CALIPSO Quality Statements: Lidar Level 2 Cloud and Aerosol Layer Products Version Releases: 1.10, 1.20

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Introduction

This document provides a high-level quality assessment of the cloud and aerosol layer products derived from the CALIPSO lidar measurements, as described in Section 2.4 of the CALIPSO Data Products Catalog (Version 2.3) (PDF). As such, it represents the minimum information needed by scientists and researchers for appropriate and successful use of these data products. We strongly suggest that all authors, researchers, and reviewers of research papers review this document periodically, and familiarize themselves with the latest status before publishing any scientific papers using these data products.

These data quality summaries are published specifically to inform users of the accuracy of CALIOP data products as determined by the CALIPSO Science Team and Lidar Science Working Group (LSWG). This document is intended to briefly summarize key validation results; provide cautions in those areas where users might easily misinterpret the data; supply links to further information about the data products and the algorithms used to generate them; and offer information about planned algorithm revisions and data improvements.

Additional Documentation and References

Algorithm Theoretical Basis Documents (ATBDs)

- PC-SCI-202.02 - Feature Detection and Layer Properties Algorithms (PDF)
- PC-SCI-202.03 - Scene Classification (PDF)

General References

- PC-SCI-503 : CALIPSO Data Products Catalog (Version 2.3) (PDF)
- Data analysis overview: Fully automated analysis of space-based lidar data: an overview of the CALIPSO retrieval algorithms and data products (PDF)
- Additional publications (journal articles and conference proceedings about CALIPSO science, algorithms, and data processing)
- CALIPSO Data Read Software

CALIPSO Cloud and Aerosol Layer Products

Each of the CALIPSO layer products contains a sequence of two tightly coupled data types. The first of these is a set of column properties, which describe the temporal and geophysical location of the vertical column (or curtain) of atmosphere being sampled. Column properties include satellite position data and viewing geometry, information about the surface type and lighting conditions, and the number of features (e.g., cloud and/or aerosol layers) identified within the column. For each set of column properties, there is an associated set of layer properties . These layer properties specify the spatial and optical characteristics of each feature found, and include quantities such as layer base and top altitudes, integrated attenuated backscatter, layer-integrated volume depolarization ratio, and optical depth. Below we provide brief descriptions of each of the column properties and the layer properties. Where appropriate, we also provide an assessment of the quality and accuracy of the data in the current release.

The layer products are generated at three different spatial resolutions.

- The *1/3 km layer products* report cloud detection information obtained at the highest spatial resolution of the lidar: 1/3 km horizontally and 30-m vertically. Due to constraints on CALIPSO's downlink bandwidth, this full resolution data is only available from ~8.3 km above mean sea level, down to -0.5 km below sea level.

- The *1 km layer products* report cloud detection information obtained at a horizontal resolution of 1 km, over a vertical range extending from ~20.2 km above mean sea level, down to -0.5 km below sea level.

- The *5 km layer products* report (separately) cloud and aerosol detection information on a 5 km horizontal grid. At present there is no separate stratospheric data product. Stratospheric features are recorded in the 5 km aerosol product.

The fundamental data product provided by the CALIPSO layer products is the vertical location of cloud and aerosol layer boundaries. All other layer properties -- e.g., integrated attenuated backscatters and layer two-way transmittances -- are computed with reference to these boundaries. To make proper use of the CALIPSO layer products, all users must be aware of the uncertainties inherent in the fully automated recognition of layer boundaries. Note too that **clouds and aerosols are reported separately** in the CALIPSO layer products. Therefore, to obtain a complete representation of all features detected within any region, users must use both the cloud and the aerosol layer products.

Column Properties

Profile ID

The lidar profile ID is a 32-bit integer generated sequentially for each single-shot profile record. Each profile ID is unique within each granule. Profile IDs reported in the 1/3 km layer products are for the individual laser pulses from which the layer statistics were derived. Profile IDs reported in the 1 km layer products designate the profile at the temporal midpoint of the three laser pulses averaged to generate the 1 km horizontal resolution. For the 5 km layer products, three values are reported: the profile ID for the first pulse included in the 15 shot average; the profile ID for the final pulse; and the profile ID at the temporal midpoint (i.e., at the 8th of 15 consecutive laser shots).

