Clouds and the Earth's Radiant Energy System

(CERES)

Data Management System

Product Name (Acyonym) Collection Document

**Release 1**

**Version 1**

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September 2011

Document Revision Record

The Document Revision Record contains information pertaining to approved document 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 document authors are listed on the cover. The Head of the CERES Data Management Team approves or disapproves the requested changes based on recommendations of the Configuration Control Board.

| Document Revision Record |
| --- |
| SCCRApprovalDate | Release/VersionNumber | SCCRNumber | Description of Revision | Section(s)Affected |
| xx/xx/11 | R1V1 | xxx | Initial draft document. | All |
|  |  |  |  |  |

Preface

The Clouds and the Earth’s Radiant Energy System (CERES) Data Management System supports the data processing needs of the CERES Science Team research to increase understanding of the Earth’s climate and radiant environment. The CERES Data Management Team works with the CERES Science Team to develop the software necessary to implement the science algorithms. This software, being developed to operate at the Langley Atmospheric Sciences Data Center (ASDC), produces an extensive set of science data products.

The Data Management System consists of 12 subsystems; each subsystem represents one or more stand-alone executable programs. Each subsystem executes when all of its required input data sets are available and produces one or more archival science products.

This Collection Guide is intended to give an overview of the science product along with definitions of each of the parameters included within the product. The document has been reviewed by the CERES Working Group teams responsible for producing the product and by the Working Group Teams who use the product.

Acknowledgment is given to *person1 and person2 (whoever helped with the logistics)* of Science Systems and Applications, Inc. (SSAI) for their support in the preparation of this document.

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Clouds and the Earth's Radiant Energy System (CERES)
*Product Acronym (XYZ)* Collection Document

Summary

The Clouds and the Earth’s Radiant Energy System (CERES) is a key component of the Earth Observing System (EOS) program. The CERES instrument provides radiometric measurements of the Earth's atmosphere from three broadband channels: a shortwave channel (0.3 - 5 m), a total channel (0.3 - 200 m), and an infrared window channel (8 - 12 m). The CERES instruments are improved models of the Earth Radiation Budget Experiment (ERBE) scanner instruments, which operated from 1984 through 1990 on National Aeronautics and Space Administration’s (NASA) Earth Radiation Budget Satellite (ERBS) and on the National Oceanic and Atmospheric Administration’s (NOAA) operational weather satellites, NOAA-9 and NOAA-10. The strategy of flying instruments on Sun-synchronous, polar orbiting satellites, such as NOAA-9 and NOAA-10, simultaneously with instruments on satellites that have precessing orbits in lower inclinations, such as ERBS, was successfully developed in ERBE to reduce time sampling errors. CERES continues that strategy by flying instruments on the polar orbiting EOS platforms simultaneously with an instrument on the Tropical Rainfall Measuring Mission (TRMM) spacecraft, which has an orbital inclination of 35 degrees. The TRMM satellite carries one CERES instrument while the Terra and Aqua EOS satellites carry two CERES instruments, one operating in a FAPS mode for continuous Earth sampling and the other operating in a RAPS mode for improved angular sampling.

To preserve historical continuity, some parts of the CERES data reduction use algorithms identical with the algorithms used in ERBE. At the same time, many of the algorithms on CERES are new. To reduce the uncertainty in data interpretation and to improve the consistency between the cloud parameters and the radiation fields, CERES includes cloud imager data and other atmospheric parameters. The CERES investigation is designed to monitor the top-of-atmosphere radiation budget as defined by ERBE, to define the physical properties of clouds, to define the surface radiation budget, and to determine the divergence of energy throughout the atmosphere. The CERES DMS produces products which support research to increase understanding of the Earth’s climate and radiant environment.

*[Product Specific Information]*

# Collection Overview

## Collection Identification

The *PSN* filename is

CER\_*PSN*\_Sampling-Strategy\_Production-Strategy\_XXXXXX.YYYYMM[DD][HH] where

CER Investigation designation for CERES,

*PSN* Product ID for the science data product (external distribution),

Sampling-Strategy Platform, instrument, and imager (e.g., TRMM-PFM-VIRS),

Production-Strategy Edition or campaign (e.g., At-launch, ValidationR1, Edition1),

XXXXXX Configuration code for file and software version management,

YYYY 4-digit integer defining data acquisition year,

MM 2-digit integer defining data acquisition month, and

DD 2-digit integer defining the data acquisition day,

HH 2-digit hour integer which defines the data acquisition date *[Modify as needed for daily and monthly products.]*

## Collection Introduction

*[Product Specific Information]*

## Objective/Purpose

The overall science objectives of the CERES investigation are

1. For climate change research, provide a continuation of the ERBE record of radiative fluxes at the top of the atmosphere (TOA) that are analyzed using the same techniques used with existing ERBE data.
2. Double the accuracy of estimates of radiative fluxes at the TOA and the Earth’s surface from existing ERBE data.
3. Provide the first long-term global estimates of the radiative fluxes within the Earth’s atmosphere.
4. Provide cloud property estimates which are consistent with the radiative fluxes from surface to TOA.

