CALIPSO Lidar Level 3 GEWEX Cloud Data Description Document
Version 2.00

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Introduction

This product is the CALIPSO-format version of the lidar level 3 (L3) cloud product developed for the Global Energy and Water Cycle Experiment (GEWEX) Cloud Assessment. Both versions of the product report global distributions of cloud occurrences and cloud top heights on a 2-dimensional spatial grid. Cloud top heights are reported in three different ways: as cloud top temperature, cloud top pressure, and geometric cloud top height. All level 3 parameters are derived from the CALIPSO version 5.00 level 2 5 km merged cloud layer and 5 km cloud profile products.

The goal of the GEWEX Cloud Assessment (Stubenrauch et al. 2012b) was to evaluate the similarities and differences of the available global, long-term satellite cloud products. The cloud products were derived from a variety of different sensor types, including multi-spectral imagers (e.g., MODIS), infrared sounders (e.g., HIRS-NOAA), a multi-angle multi-spectral imager (MISR), and the CALIOP lidar. A GEWEX data archive was developed with all cloud climatologies in a common data format to facilitate the intercomparison of datasets.

The “level 3 standard GEWEX product” refers to the cloud product that the CALIPSO science team provided to the GEWEX Cloud Assessment data archive. These data are available on the Cloud Assessment website along with L3 cloud products from other satellites. The “level 3 CALIPSO format GEWEX product” refers to a cloud product with the GEWEX cloud contents but wrapped in a familiar CALIPSO data format. It is designed to maintain consistency with other CALIOP level 3 cloud and aerosol products, which are reported monthly. The “CALIPSO format” product is hosted at the NASA Atmospheric Science Data Center and at the Cloud-Aerosol-Water-Radiation Interactions (ICARE) Data and Service Center in Lille, France.

Both the standard and the CALIPSO-format GEWEX cloud products were produced from the same intermediate cloud mask files with merged cloud layers retrieved at different horizontal averaging from the L2 cloud product after applying a numbers of quality filters. The two GEWEX products have the same contents but with different formats and parameter names.

The standard format GEWEX cloud product packages each cloud property as a yearly file, while the CALIPSO format GEWEX cloud product reports all cloud properties in monthly files. The standard format GEWEX product data files are in Network Common Data Form (netCDF) 4 format while the CALIPSO format GEWEX product data files are in Hierarchical Data Format (HDF) 4 format. Besides different file names, they also have different science data set names. The standard format GEWEX cloud product follows the GEWEX cloud assessment general guidance and used the same parameter names as other L3 cloud products participated the GEWEX cloud assessment. The CALIPSO format GEWEX cloud product followed the traditional CALIPSO naming system. It also utilized Vgroup data structure for a neat organization of hundreds of parameters. The user can find one-to-one correspondence of science data set names by reading the attributes of the CALIPSO format GEWEX data files or from the Data Product Description page.

Three level 3 data files are generated each month according to lighting conditions: daytime only, nighttime only, and both day and night.

Following the general guidance, each data product team produced a dataset for the archive from their sensor in an identical format, with one annual file per cloud property, per observation time of day, on a 1 degree latitude by 1 degree longitude grid. Cloud properties are reported at three altitude levels – high, middle and low – based on cloud top pressure (CP). Cloud properties held in the archive include cloud amount (fractional cloud cover), cloud height (in terms of pressure, temperature or altitude), cloud radiative properties (visible optical depth or infrared emissivity), cloud thermodynamic phase (liquid or ice) and bulk microphysical properties (effective particle size and water path). The CALIPSO science team at the NASA Langley Research Center contributed to the 2012 GEWEX cloud assessment but was only able to contribute two years of data (2007-2008) to the archive.

Four flavors (variations) of the CALIPSO format GEWEX cloud products were developed following four different strategies: Column, Top_Layer, Passive, and Opaque. The Column flavor aggregates all the cloud layers detected by CALIOP and represents the global cloud distribution as observed by CALIOP. The Top_Layer flavor, however, aggregates only the highest cloud layer in each profile. In the original 2012 version of the product Top_Layer was meant to mimic a passive sensor data product where only a single cloud layer is retrieved in each column. Top_Layer was included in the V1.00 product for heritage but V1.00 also introduced the Passive flavor. Because CALIOP has much higher sensitivity to thin cirrus than passive sensors, the Passive flavor was introduced to illustrate the differences to be expected in a comparison of GEWEX products from CALIOP and from a passive sensor unable to detect clouds with optical depth less than 0.3. Like Top_Layer, the Passive flavor aggregates only a single cloud layer in each column, but also ignores any ice cloud layer with optical depth less than 0.3. The Passive flavor, however, still reports the actual lidar-detected cloud top altitudes (as do all CALIOP data products) and therefore will be somewhat different from the cloud heights retrieved by (most) passive sensors. The Opaque flavor aggregates only opaque cloud layers, where 'opaque cloud' is defined as a cloud within which the CALIOP return signal is extinguished. In the algorithm, the criterion for 'opaque cloud' is the lowest cloud detected in a column where the Earth's surface below is not detected by CALIOP.

Table 1: Parameters included in the four flavors of the level 3 CALIPSO format GEWEX cloud product. Letters 'a' and 'h' mean parameters are reported as averages and histograms, while '/' means that the parameter is not reported.

Parameter		TopLayer	Passive	Column	Opaque
CA	CA	ah	ah	ah	ah
	CAH/M/L	a	a	a	a
	CAH/M/L R	a	a	a	a
	CAI/W/IH	a	a	a	a
	CAI/W/IH R	a	a	a	a
CT	CT	ah	ah	/	/
	CTH/M/L	ah	ah	/	/
	CTI/W/IH	ah	ah	/	/
CP	CP	ah	ah	/	/
CZ	CZ	ah	ah	/	/

Cloud occurrences are further described based on cloud top altitude and cloud phase, as previously described and shown in Table 1.

As shown in Figure 1, the cloud amounts and cloud top altitudes of the four flavors will be slightly different. For CA, the patterns are identical for the Top Layer and Column flavors. CA of the Column flavor is slightly larger than that of Passive, because optically thin ice clouds are filtered out of the Passive flavor. Cloud amount in the Opaque flavor is the smallest as only opaque clouds are counted.

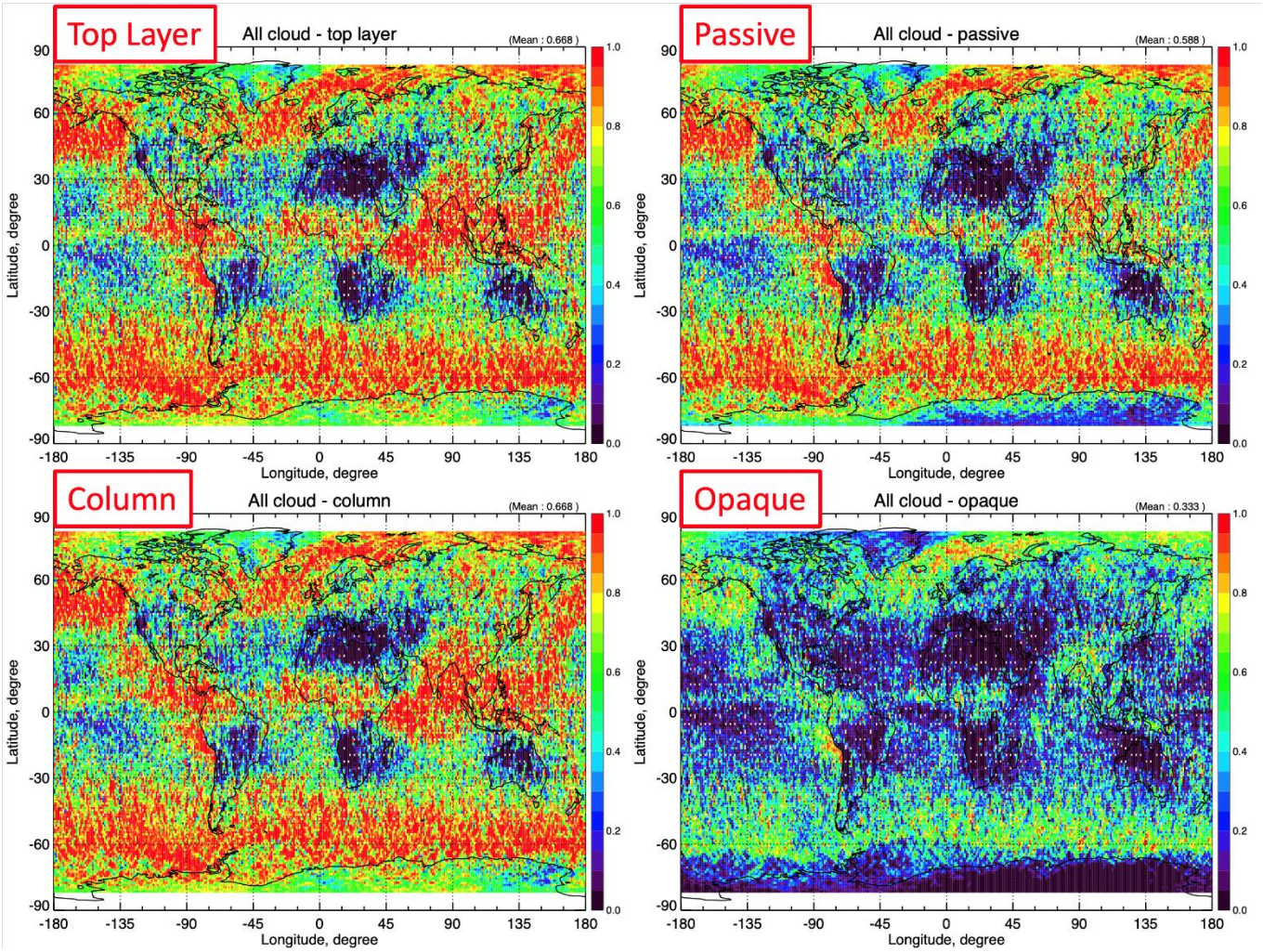


Figure 1: Cloud amount patterns of the four flavors in July 2008. The patterns are plotted as functions of longitude as X axis and latitude as Y axis. The cloud amount is described as a fraction from 0.0 to 1.0. The estimated global mean is given at the top right in each panel.

Table 2 presents a comparison of total cloud amount (CA), and high (CAH), middle (CAM), and low (CAL) cloud amounts for March 2008. Cloud amounts are typically larger at night than during day due to the reduced detection sensitivity of CALIOP during daytime. Opaque cloud amounts are larger during daytime than at night for the same reason. Clouds which are dense enough to extinguish the signal from the CALIOP laser pulse reflecting from the Earth's surface are classified as opaque. Surface detection is more difficult due to daytime, therefore the occurrence of clouds classified as Opaque increases.

Table 2: Comparison of global mean cloud amount parameters for March 2008 for each of the four flavors.

