

## **Data documentation archive**

**Cloud-Aerosol Lidar and  
Infrared Pathfinder Satellite  
Observations (CALIPSO)**

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Bogotá, Colombia

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# 1. About the CALIPSO satellite

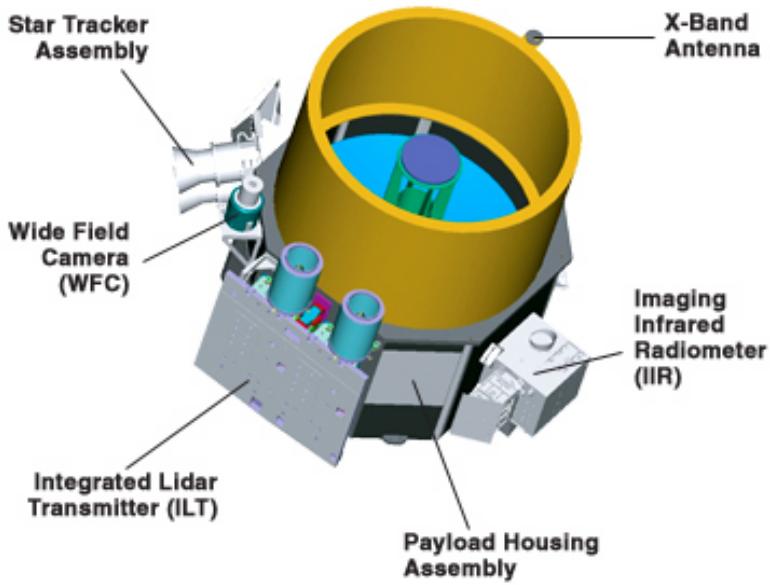
CALIPSO is a joint NASA (USA) and CNES (France) environmental satellite, built in the Cannes Mandelieu Space Center, which was launched atop a Delta II rocket on April 28, 2006. CALIPSO mission was conceived and developed to provide new insights into aerosols and clouds, their various interactions, and their roles in the climate system.<sup>1</sup>

Aerosols are tiny, airborne solid & liquid particles. About 90 percent have natural origins: volcanic eruptions, forest fires, and sandstorms among others. The remaining 10 percent of aerosols are considered anthropogenic, or human-made, and they come from a variety of sources like fossil fuel combustion, automobiles, incinerators, smelters, power plants, cigarettes, cooking stoves and fireplaces.<sup>2</sup>

The CALIPSO payload consists of three co-aligned nadir-viewing instruments:

- **The Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP):** a two-wavelength polarization-sensitive lidar that provides high-resolution vertical profiles which provide information on the vertical distribution of aerosols and clouds, cloud particle phase, and classification of aerosol size.<sup>3</sup>
- **The Imaging Infrared Radiometer (IIR):** used to detect cirrus cloud emissivity and particle size. The CALIOP laser beam is aligned with the center of the IIR image to optimize joint CALIOP/IIR observations.<sup>4</sup>
- **The Wide Field Camera (WFC):** a digital camera that collects daytime high spatial resolution imagery in the 620 - 670nm wavelength range and is used to ascertain cloud homogeneity, aid in cloud clearing, and provide meteorological context.<sup>5</sup>

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.<sup>6</sup>



**Figure 1:** CALIPSO payload.

Available in [www-calipso.larc.nasa.gov/about/payload.php](http://www-calipso.larc.nasa.gov/about/payload.php)

## 2. About the data

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 (Data Management System) at NASA Langley Research Center for autonomous processing.<sup>7</sup> The DMS generates a wide variety of data products that are described in detail [here](#). **This document will only describe and explain the use of the LIDAR Level 1 products.**

### **Important:**

The DMS generates *Standard* and *Expedited* data products. **The standard data products are the highest quality data products generated by the DMS and are recommended for research studies and journal publications.** Expedited data products have a shorter production latency because they use the latest meteorological and calibration parameters available at the time of data production. **Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications.**<sup>8</sup>

## 2.1 File naming convention

For the latest version (v4.x) of the CALIPSO data products, file naming convention is defined as:

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

where,

- **Investigation** = Mission Name: CAL
- **Subsystem** = LID | IIR | WFC
- **Level** = Product Level: L0 | L1 | L2 | L3 | L15
- **ProductID** = Product Identification: 1Km | 125m | VFM | 333mCLay | 01kmCLay | 05kmCLay | 05kmALay | 05kmAProCal | 05kmCPro | PSCMask | Ice\_Cloud | Stratospheric\_APro
- **ProductionStrategy** = Test | Beta | Quick Look | Expedited | Standard
- **Version** = Version Information, e.g., V4-10
- **Instance** = YYYY-MM-DDThh-mm-ssZ[D|N] | YYYY-MM[D|N|A] | YYYY-MM
- **File Format** = Hierarchical Data Format: .hdf

For example:

**CAL\_LID\_L1-Standard-V4-10.2010-04-17T20-09-13ZN.hdf**

Level 1 data products don't have ProductID<sup>9</sup>. For the v3.x naming convention and other details visit [this link](#).

## 2.2 File format

Each data product of the CALIPSO satellite is written in HDF. **Hierarchical Data Format (HDF)** is a set of file formats (HDF4, HDF5) designed to store and organize large amounts of data. Originally developed at the National Center for Supercomputing Applications, it is supported by The HDF Group, a non-profit corporation whose mission is to ensure continued development of HDF technologies and the

continued accessibility of data stored in HDF.<sup>10</sup>

Although some of the satellite data products are written in HDF5 due to size limitations<sup>11</sup>, **HDF4 was chosen as the primary file format for data storage and distribution in the CALIPSO mission.**<sup>12</sup>

The main difference is that the HDF5 data model is "simpler" in the sense that it can contain fewer objects (a dataset and a group) and has a consistent object model throughout. The HDF4 model has many more objects (8 basic objects that include multidimensional arrays ['Scientific Data Set' or 'SDS'], tables, raster images, palettes and annotations organised hierarchically in groups) and lacks a clear object model.<sup>13</sup>

For example, the **Lidar Level 1 V4.10 Data Product** contains, among many other SDS, one-dimensional arrays ***Latitude***, ***Longitude*** and ***Profile Time UTC*** that allow to locate datasets spatially and temporally and a multidimensional array ***Total\_Attenuated\_Backscatter\_532***, one of the primary lidar Level 1 data products and the one we will visualize.<sup>14</sup>

To familiarize yourself with the HDF4 and HDF5 structure and explore a particular file's data objects, you can check this [Introduction to Hierarchical Data Formats](#) by Earth Lab, the [official HDF Support Portal](#) and the tools [HDFView](#), [HDFCompass](#) and the [HDF API](#) (Application Programming Interface).

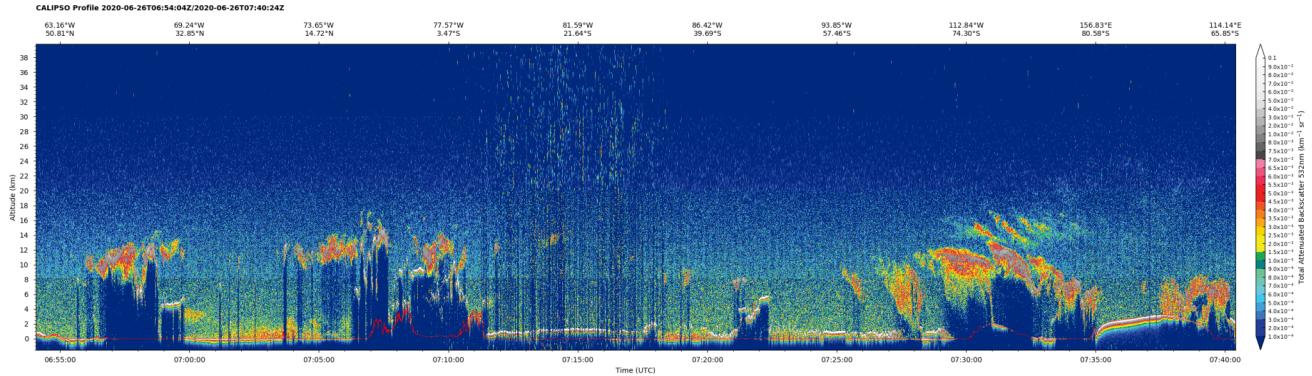
## 2.3 The Lidar Level 1 Data Product

The CALIOP Level 1B data product contains a half orbit (day or night) of calibrated and geolocated single-shot (highest resolution) lidar profiles<sup>15</sup> that store information of 532nm and 1064nm light that is backscattered from molecules and particulates (i.e. aerosols, clouds) in the atmosphere.<sup>16</sup>

When an electromagnetic wave like the light generated by the CALIOP laser passes through a particle, it can either be scattered, absorbed, or pass unperturbed.<sup>17</sup> Backscatter (or backscattering) refers to the reflection of such waves back to the source of origin.<sup>18</sup> In this case, back to the CALIPSO satellite.

