATA SCIENTIFIC DATA SETS 48
2.6 LIDAR LEVEL 2 CLOUD PROFILE DATA PRODUCT DP 2.1C 50
2.6.1 LIDAR CLOUD PROFILE DATA RECORD SUMMARY 52
2.6.2 LIDAR CLOUD PROFILE DATA METADATA 53
2.6.3 LIDAR CLOUD PROFILE SCIENTIFIC DATA SETS 54
2.7 LIDAR LEVEL 2 VERTICAL FEATURE MASK DATA PRODUCT DP 2.1D 56
2.7.1 LIDAR VERTICAL FEATURE MASK DATA RECORD SUMMARY 58
2.7.2 LIDAR VERTICAL FEATURE MASK METADATA 59

2.7.3 LIDAR VERTICAL FEATURE MASK SCIENTIFIC DATA SETS 60
2.8 LIDAR LEVEL 2 POLAR STRATOSPHERIC CLOUDS PRODUCT DP 2.3 62
2.8.1 LIDAR CLOUD PROFILE DATA RECORD SUMMARY 63
2.8.2 LIDAR POLAR STRATOSPHERIC CLOUD DATA METADATA 64
2.8.3 LIDAR POLAR STRATOSPHERIC CLOUD SCIENTIFIC DATA SETS 65
2.9 IIR/LIDAR TRACK PRODUCT DP 2.2A 66
2.9.1 IIR/LIDAR TRACK PRODUCT 67
2.9.2 IIR/LIDAR TRACK METADATA 68
2.9.3 IIR/LIDAR TRACK SCIENTIFIC DATA SETS 70
2.10 IIR LEVEL 2 SWATH PRODUCT DP 2.2B 72
2.10.1 IIR LEVEL 2 SWATH PRODUCT 73
2.10.2 IIR SWATH METADATA 74
2.10.3 IIR SWATH SCIENTIFIC DATA SETS 76
2.11 LIDAR LEVEL 3 AEROSOL PROFILE PRODUCT DP 3.1 78
2.11.1 LIDAR AEROSOL DATA SUMMARY DP 3.1 79
2.11.2 LIDAR AEROSOL DATA PRODUCT METADATA 80
2.11.3 LIDAR LEVEL 3 AEROSOL DATA PRODUCT SCIENTIFIC DATA SETS 80
3.0 LEVEL 0 INPUT DATA PRODUCTS 85
3.1 LIDAR LEVEL 0 DATA 85
3.2 IMAGING INFRARED RADIOMETER LEVEL 0 DATA 86
3.3 WIDE FIELD CAMERA LEVEL 0 DATA 87
4.0 ANCILLARY INPUT DATA PRODUCTS 88
4.1 EPHEMERIS DATA 88
4.2 ATTITUDE DATA 88
4.3 GLOBAL MODELING AND ASSIMILATION OFFICE (GMAO) 88
4.4 SDP TOOLKIT DIGITAL ELEVATION MODEL (DEM) 89
4.5 SDP TOOLKIT LAND AND WATER COVERAGE 89
4.6 INTERNATIONAL GEOSPHERE BIOSPHERE PROGRAMME (IGBP) ECOSYSTEM 89
4.7 AIR FORCE WEATHER AGENCY SNOW AND ICE MAP 91
5.0 SPECIAL PURPOSE DATA PRODUCTS 92
5.1 LIDAR LEVEL 1.5 DATA PRODUCT 92
5.1.1 LIDAR LEVEL 1.5 DATA PRODUCT 93
5.1.2 LIDAR LEVEL 1.5 DATA METADATA 93
5.1.3 LIDAR LEVEL 1.5 DATA SCIENTIFIC DATA SET 94
5.1.4 L2_FEATURE_TYPE VALUES 95

APPENDIX A **97**
APPENDIX B **99**
APPENDIX C **101**

List of Figures

Figure 1: CALIPSO Top Level Data Flow Diagram 3

List of Tables

Table 1: CALIPSO Science Archival Data Product Summary 7
Table 2: CALIPSO Level 0 Input Data Product Summary 10
Table 3: CALIPSO Ancillary Input Data Product Summary 10
Table 4: CALIPSO Engineering Data Product Summary 10
Table 5: CALIPSO DMS Total 10
Table 6: Lidar Instrument Record Summary 14
Table 7: Lidar Metadata Record 15
Table 8: Lidar Spacecraft Position, Attitude, and Celestial Record 17
Table 9: Lidar Profile Geolocation and Viewing Geometry 17
Table 10: Lidar Profile Science Record 18
Table 11: IIR Record Summary 21
Table 12: IIR Level 1 Metadata Record 22
Table 13: IIR Spacecraft Position, Attitude, and Celestial Record (1 per Earth view) 23
Table 14: Earth View Record (1 per grid line) 24
Table 15: WFC Record Summary - 1 km Registered Science 26
Table 16: WFC Record Summary - 1 km Native Science 27
Table 17: WFC Record Summary - 125 m Native Science 27
Table 18: WFC Level 1 Metadata Record 28
Table 19: 1 km Registered Science Record 29
Table 20: 1 km Native Science Record 29
Table 21: 125 m Native Science Record 30
Table 22: 1/3 km Lidar Cloud Layer Record Summary 33
Table 23: 1 km Lidar Cloud Layer Record Summary 33
Table 24: 5 km Lidar Cloud Layer Record Summary 33
Table 25: 5 km Lidar Aerosol Layer Record Summary 34
Table 26: Lidar Cloud & Aerosol Level 2 Layer Metadata Record 35
Table 27: Lidar 1/3 km Column Descriptor Record: Clouds 36
Table 28: Lidar 1/3 km Layer Descriptor Record: Clouds 37
Table 29: Lidar 1 km Column Descriptor Record: Clouds 38
Table 30: Lidar 1 km Layer Descriptor Record: Clouds 38
Table 31: Lidar 5 km Column Descriptor Record: Clouds 39

Table 32: Lidar 5 km Layer Descriptor Record: Clouds 41
Table 33: Lidar 5 km Column Descriptor Record: Aerosols 42
Table 34: Lidar 5 km Layer Descriptor Record: Aerosols 43
Table 35: Lidar Level 2 Aerosol Profile Data Record Summary 46
Table 36: Lidar Level 2 Aerosol Profile Metadata Record 47
Table 37: Lidar 5 km Aerosol Profile Record 48
Table 38: Lidar Cloud Profile Data Record Summary 52
Table 39: Lidar Cloud Profile Metadata Record 53
Table 40: Lidar 5 km Cloud Profile Record 54
Table 41: Lidar Vertical Feature Mask Data Record Summary 58
Table 42: Lidar Vertical Feature Mask Metadata Record 59
Table 43: Lidar Vertical Feature Mask Record 60
Table 44: Feature Classification Flag Definition 60
Table 45: Lidar Polar Stratospheric Cloud Profile Data Record Summary 63
Table 46: Lidar Polar Stratospheric Cloud Profile SDS Metadata Record 64
Table 47: Lidar Polar Stratospheric Cloud Record 65
Table 48: IIR/Lidar Track Product Summary 67
Table 49: IIR/Lidar Track Metadata Record 68
Table 50: IIR/Lidar Track Science Record 70
Table 51: IIR Swath Product Summary 73
Table 52: IIR Swath Product Metadata Record 74
Table 53: IIR Swath Product Science Record 76
Table 54: Lidar Aerosol Data Record 79
Table 55: Lidar Aerosol Metadata Record 80
Table 56: Spatial Coordinates 80
Table 57: Meteorological Context 80
Table 58: Surface and Overflight Parameters 81
Table 59: Static Lidar Parameters 81
Table 60: Aerosol Optical Properties - All Species 81
Table 61: Aerosol Optical Properties - Dust Only 82
Table 62: Aerosol Optical Properties - Smoke Only 82
Table 63: Aerosol Optical Properties – Polluted Dust Only 83
Table 64: Aerosol Type Distribution 83
Table 65: Aerosol Spatial Distribution - All Species 83
Table 66: Aerosol Spatial Distribution - Dust Only 83
Table 67: Aerosol Spatial Distribution - Smoke Only 84
Table 68: Aerosol Spatial Distribution – Polluted Dust Only 84
Table 69: On-orbit Lidar Profile Horizontal and Vertical Averaging for 532 nm 85

Table 70: On-orbit Lidar Profile Horizontal and Vertical Averaging for 1064 nm 85
Table 71: Lidar Level 1.5 Instrument Record Summary 93
Table 72: Lidar Level 1.5 Metadata Record 93
Table 73: Static Lidar Data 94
Table 74: Lidar Profile Data 94
Table 75: Core Metadata Record Vdata 97
Table 76: Archive Metadata Record Vdata 98
Table 77: Bit Assignments for the first QC Flag (1) 99
Table 78: Bit Assignments for the second QC Flag (2) 100
Table 79: Effective_Particle_Size_Uncertainty (track and swath) 101
Table 80: High_Cloud_vs_Background_Flag (track) 101
Table 81: IIR_Data_Quality (swath) and IIR_Data_Quality_Flag (track) 102
Table 82: Lidar_DayNight_Flag (swath) 102
Table 83: Lidar_Quality_Flag (track) 102
Table 84: Microphysics (track) 102
Table 85: Multi_Layer_Cloud_Flag (track) 103
Table 86: Particle_Shape_Index (track and swath) 103
Table 87: Particle_Shape_Index_Confidence (track and swath) 103
Table 88: Regional_Background_Standard_Deviation_Flag (track) 103
Table 89: Scene_Flag (swath) 103
Table 90: Surrounding_Obs_Quality_Flag (track) 104
Table 91: Type of Scene (track) 105

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.

Data products are released by version. In support of the different versions, quality summaries are written explaining the detailed information supporting the parameters. Quality summaries are available at the Atmospheric Science Data Center, https://eosweb.larc.nasa.gov/project/calipso/calipso_table.

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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
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
LSWG	Lidar Science Working Group
MET	Meteorological Data
MOCC	Mission Operations Control Center
N/A	Not Applicable, Not Available
NISE	Near Real-Time Ice and Snow Extent

Acronyms

NSIDC	National Snow and Ice Data Center
PDDS	Payload Data Delivery System
PGE	Program Generation Executable
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
TAI	International Atomic Time
TBD	To Be Determined
TRMM	Tropical Rainfall Measuring Mission
UNL	University of Nebraska-Lincoln
USGS	U.S. Geological Survey
UTC	Universal Time Conversion
VFM	Vertical Feature Mask
WFC	Wide Field Camera

Symbols, SI Units

AU	astronomical unit
deg	degree
°C	degree Celsius
J	joule
K	kelvin
km	kilometer
m	meter
mb	millibar
ms	millisecond
nm	nanometer
Pa	pascal
per, %	percent
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 is a continuing collaboration 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. Since its launch on April 28, 2006, CALIPSO has been providing 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).

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.

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.

CALIPSO orbits in formation with other spacecraft in the A-Train satellite constellation, and provides complementary, near-simultaneous, observations with the other active and passive instruments in the constellation to better understand the effects of clouds and aerosols on climate, weather, and air quality.

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

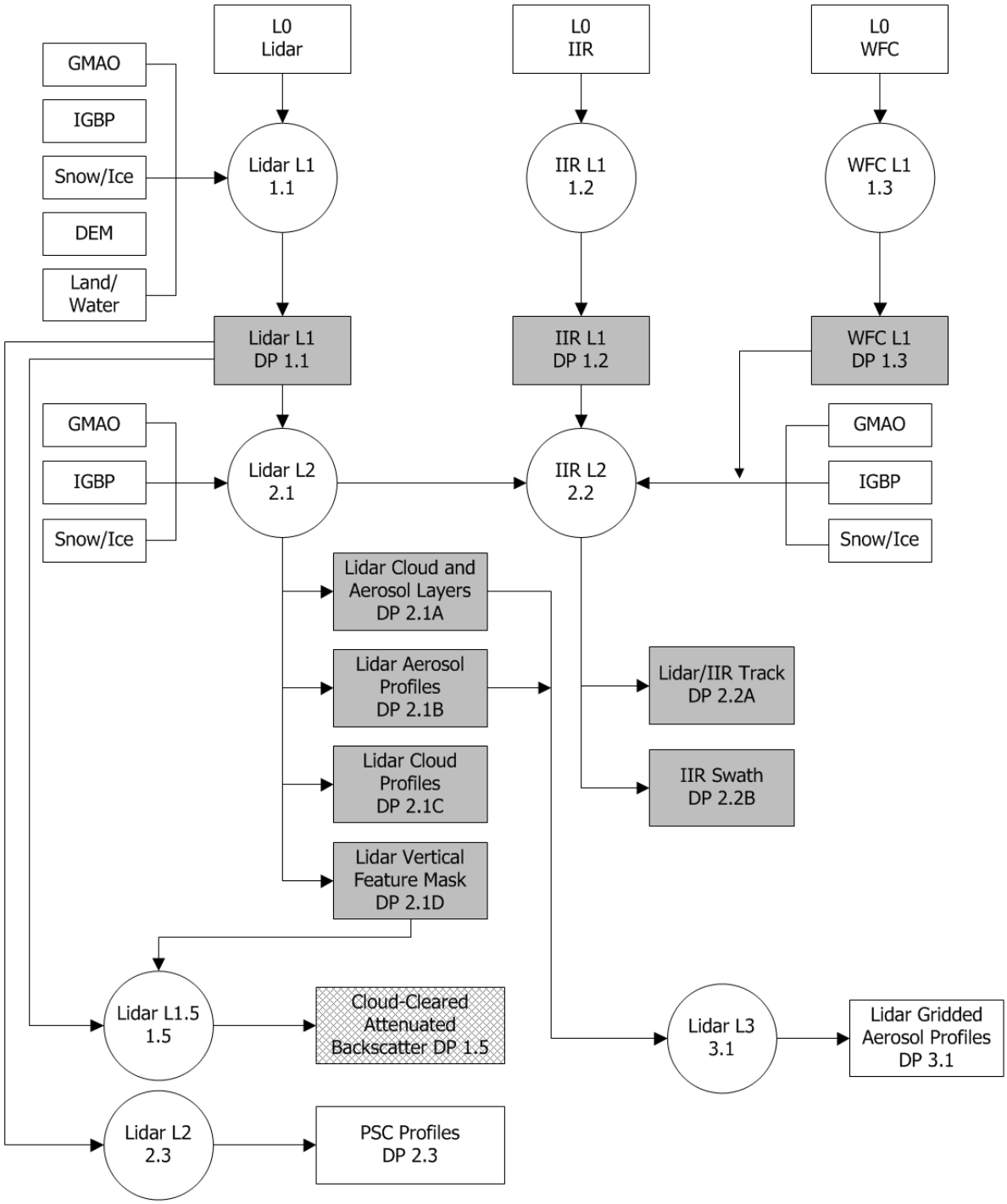
calibrated lidar return signals. Level 1 IIR and WFC data consist of calibrated radiances. There are three types of Lidar Level 2 products: layer products (cloud and aerosol), profile products (backscatter and extinction) and a vertical feature mask (cloud and aerosol locations and type). IIR Level 2 products are provided based on the IIR Swath (all pixels across swath) and IIR Track (coincident with lidar footprints). Lidar Level 3 products contain monthly-averaged parameters that are mapped onto a uniform spatial grid.

The highest quality data products generated by the DMS are referred to as Standard data products. These products have a 2-4 day latency to incorporate the global meteorological and other reference products. Night and Day orbit segments are written to separate data files. These products are described in greater detail throughout this document. A full set of browse images, including orbit track maps, are generated and posted to the science data web site. Standard data products are recommended for research studies and journal publications.

Expedited data products for all three instruments have a shorter production latency because they use the latest meteorological and calibration parameters available at the time of data production. These data products contain 90-minute segments of combined night and day orbits, and a full set of browse images also available through the science data web site. Expedited products are archived and available within a few hours after instrument data is received at the DMS. Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets only should be used for these purposes.

Quicklook data products are also available, by special request, for field missions and regional events or studies. The Quicklook products are regional subsets that receive priority transfers and processing and use a climatology instead of waiting on meteorological parameters. Browse images and data subsets are provided through a web interface for quick download.

The CALIPSO project has also developed several special products such as an Expedited Level 1.5 near-real time product released to operational forecast centers and a Lidar Level 3 Aerosol data product. The Expedited Level 1.5 data set is a merged product using the Lidar Level 1 data, Level 2 Aerosol profiles and Level 2 Vertical Feature Mask information. It provides continuous, calibrated and geo-located profiles of cloud-cleared data. The Lidar Level 3 Aerosol data product is a monthly-averaged data set derived using Lidar Level 2 products and maps aerosol parameters onto a uniform space and time grid and employs various filtering options.



NOTE: The numbers in the circles represent production subsystems. The numbers prefixed with DP (Data Product) are sections identified in this document. The solid shaded areas represent those data products that are available in both Standard and Expedited versions. The lidar level 1.5 data (i.e., DP 1.5, shown by the cross-hatched area) are distributed as Expedited products only. The lidar level 2 PSC data and lidar level 3 data are only distributed as Standard products.

Figure 1: CALIPSO Top Level Data Flow Diagram

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 al 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. Quality summaries are available on the Atmospheric Science Data Center's web site, https://eosweb.larc.nasa.gov/project/calipso/calipso_table.

The users' guide is available on the CALIPSO web site at

http://www-calipso.larc.nasa.gov/resources/calipso_users_guide/.

For the Version 3.x relase, the CALIPSO data product naming convention is defined as:

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

where

Investigation	= Mission Name, CAL
Subsystem	= [LID|IIR|WFC]
Level	= Product Level, e.g., L0, L1, L2, L3 or L15
ProductID	= Product Identification for different data products generated at the same processing level. For Version 3.x standard processing, Product IDs are [CAL, IIR, 1Km, 125m, 333mCLay, 01kmCLay, 05kmCLay, 05kmALay, 5kmAProCal, 05kmCPro, VFM, PSCMask]. For Version 3.x expedited processing, data products are identified by appending '_Exp' to the standard processing Product IDs. Expedited processing Product IDs are thus [_Exp, 05kmAPro_Exp, VFM_Exp, 01kmCLay_Exp, 05kmALay_Exp, 05kmCLay_Exp, 05kmCPro_Exp, 333mCLay_Exp, Track_Exp, Swath_Exp, 125m_Exp, 1Km_Exp, IIR_Exp].
Maturity Level	= Identifier specifying the overall validation level assigned to the data product; data products may contain individual parameters with varying validation levels (see table below).
Version	= Version information, e.g., V3.01
Instance	= YYYY-MM-DDThh-mm-ssZ[D|N]

CALIPSO Version 3.x Data Product Maturity/Validation Levels	
Beta:	Early release products for users to gain familiarity with data formats and parameters. Beta products had not been validated at time of release and many include both known and unknown artifacts. **Users should proceed with caution when using these data products as the basis for research findings or journal publications.**
Provisional:	Limited comparisons with independent sources have been made and obvious artifacts fixed.
Validated Stage 1:	Uncertainties are estimated from independent measurements at selected locations and times.
Validated Stage 2:	Uncertainties are estimated from more widely distributed independent measurements.
Validated Stage 3:	Uncertainties are estimated from independent measurements representing global conditions.

