CALIPSO Quality Statement
IIR Level 2 Swath 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 2.9 of the CALIPSO CALIPSO Data Products Catalog (Version 3.6) (PDF).

The IIR swath product DP2.2B contains brightness temperatures over the IIR swath for the three channels (8.65, 10.60 and 12.05 µm) directly derived from the Level 1 radiances, a scene classification, effective emissivity of the selected upper cloud or aerosols layers and ice cloud microphysics.

Data Product Maturity

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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- 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 swath analysis basically aims at extending to the swath the retrievals obtained under the CALIOP track where a vertical description of the scene is available. Extension from the track to the swath is based on homogeneity criteria provided in the product. The reliability of this product is therefore lower than for the IIR/Lidar track product. More details are available in Garnier et al., 2012a.

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.
- CALIPSO WFC Level 1B product DP1.3, 1-km registered science record, version V3.01 until 31 October 2011, version V3.02 since November 1, 2011.
- 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.

LIDAR_DayNight_Flag

This parameter is a replicate of the parameter "Day_night_flag" from CALIOP Lidar Level 2 5-km Cloud and Aerosols layers product.

Value	Interpretation
0	day
1	night

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.

Calibrated_WFC_Reflectance

This parameter is a replicate of the parameter **Reflectance** from the WFC-IIR Level 1B product, 1-km registered science record.

Surface_Emissivity_08_65
Surface_Emissivity_12_05
Surface_Emissivity_10_60

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

Only the surface emissivities under the track are accurate for this release. The values outside the track are not representative of the values which would be retrieved from the IGBP/NSIDC geotype map (they are an extension of the ones on the track). This will be modified in a future release.

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 (see Scene_Flag).

Pixels outside the track take the value calculated for the most similar neighboring track pixel (within +/- 50 km in V3 instead of +/- 34 km in V2) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

Please refer to "IIR/Lidar track product" for information about the track effective emissivities.

Effective_Emissivity_Uncertainty_08_65
Effective_Emissivity_Uncertainty_12_05
Effective_Emissivity_Uncertainty_10_60

This parameter gives the uncertainty Δε on the effective emissivity, ε, at 08.65 μm, 12.05 μm and 10.60 μm.

Pixels outside the track take the value calculated for the most similar neighboring track pixel (within +/- 50 km) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

Please refer to "IIR/Lidar track product" for information about the track effective emissivity uncertainties.

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.

Homogeneity_Index_BT_08_65
Homogeneity_Index_BT_12_05
Homogeneity_Index_BT_10_60

For each IIR channel, this parameter gives the absolute difference between the pixel brightness temperature (BT) and the brightness temperature of the most similar neighboring track pixel (within +/- 50 km) selected by the algorithm. It varies between 0 (identical temperatures) and 1 corresponding to a maximum acceptable difference of 1K for this release.

Homogeneity_Index_Surface_e_08_65
Homogeneity_Index_Surface_e_12_05
Homogeneity_Index_Surface_e_10_60

Not computed for this release.

Homogeneity_Index_Reflectance

Not computed for this release.

Homogeneity_Index_Surface_Temperature

Not computed for this release.

Homogeneity_Index_Humidity_Profile

Not computed for this release.

Particle_Shape_Index

This parameter is a number corresponding to the crystal microphysical model retrieved from the algorithm.

Value	Interpretation
7	Aggregates
8	Plates
9	Solid columns

Pixels outside the track take the value calculated for the most similar neighboring track pixel (within +/- 50 km) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

Please refer to “IIR/Lidar track product” for information about the track particle shape index.

Particle_Shape_Index_Confidence

This parameter is the confidence in the particle shape retrieval.

Value	Interpretation
1	Good
2	Medium

Pixels outside the track take the value calculated for the most similar neighboring track pixel (within +/- 50 km) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

Please refer to “IIR/Lidar track product” for information about the track particle shape index.

Effective_Particle_Size

This parameter is the effective particle diameter (in μm) retrieved from the algorithm.