When plotting the lidar profiles, signal return strength has been color coded such that blues correspond to molecular scattering and

weak aerosol scattering, **aerosols generally show up as yellow/red/orange**. Stronger cloud signals are plotted in gray scales, while weaker cloud returns are similar in strength to strong aerosol returns and coded in yellows and reds.<sup>19</sup>



**Figure 2:** Attenuated backscatter signal plot from a CALIPSO lidar profile.

## 3. Data download

### 3.1 Data availability

First, check what orderable data is available for a specific CALIPSO data day or a specific time range. The CALIPSO website has a comprehensive and easy-to-use data availability tool and its respective help page:

#### CALIPSO - Data Availability Site:

[https://www-calipso.larc.nasa.gov/tools/data\\_avail/](https://www-calipso.larc.nasa.gov/tools/data_avail/)

#### CALIPSO - Data Availability Site Help Page:

[https://www-calipso.larc.nasa.gov/tools/data\\_avail/help.php](https://www-calipso.larc.nasa.gov/tools/data_avail/help.php)

Once you enter the page, click on a date from the calendar to view data products available:

**GUIDE**

**DATA AVAILABILITY TOOL**

**BSETTER WEB APP**

**AD SOFTWARE**

**INSTRUMENT STATUS**

**GROUND TRACK FILES (ASCII)**

**June 20, 2018 - ATTENTION: ONGOING**  
CALIOP is experiencing an elevated frequency of low energy laser shots within and near the South Atlantic Anomaly (SAA) region which has degraded the science quality of affected profiles since September 2016. Please see the [Low Laser Energy Advisory](#) page for further information and guidance for identifying affected profiles.

Select Year: | [2021](#) | [2020](#) | [2019](#) | [2018](#) | [2017](#) | [2016](#) | [2015](#) | [2014](#) | [2013](#) | [2012](#) | [2011](#) | [2010](#) | [2009](#) | [2008](#) | [2007](#) | [2006](#) |

2021												
January			February			March			April			
S	M	T	W	T	F	S	S	M	T	W	F	S
				01	02		01	02	03	04	05	06
03	04	05	06	07	08	09	07	08	09	10	11	12
10	11	12	13	14	15	16	14	15	16	17	18	19
17	18	19	20	21	22	23	21	22	23	24	25	26
24	25	26	27	28	29	30	28					
31												
May			June			July			August			
S	M	T	W	T	F	S	S	M	T	W	T	F
				01			01	02	03	04	05	06
02	03	04	05	06	07	08	06	07	08	09	10	11
09	10	11	12	13	14	15	13	14	15	16	17	18
16	17	18	19	20	21	22	20	21	22	23	24	25
23	24	25	26	27	28	29	27	28	29	30	31	
30	31											
September			October			November			December			
S	M	T	W	T	F	S	S	M	T	W	T	F
				01	02	03	01	02	03	04	05	06
05	06	07	08	09	10	11	03	04	05	06	07	08

**Figure 3: Detail of the calendar in the Data Availability Tool.**

Only dates in blue are available for review.

+ OVERVIEW

+ USERS GUIDE

- DATA AVAILABILITY TOOL

+ DATA SUBSETTER WEB APP

+ DATA READ SOFTWARE

+ INSTRUMENT STATUS

+ GROUND TRACK FILES (ASCII)

⇒ ORDER CALIPSO DATA - HERE

Data Date: March 15, 2021

EXPEDITED Data Set Name	Number of Data Files Produced
<b>NOTE: These data files are available for ordering for 30 days.</b>	
CAL_LID_L1_Exp-Prov-V3-41	7
CAL_IIR_L1_Exp-Prov-V1-13	7
CAL_WFC_L1_125m_Exp-Prov-V3-02	0
CAL_WFC_L1_1Km_Exp-Prov-V3-02	0
CAL_WFC_L1_IIR_Exp-Prov-V3-02	0
CAL_LID_L2_01kmClay_Exp-Prov-V3-41	7
CAL_LID_L2_05kmAlay_Exp-Prov-V3-41	7
CAL_LID_L2_05kmAPro_Exp-Prov-V3-41	7
CAL_LID_L2_05kmClay_Exp-Prov-V3-41	7
CAL_LID_L2_333mClay_Exp-Prov-V3-41	7
CAL_LID_L2_VFM_Exp-Prov-V3-41	7
CAL_IIR_L2_Track_Exp-Beta-V3-46	7
CAL_IIR_L2_Swath_Exp-Beta-V3-46	7

STANDARD Data Set Name	Number of Data Files Produced
CAL_LID_L1-ValStage1-V3-41	0
CAL_LID_L2_01kmClay-ValStage1-V3-41	0
CAL_LID_L2_05kmAlay-Prov-V3-41	0
CAL_LID_L2_05kmAPro-Prov-V3-41	0
CAL_LID_L2_05kmClay-Prov-V3-41	0
CAL_LID_L2_05kmCPro-Prov-V3-41	0
CAL_LID_L2_333mClay-ValStage1-V3-41	0
CAL_LID_L2_VFM-ValStage1-V3-41	0
CAL_LID_L2_PSCMask-Prov-V1-11	0
CAL_WFC_L1_125m-ValStage1-V3-02	0
CAL_WFC_L1_1Km-ValStage1-V3-02	0
CAL_WFC_L1_IIR-ValStage1-V3-02	0
CAL_IIR_L1-Prov-V1-13	0

**Figure 4: File Count by Data Day (March 15, 2021)**

## **3.2 Download**

NASA has various methods to order data products from the CALIPSO satellite:

**- ASDC/Earthdata Search:**

The Atmospheric Science Data Center (ASDC) is one of the Distributed Active Archive Center (DAAC) that form part of the Earth Observing System Data and Information System (EOSDIS) that focuses on the Earth science disciplines Radiation Budget, Clouds, Aerosols, and Tropospheric Composition.<sup>20</sup>

The Earthdata Search is a modern web application allowing users to search, discover, visualize, refine, and access NASA Earth Observation data using the Earth Science Data and Information System's (ESDIS) wide array of service offerings.<sup>21</sup>

**- CALIPSO Search and Subsetting web application:** a web app that enables a more sophisticated approach to selecting and ordering CALIPSO lidar data by date, time and geolocation.<sup>22</sup>

**- Standard/Expedited Browse Images tool:** a website containing browse images from the CALIOP, the CALIPSO lidar. These images cannot be ordered per se, but can be viewed and downloaded individually.<sup>23</sup>

**Important:**

The first two options require an **EOSDIS Earthdata Login account**. It is free and the registration process is quick and easy. Please visit [this link](#) for more detailed information.

### **3.2.1 ASDC/Earthdata Search**

First, open the following URL in the browser:

<https://asdc.larc.nasa.gov/> and type "CALIPSO" in the search bar (figure 5).

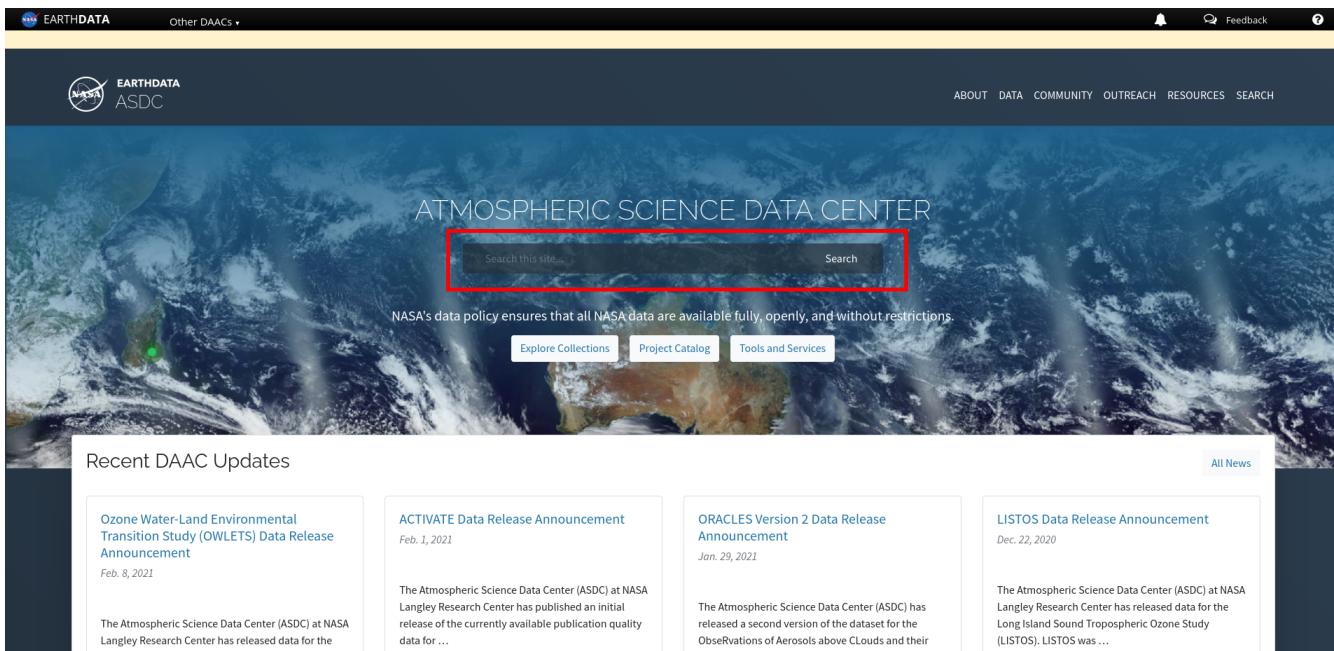


Figure 5: ASDC main page. Search bar highlighted in red.

Next, click the CALIPSO title.