	CA Night/Day	CAH Night/Day	CAM Night/Day	CAL Night/Day
Column	0.686/0.645	0.374/0.342	0.266/0.219	0.353/0.307
Passive	0.602/0.562	0.236/0.222	0.114/0.109	0.253/0.230
Top_Layer	0.645/0.686	0.374/0.342	0.101/0.103	0.211/0.200
Opaque	0.274/0.355	0.064/0.091	0.070/0.081	0.139/0.183

The CALIPSO team developed a two-year cloud climatology (2007-2008), the CALIPSO-ST dataset, for the original GEWEX Cloud Assessment. The CALIPSO-ST dataset was expanded (2007-2016) for the 2020 update to the GEWEX archive, using V4.20 level 2 data. A "CALIPSO-format" version of CALIPSO-ST was also developed, which became V1.00 of the CALIPSO Lidar Level 3 GEWEX Cloud Product. Both products contained the same cloud statistics but CALIPSO-ST packaged cloud parameters individually in annual files of monthly statistics, while the CALIPSO-format product packaged all the parameters together into monthly files. The tables below describe the spatial characteristics of the product.

Table 3: The spatial coverage and resolution of L3 CALIPSO format GEWEX cloud product.

Spatial Coverage	Spatial Resolution
360° longitude (180° W to 180° E)	1.0° longitude
180° latitude (90° S to 90° N)	1.0° latitude

Cloud properties are reported at three altitude levels, i.e., high, middle and low levels, based on cloud top pressure (CP). Table 4 lists the pressure ranges in hectopascal (hPa) of the three levels.

Table 4: Cloud top pressure ranges of the three altitude regions.

Altitude Region	Cloud Top Pressure Range
High-level	CP < 400 hPa
Middle-level	400 hPa <= CP < 680 hPa
Low-level	680 hPa <= CP

Other than reporting averages of cloud occurrence and cloud top, the product also reports histograms of selected parameters. Table 5 summarizes the dimensions of the science data sets which are described as 2-dimensional or 3-dimensional arrays depending on their purpose.

Table 5: Number of dimensions and dimension lengths of science data sets of L3 CALIPSO format GEWEX cloud product.

Number of Dimensions	Dimension Lengths
2-D	No. of latitude bins x No. of longitude bins 180 x 360
3-D	No. of latitude bins x No. of longitude bins x No. of histogram bins 180 x 360 x 10 for cloud occurrence (CA) histogram 180 x 360 x 28 for cloud top temperature (CT) histogram 180 x 360 x 10 for cloud top pressure (CP) histogram 180 x 360 x 10 for cloud top altitude (CZ) histogram

Table of Contents

Additional Documentation

Project Documentation

- CALIPSO Data Management Team: CALIPSO Data Products Catalog, PC-SCI-503, Release 5.00.
- Winker, D. M., C. A. Hostetler, M. A. Vaughan, and A. H. Omar, 2006: CALIOP Algorithm Theoretical Basis Document: Part 1 : CALIOP Instrument, and Algorithms Overview, PC-SCI-202 Part 1 Release 2.0, https://ntrs.nasa.gov/citations/20250006626.
- Vaughan, M. A., D. M. Winker, and K. A. Powell, 2005: CALIOP Algorithm Theoretical Basis Document Part 2: Feature Detection and Layer Properties Algorithms, PC-SCI-202 Part 2 Release 1.01, https://ntrs.nasa.gov/citations/20250006627.
- Liu, Z., A. H. Omar, Y. Hu, M. A. Vaughan, and D. M. Winker, 2005: CALIOP Algorithm Theoretical Basis Document: Part 3: Scene Classification Algorithms, PC-SCI-202 Part 3 Release 1.0, https://ntrs.nasa.gov/citations/20250006628.

Glossary and Acronym Dictionary

Term	Meaning
AMSL	above mean sea level

Term	Meaning
AOD	aerosol optical depth
ATBD	algorithm theoretical basis document
CALIOP	Cloud-Aerosol Lidar with Orthogonal Polarization
CALIPSO	Cloud-Aerosol Lidar and Infrared Pathfinder Satellite Observation
GMAO	Global Modeling and Assimilation Office
granule	continuous data segment in which all measurements were acquired while the lidar was configured for daytime data acquisition only or nighttime data acquisition only; each granule spans approximately one half of a full orbit, with daytime granules being slightly larger/longer than nighttime granules
HDF	Hierarchical Data Format
IAB	integrated attenuated backscatter
L1B	level 1B
LEM	low energy mitigation
MERRA-2	Modern-Era Retrospective analysis for Research and Applications, Version 2
N/A	not applicable
PSC	polar stratospheric cloud
QA	quality assurance/quality control
QC	quality control/quality assurance
SNR	signal-to-noise ratio
SDS	scientific data set
TAI	International Atomic Time
UTC	Coordinated Universal Time
WRS	Worldwide Reference System

Scientific Data Sets: Altitude and Position

Longitude_Midpoint

Units: degrees_east

Format: Float_32

Valid Range: -180, 180.0

Fill value: -9999.0

Description: Longitude at the grid cell midpoint.

Latitude_Midpoint

Units: degrees_north

Format: Float_32

Valid Range: -85.0, 85.0

Fill value: -9999.0

Description: Latitude at the grid cell midpoint.

Scientific Data Sets: Over-flight Parameters

Number_Of_Orbit_Tracks

Units: NoUnits

Format: Int_16

Valid Range: 0…32,767

Fill value: -9999

Description: Number of CALIPSO orbital tracks crossing each grid cell. One granule pass would be counted as one orbit track, regardless of the number of profiles. It corresponds to “n_tot” in a standard format GEWEX file.

Scientific Data Sets: Histogram Bin Boundaries

Cloud_Amount_Bin_Midpoint

Units: NoUnits

Format: Float_64

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Cloud amount at the midpoint of each bin. The number of the array size equals the number of histogram bins, i.e., 10. It corresponds to “bin” in a standard format GEWEX file “CA*CALIPSO-ST*.nc”.

Cloud_Amount_Bin_Boundaries

Units: NoUnits

Format: Float_64

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Cloud amount at histogram bin boundaries. The number of the array size, i.e., 11, is one larger than the number of histogram bins, i.e., 10. It corresponds to “bin_bounds” in a standard format GEWEX file “CA*CALIPSO-ST*.nc”.

Cloud_Top_Temperature_Bin_Midpoint

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Cloud top temperature at the midpoint of each bin. The number of the array size equals the number of histogram bins, i.e., 28. It corresponds to “bin” in a standard format GEWEX file “CT*CALIPSO-ST*.nc”.

Cloud_Top_Temperature_Bin_Boundaries

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Cloud top temperature at histogram bin boundaries. The number of the array size, i.e., 29, is one larger than the number of histogram bins, i.e., 28. It corresponds to “bin_bounds” in a standard format GEWEX file “CT*CALIPSO-ST*.nc”.

Cloud_Top_Pressure_Bin_Midpoint

Units: hPa

Format: Float_32

Valid Range: 100.0, 1100.0

Fill value: -9999.0

Description: Cloud top pressure at histogram bin boundaries. The number of the array size, i.e., 11, is one larger than the number of histogram bins, i.e., 10. It corresponds to “bin_bounds” in a standard format GEWEX file “CP*CALIPSO-ST*.nc”.

Cloud_Top_Altitude_Bin_Midpoint

Units: km

Format: Float_32

Valid Range: 0.0, 20.0

Fill value: -9999.0

Description: Cloud top altitude at the midpoint of each bin. The number of the array size equals to the number of histogram bins, i.e., 40. It corresponds to “bin” in a standard format GEWEX file “CZ*CALIPSO-ST*.nc”.

Cloud_Top_Altitude_Bin_Boundaries

Units: km

Format: Float_32

Valid Range: 0.0, 20.0

Fill value: -9999.0

Description: Cloud top altitude at histogram bin boundaries. The number of the array size, i.e., 41, is one larger than the number of histogram bins, i.e., 40. It corresponds to “bin_bounds” in a standard format GEWEX file “CZ*CALIPSO-ST*.nc”.

Vgroups: Cloud Amount TopLayer

Cloud_Amount_Mean_TopLayer

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean cloud amount of the top layer flavor reported within the latitude/longitude grid cell. The top layer flavor chooses only the top cloud layer in each profile. It corresponds to “a_CA” in a standard format GEWEX file “CA_TOP_LAYER_CALIPSO-ST*.nc”.

Cloud_Amount_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud amount of the top layer flavor reported within the latitude/longitude grid cell. The top layer flavor chooses only the top cloud layer in each profile. It corresponds to “h_CA” in a standard format GEWEX file “CA_TOP_LAYER_CALIPSO-ST*.nc”.

High_Cloud_Amount_Mean_TopLayer

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean cloud amount of the top layer flavor for the high-level altitude region reported within the latitude/longitude grid cell. The top layer flavor chooses only the top cloud layer in each profile. If the cloud layer is located in the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy at high-level altitude region. It corresponds to "_CAH" in a standard format GEWEX file "CAH_TOP_LAYER_CALIPSO-ST*.nc".

High_Cloud_Amount_Ratio_TopLayer

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage cloud amount of the top layer flavor for the high-level altitude region reported within the latitude/longitude grid cell. It is derived from High_Cloud_Amount_Mean_TopLayer and Cloud_Amount_Mean_TopLayer. The top layer flavor chooses only the top cloud layer in each profile. If the cloud layer is located in the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy at high-level altitude region. It corresponds to "a_CAHR" in a standard format GEWEX file "CAHR_TOP_LAYER_CALIPSO-ST*.nc".

Middle_Cloud_Amount_Mean_TopLayer

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean cloud amount of the top layer flavor for the middle-level altitude region reported within the latitude/longitude grid cell. The top layer flavor chooses only the top cloud layer in each profile. If the cloud layer is located in the middle-level altitude region where the pressure is greater than or equal to 400 hPa and less than 680 hPa, this profile would be considered cloudy at middle-level altitude region. It corresponds to "a_CAM" in a standard format GEWEX file "CAM_TOP_LAYER_CALIPSO-ST*.nc".

Middle_Cloud_Amount_Ratio_TopLayer

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage cloud amount of the top layer flavor for the middle-level altitude region reported within the latitude/longitude grid cell. It is derived from Middle_Cloud_Amount_Mean_TopLayer and Cloud_Amount_Mean_TopLayer. The top layer flavor chooses only the top cloud layer in each profile. If the highest cloud layer is located in the middle-level altitude region where the pressure is greater than or equal to 400 hPa and less than 680 hPa, this profile would be considered cloudy at middle-level altitude region. It corresponds to "a_CAMR" in a standard format GEWEX file "CAMR_TOP_LAYER_CALIPSO-ST*.nc".

Low_Cloud_Amount_Mean_TopLayer

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean cloud amount of the top layer flavor reported in low-level altitude region within the latitude/longitude grid cell. The top layer flavor chooses only the top cloud layer in each profile. If the cloud layer is located in the low-level altitude region where the pressure is greater than or equal to 680 hPa, this profile would be considered cloudy at low-level altitude region. It corresponds to "a_CAL" in a standard format GEWEX file "CAL_TOP_LAYER_CALIPSO-ST*.nc".

