CALIPSO Quality Statement
IIR Level 2 Track Data Product
Version Release: 3.30

Section Titles

Introduction

This document provides a description and preliminary quality assessment of the Level 2 IIR/Lidar track product DP2.2A, as described in Section 2.8 of the CALIPSO CALIPSO Data Products Catalog (Version 3.6) (PDF).

The primary geophysical variables reported in the IIR/Lidar track product are the brightness temperatures under the lidar track for the three IIR channels (8.65, 10.60 and 12.05 µm) directly derived from the Level 1 radiances, a scene classification derived from the CALIOP Level 2 5-km Cloud and Aerosols Layer products possibly also involving additional CALIOP constraints, effective emissivity of the selected cloud or aerosols layers and ice cloud microphysical properties for the selected layers (effective diameter of particles and ice water path). A mineral aerosols index is also provided. It is important that quality flags (see QA section) are read and used before conclusions are drawn from any data analysis.

Data Product Maturity

Because validation for different parameters can require different levels of effort, and because the uncertainties inherent in some retrievals can be substantially larger than in others, the maturity levels of the parameters reported in the different data products files are not uniform. Therefore, within this document, maturity levels are provided separately for each scientific data set (SDS) included with the data files. The data product maturity levels for the CALIPSO layer products are defined in the table below.

Maturity Level Definitions

Beta:	Early release products for users to gain familiarity with data formats and parameters. **Users are strongly cautioned against the indiscriminate use of these data products as the basis for research findings, journal publications, and/or presentations.**
Provisional:	Limited comparisons with independent sources have been made and obvious artifacts fixed.
Validated Stage 1:	Uncertainties are estimated from independent measurements at selected locations and times.
Validated Stage 2:	Uncertainties are estimated from more widely distributed independent measurements.

Validated Stage 3:	Uncertainties are estimated from independent measurements representing global conditions.
External:	Data are not CALIPSO measurements, but instead are either obtained from external sources (e.g., the Global Modeling and Assimilation Office (GMAO)) or fixed constants in the CALIPSO retrieval algorithm (e.g., the 532 nm calibration altitude).

Documentation and References

Algorithm Theoretical Basis Documents (ATBDs)

- PC-SCI-204 - revised version in preparation

General References

- PC-SCI-503 : CALIPSO Data Products Catalog (Version 3.6) (PDF)
- CALIPSO Data Read Software

Related Publications

- Chiriaco, M., H. Chepfer, P. Minnis, M. Haeffelin, S. Platnick, D. Baumgardner, P. Dubuisson, M. McGill, V. Noel, J. Pelon, D. Spangenberg, S. Sun-Mack, and G. Wind, 2007: "Comparison of CALIPSO-Like, LaRC, and MODIS Retrievals of Ice-Cloud Properties over SIRTA in France and Florida during CRYSTAL-FACE", *J. Appl. Meteor. Climatol.*, **46**, 249-272.
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Presented at the 26th International Laser Radar Conference, Papayannis, Balis, and Amiridis, Eds., pp. 691-694.

- Josset, D., J. Pelon, A. Garnier, Y. Hu, M. Vaughan, P.-W. Zhai, R. Kuehn, and P. Lucker, 2012: "Cirrus optical depth and lidar ratio retrieval from combined CALIPSO-CloudSat observations using ocean surface echo", *J. Geophys. Res.*, **117**, D05207, doi:10.1029/2011JD016959.
- Liu, Z., Liu, D., Huang, J., Vaughan, M., Uno, I., Sugimoto, N., Kittaka, C., Trepte, C., Wang, Z., Hostetler, C., and Winker, D., 2008: "Airborne dust distributions over the Tibetan Plateau and surrounding areas derived from the first year of CALIPSO lidar observations", *Atmos. Chem. Phys.*, **8**, 5045-5060.
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Standard and Expedited Data Set Definitions

Standard Data Sets: Standard data processing begins immediately upon delivery of all required ancillary data sets. The ancillary data sets used in standard processing (see next section, Input Data Summary) must be spatially and temporally matched to the CALIPSO data acquisition times, and thus the time lag latency between data onboard acquisition and the start of standard processing can be on the order of several days. The data in each data set are global, but are produced in files by half orbit, with the day portion of an orbit in one file and the night portion of the orbit in another.

Expedited Data Sets: Expedited data are processed as soon as possible after following downlink from the satellite and delivery to LaRC. Latency between onboard acquisition and analysis expedited processing is typically on the order of 6 to 28 hours. Expedited processing uses the most recently current available set of ancillary data (e.g., GMAO meteorological profiles) and calibration coefficients available, which may lag the CALIPSO data acquisition time/date by several days. Expedited data files contain at the most, 90 minutes of data. Therefore, each file may contain both day and night data. **NOTE: Users are strongly cautioned against using Expedited data products as the basis for research findings or journal publications. Standard data sets only should be used for these purposes.**

The differences between expedited processing and standard processing are explained in more detail in "Adapting CALIPSO Climate Measurements for Near Real Time Analyses and Forecasting" (PDF).

CALIPSO IIR Level 2 Data Product

Overview

The IIR Level 2 Track product is organized around the vertical information provided by the CALIOP Level 2 5-km Cloud and Aerosols layer co-located products which allow allocating a type of scene to each IIR pixel. The product contains optical and microphysical IIR retrievals applied to the single layer when identified as such or to the upper level for structures composed of several layers. This will be called upper level layer in the following. When the lowermost layer is seen as opaque by CALIOP, it constitutes the lower level used as a reference to retrieve the effective emissivities. Upper and lower level properties inferred from CALIOP are provided. Several computed radiances and a number of QA flags, including the Type of Scene and a mineral aerosols index, are provided to thoroughly document the retrievals. More details are available in Garnier et al., 2012a, 2013.

Input Data Summary

Standard Products

- CALIPSO IIR Level 1B product DP1.2, version V1.10 until 19 August 2008, version V1.11 from 20 August 2008 to 31 October 2011, and version V1.12 since November 1, 2011.
- CALIPSO Lidar Level 2, 5-km Cloud and Aerosols layer product DP2.1A, version V3.01 until 31 October 2011, version V3.02 from November 1, 2011 to 28 February 2013, and version V3.30 since March 1, 2013.
- GMAO GEOS 5 Met data: version 5.10 until 30 September 2008, version 5.20 from October 1, 2008 to 28 February 2013, and GMAO FP-IT since March 1, 2013 (version 3.30).
- IGBP surface type (same as in CALIOP products).
- Snow/ice data set: NSIDC snow/ice index until 28 February 2013 (versions 3.01 and 3.02) and AFWA snow/ice index since March 1, 2013 (version 3.30) (same as in CALIOP products).