The screenshot shows the search results for the term "calipso" on the ASDC website. The search bar at the top has "calipso" typed into it. Below the search bar, a message says "'calipso' is mentioned in the following results..". The search results are displayed in a grid of cards:

ARCTAS	CALIPSO	DC3	GloSSAC
Arctic Research of the Composition of the Troposphere from Aircraft & Satellites	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations	Deep Convective Clouds and Chemistry	Global Satellite-based Stratospheric Aerosol Climatology
CALIPSO	CALIPSO Infrared Imaging Radiometer (IIR) Level 1B Radiance, Expedited Provisional V1-13	CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Provisional V1-10	CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Provisional V1-11
CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Provisional V1-12	CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Provisional V1-13	CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Standard V2-00	CALIPSO Imaging Infrared Radiometer (IIR) Level 1B Radiance, Standard V2-01

The second card in the first row, which contains the text "Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observations", is highlighted with a red box.

Figure 6: ASDC "CALIPSO" search results.

For this example you can select the *CAL\_LID\_L1-Standard-V4-11\_V4-11* data product from the *Level 1B* tab.

Collection	Disciplines	Spatial	Temporal
CAL_IIR_L1-Prov-V1-10_V1-10 CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Provisional, V1-10	Aerosols, Clouds, Radiation Budget	Spatial Coverage: (-90, 90)	Temporal Coverage: 2006-05-13 - 2008-08-20 Temporal Resolution: 8.15 seconds
CAL_IIR_L1-Prov-V1-11_V1-11 CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Provisional, V1-11	Aerosols, Clouds, Radiation Budget	Spatial Coverage: (-90,90), (-180,180) Horizontal Resolution Range: 1 km - < 10 km or approximately 01 degree - <.09 degree	Temporal Coverage: 2006-11-09 - 2011-11-01 Temporal Resolution Range: Weekly - < Monthly Temporal Resolution: 8.15 seconds
CAL_IIR_L1-Prov-V1-12_V1-12 CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Provisional, V1-12	Aerosols, Clouds, Radiation Budget	Spatial Coverage: (-90,90), (-180,180) Horizontal Resolution Range: 1 km - < 10 km or approximately 01 degree - <.09 degree	Temporal Coverage: 2007-04-15 - Present Temporal Resolution Range: Weekly - < Monthly Temporal Resolution: 8.15 seconds
CAL_IIR_L1-Prov-V1-13_V1-13 CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Provisional, V1-13	Aerosols, Clouds, Radiation Budget	Spatial Coverage: (-90,90), (-180,180)	Temporal Coverage: 2020-10-01 - Present
CAL_IIR_L1-Standard-V2-00_V2-00 CALIPSO Imaging Infrared Radiometer Level 1B Radiance data, Standard, V2-00	Aerosols, Clouds, Radiation Budget	Spatial Coverage: (-90,90), (-180,180) Horizontal Resolution Range: 1 km - < 10 km or approximately 01 degree - <.09 degree	Temporal Coverage: 2006-06-12 - Present Temporal Resolution Range: 1 second - < 1 minute Temporal Resolution: 8.15 seconds
CAL_IIR_L1-Standard-V2-01_V2-01 CALIPSO Imaging Infrared Radiometer (IIR) Level 1B Radiance, Standard, V2-01	Aerosols, Clouds, Radiation Budget	Spatial Coverage: (-90,90), (-180,180)	Temporal Coverage: 2020-10-01 - Present
CAL_LID_L1-ValidStage-V3-01_V3-01 CALIPSO Lidar Level 1B profile data, V3-01	Aerosols, Clouds, Radiation Budget	Spatial Coverage: (-90,90), (-180,180)	Temporal Coverage: 2006-05-13 - 2020-07-01 Temporal Resolution: .05 second
<b>CAL_LID_L1-Standard-V4-11_V4-11 CALIPSO Lidar Level 1B profile data, V4-11</b>	Aerosols, Clouds, Radiation Budget	Spatial Coverage: (-90,90), (-180,180)	Temporal Coverage: 2020-07-01 - Present
CAL_LID_L1-ValidStage-V3-01_V3-01 CALIPSO Lidar Level 1B Profile data, Validated Stage 1 V3-01	Aerosols, Clouds, Radiation Budget	Spatial Coverage: (-90,90), (-180,180)	Temporal Coverage: 2006-05-07 - 2011-11-01 Temporal Resolution: .05 second

Figure 7: CALIPSO data products list in the ASDC web page.

Click on the *Get Dataset* button.

The screenshot shows the CALIPSO Lidar Level 1B profile data, V4-11 entry. The top navigation bar includes links for EARTHDATA, Other DAACs, Feedback, and a search bar. The main content area displays the following information:

- ENTRY TITLE:** CALIPSO Lidar Level 1B profile data, V4-11
- ENTRY ID:** CAL\_LID\_L1-Standard-V4-11
- DISCIPLINES:** AEROSOLS, CLOUDS, RADIATION BUDGET
- DESCRIPTION:** CAL\_LID\_L1-Standard-V4-11 is the Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation (CALIPSO) Lidar Level 1B profile data, Version 4-10 data product. This data product was collected using the Cloud-Aerosol Lidar with Orthogonal Polarization (CALIOP) instrument. The version of this product was changed from 4-10 to 4-11 to account for a change in the operating system of the CALIPSO production cluster.
- DOI:** 10.5067/CALIOP/CALIPSO/CAL\_LID\_L1-Standard-V4-11
- View Citations**
- RESOURCES AND DOCUMENTATION:** Earthdata Forum, GOTO WEB TOOL, CALIPSO Search and Subsetting Web Application
- DATA DISTRIBUTION:** File Format(s): HDF4, NetCDF-3. A red box highlights the "Get Dataset" button, which is linked to the recommended order method. An additional options dropdown is also shown.
- SPATIAL INFORMATION:** A world map showing spatial coverage. Text below it specifies: Spatial Coverage: (-90, 90), (-180, 180); Spatial Coverage Type: Horizontal; Coordinate System: Cartesian.

Figure 8: CAL\_LID\_L1-Standard-V4-11\_V4-11 description page.

The *Get Dataset* button will take you to the Earthdata Search tool page which has the following components:

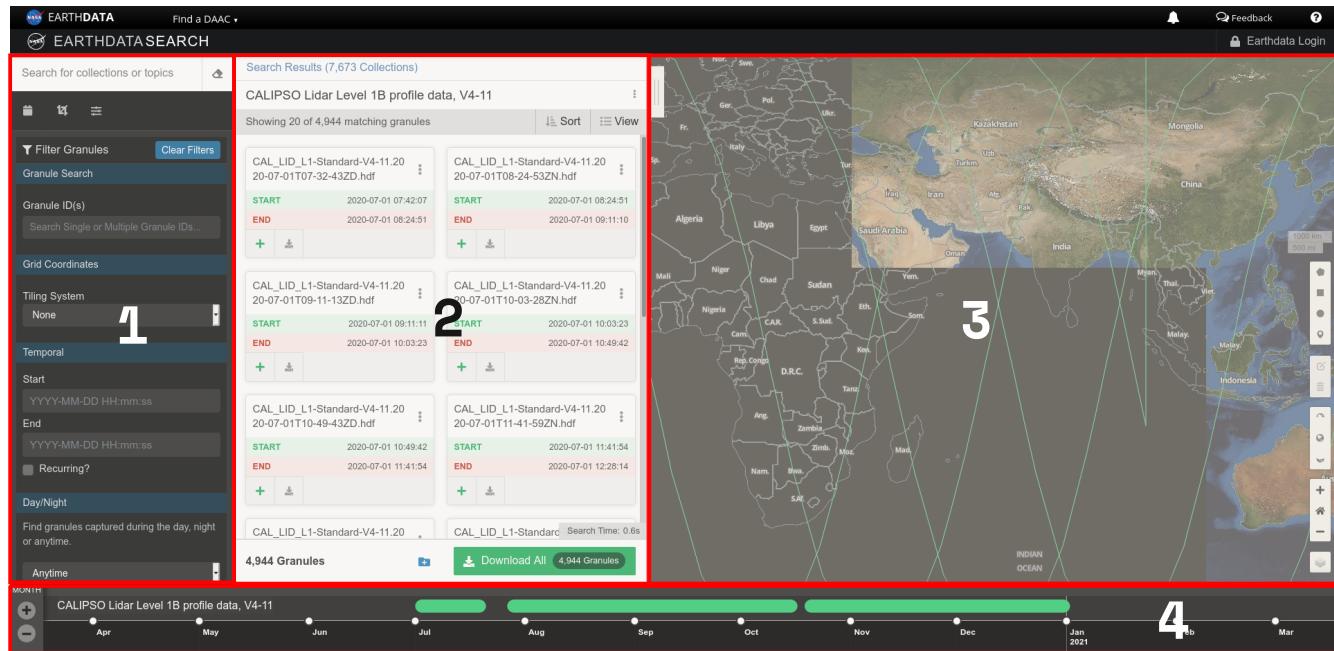


Figure 9: The Earthdata Search tool and its main components.

- 1. Search field:** the main GUI element used to search and filter data products from the NASA datasets. The queries can include text (name, short name or id), spatial coordinates and time range of the desired product.
- 2. Search results:** all the granules (the pieces in which data is sectioned) available based on search criteria.
- 3. Preview:** a map showing the spatial extent of the granules from the search results.
- 4. Timeline:** scrollable bar showing the temporal extent of the granules and its availability.