For example, the file named CAL_LID_L1-ValStage1-V3-01.2007-05-01T01-20-09ZN.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
- Maturity Level or Release named: ValStage1,
- Version: V3-01
- Instance:
    - Date 1 May, 2007 (data measurement date), (2007-05-01)
    - Time of first record: 1 hour, 20 minutes, 9 seconds (T01-20-09)
    - 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

For the Version 4.x release, the CALIPSO data product file names are constructed using a slightly different convention, as follows:

[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, L2, L3 or L15
ProductID	=	Product Identification (1Km, 125m, VFM, 333mCLay, 01kmCLay, 05kmCLay, 05kmALay, 5kmAProCal, 05kmCPro, or PSCMask)
ProductionStrategy	=	Identifier specifying the production strategy used to generate the product (see table below)
Version	=	Version information (e.g., V4.00)
Instance	=	YYYY-MM-DDThh-mm-ssZ[D|N]

CALIPSO Version 4 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-Expedited-V4-00.2007-05-01T01-20-09ZN.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: Expedited
- Version: V4-00
- 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

Versions 3.x and 4.x data products will be run in tandem for the foreseeable future, but at some point data will only be forward processed for 4.x.

There are four categories of products and they are listed in Table 1 through Table 3. These categories are described in the following summary.

Table 1: Science Archival Data Products: Output products, permanently stored by the LaRC ASDC, formatted in HDF, and available for distribution to the scientific community.

Table 2: Level 0 Products: Input payload products, permanently stored by the LaRC ASDC, and not available for distribution.

Table 3: Ancillary Products: Input products, permanently stored by the LaRC ASDC, needed to interpret the payload measurements, and not available for distribution.

Table 4: Engineering Products: Output products, permanently stored by the LaRC ASDC, required determining the health and calibration of the instruments and not available for distribution.

The tables list the subsystems that produce or use the data products; a descriptive data product name, the product spatial and temporal coverage; the file size; and the total daily and monthly data volumes. The data products that have parameters fully described in subsequent sections of this document have their corresponding DPC Table Number Reference listed parenthetically to the right of the data product name. The monthly size is based on 30 days.

Table 1: CALIPSO Science Archival Data Product Summary

Sub-system	Product (DPC Reference Table(s))	Spatial Coverage	Temporal Coverage (hrs.)	File Size (MB)	Daily Size (MB)	Monthly Size (MB)
1.1	Lidar Level 1 – Day (6) – Data Version 3	Profile	0.83	495.249	7,428.735	222,862.05
1.1	Lidar Level 1 – Night (6) – Data Version 3	Profile	0.83	495.249	7,428.735	222,862.05
1.1	Lidar Level 1 – Day (6) – Data Version 4	Profile	0.83	496.430	7,446.450	223,393.50
1.1	Lidar Level 1 – Night (6) – Data Version 4	Profile	0.83	496.430	7,446.450	223,393.50
1.2	IIR Level 1 – Day (11)	Swath	0.83	50.022	750.33	22,509.9
1.2	IIR Level 1 – Night (11)	Swath	0.83	50.022	750.33	22,509.9
1.3	WFC Level 1 Registered – Day Only (15)[1]	Swath	0.83	41.250	618.75	18,562.50
1.3	WFC Level 1 Native – Day Only (16)[1]	Swath	0.83	41.629	624.44	18,733.20
1.3	WFC Level 1 125m – Day Only (17)[1]	Swath	0.83	139.287	2,098.30	62,679.00
1.3	WFC Level 1 Registered – Day Only (15)[2]	Swath	0.83	44.907	673.60	20,208.00
1.3	WFC Level 1 Native – Day Only (16)[2]	Swath	0.83	45.240	678.60	20,358.00
1.3	WFC Level 1 125m – Day Only (17)[2]	Swath	0.83	151.622	2,274.33	68,229.90
2.1	Lidar Cloud and Aerosol Layer – Day (22-25)	Profile	0.83	60.049	900.735	27,022.05

Sub-system	Product (DPC Reference Table(s))	Spatial Coverage	Temporal Coverage (hrs.)	File Size (MB)	Daily Size (MB)	Monthly Size (MB)
2.1	Lidar Cloud and Aerosol Layer – Night (22-25)	Profile	0.83	60.049	900.735	27,022.05
2.1	Lidar Aerosol Profile – Day (35)	Profile	0.83	149.433	2,241.495	67,244.85
2.1	Lidar Aerosol Profile – Night (35)	Profile	0.83	149.433	2,241.495	67,244.85
2.1	Lidar Cloud Profile – Day (38)	Profile	0.83	106.432	1,596.48	47,894.4
2.1	Lidar Cloud Profile – Night (38)	Profile	0.83	106.432	1,596.48	47,894.4
2.1	Lidar Vertical Feature Mask – Day (41)	Profile	0.83	45.927	688.905	20,667.15
2.1	Lidar Vertical Feature Mask – Night (41)	Profile	0.83	45.927	688.905	20,667.15
2.2	IIR/Lidar Track – Day (48)	Track	0.83	5.111	74.110	2,223.30
2.2	IIR/Lidar Track – Night (48)	Track	0.83	5.111	74.110	2,223.30
2.2	IIR Swath – Day (51)	Swath	0.83	112.282	1,628.089	48,842.67
2.2	IIR Swath – Night (51)	Swath	0.83	112.282	1,628.089	48,842.67
2.3	Lidar Level 2 Polar Stratospheric Cloud Daily – Night (45)	Globe	12.45	98.709	98.709	2961.27
3.1	Lidar Level 3 – Aerosol Profile All Sky – Monthly – Day (54)	Globe	744.0	0	0	184.74
3.1	Lidar Level 3 – Aerosol Profile All Sky – Monthly – Night (54)	Globe	744.0	0	0	184.74
3.1	Lidar Level 3 – Aerosol Profile Cloud Free – Monthly – Day (54)	Globe	744.0	0	0	184.74
3.1	Lidar Level 3 – Aerosol Profile Cloud Free – Monthly – Night (54)	Globe	744.0	0	0	184.74
3.1	Lidar Level 3 – Aerosol Profile Cloudy Sky Transparent – Monthly – Day (54)	Globe	744.0	0	0	184.74
3.1	Lidar Level 3 – Aerosol Profile Cloudy Sky Transparent – Monthly – Night (54)	Globe	744.0	0	0	184.74
3.1	Lidar Level 3 – Aerosol Profile Cloudy Sky Opaque – Monthly – Day (54)	Globe	744.0	0	0	184.74
3.1	Lidar Level 3 – Aerosol Profile Cloudy Sky Opaque – Monthly – Night (54)	Globe	744.0	0	0	184.74
1.5	Lidar Level 1.5 – Expedited (71)	Profile	1.5	45.941	735.056	22,051.68
1.1	Lidar Level 1 – Expedited (6)	Profile	1.5	848.062	13,568.992	407,069.76
1.2	IIR Level 1 – Expedited (11)	Swath	1.5	90.663	1,359.945	40,798.35
1.3	WFC Level 1 Registered – Expedited (15)[1]	Swath	0.83	41.250	618.75	18,562.50
1.3	WFC Level 1 Native – Expedited (16)[1]	Swath	0.83	41.629	624.44	18,733.20
1.3	WFC Level 1 125m – Expedited (17)[1]	Swath	0.83	139.287	2,089.30	62,679.00
1.3	WFC Level 1 Registered – Expedited (15)[2]	Swath	0.83	44.907	673.60	20,208.00
1.3	WFC Level 1 Native – Expedited (16)[2]	Swath	0.83	45.240	678.60	20,358.00
1.3	WFC Level 1 125m – Expedited (17)[2]	Swath	0.83	151.622	2,274.33	68,229.90
2.1	Lidar Level 2 Cloud and Aerosol Layer – Expedited (22-25)	Profile	1.5	213.899	3,422.384	102,671.52
2.1	Lidar Level 2 Aerosol Profile – Expedited (35)	Profile	1.5	255.873	4,093.968	122,819.04
2.1	Lidar Level 2 Cloud Profile – Expedited (38)	Profile	1.5	182.239	2,915.824	87,474.72
2.1	Lidar Level 2 Vertical Feature Mask – Expedited (41)	Profile	1.5	78.629	1,258.064	37,741.92
2.2	IIR/Lidar Level 2 Track – Expedited (48)	Track	1.5	9.263	148.208	4,446.24
2.2	IIR Level 2 Swath – Expedited (51)	Swath	1.5	195.859	3,133.744	94,012.32
	File, Daily, and Monthly Totals			**5,544.540**	**82,798.60**	**2,485,537.19**

1) June 13, 2006 – June 2, 2014
2) June 3, 2014 – Present

Table 2: CALIPSO Level 0 Input Data Product Summary

Sub-system	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 3: CALIPSO Ancillary Input Data Product Summary

Sub-system	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	L0 Attitude	N/A	Daily	5.53	5.53	165.90
0.1	L0 GPS	N/A	Daily	4.84	4.84	145.20
1.1, 2.1, 2.2	Daily GMAO2	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	DEM	Global	Static	20,544	20,544	20,544.00
2.2	AFWA Snow/Ice	Global	Daily	2.30	2.30	69.00
1.1-1.3	Land/Water Coverage[1]	Global	Static	N/A	N/A	N/A
	Dynamic Daily and Monthly Totals			**22,373.29**	**28,551.29**	**240,727.22**

1) Land/Water Coverage part of Toolkit DEM; sizes already included

Table 4: CALIPSO Engineering Data Product Summary

Sub-system	Product	Spatial Coverage	Temporal Coverage	Product Size (MB)	Daily Size (MB)	Monthly Size (MB)
1.1	Lidar Calibration	N/A	24 hours	6.11	6.11	183.30
1.2	IIR Calibration	N/A	Per Orbit	24.15	351.29	10,538.73
1.3	WFC Calibration	N/A	24 Hours	6.36	6.36	190.80
1.3	WFC Raw Data	N/A	variable	0.01	N/A	N/A
	Daily and Monthly Totals			**36.63**	**363.76**	**10,912.83**

Table 5: CALIPSO DMS Total

Product Category	Reference Table	Daily Size (MB)	Monthly Size (MB)
Science	1	30,112.22	859,365.50
Level 0	2	3,481.45	104,443.76
Ancillary	3	22,373.29	240,727.22
Daily and Monthly Totals		**55,966.96**	**1,204,536.48**

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 definitions[1]
- 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

Total file sizes also are provided.

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1) **Level 0**: Reconstructed unprocessed instrument/payload data at full resolution; any and all communications artifacts (e.g. synchronization frames, communications headers) removed.

Level 1A: Reconstructed unprocessed instrument data at full resolution, time-referenced, and annotated with ancillary information, including radiometric and geometric calibration coefficients and georeferencing parameters (i.e., platform ephemeris) computed and appended, but not applied, to the Level 0 data.

Level 1B: Level 1A data processed to sensor units and geolocated.

Level 2: Derived geophysical variables at the similar resolution and location as the Level 1 source data.

Level 3: Geophysical variables are mapped on uniform space-time grids, usually with some completeness and consistency.

Level 4: Model output or results from analyses of lower level data, e.g., variables derived from multiple measurements.

Level 1.5: Merged product combining expedited level 1 and level 2 data sets.

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.ffffffff

Where each character is an ASCII character using one octed 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
ffffffff	=	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 1B Profiles DP 1.1

The lidar Level 1B data product contains a half orbit (day or night) of calibrated and geolocated lidar profiles. The product contains data from all non-diagnostic instrument modes including nominal science, depolarization gain ratio calibration, and boresight alignment. The Level 1B data product is written in HDF. A summary of the product records is listed in Table 6.

The lidar Level 1B product contains additional data not found in the Level 0 lidar input file, including post processed ephemeris data, celestial data, and converted payload status data.

The major categories of lidar Level 1B data are:

- Lidar Profile Data
- Position Data
- Viewing Geometry

Level:	1B	
Type:	Archival	
Frequency:	Standard:	2/Orbit
	Expedited:	16/day
Spatial Resolution Record:	Standard:	Full resolution profile
	Expedited:	Full resolution profile
Time Interval Covered:	Standard:	Half Orbit (Day or Night)
	Expedited:	90 minutes

Data File Name (For Version 3.x):

Standard: CAL_LID_L1-ProductionStrategy-Version.Instance.hdf
Expedited: CAL_LID_L1_Exp-ProductionStrategy-Version.Instance.hdf

Data File Name (For Version 4.x):

Standard: CAL_LID_L1-Standard-Version.Instance.hdf
Expedited: CAL_LID_L1-Expedited-Version.Instance.hdf

The expedited data product contains 90 minutes of a combination of day and night data. Like the Standard data products, the Expedited data are also generated in HDF and include the same parameters and ranges as the Standard data products.

Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets should be used for these purposes.

2.1.1 LIDAR Instrument Level 1 Data Product

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

Table 6: Lidar Instrument Record Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar Metadata Record – Data Version 3	Table 7	3,117	1	3,117
Lidar Metadata Record – Data Version 4	Table 7	3,777	1	3,777
Spacecraft Position, Attitude, and Celestial Record	Table 8	124	Standard: 63,630 Expedited: 108,960	7,890,120 13,511,040
Profile Geolocation and Viewing Geometry	Table 9	40	Standard: 63,630 Expedited: 108,960	2,545,200 4,358,400
Lidar Profile Science Record – Data Version 3	Table 10	7,806	Standard: 63,630 Expedited: 108,960	496,695,780 850,541,760
Lidar Profile Science Record – Data Version 4	Table 10	7,825	Standard: 63,630 Expedited: 108,960	497,904,750 852,612,000
Total Size – Standard (bytes) – Version 3				**507,135,120**
Total Size – Standard (Mbytes) – Version 3				**495.249**
Total Size – Standard (bytes) – Version 4				**508,344,750**
Total Size – Standard (bytes) – Version 4				**496.430**
Total Size - Expedited (bytes)				**868,415,220**
Total Size - Expedited (Mbytes)				**848.062**

2.1.2 LIDAR Instrument Level 1 Data Metadata

The LIDAR Instrument Level 1 Data products include three Vdata record types (i.e., metadata) shown in the tables above. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the LIDAR Instrument Level 1 Data Product are listed in Table 7.

Table 7: Lidar Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID[R]	Char	NoUnits	L1_LIDAR_Science	80	80
Product_ID[Q]	Char	NoUnits	LIDAR_L1_Std	80	80
Date_Time_at_Granule_Start[A]	Char	NoUnits	4/2006 – 6/2020	27	27
Date_Time_at_Granule_End[A]	Char	NoUnits	4/2006 – 6/2020	27	27
Date_Time_of_Production[A]	Char	NoUnits	4/2006 – 6/2020	27	27
Number_of_Good_Profiles	Int_32	NoUnits	Std = 0…63,630 Exp = 0…108,960	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	Std = 0…63,630 Exp = 0…108,960	1	4
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	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[D]	Float_64	NoUnits	60,426.0…200,608.0	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[D]	Float_64	NoUnits	60,426.0…200,608.0	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[Q]	Char	NoUnits	6 filenames max	480	480
Snow_Ice_Files_Used[Q]	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
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^2sr^{-1}	5.930E-32	1	4
Rayleigh_Backscatter_Cross-section_1064	Float_32	m^2sr^{-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
ScatteringRatioIn532NightCalibrationRegion[Q]	Float_32	NoUnits	1.01*	1	4
ScatteringRatioIn532NightCalibrationRegionUncertainty[Q]	Float_32	NoUnits	0.01*	1	4
MolecularModelUncertainty[Q]	Float_32	NoUnits	0.015*	1	4
CirrusBackscatterColorRatio[Q]	Float_32	NoUnits	1.00*	1	4

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
CirrusBackscatterColorRatioUncertainty[Q]	Float_32	NoUnits	0.25*	1	4
Record Size (bytes) – Data Version 3					**3,117**
Record Size (bytes) – Data Version 4					**3,777**

A) UTC CCSDS ASCII Time Code Format A
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
N) Ranges provided for both Standard data products and Expedited data products
Q) Parameters exist in data version 4.0
R) Parameter not in data version 4.0
*) Current range values are tentative, and must be approved by the CALIPSO LSWG

2.1.3 LIDAR Instrument Level 1 Data Scientific Data Sets

Table 8, Table 9 and Table 10 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 8: Lidar Spacecraft Position, Attitude, and Celestial Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Spacecraft_Altitude	Float_32	km	V3.x: 700.0…720.0 V4.x: 700.0…740.0	1	4
Spacecraft_Position[B]	Float_64	km	-8,000.0…8,000.0	3	24
Spacecraft_Velocity[B]	Float_64	$km \cdot sec^{-1}$	-10.0…10.0	3	24
Spacecraft_Attitude	Float_64	deg	-180.0…180.0	3	24
Spacecraft_Attitude_Rate	Float_64	$deg \cdot sec^{-1}$	-10.0…10.0	3	24
Subsatellite_Latitude	Float_32	deg	-90.0…90.0	1	4
Subsatellite_Longitude	Float_32	deg	-180.0…180.0	1	4
Earth-Sun_Distance	Float_64	AU	0.98…1.02	1	8
Subsolar_Latitude	Float_32	deg	-90.0…90.0	1	4
Subsolar_Longitude	Float_32	deg	-180.0…180.0	1	4
Record Size (bytes)					**124**

B) ECR Coordinate System

Table 9: Lidar Profile Geolocation and Viewing Geometry

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Latitude	Float_32	deg	-90.0…90.0	1	4
Longitude	Float_32	deg	-180.0…180.0	1	4
Off_Nadir_Angle	Float_32	deg	0.0…10.0	1	4
Viewing_Zenith_Angle	Float_32	deg	0.0…90.0	1	4
Viewing_Azimuth_Angle	Float_32	deg	-180.0…180.0	1	4
Solar_Zenith_Angle	Float_32	deg	0.0…180.0	1	4
Solar_Azimuth_Angle	Float_32	deg	-180.0…180.0	1	4
Scattering_Angle	Float_32	deg	0.0…180.0	1	4
Surface_Altitude_Shift	Float_32	km	-0.15…0.15	1	4
Number_Bins_Shift	Int_32	NoUnits	V3.x: -5…5 V4.x: -8…8	1	4
Record Size (bytes)					**40**