Low_Cloud_Amount_Ratio_TopLayer

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage cloud amount of the top layer flavor in the low-level altitude region reported within the latitude/longitude grid cell. It is derived from Low_Cloud_Amount_Mean_TopLayer and Cloud_Amount_Mean_TopLayer. The top layer flavor chooses only the top cloud layer in each profile. If the highest cloud layer is located in the low-level altitude region where the pressure is greater than or equal to 680 hPa, this profile would be considered cloudy at low-level altitude region. It corresponds to "a_CALR" in a standard format GEWEX file "CALR_TOP_LAYER_CALIPSO-ST*.nc".

Ice_Cloud_Amount_Mean_TopLayer

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean ice cloud amount of the top layer flavor reported within the latitude/longitude grid cell. The top layer flavor chooses only the top cloud layer in each profile. If this cloud layer is an ice cloud, this profile would be considered cloudy. It corresponds to "a_CAI" in a standard format GEWEX file "CAI_TOP_LAYER_CALIPSO-ST*.nc".

Ice_Cloud_Amount_Ratio_TopLayer

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage ice cloud amount of the top layer flavor reported within the latitude/longitude grid cell. It is derived from Ice_Cloud_Amount_Mean_TopLayer and Cloud_Amount_Mean_TopLayer. The top layer flavor chooses only the top cloud layer in each profile. If this cloud layer is an ice cloud, this profile would be considered cloudy. It corresponds to "a_CAIR" in a standard format GEWEX file "CAIR_TOP_LAYER_CALIPSO-ST*.nc".

Water_Cloud_Amount_Mean_TopLayer

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean water cloud amount of the top layer flavor reported within the latitude/longitude grid cell. The top layer flavor chooses only the top cloud layer in each profile. If the cloud layer is a water cloud, this profile would be considered cloudy. It corresponds to “a_CAW” in a standard format GEWEX file “CAW_TOP_LAYER_CALIPSO-ST*.nc”.

Water_Cloud_Amount_Ratio_TopLayer

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage water cloud amount of top layer flavor reported within the latitude/longitude grid cell. It is derived from Water_Cloud_Amount_Mean_TopLayer and Cloud_Amount_Mean_TopLayer. The top layer flavor chooses only the top cloud layer in each profile. If the cloud layer is a water cloud, this profile would be considered cloudy. It corresponds to “a_CAWR” in a standard format GEWEX file “CAWR_TOP_LAYER_CALIPSO-ST*.nc”.

High_Ice_Cloud_Amount_Mean_TopLayer

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean ice cloud amount of the top layer flavor in the high-level altitude region reported within the latitude/longitude grid cell. The top layer flavor chooses only the top cloud layer in each profile. If the cloud layer is an ice cloud located in the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to “_CAIH” in a standard format GEWEX file “CAIH_TOP_LAYER_CALIPSO-ST*.nc”.

High_Ice_Cloud_Amount_Ratio_TopLayer

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage ice cloud amount of the top layer flavor in the high-level altitude region reported within the latitude/longitude grid cell. It is derived from High_Ice_Cloud_Amount_Mean_TopLayer and Cloud_Amount_Mean_TopLayer. The top layer flavor chooses only the top cloud layer in each profile. If the cloud layer is an ice cloud located in the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to “a_CAIHR” in a standard format GEWEX file “CAIHR_TOP_LAYER_CALIPSO-ST*.nc”.

Vgroups: Cloud Amount Passive

Cloud_Amount_Mean_Passive

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of passive flavor reported within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. It corresponds to “a_CA” in a standard format GEWEX file “CA_PASSIVE_CALIPSO-ST*.nc”.

Cloud_Amount_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud amount of passive flavor reported within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. It corresponds to “h_CA” in a standard format GEWEX file “CA_PASSIVE_CALIPSO-ST*.nc”.

High_Cloud_Amount_Mean_Passive

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of passive flavor at high-level altitude region reported within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is located at the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy at high-level altitude region. It corresponds to “a_CAH” in a standard format GEWEX file “CAH_PASSIVE_CALIPSO-ST*.nc”.

High_Cloud_Amount_Ratio_Passive

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of cloud amount of passive flavor at high-level altitude region reported within the latitude/longitude grid cell. It is derived from High_Cloud_Amount_Mean_Passive and Cloud_Amount_Mean_Passive. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is located at the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy at high-level altitude region. It corresponds to “a_CAHR” in a standard format GEWEX file “CAHR_PASSIVE_CALIPSO-ST*.nc”.

Middle_Cloud_Amount_Mean_Passive

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of passive flavor at middle-level altitude region reported within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud

layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is located at the middle-level altitude region where the pressure greater than or equal to 400 hPa and less than 680 hPa, this profile would be considered cloudy at middle-level altitude region. It corresponds to “a_CAM” in a standard format GEWEX file “CAM_PASSIVE_CALIPSO-ST*.nc”.

Middle_Cloud_Amount_Ratio_Passive

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of cloud amount of passive flavor at middle-level altitude region reported within the latitude/longitude grid cell. It is derived from Middle_Cloud_Amount_Mean_Passive and Cloud_Amount_Mean_Passive. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is located at the middle-level altitude region where the pressure greater than or equal to 400 hPa and less than 680 hPa, this profile would be considered cloudy at middle-level altitude region. It corresponds to “a_CAMR” in a standard format GEWEX file “CAMR_PASSIVE_CALIPSO-ST*.nc”.

Low_Cloud_Amount_Mean_Passive

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of passive flavor reported at low-level altitude region within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is located at the low-level altitude region where the pressure greater than or equal to 680 hPa, this profile would be considered cloudy at low-level altitude region. It corresponds to “a_CAL” in a standard format GEWEX file “CAL_PASSIVE_CALIPSO-ST*.nc”.

Low_Cloud_Amount_Ratio_Passive

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of cloud amount of passive flavor at low-level altitude region reported within the latitude/longitude grid cell. It is derived from Low_Cloud_Amount_Mean_Passive and Cloud_Amount_Mean_Passive. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is located at the low-level altitude region where the pressure greater than or equal to 680 hPa, this profile would be considered cloudy at low-level altitude region. It corresponds to “a_CALR” in a standard format GEWEX file “CALR_PASSIVE_CALIPSO-ST*.nc”.

Ice_Cloud_Amount_Mean_Passive

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of ice cloud amount of passive flavor reported within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is an ice cloud, this profile would be considered cloudy. It corresponds to "a_CAI" in a standard format GEWEX file "CAI_PASSIVE_CALIPSO-ST*.nc".

Ice_Cloud_Amount_Percentage_Passive

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of ice cloud amount of passive flavor reported within the latitude/longitude grid cell. It is derived from Ice_Cloud_Amount_Mean_Passive and Cloud_Amount_Mean_Passive. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is an ice cloud, this profile would be considered cloudy. It corresponds to "a_CAIR" in a standard format GEWEX file "CAIR_PASSIVE_CALIPSO-ST*.nc".

Water_Cloud_Amount_Mean_Passive

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of water cloud amount of passive flavor reported within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is a water cloud, this profile would be considered cloudy. It corresponds to "a_CAW" in a standard format GEWEX file "CAW_PASSIVE_CALIPSO-ST*.nc".

Water_Cloud_Amount_Percentage_Passive

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of water cloud amount of passive flavor reported within the latitude/longitude grid cell. It is derived from Water_Cloud_Amount_Mean_Passive and Cloud_Amount_Mean_Passive. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is a water cloud, this profile would be considered cloudy. It corresponds to "_CAWR" in a standard format GEWEX file "CAWR_PASSIVE_CALIPSO-ST*.nc".

High_Ice_Cloud_Amount_Mean_Passive

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of ice cloud amount of passive flavor at high-level altitude region reported within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud

layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is an ice cloud located at the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to “a_CAIH” in a standard format GEWEX file “CAIH_PASSIVE_CALIPSO-ST*.nc”.

High_Ice_Cloud_Amount_Percentage_Passive

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of ice cloud amount of passive flavor at high-level altitude region reported within the latitude/longitude grid cell. It is derived from High_Ice_Cloud_Amount_Mean_Passive and Cloud_Amount_Mean_Passive. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, detected in each profile. If the cloud layer is an ice cloud located at the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to “a_CAIHR” in a standard format GEWEX file “CAIHR_PASSIVE_CALIPSO-ST*.nc”.

Vgroups: Cloud Amount Column

Cloud_Amount_Mean_Column

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of column flavor reported within the latitude/longitude grid cell. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. It corresponds to “a_CA” in a standard format GEWEX file “CA_COLUMN_CALIPSO-ST*.nc”.

Cloud_Amount_Histogram_Column

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud amount of column flavor reported within the latitude/longitude grid cell. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. It corresponds to “h_CA” in a standard format GEWEX file “CA_COLUMN_CALIPSO-ST*.nc”.

High_Cloud_Amount_Mean_Column

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of column flavor at high-level altitude region reported within the latitude/longitude grid cell. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If a cloud layer is detected at the high-level altitude region where the pressure is

less than 400 hPa, this profile would be considered cloudy at high-level altitude region. It corresponds to "a_CAH" in a standard format GEWEX file "CAH_COLUMN_CALIPSO-ST*.nc".

High_Cloud_Amount_Ratio_Column

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of cloud amount of column flavor at high-level altitude region reported within the latitude/longitude grid cell. It is derived from High_Cloud_Amount_Mean_Column and Cloud_Amount_Mean_Column. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If a cloud layer is detected at the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy at high-level altitude region. It corresponds to "a_CAHR" in a standard format GEWEX file "CAHR_COLUMN_CALIPSO-ST*.nc".

Middle_Cloud_Amount_Mean_Column

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of column flavor at middle-level altitude region reported within the latitude/longitude grid cell. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If a cloud layer is detected at the middle-level altitude region where the pressure is greater than or equal to 400 hPa and less than 680 hPa, this profile would be considered cloudy at middle-level altitude region. It corresponds to "a_CAM" in a standard format GEWEX file "CAM_COLUMN_CALIPSO-ST*.nc".

Middle_Cloud_Amount_Ratio_Column

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of cloud amount of column flavor at middle-level altitude region reported within the latitude/longitude grid cell. It is derived from Middle_Cloud_Amount_Mean_Column and Cloud_Amount_Mean_Column. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If a cloud layer is detected at the middle-level altitude region where the pressure is greater than or equal to 400 hPa and less than 680 hPa, this profile would be considered cloudy at middle-level altitude region. It corresponds to "a_CAMR" in a standard format GEWEX file "CAMR_COLUMN_CALIPSO-ST*.nc".

Low_Cloud_Amount_Mean_Column

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of column flavor reported at low-level altitude region within the latitude/longitude grid cell. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If a cloud layer is detected at the low-level altitude region where the pressure is

greater than or equal to 680 hPa, this profile would be considered cloudy at low-level altitude region. It corresponds to “a_CAL” in a standard format GEWEX file “CAL_COLUMN_CALIPSO-ST*.nc”.

Low_Cloud_Amount_Ratio_Column

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of cloud amount of column flavor at low-level altitude region reported within the latitude/longitude grid cell. It is derived from Low_Cloud_Amount_Mean_Column and Cloud_Amount_Mean_Column. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If a cloud layer is detected at the low-level altitude region where the pressure is greater than or equal to 680 hPa, this profile would be considered cloudy at low-level altitude region. It corresponds to “a_CALR” in a standard format GEWEX file “CALR_COLUMN_CALIPSO-ST*.nc”.

