**National Aeronautics and Space Administration**

**Langley Research Center**

**Hampton, Virginia 23681-2199**

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

# Data Management System

# Data Products Catalog

## Document No: PC-SCI-503

**Release 4.94**

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# Cloud – Aerosol LIDAR Infrared Pathfinder Satellite Observations

## Data Management System
## Data Products Catalog

## Document No: PC-SCI-503

**June 19, 2022**

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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 | DCR 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.<br><br>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.<br><br>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.<br><br>Updates to the IIR Level 1 Data Products to reflect new specifications provided in the latest CALIPSO Processing Requirements Document provided by CNES.<br><br>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.<br><br>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. | |
| 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 |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 10/21/2004 | CCR #003 | The following fields were removed from the Lidar Level 2 Cloud and Aerosol Layer Products:<br>• Column_Reflectance_1064<br>• Column_Reflectance_Uncertainty_1064<br>• 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:<br>• 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)<br>• the Viewing_Zenith_Angle and Viewing_Azimuth_Angle parameters were removed, and replaced with a single Off_Nadir_Angle parameter<br>• 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:<br>• 1 km Registered Geolocation and Viewing Geometry<br>• 125 m Native Geolocation and Viewing Geometry<br>• 5 km Packet Record<br>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 |
| 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 |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 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).<br>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 |
| 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 |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 02/22/2006 | CCR #033 | Version 2.2.<br>1. Changed all N/A under the Units Table entries to NoUnits for all Lidar and WFC tables.<br>2. Updated Reference Publication page to include latest project documentation numbers and titles for ATBDs.<br>3. Revised acronyms and symbols tables (added CAPS, DPC, and CALIOP, added volts).<br>4. Changed shots per second to 20.16 (from 20.25 – 2 places in document).<br>5. Updated Section 1.0 Introduction including text, Figure 1, and Tables 1, 4, and 5 to add DPC reference Tables.<br>6. Revised the conversion from bytes to Mbytes. Old conversion equation:<br>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.<br>8. Section 2.0 Archival Data Products:<br>a. Added UTC CCSDS and TAI time parameter descriptions<br>b. Corrected the description of columns in the DPC Tables<br>c. Added the data file name category to data attributes (included data file name in every section)<br>9. Section 2.1 Lidar Level 1B Profiles DP 1.1:<br>a. Revised Tables to match the HDF files. Revised Tables 7-10.<br>10. Section 2.4 Lidar Level 2 Cloud and Aerosol Layer Products DP 2.1A:<br>a. Revised Tables to match the HDF files. Revised Tables 26, 28, 30, 31, 32, 33, 34.<br>11. Section 2.5 Lidar Level 2 Aerosol Profile Data Product DP 2.1B:<br>a. Revised Tables to match the HDF files. Revised Tables 35, 36, 37, and 38.<br>12. Section 2.6 Lidar Level 2 Cloud Profile Data Product DP 2.1C:<br>a. Revised Tables to match the HDF files. Revised Tables 40, 41, and 43.<br>13. Section 2.7 Lidar Level 2 Vertical Feature Mask Data Product DP 2.1D:<br>a. Revised Tables to match the HDF files. Revised Table 44.<br>14. Section 5.1 Lidar Calibration:<br>a. Revised Tables to match the HDF files. Removed parameters. Revised Tables 58-63.<br>15. Section 5.2.3 IIR Calibration Scientific Data Sets:<br>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:<br>a. Added solar and viewing azimuth and zenith angle parameters, Table 20.<br>2. Section 5.3 WFC Calibration:<br>a. Divided Table 75 into Table 75 and 76 for clarity of SDS parameters. This created a new Table 76.<br>b. Renumbered old Tables 76 – 78.<br>3. Appendix A<br>a. Renumbered Tables 79 and 80. | 2.3.3, 5.3, Appendix A |
| 12/08/2006 | CCR #035 | Section 2.8 IIR/Lidar Track Product DP 2.2A<br>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 |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 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.<br>Removed Table 38 "Lidar 40km Aerosol Profile Record, Fixed Lidar Ratio".<br>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 |
| 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 |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 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.<br>Adjusted spacing for content to fit on one page. | 2.0 |
| 08/04/2009 | Edits Only | Corrected file name convention example.<br>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 |
| 01/10/2010 | CCR #064 | Added classifier coefficients file information to metadata for all lidar level 2 data products. | 2.4.2 |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 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 |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 07/26/2013 | CCR #087 | Modify DPC as needed (minor changes) | 1 |
| 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 |
| | | Data Products Catalog – Version 4.10 | |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 10/21/2015 | CCR #105 | Add lidar surface elevation, profile ID, IGBP surface type and ozone number density to the level 2 profile products. | 2.10.3 |
| 03/08/2016 | CCR #106a | Add single shot information to VFM, 5-km cloud layer, 5-km aersosol layer, and 5-km merged layer products (Lidar Level 2). | 2.6, 2.12 |
| 10/01/2015 | CCR #108 | Add 532 nm attenuated scattering ratio statistics to level 2 layer products. | 2.6.3 |
| 10/21/2015 | CCR #109 | Add lidar ratio uncertainties to the 5-km cloud and aerosol layer. | 2.6.3 |
| 10/21/2015 | CCR #110 | Generate merged 5-km cloud and aerosol layer products as a standard component of the version 4 data release. | 2.6.3 |
| 10/15/2015 | CCR #112 | Remove Cirrus Shape Parameter Variables from the 5-km Cloud Layer Product | 2.6.3 |
| 10/15/2015 | CCR #114 | Report profile data in 5 km cloud profile product up to 30 km | 2.8 |
| 03/30/2016 | CCR #115 | Add stratospheric aerosol subtypes to level 2 products | 2.6 |
| 10/30/2015 11/09/2015 | CCR #120, #122 | Lidar Level 2 End Date Change From 06/2016 to 12/2026 | 2.6, 2.8, 2.10, 2.12, Appendix A |
| 10/27/2015 | CCR #121 | Add Centroid Temperature to Cloud and Merged Layer Products | 2.6 |
| 10/27/2015 | CCR #125 | Reporting ‘Transparent Orphans” in the 5-km layer products | 2.6 |
| 03/23/2016 | CCR #126 | Lidar Level 2 Script File Exceeds Maximum Length | 2.6, 2.8, 2.10, 2.12 |
| 03/28/2016 | CCR #131 | Add documentation for level 1.5 standard V3V4 product to data products catalog | 5.2 |
| 03/28/2016 | CCR #129 | Add attenuated backscatter 1064 nm statistics and to level 1.5 and remove extinction coefficients from standard V3V4 hybrid product. | 5.1, 5.2 |
| 10/14/2015 10/19/2016 | CCR #116 | **Add Land/Water Information to Level 1.5 Expedited Product** | 5.1 |
| 05/20/2016 | CCR #132 | Add new lidar surface detection parameters | 2.6 |
| 01/30/2014 | CCR #123 | Add GMAO surface altitudes to Lidar Level 1B data product (Version 4.10) | 2.2.3 |
| 05/20/2016 | CCR #132 | Add new lidar surface detection parameters for V4, delete old parameters where appropriate | 2.x/Lidar Level 2 Version 4.10 Sections |
| 08/02/2016 | CCR #133 | Add additional parameters to the new product, Lidar Level 1.5 Standard V3V4 | 5.2 |
| 08/17/2016 | CCR #134 | Change nomenclature of Version 4 polluted continental and smoke aerosol subtypes | 2.12.3 |
| 10/07/2015 10/17/2016 | CCR #117 | Add single-shot time, position and ancillary data to VFM files | 2.12.1 |
| 08/22/2016 10/17/2016 | CCR #135 | Add single shot lidar surface detection to 5km layer products | 2.6.3 |
| 08/19/2016 10/17/2016 | CCR #137 | Updates to draft DPC Release 4.10 – Catch All | Entire Document |
| 10/26/2016 | CCR #140 | Modify description of the DPC section 4.4 and 4.5 to reflect new CloudSAT DEM | 4.4, 4.5 |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 01/30/2014 | CCR #123 | Add GMAO surface altitudes to lidar level 1B data product | 2.2 |
| 06/06/2017 | * | Tables 33, 35, 37, and 39 all refer to Table 73 and is now Table 74.<br>Table 25, Table 26, Table 21, and Table 22 references to tables were corrected.<br>A reference to Table 113 is now 114 in Appendix A. | 2.7, 2.4, Appendix A |
| | | Data Products Catalog – Version 4.20 | |
| 06/14/2017 | CCR #141 | Add IIR Level 1 Version 2.00 Information to the DPC | Table 1, 2.4, Appendix D |
| | | Data Products Catalog – Version 4.30 | |
| 02/15/2018<br>03/29/2018 | CCR #142 | Add new Lidar Level 3 Ice Cloud product information to the DPC. | Table 1, 2.18 |
| | | Data Products Catalog – Version 4.40 | |
| 06/12/2018<br>07/12/2018 | CCR #143 | Add new Lidar Level 3 Stratospheric Aerosol Profile product information to the DPC | 2.19 |
| 07/23/2018 | CCR #144 | Add Missing row of information to Lidar Level 2 5km Merged Layer Record Summary Table to DPC | Table 1, Table 48 |
| 07/31/2018 | CCR #145 | Correction to Table 47 – (Row) Single Shot Parameters Record Size | Table 1, Table 47 |
| | | Data Products Catalog – Version 4.50 | |
| 07/30/2018 | CCR #146 | Add Laser Energy information to the Lidar Level 2 data and bump version from V4.10 to V4.20 | Sections 1 and 2 |
| | | Data Products Catalog – Version 4.60 | |
| 10/01/2018 | CCR #147 | Add NEW Lidar Level 2 Blowing Snow (Region = Antarctica) Product Information to DPC | New Section 2.15 |
| | | Data Products Catalog – Version 4.70 | |
| 11/14/2018 | CCR #148 | Add NEW Lidar Level 3 Cloud Occurrence product information to the DPC | New Section 2.21 |
| | | Data Products Catalog – Version 4.80 | |
| 01/17/2019 | CCR #149 | Remove Level 1.5 Standard_V3V4 Product from DPC | Remove Section 5.2 |
| 01/17/2019 | CCR #150 | Update Level 1.5 Expedited Product to V3.50 in DPC | Section 5.1 |
| 01/18/2019 | CCR #151 | Add New Level 1.5 Standard Version 1.00 to DP | New Section 5.2 |
| 02/05/2019 | | As a follow-on to CCR #149, remove the Standard_V3V4 definition from the CALIPSO Data Product Production Strategies table in Section 1. | Section 1 |
| 02/12/2019 | CCR #152 | Add new table 69 that provides the Atmospheric Volume Descriptor information. | Section 2.9.3 |
| 03/14/2019 | | Corrected Table 46. “5 km Layer Descriptor Record: Clouds referred to table 59 but should have been 58. | Section 2.7 |
| 03/14/2019 | | Removed 4 rows in Table 143 that included “Initial_Lidar_Ratio_Aerosols…”. These parameters were not included in this version of the Lidar Level 1.5 Standard product. | Section 5.2 |
| 07/23/2019 | CCR #155 | Remove the parameters, Extinction_532_Median, Extinction_532_Skew, and Extinction_532_RMS from Table 105 (as referenced in DPC Release 4.80). These parameters should not have been included in this table. These parameters are not included in the Lidar Level 3 Aerosol Profile Version 3.10 data products. | Section 2.18, Section 1 |
| | | Data Products Catalog – Version 4.90 | |

| Issue Date | DCR Number | Description of Revision | Section Affected |
|---|---|---|---|
| 08/29/2019; Rev: 09/03/2019 | CCR #156 | Update Level 3 Aerosol product to Version 4.x | Section 2.18, Section 1 |
| | | Data Products Catalog – Version 4.91 | |
| 10/22/2019 | CCR #157 | Add NEW Lidar Level 3 GEWEX Cloud Monthly Product Information to DPC | New Section 2.22 & New Appendix E, Figure 1 |
| | | Data Products Catalog – Version 4.92 | |
| 01/29/2020 | CCR #158 | Add NEW IIR Level 2 Track and Swath Products Version 4.20 to DPC | New Sections 2.17 & 2.19 & New Appendix F |
| 04/29/2020 | N/A | Changed ASDC's link from eosweb.larc.nasa.gov to asdc.larc.nasa.gov. | Pages: xxvii & 4 |
| | | Data Products Catalog – Version 4.92 Updates | |
| 09/01/2021 | N/A | Changed reference from Appendix E to Appendix A. | 2.24.2 |
| 09/01/2021 | N/A | Changed reference from Appendix A to Appendix E. | 2.24.3 |
| 03/24/2021 | CCR #163 | Correct Errors noted in Data Products Catalog (DPC) 4.92 | Authors, Tables 60 & 62 |
| | | Data Products Catalog – Version 4.93 | |
| 08/17/2021 | CCR #169 | Add NEW IIR Level 3 GEWEX Cloud Product Version 1.00 to DPC | 2.25 |
| | | Data Products Catalog – Version 4.94 | |
| 05/27/2020 | CCR #159 | Add V2.00 Lidar Level 2 Polar Stratospheric Cloud Product to DPC | 2.14, Table 1 |
| 01/26/2022 | CCR #175 | Additional corrections to V2.00 Lidar Level 2 Polar Stratospheric Cloud Product in the DPC | 2.14, Table 1 |
| 06/19/2022 | Edits Only | New files sizes were not included in release. | Table 1 |

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

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# Acronyms

| | |
|---|---|
| AFWA | Air Force Weather Agency |
| ASDC | Atmospheric Science Data Center |
| ATBD | Algorithm Theoretical Basis Document |
| BATC | Ball Aerospace and Technologies Corporation |
| CALIOP | Cloud-Aerosol Lidar with Orthogonal Polarization |
| CALIPSO | Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations |
| CAPS | CALIPSO Automated Processing System |
| CCD | Charge Coupled Device |
| CCR | Configuration Change Request |
| CCSDS | Consultative Committee for Spacecraft Data Systems |
| CERES | Clouds and the Earth's Radiant Energy System |
| CNES | Centre National D'Etudes Spatiales |
| CRS | CERES Clouds and Radiative Swath Data Product |
| DPC | Data Products Catalog |
| DPREP | Data Pre-processing |
| DCR | Document Change Request |
| DEM | Digital Elevation Models |
| DMS | Data Management System |
| DMSP | Defense Meteorological Satellite Program |
| DRD | Data Requirements Description |
| ECI | Earth Centered Inertial |
| ECR | Earth Centered Rotation |
| ECS | EOSDIS Core System |
| EOS | Earth Observing Systems |
| EOSDIS | Earth Observing System Data and Information System |
| EROS | Earth Resources Observation System |
| 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 | degrees Celsius |
| hPa | hectopascal |
| 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

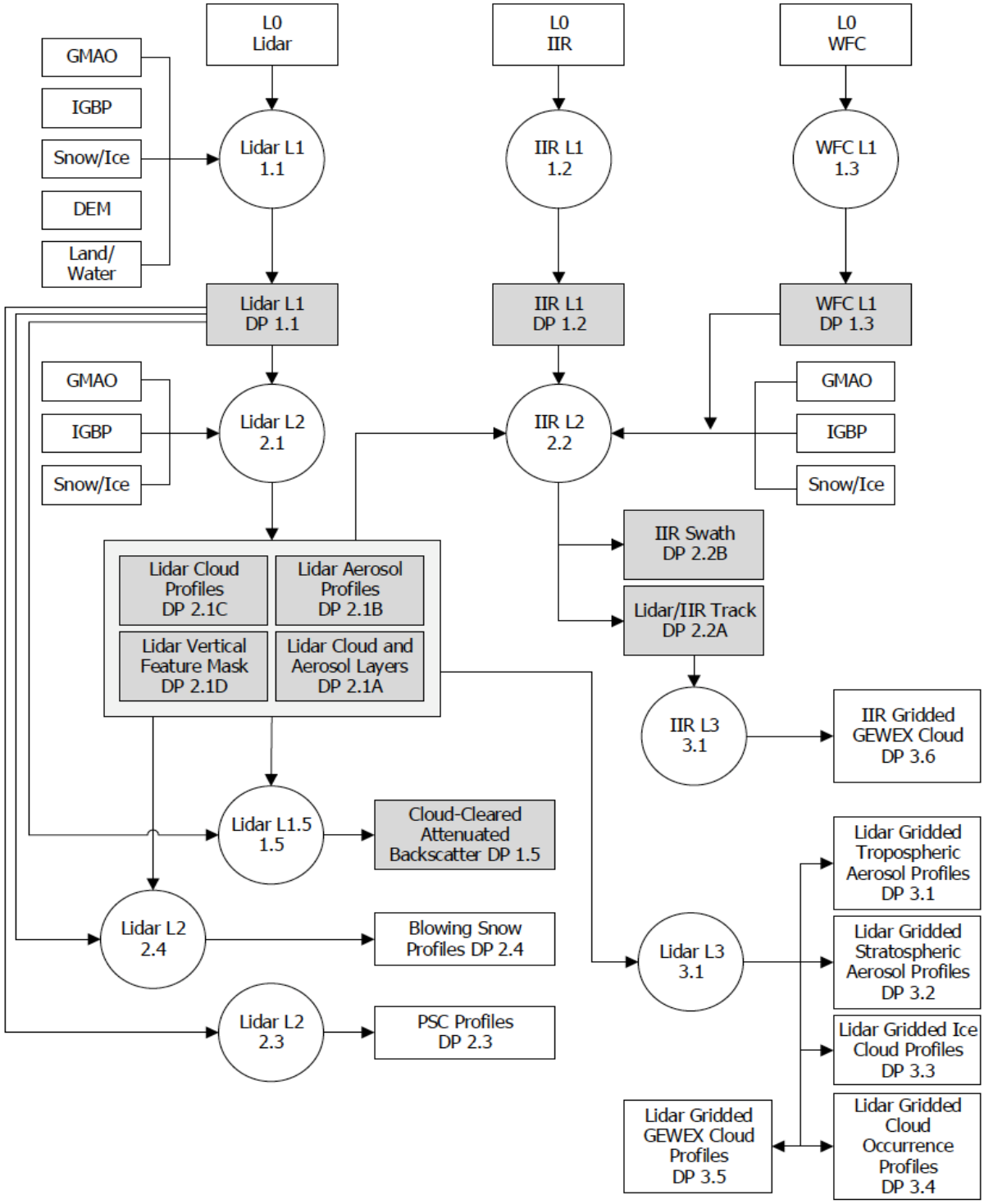
the IIR Swath (all pixels across swath) and IIR Track (coincident with lidar footprints). Lidar Level 3 products contain monthly-averaged parameters that are mapped onto a uniform spatial grid.

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 as well as a suite of Lidar Level 3 aerosol and cloud data products. 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 data products are monthly-averaged data sets derived using Lidar Level 1 and Lidar Level 2 products and maps aerosol and cloud parameters onto a uniform space and time grid.




*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 2 PSC data, lidar level 2 Blowing Snow 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://asdc.larc.nasa.gov.

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

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

For the Version 3.x release, 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.<br>For Version 3.x standard processing, Product IDs are [CAL, IIR, 1Km, 125m, 333mCLay, 01kmCLay, 05kmCLay, 05kmALay, 5kmAProCal, 05kmCPro, VFM, PSCMask, APro_AllSky, APro_CloudFree, APro_CloudySkyTransparent, APro_CloudySkyOpaque].<br><br>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 Lidar Levels 1 and 2 Version 4.x releases, IIR Level 1 Version 2.00, and all products which depend on these new versions as input, 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, 333mMLay, 01kmCLay, 05kmCLay, 05kmALay, 05kmMLay, 05kmAPro, 05kmCPro, PSCMask, Ice_Cloud, Stratospheric_APro, Tropospheric_APro, BlowingSnow_Region, Cloud_Occurrence, GEWEX_Cloud) |
| ProductionStrategy | = | Identifier specifying the production strategy used to generate the product (see table below) |
| Version | = | Version information (e.g., V4.10) |
| Instance | = | YYYY-MM-DDThh-mm-ssZ[D\|N\|A] |

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

For example, the file named CAL_LID_L1-Standard-V4-10.2007-05-01T01-20-09ZN.hdf would contain the following:

- Investigation: CAL (i.e., the CALIPSO mission),
- Subsystem: LID (i.e., Lidar)
- Level: L1 (i.e., Level 1)
- ProductID – none for level 1 data
- ProductionStrategy: Standard
- Version: V4-10
- 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 (includes IIR Level 1 Version 2.00, Levels 2 & 3 Version 1.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) – Version 3.x | Profile | 0.83 | 495.249 | 7,428.735 | 222,862.05 |
| 1.1 | Lidar Level 1 – Night (6) – Version 3.x | Profile | 0.83 | 495.249 | 7,428.735 | 222,862.05 |
| 1.1 | Lidar Level 1 – Day (11) – Version 4.10 | Profile | 0.83 | 496.430 | 7,446.450 | 223,393.50 |
| 1.1 | Lidar Level 1 – Night (11) – Version 4.10 | Profile | 0.83 | 496.430 | 7,446.450 | 223,393.50 |
| | | | | | | |
| 1.2 | IIR Level 1 – Day (16) – Version 1.x | Swath | 0.83 | 50.022 | 750.33 | 22,509.9 |
| 1.2 | IIR Level 1 – Night (16) – Version 1.x | Swath | 0.83 | 50.022 | 750.33 | 22,509.9 |
| 1.2 | IIR Level 1 – Day (20) – Version 2.00 | Swath | 0.83 | 50.022 | 750.33 | 22,509.9 |
| 1.2 | IIR Level 1 – Night (20) – Version 2.00 | Swath | 0.83 | 50.022 | 750.33 | 22,509.9 |
| | | | | | | |
| 1.3 | WFC Level 1 Registered – Day Only (24)[2] | Swath | 0.83 | 44.907 | 673.60 | 20,208.00 |
| 1.3 | WFC Level 1 Native – Day Only (25)[2] | Swath | 0.83 | 45.240 | 678.60 | 20,358.00 |
| 1.3 | WFC Level 1 125m – Day Only (26)[2] | Swath | 0.83 | 151.622 | 2,274.33 | 68,229.90 |
| | | | | | | |
| 1.5 | Lidar Level 1.5 – Standard – Day (155) – Version 1.00 | Profile | 0.83 | 32.46 | 486.90 | 14,607.00 |
| 1.5 | Lidar Level 1.5 – Standard – Night (155) – Version 1.00 | Profile | 0.83 | 32.46 | 486.90 | 14,607.00 |
| | | | | | | |
| 2.1 | Lidar Level 2 1/3 km Cloud Layer – Day (31) – Version 3.x | Profile | 0.83 | 60.049 | 900.735 | 27,022.05 |
| 2.1 | Lidar Level 2 1/3 km Cloud Layer – Night (31) – Version 3.x | Profile | 0.83 | 60.049 | 900.735 | 27,022.05 |
| 2.1 | Lidar Level 2 1 km Cloud Layer – Day (32) – Version 3.x | Profile | 0.83 | 35.773 | 536.595 | 16,097.85 |
| 2.1 | Lidar Level 2 1 km Cloud Layer – Night (32) – Version 3.x | Profile | 0.83 | 35.773 | 536.595 | 16,097.85 |
| 2.1 | Lidar Level 2 5 km Cloud Layer – Day (33) – Version 3.x | Profile | 0.83 | 12.828 | 192.42 | 5,772.60 |
| 2.1 | Lidar Level 2 5 km Cloud Layer – Night (33) – Version 3.x | Profile | 0.83 | 12.828 | 192.42 | 5,772.60 |
| 2.1 | Lidar Level 2 5 km Aerosol Layer – Day (34) – Version 3.x | Profile | 0.83 | 11.610 | 174.15 | 5,224.50 |
| 2.1 | Lidar Level 2 5 km Aerosol Layer – Night (34) – Version 3.x | Profile | 0.83 | 11.610 | 174.15 | 5,224.50 |
| 2.1 | Lidar Level 2 Aerosol Profile – Day (63) – Version 3.x | Profile | 0.83 | 149.433 | 2,241.495 | 67,244.85 |
| 2.1 | Lidar Level 2 Aerosol Profile – Night (63) – Version 3.x | Profile | 0.83 | 149.433 | 2,241.495 | 67,244.85 |
| 2.1 | Lidar Level 2 Cloud Profile – Day (70) – Version 3.x | Profile | 0.83 | 106.432 | 1,596.48 | 47,894.4 |
| 2.1 | Lidar Level 2 Cloud Profile – Night (70) – Version 3.x | Profile | 0.83 | 106.432 | 1,596.48 | 47,894.4 |
| 2.1 | Lidar Level 2 Vertical Feature Mask – Day (76) – Version 3.x | Profile | 0.83 | 45.927 | 688.905 | 20,667.15 |
| 2.1 | Lidar Level 2 Vertical Feature Mask – Night (76) – Version 3.x | Profile | 0.83 | 45.927 | 688.905 | 20,667.15 |

| Sub-system | Product (DPC Reference Table(s)) | Spatial Coverage | Temporal Coverage (hrs.) | File Size (MB) | Daily Size (MB) | Monthly Size (MB) |
|---|---|---|---|---|---|---|
| | | | | | | |
| 2.3 | Lidar Level 2 Polar Stratospheric Cloud Daily – Night (85) – Version 2.00 | Globe | 12.45 | 415.63 | 415.63 | 12,468.90 |
| | | | | | | |
| 2.1 | Lidar Level 2 1/3 km Merged Layer – Day (44) – Version 4.20 | Profile | 0.83 | 66.04 | 990.60 | 29,718.00 |
| 2.1 | Lidar Level 2 1/3 km Merged Layer – Night (44) – Version 4.20 | Profile | 0.83 | 66.04 | 990.60 | 29,718.00 |
| 2.1 | Lidar Level 2 1 km Cloud Layer – Day (45) – Version 4.20 | Profile | 0.83 | 41.76 | 626.40 | 18,792.00 |
| 2.1 | Lidar Level 2 1 km Cloud Layer – Night (45) – Version 4.20 | Profile | 0.83 | 41.76 | 626.40 | 18,792.00 |
| 2.1 | Lidar Level 2 5 km Cloud Layer – Day (46) – Version 4.20 | Profile | 0.83 | 91.77 | 1,376.55 | 41,296.50 |
| 2.1 | Lidar Level 2 5 km Cloud Layer – Night (46) – Version 4.20 | Profile | 0.83 | 91.77 | 1,376.55 | 41,296.50 |
| 2.1 | Lidar Level 2 5 km Aerosol Layer – Day (47) – Version 4.20 | Profile | 0.83 | 91.22 | 1,368.75 | 41,062.50 |
| 2.1 | Lidar Level 2 5 km Aerosol Layer – Night (47) – Version 4.20 | Profile | 0.83 | 91.22 | 1,368.75 | 41,062.50 |
| 2.1 | Lidar Level 2 5 km Merged Layer – Day (48) – Version 4.20 | Profile | 0.83 | 101.52 | 1,522.80 | 45,684.00 |
| 2.1 | Lidar Level 2 5 km Merged Layer – Night (48) – Version 4.20 | Profile | 0.83 | 101.52 | 1,522.80 | 45,684.00 |
| 2.1 | Lidar Level 2 Aerosol Profile – Day (66) – Version 4.20 | Profile | 0.83 | 143.47 | 2,152.05 | 64,561.50 |
| 2.1 | Lidar Level 2 Aerosol Profile – Night (66) – Version 4.20 | Profile | 0.83 | 143.47 | 2,152.05 | 64,561.50 |
| 2.1 | Lidar Level 2 Cloud Profile – Day (73) – Version 4.20 | Profile | 0.83 | 107.87 | 1,618.05 | 48,541.50 |
| 2.1 | Lidar Level 2 Cloud Profile – Night (73) – Version 4.20 | Profile | 0.83 | 107.87 | 1,618.05 | 48,541.50 |
| 2.1 | Lidar Level 2 Vertical Feature Mask – Day (80) – Version 4.20 | Profile | 0.83 | 45.24 | 678.60 | 20,358.00 |
| 2.1 | Lidar Level 2 Vertical Feature Mask – Night (80) – Version 4.20 | Profile | 0.83 | 45.24 | 678.60 | 20,358.00 |
| 2.4 | Lidar Level 2 Blowing Snow Region – Monthly (88) – Version 1.00 | Globe | 744.0 | 4,522.17 | 0 | 4,522.17 |
| | | | | | | |
| 2.2 | IIR/Lidar Level 2 Track – Day (96) – Version 4.20 | Track | 0.83 | 7.40 | 118.40 | 3,552.00 |
| 2.2 | IIR/Lidar Level 2 Track – Night (96) – Version 4.20 | Track | 0.83 | 7.40 | 118.40 | 3,552.00 |
| 2.2 | IIR Level 2 Swath – Day (102) – Version 4.20 | Swath | 0.83 | 151.46 | 2,423.36 | 72,700.00 |
| 2.2 | IIR Level 2 Swath – Night (102) – Version 4.20 | Swath | 0.83 | 151.46 | 2,423.36 | 72,700.00 |
| | | | | | | |
| 3.1 | Lidar Level 3 – Tropospheric Aerosol Profile All Sky – Monthly – Day (105) – Version 4.x | Globe | 744.0 | 182.932 | 0 | 182.932 |
| 3.1 | Lidar Level 3 – Tropospheric Aerosol Profile All Sky – Monthly – Night (105) – Version 4.x | Globe | 744.0 | 182.932 | 0 | 182.932 |
| 3.1 | Lidar Level 3 – Tropospheric Aerosol Profile Cloud Free – Monthly – Day (105) – Version 4.x | Globe | 744.0 | 182.932 | 0 | 182.932 |

| Sub-system | Product (DPC Reference Table(s)) | Spatial Coverage | Temporal Coverage (hrs.) | File Size (MB) | Daily Size (MB) | Monthly Size (MB) |
|---|---|---|---|---|---|---|
| 3.1 | Lidar Level 3 – Tropospheric Aerosol Profile Cloud Free – Monthly – Night (105) – Version 4.x | Globe | 744.0 | 182.932 | 0 | 182.932 |
| 3.1 | Lidar Level 3 – Tropospheric Aerosol Profile Cloudy Sky Transparent – Monthly – Day (105) – Version 4.x | Globe | 744.0 | 182.932 | 0 | 182.932 |
| 3.1 | Lidar Level 3 – Tropospheric Aerosol Profile Cloudy Sky Transparent – Monthly – Night (105) – Version 4.x | Globe | 744.0 | 182.932 | 0 | 182.932 |
| 3.1 | Lidar Level 3 – Tropospheric Aerosol Profile Cloudy Sky Opaque – Monthly – Day (105) – Version 4.x | Globe | 744.0 | 182.932 | 0 | 182.932 |
| 3.1 | Lidar Level 3 – Tropospheric Aerosol Profile Cloudy Sky Opaque – Monthly – Night (105) – Version 4.x | Globe | 744.0 | 182.932 | 0 | 182.932 |
| 3.2 | Lidar Level 3 – Stratospheric Aerosol – Monthly – Night (128) – Version 1.00 | Globe | 744.0 | 2.23 | 0 | 2.23 |
| 3.3 | Lidar Level 3 – Ice Cloud – Monthly – Day (120) – Version 1.00 | Globe | 744.0 | 465.04 | 0 | 465.04 |
| 3.3 | Lidar Level 3 – Ice Cloud – Monthly – Night (120) – Version 1.00 | Globe | 744.0 | 465.04 | 0 | 465.04 |
| 3.3 | Lidar Level 3 – Ice Cloud – Monthly – All (120) – Version 1.00 | Globe | 744.0 | 465.04 | 0 | 465.04 |
| 3.4 | Lidar Level 3 – Cloud Occurrence – Monthly – Day (136) – Version 1.00 | Globe | 744.0 | 255.58 | 0 | 255.58 |
| 3.4 | Lidar Level 3 – Cloud Occurrence – Monthly – Night (136) – Version 1.00 | Globe | 744.0 | 255.58 | 0 | 255.58 |
| 3.4 | Lidar Level 3 – Cloud Occurrence – Monthly – All (136) – Version 1.00 | Globe | 744.0 | 255.58 | 0 | 255.58 |
| 3.5 | Lidar Level 3 – GEWEX Cloud – Monthly – Day (143) – Version 1.00 | Globe | 744.0 | 152.57 | 0 | 152.57 |
| 3.5 | Lidar Level 3 – GEWEX Cloud – Monthly – Night (143) – Version 1.00 | Globe | 744.0 | 152.57 | 0 | 152.57 |
| 3.5 | Lidar Level 3 – GEWEX Cloud – Monthly – All (143) – Version 1.00 | Globe | 744.0 | 152.57 | 0 | 152.57 |
| | | | | | | |
| 3.6 | IIR Level 3 – GEWEX Cloud – Monthly – Day (150) – Version 1.00 | Globe | 744.0 | 111.57 | 0 | 111.57 |
| 3.6 | IIR Level 3 – GEWEX Cloud – Monthly – Night (150) – Version 1.00 | Globe | 744.0 | 111.57 | 0 | 111.57 |
| 3.6 | IIR Level 3 – GEWEX Cloud – Monthly – All (150) – Version 1.00 | Globe | 744.0 | 111.57 | 0 | 111.57 |
| | | | | | | |
| 1.1 | Lidar Level 1 – Expedited (6) – Version 3.x | Profile | 1.5 | 848.062 | 13,568.992 | 407,069.76 |
| 1.2 | IIR Level 1 – Expedited (16) – Version 1.x | Swath | 1.5 | 90.663 | 1,359.945 | 40,798.35 |
| 1.3 | WFC Level 1 Registered – Expedited (24)[2] – Version 3.x | Swath | 0.83 | 44.907 | 673.60 | 20,208.00 |
| 1.3 | WFC Level 1 Native – Expedited (25)[2] – Version 3.x | Swath | 0.83 | 45.240 | 678.60 | 20,358.00 |
| 1.3 | WFC Level 1 125m – Expedited (26)[2] – Version 3.x | Swath | 0.83 | 151.622 | 2,274.33 | 68,229.90 |

| Sub-system | Product (DPC Reference Table(s)) | Spatial Coverage | Temporal Coverage (hrs.) | File Size (MB) | Daily Size (MB) | Monthly Size (MB) |
|---|---|---|---|---|---|---|
| 1.5 | Lidar Level 1.5 – Expedited (163) – Version 3.50 | Profile | 1.5 | 68.32 | 1,024.80 | 30,744.00 |
| | | | | | | |
| 2.1 | Lidar Level 2 1/3 km Cloud Layer – Expedited (31) – Version 3.x | Profile | 1.5 | 213.899 | 3,422.384 | 102,671.52 |
| 2.1 | Lidar Level 2 1 km Cloud Layer – Expedited (32) – Version 3.x | Profile | 1.5 | 61.242 | 979.87 | 29,396.16 |
| 2.1 | Lidar Level 2 5 km Cloud Layer – Expedited (33) – Version 3.x | Profile | 1.5 | 21.950 | 351.20 | 10,536.00 |
| 2.1 | Lidar Level 2 5 km Aerosol Layer – Expedited (34) – Version 3.x | Profile | 1.5 | 19.864 | 317.824 | 9,534.72 |
| 2.1 | Lidar Level 2 Aerosol Profile – Expedited (64) – Version 3.x | Profile | 1.5 | 255.873 | 4,093.968 | 122,819.04 |
| 2.1 | Lidar Level 2 Cloud Profile – Expedited (71) – Version 3.x | Profile | 1.5 | 182.239 | 2,915.824 | 87,474.72 |
| 2.1 | Lidar Level 2 Vertical Feature Mask – Expedited (77) – Version 3.x | Profile | 1.5 | 78.629 | 1,258.064 | 37,741.92 |
| 2.2 | IIR/Lidar Level 2 Track – Expedited (93) – Version 3.x | Track | 1.5 | 9.263 | 148.208 | 4,446.24 |
| 2.2 | IIR Level 2 Swath – Expedited (99) – Version 3.x | Swath | 1.5 | 195.859 | 3,133.744 | 94,012.32 |
| | | | | | | |
| | **File, Daily, and Monthly Totals** | | | **16,675.152** | **112,381.683** | **3,380,390.181** |

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 |
| | | | | | | |

| Sub-system | Product | Spatial Coverage | Temporal Coverage | Product Size (MB) | Daily Size (MB) | Monthly Size (MB) |
|---|---|---|---|---|---|---|
| | **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.

