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Cloud – Aerosol LIDAR and Infrared Pathfinder Satellite Observations (CALIPSO)

Data Description and Quality Summary

Imaging Infrared Radiometer Level 1 Data

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Imaging Infrared Radiometer Level 1 Data

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CALIPSO IIR Level 1B Data Description Document
Version 3.00

Data Version: 3.00
Data Release Date: October 01, 2025
Data Date Range: June 13, 2006 to June 30, 2023

Introduction

The Imaging Infrared Radiometer (IIR) Level 1B data product contains geolocated and calibrated radiances. The data are geo-located on a 1-km grid centered on the CALIOP track, with a 69-km swath. Along the track, each IIR 1-km pixel has its center co-located with a CALIOP lidar shot, and two successive IIR pixels are separated by exactly 3 lidar shots. For consistency with the CALIOP products, the measurements are partitioned into daytime and nighttime granules corresponding to approximately one-half orbit each.

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Additional Documentation

Project Documentation

- CALIPSO Data Management Team: CALIPSO Data Products Catalog, PC-SCI-503, Release 5.00.
- IIR Level 1 Processing Requirements, CNES, Ed. 4, 12 March, 2014.

Peer-Reviewed Algorithm Papers

- Garnier, A., T. Trémas, J. Pelon, K.-P. Lee, D. Nobileau, L. Gross-Colzy, N. Pascal, P. Ferrage and N. A. Scott, 2018: CALIPSO IIR Version 2 Level 1b calibrated radiances: analysis and reduction of residual biases in the Northern Hemisphere, *Atmos. Meas. Tech.*, 11, 2485–2500, https://doi.org/10.5194/amt-11-2485-2018.
- Garnier, A., N. A. Scott, J. Pelon, R. Armante, L. Crépeau, B. Six and N. Pascal, 2017: Long term assessment of the CALIPSO Imaging Infrared Radiometer (IIR) calibration and stability through comparisons with MODIS/Aqua and SEVIRI/Meteosat, *Atmos. Meas. Tech.*, 10, 1403–1424, https://doi.org/10.5194/amt-10-1403-2017.

Data Product Descriptions: Earth View Record

Lidar_Shot_Time

Units: s

Format: Float_64

Valid Range: 4.203E8, 9.623E8

Fill Value: -9999.0

Description: Reports the International Atomic Time (TAI) in elapsed seconds from January 1, 1993 of the lidar shot co-located with the center of the lidar track pixel (column 34, counting from 0 to 68). Calibrated IIR images are registered on a 1 km resolution grid centered on the lidar ground track.

Lidar_Shot_UTC_Time

Units: yymmdd.ffffffff

Format: Float_64

Valid Range: 60428.0, 230701.0

Fill Value: -9999.0

Description: Reports the Coordinated Universal Time (UTC) of the lidar shot co-located with the center of the lidar track pixel (column 34, counting from 0 to 68). The format is yymmdd.ffffffff, where yy is a two-digit data acquisition year number (06 to 23), mm is a month number (01 to 12), dd is a day number (01 to 31), and ffffffff is the elapsed fraction of the data acquisition day. Calibrated IIR images are registered on a 1 km resolution grid centered on the lidar ground track.

Latitude

Units: °

Format: Float_32

Valid Range: -90.0, 90.0

Fill Value: -9999.0

Description: Geodetic latitude of the center of the IIR pixel on the Earth's surface.

Longitude

Units: °

Format: Float_32

Valid Range: -180.0, 180.0

Fill Value: -9999.0

Description: Longitude of the center of the IIR pixel on the Earth's surface.

Image_Time_8.65

Image_Time_10.6

Image_Time_12.05

Units: s

Format: Float_64

Valid Range: 4.203E8, 9.623E8

Fill Value: -9999.0

Description: Earth view image in International Atomic Time (TAI) in elapsed seconds from January 1, 1993 acquisition time of the pixel for channels 8.65, 10.6, and 12.05.

