

## Instrument Earth Scans (IES)

The IES data product contains one hour of data from a single CERES scanner. The data records are ordered in time with a separate index that sorts the records by an along-track angle relating each footprint position to the spacecraft's suborbital point at the start of the hour. The spatial ordering of records using this index will ease the comparison of CERES data with cloud imager data in Subsystem 4. The footprint record is the basic data structure for this data product. This record contains the following kinds of information:

- 1) Time of Observation
- 2) Geolocation data (at both the Top-of-Atmosphere (TOA) and the Earth's surface)
- 3) Filtered radiances (at satellite altitude), with associated quality measures
- 4) Spacecraft orbital data
- 5) Footprint viewing geometric data

The IES data product contain only Earth-viewing measurements. For the Tropical Rainfall Measuring Mission (TRMM) mission, there are approximately 225 Earth-viewing footprints (records) that are stored on an IES from each 3.3-second half-scan. The IES product size is derived by using the number of 3.3-second half-scans per hour (approximately 1091) times the number of Earth-viewing measurements per half-scan (approximately 225 for TRMM and 195 for Terra). This yields approximately 245475 and 212745 measurements per TRMM and Terra IES data products, respectively. The product size used within this catalog is determined using the TRMM numbers. The summary of HDF structures is shown in [Table 1](#). The metadata are listed in [Appendix B](#), [Table 2](#), and [Table 3](#). The complete listing of science parameters for this data product can be found in [Table 4](#) and [Table 5](#).

**Level:** 1B  
**Frequency:** 1/Hour  
**Configuration Code:** 009001 and greater

**Portion of Globe Covered**  
**File:** Satellite Swath  
**Record:** 1 CERES Footprint

**Time Interval Covered**  
**File:** 1 Hour  
**Record:** 1/100-Second

**Portion of Atmosphere Covered**  
**File:** Satellite Altitude



## Instrument Earth Scans (IES) Definition

Table 1 summarizes the contents and estimated product size of each data structure type contained within an IES file. Each IES product contains three metadata structures and three Vdata structures.

Table 1. IES HDF Structure Summary

Name	Description Table	Records	Number of Fields	Nominal Size (Bytes)
CERES Baseline Header Metadata	<a href="#">Table B-1</a>	1	36	~25907
CERES_metadata Vdata	<a href="#">Table B-2</a>	1	14	~1024
IES Product-specific Metadata	<a href="#">Table 2</a>	1	11	~66
IES Header Vdata	<a href="#">Table 3</a>	1	22	132
Along Track Sort Index	<a href="#">Table 4</a>	n: 1..245,475	2	1,963,800
IES Data Record	<a href="#">Table 5</a>	n: 1..245,475	30	33,384,600
<b>Total Size (Bytes):</b>				<b>35,375,529</b>
<b>Total Size (MBytes, including ~0.2% HDF overhead; 1MByte = 1024<sup>2</sup>Bytes):</b>				<b>33.8</b>

## IES Metadata

The IES product includes three metadata structures. These include the CERES Baseline Header Metadata and the CERES\_metadata Vdata Metadata, which are listed in [Appendix B](#). The IES-specific metadata parameters are listed in [Table 2](#). An IES Header Vdata is also included as part of the IES metadata and the parameters are listed in [Table 3](#).

Table 2. IES Product-Specific Metadata

Item	Parameter Name	Units	Range	Data Type
1	ScanMode	N/A	XtrkOnly, RapsOnly, FapsOnly, Raps/Faps, Xtrk/Raps, Xtrk/Faps, Xtrk/Raps/Faps	s(14)
2	Second Time Constant Mode	N/A	Off, On	s(3)
3	Ephemeris Data Used	N/A	Real, Pred, Sim	s(4)
4	Attitude Data Used	N/A	Real, Sim	s(4)
5	Percent Total Channel Bad	N/A	0.0 .. 100.0	F11.6
6 <sup>1</sup>	Percent Window Channel Bad (PFM, FM1 thru FM5)	N/A	0.0 .. 100.0	F11.6
6 <sup>1</sup>	Percent Longwave Channel Bad (FM6 only)	N/A	0.0 .. 100.0	F11.6
7	Percent Short Wave Channel Bad	N/A	0.0 .. 100.0	F11.6
8	Percent FAPS	N/A	0.0 .. 100.0	F11.6
9	Percent RAPS	N/A	0.0 .. 100.0	F11.6
10	Percent Transitional	N/A	0.0 .. 100.0	F11.6
11	Percent Crosstrack	N/A	0.0 .. 100.0	F11.6



Table 2. IES Product-Specific Metadata

Item	Parameter Name	Units	Range	Data Type
12	TOA_Model_Used	N/A	CERES-TOA or WGS 84	s(9)
13	Number Input Files	N/A	1 .. n	uint32

Note: 1 – Window Percent bad was replaced with Longwave Percent bad for J01-FM6. For the FM6 instrument, the Window channel was replaced with a Longwave channel. All other instruments (PFM, FM1 – FM5) have the Window channel.