The CERES Data Management System (DMS) is a software management and processing system which processes CERES instrument measurements and associated engineering data to produce archival science and other data products. The DMS is executed at the LaRC ASDC, which is also responsible for distributing the data products. A high-level view of the CERES DMS is illustrated by the CERES Top Level Data Flow Diagram shown in .

Circles in the diagram represent algorithm processes called subsystems, which are a logical collection of algorithms that together convert input products into output products. Boxes represent archival products. Two parallel lines represent data stores which are designated as nonarchival or temporary data products. Boxes or data stores with arrows entering a circle are input sources for the subsystem, while boxes or data stores with arrows exiting the circles are output products.

## Summary of Parameters

*[Product Specific Information – could be table of parameters here instead of in Section 4]*

## Discussion

*[Product Specific Information]*

## Related Collections

See the CERES Data Products Catalog (Reference ) for a complete product listing.

Grid TOA

and Surface

Fluxes:

Clouds

9

ERBE-like

Averaging to

Monthly TOA

Fluxes

3

Grid GEO

Narrowband

Radiances,

Clouds

11

GEO:

Geostationary

Narrowband

Radiances

Time
Interpolate,
Compute
Fluxes

7

Grid

Radiative

Fluxes and

Clouds

6

MOA:

Meteorological,

Ozone, and

Aerosol Data

ES-8:

ERBE-like

Instantaneous
TOA Estimates

ERBE-like

Inversion to

Instantaneous

TOA Fluxes

2

Regrid

Humidity

and

Temperature

Fields

12

BDS:

BiDirectional

Scans

SRBAVG:

Monthly

TOA/Surface Averages

SYNI:

Intermediate

Synoptic

Radiative

Fluxes and Clouds

Compute

Monthly and

Regional TOA

and Surface

Averages

10

Determine

Cloud

Properties, TOA

and Surface Fluxes

4

Geolocate

and Calibrate

Earth

Radiances

1

SSF: Single

Scanner Footprint TOA/Surface Fluxes and Clouds

CRS:
Clouds

and Radiative

Swath

VIRS CID:

MODIS CID:

Cloud

Imager Data

SURFMAP:

Surface

Map

INSTR:

Instrument

Production Data Set

EID6:

ERBE-like Regional Data

AVG:

Monthly Regional

Radiative Fluxes

and Clouds

ZAVG:

Monthly Zonal and Global Radiative Fluxes and Clouds

Compute

Regional,

Zonal and

Global

Averages

8

GGEO:

Gridded GEO

Narrowband

Radiances, Clouds

FSW: Monthly

Gridded Radiative Fluxes and

Clouds

IES: Instrument

Earth Scans

CRH:

Clear

Reflectance

History

GAP:

Gridded Analysis Product

OPD:

Ozone

Profile

Data

MWH:

Microwave

Humidity

APD:

Aerosol

Data

SFC: Monthly

Gridded TOA/Surface

Fluxes and Clouds

ES-9:

ERBE-like

Monthly Regional Averages

ES-4:

ERBE-like
Monthly Geographical Averages

Compute

Surface and

Atmospheric

Radiative

Fluxes

5

SYN

Synoptic

Radiative

Fluxes and Clouds

ISCCP-D2like-Day/Nit:

Monthly Gridded Cloud Averages

ISCCP-D2like-GEO:

Monthly Cloud Averages

Modified Date: October 2008

Figure ‑. CERES Top Level Data Flow Diagram

# Investigators

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## Title of Investigation

*Subsystem Name [Subsystem #]*

*e.g.*,. Geolocate and Calibrate Earth Radiances (Subsystem 1.0)

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# Origination

The CERES data originate from CERES instruments on-board either the TRMM, Terra or Aqua EOS Earth-orbiting spacecrafts. lists the CERES instruments and their host satellites.

Table ‑. CERES Instruments

|  |  |
| --- | --- |
| Satellite | CERES Instrument |
| TRMM | PFM |
| Terra | FM1 | FM2 |
| Aqua | FM3 | FM4 |

The CERES instrument contains three scanning thermistor bolometer radiometers that measure the radiation in the near-visible through far-infrared spectral region. The shortwave detector measures Earth-reflected and Earth-emitted solar radiation and the window detector measures Earth-emitted longwave radiation in the water vapor window. The total detector measures total Earth-reflected and Earth-emitted radiation. The detectors are coaligned and mounted on a spindle that rotates about the instrument elevation axis. The resolution of the CERES radiometers is usually referenced to the optical FOV (See *Note TBD*).