Image_UTC_Time_8.65

Image_UTC_Time_10.6

Image_UTC_Time_12.05

Units: yymmdd.ffffffff

Format: Float_64

Valid Range: 60428.0, 230701.0

Fill Value: 921231.88

Description: Earth view image UTC acquisition time of the pixel for channels 8.65, 10.6, and 12.05.

Calibrated_Radiances_8.65

Calibrated_Radiances_10.6

Calibrated_Radiances_12.05

Units: W/((m^2)·sr·µm)

Format: Int_16
Raw Data Valid Range: 0, 32000
Valid Range: 0, 32
Fill Value: -9999
Scale Factor: 1000.0
Offset: 0.0
Scale Equation: (data/scale factor) + offset
Description: Calibrated radiances for channels 8.65, 10.6, and 12.05.

Viewing_Zenith_Angle_8.65
Viewing_Zenith_Angle_10.6
Viewing_Zenith_Angle_12.05
Units: °
Format: Int_16
Raw Data Valid Range: 0, 18000
Valid Range: 0.0, 180.0
Fill Value: -9999
Scale Factor: 100.0
Offset: 0.0
Scale Equation: (data/scale factor) + offset
Description: Viewing zenith angles for channels 8.65, 10.6, and 12.05.

Viewing_Azimuth_Angle_8.65
Viewing_Azimuth_Angle_10.6
Viewing_Azimuth_Angle_12.05
Units: °
Format: Int_16
Raw Data Valid Range: -18000, 18000
Valid Range: -180.0, 180.0
Fill Value: -9999
Scale Factor: 100.0
Offset: 0.0
Scale Equation: (data/scale factor) + offset
Description: Viewing azimuth angles for channels 8.65, 10.6, and 12.05.

Sequence_Number_8.65
Sequence_Number_10.6
Sequence_Number_12.05
Units: NoUnits
Format: Int_16
Valid Range: 0, 20479
Fill Value: -9999

Description: Earth view image sequence number for channels 8.65, 10.6, and 12.05.

Pixel_Quality_Index

Units: NoUnits

Format: UInt_32

Valid Range: 0, 15745287

Description: Pixel quality index

The Pixel Quality Index is an indicator provided for each pixel. It is related to specific steps in the processing and indicates whether a pixel is of good or bad quality.

Bits 1-3 give the overall quality of the pixel for scientific analysis. Bits 4-21 include more detailed information and bits 22-24 indicate if an equalization correction has been applied.

Table 1: Interpretation of the bits in the Pixel Quality Index

Bit(s)	Interpretation
1	Pixel quality for channel 12.05 (1: bad; 0: good)
2	Pixel quality for channel 10.60 (1: bad; 0: good)
3	Pixel quality for channel 8.65 is bad (1: bad; 0: good)
4-8	Number of interpolated pixels in IIR matrix used in Level 1 bi-cubic interpolation (from 0 to 16), channel 12.05. If bit 9 is set, then this flag is equal to 1 (Saturated pixel) or 2 (Missing pixel)
9	Bad pixel, channel 12.05
10-14	Number of interpolated pixels in IIR matrix used in Level 1 bi-cubic interpolation (from 0 to 16), channel 10.6. If bit 15 is set, then this flag is equal to 1 (Saturated pixel) or 2 (Missing pixel).
15	Bad pixel, channel 10.6
16-20	Number of interpolated pixels in IIR matrix used in Level 1 bi-cubic interpolation (from 0 to 16), channel 8.65. If bit 21 is set, then this flag is equal to 1 (Saturated pixel) or 2 (Missing pixel).
21	Bad pixel, channel 8.65
22	Equalization correction applied, channel 12.05 (1: yes; 0: no)
23	Equalization correction applied, channel 10.6 (1: yes; 0: no)
24	Equalization correction applied, channel 8.65 (1: yes; 0: no)
25–32	Not used

Data Product Descriptions: Spacecraft Record

Time_TAI_8.65

Time_TAI_10.6

Time_TAI_12.05

Units: s

Format: Float_64

Valid Range: 4.203E8, 9.623E8

Fill Value: -9999.0

Description: Earth view image acquisition time in seconds from Jan. 1, 1993 (TAI) for channels 8.65, 10.6, and 12.05. Spacecraft record (1 record per Earth view).