Latitude

Geodetic latitude, in degrees, of the laser footprint. Latitudes reported in the 1/3 km layer products are for the individual laser pulses from which the layer statistics were derived. The latitudes reported in the 1 km layer products represent footprint latitude at the temporal midpoint of the three laser pulses averaged to generate the 1 km horizontal resolution. For the 5 km layer products, three values are reported: the footprint latitude for the first pulse included in the 15 shot average; the footprint latitude for the final pulse; and the footprint latitude at the temporal midpoint (i.e., at the 8th of 15 consecutive laser shots).

Longitude

Longitude, in degrees, of the laser footprint. Longitudes reported in the 1/3 km layer products are for the individual laser pulses from which the layer statistics were derived. The longitudes reported in the 1 km layer products represent footprint longitude at the temporal midpoint of the three laser pulses averaged to generate the 1 km horizontal resolution. For the 5 km layer products, three values are reported: the footprint longitude for the first pulse included in the 15 shot average; the footprint longitude for the final pulse; and the footprint longitude at the temporal midpoint (i.e., at the 8th of 15 consecutive laser shots).

Profile Time TAI

Time expressed in International Atomic Time (TAI). Units are in seconds, starting from January 1, 1993. Times reported in the 1/3 km layer products are for the individual laser pulses from which the layer statistics were derived. Times reported in the 1 km layer products represent the temporal midpoint of the three laser pulses averaged to generate the 1 km horizontal resolution. For the 5 km layer products, three values are reported: the time for the first pulse included in the 15 shot average; the time for the final pulse; and the time at the temporal midpoint (i.e., at the 8th of 15 consecutive laser shots).

Profile Time UTC

Time expressed in Coordinated Universal Time (UTC), and formatted as 'yymmdd.ffffffff', where 'yy' represents the last two digits of year, 'mm' and 'dd' represent month and day, respectively, and 'ffffffff' is the fractional part of the day. Times reported in the 1/3 km layer products are for the individual laser pulses from which the layer statistics were derived. Times reported in the 1 km layer products represent the temporal midpoint of the three laser pulses averaged to generate the 1 km horizontal resolution. For the 5 km layer products, three values are reported: the time for the first pulse included in the 15 shot average; the time for the final pulse; and the time at the temporal midpoint (i.e., at the 8th of 15 consecutive laser shots).

Day Night Flag

Indicates the lighting conditions at an altitude of ~24 km above mean sea level; 0 = day, 1 = night.

Off Nadir Angle

The angle, in degrees, between the viewing vector of the lidar and the nadir angle of the spacecraft. For nominal science measurements, this angle is usually about 0.3 degrees.

Solar Zenith Angle

The angle, in degrees, between the zenith at the lidar footprint on the surface and the line of sight to the sun.

Solar Azimuth Angle

The azimuth angle, in degrees, from north of the line of sight to the sun.

Scattering Angle

The angle, in degrees, between the lidar viewing vector and the line of sight to the sun.

Parallel Column Reflectance 532

Not calculated for this data release; data products contain fill values in this field

Parallel Column Reflectance Uncertainty 532

Not calculated for this data release; data products contain fill values in this field

Parallel Column Reflectance RMS Variation 532 (5 km products only)

Not calculated for this data release; data products contain fill values in this field

Perpendicular Column Reflectance 532
Not calculated for this data release; data products contain fill values in this field

Perpendicular Column Reflectance Uncertainty 532
Not calculated for this data release; data products contain fill values in this field

Perpendicular Column Reflectance RMS Variation 532 (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Tropopause Height
Tropopause height, in kilometers above local mean sea level; derived from the GEOS-4 data product provided to the CALIPSO project by the GMAO Data Assimilation System

Tropopause Temperature
Tropopause temperature, in degrees C; derived from the GEOS-4 data product provided to the CALIPSO project by the GMAO Data Assimilation System

IGBP Surface Type
International Geosphere/Biosphere Programme (IGBP) classification of the surface type at the lidar footprint. The IGBP surface types reported by CALIPSO are the same as those used in the CERES/SARB surface map.

NSIDC Surface Type
Snow and ice coverage for the surface at the lidar footprint; data obtained from the National Snow and Ice Data Center (NSIDC).

DEM Surface Elevation
Surface elevation at the lidar footprint, in kilometers above local mean sea level, obtained from the GTOPO30 digital elevation map (DEM).