---

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 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 – Version 3.x

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

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 – Version 3.x

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 – Version 3.x**

| 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.x | Table 7 | 3,117 | 1 | 3,117 |
| Spacecraft Position, Attitude, and Celestial Record | Table 8 | 124 | Standard: 63,630<br>Expedited: 108,960 | 7,890,120<br>13,511,040 |
| Profile Geolocation and Viewing Geometry | Table 9 | 40 | Standard: 63,630<br>Expedited: 108,960 | 2,545,200<br>4,358,400 |
| Lidar Profile Science Record – Data Version 3.x | Table 10 | 7,806 | Standard: 63,630<br>Expedited: 108,960 | 496,695,780<br>850,541,760 |
| | | | | |
| **Total Size – Standard (bytes) – Version 3.x** | | | | **507,135,120** |
| **Total Size – Standard (Mbytes) – Version 3.x** | | | | **495.249** |
| | | | | |
| **Total Size - Expedited (bytes) – Version 3.x** | | | | **868,415,220** |
| **Total Size - Expedited (Mbytes) – Version 3.x** | | | | **848.062** |

### 2.1.2 LIDAR Instrument Level 1 Data Metadata – Version 3.x

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 – Version 3.x**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | L1_LIDAR_Science | 80 | 80 |
| Date_Time_at_Granule_Start[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | Std = 0…63,630<br>Exp = 0…108,960 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | Std = 0…63,630<br>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…261,231.0 | 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…261,231.0 | 1 | 8 |
| Ephemeris_Files_Used | Char | NoUnits | 2 file names max. | 160 | 160 |
| Attitude_Files_Used | Char | NoUnits | 2 file names max. | 160 | 160 |
| 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 | $m^2 \cdot sr^{-1}$ | 5.930E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_1064 | Float_32 | $m^2 \cdot sr^{-1}$ | 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 |
| | | | | | |
| **Record Size (bytes) – Data Version 3.x** | | | | | **3,117** |

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
*) Current range values are tentative, and must be approved by the CALIPSO LSWG

### 2.1.3 LIDAR Instrument Level 1 Data Scientific Data Sets – Version 3.x

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 – Version 3.x**

| Parameter | Data Type | Units | Nominal Range | Elem/Rec | Bytes |
|---|---|---|---|---|---|
| Spacecraft_Altitude | Float_32 | km | 700.0…720.0 | 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 – Version 3.x**

| 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 | -5…5 | 1 | 4 |
| | | | | | |
| **Record Size (bytes)** | | | | | **40** |

## Table 10: Lidar Profile Science Record – Version 3.x

| 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…261,231.0 | 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 | 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 |
| Laser_Energy_532 | Float_32 | J | 0.003…0.135 | 1 | 4 |
| Perpendicular_Amplifier_Gain_532 | Float_32 | V/V | 28.2…178.0 | 1 | 4 |
| Parallel_Amplifier_Gain_532 | Float_32 | V/V | 28.2…178.0 | 1 | 4 |
| Perpendicular_Background_Monitor_532 | Float_32 | count | 800.0…4,000.0 | 1 | 4 |
| Parallel_Background_Monitor_532 | Float_32 | count | -100.0…4,000.0 | 1 | 4 |
| Depolarization_Gain_Ratio_532 | Float_32 | NoUnits | 0.0…2.5 | 1 | 4 |
| Depolarization_Gain_Ratio_Uncertainty_532 | Float_32 | NoUnits | 0.0…0.01 | 1 | 4 |
| Calibration_Constant_532 | Float_32 | $km^3 \cdot sr \cdot count$ | 3.0E10…9.0E10 | 1 | 4 |
| Calibration_Constant_Uncertainty_532 | Float_32 | $km^3 \cdot sr \cdot count$ | 1.2E9…2.6E9 | 1 | 4 |
| Total_Attenuated_Backscatter_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.1 | 583 | 2,332 |
| Perpendicular_Attenuated_Backscatter_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…1.5 | 583 | 2,332 |
| Perpendicular_RMS_Baseline_532[F] | Float_32 | count | 0.0…2,700.0 | 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 | $km^3 \cdot sr \cdot count$ | 4.0E9…1.2E12 | 1 | 4 |
| Calibration_Constant_Uncertainty_1064 | Float_32 | $km^3 \cdot sr \cdot count$ | 5.0E7…4.6E8 | 1 | 4 |
| Attenuated_Backscatter_1064 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…2.0 | 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 |
| 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 | 0…33,554,431 | 1 | 4 |
| | | | | | |
| **Total Bytes per Record – Data Version 3.x** | | | | | **7,806** |

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

## 2.2 Lidar Level 1B Profiles DP 1.1 – Version 4.10

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 11.

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 |
| Spatial Resolution Record: | Standard: | Full resolution profile |
| Time Interval Covered: | Standard: | Half Orbit (Day or Night) |

Data File Name (For Version 4.10):

Standard: CAL_LID_L1-Standard-Version.Instance.hdf

### 2.2.1 LIDAR Instrument Level 1 Data Product – Version 4.10

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

**Table 11: Lidar Instrument Record Summary – Version 4.10**

| 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 4.10 | Table 12 | 3,777 | 1 | 3,777 |
| Spacecraft Position, Attitude, and Celestial Record | Table 13 | 124 | 63,630 | 7,890,120 |
| Profile Geolocation and Viewing Geometry | Table 14 | 40 | 63,630 | 2,545,200 |
| Lidar Profile Science Record – Data Version 4.10 | Table 15 | 7,825 | 63,630 | 497,904,750 |
| | | | | |
| **Total Size – Standard (bytes) – Version 4.10** | | | | **508,344,750** |
| **Total Size – Standard (Mbytes) – Version 4.10** | | | | **496.430** |

### 2.2.2 LIDAR Instrument Level 1 Data Metadata – Version 4.10

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 12.

**Table 12: Lidar Metadata Record – Version 4.10**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | L1_LIDAR_Science | 80 | 80 |
| Date_Time_at_Granule_Start[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | 0…63,630 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | 0…63,630 | 1 | 4 |
| Initial_Subsatellite_Latitude | Float_32 | 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…261,231.0 | 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…261,231.0 | 1 | 8 |
| Ephemeris_Files_Used | Char | NoUnits | 2 file names max | 160 | 160 |
| Attitude_Files_Used | Char | NoUnits | 2 file names max | 160 | 160 |
| GMAO_Files_Used[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 | $m^2 \cdot sr^{-1}$ | 5.930E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_1064 | Float_32 | $m^2 \cdot sr^{-1}$ | 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 |
| 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 |
| CirrusBackscatterColorRatioUncertainty[Q] | Float_32 | NoUnits | 0.25* | 1 | 4 |
| | | | | | |
| **Record Size (bytes) – Data Version 4.10** | | | | | **3,777** |

A) UTC CCSDS ASCII Time Code Format A

D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
Q) Parameters exist in data version 4.10
*) Current range values are tentative, and must be approved by the CALIPSO LSWG

### 2.2.3 LIDAR Instrument Level 1 Data Scientific Data Sets – Version 4.10

Table 13, Table 14 and Table 15 summarize the contents of each scientific data set (SDS) contained within the LIDAR Instrument Level 1 Data products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

**Table 13: Lidar Spacecraft Position, Attitude, and Celestial Record – Version 4.10**

| Parameter | Data Type | Units | Nominal Range | Elem/Rec | Bytes |
|---|---|---|---|---|---|
| Spacecraft_Altitude | Float_32 | km | 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 14: Lidar Profile Geolocation and Viewing Geometry – Version 4.10**

| 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 | -8…8 | 1 | 4 |
| | | | | | |
| **Record Size (bytes)** | | | | | **40** |

## Table 15: Lidar Profile Science Record – Version 4.10

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Profile_Time[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Profile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261,231.0 | 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 |
| 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 | 26.0…178.0 | 1 | 4 |
| Parallel_Amplifier_Gain_532 | Float_32 | V/V | 26.0…178.0 | 1 | 4 |
| Perpendicular_Background_Monitor_532 | Float_32 | count | 120.0…6,000.0 | 1 | 4 |
| Parallel_Background_Monitor_532 | Float_32 | count | 6.0…6,000.0 | 1 | 4 |
| Depolarization_Gain_Ratio_532 | Float_32 | NoUnits | 0.0…2.5 | 1 | 4 |
| Depolarization_Gain_Ratio_Uncertainty_532 | Float_32 | NoUnits | 0.0…0.01 | 1 | 4 |
| Calibration_Constant_532 | Float_32 | $km^3 \cdot sr \cdot count$ | 3.0E10…8.0E10 | 1 | 4 |
| Calibration_Constant_Uncertainty_532 | Float_32 | $km^3 \cdot sr \cdot count$ | 2.0E8…1.6E9 | 1 | 4 |
| Total_Attenuated_Backscatter_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | -0.1…3.3 | 583 | 2,332 |
| Perpendicular_Attenuated_Backscatter_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | -0.08…1.7 | 583 | 2,332 |
| Perpendicular_RMS_Baseline_532[F] | Float_32 | count | 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 | $km^3 \cdot sr \cdot count$ | 4.0E9…1.0E10 | 1 | 4 |
| Calibration_Constant_Uncertainty_1064 | Float_32 | $km^3 \cdot sr \cdot count$ | 5.0E7…4.0E9 | 1 | 4 |
| Attenuated_Backscatter_1064 | Float_32 | $km^{-1} \cdot sr^{-1}$ | -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 | $m^{-3}$ | 9.0E16…1.0E19 | 33 | 132 |
| Temperature | Float_32 | ºC | -120.0…60.0 | 33 | 132 |
| Pressure | Float_32 | mb | 1.0…1,086.0 | 33 | 132 |
| Relative_Humidity | Float_32 | NoUnits | 0.0…1.5 | 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 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| 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 | 0…134,217,727 | 1 | 4 |
| | | | | | |
| **Total Bytes per Record – Data Version 4.10** | | | | | **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 4.10

## 2.3 IIR Level 1B Radiances DP 1.2 – Version 1.x

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 16.

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.**

### 2.3.1 Infrared Imaging Radiometer Level 1 Data Product – Version 1.x

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

**Table 16: IIR Record Summary – Version 1.x**

| 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 | 1 |
| IIR Metadata Record | Table 17 | 821 | 1 | 821 |
| Spacecraft Position, Attitude, and Celestial Record | Table 18 | 360 | Standard: 384<br>Expedited: 696 | 138,240<br>250,560 |
| Earth View Record | Table 19 | 2,548 | Standard: 20,048<br>Expedited: 36,337 | 51,082,304<br>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** |

### 2.3.2 IIR Level 1 Metadata – Version 1.x

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 17.

**Table 17: IIR Level 1 Metadata Record – Version 1.x**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | N/A | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | N/A | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_IIR_Grid_Line_Records | UInt_16 | N/A | Std = 0…20,048<br>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…261,231.0 | 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…261,231.0 | 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 – 12/2026 | 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 – 12/2026 | 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…24,576 | 1 | 2 |
| Final_Absolute_Sequence | Int_16 | N/A | 0…24,576 | 1 | 2 |
| Grid_Line_Delta_Time | Float_32 | sec | 0.0…0.2 | 1 | 4 |
| Scale_Factor_for_Radiance | Float_32 | N/A | 100.0 | 1 | 4 |
| Radiance_Offset | Float_32 | N/A | 0.0 | 1 | 4 |
| Scale_Factor_for_Viewing_Angle | Float_32 | N/A | 100.0 | 1 | 4 |
| Viewing_Angle_Offset | Float_32 | N/A | 0.0 | 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.

### 2.3.3 IIR Level 1 Scientific Data Sets – Version 1.x

Table 18 and Table 19 summarize the contents of each scientific data set (SDS) contained within the IIR Level 1 products. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

**Table 18: IIR Spacecraft Position, Attitude, and Celestial Record (1 per Earth view) – Version 1.x**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Time_TAI_8.65[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Time_TAI_10.6[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Time_TAI_12.05[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Time_UTC_8.65[D] | Float_64 | NoUnits | 60,426.0...261,231.0 | 1 | 8 |
| Time_UTC_10.6[D] | Float_64 | NoUnits | 60,426.0...261,231.0 | 1 | 8 |
| Time_UTC_12.05[D] | Float_64 | NoUnits | 60,426.0...261,231.0 | 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 19: Earth View Record (1 per grid line) – Version 1.x**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Lidar_Shot_Time[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Lidar_Shot_UTC_Time[D] | Float_64 | NoUnits | 60,426.0...261,231.0 | 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…1.072E9 | 1 | 8 |
| Image_Time_10.6[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Image_Time_12.05[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Image_UTC_Time_8.65[D] | Float_64 | NoUnits | 60,426.0...261,231.0 | 1 | 8 |
| Image_UTC_Time_10.6[D] | Float_64 | NoUnits | 60,426.0...261,231.0 | 1 | 8 |
| Image_UTC_Time_12.05[D] | Float_64 | NoUnits | 60,426.0...261,231.0 | 1 | 8 |
| Calibrated_Radiances_8.65 | Int_16 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0…100 [P] | 69 | 138 |
| Calibrated_Radiances_10.6 | Int_16 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0…100 [P] | 69 | 138 |
| Calibrated_Radiances_12.05 | Int_16 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 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

Appendix D provides flag definitions for Pixel_Quality_Index.

## 2.4 IIR Level 1B Radiances DP 1.2 – Version 2.00

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 20.

The major categories for IIR Level 1B data are:

- IIR Earth View
- Position Data
- Viewing Geometry

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

Data File Name:

Standard: CAL_IIR_L1-Standard-Version.Instance.hdf

### 2.4.1 Infrared Imaging Radiometer Level 1 Data Product – Version 2.00

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 20: IIR Record Summary – Version 2.00**

| 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 | 1 |
| IIR Metadata Record | Table 21 | 821 | 1 | 821 |
| Spacecraft Position, Attitude, and Celestial Record | Table 22 | 360 | 384 | 138,240 |
| Earth View Record | Table 23 | 2,548 | 20,048 | 51,082,304 |
| | | | | |
| **Total Size - Standard (bytes)** | | | | **51,222,268** |
| **Total Size – Standard (Mbytes)** | | | | **50.022** |

### 2.4.2 IIR Level 1 Metadata – Version 2.00

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 21.

**Table 21: IIR Level 1 Metadata Record – Version 2.00**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | N/A | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | N/A | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_IIR_Grid_Line_Records | UInt_16 | N/A | 0…20,048 | 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…261,231.0 | 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…261,231.0 | 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 – 12/2026 | 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 – 12/2026 | 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…24,576 | 1 | 2 |
| Final_Absolute_Sequence | Int_16 | N/A | 0…24,576 | 1 | 2 |
| Grid_Line_Delta_Time | Float_32 | sec | 0.0…0.2 | 1 | 4 |
| Scale_Factor_for_Radiance | Float_32 | N/A | 1,000.0 | 1 | 4 |
| Radiance_Offset | Float_32 | N/A | 0.0 | 1 | 4 |
| Scale_Factor_for_Viewing_Angle | Float_32 | N/A | 100.0 | 1 | 4 |
| Viewing_Angle_Offset | Float_32 | N/A | 0.0 | 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

### 2.4.3 IIR Level 1 Scientific Data Sets – Version 2.00

Table 22 and Table 23 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 22: IIR Spacecraft Position, Attitude, and Celestial Record (1 per Earth view) – Version 2.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Time_TAI_8.65[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Time_TAI_10.6[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Time_TAI_12.05[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Time_UTC_8.65[D] | Float_64 | NoUnits | 60,426.0...261,231.0 | 1 | 8 |
| Time_UTC_10.6[D] | Float_64 | NoUnits | 60,426.0... 261,231.0 | 1 | 8 |
| Time_UTC_12.05[D] | Float_64 | NoUnits | 60,426.0... 261,231.0 | 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. (Range not recorded in HDF data file.)
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff

**Table 23: Earth View Record (1 per grid line) – Version 2.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Lidar_Shot_Time[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Lidar_Shot_UTC_Time[D] | Float_64 | NoUnits | 60,426.0...261,231.0 | 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…1.072E9 | 1 | 8 |
| Image_Time_10.6[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Image_Time_12.05[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Image_UTC_Time_8.65[D] | Float_64 | NoUnits | 60,426.0... 261,231.0 | 1 | 8 |
| Image_UTC_Time_10.6[D] | Float_64 | NoUnits | 60,426.0... 261,231.0 | 1 | 8 |
| Image_UTC_Time_12.05[D] | Float_64 | NoUnits | 60,426.0... 261,231.0 | 1 | 8 |
| Calibrated_Radiances_8.65 | Int_16 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0…32 [P] | 69 | 138 |
| Calibrated_Radiances_10.6 | Int_16 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0…32 [P] | 69 | 138 |
| Calibrated_Radiances_12.05 | Int_16 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0…32 [P] | 69 | 138 |
| Viewing_Zenith_Angle_8.65 | Int_16 | deg | 0.0…180.0 | 69 | 138 |
| Viewing_Zenith_Angle_10.6 | Int_16 | deg | 0.0…180.0 | 69 | 138 |
| Viewing_Zenith_Angle_12.05 | Int_16 | deg | 0.0…180.0 | 69 | 138 |
| Viewing_Azimuth_Angle_8.65 | Int_16 | deg | -180.0…180.0 | 69 | 138 |
| Viewing_Azimuth_Angle_10.6 | Int_16 | deg | -180.0…180.0 | 69 | 138 |
| Viewing_Azimuth_Angle_12.05 | Int_16 | deg | -180.0…180.0 | 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 | 0…15,745,287 | 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

Appendix D provides flag definitions for Pixel_Quality_Index.

## 2.5 WFC Level 1B Scans DP 1.3 – Version 3.x

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.**

### 2.5.1 Wide Field Camera Level 1 Data Product – Version 3.x

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 24, Table 25, and Table 26 show the data structure of each file.

**Table 24: WFC Record Summary - 1 km Registered Science – Version 3.x**

| 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 27 | 2,149 | 1 | 2,149 |
| 1 km Registered Science Record | Table 28 | 2,704 | Standard: 17,005<br>Expedited: 17,005 | 45,981,520<br>45,981,520 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **45,984,572** |
| **Total Size – Standard (Mbytes)** | | | | **44.907** |
| | | | | |
| **Total Size – Expedited (bytes)** | | | | **45,984,572** |
| **Total Size – Expedited (Mbytes)** | | | | **44.907** |

**Table 25: WFC Record Summary - 1 km Native Science – Version 3.x**

| 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 27 | 2,149 | 1 | 2,149 |
| 1 km Native Science Record | Table 29 | 2,712 | Standard: 17,005<br>Expedited: 17,005 | 46,117,560<br>46,117,560 |
| Reflectance Bin Record | Table 29 | 288 | 915 | 263,520 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **46,384,132** |
| **Total Size – Standard (Mbytes)** | | | | **45.240** |
| | | | | |
| **Total Size – Expedited (bytes)** | | | | **46,384,132** |
| **Total Size – Expedited (Mbytes)** | | | | **45.240** |

**Table 26: WFC Record Summary - 125 m Native Science – Version 3.x**

| 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 27 | 2,149 | 1 | 2,149 |
| 125 m Native Science Record | Table 30 | 1,140 | Standard: 136,040<br>Expedited: 136,040 | 155,085,600<br>155,085,600 |
| Reflectance Bin Record | Table 30 | 288 | 600 | 172,800 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **155,261,456** |
| **Total Size – Standard (Mbytes)** | | | | **151.622** |
| | | | | |
| **Total Size – Expedited (bytes)** | | | | **155,261,456** |
| **Total Size – Expedited (Mbytes)** | | | | **151.622** |

### 2.5.2 WFC Level 1 data Metadata – Version 3.x

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 27.

**Table 27: WFC Level 1 Metadata Record – Version 3.x**

| Parameter | Data Type | Units | Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | WFC_Native_125m<br>WFC_Native_1Km<br>WFC_IIR_Registered_1km | 80 | 80 |
| Date_Time_at_Granule_Start[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| 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…261,231.0 | 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…261,231.0 | 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 | $(Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1})$ $(count^{-1})(ms)$ | N/A | 61 | 488 |
| 125m_Radiance_Calibration_Coefficients | Float_64 | $(Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1})$ $(count^{-1})(ms)$ | 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

### 2.5.3 WFC Level 1 Scientific Data Sets – Version 3.x

Table 28, Table 29, and Table 30 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 28: 1 km Registered Science Record – Version 3.x**

| 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 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 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 29: 1 km Native Science Record – Version 3.x**

| 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 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 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 25.

## Table 30: 125 m Native Science Record – Version 3.x

| 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[D] | 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 | $Wm^{-2} \cdot sr^{-1} \cdot \mu m^{-1}$ | 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 26.

## 2.6 Lidar Level 2 Cloud and Aerosol Layer Products DP 2.1A – Version 3.x

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 31, Table 32, Table 33, and Table 34 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 geophysical location of the column of the atmosphere through which a given lidar pulse travels. Also included in the column descriptors are indicators of surface lighting conditions, information about the surface type, and the number of features (e.g., cloud and/or aerosol layers) identified within the column.

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

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

| | | |
|---|---|---|
| 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 (Version 3.x):

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.**

### 2.6.1 Lidar Level 2 Cloud and Aerosol Layers Record Summary – Version 3.x

**Table 31: 1/3 km Lidar Cloud Layer Record Summary – Version 3.x**

| 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 35 | 22,670 | 1 | 22,670 |
| 1/3 km Column Descriptor Record: Clouds | Table 36 | 116 | Standard: 63,630<br>Expedited: 108,960 | 7,381,080<br>126,393,360 |
| 1/3 km Layer Descriptor Record: Clouds | Table 37 | 850 | Standard: 63,630<br>Expedited: 108,960 | 54,085,500<br>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 32: 1 km Lidar Cloud Layer Record Summary – Version 3.x**

| 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 35 | 22,670 | 1 | 22,670 |
| 1 km Column Descriptor Record: Clouds | Table 38 | 116 | Standard: 21,210<br>Expedited: 36,320 | 6,673,480 |
| 1 km Layer Descriptor Record: Clouds | Table 39 | 1,610 | Standard: 21,210<br>Expedited: 36,320 | 34,148,100<br>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 33: 5 km Lidar Cloud Layer Record Summary – Version 3.x**

| 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 35 | 22,670 | 1 | 22,670 |
| 5 km Column Descriptor Record: Clouds | Table 40 | 331 | Standard: 4,010<br>Expedited: 7,264 | 3,731,694<br>2,404,384 |
| 5 km Layer Descriptor Record: Clouds | Table 41 | 2,760 | Standard: 4,010<br>Expedited: 7,264 | 31,116,240<br>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 34: 5 km Lidar Aerosol Layer Record Summary – Version 3.x

| 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 35 | 22,670 | 1 | 22,670 |
| 5 km Column Descriptor Record: Aerosols | Table 42 | 331 | Standard: 4,010<br>Expedited: 7,264 | 3,731,694<br>2,404,384 |
| 5 km Layer Descriptor Record: Aerosols | Table 43 | 2,466 | Standard: 4,010<br>Expedited: 7,264 | 10,460,772<br>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** |

### 2.6.2 Lidar Cloud & Aerosol Level 2 Metadata – Version 3.x

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 35.

**Table 35: Lidar Cloud & Aerosol Level 2 Layer Metadata Record – Version 3.x**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | Std = 0…63,630<br>Exp = 0…108,960 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | Std = 0…63,630<br>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…261,231.0 | 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…261,231.0 | 1 | 8 |
| Lidar_L1_Production_Date_Time | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Single_Shot_Records_in_File | Int_32 | NoUnits | Std = 0…63,630<br>Exp = 0…108,960 | 1 | 4 |
| Number_of_Average_Records_in_File | Int_32 | NoUnits | Std = 0…21,210<br>Exp = 0…36,320 | 1 | 4 |
| Number_of_Features_Found | Int_32 | NoUnits | Std = 0…616,606<br>Exp = 0…1,038,752 | 1 | 4 |
| Number_of_Cloud_Features_Found | Int_32 | NoUnits | Std = 0…572,670<br>Exp = 0…980,640 | 1 | 4 |
| Number_of_Aerosol_Features_Found | Int_32 | NoUnits | Std = 0…33,936<br>Exp = 0…58,112 | 1 | 4 |
| Number_of_Indeterminate_Features_Found | Int_32 | NoUnits | Std = 0…572,640<br>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 | NoUnits | 4/2006 – 12/2026 | 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

### 2.6.3 Lidar Cloud & Aerosol Level 2 Scientific Data Sets – Version 3.x

Table 36 through Table 43 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 37, Table 39, Table 41, and Table 43. 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 37, $km^{-1} \cdot sr^{-1}$.

## Table 36: Lidar 1/3 km Column Descriptor Record: Clouds – Version 3.x

| 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 37: Lidar 1/3 km Layer Descriptor Record: Clouds – Version 3.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Layer_Top_Altitude | Float_32 | km | -0.5…8.2 | 5 | 20 |
| Layer_Base_Altitude | Float_32 | km | -0.5…8.2 | 5 | 20 |
| Layer_Top_Pressure | Float_32 | hPa | 1.0…1,086.0 | 5 | 20 |
| Midlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 5 | 20 |
| Layer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 5 | 20 |
| Layer_Top_Temperature | Float_32 | 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 | $km^{-1} \cdot sr^{-1}$ | 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 | $km^{-1} \cdot sr^{-1}$ | 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 79 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 38: Lidar 1 km Column Descriptor Record: Clouds – Version 3.x

| 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 39: Lidar 1 km Layer Descriptor Record: Clouds – Version 3.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Layer_Top_Altitude | Float_32 | km | -0.5…20.2 | 10 | 40 |
| Layer_Base_Altitude | Float_32 | km | -0.5…20.2 | 10 | 40 |
| Layer_Top_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 20 |
| Midlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 20 |
| Layer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 20 |
| Layer_Top_Temperature | Float_32 | 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 | $km^{-1} \cdot sr^{-1}$ | 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 | $km^{-1} \cdot sr^{-1}$ | 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 79 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 40: Lidar 5 km Column Descriptor Record: Clouds – Version 3.x

| 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[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 41: Lidar 5 km Layer Descriptor Record: Clouds – Version 3.x

| 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…1,086.0 | 10 | 40 |
| Midlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 40 |
| Layer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 40 |
| Layer_Top_Temperature | Float_32 | 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 | $km^{-1}\cdot sr^{-1}$ | 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 | $km^{-1}\cdot sr^{-1}$ | 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 79 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 41 and 43 (5 km Layer Descriptor Record for Aerosols) are identical.

## Table 42: Lidar 5 km Column Descriptor Record: Aerosols – Version 3.x

| 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 | $ms^{-1}$ | -80.0…80.0 | 2 | 8 |
| | | | | | |
| **Record Size (bytes)** | | | | | **331** |

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

## Table 43: Lidar 5 km Layer Descriptor Record: Aerosols – Version 3.x

| 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…1,086.0 | 8 | 32 |
| Midlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 8 | 32 |
| Layer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 8 | 32 |
| Layer_Top_Temperature | Float_32 | 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 | $km^{-1}\cdot sr^{-1}$ | 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 | $km^{-1}\cdot sr^{-1}$ | 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 |
| 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 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| 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 79 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.