Time_UTC_8.65

Time_UTC_10.6

Time_UTC_12.05

Units: yymmdd.ffffffff

Format: Float_64

Valid Range: 60428.0, 230701.0

Fill Value: -9999.0

Description: Earth view image UTC acquisition time for channels 8.65, 10.6, and 12.05. Spacecraft record (1 record per Earth view).

Spacecraft_Position_8.65

Spacecraft_Position_10.6

Spacecraft_Position_12.05

Units: km

Format: Float_64

Valid Range: -8000.0, 8000.0

Fill Value: -9999.0

Description: Spacecraft (X, Y, Z) position in the Earth Centered Rotating (ECR) coordinate system for channels 8.65, 10.6, and 12.05. The X-axis is in the equatorial plane through the Greenwich meridian, the Y-axis lies in the equatorial plane 90 degrees to the east of the X-axis, and the Z-axis is toward the North Pole. Spacecraft record (1 record per Earth view).

Spacecraft_Velocity_8.65

Spacecraft_Velocity_10.6

Spacecraft_Velocity_12.05

Units: km/s

Format: Float_64

Valid Range: -8000.0, 8000.0

Fill Value: -9999.0

Description: Spacecraft (X, Y, Z) velocity in the Earth Centered Rotating (ECR) coordinate system for channels 8.65, 10.6, and 12.05. The X-axis is in the equatorial plane through the Greenwich meridian, the Y-axis lies in the equatorial plane 90 degrees to the east of the X-axis, and the Z-axis is toward the North Pole. Spacecraft record (1 record per Earth view).

Spacecraft_Attitude_8.65

Spacecraft_Attitude_10.6

Spacecraft_Attitude_12.05

Units: °

Format: Float_64

Valid Range: -180.0, 180.0

Fill Value: -9999.0

Description: Attitude data of the satellite, expressed as a set of Euler angles (roll, pitch, yaw angles) for channels 8.65, 10.6, and 12.05. The Euler angles represent the rotation between orbital and spacecraft coordinates. Spacecraft record (1 record per Earth view).

Spacecraft_Attitude_Rate_8.65

Spacecraft_Attitude_Rate_10.6

Spacecraft_Attitude_Rate_12.05

Units: °/s

Format: Float_64

Valid Range: -10.0, 10.0

Fill Value: -9999.0

Description: Change of attitude data of the satellite, expressed as the changes of a set of Euler angles (roll, pitch, yaw angles) for channels 8.65, 10.6, and 12.05. The Euler angles represent the rotation between orbital and spacecraft coordinates. Spacecraft record (1 record per Earth view).

Subsatellite_Latitude_8.65

Subsatellite_Latitude_10.6

Subsatellite_Latitude_12.05

Units: °

Format: Float_32

Valid Range: -90.0, 90.0

Fill Value: -9999.0

Description: Latitude of the geodetic subsatellite point, which is the point on the surface where the geodetic zenith vector points toward the satellite, for channels 8.65, 10.6, and 12.05. Spacecraft record (1 record per Earth view).

Subsatellite_Longitude_8.65

Subsatellite_Longitude_10.6

Subsatellite_Longitude_12.05

Units: °

Format: Float_32

Valid Range: -180.0, 180.0

Fill Value: -9999.0

Description: Longitude of the geodetic subsatellite point, which is the point on the surface where the geodetic zenith vector points toward the satellite, for channels 8.65, 10.6, and 12.05. Spacecraft record (1 record per Earth view).