Ice_Cloud_Amount_Mean_Column

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of ice cloud amount of column flavor reported within the latitude/longitude grid cell. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If an ice cloud layer is detected at any altitude region, this profile would be considered cloudy. It corresponds to “a_CAI” in a standard format GEWEX file “CAI_COLUMN_CALIPSO-ST*.nc”.

Ice_Cloud_Amount_Ratio_Column

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of ice cloud amount of column flavor reported within the latitude/longitude grid cell. It is derived from Ice_Cloud_Amount_Mean_Column and Cloud_Amount_Mean_Column. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If an ice cloud layer is detected at any altitude region, this profile would be considered cloudy. It corresponds to “a_CAIR” in a standard format GEWEX file “CAIR_COLUMN_CALIPSO-ST*.nc”.

Water_Cloud_Amount_Mean_Column

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of water cloud amount of column flavor reported within the latitude/longitude grid cell. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If a water cloud layer is detected at any altitude region, this profile would be considered cloudy. It corresponds to “a_CAW” in a standard format GEWEX file “CAW_COLUMN_CALIPSO-ST*.nc”.

Water_Cloud_Amount_Ratio_Column

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of water cloud amount of column flavor reported within the latitude/longitude grid cell. It is derived from Water_Cloud_Amount_Mean_Column and Cloud_Amount_Mean_Column. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If a water cloud layer is detected at any altitude region, this profile would be considered cloudy. It corresponds to "a_CAWR" in a standard format GEWEX file "CAWR_COLUMN_CALIPSO-ST*.nc".

High_Ice_Cloud_Amount_Mean_Column

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of ice cloud amount of column flavor at high-level altitude region reported within the latitude/longitude grid cell. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If an ice cloud layer is detected at high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to "a_CAI" in a standard format GEWEX file "CAIH_COLUMN_CALIPSO-ST*.nc".

High_Ice_Cloud_Amount_Ratio_Column

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of ice cloud amount of column flavor at high-level altitude region reported within the latitude/longitude grid cell. It is derived from High_Ice_Cloud_Amount_Mean_Column and Cloud_Amount_Mean_Column. The column flavor considers multiple layer clouds detected at different altitude regions in each profile. If an ice cloud layer is detected at high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to "a_CAIHR" in a standard format GEWEX file "CAIHR_COLUMN_CALIPSO-ST*.nc".

Vgroups: Cloud Amount Opaque

Cloud_Amount_Mean_Opaque

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of opaque flavor reported within the latitude/longitude grid cell. The opaque flavor chooses profiles when an opaque cloud layer is detected. It corresponds to "a_CA" in a standard format GEWEX file "CA_OPAQUE_CALIPSO-ST*.nc".

Cloud_Amount_Histogram_Opaque

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud amount of opaque flavor reported within the latitude/longitude grid cell. The opaque flavor chooses profiles when an opaque cloud layer is detected. It corresponds to “h_CA” in a standard format GEWEX file “CA_OPAQUE_CALIPSO-ST*.nc”.

High_Cloud_Amount_Mean_Opaque

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of opaque flavor at high-level altitude region reported within the latitude/longitude grid cell. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is located at the high-level altitude where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to “a_CAH” in a standard format GEWEX file “CAH_OPAQUE_CALIPSO-ST*.nc”.

High_Cloud_Amount_Ratio_Opaque

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of cloud amount of opaque layer flavor at high-level altitude region reported within the latitude/longitude grid cell. It is derived from High_Cloud_Amount_Mean_Opaque and Cloud_Amount_Mean_Opaque. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is located at the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to “a_CAHR” in a standard format GEWEX file “CAHR_OPAQUE_CALIPSO-ST*.nc”.

Middle_Cloud_Amount_Mean_Opaque

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of opaque flavor at middle-level altitude region reported within the latitude/longitude grid cell. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is located at the middle-level altitude region where the pressure is greater than or equal to 400 hPa and less than 680 hPa, this profile would be considered cloudy. It corresponds to “a_CAM” in a standard format GEWEX file “CAM_OPAQUE_CALIPSO-ST*.nc”.

Middle_Cloud_Amount_Ratio_Opaque

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of cloud amount of opaque layer flavor at middle-level altitude region reported within the latitude/longitude grid cell. It is derived from Middle_Cloud_Amount_Mean_Opaque and Cloud_Amount_Mean_Opaque. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is located at the middle-level altitude region where the atmosphere pressure

is greater than or equal to 400 hPa and less than 680 hPa, this profile would be considered cloudy. It corresponds to “a_CAMR” in a standard format GEWEX file “CAMR_OPAQUE_CALIPSO-ST*.nc”.

Low_Cloud_Amount_Mean_Opaque

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of cloud amount of opaque flavor reported at low-level altitude region within the latitude/longitude grid cell. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is located at the low-level altitude region where the pressure is greater than or equal to 680 hPa, this profile would be considered cloudy. It corresponds to “a_CAL” in a standard format GEWEX file “CAL_OPAQUE_CALIPSO-ST*.nc”.

Low_Cloud_Amount_Ratio_Opaque

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of cloud amount of top layer flavor at low-level altitude region reported within the latitude/longitude grid cell. It is derived from Low_Cloud_Amount_Mean_Opaque and Cloud_Amount_Mean_Opaque. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is located at the low-level altitude region where the pressure is greater than or equal to 680 hPa, this profile would be considered cloudy. It corresponds to “a_CALR” in a standard format GEWEX file “CALR_OPAQUE_CALIPSO-ST*.nc”.

Ice_Cloud_Amount_Mean_Opaque

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of ice cloud amount of opaque flavor reported within the latitude/longitude grid cell. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is an ice cloud, this profile would be considered cloudy. It corresponds to “a_CAI” in a standard format GEWEX file “CAI_OPAQUE_CALIPSO-ST*.nc”.

Ice_Cloud_Amount_Ratio_Opaque

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of ice cloud amount of opaque flavor reported within the latitude/longitude grid cell. It is derived from Ice_Cloud_Amount_Mean_Opaque and Cloud_Amount_Mean_Opaque. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is an ice cloud, this profile would be considered cloudy. It corresponds to “a_CAIR” in a standard format GEWEX file “CAIR_OPAQUE_CALIPSO-ST*.nc”.

Water_Cloud_Amount_Mean_Opaque

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of water cloud amount of opaque flavor reported within the latitude/longitude grid cell. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is a water cloud, this profile would be considered cloudy. It corresponds to “a_CAW” in a standard format GEWEX file “CAW_OPAQUE_CALIPSO-ST*.nc”.

Water_Cloud_Amount_Ratio_Opaque

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of water cloud amount of opaque layer flavor reported within the latitude/longitude grid cell. It is derived from Water_Cloud_Amount_Mean_Opaque and Cloud_Amount_Mean_Opaque. If the cloud layer is a water cloud, this profile would be considered cloudy. It corresponds to “a_CAWR” in a standard format GEWEX file “CAWR_OPAQUE_CALIPSO-ST*.nc”.

High_Ice_Cloud_Amount_Mean_Opaque

Units: NoUnits

Format: Float_32

Valid Range: 0.0, 1.0

Fill value: -9999.0

Description: Mean of ice cloud amount of opaque flavor at high-level altitude region reported within the latitude/longitude grid cell. The opaque flavor chooses profiles when an opaque cloud layer is detected. If the cloud layer is an ice cloud located at the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to “_CAIH” in a standard format GEWEX file “CAIH_OPAQUE_CALIPSO-ST*.nc”.

High_Ice_Cloud_Amount_Ratio_Opaque

Units: %

Format: Float_32

Valid Range: 0.0, 100.0

Fill value: -9999.0

Description: Percentage of ice cloud amount of opaque layer flavor at high-level altitude region reported within the latitude/longitude grid cell. It is derived from High_Ice_Cloud_Amount_Mean_Opaque and Cloud_Amount_Mean_Opaque. If the cloud layer is an ice cloud located at the high-level altitude region where the pressure is less than 400 hPa, this profile would be considered cloudy. It corresponds to “a_CAIHR” in a standard format GEWEX file “CAIHR_OPAQUE_CALIPSO-ST*.nc”.

Vgroups: Cloud Top Temperature TopLayer

Cloud_Top_Temperature_Mean_TopLayer

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of cloud top temperature of top layer flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. It corresponds to "a_CT" in a standard format GEWEX file "CT_TOP_LAYER_CALIPSO-ST*.nc".

Cloud_Top_Temperature_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top temperature of top layer flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. It corresponds to "h_CT" in a standard format GEWEX file "CT_TOP_LAYER_CALIPSO-ST*.nc".

High_Cloud_Top_Temperature_Mean_TopLayer

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is located at the high-level altitude region where the pressure is less than 400 hPa, the cloud top temperature would be included in the statistics. It corresponds to "a_CTH" in a standard format GEWEX file "CTH_TOP_LAYER_CALIPSO-ST*.nc".

High_Cloud_Top_Temperature_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is located at the high-level altitude region where the pressure is less than 400 hPa, the cloud top temperature would be included in the statistics. It corresponds to "h_CTH" in a standard format GEWEX file "CTH_TOP_LAYER_CALIPSO-ST*.nc".

Middle_Cloud_Top_Temperature_Mean_TopLayer

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of cloud top temperature of top layer flavor at middle-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is located at the middle-level altitude region where the pressure is greater than or equal to 400 hPa and less than 680 hPa, the cloud top temperature would be included in the statistics. It corresponds to "a_CTM" in a standard format GEWEX file "CTM_TOP_LAYER_CALIPSO-ST*.nc".

Middle_Cloud_Top_Temperature_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top temperature of top layer flavor at low-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is located at the middle-level altitude region where the pressure is greater than or equal to 400 hPa and less than 680 hPa, the cloud top temperature would be included in the statistics. It corresponds to "h_CTM" in a standard format GEWEX file "CTM_TOP_LAYER_CALIPSO-ST*.nc".

Low_Cloud_Top_Temperature_Mean_TopLayer

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of cloud top temperature of top layer flavor reported at low-level altitude region within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is located at the low-level altitude region where the pressure is greater than or equal to 680 hPa, the cloud top temperature would be included in the statistics. It corresponds to "a_CTL" in a standard format GEWEX file "CTL_TOP_LAYER_CALIPSO-ST*.nc".

Low_Cloud_Top_Temperature_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top temperature of top layer flavor at low-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is located at the low-level altitude region where the pressure is greater than or equal to 680 hPa, the cloud top temperature would be included in the statistics. It corresponds to "h_CTL" in a standard format GEWEX file "CTL_TOP_LAYER_CALIPSO-ST*.nc".

Ice_Cloud_Top_Temperature_Mean_TopLayer

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of ice cloud top temperature of top layer flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is an ice cloud, the cloud top temperature would be included in the statistics. It corresponds to "a_CTI" in a standard format GEWEX file "CTI_TOP_LAYER_CALIPSO-ST*.nc".

Ice_Cloud_Top_Temperature_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of ice cloud top temperature of top layer flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is an ice cloud, the cloud top temperature would be included in the statistics. It corresponds to "h_CTI" in a standard format GEWEX file "CTI_TOP_LAYER_CALIPSO-ST*.nc".