## 2.7 Lidar Level 2 Cloud, Aerosol and Merged Layer Products DP 2.1A – Version 4.20

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 and merged layer products are produced at a 5 km horizontal resolution. The merged layer product is a combination of the aerosol and cloud layer products. The cloud, aerosol and merged layer data products are written in Hierarchical Data Format (HDF). Tables 44-48 summarize the content and estimated size of each of the layer products. Five 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, a 5 km resolution aerosol product, and a 5 km resolution merged product.

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

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

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

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

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

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

Data File Name:

| | |
|---|---|
| Standard: | CAL_LID_L2_333mMLay-Standard-Version.Instance.hdf |
| Standard: | CAL_LID_L2_01kmCLay-Standard-Version.Instance.hdf |
| Standard: | CAL_LID_L2_05kmCLay-Standard-Version.Instance.hdf |
| Standard: | CAL_LID_L2_05kmALay-Standard-Version.Instance.hdf |
| Standard: | CAL_LID_L2_05kmMLay-Standard-Version.Instance.hdf |

### 2.7.1 Lidar Level 2 Cloud and Aerosol Layers Record Summary – Version 4.20

**Table 44: 1/3 km Lidar Merged Layer Record Summary – Version 4.20**

| 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 49 | 42,670 | 1 | 42,670 |
| 1/3 km Column Descriptor Record: Merged | Table 53 | 112 | 60,143 | 6,736,016 |
| Lidar Surface Detection Information | Table 51 | 84 | 4,010 | 336,840 |
| 1/3 km Layer Descriptor Record: Merged | Table 54 | 1,010 | 60,143 | 60,744,430 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **67,860,859** |
| **Total Size – Standard (Mbytes)** | | | | **66.27** |

**Table 45: 1 km Lidar Cloud Layer Record Summary – Version 4.20**

| 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 49 | 42,670 | 1 | 42,670 |
| 1 km Column Descriptor Record: Clouds | Table 55 | 112 | 21,210 | 2,375,520 |
| Lidar Surface Detection Information | Table 51 | 84 | 4,010 | 336,840 |
| 1 km Layer Descriptor Record: Clouds | Table 56 | 1,890 | 21,210 | 40,086,900 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **42,842,833** |
| **Total Size – Standard (Mbytes)** | | | | **41.84** |

**Table 46: 5 km Lidar Cloud Layer Record Summary – Version 4.20**

| 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 49 | 42,670 | 1 | 42,670 |
| 5 km Column Descriptor Record: Clouds | Table 57 | 295 | 4,010 | 1,182,950 |
| 5 km Layer Descriptor Record: Clouds | Table 58 | 2,912 | 4,010 | 11,677,120 |
| Single Shot Parameters | Table 50 | 1,193 | 63,630 | 75,910,590 |
| Lidar Surface Detection Information | Table 51 | 84 | 4,010 | 336,840 |
| Single Shot Lidar Surface Detection Information | Table 52 | 80 | 63,630 | 5,090,400 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **94,241,473** |
| **Total Size – Standard (Mbytes)** | | | | **92.03** |

## Table 47: 5 km Lidar Aerosol Layer Record Summary – Version 4.20

| 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 49 | 42,670 | 1 | 42,670 |
| 5 km Column Descriptor Record: Aerosols | Table 59 | 304 | 4,010 | 1,219,040 |
| 5 km Layer Descriptor Record: Aerosols | Table 60 | 2,770 | 4,010 | 11,107,700 |
| Single Shot Parameters | Table 50 | 1,188 | 63,630 | 75,592,440 |
| Lidar Surface Detection Information | Table 51 | 84 | 4,010 | 336,840 |
| Single Shot Lidar Surface Detection Information | Table 52 | 80 | 63,630 | 5,090,400 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **93,414,053** |
| **Total Size – Standard (Mbytes)** | | | | **91.22** |

## Table 48: 5 km Lidar Merged Layer Record Summary – Version 4.20

| 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 49 | 42,670 | 1 | 42,670 |
| 5 km Column Descriptor Record: Merged | Table 61 | 304 | 4,010 | 1,219,040 |
| 5 km Layer Descriptor Record: Merged | Table 62 | 5,355 | 4,010 | 21,473,550 |
| Single Shot Parameters | Table 50 | 1,193 | 63,630 | 75,910,590 |
| Lidar Surface Detection Information | Table 51 | 84 | 4,010 | 336,840 |
| Single Shot Lidar Surface Detection Information | Table 52 | 80 | 63,630 | 5,090,400 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **103,953,693** |
| **Total Size – Standard (Mbytes)** | | | | **101.52** |

### 2.7.2 Lidar Cloud, Aerosol and Merged Level 2 Metadata – Version 4.20

The Lidar Cloud, Aerosol, and Merged 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 49.

**Table 49: Lidar Cloud, Aerosol and Merged Level 2 Layer Metadata Record – Version 4.20**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | 0…63,630 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | 0…63,630 | 1 | 4 |
| Initial_Subsatellite_Latitude | Float_32 | 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…261,231.0 | 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…261,231.0 | 1 | 8 |
| Lidar_L1_Production_Date_Time | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Single_Shot_Records_in_File | Int_32 | NoUnits | 0…63,630 | 1 | 4 |
| Number_of_Average_Records_in_File | Int_32 | NoUnits | 0…21,210 | 1 | 4 |
| Number_of_Features_Found | Int_32 | NoUnits | 0…616,606 | 1 | 4 |
| Number_of_Cloud_Features_Found | Int_32 | NoUnits | 0…572,670 | 1 | 4 |
| Number_of_Aerosol_Features_Found | Int_32 | NoUnits | 0…33,936 | 1 | 4 |
| Number_of_Indeterminate_Features_Found | Int_32 | NoUnits | 0…572,640 | 1 | 4 |
| 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 | NoUnits | 4/2006 – 12/2026 | 1 | 6 |
| Production_Script | Char | N/A | N/A | 40,000 | 40,000 |
| | | | | | |
| **Record Size (bytes)** | | | | | **42,670** |

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 Cloud, Aerosol and Merged Level 2 Shared Parameter Information – Version 4.20

The Lidar Cloud, Aerosol, and Merged Level 2 layer products contain the same parameter information. Single Shot Parameter information within each data product found in Table 50. Table 51 contains Lidar Surface Detection information.

## Table 50: Lidar Cloud, Aerosol and Merged Level 2 Layer Single Shot Parameters – Version 4.20

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Lidar_Surface_Detection | Table | Info | Information | 1 | 80 |
| ssProfile_ID | Int_32 | NoUnits | 1…3,153,600,000 | 2 | 8 |
| ssLatitude | Float_32 | deg | -90.0…90.0 | 3 | 12 |
| ssLongitude | Float_32 | deg | -180.0…180.0 | 3 | 12 |
| ssProfile_Time[C] | Float_64 | sec | 4.204E8…1.072E9 | 3 | 24 |
| ssProfile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261231.0 | 3 | 24 |
| ssParallel_Column_Reflectance_532 | Float_32 | NoUnits | 0.0…2.0 | 1 | 4 |
| ssParallel_Column_Reflectance_Uncertainty_532 | Float_32 | NoUnits | 0.0…TBD | 1 | 4 |
| ssPerpendicular_Column_Reflectance_532 | Float_32 | NoUnits | 0.0…2.0 | 1 | 4 |
| ssPerpendicular_Column_Reflectance_Uncertainty_532 | Float_32 | NoUnits | 0.0…TBD | 1 | 4 |
| ssColumn_Integrated_Attenuated_Backscatter_532 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 1 | 4 |
| ssColumn_IAB_Cumulative_Probability | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| ssDEM_Surface_Elevation | Float_32 | km | -1.0…9.0 | 4 | 16 |
| ssLaser_Energy_532 | Float_32 | Joules | 0.003…0.135 | 1 | 4 |
| ssNumber_Layers_Found | Int_8 | NoUnits | 0…5 | 1 | 1 |
| ssLayer_Top_Altitude | Float_32 | km | -0.5…8.2 | 5 | 20 |
| ssLayer_Base_Altitude | Float_32 | km | -0.5…8.2 | 5 | 20 |
| ssLayer_Top_Pressure | Float_32 | hPa | 1.0…1,086.0 | 5 | 20 |
| ssMidlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 5 | 20 |
| ssLayer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 5 | 20 |
| ssLayer_Top_Temperature | Float_32 | ºC | -110.0…60.0 | 5 | 20 |
| ssLayer_Centroid_Temperature | Float_32 | ºC | -110.0…60.0 | 5 | 20 |
| ssMidlayer_Temperature | Float_32 | ºC | -110.0…60.0 | 5 | 20 |
| ssLayer_Base_Temperature | Float_32 | ºC | -110.0…60.0 | 5 | 20 |
| ssOpacity_Flag | Int_8 | NoUnits | 0…1 | 5 | 5 |
| ssAttenuated_Scattering_Ratio_Statistics_532 | Float_32 | NoUnits | N/A | 30 | 120 |
| ssAttenuated_Backscatter_Statistics_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | N/A | 30 | 120 |
| ssIntegrated_Attenuated_Backscatter_532 | Float_32 | $sr^{-1}$ | 0.0…1.8 | 5 | 20 |
| ssIntegrated_Attenuated_Backscatter_Uncertainty_532 | Float_32 | $sr^{-1}$ | 0.0…0.5 | 5 | 20 |
| ssAttenuated_Backscatter_Statistics_1064 | Float_32 | $km^{-1}\cdot sr^{-1}$ | N/A | 30 | 120 |
| ssIntegrated_Attenuated_Backscatter_1064 | Float_32 | $sr^{-1}$ | 0.0…1.8 | 5 | 20 |
| ssIntegrated_Attenuated_Backscatter_Uncertainty_1064 | Float_32 | $sr^{-1}$ | 0.0…0.5 | 5 | 20 |
| ssVolume_Depolarization_Ratio_Statistics | Float_32 | NoUnits | N/A | 30 | 120 |
| ssIntegrated_Volume_Depolarization_Ratio | Float_32 | NoUnits | 0.0…1.0 | 5 | 20 |
| ssIntegrated_Volume_Depolarization_Ratio_Uncertainty | Float_32 | NoUnits | 0.0…2.0 | 5 | 20 |
| ssAttenuated_Total_Color_Ratio_Statistics | Float_32 | NoUnits | N/A | 30 | 120 |
| ssIntegrated_Attenuated_Total_Color_Ratio | Float_32 | NoUnits | 0.0…2.0 | 5 | 20 |
| ssIntegrated_Attenuated_Total_Color_Ratio_Uncertainty | Float_32 | NoUnits | 0.0…3.0 | 5 | 20 |
| ssOverlying_Integrated_Attenuated_Backscatter_532 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 5 | 20 |
| ssLayer_IAB_QA_Factor | Float_32 | NoUnits | 0.0…1.0 | 5 | 20 |
| ssCAD_Score | Int_8 | NoUnits | -101…106 | 5 | 8 |
| ssInitial_CAD_Score[R] | Int_8 | NoUnits | -101…119 | 5 | 5 |
| ssFeature_Classification_Flags[W] | UInt_16 | NoUnits | 1…49,146 | 5 | 10 |
| ssWas_Cleared | Int_8 | NoUnits | 0…1 | 5 | 5 |
| | | | | | |
| | | | | | |
| **Record Size (bytes)** | | | | | **1,193** |

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
R) ssInitial_CAD_Score is excluded from the 5 km Aerosol Layer Product.

W) ssFeature_Classification_Flags appears above ssCAD_Score in the data product, 05kmCLay Version 4.20.

## Table 51: Lidar Surface Detection Information – Version 4.20

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Surface_Top_Altitude_532 | Float_32 | km | -0.5…8.2 | 1 | 4 |
| Surface_Base_Altitude_532 | Float_32 | km | -0.5…8.2 | 1 | 4 |
| Surface_Integrated_Attenuated_Backscatter_532 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 1 | 4 |
| Surface_532_Integrated_Depolarization_Ratio | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Surface_532_Integrated_Attenuated_Color_Ratio | Float_32 | NoUnits | 0.0…2.0 | 1 | 4 |
| Surface_Detection_Flags_532 | UInt_16 | NoUnits | 0…8,192 | 1 | 2 |
| Surface_Detection_Confidence_532 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Surface_Overlying_Integrated_Attenuated_Backscatter_532 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 1 | 4 |
| Surface_Scaled_RMS_Background_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…0.05 | 1 | 4 |
| Surface_Peak_Signal_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.5 | 1 | 4 |
| Surface_Detections_333m_532[S U] | Int_16 | NoUnits | 0…15 | 1 | 2 |
| Surface_Detections_1km_532[T U] | Int_16 | NoUnits | 0…5 | 1 | 2 |
| Surface_Top_Altitude_1064 | Float_32 | km | -0.5…8.2 | 1 | 4 |
| Surface_Base_Altitude_1064 | Float_32 | km | -0.5…8.2 | 1 | 4 |
| Surface_Integrated_Attenuated_Backscatter_1064 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 1 | 4 |
| Surface_1064_Integrated_Depolarization_Ratio | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Surface_1064_Integrated_Attenuated_Color_Ratio | Float_32 | NoUnits | 0.0…2.0 | 1 | 4 |
| Surface_Detection_Flags_1064 | UInt_16 | NoUnits | 0…16,384 | 1 | 2 |
| Surface_Detection_Confidence_1064 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Surface_Overlying_Integrated_Attenuated_Backscatter_1064 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 1 | 4 |
| Surface_Scaled_RMS_Background_1064 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…0.05 | 1 | 4 |
| Surface_Peak_Signal_1064 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.5 | 1 | 4 |
| Surface_Detections_333m_1064[S U] | Int_16 | NoUnits | 0…15 | 1 | 2 |
| Surface_Detections_1km_1064[T U] | Int_16 | NoUnits | 0…5 | 1 | 2 |
| | | | | | |
| **Record Size (bytes)** | | | | | **84** |

S) included in the 1 km and 5 km resolution products only
T) included in the 5 km resolution products only
U) not included in the 333 m merged layer product

## Table 52: Single Shot Lidar Surface Detection Information – Version 4.20

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| ssSurface_Top_Altitude_532 | Float_32 | km | -0.5…8.2 | 1 | 4 |
| ssSurface_Base_Altitude_532 | Float_32 | km | -0.5…8.2 | 1 | 4 |
| ssSurface_Integrated_Attenuated_Backscatter_532 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 1 | 4 |
| ssSurface_532_Integrated_Depolarization_Ratio | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| ssSurface_532_Integrated_Attenuated_Color_Ratio | Float_32 | NoUnits | 0.0…2.0 | 1 | 4 |
| ssSurface_Detection_Flags_532 | UInt_16 | NoUnits | 1…8,192 | 1 | 2 |
| ssSurface_Detection_Confidence_532 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| ssSurface_Overlying_Integrated_Attenuated_Backscatter_532 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 1 | 4 |
| ssSurface_Scaled_RMS_Background_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…0.05 | 1 | 4 |
| ssSurface_Peak_Signal_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…3.5 | 1 | 4 |
| ssSurface_Top_Altitude_1064 | Float_32 | km | -0.5…8.2 | 1 | 4 |
| ssSurface_Base_Altitude_1064 | Float_32 | km | -0.5…8.2 | 1 | 4 |
| ssSurface_Integrated_Attenuated_Backscatter_1064 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 1 | 4 |
| ssSurface_1064_Integrated_Depolarization_Ratio | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| ssSurface_1064_Integrated_Attenuated_Color_Ratio | Float_32 | NoUnits | 0.0…2.0 | 1 | 4 |
| ssSurface_Detection_Flags_1064 | UInt_16 | NoUnits | 1…16,384 | 1 | 2 |
| ssSurface_Detection_Confidence_1064 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| ssSurface_Overlying_Integrated_Attenuated_Backscatter_1064 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 1 | 4 |
| ssSurface_Scaled_RMS_Background_1064 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…0.05 | 1 | 4 |
| ssSurface_Peak_Signal_1064 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…3.5 | 1 | 4 |
| | | | | | |
| **Record Size (bytes)** | | | | | **80** |

### 2.7.4 Lidar Cloud, Aerosol and Merged Level 2 Scientific Data Sets – Version 4.20

Table 53 through Table 62 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 54, Table 56, and Table 58, and Table 60. 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 54, $km^{-1} \cdot sr^{-1}$.

## Table 53: Lidar 1/3 km Column Descriptor Record: Merged – Version 4.20

| 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…1.072E9 | 1 | 8 |
| Profile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261,231.0 | 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 |
| Laser_Energy_532 | Float_32 | joules | 0.003…0.135 | 1 | 4 |
| 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 |
| Snow_Ice_Surface_Type | UInt_8 | NoUnits | 0…255 | 1 | 1 |
| DEM_Surface_Elevation | Float_32 | km | -1.0…9.0 | 1 | 4 |
| Number_Layers_Found | Int_8 | NoUnits | 0…5 | 1 | 1 |
| | | | | | |
| **Record Size (bytes)** | | | | | **112** |

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

## Table 54: Lidar 1/3 km Layer Descriptor Record: Merged – Version 4.20

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Layer_Top_Altitude | Float_32 | km | -0.5…8.2 | 5 | 20 |
| Layer_Base_Altitude | Float_32 | km | -0.5…8.2 | 5 | 20 |
| Layer_Top_Pressure | Float_32 | hPa | 1.0…1,086.0 | 5 | 20 |
| Midlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 5 | 20 |
| Layer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 5 | 20 |
| Layer_Top_Temperature | Float_32 | ºC | -110.0…60.0 | 5 | 20 |
| Layer_Centroid_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 |
| Opacity_Flag | Int_8 | NoUnits | 0…1 | 5 | 5 |
| Attenuated_Scattering_Ratio_Statistics_532 | Float_32 | NoUnits | N/A | 30 | 120 |
| Attenuated_Backscatter_Statistics_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 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 | $km^{-1} \cdot sr^{-1}$ | 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 |
| CAD_Score | Int_8 | NoUnits | -101…106 | 5 | 5 |
| Initial_CAD_Score | Int_8 | NoUnits | -101…119 | 5 | 5 |
| Was_Cleared | Int_8 | NoUnits | 0…1 | 5 | 5 |
| | | | | | |
| **Record Size (bytes)** | | | | | **1,010** |

J) Refer to Table 84 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 55: Lidar 1 km Column Descriptor Record: Clouds – Version 4.20

| 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…1.072E9 | 1 | 8 |
| Profile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261,231.0 | 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 |
| Snow_Ice_Surface_Type | UInt_8 | NoUnits | 0…255 | 1 | 1 |
| DEM_Surface_Elevation | Float_32 | km | -1.0…9.0 | 1 | 4 |
| Minimum_Laser_Energy_532 | Float_32 | joules | 0.003…0.135 | 1 | 4 |
| Number_Layers_Found | Int_8 | NoUnits | 0…10 | 1 | 1 |
| | | | | | |
| **Record Size (bytes)** | | | | | **112** |

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

## Table 56: Lidar 1 km Layer Descriptor Record: Clouds – Version 4.20

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Layer_Top_Altitude | Float_32 | km | -0.5…20.2 | 10 | 40 |
| Layer_Base_Altitude | Float_32 | km | -0.5…20.2 | 10 | 40 |
| Layer_Top_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 20 |
| Midlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 20 |
| Layer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 20 |
| Layer_Top_Temperature | Float_32 | ºC | -110.0…60.0 | 10 | 20 |
| Layer_Centroid_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 |
| Opacity_Flag | Int_8 | NoUnits | 0…1 | 10 | 10 |
| Attenuated_Scattering_Ratio_Statistics_532 | Float_32 | NoUnits | N/A | 60 | 240 |
| Attenuated_Backscatter_Statistics_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | N/A | 60 | 240 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| 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 | $km^{-1} \cdot sr^{-1}$ | 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 |
| CAD_Score | Int_8 | NoUnits | -101…106 | 10 | 10 |
| Initial_CAD_Score | Int_8 | NoUnits | -101…119 | 10 | 10 |
| Feature_Classification_Flags[J] | UInt_16 | NoUnits | 1…49,146 | 10 | 20 |
| | | | | | |
| **Record Size (bytes)** | | | | | **1,890** |

J) Refer to Table 84 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 57: Lidar 5 km Column Descriptor Record: Clouds – Version 4.20

| 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…1.072E9 | 3 | 24 |
| Profile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261,231.0 | 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[V] | 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…25.0[M] | 1 | 4 |
| Column_Optical_Depth_Cloud_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_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 |
| Snow_Ice_Surface_Type | UInt_8 | NoUnits | 0…255 | 1 | 1 |
| DEM_Surface_Elevation | Float_32 | km | -1.0…9.0 | 4 | 16 |
| Minimum_Laser_Energy_532 | Float_32 | joules | 0.003…0.135 | 1 | 4 |
| Normalization_Constant_Uncertainty | Float_32 | NoUnits | 0.0…1.0 | 2 | 8 |
| FeatureFinderQC | UInt_16 | NoUnits | 0…32,767 | 1 | 2 |
| High_Resolution_Layers_Cleared | UInt_16 | NoUnits | 0…32,767 | 1 | 2 |
| Calibration_Altitude_532 | Float_32 | km | 0.0…40.0 | 2 | 8 |
| Number_Layers_Found | Int_8 | NoUnits | 0…10 | 1 | 1 |
| | | | | | |
| **Record Size (bytes)** | | | | | **295** |

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

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

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.

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

## Table 58: Lidar 5 km Layer Descriptor Record: Clouds – Version 4.20

| 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 | 0…49,146 | 10 | 20 |
| Layer_Top_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 40 |
| Midlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 40 |
| Layer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 10 | 40 |
| Layer_Top_Temperature | Float_32 | ºC | -110.0…60.0 | 10 | 40 |
| Layer_Centroid_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_Scattering_Ratio_Statistics_532 | Float_32 | NoUnits | N/A | 60 | 240 |
| Attenuated_Backscatter_Statistics_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 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 | $km^{-1}\cdot sr^{-1}$ | 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 | 32 |
| CAD_Score | Int_8 | NoUnits | -101…106 | 10 | 10 |
| Initial_CAD_Score | Int_8 | NoUnits | -101…119 | 10 | 10 |
| Measured_Two_Way_Transmittance_532 | Float_32 | NoUnits | 0.0…1.0 | 10 | 40 |
| Measured_Two_Way_Transmittance_Uncertainty_532 | Float_32 | NoUnits | 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 |
| Final_532_Lidar_Ratio_Uncertainty | Float_32 | sr | 0.0…TBD | 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 | 0.01…1.0 | 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…99.99 | 10 | 40 |
| Particulate_Depolarization_Ratio_Statistics | Float_32 | NoUnits | N/A | 60 | 240 |
| 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)** | | | | | **2,912** |

J) Refer to Table 84 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.

## Table 59: Lidar 5 km Column Descriptor Record: Aerosols – Version 4.20

| 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…1.072E9 | 3 | 24 |
| Profile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261231.0 | 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[V] | 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…25.0[M] | 1 | 4 |
| Column_Optical_Depth_Cloud_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_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 |
| Snow_Ice_Surface_Type | UInt_8 | NoUnits | 0…255 | 1 | 1 |
| DEM_Surface_Elevation | Float_32 | km | -1.0…9.0 | 4 | 16 |
| Minimum_Laser_Energy_532 | Float_32 | joules | 0.003…0.135 | 1 | 4 |
| Normalization_Constant_Uncertainty | Float_32 | NoUnits | 0.0…1.0 | 2 | 8 |
| Calibration_Altitude_532 | Float_32 | km | 0.0…40.0 | 2 | 8 |
| FeatureFinderQC | UInt_16 | NoUnits | 0…32,767 | 1 | 2 |
| High_Resolution_Layers_Cleared | UInt_16 | NoUnits | 0…32,767 | 1 | 2 |
| Number_Layers_Found | Int_8 | NoUnits | 0…8 | 1 | 1 |
| Surface_Wind_Speed | Float_32 | $m \cdot s^{-1}$ | -80.0…80.0 | 2 | 8 |
| | | | | | |
| **Record Size (bytes)** | | | | | **304** |

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

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

## Table 60: Lidar 5 km Layer Descriptor Record: Aerosols – Version 4.20

| 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 | 0…49,146 | 8 | 16 |
| Layer_Top_Pressure | Float_32 | hPa | 1.0…1,086.0 | 8 | 32 |
| Midlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 8 | 32 |
| Layer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 8 | 32 |
| Layer_Top_Temperature | Float_32 | 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_Scattering_Ratio_Statistics_532 | Float_32 | NoUnits | N/A | 48 | 192 |
| Attenuated_Backscatter_Statistics_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 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 | $km^{-1}\cdot sr^{-1}$ | 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…32,768 | 8 | 32 |
| ExtinctionQC_1064 | UInt_16 | NoUnits | 0…32,768 | 8 | 32 |
| CAD_Score | Int_8 | NoUnits | -101…106 | 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 |
| Final_532_Lidar_Ratio_Uncertainty | Float_32 | sr | 0.0…TBD | 10 | 40 |
| 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 |
| Initial_1064_Lidar_Ratio | Float_32 | sr | 30.0…55.0 | 8 | 32 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Final_1064_Lidar_Ratio | Float_32 | sr | 0.0…250.0 | 8 | 32 |
| Final_1064_Lidar_Ratio_Uncertainty | Float_32 | sr | 0.0…TBD | 10 | 40 |
| 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 | NoUnits | 0.0…1.5 | 8 | 32 |
| Single_Shot_Cloud_Cleared_Fraction | Float_32 | NoUnits | 0.0…1.0 | 8 | 32 |
| | | | | | |
| **Record Size (bytes)** | | | | | **2,776** |

J) Refer to Table 84 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 61: Lidar 5 km Column Descriptor Record: Merged – Version 4.20

| 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…1.072E9 | 3 | 24 |
| Profile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261231.0 | 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[V] | 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…25.0[M] | 1 | 4 |
| Column_Optical_Depth_Cloud_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_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 |
| Snow_Ice_Surface_Type | UInt_8 | NoUnits | 0…255 | 1 | 1 |
| DEM_Surface_Elevation | Float_32 | km | -1.0…9.0 | 4 | 16 |
| Minimum_Laser_Energy_532 | Float_32 | joules | 0.003…0.135 | 1 | 4 |
| Normalization_Constant_Uncertainty | Float_32 | NoUnits | 0.0…1.0 | 2 | 8 |
| Calibration_Altitude_532 | Float_32 | km | 0.0…40.0 | 2 | 8 |
| FeatureFinderQC | UInt_16 | NoUnits | 0…32,767 | 1 | 2 |
| High_Resolution_Layers_Cleared | UInt_16 | NoUnits | 0…32,767 | 1 | 2 |
| Number_Layers_Found | Int_8 | NoUnits | 0…15 | 1 | 1 |
| Surface_Wind_Speed | Float_32 | $m \cdot s^{-1}$ | -80.0…80.0 | 2 | 8 |
| | | | | | |
| **Record Size (bytes)** | | | | | **304** |

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

## Table 62: Lidar 5 km Layer Descriptor Record: Merged – Version 4.20

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Layer_Top_Altitude | Float_32 | km | -0.5…30.1 | 15 | 60 |
| Layer_Base_Altitude | Float_32 | km | -0.5…30.1 | 15 | 60 |
| Layer_Base_Extended | UInt_16 | NoUnits | 0…49,146 | 15 | 30 |
| Layer_Top_Pressure | Float_32 | hPa | 1.0…1,086.0 | 15 | 60 |
| Midlayer_Pressure | Float_32 | hPa | 1.0…1,086.0 | 15 | 60 |
| Layer_Base_Pressure | Float_32 | hPa | 1.0…1,086.0 | 15 | 60 |
| Layer_Top_Temperature | Float_32 | ºC | -110.0…60.0 | 15 | 60 |
| Layer_Centroid_Temperature | Float_32 | ºC | -110.0…60.0 | 15 | 60 |
| Midlayer_Temperature | Float_32 | ºC | -110.0…60.0 | 15 | 60 |
| Layer_Base_Temperature | Float_32 | ºC | -110.0…60.0 | 15 | 60 |
| Opacity_Flag | Int_8 | NoUnits | 0…1 | 15 | 15 |
| Horizontal_Averaging | Int_8 | km | 5…80 | 15 | 15 |
| Attenuated_Scattering_Ratio_Statistics_532 | Float_32 | NoUnits | N/A | 90 | 360 |
| Attenuated_Backscatter_Statistics_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | N/A | 90 | 360 |
| Integrated_Attenuated_Backscatter_532 | Float_32 | $sr^{-1}$ | 0.0…1.8 | 15 | 60 |
| Integrated_Attenuated_Backscatter_Uncertainty_532 | Float_32 | $sr^{-1}$ | 0.0…0.5 | 15 | 60 |
| Attenuated_Backscatter_Statistics_1064 | Float_32 | $km^{-1} \cdot sr^{-1}$ | N/A | 90 | 360 |
| Integrated_Attenuated_Backscatter_1064 | Float_32 | $sr^{-1}$ | 0.0…1.8 | 15 | 60 |
| Integrated_Attenuated_Backscatter_Uncertainty_1064 | Float_32 | $sr^{-1}$ | 0.0…0.5 | 15 | 60 |
| Volume_Depolarization_Ratio_Statistics | Float_32 | NoUnits | N/A | 90 | 360 |
| Integrated_Volume_Depolarization_Ratio [L] | Float_32 | NoUnits | 0.0…1.0 | 15 | 60 |
| Integrated_Volume_Depolarization_Ratio_Uncertainty | Float_32 | NoUnits | 0.0…2.0 | 15 | 60 |
| Attenuated_Total_Color_Ratio_Statistics | Float_32 | NoUnits | N/A | 90 | 360 |
| Integrated_Attenuated_Total_Color_Ratio [L] | Float_32 | NoUnits | 0.0…2.0 | 15 | 60 |
| Integrated_Attenuated_Total_Color_Ratio_Uncertainty | Float_32 | NoUnits | 0.0…3.0 | 15 | 60 |
| Overlying_Integrated_Attenuated_Backscatter_532 | Float_32 | $sr^{-1}$ | 0.0…2.0 | 15 | 60 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Layer_IAB_QA_Factor | Float_32 | NoUnits | 0.0…1.0 | 15 | 60 |
| Feature_Classification_Flags[J] | UInt_16 | NoUnits | 1…49,146 | 15 | 30 |
| Layer_Type | Int_8 | NoUnits | 2…4 | 15 | 15 |
| ExtinctionQC_532 | UInt_16 | NoUnits | 0…32,768 | 15 | 30 |
| ExtinctionQC_1064 | UInt_16 | NoUnits | 0…32,768 | 15 | 30 |
| CAD_Score | Int_8 | NoUnits | -101…106 | 15 | 15 |
| Initial_CAD_Score | Int_8 | NoUnits | -101…119 | 15 | 15 |
| Measured_Two_Way_Transmittance_532 | Float_32 | NoUnits | 0.0…1.0[K] | 15 | 60 |
| Measured_Two_Way_Transmittance_Uncertainty_532 | Float_32 | NoUnits | 0.0…TBD | 15 | 60 |
| Two_Way_Transmittance_Measurement_Region | Float_32 | km | 0.0…30.0 | 30 | 120 |
| Feature_Optical_Depth_532 | Float_32 | NoUnits | 0.0…3.0 | 15 | 60 |
| Feature_Optical_Depth_Uncertainty_532 | Float_32 | NoUnits | 0.0…TBD | 15 | 60 |
| Initial_532_Lidar_Ratio | Float_32 | sr | Aerosol: 20.0…70.0<br>Cloud: 19.0…25.0 | 15 | 60 |
| Final_532_Lidar_Ratio | Float_32 | sr | Aerosol: 0.0…250.0<br>Cloud: 0.0…250.0 | 15 | 60 |
| Final_532_Lidar_Ratio_Uncertainty | Float_32 | sr | 0.0…TBD | 15 | 60 |
| Lidar_Ratio_532_Selection_Method | Int_8 | NoUnits | 0…5 | 15 | 15 |
| Layer_Effective_532_Multiple_Scattering_Factor | Float_32 | NoUnits | Aerosol: 1.0<br>Cloud: 0.01…1.0 | 15 | 60 |
| Integrated_Particulate_Depolarization_Ratio | Float_32 | NoUnits | 0.0…1.0 | 15 | 60 |
| Integrated_Particulate_Depolarization_Ratio_Uncertainty | Float_32 | NoUnits | 0.0…99.99 | 15 | 60 |
| Particulate_Depolarization_Ratio_Statistics | Float_32 | NoUnits | N/A | 90 | 360 |
| Feature_Optical_Depth_1064 | Float_32 | NoUnits | Aerosol: 0.0…3.0 | 15 | 60 |
| Feature_Optical_Depth_Uncertainty_1064 | Float_32 | NoUnits | Aerosol: 0.0…TBD | 15 | 60 |
| Initial_1064_Lidar_Ratio | Float_32 | sr | Aerosol: 30.0…55.0 | 15 | 60 |
| Final_1064_Lidar_Ratio | Float_32 | sr | Aerosol: 0.0…250.0 | 15 | 60 |
| Final_1064_Lidar_Ratio_Uncertainty | Float_32 | sr | Aerosol: 0.0…TBD | 15 | 60 |
| Lidar_Ratio_1064_Selection_Method | Int_8 | NoUnits | Aerosol: 0…5 | 15 | 15 |
| Layer_Effective_1064_Multiple_Scattering_Factor | Float_32 | NoUnits | Aerosol: 1.0 | 15 | 60 |
| Integrated_Particulate_Color_Ratio | Float_32 | NoUnits | Aerosol: 0.0…4.0 | 15 | 60 |
| Integrated_Particulate_Color_Ratio_Uncertainty | Float_32 | NoUnits | Aerosol: 0.0…1.0 | 15 | 60 |
| Particulate_Color_Ratio_Statistics | Float_32 | NoUnits | Aerosol: N/A | 90 | 360 |
| Relative_Humidity | Float_32 | NoUnits | 0.0…1.5 | 15 | 60 |
| Single_Shot_Cloud_Cleared_Fraction | Float_32 | NoUnits | Aerosol: 0.0…1.0 | 15 | 60 |
| Ice_Water_Path | Float_32 | $g/m^2$ | Cloud: 0.0…200.0 | 15 | 60 |
| Ice_Water_Path_Uncertainty | Float_32 | $g/m^2$ | Cloud: 0.0…99.99 | 15 | 60 |
| | | | | | |
| **Record Size (bytes)** | | | | | **5,325** |

J) Refer to Table 84 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.