Lidar Surface Elevation [provisional]
Surface elevation at the lidar footprint, in kilometers above local mean sea level, determined by analysis of the lidar backscatter signal; see section 7.3 of the CALIPSO CALIPSO Feature Detection ATBD (PDF). The 1/3 km and 1 km layer products report the base and top of the detected surface spike. The 5 km layer products report statistics (minimum, maximum, mean, and standard deviation for both the upper and lower boundaries of the surface echo) derived from an analysis of the 1 km signal. If the surface is detected at the 5 km resolution but not at 1 km, only a maximum and minimum value are reported for each boundary. If no surface is detected, this field will contain fill values.

In the very best case, lidar surface elevations are as reliable as the DEM. GTOPO30 tends to be very reliable over oceans, and considerably less so in rugged terrain such as in the Andes mountains of Peru. However, due to aberrations in the signal caused by a non-ideal transient response in the 532 nm detectors, the geometric thickness associated with the lidar surface elevation (i.e., surface top - surface base) can be extremely misleading. **IMPORTANT**: At present, users should treat **ALL** signal beneath the reported lidar surface elevation top as being pure instrument artifact introduced by the non-ideal transient response of the detectors. No geophysical significance should be attributed to the (apparent!) subsurface portion of the lidar return.

Number Layers Found [provisional]
The number of layers found in this column; cloud data products report (only) the number of cloud layers found, and aerosol report (only) the number of aerosol layers found.

Calibration Altitude 532 [provisional; 5 km products only]
Top and base altitudes, in kilometers above mean sea level, of the region of the atmosphere used for calibrating the 532 nm parallel channel. The calibration algorithm and procedures are explained in detail in the CALIOP Level 1 ATBD (PDF).

Normalization Constant Uncertainty 532 (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Feature Finder QC Flags [provisional; 5 km products only]
To generate data at a nominal 5 km horizontal resolution requires averaging 15 consecutive laser pulses. For each 5 km average, we report a set of feature finder QC flags. Conceptually, these flags are a set of 15 boolean values which tell the user whether or not a feature (cloud, aerosol, or surface echo) was detected in each of the 15 laser pulses. The flags are implemented as a 16-bit integer. The most significant bit is unused, and always set to zero. Each of the 15 remaining bits represents the "features found" state for a single full-resolution profile. A bit value of zero indicates that one or more features were found within the profile. A feature finder QC flag value of zero for any 5 km column indicates complete feature finder success.

Surface Wind Speed [provisional; 5 km aerosol products only]
Zonal and meridional surface wind speeds, in meters per second, obtained from the GEOS-4 data product provided to the CALIPSO project by the GMAO Data Assimilation System

Layer Properties: Data Release 1.10

Layer Top Altitude and **Layer Base Altitude** [provisional]

Layer top and base altitudes are reported in units of kilometers above *mean sea level*. Due to the on-board data averaging scheme, the precision with which CALIPSO can make this measurement is itself a function of altitude. Between -0.5 km and ~8.2 km, the vertical resolution of the lidar is 30-meters. From ~8.2 km to ~20.2 km, the vertical resolution of the lidar is 60-meters. Above ~20.2 km, the vertical resolution is 180-meters.

The uncertainties associated with detection of cloud and aerosol layers in backscatter lidar data are examined in detail in Section 5 of the CALIPSO Feature Detection ATBD (PDF). The ATBD contains quantitative assessments of feature finder performance derived using simulated data sets, for which all layer boundaries were known exactly. In the real world of layer detection, we do not have access to this underlying truth. Therefore in this document we provide the following set of "rules of thumb" that users can apply to the data products to obtain a qualitative understanding of the layer boundaries reported, and of the optical properties associated with these layers.

a. Strongly scattering features are easier to detect than weakly scattering features. The scattering intensity of each layer is reported in the 532 nm and 1064 nm attenuated backscatter statistics and by the integrated attenuated backscatter at 532 nm and 1064 nm.

b. Detection of layers during the nighttime portion of the orbits is more reliable than during the daytime portion of the orbits. Due to solar background signals, the noise levels in the daytime measurements are much larger than those at night, and this additional noise can obscure faint features, and can lead to boundary detection errors even in more strongly scattering layers.

c. Features become increasingly difficult to detect with increasing optical depth above feature top. Put another way, detection of the lower layers in a multi-layer scene is made more difficult by the signal losses that occur as the laser light passes through the upper layers. (In a sense, this is a restatement of (a), since the backscatter intensity of secondary features is reduced from what it otherwise might be by the signal attenuation caused by the overlying features.)

d. In general, our confidence in the location of the top of a layer is somewhat greater than our confidence in the location of the base of the same layer. For transmissive features, one reason for this is that the backscatter signal is attenuated by traversing the feature, thus degrading the potential contrast between feature and "non-feature" at the base. Additionally, in strongly scattering layers, multiple scattering effects and signal perturbations introduced by the non-ideal transient response of the 532 nm detectors can also make base determination less certain.

e. For opaque features that completely attenuate the backscatter signal, the base altitude reported must be considered as an "apparent" base rather than a true base.

f. Stratospheric features reported during daylight -- especially those reported between 60N and 60S -- should be treated with extreme suspicion.