Water_Cloud_Top_Temperature_Mean_TopLayer

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of water cloud top temperature of top layer flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is a water cloud, the cloud top temperature would be included in the statistics. It corresponds to "a_CTW" in a standard format GEWEX file "CTW_TOP_LAYER_CALIPSO-ST*.nc".

Water_Cloud_Top_Temperature_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of water cloud top temperature of top layer flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is a water cloud, the cloud top temperature would be included in the statistics. It corresponds to "h_CTW" in a standard format GEWEX file "CTW_TOP_LAYER_CALIPSO-ST*.nc".

High_Ice_Cloud_Top_Temperature_Mean_TopLayer

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of ice cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is an ice cloud located at the high-level altitude region where the pressure is less than 400 hPa, the cloud top temperature would be included in the statistics. It corresponds to "a_CTIH" in a standard format GEWEX file "CTIH_TOP_LAYER_CALIPSO-ST*.nc".

High_Ice_Cloud_Top_Temperature_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of ice cloud top temperature of top layer flavor at high-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. If the cloud layer is an ice cloud located at the high-level altitude region where the pressure is less than 400 hPa, the cloud top temperature would be included in the statistics. It corresponds to "h_CTIH" in a standard format GEWEX file "CTIH_TOP_LAYER_CALIPSO-ST*.nc".

Vgroups: Cloud Top Temperature Passive

Cloud_Top_Temperature_Mean_Passive

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of cloud top temperature of passive flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. It corresponds to "a_CT" in a standard format GEWEX file "CT_PASSIVE_CALIPSO-ST*.nc".

Cloud_Top_Temperature_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top temperature of passive flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided

to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. It corresponds to "h_CT" in a standard format GEWEX file "CT_PASSIVE_CALIPSO-ST*.nc".

High_Cloud_Top_Temperature_Mean_Passive

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of cloud top temperature of passive flavor at high-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is located at the high-level altitude region where the pressure is less than 400 hPa, the cloud top temperature would be included in the statistics. It corresponds to "a_CTH" in a standard format GEWEX file "CTH_PASSIVE_CALIPSO-ST*.nc".

High_Cloud_Top_Temperature_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top temperature of passive flavor at high-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is located at the high-level altitude region where the pressure is less than 400 hPa, the cloud top temperature would be included in the statistics. It corresponds to "h_CTH" in a standard format GEWEX file "CTH_PASSIVE_CALIPSO-ST*.nc".

Middle_Cloud_Top_Temperature_Mean_Passive

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of cloud top temperature of passive flavor at middle-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is located at the middle-level altitude region where the pressure is greater than or equal to 400 hPa and less than 680 hPa, the cloud top temperature would be included in the statistics. It corresponds to "a_CTM" in a standard format GEWEX file "CTM_PASSIVE_CALIPSO-ST*.nc".

Middle_Cloud_Top_Temperature_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top temperature of passive flavor at low-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is located at the middle-level altitude region where the pressure is greater than or equal to 400 hPa and less than 680 hPa, the cloud top temperature would be included in the statistics. It corresponds to "h_CTM" in a standard format GEWEX file "CTM_PASSIVE_CALIPSO-ST*.nc".

Low_Cloud_Top_Temperature_Mean_Passive

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of cloud top temperature of passive flavor at low-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is located at the low-level altitude region where the pressure is greater than or equal to 680 hPa, the cloud top temperature would be included in the statistics. It corresponds to "a_CTL" in a standard format GEWEX file "CTL_PASSIVE_CALIPSO-ST*.nc".

Low_Cloud_Top_Temperature_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top temperature of passive flavor at low-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is located at the low-level altitude region where the pressure is greater than or equal to 680 hPa, the cloud top temperature would be included in the statistics. It corresponds to "h_CTL" in a standard format GEWEX file "CTL_PASSIVE_CALIPSO-ST*.nc".

Ice_Cloud_Top_Temperature_Mean_Passive

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of ice cloud top temperature of passive flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than

or equal to 0.3, in each profile. If the cloud layer is an ice cloud, the cloud top temperature would be included in the statistics. It corresponds to “a_CTI” in a standard format GEWEX file “CTI_PASSIVE_CALIPSO-ST*.nc”.

Ice_Cloud_Top_Temperature_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of ice cloud top temperature of passive flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is an ice cloud, the cloud top temperature would be included in the statistics. It corresponds to “h_CTI” in a standard format GEWEX file “CTI_PASSIVE_CALIPSO-ST*.nc”.

Water_Cloud_Top_Temperature_Mean_Passive

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of water cloud top temperature of passive flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is a water cloud, the cloud top temperature would be included in the statistics. It corresponds to “a_CTW” in a standard format GEWEX file “CTW_PASSIVE_CALIPSO-ST*.nc”.

Water_Cloud_Top_Temperature_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of water cloud top temperature of passive flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is a water cloud, the cloud top temperature would be included in the statistics. It corresponds to “h_CTW” in a standard format GEWEX file “CTW_PASSIVE_CALIPSO-ST*.nc”.

High_Ice_Cloud_Top_Temperature_Mean_Passive

Units: K

Format: Float_32

Valid Range: 150.0, 320.0

Fill value: -9999.0

Description: Mean of ice cloud top temperature of passive flavor at high-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is an ice cloud located at the high-level altitude region where the pressure is less than 400 hPa, the cloud top temperature would be included in the statistics. It corresponds to "a_CTIH" in a standard format GEWEX file "CTIH_PASSIVE_CALIPSO-ST*.nc".

High_Ice_Cloud_Top_Temperature_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of ice cloud top temperature of passive flavor at high-level altitude region reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. If the cloud layer is an ice cloud located at the high-level altitude region where the pressure is less than 400 hPa, the cloud top temperature would be included in the statistics. It corresponds to "h_CTIH" in a standard format GEWEX file "CTIH_PASSIVE_CALIPSO-ST*.nc".

Vgroups: Cloud Top Pressure TopLayer

Cloud_Top_Pressure_Mean_TopLayer

Units: hPa

Format: Float_32

Valid Range: 100.0, 1100.0

Fill value: -9999.0

Description: Mean of cloud top pressure of top layer flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. It corresponds to "a_CP" in a standard format GEWEX file "CP_TOP_LAYER_CALIPSO-ST*.nc".

Cloud_Top_Pressure_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top pressure of top layer flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The top layer flavor chooses the top cloud layer only in each profile. It corresponds to "h_CP" in a standard format GEWEX file "CP_TOP_LAYER_CALIPSO-ST*.nc".

Vgroups: Cloud Top Pressure Passive

Cloud_Top_Pressure_Mean_Passive

Units: hPa

Format: Float_32

Valid Range: 100.0, 1100.0

Fill value: -9999.0

Description: Mean of cloud top pressure of passive flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. It corresponds to "a_CP" in a standard format GEWEX file "CP_PASSIVE_CALIPSO-ST*.nc".

Cloud_Top_Pressure_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top pressure of passive flavor reported within the latitude/longitude grid cell derived from the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided to the CALIPSO project by the GMAO Data Assimilation System. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. It corresponds to "h_CP" in a standard format GEWEX file "CP_PASSIVE_CALIPSO-ST*.nc".

Vgroups: Cloud Top Altitude TopLayer

Cloud_Top_Altitude_Mean_TopLayer

Units: km

Format: Float_32

Valid Range: 0.0, 20.0

Fill value: -9999.0

Description: Mean of cloud top altitude of top layer flavor reported within the latitude/longitude grid cell. The top layer flavor chooses the top cloud layer only in each profile. It corresponds to "a_CZ" in a standard format GEWEX file "CZ_TOP_LAYER_CALIPSO-ST*.nc".

Cloud_Top_Altitude_Histogram_TopLayer

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top altitude of top layer flavor reported within the latitude/longitude grid cell. The top layer flavor chooses the top cloud layer only in each profile. It corresponds to "h_CZ" in a standard format GEWEX file "CZ_TOP_LAYER_CALIPSO-ST*.nc".

Vgroups: Cloud Top Altitude Passive

Cloud_Top_Altitude_Mean_Passive

Units: km

Format: Float_32

Valid Range: 0.0, 20.0

Fill value: -9999.0

Description: Mean of cloud top altitude of passive flavor reported within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. It corresponds to "a_CZ" in a standard format GEWEX file "CZ_PASSIVE_CALIPSO-ST*.nc".

Cloud_Top_Altitude_Histogram_Passive

Units: NoUnits

Format: Int_32

Valid Range: 0.0…2,147,483,647

Fill value: -9999

Description: Histogram of cloud top altitude of passive flavor reported within the latitude/longitude grid cell. The passive flavor chooses the top cloud layer, if the top layer is a water cloud layer or an ice cloud layer with the layer optical depth greater than or equal to 0.3, in each profile. It corresponds to "h_CZ" in a standard format GEWEX file "CZ_PASSIVE_CALIPSO-ST*.nc".

Metadata Descriptions

Product_ID

Units: NoUnits

Format: Char

Valid range: CAL_LID_L3_GEWEX_Cloud

Definition: A character string (80-byte maximum) specifying the data product name. For all CALIPSO Lidar Level 3 GEWEX Cloud products, this string will always be "CAL_LID_L3_GEWEX_Cloud".

Date_Time_of_Production

Units: NoUnits

Format: Char

Valid range: 4/2006 - 10/2025

Definition: A 27-byte character string that specifies the UTC date and time at which the data was generated. The format is yyyy-mm-ddThh:nn:ss.ffffffZ, where yyyy is the year, mm is the month, dd is the day, hh is the hour, nn is the minute, ss is the second, and ffffff is the fractional second. Date and time are separated by the character 'T'. The 'Z' indicates that time is given in UTC.

Nominal_Year_Month

Units: NoUnits

Format: Char

Valid range: 200606 - 202306

Definition: A six-digit integer indicating the year and month when data within the level 3 file was measured by CALIPSO in the format yyyymm.

Day_Night_Flag

Units: NoUnits

Format: Char

Definition: A 2-byte character string that indicating the lighting conditions at an altitude of about 24 km above mean sea level. It is one of the following characters, D, N and A which representing daytime, nighttime and all time.

Program_Configuration

Units: NoUnits

Format: Char

Definition: This parameter contains the contents of the runtime program configuration file. The file controls the sizes of dimensions used by the program, the cloud quality filter parameters, and an input file check.

Number_of_Level2_Files_Analyzed

Units: NoUnits

Format: UInt_16

Valid range: 0...900

Definition: Number of level 2 granules analyzed to generate this level 3 CALIPSO format GEWEX cloud product file.

List_of_Input_Files

Units: NoUnits

Format: Char

Definition: List of included granules of level 2 5 km merged layer product to generate this level 3 CALIPSO format GEWEX cloud product file.