## 2.8 Lidar Level 2 Aerosol Profile Data Product DP 2.1B – Version 3.x

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 63.

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** |

### 2.8.1 Lidar Level 2 Aerosol Profile Data Summary – Version 3.x

**Table 63: Lidar Level 2 Aerosol Profile Data Record Summary – Version 3.x**

| 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 64 | 22,062 | 1 | 22,062 |
| Lidar 5 km Aerosol Profile Record, CALIPSO Lidar Ratio (Standard data product) | Table 65 | 36,067 | Standard: 4,242<br>Expedited: 7,264 | 152,996,214<br>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** |

### 2.8.2 Lidar Aerosol Profile Data Metadata – Version 3.x

The Lidar Aerosol Profile Data products include three Vdata record types (i.e., metadata), as specified in Table 64. 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 64.

**Table 64: Lidar Level 2 Aerosol Profile Metadata Record – Version 3.x**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | Std = 0…4,242<br>Exp = 0…7,264 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | Std = 0…4,242<br>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… 261,231.0 | 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…261,231.0 | 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 | $m^2 \cdot sr^{-1}$ | 5.930E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_1064 | Float_32 | $m^2 \cdot sr^{-1}$ | 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 | NoUnits | 4/2006 – 12/2026 | 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 | NoUnits | 4/2006 – 12/2026 | 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

### 2.8.3 Lidar Aerosol Profile Data Scientific Data Sets –Version 3.x

Table 65 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 65: Lidar 5 km Aerosol Profile Record – Version 3.x**

| 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…1,086.0 | 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 | $m{\cdot}s^{-1}$ | -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 | $sr^{-1}{\cdot}km^{-1}$ | 0.0…0.05 | 399 | 1,596 |
| Total_Backscatter_Coefficient_Uncertainty_532 | Float_32 | $sr^{-1}{\cdot}km^{-1}$ | 0.0…99.99 | 399 | 1,596 |
| Perpendicular_Backscatter_Coefficient_532 | Float_32 | $sr^{-1}{\cdot}km^{-1}$ | 0.0…0.01 | 399 | 1,596 |
| Perpendicular_Backscatter_Coefficient_Uncertainty_532 | Float_32 | $sr^{-1}{\cdot}km^{-1}$ | 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 | $sr^{-1}{\cdot}km^{-1}$ | 0.0…0.03 | 399 | 1,596 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Backscatter_Coefficient_Uncertainty_1064 | Float_32 | $sr^{-1} \cdot km^{-1}$ | 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

## 2.9 Lidar Level 2 Aerosol Profile Data Product DP 2.1B – Version 4.20

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 66.

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 |
| Spatial Resolution Record: | Standard: | 60 m vertical resolution x 5 km |
| Time Interval Covered: | Standard: | Half Orbit (Day or Night) |

Data File Name:

Standard: CAL_LID_L2_5kmAPro-Standard-Version.Instance.hdf

**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** |

### 2.9.1 Lidar Level 2 Aerosol Profile Data Summary – Version 4.20

**Table 66: Lidar Level 2 Aerosol Profile Data Record Summary – Version 4.20**

| 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 67 | 42,062 | 1 | 42,062 |
| Lidar Surface Detection Information | Table 51 | 84 | 4,010 | 336,840 |
| Lidar 5 km Aerosol Profile Record | Table 68 | 34,548 | 4,242 | 146,552,616 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **146,932,421** |
| **Total Size – Standard (Mbytes)** | | | | **143.49** |

### 2.9.2 Lidar Level 2 Aerosol Profile Data Metadata – Version 4.20

The Lidar Level 2 Aerosol Profile Data products include three Vdata record types (i.e., metadata), as specified in Table 67. 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 67.

**Table 67: Lidar Level 2 Aerosol Profile Metadata Record – Version 4.20**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | 0…4,242 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | 0…4,242 | 1 | 4 |
| Initial_Subsatellite_Latitude | Float_32 | 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…261,231.0 | 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…261,231.0 | 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 | $m^2 \cdot sr^{-1}$ | 5.930E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_1064 | Float_32 | $m^2 \cdot sr^{-1}$ | 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 | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Lidar_Data_Altitudes | Float_32 | km | -0.5…30.0 | 399 | 1596 |
| Initial_Lidar_Ratio_Tropospheric_Aerosols_532 | Float_32 | sr | 20.0…70.0 | 8 | 32 |
| Initial_Lidar_Ratio_Stratospheric_Aerosols_532 | Float_32 | sr | 44.0…70.0 | 8 | 32 |
| Initial_Lidar_Ratio_Tropospheric_Aerosols_1064 | Float_32 | sr | 30.0…55.0 | 8 | 32 |
| Initial_Lidar_Ratio_Stratospheric_Aerosols_1064 | Float_32 | sr | 25.0…50.0 | 8 | 32 |
| GEOS_Version | Char | NoUnits | N/A | 64 | 64 |
| Classifier_Coefficients_Version_Number | Char | NoUnits | 0.0…99.9 | 1 | 4 |
| Classifier_Coefficients_Version_Date | Char | NoUnits | 4/2006 – 12/2026 | 1 | 6 |
| Production_Script | Char | NoUnits | N/A | 40,000 | 40,000 |
| | | | | | |
| **Record Size (bytes)** | | | | | **42,062** |

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

### 2.9.3 Lidar Level 2 Aerosol Profile Data Scientific Data Sets – Version 4.20

Table 68 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 68: Lidar Level 2 5 km Aerosol Profile Record – Version 4.20**

| 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…1.072E9 | 3 | 24 |
| Profile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261231.0 | 3 | 24 |
| Day_Night_Flag | Int_8 | NoUnits | 0…1 | 1 | 1 |
| Minimum_Laser_Energy_532 | Float_32 | joules | 0.003…0.135 | 1 | 4 |
| Column_Optical_Depth_Cloud_532 | Float_32 | NoUnits | 0.0…25.0[M] | 1 | 4 |
| Column_Optical_Depth_Cloud_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_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…1,086.0 | 399 | 1,596 |
| Molecular_Number_Density | Float_32 | $m^{-3}$ | $8x10^{22}…5x10^{25}$ | 399 | 1,596 |
| Ozone_Number_Density | Float_32 | $m^{-3}$ | $9x10^{16}…1x10^{19}$ | 399 | 1,596 |
| Relative_Humidity | Float_32 | NoUnits | 0.0…1.5 | 399 | 1,596 |
| IGBP_Surface_Type | Int_8 | NoUnits | 1…18 | 1 | 1 |
| Surface_Elevation_Statistics | Float_32 | km | -1.0…9.0 | 4 | 16 |
| Surface_Winds | Float_32 | $m \cdot s^{-1}$ | -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[X] | UInt_16 | NoUnits | 1…57,338 | 399x2 | 1,596 |
| Extinction_QC_Flag_532 | UInt_16 | NoUnits | 0…32,768 | 399x2 | 32 |
| Extinction_QC_Flag_1064 | UInt_16 | NoUnits | 0…32,768 | 399x2 | 32 |
| CAD_Score | Int_8 | NoUnits | -101…106 | 399x2 | 798 |
| Total_Backscatter_Coefficient_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…0.05 | 399 | 1,596 |
| Total_Backscatter_Coefficient_Uncertainty_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…99.99 | 399 | 1,596 |
| Perpendicular_Backscatter_Coefficient_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…0.01 | 399 | 1,596 |
| Perpendicular_Backscatter_Coefficient_Uncertainty_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 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 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| 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 | $km^{-1} \cdot sr^{-1}$ | 0.0…0.03 | 399 | 1,596 |
| Backscatter_Coefficient_Uncertainty_1064 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 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)** | | | | | **34,548** |

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
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.
X) Refer to Table 69 for a detailed description of this parameter.

Table 69 is the definition of the Atmospheric Volume Description which is a profile descriptive flag containing the Feature Classification Flags associated with each 5 km x 60 m (or 5 km x 180 m) range bin in the Profile Products. Note that the interpretation of final three bits in the atmospheric volume description (i.e., the averaging required for detection) is slightly different from the interpretation that would be used for the feature classification flags.

**Table 69: Atmospheric_Volume_Description Definition**

| Bit(s) | Field Description | Bit Interpretation |
|---|---|---|
| 1-3 | Feature Type | 0 = invalid (bad or missing data)<br>1 = “clear air”<br>2 = cloud<br>3 = tropospheric aerosol<br>4 = stratospheric aerosol<br>5 = surface<br>6 = subsurface<br>7 = no signal (totally attenuated) |
| 4-5 | Feature Type QA | 0 = none<br>1 = low<br>2 = medium<br>3 = high |
| 6-7 | Ice/Water Phase | 0 = unknown/not determined<br>1 = ice<br>2 = water<br>3 = oriented ice crystals |
| 8-9 | Ice/Water Phase QA | 0 = none<br>1 = low<br>2 = medium<br>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<br>1 = clean marine<br>2 = dust<br>3 = polluted continental/smoke<br>4 = clean continental<br>5 = polluted dust<br>6 = elevated smoke<br>7 = dusty marine |
| | If feature type = cloud, bits 10-12 will specify the cloud type. | 0 = low overcast, transparent<br>1 = low overcast, opaque<br>2 = transition stratocumulus<br>3 = low, broken cumulus<br>4 = altocumulus (transparent)<br>5 = altostratus (opaque)<br>6 = cirrus (transparent)<br>7 = deep convective (opaque) |
| | If feature type = Stratospheric Aerosol, bits 10-12 will specify the stratospheric aerosol type. | 0 = invalid<br>1 = PSC aerosol<br>2 = volcanic ash<br>3 = sulfate/other<br>4 = elevated smoke<br>5 = spare<br>6 = spare<br>7 = spare |
| 13 | Cloud/Aerosol/PSC Type QA | 0 = not confident<br>1 = confident |
| 14-16 | Horizontal averaging required for detection (provides a coarse measure of feature backscatter intensity) | 0 = not applicable<br>1 = 5 km<br>2 = 20 km<br>3 = 80 km<br>4 = 5 km w/ subgrid feature detected at 1/3 km<br>5 = 20 km w/ subgrid feature detected at 1/3 km<br>6 = 80 km w/ subgrid feature detected at 1/3 km<br>7 = spare |

## 2.10 Lidar Level 2 Cloud Profile Data Product DP 2.1C – Version 3.x

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 70.

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** |

### 2.10.1 Lidar Level 2 Cloud Profile Data Record Summary – Version 3.x

**Table 70: Lidar Level 2 Cloud Profile Data Record Summary – Version 3.x**

| 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 71 | 21,726 | 1 | 21,726 |
| Lidar 5 km Cloud Profile Record | Table 72 | 25,687 | Standard: 4,242<br>Expedited: 7,264 | 108,964,254<br>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** |

### 2.10.2 Lidar Level 2 Cloud Profile Data Metadata – Version 3.x

Lidar Cloud Profile Data Products include three Vdata record types (i.e., metadata), as specified in Table 71. 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 71.

**Table 71: Lidar Level 2 Cloud Profile Metadata Record – Version 3.x**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | Std = 0…4,242<br>Exp = 0…7,264 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | Std = 0…4,242<br>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…261,231.0 | 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…261,231.0 | 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 | $m^2 \cdot sr^{-1}$ | 5.930E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_1064 | Float_32 | $m^2 \cdot sr^{-1}$ | 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 | NoUnits | 4/2006 – 12/2026 | 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 | NoUnits | 4/2006 – 12/2026 | 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

### 2.10.3 Lidar Level 2 Cloud Profile Scientific Data Sets – Version 3.x

Table 72 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 72: Lidar Level 2 5 km Cloud Profile Record – Version 3.x**

| 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_Tropospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_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 | $m \cdot s^{-1}$ | -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 | $sr^{-1} \cdot km^{-1}$ | 0.0…1.5 | 345 | 1,380 |
| Total_Backscatter_Coefficient_Uncertainty_532 | Float_32 | $sr^{-1} \cdot km^{-1}$ | 0.0…99.99 | 345 | 1,380 |
| Perpendicular_Backscatter_Coefficient_532 | Float_32 | $sr^{-1} \cdot km^{-1}$ | 0.0…0.35 | 345 | 1,380 |
| Perpendicular_Backscatter_Coefficient_Uncertainty_532 | Float_32 | $sr^{-1} \cdot km^{-1}$ | 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 | $g \cdot m^{-3}$ | 0.0…0.54 | 345 | 1,380 |
| Ice_Water_Content_Profile_Uncertainty | Float_32 | $g \cdot m^{-3}$ | 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

## 2.11 Lidar Level 2 Cloud Profile Data Product DP 2.1C – Version 4.20

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 73.

The 1064 calibration scheme assumes that both the extinction and the backscatter from clouds are spectrally independent. Consistent with this assumption, extinction and backscatter profiles will be reported for clouds only at 532 nm.

The major categories of the cloud profile data product are:

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

| | | |
|---|---|---|
| Level: | 2 | |
| Type: | Archival | |
| Frequency: | Standard: | 2/Orbit |
| Spatial Resolution Record: | Standard: | 60 m vertical resolution<br>5 km Along Track |
| Time Interval Covered: | Standard: | Half Orbit (Day or Night) |

Data File Name:

Standard: CAL_LID_L2_5kmCPro-Standard-Version.Instance.hdf

**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** |

### 2.11.1 Lidar Level 2 Cloud Profile Data Record Summary – Version 4.20

**Table 73: Lidar Level 2 Cloud Profile Data Record Summary – Version 4.20**

| 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 74 | 41,942 | 1 | 41,942 |
| Lidar Surface Detection Information | Table 52 | 84 | 4,010 | 336,840 |
| Lidar 5 km Cloud Profile Record | Table 75 | 27,456 | 4,010 | 110,098,560 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **110,478,245** |
| **Total Size – Standard (Mbytes)** | | | | **107.89** |

### 2.11.2 Lidar Level 2 Cloud Profile Data Metadata – Version 4.20

Lidar Cloud Profile Data Products include three Vdata record types (i.e., metadata), as specified in Table 74. 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 74.

**Table 74: Lidar Level 2 Cloud Profile Metadata Record – Version 4.20**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | 0…4,242 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | 0…4,242 | 1 | 4 |
| Initial_Subsatellite_Latitude | Float_32 | 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…261,231.0 | 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…261,231.0 | 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 | $m^2 \cdot sr^{-1}$ | 5.930E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_1064 | Float_32 | $m^2 \cdot sr^{-1}$ | 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 | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Lidar_Data_Altitudes | Float_32 | km | -0.480…20.175 | 399 | 1,596 |
| Initial_Lidar_Ratio_Clouds_532 | Float_32 | sr | 19.0…25.0 | 2 | 8 |
| GEOS_Version | Char | NoUnits | N/A | 64 | 64 |
| Classifier_Coefficients_Version_Number | Char | NoUnits | 0.0…99.9 | 1 | 4 |
| Classifier_Coefficients_Version_Date | Char | NoUnits | 4/2006 – 12/2026 | 1 | 6 |
| Production_Script | Char | NoUnits | N/A | 40,000 | 40,000 |
| | | | | | |
| **Record Size (bytes)** | | | | | **41,942** |

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

### 2.11.3 Lidar Level 2 Cloud Profile Scientific Data Sets – Version 4.20

Table 75 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 75: Lidar Level 2 5 km Cloud Profile Record – Version 4.20**

| 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…1.072E9 | 3 | 24 |
| Profile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261,231.0 | 3 | 24 |
| Day_Night_Flag | Int_8 | NoUnits | 0…1 | 1 | 1 |
| Minimum_Laser_Energy_532 | Float_32 | joules | 0.003…0.135 | 1 | 4 |
| Column_Optical_Depth_Cloud_532 | Float_32 | NoUnits | 0.0…25.0[M] | 1 | 4 |
| Column_Optical_Depth_Cloud_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_532 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_Uncertainty_532 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Tropospheric_Aerosols_Uncertainty_1064 | Float_32 | NoUnits | 0.0…99.99 | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_1064 | Float_32 | NoUnits | 0.0…3.0[M] | 1 | 4 |
| Column_Optical_Depth_Stratospheric_Aerosols_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…1,086.0 | 399 | 1,596 |
| Molecular_Number_Density | Float_32 | $m^{-3}$ | $8x10^{22}…5x10^{25}$ | 399 | 1,596 |
| Ozone_Number_Density | Float_32 | $m^{-3}$ | $9x10^{16}…1x10^{19}$ | 399 | 1,596 |
| Relative_Humidity | Float_32 | NoUnits | 0.0…1.5 | 399 | 1,596 |
| IGBP_Surface_Type | Int_8 | NoUnits | 1…18 | 1 | 1 |
| Surface_Elevation_Statistics | Float_32 | km | -1.0…9.0 | 4 | 16 |
| Surface_Winds | Float_32 | $m \cdot s^{-1}$ | -80.0…80.0 | 2 | 8 |
| Samples_Averaged | Int_16 | NoUnits | 0…480 | 399 | 690 |
| Aerosol_Layer_Fraction | UInt_8 | NoUnits | 0…30 | 399 | 1 |
| Cloud_Layer_Fraction | UInt_8 | NoUnits | 0…30 | 399 | 345 |
| Atmospheric_Volume_Description[X] | UInt_16 | NoUnits | 1…57,338 | 399x2 | 16 |
| Extinction_QC_Flag_532 | UInt_16 | NoUnits | 0…32,768 | 399x2 | 8 |
| CAD_Score | Int_8 | NoUnits | -101…106 | 399x2 | 690 |
| Total_Backscatter_Coefficient_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…1.5 | 399 | 1,596 |
| Total_Backscatter_Coefficient_Uncertainty_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…99.99 | 399 | 1,596 |
| Perpendicular_Backscatter_Coefficient_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…0.35 | 399 | 1,596 |
| Perpendicular_Backscatter_Coefficient_Uncertainty_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 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…12.0 | 399 | 1,596 |
| Extinction_Coefficient_Uncertainty_532 | Float_32 | $km^{-1}$ | 0.0…99.99 | 399 | 1,596 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Cloud_Multiple_Scattering_Profile_532 | Float_32 | NoUnits | 0.01…1.0 | 399 | 1,596 |
| Ice_Water_Content_Profile | Float_32 | $g \cdot m^{-3}$ | 0.0…0.54 | 399 | 1,596 |
| Ice_Water_Content_Profile_Uncertainty | Float_32 | $g \cdot m^{-3}$ | 0.0…99.99 | 399 | 1,596 |
| | | | | | |
| **Record Size (bytes)** | | | | | **27,456** |

C) International Atomic Time (TAI) seconds from Jan. 1, 1993
D) TAI time converted to UTC time and stored in format: yymmdd.ffffffff
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.
X) Refer to Table 69 for a detailed description of this parameter.

## 2.12 Lidar Level 2 Vertical Feature Mask Data Product DP 2.1D – Version 3.x

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 76.

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 79.

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** |

### 2.12.1 Lidar Level 2 Vertical Feature Mask Data Record Summary – Version 3.x

**Table 76: Lidar Level 2 Vertical Feature Mask Data Record Summary – Version 3.x**

| 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 77 | 22,646 | 1 | 22,646 |
| Lidar 5 km Vertical Feature Mask Record | Table 78 | 11,081 | Standard: 4,242<br>Expedited: 7,264 | 47,005,602<br>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** |

### 2.12.2 Lidar Level 2 Vertical Feature Mask Metadata – Version 3.x

The Lidar Vertical Feature Mask products include three Vdata record types (i.e., metadata), as shown in Table 77. 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 77.

**Table 77: Lidar Level 2 Vertical Feature Mask Metadata Record – Version 3.x**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Lidar_L1_Production_Date_Time[A] | Char | NoUnits | 4/2006…12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | Std = 0…4,242<br>Exp = 0…7,264 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | Std = 0…4,242<br>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…261,231.0 | 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…261,231.0 | 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 | NoUnits | 4/2006…12/2026 | 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

### 2.12.3 Lidar Level 2 Vertical Feature Mask Scientific Data Sets – Version 3.x

Table 78 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 78: Lidar Level 2 Vertical Feature Mask Record – Version 3.x**

| 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 | -8,000.0…8,000.0 | 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 79 for a detailed description of this parameter

**Table 79: Feature Classification Flag Definition – Version 3.x**

| Bit(s) | Field Description | Bit Interpretation |
|---|---|---|
| 1-3 | Feature Type | 0 = invalid (bad or missing data)<br>1 = "clear air"<br>2 = cloud<br>3 = aerosol<br>4 = stratospheric feature; polar stratospheric cloud (PSC) or stratospheric aerosol<br>5 = surface<br>6 = subsurface<br>7 = no signal (totally attenuated) |
| 4-5 | Feature Type QA | 0 = none<br>1 = low<br>2 = medium<br>3 = high |
| 6-7 | Ice/Water Phase | 0 = unknown/not determined<br>1 = ice<br>2 = water<br>3 = oriented ice crystals |
| 8-9 | Ice/Water Phase QA | 0 = none<br>1 = low<br>2 = medium<br>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<br>1 = clean marine<br>2 = dust<br>3 = polluted continental<br>4 = clean continental<br>5 = polluted dust<br>6 = smoke<br>7 = other |
| | If feature type = cloud, bits 10-12 will specify the cloud type. | 0 = low overcast, transparent<br>1 = low overcast, opaque<br>2 = transition stratocumulus<br>3 = low, broken cumulus<br>4 = altocumulus (transparent)<br>5 = altostratus (opaque)<br>6 = cirrus (transparent)<br>7 = deep convective (opaque) |
| | If feature type = Polar Stratospheric Cloud, bits 10-12 will specify PSC classification. | 0 = not determined<br>1 = non-depolarizing PSC<br>2 = depolarizing PSC<br>3 = non-depolarizing aerosol<br>4 = depolarizing aerosol<br>5 = spare<br>6 = spare<br>7 = other |
| 13 | Cloud/Aerosol/PSC Type QA | 0 = not confident<br>1 = confident |
| 14-16 | Horizontal averaging required for detection (provides a coarse measure of feature backscatter intensity) | 0 = not applicable<br>1 = 1/3 km<br>2 = 1 km<br>3 = 5 km<br>4 = 20 km<br>5 = 80 km |

## 2.13 Lidar Level 2 Vertical Feature Mask Data Product DP 2.1D – Version 4.20

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 80.

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 85.

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 |
| Spatial Resolution Record: | Standard: | Single shot, full resolution |
| Time Interval Covered: | Standard: | Half Orbit (Day or Night) |

Data File Name:

Standard: CAL_LID_L2_VFM-ProductionStrategy-Version.Instance.hdf

**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** |

### 2.13.1 Lidar Level 2 Vertical Feature Mask Data Record Summary –Version 4.20

**Table 80: Lidar Level 2 Vertical Feature Mask Data Record Summary – 4.20**

| 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 82 | 42,646 | 1 | 42,646 |
| Lidar 5 km Vertical Feature Mask Record | Table 83 | 11,089 | 4,010 | 44,466,890 |
| Single Shot Parameters | Table 81 | 33 | 63,630 | 2,099,790 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **46,610,229** |
| **Total Size – Standard (Mbytes)** | | | | **45.52** |

**Table 81: Lidar Level 2 Vertical Feature Mask Record – Single Shot Parameters - Version 4.20**

| Parameter | Data Type | Units | Nominal Range | Elem/Rec | Bytes |
|---|---|---|---|---|---|
| ssProfile_ID | Int_32 | NoUnits | 1…3,153,600,000 | 1 | 4 |
| ssLatitude | Float_32 | deg | -90.0…90.0 | 1 | 4 |
| ssLongitude | Float_32 | deg | -180.0…180.0 | 1 | 4 |
| ssProfile_Time[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| ssProfile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261,231.0 | 1 | 8 |
| ssLand_Water_Mask | Int_8 | NoUnits | 0…7 | 1 | 1 |
| ssLaser_Energy_532 | Float_32 | joules | 0.003…0.135 | 1 | 4 |
| | | | | | |
| **Record Size (bytes)** | | | | | **33** |

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

### 2.13.2 Lidar Level 2 Vertical Feature Mask Metadata – Version 4.20

The Lidar Vertical Feature Mask products include three Vdata record types (i.e., metadata), as shown in Table 82. 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 82.

**Table 82: Lidar Level 2 Vertical Feature Mask Metadata Record – Version 4.20**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Lidar_L1_Production_Date_Time[A] | Char | NoUnits | 4/2006…12/2026 | 27 | 27 |
| Number_of_Good_Profiles | Int_32 | NoUnits | 0…4,242 | 1 | 4 |
| Number_of_Bad_Profiles | Int_32 | NoUnits | 0…4,242 | 1 | 4 |
| Initial_Subsatellite_Latitude | Float_32 | 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…261,231.0 | 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…261,231.0 | 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 | NoUnits | 4/2006…12/2026 | 1 | 6 |
| Production_Script | Char | NoUnits | N/A | 40,000 | 40,000 |
| | | | | | |
| **Record Size (bytes)** | | | | | **42,646** |

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

### 2.13.3 Lidar Level 2 Vertical Feature Mask Scientific Data Sets – Version 4.20

Table 83 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 83: Lidar Level 2 Vertical Feature Mask Record – Version 4.20**

| 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…1.072E9 | 1 | 8 |
| Profile_UTC_Time[D] | Float_64 | NoUnits | 60,426.0…261,231.0 | 1 | 8 |
| Day_Night_Flag | UInt_16 | NoUnits | 0…1 | 1 | 2 |
| Land_Water_Mask | Int_8 | NoUnits | 0…7 | 1 | 1 |
| Minimum_Laser_Energy_532 | Float_32 | joules | 0.003…0.135 | 1 | 4 |
| Spacecraft_Position | Float_64 | km | -8,000.0…8,000.0 | 3 | 24 |
| Feature_Classification_Flags[J] | UInt_16 | NoUnits | 1…49,146 | 5,515 | 11,030 |
| | | | | | |
| **Record Size (bytes)** | | | | | **11,089** |

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 84 for a detailed description of this parameter

**Table 84: Feature Classification Flag Definition – Version 4.20**

| Bit(s) | Field Description | Bit Interpretation |
|---|---|---|
| 1-3 | Feature Type | 0 = invalid (bad or missing data)<br>1 = “clear air”<br>2 = cloud<br>3 = tropospheric aerosol<br>4 = stratospheric aerosol<br>5 = surface<br>6 = subsurface<br>7 = no signal (totally attenuated) |
| 4-5 | Feature Type QA | 0 = none<br>1 = low<br>2 = medium<br>3 = high |
| 6-7 | Ice/Water Phase | 0 = unknown/not determined<br>1 = ice<br>2 = water<br>3 = oriented ice crystals |
| 8-9 | Ice/Water Phase QA | 0 = none<br>1 = low<br>2 = medium<br>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<br>1 = clean marine<br>2 = dust<br>3 = polluted continental/smoke<br>4 = clean continental<br>5 = polluted dust<br>6 = elevated smoke<br>7 = dusty marine |
| | If feature type = cloud, bits 10-12 will specify the cloud type. | 0 = low overcast, transparent<br>1 = low overcast, opaque<br>2 = transition stratocumulus<br>3 = low, broken cumulus<br>4 = altocumulus (transparent)<br>5 = altostratus (opaque)<br>6 = cirrus (transparent)<br>7 = deep convective (opaque) |
| | If feature type = Stratospheric Aerosol, bits 10-12 will specify the stratospheric aerosol type. | 0 = invalid<br>1 = PSC aerosol<br>2 = volcanic ash<br>3 = sulfate/other<br>4 = elevated smoke<br>5 = spare<br>6 = spare<br>7 = spare |
| 13 | Cloud/Aerosol/PSC Type QA | 0 = not confident<br>1 = confident |
| 14-16 | Horizontal averaging required for detection (provides a coarse measure of feature backscatter intensity) | 0 = not applicable<br>1 = 1/3 km<br>2 = 1 km<br>3 = 5 km<br>4 = 20 km<br>5 = 80 km |

## 2.14 Lidar Level 2 Polar Stratospheric Clouds Product DP 2.3 – Version 2.00

The Lidar Level 2 Polar Stratospheric Clouds (PSC) data product ensemble describes the spatial distribution and optical properties of PSC layers observed by the CALIPSO lidar. The product contains profiles of PSC presence, composition, optical properties, and meteorological information along CALIPSO orbit tracks. Each file contains data from all nighttime orbit segments from a single day reported on a 5-km horizontal by 180-m vertical grid. PSC detection is limited to nighttime CALIOP observations because higher levels of background light during daytime significantly reduce the signal-to-noise and, hence, the PSC detection sensitivity. The files also include Aura Microwave Limb Sounder (MLS) measurements of the primary PSC condensable vapors $HNO_3$ and $H_2O$, and selected parameters from the Aura MLS v2 Derived Meteorological Products (DMPs), including equivalent latitude, vortex edge location, and dynamic tropopause altitude. The file is written in HDF. A summary of the product records is listed in Table 85.