Metadata Parameter Descriptions

Product_ID

An 80-byte character string containing the product name. For the IIR Level 1 product, the value of this string is "IIR_L1".

Date_Time_at_Granule_Start

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

Date_Time_at_Granule_End

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

Date_Time_of_Production

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

Number_of_IIR_Grid_Line_Records

This field reports the number of IIR grid line records.

Initial_Subsatellite_Latitude

This field reports the first subsatellite latitude of the granule.

Initial_Subsatellite_Longitude

This field reports the first subsatellite longitude of the granule.

Final_Subsatellite_Latitude

This field reports the last subsatellite latitude of the granule.

Final_Subsatellite_Longitude

This field reports the last subsatellite longitude of the granule.

Orbit_Number_at_Granule_Start

Orbit_Number_at_Granule_Stop

Orbit_Number_Change_Time

Orbit Number consists of three fields that define the number of revolutions by the CALIPSO spacecraft around the Earth. This number is incremented each time the spacecraft passes the equator on the ascending node. To maintain consistency between the CALIPSO and CloudSat orbit parameters, the Orbit Number is keyed to the CloudSat orbit 2121 at 23:00:47 on 2006/09/20. Because the CALIPSO data granules are organized according to the day and night conditions, based on fixed Sun-Earth-Satellite angles, day/night boundaries do not coincide with transition points for defining orbit number. As such, three parameters are needed to describe the orbit number for each granule as:

- **Orbit Number at Granule Start:** orbit number at the granule start time.
- **Orbit Number at Granule End:** orbit number at the granule stop time.
- **Orbit Number Change Time:** time at which the orbit number changes in the granule.

Path_Number_at_Granule_Start

Path_Number_at_Granule_Stop

Path_Number_Change_Time

Path Number consists of three fields that define an index ranging from 1-233 that references orbits to the Worldwide Reference System (WRS). This global grid system was developed to support scene identification for LandSat imagery. Since the A-Train is maintained to the WRS grid within +/- 10 km, the Path Number provides a convenient index to support data searches, instead of having to define complex latitude and longitude regions along the orbit track. The Path Number is incremented after the maximum latitude in the orbit is attained and changes by a value of 16 between successive orbits. Because the CALIPSO data granules are organized according to the day and night conditions, based on fixed Sun-Earth-Satellite angles, day/night boundaries do not coincide with transition points for defining path number. As such, three parameters are needed to describe the path number for each granule as:

- **Path Number at Granule Start:** path number at the granule start time.
- **Path Number at Granule End:** path number at the granule stop time.
- **Path Number Change Time:** time at which the path number changes in the granule.

While CALIPSO was formation flying in the A-Train all path numbers in the metadata are exact. Beginning in September 2018, when CALIPSO lowered its orbit into the C-Train, path numbers are no longer exact, but they instead indicate the closest WRS reference orbit.

Ephemeris_Files_Used

This is a 160-byte character that reports a maximum of two ephemeris files used in processing the spacecraft position and velocity.

Attitude_Files_Used

This is a 160-byte character that reports a maximum of two attitude files used in processing the spacecraft attitude and attitude rate.

Level_0_Files_Used

This parameter gives the name of the level 0 files used.

Level_1_Code_Version_Used

This parameter gives the level 1 code version used to process the granule.

Input_Parameter_File_Versions_Number_Used_Radiometry

This parameter gives the version number of the calibration module.

Input_Parameter_Date_of_Application_Radiometry

This parameter gives the date at which the calibration module was applied in Format: yyyy-mm-ddThh:nn:ss.ffffffZ, where yyyy is the year, mm is the month, dd is the day, hh is the hour, nn is the minute, ss is the second, and ffffff is the fractional second. Date and time are separated by the character ‘T’. The ‘Z’ indicates that time is given in UTC.