Table 10: Lidar Profile Science Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Profile_Time[C]	Float_64	sec	4.204E8…8.657E8	1	8
Profile_UTC_Time[D]	Float_64	NoUnits	60,426.0…200,608.0	1	8
Profile_ID[E]	Int_32	NoUnits	1…228,630	1	4
Land_Water_Mask	Int_8	NoUnits	0…7	1	1
IGBP_Surface_Type	Int_8	NoUnits	1…18	1	1
NSIDC_Surface_Type[R]	UInt_8	NoUnits	0…255	1	1
Snow_Ice_Surface_Type[Q]	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	Int_16	NoUnits	1…6	1	2
Lidar_Submode	Int_16	NoUnits	1…25	1	2
Surface_Elevation	Float_32	km	-1.0…9.0	1	4
GMAO_Surface_Elevation[Q]	Float_32	Km	-1.0…9.0	1	4
Surface_Saturation_Flag_532Par[Q]	UInt_8	NoUnits	0…2	1	1
Surface_Saturation_Index_532Par[Q]	Int_16	NoUnits	-1…582	1	2
Negative_Signal_Anomaly_Index_532Par[Q]	Int_16	NoUnits	-1…582	1	2
Surface_Saturation_Flag_532Perp[Q]	UInt_8	NoUnits	0…2	1	1
Surface_Saturation_Index_532Perp[Q]	Int_16	NoUnits	-1…582	1	2
Negative_Signal_Anomaly_Index_532Perp[Q]	Int_16	NoUnits	-1…582	1	2
Surface_Saturation_Flag_1064[Q]	UInt_8	NoUnits	0…2	1	1
Surface_Saturation_Index_1064[Q]	Int_16	NoUnits	-1…582	1	2
Negative_Signal_Anomaly_Index_1064[Q]	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	V3.x: 28.2…178.0 V4.x: 26.0…178.0	1	4
Parallel_Amplifier_Gain_532	Float_32	V/V	V3.x: 28.2…178.0 V4.x: 26.0…178.0	1	4
Perpendicular_Background_Monitor_532	Float_32	count	V3.x: 800.0…4,000.0 V4.x: 120…6,000	1	4
Parallel_Background_Monitor_532	Float_32	count	V3.x: -100.0…4,000.0 V4.x: 6…6,000	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	$km^3 \cdot sr \cdot$ count	V3.x: 3.0E10…9.0E10 V4.x: 3.0E10…8.0E10	1	4
Calibration_Constant_Uncertainty_532	Float_32	$km^3 \cdot sr \cdot$ count	V3.x: 1.2E9…2.6E9 V4.x: 2E8…1.6E9	1	4
Total_Attenuated_Backscatter_532	Float_32	$km^{-1}\ sr^{-1}$	V3.x: 0.0…3.1 V4.x: -0.1…3.3	583	2,332
Perpendicular_Attenuated_Backscatter_532	Float_32	$km^{-1}\ sr^{-1}$	V3.x: 0.0…1.5 V4.x: -0.08…1.7	583	2,332
Perpendicular_RMS_Baseline_532[F]	Float_32	count	V3.x: 0.0…2,700.0 V4.x: 0.0…3,200.0	1	4
Parallel_RMS_Baseline_532[F]	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	$km^3 \cdot sr \cdot$ count	V3.x: 4.0E9…1.2E12 V4.x: 4.0E9…1E10	1	4
Calibration_Constant_Uncertainty_1064	Float_32	$km^3 \cdot sr \cdot$ count	V3.x: 5.0E7…4.6E8 V4.x: 5.0E7…4E9	1	4
Attenuated_Backscatter_1064	Float_32	$km^{-1}\ sr^{-1}$	V3.x: 0.0…2.0 V4.x: -0.04…2.5	583	2,332
RMS_Baseline_1064[F]	Float_32	count	200.0…1,800.0	1	4
Molecular_Number_Density	Float_32	m^{-3}	4.8E22…4.8E25	33	132
Ozone_Number_Density	Float_32	m^{-3}	9E16…1E19	33	132

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Temperature	Float_32	ºC	-120.0…60.0	33	132
Pressure	Float_32	mb	1.0…1086.0	33	132
Relative_Humidity	Float_32	%	0.0…150.0	33	132
Surface_Wind_Speeds	Float_32	m/sec	-80.0…80.0	2	8
Tropopause_Height	Float_32	km	4.0…22.0	1	4
Tropopause_Temperature	Float_32	°C	-95.0…-20.0	1	4
Noise_Scale_Factor_532_Perpendicular	Float_32	$count^{1/2}$	3.4…8.0[G]	1	4
Noise_Scale_Factor_532_Parallel	Float_32	$count^{1/2}$	4.0…8.0[G]	1	4
Noise_Scale_Factor_1064	Float_32	$count^{1/2}$	0.0[H]	1	4
Perpendicular_Column_Reflectance_532	Float_32	NoUnits	0.0…1.0	1	4
Perpendicular_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	TBD…TBD	1	4
Parallel_Column_Reflectance_532	Float_32	NoUnits	0.0…1.0	1	4
Parallel_Column_Reflectance_Uncertainty_532	Float_32	NoUnits	TBD…TBD	1	4
QC_Flag	UInt_32	NoUnits	0…16,777,215	1	4
QC_Flag_2	UInt_32	NoUnits	V3.x: 0…33,554,431 V4.x: 0…134,217,727	1	4
Total Bytes per Record – Data Version 3					**7,806**
Total Bytes per Record – Data Version 4					**7,825**

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
E) The minimum is the first profile and the maximum is 90 + 99 minutes
F) 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 SAA when the gain is high and the noise is fairly high. The highest 1064 values (except for noise spikes) occur in the daytime.
G) Nighttime granule values are a mean derived from previous daytime granule values. For daytime granules, values are computed for every column and users are suggested to use the mean or median instead of individual values for each column.
H) Noise scale factor for the 1064 nm channel is currently set to be 0
Q) Parameters exist in data version 4.0
R) Parameter not in data version 4.0

2.2 IIR Level 1B Radiances DP 1.2

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 Level 1B data product is written in HDF. A summary of the product records is listed in Table 11.

The major categories for IIR Level 1B data are:

- IIR Earth View
- Position Data
- Viewing Geometry

Level:	1B	
Type:	Archival	
Frequency:	Standard:	2/Orbit
	Expedited:	16/day
Spatial Resolution Record:	Standard:	1 km pixels x 70 km wide swath
	Expedited:	1 km pixels x 70 km wide swath
Time Interval Covered:	Standard:	Half Orbit (Day or Night)
	Expedited:	90 minutes

Data File Name:

Standard: CAL_IIR_L1-ProductionStrategy-Version.Instance.hdf
Expedited: CAL_IIR_L1_Exp-ProductionStrategy-Version.Instance.hdf

The expedited data product contains 90 minutes of a combination of day and night data. Like the Standard data products, the Expedited data are also generated in HDF and include the same parameters and ranges as the Standard data products.

Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets should be used for these purposes.

2.2.1 Infrared Imaging Radiometer 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 11: IIR Record Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
IIR Metadata Record	Table 12	821	1	821
Spacecraft Position, Attitude, and Celestial Record	Table 13	360	Standard: 384 Expedited: 696	138,240 250,560
Earth View Record	Table 14	2,548	Standard: 20,048 Expedited: 36,337	51,082,304 92,586,676
Total Size - Standard (bytes)				**51,222,268**
Total Size – Standard (Mbytes)				**50.022**
Total Size - Expedited (bytes)				**92,838,960**
Total Size - Expedited (Mbytes)				**90.663**

2.2.2 IIR Level 1 Metadata

The IIR Level 1 products include three Vdata record types (i.e., metadata) shown in the tables above. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the IIR Level 1 Product are listed in Table 12.

Table 12: IIR Level 1 Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	N/A	L1_IIR	80	80
Date_Time_at_Granule_Start[A]	Char	N/A	4/2006 – 6/2016	27	27
Date_Time_at_Granule_End[A]	Char	N/A	4/2006 – 6/2016	27	27
Date_Time_of_Production[A]	Char	N/A	4/2006 – 6/2016	27	27
Number_of_IIR_Grid_Line_Records	UInt_16	N/A	Std = 0…20,048 Exp = 0…36,337	1	2
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	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[D]	Float_64	NoUnits	60,426.0…160,601.0	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[D]	Float_64	NoUnits	60,426.0…160,601.0	1	8
Ephemeris_Files_Used	Char	N/A	2 file names max.	160	160
Attitude_Files_Used	Char	N/A	2 file names max.	160	160
Level_0_Files_Used	Char	N/A	2 file names max.	160	160
Level_1_code_version_Used	Char	N/A	N/A	20	20
Input_parameter_version_number_used_Radiometry	UInt_16	N/A	N/A	1	2
Input_parameter_date_of _application_Radiometry	Int_8	N/A	4/2006 – 6/2016	27	27
Input_parameter_version_number_used_Geometry	UInt_16	N/A	N/A	1	2
Input_parameter_date_of _application_Geometry	Int_8	N/A	4/2006 – 6/2016	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	N/A	0…2,187	1	2
Percentage_of_Missing_Images	Float_32	%	0.0…100.0	1	4
Number_of_Equalization_mode	Int_16	N/A	0…TBD	1	2
Altitude_of_Projection	Float_32	km	0.0…40.0	1	4
Initial_Absolute_Sequence	Int_16	N/A	0…TBD	1	2
Final_Absolute_Sequence	Int_16	N/A	0…TBD	1	2
Grid_Line_Delta_Time	Float_32	sec	0.0…TBD	1	4
Scale_Factor_for_Radiance	Float_32	N/A	0.0…TBD	1	4
Radiance_Offset	Float_32	N/A	0.0…TBD	1	4
Scale_Factor_for_Viewing_Angle	Float_32	N/A	0.0…TBD	1	4
Viewing_Angle_Offset	Float_32	N/A	0.0…TBD	1	4
Record Size (bytes)					**821**

A) UTC CCSDS ASCII Time Code Format A

D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

NOTE: Versions 1.11 and 1.10 do not contain the following metadata parameters, Orbit_Number_at_Granule_Start, Orbit_Number_at_Granule_End, Orbit_Number_Change_Time, Path_Number_at_Granule_Start, Path_Number_at_Granule_End, and Path_Number_Change_Time. Therefore the record size in bytes is 793.

2.2.3 IIR Level 1 Scientific Data Sets

Table 13 and Table 14 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 13: IIR Spacecraft Position, Attitude, and Celestial Record (1 per Earth view)

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Time_TAI_8.65[C]	Float_64	sec	4.204E8…7.389E8	1	8
Time_TAI_10.6[C]	Float_64	sec	4.204E8…7.389E8	1	8
Time_TAI_12.05[C]	Float_64	sec	4.204E8…7.389E8	1	8
Time_UTC_8.65[D]	Float_64	NoUnits	60426.0...160601.0	1	8
Time_UTC_10.6[D]	Float_64	NoUnits	60426.0...160601.0	1	8
Time_UTC_12.05[D]	Float_64	NoUnits	60426.0...160601.0	1	8
Spacecraft_Position_8.65[B]	Float_64	km	-8,000.0...8,000.0	3	24
Spacecraft_Position_10.6[B]	Float_64	km	-8,000.0...8,000.0	3	24
Spacecraft_Position_12.05[B]	Float_64	km	-8,000.0...8,000.0	3	24
Spacecraft_Velocity_8.65[B]	Float_64	$km \cdot sec^{-1}$	-8,000.0...8,000.0	3	24
Spacecraft_Velocity_10.6[B]	Float_64	$km \cdot sec^{-1}$	-8,000.0...8,000.0	3	24
Spacecraft_Velocity_12.05[B]	Float_64	$km \cdot sec^{-1}$	-8,000.0...8,000.0	3	24
Spacecraft_Attitude_8.65	Float_64	deg	-180.0...180.0	3	24
Spacecraft_Attitude_10.6	Float_64	deg	-180.0...180.0	3	24
Spacecraft_Attitude_12.05	Float_64	deg	-180.0...180.0	3	24
Spacecraft_Attitude_Rate_8.65	Float_64	$deg \cdot sec^{-1}$	-10.0...10.0	3	24
Spacecraft_Attitude_Rate_10.6	Float_64	$deg \cdot sec^{-1}$	-10.0...10.0	3	24
Spacecraft_Attitude_Rate_12.05	Float_64	$deg \cdot sec^{-1}$	-10.0...10.0	3	24
Subsatellite_Latitude_8.65	Float_32	deg	-90.0...90.0	1	4
Subsatellite_Latitude_10.6	Float_32	deg	-90.0...90.0	1	4
Subsatellite_Latitude_12.05	Float_32	deg	-90.0...90.0	1	4
Subsatellite_Longitude_8.65	Float_32	deg	-180.0...180.0	1	4
Subsatellite_Longitude_10.6	Float_32	deg	-180.0...180.0	1	4
Subsatellite_Longitude_12.05	Float_32	deg	-180.0...180.0	1	4
Record Size (bytes)					**360**

B) ECR Coordinate System

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

D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

Table 14: Earth View Record (1 per grid line)

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Lidar_Shot_Time[C]	Float_64	sec	4.204E8…7.389E8	1	8
Lidar_Shot_UTC_Time[D]	Float_64	NoUnits	60426.0...160601.0	1	8
Latitude	Float_32	deg	-90.0…90.0	69	276
Longitude	Float_32	deg	-180.0…180.0	69	276
Image_Time_8.65[C]	Float_64	sec	4.204E8…7.389E8	1	8
Image_Time_10.6[C]	Float_64	sec	4.204E8…7.389E8	1	8
Image_Time_12.05[C]	Float_64	sec	4.204E8…7.389E8	1	8
Image_UTC_Time_8.65[D]	Float_64	NoUnits	60426.0...160601.0	1	8
Image_UTC_Time_10.6[D]	Float_64	NoUnits	60426.0...160601.0	1	8
Image_UTC_Time_12.05[D]	Float_64	NoUnits	60426.0...160601.0	1	8
Calibrated_Radiances_8.65	Int_16	$Wm^{-2}sr^{-1}\mu m^{-1}$	0…100 [P]	69	138
Calibrated_Radiances_10.6	Int_16	$Wm^{-2}sr^{-1}\mu m^{-1}$	0…100 [P]	69	138
Calibrated_Radiances_12.05	Int_16	$Wm^{-2}sr^{-1}\mu m^{-1}$	0…100 [P]	69	138
Viewing_Zenith_Angle_8.65	Int_16	deg	0…180	69	138
Viewing_Zenith_Angle_10.6	Int_16	deg	0…180	69	138
Viewing_Zenith_Angle_12.05	Int_16	deg	0…180	69	138
Viewing_Azimuth_Angle_8.65	Int_16	deg	-180…180	69	138
Viewing_Azimuth_Angle_10.6	Int_16	deg	-180…180	69	138
Viewing_Azimuth_Angle_12.05	Int_16	deg	-180…180	69	138
Sequence_Number_8.65	Int_16	N/A	0…24,576	69	138
Sequence_Number_10.6	Int_16	N/A	0…24,576	69	138
Sequence_Number_12.05	Int_16	N/A	0…24,576	69	138
Pixel_Quality_Index	UInt_32	N/A	N/A	69	276
Record Size (bytes)					**2,548**

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
P) Range after scale equation reported in HDF file

2.3 WFC Level 1B Scans DP 1.3

The Wide Field Camera Level 1B data product contains geolocated radiance data. The data product is written in HDF. A summary of the product records is listed for each file in the following:

The major categories of WFC Level 1B data are:

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

Level:	1B	
Type:	Archival	
Frequency:	Standard:	1 Orbit
	Expedited:	90 Minutes (Day Only)
Spatial Resolution Record:	Standard:	1 km pixels x 61 km wide swath
		125 m pixels x 5 km wide swath
	Expedited:	1 km pixels x 61 km wide swath
		125 m pixels x 5 km wide swath
Time Interval Covered:	Standard:	Half Orbit (Day Only)
	Expedited:	90 minutes (Day Only)

Data File Name:

Standard:	CAL_WFC_L1_1Km-ProductionStrategy-Version.Instance.hdf
Expedited:	CAL_WFC_L1_1Km_Exp-ProductionStrategy-Version.Instance.hdf
Standard:	CAL_WFC_L1_125m-ProductionStrategy-Version.Instance.hdf
Expedited:	CAL_WFC_L1_125m_Exp-ProductionStrategy-Version.Instance.hdf
Standard:	CAL_WFC_L1_IIR-ProductionStrategy-Version.Instance.hdf
Expedited:	CAL_WFC_L1_IIR_Exp-ProductionStrategy-Version.Instance.hdf

The expedited data product contains 90 minutes of day data. Like the Standard data products, the Expedited data are also generated in HDF and include the same parameters and ranges as the Standard data products.

Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets should be used for these purposes.

2.3.1 Wide Field Camera Level 1 Data Product

The maximum number of 5 km WFC packets processed in one orbit is 3,124 (daytime only).

For each orbit, 3 files are created to represent the WFC Level 1 data product. They are the "1 km Registered Science Data", the "1 km Native Science Data" and the "125 m Native Science Data". Table 15, Table 16 and Table 17 show the data structure of each file.

Table 15: WFC Record Summary - 1 km Registered Science

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
WFC Metadata Record	Table 18	2,149	1	2,149
1 km Registered Science Record[1]	Table 19	2,704	Standard: 15,620 Expedited: 15,620	42,236,480 42,236,480
1 km Registered Science Record[2]	Table 19	2,704	Standard: 17,005 Expedited: 17,005	45,981,520 45,981,520
Total Size – Standard (bytes)[1]				**42,239,32**
Total Size – Standard (Mbytes)[1]				**41.250**
Total Size – Expedited (bytes)[1]				**42,239,503**
Total Size – Expedited (Mbytes)[1]				**41.250**
Total Size – Standard (bytes)[2]				**45,984,572**
Total Size – Standard (Mbytes)[2]				**44.907**
Total Size – Expedited (bytes)[2]				**45,984,572**
Total Size – Expedited (Mbytes)[2]				**44.907**

1) June 13, 2006 – June 2, 2014
2) June 3, 2014 – Present

Table 16: WFC Record Summary - 1 km Native Science

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
WFC Metadata Record	Table 18	2,149	1	2,149
1 km Native Science Record[1]	Table 20	2,712	Standard: 15,620 Expedited: 15,620	42,361,440 42,361,440
1 km Native Science Record[2]	Table 20	2,712	Standard: 17,005 Expedited: 17,005	46,117,560 46,117,560
Reflectance Bin Record	Table 20	288	915	263,520
Total Size – Standard (bytes)[1]				**42,628,012**
Total Size – Standard (Mbytes)[1]				**41.629**
Total Size – Expedited (bytes)[1]				**42,628,012**
Total Size – Expedited (Mbytes)[1]				**41.629**
Total Size – Standard (bytes)[2]				**46,384,132**
Total Size – Standard (Mbytes)[2]				**45.240**
Total Size – Expedited (bytes)[2]				**46,384,132**
Total Size – Expedited (Mbytes)[2]				**45.240**

1) June 13, 2006 – June 2, 2014
2) June 3, 2014 – Present

Table 17: WFC Record Summary - 125 m Native Science

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
WFC Metadata Record	Table 18	2,149	1	2,149
125 m Native Science Record	Table 21	1,140	Standard: 124,960 Expedited: 124,960	142,454,400 142,454,400
125 m Native Science Record	Table 21	1,140	Standard: 136,040 Expedited: 136,040	155,085,600 155,085,600
Reflectance Bin Record	Table 21	288	600	172,800
Total Size – Standard (bytes)				**142,630,252**
Total Size – Standard (Mbytes)				**139.287**
Total Size – Standard (bytes)[1]				**142,630,391**
Total Size – Standard (Mbytes)[1]				**139.287**
Total Size – Expedited (bytes)[1]				**155,261,456**
Total Size – Expedited (Mbytes)[1]				**151.622**
Total Size – Standard (bytes)[2]				**155,261,456**
Total Size – Standard (Mbytes)[2]				**151.622**

1) June 13, 2006 – June 2, 2014
2) June 3, 2014 – Present

2.3.2 WFC Level 1 data Metadata

The WFC Level 1 data products include three Vdata record types (i.e., metadata) shown in the tables above. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the WFC Level 1 data Product are listed in Table 18.

