Bidirectional Scans (BDS)

The BiDirectional Scans (BDS) product contains 24 hours of instantaneous Level‑1b CERES data for a single scanner instrument. The BDS contains instantaneous radiance measurements recorded every 0.01-second for views of space, internal calibration, solar calibration and Earth. It contains all elevation scan modes which include the normal Earth scan and the short Earth scan modes and both the fixed and rotating azimuth plane scan modes.

The BDS product includes:

* Filtered broadband radiances for the total, shortwave, and window (FM-6 longwave) channels for each 0.01 second measurement
* Geolocation and viewing geometry for every Earth-viewing measurement
* Instrument status, engineering temperatures and voltages for each 6.6 second scan
* Sun geometry, satellite position and velocity for each scan
* All raw engineering and status data from the instrument

A more detailed listing of the data parameters for this product can be found in the [BDS Collection Guide](http://ceres.larc.nasa.gov/documents/collect_guide/pdf/BDS_CG_R3V4.pdf): ([Reference 3](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_References.pdf)).

**Level:** 1B

**Frequency:** 1/Day

**Portion of Atmosphere Covered:** Satellite Altitude

Time Interval Covered: Portion of Globe Covered:

**File:** 24 Hours **File:** Satellite Altitude

**Record:** Single 6.6-Second Scans **Record:** N/A

**Product Version:**

**TRMM:** Edition1-CV ++ see NOTE

**Terra:** Edition1, Edition1-CV, Edition2, Edition3, Edition4 ++ see NOTE

**Aqua:** Edition1, Edition1-CV, Edition2, Edition3, Edition4 ++ see NOTE

**NPP:** Edition1-CV, Edition1

**J01:** Edition1-CV

**NOTE:** The Slow Mode and Drift Corrected Counts SDSs are only available on Edition1 BDS products with a configuration code of 027025 or greater and Edition2 BDS products with a configuration code of 028028 or greater. Solar and Lunar Azimuth and Elevation Angle SDSs are only available on Edition1-CV BDS products and Edition2 BDS products with a configuration code of 031033 or higher, Edition3 and Edition4. In addition, the Satellite-Celestial Vdata parameters for Solar and Lunar Beta and Eta Angles along with Earth-Moon Distance, Moon Colatitude at start of record and Moon Longitude at start of record are only available for Edition1-CV BDS products, Edition2 BDS products with a configuration code of 031033 or higher, Edition3 and Edition4 BDS products.

Bidirection Scans (BDS) Definition

Table 1 summarizes the contents and estimated product size of each data structure type contained within an BDS file. Each BDS product contains three metadata structures, 47 SDS structures, and eight VData structures.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 1. BDS HDF Structure Summary | | | | |
| Name | Description Table | Records | Number of Fields | Nominal Size (Bytes) |
| CERES Baseline Header Metadata | [Table B-1](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_AppB.pdf) | 1 | 36 | ~25907 |
| CERES\_metadata Vdata | [Table B-2](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_AppB.pdf) | 1 | 14 | ~1024 |
| BDS Product-specific Metadata | Table 2 | 1 | 11 | ~66 |
| BDS SDS Summary | Table 3 | 1 .. 13091 | 47 | 1,249,567,630 |
| BDS Vdata Summary | Table 4 | 1 .. 13091 | 185 | 32,230,162 |
| **Total Size** (Bytes): | | | | **1,281,824,789** |
| **Total Size** (MBytes, including ~0.2% HDF overhead; 1MByte = 10242 Bytes): | | | | **1,224.89** |

BDS Metadata

The BDS product includes three data structures. These include the CERES Baseline Header Metadata and the CERES\_metadata Vdata parameters, which are listed in [Appendix B](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_AppB.pdf). The BDS-specific metadata parameters are listed in Table 2.

| Table 2. BDS 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**1** | Percent Window Channel Bad  (PFM, FM1 through FM5) | N/A | 0.0 .. 100.0 | F11.6 | |
| 6**1** | 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 | |
| 12 | TOA\_Model\_Used | N/A | CERES-TOA or WGS 84 | s(9) | |
| 13 | Number Input Files | N/A | 1 .. n | uint32 | |

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.

BDS Scientific Data Sets

Every Scientific Data Set (SDS) in the BDS file represents a time ordered collection of data where each row in the SDS corresponds to a packet of data, and each column corresponds to a single sample within a packet. Most of the SDSs have 660 samples per packet of a single parameter arranged as shown in Figure 1.