Input_Parameter_File_Version_Number_Used_Geometry

This parameter gives the version number of the geometry module.

Input_Parameter_Date_of_Application_Geometry

This parameter gives the date at which the geometry module was applied. The format is yyyy-mm-ddThh:nn:ss.ffffffZ, where yyyy is the year, mm is the month, dd is the day, hh is the hour, nn is the minute, ss is the second, and ffffff is the fractional second. Date and time are separated by the character 'T'. The 'Z' indicates that time is given in UTC.

Percentage_of_8.65_Good_Pixels

Percentage_of_10.6_Good_Pixels

Percentage_of_12.05_Good_Pixels

Percentage_of_Good_Pixels_3_Channels

These fields provide the percentage of good pixels for each channel and simultaneously for all three channels.

Percentage_of_Missing_Pixels

This parameter gives the percentage of missing pixels.

Number_of_Images_Processed

This parameter gives the number of images processed.

Percentage_of_Missing_Images

This parameter gives the percentage of missing images.

Number_of_Equalization_Mode

This parameter gives the number of equalization modes.

Altitude_of_Projection

This parameter gives the altitude of projection in km.

Initial_Absolute_Sequence

This parameter gives the smallest sequence number at granule start.

Final_Absolute_Sequence

This parameter gives the largest sequence number at granule end.

Scale_Factor_for_Radiance

This parameter gives the scale factor used to report the calibrated radiances.

Radiance_Offset

This parameter gives the offset used to report the calibrated radiances.

Scale_Factor_for_Viewing_Angle

This parameter gives the scale factor used to report the viewing angles.

Viewing_Angle_Offset

This parameter gives the offset used to report the viewing angles.

Data Release Information

Table 2: Dates, versions, and production strategy for all CALIPSO IIR level 1B data releases

IIR Level 1B: Half Orbit (day & night)			
Release Date	**Version**	**Data Date Range**	**Production Strategy**
September 2025	3.00	June 13, 2006 to June 30, 2023	Standard
October 2020	2.01	October 1, 2020 to June 30, 2023	Standard
July 2017	2.00	June 13, 2006 to September 30, 2020	Standard
October 2020	1.13	October 1, 2020 to June 30, 2023	Provisional
December 2011	1.12	November 1, 2011 to September 30, 2020	Provisional
November 2008	1.11	August 20, 2008 to October 31, 2011	Provisional
December 2006	1.10	June 13, 2006 to August 19, 2008	Provisional

Data Quality Information

Data Quality Statement for the release of the CALIPSO IIR Level 1B Product Version 3.00

No change to the science algorithm that pertains to this specific product. A new version was generated to accommodate new code that generated two new public products, namely the IIR Level 1 Calibration and IIR Level 1 Calibration Correction data products.

Data Quality Statement for the release of the CALIPSO IIR Level 1B Product Version 2.01

A minor version bump (+0.01) has been applied to all CALIPSO data products due to a required upgrade to the operating system on the CALIPSO production cluster. All algorithms were re-compiled to process in this new environment with no change to the underlying science algorithms or inputs.

Data Quality Statement for the release of the CALIPSO IIR Level 1B Product Version 2.00

The brightness temperature differences between similar channels of IIR (Version 1 data) and MODIS (Collection 5 data) have been monitored since launch. These inter-comparisons have been further assessed by directly comparing each IIR and MODIS channel with radiative transfer simulations in clear sky conditions using meteorological profiles from reanalysis. In the tropics, the agreement with MODIS is better than 0.05 K for IIR channels 8.65 µm and 10.6 µm and is within 0.26 K for IIR channel 12.05 µm. No drift is evidenced for any of the IIR channels: values are smaller than ± 0.004 K/year.