A direct search in the Earthdata Search tool can also be done to find the CALIPSO data products (skipping the ASDC website). How-To articles and step-by-step guides can be found in the [Earthdata Wiki](#).

To directly download individual granules click on the *Download single granule data* button:

The screenshot shows the Earthdata search interface for CALIPSO Lidar Level 1B profile data, V4-11. On the left, there's a sidebar with 'Filter Granules' and 'Granule Search' sections. The main area displays 20 of 4,944 matching granules. One granule is selected, and its details are shown in a box: 'CAL\_LID\_L1-Standard-V4-11.20 20-07-01T07-32-43ZD.hdf'. Below the details are 'START' (2020-07-01 07:42:07) and 'END' (2020-07-01 08:24:51). To the right of these are a green '+' button and a red circled blue download icon. Other granules are listed in adjacent boxes.

Figure 10: *Download single granule data* button detail in the Earthdata search tool.

To download multiple granules first click on the *Add granule* button or select granules using the search field or the timeline. Once you have selected all desired granules, click on the *Download* button:

This screenshot shows the same Earthdata search interface as Figure 10, but with different interactions. The 'Add granule' button (a green '+' icon) is circled in red on the left side of the screen. On the right, a green 'Download' button with a red border and the text '2 Granules' is also circled in red. The granules listed are the same as in Figure 10, with their details visible.

Figure 11: *Add granule* button detail in the Earthdata search tool.

Figure 12: *Download granules* button detail in the Earthdata search tool.

A download options window will appear. The following methods are available to download NASA datasets:

- **Stage for delivery:** The requested data files will be compressed in zip format and stored for retrieval via HTTP. You will receive an email from the data provider when your files are ready to download.<sup>24</sup>

**Important:**

To download data files using this method you will have to use wget to download the files from the URL links within the email.

- **Direct download:** The requested data files will be available for download immediately. Files will be accessed from a list of links displayed in the browser or by using a download script.

If you select *Direct download*, click on the *Download Data* button:

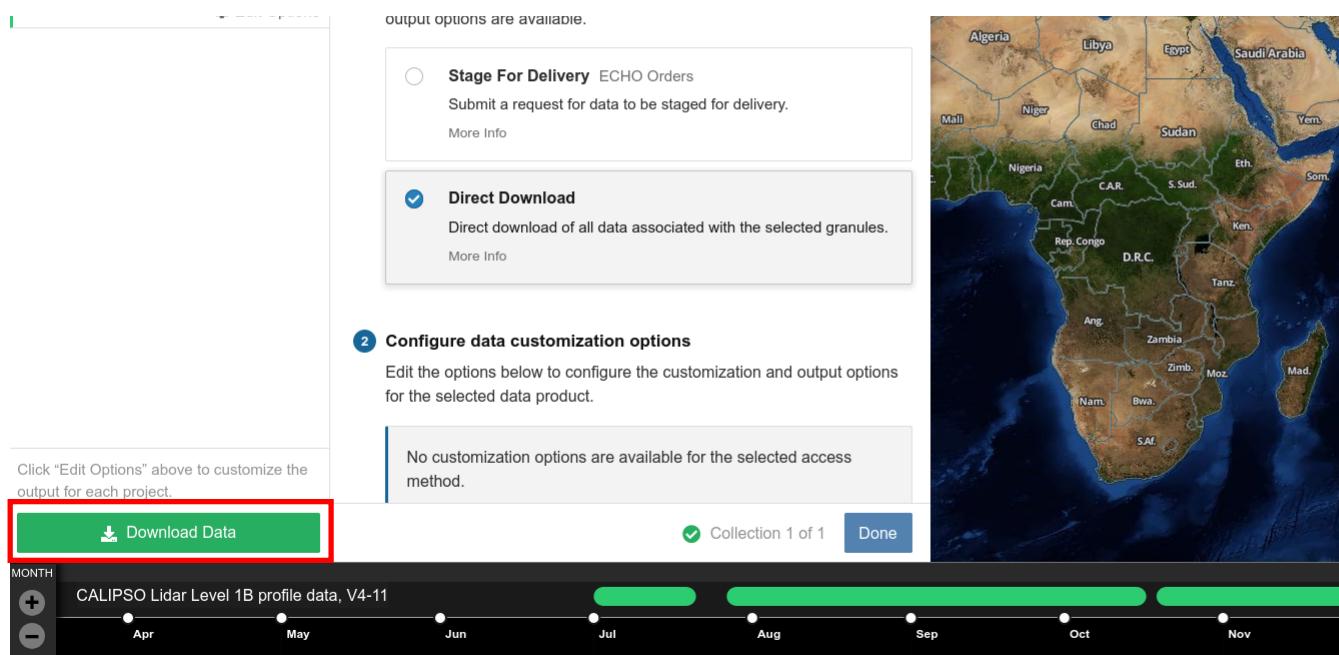


Figure 13: *Download Data* button detail in the download options page.

A download status page will appear. Once the order is processed, a list of links will appear to download the data directly (figure 14) and a download script (figure 15) in case you want to use it. NASA recommends users to use the download access script to download a large number of files.<sup>25</sup>

The screenshot shows the Earthdata Search interface. At the top, there are navigation links for 'EARTHDATA', 'Find a DAAC', 'Feedback', 'Back to Project', and 'Near Space'. The main content area is titled 'Download Status' for a 'CALIPSO Lidar Level 1B profile data, V4-11' order. The status is shown as 'Complete (100%)' with an 'Access Method' of 'Download' and '2 Granules'. Below this, a message says 'Download your data directly from the links below, or use the provided download script.' A tab bar at the bottom of the box shows 'Download Links' (which is selected) and 'Download Script'. Under 'Download Links', it says 'Retrieved 2 links for 2 granules.' and lists two URLs: [https://asdc.larc.nasa.gov/data/CALIPSO/LID\\_L1-Standard-V4-11/2020/07/CAL\\_LID\\_L1-Standard-V4-11.2020-07-01T07-32-43ZD.hdf](https://asdc.larc.nasa.gov/data/CALIPSO/LID_L1-Standard-V4-11/2020/07/CAL_LID_L1-Standard-V4-11.2020-07-01T07-32-43ZD.hdf) and [https://asdc.larc.nasa.gov/data/CALIPSO/LID\\_L1-Standard-V4-11/2020/07/CAL\\_LID\\_L1-Standard-V4-11.2020-07-01T08-24-53ZN.hdf](https://asdc.larc.nasa.gov/data/CALIPSO/LID_L1-Standard-V4-11/2020/07/CAL_LID_L1-Standard-V4-11.2020-07-01T08-24-53ZN.hdf). At the bottom right of the box are 'Copy', 'Save', and 'Expand' buttons.

**Figure 14:** Download links for a processed data order in the Earthdata Search tool.

The screenshot shows the Earthdata Search interface. At the top, there are navigation links for 'EARTHDATA', 'Find a DAAC', 'Feedback', 'Back to Project', and 'Near Space'. The main content area is titled 'Download Status' for a 'CALIPSO Lidar Level 1B profile data, V4-11' order. The status is shown as 'Complete (100%)' with an 'Access Method' of 'Download' and '2 Granules'. Below this, a message says 'Download your data directly from the links below, or use the provided download script.' A tab bar at the bottom of the box shows 'Download Links' (which is selected) and 'Download Script' (which is underlined). Under 'Download Script', it says 'Retrieved 2 links for 2 granules.' and provides instructions on how to use the script. It then details the process for both Linux and Windows users. At the bottom right of the box are 'Copy', 'Save', and 'Expand' buttons. The script code itself is displayed in a large text block.

```

#!/bin/bash
GREP_OPTIONS=''
cookiejar=$(mktemp cookies.XXXXXXXXXX)
netrc=$(mktemp netrc.XXXXXXXXXX)
chmod 0600 "$cookiejar" "$netrc"
function finish {
    rm -f "$cookiejar" "$netrc"
}

```

**Figure 15:** Download script for a processed data order in the Earthdata Search tool.

### 3.2.2 CALIPSO Search and Subsetting web application

First open the following URL in the browser:

<https://subset.larc.nasa.gov/calipso/login.php> and click in the Login button.