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

Data File Name:

Standard: CAL_LID_L2_PSCMask-ProductionStrategy-Version.Instance.hdf

### 2.14.1 Lidar Level 2 Polar Stratospheric Cloud Profile Data Record Summary – Version 2.00

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 86.

**Table 85: Lidar Level 2 Polar Stratospheric Cloud Profile Data Record Summary – Version 2.00**

| Record Name | Reference | Record Size | Records / File | File Size (bytes) |
|---|---|---|---|---|
| Core Metadata Record | Appendix A | 871 | 1 | 871 |
| Archive Metadata Record | Appendix A | 4 | 1 | 4 |
| PSC Metadata Record | N/A | N/A | N/A | N/A |
| PSC SDS Metadata Record | Table 86 | 1,205 | 1 | 1,205 |
| PSC Record | Table 87 | 20,506 | 20,755 | 425,602,030 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **425,604,110** |
| **Total Size – Standard (Mbytes)** | | | | **415.63** |

### 2.14.2 Lidar Level 2 Polar Stratospheric Cloud Data Metadata – Version 2.00

Lidar Polar Stratospheric Cloud Data Products include SDS record types (i.e., metadata), as specified in Table 86. 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 86.

**Table 86: Lidar Level 2 Polar Stratospheric Cloud Profile SDS Metadata Record – Version 2.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Number_Of_LIDAR_L1_Files | Int_16 | NoUnits | 1...15 | 1 | 2 |
| Number_Altitudes | Int_32 | NoUnits | 1...121 | 1 | 4 |
| Number_Profiles | Int_32 | NoUnits | 1...30,000 | 1 | 4 |
| L1_Input_Filenames | String | NoUnits | N/A | 1...15 | 315 |
| L1_Input_Start_Times | Float_64 | NoUnits | 60,426.0...261,231.0 | 1...15 | 120 |
| L1_Input_End_Times | Float_64 | NoUnits | 60,426.0...261,231.0 | 1...15 | 120 |
| Number_HNO3_Pressure_Levels | Int_32 | NoUnits | 0...25 | 1 | 4 |
| Number_H2O_Pressure_Levels | Int_32 | NoUnits | 0...25 | 1 | 4 |
| Pressure_HNO3 | Float_32 | hPa | 1.0...500.0 | 12 | 48 |
| Pressure_H2O | Float_32 | hPa | 1.0...500.0 | 25 | 100 |
| Altitude | Float_32 | km | 8.0...31.0 | 121 | 484 |
| | | | | | |
| **Record Size (bytes)** | | | | | **1,205** |

### 2.14.3 Lidar Level 2 Polar Stratospheric Cloud Scientific Data Sets – Version 2.00

Table 87 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 87: Lidar Level 2 Polar Stratospheric Cloud Record – Version 2.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Profile_Time[C] | Float_64 | sec | 4.204E8...1.072E9 | 1 | 8 |
| Profile_UTC_Time | Float_64 | NoUnits | 60,426.0...261,231.0 | 1 | 8 |
| Latitude | Float_32 | deg | -90.0...90.0 | 1 | 4 |
| Longitude | Float_32 | deg | -180.0...180.0 | 1 | 4 |
| Orbit_Index | Int_16 | NoUnits | 0...15 | 1 | 2 |
| Temperature | Float_32 | K | 150.0...350.0 | 121 | 484 |
| Potential_Temperature | Float_32 | K | 200.0...1,200.0 | 121 | 484 |
| Pressure | Float_32 | hPa | 1.0...1000.0 | 121 | 484 |
| Vortex_Edge_Outer | Float_32 | deg | -90.0...90.0 | 121 | 484 |
| Vortex_Edge_Center | Float_32 | deg | -90.0...90.0 | 121 | 484 |
| Equivalent_Latitude | Float_32 | deg | -90.0...90.0 | 121 | 484 |
| Tropopause_Altitude_MERRA2 | Float_32 | km | 3.0...25.0 | 1 | 4 |
| Parallel_Attenuated_Backscatter_532_Initial | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.1 | 121 | 484 |
| Perpendicular_Attenuated_Backscatter_532_Initial | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.05 | 121 | 484 |
| Parallel_Attenuated_Backscatter_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.1 | 121 | 484 |
| Parallel_Attenuated_Backscatter_532_Uncertainty | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.1 | 121 | 484 |
| Perpendicular_Attenuated_Backscatter_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.05 | 121 | 484 |
| Perpendicular_Attenuated_Backscatter_532_Uncertainity | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.05 | 121 | 484 |
| Particulate_Depolarization_Ratio_532 | Float_32 | NoUnits | 0.0...1.0 | 121 | 484 |
| Particulate_Depolarization_Ratio_532_Uncertainty | Float_32 | NoUnits | 0.0...99.0 | 121 | 484 |
| Total_Attenuated_Scattering_Ratio_532 | Float_32 | NoUnits | 0.0...1.0 | 121 | 484 |
| Total_Attenuated_Scattering_Ratio_532_Uncertainty | Float_32 | NoUnits | 0.0...99.0 | 121 | 484 |
| Total_Attenuated_Backscatter_1064 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.1 | 121 | 484 |
| Total_Attenuated_Backscatter_1064_Uncertainty | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.1 | 121 | 484 |
| Molecular_Backscatter_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.1 | 121 | 484 |
| Particulate_Backscatter_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0 ...0.8 | 121 | 484 |
| Particulate_Backscatter_532_Uncertainty | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.1 | 121 | 484 |
| Total_Scattering_Ratio_532 | Float_32 | NoUnits | 0.0...1.0 | 121 | 484 |
| Total_Scattering_Ratio_532_Uncertainty | Float_32 | NoUnits | 0.0...1.0 | 121 | 484 |
| Perpendicular_Scattering_Ratio_532 | Float_32 | NoUnits | 0.0...1.0 | 121 | 484 |
| Perpendicular_Scattering_Ratio_532_Uncertainty | Float_32 | NoUnits | 0.0...1.0 | 121 | 484 |
| Perpendicular_Backscatter_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.5 | 121 | 484 |
| Perpendicular_Backscatter_532_Uncertainty | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.1 | 121 | 484 |
| Parallel_Backscatter_532 | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.5 | 121 | 484 |
| Parallel_Backscatter_532_Uncertainty | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0...0.2 | 121 | 484 |
| Particulate_Extinction | Float_32 | $km^{-1}$ | 0.0...10.0 | 121 | 484 |
| Particulate_Surface_Area_Density_532 | Float_32 | $\mu m^2 cm^{-3}$ | 0.0...350.0 | 121 | 484 |
| Particulate_Volume_Density_532 | Float_32 | $\mu m^3 cm^{-3}$ | 0.0...350.0 | 121 | 484 |
| Lidar_Ratio_532 | Float_32 | sr | 0.0...250.0 | 121 | 484 |
| Multiple_Scattering_Factor_532 | Float_32 | NoUnits | 0.5...1.0 | 121 | 484 |
| Retrieval_QC_Flag | Float_32 | NoUnits | 8.0...30.05 | 121 | 484 |
| PSC_Feature_Mask | Int_16 | NoUnits | -350...350 | 121 | 242 |
| PSC_Composition | Int_16 | NoUnits | -6...6 | 121 | 242 |

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

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

## 2.15 Lidar Level 2 Blowing Snow Product DP 2.4 – Version 1.00

The Lidar Level 2 Blowing Snow product reports distribution of blowing snow properties based on backscatter retrievals fro a specific region of the globe. This data product is distributed in hierarchical data format (HDF5) files, due to the size limitations of HDF4, which is the file format for all other CALIPSO data products. A summary of the product records is listed in Table 88.

The major categories of the blowing snow product are:

- Blowing Snow
- Backscatter

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

Data File Name:

Standard: CAL_LID_L2_BlowingSnow_Region-ProductionStrategy-Version.Instance.hdf5

### 2.15.1 Lidar Level 2 Blowing Snow Data Record Summary – Version 1.00

Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the Blowing Snow data are provided in Table 89.

**Table 88: Lidar Level 2 Blowing Snow Data Record Summary – Version 1.00**

| Record Name | Reference | Record Size | Records / File | File Size (bytes) |
|---|---|---|---|---|
| Core Metadata | Appendix A | 870 | 1 | 870 |
| Archive Metadata | Appendix A | 4 | 1 | 4 |
| Metadata | Table 89 | 5,256 | 1 | 5,256 |
| Ancillary Fields | Table 90 | 22 | 8,765,352 | 192,837,436 |
| Geolocation Fields | Table 91 | 12 | 8,765,352 | 105,184,224 |
| Snow Fields | Table 92 | 494 | 8,765,352 | 4,330,083,888 |
| Observation_Grid | Table 92 | 259,200 | 1 | 259,200 |
| Blowing_Snow_Frequency_Grid | Table 92 | 2,332,800 | 1 | 2,332,800 |
| | | | | |
| **Total Size Bytes** | | | | **4,630,703,678** |
| **Total Size Mbytes** | | | | **4,522.17** |

### 2.15.2 Lidar Level 2 Blowing Snow Data Metadata – Version 1.x

The Lidar Level 2 Blowing Snow Product includes metadata, specified as a scientific data set (SDS) record. Listings for the core metadata and the archive metadata are provided in Appendix A. The metadata parameters specific to the Lidar Level 2 Blowing Snow Product, and stored as an SDS, are listed in Table 89.

**Table 89: Lidar Level 2 Blowing Snow SDS Metadata Record – Version 1.00**

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

### 2.15.3 Lidar Level 2 Blowing Snow Data Product Scientific Data Sets – Version 1.00

Tables 90 through 92 summarize the contents of each scientific data set (SDS) contained within the Lidar Level 2 Blowing Snow Data product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

**Table 90: Lidar Level 2 Blowing Snow SDS – Ancillary Fields – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Land_Water_Mask | Int_16 | NoUnits | 0…7 | 1 | 2 |
| Solar_Zenith_Angle | Float_32 | deg | 0.0…180.0 | 1 | 4 |
| Surface_Temperature | Float_32 | ºC | -95.0…13.0 | 1 | 4 |
| Surface_Type_IGBP | Int_16 | NoUnits | 1…18 | 1 | 2 |
| Surface_Type_NSIDC | Int_16 | NoUnits | 0.0…255.0 | 1 | 2 |
| Surface_Wind_Direction | Float_32 | deg | 0.0…360.0 | 1 | 4 |
| Surface_Wind_Speed | Float_32 | $m \cdot s^{-1}$ | 0.0…33.0 | 1 | 4 |
| | | | | | |
| **Record Size (bytes)** | | | | | **22** |

**Table 91: Lidar Level 2 Blowing Snow SDS – Geolocation Fields – Version 1.00**

| 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_UTC_Time | Float_32 | NoUnits | 60,426.0…261, 231.0 | 1 | 4 |
| | | | | | |
| **Total Bytes per Record** | | | | | **12** |

## Table 92: Lidar Level 2 Blowing Snow SDS – Snow Fields – Version 1.00

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

## 2.16 IIR/Lidar Level 2 Track Product DP 2.2A – Version 3.x

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 93.

The major categories of the data product are:

- Cloud Emissivity
- Cloud Properties
- Lidar Profile Data

| | | |
|---|---|---|
| Level: | 2 | |
| Type: | Archival | |
| Frequency: | Expedited: | 16/day |
| Spatial Resolution Record: | Expedited: | 1 km pixels at nadir |
| Time Interval Covered: | Expedited: | 90 minutes |

Data File Name:

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.**

### 2.16.1 IIR/Lidar Level 2 Track Product – Version 3.x

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 93: IIR/Lidar Level 2 Track Product Summary – Version 3.x**

| 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 94 | 377 | 1 | 377 |
| IIR/Lidar Track Science Record | Table 95 | 261 | Expedited: 36,337 | 9,483,957 |
| | | | | |
| **Total Size – Expedited (bytes)** | | | | **9,485,237** |
| **Total Size – Expedited (Mbytes)** | | | | **9.263** |

### 2.16.2 IIR/Lidar Level 2 Track Metadata – Version 3.x

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 94.

**Table 94: IIR/Lidar Level 2 Track Metadata Record – Version 3.x**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Initial_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…261,231.0 | 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…261,231.0 | 1 | 8 |
| Number_of_IIR_Records_in_File | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Valid_08_65_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Valid_12_05_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Valid_10_60_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Invalid_08_65_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Invalid_12_05_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Invalid_10_60_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_08_65_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_12_05_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_10_60_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_08_65_Pixels_Location | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_12_05_Pixels_Location | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_10_60_Pixels_Location | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_08_65_Pixels_Radiance | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_12_05_Pixels_Radiance | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_10_60_Pixels_Radiance | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Mean_08_65_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_12_05_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_10_60_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_08_65_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_12_05_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_10_60_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 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 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Number_of_Valid_LIDAR_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Invalid_LIDAR_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Rejected_LIDAR_Pixels | Int_16 | NoUnits | Exp = 0…36,337 | 1 | 2 |
| Number_of_Identified_Pixels_Upper_Level | Int_16 | NoUnits | 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 | 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 | 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

### 2.16.3 IIR/Lidar Level 2 Track Scientific Data Sets – Version 3.x

Table 95 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 95: IIR/Lidar Level 2 Track Science Record – Version 3.x**

| 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 | $gm^{-2}$ | 0.0...1,000.0 | 1 | 4 |
| Ice_Water_Path_Confidence | Float_32 | $gm^{-2}$ | 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...32,767 | 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.

## 2.17 IIR/Lidar Level 2 Track Product DP 2.2A – Version 4.20

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 96.

The major categories of the data product are:

- Cloud Emissivity
- Cloud Properties
- Lidar Profile Data

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

Data File Name:

Standard: CAL_IIR_L2_Track-Standard-Version.Instance.hdf

### 2.17.1 IIR/Lidar Level 2 Track Product – Version 4.20

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 96: IIR/Lidar Level 2 Track Product Summary – Version 4.20**

| 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 97 | 377 | 1 | 377 |
| IIR/Lidar Track Science Record | Table 98 | 378 | 20,048 | 7,578,144 |
| | | | | |
| **Total Size – Standard (bytes)** | | | | **7,579,424** |
| **Total Size – Standard (Mbytes)** | | | | **7.402** |

### 2.17.2 IIR/Lidar Level 2 Track Metadata – Version 4.20

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 97.

**Table 97: IIR/Lidar Level 2 Track Metadata Record – Version 4.20**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Initial_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…261,231.0 | 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…261,231.0 | 1 | 8 |
| Number_of_IIR_Records_in_File | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Valid_08_65_Pixels | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Valid_12_05_Pixels | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Valid_10_60_Pixels | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Invalid_08_65_Pixels | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Invalid_12_05_Pixels | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Invalid_10_60_Pixels | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Rejected_08_65_Pixels | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Rejected_12_05_Pixels | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Rejected_10_60_Pixels | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Rejected_08_65_Pixels_Location | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Rejected_12_05_Pixels_Location | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Rejected_10_60_Pixels_Location | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Rejected_08_65_Pixels_Radiance | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Rejected_12_05_Pixels_Radiance | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Rejected_10_60_Pixels_Radiance | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Mean_08_65_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_12_05_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_10_60_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_08_65_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_12_05_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_10_60_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 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 |

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

A) UTC CCSDS ASCII Time Code Format A

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

### 2.17.3 IIR/Lidar Level 2 Track Scientific Data Sets – Version 4.20

Table 98 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 98: IIR/Lidar Level 2 Track Science Record – Version 4.20**

| 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 | 4.204E8…1.072E9 | 1 | 8 |
| LIDAR_Profile_ID | Int_32 | NoUnits | 1…3,153,600,000 | 1 | 4 |
| IIR_Image_Time_12_05[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Brightness_Temperature_08_65 | Float_32 | K | 0.0…400.0 | 1 | 4 |
| Brightness_Temperature_12_05 | Float_32 | K | 0.0…400.0 | 1 | 4 |
| Brightness_Temperature_10_60 | Float_32 | K | 0.0…400.0 | 1 | 4 |
| Type_of_Scene[I] | Int_8 | NoUnits | 0…99 | 1 | 1 |
| Was_Cleared_Flag_1km | Int_8 | NoUnits | 0…15 | 1 | 1 |
| Multi_Layer_Flag[I] | Float_32 | NoUnits | -8,030…8,030.0 | 1 | 4 |
| Effective_Emissivity_08_65 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Effective_Emissivity_12_05 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Effective_Emissivity_10_60 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Effective_Emissivity_Uncertainty_08_65 | Float_32 | NoUnits | TBD | 1 | 4 |
| Effective_Emissivity_Uncertainty_12_05 | Float_32 | NoUnits | TBD | 1 | 4 |
| Effective_Emissivity_Uncertainty_10_60 | Float_32 | NoUnits | TBD | 1 | 4 |
| Effective_Emissivity_Uncertainty_Terms_08_65 | Float_32 | NoUnits | TBD | 3 | 12 |
| Effective_Emissivity_Uncertainty_Terms_12_05 | Float_32 | NoUnits | TBD | 3 | 12 |
| Effective_Emissivity_Uncertainty_Terms_10_60 | Float_32 | NoUnits | TBD | 3 | 12 |
| Particle_Shape_Index[I] | Int_8 | NoUnits | 1…9 | 1 | 1 |
| Particle_Shape_Index_Confidence[I] | Int_8 | NoUnits | 1…4 | 1 | 1 |
| Effective_Particle_Size | Float_32 | μm | 0.0…200.0 | 1 | 4 |
| Effective_Particle_Size_Uncertainty | Float_32 | μm | 0.0…200.0 | 1 | 4 |
| Ice_Liquid_Water_Path | Float_32 | $gm^{-2}$ | 0.0…1,300.0 | 1 | 4 |
| Ice_Liquid_Water_Path_Confidence | Float_32 | $gm^{-2}$ | 0.0…1,300.0 | 1 | 4 |
| Reference_Brightness_Temperature[J] | Int_16 | K | 0.0…400.0 | 6 | 12 |
| Blackbody_Brightness_Temperature[J] | Int_16 | K | 0.0…400.0 | 6 | 12 |
| 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 |
| 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 |

| Parameter | Data Type | Units | Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Temperature_Centroid_IAB_0532_Upper_Level | Float_32 | K | 160.0…340.0 | 1 | 4 |
| Layer_Bottom_Temperature_Upper_Level | Float_32 | K | 160.0…340.0 | 1 | 4 |
| Layer_Top_Pressure_Upper_Level | Float_32 | hPa | 1.0…1,086.0 | 1 | 4 |
| Pressure_Centroid_IAB_0532_Upper_Level | Float_32 | hPa | 1.0…1,086.0 | 1 | 4 |
| Layer_Bottom_Pressure_Upper_Level | Float_32 | hPa | 1.0…1,086.0 | 1 | 4 |
| Ice_Water_Flag_Upper_Level[I] | Int_8 | NoUnits | 1…9 | 1 | 1 |
| Ice_Water_Flag_QA_Upper_Level[I] | Float_32 | NoUnits | 0.0…100.1 | 1 | 4 |
| Ice_Water_Path_CALIOP_Upper_Level | Float_32 | $gm^{-2}$ | TBD | 1 | 4 |
| Optical_Depth_0532_Lower_Level | Float_32 | NoUnits | 0.0…5.0 | 1 | 4 |
| Depolarization_Lower_Level | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Integrated_Backscatter_Lower_Level | Float_32 | $sr^{-1}$ | 0.0…1.0 | 1 | 4 |
| Layer_Top_Height_Lower_Level | Float_32 | km | -0.5…30.1 | 1 | 4 |
| Centroid_IAB_0532_Lower_Level | Float_32 | km | -0.5…30.1 | 1 | 4 |
| Layer_Bottom_Height_Lower_Level | Float_32 | km | -0.5…30.1 | 1 | 4 |
| Layer_Top_Temperature_Lower_Level | Float_32 | K | 160.0…340.0 | 1 | 4 |
| Temperature_Centroid_IAB_0532_Lower_Level | Float_32 | K | 160.0…340.0 | 1 | 4 |
| Layer_Bottom_Temperature_Lower_Level | Float_32 | K | 160.0…340.0 | 1 | 4 |
| Layer_Top_Pressure_Lower_Level | Float_32 | hPa | 1.0…1,086.0 | 1 | 4 |
| Pressure_Centroid_IAB_0532_Lower_Level | Float_32 | hPa | 1.0…1,086.0 | 1 | 4 |
| Layer_Bottom_Pressure_Lower_Level | Float_32 | hPa | 1.0…1,086.0 | 1 | 4 |
| Ice_Water_Flag_Lower_Level[I] | Int_8 | NoUnits | -9…9 | 1 | 1 |
| Ice_Water_Flag_QA_Lower_Level[I] | Float_32 | NoUnits | 0.0…100.1 | 1 | 4 |
| Surface_Emissivity_08_65 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Surface_Emissivity_12_05 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Surface_Emissivity_10_60 | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| IGBP_Surface_Type | Int_8 | NoUnits | 1…18 | 1 | 1 |
| Snow_Ice_Surface_Type | UInt_8 | NoUnits | 0…255 | 1 | 1 |
| Surface_532_Integrated_Depolarization_Ratio | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| TGeotype[I] | Int_16 | NoUnits | 100…1,800 | 1 | 2 |
| Initial_Surface_Temperature | Float_32 | K | 160.0…340.0 | 1 | 4 |
| Surface_Temperature | Float_32 | K | 160.0…340.0 | 1 | 4 |
| IIR_Data_Quality_Flag[I] | Int_8 | NoUnits | 0…15 | 1 | 1 |
| Equalization_Flag[I] | Int_8 | NoUnits | 0…7 | 1 | 1 |
| LIDAR_Data_Quality_Flag[I] | Int_8 | NoUnits | 0…3 | 1 | 1 |
| Surrounding_Obs_Quality_Flag[I] | Int_16 | NoUnits | 0…412 | 1 | 2 |
| High_Cloud_vs_Background_Flag[I] | Float_32 | NoUnits | -93.0…412.0 | 1 | 4 |
| Computed_vs_Observed_Background_Flag[I] | Float_32 | NoUnits | -10.0…10.0 | 3 | 12 |
| Regional_Background_Std_Dev_Flag[I] | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Microphysics[I] | Float_32 | NoUnits | 0.0…2,002,009.0 | 10 | 40 |
| Dust_Stratospheric_Aerosol_Flag[I] | Int_8 | NoUnits | 0…8 | 1 | 1 |
| Dust_Stratospheric_Aerosol_Flag_QA[I] | Float_32 | NoUnits | 0.0…100.1 | 1 | 4 |
| Reflectance | Float_32 | NoUnits | 0.0…2.0 | 1 | 4 |
| Integrated_Water_Vapor_Path | Float_32 | $gcm^{-2}$ | 0.0…10.0 | 1 | 4 |
| | | | | | |
| **Record Size (bytes)** | | | | | **378** |

C) International Atomic Time (TAI) seconds from Jan 1, 1993
I) CALIPSO's Online User's Guide - data product description for interpretation
J) Range after scale equation reported in the HDF file

Appendix F provides flag definitions for selected science parameters.

## 2.18 IIR Level 2 Swath Product DP 2.2B – Version 3.x

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 99.

The major categories of the data product are:

- Cloud Emissivity
- Cloud Properties

| | | |
|---|---|---|
| Level: | 2 | |
| Type: | Archival | |
| Frequency: | Expedited: | 16/day |
| Spatial Resolution Record: | Expedited: | 1 km pixels x km swath |
| Time Interval Covered: | Expedited: | 90 minutes |

Data File Name:

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.**

### 2.18.1 IIR Level 2 Swath Product – Version 3.x

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 99: IIR Level 2 Swath Product Summary – Version 3.x**

| 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 100 | 379 | 1 | 379 |
| Swath Science Record | Table 101 | 5,735 | Expedited: 36,337 | 208,392,695 |
| | | | | |
| **Total Size - Expedited (bytes)** | | | | **208,393,977** |
| **Total Size – Expedited (Mbytes)** | | | | **195.859** |

### 2.18.2 IIR Level 2 Swath Metadata – Version 3.x

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 100.

**Table 100: IIR Level 2 Swath Product Metadata Record – Version 3.x**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production | Char | NoUnits | 4/2006 – 12/2026 | 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…261,231.0 | 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…261,231.0 | 1 | 8 |
| Number_of_IIR_Records_in_File | Int_16 | NoUnits | Exp = 0...36,337 | 1 | 2 |
| Number_of_Valid_08_65_Pixels | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Valid_12_05_Pixels | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Valid_10_60_Pixels | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Invalid_08_65_Pixels | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Invalid_12_05_Pixels | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Invalid_10_60_Pixels | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Rejected_08_65_Pixels | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Rejected_12_05_Pixels | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Rejected_10_60_Pixels | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Rejected_08_65_Pixels_Loc | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Rejected_12_05_Pixels_Loc | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Rejected_10_60_Pixels_Loc | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Rejected_08_65_Pixels_Rad | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Rejected_12_05_Pixels_Rad | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Number_of_Rejected_10_60_Pixels_Rad | Int_32 | NoUnits | Exp = 0...2,507,253 | 1 | 4 |
| Mean_08_65_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_12_05_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_10_60_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_08_65_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_12_05_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0...40.0 | 1 | 4 |
| Mean_10_60_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 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 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| 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

### 2.18.3 IIR Level 2 Swath Scientific Data Sets – Version 3.x

Table 101 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 101: IIR Level 2 Swath Product Science Record – Version 3.x**

| 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 | $gm^{-2}$ | 0.0...1,000.0 | 69 | 138 |
| Ice_Water_Path_Confidence | Int_16 | $gm^{-2}$ | TBD | 69 | 138 |
| Scene_Flag[I] | Int_32 | NoUnits | 0...1,900 | 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.

## 2.19 IIR Level 2 Swath Product DP 2.2B – Version 4.20

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 102.

The major categories of the data product are:

- Cloud Emissivity
- Cloud Properties

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

Data File Name:

Standard: CAL_IIR_L2_Swath-ProductionStrategy-Version.Instance.hdf

### 2.19.1 IIR Level 2 Swath Product – Version 4.20

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 102: IIR Level 2 Swath Product Summary – Version 4.20**

| 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 103 | 379 | 1 | 379 |
| Swath Science Record | Table 104 | 7,736 | 20,048 | 155,091,328 |
| | | | | |
| **Total Size - Standard (bytes)** | | | | **155,092,610** |
| **Total Size – Standard (Mbytes)** | | | | **151.458** |

### 2.19.2 IIR Level 2 Swath Metadata – Version 4.20

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 103.

**Table 103: IIR Level 2 Swath Product Metadata Record – Version 4.20**

| 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 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production | Char | NoUnits | 4/2006 – 12/2026 | 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…261,231.0 | 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…261,231.0 | 1 | 8 |
| Number_of_IIR_Records_in_File | Int_16 | NoUnits | 0…20,048 | 1 | 2 |
| Number_of_Valid_08_65_Pixels | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Valid_12_05_Pixels | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Valid_10_60_Pixels | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Invalid_08_65_Pixels | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Invalid_12_05_Pixels | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Invalid_10_60_Pixels | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Rejected_08_65_Pixels | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Rejected_12_05_Pixels | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Rejected_10_60_Pixels | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Rejected_08_65_Pixels_Loc | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Rejected_12_05_Pixels_Loc | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Rejected_10_60_Pixels_Loc | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Rejected_08_65_Pixels_Rad | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Rejected_12_05_Pixels_Rad | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Number_of_Rejected_10_60_Pixels_Rad | Int_32 | NoUnits | 0…1,383,312 | 1 | 4 |
| Mean_08_65_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_12_05_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_10_60_Radiance_All | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_08_65_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_12_05_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 0.0…40.0 | 1 | 4 |
| Mean_10_60_Radiance_Selected_Cases | Float_32 | $Wm^{-2}\cdot sr^{-1}\cdot \mu m^{-1}$ | 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 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| 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

### 2.19.3 IIR Level 2 Swath Scientific Data Sets – Version 4.20

Table 104 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 104: IIR Level 2 Swath Product Science Record – Version 4.20**

| 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 | 4.204E8…1.072E9 | 69 | 552 |
| IIR_Track_Pixel_ID | Int_16 | NoUnits | 1…20,048 | 69 | 138 |
| IIR_Image_Time_12_05[C] | Float_64 | sec | 4.204E8…1.072E9 | 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 | TBD | 69 | 138 |
| Effective_Emissivity_Uncertainty_12_05[J] | Int_16 | NoUnits | TBD | 69 | 138 |
| Effective_Emissivity_Uncertainty_10_60[J] | 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…9 | 69 | 69 |
| Particle_Shape_Confidence[I] | Int_8 | NoUnits | 1…4 | 69 | 69 |
| Effective_Particle_Size[J] | Int_16 | μm | 0.0…200.0 | 69 | 138 |
| Effective_Particle_Size_Uncertainty[J] | Int_16 | μm | 0.0…200.0 | 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 |
| Ice_Liquid_Water_Path[J] | Int_16 | $gm^{-2}$ | 0.0…1,300.0 | 69 | 138 |
| Ice_Liquid_Water_Path_Confidence[J] | Int_16 | $gm^{-2}$ | 0.0…1,300.0 | 69 | 138 |
| Integrated_Water_Vapor_Path[J] | Int_16 | $gcm^{-2}$ | 0.0…10.0 | 69 | 138 |
| Scene_Flag[I] | Int_32 | NoUnits | 10,010…180,099 | 69 | 276 |
| IIR_Data_Quality[I] | Int_8 | NoUnits | 0…15 | 69 | 69 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Equalization_Flag[I] | Int_8 | NoUnits | 0…7 | 69 | 69 |
| Layer_Top_Height_Upper_Level[J] | Int_16 | km | -0.5…30.1 | 69 | 138 |
| Centroid_IAB_0532_Upper_Level[J] | Int_16 | km | -0.5…30.1 | 69 | 138 |
| Layer_Bottom_Height_Upper_Level[J] | Int_16 | km | -0.5…30.1 | 69 | 138 |
| Layer_Top_Temperature_Upper_Level[J] | Int_16 | K | 160.0…340.0 | 69 | 138 |
| Temperature_Centroid_IAB_0532_Upper_Level[J] | Int_16 | K | 160.0…340.0 | 69 | 138 |
| Layer_Bottom_Temperature_Upper_Level[J] | Int_16 | K | 160.0…340.0 | 69 | 138 |
| Layer_Top_Pressure_Upper_Level[J] | Int_16 | hPa | 1.0…1,086.0 | 69 | 138 |
| Pressure_Centroid_IAB_0532_Upper_Level[J] | Int_16 | hPa | 1.0…1,086.0 | 69 | 138 |
| Layer_Bottom_Pressure_Upper_Level[J] | Int_16 | hPa | 1.0…1,086.0 | 69 | 138 |
| Layer_Top_Height_Lower_Level[J] | Int_16 | km | -0.5…30.1 | 69 | 138 |
| Centroid_IAB_0532_Lower_Level[J] | Int_16 | km | -0.5…30.1 | 69 | 138 |
| Layer_Bottom_Height_Lower_Level[J] | Int_16 | km | -0.5…30.1 | 69 | 138 |
| Layer_Top_Temperature_Lower_Level[J] | Int_16 | K | 160.0…340.0 | 69 | 138 |
| Temperature_Centroid_IAB_0532_Lower_Level[J] | Int_16 | K | 160.0…340.0 | 69 | 138 |
| Layer_Bottom_Temperature_Lower_Level[J] | Int_16 | K | 160.0…340.0 | 69 | 138 |
| Layer_Top_Pressure_Lower_Level[J] | Int_16 | hPa | 1.0…1,086.0 | 69 | 138 |
| Pressure_Centroid_IAB_0532_Lower_Level[J] | Int_16 | hPa | 1.0…1,086.0 | 69 | 138 |
| Layer_Bottom_Pressure_Lower_Level[J] | Int_16 | hPa | 1.0…1,086.0 | 69 | 138 |
| | | | | | |
| **Record Size (bytes)** | | | | | **7,736** |

C) International Atomic Time (TAI) seconds from Jan 1, 1993
I) See CALIPSO's online User's Guide - data product description for interpretation
J) Range after scale equation reported in the HDF file

Appendix F provides flag definitions for selected science parameters.

