

CALIPSO IIR Level 1 Calibration Data Description Document

Version 3.00

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Introduction

The Infrared Imaging Radiometer (IIR) Level 1 Calibration data product contains a full orbit of the space view (SV) and blackbody (BB) images and the gains derived in each of the three channels at 8.65, 10.6, and 12.05 μm . The Earth view calibrated radiances reported in the IIR Level 1B science product are obtained after applying additional semi-empirical corrections reported in the IIR Level 1 Calibration Correction data product.

The IIR acquisition is organized around cycles composed of 5 sequences with 1 sequence every 8.184 seconds. A sequence is a collection of 6 images composed of $64 \times 64 = 4096$ pixels: 1 Earth view and 1 calibration view for each of the 3 IIR channels. In each cycle, the calibration views are BB images in the first sequence and SV images in the four following sequences. The maximum number of sequences in one full orbit is 730.

Table 1: IIR acquisition timing for one cycle

1 Cycle, duration: 40.92 s																							
Sequence 1 8.184 s						Sequence 2 8.184 s						Sequence 3 8.184 s						Sequence 4 8.184 s					
BB			Earth			SV			Earth			SV			Earth			SV			Earth		
1	2	3	3	2	1	1	2	3	3	2	1	1	2	3	3	2	1	1	2	3	3	2	1

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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

SV_Cycle_Number

Units: NoUnits

Format: Int_16

Valid Range: 0, 4095

Fill Value: -9999

Description: Space view (SV) image cycle number (1 cycle includes 5 sequences).

SV_Sequence_Number

Units: NoUnits

Format: Int_16

Valid Range: 0, 20479

Fill Value: -9999

Description: Space view (SV) image sequence number.

SV_Image_Time_8.65

SV_Image_Time_12.05

SV_Image_Time_10.6

Units: s

Format: Float_64

Valid Range: 4.203E8, 9.623E8

Fill Value: -9999.0

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

SV_Image_UTC_Time_8.65

SV_Image_UTC_Time_12.05

SV_Image_UTC_Time_10.6

Units: yymmdd.ffffff

Format: Float_64

Valid Range: 60428.0, 230701.0

Fill Value: -9999.0

Description: Space view (SV) image acquisition time in UTC for channels 8.65, 12.05, and 10.6.

SV_View_Image_8.65

SV_View_Image_12.05

SV_View_Image_10.6

Units: count

Format: UInt_16

Valid Range: 500, 2000

Fill Value: 65535

Description: Counts in each of the 64x64 pixels of the space view image for channels 8.65, 12.05, and 10.6.

SV_Blackbody_Temp_8.65

SV_Blackbody_Temp_12.05

SV_Blackbody_Temp_10.6

Units: °C

Format: Float_32

Valid Range: -20.0...50.0

Fill Value: -9999.0

Description: Space view (SV) image blackbody temperature for channels 8.65, 12.05, and 10.6.

SV_Mean_of_All_Image_Pixels_8.65

SV_Mean_of_All_Image_Pixels_12.05

SV_Mean_of_All_Image_Pixels_10.6

Units: count

Format: Float_32

Valid Range: 500.0, 2000.0

Fill Value: -9999.0

Description: Space view (SV) counts: mean of the 64x64 pixels for channels 8.65, 12.05, and 10.6.

SV_Std_Dev_of_All_Image_Pixels_8.65

SV_Std_Dev_of_All_Image_Pixels_12.05

SV_Std_Dev_of_All_Image_Pixels_10.6

Units: count

Format: Float_32

Valid Range: 10.0, 30.0

Fill Value: -9999.0

Description: Space view (SV) counts: standard deviation for the 64x64 pixels for channels 8.65, 12.05, and 10.6.

Earth_Average_First_Cycle_Number

Units: NoUnits

Format: Int_16

Valid Range: 0, 4095

Fill Value: -9999

Description: First cycles used to compute the Earth averages. There are 2 values for 2 averages in each channel.