Expedited Products

- CALIPSO IIR Level 1B product, expedited product version V1.12.
- CALIPSO Lidar Level 2, 5-km Cloud and Aerosols layer product, expedited product, version V3.30.

- GMAO GEOS 5 Met data: most current.
- IGBP surface type and AFWA snow/ice index: most current.

Pixel Geolocation and Time Parameters

Latitude

This parameter is a replicate of the parameter "Latitude" in Level 1B IIR product. It gives the geodetic latitude at the center of the pixel.

Longitude

This parameter is a replicate of the parameter "Longitude" in Level 1B IIR product. It gives the geodetic longitude at the center of the pixel.

LIDAR_Shot_Time

This parameter is a replicate of the parameter "Lidar_Shot_Time" in Level 1B IIR product.

Time expressed in International Atomic Time (Temps Atomique International, TAI). Units are in seconds, starting from January 1, 1993.

IIR_Image_Time_12_05

This parameter is a replicate of the parameter "Image_Time_12.05" in Level 1B IIR product.

Time expressed in International Atomic Time (Temps Atomique International, TAI). Units are in seconds, starting from January 1, 1993.

IIR Retrievals

Brightness_Temperature_08_65
Brightness_Temperature_12_05
Brightness_Temperature_10_60

These parameters give the brightness temperatures expressed in Kelvin of IIR channel 1 centered on 8.65 µm, IIR channel 3 centered on 12.05 µm and IIR channel 2 centered on 10.60 µm respectively. It is calculated from the corresponding IIR Level 1 calibrated radiance (Calibrated_Radiances_8.65, Calibrated_Radiances_12.05 and Calibrated_Radiances_10.60), expressed in $W.m^{-2}.sr^{-1}.\mu m^{-1}$ assuming spectral blackbody radiances centered respectively on 8.65 µm, 12.05 µm and 10.60 µm.

Effective_Emissivity_08_65
Effective_Emissivity_12_05
Effective_Emissivity_10_60

These parameters give the effective emissivity at 8.65 µm, 12.05 µm and 10.60 µm of the single or *upper cloud or aerosols layer(s)*, defined as the *upper level* of the scene selected according to the Level 2 Cloud and Aerosols Layer Product.

Scene classification and description are given in **Type_of_scene**.

For each spectral channel k, centered on the wavelength λ_k, the track effective emissivity, $\varepsilon_{eff,\,k}$

of the selected *upper level*, located at the equivalent altitude Z_c, is defined according to the ATBD as

$$\varepsilon_{eff,\,k} = [R_k - R_{k,BG}]/[B_k(T,Z_c) - R_{k,BG}]$$

where:

- R_k is the IIR Level 1 calibrated radiance measured in channel k,
- $R_{k,BG}$ or background radiance is the outgoing top of the atmosphere background radiance which would be observed in the absence of the upper level. It is either derived from measurements in suitable neighboring pixels (distance < 100 km) or from calculations using the fast radiative transfer model FASRAD (Dubuisson et al, 2005) if no measured reference can be found (see **High_Cloud_vs_Background**). This model is not accounting for cloud scattering. For this release (V3), the $R_{k,BG}$ values are provided in **Reference_Brightness_Temperature** after conversion to the equivalent brightness temperatures.
- $B_k(T,Z_c)$ is the radiance of a black-body source located at the equivalent altitude Z_c defined from lidar observations, corresponding to a temperature $T(Z_c)$ retrieved from ancillary meteorological data (GMAO GEOS 5). It is computed using the FASRAD model (Dubuisson et al., 2005). For this release (V3), the $B_k(T,Z_c)$ values are provided in **Blackbody_Brightness_Temperature** after conversion to the equivalent brightness temperatures.
- *Effective_Emissivity* is set to invalid if found outside the physical [0. , 1.] range. Further analysis can be done by inter-comparing the observed, reference and blackbody brightness temperatures used for the retrievals which are provided even if the retrieved effective emissivity is found invalid. For instance, when the *upper level* is very low, or very close to the background reference layer, the retrievals are more difficult, and non-physical or invalid results may be found. This also corresponds to larger values of the uncertainties when physical values are obtained.

Effective_Emissivity_Uncertainty_08_65
Effective_Emissivity_Uncertainty_12_05
Effective_Emissivity_Uncertainty_10_60

These parameters give the uncertainty Δε on the effective emissivity, ε, at 08.65 µm, 12.05 µm and 10.60 µm.

According to the ATBD, the effective emissivity uncertainty, $\Delta\varepsilon_{eff,\,k}$ for each spectral channel k, centered on the wavelength λ_k is composed of 3 terms which can be written as

$\Delta\varepsilon1_{eff,\,k} = \Delta R_k \times 1/ (R_{k,BG} - B_k(T,Z_c))$ due to the uncertainty on the radiance measurement,

$\Delta\varepsilon2_{eff,\,k} = (1 - \varepsilon_{eff,k}) \times \Delta R_{k,BG} \times 1/ [R_{k,BG} - B_k(T,Z_c)]$ due to the uncertainty on the background reference,

$\Delta\varepsilon3_{eff,\,k} = \varepsilon_{eff,k} \times \Delta B_k(T,Z_c) \times 1/ [R_{k,BG} - B_k(T,Z_c)]$ due to the uncertainty on the equivalent black-body source radiance.

For each channel, the Effective_Emissivity_Uncertainty, $\Delta\varepsilon_{eff,\,k}$ is the overall uncertainty derived from the 3 independent terms listed above considered as random errors so that:

$$\Delta\varepsilon_{eff,\,k} = [R_{k,BG} - B_k(T,Z_c)]^{-1} \times [(\Delta Rk)^2 + (1 - \varepsilon_{eff,k})^2 \times (\Delta Rk,BG)^2 + \varepsilon_{eff,k}{}^2 \times (\Delta B_k(T,Z_c))^2]^{1/2}$$

It is inversely proportional to the radiative difference between the background reference and the upper level of thermodynamic temperature $T(Z_c)$.

The effective emissivity uncertainty is set to invalid if found outside the [0. , 1.] range (V3). If the effective emissivity is invalid, the corresponding uncertainty is invalid too.

Reported emissivity uncertainties are less than 0.03 for most of the high (>7 km) semi-transparent clouds. They are computed assuming a 1 K equivalent error in measured and calculated radiances, which is a realistic/conservative value for the IIR measurements.

The background reference is preferably measured in neighboring pixels (distance < 100km) and its representativeness evaluated through its mean distance from the current pixel (cf High_Cloud_vs_Background_Flag which gives also the type of reference used). Otherwise, the background reference is computed using the FASRAD model.

When a measured background reference is used, Computed_vs_Observed_Background_Flag gives the mean relative difference between this observation and the computed radiance derived from the FASRAD model. The standard deviation associated to this parameter is given in Regional_Background_Std_Dev.