The CERES instrument has an operational scanning cycle of 6.6 seconds and various scan elevation profiles. Radiometric measurements are sampled from the detectors every 0.01 seconds in all scanning profiles. The instrument makes Earth-viewing science measurements while the detectors rotate in the vertical (elevation scan) plane, and while the instrument horizontal (azimuth scan) plane is either fixed or rotating. The instrument has built-in calibration sources for performing in-flight calibrations, and can also be calibrated by measuring solar radiances reflected by a solar diffuser plate into the instrument field of view. See the In-flight Measurement Analysis document, DRL 64, provided by the CERES instrument builder TRW (Reference ), and the CERES ATBD for Subsystem 1.0 (Reference ).

# Data Description

## Spatial Characteristics

### Spatial Coverage

The XYZ collection is a global data set whose spatial coverage depends on the satellite orbit as shown in . *[Product Specific Information].*

Table ‑. *XYZ* Spatial Coverage

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Spacecraft | Instrument | MinimumLatitude(deg) | MaximumLatitude(deg) | MinimumLongitude(deg) | MaximumLongitude(deg) | SpacecraftAltitude(km) |
| TRMM | PFM | -45 | 45 | -180 | 180 | 350 |
| Terra | FM1 & FM2 | -90 | 90 | -180 | 180 | 705 |
| Aqua | FM3 & FM4 | -90 | 90 | -180 | 180 | 705 |

### Spatial Coverage Map

*[Product Specific Information – use postage stamp size images that links to full-sized images – recommendation from the ASDC – or delete if image is in ASDC HTML overview]*

### Spatial Resolution

*[Product Specific Information]*

### Projection

*[Applies to gridded data. Delete section from instantaneous products.]*

### Grid Description

*[Applies to gridded data. Delete section from instantaneous products.]*

## Temporal Characteristics

### Temporal Coverage

The XYZ temporal coverage begins after the spacecraft is launched, the scan covers are opened, and the early in-orbit calibration check-out is completed (see ).

Table ‑. *XYZ* Temporal Coverage

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Spacecraft | Instrument | Launch Date | Start Date | End Date |
| TRMM | PFM | 11/27/1997 | 12/27/1997 | 8/31/1998 |
| Terra | FM1 & FM2 | 12/18/1999 | 02/24/2000 | TBD |
| Aqua | FM3 & FM4 | 05/05/2002 | 06/19/2002 | TBD |

a. The CERES instrument on TRMM has operated only occasionally since 9/1/98 due to a power converter anomaly.

*[Product Specific Information]*

### Temporal Resolution

*[Product Specific Information]*

## Data Characteristics

*[Product Specific Information]*

### Parameter/Variable

*[Product Specific Information]* Table of parameters, units, ranges, …- similar to Table in Data Products Catalog. Describe the table and any hyperlinking. The *XYZ* metadata are listed in .

### Variable Description/Definition

*[Product Specific Information - a detailed definition of each parameter. If the parameter is copied from a product produced by a previous subsystem, the producing subsystem will define the parameter. All users must have chance to review and approve the definitions. A parameter will be defined only once and will be pulled into each relevant document - the following parameters are examples from the BDS Guide, in which the parameters are grouped into 3 major divisions - 2 of those are shown as examples.]*

#### Science Parameter Descriptions

The CERES science parameters are computed using the geodetic coordinate system. However, several parameters are computed in the geocentric coordinate system, and will specifically include the term "geocentric" in the parameter name. The geocentric parameters are used by the ERBE­like Subsystems since ERBE products are archived in the geocentric coordinate system.

**SCI-1 CERES Relative Azimuth at Surface**

This parameter is the geodetic azimuth angle  (See ) at the Earth point (See ) of the satellite relative to the solar plane. (deg) [0 .. 360] {Section Scientific Data Sets (SDS)}

The relative azimuth is measured clockwise in the plane normal to the geodetic zenith (See ) so that the relative azimuth of the Sun is always 180o. The solar plane is the plane which contains the geodetic zenith vector and a vector from the Earth point to the Sun. If the Earth point is north of the geodetic subsolar point (See ) on the same meridian, then an azimuth of 90o would imply the satellite is east of the Earth point.