Midlayer Temperature[provisional]

Temperature, in degrees C, at the geometric midpoint of the layer in the vertical dimension; derived from the GEOS-4 data product provided to the CALIPSO project by the GMAO Data Assimilation System

Relative Humidity [provisional; 5 km aerosol products only]

Relative humidity, in percent, at the geometric midpoint of the layer in the vertical dimension; derived from the GEOS-4 data product provided to the CALIPSO project by the GMAO Data Assimilation System

Integrated Attenuated Backscatter 532 [provisional]

The 532 nm integrated attenuated backscatter (hereafter, γ'_{532}) for any layer is computed according to equation 3.14 in section 3.2.9.1 of the CALIPSO Feature Detection ATBD (PDF). The values reported for γ'_{532} will always be positive.

For the uppermost layer in any column, the quality of the estimate for γ'_{532} is determined by the accuracy of the top and base identification, the reliability of the 532 nm channel calibrations, and by the signal-to-noise ratio (SNR) of the backscatter data within the layer. For layers beneath the uppermost, the quality of our estimate for γ'_{532} also depends on either obtaining an independent estimate of the two-way transmittance, T^2, for all overlying layers, or by estimating this quantity directly from the lidar backscatter data. Estimating T^2 directly from the data is something of a black art. In tractable situations (i.e., where there exists an extended region of "clear air" between successive layers, and where the uppermost layer has no more than a moderate optical depth of -- say -- 1.0 or less), the calculation can be fairly reliable. In especially awkward situations (e.g., vertically adjacent layers, such as clouds embedded in aerosols), the only way to estimate T^2 is to compute a full extinction retrieval for the profile being examined. Furthermore, the effects of errors caused by misestimating T^2 can increase sharply as the optical thickness above a layer increases. We note that the CALIOP processing scheme ***always*** attempts to correct estimates of γ'_{532} for the attenuation imparted by previously identified overlying features. As a consequence, we will occasionally report unrealistically large values for γ'_{532}.

Integrated Attenuated Backscatter Uncertainty 532 [provisional]

The uncertainties reported for the 532 nm integrated attenuated backscatters provide an estimate of the random error in the backscatter signal. The general procedure used for calculating uncertainties for integrated quantities is described by Liu et al., 2006 (PDF). The specific formula is given by equation 6.7 in the CALIPSO Feature Detection ATBD (PDF).

There are occasions (e.g., in regions of especially low SNR) where the uncertainty calculation can fail. In these cases, the value recorded in the data product will be set to -1. In all other cases, uncertainty values will be positive.

Attenuated Backscatter Statistics 532 [provisional]

This field reports the minimum, maximum, mean, standard deviation, centroid, and skewness coefficient of the 532 nm attenuated backscatter coefficients for each layer. Formulas used for each of the statistical calculations can be found in section 6 of the CALIPSO Feature Detection ATBD (PDF).

Integrated Attenuated Backscatter 1064 [provisional]

The 1064 nm integrated attenuated backscatter (hereafter, γ'_{1064}) for any layer is computed according to equation 6.6 in section 6.5 of the CALIPSO Feature Detection ATBD (PDF).

As is the case for γ'_{532}, in the uppermost layer within any column, the quality of the estimate for γ'_{1064} is determined by the accuracy of the top and base identification, the reliability of the 1064 nm calibration constant, and by the signal-to-noise ratio (SNR) of the backscatter data within the layer. In layers beneath the uppermost, γ'_{1064} will be underestimated by a factor equal to the total particulate two-way transmittance, T^2, above the layer. In contrast to the techniques applied at 532 nm, reliable estimates of T^2 cannot be derived from an analysis of the 1064 nm backscatter signal in the (assumed to be) clear air regions.