Statistical analyses show that the brightness temperature differences between clear sky observations and computations (available in Computed_Brightness_Temperature_Surface in V3) are most of the time smaller than 1K over ocean for each IIR channel even though GMAO moisture and temperature profiles are expected to be less accurate than over land due to fewer sounding stations available for the analysis. Over land, significant differences are observed (up to several K) due to errors in surface emissivities and temperatures. Large differences (up to 10 K) are observed in a limited number of cases.

Statistical analyses show that brightness temperature differences between low opaque cloud observations and computations (available in Blackbody_Brightness_Temperature in V3) are typically within 3 K for each IIR channel. Larger differences can be observed on sporadic points.

The uncertainty on the black-body radiance is driven by the uncertainty on the equivalent radiative altitude and the corresponding temperature derived from GMAO. In case of thick features or vertically stretched multi-layer upper levels (cf Multi_Layer_Cloud_Flag added in V3), the equivalent black-body radiance is not as accurate as for thin mono-layer systems, due to the expected error on the equivalent altitude chosen to retrieve the thermodynamic temperature.

Emissivity_08_65
Emissivity_12_05
Emissivity_10_60

These parameters correspond to the emissivities, they are not computed for this release.

Emissivity_Uncertainty_08_65
Emissivity_Uncertainty_12_05

Emissivity_Uncertainty_10_60

Not computed for this release.

Particle_Shape_Index

Ice cloud microphysical properties are derived from two microphysical indices, defined as the ratio of the effective absorption optical depths in the pairs of IIR channels 12.05-8.65 and 12.05-10.60 µm (Parol et al, 1991) derived from the respective effective emissivities (see **Effective_Emissivity_08_65, Effective_Emissivity_10_60, Effective_Emissivity_12_05**).

Retrievals are performed for three crystal families selected from pre-computed look-up tables identified as representative of the main relationships between the microphysical indices (Garnier et al., 2013). These tables are built using the FASDOM radiative transfer model (Dubuisson et al, 2005, 2008). The model calculations take into account cloud scattering, theoretical optical properties of the complex crystals (Yang et al, 2005), and various atmospheric and surface parameters.

This parameter is the family of crystal models leading to the best agreement between the effective particle diameters D($_{12.05,8.65}$) and D($_{12.05, 10.60}$) derived from each microphysical index. If the microphysical indices are not within the range of values expected from the look-up tables, **Particle_Shape_Index** cannot be retrieved and is set to invalid.

Value	Interpretation
7	Aggregates family
8	Plates family
9	Solid columns family

The full set of effective diameters obtained for each shape is provided in Microphysics.

Particle_Shape_Index_Confidence

The particle shape index confidence reflects the relative difference between the effective particle diameters D($_{12.05,8.65}$) and D($_{12.05, 10.60}$) associated to each microphysical index. Confidence is considered as good (1) when both diameters agree within 30% and medium (2) otherwise. It is set to invalid when **Particle_Shape_Index** could not be retrieved.

Value	Interpretation
1	Good confidence
2	Medium confidence

Effective_Particle_Size

In nominal conditions, i.e. when the microphysical indices derived from the 3 IIR effective emissivities are within the range of values expected from the look-up tables, this parameter is the mean of the effective *diameters* D($_{12.05,8.65}$) and D($_{12.05, 10.60}$) retrieved from the microphysical indices and the model identified in **Particle_Shape_Index**. In nominal conditions, both the **Effective_Particle_Size** and the **Particle_Shape_Index** are retrieved and

Particle_Size_Uncertainty is half of the difference between D($_{12.05,8.65}$) and D($_{12.05,\ 10.60}$). These parameters characterize the layer(s) for which effective emissivities are retrieved, i.e. the scene's upper layer(s) (cf **Type of Scene**).

However, numerous other conditions are encountered where the microphysical indices are not within the range of values expected from the look-up tables. It can be due to the absence of the adapted look-up table (for instance in case of aerosols or liquid clouds) or to a wrong value of at least one microphysical index. If only one microphysical index is within the expected range, or if the microphysical indices slightly deviate from the closest possible value (with a 15% tolerance), the algorithm attempts to provide an **Effective_Particle_Size** estimate. These degraded configurations are flagged in **Effective_Particle_Size_Uncertainty**. Otherwise, **Effective_Particle_Size** is set to invalid.

It is very important that the users refer to **Effective_Particle_Size_Uncertainty** to find out if the **Effective_Particle_Size** has been retrieved in a nominal or a degraded configuration.

Effective_Particle_Size_Uncertainty

In the nominal configuration, the effective particle size is derived from the pair of microphysical indices and the model identified in **Particle_Shape_Index**.
Effective_Particle_Size_Uncertainty is defined as half of the difference between both effective particle diameters (in microns). In the nominal configuration, **Effective_Particle_Size_Uncertainty** is always strictly smaller than 100 as an absolute value (and *can be negative* due to its definition).

Effective_Particle_Size_Uncertainty values of 100 or more are used to flag specific degraded configurations when one (or both) microphysical indices is (are) outside the value range expected from the look-up tables (see **Effective_Particle_Size**). For these a priori medium to very low confidence cases, the algorithm cannot provide the **Particle_Shape_Index** but still attempts to provide some piece of information about the size.

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

	very low confidence	

Reference_Brightness_Temperature

This parameter is the brightness temperature (in Kelvin) derived from the background (surface or dense cloud) reference radiance computed using the FASRAD model. The three elements are for the IIR channels 08.65 µm, 10.60 µm and 12.05 µm respectively. This parameter constitutes a more general information than the parameters Clear_Sky_Radiance_08_65, Clear_Sky_Radiance_10_60, Clear_Sky_Radiance_12_05 ($W.m^{-2}.sr^{-1}.\mu m^{-1}$) previously available in version V2 which were limited to clear sky background reference only.

The background reference radiance is preferably measured in neighboring pixels. Criteria for deciding to use a measured reference are:

- the distance between the measured background radiance and the *upper level* must be smaller than 100 km and both must be of the same IGBP type (new condition added in V3);
- if the reference is an opaque layer, the permitted altitude difference is +/- 100 m corresponding to +/- 1 K radiative difference (worst case).

If the background radiance cannot be derived from measurements, it is computed using the FASRAD model:

- assuming clear sky if the reference is clear sky or a low altitude (<7 km) non - depolarizing aerosols layer,
- and assuming a blackbody located at the altitude "**Centroid_IAB_0532_Lower_Level**" for opaque layers.

FASRAD uses temperature, water vapor and ozone profiles from the GMAO GEOS 5 model. For clear sky simulations, it uses also surface emissivities derived from the IGBP geotype (see **Surface_emissivities**) and GMAO GEOS 5 surface temperatures.