## 2.20 Lidar Level 3 Tropospheric Aerosol Profile Product DP 3.1 – Version 4.x

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

The major categories of the aerosol data product are:

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

| | | |
|---|---|---|
| Level: | 3 | |
| 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_Tropospheric_APro_AllSky-ProductionStrategy-Version.Instance.hdf
CAL_LID_L3_Tropospheric_APro_CloudFree-ProductionStrategy-Version.Instance.hdf
CAL_LID_L3_Tropospheric_APro_CloudySkyTransparent-ProductionStrategy-Version.Instance.hdf
CAL_LID_L3_Tropospheric_APro_CloudySkyOpaque-ProductionStrategy-Version.Instance.hdf

### 2.20.1 Lidar Level 3 Tropospheric Aerosol Data Summary DP 3.1 – Version 4.x

**Table 105: Lidar Level 3 Tropospheric Aerosol Data Record – Version 4.x**

| 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 106 | 35,568 | 1 | 35,568 |
| Spatial Coordinates | Table 107 | 1,460 | 1 | 1,460 |
| Meteorological Context | Table 108 | 5,014 | 6,120 | 30,685,680 |
| Surface and Over-flight Parameters | Table 109 | 20 | 6,120 | 122,400 |
| Static Lidar Parameters | Table 110 | 56 | 1 | 56 |
| Aerosol Optical Properties: All Species | Table 111 | 12,908 | 6,120 | 78,996,960 |
| Aerosol Optical Properties: Dust Only | Table 112 | 2,916 | 6,120 | 17,845,920 |
| Aerosol Optical Properties: Elevated Smoke Only | Table 113 | 2,916 | 6,120 | 17,845,920 |
| Aerosol Optical Properties: Polluted Dust Only | Table 114 | 2,916 | 6,120 | 17,845,920 |
| Aerosol Type Distribution: All Species | Table 115 | 2,928 | 6,120 | 17,919,360 |
| Aerosol Spatial Distribution: All Species | Table 116 | 246 | 6,120 | 1,505,520 |
| Aerosol Spatial Distribution: Dust Only | Table 117 | 246 | 6,120 | 1,505,520 |
| Aerosol Spatial Distribution: Elevated Smoke Only | Table 118 | 246 | 6,120 | 1,505,520 |
| Aerosol Spatial Distribution: Polluted Dust Only | Table 119 | 246 | 6,120 | 1,505,520 |
| | | | | |
| **Total Size Profile Data Product (bytes)** | | | | **187,322,227** |
| **Total Size Data Product (Mbytes)** | | | | **182.932** |

### 2.20.2 Lidar Level 3 Tropospheric Aerosol Data Product Metadata – Version 4.x

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 Tropospheric Aerosol Data Product are listed in Table 106.

**Table 106: Lidar Level 3 Tropospheric Aerosol Metadata Record – Version 4.x**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | CAL_LID_L3_Tropospheric_APro_AllSk, CAL_LID_L3_Tropospheric_APro_CloudFree, CAL_LID_L3_Tropospheric_APro_CloudySky Transparent, CAL_LID_L3_Tropospheric_APro_CloudySky Opaque | 80 | 80 |
| Nominal_Year_Month | Char | NoUnits | N/A | 6 | 6 |
| Number_of_Level2_Files_Analyzed | UInt_16 | NoUnits | 0…900 | 1 | 2 |
| Earliest_Input_Filename | Char | NoUnits | N/A | 160 | 160 |
| Latest_Input_Filename | Char | NoUnits | N/A | 160 | 160 |
| Data_Screening_Script_Filename | Char | NoUnits | N/A | 160 | 160 |
| Data_Screening_Script_File_Contents | Char | NoUnits | N/A | 5,000 | 5,000 |
| List_of_Input_Files | Char | NoUnits | N/A | 30,000 | 30,000 |
| | | | | | |
| **Record Size (bytes)** | | | | | **35,568** |

### 2.20.3 Lidar Level 3 Tropospheric Aerosol Data Product Scientific Data Sets – Version 4.x

Tables 107 through 119 summarize the contents of each scientific data set (SDS) contained within the CALIPSO Lidar Level 3 Tropospheric Aerosol Data Product. Each parameter is listed using the same (SDS) name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

**Table 107: Spatial Coordinates – Version 4.x**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Longitude_Midpoint | Float_32 | deg | -180.0…180.0 | 72 | 288 |
| 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 108: Meteorological Context – Version 4.x**

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

## Table 109: Surface and Over-flight Parameters – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Surface_Elevation_Minimum | Float_32 | km | -1.0…9.0 | 1 | 4 |
| Surface_Elevation_Maximum | Float_32 | km | -1.0…9.0 | 1 | 4 |
| Surface_Elevation_Median | Float_32 | km | -1.0…9.0 | 1 | 4 |
| | | | | | |
| Land_Samples | Int_16 | NoUnits | 0…32,767 | 1 | 2 |
| Water_Samples | Int_16 | NoUnits | 0…32,767 | 1 | 2 |
| | | | | | |
| Days_Of_Month_Observed | UInt_32 | NoUnits | 0…4,294,967,295 | 1 | 4 |
| | | | | | |
| **Record Size (bytes)** | | | | | **20** |

## Table 110: Static Lidar Parameters – Version 4.x

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

## Table 111: Aerosol Optical Properties - All Species – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Extinction_Coefficient_532_Mean | Float_32 | $km^{-1}$ | 0.0…4.0 | 208 | 832 |
| Extinction_Coefficient_532_Standard_Deviation | Float_32 | $km^{-1}$ | 0.0…0.15 | 208 | 832 |
| Extinction_Coefficient_532_Percentiles | Float_32 | $km^{-1}$ | 0.0…4.0 | 2,288 | 9,152 |
| | | | | | |
| Samples_Searched | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Aerosol_Detected_Accepted | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Aerosol_Detected_Rejected | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Cloud_Detected | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Averaged | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| | | | | | |
| AOD_Mean | Float_32 | NoUnits | 0.0…5.0 | 1 | 4 |
| AOD_63_Percent_Below | Float_32 | km | 0.0…12.0 | 1 | 4 |
| AOD_90_Percent_Below | Float_32 | km | 0.0…12.0 | 1 | 4 |
| | | | | | |
| **Total Bytes per Record** | | | | | **12,908** |

## Table 112: Aerosol Optical Properties - Dust Only – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Extinction_Coefficient_532_Mean_Dust | Float_32 | $km^{-1}$ | 0.0…4.0 | 208 | 832 |
| Extinction_Coefficient_532_Standard_Deviation_Dust | Float_32 | $km^{-1}$ | 0.0…0.1 | 208 | 832 |
| | | | | | |
| Samples_Aerosol_Detected_Accepted_Dust | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Aerosol_Detected_Rejected_Dust | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Averaged_Dust | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| | | | | | |
| AOD_Mean_Dust | Float_32 | NoUnits | 0.0…5.0 | 1 | 4 |
| | | | | | |
| **Total Bytes per Record** | | | | | **2,916** |

## Table 113: Aerosol Optical Properties – Elevated Smoke Only – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Extinction_Coefficient_532_Mean_Elevated_Smoke | Float_32 | $km^{-1}$ | 0.0…4.0 | 208 | 832 |
| Extinction_Coefficient_532_Standard_Deviation_Elevated_Smoke | Float_32 | $km^{-1}$ | 0.0…0.1 | 208 | 832 |
| | | | | | |
| Samples_Aerosol_Detected_Accepted_Elevated_Smoke | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Aerosol_Detected_Rejected_Elevated_Smoke | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Averaged_Elevated_Smoke | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| | | | | | |
| AOD_Mean_Elevated_Smoke | Float_32 | NoUnits | 0.0…5.0 | 1 | 4 |
| | | | | | |
| **Total Bytes per Record** | | | | | **2,916** |

## Table 114: Aerosol Optical Properties – Polluted Dust Only – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Extinction_Coefficient_532_Mean_Polluted_Dust | Float_32 | $km^{-1}$ | 0.0…4.0 | 208 | 832 |
| Extinction_Coefficient_532_Standard_Deviation_Polluted_Dust | Float_32 | $km^{-1}$ | 0.0…0.1 | 208 | 832 |
| | | | | | |
| Samples_Aerosol_Detected_Accepted_Polluted_Dust | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Aerosol_Detected_Rejected_Polluted_Dust | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| Samples_Averaged_Polluted_Dust | Int_16 | NoUnits | 0…32,767 | 208 | 416 |
| | | | | | |
| AOD_Mean_Polluted_Dust | Float_32 | NoUnits | 0.0…5.0 | 1 | 4 |
| | | | | | |
| **Total Bytes per Record** | | | | | **2,916** |

## Table 115: Aerosol Type Distribution – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Aerosol_Type | Int_16 | NoUnits | 0…32,767 | 1,456 | 2,912 |
| Multiple_Aerosol_Type_Count | Int_16 | NoUnits | 0…32,767 | 8 | 16 |
| | | | | | |
| **Total Bytes per Record** | | | | | **2,928** |

## Table 116: Aerosol Spatial Distribution - All Species – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Number_Layers_Per_Column | Int_16 | NoUnits | 0…32,767 | 9 | 18 |
| Highest_Aerosol_Layer_Detected | Float_32 | km | 0.0…20.0 | 11 | 44 |
| Lowest_Aerosol_Layer_Detected | Float_32 | km | 0.0…20.0 | 11 | 44 |
| Layer_Separation_Minimum | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Maximum | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Median | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Mean | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Standard_Deviation | Float_32 | km | 0.0…5.0 | 7 | 28 |
| | | | | | |
| **Total Bytes per Record** | | | | | **246** |

## Table 117: Aerosol Spatial Distribution - Dust Only – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Number_Layers_Per_Column_Dust | Int_16 | NoUnits | 0…32,767 | 9 | 18 |
| Highest_Aerosol_Layer_Detected_Dust | Float_32 | km | 0.0…20.0 | 11 | 44 |
| Lowest_Aerosol_Layer_Detected_Dust | Float_32 | km | 0.0…20.0 | 11 | 44 |
| Layer_Separation_Minimum_Dust | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Maximum_Dust | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Median_Dust | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Mean_Dust | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Standard_Deviation_Dust | Float_32 | km | 0.0…5.0 | 7 | 28 |
| | | | | | |
| **Total Bytes per Record** | | | | | **246** |

## Table 118: Aerosol Spatial Distribution – Elevated Smoke Only – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Number_Layers_Per_Column_Elevated_Smoke | Int_16 | NoUnits | 0…32,767 | 9 | 18 |
| Highest_Aerosol_Layer_Detected_Elevated_Smoke | Float_32 | km | 0.0…20.0 | 11 | 44 |
| Lowest_Aerosol_Layer_Detected_Elevated_Smoke | Float_32 | km | 0.0…20.0 | 11 | 44 |
| Layer_Separation_Minimum_Elevated_Smoke | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Maximum_Elevated_Smoke | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Median_Elevated_Smoke | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Mean_Elevated_Smoke | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Standard_Deviation_Elevated_Smoke | Float_32 | km | 0.0…5.0 | 7 | 28 |
| | | | | | |
| **Total Bytes per Record** | | | | | **246** |

## Table 119: Aerosol Spatial Distribution – Polluted Dust Only – Version 4.x

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Number_Layers_Per_Column_Polluted_Dust | Int_16 | NoUnits | 0…32,767 | 9 | 18 |
| Highest_Aerosol_Layer_Detected_Polluted_Dust | Float_32 | km | 0.0…20.0 | 11 | 44 |
| Lowest_Aerosol_Layer_Detected_Polluted_Dust | Float_32 | km | 0.0…20.0 | 11 | 44 |
| Layer_Separation_Minimum_Polluted_Dust | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Maximum_Polluted_Dust | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Median_Polluted_Dust | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Mean_Polluted_Dust | Float_32 | km | 0.0…20.0 | 7 | 28 |
| Layer_Separation_Standard_Deviation_Polluted_Dust | Float_32 | km | 0.0…5.0 | 7 | 28 |
| | | | | | |
| **Total Bytes per Record** | | | | | **246** |

## 2.21 Lidar Level 3 Ice Cloud Product DP 3.3 – Version 1.00

The Lidar Level 3 ice cloud product reports global distributions of ice cloud extinction and ice water content histograms on a uniform spatial grid. All level 3 parameters are derived from the CALIPSO version 4.x level 2 5-km cloud profile products, with a temporal averaging of one month. The level 3 data product is distributed in hierarchical data format (HDF) files.

The major categories of the ice cloud product are:

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

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

Data File Name:

Standard: CAL_LID_L3_Ice_Cloud-ProductionStrategy-Version.Instance.hdf

### 2.21.1 Lidar Level 3 Ice Cloud Data Summary DP 3.3 – Version 1.00

**Table 120: Lidar Level 3 Ice Cloud Data Record – Version 1.00**

| Record Name | Reference | Record Size | Records/File | File Size (bytes) |
|---|---|---|---|---|
| Core Metadata | Appendix A | 899 | 1 | 899 |
| Archive Metadata | Appendix A | 4 | 1 | 4 |
| Lidar Level 3 Ice Cloud Data Product Metadata | Table 121 | 65,110 | 1 | 65,110 |
| Spatial Coordinates | Table 122 | 1,604 | 1 | 1,604 |
| Meteorological Context | Table 123 | 4,136 | 12,240 | 50,624,640 |
| Surface and Over-flight Parameters | Table 124 | 20 | 12,240 | 244,800 |
| Histogram Bin Boundaries | Table 125 | 1,056 | 1 | 1,056 |
| Extinction Coefficient and Ice Water Content | Table 126 | 31,648 | 12,240 | 387,371,520 |
| Sampling | Table 127 | 3,096 | 12,240 | 37,895,040 |
| | | | | |
| **Total Size Bytes** | | | | **476,204,673** |
| **Total Size Mbytes** | | | | **465.04** |

### 2.21.2 Lidar Level 3 Ice Cloud Data Product Metadata – Version 1.00

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 ice cloud data product are listed in Table 121.

**Table 121: Lidar Level 3 Ice Cloud Metadata Record – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | CAL_LID_L3_Ice_Cloud | 80 | 80 |
| Date_Time_of_Production | Char | NoUnits | 4/2006 – 12/2026 | 20 | 20 |
| Nominal_Year_Month | Char | NoUnits | N/A | 6 | 6 |
| Program_Configuration | Char | NoUnits | N/A | 5,000 | 5,000 |
| Number_of_Level2_Files_Analyzed | UInt_16 | NoUnits | 0…900 | 1 | 2 |
| Number_of_Bad_Profiles | UInt_16 | NoUnits | 0…65,535 | 1 | 2 |
| List_of_Input_Files | Char | NoUnits | N/A | 60,000 | 60,000 |
| | | | | | |
| **Record Size (bytes)** | | | | | **65,110** |

### 2.21.3 Lidar Level 3 Ice Cloud Data Product Scientific Data Sets – Version 1.00

Tables 122 through 127 summarize the contents of each scientific data set (SDS) contained within the CALIPSO lidar level 3 ice cloud product. Each parameter is listed using the same (SDS) name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

**Table 122: Spatial Coordinates – Version 1.00**

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

**Table 123: Meteorological Context – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Pressure_Mean | Float_32 | hPa | 1.0…1,086.0 | 172 | 688 |
| Pressure_Standard_Deviation | Float_32 | hPa | 0.0…50.0 | 172 | 688 |
| Temperature_Mean | Float_32 | $^{o}$C | -120.0…60.0 | 172 | 688 |
| Temperature_Standard_Deviation | Float_32 | $^{o}$C | 0.0…30.0 | 172 | 688 |
| Relative_Humidity_Mean | Float_32 | NoUnits | 0.0…1.5 | 172 | 688 |
| Relative_Humidity_Standard_Deviation | Float_32 | NoUnits | 0.0…0.80 | 172 | 688 |
| | | | | | |
| 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 |
| | | | | | |
| **Total Bytes per Record** | | | | | **4,136** |

**Table 124: Surface and Over-flight Parameters – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| DEM_Surface_Elevation_Minimum | Float_32 | km | -1.0…9.0 | 1 | 4 |
| DEM_Surface_Elevation_Maximum | Float_32 | km | -1.0…9.0 | 1 | 4 |
| DEM_Surface_Elevation_Median | Float_32 | km | -1.0…9.0 | 1 | 4 |
| | | | | | |
| Land_Surface_Samples | Int_16 | NoUnits | 0...32,767 | 1 | 2 |
| Water_Surface_Samples | Int_16 | NoUnits | 0...32,767 | 1 | 2 |
| Days_Of_Month_Observed | UInt_32 | NoUnits | 0…4,294,967,295 | 1 | 4 |
| | | | | | |
| **Record Size per record** | | | | | **20** |

## Table 125: Histogram Bin Boundaries – Version 1.00

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Extinction_Coefficient_532_Bin_Boundaries | Float_32 | $km^{-1}$ | -0.1…10.0 | 132 | 528 |
| Ice_Water_Content_Bin_Boundaries | Float_32 | $g{\cdot}m^{-3}$ | -0.01…1.0 | 132 | 528 |
| | | | | | |
| **Record Size (bytes)** | | | | | **1,056** |

## Table 126: Extinction Coefficient and Ice Water Content – Version 1.00

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Extinction_Coefficient_532_Histogram | Int_16 | NoUnits | 0…32,767 | 7,568 | 15,136 |
| Ice_Water_Content_Histogram | Int_16 | NoUnits | 0…32,767 | 7,568 | 15,136 |
| | | | | | |
| Extinction_Coefficient_532_Median | Float_32 | $km^{-1}$ | -0.1…10.0 | 172 | 688 |
| Ice_Water_Content_Median | Float_32 | $g{\cdot}m^{-3}$ | -0.01…1.0 | 172 | 688 |
| | | | | | |
| **Total Bytes per Record** | | | | | **31,648** |

## Table 127: Sampling – Version 1.00

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Lidar_Surface_Subsurface_Samples | Int_16 | NoUnits | 0…32,767 | 172 | 344 |
| Totally_Attenuated_Samples | Int_16 | NoUnits | 0…32,767 | 172 | 344 |
| Cloud_Free_Samples | Int_16 | NoUnits | 0…32,767 | 172 | 344 |
| Cloud_Samples | Int_16 | NoUnits | 0…32,767 | 172 | 344 |
| Water_Cloud_Samples | Int_16 | NoUnits | 0…32,767 | 172 | 344 |
| Unknown_Cloud_Samples | Int_16 | NoUnits | 0…32,767 | 172 | 344 |
| Ice_Cloud_Samples | Int_16 | NoUnits | 0…32,767 | 172 | 344 |
| Ice_Cloud_Rejected_Samples | Int_16 | NoUnits | 0…32,767 | 172 | 344 |
| Ice_Cloud_Accepted_Samples | Int_16 | NoUnits | 0…32,767 | 172 | 344 |
| | | | | | |
| **Total Bytes per Record** | | | | | **3,096** |

## 2.22 Lidar Level 3 Stratospheric Aerosol Profile Data Product DP 3.2 – Version 1.00

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

The major categories of the stratospheric aerosol product are:

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

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

Data File Name:

Standard: CAL_LID_L3_Stratospheric_APro-ProductionStrategy-Version.Instance.hdf

### 2.22.1 Lidar Level 3 Stratospheric Aerosol Profile Data Product Summary DP 3.2 – Version 1.00

**Table 128: Lidar Level 3 Stratospheric Aerosol Profile Data Record – Version 1.00**

| Record Name | Reference | Record Size | Records/File | File Size (bytes) |
|---|---|---|---|---|
| Core Metadata | Appendix A | 899 | 1 | 899 |
| Archive Metadata | Appendix A | 4 | 1 | 4 |
| Lidar Level 3 Stratospheric Aerosol Data Product Metadata | Table 129 | 61,300 | 1 | 61,300 |
| Spatial Coordinates | Table 130 | 332 | 1 | 332 |
| Meteorological Context | Table 131 | 128 | 612 | 78,336 |
| Over-flight Parameters | Table 132 | 2 | 612 | 1,224 |
| 532 nm Calibration Coefficients | Table 133 | 12 | 612 | 7,344 |
| 532 nm Background Component | Table 134 | 1,744 | 612 | 1,067,328 |
| 532 nm All Aerosol Component | Table 135 | 1,744 | 612 | 1,067,328 |
| | | | | |
| **Total Size Bytes** | | | | **2,284,095** |
| **Total Size Mbytes** | | | | **2.23** |

### 2.22.2 Lidar Level 3 Stratospheric Aerosol Profile Data Product Metadata – Version 1.00

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 stratospheric aerosol profile data product, are listed in Table 129.

**Table 129: Lidar Level 3 Stratospheric Aerosol Profile Metadata Record – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | CAL_LID_L3_Stratospheric_APro | 80 | 80 |
| Date_Time_of_Production | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Nominal_Year_Month | Char | NoUnits | N/A | 6 | 6 |
| Number_of_Level_1_Files_Analyzed | UInt_16 | NoUnits | 0…451 | 1 | 2 |
| List_of_Level_1_Input_Files | Char | NoUnits | N/A | 29,575 | 29,575 |
| List_of_Level_2_5kmMerged_Input_Files | Char | NoUnits | N/A | 29,575 | 29,575 |
| List_of_Level_2_PSC_Input_Files | Char | NoUnits | N/A | 2,015 | 2,015 |
| Initial_Aerosol_Lidar_Ratio_532 | Float_32 | NoUnits | N/A | 1 | 4 |
| Initial_Aerosol_Lidar_Ratio_Uncertainty_532 | Float_32 | NoUnits | N/A | 1 | 4 |
| Molecular_Backscatter_Cross_Section | Float_32 | NoUnits | N/A | 1 | 4 |
| Molecular_Extinction_Cross_Section | Float_32 | NoUnits | N/A | 1 | 4 |
| Ozone_Absorption_Cross_Section | Float_32 | NoUnits | N/A | 1 | 4 |
| | | | | | |
| **Record Size (bytes)** | | | | | **61,300** |

### 2.22.3 Lidar Level 3 Stratospheric Aerosol Profile Data Product Scientific Data Sets – Version 1.00

Tables 130 through 135 summarize the contents of each scientific data set (SDS) contained within the CALIPSO lidar level 3 stratospheric aerosol profile product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values.

**Table 130: Spatial Coordinates**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Longitude_Midpoint | Float_32 | deg | -180.0…180.0 | 18 | 72 |
| Latitude_Midpoint | Float_32 | deg | -85.0…85.0 | 34 | 136 |
| Altitude_Midpoint | Float_32 | km | 8.2…36.2 | 31 | 124 |
| | | | | | |
| **Record Size (bytes)** | | | | | **332** |

**Table 131: Meteorological Context**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Tropopause_Height_Mean | Float_32 | km | 5.0…18.0 | 1 | 4 |
| Potential_Temperature_Mean | Float_32 | K | 300.0…1,250.0 | 31 | 124 |
| | | | | | |
| **Total Bytes per Record** | | | | | **128** |

**Table 132: Over-flight Parameters**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Number_of_Granules | Int_16 | NoUnits | 0…451 | 1 | 2 |
| | | | | | |
| **Record Size per record** | | | | | **2** |

**Table 133: 532 nm Calibration Coefficients**

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

## Table 134: 532 nm Background Component

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Stratospheric_Optical_Depth_Background | Float_32 | NoUnits | -0.05…0.06 | 1 | 4 |
| Stratospheric_Optical_Depth_Uncertainty_Background | Float_32 | NoUnits | 0.0…0.02 | 1 | 4 |
| Total_Attenuated_Backscatter_Background | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…5.3E-4 | 31 | 124 |
| Total_Attenuated_Backscatter_Standard_Deviation_Background | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…2.1E-5 | 31 | 124 |
| Samples_Accepted_Background | Int_32 | NoUnits | 0…8,000 | 31 | 124 |
| Samples_Rejected_Background | Int_32 | NoUnits | 0…8,000 | 31 | 124 |
| Molecular_Backscatter_Background | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…5.3E-4 | 31 | 124 |
| Molecular_Backscatter_Standard_Deviation_Background | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…2.1E-5 | 31 | 124 |
| Ozone_Absorption_Coefficient_Background | Float_32 | $km^{-1}$ | 0.0…1.9E-3 | 31 | 124 |
| Ozone_Absorption_Coefficient_Standard_Deviation_Background | Float_32 | $km^{-1}$ | 0.0…8.0E-5 | 31 | 124 |
| Attenuated_Scattering_Ratio_Background | Float_32 | NoUnits | 0.30…1.70 | 31 | 124 |
| Attenuated_Scattering_Ratio_Uncertainty_Background | Float_32 | NoUnits | 0.03…0.35 | 31 | 124 |
| Particulate_Backscatter_Background | Float_32 | $km^{-1}\cdot sr^{-1}$ | -1.1E-4…1.3E-4 | 31 | 124 |
| Particulate_Backscatter_Uncertainty_Background | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…4.5E-5 | 31 | 124 |
| Extinction_Coefficient_Background | Float_32 | $km^{-1}$ | -5.4E-3…6.5E-3 | 31 | 124 |
| Extinction_Coefficient_Uncertainty_Background | Float_32 | $km^{-1}$ | 0.0…2.6E-3 | 31 | 124 |
| | | | | | |
| **Total Bytes per Record** | | | | | **1,744** |

## Table 135: 532 nm All Aerosol Component

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Stratospheric_Optical_Depth | Float_32 | NoUnits | -0.02…2.00 | 1 | 4 |
| Stratospheric_Optical_Depth_Uncertainty | Float_32 | NoUnits | 2.4E-4…0.40 | 1 | 4 |
| Total_Attenuated_Backscatter | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…6.3E-4 | 31 | 124 |
| Total_Attenuated_Backscatter_Standard_Deviation | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…2.2E-4 | 31 | 124 |
| Samples_Accepted | Int_32 | NoUnits | 0…8,000 | 31 | 124 |
| Samples_Rejected | Int_32 | NoUnits | 0…8,000 | 31 | 124 |
| Molecular_Backscatter | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…5.3E-4 | 31 | 124 |
| Molecular_Backscatter_Standard_Deviation | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…2.1E-5 | 31 | 124 |
| Ozone_Absorption_Coefficient | Float_32 | $km^{-1}$ | 0.0…1.9E-3 | 31 | 124 |
| Ozone_Absorption_Coefficient_Standard_Deviation | Float_32 | $km^{-1}$ | 0.0…9.5E-5 | 31 | 124 |
| Attenuated_Scattering_Ratio | Float_32 | NoUnits | 0.60…25.0 | 31 | 124 |
| Attenuated_Scattering_Ratio_Uncertainty | Float_32 | NoUnits | 0.03…5.6 | 31 | 124 |
| Particulate_Backscatter | Float_32 | $km^{-1}\cdot sr^{-1}$ | -6.2E-5…0.15 | 31 | 124 |
| Particulate_Backscatter_Uncertainty | Float_32 | $km^{-1}\cdot sr^{-1}$ | 0.0…2.1E-2 | 31 | 124 |
| Extinction_Coefficient | Float_32 | $km^{-1}$ | -3.2E-3…7.5 | 31 | 124 |
| Extinction_Coefficient_Uncertainty | Float_32 | $km^{-1}$ | 0.0…1.56 | 31 | 124 |
| | | | | | |
| **Total Bytes per Record** | | | | | **1,744** |

## 2.23 Lidar Level 3 Cloud Occurrence Data Product DP 3.4 – Version 1.00

The Lidar Level 3 Cloud Occurrence product reports global distributions of cloud occurrence by counts on a uniform spatial grid. At each grid, the number of detected ice cloud samples is also reported as a histogram of ice cloud layer optical depth. All level 3 parameters are derived from the CALIPSO version 4.x level 2 5 km cloud profile products, with a temporal averaging of one month. The level 3 data product is distributed in hierarchical data format (HDF) files.

The major categories of the cloud occurrence product are:

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

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

Data File Name:

Standard: CAL_LID_L3_Cloud_Occurrence-ProductionStrategy-Version.Instance.hdf

### 2.23.1 Lidar Level 3 Cloud Occurrence Data Product Summary DP 3.4 – Version 1.00

**Table 136: Lidar Level 3 Cloud Occurrence Data Record Summary – Version 1.00**

| Record Name | Reference | Record Size | Records/File | File Size (bytes) |
|---|---|---|---|---|
| Core Metadata | Appendix A | 899 | 1 | 899 |
| Archive Metadata | Appendix A | 4 | 1 | 4 |
| Lidar Level 3 Cloud Occurrence Data Product Metadata | Table 137 | 15,112 | 1 | 15,112 |
| Spatial Coordinates | Table 138 | 2,292 | 1 | 2,292 |
| Meteorological Context | Table 139 | 8,264 | 12,240 | 101,151,360 |
| Surface and Over-flight Parameters | Table 140 | 44 | 12,240 | 538,560 |
| Sampling | Table 141 | 13,072 | 12,240 | 160,001,280 |
| | | | | |
| **Total Size Bytes** | | | | **261,709,507** |
| **Total Size Mbytes** | | | | **255.58** |

### 2.23.2 Lidar Level 3 Cloud Occurrence Data Product Metadata – Version 1.00

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 cloud occurrence data product are listed in Table 137.

**Table 137: Lidar Level 3 Cloud Occurrence Metadata Record – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | CAL_LID_L3_Cloud_ Occurrence | 80 | 80 |
| Date_Time_of_Production | Char | NoUnits | 4/2006 – 12/2026 | 20 | 20 |
| Nominal_Year_Month | Char | NoUnits | N/A | 6 | 6 |
| Program_Configuration | Char | NoUnits | N/A | 5,000 | 5,000 |
| Number_of_Level2_Files_Analyzed | UInt_16 | NoUnits | 0…900 | 1 | 2 |
| Number_of_Bad_333m_Profiles | UInt_16 | NoUnits | 0…6,553 | 1 | 2 |
| Number_of_Bad_5km_Profiles | UInt_16 | NoUnits | 0…6,553 | 1 | 2 |
| List_of_Input_MLay_Files | Char | NoUnits | N/A | 5,000 | 5,000 |
| List_of_Input_CPro_Files | Char | NoUnits | N/A | 5,000 | 5,000 |
| | | | | | |
| **Record Size (bytes)** | | | | | **15,112** |

### 2.23.3 Lidar Level 3 Cloud Occurrence Data Product Scientific Data Sets – Version 1.00

Tables 138 through 141 summarize the contents of each scientific data set (SDS) contained within the CALIPSO lidar level 3 cloud occurrence product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values. Table 142 contains the bin boundaries of the ice cloud optical depth histogram.