## IES Vdata

The IES product contains three Vdata structures: the IES Header Vdata (Table 3), the Along-track Sort Index Vdata (Table 4), and the IES Data Record (Table 5). These data structures are listed below, where each list contains the field number, the field or parameter name, the data type, the units, and the range. The fields are listed in the order they are written to an IES. Data types are referenced by their HDF classification (e.g. Char8, Float32, Float64, Int8, UInt8, Int16, UInt16, Int32, UInt32, Int64, UInt64).

Table 3. IES Header Vdata

Field No.	Field Name	Data Type	Units	Range
1	Whole Julian Day	float64	day	2449353 .. 2458500
2	Fractional Julian Day	float64	day	-0.01 .. 1.01
3	Hour Number	uint32	N/A	0 .. 23
4	Colatitude of Subsatellite Point at Surface at Hour Start	float32	deg	0.0 .. 180.0
5	Longitude of Subsatellite Point at Surface at Hour Start	float32	deg	0.0 .. 360.0
6	Colatitude of Subsatellite Point at Surface at Hour End	float32	deg	0.0 .. 180.0
7	Longitude of Subsatellite Point at Surface at Hour End	float32	deg	0.0 .. 360.0
8	Along-track Angle of Satellite at Hour End	float32	deg	0.0 .. 360.0
9	Number of Footprints	uint32	N/A	0 .. 245475
10	Earth-Sun Distance at Hour Start	float32	AU	0.98 .. 1.02
11	Satellite Position X	float64	km	-8000.0 .. 8000.0
12	Satellite Position Y	float64	km	-8000.0 .. 8000.0
13	Satellite Position Z	float64	km	-8000.0 .. 8000.0
14	Satellite Velocity X	float64	km sec <sup>-1</sup>	-10.0 .. 10.0
15	Satellite Velocity Y	float64	km sec <sup>-1</sup>	-10.0 .. 10.0
16	Satellite Velocity Z	float64	km sec <sup>-1</sup>	-10.0 .. 10.0
17	N Vector X	float64	N/A	0.0 .. 1.0
18	N Vector Y	float64	N/A	0.0 .. 1.0



Table 3. IES Header Vdata

Field No.	Field Name	Data Type	Units	Range
19	N Vector Z	float64	N/A	0. 0.. 1.0
20	Satellite Type	uint32	N/A	0 = TRMM, 1 = Terra, 4 = Aqua, 6 = SNPP, 7 = J01
21	Instrument Type	uint32	N/A	0 = Fore (FM1, FM3) 1 = Aft (FM2, FM4) 2 = Single (PFM, FM5, FM6)
22	Instrument Scan Mode	uint32	N/A	0 = Crosstrack, 1 = RAPS, 2 = FAPS, 3 =Transitional
<b>Number of bytes per Vdata record:</b>				<b>132</b>

Table 4. Along-track Sort Index

Field No.	Field Name	Data Type	Units	Range
1	Footprint_index	uint32	N/A	1 .. n
2	Along_Track_Angle	float32	N/A	-20.0 .. 360.0
<b>Number of bytes per Vdata record:</b>				<b>8</b>

Table 5. IES Data Record

Field No.	Field Name / Parameter	Data Type	Units	Range
1	Colatitude of CERES FOV at TOA	float32	deg	0.0 .. 180.0
2	Longitude of CERES FOV at TOA	float32	deg	0.0 .. 360.0
3	Colatitude of CERES FOV at Surface	float32	deg	0.0 .. 180.0
4	Longitude of CERES FOV at Surface	float32	deg	0.0 .. 360.0
5	CERES Viewing Zenith at Surface	float32	deg	0.0 .. 90.0
6	CERES Solar Zenith at Surface	float32	deg	0.0 .. 180.0
7	CERES Relative Azimuth at Surface	float32	deg	0.0 .. 360.0
8	CERES Viewing Azimuth at Surface wrt North	float32	deg	0.0 .. 360.0
9	Cross-track Angle of CERES FOV at Surface	float32	deg	-90.0 .. 90.0
10	Along-track Angle of CERES FOV at Surface	float32	deg	-20.0 .. 360.0