Sun

Zenith (geodetic or geocentric)

Earth Point or

TOA Point

Satellite

Solar

Plane

Forward

Scatter

Plane

normal

to Zenith







Figure ‑. Viewing Angles at Surface or TOA

**SCI-2 CERES Relative Azimuth at TOA - Geocentric**

This parameter is the geocentric azimuth angle  (See ) at the TOA point (See ) of the satellite relative to the solar plane. (deg) [0 .. 360] {Section Scientific Data Sets (SDS)}

The relative azimuth is measured clockwise in the plane normal to the geocentric zenith (See ) so that the relative azimuth of the Sun is always 180o. The solar plane is the plane which contains the geocentric zenith vector and a vector from the TOA point to the Sun. If the TOA point is north of the geocentric subsolar point (See ) on the same meridian, then an azimuth of 90o would imply the satellite is east of the target point.

**SCI-3 CERES Solar Zenith at Surface**

This parameter is the geodetic zenith angle o (See ) at the Earth point (See ) of the Sun. (deg) [0 .. 180] {Section Scientific Data Sets (SDS)}

The geodetic solar zenith is the angle between the geodetic zenith (See ) vector and a vector from the Earth point to the Sun.

**SCI-4 CERES Solar Zenith at TOA - Geocentric**

This parameter is the geocentric zenith angle o (See ) at the TOA point (See ) of the Sun. (deg) [0 .. 180] {Section Scientific Data Sets (SDS)}

The geocentric solar zenith is the angle between the geocentric zenith (See ) vector and a vector from the TOA point to the Sun.

**SCI-5 CERES Viewing Zenith at Surface**

This parameter is the geodetic angle  (See ) at the Earth point (See ) to the satellite. (deg) [0 .. 90] {Section Scientific Data Sets (SDS)}

The geodetic viewing zenith is the angle between the geodetic zenith (See ) vector and a vector from the Earth point to the satellite.

**SCI-6 Clock Angle of CERES FOV at Satellite wrt Inertial Velocity**

The clock angle (See and ) is the azimuth angle of the instrument view vector from the satellite to the Earth point (See ) relative to the inertial velocity vector. (deg) [0 .. 360] {Section Scientific Data Sets (SDS)}

Angular

momentum

vector

**Greenwich**

Earth Equator

Earth point

at surface

Satellite

Inertial

Velocity

=clock

Radius to

satellite

Z

X

Y

Figure ‑. Clock Angle

The clock angle, along with the cone angle (See and ) define the direction of the instrument view vector to the Earth point.

The clock angle  is defined in a right-handed coordinate system centered at the satellite where z is toward the center of the Earth, x is in the direction of the inertial velocity vector, and y completes the triad.

When  = 270o, the Earth point is on the same side of the orbit as the orbital angular momentum vector (See ). When  = 0o, the Earth point is directly ahead of the satellite.

The toolkit call (See Reference ) PGS\_CSC\_SCtoORB transforms the instrument view vector in spacecraft coordinates to (x,y,z) orbital coordinates and the clock angle is defined by

and

and

**SCI-7 Cone Angle of CERES FOV at Satellite**

The cone angle (See ) is the angle between a vector from the satellite to the center of the Earth and the instrument view vector from the satellite to the Earth point (See ). (deg) [0 .. 90] {Section Scientific Data Sets (SDS)}

The cone angle, along with the clock angle, (See and ) define the direction of the instrument view vector to the Earth point.

The toolKit call (See Reference ) PGS\_CSC\_SCtoORB transforms the instrument view vector in spacecraft coordinates to (x,y,z) orbital coordinates (See ) and the cone angle is defined by

Earth

point

Nadir

Center of Earth

 = clock

satellite

 = cone

Figure ‑. Cone and Clock Angles

#### Instrument Parameter Descriptions

*[Bunch of parameters in alphabetical ordered related to the instrument or housekeeping parameters.]*

**INS-1 Elevation Offset Correction**

This parameter indicates an internal count adjustment to compensate for the encoder position to actual gimbal position misalignment. This value will reflect the internal default value or the last update by the Set\_Elevation\_Offset\_Correction command. The converted value is computed using DRL-64 (Reference ) Algorithm Linear Coefficients. This value needs to be treated as a signed integer data representation. The default nominal unsigned and signed integer offset values for each instrument, as specified in the flight codes, are shown in Table B-4. (deg) [0 .. 360] {Section Converted Instrument Status Data}

**INS-2 Packet Data Version**

This parameter indicates the flight code version burned into the Instrument’s EPROMs. The default values for each of the instrument are shown below.