However, in Version 1, a striping effect as well as residual biases with respect to MODIS were occurring in the northern hemisphere, mostly north of 30°N, at season-dependent latitudes. These effects were caused by calibration drifts synchronized with the elapsed time since the night-to-day transition. Two distinct sets of correction coefficients were implemented in the Version 2 algorithm:

- The first is an equalization correction, which is applied to about half of each individual image with respect to the other part of the image.
- The second set of coefficients corrects overall radiometric biases that affected the whole image.

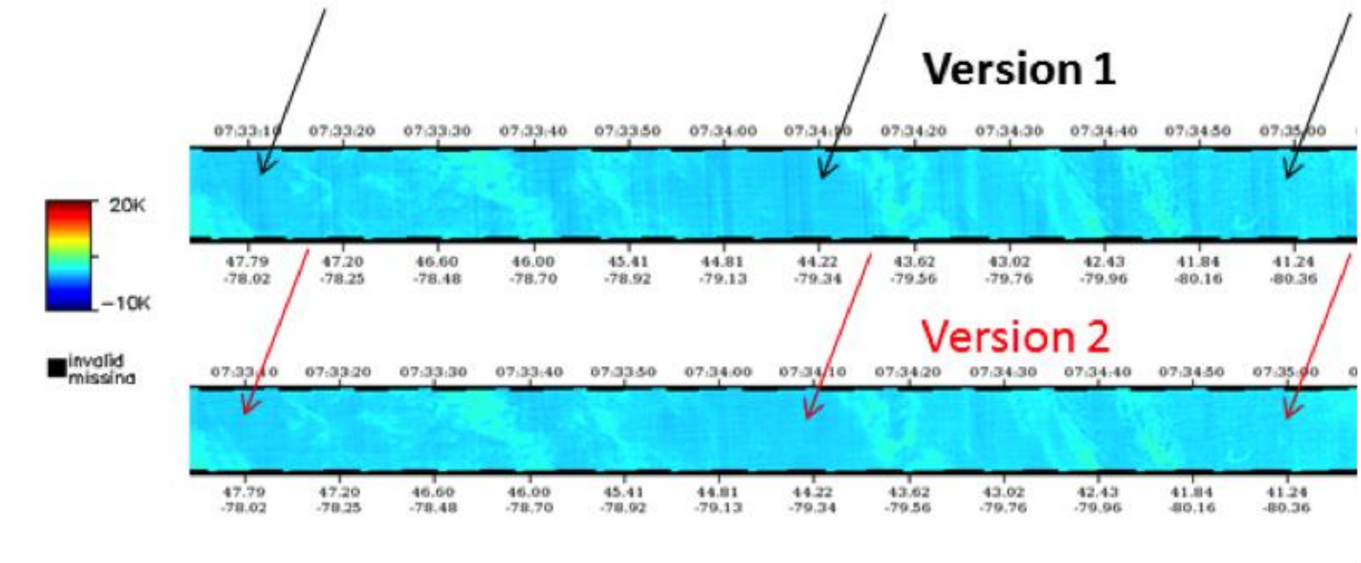

Figure 1: IIR 10.6 µm-12.05 µm inter-channel brightness temperature difference during the nighttime descending portion of an orbit between 48°N and 41°N in June 2008. Top: Version 1; Bottom: Version 2. The arrows point to some of the darker stripes seen periodically in Version 1. This striping effect seen in Version 1 is significantly attenuated in Version 2.