The CALIOP layer detection algorithm operates exclusively on the 532 nm backscatter signals. Users should thus be aware that, unlike γ'_{532}, negative (i.e., non-physical) values can occasionally be reported for γ'_{1064}. This situation occurs most often for very weak features and in those layers for which the backscatter signal has been highly attenuated by other, overlying layers.

Integrated Attenuated Backscatter Uncertainty 1064 [provisional]

The uncertainties reported for the 1064 nm integrated attenuated backscatter values provide an estimate of the random error in the backscatter signal. The general procedure used for calculating uncertainties for integrated quantities is described by Liu et al., 2006 (PDF). The specific formula is given by equation 6.7 in the CALIPSO Feature Detection ATBD (PDF).

There are occasions (e.g., in regions of especially low SNR) where the uncertainty calculation can fail. In these cases, the value recorded in the data product will be set to -1. In all other cases, uncertainty values will be positive.

Attenuated Backscatter Statistics 1064 [provisional]

This field reports the minimum, maximum, mean, standard deviation, centroid, and skewness coefficient of the 1064 nm attenuated backscatter coefficients for each layer. Formulas used for each of the statistical calculations can be found in section 6 of the CALIPSO Feature Detection ATBD (PDF).

Integrated Volume Depolarization Ratio [provisional]

The layer integrated 532 nm volume depolarization ratio (hereafter, δ_{layer}) is computed according to equation 6.10 in section 6.7 of the CALIPSO Feature Detection ATBD (PDF).

The quality of the estimate for δ_{layer} is determined by the accuracy of the top and base identification, the reliability of the polarization gain ratio calibration, and by the signal-to-noise ratio (SNR) of the backscatter data within the layer. In general, the CALIOP δ_{layer} estimates are highly reliable. Histograms of δ_{layer} compiled for midlatitude cirrus in the northern hemisphere compare very well with previously reported distributions, e.g., Sassen & Benson, 2001 (PDF).

Integrated Volume Depolarization Ratio Uncertainty [provisional]

The uncertainties reported for the 532 nm layer-integrated volume depolarization ratios provide an estimate of the total random error in the combined backscatter signals (i.e., the 532 nm parallel and perpendicular signals within the feature). The general procedure used for calculating uncertainties for integrated quantities is described by Liu et al., 2006 (PDF). The specific formula is given by equation 6.11 in the CALIPSO Feature Detection ATBD (PDF).

There are occasions (e.g., in regions of especially low SNR) where the uncertainty calculation can fail. In these cases, the value recorded in the data product will be set to -1. In all other cases, uncertainty values will be positive.

Volume Depolarization Ratio Statistics [provisional]

This field reports the minimum, maximum, mean, standard deviation, centroid, and skewness coefficient of the 532 nm volume depolarization ratios for each layer. Formulas used for each of the statistical calculations can be found in section 6 of the CALIPSO Feature Detection ATBD (PDF).

In regions with acceptable SNR, the accuracy with which the range resolved depolarization ratios can be determined will depend almost entirely on the accuracy of the polarization gain ratio calibration.

Users can have high confidence in the *calculation* of all of the values in the depolarization ratio statistics fields. However, the meaning of these numbers can be somewhat obscure. This is because each of the range resolved depolarization ratios within any layer is the ratio of two noisy numbers. Especially where the feature is relatively faint, and in regions of low SNR, data values in both the numerator (the 532 nm perpendicular channel) and the denominator (the 532 nm parallel channel) can randomly and independently approach zero, which in turn can generate extremely large or extremely small (and even non-physical) depolarization ratios. When computing layer means, standard deviations, and centroids, these values can dominate the calculation, and thus return entirely unrealistic estimates. When assessing the depolarization ratio that characterizes a layer, δ_{layer} and the layer median are both more reliable indicators than the mean.

Integrated Attenuated Total Color Ratio [provisional]

The layer integrated attenuated total color ratio (hereafter, χ'_{layer}) is computed according to equation 6.13 in section 6.7 of the CALIPSO Feature Detection ATBD (PDF).

The quality of the estimate for χ'_{layer} is determined by the accuracy of the top and base identification, the reliability of the 532 nm calibration constant and the 1064 nm calibration constant, and by the signal-to-noise ratio (SNR) of the backscatter data within the layer.