Table 18: 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 – 6/2016	27	27
Date_Time_at_Granule_End[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_of_Production[A]	Char	NoUnits	4/2006 – 6/2016	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	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	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[D]	Float_64	NoUnits	60,426.0…160,601.0	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[D]	Float_64	NoUnits	60,426.0…160,601.0	1	8
Ephemeris_Files_Used	Char	N/A	2 file names max.	160	160
Attitude_Files_Used	Char	N/A	2 file names max.	160	160
Vicarious_Calibration_File_Used	Char	N/A	N/A	80	80
1km_Radiance_Calibration_Coefficients	Float_64	$(Wm^{-2}\ sr^{-1}\mu m^{-1})$ $(count^{-1})(ms)$	N/A	61	488
125m_Radiance_Calibration_Coefficients	Float_64	$(Wm^{-2}\ sr^{-1}\mu m^{-1})$ $(count^{-1})(ms)$	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	ms	N/A	1	4
Integration_Time	Float_32	ms	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	deg	0.0…70.0	15	60
Solar_Zenith_Bins_Max	Float_32	deg	5.0…75.0	15	60
Record Size (bytes)					**2,149**

A) UTC CCSDS ASCII Time Code Format A
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

2.3.3 WFC Level 1 Scientific Data Sets

Table 19, Table 20, and Table 21 summarize the contents of each scientific data set (SDS) contained within 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 19: 1 km Registered Science Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Shot_Time[3]	Float_64	sec	0.0…1.0E9	1	8
Lidar_Shot_UTC_Time[4]	Float_64	NoUnits	0.0…1.0E9	1	8
Latitude	Float_64	deg	-90.0…90.0	61	488
Longitude	Float_64	deg	-180.0…180.0	61	488
Radiance	Float_32	$Wm^{-2}sr^{-1}\mu m^{-1}$	0.0...2,000.0	61	244
Reflectance	Float_32	NoUnits	0.0…2.0	61	244
1km_Homogeneity	Float_32	NoUnits	N/A	1	4
Solar_Zenith	Float_32	deg	0.0…90.0	61	244
Solar_Azimuth	Float_32	deg	-180.0…180.0	61	244
Viewing_Zenith	Float_32	deg	0.0…90.0	61	244
Viewing_Azimuth	Float_32	deg	-180.0…180.0	61	244
Pixel_QC_Flag	UInt_32	NoUnits	N/A	61	244
Total Bytes per Record					**2,704**

Table 20: 1 km Native Science Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Scan_Time[C]	Float_64	sec	0.0…1.0E9	1	8
Scan_UTC_Time[D]	Float_64	NoUnits	0.0…1.0E9	1	8
Latitude	Float_64	deg	-90.0…90.0	61	488
Longitude	Float_64	deg	-180.0…180.0	61	488
Radiance	Float_32	$Wm^{-2}sr^{-1}\mu m^{-1}$	0.0…2,000.0	61	244
Reflectance	Float_32	NoUnits	0.0...2.0	61	244
1km_Homogeneity	Float_32	NoUnits	N/A	1	4
Solar_Zenith	Float_32	deg	0.0…90.0	61	244
Solar_Azimuth	Float_32	deg	-180.0…180.0	61	244
Viewing_Zenith	Float_32	deg	0.0…90.0	61	244
Viewing_Azimuth	Float_32	deg	-180.0…180.0	61	244
CCD_Temperature	Float_32	°C	-100.0…100.0	1	4
BasePlate_Temperature	Float_32	°C	-100.0…100.0	1	4
Reflectance_Bins[E]	Int_32	NoUnits	0…20,000	0	0
Pixel_QC_Flag	UInt_32	NoUnits	N/A	61	244
Total Bytes per Record					**2,712**

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
E) For each pixel there are 72 reflectance bins within 15 solar zenith angle bins and are totaled for the entire orbit. The total number of bytes for this parameter is reported in Table 16.

Table 21: 125 m Native Science Record

Parameter/Field	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Scan_Time[C]	Float_64	sec	0.0…1.0E9	1	8
Scan_UTC_Time[C]	Float_64	NoUnits	0.0…1.0E9	1	8
Latitude	Float_64	deg	-90.0…90.0	40	320
Longitude	Float_64	deg	-180.0…180.0	40	320
Radiance	Float_32	$Wm^{-2}sr^{-1}\mu m^{-1}$	0.0...2,000.0	40	160
Reflectance	Float_32	NoUnits	0.0...2.0	40	160
125m_Homogeneity	Float_32	NoUnits	N/A	1	4
Reflectance_Bins_125[E]	Int_32	NoUnits	0…160,000	0	0
Pixel_QC_Flag	UInt_32	NoUnits	N/A	40	160
Total Bytes per Record					**1,140**

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
E) For each pixel there are 72 reflectance bins within 15 solar zenith angle bins and are totaled for the entire orbit. The total number of bytes for this parameter is reported in Table 17.

2.4 Lidar Level 2 Cloud and Aerosol Layer Products DP 2.1A

The Lidar Level 2 cloud layer products are produced at three horizontal resolutions: 1/3 km, 1 km, and 5 km. The Lidar Level 2 aerosol layer products are produced at a 5 km horizontal resolution. The cloud and aerosol layer data products are written in Hierarchical Data Format (HDF). Table 22, Table 23, Table 24 and Table 25 summarize the content and estimated size of each of the layer products. Four data files will be produced for each granule: a 1/3 km resolution cloud product, 1 km resolution cloud product, a 5 km resolution cloud product, and a 5 km resolution aerosol product.

Within the Lidar Cloud and Aerosol Layer Product there are two general classes of data:

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

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 geo-physical 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.

Level:	2	
Type:	Archival	
Frequency:	Standard:	2/Orbit
	Expedited:	16/day
Spatial Resolution Record:	Standard:	1/3 km (full resolution)
		1 km horizontal
		5 km horizontal
	Expedited:	1/3 km (full resolution)
		1 km horizontal
		5 km horizontal
Time Interval Covered:	Standard:	Half Orbit (Day or Night)
	Expedited:	90 minutes

Data File Name:

Standard: CAL_LID_L2_333mCLay-ProductionStrategy-Version.Instance.hdf
Expedited: CAL_LID_L2_333mCLay_Exp-ProductionStrategy-Version.Instance.hdf

Standard: CAL_LID_L2_01kmCLay-ProductionStrategy-Version.Instance.hdf
Expedited: CAL_LID_L2_01kmCLay_Exp-ProductionStrategy-Version.Instance.hdf

Standard: CAL_LID_L2_05kmCLay-ProductionStrategy-Version.Instance.hdf
Expedited: CAL_LID_L2_05kmCLay_Exp-ProductionStrategy-Version.Instance.hdf

Standard: CAL_LID_L2_05kmALay-ProductionStrategy-Version.Instance.hdf
Expedited: CAL_LID_L2_05kmALay_Exp-ProductionStrategy-Version.Instance.hdf

The expedited data product contains 90 minutes of a combination of day and night data. Like the Standard data products, the Expedited data are also generated in HDF and include the same parameters and ranges as the Standard data products.

Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets should be used for these purposes.

2.4.1 Lidar Level 2 Cloud and Aerosol Layers Record Summary

Table 22: 1/3 km Lidar Cloud Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar Cloud & Aerosol Metadata Record	Table 26	22,670	1	22,670
1/3 km Column Descriptor Record: Clouds	Table 27	116	Standard: 63,630 Expedited: 108,960	7,381,080 126,393,360
1/3 km Layer Descriptor Record: Clouds	Table 28	850	Standard: 63,630 Expedited: 108,960	54,085,500 92,616,000
Total Size – Standard (bytes)				**61,490,153**
Total Size – Standard (Mbytes)				**60.049**
Total Size – Expedited (bytes)				**219,032,933**
Total Size – Expedited (Mbytes)				**213.899**

Table 23: 1 km Lidar Cloud Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar Cloud & Aerosol Metadata Record	Table 26	22,670	1	22,670
1 km Column Descriptor Record: Clouds	Table 29	116	Standard: 21,210 Expedited: 36,320	2,460,360 4,213,120
1 km Layer Descriptor Record: Clouds	Table 30	1,610	Standard: 21,210 Expedited: 36,320	34,148,100 58,475,200
Total Size – Standard (bytes)				**36,632,033**
Total Size – Standard (Mbytes)				**35.773**
Total Size – Expedited (bytes)				**62,711,893**
Total Size – Expedited (Mbytes)				**61.242**

Table 24: 5 km Lidar Cloud Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar Cloud & Aerosol Metadata Record	Table 26	22,670	1	22,670
5 km Column Descriptor Record: Clouds	Table 31	331	Standard: 4,242 Expedited: 7,264	1,404,102 2,404,384
5 km Layer Descriptor Record: Clouds	Table 32	2,760	Standard: 4,242 Expedited: 7,264	11,707,920 20,048,640
Total Size – Standard (bytes)				**13,135,595**
Total Size – Standard (Mbytes)				**12.828**
Total Size – Expedited (bytes)				**22,476,597**
Total Size – Expedited (Mbytes)				**21.950**

Table 25: 5 km Lidar Aerosol Layer Record Summary

Record Name	Reference Table	Individual Record Size	Records/ File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar Cloud & Aerosol Metadata Record	Table 26	22,670	1	22,670
5 km Column Descriptor Record: Aerosols	Table 33	331	Standard: 4,242 Expedited: 7,264	1,404,102 2,404,384
5 km Layer Descriptor Record: Aerosols	Table 34	2,466	Standard: 4,242 Expedited: 7,264	10,460,772 17,913,024
Total Size – Standard (bytes)				**11,888,447**
Total Size – Standard (Mbytes)				**11.610**
Total Size – Expedited (bytes)				**20,340,981**
Total Size – Expedited (Mbytes)				**19.864**

2.4.2 Lidar Cloud & Aerosol Level 2 Metadata

The Lidar Cloud & Aerosol Level 2 layer products include three Vdata record types (i.e., metadata), as specified in the tables above. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the cloud and aerosol Level 2 Layer Products are listed in Table 26.

Table 26: Lidar Cloud & Aerosol 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 – 6/2016	27	27
Date_Time_at_Granule_End[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_of_Production[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Number_of_Good_Profiles	Int_32	NoUnits	Std = 0…63,630 Exp = 0…108,960	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	Std = 0…63,630 Exp = 0…108,960	1	4
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	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[D]	Float_64	NoUnits	60,426.0…160,601.0	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[D]	Float_64	NoUnits	60,426.0…160,601.0	1	8
Lidar_L1_Production_Date_Time	Char	yymmdd	4/2006 – 6/2016	27	27
Number_of_Single_Shot_Records_in_File	Int_32	NoUnits	Std = 0…63,630 Exp = 0…108,960	1	4
Number_of_Average_Records_in_File	Int_32	NoUnits	Std = 0…21,210 Exp = 0…36,320	1	4
Number_of_Features_Found	Int_32	NoUnits	Std = 0…616,606 Exp = 0…1,038,752	1	4
Number_of_Cloud_Features_Found	Int_32	NoUnits	Std = 0…572,670 Exp = 0…980,640	1	4
Number_of_Aerosol_Features_Found	Int_32	NoUnits	Std = 0…33,936 Exp = 0…58,112	1	4
Number_of_Indeterminate_Features_Found	Int_32	NoUnits	Std = 0…572,640 Exp = 0…980,640	1	4
Lidar_Data_Altitudes	Float_32	km	-2.0…40.0	583	2,332
GEOS_Version	Char	NoUnits	N/A	64	64
Classifier_Coefficients_Version_Number	Char	NoUnits	0.0…99.9	1	4
Classifier_Coefficients_Version_Date	Char	yymmdd	4/2006 – 6/2016	1	6
Production_Script	Char	N/A	N/A	20,000	20,000
Record Size (bytes)					**22,670**

A) UTC CCSDS ASCII Time Code Format A
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

2.4.3 Lidar Cloud & Aerosol Level 2 Scientific Data Sets

Table 27 through Table 34 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.

Within the layer descriptors are a number of "Statistics" fields; for example, see the *Attenuated_Backscatter_Statistics_532* in Table 28, Table 30, Table 32, and Table 34. These fields are composite data structures that contain the following descriptive statistics for the named parameter:

- minimum value
- maximum value
- mean value
- standard deviation of the mean
- centroid (units = kilometers; range = feature base to feature top)
- skewness coefficient (unitless)

The units for the first four values are supplied in the 'Units' field corresponding to each "Statistics" field; e.g., the units for the first four values of the *Attenuated_Backscatter_Statistics_532* are, as indicated in Table 28, km^{-1} sr^{-1}.

Table 27: Lidar 1/3 km Column Descriptor Record: Clouds

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Profile_ID	Int_32	NoUnits	1…3,153,600,000	1	4
Latitude	Float_32	deg	-90.0…90.0	1	4
Longitude	Float_32	deg	-180.0…180.0	1	4
Profile_Time[C]	Float_64	sec	4.204E8…7.389E8	1	8
Profile_UTC_Time[D]	Float_64	NoUnits	60,426.0…160,601.0	1	8
Day_Night_Flag	Int_8	NoUnits	0…1	1	1
Off_Nadir_Angle	Float_32	deg	0.0…5.0	1	4
Solar_Zenith_Angle	Float_32	deg	0.0…180.0	1	4
Solar_Azimuth_Angle	Float_32	deg	-180.0…180.0	1	4
Scattering_Angle	Float_32	deg	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…TBD	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…TBD	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	0.0…2	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	ºC	-100.0…-20.0	1	4
IGBP_Surface_Type	Int_8	NoUnits	1…18	1	1
NSIDC_Surface_Type	UInt_8	NoUnits	0…255	1	1
Lidar_Surface_Elevation	Float_32	km	-1.0…9.0	2	8
DEM_Surface_Elevation	Float_32	km	-1.0…9.0	1	4
Number_Layers_Found	Int_8	NoUnits	0…5	1	1

Record Size (bytes)					**116**

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

Table 28: Lidar 1/3 km Layer Descriptor Record: Clouds

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…1086.0	5	20
Midlayer_Pressure	Float_32	hPa	1.0…1086.0	5	20
Layer_Base_Pressure	Float_32	hPa	1.0…1086.0	5	20
Layer_Top_Temperature	Float_32	ºC	-110.0…60.0	5	20
Midlayer_Temperature	Float_32	ºC	-110.0…60.0	5	20
Layer_Base_Temperature	Float_32	ºC	-110.0…60.0	5	20
Attenuated_Backscatter_Statistics_532	Float_32	km^{-1} sr^{-1}	N/A	30	120
Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	0.0…1.8	5	20
Integrated_Attenuated_Backscatter_Uncertainty_532	Float_32	sr^{-1}	0.0…0.5	5	20
Attenuated_Backscatter_Statistics_1064	Float_32	km^{-1} sr^{-1}	N/A	30	120
Integrated_Attenuated_Backscatter_1064	Float_32	sr^{-1}	0.0…1.8[K]	5	20
Integrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	sr^{-1}	0.0…0.5	5	20
Volume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	30	120
Integrated_Volume_Depolarization_Ratio [L]	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 [L]	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	sr^{-1}	0.0…2.0	5	20
Layer_IAB_QA_Factor	Float_32	NoUnits	0.0…1.0	5	20
Feature_Classification_Flags [J]	UInt_16	NoUnits	1…49,146	5	10
Record Size (bytes)					**850**

J) Refer to Table 44 for a detailed description of this parameter
K) While zero is the physically meaningful lower limit, small negative values may be encountered due to noise in weak signals
L) 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 29: Lidar 1 km Column Descriptor Record: Clouds

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Profile_ID	Int_32	NoUnits	1…3,153,600,000	1	4
Latitude	Float_32	deg	-90.0…90.0	1	4
Longitude	Float_32	deg	-180.0…180.0	1	4
Profile_Time[C]	Float_64	sec	4.204E8…7.389E8	1	8
Profile_UTC_Time[D]	Float_64	NoUnits	60,426.0…160,601.0	1	8
Day_Night Flag	Int_8	NoUnits	0…1	1	1
Off_Nadir_Angle	Float_32	deg	0.0…5.0	1	4
Solar_Zenith_Angle	Float_32	deg	0.0…180.0	1	4
Solar_Azimuth_Angle	Float_32	deg	-180.0…180.0	1	4
Scattering_Angle	Float_32	deg	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…TBD	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…TBD	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	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	ºC	-100.0…-20.0	1	4
IGBP_Surface_Type	Int_8	NoUnits	1…18	1	1
NSIDC_Surface_Type	UInt_8	NoUnits	0…255	1	1
Lidar_Surface_Elevation	Float_32	km	-1.0…9.0	2	8
DEM_Surface_Elevation	Float_32	km	-1.0…9.0	1	4
Number_Layers_Found	Int_8	NoUnits	0…10	1	1
Record Size (bytes)					**116**

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

Table 30: 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…1086.0	10	20
Midlayer_Pressure	Float_32	hPa	1.0…1086.0	10	20
Layer_Base_Pressure	Float_32	hPa	1.0…1086.0	10	20
Layer_Top_Temperature	Float_32	ºC	-110.0…60.0	10	20
Midlayer_Temperature	Float_32	ºC	-110.0…60.0	10	40
Layer_Base_Temperature	Float_32	ºC	-110.0…60.0	10	20
Attenuated_Backscatter_Statistics_532	Float_32	$km^{-1}\ sr^{-1}$	N/A	60	240
Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	0.0…1.8	10	40
Integrated_Attenuated_Backscatter_Uncertainty_532	Float_32	sr^{-1}	0.0…0.5	10	40
Attenuated_Backscatter_Statistics_1064	Float_32	$km^{-1}\ sr^{-1}$	N/A	60	240

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Integrated_Attenuated_Backscatter_1064	Float_32	sr^{-1}	0.0…1.8[K]	10	40
Integrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	sr^{-1}	0.0…0.5	10	40
Volume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
Integrated_Volume_Depolarization_Ratio [L]	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 [L]	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	sr^{-1}	0.0…2.0	10	40
Layer_IAB_QA_Factor	Float_32	NoUnits	0.0…1.0	10	40
CAD_Score	Int_8	NoUnits	-101…105	10	10
Feature_Classification_Flags [J]	UInt_16	NoUnits	1…49,146	10	20
Record Size (bytes)					**1,610**

J) Refer to Table 44 for a detailed description of this parameter

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

L) 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 31: Lidar 5 km Column Descriptor Record: Clouds

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Profile_ID	Int_32	NoUnits	1…3,153,600,000	2	8
Latitude	Float_32	deg	-90.0…90.0	3	12
Longitude	Float_32	deg	-180.0…180.0	3	12
Profile_Time[C]	Float_64	sec	4.204E8…7.389E8	3	24
Profile_UTC_Time[D]	Float_64	NoUnits	60,426.0…160,601.0	3	24
Day_Night_Flag	Int_8	NoUnits	0…1	1	1
Off_Nadir_Angle	Float_32	deg	0.0…5.0	1	4
Solar_Zenith_Angle	Float_32	deg	0.0…180.0	1	4
Solar_Azimuth_Angle	Float_32	deg	-180.0…180.0	1	4
Scattering_Angle	Float_32	deg	0.0…180.0	1	4
Spacecraft_Position[L]	Float_64	km	-8000.0…8000.0	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…TBD	1	4
Parallel_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	0.0…TBD	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…TBD	1	4
Perpendicular_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	0.0…TBD	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	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…5[M]	1	4
Column_Optical_Depth_Cloud_Uncertainty_532	Float_32	NoUnits	0.0…99.99[M]	1	4
Column_Optical_Depth_Aerosols_532	Float_32	NoUnits	0.0…3[M]	1	4
Column_Optical_Depth_Aerosols_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Stratospheric_532	Float_32	NoUnits	0.0…3[M]	1	4

Column_Optical_Depth_Stratospheric_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Aerosols_1064	Float_32	NoUnits	0.0…3[M]	1	4
Column_Optical_Depth_Aerosols_Uncertainty_1064	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Stratospheric_1064	Float_32	NoUnits	0.0…3[M]	1	4
Column_Optical_Depth_Stratospheric_Uncertainty_1064	Float_32	NoUnits	0.0…99.99	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	ºC	-100.0…-20.0	1	4
IGBP_Surface_Type	Int_8	NoUnits	1…18	1	1
NSIDC_Surface_Type	UInt_8	NoUnits	0…255	1	1
Lidar_Surface_Elevation	Float_32	km	-1.0…9.0	8	32
DEM_Surface_Elevation	Float_32	km	-1.0…9.0	4	16
Surface_Elevation_Detection_Frequency	UInt_8	NoUnits	0…165	1	1
Normalization_Constant_Uncertainty	Float_32	NoUnits	0.0…1.0	2	8
FeatureFinderQC	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
Record Size (bytes)					**323**

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

D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

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

M) 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.