Table 5. IES Data Record

Field No.	Field Name / Parameter	Data Type	Units	Range
11	Cone Angle of CERES FOV at Satellite	float32	deg	0.0 .. 90.0
12	Clock Angle of CERES FOV at Satellite wrt Inertial Velocity	float32	deg	0.0 .. 360.0
13	Rate of Change of Cone Angle	float32	deg sec <sup>-1</sup>	-100.0 .. 100.0
14	Rate of Change of Clock Angle	float32	deg sec <sup>-1</sup>	-10.0 .. 10.0
15	X Component of Satellite Inertial Velocity	float64	km sec <sup>-1</sup>	-10.0 .. 10.0
16	Y Component of Satellite Inertial Velocity	float64	km sec <sup>-1</sup>	-10.0 .. 10.0
17	Z Component of Satellite Inertial Velocity	float64	km sec <sup>-1</sup>	-10.0 .. 10.0
18	Radius of Satellite from Center of Earth at Observation	float64	km	6000.0 .. 8000.0
19	CERES TOT Filtered Radiance, Upwards	float32	W m <sup>-2</sup> sr <sup>-1</sup>	0.0 .. 700.0
20	CERES SW Filtered Radiance, Upwards	float32	W m <sup>-2</sup> sr <sup>-1</sup>	-10.0 .. 510.0
21 <sup>1</sup>	CERES WN Filtered Radiance, Upwards (FM1 - FM5)	float32	W m <sup>-2</sup> sr <sup>-1</sup> μm <sup>-1</sup>	0.0 .. 50.0
21 <sup>1</sup>	CERES LW Filtered Radiance, Upwards (FM6)	float32	W m <sup>-2</sup> sr <sup>-1</sup>	0.0 .. 180.0
22	Colatitude of Subsatellite Point at Surface at Observation	float32	deg	0.0 .. 180.0
23	Longitude of Subsatellite Point at Surface at Observation	float32	deg	0.0 .. 360.0
24	Colatitude of Subsolar Point at Surface at Observation	float32	deg	0.0 .. 180.0
25	Longitude of Subsolar Point at Surface at Observation	float32	deg	0.0 .. 360.0
26	Scan Sample Number	uint16	N/A	1 .. 660
27	Packet Number	uint16	N/A	0 .. 32767
28	Time of Observation	float64	day	2449353.0 .. 2458500.0
29	Radiance and mode flags	uint32	N/A	0 .. (2**31)-1
30	Absolute Packet Number	uint32	N/A	0 .. 65535
<b>Number of bytes per Vdata record:</b>				<b>136</b>

1. For the FM-6 instrument, the “LW” channel substitutes for the “WN” channel



## IES Revision Record

The product Revision Record contains information pertaining to approved section changes. The table lists the date the Software Configuration Change Request (SCCR) was approved, the Release and Version Number, the SCCR number, a short description of the revision, and the revised sections. The authors are listed on the document cover.

IES Revision Record

SCCR Approval Date	Release/Version Number	SCCR Number	Description of Revision	Section(s) Affected
N/A	R3V1	N/A	<ul style="list-style-type: none"> <li>• Updated format to comply with standards.</li> <li>• The EOSDIS Product Code line was removed from the document. (6/17/2008)</li> <li>• Some links were not working. They have now been modified. (12/09/2010)</li> <li>• The ASDC footer was added to the bottom of the document. (06/06/2013)</li> <li>• Eliminated section numbers from the Data Products Catalog. Specifically, in this document, section number 3.2 was removed. (12/17/2013)</li> <li>• Updated some links to refer to the .pdf file instead of the .doc file. (06/20/2014)</li> </ul>	All Sec. 3.2  All  All  All  All
N/A	R6V1	N/A	<ul style="list-style-type: none"> <li>• Updated Satellite_Type to contain only instruments being used. Added J01 for upcoming FM6 launch in 2016.</li> <li>• Updated Instrument_Type to be the correct values being used in production. Added FM6, which will launch in 2016.</li> </ul>	Table 3  Table 3
N/A	R7V1	N/A	<ul style="list-style-type: none"> <li>• Updated tables to include Longwave values for FM6 which replace the Window values used by all other instruments. Added a note at the bottom of the table to explain duplicate parameter numbers in the table.</li> </ul>	Table 2, Table 5
N/A	R7V2	N/A	<ul style="list-style-type: none"> <li>• Updated to fix the issue with WN-channel radiance missing the per micron in the units.</li> </ul>	Table 5