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Value

Sample 2

Sample 3

Sample 4

Sample 5

Sample 1

Value

Value

Value

Value

Value

Value

Sample 660

Packet 1

Packet 2

Packet 3

Packet 4

Packet 5

Packet n

Figure 1. BDS SDS Schematic

Table 3 summarizes the alphabetical contents of each SDS structure contained within the BDS file (listed in alphabetical order by their SDS structure name). All SDS parameters have an HDF Rank = 2 and the maximum number of SDS elements corresponds to the number of rows by the number of columns. Data types are referenced by their HDF classification (e.g. Char8, Float32, Float64, Int8, UInt8, Int16, UInt16, Int32, UInt32, Int64, UInt64).

| Table 3. BDS SDS Summary | | | | | |
| --- | --- | --- | --- | --- | --- |
| SDS Name | Maximum SDS Elements | Data Type | Range | Units | Maximum Size (Bytes) |
| Azimuth Position Count | 13091x660 | uint16 | 0 .. 4095 | count | 17,280,120 |
| CERES Relative Azimuth at Surface | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| CERES Relative Azimuth at TOA - Geocentric | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| CERES Solar Zenith at Surface | 13091x660 | float32 | 0.0 .. 180.0 | deg | 34,560,240 |
| CERES Solar Zenith at TOA - Geocentric | 13091x660 | float32 | 0.0 .. 180.0 | deg | 34,560,240 |
| CERES SW Filtered Radiance Upwards | 13091x660 | float32 | -10.0 .. 510.0 | W m-2sr-1 | 34,560,240 |
| CERES TOT Filtered Radiance Upwards | 13091x660 | float32 | 0.0 .. 700.0 | W m-2sr-1 | 34,560,240 |
| CERES Viewing Zenith at Surface | 13091x660 | float32 | 0.0 .. 90.0 | deg | 34,560,240 |
| CERES Viewing Zenith at TOA - Geocentric | 13091x660 | float32 | 0.0 .. 90.0 | deg | 34,560,240 |
| CERES WN Filtered Radiance Upwards4 | 13091x660 | float32 | 0.0 .. 15.0 | W m-2sr-1m-1 | 34,560,240 |
| CERES LW Filtered Radiance Upwards4 | 13091x660 | float32 | 0.0 .. 180.0 | W m-2sr-1 | 34,560,240 |
| Clock Angle Rates | 13091x660 | float32 | -10.0 .. 10.0 | deg sec-1 | 34,560,240 |
| Clock Angles | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| Colatitude of CERES FOV at Surface | 13091x660 | float32 | 0.0 .. 180.0 | deg | 34,560,240 |
| Colatitude of CERES FOV at TOA | 13091x660 | float32 | 0.0 .. 180.0 | deg | 34,560,240 |
| Cone Angle Rates | 13091x660 | float32 | -100.0 .. 100.0 | deg sec-1 | 34,560,240 |
| Cone Angles | 13091x660 | float32 | 0.0 .. 90.0 | deg | 34,560,240 |
| Converted Azimuth Angles | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| Converted Elevation Angles | 13091x660 | float32 | 0.0 .. 260.0 | deg | 34,560,240 |
| Count Conversion SW Sample Offsets | 4x660 | float32 | N/A | count | 10,560 |
| Count Conversion TOT Sample Offsets | 4x660 | float32 | N/A | count | 10,560 |
| Count Conversion WN/LW Sample Offsets4 | 4x660 | float32 | N/A | count | 10,560 |
| Drift Corrected SW Counts | 13091x660 | float32 | 0.0 .. 4095.0 | count | 34,560,240 |
| Drift Corrected TOT Counts | 13091x660 | float32 | 0.0 .. 4095.0 | count | 34,560,240 |
| Drift Corrected WN/LW Counts4 | 13091x660 | float32 | 0.0 .. 4095.0 | count | 34,560,240 |
| Elevation Position Count | 13091x660 | uint16 | 0 .. 4095 | count | 17,280,120 |
| Julian Date and Time | 13091x2 | float64 | 2449353.0 .. 2458500.0 | day | 209,456 |
| Longitude of CERES FOV at Surface | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| Longitude of CERES FOV at TOA | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| Lunar Azimuth Angles2 | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| Lunar Elevation Angles2 | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| Primary Scan Level QA Flags | 13091x660 | uint32 | [Reference 3](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_References.pdf) | N/A | 34,560,240 |
| Radiance and Mode Flags | 13091x660 | uint32 | [Table 1](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_IES_R3V1.pdf) | N/A | 34,560,240 |
| Raw Instrument Status Data | 13091x185 | uint16 | [Reference 3](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_References.pdf) | N/A | 4,843,670 |
| Sample Aligned Analog Data | 13091x660 | uint16 | 0 ..4095 | count | 17,280,120 |
| Secondary Sample Level QA Flags | 13091x660 | uint32 | [Reference 3](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_References.pdf) | N/A | 34,560,240 |
| Secondary Scan Level QA Flags | 13091x660 | uint32 | [Reference 3](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_References.pdf) | N/A | 34,560,240 |
| Shortwave Detector Output | 13091x660 | uint16 | 0 .. 4095 | count | 17,280,120 |
| Solar Azimuth Angles2 | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| Solar Elevation Angles2 | 13091x660 | float32 | 0.0 .. 360.0 | deg | 34,560,240 |
| SW Slow Mode and Drift Corrected Counts1 | 13091x660 | float32 | 0.0 .. 4095.0 | count | 34,560,240 |
| SW Spaceclamp Values | 13091x2 | float32 | N/A | count | 104,728 |
| TOT Slow Mode and Drift Corrected Counts1 | 13091x660 | float32 | 0.0 .. 4095.0 | count | 34,560,240 |
| TOT Spaceclamp Values | 13091x2 | float32 | N/A | count | 104,728 |
| Total Detector Output | 13091x660 | uint16 | 0 .. 4095 | count | 17,280,120 |
| Window/Longwave Detector Output4 | 13091x660 | uint16 | 0 .. 4095 | count | 17,280,120 |
| WN/LW Slow Mode and Drift Corrected Counts1,4 | 13091x660 | float32 | 0.0 .. 4095.0 | count | 34,560,240 |
| WN/LW Spaceclamp Values4 | 13091x2 | float32 | N/A | count | 104,728 |
| SDS Total Size (Bytes) |  |  |  |  | 1,249,567,630 |
| SDS Total Size (MBytes, plus a small HDF overhead percentage) |  |  |  |  | 1194.06 |