Table 32: Lidar 5 km Layer Descriptor Record: Clouds

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
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	1…49,146	10	20
Layer_Top_Pressure	Float_32	hPa	1.0…1086.0	10	40
Midlayer_Pressure	Float_32	hPa	1.0…1086.0	10	40
Layer_Base_Pressure	Float_32	hPa	1.0…1086.0	10	40
Layer_Top_Temperature	Float_32	ºC	-110.0…60.0	10	40
Midlayer_Temperature	Float_32	ºC	-110.0…60.0	10	40
Layer_Base_Temperature	Float_32	ºC	-110.0…60.0	10	40
Opacity_Flag	Int_8	NoUnits	0…1	10	10
Horizontal_Averaging	Int_8	km	5…80	10	10
Single_Shot_Cloud_Cleared_Fraction	Float_32	NoUnits	0.0…1.0	10	40
Attenuated_Backscatter_Statistics_532	Float_32	km^{-1} sr^{-1}	N/A	60	240
Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	0.0…1.8	10	40
Integrated_Attenuated_Backscatter_Uncertainty_532	Float_32	sr^{-1}	0.0…0.5	10	40
Attenuated_Backscatter_Statistics_1064	Float_32	km^{-1} sr^{-1}	N/A	60	240
Integrated_Attenuated_Backscatter_1064	Float_32	sr^{-1}	0.0…1.8[K]	10	40
Integrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	sr^{-1}	0.0…0.5	10	40
Volume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
Integrated_Volume_Depolarization_Ratio [L]	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 [L]	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	sr^{-1}	0.0…2.0	10	40
Layer_IAB_QA_Factor	Float_32	NoUnits	0.0…1.0	10	40
Feature_Classification_Flags[J]	UInt_16	NoUnits	1…49,146	10	20
ExtinctionQC_532	UInt_16	NoUnits	0…32,768	10	20
CAD_Score	Int_8	NoUnits	-101…105	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	0.0…1.5	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	0.0…TBD	10	40
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
Lidar_Ratio_532_Selection_Method	Int_8	NoUnits	0.0…5.0	10	10
Layer_Effective_532_Multiple_Scattering_Factor	Float_32	NoUnits	0.6	10	40
Integrated_Particulate_Depolarization_Ratio	Float_32	NoUnits	0.0…1.0	10	40
Integrated_Particulate_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	0.0…99.9	10	40
Particulate_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	60	240
Cirrus_Shape_Parameter	Int_16	NoUnits	N/A	40	80
Cirrus_Shape_Parameter_Uncertainty	Int_16	NoUnits	N/A	40	80
Cirrus_Shape_Parameter_Invalid_Points	Int_16	NoUnits	N/A	10	20
Ice_Water_Path	Float_32	g/m^2	0.0…200.0	10	40
Ice_Water_Path_Uncertainty	Float_32	g/m^2	0.0…99.99	10	40
Record Size (bytes)					**2,760**

J) Refer to Table 44 for a detailed description of this parameter

K) While zero is the physically meaningful lower limit, small negative values may result due to noise in weak signals
L) 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.
Note: The first 32 parameters in Tables 32 and 34 (5 km Layer Descriptor Record for Aerosols) are identical.

Table 33: Lidar 5 km Column Descriptor Record: Aerosols

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Profile_ID	Int_32	NoUnits	1…3,153,600,000	2	8
Latitude	Float_32	deg	-90.0…90.0	3	12
Longitude	Float_32	deg	-180.0…180.0	3	12
Profile_Time[C]	Float_64	sec	4.204E8…7.389E8	3	24
Profile_UTC_Time[D]	Float_64	NoUnits	60,426.0…160,601.0	3	24
Day_Night_Flag	Int_8	NoUnits	0…1	1	1
Off_Nadir_Angle	Float_32	deg	0.0…5.0	1	4
Solar_Zenith_Angle	Float_32	deg	0.0…180.0	1	4
Solar_Azimuth_Angle	Float_32	deg	-180.0…180.0	1	4
Scattering_Angle	Float_32	deg	0.0…180.0	1	4
Spacecraft_Position[L]	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…TBD	1	4
Parallel_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	0.0…TBD	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…TBD	1	4
Perpendicular_Column_Reflectance_RMS_Variation_532	Float_32	NoUnits	0.0…TBD	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	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…5.0[M]	1	4
Column_Optical_Depth_Cloud_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Aerosols_532	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Aerosols_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Stratospheric_532	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Stratospheric_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Aerosols_1064	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Aerosols_Uncertainty_1064	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Stratospheric_1064	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Stratospheric_Uncertainty_1064	Float_32	NoUnits	0.0…99.99	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	ºC	-100.0…-20.0	1	4
IGBP_Surface_Type	Int_8	NoUnits	1…18	1	1
NSIDC_Surface_Type	UInt_8	NoUnits	0…255	1	1
Lidar_Surface_Elevation	Float_32	km	-1.0…9.0	8	32
DEM_Surface_Elevation	Float_32	km	-1.0…9.0	4	16
Surface_Elevation_Detection_Frequency	UInt_8	NoUnits	0…165	1	1
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
Number_Layers_Found	Int_8	NoUnits	0…8	1	1
Surface_Wind_Speed	Float_32	$m\ s^{-1}$	-80.0…80.0	2	8

Record Size (bytes)					**331**

3) International Atomic Time (TAI) seconds from Jan. 1, 1993
4) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
L) Spacecraft_Position is a 3x3 array which includes the position for the three latitudes

Table 34: Lidar 5 km Layer Descriptor Record: Aerosols

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
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	1…49,146	8	10
Layer_Top_Pressure	Float_32	hPa	1.0…1086.0	8	32
Midlayer_Pressure	Float_32	hPa	1.0…1086.0	8	32
Layer_Base_Pressure	Float_32	hPa	1.0…1086.0	8	32
Layer_Top_Temperature	Float_32	ºC	-110.0…60.0	8	32
Midlayer_Temperature	Float_32	ºC	-110.0…60.0	8	32
Layer_Base_Temperature	Float_32	ºC	-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_Backscatter_Statistics_532	Float_32	km^{-1} sr^{-1}	N/A	48	192
Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	0.0…1.8	8	32
Integrated_Attenuated_Backscatter_Uncertainty_532	Float_32	sr^{-1}	0.0…0.5	8	32
Attenuated_Backscatter_Statistics_1064	Float_32	km^{-1} sr^{-1}	N/A	48	192
Integrated_Attenuated_Backscatter_1064	Float_32	sr^{-1}	0.0…1.8	8	32
Integrated_Attenuated_Backscatter_Uncertainty_1064	Float_32	sr^{-1}	0.0…0.5	8	32
Volume_Depolarization_Ratio_Statistics	Float_32	NoUnits	N/A	48	192
Integrated_Volume_Depolarization_Ratio [L]	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 [L]	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	sr^{-1}	0.0…2.0	8	32
Layer_IAB_QA_Factor	Float_32	NoUnits	0.0…1.0	8	32
Feature_Classification_Flags[J]	UInt_16	NoUnits	1…49,146	8	16
ExtinctionQC_532	UInt_16	NoUnits	0…65,535	8	16
ExtinctionQC_1064	UInt_16	NoUnits	0…65,535	8	16
CAD_Score	Int_8	NoUnits	-101…105	8	8
Measured_Two_Way_Transmittance_532	Float_32	NoUnits	0.0…1.0[K]	8	32
Measured_Two_Way_Transmittance_Uncertainty_532	Float_32	NoUnits	0.0…TBD	8	32
Two_Way_Transmittance_Measurement_Region	Float_32	km	0.0…30.0	16	64
Feature_Optical_Depth_532	Float_32	NoUnits	0.0…3.0	8	32
Feature_Optical_Depth_Uncertainty_532	Float_32	NoUnits	0.0…TBD	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
Lidar_Ratio_532_Selection_Method	Int_8	NoUnits	0…5	8	8
Layer_Effective_532_Multiple_Scattering_Factor	Float_32	NoUnits	1.0	8	32
Integrated_Particulate_Depolarization_Ratio	Float_32	NoUnits	0.0…1.0	8	32
Integrated_Particulate_Depolarization_Ratio_Uncertainty	Float_32	NoUnits	0.0…99.99	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	0.0…TBD	8	32

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
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
Lidar_Ratio_1064_Selection_Method	Int_8	NoUnits	0…5	8	8
Layer_Effective_1064_Multiple_Scattering_Factor	Float_32	NoUnits	1.0	8	32
Integrated_Particulate_Color_Ratio	Float_32	NoUnits	0.0…4.0	8	32
Integrated_Particulate_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	%	0.0…150.0	8	32
Single_Shot_Cloud_Cleared_Fraction	Float_32	NoUnits	0.0…1.0	8	32
Record Size (bytes)					**2,466**

J) Refer to Table 44 for a detailed description of this parameter

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

L) 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.

2.5 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 are 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 (refer to the Scene Classification ATBD).

The data products are written in HDF. A summary of the product records is listed in Table 35.

The major categories of the data product are:

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

Level:	2	
Type:	Archival	
Frequency:	Standard:	2/Orbit
	Expedited:	16/day
Spatial Resolution Record:	Standard:	60 m vertical resolution x 5 km
	Expedited:	60 m vertical resolution x 5 km
Time Interval Covered:	Standard:	Half Orbit (Day or Night)
	Expedited:	90 minutes

Data File Name:

Standard:	CAL_LID_L2_5kmAPro-ProductionStrategy-Version.Instance.hdf
Expedited:	CAL_LID_L2_5kmAPro_Exp-ProductionStrategy-Version.Instance.hdf

The expedited data product contains 90 minutes of a combination of day and night data. Like the Standard data products, the Expedited data are also generated in HDF and include the same parameters and ranges as the Standard data products.

Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets should be used for these purposes.

Profile Vertical Resolution

Altitude Region		Vertical Resolution, meters	Samples per Profile
Base, km	**Top, km**		
-0.5	8.2	60	145
8.2	20.2	60	200
20.2	30.1	180	54
Total			**399**

2.5.1 Lidar Level 2 Aerosol Profile Data Summary

Table 35: Lidar Level 2 Aerosol Profile Data Record Summary

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar Aerosol Metadata Record	Table 36	22,062	1	22,062
Lidar 5 km Aerosol Profile Record, CALIPSO Lidar Ratio (Standard data product)	Table 37	36,067	Standard: 4,242 Expedited: 7,264	152,996,214 261,990,688
Total Size – Standard (bytes)				**153,019,179**
Total Size – Standard (Mbytes)				**149.433**
Total Size – Expedited (bytes)				**262,013,624**
Total Size – Expedited (Mbytes)				**255.873**

2.5.2 Lidar Aerosol Profile Data Metadata

The Lidar Aerosol Profile Data products include three Vdata record types (i.e., metadata), as specified in Table 35. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the Lidar Level 2 Aerosol Profile Data Product are listed in Table 36.

Table 36: 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 – 6/2016	27	27
Date_Time_at_Granule_End[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_of_Production[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Number_of_Good_Profiles	Int_32	NoUnits	Std = 0…4,242 Exp = 0…7,264	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	Std = 0…4,242 Exp = 0…7,264	1	4
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	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[D]	Float_64	NoUnits	60,426.0…160,601.0	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[D]	Float_64	NoUnits	60,426.0…160,601.0	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	$m^2\ sr^{-1}$	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
Lidar_L1_Production_Date_Time[A]	Char	yymmdd	4/2006 – 6/2016	27	27
Lidar_Data_Altitudes	Float_32	km	-0.5…30.0	399	1596
Initial_Lidar_Ratio_Aerosols_532	Float_32	sr	20.0…70.0	8	32
Initial_Lidar_Ratio_Stratosphere_532	Float_32	sr	25.0	8	32
Initial_Lidar_Ratio_Aerosols_1064	Float_32	sr	30.0…55.0	8	32
Initial_Lidar_Ratio_Stratosphere_1064	Float_32	sr	25.0	8	32
GEOS_Version	Char	NoUnits	N/A	64	64
Classifier_Coefficients_Version_Number	Char	NoUnits	0.0…99.9	1	4
Classifier_Coefficients_Version_Date	Char	yymmdd	4/2006 – 6/2016	1	6
Production_Script	Char	NoUnits	N/A	20,000	20,000
Record Size (bytes)					**22,062**

A) UTC CCSDS ASCII Time Code Format A
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

2.5.3 Lidar Aerosol Profile Data Scientific Data Sets

Table 37 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 37: Lidar 5 km Aerosol Profile Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Latitude	Float_32	deg	-90.0…90.0	3	12
Longitude	Float_32	deg	-180.0…180.0	3	12
Profile_Time[C]	Float_64	sec	4.204E8…7.389E8	3	24
Profile_UTC	Float_64	NoUnits	60,426.0…160,601.0	3	24
Day_Night_Flag	Int_8	NoUnits	0…1	1	1
Column_Optical_Depth_Cloud_532	Float_32	NoUnits	0.0…5.0[M]	1	4
Column_Optical_Depth_Cloud_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Aerosols_532	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Aerosols_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Stratospheric_532	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Stratospheric_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Aerosols_1064	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Aerosols_Uncertainty_1064	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Stratospheric_1064	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Stratospheric_Uncertainty_1064	Float_32	NoUnits	0.0…99.99	1	4
Column_Feature_Fraction	Float_32	NoUnits	0.0…1.0	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	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	°C	-100.0…-20.0	1	4
Temperature	Float_32	°C	-120.0…60.0	399	1,596
Pressure	Float_32	hPa	1.0…1086.0	399	1,596
Molecular_Number_Density	Float_32	m^{-3}	$8x10^{22}…5x10^{25}$	399	1,596
Relative_Humidity	Float_32	%	0.0…150.0	399	1,596
Surface_Elevation_Statistics	Float_32	km	-1.0…9.0	4	16
Surface_Winds	Float_32	$m\ s^{-1}$	-80.0…80.0	2	8
Samples_Averaged	Int_16	NoUnits	0…480	399	798
Aerosol_Layer_Fraction	UInt_8	NoUnits	0…30	399	399
Cloud_Layer_Fraction	UInt_8	NoUnits	0…30	399	399
Atmospheric_Volume_Description	UInt_16	NoUnits	1…49,146	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…105	399x2	798
Total_Backscatter_Coefficient_532	Float_32	$sr^{-1}\ km^{-1}$	0.0…0.05	399	1,596
Total_Backscatter_Coefficient_Uncertainty_532	Float_32	$sr^{-1}\ km^{-1}$	0.0…99.99	399	1,596
Perpendicular_Backscatter_Coefficient_532	Float_32	$sr^{-1}\ km^{-1}$	0.0…0.01	399	1,596
Perpendicular_Backscatter_Coefficient_Uncertainty_532	Float_32	$sr^{-1}\ km^{-1}$	0.0…99.99	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	0.0…99.99	399	1,596
Extinction_Coefficient_532	Float_32	km^{-1}	0.0…1.25	399	1,596
Extinction_Coefficient_Uncertainty_532	Float_32	km^{-1}	0.0…99.99	399	1,596
Aerosol_Multiple_Scattering_Profile_532	Float_32	NoUnits	1.0	399	1,596
Backscatter_Coefficient_1064	Float_32	$sr^{-1}\ km^{-1}$	0.0…0.03	399	1,596

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Backscatter_Coefficient_Uncertainty_1064	Float_32	sr^{-1} km^{-1}	0.0…99.99	399	1,596
Extinction_Coefficient_1064	Float_32	km^{-1}	0.0…1.0	399	1,596
Extinction_Coefficient_Uncertainty_1064	Float_32	km^{-1}	0.0…99.99	399	1,596
Aerosol_Multiple_Scattering_Profile_1064	Float_32	NoUnits	1.0	399	1,596
Record Size (bytes)					**36,067**

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

2.6 Lidar Level 2 Cloud Profile Data Product DP 2.1C

The Lidar Level 2 Cloud Profile data product contains cloud profile data and ancillary data. The cloud profile product is produced at 5 km horizontal resolution and is written in HDF. A summary of the product records is listed in Table 38.

Note that there is no atmospheric volume characterization associated with the cloud profile products. Also, 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.

Additionally, it is important to note that the aerosol profile product extends upward to 30.1 km, while the cloud profile product ceases at 20.2. Therefore, users interested in polar stratospheric clouds will need to order the aerosol profile data product.

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	
Type:	Archival	
Frequency:	Standard:	2/Orbit
	Expedited:	16/day
Spatial Resolution Record:	Standard:	60 m vertical resolution
		5 km Along Track
	Expedited:	60 m vertical resolution
		5 km Along Track
Time Interval Covered:	Standard:	Half Orbit (Day or Night)
	Expedited:	90 minutes

Data File Name:

Standard: CAL_LID_L2_5kmCPro-ProductionStrategy-Version.Instance.hdf

Expedited: CAL_LID_L2_5kmCPro_Exp-ProductionStrategy-Version.Instance.hdf

The expedited data product contains 90 minutes of a combination of day and night data. Like the Standard data products, the Expedited data are also generated in HDF and include the same parameters and ranges as the Standard data products.

Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets should be used for these purposes.

Profile Vertical Resolution

Altitude Region		Vertical Resolution, meters	Samples per Profile
Base, km	**Top, km**		
-0.5	8.2	60	145
8.2	20.2	60	200
Total			**345**

2.6.1 Lidar Cloud Profile Data Record Summary

Table 38: Lidar Cloud Profile Data Record Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar Cloud Metadata Record	Table 39	21,726	1	21,726
Lidar 5 km Cloud Profile Record	Table 40	25,687	Standard: 4,242 Expedited: 7,264	108,964,254 186,590,368
Total Size – Standard (bytes)				**108,986,883**
Total Size – Standard (Mbytes)				**106.432**
Total Size – Expedited (bytes)				**186,612,997**
Total Size – Expedited (Mbytes)				**182.239**

2.6.2 Lidar Cloud Profile Data Metadata

Lidar Cloud Profile Data Products include three Vdata record types (i.e., metadata), as specified in Table 38. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the Lidar Cloud Profile Data Product are listed in Table 39.