Data Release Information

Release Date	Version	Data Date Range	Production Strategy	Input Products and Versions
October 2025	2.00	June 13, 2006 to June 30, 2023	Standard	V5.00 Level 2 5km MLay
December 2019	1.00	June 13, 2016 to December 31, 2016	Standard	V4.20 Level 2 5km MLay

Data Quality Information

Data Quality Statement for the release of the CALIPSO Lidar Level 3 GEWEX Cloud Version 2.00

Version 2.00 of the level 3 (L3) "CALIPSO-format" GEWEX cloud product is processed from the V5.0 level 2 (L2) 5-km merged cloud layer product and extends the record to June 2023. The major change in the version 2.00 product, other than benefiting from the improved V5.0 level 1 and level products, is the addition of the low energy mitigation (LEM) algorithm (Tackett et al. 2025) to remove impacts of the low energy shots which occurred with occurring frequency in the last years of the mission. From the beginning of the CALIPSO mission through 2018 the mean local time (MLT) of the equator crossing was held constant. The CALIPSO orbit began to drift in 2019 and the MLT of the orbit changed significantly by the end of the mission, which risks aliasing the diurnal cycle into the long-term record.

<u>Low Laser Energy Mitigation</u>

CALIOP began experiencing a significant number of intermittent low energy laser pulses starting in mid-2017, primarily over the South Atlantic Anomaly (SAA) region (Tackett et al. 2025). These low energy pulses degraded

data quality in affected profiles and also impacted retrievals in 5-km columns containing low energy shots. In the V1.00 release of the level 3 cloud products, low energy laser shots were rare and the algorithms that produced the V1.00 level 3 cloud products was not aware whether low energy shots were present or not. In the later years of the mission, however, low energy shots became more frequent, especially in the SAA, and impacts of low energy shots could no longer be ignored. The major difference between V2.00 and V1.00 level 3 cloud products is that the V2.00 algorithms are now aware of the application of a low energy mitigation (LEM) algorithm that was used in the production of all V5.0 level 2 products (Tackett et al., 2025). The LEM algorithm removes level 1 data affected by low energy from L2 processing in small, targeted segments to minimize data loss. The remaining data not excluded from L2 processing yields cloud (and aerosol) retrievals with similar quality as data in regions unaffected by low energy pulses. Despite efforts to minimize data loss, some L2 data is totally rejected by LEM, particularly over the SAA. The V5.0 L2 product identifies LEM-rejected data using a special flag value (−444) and with a new LEM column QC flag. All L3 cloud products benefit from the L2 LEM algorithm and L2 profiles that are rejected by LEM are now excluded from L3 monthly aggregation.

The figure below compares monthly CA in 2008, a year with few low energy laser shots, and 2021, a year with a high occurrence of low energy shots in the SAA and an enhanced but much lower frequency of occurrence outside the SAA (Tackett et al. 2025). The (apparently) cloud-free region centered on South America is the result of the LEM algorithm clearing data impacted by low energy shots.

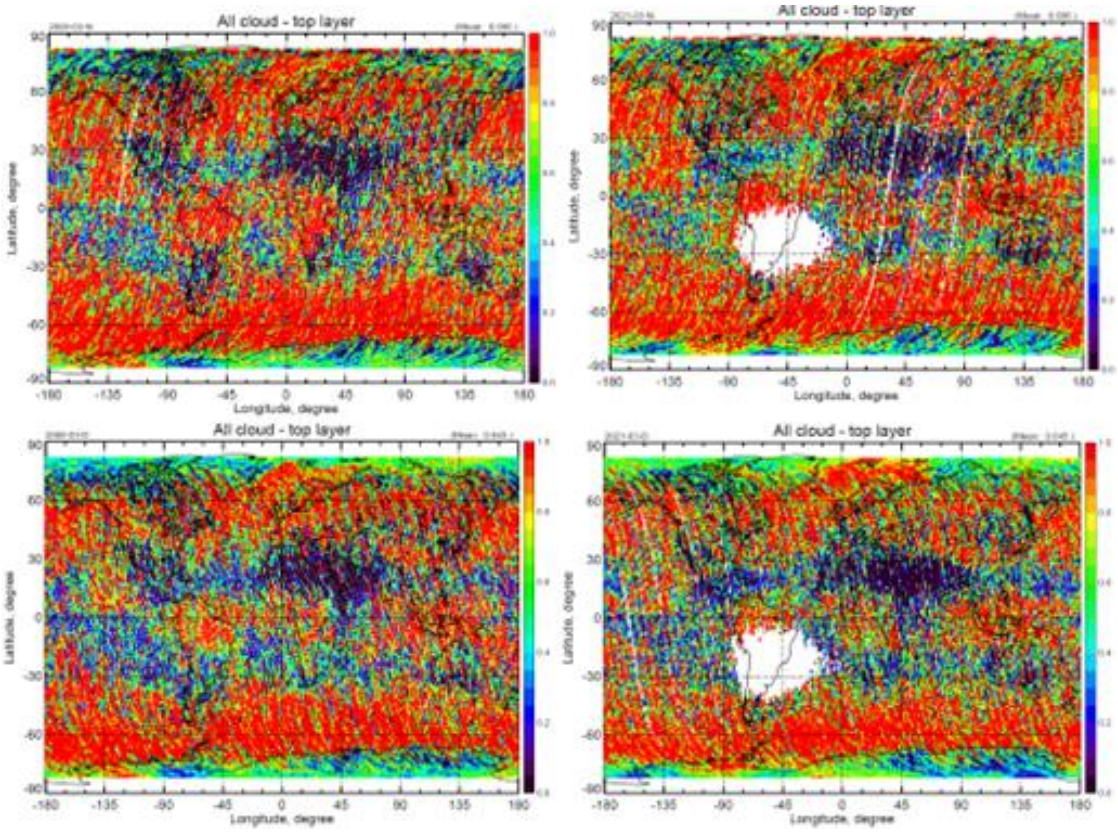


Figure 2: Version 2.00 total cloud amount for the top layer for March 2008 Night (upper left), March 2021 Night (upper right), March 2021 Day (lower left), and March 2021 day (lower right).

The evolution of total cloud amount (CA) over the mission is shown in Figure 3. In V1.00 (left), impacts of low energy shots within the SAA on cloud detection can be seen around 0° to 30°S starting in 2019. In V2.00 (right), the LEM algorithm has removed unreliable cloud data impacted by low energy shots and biases in the zonal mean are corrected.

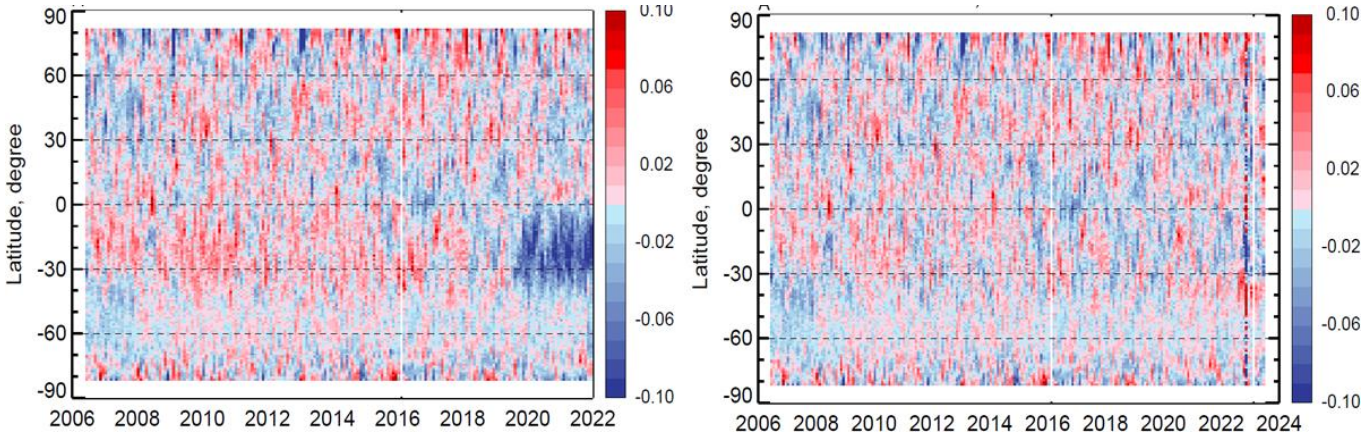


Figure 3: Zonal mean timeseries of CA over the CALIPSO mission. Left: V1.00; Right: V2.00

Comparison of V2.00 and V1.00

The detection sensitivity of CALIOP is less during daytime than at night because of the daytime solar background. This leads to day-night differences in reported cloud amounts, as was shown above. Small corrections in the V5 Level 1 calibration lead to small differences between V1.00 and V2.00 daytime cloud amounts, while nighttime cloud amounts are nearly identical in the two versions. Figure 4 shows comparisons of total cloud amount (CA). The lower panel on the right shows' zonal mean daytime biases between the two versions are less than about 1%. The maps in the left panel show these daytime biases are larger over land than over the oceans. These differences in CA are due to differences in CAM and CAL. Figure 5 shows that CAH in V1.00 and V2.00 are nearly identical.

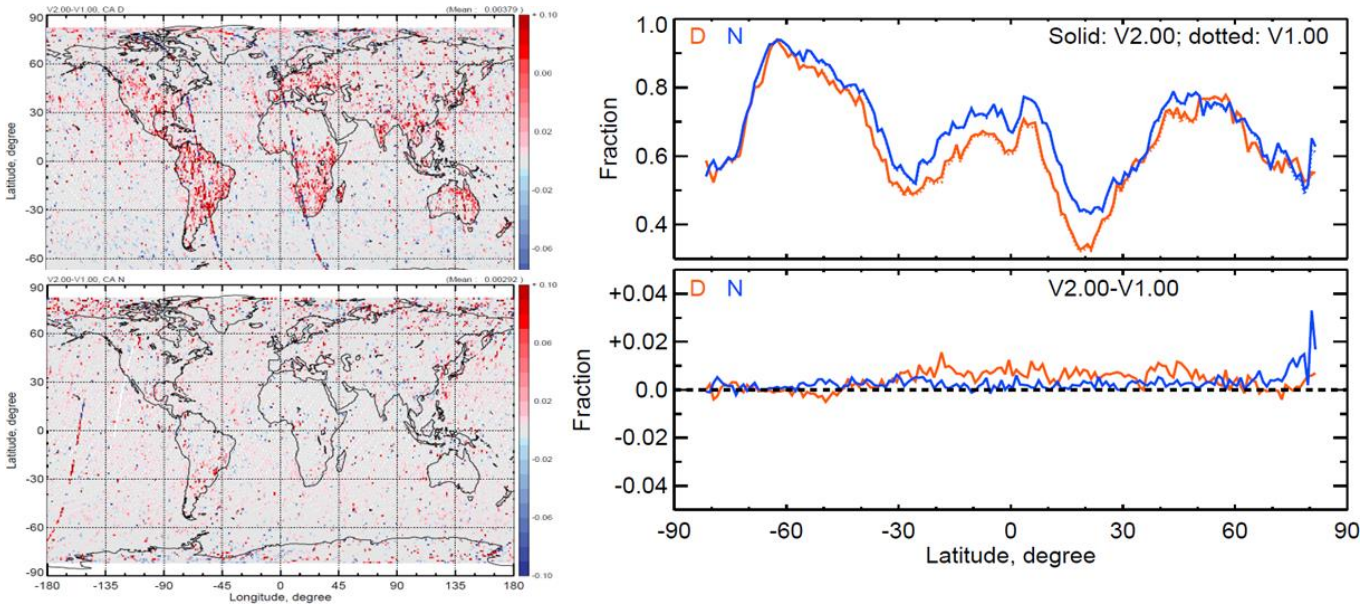


Figure 4: Difference of total cloud amount (CA), March 2008, in V2.00 and V1.00. Left: (V2.00 – V1.00); Right: zonal means of V2 and V1 are overplotted, and V2-V1 zonal difference.