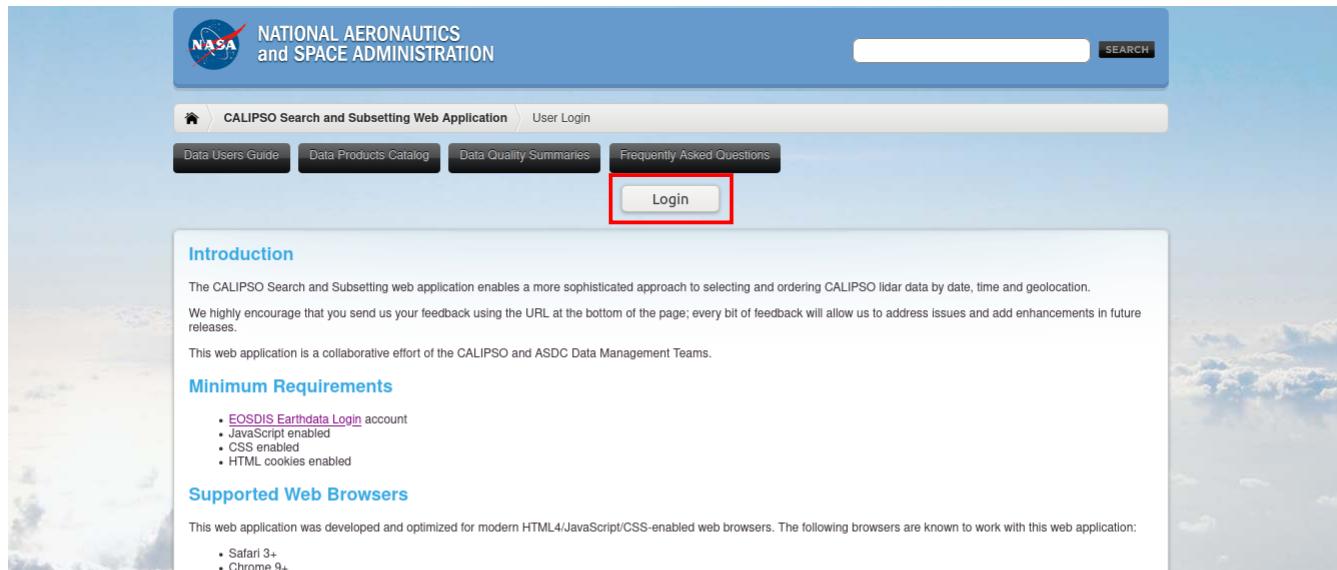


Figure 16: CALIPSO Search and Subsetting web application. Intro page.

Login using your Earthdata account's username and password. Then, add the 532nm Calibration and 532nm Backscatter parameter groups (or any other parameter groups you would like to download).

A screenshot of the CALIPSO Search and Subsetting web application's search criteria page. The page has a left sidebar with a "Choose Granule Type" dropdown set to "Day", a "Choose Data Product" dropdown set to "LIDAR Level 1 Version 4.1", and a "Choose Parameter Group(s)" section. In the "Choose Parameter Group(s)" section, several groups are listed: "Instrument", "532nm Calibration" (highlighted with a red box), "1064nm Calibration" (highlighted with a red box), "532nm Backscatter" (highlighted with a red box), "1064nm Backscatter", "532nm Reflectance", "532nm Surface Characterization", "1064nm Surface Characterization", "Atmospheric", and "Spacecraft and Footprint". To the right of this list are "Add" and "Add all" buttons, and "Remove" and "Remove all" buttons. A "Selected Parameter Group(s)" section shows "532nm Calibration" and "532nm Backscatter". To the right of this is a "Data variables included in the output file" section with a "Default" heading and a list of variables: Latitude, Longitude, Day\_Night\_Flag, GMAO\_Surface\_Elevation, IGBP\_Surface\_Type, Land\_Water\_Mask, Off\_Nadir\_Angle, Profile\_ID, and Profile\_Time. At the bottom of the page is a section titled "Step 2: Select a temporal range (optional)" with "Calendar dates" and "Orbit number" buttons.

Figure 17: CALIPSO Search and Subsetting web application. Set search criteria page, step 1.

Select the temporal (figure 18) and spatial (figure 19) range of the data you want to download.

**Step 2: Select a temporal range (optional)**

Use the temporal options to narrow your search to a specific temporal domain. If you do not make a temporal selection, the default is to search the complete range of time in which the satellite has acquired data. If you limit your search to a specific time domain, the search will return all available data that intersect with your selected time range.

**Calendar dates**

The CALIPSO satellite began nominal operations on June 13, 2006. The dates reflected in the calendar will represent the range in which the satellite has been in data acquisition mode.

From  to

**Start date**

Feb	2020	1				
Su	Mo	Tu	We	Th	Fr	Sa
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

**End date**

Feb	2020	1				
Su	Mo	Tu	We	Th	Fr	Sa
2	3	4	5	6	7	8
9	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29

**Done**

Figure 18: CALIPSO Search and Subsetting web application. Set search criteria page, step 2.

**Step 3: Select a geospatial range (optional)**

Use the geospatial options to narrow your search to a specific geospatial area. If you do not make a geospatial selection, the default is to search the whole globe. If you limit your search to a specific area, the search will return all available data that intersect with your selected area.

**User-defined bounding box**

Modify the geospatial fields to specify your area of interest, or use your mouse directly on the map to draw a bounding box by clicking and dragging. The map uses latitude/longitude bounds (north, south, east, and west) to define the area of a box. If you use the mouse to draw the area on the map, the fields are filled in automatically, based on the box drawn.

Latitudes and longitudes are in Decimal Degrees (DD) format.

Use: '+' for north latitudes or east longitudes; use '-' for south latitudes or west longitudes. Example: +40.68, -74.04

To cross the anti-meridian, left must be greater than right. Example: (left) +148.64, (right) -115.73

Top   
Left  Right   
Bottom

(-51.06, -5.98)

**BROWSE IMAGES** **DATA** **DOCUMENTATION** **TOOLS** **OTHER** **ABOUT CALIPSO**

- Expedited Browse Data User's Guide Algorithm Thesis Basis Search and Subsetting CloudSat Home Page Overview
- Nominal Browse Atmospheric Science Data Documents (ATBD) Web Application Frequently Asked Questions A-Train Constellation
- Wide Field Camera (WFC) Center (ASDC) Data Products Catalog Ground Track Files Science Objectives NASA Official

Figure 19: CALIPSO Search and Subsetting web application. Set search criteria page, step 3.

In the *Confirm Query Result* page, click on the *Submit Request to ASDC* button.

**Step 4: Confirm Query Result**

Product ID	Temporal constraints	Spatial constraints
CAL_LID_L1-V4-10	2020-02-01T00:00:00.000000Z to 2020-02-02T23:59:59.999999Z	22.8515625°,-86.917991638184°,-51.761741638184°

Display 30 granules

Select	Granule name	Day/Night	Orbit start	Orbit end	Path start	Path end	Start date	Stop date
<input checked="" type="checkbox"/>	CAL_LID_L1-Standard-V4-10.2020-02-01T08-25-30ZN.hdf View browse image segment: [1][2][3][4]	N	73231	73231	224	-7	2020-02-01 06:25:25	2020-02-01 07:11:36
<input checked="" type="checkbox"/>	CAL_LID_L1-Standard-V4-10.2020-02-01T17-02-52ZD.hdf View browse image segment: [1][2][3][4]	D	73237	73238	-103	103	2020-02-01 17:02:48	2020-02-01 17:55:09
<input checked="" type="checkbox"/>	CAL_LID_L1-Standard-V4-10.2020-02-01T18-41-22ZD.hdf View browse image segment: [1][2][3][4]	D	73238	73239	-119	119	2020-02-01 18:41:20	2020-02-01 19:33:41
<input checked="" type="checkbox"/>	CAL_LID_L1-Standard-V4-10.2020-02-02T08-24-58ZN.hdf View browse image segment: [1][2][3][4]	N	73245	73245	214	-230	2020-02-02 05:24:53	2020-02-02 06:11:05
<input checked="" type="checkbox"/>	CAL_LID_L1-Standard-V4-10.2020-02-02T07-03-29ZN.hdf View browse image segment: [1][2][3][4]	N	73246	73246	230	-13	2020-02-02 07:03:26	2020-02-02 07:49:37
<input checked="" type="checkbox"/>	CAL_LID_L1-Standard-V4-10.2020-02-02T17-40-50ZD.hdf View browse image segment: [1][2][3][4]	D	73252	73253	-109	109	2020-02-02 17:40:49	2020-02-02 18:33:10
<input checked="" type="checkbox"/>	CAL_LID_L1-Standard-V4-10.2020-02-02T18-19-25ZD.hdf View browse image segment: [1][2][3][4]	D	73253	73254	-125	125	2020-02-02 19:19:21	2020-02-02 20:11:42

Showing 1 to 7 of 7 entries

[First](#) [Previous](#) [1](#) [Next](#) [Last](#)

[Select All](#) [Deselect All](#)

[Logout](#) [Cancel Request](#) [Download File Listing](#) [Download Request XML](#) [Submit Request to ASDC](#)

BROWSE IMAGES DATA DOCUMENTATION TOOLS OTHER ABOUT CALIPSO

Expedited Browse Data User's Guide Algorithm Thesis Basis Search and Subsetting CloudSat Home Page Overview

Atmospheric Science Data Center (ASDC) Data Products Catalog Ground Track Files Frequently Asked Questions A-Train Constellation

Wide Field Camera (WFC) Browse Data Quality Summaries Satellite Overpass Educational Outreach Science Objectives

Imaging Infrared Radiometer (IIR) Browse Search and Subsetting Predictor Project Partners CALIPSO Payload

Peer Reviewed Papers Conference Papers Contacts Instrument Status

Images / Videos

Figure 20: CALIPSO Search and Subsetting web application. Confirm request results page.

**Step 5: Request Submitted**

Your request has been submitted to ASDC. When your request is fulfilled and ready for download, an e-mail confirmation will be sent to:

nearspaceinterface@gmail.com

Please contact [ASDC User Services](#) ([support-asdc@earthdata.nasa.gov](mailto:support-asdc@earthdata.nasa.gov)) if you have a question regarding your order.