Earth_Average_Last_Cycle_Number

Units: NoUnits

Format: Int_16

Valid Range: 0, 4095

Fill Value: -9999

Description: Last cycles used to compute the Earth averages. There are 2 values for 2 averages in each channel.

Earth_Average_Image_8.65

Earth_Average_Image_12.05

Earth_Average_Image_10.6

Units: $W/((m^2) \cdot sr \cdot \mu m)$

Format: Float_32

Valid Range: 0.0, 30.0

Fill Value: -9999.0

Description: Mean Earth view calibrated radiance between first and last cycles for channels 8.65, 12.05, and 10.6.

Dead_Pixels

Units: NoUnits

Format: Int_8

Valid Range: 0, 1

Description: Identifies the dead pixels (0: nominal; 1: dead pixel).

Blind_Pixels

Units: NoUnits

Format: Int_8

Valid Range: 0, 1

Description: Identifies the blind pixels (0: nominal; 1: blind pixel).

BB_Cycle_Number

Units: NoUnits

Format: Int_16

Valid Range: 0, 4095

Fill Value: -9999

Description: Blackbody (BB) image cycle number (1 cycle includes 5 sequences).

BB_Sequence_Number

Units: NoUnits

Format: Int_16

Valid Range: 0, 20475

Fill Value: -9999

Description: Blackbody (BB) image sequence number.

BB_Image_Time_8.65

BB_Image_Time_12.05

BB_Image_Time_10.6

Units: s

Format: Float_64

Valid Range: 4.203E8, 9.623E8

Fill Value: -9999.0

Description: Blackbody (BB) image acquisition time in International Atomic Time (TAI) in elapsed seconds from January 1, 1993 for channels 8.65, 12.05, and 10.6.

BB_Image_UTC_Time_8.65

BB_Image_UTC_Time_12.05

BB_Image_UTC_Time_10.6

Units: yymmdd.ffffff

Format: Float_64

Valid Range: 60428.0, 230701.0

Fill Value: -9999.0

Description: Blackbody (BB) image acquisition time in UTC for channels 8.65, 12.05, and 10.6.

Blackbody_Image_8.65

Blackbody_Image_12.05

Blackbody_Image_10.6

Units: count

Format: UInt_16

Valid Range: 1000, 3000

Fill Value: 65535

Description: Counts in each of the 64 x 64 pixels of the blackbody image for channels 8.65, 12.05, and 10.6.

BB_Blackbody_Temp_8.65

BB_Blackbody_Temp_12.05

BB_Blackbody_Temp_10.6

Units: °C

Format: Float_32

Valid Range: -20.0, 50.0

Fill Value: -9999.0

Description: Blackbody (BB) image blackbody temperature for channels 8.65, 12.05, and 10.6.

BB_Mean_of_All_Image_Pixels_8.65

BB_Mean_of_All_Image_Pixels_12.05

BB_Mean_of_All_Image_Pixels_10.6

Units: count

Format: Float_32

Valid Range: 1000.0, 3000.0

Fill Value: -9999.0

Description: Blackbody (BB) counts: mean of the 64 x 64 pixels for channels 8.65, 12.05, and 10.6.

BB_Std_Dev_of_All_Image_Pixels_8.65

BB_Std_Dev_of_All_Image_Pixels_12.05

BB_Std_Dev_of_All_Image_Pixels_10.6

Units: count

Format: Float_32

Valid Range: 10.0, 30.0

Fill Value: -9999.0

Description: Blackbody (BB) counts: standard deviation for the 64 x 64 pixels for channels 8.65, 12.05, and 10.6.

Gain_Image_8.65

Gain_Image_12.05

Gain_Image_10.6

Units: count·(m²)·sr·μm/W

Format: Float_32

Valid Range: 100.0, 160.0

Fill Value: -9999.0

Description: Gain in each of the 64 x 64 pixels as derived from the space and blackbody views for channels 8.65, 12.05, and 10.6.