**Table 138: Spatial Coordinates**

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

**Table 139: Meteorological Context**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Pressure_Mean | Float_32 | hPa | 1.0…1,086.0 | 344 | 1,376 |
| Pressure_Standard_Deviation | Float_32 | hPa | 0.0…50.0 | 344 | 1,376 |
| Temperature_Mean | Float_32 | ºC | -120.0…60.0 | 344 | 1,376 |
| Temperature_Standard_Deviation | Float_32 | ºC | 0.0…30.0 | 344 | 1,376 |
| Relative_Humidity_Mean | Float_32 | NoUnits | 0.0…1.5 | 344 | 1,376 |
| Relative_Humidity_Standard_Deviation | Float_32 | NoUnits | 0.0…0.80 | 344 | 1,376 |
| | | | | | |
| 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 |
| | | | | | |
| **Total Bytes per Record** | | | | | **8,264** |

**Table 140: Surface and Over-flight Parameters**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| DEM_Surface_Elevation_Minimum | Float_32 | km | -1.0…9.0 | 1 | 4 |
| DEM_Surface_Elevation_Maximum | Float_32 | km | -1.0…9.0 | 1 | 4 |
| DEM_Surface_Elevation_Median | Float_32 | km | -1.0…9.0 | 1 | 4 |
| | | | | | |
| Snow_Ice_Surface_Mean | Float_32 | % | 0.0…100.0 | 1 | 4 |
| Snow_Ice_Surface_Standard_Deviation | Float_32 | % | 0.0…100.0 | 1 | 4 |
| Snow_Ice_Surface_Minimum | Float_32 | % | 0.0…100.0 | 1 | 4 |
| Snow_Ice_Surface_Maximum | Float_32 | % | 0.0…100.0 | 1 | 4 |
| Snow_Ice_Surface_Median | Float_32 | % | 0.0…100.0 | 1 | 4 |
| | | | | | |
| Land_Surface_Samples | Int_32 | NoUnits | 0...65,535 | 1 | 4 |
| Water_Surface_Samples | Int_32 | NoUnits | 0...65,535 | 1 | 4 |
| Days_Of_Month_Observed | UInt_32 | NoUnits | 0…4,294,967,295 | 1 | 4 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| | | | | | |
| **Record Size per record** | | | | | **44** |

**Table 141: Sampling**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Lidar_Surface_Subsurface_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Totally_Attenuated_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Cloud_Free_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Cloud_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Cloud_Rejected_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Cloud_Accepted_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Unknown_Cloud_Transparent_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Unknown_Cloud_Opaque_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Water_Cloud_Transparent_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Water_Cloud_Opaque_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Ice_Cloud_Transparent_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Ice_Cloud_Opaque_Samples | Int_16 | NoUnits | 0…32,767 | 344 | 688 |
| Ice_Cloud_Optical_Depth_Histogram[A] | Int_16 | NoUnits | 0…32,767 | 2,408 | 4,816 |
| | | | | | |
| **Total Bytes per Record** | | | | | **13,072** |

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

**Table 142: Ice Cloud Optical Depth Histogram Boundaries**

| Bin | Optical Depth Range |
|---|---|
| 0 | Optical Depth < 0.01 |
| 1 | 0.01 ≤ Optical Depth < 0.03 |
| 2 | 0.03 ≤ Optical Depth < 0.10 |
| 3 | 0.10 ≤ Optical Depth < 0.30 |
| 4 | 0.30 ≤ Optical Depth < 1.00 |
| 5 | Optical Depth ≥ 1.00 & Transparent |
| 6 | Reserved |

## 2.24 Lidar Level 3 GEWEX Cloud Data Product DP 3.5 – Version 1.00

The Lidar Level 3 (L3) CALIPSO Global Energy and Water cycle Experiment (GEWEX) Cloud product is a reformatted version of CALIPSO's contribution to the GEWEX cloud assessment of global cloud datasets from satellites (https://climserv.ipsl.polytechnique.fr/gewexca/index.html). The data provided by CALIPSO for this project had to conform to a very specific format; yearly netCDF files organized by parameter. In order to be compatible with other publicly orderable Lidar L3 CALIPSO aerosol and cloud products, which are reported as monthly HDF files, this new Lidar L3 CALIPSO GEWEX cloud product was created. These files report global distributions of cloud amount and cloud top as averages and histograms on a uniform 2-dimensional (2D) spatial grid. All level 3 parameters are derived from the CALIPSO version 4.x level 2 5-km cloud merged layer products, with a temporal averaging of one month.

The major categories of the cloud occurrence product are:

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

| | | |
|---|---|---|
| Level: | 3 | |
| Type: | Archival | |
| Frequency: | 3 files per month | |
| Missing Value: | -9999.0 | |
| Record Temporal Coverage: | daytime, nighttime, all | |
| Record Spatial Coverage: | horizontal: | 360° longitude (180°W to 180°E) |
| | | 180° latitude (90°N to 90°S) |
| | vertical: | -0.5 km to 20.2 km |
| Record Spatial Resolution: | horizontal: | 1.0 ° longitude by 1.0° latitude |
| | vertical: | low, middle and high altitudes |

Data File Name:

Standard: CAL_LID_L3_GEWEX_Cloud-ProductionStrategy-Version.Instance.hdf

### 2.24.1 Lidar Level 3 GEWEX Cloud Data Product Summary DP 3.5 – Version 1.00

**Table 143: Lidar Level 3 GEWEX Cloud Data Product Summary – Version 1.00**

| Record Name | Reference | Record Size | Records/File | File Size (bytes) |
|---|---|---|---|---|
| Core Metadata | Appendix A | 899 | 1 | 899 |
| Archive Metadata | Appendix A | 4 | 1 | 4 |
| Lidar Level 3 GEWEX Data Product Metadata | Table 144 | 65,110 | 1 | 65,110 |
| Spatial Coordinates | Table 145 | 2,160 | 1 | 2,160 |
| Over-flight Parameter | Table 146 | 2 | 64,800 | 129,600 |
| Histogram Bin Boundaries | Table 147 | 804 | 1 | 804 |
| Cloud Amount | Table 148 | 368 | 64,800 | 23,846,400 |
| Cloud top temperature, pressure and height | Table 149 | 2,040 | 64,800 | 132,192,000 |
| | | | | |
| **Total Size Bytes** | | | | **156,236,977** |
| **Total Size Mbytes** | | | | **152.57** |

### 2.24.2 Lidar Level 3 GEWEX Cloud Data Product Metadata – Version 1.00

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 GEWEX cloud data product are listed in Table 144.

**Table 144: Lidar Level 3 GEWEX Cloud Metadata Record – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | CAL_LID_L3_GEWEX_Cloud | 80 | 80 |
| Date_Time_of_Production | Char | NoUnits | 4/2006 – 12/2026 | 20 | 20 |
| Nominal_Year_Month | Char | NoUnits | N/A | 6 | 6 |
| Day_Night_Flag | Char | NoUnits | D = daytime<br>N = nighttime<br>A = all | 2 | 2 |
| Program_Configuration | Char | NoUnits | N/A | 5,000 | 5,000 |
| Number_of_Level2_Files_Analyzed | UInt_16 | NoUnits | 0…900 | 1 | 2 |
| List_of_Input_Files | Char | NoUnits | N/A | 60,000 | 60,000 |
| | | | | | |
| **Total Size (bytes)** | | | | | **65,110** |

### 2.24.3 Lidar Level 3 GEWEX Cloud Data Product Scientific Data Sets – Version 1.00

Tables 145 through 149 summarize the contents of each scientific data set (SDS) contained within the CALIPSO lidar Level 3 GEWEX Cloud Product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values. Appendix E provides a detailed comparison between the variables in this product and the corresponding parameter names in the GEWEX Cloud Assessment Database.

**Table 145: Spatial Coordinates – Version 1.00**

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

**Table 146: Over-flight Parameters – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Number_Of_Orbit_Tracks | Int_16 | NoUnits | 0…32,767 | 1 | 2 |
| | | | | | |
| **Total Size Per Record (bytes)** | | | | | **2** |
| **Total Size (bytes)** | | | | | **129,600** |

**Table 147: Histogram Bin Boundaries – Version 1.00**

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

## Table 148: Cloud Amount – Version 1.00

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

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Middle_Cloud_Amount_Mean_Opaque | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Middle_Cloud_Amount_Ratio_Opaque | Float_32 | % | 0.0…100.0 | 1 | 4 |
| Low_Cloud_Amount_Mean_Opaque | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Low_Cloud_Amount_Ratio_Opaque | Float_32 | % | 0.0…100.0 | 1 | 4 |
| Ice_Cloud_Amount_Mean_Opaque | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Ice_Cloud_Amount_Ratio_Opaque | Float_32 | % | 0.0…100.0 | 1 | 4 |
| Water_Cloud_Amount_Mean_Opaque | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Water_Cloud_Amount_Ratio_Opaque | Float_32 | % | 0.0…100.0 | 1 | 4 |
| High_Ice_Cloud_Amount_Mean_Opaque | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| High_Ice_Cloud_Amount_Ratio_Opaque | Float_32 | % | 0.0…100.0 | 1 | 4 |
| | | | | | |
| **Total Size Per Record (Bytes)** | | | | | **368** |

## Table 149: Cloud Top Temperature, Pressure, and Height – Version 1.00

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

## 2.25 IIR Level 3 GEWEX Cloud Data Product DP 3.6 – Version 1.00

The IIR Level 3 (L3) Global Energy and Water cycle Experiment (GEWEX) Cloud Product reports global distributions of IIR cloud effective radius and water path averages and histograms on a uniform 2-dimensional (2D) spatial grid. This product is designed to follow the general guidance of the GEWEX Cloud Assessment. Cloud amount, radiative temperature, effective emissivity, and optical depth characterize the cloud samples for which IIR microphysical retrievals are reported. Cloud properties are reported for ice clouds, liquid water clouds, and for high ice clouds of layer pressure lower than 440 hPa. All level 3 parameters are derived from the IIR version 4 level 2 track products, with a temporal averaging of one month.

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

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

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

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

Data File Name:

Standard: CAL_IIR_L3_GEWEX_Cloud-ProductionStrategy-Version.Instance.hdf

### 2.25.1 IIR Level 3 GEWEX Cloud Data Product Summary DP 3.6 – Version 1.00

**Table 150: IIR Level 3 GEWEX Cloud Data Product Summary – Version 1.00**

| Record Name | Reference | Record Size | Records/File | File Size (bytes) |
|---|---|---|---|---|
| Core Metadata | Appendix A | 899 | 1 | 899 |
| Archive Metadata | Appendix A | 4 | 1 | 4 |
| IIR Level 3 GEWEX Cloud Data Product Metadata | Table 151 | 65,100 | 1 | 65,100 |
| Spatial Coordinates | Table 152 | 2,160 | 1 | 2,160 |
| Over-flight Parameter | Table 153 | 2 | 64,800 | 129,600 |
| Histogram Bin Boundaries | Table 154 | 1,144 | 1 | 1,144 |
| Cloud Amount | Table 155 | 24 | 64,800 | 1,555,200 |
| Cloud Radiative Temperature | Table 156 | 348 | 64,800 | 22,550,400 |
| Cloud Effective Emissivity | Table 157 | 72 | 64,800 | 4,665,600 |
| Cloud Effective Radius | Table 158 | 340 | 64,800 | 22,032,000 |
| Cloud Water Path | Table 159 | 276 | 64,800 | 17,884,800 |
| Cloud Optical Depth | Table 160 | 700 | 64,800 | 45,360,000 |
| | | | | |
| **Total Size Bytes** | | | | **114,246,907** |
| **Total Size Mbytes** | | | | **111.569** |

### 2.25.2 IIR Level 3 GEWEX Cloud Data Product Metadata – Version 1.00

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 IIR Level 3 GEWEX cloud data product are listed in Table 151.

**Table 151: IIR Level 3 GEWEX Cloud Metadata Record – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | CAL_IIR_L3_GEWEX_Cloud | 80 | 80 |
| Date_Time_of_Production | Char | NoUnits | 4/2006 – 12/2026 | 20 | 20 |
| Nominal_Year_Month | Char | NoUnits | N/A | 6 | 6 |
| Day_Night_Flag | Char | NoUnits | D = daytime<br>N = nighttime<br>A = all | 2 | 2 |
| Program_Configuration | Char | NoUnits | N/A | 5,000 | 5,000 |
| Number_of_Level2_Files_Analyzed | UInt_16 | NoUnits | 0…900 | 1 | 2 |
| List_of_Input_Files | Char | NoUnits | N/A | 60,000 | 60,000 |
| | | | | | |
| **Total Size (bytes)** | | | | | **65,110** |

### 2.25.3 IIR Level 3 GEWEX Cloud Data Product Scientific Data Sets – Version 1.00

Tables 152 through 160 summarize the contents of each scientific data set (SDS) contained within the CALIPSO IIR Level 3 GEWEX Cloud Product. Each parameter is listed using the same SDS name that is used in the respective HDF files. Units are given for each parameter, as is the range of valid data values. Appendix G provides a detailed comparison between the variables in this product and the corresponding parameter names in the GEWEX Cloud Assessment Database.

**Table 152: Spatial Coordinates – Version 1.00**

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

**Table 153: Over-Flight Parameter – Version 1.00**

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

**Table 154: Histogram Bin Boundaries – Version 1.00**

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

## Table 155: Cloud Amount – Version 1.00

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Number_Of_Valid_Pixels_IIR | Int_32 | NoUnits | 0…18,043,200 | 1 | 4 |
| Number_Of_Candidate_Clouds_IIR | Int_32 | NoUnits | 0…18,043,200 | 1 | 4 |
| Cloud_Amount_Mean_IIR | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Ice_Cloud_Amount_Mean_IIR | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| Water_Cloud_Amount_Mean_IIR | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| High_Ice_Cloud_Amount_Mean_IIR | Float_32 | NoUnits | 0.0…1.0 | 1 | 4 |
| | | | | | |
| **Total Size Per Record (Bytes)** | | | | | **24** |

## Table 156: Cloud Radiative Temperature – Version 1.00

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

## Table 157: Cloud Effective Emissivity – Version 1.00

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

## Table 158: Cloud Effective Radius – Version 1.00

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

## Table 159: Cloud Water Path – Version 1.00

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Ice_Water_Path_Mean_IIR | Float_32 | $g/m^2$ | 0.0…3000.0 | 1 | 4 |
| Ice_Water_Path_Histogram_IIR | Int_32 | NoUnits | 0…18,043,200 | 22 | 88 |
| Liquid_Water_Path_Mean_IIR | Float_32 | $g/m^2$ | 0.0…3000.0 | 1 | 4 |
| Liquid_Water_Path_Histogram_IIR | Int_32 | NoUnits | 0…18,043,200 | 22 | 88 |
| High_Ice_Water_Path_Mean_IIR | Float_32 | $g/m^2$ | 0.0…3000.0 | 1 | 4 |
| High_Ice_Water_Path_Histogram_IIR | Int_32 | NoUnits | 0…18,043,200 | 22 | 88 |
| | | | | | |
| **Total Size Per Record (Bytes)** | | | | | **276** |

## Table 160: Cloud Optical Depth – Version 1.00

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

## 3.0 Level 0 Input Data Products

This section describes the CALIPSO Level 0 input data products that are stored at the NASA 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 161 consists of data averaged from 15 lidar shots with the instantaneous field of view for each shot occurring every 333 m along track.

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

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

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

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

## 3.2 Imaging Infrared Radiometer Level 0 Data

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

## 3.3 Wide Field Camera Level 0 Data

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

## 4.0 Ancillary Input Data Products

This section describes the ancillary data products, which are stored at the NASA 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 or 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 Digital Elevation Model (DEM)

For version 3.x and version 4.x, a DEM provided by the SDP Toolkit is employed. The Toolkit's DEM tools provide access to a hierarchy of DEM data sets irrespective of tile boundaries or resolutions. The version(s) of the toolkit used by CALIPSO relies on the GTOPO30 DEM. 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: https://newsroom.gsfc.nasa.gov/sdptoolkit/3km_announcement_5261.txt for more information.

For version 4.x Lidar Level 1 and Level 2, a DEM derived by CloudSat is employed. In this instance, the elevations are not read in by the Toolkit, but rather are imported directly from the DEM files provided by the CloudSat Science Team.

## 4.5 Land and Water Coverage

The land/water mask included in either the Toolkit DEM (30 arc second resolution) or the CloudSat DEM (15 arc second resolution) data set is 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[a] |
| Moderated or continental ocean | 6 [a] |
| Deep ocean | 7 |

a – Land/Water Masks values of 0, 5, and 6 are not contained in both Version 4.x Lidar Levels 1 and 2.

## 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 18$^{th}$ 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
https://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: https://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 (Version 3.x) and Snow_Ice_Surface_Type (Lidar Version 4.x) 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 Expedited Data Product – Version 3.50

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. 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 (-0.5 km to 20.2 km) |
| | 20 km horizontal x 180 m vertical (20.2 km to 30.1 km) |
| **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 Expedited Data Product – Version 3.50

**Table 163: Lidar Level 1.5 Instrument Record Summary – Version 3.50**

| 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 164 | 22,437 | 1 | 22,437 |
| Lidar Profile Science Record | Table 165 | 38,509 | 1,816 | 69,932,344 |
| | | | | |
| **Total Size (bytes)** | | | | 69,955,684 |
| **Total Size (Mbytes)** | | | | 68.31 |

### 5.1.2 Lidar Level 1.5 Expedited Data Metadata – Version 3.50

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 164.

**Table 164: Lidar Level 1.5 Metadata Record – Version 3.50**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | L1.5_LIDAR_Expedited | 80 | 80 |
| Date_Time_at_Granule_Start[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Initial_Subsatellite_Latitude | Float_32 | deg | -90.0…90.0 | 1 | 4 |
| Initial_Subsatellite_Longitude | Float_32 | deg | -180.0…180.0 | 1 | 4 |
| Final_Subsatellite_Latitude | Float_32 | deg | -90.0…90.0 | 1 | 4 |
| Final_Subsatellite_Longitude | Float_32 | deg | -180.0…180.0 | 1 | 4 |
| Orbit_Number_at_Granule_Start | UInt_32 | 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…261,231.0 | 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…261,231.0 | 1 | 8 |
| GEOS_Version | Char | NoUnits | N/A | 64 | 64 |
| Level1_Filename | Char | NoUnits | N/A | 160 | 160 |
| Level2_VFM_Filename | Char | NoUnits | N/A | 160 | 160 |
| Level2_APro_Filename | Char | NoUnits | N/A | 160 | 160 |
| Lidar_Data_Altitudes | Float_32 | km | -0.5…30.1 | 400 | 1,600 |
| Rayleigh_Extinction_Cross-section_532 | Float_32 | $m^2$ | 5.167E-31 | 1 | 4 |
| Rayleigh_Extinction_Cross-section_1064 | Float_32 | $m^2$ | 3.127E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_532 | Float_32 | $m^2 \cdot sr^{-1}$ | 5.930E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_1064 | Float_32 | $m^2 \cdot sr^{-1}$ | 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 |
| 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 |
| Production_Script | Char | NoUnits | N/A | 20,000 | 20,000 |
| | | | | | |
| **Record Size (bytes)** | | | | | **22,437** |

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 Expedited Data Scientific Data Set – Version 3.50

Table 165 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 165: Lidar Profile Data – Version 3.50**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Latitude (midpoint) | Float_32 | deg | -90.0…90.0 | 1 | 4 |
| Longitude (midpoint) | Float_32 | deg | -180.0…180.0 | 1 | 4 |
| Profile_Time (midpoint)[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 |
| Land_Water_Mask | Int_8 | NoUnits | 0…7 | 4 | 4 |
| Surface_Elevation_Mean | Float_32 | km | -1.0…9.0 | 1 | 4 |
| Surface_Elevation_StDev | Float_32 | km | 0.0…9.0 | 1 | 4 |
| Samples_Averaged | UInt_16 | NoUnits | 0… 360 | 400 | 800 |
| Laser_Energy_Statistics_532 (min, max, mean, median) | Float_32 | J | 0.003…0.135 | 4 | 16 |
| Laser_Energy_Statistics_1064 (min, max, mean, median) | Float_32 | J | 0.003…0.135 | 4 | 16 |
| Minimum_Laser_Energy_532 | Float_32 | J | 0.003…0.135 | 1 | 4 |
| Calibration_Constant_Parallel_532 | Float_32 | $km^3 \cdot sr \cdot J^1 \cdot count$ | 3.0E10…9.0E10 | 1 | 4 |
| Calibration_Constant_Parallel_Uncertainty_532 | Float_32 | $km^3 \cdot sr \cdot J^1 \cdot count$ | 1.2E9…2.6E9 | 1 | 4 |
| Total_Attenuated_Backscatter_532_Mean | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.1 | 400 | 1,600 |
| Total_Attenuated_Backscatter_532_Median | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.1 | 400 | 1,600 |
| Total_Attenuated_Backscatter_532_StDev | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.3 | 400 | 1,600 |
| Total_Attenuated_Backscatter_Uncertainty_532 | Float 32 | $km^{-1} \cdot sr^{-1}$ | 1E-5…1E-2 | 400 | 1,600 |
| Extinction_Coefficient_532_Mean | Float_32 | $km^{-1}$ | 0.0…1.25 | 400 | 1,600 |
| Extinction_Coefficient_532_Median | Float_32 | $km^{-1}$ | 0.0…1.25 | 400 | 1,600 |
| Extinction_Coefficient_532_StDev | Float_32 | $km^{-1}$ | 0.0…1.25 | 400 | 1,600 |
| Extinction_Coefficient_Uncertainty_532 | Float_32 | $km^{-1}$ | 0.0…99.99 | 400 | 1,600 |
| Extinction_QC_Flag_532[F] | UInt_16 | NoUnits | 0…32,768 | 400 | 800 |
| Calibration_Constant_Perpendicular_532 | Float_32 | $km^3 \cdot sr \cdot J^1 \cdot count$ | 3.0E10…9.0E10 | 1 | 4 |
| Calibration_Constant_Perpendicular_Uncertainty_532 | Float_32 | $km^3 \cdot sr \cdot J^1 \cdot count$ | 1.2E9…2.6E9 | 1 | 4 |
| Perpendicular_Attenuated_Backscatter_532_Mean | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…1.5 | 400 | 1,600 |
| Perpendicular_Attenuated_Backscatter_532_Median | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…1.5 | 400 | 1,600 |
| Perpendicular_Attenuated_Backscatter_532_StDev | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.3 | 400 | 1,600 |
| Perpendicular_Attenuated_Backscatter_Uncertainty_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 1E-6…1E-3 | 400 | 1,600 |
| Calibration_Constant_1064 | Float_32 | $km^3 \cdot sr \cdot J^1 \cdot count$ | 3.0E10…9.0E10 | 1 | 4 |
| Calibration_Constant_Uncertainty_1064 | Float_32 | $km^3 \cdot sr \cdot J^1 \cdot count$ | 1.2E9…2.6E9 | 1 | 4 |
| Attenuated_Backscatter_1064_Mean | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.1 | 400 | 1,600 |
| Attenuated_Backscatter_1064_Median | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.1 | 400 | 1,600 |
| Attenuated_Backscatter_1064_StDev | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.3 | 400 | 1,600 |
| Attenuated_Backscatter_Uncertainty_1064 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 1E-5…1E-2 | 400 | 1,600 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Molecular_Number_Density[G] | Float_32 | $m^{-3}$ | $8x10^{22}…5x10^{25}$ | 400 | 1,600 |
| Ozone_Number_Density[G] | Float_32 | $m^{-3}$ | $1x10^{17}…1x10^{19}$ | 400 | 1,600 |
| Molecular_Model_Attenuated_Backscatter_532[G] | Float_32 | $km^{-1}·sr^{-1}$ | 5E-4…2E-3 | 400 | 1,600 |
| Molecular_Model_Attenuated_Backscatter_1064[G] | Float_32 | $km^{-1}·sr^{-1}$ | 5E-4…2E-3 | 400 | 1,600 |
| Temperature[G] | Float_32 | ºC | -120.0…60.0 | 400 | 1,600 |
| Pressure[G] | Float_32 | mb | 1.0…1086.0 | 400 | 1,600 |
| Tropopause_Height_Mean[G] | Float_32 | km | 4.0…22.0 | 1 | 4 |
| L2_Feature_Type | UInt_8 | NoUnits | 0… 29 | 400 x 4 | 1,600 |
| | | | | | |
| **Total Bytes per Record** | | | | | **38,509** |

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 expedited version of the lidar level 1.5 data product contains data recorded during both day and night since each granule spans 90 continuous minutes of the satellite orbit. Consequently, the day/night terminator can be crossed within the 20 km horizontal averaging interval. The Day_Night_Flag is assigned a value of 2 denoting day & night segments when the day/night terminator is crossed within a lidar level 1.5 expedited product profile.
F) Reports the bitwise OR of all extinction QC flags within each 20 km x 60 m segment.
G) Based on GMAO data.

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

### 5.1.4 L2_Feature_Type values – Version 3.50

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

| | | |
|---|---|---|
| 0 | = | invalid (bad or missing data) |
| 1 | = | totally attenuated |
| 2 | = | surface |
| 3 | = | subsurface |
| 4 | = | cloud |
| 5 | = | clean marine |
| 6 | = | dust |
| 7 | = | polluted continental |
| 8 | = | clean continental |
| 9 | = | polluted dust |
| 10 | = | smoke |
| 11 | = | dusty marine |
| 12 | = | PSC aerosol |
| 13 | = | volcanic ash |
| 14 | = | sulfate/other |
| 15 | = | mixed aerosol |
| 16 | = | cloud-cleared clean marine |
| 17 | = | cloud-cleared dust |
| 18 | = | cloud-cleared polluted continental |
| 19 | = | cloud-cleared clean continental |
| 20 | = | cloud-cleared polluted dust |
| 21 | = | cloud-cleared smoke |
| 22 | = | cloud-cleared dusty marine |
| 23 | = | cloud-cleared PSC aerosol |
| 24 | = | cloud-cleared volcanic ash |
| 25 | = | cloud-cleared sulfate/other |
| 26 | = | cloud-cleared mixed aerosol |
| 27 | = | "clear air" |
| 28 | = | cloud-cleared "clear-air" |
| 29 | = | overcast |

Note that aerosol type classifications of dusty marine, PSC aerosol, volcanic ash, and sulfate/other do not exist in the level 1.5 expedited version 3.x data product because these aerosol types were not implemented until version 4.x of the CALIOP level 2 products.

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

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

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

Note that no features are labeled “stratospheric” in the level 1.5 expedited product. The convention for handling stratospheric features is as follows. Between 60° N and 60° S, stratospheric features having medium and high feature type QA confidence 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 29 are not included when computing the cloud-cleared averaged data that is recorded in the attenuated backscatter and aerosol extinction coefficient profiles.

## 5.2 Lidar Level 1.5 Standard Data Product – Version 1.00

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

| | |
|---|---|
| **Level**: | 1.5* |
| **Type**: | Archival |
| **Frequency:** | Standard: 2/Orbit |
| **Record Spatial Resolution:** | 20 km horizontal x 60 m vertical (-0.5 km to 20.2 km) |
| | 20 km horizontal x 180 m vertical (20.2 km to 30.1 km) |
| **Time Interval Covered:** | Standard: Half Orbit (Day or Night) |

**Data File Name:**

Standard: CAL_LID_L15-Standard-Version.Instance.hdf

* This level does not conform to official EOS definitions.

### 5.2.1 Lidar Level 1.5 Standard Data Product – Version 1.00

**Table 166: Lidar Level 1.5 Standard Instrument Record Summary – Version 1.00**

| 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 167 | 22,373 | 1 | 22,373 |
| Lidar Profile Science Record | Table 168 | 31,309 | 1,061 | 33,218,849 |
| | | | | |
| **Total Size (bytes)** | | | | 33,242,125 |
| **Total Size (Mbytes)** | | | | 32.46 |

### 5.2.2 Lidar Level 1.5 Standard Data Metadata – Version 1.00

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 Standard data product are listed in Table 167.