Integrated Attenuated Total Color Ratio Uncertainty [provisional]

The uncertainties reported for the layer-integrated attenuated total color ratios provide an estimate of the total random error in the combined backscatter signals (i.e., at 532 nm and 1064 nm). The general procedure used for calculating uncertainties for integrated quantities is described by Liu et al., 2006 (PDF). The specific formula is given by equation 6.14 in the CALIPSO Feature Detection ATBD (PDF).

There are occasions (e.g., in regions of especially low SNR) where the uncertainty calculation can fail. In these cases, the value recorded in the data product will be set to -1. In all other cases, uncertainty values will be positive.

Attenuated Total Color Ratio Statistics [provisional]

This field reports the minimum, maximum, mean, standard deviation, centroid, and skewness coefficient of the attenuated total color ratios for each layer. Formulas used for each of the statistical calculations can be found in section 6 of the CALIPSO Feature Detection ATBD (PDF).

Users can have high confidence in the *calculation* of all of the values in the attenuated total color ratio statistics fields. However, as with the 532 nm depolarization ratio statistics, the meaning of the various numbers can be somewhat misleading. Like the depolarization ratios, the attenuated total color ratios are produced by dividing one noisy number (the 1064 nm attenuated backscatter coefficient) by a second noisy number (the 532 nm attenuated backscatter coefficient). Depending on the noise in any pair of samples, the resulting values can range from large negative values to extremely large positive values. When computing layer means, standard deviations, and centroids, these outliers can dominate the calculation, and thus return entirely unrealistic estimates.

Feature Classification Flags [beta]

For each layer, we report a set of feature classification flags that provide assessments of (a) feature type (e.g., cloud vs. aerosol vs. stratospheric layer); (b) feature subtype; (c) layer ice-water phase (clouds only); and (d) the amount of horizontal averaging required for layer detection. The complete set of flags is stored as a single 16-bit integer. A comprehensive description of the feature finder classification flags, including their derivation and physical significance, quality assessments, and guidelines for interpreting them in computer codes, can be found in the documentation for the vertical feature mask data product.

CAD score [beta]

The cloud-aerosol discrimination (CAD) score provides the numerical result obtained for each layer by the CALIOP cloud-aerosol discrimination algorithm. The CAD algorithm separates clouds and aerosols based on multi-dimensional, altitude-dependent histograms of scattering properties (e.g., intensity and spectral dependence). In areas where there is no overlap or intersection between these histograms, features can be classified with complete confidence. Detailed descriptions of the CAD algorithm can be found in Sections 4 and 5 of the CALIPSO Scene Classification ATBD (PDF) and in Liu et al., 2004 (PDF).

The CAD scores reported in the CALIPSO layer products range between -100 and 100. The sign of the CAD score indicates the feature type: positive values signify clouds, whereas negative values signify aerosols. The absolute value of the CAD score provides a confidence level for the classification. The larger the magnitude of the CAD score, the higher our confidence that the classification is correct. An absolute value of 100 therefore indicates complete confidence. Absolute values less that 100 indicate some ambiguity in the classification; that is, the scattering properties of the feature are represented to some degree in both the cloud PDF and in the aerosol PDF. In this case, a definitive classification cannot be made; that is, although we can provide a "best guess" classification, this guess could be wrong, with a probability of error related to the absolute value of the CAD score. A value of 0 indicates that a feature has an equal likelihood of being a cloud and an aerosol.

Users are encouraged to refer to the CAD score when the cloud and aerosol classification results are used and interpreted.

The accuracy of the CAD score depends on how accurately the PDFs approximate the cloud and aerosol distributions found in the real world. The PDFs used in version 1.10 of the CAD algorithm were initially developed based on measurements made by NASA's airborne Cloud Physics Lidar (CPL). Subsequent coarse adjustments were made based on very preliminary analyses of the CALIPSO data. Because CALIPSO measures clouds and aerosols on a continuous, global scale, as opposed to the targeted field campaigns conducted by CPL, the PDFs currently in use are not universally applicable. We find this to be especially true for very dense aerosols. Dense dust and smoke layers are very frequently observed over Africa and in the southern Atlantic Ocean. These features fall squarely in the overlap region between the cloud and aerosol PDFs, and thus are sometimes misclassified as cloud. The CAD score reported is judged to be accurate for most dense clouds and thin aerosols, and for these features the CAD score generally has a large value. On the other hand, the CAD score is suspicious when the feature falls in the deep overlap region of PDFs. The quantitative assessment of the CAD score is still underway. New PDFs are being developed based on the CALIOP measurements, and these will be used in future releases.