PFM (TRMM) = 4

FM1/FM2 (EOS-AM) = 5

FM3/FM4 (EOS-PM) = 6

(N/A) [0..31] {Section Converted Instrument Status Data}

### Fill Values

 lists the default CERES Fill Values. These are used when data are missing, when there is insufficient data to make a calculation, or the data are suspect and there is no quality flag associated with the parameter. A value which has a corresponding flag need not be set to the CERES default value when the data value is suspect. Suspect values are values that were calculated but failed edit checks. The CERES default fill values are defined as follows:

Table ‑. CERES Fill Values

|  |  |  |
| --- | --- | --- |
| **Fill Value Name** | **Value** | **Fill Value Description\*** |
| INT1\_DFLT | 127 | default value for a 1-byte integer |
| INT2\_DFLT | 32767 | default value for a 2-byte integer |
| INT4\_DFLT | 2147483647 | default value for a 4-byte integer |
| REAL4\_DFLT | 3.4028235E+38 | default value for a 4-byte real |
| REAL8\_DFLT | 1.7976931348623157E+308 | default value for a 8-byte real |

\* l byte = 8 bits

### Data Types

*[Include if relevant]*

The following data types are used to represent numerical parameters in the *XYZ* product:

Table ‑. Data Types and Formats

|  |  |  |
| --- | --- | --- |
| **Data Type** | **Range** | **Format** |
| Unsigned 8 Bit Integer | 0..255 | N/A |
| Signed 8 Bit Integer | -127..127 | N/A |
| Unsigned 16 Bit Integer | 0..65536 | N/A |
| Signed 16 Bit Integer | -32767..32767 | N/A |
| Unsigned 32 Bit Integer | 0..4294967296 | N/A |
| Signed 32 Bit Integer | -2147483648..2147483648 | N/A |
| 32 Bit Float | platform dependent | 11.6 |
| 64 Bit Float | platform dependent | 13.8 |

## Sample Data Record

*[Include 1 sample record with parameter labels or delete section.]*

# Data Organization

*[Product Specific Information - discuss your HDF structures. e.g.]*

This section discusses the organization of the BDS structures as written to the output data file. All BDS data products use Hierarchical Data Format (HDF) structures such as Vertex Data (Vdata) and Scientific Data Sets (SDSs). See the HDF User’s Guide for additional information (Reference ). BDS Metadata is implemented using the ECS ToolKit metadata routines (Reference ), which are based on HDF Annotations.

## Data Granularity

*[Product Specific Information - e.g.]*

All BDS data granules are stored in the HDF developed by the National Center for Supercomputing Applications (NCSA). The HDF permits aggregation of commonly used data structures within a single file, and a common, platform independent Application Programming Interface (API). The BDS product contains HDF SDSs and Vdata structures.

## Data Format

*[Product Specific Information - e.g.]*

All BDS data granules are stored in the HDF developed by the National Center for Supercomputing Applications (NCSA). The HDF permits aggregation of commonly used data structures within a single file, and a common, platform independent Application Programming Interface (API). The BDS product contains HDF SDSs and Vdata structures.

### Scientific Data Sets (SDS)

*[An example from BDS]*

A Scientific Data Set is an HDF structure capable of storing large quantities of a single data type. SDSs are organized by dimensions, and a single SDS can have up to 32 dimensions. lists the parameters that are stored as SDSs. The entries in the Link and SDS Name columns are hyperlinked to a definition of the parameter. The HDF rank of all BDS SDSs is 2 (2-dimensional arrays). The size column specifies the dimensions where n is the number of packets. The HDF data type, the size of the SDS, and which products contain each SDS are also shown in the summary table. The key for the Product Types is in the summary table header.

Table ‑. BDS Scientific Data Set (SDS) Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Link** | **SDS Name** | **Size** | **Data Type** | **NominalSize MB** | **BDS ProductTypes (\*)** |
| **(\*) A=BDS, S=BDSS, D=BDSD, F=BDSF, G=BDSG, M=BDSM, P=BDSP** |
|  | CERES Relative Azimuth at Surface | 660 x n | 32 bit float |  | A, S, D, --, G, M, P |
|  | CERES Relative Azimuth at TOA - Geocentric | 660 x n | 32 bit float |  | A, S, D, --, G, M, P |
|  | CERES Solar Zenith at Surface | 660 x n | 32 bit float |  | A, S, D, --, G, M, P |
|  | CERES Solar Zenith at TOA - Geocentric | 660 x n | 32 bit float |  | A, S, D, --, G, M, P |

### Vertex Data (VData)

*[An example]*

A Vdata is an HDF structure that allows record-based storage of multiple parameters and/or multiple data types as shown in the example in . Vdata records are analogous to records found in relational database systems where a single record is composed of one or more data fields, and each data field can be represented by its own data type.

Table ‑. Vdata Record Example

|  |  |  |
| --- | --- | --- |
| **Field 1Unsigned 16 bit Integer** | **Field 232 bit Floats** | **Field 3Signed 8 bit Integer** |
| Value | Value 1 | Value 2 | Value |

 is a summary of the Vdata structures contained in the BDS products. Following the summary table are tables that list the components of each of the Vdatas. These tables represent the Vdata structures as written to the data products. The data descriptions are hyperlinked from the Parameter Name column in each of the tables.