The conditions selected by the algorithm to compute the background radiance are given in **High_Cloud_vs_Background**. When a measured reference is used, **Computed_vs_Observed_Background_Flag** gives the mean relative difference between this observation and the computed radiance derived from the FASRAD model. The standard deviation associated to this parameter is given in **Regional_Background_Std_Dev**.

Blackbody_Brightness_Temperature

This parameter is the brightness temperature (in Kelvin) derived from the blackbody radiance computed using the FASRAD model and GMAO GEOS 5 profiles to retrieve the effective emissivity of the selected upper layer(s). The three elements are for the IIR channels 08.65 µm, 10.60 µm and 12.05 µm respectively.

Computed_Brightness_Temperature_Surface

This parameter is the brightness temperature (in Kelvin) derived from the surface radiance computed using the FASRAD model assuming a clear sky atmosphere for types of scenes identified as clear sky (10), or containing semi-transparent aerosols (52, 53 and 54, see **Type_of_Scene**). FASRAD uses temperature, water vapor and ozone profiles and surface temperatures from the GMAO GEOS 5 model, and surface emissivities derived from the IGBP geotype (see **Surface_Emissivities**). The three elements are for the IIR channels 08.65 μm, 10.60 μm and 12.05 μm respectively.

Optical_Depth_12_05

This parameter is the effective absorption optical depth at 12.05 μm derived from the effective emissivity at 12.05 μm as:

Optical_Depth_12_05 = - *ln* (1 - Effective_Emissivity_12_05)

Optical_Depth_12_05 is set to invalid if found outside the [0. , 10.] range (V3) and if **Effective_Emissivity_12_05** is invalid. For cirrus clouds, this parameter has been shown to be a good proxy for about half of the CALIOP (SW) cloud optical depth, depending on ice crystal sizes (Garnier et al. 2012a, 2012b).

Optical_Depth_12_05_Uncertainty

This parameter is the **Optical_Depth_12_05** uncertainty derived from **Effective_Emissivity_Uncertainty_12_05**.

Optical_Depth_12_05_Uncertainty is set to invalid if found outside the [0. , 10.] range (V3) and if Optical_Depth_12_05 is invalid.

Ice_Water_Path

This parameter is an estimate for the *upper level* ice water path (in $g.m^{-2}$) derived from the effective particle size and the optical depth at 12.05 μm as:

IWP (g.m-2) = 0.307 x Effective_Particle_Size (μm) x (2 x Optical_Depth_12_05).

Ice_Water_Path_Confidence

As **Ice_Water_Path** provided in this release is an estimate, this parameter is not computed. However, the users should refer to **Effective_Particle_Size_Uncertainty** and **Optical_Depth_12_05_Uncertainty**.

Upper Level Properties Inferred from CALIOP

Optical_Depth_0532_Upper_Level

This parameter is the summation of the layers' **Feature_Optical_Depth_532** provided in the CALIOP lidar Level 2 Cloud or Aerosols layers products for the layers included in the *upper level* (V3). In V2, this parameter reported the optical depth of the uppermost layer.

This parameter is set to invalid if no feature is selected (clear sky) or if the type of scene is undetermined.

Depolarization_Upper_Level

This parameter is the layers' average **Integrated_Volume_Depolarization_Ratio** from CALIOP lidar Level 2 Cloud or Aerosols layers products weighted with the individual mean attenuated backscatter for the layers included in the *upper level* (V3). It is different from the parameter reported in V2, which was the depolarization ratio of the uppermost layer.

This parameter is set to invalid if no feature has been detected (clear sky) or if the type of scene is undetermined.

Integrated_Backscatter_Upper_Level

This parameter is the summation of the layers' **Integrated_Attenuated_Backscatter_532** from CALIOP lidar Level 2 Cloud or Aerosols layers products for the layers included in the *upper level*. In V2, this parameter reported the integrated attenuated backscatter of the uppermost layer.

This parameter is set to invalid if no feature has been detected (clear sky) or if the type of scene is undetermined.

Layer_Top_Height_Upper_Level

This parameter is a replicate of the **Layer_Top_Altitude** parameter from CALIOP lidar Level 2 Cloud or Aerosols layers product for the uppermost layer in the *upper level*. As the algorithm only keeps features detected with 5 or 20 km horizontal averaging, the uppermost layer reported here can be lower than in the CALIOP product.

This parameter is set to invalid if no feature has been detected (clear sky) or if the type of scene is undetermined.

Centroid_IAB_0532_Upper_Level

This parameter is the *upper level* centroid altitude Z_c used to compute the radiance of the equivalent blackbody $B(T, Z_c)$.

For single-layer systems (cf **Multi_Layer_Cloud_Flag**), this parameter is a replicate of the centroid altitude provided in Attenuated_Backscatter_Statistics_532 in CALIOP lidar Level 2 Cloud or Aerosols layers product.

In case of a multi-layer scenes (N layers), this parameter is the mean of the centroid altitudes z(i) of each layer, i, weighted with the mean attenuated backscatter beta_mean (i) in each layer:

Centroid_IAB_0532_Upper_Level = som[1,N : z(i).beta_mean(i)]/N.som[1,N : beta_mean(i)]

This parameter is set to invalid if no feature has been detected (clear sky) or if the type of scene is undetermined.

Layer_Bottom_Height_Upper_Level

This parameter is a replicate of the **Layer_Base_Altitude** parameter from CALIOP lidar Level 2 Cloud or Aerosols layers products for the lowermost layer in the upper level.

This parameter is set to invalid only if no feature has been detected (clear sky) or if the type of scene is undetermined.

Layer_Top_Temperature_Upper_Level

Not computed for this release.

Temperature_Centroid_IAB_0532_Upper_Level

This parameter is the *upper level* centroid temperature derived from **Centroid_IAB_0532_Upper_Level** and GMAO temperature profiles.

This parameter is set to invalid if no feature has been detected (clear sky) or if the type of scene is undetermined.

Lower Level Properties Inferred from CALIOP

Optical_Depth_0532_Lower_Level

Not provided for this release.

Depolarization_Lower_Level

This parameter is a replicate of the parameter **Integrated_Volume_Depolarization_Ratio** from CALIOP lidar Level 2 Cloud or Aerosols layers products for the opaque reference level, if any, according to "**Type_of_Scene**". Otherwise, this parameter is set to invalid.

Integrated_Backscatter_Lower_Level

This parameter is a replicate of the parameter "**Integrated_Attenuated_Backscatter_532**" from CALIOP lidar Level 2 Cloud or Aerosols layers products for the opaque reference level, if any, according to "Type_of_Scene". Otherwise, this parameter is set to invalid.