[Logout](#) [Start another request](#) [Exit](#)

**BROWSE IMAGES** **DATA** **DOCUMENTATION** **TOOLS** **OTHER** **ABOUT CALIPSO**

Expedited Browse	Data User's Guide	Algorithm Thesis Basis Documents (ATBD)	Search and Subsetting Web Application	CloudSat Home Page	Overview
Nominal Browse	Atmospheric Science Data Center (ASDC)	Data Products Catalog	Ground Track Files	Frequently Asked Questions	A-Train Constellation
Wide Field Camera (WFC) Browse	Search and Subsetting Web Application	Data Quality Summaries	Satellite Overpass Predictor	Educational Outreach	Science Objectives
Imaging Infrared Radiometer (IIR) Browse	Search and Subsetting Web Application	Data Read Software	Peer Reviewed Papers	Project Partners	CALIPSO Payload
		Conference Papers		Contacts	Instrument Status
		Images / Videos			

NASA Official: Charles R. Trepte Last Updated: March 01, 2021

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Figure 21: CALIPSO Search and Subsetting web application. Request submitted page.

Once the request is fulfilled, you can open the e-mail confirmation that contains the URL with the data products for direct download and a wget command line script as an alternative download option.

Your Langley ASDC HTTPS Subset Order <CALIPSO\_58015> Inbox x

 **ASDC User Services** <support-asdc@earthdata.nasa.gov>  
to me, larc-dl-asdc-user-services ▾

Welcome!

Your HTTPS order (CALIPSO\_58015) has completed and result files have been staged in the following url folder:

[https://xfr139.larc.nasa.gov/sflops/Distribution/2021084115532\\_58015/](https://xfr139.larc.nasa.gov/sflops/Distribution/2021084115532_58015/)

The subset result files can be downloaded individually using this URL in a web browser.

The following example illustrates a command-line scriptable command for downloading the subset results folder and all the files in this directory. This example assumes the 'wget' utility is installed on the computer executing the download.

```
wget -r -np -nH -w1 --cut-dirs=2 --reject="index.html*" https://xfr139.larc.nasa.gov/sflops/Distribution/2021084115532_58015/
```

The directory: 2021084115532\_58015 will be created within the directory the wget command was executed.

This staging directory URL is valid for 7 days, after which time it will be deleted.

**Figure 22: ASDC order confirmation e-mail.**

## **Index of /sflops/Distribution/2021084115532\_58015**

Name	Last modified	Size	Description
 <a href="#">Parent Directory</a>		-	
 <a href="#">58015-FILES.MD5</a>	2021-03-25 11:55	651	
 <a href="#">CAL_LID_L1-Standard-&gt;</a>	2021-03-25 11:55	52M	
 <a href="#">CAL_LID_L1-Standard-&gt;</a>	2021-03-25 11:55	52M	
 <a href="#">CAL_LID_L1-Standard-&gt;</a>	2021-03-25 11:55	52M	
 <a href="#">CAL_LID_L1-Standard-&gt;</a>	2021-03-25 11:55	52M	
 <a href="#">CAL_LID_L1-Standard-&gt;</a>	2021-03-25 11:55	52M	
 <a href="#">CAL_LID_L1-Standard-&gt;</a>	2021-03-25 11:55	52M	
 <a href="#">CAL_LID_L1-Standard-&gt;</a>	2021-03-25 11:55	4.0M	

**Figure 23: Order page with the CALIPSO data products.**

### 3.2.3 Standard/Expedited Browse Images tool

First, open one of the following URLs in the browser:

- **CALIPSO EXPEDITED Browse Images:**

[https://www-calipso.larc.nasa.gov/products/lidar/browse\\_images/exp\\_index.php](https://www-calipso.larc.nasa.gov/products/lidar/browse_images/exp_index.php)

- **CALIPSO STANDARD Browse Images (Select Data Version page)**

[https://www-calipso.larc.nasa.gov/products/lidar/browse\\_images/production](https://www-calipso.larc.nasa.gov/products/lidar/browse_images/production)

- **CALIPSO STANDARD Browse Images - Version 4.11 (Latest):**

[https://www-calipso.larc.nasa.gov/products/lidar/browse\\_images/std\\_v411\\_index.php](https://www-calipso.larc.nasa.gov/products/lidar/browse_images/std_v411_index.php)

If you select the *Select Data Version* page, click on the version number of the data you want to browse:

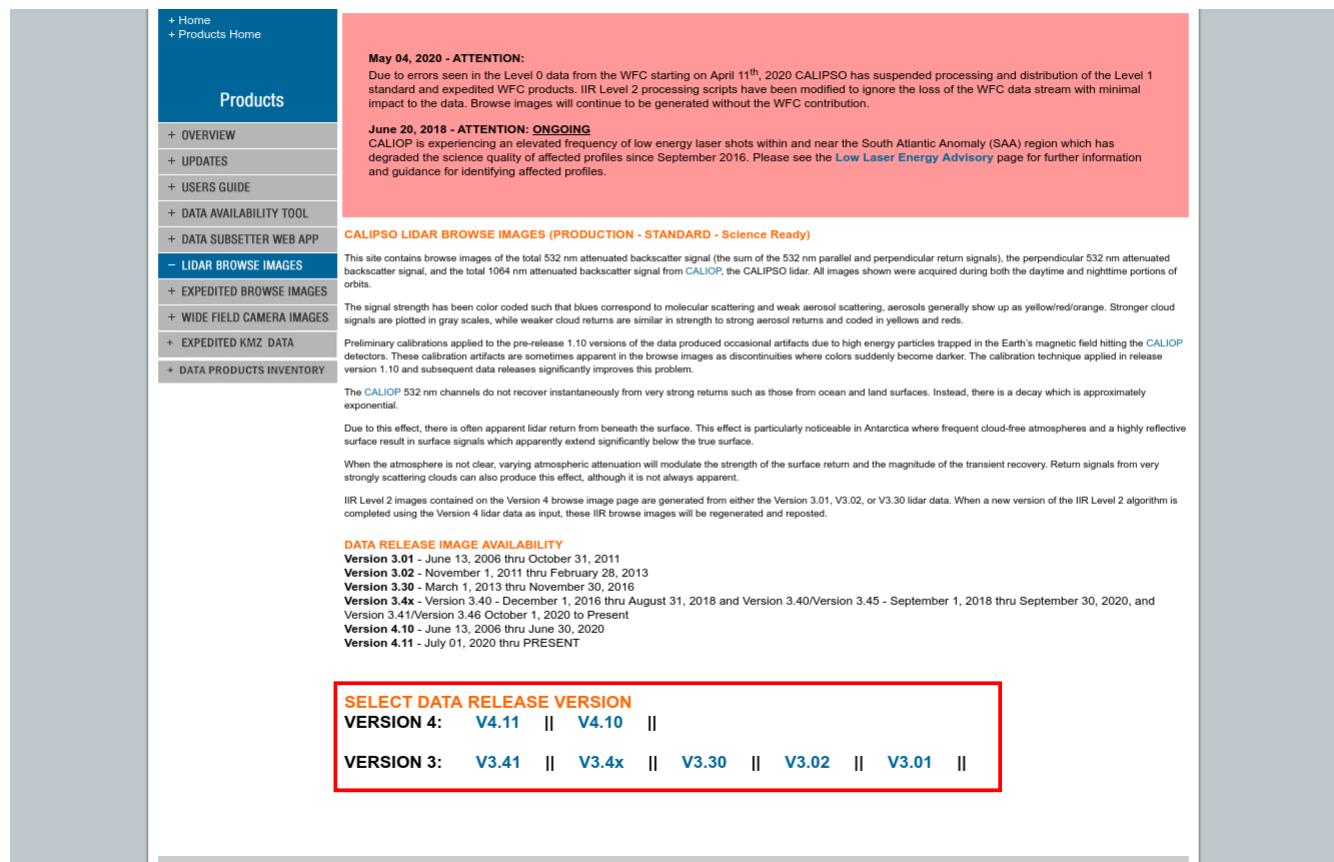


Figure 24: CALIPSO LIDAR BROWSE IMAGES (PRODUCTION - STANDARD - Science Ready). Select Data Version page.

Click on a date from the calendar to view data images available:

Select Year: | 2021 | 2020 |

2020						
July						
S	M	T	W	T	F	S
			01	02	03	04
05	06	07	08	09	10	11
12	13	14	15	16	17	18
19	20	21	22	23	24	25
26	27	28	29	30	31	

August						
S	M	T	W	T	F	S
					01	
02	03	04	05	06	07	08
09	10	11	12	13	14	15
16	17	18	19	20	21	22
23	24	25	26	27	28	29
30	31					

September						
S	M	T	W	T	F	S
			01	02	03	04
06	07	08	09	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30			

October						
S	M	T	W	T	F	S
			01	02	03	
04	05	06	07	08	09	10
11	12	13	14	15	16	17
18	19	20	21	22	23	24
25	26	27	28	29	30	31

November						
S	M	T	W	T	F	S
01	02	03	04	05	06	07
08	09	10	11	12	13	14
15	16	17	18	19	20	21
22	23	24	25	26	27	28
29	30					

December						
S	M	T	W	T	F	S
			01	02	03	04
06	07	08	09	10	11	12
13	14	15	16	17	18	19
20	21	22	23	24	25	26
27	28	29	30	31		

Page Generated: Thu March 25th, 2021 - 17:22:19 GMT

Last Updated: March 23, 2021  
Curator: Charles R. Trepte  
NASA Official: Charles R. Trepte

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+ Privacy

+ Office of Inspector General  
+ Office of Special Counsel  
+ Agency Financial Reports

+ Contact NASA

Figure 25: PRODUCTS - CALIPSO STANDARD Browse Images - Version 4.11.