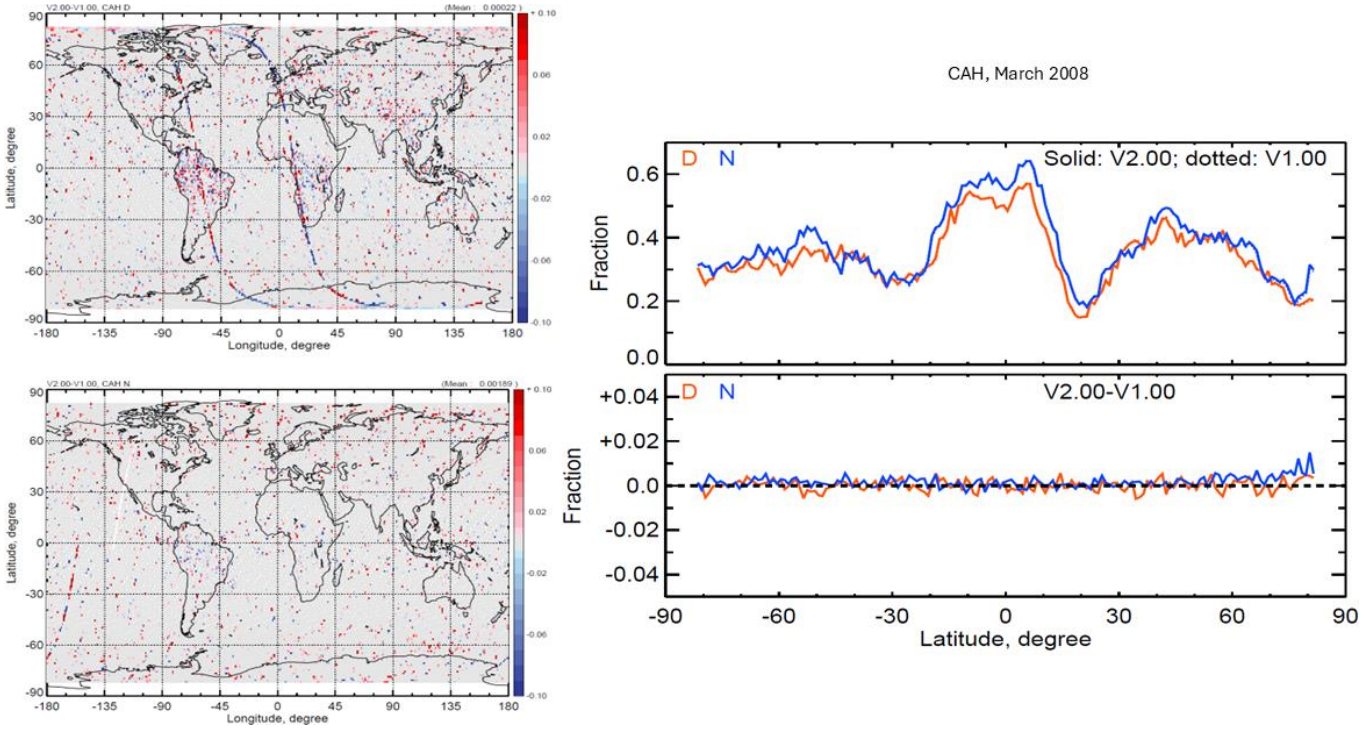


Figure 5: Difference of high cloud amount (CAH), March 2008, in V2.00 and V1.00. Left: (V2.00 – V1.00); Right: zonal means of V2 and V1 are overplotted, and V2-V1 zonal difference.

Orbit Drift

The CALIPSO orbit began to drift in 2019 after the orbit was lowered and the satellite ran out of fuel to perform orbit control maneuvers. As shown in the Figure 6 and Table 6, mean local time (MLT) of the ascending node was tightly controlled to 13:45 from 2006 until the orbit lowering in September 2018 and began to drift after that. By the end of the mission, the MLT had drifted to about 15:30. As discussed in Noël et al. (ACP, 2018) studies of trends in the long-term cloud record should consider potential biases due the orbit drift aliasing the diurnal cycle into the long-term record.

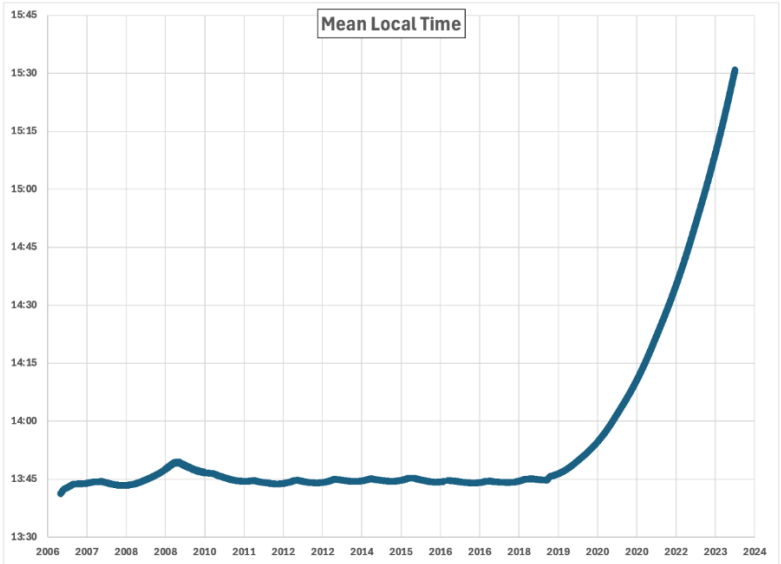


Figure 6: Mean local time of the equatorial crossing time (ascending node) over the CALIPSO mission.

Table 6: Mean local time of the equatorial crossing time (ascending node) over the CALIPSO mission.

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2006	-	-	-	-	-	13:42	13:43	13:43	13:43	13:43	13:43	13:44
2007	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:43	13:43	13:43	13:43	13:43
2008	13:43	13:43	13:43	13:44	13:44	13:44	13:45	13:45	13:45	13:46	13:46	13:47
2009	13:47	13:48	13:49	13:49	13:49	13:48	13:48	13:47	13:47	13:47	13:46	13:46
2010	13:46	13:46	13:46	13:46	13:45	13:45	13:45	13:45	13:44	13:44	13:44	13:44
2011	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:43	13:43	13:43	13:43
2012	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44
2013	13:44	13:44	13:44	13:45	13:45	13:44	13:44	13:44	13:44	13:44	13:44	13:44
2014	13:44	13:44	13:45	13:45	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44
2015	13:44	13:45	13:45	13:45	13:45	13:45	13:44	13:44	13:44	13:44	13:44	13:44
2016	13:44	-	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44
2017	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44	13:44
2018	13:44	13:45	13:45	13:45	13:45	13:44	13:44	13:44	13:44	13:45	13:46	13:46
2019	13:46	13:47	13:47	13:48	13:48	13:49	13:50	13:50	13:51	13:52	13:53	13:54
2020	13:55	13:56	13:57	13:58	13:59	14:01	14:02	14:04	14:05	14:06	14:08	14:10
2021	14:11	14:13	14:15	14:17	14:19	14:21	14:23	14:25	14:27	14:29	14:31	14:34
2022	14:36	14:39	14:41	14:44	14:47	14:49	14:52	14:55	14:58	15:01	15:04	15:08
2023	15:11	15:14	15:17	15:21	15:25	15:28	-	-	-	-	-	-

Data Quality Statement for the release of the CALIPSO Lidar Level 3 GEWEX Cloud Version 1.00

Version 1.00 of the level 3 (L3) "CALIPSO-format" GEWEX cloud product is processed from the V4.20 level 2 (L2) 5-km merged cloud layer product.

Quality Filter Information

The version 1.00 level 3 CALIPSO format GEWEX cloud product is produced applying quality filters similar to those used for the level 3 cloud occurrence product, to ensure only high confidence clouds retrieved by the level 2 algorithm go to the level 3 aggregation algorithm. In addition to the cloud feature quality filter, cloud phase quality filter and low water cloud filter, one extra range filter has been applied to the GEWEX product to accommodate the cloud top temperature/pressure/altitude ranges defined by the GEWEX cloud assessment general guidance.

1. **Cloud Feature Quality Filter:** this filter chooses confident cloud features only, when the quality assurance flag FeatureQA is set to low, medium or high, i.e., FeatureQA = 1, 2, 3. The FeatureQA is decoded from Feature_Classification_Flags. This is equivalent to choosing clouds with CAD score between 20 and 100. Compared to the level 2 version 3 feature retrieval algorithm, the version 4 algorithm was less confident resulting a smaller percentage of high confident clouds with CAD between 70 and 100. To maximize clouds sampling count, low and medium confidence clouds are passed to the next stage of filtering.
2. **Cloud Phase Quality Filter:** this filter chooses high confidence ice and water clouds only. If cloud phase is liquid water (cloud phase = 2) or ice (cloud phase = 1 or 3) the cloud phase quality assurance must be high (PhaseQA = 3). Note that 'ice cloud' includes both randomly orientated ice (cloud phase = 1) and horizontally orientated ice (cloud phase = 3). About 95% of high confidence cloud features have a high confidence classification of phase. High confidence cloud layers with unknown/not determined phase (cloud phase = 0) contribute to CA, CAH, CAM, and CAL but not to ice cloud or water cloud amounts. choose unknown/not determined phase clouds with PhaseQA = 0, as all these clouds have none confidence in PhaseQA (PhaseQA = 0).
3. **Low water cloud filter:** this filter excludes water clouds with cloud tops lower than 8.2 km identified from coarse horizontal averaging (HA), i.e., HA = 5, 20 or 80 km. It is assumed that optically thick broken water

clouds such as marine boundary clouds would be detected from HA = 333 m attenuated backscattering. If the same water cloud were reported from HA = 5, 20, or 80 km, including this water clouds would overestimate the water cloud coverage. There is also an argument of possibly underestimation of optically thin water cloud coverage over the Southern Ocean with this filter. More analyses would be conducted in future to weigh the pros and cons of this filter.

4. **Temperature/pressure/altitude range filters:** following the GEWEX cloud assessment general guidance, only clouds with cloud top temperature between 150 K and 320 K and cloud top pressure between 100 hPa and 1100 hPa and cloud top altitude between 0.0 km and 20.0 km are included in the monthly statistics.