**Table 167: Lidar Level 1.5 Standard Metadata Record – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Product_ID | Char | NoUnits | L1.5_LIDAR_Standard | 80 | 80 |
| Date_Time_at_Granule_Start[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_at_Granule_End[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Date_Time_of_Production[A] | Char | NoUnits | 4/2006 – 12/2026 | 27 | 27 |
| Initial_Subsatellite_Latitude | Float_32 | deg | -90.0…90.0 | 1 | 4 |
| Initial_Subsatellite_Longitude | Float_32 | deg | -180.0…180.0 | 1 | 4 |
| Final_Subsatellite_Latitude | Float_32 | deg | -90.0…90.0 | 1 | 4 |
| Final_Subsatellite_Longitude | Float_32 | deg | -180.0…180.0 | 1 | 4 |
| Orbit_Number_at_Granule_Start | UInt_32 | 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…261,231.0 | 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 |
| Lidar_Data_Altitudes | Float_32 | km | -0.5… 30.1 | 400 | 1,600 |
| Rayleigh_Extinction_Cross-section_532 | Float_32 | $m^2$ | 5.167E-31 | 1 | 4 |
| Rayleigh_Extinction_Cross-section_1064 | Float_32 | $m^2$ | 3.127E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_532 | Float_32 | $m^2 \cdot sr^{-1}$ | 5.930E-32 | 1 | 4 |
| Rayleigh_Backscatter_Cross-section_1064 | Float_32 | $m^2 \cdot sr^{-1}$ | 3.592E-33 | 1 | 4 |
| Ozone_Absorption_Cross-section_532 | Float_32 | $m^2$ | 2.728461E-25 | 1 | 4 |
| Ozone_Absorption_Cross-section_1064 | Float_32 | $m^2$ | 0.0 | 1 | 4 |
| Production_Script | Char | NoUnits | N/A | 20,000 | 20,000 |
| | | | | | |
| **Record Size (bytes)** | | | | | **22,373** |

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

### 5.2.3 Lidar Level 1.5 Standard Data Scientific Data Set – Version 1.00

Table 168 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 168: Lidar Profile Data – Version 1.00**

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Latitude (midpoint) | Float_32 | deg | -90.0…90.0 | 1 | 4 |
| Longitude (midpoint) | Float_32 | deg | -180.0…180.0 | 1 | 4 |
| Profile_Time (midpoint)[C] | Float_64 | sec | 4.204E8…1.072E9 | 1 | 8 |
| Profile_UTC_Time (midpoint)[D] | Float_64 | NoUnits | 60,4260.0…26,1231.0 | 1 | 8 |
| Profile_ID (first and last) | Int_32 | NoUnits | 1…228,630 | 2 | 8 |
| Day_Night_Flag[E] | Int_8 | NoUnits | 0…2 | 1 | 1 |
| Land_Water_Mask | Int_8 | NoUnits | 0…7 | 4 | 4 |
| Surface_Elevation_Mean | Float_32 | km | -1.0…9.0 | 1 | 4 |
| Surface_Elevation_StDev | Float_32 | km | -1.0…9.0 | 1 | 4 |
| Samples_Averaged | UInt_16 | NoUnits | 0… 360 | 400 | 800 |
| Laser_Energy_Statistics_532 (min, max, mean, median) | Float_32 | J | 0.003…0.135 | 4 | 16 |
| Laser_Energy_Statistics_1064 (min, max, mean, median) | Float_32 | J | 0.038…0.12 | 4 | 16 |
| Minimum_Laser_Energy_532 | Float_32 | J | 0.003…0.135 | 1 | 4 |
| Calibration_Constant_Parallel_532 | Float_32 | $km^3 \cdot sr \cdot J^{-1} \cdot count$ | 3.0E10…8.0E10 | 1 | 4 |
| Calibration_Constant_Parallel_Uncertainty_532 | Float_32 | $km^3 \cdot sr \cdot J^{-1} \cdot count$ | 2.0E8…1.6E9 | 1 | 4 |
| Total_Attenuated_Backscatter_532_Mean | Float_32 | $km^{-1} \cdot sr^{-1}$ | -0.1…3.3 | 400 | 1,600 |
| Total_Attenuated_Backscatter_532_Median | Float_32 | $km^{-1} \cdot sr^{-1}$ | -0.1…3.3 | 400 | 1,600 |
| Total_Attenuated_Backscatter_532_StDev | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.3 | 400 | 1,600 |
| Total_Attenuated_Backscatter_Uncertainty_532 | Float 32 | $km^{-1} \cdot sr^{-1}$ | 1.0E-5…1.0E-2 | 400 | 1,600 |
| Calibration_Constant_Perpendicular_532 | Float_32 | $km^3 \cdot sr \cdot J^{-1} \cdot count$ | 3.0E10…8.0E10 | 1 | 4 |
| Calibration_Constant_Perpendicular_Uncertainty_532 | Float_32 | $km^3 \cdot sr \cdot J^{-1} \cdot count$ | 2.0E9…1.6E9 | 1 | 4 |
| Perpendicular_Attenuated_Backscatter_532_Mean | Float_32 | $km^{-1} \cdot sr^{-1}$ | -0.08…1.7 | 400 | 1,600 |
| Perpendicular_Attenuated_Backscatter_532_Median | Float_32 | $km^{-1} \cdot sr^{-1}$ | -0.08…1.7 | 400 | 1,600 |
| Perpendicular_Attenuated_Backscatter_532_StDev | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.3 | 400 | 1,600 |
| Perpendicular_Attenuated_Backscatter_Uncertainty_532 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 1.0E-6…1.0E-3 | 400 | 1,600 |
| Calibration_Constant_1064 | Float_32 | $km^3 \cdot sr \cdot J^{-1} \cdot count$ | 4.0E9…1.0E10 | 1 | 4 |
| Calibration_Constant_Uncertainty_1064 | Float_32 | $km^3 \cdot sr \cdot J^{-1} \cdot count$ | 5.0E7…4.0E9 | 1 | 4 |
| Attenuated_Backscatter_1064_Mean | Float_32 | $km^{-1} \cdot sr^{-1}$ | -0.04…2.5 | 400 | 1,600 |
| Attenuated_Backscatter_1064_Median | Float_32 | $km^{-1} \cdot sr^{-1}$ | -0.04…2.5 | 400 | 1,600 |
| Attenuated_Backscatter_1064_StDev | Float_32 | $km^{-1} \cdot sr^{-1}$ | 0.0…3.3 | 400 | 1,600 |
| Attenuated_Backscatter_Uncertainty_1064 | Float_32 | $km^{-1} \cdot sr^{-1}$ | 1.0E-5…1.0E-2 | 400 | 1,600 |
| Molecular_Number_Density[G] | Float_32 | $m^{-3}$ | 4.8E22…4.8E25 | 400 | 1,600 |
| Ozone_Number_Density[G] | Float_32 | $m^{-3}$ | 9.0E16…1.0E19 | 400 | 1,600 |
| Molecular_Model_Attenuated_Backscatter_532[G] | Float_32 | $km^{-1} \cdot sr^{-1}$ | 5.0E-4…2.0E-3 | 400 | 1,600 |
| Molecular_Model_Attenuated_Backscatter_1064[G] | Float_32 | $km^{-1} \cdot sr^{-1}$ | 5.0E-4…2.0E-3 | 400 | 1,600 |
| Temperature[G] | Float_32 | ºC | -120.0…60.0 | 400 | 1,600 |

| Parameter | Data Type | Units | Nominal Range | Elem/ Rec | Bytes |
|---|---|---|---|---|---|
| Pressure[G] | Float_32 | mb | 1.0…1,086.0 | 400 | 1,600 |
| Tropopause_Height_Mean[G] | Float_32 | km | 4.0…22.0 | 1 | 4 |
| L2_Feature_Type | UInt_8 | NoUnits | 0… 29 | 400 x 4 | 1,600 |
| | | | | | |
| **Total Bytes per Record** | | | | | **31,309** |

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, expedited version of the lidar level 1.5 data product contains data recorded during both day and night since each granule spans 90 continuous minutes of the satellite orbit. Consequently, the day/night terminator can be crossed within the 20 km horizontal averaging interval. The Day_Night_Flag is assigned a value of 2 denoting day & night segments when the day/night terminator is crossed within a lidar level 1.5 expedited product profile.
F) Reports the bitwise OR of all extinction QC flags within each 20 km x 60 m segment.
G) Based on GMAO data.

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

### 5.2.4 L2_Feature_Type values – Version 1.00

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

| | | |
|---|---|---|
| 0 | = | invalid (bad or missing data) |
| 1 | = | totally attenuated |
| 2 | = | surface |
| 3 | = | subsurface |
| 4 | = | cloud |
| 5 | = | clean marine |
| 6 | = | dust |
| 7 | = | polluted continental |
| 8 | = | clean continental |
| 9 | = | polluted dust |
| 10 | = | smoke |
| 11 | = | dusty marine |
| 12 | = | PSC aerosol |
| 13 | = | volcanic ash |
| 14 | = | sulfate/other |
| 15 | = | mixed aerosol |
| 16 | = | cloud-cleared clean marine |
| 17 | = | cloud-cleared dust |
| 18 | = | cloud-cleared polluted continental |
| 19 | = | cloud-cleared clean continental |
| 20 | = | cloud-cleared polluted dust |
| 21 | = | cloud-cleared smoke |
| 22 | = | cloud-cleared dusty marine |
| 23 | = | cloud-cleared PSC aerosol |
| 24 | = | cloud-cleared volcanic ash |
| 25 | = | cloud-cleared sulfate/other |
| 26 | = | cloud-cleared mixed aerosol |
| 27 | = | "clear air" |
| 28 | = | cloud-cleared "clear-air" |
| 29 | = | overcast |

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

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

cleared “clear air” refers to segments of “clear air” where 1/3 km and/or 1 km resolution clouds have been cleared.

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

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

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

# Appendix A

## CALIPSO Metadata

This section describes the metadata that are written to all CALIPSO HDF products. Table 169 describes the Core metadata record that is written to both the HDF and the ASCII file for the ASDC to be used to identify output science data products. Table 170 describes the Archive metadata record that is written to both an HDF and an ASCII file.

Table 169 and Table 170 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 169: 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 – 12/2026 | 20 | 1 | 20 |
| 9 | START_DATE | Char | NoUnits | 4/2006 – 12/2026 | 27 | 1 | 27 |
| 10 | STOP_DATE | Char | NoUnits | 4/2006 – 12/2026 | 27 | 1 | 27 |
| 11 | QAFLAG | Char | NoUnits | “Passed” or “Failed” | 6 | 1 | 6 |
| 12 | QAEXPLANATION | Char | NoUnits | N/A | 80 | 1 | 80 |
| 13 | MINLAT | Float_32 | deg | -90.0…90.0 | 4 | 1 | 16 |
| 14 | MINLON | Float_32 | deg | -180.0…180.0 | 4 | 1 | 16 |
| 15 | MAXLAT | Float_32 | deg | -90.0…90.0 | 4 | 1 | 16 |
| 16 | MAXLON | Float_32 | deg | -180.0…180.0 | 4 | 1 | 16 |
| 17 | GRINGLATITUDE | Float_64 | deg | -90.0…90.0 | 21 | 1 | 162 |
| 18 | GRINGLONGITUDE | Float_64 | deg | -180.0…180.0 | 21 | 1 | 162 |
| 19 | STARTORBITNUMBER | UInt_32 | NoUnits | $1…2^{32}-1$ | 1 | 1 | 4 |
| 20 | STOPORBITNUMBER | UInt_32 | NoUnits | $1…2^{32}-1$ | 1 | 1 | 4 |
| 21 | ORBITCHANGETIME | Float_64 | NoUnits | 60,426.0…261,231.0 | 1 | 1 | 8 |
| 22 | STARTPATHNUMBER | Int_16 | NoUnits | 1…233 | 1 | 1 | 2 |
| 23 | STOPPATHNUMBER | Int_16 | NoUnits | 1…233 | 1 | 1 | 2 |
| 24 | PATHCHANGETIME | Float_64 | NoUnits | 60,426.0…261,231.0 | 1 | 1 | 8 |
| | | | | | | | |
| | **Total Bytes per Record** | | | | | | **899** |

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 170: Archive Metadata Record Vdata – (not included - Lidar Version 4.x)**

| 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 – Version 3.x

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 171) provides laser energy, geo-location and calibration status, while the second QC flag (Table 172) summarizes observed error conditions.

**Table 171: Bit Assignments for the first QC Flag (1) – Version 3.x**

| 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 172: Bit Assignments for the second QC Flag (2) – Version 3.x**

| 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 |
| 27-32 | Spare |

## Lidar Level 1 Quality Check Flags – Version 4.10

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 173) provides laser energy, geo-location and calibration status, while the second QC flag (Table 174) summarizes observed error conditions.

**Table 173: Bit Assignments for the first QC Flag (1) – Version 4.10**

| 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 174: Bit Assignments for the second QC Flag (2) – Version 4.10**

| 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 |
| 27 | 1064 nm calibration coefficients suspect due to low temperatures associated with power up |
| 28-32 | Spare |

# 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 175: 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 176: 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 177: 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 178: Lidar_DayNight_Flag (swath)**

| Value | Interpretation |
|---|---|
| 0 | day |
| 1 | night |

**Table 179: Lidar_Quality_Flag (track)**

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

**Table 180: 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 181: 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 182: Particle_Shape_Index (track and swath)**

| Value | Interpretation |
|---|---|
| 7 | Aggregates |
| 8 | Plates |
| 9 | Solid columns |

**Table 183: Particle_Shape_Index_Confidence (track and swath)**

| Value | Interpretation |
|---|---|
| 1 | Good |
| 2 | Medium |

**Table 184: 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 185: Scene_Flag (swath)**

| Digits | Interpretation |
|---|---|
| *Tens-Units* | Type_of_Scene |
| *Thousands-Hundreds* | IGBP index |

**Table 186: 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 187: 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 |

# Appendix D

## IIR Level 1 Quality Calibration Flag

This section details the bit assignments for the Pixel_Quality_Index included in the IIR Level 1 Scientific Data Sets. Bits 1-3 give the overall quality of the pixel for scientific analysis. Bits 4-21 include more detailed information and bits 22-24 indicate if an equalization correction has been applied (Version 2.00 only).

**Table 188: Bit Assignment for Pixel Quality Index**

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

# Appendix E

## CALIPSO/GEWEX Lidar Level 3 Cloud Parameters – Version 1.00

This section explicitly compares the SDS parameters contained in the two differing formats of CALIPSO derived data; yearly netCDF files sent to GEWEX for the multi-satellite cloud assessment and the monthly HDF format consistent with other publicly released Lidar L3 CALIPSO products. Both versions of these data products are produced from identical input data and algorithms, however the file structure and parameter naming contained in the files substantially differ. Table 8 provides a translation between these two formats, as the left most column are the SDS parameters contained the CALIPSO publicly released monthly HDF files and the right most column is the yearly netCDF file available from the GEWEX Cloud Assessment Database (https://climserv.ipsl.polytechnique.fr/gewexca/index-2.html).

**Table 189: CALIPSO/GEWEX SDS Parameter Comparison – Version 1.00**

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

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

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

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

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

| | | |
|---|---|---|
| | reported within the latitude/longitude grid cell | |
| Middle_Cloud_Top_Temperature_Histogram_Top Layer | Histogram of cloud top temperature of top layer flavor at low-level altitude region reported within the latitude/longitude grid cell | h_CTM, topLayer |
| Low_Cloud_Top_Temperature_Mean_TopLayer | Mean of cloud top temperature of top layer flavor reported at low-level altitude region within the latitude/longitude grid cell | a_CTL, topLayer |
| Low_Cloud_Top_Temperature_Histogram_TopLay er | Histogram of cloud top temperature of top layer flavor at low-level altitude region reported within the latitude/longitude grid cell | h_CTL, topLayer |
| Ice_Cloud_Top_Temperature_Mean_TopLayer | Mean of ice cloud top temperature of top layer flavor reported within the latitude/longitude grid cell | a_CTI, topLayer |
| Ice_Cloud_Top_Temperature_Histogram_TopLaye r | Histogram of ice cloud top temperature of top layer flavor reported within the latitude/longitude grid cell | h_CTI, topLayer |
| Water_Cloud_Top_Temperature_Mean_TopLayer | Mean of water cloud top temperature of top layer flavor reported within the latitude/longitude grid cell | a_CTW, topLayer |
| Water_Cloud_Top_Temperature_Histogram_TopL ayer | Histogram of water cloud top temperature of top layer flavor reported within the latitude/longitude grid cell | h_CTW, topLayer |
| High_Ice_Cloud_Top_Temperature_Mean_TopLay er | Mean of ice cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell | a_CTIH, topLayer |
| High_Ice_Cloud_Top_Temperature_Histogram_To pLayer | Histogram of ice cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell | h_CTIH, topLayer |
| Cloud_Top_Pressure_Mean_TopLayer | Mean of cloud top pressure of top layer flavor reported within the latitude/longitude grid cell | a_CP, topLayer |
| Cloud_Top_Pressure_Histogram_TopLayer | Histogram of cloud top pressure of top layer flavor reported within the latitude/longitude grid cell | h_CP, topLayer |
| Cloud_Top_Altitude_Mean_TopLayer | Mean of cloud top altitude of top layer flavor reported within the latitude/longitude grid cell | a_CZ, topLayer |
| Cloud_Top_Altitude_Histogram_TopLayer | Histogram of cloud top altitude of top layer flavor reported within the latitude/longitude grid cell | h_CZ, topLayer |

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

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

# Appendix F

## IIR Level 2 Track and Swath Flag Values – Version 4.20

This section describes the IIR Level 2 Track and Swath Version 4.20 science parameter flag values.

### Table 190: Dust_Stratospheric_Aerosol_Flag (track) – Version 4.20

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

### Table 191: Dust_Stratospheric_Aerosol_Flag_QA (track) – Version 4.20

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

### Table 192: Equalization_Flag (track and swath) – Version 4.20

| Bit | Bit value | Interpretation: equalization correction |
|---|---|---|
| 1 | 0 | Channel 12.05: no |
| | 1 | Channel 12.05: yes |
| 2 | 0 | Channel 10.60: no |
| | 1 | Channel 10.60: yes |
| 3 | 0 | Channel 08.65: no |
| | 1 | Channel 08.65: yes |
| 4-8 | 0 | N/A |

### Table 193: High_Cloud_vs_Background_Flag (track) – Version 4.20

| **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 194: Ice_Water_Flag_Lower_Level (track) – Version 4.20**

| Value | Interpretation |
|---|---|
| 1 | Randomly oriented ice crystals (ROI) |
| 2 | Liquid water |
| 3 | Horizontally oriented ice crystals (HOI) |
| 9 | Unknown/not determined phase |
| 5 | Aerosol layer |
| -9 | No lower level |

**Table 195: Ice_Water_Flag_QA_Lower_Level (track) – Version 4.20**

| | Interpretation |
|---|---|
| *Decimal part* | Ice/Water Phase score (0.100: high; 0.050: medium; 0.025: low; 0.000: none) |
| *Integer part* | Feature Type score (100: high; 50: medium; 25: low; 0: none) |

**Table 196: Ice_Water_Flag_QA_Uper_Level (track) – Version 4.20**

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

**Table 197: Ice_Water_Flag_Upper_Level (track) – Version 4.20**

| Value | Interpretation |
|---|---|
| 1 | Randomly oriented ice crystals (ROI) |
| 2 | Liquid water |
| 3 | Horizontally oriented ice crystals (HOI) |
| 4 | ROI and HOI |
| 6 | Ice (ROI and/or HOI) and liquid water |
| 9 | At least one layer has unknown/not determined phase |

**Table 198: IIR_Data_Quality (swath) and IIR_Data_Quality_Flag (track) – Version 4.20**

| 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 199: Lidar_DayNight_Flag (swath) – Version 4.20**

| Value | Interpretation |
|---|---|
| 0 | day |
| 1 | night |

**Table 200: Lidar_Quality_Flag (track) – Version 4.20**

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

**Table 201: Microphysics (track) – Version 4.20**

| Digits | Interpretation |
|---|---|
| | Records 1 to 3: Version 3; records 4 to 6: Version 4; records 7 to 10: LUTs from in situ data |
| *Units* | Particle_Shape_Index |
| *Thousands-Hundreds-Tens* | Effective diameter in microns derived from the (12.05 ; 8.65) IIR channels couple. |
| *Millions-Hundred thousands-Ten thousands* | Effective diameter in microns derived from the (12.05 ; 10.6) IIR channels couple. |

**Table 202: Multi_Layer_Flag (track) – Version 4.20**

| 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_Flag takes the sign of this quantity. This quantity is set to zero for mono-layer cases. |
| *Hundreds* | 0 |
| *Ten thousands-Thousands* | Number of layers in the upper level. |

**Table 203: Particle_Shape_Index (track and swath) – Version 4.20**

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

**Table 204: Particle_Shape_Index_Confidence (track and swath) – Version 4.20**

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

**Table 205: Regional_Background_Standard_Deviation_Flag (track) - Version 4.20**

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

**Table 206: Scene_Flag (swath) – Version 4.20**

| Digits | Interpretation |
|---|---|
| *Tens-Units* | Type_of_Scene |
| *Hundred thousands toHundreds* | TGeotype |

**Table 207: Surrounding_Obs_Quality_Flag (track) – Version 4.20**

| 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 208: TGeotype (track) – Version 4.20**

| Value | Interpretation |
|---|---|
| 1700, 1705, 1750 | Water |
| 1710 | Water/sea ice transition |
| 1510 | Sea ice |
| 1560 | Snow |

| | |
|---|---|
| IGBP x 100, 1730 | Snow-free land |

## Table 209: Type of Scene (track) – Version 4.20

| Value | Description |
|---|---|
| **CLEAR SKY, Was_Cleared_Flag_1km=0** | |
| 10 | Clear sky (no aerosols detected by lidar) |
| **AEROSOLS ONLY, Was_Cleared_Flag_1km=0** | |
| 51 | 1 to 4 high ST aerosols |
| 52 | 1 to 4 low ST aerosols, vol_depolarization_ratio_mean* < 6% |
| 53 | 1 to 4 low ST aerosols, vol_depolarization_ratio_mean* > 6% |
| 54 | 1 to 4 high ST aerosols and 1 to 3 low ST aerosols |
| 55 | 1 high opaque aerosol |
| 56 | 1 low opaque aerosol |
| 64 | 1 to 4 high ST aerosols/ 1 low opaque aerosol |
| 57 | Any other aerosols only |
| **CLOUDS** | |
| 20 | Low opaque cloud, no aerosol, vol_depolarization_ratio_max** >40% |
| 70 | Low opaque cloud, no aerosol, vol_depolarization_ratio_max** < 40% |
| 40 | High opaque cloud, no aerosol, vol_depolarization_ratio_max** >40% |
| 80 | High opaque cloud, no aerosol, vol_depolarization_ratio_max** < 40% |
| 81 | 1 high ST cloud and 1 high opaque cloud, centroid altitudes difference < 1km |
| 85 | 1 high ST aerosol and 1 high opaque cloud, centroid altitudes difference < 1km |
| 21 | 1 high ST cloud only (no aerosol) |
| 22 | 2 high ST clouds, no high ST aerosol |
| 23 | 1 high ST cloud and 1 low ST cloud, no high ST aerosol |
| 24 | 1 low ST cloud, attenuated_backscatter_max*** > 0.02 $sr^{-1}$ or vol_depolarization_ratio_max** > 6%, no high ST aerosol |
| 59 | 1 low ST cloud, attenuated_backscatter_max*** < 0.02 $sr^{-1}$ and vol_depolarization_ratio_max** < 6%, no high ST aerosol |
| 25 | 2 low ST clouds only (no aerosol) |
| 26 | 3 high ST clouds |
| 27 | 2 high ST clouds and 1 low ST cloud |
| 67 | 3-4 high ST clouds and 1 low ST cloud |
| 28 | 1 high ST cloud and 2 low ST clouds |
| 68 | 2-3 high ST clouds and 2 low ST clouds or 3 high ST clouds and 3 low ST clouds |
| 29 | 3 to 7 low ST clouds only (no aerosol) |
| 31 | 1 high ST cloud / 1 low opaque cloud, no high ST aerosol |
| 32 | 2 to 6 high ST clouds/ 1 opaque cloud |
| 62 | 3 to 6 ST clouds (at least 1 high ST and 1 low ST)/ 1 opaque cloud |
| 33 | 1 high ST cloud and 1 low ST cloud/ 1 opaque cloud |
| 34 | 1 low ST cloud/ 1 opaque cloud |
| 39 | 2 to 4 low ST clouds/ 1 low opaque cloud |
| 41 | 1 high ST cloud/ 1 high opaque cloud, centroid altitudes difference > 1km |
| 42 | 2 high ST clouds/ 1 high opaque cloud |
| **MIXED AEROSOLS/CLOUDS** | |
| 30 | 1 high ST cloud / 1 to 4 low ST aerosols |
| 66 | 1 high ST aerosol above 1 high ST cloud and 1 low ST cloud |
| 63 | 1 to 4 low aerosols above 1 low ST cloud |
| 35 | 1 to 4 high ST aerosols/ 1 low opaque cloud |
| 36 | 1 to 4 low ST aerosols/ 1 low opaque cloud |
| 37 | 1 high ST cloud/ 1 low opaque aerosol |
| 38 | 1 low ST cloud/ 1 low opaque aerosol |

| | |
|---|---|
| 65 | 1 to 4 high ST aerosols / 1 high opaque cloud; if 1 high ST aerosol, centroid altitudes difference > 1km |
| **OTHERS** | |
| 50 | Clear sky (no aerosol), Was_Cleared_Flag_1km > 0 |
| 91 | 1 to 4 high ST aerosols, Was_Cleared_Flag_1km > 0 |
| 92 | 1 to 4 low ST aerosols, vol_depolarization_ratio_mean* < 6%, Was_Cleared_Flag_1km > 0 |
| 93 | 1 to 4 low ST aerosols, vol_depolarization_ratio_mean* > 6%, Was_Cleared_Flag_1km > 0 |
| 94 | 1 to 4 high ST aerosols and 1 to 3 low ST aerosols, Was_Cleared_Flag_1km > 0 |
| 95 | 1 high opaque aerosol, Was_Cleared_Flag_1km > 0 |
| 96 | 1 low opaque aerosol, Was_Cleared_Flag_1km > 0 |
| 97 | Any other aerosols only, Was_Cleared_Flag_1km > 0 |
| 98 | 1 to 4 high ST aerosols/ 1 low opaque aerosol, Was_Cleared_Flag_1km > 0 |
| 99 | No classification |

*Mean value reported in Volume_Depolarization_Ratio_Statistics (Table 60)

**Maximum value reported in Volume_Depolarization_Ratio_Statistics (Table 58)

***Maximum value reported in Attenuated_Backscatter_Statistics_532 (Table 58)

# Appendix G

## CALIPSO/GEWEX IIR Level 3 Cloud Parameters – Version 1.00

This section explicitly compares the SDS parameters contained in the two differing formats of CALIPSO derived data; yearly netCDF files sent to GEWEX for the multi-satellite cloud assessment and the monthly HDF format consistent with other publicly released L3 CALIPSO products. Both versions of these data products are produced from identical input data and algorithms. Daytime (D), nighttime (N), and all time (A) statistics are reported in GEWEX files with observational time in filenames set to '0130PM', '0130AM', and '0130AMPM', respectively. However, the file structure and parameter naming contained in the files substantially differ. Table 210 provides a translation between these two formats, as the left most column lists the SDS parameters contained in the CALIPSO monthly HDF files and the right most column gives the corresponding GEWEX parameters in italic and the relevant yearly netCDF file(s) available from the GEWEX Cloud Assessment Database (https://climserv.ipsl.polytechnique.fr/gewexca/index-2.html).

**Table 210: CALIPSO/GEWEX SDS Parameter Comparison – Version 1.00**

| CALIPSO Parameter | Description | *GEWEX Parameter*<br>GEWEX File(s) |
|---|---|---|
| Longitude_Midpoint | Longitude at grid cell midpoint | *longitude*<br>Any file |
| Latitude_Midpoint | Latitude at grid cell midpoint | *latitude*<br>Any file |
| Number_Of_Orbit_Tracks | Number of CALIPSO orbital tracks in grid cell | *n_tot*<br>Any file |
| Cloud_Radiative_Temperature_Bin_Midpoint | Radiative cloud temperature at the midpoint of each bin of the temperature histograms. | *bins*<br>CTI_IIR, CTW_IIR, CTIH_IIR |
| Cloud_Radiative_Temperature_Bin_Boundaries | Radiative cloud temperature at the boundaries of each bin of the temperature histograms. | *bin_bounds*<br>CTI_IIR, CTW_IIR, CTIH_IIR |
| Cloud_Effective_Emissivity_12_05_Bin_Midpoint | Effective emissivity at the midpoint of each bin of the effective emissivity histograms. | *bins*<br>CEMI_IIR, CEMW_IIR, CEMIH_IIR |
| Cloud_Effective_Emissivity_12_05_Bin_Boundaries | Effective emissivity at the boundaries of each bin of the effective emissivity histograms. | *bin_bounds*<br>CEMI_IIR, CEMW_IIR, CEMIH_IIR |

| | | |
|---|---|---|
| Ice_Cloud_Effective_Radius_Bin_Midpoint | Effective radius at the midpoint of each bin of the ice and high ice cloud effective radius histograms. | *bins*<br>CREI_IIR, CREIH_IIR |
| Ice_Cloud_Effective_Radius_Bin_Boundaries | Effective radius at the boundaries of each bin of the ice and high ice cloud effective radius histograms | *bin_bounds*<br>CREI_IIR, CREIH_IIR |
| Water_Cloud_Effective_Radius_Bin_Midpoint | Effective radius at the midpoint of each bin of the water cloud effective radius histograms. | *bins*<br>CREW_IIR |
| Water_Cloud_Effective_Radius_Bin_Boundaries | Effective radius at the boundaries of each bin of the water cloud effective radius histograms. | *bin_bounds*<br>CREW_IIR |
| Cloud_Water_Path_Bin_Midpoint | Ice or liquid water path at the midpoint of each bin of the ice or liquid water path histograms. | *bins*<br>CIWP_IIR, CLWP_IIR, CIWPH_IIR |
| Cloud_Water_Path_Bin_Boundaries | Ice or liquid water path at the boundaries of each bin of the ice or liquid water path histograms. | *bin_bounds*<br>CIWP_IIR, CLWP_IIR, CIWPH_IIR |
| Cloud_Optical_Depth_Bin_Midpoint | Cloud optical depth at the midpoint of each bin of the cloud optical depth histograms. | *bins*<br>CODI_IIR, CODW_IIR, CODIH_IIR, CODI_IIR-LIDAR, CODIH_IIR-LIDAR |
| Cloud_Optical_Depth_Bin_Boundaries | Cloud optical depth at the boundaries of each bin of the cloud optical depth histograms. | *bin_bounds*<br>CODI_IIR, CODW_IIR, CODIH_IIR, CODI_IIR-LIDAR, CODIH_IIR-LIDAR |
| Number_Of_Valid_Pixels_IIR | Number of valid IIR pixels used in grid cell. | None |
| Number_Of_Candidate_Clouds_IIR | Number of IIR cloudy pixels in grid cell accepted as a pre-requisite for meaningful microphysical retrievals, before microphysics and thermodynamic phase quality filters are applied. | None |

| | | |
|---|---|---|
| Cloud_Amount_Mean_IIR | Mean amount of candidate cloudy pixels with only ice or only liquid water clouds in the atmospheric column, and where IIR has confident microphysical retrievals. | None |
| Ice_Cloud_Amount_Mean_IIR | Mean amount of pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CAI*<br>CAI_IIR |
| Water_Cloud_Amount_Mean_IIR | Mean amount of pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CAW*<br>CAW_IIR |
| High_Ice_Cloud_Amount_Mean_IIR | Mean amount of pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CAIH*<br>CAIH_IIR |
| Ice_Cloud_Radiative_Temperature_Mean_IIR | Mean cloud radiative temperature at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CTI*<br>CTI_IIR |
| Ice_Cloud_Radiative_Temperature_Histogram_IIR | Cloud radiative temperature histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *h_CTI*<br>CTI_IIR |
| Water_Cloud_Radiative_Temperature_Mean_IIR | Mean cloud radiative temperature at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CTW*<br>CTW_IIR |
| Water_Cloud_Radiative_Temperature_Histogram_IIR | Cloud radiative temperature histogram at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where | *h_CTW*<br>CTW_IIR |

| | | |
|---|---|---|
| | IIR has confident microphysical retrievals. | |
| High_Ice_Cloud_Radiative_Temperature_Mean_IIR | Mean cloud radiative temperature at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CTIH*<br>CTIH_IIR |
| High_Ice_Cloud_Radiative_Temperature_Histogram_IIR | Cloud radiative temperature histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *h_CTIH*<br>CTIH_IIR |
| Ice_Cloud_Effective_Emissivity_12_05_Mean_IIR | Mean cloud effective emissivity at 12.05 µm at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CEMI*<br>CEMI_IIR |
| Ice_Cloud_Effective_Emissivity_12_05_Histogram_IIR | Cloud effective emissivity at 12.05 µm histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *h_CEMI*<br>CEMI_IIR |
| Water_Cloud_Effective_Emissivity_12_05_Mean_IIR | Mean cloud effective emissivity at 12.05 µm at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CEMW*<br>CEMW_IIR |
| Water_Cloud_Effective_Emissivity_12_05_Histogram_IIR | Cloud effective emissivity at 12.05 µm histogram at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *h_CEMW*<br>CEMW_IIR |
| High_Ice_Cloud_Effective_Emissivity_12_05_Mean_IIR | Mean cloud effective emissivity at 12.05 µm at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in | *a_CEMIH*<br>CEMIH_IIR |

| | | |
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| | the column, and where IIR has confident microphysical retrievals. | |
| High_Ice_Cloud_Effective_Emissivity_12_05_Histogram_IIR | Cloud effective emissivity at 12.05 µm histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *h_CEMIH*<br>CEMIH_IIR |
| Ice_Cloud_Effective_Radius_Mean_IIR | Mean effective radius at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CREI*<br>CREI_IIR |
| Ice_Cloud_Effective_Radius_Histogram_IIR | Effective radius histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *h_CREI*<br>CREI_IIR |
| Water_Cloud_Effective_Radius_Mean_IIR | Mean effective radius at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CREW*<br>CREW_IIR |
| Water_Cloud_Effective_Radius_Histogram_IIR | Effective radius histogram at grid cell in pixels with only candidate liquid water clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *h_CREW*<br>CREW_IIR |
| High_Ice_Cloud_Effective_Radius_Mean_IIR | Mean effective radius at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CREIH*<br>CREIH_IIR |
| High_Ice_Cloud_Effective_Radius_Histogram_IIR | Effective radius histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and | *h_CREIH*<br>CREIH_IIR |

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

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

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| Ice_Cloud_Optical_Depth_Histogram_LIDAR | CALIOP-derived visible cloud optical depth histogram at grid cell in pixels with only candidate ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *h_CODI*<br>CODI_IIR-LIDAR |
| High_Ice_Cloud_Optical_Depth_Mean_LIDAR | Mean CALIOP-derived visible cloud optical depth at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *a_CODIH*<br>CODIH_IIR-LIDAR |
| High_Ice_Cloud_Optical_Depth_Histogram_LIDAR | CALIOP-derived visible cloud optical depth histogram at grid cell in pixels with only candidate high ice clouds passing the phase quality filters in the column, and where IIR has confident microphysical retrievals. | *h_CODIH*<br>CODIH_IIR-LIDAR |