Layer Properties: Planned for Future Releases

Future releases of the CALIPSO cloud and aerosol layer products will include a number of additional fields that will report an expanded range of layer optical properties. All currently planned fields are listed (but not described) below.

Measured Two Way Transmittance 532 (5 km products only)

Not calculated for this data release; data products contain fill values in this field

Measured Two Way Transmittance Uncertainty 532 (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Two Way Transmittance Measurement Region (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Extinction QC 532 (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Feature Optical Depth 532 (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Feature Optical Depth Uncertainty 532 (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Initial 532 Lidar Ratio (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Final 532 Lidar Ratio (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Lidar Ratio 532 Selection Method (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Layer Effective 532 Multiple Scattering Factor (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Fixed 532 Lidar Ratio (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Fixed 532 Lidar Ratio Optical Depth (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Fixed 532 Lidar Ratio Optical Depth Uncertainty (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Extinction QC 1064 (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Feature Optical Depth 1064 (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Feature Optical Depth Uncertainty 1064 (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Initial 1064 Lidar Ratio (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Final 1064 Lidar Ratio (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Lidar Ratio 1064 Selection Method (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Layer Effective 1064 Multiple Scattering Factor (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Integrated Particulate Color Ratio (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Integrated Particulate Color Ratio Uncertainty (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Particulate Color Ratio Statistics (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Cloud Fraction (5 km aerosol products only)
Not calculated for this data release; data products contain fill values in this field

Integrated Particulate Depolarization Ratio (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Integrated Particulate Depolarization Ratio Uncertainty (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Particulate Depolarization Ratio Statistics (5 km products only)
Not calculated for this data release; data products contain fill values in this field

Cirrus Shape Parameter (5 km cloud products only)
Not calculated for this data release; data products contain fill values in this field

Cirrus Shape Parameter Uncertainty (5 km cloud products only)
Not calculated for this data release; data products contain fill values in this field

Cirrus Shape Parameter Invalid Points (5 km cloud products only)
Not calculated for this data release; data products contain fill values in this field

Ice Water Path (5 km cloud products only)
Not calculated for this data release; data products contain fill values in this field

Ice Water Path Uncertainty (5 km cloud products only)
Not calculated for this data release; data products contain fill values in this field

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Data Release Versions

Lidar Level 2 Cloud and Aerosol Layer Information ***Half orbit (Night and Day) lidar cloud and aerosol layer products describe both column and layer properties***			
Release Date	**Version**	**Data Date Range**	**Maturity Level**
March 2007	1.20	March 01, 2007 to November 11, 2007	• Layer Heights - Provisional • Aerosol/Cloud/ Stratospheric Classifications - Beta
December 8, 2006	1.10	June 13, 2006 to March 13, 2007	• Layer Heights - Provisional • Aerosol/Cloud/ Stratospheric Classifications - Beta

Data Quality Statement for the release of the CALIPSO Lidar Level 2 Cloud and Aerosol Layer Products Version 1.20, March 2007

Description Coming Soon.

Data Quality Statement for the release of the CALIPSO Lidar Level 2 Cloud and Aerosol Layer Products Version 1.10, December 8, 2006

Given the accuracy of the CALIPSO altitude registration, the layer heights reported in the Lidar Level 2 Cloud and Aerosol Layer Products appear to be quite accurate. In optically dense layers, the lowest altitude where signal is observed is reported as the base. In actuality, this point may lie well above the true base. In this release, the layers which are reported represent a choice in favor of high reliability over maximum sensitivity. Weakly scattering layers sometimes will go unreported, in the interest of minimizing the number of false positives.

A preliminary version of the algorithm to discriminate cloud and aerosol has been used in this release. Overall, the algorithm performance is fairly good at labeling cloud as cloud and somewhat less successful in labeling aerosol as aerosol. Several types of misclassifications are fairly common and should be watched for. The most common misclassification is portions of dense aerosol layers being labeled as cloud. The algorithm operates on individual profiles, so small regions within an aerosol layer are sometimes labeled as cloud. These misclassifications are often apparent from study of Level 1 browse images. Actual clouds occurring within aerosol layers appear to be correctly classified as cloud most of the time. Additionally, portions of the bases of some cirrus clouds are mislabeled as aerosol, and some tropospheric polar clouds are erroneously labeled as aerosol. Improvements to the cloud/aerosol discrimination algorithm are underway and misclassifications should be greatly reduced in future data releases.