Pixels outside the track take the value calculated for the most similar neighboring track pixel (within +/- 50 km) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

Please refer to “IIR/Lidar track product” for information about the track effective particle size.

Effective_Particle_Size_Uncertainty

This parameter reflects the confidence in the effective particle size retrieval both in nominal (value < 100) and degraded conditions.

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 very low confidence	No

Pixels outside the track take the value calculated for the most similar neighboring track pixel (within +/- 50 km) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

Please refer to “IIR/Lidar track product” for more information about the track effective particle size uncertainty.

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.

Pixels outside the track take the value calculated for the most similar neighboring track pixel (within +/- 50 km) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

Please refer to "IIR/Lidar track product" for more information about the track optical depth at 12.05 µm.

Optical_Depth_12_05_Uncertainty

This parameter if the Optical_Depth_12_05 uncertainty derived from the effective emissivity uncertainty at 12.05 µm.

Pixels outside the track take the value calculated for the most similar neighboring track pixel (within +/- 50 km) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

Please refer to "IIR/Lidar track product" for information about the track IR optical depth uncertainty.

Ice_Water_Path

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

Pixels outside the track take the value calculated for the most similar neighboring track pixel (within +/- 50 km) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

Please refer to "IIR/Lidar track product" for information about track ice water path.

Ice_Water_Path_Confidence

Not computed for this release. Please refer to "IIR/Lidar track product" for information about the track ice water path confidence.

QA information

Scene_Flag

The **Scene_Flag** parameter is a composite of two parameters:

- Type_of_Scene as defined in IIR/Lidar track product and
- the geotype index defined according to the IGBP classification.

Digits	Interpretation
Tens-Units	Type_of_Scene
Thousands-Hundreds	IGBP index

Pixels outside the track take the value calculated for the most similar neighbour track pixel (within +/- 50 km) according to the homogeneity indices. If no similar pixel is found, this parameter is set to invalid.

This approach is obviously not accurate for the "geotype" which should not be used for scientific analysis. It does not impact the swath effective emissivities as they are not computed over the swath but extrapolated from the track emissivities.

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 1b product.

If not zero, corresponding to nominal quality:

- either one channel has poor quality or is missing, most of the time at the edge of the swath, or
- the radiances in the 3 channels are not all part of the same image measurement sequences 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

Metadata Parameters

Product_ID

An 80-byte (max) character string specifying the data product name. For the IIR Level 2 swath products, the value of this string is "CAL_IIR_L2_Swath".

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_Loc
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_Loc
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_Loc
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_Rad
This field is set to 0.

Number_of_Rejected_12_05_Pixels_Rad
This field is set to 0.

Number_of_Rejected_10_60_Pixels_Rad
This field is set to 0.

Mean_08_65_Radiance_All
This field reports the mean radiance (in $W.m^{-2}.sr^{-1}.\ \mu m^{-1}$) in the file in channel 08_65.

Mean_12_05_Radiance_All
This field reports the mean radiance (in $W.m^{-2}.sr^{-1}.\ \mu m^{-1}$) in the file in channel 12_05.

Mean_10_60_Radiance_All
This field reports the mean radiance (in $W.m^{-2}.sr^{-1}.\ \mu m^{-1}$) in the file in channel 10_60.

Mean_08_65_Radiance_Selected_Cases
This field is set to -9999.

Mean_12_05_Radiance_Selected_Cases
This field is set to -9999.

Mean_10_60_Radiance_Selected_Cases
This field is set to -9999.

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 is set to -9999.

Mean_12_05_Brightness_Temp_Selected_Cases
This field is set to -9999.

Mean_10_60_Brightness_Temp_Selected_Cases
This field is set to -9999.

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

Data Release Versions

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*			
Expedited Data Sets			
Release Date	**Version**	**Data Date Range**	**Maturity Level**
July 2013	3.30	June 1, 2013 to present	Beta
Standard Data Sets			
Release Date	**Version**	**Data Date Range**	**Maturity Level**
August 2013	3.30	March 1, 2013 to present	Beta

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.