Mean_of_All_Gain_Image_Pixels_8.65

Mean_of_All_Gain_Image_Pixels_12.05

Mean_of_All_Gain_Image_Pixels_10.6

Units: count·(m²)·sr·μm/W

Format: Float_32

Valid Range: 100.0, 160.0

Fill Value: -9999.0

Description: Gain derived from the space and blackbody views: mean of the 64 x 64 pixels for channels 8.65, 12.05, and 10.6.

Std_Dev_All_Gain_Image_Pixels_8.65

Std_Dev_of_All_Gain_Image_Pixels_12.05

Std_Dev_of_All_Gain_Image_Pixels_10.6

Units: $\text{count} \cdot (\text{m}^2) \cdot \text{sr} \cdot \mu\text{m}/\text{W}$

Format: Float_32

Valid Range: 0.5, 2.0

Fill Value: -9999.0

Description: Gain derived from the space and blackbody views: standard deviation for the 64 x 64 pixels for channels 8.65, 12.05, and 10.6.

Metadata Parameter Descriptions

Product_ID

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

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 fffffffZ

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 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 fffffff is the fractional second. Date and time are separated by the character 'T'. The 'Z' indicates that time is given in UTC.

Number_of_Blackbody_Records_8.65

Number_of_Blackbody_Records_12.05

Number_of_Blackbody_Records_10.6

Number of blackbody records for each of the three channels.

Number_of_BB_Images_Interpolated_Missing_8.65

Number_of_BB_Images_Interpolated_Missing_12.05

Number_of_BB_Images_Interpolated_Missing_10.6

Number of missing interpolated blackbody images for each of the three channels.

Number_of_SpaceLook_Records_8.65

Number_of_SpaceLook_Records_12.05

Number_of_SpaceLook_Records_10.6

Number of space view records for each of the three channels.

Number_of_CS_Images_Interpolated_Missing_8.65

Number_of_CS_Images_Interpolated_Missing_10.6

Number_of_CS_Images_Interpolated_Missing_12.05

Number of missing interpolated space view images for each of the three channels.

Initial_Sequence_Number

This parameter gives the smallest sequence number at granule start.

Final_Sequence_Number

This parameter gives the largest sequence number at granule end.

Percentage_of_Missing_Cycles

Percentage_of_Missing-Sequences

Percentage_of_Missing_Single_Images

Percentage of missing cycles, sequences, and images.

Number_of_Equalization_Mode

Number of equalization modes. This parameter was always 0 during the mission.

Blackbody_Temperature_Alert

Identifies the presence of abnormal blackbody temperatures in the granule (0: no; 1: yes).

Cold_Space_Image_Alert

Identifies the presence of abnormal space view images in the granule (0: no; 1: yes).

Blind_Pixel_Alert

Identifies the presence of new blind pixels in the granule (0: no; 1: yes).

Dead_Pixel_Alert

Identifies the presence of new dead pixels in the granule (0: no; 1: yes).

Moon_Detect

Number of pixels with moon detected in the space view images. This parameter is set to -9 when the moon is not detected.

Scale_Factor_for_Radiance

This parameter gives the scale factor used to report the calibrated radiances. This factor is always 1000.0 for this release.

Radiance_Offset

This parameter gives the offset used to report the calibrated radiances. This factor is always 0. for this release.

IIR_LO_Filename_Processed

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

Number_Single_Packets_Read

This parameter gives the number of earth view or calibration images read.

Number_Sequences_Read

This parameter gives the number of sequences read.

Number_Cycles_Read

This parameter gives the number of cycles read.

File_Beginning_Time

Time at the beginning of the file in International Atomic Time (TAI) in elapsed seconds from January 1, 1993.

File_End_Time

Time at the end of the file in International Atomic Time (TAI) in elapsed seconds from January 1, 1993.

Data Release Information

Table 2: Date, version, and production strategy for this first public release of the CALIPSO IIR level 1 Calibration data product

IIR Level 1 Calibration: Full Orbit			
Release Date	Version	Data Date Range	Production Strategy
September 2025	3.00	June 13, 2006 to June 30, 2023	Standard