Table 39: Lidar 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 – 6/2016	27	27
Date_Time_at_Granule_End[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_of_Production[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Number_of_Good_Profiles	Int_32	NoUnits	Std = 0…4,242 Exp = 0…7,264	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	Std = 0…4,242 Exp = 0…7,264	1	4
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	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[D]	Float_64	NoUnits	60,426.0…160,601.0	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[D]	Float_64	NoUnits	60,426.0…160,601.0	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	$m^2\ sr^{-1}$	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
Lidar_L1_Production_Date_Time[A]	Char	yymmdd	4/2006 – 6/2016	27	27
Lidar_Data_Altitudes	Float_32	km	-0.480…20.175	345	1,380
Initial_Lidar_Ratio_Clouds_532	Float_32	sr	19.0…25.0	2	8
GEOS_Version	Char	NoUnits	N/A	64	64
Classifier_Coefficients_Version_Number	Char	NoUnits	0.0…99.9	1	4
Classifier_Coefficients_Version_Date	Char	yymmdd	4/2006 – 6/2016	1	6
Production_Script	Char	NoUnits	N/A	20,000	20,000
Record Size (bytes)					**21,726**

A) CCSDS ASCII Time Code Format A
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

2.6.3 Lidar Cloud Profile Scientific Data Sets

Table 40 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 40: Lidar 5 km Cloud Profile Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Latitude	Float_32	deg	-90.0…90.0	3	12
Longitude	Float_32	deg	-180.0…180.0	3	12
Profile_Time[C]	Float_64	sec	4.204E8…7.389E8	3	24
Profile_UTC	Float_64	NoUnits	60,426.0…160,601.0	3	24
Day_Night_Flag	Int_8	NoUnits	0…1	1	1
Column_Optical_Depth_Cloud_532	Float_32	NoUnits	0.0…5.0[M]	1	4
Column_Optical_Depth_Cloud_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Aerosols_532	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Aerosols_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Stratospheric_532	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Stratospheric_Uncertainty_532	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Aerosols_1064	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Aerosols_Uncertainty_1064	Float_32	NoUnits	0.0…99.99	1	4
Column_Optical_Depth_Stratospheric_1064	Float_32	NoUnits	0.0…3.0[M]	1	4
Column_Optical_Depth_Stratospheric_Uncertainty_1064	Float_32	NoUnits	0.0…99.99	1	4
Column_Feature_Fraction	Float_32	NoUnits	0.0…1.0	1	4
Column_Integrated_Attenuated_Backscatter_532	Float_32	sr^{-1}	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	°C	-100.0…-20.0	1	4
Temperature	Float_32	°C	-120.0…60.0	345	1,380
Pressure	Float_32	hPa	1.0…1086.0	345	1,380
Molecular_Number_Density	Float_32	m^{-3}	$8x10^{22}…5x10^{25}$	345	1,380
Relative_Humidity	Float_32	%	0.0…150.0	345	1,380
Surface_Elevation_Statistics	Float_32	km	-1.0…9.0	4	16
Surface_Winds	Float_32	ms^{-1}	-80.0…80.0	2	8
Samples_Averaged	Int_16	NoUnits	0…480	345	690
Aerosol_Layer_Fraction	UInt_8	NoUnits	0…30	345	345
Cloud_Layer_Fraction	UInt_8	NoUnits	0…30	345	345
Atmospheric_Volume_Description	UInt_16	NoUnits	1…49,146	345x2	1,380
Extinction_QC_Flag_532	UInt_16	NoUnits	0…32,768	345x2	1,380
CAD_Score	Int_8	NoUnits	-101…105	345x2	690
Total_Backscatter_Coefficient_532	Float_32	sr^{-1} km^{-1}	0.0…1.5	345	1,380
Total_Backscatter_Coefficient_Uncertainty_532	Float_32	sr^{-1} km^{-1}	0.0…99.99	345	1,380
Perpendicular_Backscatter_Coefficient_532	Float_32	sr^{-1} km^{-1}	0.0…0.35	345	1,380
Perpendicular_Backscatter_Coefficient_Uncertainty_532	Float_32	sr^{-1} km^{-1}	0.0…99.99	345	1,380
Particulate_Depolarization_Ratio_Profile_532	Float_32	NoUnits	0.0…1.0	345	1,380
Particulate_Depolarization_Ratio_Uncertainty_532	Float_32	NoUnits	0.0…99.99	345	1,380
Extinction_Coefficient_532	Float_32	km^{-1}	0.0…12.0	345	1,380
Extinction_Coefficient_Uncertainty_532	Float_32	km^{-1}	0.0…99.99	345	1,380
Cloud_Multiple_Scattering_Profile_532	Float_32	NoUnits	0.5…1.0	345	1,380
Ice_Water_Content_Profile	Float_32	$g\ m^{-3}$	0.0…0.54	345	1,380
Ice_Water_Content_Profile_Uncertainty	Float_32	$g\ m^{-3}$	0.0…99.99	345	1,380

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Record Size (bytes)					**25,687**

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

2.7 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 feature mask product is written in HDF. A summary of the product records is listed in Table 41.

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 descriptive information contained within these feature classification flags is described in detail in Table 44.

The major categories contained within the data product are:

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

Level:	2	
Type:	Archival	
Frequency:	Standard:	2/Orbit
	Expedited:	16/day
Spatial Resolution Record:	Standard:	Single shot, full resolution
	Expedited:	Single shot, full resolution
Time Interval Covered:	Standard:	Half Orbit (Day or Night)
	Expedited:	90 minutes

Data File Name:

Standard: CAL_LID_L2_VFM-ProductionStrategy-Version.Instance.hdf

Expedited: CAL_LID_L2_VFM_Exp-ProductionStrategy-Version.Instance.hdf

The expedited data product contains 90 minutes of a combination of day and night data. Like the Standard data products, the Expedited data are also generated in HDF and include the same parameters and ranges as the Standard data products.

Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets should be used for these purposes.

Profile Spatial Resolution

Altitude Region		Vertical Resolution (meters)	Horizontal Resolution (meters)	Profiles per 5 km	Samples per Profile
Base (km)	Top (km)				
-0.5	8.2	30	333	15	290
8.2	20.2	60	1,000	5	200
20.2	30.1	180	1,667	3	55
Total					**545**

2.7.1 Lidar Vertical Feature Mask Data Record Summary

Table 41: Lidar Vertical Feature Mask Data Record Summary

Record Name	Reference	Record Size	Records/ File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar Vertical Feature Mask Metadata Record	Table 42	22,646	1	22,646
Lidar 5 km Vertical Feature Mask Record	Table 43	11,081	Standard: 4,242 Expedited: 7,264	47,005,602 80,492,384
Total Size – Standard (bytes)				**47,029,151**
Total Size – Standard (Mbytes)				**45.927**
Total Size – Expedited (bytes)				**80,515,933**
Total Size – Expedited (Mbytes)				**78.629**

2.7.2 Lidar Vertical Feature Mask Metadata

The Lidar Vertical Feature Mask products include three Vdata record types (i.e., metadata), as shown in Table 41. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the Lidar Vertical Feature Mask Product are listed in Table 42.

Table 42: Lidar 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 – 6/2016	27	27
Date_Time_at_Granule_End[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_of_Production[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Lidar_L1_Production_Date_Time[A]	Char	NoUnits	4/2006…6/2016	27	27
Number_of_Good_Profiles	Int_32	NoUnits	Std = 0…4,242 Exp = 0…7,264	1	4
Number_of_Bad_Profiles	Int_32	NoUnits	Std = 0…4,242 Exp = 0…7,264	1	4
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	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[D]	Float_64	NoUnits	60,426.0…160,601.0	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[D]	Float_64	NoUnits	60,426.0…160,601.0	1	8
Lidar_Data_Altitudes	Float_32	km	-2.0…40.0	583	2,332
GEOS_Version	Char	NoUnits	N/A	64	64
Classifier_Coefficients_Version_Number	Char	NoUnits	0.0…99.9	1	4
Classifier_Coefficients_Version_Date	Char	yymmdd	4/2006…6/2016	1	6
Production_Script	Char	NoUnits	N/A	20,000	20,000
Record Size (bytes)					**22,646**

A) UTC CCSDS ASCII Time Code Format A
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

2.7.3 Lidar Vertical Feature Mask Scientific Data Sets

Table 43 summarizes 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 43: Lidar Vertical Feature Mask Record

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Latitude	Float_32	deg	-90.0…90.0	1	4
Longitude	Float_32	deg	-180.0…180.0	1	4
Profile_Time[C]	Float_64	sec	4.204E8…7.389E8	1	8
Profile_UTC_Time[D]	Float_64	NoUnits	60,426.0…160,601.0	1	8
Day_Night_Flag	UInt_16	NoUnits	0…1	1	2
Land_Water_Mask	Int_8	NoUnits	0…7	1	1
Spacecraft_Position	Float_64	km	-8000.0…8000.0	3	24
Feature_Classification_Flags[J]	UInt_16	NoUnits	1…49,146	5,515	11,030
Record Size (bytes)					**11,081**

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
J) Refer to Table 44 for a detailed description of this parameter

Table 44: Feature Classification Flag Definition

Bit(s)	Field Description	Bit Interpretation
1-3	Feature Type	0 = invalid (bad or missing data) 1 = "clear air" 2 = cloud 3 = aerosol 4 = stratospheric feature; polar stratospheric cloud (PSC) or stratospheric aerosol 5 = surface 6 = subsurface 7 = no signal (totally attenuated)
4-5	Feature Type QA	0 = none 1 = low 2 = medium 3 = high
6-7	Ice/Water Phase	0 = unknown/not determined 1 = ice 2 = water 3 = oriented ice crystals
8-9	Ice/Water Phase QA	0 = none 1 = low 2 = medium 3 = high
10-12	Feature Sub-type	

Bit(s)	Field Description	Bit Interpretation
	If feature type = aerosol, bits 10-12 will specify the aerosol type.	0 = not determined 1 = clean marine 2 = dust 3 = polluted continental 4 = clean continental 5 = polluted dust 6 = smoke 7 = other
	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 = Polar Stratospheric Cloud, bits 10-12 will specify PSC classification.	0 = not determined 1 = non-depolarizing PSC 2 = depolarizing PSC 3 = non-depolarizing aerosol 4 = depolarizing aerosol 5 = spare 6 = spare 7 = other
13	Cloud/Aerosol/PSC Type QA	0 = not confident 1 = confident
14-16	Horizontal averaging required for detection (provides a coarse measure of feature backscatter intensity)	0 = not applicable 1 = 1/3 km 2 = 1 km 3 = 5 km 4 = 20 km 5 = 80 km

2.8 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 file is written in HDF. A summary of the product records is listed in Table 45.

Level:	2	
Type:	Archival	
Frequency:	Standard:	Daily
	Expedited:	Not Produced
Spatial Resolution Record:	Standard:	360° longitude (180°W to 180°E)
		35° latitude (50° to 85°; winter hemisphere)
	Expedited:	Not Available
Time Interval Covered:	Standard:	Nighttime Data Only
		Southern Hemisphere Months: May - October
		Northern Hemisphere Months: November - April
	Expedited:	Not Available

Data File Name:

Standard: CAL_LID_L2_PSCMask-ProductionStrategy-Version.Instance.hdf

Expedited: Not Produced

2.8.1 Lidar Cloud Profile Data Record Summary

Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the Polar Stratospheric Cloud (PSC) data are provided in Table 46.

Table 45: Lidar Polar Stratospheric Cloud Profile Data Record Summary

Record Name	Reference	Record Size	Records / File	File Size (bytes)
Core Metadata Record	Appendix A	870	1	870
Archive Metadata Record	Appendix A	4	1	4
PSC Metadata Record	N/A	N/A	N/A	N/A
PSC SDS Metadata Record	Table 46	1,041	1	1,041
PSC Record	Table 47	4,870	20,755	101,076,850
Total_Scattering_Ratio_532_Threshold Record	Table 46	16	5	80
Perpendicular_Attenuated_Backscatter_532_Threshold Record	Table 46	16	5	80
Total Size – Standard (bytes)				**101,078,925**
Total Size – Standard (Mbytes)				**98.709**

2.8.2 Lidar Polar Stratospheric Cloud Data Metadata

Lidar Polar Stratospheric Cloud Data Products include SDS record types (i.e., metadata), as specified in Table 45. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the Lidar Polar Stratospheric Cloud Profile Data Product are listed in Table 46.

Table 46: Lidar Polar Stratospheric Cloud Profile SDS Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Of_LIDAR_L1_Files	Int_16	NoUnits	1 … 15	1	2
L1_Input_Filenames	String	NoUnits	N/A	1…15	315
L1_Input_Start_Times	Float_64	NoUnits	60426.0 ... 160601.0	1…15	120
L1_Input_End_Times	Float_64	NoUnits	60426.0 ... 160601.0	1…15	120
Total_Scattering_Ratio_532_Threshold[Q]	Float_32	NoUnits	0.0 …5.0	0	0
Perpendicular_Attenuated_Backscatter_532_Threshold[Q]	Float_32	NoUnits	0.0E0 ... 1.0E-4	0	0
Altitude	Float_32	km	8.0 … 30.0	121	484
Record Size (bytes)					**1,041**

Q) Total_Scattering_Ratio_532_Threshold and Perpendicular_Attenuated_Backscatter_532_Threshold are 4x5 thresholds in bins of horizontal averaging by potential temperature. The total number of bytes is reported in Table 45.

2.8.3 Lidar Polar Stratospheric Cloud Scientific Data Sets

Table 47 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 47: Lidar Polar Stratospheric Cloud Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Latitude	Float_32	deg	-90.0 … 90.0	1	4
Longitude	Float_32	deg	-180.0 … 180.0	1	4
Profile_Time[C]	Float_64	sec	4.204E8 ... 7.389E8	1	8
Profile_UTC_Time	Float_64	NoUnits	60426.0 ... 160601.0	1	8
PSC_Feature_Mask	Int_16	NoUnits	-350 ... 350	121	242
PSC_Composition	Int_16	NoUnits	0 ... 6	121	242
Temperature	Float_32	K	150.0 ... 350.0	121	484
Potential_Temperature	Float_32	K	200.0 ... 1200.0	121	484
Total_Scattering_Ratio_532	Float_32	NoUnits	-100.0 ... 1000.0	121	484
Perpendicular_Scattering_Ratio_532	Float_32	NoUnits	-7500.0 ... 150000.0	121	484
Particulate_Color_Ratio	Float_32	NoUnits	-5.0E7 ... 5.0E7	121	484
Perpendicular_Attenuated_Backscatter_532	Float_32	km^{-1} sr^{-1}	-0.1 ... 1.0	121	484
Particulate_Depolarization_Ratio_532	Float_32	NoUnits	-2.5E6 ... 6.0E5	121	484
Total_Attenuated_Backscatter_532	Float_32	km^{-1} sr^{-1}	-0.1 ... 1.0	121	484
Particulate_Attenuated_Backscatter_532	Float_32	km^{-1} sr^{-1}	-0.1 ... 1.0	121	484
Tropopause_Height	Float_32	km	3.0 ... 25.0	1	4
Orbit_Index	Int_16	NoUnits	0 … 14	1	2
Record Size (bytes)					**4,870**

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

2.9 IIR/Lidar 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 Level 2 data product is written in HDF. The records are listed in Table 45.

The major categories of the data product are:

- Cloud Emissivity
- Cloud Properties
- Lidar Profile Data

Level:	2	
Type:	Archival	
Frequency:	Standard:	2/Orbit
	Expedited:	16/day
Spatial Resolution Record:	Standard:	1 km pixels at nadir
	Expedited:	1 km pixels at nadir
Time Interval Covered:	Standard:	Half Orbit (Day or Night)
	Expedited:	90 minutes

Data File Name:

Standard: CAL_IIR_L2_Track-ProductionStrategy-Version.Instance.hdf
Expedited: CAL_IIR_L2_Track_Exp-ProductionStrategy-Version.Instance.hdf

The expedited data product contains 90 minutes of a combination of day and night data. Like the Standard data products, the Expedited data are also generated in HDF and include the same parameters and ranges as the Standard data products.

Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets should be used for these purposes.

2.9.1 IIR/Lidar 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 48: IIR/Lidar Track Product Summary

Record Name	Reference	Record Size	Records/File	File Size (Bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
IIR Track Metadata Record	Table 49	377	1	377
IIR/Lidar Track Science Record	Table 50	261	Standard: 20,048 Expedited: 36,337	5,232,528 9,483,957
Total Size – Standard (bytes)				**5,233,808**
Total Size – Standard (Mbytes)				**5.111**
Total Size – Expedited (bytes)				**9,485,237**
Total Size – Expedited (Mbytes)				**9.263**

2.9.2 IIR/Lidar Track Metadata

The IIR/Lidar Track products include three Vdata record types (i.e., metadata) shown in the tables above. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the IIR/Lidar Track Product are listed in Table 49.

Table 49: IIR/Lidar 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	4/2006 – 6/2016	27	27
Date_Time_at_Granule_End[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_of_Production[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Initial_IIR_Scan_Center_Latitude	Float_32	deg	-90.0…90.0	1	4
Initial_IIR_Scan_Center_Longitude	Float_32	deg	-180.0…180.0	1	4
Ending_IIR_Scan_Center_Latitude	Float_32	deg	-90.0…90.0	1	4
Ending_IIR_Scan_Center_Longitude	Float_32	deg	-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[D]	Float_64	NoUnits	60,426.0…160,601.0	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[D]	Float_64	NoUnits	60,426.0…160,601.0	1	8
Number_of_IIR_Records_in_File	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Valid_08_65_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Valid_12_05_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Valid_10_60_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Invalid_08_65_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Invalid_12_05_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Invalid_10_60_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Rejected_08_65_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Rejected_12_05_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Rejected_10_60_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Rejected_08_65_Pixels_Location	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Rejected_12_05_Pixels_Location	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Rejected_10_60_Pixels_Location	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Rejected_08_65_Pixels_Radiance	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Rejected_12_05_Pixels_Radiance	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_of_Rejected_10_60_Pixels_Radiance	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Mean_08_65_Radiance_All	Float_32	$Wm^{-2}sr^{-1}\mu m^{-1}$	0.0...40.0	1	4
Mean_12_05_Radiance_All	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	0.0...40.0	1	4
Mean_10_60_Radiance_All	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	0.0...40.0	1	4
Mean_08_65_Radiance_Selected_Cases	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	0.0...40.0	1	4
Mean_12_05_Radiance_Selected_Cases	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	0.0...40.0	1	4
Mean_10_60_Radiance_Selected_Cases	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	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	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Invalid_LIDAR_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Rejected_LIDAR_Pixels	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Number_of_Identified_Pixels_Upper_Level	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Percent_of_Identified_Pixels_Upper_Level	Float_32	%	0.0…100.0	1	4
Number_of_Identified_Pixels_Lower_Level	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Percent_of_Identified_Pixels_Lower_Level	Float_32	%	0.0…100.0	1	4
Number_of_Identified_Pixels_Clear_Sky	Int_16	NoUnits	Std = 0…20,048 Exp = 0…36,337	1	2
Percent_of_Identified_Pixels_Clear_Sky	Float_32	%	0.0…100.0	1	4
Mean_Altitude_Upper_Level	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
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
N) Ranges provided for both Standard data products and Expedited data products

2.9.3 IIR/Lidar Track Scientific Data Sets

Table 50 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. Parameters for which a valid range has not yet been established are listed as TBD (to be determined).

Table 50: IIR/Lidar Track Science Record

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
Latitude	Float_32	deg	-90.0…90.0	1	4
Longitude	Float_32	deg	-180.0…180.0	1	4
LIDAR_Shot_Time[C]	Float_64	sec	N/A	1	8
IIR_Image_Time_12_05[C]	Float_64	sec	N/A	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
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
Emissivity_08_65	Float_32	NoUnits	0.0…1.0	1	4
Emissivity_12_05	Float_32	NoUnits	0.0…1.0	1	4
Emissivity_10_60	Float_32	NoUnits	0.0…1.0	1	4
Emissivity_Uncertainty_08_65	Float_32	NoUnits	TBD	1	4
Emissivity_Uncertainty_12_05	Float_32	NoUnits	TBD	1	4
Emissivity_Uncertainty_10_60	Float_32	NoUnits	TBD	1	4
Particle_Shape_Index[I]	Int_8	NoUnits	0...127	1	1
Particle_Shape_Index_Confidence[I]	Int_8	NoUnits	0…3	1	1
Effective_Particle_Size	Float_32	μm	0.0…300.0	1	4
Effective_Particle_Size_Uncertainty[I]	Float_32	NoUnits	-100.0...500.0	1	4
Reference_Brightness_Temperature[J]	Int_16	K	0.0...400.0	3	6
Blackbody_Brightness_Temperature[J]	Int_16	K	0.0...400.0	3	6
Computed_Brightness_Temperature_Surface[J]	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
Ice_Water_Path	Float_32	$g.m^{-2}$	0.0...1,000.0	1	4
Ice_Water_Path_Confidence	Float_32	$g.m^{-2}$	TBD	1	4
Optical_Depth_0532_Upper_Level	Float_32	NoUnits	0.0…20.0	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
Temperature_Centroid_IAB_0532_Upper_Level	Float_32	K	160.0…340.0	1	4

Parameter	Data Type	Units	Range	Elem/ Rec	Bytes
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
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
IIR_Data_Quality_Flag[I]	Int_8	NoUnits	0…15	1	1
LIDAR_Data_Quality_Flag[I]	Int_8	NoUnits	0…3	1	1
Type_of_Scene[I]	Int_8	NoUnits	0...99	1	1
Surrounding_Obs_Quality_Flag	Int_16	NoUnits	0...32767	1	2
High_Cloud_vs_Background_Flag[I]	Float_32	NoUnits	-100.0...500.0	1	4
Computed_vs_Observed_Background_Flag	Float_32	NoUnits	-10.0...10.0	3	12
Regional_Background_Std_Dev_Flag[I]	Float_32	NoUnits	0.0...1.0	1	4
Multi_Layer_Cloud_Flag[I]	Float_32	NoUnits	-9,030...12,030.0	1	4
Microphysics[I]	Float_32	NoUnits	0...1,500,000.0	7	28
Record Size (bytes)					**261**

C) International Atomic Time (TAI) seconds from Jan 1, 1993
I) See data product quality summary for interpretation
J) Range after scale equation reported in the HDF file

Appendix C provides flag definitions for selected science parameters.