Table ‑. Vdata Summary

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Vdata Name** | **Section Link** | **Records** | **Number ofFields** | **NominalSize (MB)** | **BDS Product Types (\*)** |
| Converted Instrument Status Data | Sec.  | n | 25 | 1.1 | A, S, D, F, G, M, P |
| **Vdata Total Size** |  |  |  | 30.36 |  |
| (\*) A=BDS, S=BDSS, D=BDSD, F=BDSF, G=BDSG, M=BDSM, P=BDSP |

#### Converted Instrument Status Data

**BDS Product Types: BDS, BDSS, BDSD, BDSF, BDSM, BDSG, BDSP**

This data set contains the converted values for instrument status parameters that have defined conversion algorithms. Packet status information that is not part of the raw digital status data block is also included in this data set.

Table ‑. Converted Instrument Status Data Field Summary

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **Link** | **FieldNum** | **Parameter Name** | **Order** | **Data Type** |
| INS-1 | 1 | Elevation Offset Correction | 1 | 32 bit float |
| INS-2 | 21 | Packet Data Version | 1 | Unsigned 16 bit integer |
|  | Record Size (bytes) | 92 |

# Theory of Measurements and Data Manipulations

## Theory of Measurements

See Reference 3 for the basic theory of measurements.

## Data Processing Sequence

*[Product Specific Information]*

For detailed information see the Subsystem Architectural Design Document. (Reference )

## Special Corrections/Adjustments

Algorithms not discussed in the ATBD are discussed in this section.

# Errors

See CERES ATBD Subsystem Number. (Reference )

*[may wish to include high level accuracy goals]*

## Quality Assessment

Quality Assessment (QA) activities are performed at the Science Computing Facility (SCF) by the Data Management Team. Processing reports containing statistics and processing results are examined for anomalies. If the reports show anomalies, data visualization tools are used to examine those products in greater detail to begin the anomaly investigation. (See the QA flag description for this product.)

## Data Validation by Source

See Subsystem *Subsystem Number* Validation Document. (Reference ) for details on the data validation plans.

# Notes

**Note-1 Field-of-View (FOV)**

Field-of-View and footprint are synonymous. The CERES FOV is determined by its PSF (See and ) which is a two-dimensional, bell-shaped function that defines the CERES instrument response to the viewed radiation field.

The resolution of the CERES radiometers is usually referenced to the optical FOV which is 1.3o in the along-track direction and 2.6o in the cross-track direction. For example, on TRMM with a satellite altitude of 350 km, the optical FOV at nadir is 8 × 16 km which is frequently referred to as an equivalent circle with a 10 km diameter, or simply as 10 km resolution. On EOS-AM with a satellite altitude of 705 km, the optical FOV at nadir is 16 × 32 km or 20 km resolution.

The CERES FOV or footprint size is referenced to an oval area that represents approximately 95% of the PSF response (See and ) for numerical representation of FOV). Since the PSF is defined in angular space at the instrument, the CERES FOV is a constant in angular space, but grows in surface area from a minimum at nadir to a larger area at shallow viewing angles (See ). For TRMM, the length and width of this oval at nadir is 19 × 15 km and grows to 138 × 38 km at a viewing zenith angle (See ) of 70o. For EOS-AM/PM, the length and width at nadir is 38 × 31 km and grows to 253 × 70 km at a viewing zenith angle of 70o.

**Note-2 CERES Point Spread Function**

**Note-2.1 CERES Point Spread Function**

The CERES scanning radiometer is an evolutionary development of the ERBE scanning radiometer. It is desired to increase the resolution as much as possible, using a thermistor bolometer as the detector. As the resolution is increased, the sampling rate must increase to achieve spatial coverage. When the sampling rate becomes comparable to the response time of the detector, the effect of the time response of the detector on the PSF must be considered. Also, the signal is usually filtered electronically prior to sampling in order to attenuate electronic noises and to remove high frequency components of the signal which would cause aliasing errors. The time response of the filter, together with that of the detector causes a lag in the output relative to the input radiance. This time lag causes the centroid of the PSF to be displaced from the centroid of the optical FOV. Thus, the signal as sampled comes not only from where the radiometer is pointed, but includes a “memory” of the input from where it had been looking. Another effect of the time response is to broaden the PSF, which will reduce the resolution of the measurement, increase blurring errors, and decrease aliasing errors.