Each page contains the following information (figure 26, next page):

1. The name and date of the data images.
2. The data availability percentage.
3. A description of the data displayed in each image.
4. A description of the orbit tracks and maps that accompany the images.
5. Orbit tracks plotted on the maps that show the measurement locations for each granule.
6. The scaled images of the CALIPSO data product (day and night orbit granules).

1

## STANDARD LIDAR BROWSE IMAGES FOR PRODUCTION RELEASE [V4.11] BROWSE DATE [2020-12-31]

Return to STANDARD V4.11 Browse Page → → HOME

### DATA AVAILABILITY

99.0%

Displayed on this page are scaled, color-modulated, altitude-time images of CALIPSO attenuated backscatter (/km<sup>2</sup>/sr) including:

- 532 nm total (parallel + perpendicular) attenuated backscatter
- 532 nm perpendicular attenuated backscatter
- 1064 nm total attenuated backscatter

The orbit track locations for the entire Level 1 .hdf file are in black and the orbit track locations corresponding to this page are color coded.

For the full scale images:

- the color bars for attenuated backscatter show the colors assigned to ranges of attenuated backscatter, /km<sup>2</sup>/sr
- the horizontal axes are annotated with latitude (deg) and longitude (deg)
- the vertical axes are annotated to indicate altitude in kilometers
- the date and time of the measurements are listed in UTC time
- the names of the CALIPSO data products for the Lidar Level 1 attenuated backscatter granules are included

The scaled images on this page are organized by CALIPSO data product day and night orbit granules.

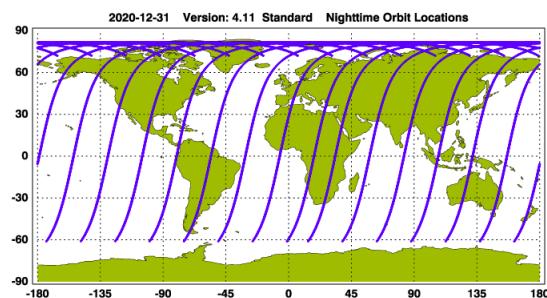
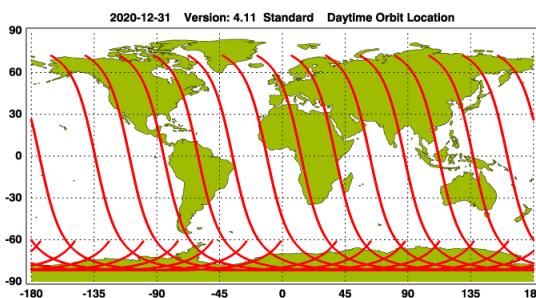
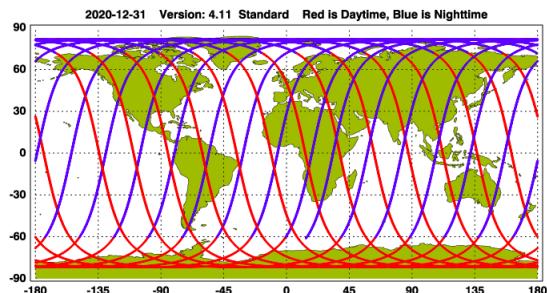
The maps with a shaded background indicate nighttime measurements.

There are a maximum of 4 scaled images per granule.

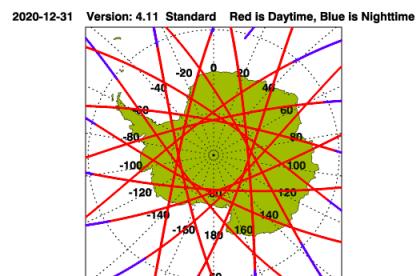
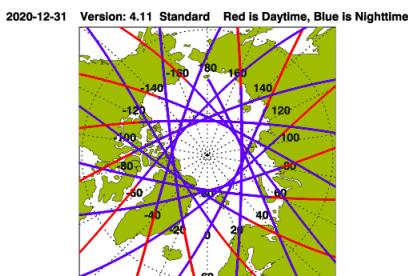
The orbit tracks plotted on the maps show the measurement locations for each granule.

For each granule, the scaled images are ordered from left to right and their locations along the orbit tracks are color coded as: [image one](#), [image two](#), [image three](#), [image four](#).

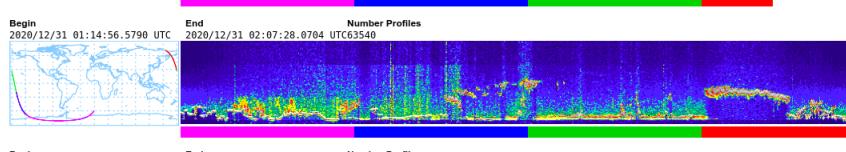
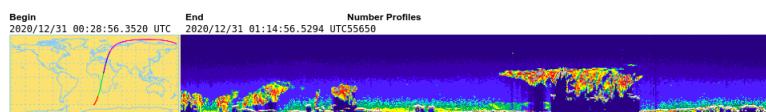
4



5



6

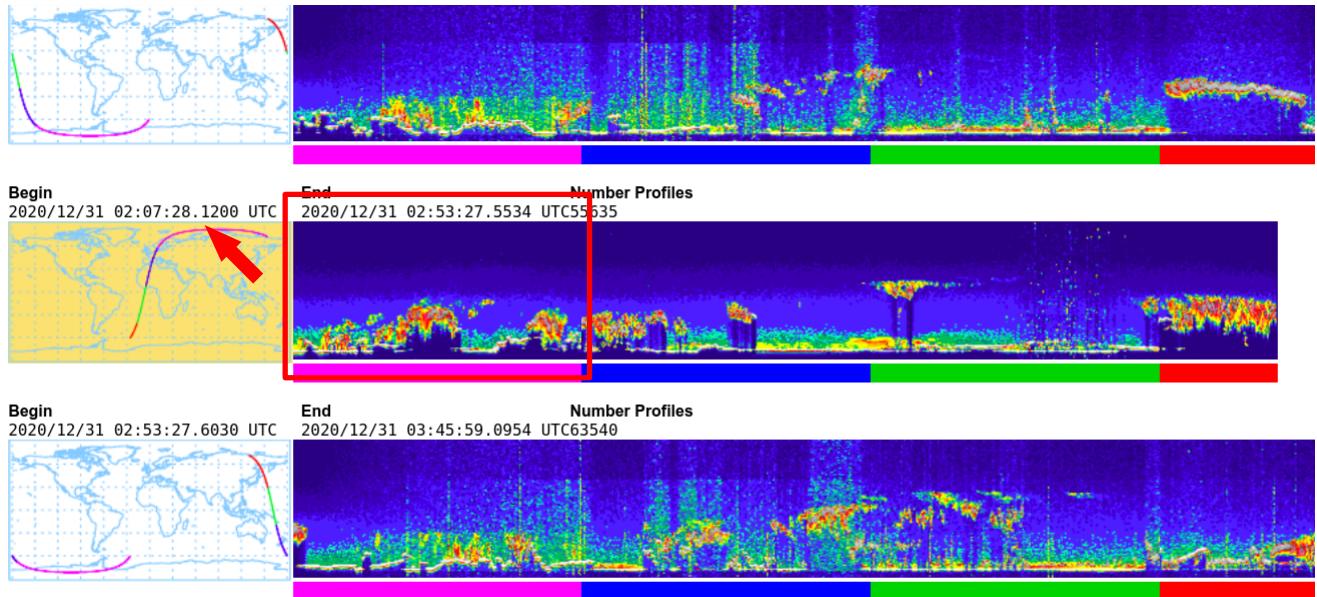


**Figure 26: STANDARD LIDAR BROWSE IMAGES FOR PRODUCTION RELEASE [V4.11] BROWSE DATE [2020-12-31]**

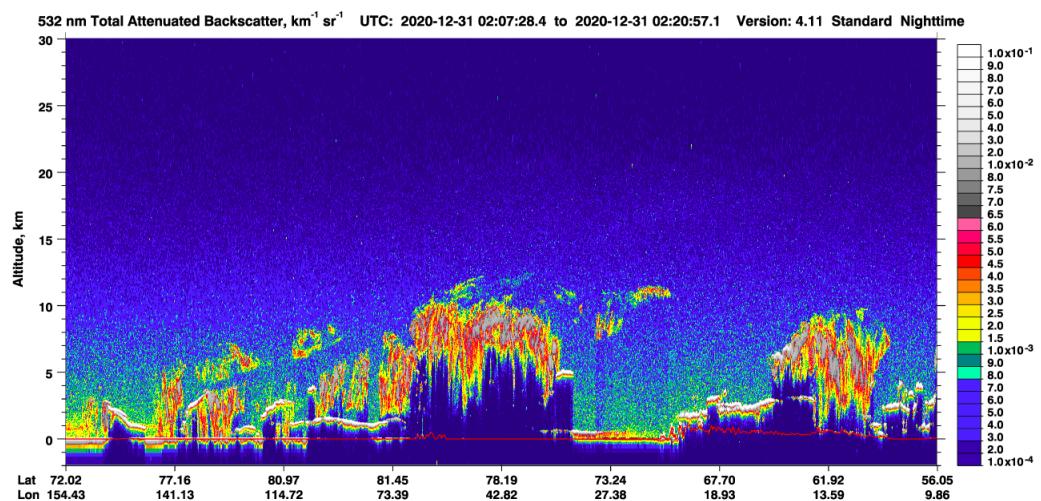
For each granule, the scaled images are ordered from left to right and their locations along the orbit tracks are color coded as:

- Image one: magenta
- Image two: blue
- Image three: green
- Image four: red<sup>26</sup>

Select the image according to the color code and click on it.