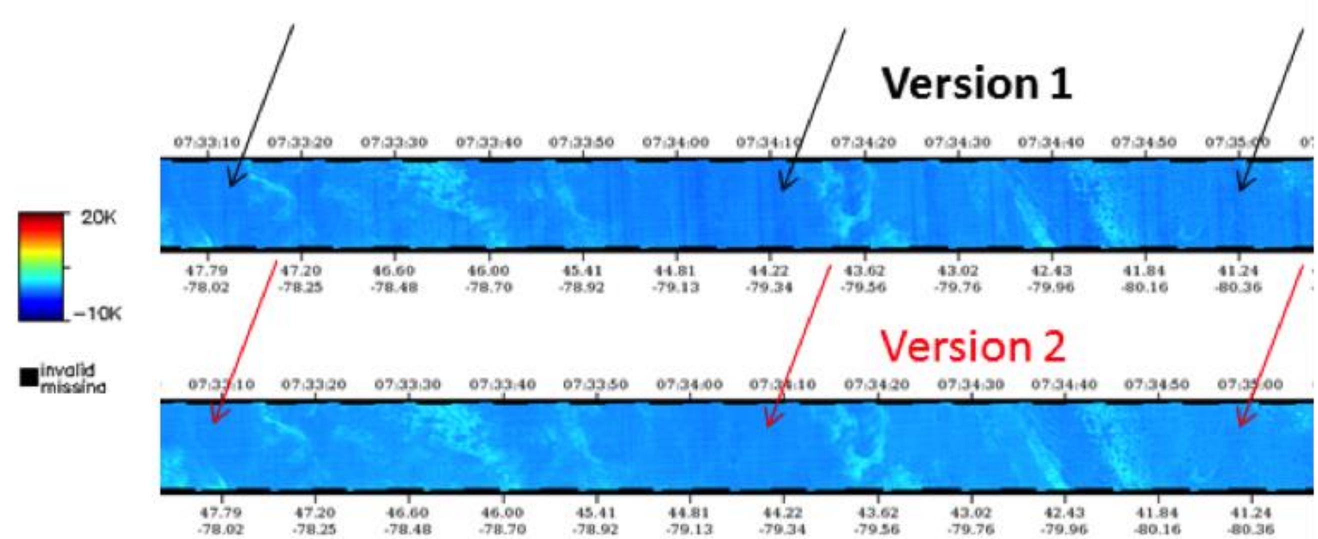

Figure 2: IIR 8.65 µm-12.05 µm inter-channel brightness temperature difference during the nighttime descending portion of an orbit between 48°N and 41°N in June 2008. Top: Version 1; Bottom: Version 2. The arrows point to some of the darker stripes seen periodically in Version 1.0. This striping effect seen in Version 1 is significantly attenuated in Version 2.

In Version 1, residual IIR calibration biases were clearly evident at 30-60°N in June and July, where the IIR-MODIS brightness temperature differences were on average larger by 0.2 K at 8.65 µm and by 0.4 K at 10.6 and 12.05 µm in the nighttime descending portion of each orbit than in the daytime ascending portion (Figure 3, left). With the refined Version 2 calibration (Figure 3, right), these differences are substantially reduced.