Layer_Top_Height_Lower_Level

This parameter is a replicate of the parameter "**Layer_Top_Altitude**" from CALIOP lidar Level 2 Cloud or Aerosols layers products for the opaque reference level, if any, according to "**Type_of_Scene**". Otherwise, this parameter is set to invalid.

Centroid_IAB_0532_Lower_Level

This parameter is the centroid altitude of the opaque reference level, if any, according to "**Type_of_Scene**". Otherwise, this parameter is set to invalid.

It is a replicate of the centroid altitude provided in **Attenuated_Backscatter_Statistics_532** in CALIOP lidar Level 2 Cloud or Aerosols layers products.

Layer_Bottom_Height_Lower_Level

This parameter is a replicate of the parameter "**Layer_Base_Altitude**" from CALIOP lidar Level 2 Cloud or Aerosols layers products for the opaque reference level, if any, according to "**Type_of_Scene**". Otherwise, this parameter is set to invalid.

Layer_Top_Temperature_Lower_Level

Not computed for this release.

Temperature_Centroid_IAB_0532_Lower_Level

This parameter is the centroid temperature of the opaque reference level if any, according to "**Type_of_Scene**" Otherwise, this parameter is set to invalid.

It is derived from the Centroid_IAB_0532_Lower_Level altitude and GMAO temperature profile (V3, was a replicate of the CALIOP parameter "**Mid_Layer_Temperature**" in V2).

QA information

Surface_Emissivity_08_65
Surface_Emissivity_12_05
Surface_Emissivity_10_60

These parameters are the surface emissivities for channels centered on 08.65, 12.05 and 10.60 µm respectively.

They are derived from IGBP surface type and NSIDC snow/ice indices (1/6° resolution, same as in CALIOP products). For NSDIC indices between 10 and 103, geotype index takes the IGBP snow/ice index (15).

Surface emissivities are computed accounting for the IIR spectral response functions (D. P. Kratz, NASA Langley, CERES team, see also Wilbert et al, 1999). The following values are used:

IIR Ch. 1 8.2 - 9.2 µm	**IIR Ch. 2 10.35 - 10.95 µm**	**IIR Ch. 3 11.50 - 12.50 µm**	**IGBP surface**
0.9904	0.9888	0.9909	(1) evergreen needleleaf
0.9904	0.9888	0.9909	(2) evergreen broadleaf
0.9775	0.9738	0.9733	(3) deciduous needleleaf
0.9775	0.9738	0.9733	(4) deciduous broadleaf
0.9839	0.9813	0.9821	(5) mixed forests
0.9478	0.9653	0.9685	(6) closed shrublands
0.8754	0.9332	0.9411	(7) open shrublands
0.9801	0.9812	0.9886	(8) woody savannas
0.9801	0.9812	0.9886	(9) savannas
0.9801	0.9812	0.9886	(10) grasslands
0.9819	0.9857	0.9871	(11) permanent wetlands
0.9801	0.9812	0.9886	(12) croplands
1.0000	1.0000	1.0000	(13) urban
0.9820	0.9812	0.9854	(14) mosaic
0.9951	0.9967	0.9854	(15) snow/ice
0.8392	0.9171	0.9275	(16) barren/sparsely vegetated
0.9838	0.9903	0.9857	(17) water
0.9753	0.9936	0.9909	(18) tundra

IIR_Data_Quality_Flag

This parameter is an indicator of the IIR calibrated radiance quality and is extracted from the "**Pixel_Quality_Index**" parameter of the IIR Level 1 product.

If not zero, corresponding to nominal quality:

- either one channel has poor quality or is missing, or
- the radiances in the 3 channels are not all part of the same image measurement sequences (information added in V3) which, for scenes with high broken clouds, could lead to some errors at the edge of the images for geometrical reasons.

-

Bit	Bit value	Interpretation
1	0	IIR calibrated radiances in the 3 channels are of nominal quality
	1	At least one of the channels has poor quality or is missing
2	0	Channels 08.65 and 10.60 derived from the same sequence of acquisition
	1	Channels 08.65 and 10.60 not derived from the same sequence of acquisition
3	0	Channels 08.65 and 12.05 derived from the same sequence of acquisition
	1	Channels 08.65 and 12.05 not derived from the same sequence of acquisition
4	0	Channels 10.60 and 12.05 derived from the same sequence of acquisition
	1	Channels 10.60 and 12.05 not derived from the same sequence of acquisition
5-8	0	N/A

LIDAR_Data_Quality_Flag

This flag is the Feature Type QA derived from the parameter "**Feature_Classification_Flag**" in the CALIOP lidar Level 2 Cloud and Aerosols layers product for the uppermost layer in the *upper level*.

Value	Interpretation : Feature QA from Feature_Classification_Flag
0	none
1	low
1	medium
2	high

Type_of_Scene

This parameter is the scene classification derived from the CALIOP lidar Level 2 Cloud and Aerosols layers products, designed to select the scenes to be further analyzed in term of effective emissivity and in the meantime to be possibly compared with existing well established clouds classifications.

Only layers identified with a 5 or 20-km horizontal resolution are used in the analysis. Those obtained at a horizontal averaging of 80km are systematically rejected as they are not expected to impact the thermal IR signals.

The scenes are first organized according to the background reference scene (4th column in the table below), which can be either the surface (scenes identified as clear sky or possibly containing low semi-transparent depolarizing aerosol layers) or an opaque layer.

For each category, one to several semi-transparent (ST) layers can be considered as the *upper level* to compute the effective emissivity (3rd column in the table). Layers are high when their centroid altitude is above 7 km, and are low otherwise.

Low altitude aerosols layers are classified according to their mean volume depolarization ratio, with a threshold of 6%. Type 53 contains the depolarizing features (>6%), typically corresponding to desert dust aerosols (Liu et al, 2008). Type 52 are the non-depolarizing features. The threshold was set to 7% in V2.

Low level (Type 20 and 70) and high level (Type 40 and 80) opaque clouds are classified in V3 according to the maximum volume depolarization ratio in the layer, with a threshold of 40% (there was no distinction in V2).

A low altitude ST cloud layer (Type 24) is re-classified to Type 59 if the maximum attenuated backscatter and the maximum volume depolarization ratio in the layer are smaller than 0.02 sr^{-1} and 7% respectively, as a possible indicator of the presence of aerosols (V3).

Besides the changes described above, the classification has been updated with the addition of some complex types of scenes. Several types involving high ST aerosols layers have been added (Types 64, 65, 66) to better account for stratospheric clouds, classified as "aerosols" in the CALIOP product. The remaining scenes which do not match the classification are reported as #99.