**Figure 27: Selecting a CALIPSO browse image.**



**Figure 28: LIDAR LEVEL 1 BROWSE IMAGES - 2020-12-31 05:24:33Z - SECTION 1**

# 4. Data visualization

## 4.1 ccplot

The easiest way to visualize CALIPSO lidar profiles is using [ccplot](#). ccplot is an open source command-line program for plotting profile, layer and earth view data sets from CloudSat, CALIPSO and Aqua MODIS products.<sup>27</sup> ccplot is written in Python and works on Linux, macOS and Windows.

To install it, download the latest version for your operating system from the [download page](#) or the [GitHub repo](#). Make sure you have all the required programs and libraries and follow the installation guide. To verify the installation you can run **ccplot -v** (print version):

```
$ ccplot -V  
ccplot 1.5.6
```

**Third-party libraries:**

**matplotlib 3.3.4**  
**basemap 1.2.2+dev**

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**This software is provided under the terms of a 2-clause BSD licence.**

If you get any error, please visit the [Issues page](#).

## 4.2 Plotting CALIPSO L1 Data Products

### 4.2.1 Get information

To print summary information about a file, use the **-i** option:

```
$ ccplot -i CAL_LID_L1-Standard-V4-10.2020-02-01T06-25-30ZN_Subset.hdf  
Type: CALIPSO  
Subtype: profile  
Time: 2020-02-01 06:46:20, 2020-02-01 06:55:14  
Height: -1818m, 39795m  
nray: 10758  
nbin: 583  
Longitude: 76.21W, 69.14W  
Latitude: 9.49S, 22.85N
```

#### 4.2.2 Plot Total Attenuated Backscatter 532nm

To plot the Total Attenuated Backscatter into a .png image, run the following command:

```
$ ccplot -o calipso532.png -d 72 -a 25 -c calipso-backscatter.cmap calipso532  
CAL_LID_L1-Standard-V4-10.2020-02-01T06-25-30ZN_Subset.hdf
```

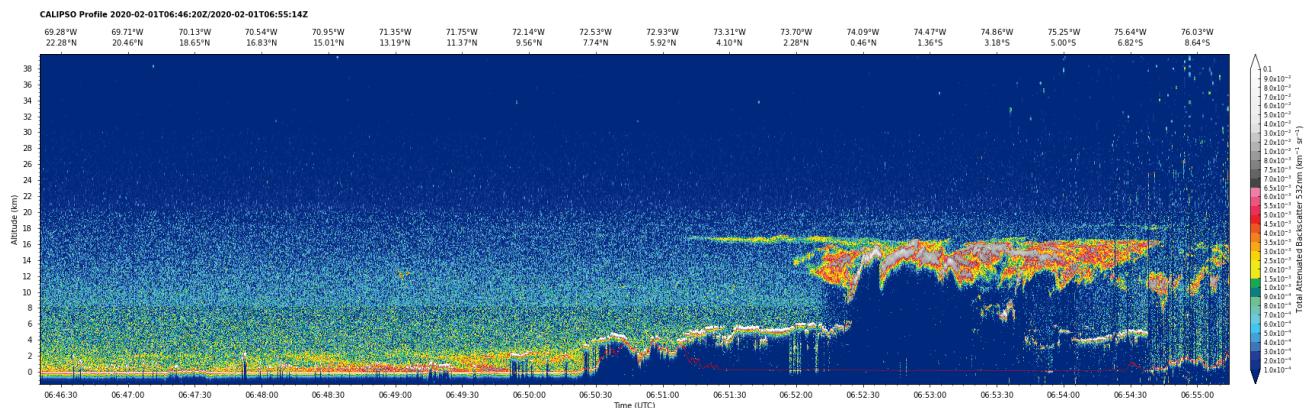


Figure 29: CAL\_LID\_L1-Standard-V4-10.2020-02-01T06-25-30ZN\_Subset.hdf plot image.

- **The -o option defines the output file.**

You can choose between SVG (.svg), PNG (.png), PDF (.pdf), EPS (.eps) and PS (.ps).

- **The -d option defines the DPI of the output image.**

The default is 300ppi.

- **The -a option defines the aspect ratio in km horizontal per km vertical.**

The default is 1:14.

- **The -c option defines the colormap.**

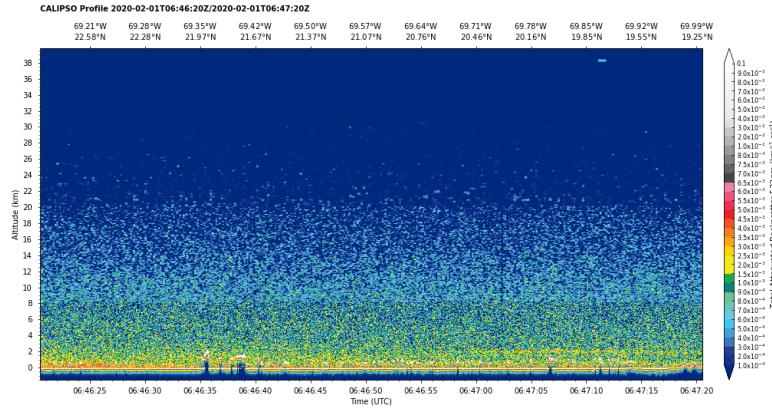
Colormaps can typically be found in /usr/share/ccplot/cmap or /usr/local/share/ccplot/cmap<sup>28</sup> (in Linux operating systems).

- **calipso532 tells ccplot to plot the CALIPSO L1B Total Attenuated Backscatter 532nm.**

If you get a **Figure size exceeds 32767 pixels, please specify a smaller region** error, you can either change the values of the -d and -a options or select a smaller region using the -x option. You can use it with a relative time in the format (+|-)[HH]:MM:SS. The preceding plus sign

means ‘relative to the beginning’, whereas the minus sign means ‘relative to the end’.<sup>29</sup> For example, to plot the first minute of the lidar profile, run the following command:

```
ccplot -o calipso532_1min.png -x +0:00..+1:00 -d 72 -a 5 -c calipso-backscatter.cmap
calipso532 CAL_LID_L1-Standard-V4-10.2020-02-01T06-25-30ZN_Subset.hdf
```



**Figure 30:** CAL\_LID\_L1-Standard-V4-10.2020-02-01T06-25-30ZN\_Subset.hdf’s first minute plot image.

For other options description, related resources and more detailed information please visit the [ccplot Documentation](#), the [ccplot Manual](#) or take a look to the thesis [\*Visualising Data from CloudSat and CALIPSO Satellites\*](#) by Peter Kuma.

## 5. References

- 1 Winker, D. M. et al. (2010) "The CALIPSO mission," *Bulletin of the American Meteorological Society*, 91(9), pp. 1211–1230.
- 2 Voiland, A. (2010) *Aerosols: Tiny Particles, Big Impact*, NASA Earth Observatory. Available at: <https://earthobservatory.nasa.gov/features/Aerosols>
- 3 Mark Vaughan, Michael Pitts, Charles Trepte, David Winker, Pauline Detweiler, Anne Garnier, Brian Getzewich, William Hunt, James Lambeth, Kam-Pui Lee, Patricia Lucke, Timothy Murray, Sharon Rodier, Thierry Tremas, Ariane Bazzureau, Jacques Pelon (2020) *CALIPSO\_DPC\_Rev4x90*. Available at: [https://www-calipso.larc.nasa.gov/products/CALIPSO\\_DPC\\_Rev4x90.pdf](https://www-calipso.larc.nasa.gov/products/CALIPSO_DPC_Rev4x90.pdf).
- 4 Wikipedia contributors (2020) *CALIPSO*, *Wikipedia, The Free Encyclopedia*. Available at: <https://en.wikipedia.org/wiki/CALIPSO>
- 5 Mark Vaughan, Michael Pitts, Charles Trepte, David Winker, Pauline Detweiler, Anne Garnier, Brian Getzewich, William Hunt, James Lambeth, Kam-Pui Lee, Patricia Lucke, Timothy Murray, Sharon Rodier, Thierry Tremas, Ariane Bazzureau, Jacques Pelon (2020).
- 6 Ibid.
- 7 Ibid.
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- 11 Kuma, P. (2010) *Visualising Data from CloudSat and CALIPSO Satellites*. Comenius University.
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- 14 "CALIPSO Data User's Guide - Lidar Level 1 V4.10 Data Product Description" Available at: [https://www-calipso.larc.nasa.gov/resources/calipso\\_users\\_guide/data\\_summaries/l1b/index\\_v4-x.php](https://www-calipso.larc.nasa.gov/resources/calipso_users_guide/data_summaries/l1b/index_v4-x.php)
- 15 Ibid.
- 16 Kuma, P. (2010)
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## 6. Revision record

The following table shows the revision and change log for this document: the date it was made, a short description, and the sections of the document that changed.

Number and date	Description	Section affected
001_2021-03	Creation and edition of the first version of the document.	All