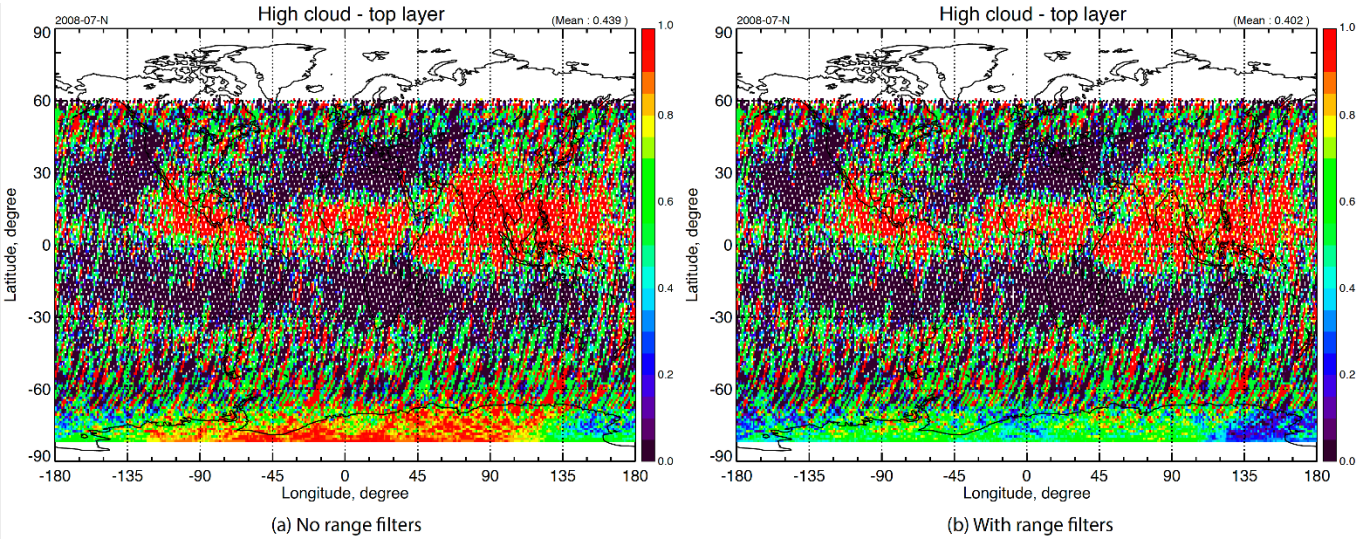
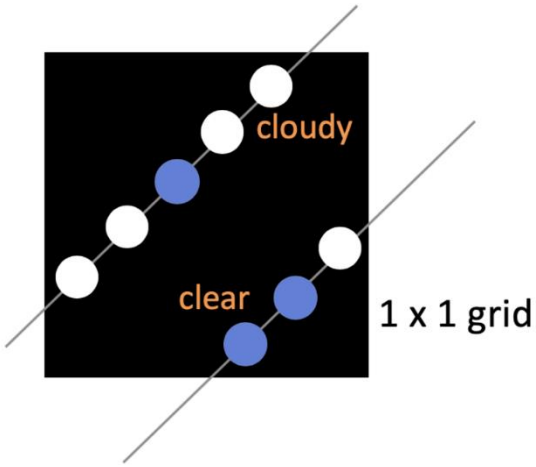


Figure 7: High cloud occurrence of top layer flavor, without (a) and with (b) range filters at night in July 2008.

These range filters exclude a few high thin cirrus clouds found in the tropics and many of the polar stratospheric clouds in the polar regions, which can be observed by the CALIOP only due to its high sensitivity but probably would be missed by a passive sensor. As a result, it leads to slightly smaller cloud occurrence as shown in Figure 7, with warmer cloud top temperatures, higher cloud top pressures and lower cloud top altitutdes in those regions. However, if a user is interested in comparing cloud top from CALIOP and passive sensors, the exclusion seems a valid approximation since those high clouds appear “clear” or “invisible” to passive sensors.

How cloud amount and mean histogram are estimated



$$CA = \overline{CA_{tracks}}$$

$$= \frac{\frac{4}{5}+\frac{1}{3}}{2}$$

$$\approx 0.57$$

Figure 8: An illustration of two CALIPSO tracks with cloud-free profiles (blue dots) and cloudy profiles (white dots) on a 1-degree longitude by 1-degree latitude grid (left). The average or mean CA in this grid is estimated using the formula shown on the right.

Figure 8 explains how the cloud amount (CA) averages in each 2-dimensional (2D) grid cell was estimated, adopting a similar methodology of a passive sensor. On the left, two CALIPSO orbits are illustrated with gray lines and each dot represents one lidar profile, while a white dot means a cloudy profile and a blue one a clear profile. A track CA is estimated from the cloudy and clear profiles along the track within each grid assuming the track CA can represent the grid CA. For these two tracks, the track CA would be 4/5 and 1/3, respectively. The monthly average CA would be the means of all track CA, and each track CA would be binned into the CA histogram. If these two tracks were the only tracks passing this grid during the whole month, the monthly average CA would be 0.57 as shown on the right. One track CA 4/5 (0.8) would go to bin 8 holding $0.8 \leq CA < 0.9$ and other CA 1/3 (0.33) would go to bin 3 holding $0.3 \leq CA < 0.4$.

No Clouds Observed Above 17 km with the Pressure Range Filter

As mentioned before, three range filters were applied to clouds to ensure the cloud top are within the histogram ranges as defined in GEWEX cloud assessment general guidance: cloud top temperature is from 150 K to 320 K, cloud top pressure is from 100 hPa to 1100 hPa and cloud top altitude from 0.0 km to 20.0 km.

These filters removed thin cirrus clouds in the tropics and polar stratospheric clouds in polar regions which are detected by the CALIOP, resulting in a slightly smaller cloud occurrence, warmer cloud top temperature, higher cloud top pressure and lower cloud top altitude in those regions.

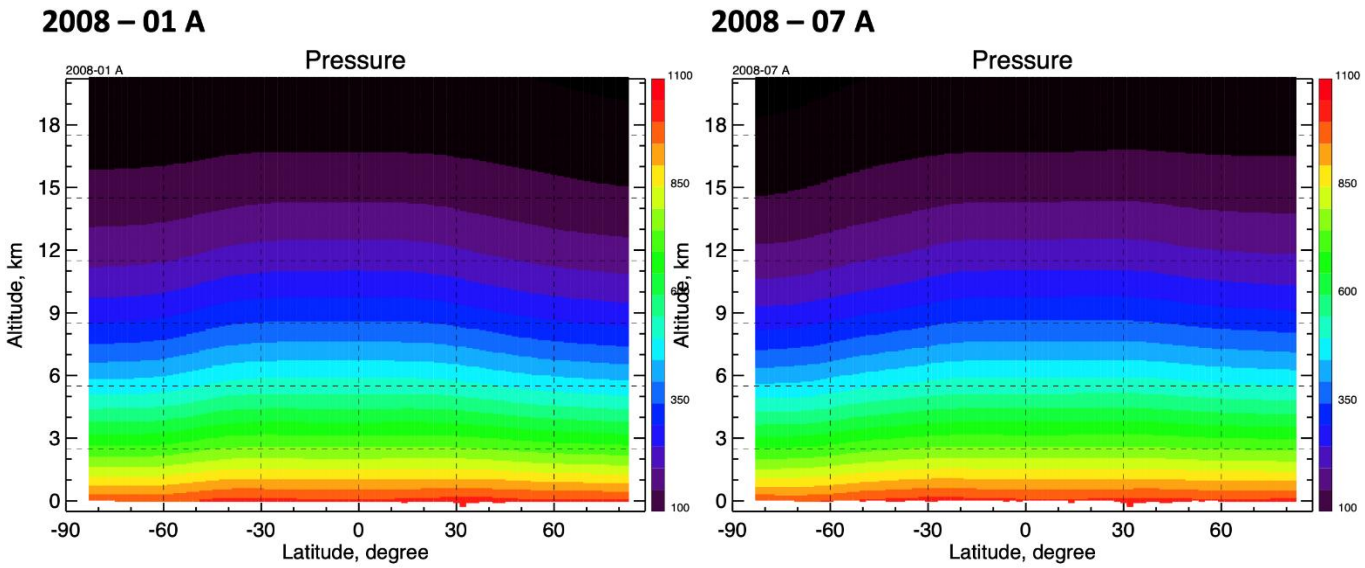


Figure 9: Zonal patterns of atmosphere pressure in 2008-01 and 2008-07. The patterns are filled in black where pressure is less than 100 hPa.

The altitude limits also led to no clouds reported above 17 km as the pressure is less than 100 hPa above 17 km globally in the Modern Era Retrospective-Analysis for Research (MERRA-2) reanalysis product provided by the NASA GMAO Data Assimilation System. As shown in Figure 9, the pressure is less than 100 hPa at 17 km at all latitudes in both winter and summer, though the exact altitude threshold varies with latitude and there is a seasonal asymmetry. Note the contours were filled in black where the pressure is less than 100 hPa.

When applying the pressure range filter, it automatically chooses clouds with cloud top less than about 17 km. Therefore, there are no clouds with cloud top higher than 17.0 km in the cloud top (CZ) histogram, as shown in Figure 10.

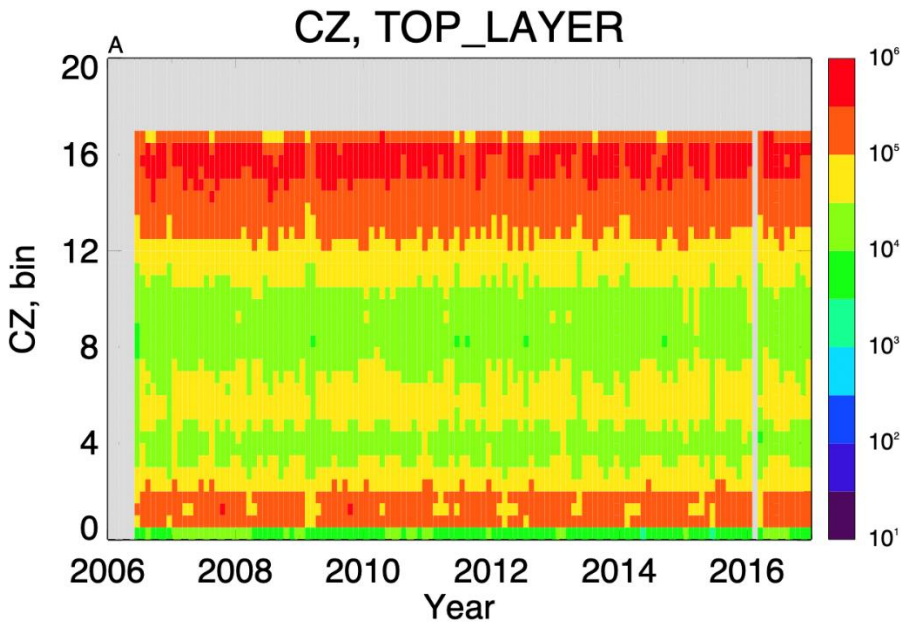


Figure 10: Histogram of cloud top height of the top layer flavor from June 2006 to December 2016. The logarithm of the number of cloud tops in each height bin in each month are presented.

References

Stubenrauch, C. J., W. B. Rossow, S. Kinne, 2012a: Assessment of Global Cloud Data Sets from Satellites. WCRP Report No. 23/2012.

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