2.10 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 Level 2 data product is written in HDF. The records are listed in Table 51.

The major categories of the data product are:

- Cloud Emissivity
- Cloud Properties

Level:	2	
Type:	Archival	
Frequency:	Standard:	2/Orbit
	Expedited:	16/day
Spatial Resolution Record:	Standard:	1 km pixels x km swath
	Expedited:	1 km pixels x km swath
Time Interval Covered:	Standard:	Half Orbit (Day or Night)
	Expedited:	90 minutes

Data File Name:

Standard: CAL_IIR_L2_Swath-ProductionStrategy-Version.Instance.hdf

Expedited: CAL_IIR_L2_Swath_Exp-ProductionStrategy-Version.Instance.hdf

The expedited data product contains 90 minutes of a combination of day and night data. Like the Standard data products, the Expedited data are also generated in HDF and include the same parameters and ranges as the Standard data products.

Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets should be used for these purposes.

2.10.1 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 51: IIR Swath Product Summary

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Swath Metadata	Table 52	379	1	379
Swath Science Record	Table 53	5,735	Standard: 20,048 Expedited: 36,337	114,975,280 208,392,695
Total Size - Standard (bytes)				**114,976,562**
Total Size – Standard (Mbytes)				**112.282**
Total Size - Expedited (bytes)				**208,393,977**
Total Size – Expedited (Mbytes)				**195.859**

2.10.2 IIR Swath Metadata

The IIR Swath products include three Vdata record types (i.e., metadata) shown in the tables above. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the IIR Swath Product are listed in Table 52.

Table 52: IIR 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	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_at_Granule_End	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_of_Production	Char	NoUnits	4/2006 – 6/2016	27	27
Initial_IIR_Scan_Center_Latitude	Float_32	deg	-90.0…90.0	1	4
Initial_IIR_Scan_Center_Longitude	Float_32	deg	-180.0…180.0	1	4
Ending_IIR_Scan_Center_Latitude	Float_32	deg	-90.0…90.0	1	4
Ending_IIR_Scan_Center_Longitude	Float_32	deg	-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[A]	Float_64	NoUnits	60,426.0…160,601.0	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[A]	Float_64	NoUnits	60,426.0…160,601.0	1	8
Number_of_IIR_Records_in_File	Int_16	NoUnits	Std = 0…20,048 Exp = 0...36,337	1	2
Number_of_Valid_08_65_Pixels	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Valid_12_05_Pixels	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Valid_10_60_Pixels	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Invalid_08_65_Pixels	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Invalid_12_05_Pixels	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Invalid_10_60_Pixels	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Rejected_08_65_Pixels	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Rejected_12_05_Pixels	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Rejected_10_60_Pixels	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Rejected_08_65_Pixels_Loc	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Rejected_12_05_Pixels_Loc	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Rejected_10_60_Pixels_Loc	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Rejected_08_65_Pixels_Rad	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_of_Rejected_12_05_Pixels_Rad	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Number_of_Rejected_10_60_Pixels_Rad	Int_32	NoUnits	Std = 0…1,383,312 Exp = 0...2,507,253	1	4
Mean_08_65_Radiance_All	Float_32	$Wm^{-2}sr^{-1}\mu m^{-1}$	0.0...40.0	1	4
Mean_12_05_Radiance_All	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	0.0...40.0	1	4
Mean_10_60_Radiance_All	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	0.0...40.0	1	4
Mean_08_65_Radiance_Selected_Cases	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	0.0...40.0	1	4
Mean_12_05_Radiance_Selected_Cases	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	0.0...40.0	1	4
Mean_10_60_Radiance_Selected_Cases	Float_32	$Wm^{-2}sr^{-1}\ \mu m^{-1}$	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
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
N) Ranges provided for both Standard data products and Expedited data products

2.10.3 IIR Swath Scientific Data Sets

Table 53 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. Parameters for which a valid range has not yet been established are listed as TBD (to be determined).

Table 53: IIR Swath Product Science Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Latitude	Float_32	deg	-90.0…90.0	69	276
Longitude	Float_32	deg	-180.0…180.0	69	276
LIDAR_Shot_Time[C]	Float_64	sec	N/A	69	552
IIR_Image_Time_12_05[C]	Float_64	sec	N/A	1	8
LIDAR_DayNight_Flag[I]	Int_8	NoUnits	0…1	69	69
Brightness_Temperature_08_65[J]	Int_16	K	0…400.0	69	138
Brightness_Temperature_12_05[J]	Int_16	K	0…400.0	69	138
Brightness_Temperature_10_60[J]	Int_16	K	0…400.0	69	138
Calibrated_WFC_Reflectance[J]	Int_16	NoUnits	0.0…2.0	69	138
Surface_Emissivity_08_65[J]	Int_16	NoUnits	0.0…1.0	69	138
Surface_Emissivity_12_05[J]	Int_16	NoUnits	0.0…1.0	69	138
Surface_Emissivity_10_60[J]	Int_16	NoUnits	0.0…1.0	69	138
Effective_Emissivity_08_65[J]	Int_16	NoUnits	0.0…1.0	69	138
Effective_Emissivity_12_05[J]	Int_16	NoUnits	0.0…1.0	69	138
Effective_Emissivity_10_60[J]	Int_16	NoUnits	0.0…1.0	69	138
Effective_Emissivity_Uncertainty_08_65[J]	Int_16	NoUnits	0.0…1.0	69	138
Effective_Emissivity_Uncertainty_12_05[J]	Int_16	NoUnits	0.0…1.0	69	138
Effective_Emissivity_Uncertainty_10_60[J]	Int_16	NoUnits	0.0…1.0	69	138
Emissivity_08_65[J]	Int_16	NoUnits	0.0…1.0	69	138
Emissivity_12_05[J]	Int_16	NoUnits	0.0…1.0	69	138
Emissivity_10_60[J]	Int_16	NoUnits	0.0…1.0	69	138
Emissivity_Uncertainty_08_65	Int_16	NoUnits	TBD	69	138
Emissivity_Uncertainty_12_05	Int_16	NoUnits	TBD	69	138
Emissivity_Uncertainty_10_60	Int_16	NoUnits	TBD	69	138
Homogeneity_Index_BT_08_65[J]	Int_8	NoUnits	0.0…1.0	69	69
Homogeneity_Index_BT_12_05[J]	Int_8	NoUnits	0.0…1.0	69	69
Homogeneity_Index_BT_10_60[J]	Int_8	NoUnits	0.0…1.0	69	69
Homogeneity_Index_Surface_e_08_65[J]	Int_8	NoUnits	0.0…1.0	69	69
Homogeneity_Index_Surface_e_12_05[J]	Int_8	NoUnits	0.0…1.0	69	69
Homogeneity_Index_Surface_e_10_60[J]	Int_8	NoUnits	0.0…1.0	69	69
Homogeneity_Index_Reflectance[J]	Int_8	NoUnits	0.0…1.0	69	69
Homogeneity_Index_Surface_Temperature[J]	Int_8	NoUnits	0.0…1.0	69	69
Homogeneity_Index_Humidity_Profile[J]	Int_8	NoUnits	0.0…1.0	69	69
Particle_Shape_Index[I]	Int_8	NoUnits	1...127	69	69
Particle_Shape_Confidence[I]	Int_8	NoUnits	0...3	69	69
Effective_Particle_Size[J]	Int_16	μm	0.0…300.0	69	138
Effective_Particle_Size_Uncertainty[J]	Int_16	μm	-100.0...500.0	69	138
Optical_Depth_12_05[J]	Int_16	NoUnits	0.0...10.0	69	138
Optical_Depth_12_05_Uncertainty[I,J]	Int_16	NoUnits	0.0...10.0	69	138

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Ice_Water_Path[J]	Int_16	$g.m^{-2}$	0.0...1,000.0	69	138
Ice_Water_Path_Confidence	Int_16	$g.m^{-2}$	TBD	69	138
Scene_Flag[I]	Int_32	NoUnits	0...1900	69	276
IIR_Data_Quality[I]	Int_8	NoUnits	0…15	69	69
Record Size (bytes)					**5,735**

C) International Atomic Time (TAI) seconds from Jan 1, 1993
I) See data product quality summary for interpretation
J) Range after scale equation reported in the HDF file

Appendix B provides flag definitions for selected science parameters.

2.11 Lidar Level 3 Aerosol Profile Product DP 3.1

The Lidar Level 3 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	
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:

Standard: CAL_LID_L3_APro_AllSky-ProductionStrategy-Version.Instance.hdf
CAL_LID_L3_APro_CloudFree-ProductionStrategy-Version.Instance.hdf
CAL_LID_L3_APro_CloudySkyTransparent-ProductionStrategy-Version.Instance.hdf
CAL_LID_L3_APro_CloudySkyOpaque-ProductionStrategy-Version.Instance.hdf

2.11.1 Lidar Aerosol Data Summary DP 3.1

Table 54: Lidar Aerosol Data Record

Record Name	Reference	Record Size	Records/File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar Level 3 Aerosol Data Product Metadata	Table 55	568	1	5568
Spatial Coordinates	Table 56	1460	1	1460
Meteorological Context	Table 57	5014	6120	30685680
Surface and Overflight Parameters	Table 58	20	6120	122400
Static Lidar Parameters	Table 59	48	1	48
Aerosol Optical Properties: All Species	Table 60	12908	6120	78996960
Aerosol Optical Properties: Dust Only	Table 61	2916	6120	17845920
Aerosol Optical Properties: Smoke Only	Table 62	2916	6120	17845920
Aerosol Optical Properties: Polluted Dust Only	Table 63	2916	6120	17845920
Aerosol Type Distribution: All Species	Table 64	2510	6120	15361200
Aerosol Spatial Distribution: All Species	Table 65	246	6120	1505520
Aerosol Spatial Distribution: Dust Only	Table 66	246	6120	1505520
Aerosol Spatial Distribution: Smoke Only	Table 67	246	6120	1505520
Aerosol Spatial Distribution: Polluted Dust Only	Table 68	246	6120	1505520
Total Size Profile Data Product (bytes)				**184,734,059**
Total Size Data Product (Mbytes)				**180.404**

2.11.2 Lidar Aerosol Data Product Metadata

Listings for the core metadata and the archive metadata are provided in Appendix A of the CALIPSO Data Products Catalog. The metadata parameters specific to the Lidar Level 3 Aerosol Data Product are listed in Table 55.

Table 55: Lidar Aerosol Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	CAL_LID_L3_APro_AllSky-Standard, CAL_LID_L3_APro_CloudFree-Standard, CAL_LID_L3_APro_CloudySkyTransparent-Standard, CAL_LID_L3_APro_CloudySkyOpaque-Standard	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 (TBR)	5,000
Record Size (bytes)					**5,568**

2.11.3 Lidar Level 3 Aerosol Data Product Scientific Data Sets

Tables 56 through 68 summarize the contents of each scientific data set (SDS) contained within the CALIPSO Lidar Level 3 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 56: Spatial Coordinates

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

Table 57: Meteorological Context

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Pressure_Mean	Float_32	hPa	1.0…1086.0	208	832
Pressure_Standard_Deviation	Float_32	hPa	0.0…15.0	208	832
Temperature_Mean	Float_32	°C	-120.0…60.0	208	832
Temperature_Standard_Deviation	Float_32	°C	0.0…10.0	208	832

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Relative_Humidity_Mean	Float_32	%	0.0…150.0	208	832
Relative_Humidity_Standard_Deviation	Float_32	%	0.0…40.0	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	UInt_16	NoUnits	0…65535	1	2
Total Bytes per Record					**5,014**

Table 58: Surface and Overflight 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	UInt_16	NoUnits	0…65535	1	2
Water_Samples	UInt_16	NoUnits	0…65535	1	2
Days_Of_Month_Observed	UInt_32	NoUnits	0…4294967295	1	4
Record Size (bytes)					**20**

Table 59: Static Lidar Parameters

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Initial_Aerosol_Lidar_Ratio_532	Float_32	sr	20.0…70.0	6	24
Initial_Aerosol_Lidar_Ratio_Uncertainty_532	Float_32	sr	2.0…30.0	6	24
Record Size (bytes)					**48**

Table 60: Aerosol Optical Properties - All Species

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_532_Mean	Float_32	km^{-1}	0.0…4.0	208	832
Extinction_532_Standard_Deviation	Float_32	km^{-1}	0.0…0.15	208	832
Extinction_532_Median	Float_32	km^{-1}	0.0…4.0	208	832
Extinction_532_Skew	Float_32	NoUnits	TBD	208	832

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_532_RMS	Float_32	km^{-1}	0.0…TBD	208	832
Extinction_532_Percentiles	Float_32	km^{-1}	0.0…4.0	2,288	9152
					0
Samples_Searched	UInt_16	NoUnits	0…65,535	208	416
Samples_Aerosol_Detected_Accepted	UInt_16	NoUnits	0…65,535	208	416
Samples_Aerosol_Detected_Rejected	UInt_16	NoUnits	0…65,535	208	416
Samples_Cloud_Detected	UInt_16	NoUnits	0…65,535	208	416
Samples_Averaged	UInt_16	NoUnits	0…65,535	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
Total Bytes per Record					**12908**

Table 61: Aerosol Optical Properties - Dust Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_532_Mean_Dust	Float_32	km^{-1}	0.0…4.0	208	832
Extinction_532_Standard_Deviation_Dust	Float_32	km^{-1}	0.0…0.1	208	832
Samples_Aerosol_Detected_Accepted_Dust	UInt_16	NoUnits	0…65535	208	416
Samples_Aerosol_Detected_Rejected_Dust	UInt_16	NoUnits	0…65535	208	416
Samples_Averaged_Dust	UInt_16	NoUnits	0…65535	208	416
AOD_Mean_Dust	Float_32	NoUnits	0.0…5.0	1	4
Total Bytes per Record					**2916**

Table 62: Aerosol Optical Properties - Smoke Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_532_Mean_Smoke	Float_32	km^{-1}	0.0…4.0	208	832
Extinction_532_Standard_Deviation_Smoke	Float_32	km^{-1}	0.0…0.1	208	832
Samples_Aerosol_Detected_Accepted_Smoke	UInt_16	NoUnits	0…65535	208	416
Samples_Aerosol_Detected_Rejected_Smoke	UInt_16	NoUnits	0…65535	208	416
Samples_Averaged_ Smoke	UInt_16	NoUnits	0…65535	208	416
AOD_Mean_Smoke	Float_32	NoUnits	0.0…5.0	1	4
Total Bytes per Record					**2916**

Table 63: Aerosol Optical Properties – Polluted Dust Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Extinction_532_Mean_Polluted_Dust	Float_32	km^{-1}	0.0…4.0	208	832
Extinction_532_Standard_Deviation_Polluted_Dust	Float_32	km^{-1}	0.0…0.1	208	832
Samples_Aerosol_Detected_Accepted_Polluted_Dust	UInt_16	NoUnits	0…65535	208	416
Samples_Aerosol_Detected_Rejected_Polluted_Dust	UInt_16	NoUnits	0…65535	208	416
Samples_Averaged_Polluted_Dust	UInt_16	NoUnits	0…65535	208	416
AOD_Mean_Polluted_Dust	Float_32	NoUnits	0.0…5.0	1	4
Total Bytes per Record					**2916**

Table 64: Aerosol Type Distribution

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Aerosol_Type	UInt_16	NoUnits	0…65535	1248	2496
Multiple_Aerosol_Type_Count	UInt_16	NoUnits	0…65535	7	14
Total Bytes per Record					**2510**

Table 65: Aerosol Spatial Distribution - All Species

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column	UInt_16	NoUnits	0…65535	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
Total Bytes per Record					**246**

Table 66: Aerosol Spatial Distribution - Dust Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Dust	UInt_16	NoUnits	0…65535	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

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
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
Total Bytes per Record					**246**

Table 67: Aerosol Spatial Distribution - Smoke Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Smoke	UInt_16	NoUnits	0…65535	9	18
Highest_Aerosol_Layer_Detected_Smoke	Float_32	km	0.0…20.0	11	44
Lowest_Aerosol_Layer_Detected_Smoke	Float_32	km	0.0…20.0	11	44
Layer_Separation_Minimum_Smoke	Float_32	km	0.0…20.0	7	28
Layer_Separation_Maximum_Smoke	Float_32	km	0.0…20.0	7	28
Layer_Separation_Median_Smoke	Float_32	km	0.0…20.0	7	28
Layer_Separation_Mean_Smoke	Float_32	km	0.0…20.0	7	28
Layer_Separation_Standard_Deviation_Smoke	Float_32	km	0.0…5.0	7	28
Total Bytes per Record					**246**

Table 68: Aerosol Spatial Distribution – Polluted Dust Only

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Number_Layers_Per_Column_Polluted_Dust	UInt_16	NoUnits	0…65535	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
Total Bytes per Record					**246**

3.0 Level 0 Input Data Products

This section describes the CALIPSO Level 0 input data products that are stored at the Langley ASDC. Each subsection contains a brief overview of the purpose and content of the data product. See references for Level 0 format details.

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 in Table 69 consists of data averaged from 15 lidar shots with the instantaneous field of view for each shot occurring every 333 m along track.

Table 69: 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 70: 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 m, 10.6 m and 12.05 m. 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 the ancillary data products, which are stored at the Langley ASDC. Each subsection contains a brief overview of the data product content. See references for ancillary data format details.

4.1 Ephemeris Data

CNES is the primary source of post-processed ephemeris data used in science data processing. The post-processed ephemeris data are received from the CALIPSO Mission Operations Control Center (MOCC) via the LATIS Ingest System. See PC-GND-905 ICD between the CALIPSO MOCC and the ASDC for data format and content.

To use the EOSDIS Core System (ECS) Toolkit geolocation routines, spacecraft ephemeris data must be in a Toolkit compatible format. Appendix L of the Toolkit Users Guide (See Reference 11) specifies the EOSDIS spacecraft ephemeris data contents and structure. Appendix L specifies time standards, reference coordinate systems for both ephemeris and orbital elements, and orbit numbering. *Terra Spacecraft Ephemeris and Attitude Data Preprocessing* (See Reference 12) describes the task used to reformat the Terra spacecraft ephemeris data into a compatible Toolkit format. The DMS data subsystem DPREP 0.2 converts CNES provided ephemeris into the Toolkit format.