**Note-2.2 Geometry of the Point Spread Function**

The scanner footprint geometry is given in . The optical FOV is a truncated diamond (or hexagon) and is 1.3o in the along-scan direction and 2.6o in the across-scan direction. The

Figure ‑. Scanner Footprint

effective FOV (or footprint) is given by the PSF and is shown as an ellipse. A point within the footprint is located by  and . The cone angle  (or nadir angle) determines the location of the footprint centroid on the Earth. If  = 0, the footprint is at nadir. The viewing zenith angle  is a direct result of the satellite altitude h, the Earth radius rE, and the cone angle . The surface distance *l* and the Earth central angle  between nadir and the centroid are also a result of the viewing geometry. In we have denoted the length of the FOV by Δ*l*.

 gives three CERES FOVs. The shaded area is the optical FOV. Note that only half of the FOV is given since it is symmetrical about the scan line. The origin has been placed at the centroid of the PSF which trails the optical axis by about 1.5 degree. This is the lag that is inherent in the system. About the PSF centroid, the outline has been drawn on the 95-percent energy boundary. An angular grid, also has been drawn over the 95% energy FOV for weighting cloud parameters in a later process. All of the pertinent dimensions are given.

**Note-2.3 Analytic form of the Point Spread Function**

A full discussion of an analytic model of the point spread function and its development are given in Smith (See Reference ). From , we redraw half of the optical FOV in

(a,0)

(-a,0)

(a,a)

(0,2a)



a=0.65

PSF=0

PSF≠0

Scan Direction

Figure ‑. Optical FOV

where δ' is the along-scan angle and  is the cross-scan angle. Note that δ' points opposite the scan direction and increases toward the tail of the PSF (See ). The forward and back boundaries are given by δ'*f*() and δ'*b*(), respectively. With these definitions the CERES PSF is written as

|  |  |
| --- | --- |
|  | (1) |

where

|  |  |
| --- | --- |
| + +  | (2) |

and

|  |  |
| --- | --- |
|  = -0.18956 = 1.02431 |  |

where ξ is in degrees and (0.91043ξ) and (2.78981ξ) are in radians. The centroid of the PSF is derived in Smith (See Reference )and is 1.51o from the optical axis. This shift is denoted in and a new angle δ is defined relative to the centroid. To evaluate the PSF, determine δ and then set where is the shift (or offset) from the optical axis to the centroid.

The numerical values given in equation are based on the following prelaunch calibration constants:

|  |  |
| --- | --- |
|  | Characteristic frequency of the Bessel Filter |

|  |  |
| --- | --- |
|  | Scan rate |

Table ‑. Detector Constant ( seconds)

|  |  |
| --- | --- |
| **Instrument** | **Detector Channel** |
| **Total** | **Window** | **Shortwave** |
| PFM | 0.00860 | 0.00830 | 0.00815 |
| FM1 | 0.00850 | 0.00795 | 0.00825 |
| FM2 | 0.00800 | 0.00820 | 0.00820 |
| FM3 | N/A | N/A | N/A |
| FM4 | N/A | N/A | N/A |

The general form of equation is given by

|  |  |
| --- | --- |
| +  | (3) |

where

|  |  |
| --- | --- |
|  |  |

and where the complex roots of the 4-pole Besssel filter are

|  |  |
| --- | --- |
|  |  |

the residues of the Bessel filter are

and

Note that are non-dimensional so that is in radians. The cone angle ξ has units of degrees. The complex variables *pi*, *vi*, *ui* define *ai* and *bi* as

The centroid of the PSF can be derived from the analytic expression and is given by

|  |  |
| --- | --- |
|  | (4) |

Figure ‑. CERES Field-of-View Angular Grid

**Note-3 Conversion of Julian Date to Calendar Date**

The Julian Date is a time system that has been adopted by astronomers and is used in many scientific experiments. The Julian Date or Julian Day is the number of mean solar days since 1200 hours (GMT/UT/UTC/Zulu) on Monday, 24 November 4714 BCE, based on the current Gregorian calendar, or more precisely, the Gregorian Proleptic calendar. In other words, Julian day number 0 (zero) was Monday, 24 November 4714 Before Current Era (BCE), 1200 hours (noon). A new Julian day starts when the mean Sun at noon crosses the Greenwich meridian. This differs from Universal Time (UT) or Greenwich Mean Solar Time by 12 hours since UT changes day at Greenwich midnight. below provides Julian day numbers which relate Universal Time to Julian date.

Important facts related to the Gregorian calendar are:

1. There is no year zero; year -1 is immediately followed by year 1.
2. A leap year is any year which is divisible by 4, except for those centesimal years (years divisible by 100) which must also be divisible by 400 to be considered a leap year.
3. A leap year has 366 days, with the month of February containing 29 days.
4. Year -1 is defined as a leap year, thus being also defined as containing 366 days, and being divisible by 4, 100, and 400.

Information on history, calendars, and Julian day numbers can be found in Blackadar’s (Reference ) “A Computer Almanac”, and on the WWW (Reference ).