In V2, scenes composed of 1, 2 or 3 high ST clouds (types 21, 22, 26) were re-classified as type 40 (opaque cloud) when the retrieved effective emissivity was greater than 0.6. It is not the case anymore for this release (V3) where the classification relies only on the CALIOP product.

The types of scenes are listed in the table below. Ice cirrus clouds fall in the scenes containing 1 to 5 high semi-transparent cloud layers overlying either the surface or a dense opaque layer, or in the scenes containing 1 high opaque cloud (Types 40, 80, 21, 22, 26, 31, 32, 41, 42, 30, 37). Overall, the changes with respect to version V2 are significant, due to changes in the IIR classification as described above, corrections of bugs and also due to the changes in the Version 3 CALIOP Level 2 layer products (for instance cloud/aerosols discrimination, opacity flags). Comparing IIR Level 2 V2 and V3 classifications is therefore not straightforward.

Value	Description	Number of layers in upper level	Reference Type of scene	Version 3 vs Version 2
CLEAR SKY				
10	Clear sky (no aerosols detected by lidar)	n/a	n/a	Same
AEROSOLS				
51	1 to 4 high ST aerosol	1 to 4	10	Different
52	1 to 4 low ST aerosols, vol_depolarization_ratio_mean < 6%	1 to 4	10	Different
53	1 to 4 low ST aerosols, vol_depolarization_ratio_mean > 6%	1 to 4	10	Different
54	1 to 4 high ST aerosols and 1 low ST aerosol	2 to 5	10	Different
55	1 high opaque aerosols	1	10	Same
56	1 low opaque aerosol	1	10	Same
64	1 to 4 high ST aerosols/ 1 low opaque aerosols	1 to 4	56	New
57	Any other aerosols only	3 to 8	10	Different
CLOUDS				

20	Low opaque cloud, vol_depol_ratio_max >40%	1	10 (or 52 backup)	Different
70	Low opaque cloud, vol_depol_ratio_max < 40%	1	10 (or 52 backup)	New
40	High opaque cloud, vol_depol_ratio_max >40%	1	10 (or 52 backup)	Different
80	High opaque cloud, vol_depol_ratio_max < 40%	1	10 (or 52 backup)	New
21	1 high ST cloud only (no aerosol)	1	10 (or 52 backup)	Different
22	2 high ST clouds	2	10 (or 52 backup)	Different
23	1 high ST cloud and 1 low ST cloud	2	10 (or 52 backup)	Same
24	1 low ST cloud, attenuated_backscatter_max > 0.02 sr^{-1} or vol_depol_ratio_max > 7%.	1	10 (or 52 backup)	Different
59	1 low ST cloud, attenuated_backscatter_max < 0.02 sr^{-1} and vol_depol_ratio_max < 7%.	1	10 (or 52 backup)	New
25	2 low ST clouds only (no aerosols)	2	10 (or 52 backup)	Same
26	3 high ST clouds	3	10 (or 52 backup)	Same
27	2 high ST clouds and 1 low ST cloud	3	10 (or 52 backup)	Different
67	3-4 high ST clouds and 1 low ST cloud	4 or 5	10 (or 52 backup)	New
28	1 high ST cloud and 2 low ST clouds	3	10 (or 52 backup)	Different
68	2-3 high ST clouds and 2 low ST clouds or 3 high ST clouds and 3 low ST clouds	4 to 6	10 (or 52 backup)	New
29	3 low ST clouds only (no aerosols)	3	10 (or 52 backup)	Same
31	1 high ST cloud / 1 low opaque cloud	1	20	Same
32	2 to 5 high ST cloud/ 1 opaque cloud	2 to 5	20	Different
62	3 to 6 ST cloud (at least 1 low ST)/ 1 opaque cloud	3 to 6	20	New
33	1 high ST cloud and 1 low ST cloud/ 1 opaque cloud	2	20	Same
34	1 low ST cloud/ 1 opaque cloud	1	20	Same
39	2 to 4 low ST clouds/ 1 low opaque cloud	2 to 4	20	Same
41	1 high ST cloud/ 1 high opaque cloud	1	40	Different
42	2 high ST cloud/ 1 high opaque cloud	2	40	Different
MIXED AEROSOLS/CLOUDS				
30	1 high ST cloud / 1 low ST aerosol	1	52	Same
66	1 high ST aerosols / 1 high ST cloud and 1 low ST cloud	3	10 (or 52 backup)	New
63	1 to 4 low aerosols and 1 low ST cloud	2 to 5	10 (or 52 backup)	New

35	1 high ST aerosols/ 1 low opaque cloud	1	20	Same
36	1 low ST aerosols/ 1 low opaque cloud	1	20	Same
37	1 high ST cloud/ 1 low opaque aerosols	1	56	Same
38	1 low ST cloud/ 1 low opaque aerosols	1	56	Same
65	1 high ST aerosols / 1 high opaque cloud	1	40	New
OTHERS				
99	OTHERS	Not processed	Not processed	Different

Surrounding_Obs_Quality_Flag

This flag is a composite of 3 different pieces of information:

- the units digit indicates if the studied pixel is isolated or part of a structure with consecutive IIR pixels of same "**Type_of_scene**" (same as in V2).
- the tens digit is a *mineral aerosols index* based on IIR inter-channels brightness temperature differences (BTD). Mineral aerosols layers are identified (tens digit=1) when the 08_65 minus 12_05 BTD is < -2K and the 10_60 minus 12_05 BTD is < -0.5 K (added in V3).
- the hundreds digit is an index describing the difference between observed and computed brightness temperatures for specific types of scenes: scenes identified as clear sky (10) or containing low aerosols (52, 53) and scenes containing opaque clouds (20, 40). This index is designed to identify the pixels exhibiting large differences and which may require further analysis (added in V3).

Digit	Digit value	Digit Interpretation
Units	0	3 or more consecutive pixels with the same Type_of_Scene
	1	2 consecutive pixels with the same Type_of_Scene
	2	Not computed
Tens IIR aerosols index	0	No mineral aerosols detected
	1	Mineral aerosols detected
Hundreds Obs-Computed BTs	0	Not computed or satisfactory for computed cases: Mean (Observed - Computed) Brightness Temperatures between -2K and +2K
	1	Low Mean (Observed - Computed) Brightness Temperatures between -5K and -2K
	2	High Mean (Observed - Computed) Brightness Temperatures between +2K and +5K
	3	Very low Mean (Observed - Computed) Brightness Temperatures < -5K
	4	Very high Mean (Observed - Computed) Brightness Temperatures > 5K

High_Cloud_vs_Background_Flag

This flag is to give the main characteristics of the background radiance used to retrieve the effective emissivity of the current pixel.

If the background radiance is derived from reference measurements in the vicinity of the pixel, the unit digit gives an indication of the mean distance from the current pixel. If it is derived from the FASRAD model, the unit digit is set to zero.