1. These SDSs are available on Aqua and Terra Edition1 BDSs beginning with CC-Code 027025 and Aqua and Terra Edition2 BDSs beginning with CC-Code 028028. These SDSs are also available on TRMM, Terra and Aqua Edition1-CV and Terra and Aqua Edition2 BDSs beginning with CC-Code 031033 and TRMM, Aqua and Terra Edition3 BDSs.

2. These SDSs are available on TRMM, Aqua,Terra, NPP, and J01 Edition1-CV BDSs and Terra and Aqua Edition2 BDSs beginning with CC-Code 031033 and TRMM, Aqua and Terra Edition3 BDSs.

3. This table refers to Table 1 in the Instrument Earth Scans (IES) Data Products Catalog.

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

BDS Vdata

The BDS contains eight Vdatas which are collections of records containing one or more fields. Each of the eight Vdatas contains *n* (1..10391) records of packet level data, and there is a one-to-one correspondence of the Vdatas record numbers to the BDS SDSs row numbers. Table 4 summarizes each of the alphbetical BDS Vdatas. [Reference 3](http://ceres.larc.nasa.gov/documents/DPC/DPC_current/pdfs/DPC_References.pdf) provides detailed descriptions of the parameters.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 4. BDS Vdata Summary | | | | |
| Vdata Name | Number of Fields | Maximum Records | Number Bytes per Record | Maximum Size (Bytes) |
| Converted Instrument Status Data | 25 | 13091 | 88 | 1,152,008 |
| Converted Temperatures | 35 | 13091 | 708 | 9,268,428 |
| Converted Voltages and Torques | 23 | 13091 | 348 | 4,555,668 |
| Count Conversion Constants | 9 | 1 | 120 | 120 |
| Position Counts | 12 | 13091 | 528 | 6,912,048 |
| Satellite-Celestial Data | 18 | 13091 | 160 | 2,094,560 |
| Temperature Counts | 39 | 13091 | 450 | 5,890,950 |
| Voltage and Torque Counts | 24 | 13091 | 180 | 2,356,380 |
| Vdata Total Size (Bytes) | | | | 32,230,162 |
| Vdata Total Size (MBytes, plus a small HDF overhead percentage) | | | | 30.80 |

BDS 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.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| BDS Revision Record | | | | |
| SCCR  Approval  Date | Release/  Version  Number | SCCR  Number | Description of Revision | Section(s)  Affected |
| N/A | R3V1 | N/A | Updated format to comply with standards. | All |
| 1/16/04 | R4V1 | 497 | Updated to add newly added SDSs. Also reordered the tables to match the order on the BDS. | All |
|  |  |  | Updated format to comply with standards. | All |
| 11/18/05 | R4V2 | 599 | Updated to add newly added SDSs containing Solar and Lunar Azimuth and Elevation Angles along with updated Satellite-Celestial Vdata to add Solar and Lunar Beta and Eta Angles, Earth-Moon Distance, Colatitude of Moon at start of record and Longitude of Moon at start of record, per Reqt.# 1-5. | All |
|  |  |  | Updated format to comply with standards. | All |
|  |  |  | The EOSDIS Product Code line was removed from the document. (6/17/2008) | Sec. 2.1 |
|  |  |  | Some links were not working. They have now been modified. (12/09/2010) | All |
| 04/13/12 | R5V1 | 890 | Updated to add NPP Edition1-CV. | Sec. 2.1 |
|  |  |  | The ASDC footer was added to the bottom of the document. (06/04/2013) | All |
|  |  |  | Eliminated section numbers from the Data Products Catalog. Specifically, in this document, section number 2.1 was removed. (12/05/2013) | All |
| 09/11/13 | R6V1 | 979 | Updated to add NPP Edition1 and Terra and Aqua Edition4. | Sec. 2.1 |
|  |  |  | Updated some links. | All |
|  |  |  | Modified a few more links as the document linked names had changed. (06/20/2014) | All |
| 09/11/18 | R7V1 | 1376 | Updated to include J01 Edition1-CV longwave channel parameters. | All |
|  |  |  | Tables were modified. (01/10/2019) | Tables 2, 3, & 4 |