4.2 Attitude Data

The Payload Data Delivery System (PDDS), or Level 0 processing facility, is the primary source of attitude data for science data processing. See PDDS/ASDC ICD for data format and content.

To use the ECS Toolkit geolocation routines, spacecraft attitude data must be in a compatible Toolkit format. Appendix L of the Toolkit Users Guide (See Reference 11) 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. *Terra Spacecraft Ephemeris and Attitude Data Preprocessing* (See Reference 12) describes the task used to reformat the Terra spacecraft attitude data into the Toolkit format. The DMS data subsystem DPREP 0.1 converts PDDS provided attitude data into a compatible Toolkit format.

4.3 Global Modeling and Assimilation Office (GMAO)

The GMAO at the Goddard Space Flight Center is the primary source of meteorological data used for the standard CALIPSO data processing. CALIPSO is using a spatially subset version of the V5.91 D57I3NXASM D57I3NVASM data products produced for the Instrument Teams. These products are DFPITI3NXASMCAL and DFPITI3NVASMCAL respectively. DFPITI3NXASMCAL is a global, gridded product providing 2D assimilated fields. DFPITI3NVASMCAL is a global, gridded product providing 3D assimilated fields. Both products are provided on 3 hour intervals starting at 00 GMT and yielding 8 files per day.

Reference 18 describes these files in detail, including file format, sizes, and content.

4.4 SDP Toolkit Digital Elevation Model (DEM)

The Toolkit's DEM tools provide access to a hierarchy of DEM data sets irrespective of tile boundaries or resolutions. Three resolutions are available, 3 arc second (~100 m), 30 arc second (~1 km), and 90 arc second (~3 km). The 30 arc second resolution consists of six tiles. These tiles collectively cover the whole world. Each tile consists of two files. The first file includes elevation, land/sea mask, slope, aspect, and geoid data. The second file includes data for the standard deviations. Each file covers 120 degrees of longitude and 90 degrees of latitude.

The upper left corner of the entire data set is at 180 degrees West and 90 degrees North. The pixels are center located. Therefore, the location of global pixel (0, 0) is actually (89.99583333333334, -179.99583333333334) signed decimal degrees. The lower right corner is (-89.99583333333334, 179.99583333333334) decimal degrees, or (21599, 43199) in global pixels. Querying of points outside this region will result in an error.

The primary file for each 30 arc second tile is approximately 1090 MB. The secondary standard deviation file for each tile is approximately 622 MB.

Available metadata are PGSd_DEM_GEOID, PGSd_DEM_SOURCE, PGSd_DEM_METHOD, PGSd_DEM_VERTICAL_ACCURACY, and PGSd_DEM_HORIZONTAL_ACCURACY.

Please see: http://newsroom.gsfc.nasa.gov/sdptoolkit/3km_announcement_5261.txt for more information.

4.5 SDP Toolkit Land and Water Coverage

The 30 arc second resolution land/water mask is included in the Toolkit DEM data set described in section 4.4. The 8 surface types available in the land/water mask are:

Land/Water Mask Legend

Type:	Land/Water Mask
Shallow ocean	0
Land (Nothing else but land)	1
Ocean coastlines and lake	2
Shallow inland water	3
Ephemeral water	4
Deep inland water	5
Moderated or continental ocean	6
Deep ocean	7

4.6 International Geosphere Biosphere Programme (IGBP) Ecosystem

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 have 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 is part of the NASA Cloud – Aerosol Lidar Infrared Pathfinder Satellite Observations Program and 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 map in use is provided by the CERES Surface and Atmospheric Radiation Budget (SARB) working group. The map is determined 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.

Additional details may be found at
http://ceres.larc.nasa.gov/science_information.php?page=CeresSurfID
under “Data Products” and “Global Land Cover Characterization”.

IGBP Land Cover Legend

Value	Description
1	Evergreen Needleleaf Forest
2	Evergreen Broadleaf Forest
3	Deciduous Needleleaf Forest
4	Deciduous Broadleaf Forest
5	Mixed Forest
6	Closed Shrublands
7	Open Shrublands
8	Woody Savannas
9	Savannas
10	Grasslands
11	Permanent Wetlands
12	Croplands
13	Urban and Built-Up
14	Cropland/Natural Vegetation Mosaic
15	Snow and Ice
16	Barren / Desert
17	Water Bodies
18	Tundra

4.7 Air Force Weather Agency 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 (SSMI) 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. The Surface Type variable contains the following parameter settings:

See: http://www.nsidc.org and look under Sea Ice and Ice Extent for "Near Real-Time SSM/I EASE-Grid Daily Global Ice Concentration And Snow Extent" for further information.

The NSIDC_Surface_Type variable contains the following data which is merged from the CERES EICE and ESNOW data sets:

AFWA SEA Ice and Snow Extent Legend

Data Value	Parameter
0 - 100	Sea ice concentration %
101	Permanent ice (Greenland, Antarctica)
102	Not used
103	Snow
104 - 254	Not used
255	Mixed pixels at coastlines (unable to reliably apply microwave algorithms)

5.0 Special Purpose Data Products

This section describes the CALIPSO special purpose 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
- Type – Data type (special products)
- 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)

5.1 Lidar Level 1.5 Data Product

The lidar level 1.5 data product is a continuous segment of calibrated, geolocated, cloud-cleared, and spatially averaged profiles of lidar attenuated backscatter and aerosol extinction. 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 expedited data product is derived using expedited versions of these levels 1B and level 2 data products and files are 90 minutes in duration. Currently, only level 1.5 expedited products are produced. The level 1.5 data product is written in HDF.

Level: 1.5*

Type: Archival

Frequency: Expedited: 1/Orbit

Record Spatial Resolution: 20 km horizontal x 60 m vertical

Time Interval Covered: Expedited: 90 minutes

Data File Name:

Expedited: CAL_LID_L15_Exp-ProductionStrategy-Version.Instance.hdf

* This level does not conform to official EOS definitions.

5.1.1 Lidar Level 1.5 Data Product

Table 71: Lidar Level 1.5 Instrument Record Summary

Record Name	Reference	Record Size	Recs/File	File Size (bytes)
Core Metadata Record	Appendix A	899	1	899
Archive Metadata Record	Appendix A	4	1	4
Lidar 1.5 Metadata Record	Table 72	749	1	749
Static Lidar Data Record	Table 73	1,468	1	1,468
Lidar Profile Science Record	Table 74	25,932	1,814	47,040,648
Total Size (bytes)				47,043,768
Total Size (Mbytes)				45.941

5.1.2 Lidar Level 1.5 Data Metadata

Listings for the core metadata and the archive metadata are provided in Appendix A of the CALIPSO Data Products Catalog. The metadata parameters specific to the lidar level 1.5 expedited data product are listed in Table 72.

Table 72: Lidar Level 1.5 Metadata Record

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Product_ID	Char	NoUnits	Level1.5_Science	80	80
Date_Time_at_Granule_Start[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_at_Granule_End[A]	Char	NoUnits	4/2006 – 6/2016	27	27
Date_Time_of_Production[A]	Char	NoUnits	4/2006 – 6/2016	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	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	60,426.0…160,601.0	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	60,426.0…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
Record Size (bytes)					**749**

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

5.1.3 Lidar Level 1.5 Data Scientific Data Set

Table 73 and Table 74 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 73: Static Lidar Data

Parameter	Data Type	Units	Nominal Range	Elem/Rec	Bytes
Lidar_Data_Altitudes	Float_32	km	-0.5…20.2	345	1380
Initial_Lidar_Ratio_Aerosols_532	Float_32	sr	20.0…70.0	8	32
Initial_Lidar_Ratio_Aerosols_1064	Float_32	sr	30.0…55.0	8	32
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^2sr^{-1}	5.930E-32	1	4
Rayleigh_Backscatter_Cross-section_1064	Float_32	m^2sr^{-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
Record Size (bytes)					**1,468**

Table 74: Lidar Profile Data

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Latitude (midpoint)	Float_32	deg	-90…90	1	4
Longitude (midpoint)	Float_32	deg	-180…180	1	4
Profile_Time (midpoint)[C]	Float_64	sec	4.204E8…7.389E8	1	8
Profile_UTC_Time (midpoint)[D]	Float_64	NoUnits	60,426…160,601	1	8
Profile_ID (first and last)	Int_32	NoUnits	1…228,630	2	8
Day_Night_Flag[E]	Int_8	NoUnits	0…2	1	1
Surface_Elevation_Mean	Float_32	km	-1…9	1	4
Surface_Elevation_StDev	Float_32	km	0…9	1	4
Samples_Averaged	UInt_8	NoUnits	0…120	345	345
Calibration_Constant_Parallel_532	Float_32	$km^3 \cdot sr \cdot$ count	3.0E10…9.0E10	1	4
Calibration_Constant_Parallel_Uncertainty_532	Float_32	$km^3 \cdot sr \cdot$ count	1.2E9…2.6E9	1	4
Total_Attenuated_Backscatter_532_Mean	Float_32	$km^{-1}\ sr^{-1}$	0.0…3.1	345	1380
Total_Attenuated_Backscatter_532_Median	Float_32	$km^{-1}\ sr^{-1}$	0.0…3.1	345	1380
Total_Attenuated_Backscatter_532_StDev	Float_32	$km^{-1}\ sr^{-1}$	0.0…3.1	345	1380
Total_Attenuated_Backscatter_Uncertainty_532	Float 32	$km^{-1}\ sr^{-1}$	1E-5…1E-2	345	1380
Extinction_Coefficient_532_Mean	Float_32	km^{-1}	0…1.25	345	1380
Extinction_Coefficient_532_Median	Float_32	km^{-1}	0…1.25	345	1380
Extinction_Coefficient_532_StDev	Float_32	km^{-1}	0…1.25	345	1380
Extinction_Coefficient_Uncertainty_532	Float_32	km^{-1}	0…99.99	345	1380
Extinction_QC_Flag_532_Maximum[F]	UInt_16	NoUnits	0…34,768	345	690
Calibration_Constant_Perpendicular_532	Float_32	$km^3 \cdot sr \cdot$ count	3.0E10…9.0E10	1	4
Calibration_Constant_Perpendicular_Uncertainty_532	Float_32	$km^3 \cdot sr \cdot$ count	1.2E9…2.6E9	1	4
Perpendicular_Attenuated_Backscatter_532_Mean	Float_32	$km^{-1}\ sr^{-1}$	0.0…1.5	345	1380
Perpendicular_Attenuated_Backscatter_532_Median	Float_32	$km^{-1}\ sr^{-1}$	0.0…1.5	345	1380
Perpendicular_Attenuated_Backscatter_532_StDev	Float_32	$km^{-1}\ sr^{-1}$	0.0…1.5	345	1380
Perpendicular_Attenuated_Backscatter_Uncertainty_532	Float_32	$km^{-1}\ sr^{-1}$	1E-6…1E-3	345	1380

Parameter	Data Type	Units	Nominal Range	Elem/ Rec	Bytes
Molecular_Number_Density[G]	Float_32	m^{-3}	$8x10^{22}…5x10^{25}$	345	1380
Ozone_Number_Density[G]	Float_32	m^{-3}	$1x10^{17}…1x10^{19}$	345	1380
Molecular_Model_Attenuated_Backscatter_532[G]	Float_32	$km^{-1}\ sr^{-1}$	5E-4…2E-3	345	1380
Temperature[G]	Float_32	ºC	-120…60	345	1380
Pressure[G]	Float_32	mb	1…1086	345	1380
L2_Feature_Type	UInt_8	NoUnits	0…21	345 x 4	1380
Total Bytes per Record					**25,932**

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time stored in format: yymmdd.ffffffff
E) Reports the lighting conditions. For standard data products, 0 = day and 1 = night. However, the lidar level 1.5 expedited 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.
F) Reports the maximum (non-fill) extinction QC flag within each 20 km x 60 m segment.
G) Based on GMAO data. Calculated and reported at the horizontal midpoint of each 20 km profile.

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 and the extinction coefficients at 532 nm found in the lidar level 2 aerosol profile product.

5.1.4 L2_Feature_Type values

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/biomass burning
11 = mixed aerosol
12 = cloud cleared mixed aerosol
13 = cloud-cleared clean marine
14 = cloud-cleared dust

15	=	cloud-cleared polluted continental
16	=	cloud-cleared clean continental
17	=	cloud-cleared polluted dust
18	=	cloud-cleared smoke/biomass burning
19	=	"clear air"
20	=	cloud-cleared "clear air"
21	=	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 (21) 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.

Note that no features are are labeled "stratospheric" in the level 1.5 products. The convention for handling stratospheric features is as follows. Between 60° N and 60° S, medium and high confidence stratospheric features are reported as "clear air"; all other stratospheric features are assumed to be tropospheric clouds. Poleward of 60°, all stratospheric features are assumed to be clouds (e.g., PSCs).

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 and 21 are not included when computing the cloud-cleared averaged data that is recorded in the attenuated backscatter and aerosol extinction coefficient profiles.

Appendix A

CALIPSO Metadata

This section describes the metadata that are written to all CALIPSO HDF products. Table 75 describes the Core metadata record that is written to both the HDF and the ASCII file for the DAAC to be used to identify output science data products. Table 72 describes the Archive metadata record that is written to both a HDF and an ASCII file.

Table 75 and Table 76 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.

Table 75: 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 – 6/2020	20	1	20
9	START_DATE	Char	NoUnits	4/2006 – 6/2020	27	1	27
10	STOP_DATE	Char	NoUnits	4/2006 – 6/2020	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…200,608.0	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…200,608.0	1	1	8
	Total Bytes per Record						**899**

Items #19-24 are included as part of the Core Metadata Record in the following products: Lidar Level 1, Lidar level 2, Lidar Level 3, Wide Field Camera, IIR Level 1 (V1.12 – starting on November 1, 2011 through the present), IIR Level 2, and Lidar Level 1.5 Expedited.

Items #19-24 parameters do not apply for IIR Level 1 (V1.10 & V1.11 – starting on June 13, 2006 through October 31, 2011) and the Polar Stratospheric Cloud products.

Table 76: Archive Metadata Record Vdata

Item	Parameter Name	Data Type	Unit	Nominal Range	Max Number of Elements	Number of Records	Bytes
1	NUMBEROFRECORDS	Int_32	NoUnits	1…9,999,999,999	1	1	4
	Total Bytes per Record						**4**

Appendix B

Lidar Level 1 Quality Check Flags

Two sets of unsigned 32-bit Quality Check (QC) flags, at single shot resolution, are contained in the Lidar Level 1 data products. This section details the bit assignments for each of these flags. The first QC flag (Table 77) provides laser energy, geo-location and calibration status, while the second QC flag (Table 78) summarizes observed error conditions.

Table 77: 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 78: 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
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 indicate bad data, 532 nm parallel channel
15	Quality Flags in SAD packet indicate bad data, 532 nm perpendicular channel
16	Quality Flags in SAD packet indicate 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[S]
27	1064 nm calibration coefficients suspect due to low temperatures associated with power up[S]
26-32	Spare

S) Only applies to version 4.x and above Lidar Level 1 data products, otherwise bits 26 and 27 are considered spares.

Appendix C

IIR Level 2 Track and Swath Flag Values

This section describes the IIR Level 2 Track and Swath science parameter flag values.

Table 79: Effective_Particle_Size_Uncertainty (track and swath)

Value	Interpretation	Shape Index Provide
< 100.	= 0.5 x [Size from (12.05; 8.65) – Size from (12.05; 10.6)] (microns)	Yes
100.	Particle_Size from (12.05; 8.65) only medium confidence	No
200.	Particle_Size from (12.05;10.6) only medium confidence	No
300.	size < Particle_size low confidence	No
310.	size < Particle_Size (12.05;10.6) questionable very low confidence	No
320.	size < Particle_Size (12.05; 8.65) questionable very low confidence	No
400.	size > Particle_Size low confidence	No
410.	size > Particle_Size (12.05;10.6) questionable very low confidence	No
420.	size > Particle_Size (12.05; 8.65) questionable very low confidence	No

Table 80: High_Cloud_vs_Background_Flag (track)

Digit	Digit value	Digit interpretation
Units	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
Tens	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
Hundreds	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 81: IIR_Data_Quality (swath) and IIR_Data_Quality_Flag (track)

Bit	Bit 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 82: Lidar_DayNight_Flag (swath)

Value	Interpretation
0	day
1	night

Table 83: Lidar_Quality_Flag (track)

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

Table 84: Microphysics (track)

Digits	Interpretation
Units	Shape_index: 7 (aggregates, record #1) ; 8 (plates, record #2), 9(solid column, record #3)
Thousands-Hundreds-Tens	Effective diameter in microns derived from the (12.05 ; 8.65) IIR channels couple.
Millions-Hundred and ten thousands	Effective diameter in microns derived from the (12.05 ;10.6) IIR channels couple.

Table 85: Multi_Layer_Cloud_Flag (track)

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

Table 86: Particle_Shape_Index (track and swath)

Value	Interpretation
7	Aggregates
8	Plates
9	Solid columns

Table 87: Particle_Shape_Index_Confidence (track and swath)

Value	Interpretation
1	Good
2	Medium

Table 88: Regional_Background_Standard_Deviation_Flag (track)

Value	Interpretation
0	Computed_vs_Observed_Background standard deviation <= 0.15
1	Computed_vs_Observed_Background standard deviation > 0.15

Table 89: Scene_Flag (swath)

Digits	Interpretation
Tens-Units	Type_of_Scene
Thousands-Hundreds	IGBP index

Table 90: Surrounding_Obs_Quality_Flag (track)

Digit	Digit value	Interpretation
Units	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
Tens IIR aerosols index	0	No mineral aerosols detected
	1	Mineral aerosols detected
Hundreds Obs-Computed	0	Not computed or satisfactory for computed cases
	1	Low
	2	High
	3	Very low
	4	Very high

Table 91: Type of Scene (track)

Value	Description
CLEAR SKY	
10	Clear sky (no aerosols detected by lidar)
AEROSOLS	
51	1 to 4 high ST aerosol
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 low ST aerosol
55	1 high opaque aerosols
56	1 low opaque aerosol
64	1 to 4 high ST aerosols/ 1 low opaque aerosols
57	Any other aerosols only
CLOUDS	
20	Low opaque cloud, vol_depol_ratio_max >40%
70	Low opaque cloud, vol_depol_ratio_max < 40%
40	High opaque cloud, vol_depol_ratio_max >40%
80	High opaque cloud, vol_depol_ratio_max < 40%
21	1 high ST cloud only (no aerosol)
22	2 high ST clouds
23	1 high ST cloud and 1 low ST cloud
24	1 low ST cloud, attenuated_backscatter_max > 0.02 sr-1 or vol_depol_ratio_max > 7%.
59	1 low ST cloud, attenuated_backscatter_max < 0.02 sr-1 and vol_depol_ratio_max < 7%.
25	2 low ST clouds only (no aerosols)
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 low ST clouds only (no aerosols)
31	1 high ST cloud / 1 low opaque cloud
32	2 to 5 high ST cloud/ 1 opaque cloud
62	3 to 6 ST cloud (at least 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
42	2 high ST cloud/ 1 high opaque cloud
MIXED AEROSOLS/CLOUDS	
30	1 high ST cloud / 1 low ST aerosol
66	1 high ST aerosols / 1 high ST cloud and 1 low ST cloud
63	1 to 4 low aerosols and 1 low ST cloud
35	1 high ST aerosols/ 1 low opaque cloud
36	1 low ST aerosols/ 1 low opaque cloud
37	1 high ST cloud/ 1 low opaque aerosols
38	1 low ST cloud/ 1 low opaque aerosols
65	1 high ST aerosols / 1 high opaque cloud
OTHERS	
99	OTHERS