Depending on **Type_of_Scene**, the reference can be clear sky (10) or possibly low ST non depolarizing aerosols (52), a low opaque cloud (20), a high opaque cloud (40), or a low opaque aerosols layer (56). This information is provided in the hundreds digit (added in V3). When the reference is a cloud or aerosol layer selected among nearby observations (i.e. not computed), the tens digit (added in V3) indicates the range of values of its effective emissivity. Otherwise, it is set to 0 (computed reference) or -9 (clear sky).

Digit	Digit value	Digit interpretation
Units	0	Background reference computed
	1	Background reference measured at a distance <= 10 km
	2	Background reference measured, 10 km < distance <= 50 km
	3	Background reference measured, 50 km < distance <= 100 km
Tens	0	Background reference computed
	1	Measured background reference effective emissivity between -0.1 and 1.1
	2	Measured background reference effective emissivity < -0.1
	3	Measured background reference effective emissivity > 1.1
	-9	Measured background reference is clear sky
Hundreds	0	Background reference: clear sky (10)
	1	Background reference: low opaque cloud (20)
	2	Background reference: high opaque cloud (40)
	3	Background reference: low semi-transparent non depolarizing aerosols (52)
	4	Background reference: low opaque aerosols (56)

Computed_vs_Observed_Background_Flag

This parameter is to assess the impact of computed versus measured background reference radiances in the retrieved effective emissivities. If the background reference is derived from a series of neighboring pixels (cf **High_Cloud_vs_Background_Flag**), this parameter gives the mean relative difference between those measurements and the computed radiances (not used to retrieve the effective emissivities). Otherwise, the parameter is set to invalid. The three elements are for the IIR channels 08.65 µm, 10.60 µm and 12.05 µm respectively.

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

Regional_Background_Std_Dev_Flag

This parameter is the standard deviation associated to the previous parameter. (W.m^{-2}.sr^{-1}.µm^{-1})

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

Multi_Layer_Cloud_Flag

This flag is to give some information about the *upper level* whose effective emissivity is provided especially when composed of several layers (ten thousands and thousands digits). The difference between the bottom altitude of the uppermost layer and the top altitude of the lowermost layer (tens-units-decimals digits) is an indicator of the confidence in the retrieved effective emissivity in case of multi-layer *upper levels*.

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

Microphysics

Ice cloud microphysical properties are derived from two microphysical indices, defined as the ratio of the effective infrared optical depths in the pairs of channels 12.05-8.65 and 12.05-10.60 µm (Parol et al, 1991). Look-up tables allow deriving the effective size of the cirrus ice crystals and their shape.

The model leading to the best agreement between both microphysical indices is the one selected by the algorithm (see Particle_Shape_Index) to retrieve **Effective_Particle_Size**.

Microphysics gives the whole set of effective sizes retrieved from each the pair of channels for each model considered in the algorithm, allowing the user to evaluate the robustness of the model selection. The first three elements are for aggregates, plates and solid column models respectively (Yang et al, 2005).

Digits	Interpretation
Units	Shape_index: 7 (aggregates, record #1); 8 (plates, record #2), 9 (solid column, record #3)
Thousands-Hundreds-Tens	Effective diameter in microns derived from the (12.05 ; 8.65) pair
Millions- Hundred and ten thousands	Effective diameter in microns derived from the (12.05 ;10.60) pair

Metadata Parameters

Product_ID

An 80-byte (max) character string specifying the data product name. For the IIR Level 2 track products, the value of this string is "CAL_IIR_L2_Track".

Date_Time_at_Granule_Start

A 27-byte character string that reports the date and time at the start of the file orbit segment (i.e., granule). The format is yyyy-mm-ddThh:mm:ss.ffffffZ.

Date_Time_at_Granule_End

A 27-byte character string that reports the date and time at the end of the file orbit segment (i.e., granule). The format is yyyy-mm-ddThh:mm:ss.ffffffZ.

Date_Time_at_Granule_Production

This is a 27-byte character string that defines the date at granule production. The format is yyyy-mm-ddThh:mm:ss.ffffffZ.

Initial_IIR_Scan_Center_Latitude

This field reports the first subsatellite latitude of the granule.

Initial_IIR_Scan_Center_Longitude

This field reports the first subsatellite longitude of the granule.

Ending_IIR_Scan_Center_Latitude

This field reports the last subsatellite latitude of the granule.

Ending_IIR_Scan_Center_Longitude

This field reports the last subsatellite longitude of the granule.

Orbit_Number_at_Granule_Start

This field reports the orbit number at the granule start time.

Orbit_Number_at_Granule_End

This field reports the orbit number at the granule stop time.

Orbit_Number_Change_Time

This field reports the time at which the orbit number changes in the granule.

Path_Number_at_Granule_Start

This field reports the path number at the start time.

Path_Number_at_Granule_End

This field reports the path number at the granule stop time.

Path_Number_Change_Time

This field reports the time at which the path number changes in the granule.

Number_of_IIR_Records_in_File

This field reports the number of IIR records in the file.

Number_of_Valid_08_65_Pixels

This field reports the number of IIR pixels in the file with valid and good quality radiance in channel 08_65.

Number_of_Valid_12_05_Pixels

This field reports the number of IIR pixels in the file with valid and good quality radiance in channel 12_05.

Number_of_Valid_10_60_Pixels

This field reports the number of IIR pixels in the file with valid and good quality radiance in channel 10_60.

Number_of_Invalid_08_65_Pixels

This field reports the number of IIR pixels in the file with invalid or poor quality radiance in channel 08_65.

Number_of_Invalid_12_05_Pixels

This field reports the number of IIR pixels in the file with invalid or poor quality radiance in channel 12_05.

Number_of_Invalid_10_60_Pixels

This field reports the number of IIR pixels in the file with invalid or poor quality radiance in channel 10_60.

Number_of_Rejected_08_65_Pixels

This field reports the number of IIR pixels in the file in channel 08_65 rejected by the algorithm.

Number_of_Rejected_12_05_Pixels

This field reports the number of IIR pixels in the file in channel 12_05 rejected by the algorithm.

Number_of_Rejected_10_60_Pixels

This field reports the number of IIR pixels in the file in channel 10_60 rejected by the algorithm.

Number_of_Rejected_08_65_Pixels_Location

This field reports the number of IIR pixels in the file in channel 08_65 rejected by the algorithm due to co-location.

Number_of_Rejected_12_05_Pixels_Location

This field reports the number of IIR pixels in the file in channel 12_05 rejected by the algorithm due to co-location.

Number_of_Rejected_10_60_Pixels_Location

This field reports the number of IIR pixels in the file in channel 10_60 rejected by the algorithm due to co-location.