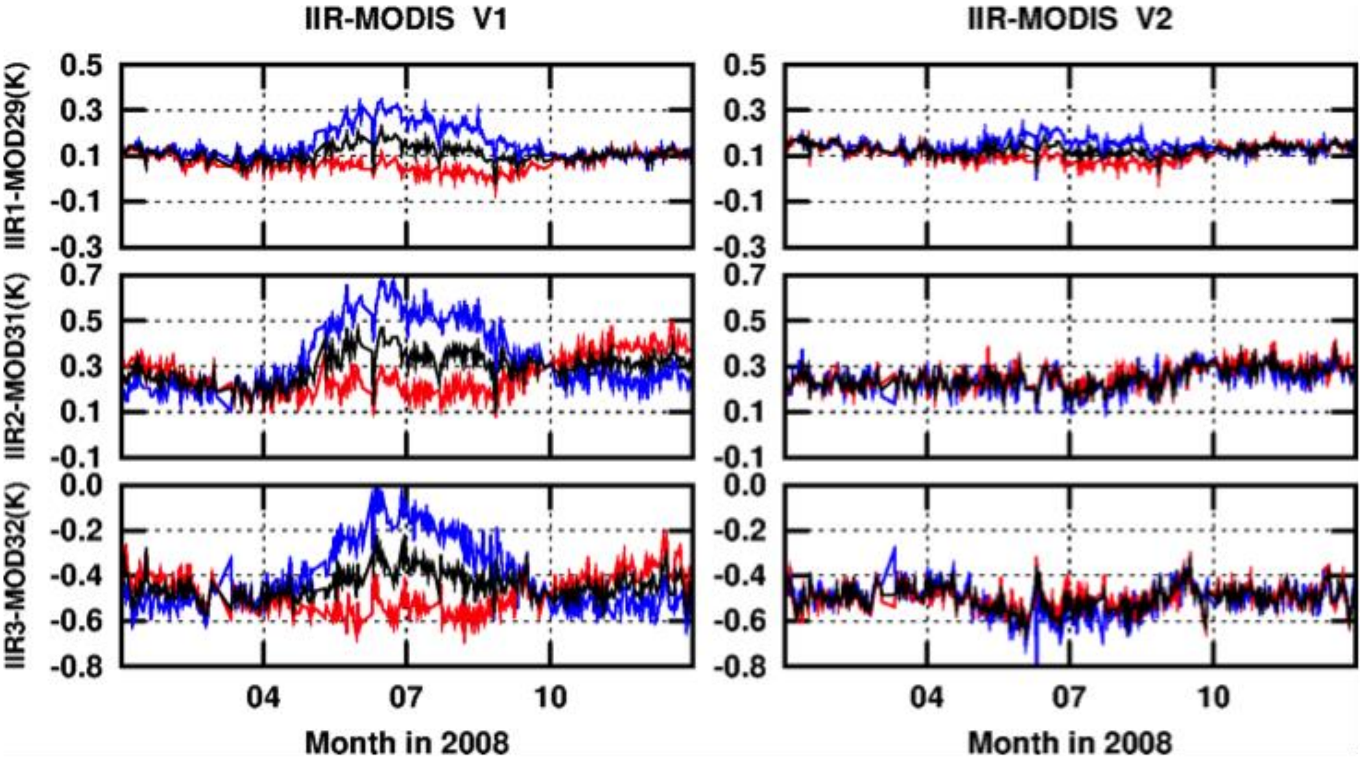

Figure 3: Daily averaged brightness temperature differences between each IIR channel and a radiatively similar MODIS-Aqua band during 2008 (blue: night only; red: day only, black: day and night). Analysis applied to collocated oceanic pixels in the 30°-60°N latitude band and in the 280-290 K brightness temperature range. Top, middle, and bottom panels are for the three paired IIR/MODIS Collection 5 channels. Left and right are for Version 1 and Version 2, respectively.

Data Quality Statement for the release of the CALIPSO IIR Level 1B Product Version 1.13

A minor version bump (+0.01) has been applied to all CALIPSO data products due to a required upgrade to the operating system on the CALIPSO production cluster. All algorithms were re-compiled to process in this new environment with no change to the underlying science algorithms or inputs.

Data Quality Statement for the release of the CALIPSO IIR Level 1B Product Version 1.12

Version 1.12 represents a transition of the Lidar, IIR, and WFC processing and browse code to a new cluster computing system. No algorithm changes were introduced, and very minor changes were observed between V 1.11 and V 1.12 as a result of the compiler and computer architecture differences.

Data Quality Statement for the release of the CALIPSO IIR Level 1B Product Version 1.11

Minor changes were applied to the algorithm, with no impact regarding the calibrated radiances.

Data Quality Statement for the release of the CALIPSO IIR Level 1B Product Version 1.10

Initial version of the data product. In-flight performances were assessed by CNES at the beginning of the mission. The in-flight short-term gain stability was found to be better than 0.1 K of equivalent brightness temperature, except during the day-to-night transitions, during which the gain varies by up to 0.45 K. The in-flight noise equivalent differential temperature at 210 K was between 0.2 and 0.3 K, similar to values measured before launch and better than the specified value of 0.5 K.