Number_of_Rejected_08_65_Pixels_Radiance

This field is set to 0.

Number_of_Rejected_12_05_Pixels_Radiance

This field is set to 0.

Number_of_Rejected_10_60_Pixels_Radiance

This field is set to 0.

Mean_08_65_Radiance_All

This field reports the mean radiance (in W.m^{-2}.sr^{-1}. μm^{-1}) in the file in channel 08_65.

Mean_12_05_Radiance_All

This field reports the mean radiance (in W.m^{-2}.sr^{-1}. μm^{-1}) in the file in channel 12_05.

Mean_10_60_Radiance_All

This field reports the mean radiance (in W.m^{-2}.sr^{-1}. μm^{-1}) in the file in channel 10_60.

Mean_08_65_Radiance_Selected_Cases

This field reports the mean radiance (in W.m^{-2}.sr^{-1}. μm^{-1}) in the file in channel 08_65 for cloudy and aerosols pixels selected by the algorithm (low opaque features excluded)

Mean_12_05_Radiance_Selected_Cases

This field reports the mean radiance (in W.m^{-2}.sr^{-1}. μm^{-1}) in the file in channel 12_05 for cloudy and aerosols pixels selected by the algorithm (low opaque features excluded).

Mean_10_60_Radiance_Selected_Cases

This field reports the mean radiance (in W.m^{-2}.sr^{-1}. μm^{-1}) in the file in channel 10_60 for cloudy and aerosols pixels selected by the algorithm (low opaque features excluded).

Mean_08_65_Brightness_Temp_All

This field reports the mean brightness temperature (in Kelvin) in the file in channel 08_65.

Mean_12_05_Brightness_Temp_All

This field reports the mean brightness temperature (in Kelvin) in the file in channel 12_05.

Mean_10_60_Brightness_Temp_All

This field reports the mean brightness temperature (in Kelvin) in the file in channel 10_60.

Mean_08_65_Brightness_Temp_Selected_Cases

This field reports the mean brightness temperature (in Kelvin) in the file in channel 08_65 for cloudy and aerosols pixels selected by the algorithm (low opaque features excluded).

Mean_12_05_Brightness_Temp_Selected_Cases

This field reports the mean brightness temperature (in Kelvin) in the file in channel 12_05 for cloudy and aerosols pixels selected by the algorithm (low opaque features excluded).

Mean_10_60_Brightness_Temp_Selected_Cases

This field reports the mean brightness temperature (in Kelvin) in the file in channel 10_60 for cloudy and aerosols pixels selected by the algorithm (low opaque features excluded).

Number_of_Valid_LIDAR_Pixels

This field reports the number records in the lidar input product available at IIR pixel resolution.

Number_of_Invalid_LIDAR_Pixels

This field is set to 0.

Number_of_Rejected_LIDAR_Pixels

This field is set to 0.

Number_of_Identified_Pixels_Upper_Level

This field reports the number of cloudy and aerosols pixels in the file (low opaque clouds excluded).

Percent_of_Identified_Pixels_Upper_Level

This field reports the percentage of cloudy and aerosols pixels in the file (low opaque features excluded).

Number_of_Identified_Pixels_Lower_Level

This field reports the number of pixels in the file with a low level opaque cloud.

Percent_of_Identified_Pixels_Lower_Level

This field reports the percentage of pixels in the file with a low level opaque cloud.

Number_of_Identified_Pixels_Clear_Sky

This field reports the number of "clear sky" pixels in the file (i. e no clouds and no aerosols).

Percent_of_Identified_Pixels_Clear_Sky

This field reports the percentage of "clear sky" pixels in the file (i. e no clouds and no aerosols).

Mean_Altitude_Upper_Level

This field reports the mean altitude (in km) of the scattering features selected by the algorithm (low opaque features excluded).

GEOS_Version

This is a 64-byte character that reports the version of the GEOS data product provided by the GMAO.

Data Release Versions

<table>
<tr><th colspan="4">IIR Level 2 Track
Half orbit (Night and Day) emissivity and cloud particle data related to pixels that have been co-located to the Lidar track</th></tr>
<tr><th colspan="4">Expedited Data Sets</th></tr>
<tr><th>Release Date</th><th>Version</th><th>Data Date Range</th><th>Maturity Level</th></tr>
<tr><td>July 2013</td><td>3.30</td><td>June 1, 2013 to present</td><td>Beta</td></tr>
<tr><th colspan="4">Standard Data Sets</th></tr>
<tr><th>Release Date</th><th>Version</th><th>Data Date Range</th><th>Maturity Level</th></tr>
<tr><td>August 2013</td><td>3.30</td><td>March 1, 2013 to present</td><td>Beta</td></tr>
</table>

Data Quality Statement for the release of the CALIPSO IIR Level 2 Track Product Version 3.30, August 2013

The Version 3.30 CALIOP and IIR data products incorporate the updated GMAO Forward Processing - Instrument Teams (FP-IT) meteorological data, and the enhanced Air Force Weather Authority (AFWA) Snow and Ice Data Set as ancillary inputs to the production of these data sets, beginning with data date March 1, 2013.

Impacts on CALIOP data products caused by the transition to GEOS-5 FP-IT are predicted to be minimal, based on a comparison of CALIOP Version 3.02 against CALIOP Version 3.30. Details are given in the following document: Impacts of Change in GEOS-5 Version on CALIOP Products (PDF).

In addition, the IIR Level 2 algorithm uses ancillary surface and atmospheric data to compute background and blackbody radiances before retrieving effective emissivity and optical depth.

In case of cirrus clouds over ocean, absorption optical depth derived from computed background radiances is predicted to change by less than 0.01 on average between 60S and 60N, and to be more accurate in V3.30. These predictions are inferred from distributions of brightness temperature (BT) differences between observations and computations in clear sky conditions over ocean for several ranges of latitude in August 2013 (V3.30), which have been compared to distributions for the months of August 2012 and 2010 (V3.02 and V3.01, respectively). The mean BT differences are reduced by 0.1 to 0.3 Kelvin in absolute value in V3.30, with similar standard deviations (1.2 and 1.9 Kelvin). At high latitude, a more accurate identification of the IIR pixels not impacted by snow or ice results into smaller standard deviations in V3.30. No significant change of the computed blackbody radiances has been identified for opaque ice clouds for the month of August 2013.

In case of cirrus clouds overlying a low opaque cloud, changes in absorption optical depth derived from computed background radiances are predicted from distributions of differences between observations and computations for low opaque clouds. The median BT differences are improved by 0.4 to 1.2 Kelvin in August 2013 (V3.30) compared to August 2010 and 2012, corresponding to changes of the order of 0.01 to 0.03 in absorption optical depth.