The Julian day whole number is followed by the fraction of the day that has elapsed since the preceding noon (1200 hours UTC). The Julian Date JDATE can be represented as:

 JDATE = JDay + JFract

where:

 JDay = the integer Julian Day number and

 JFract = the “fractional” Julian day (0 to 0.99...9)

 (e.g. 245\_0814.0 = 1200 or noon, 31 December, 1997 UT)

When the fractional part of the combined julian data is .0, it is noon or 1200 hours GMT and when the fraction part is .5, then it is midnight or 0000 hours GMT.

The calculation of GMT (YYYYMMDD-HH:MM:SS.SSS) from Julian date (JDATE) is performed using the following process.

1. The YYYYMMDD can be determined using to find the year and the beginning of the month whose Julian Day occurs before the JDay integer value.
2. Calculate the number of days past the 0.5 day of the month via which provides Julian day numbers which relate Universal Time to Julian date.

The GMT is determined by first computing the number of seconds in the day since midnight:

 if JFract > 0.5,

 then Seconds = 86400.0 \* (JFract-0.5)

 if JFract <= 0.5,

 then Seconds = 86400.0 \* (JFract+0.5)

Then compute HH, MM, and SS where:

 HH = Int(Seconds/3600)

 MM = Int(Seconds-(HH\*3600.0)/60)

 SS = Seconds-(HH\*60.0 + MM)\*60.0

As an example, if JD = 244\_5733.5833, then the GMT date is computed using by finding the closest beginning monthly calendar noon date, which is Feb 0.5, 1984 (UT).

 (Feb 0.5) Jday

 244 5731 < 244 5733.5833

JD = 244\_5733.5833 is 2.5833 days past Feb 0.5, 1984 UT (i.e., past 1984 Jan 31d 12h 0m 0s) where 1984 Jan 31d 12h 0m 0ss = (244\_5733-244\_5731).

Beginning with the whole days portion of 2.5833 (i.e., 2), the GMT Date is 1984 Jan 31d 12h 0m 0s + 2 = 1984 Feb 2d 12h 0m 0s.

Next, since JFract (0.5833) is > 0.5, 12h is added to the GMT Date, yielding: 1984 Feb 2d 12h 0m 0s + 12h 0m 0s = 1984 Feb 3d 0h 0m 0s.

Finally, to get the GMT time and since JFract (0.5833) is > 0.5, the number of seconds = 86400 \*(0.5833 -0.5) = 7197.12 yielding:

 HH = 7197.12 / 3600 = 01.9992 = 01h

 MM = 7197.12 - ((1\*3600) / 60) = 59.952 = 59m

 SS = 7197.12 - ((1\*60) + 59)\*60) = 57.12s

Therefore, the GMT Date corresponding to the Julian Date 244\_5733.5833 = 1984 Feb 3d 1h 59m 57.12s, which is UT = 1984 Jan 31d 12h 0m 0s + 2.5833 days.

Table ‑. Julian Day Number

|  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Year | Jan0.5 | Feb 0.5 | Mar 0.5 | Apr 0.5 | May 0.5 | June 0.5 | July 0.5 | Aug 0.5 | Sept 0.5 | Oct 0.5 | Nov 0.5 | Dec 0.5 |
| 1980t | 244\_4239 | \_4270 | \_4299 | \_4330 | \_4360 | \_4391 | \_4421 | \_4452 | \_4483 | \_4513 | \_4544 | \_4574 |
| 1981 | \_4605 | \_4636 | \_4664 | \_4695 | \_4725 | \_4756 | \_4786 | \_4817 | \_4848 | \_4878 | \_4909 | \_4939 |
| 1982 | \_4970 | \_5001 | \_5029 | \_5060 | \_5090 | \_5121 | \_5151 | \_5182 | \_5213 | \_5243 | \_5274 | \_5304 |
| 1983 | \_5335 | \_5366 | \_5394 | \_5425 | \_5455 | \_5486 | \_5516 | \_5547 | \_5578 | \_5608 | \_5639 | \_5669 |
| 1984t | \_5700 | \_5731 | \_5760 | \_5791 | \_5821 | \_5852 | \_5882 | \_5913 | \_5944 | \_5974 | \_6005 | \_6035 |
| 1985 | 244\_6066 | \_6097 | \_6125 | \_6156 | \_6186 | \_6217 | \_6247 | \_6278 | \_6309 | \_6339 | \_6370 | \_6400 |
| 1986 | \_6431 | \_6462 | \_6490 | \_6521 | \_6551 | \_6582 | \_6612 | \_6643 | \_6674 | \_6704 | \_6735 | \_6765 |
| 1987 | \_6796 | \_6827 | \_6855 | \_6886 | \_6916 | \_6947 | \_6977 | \_7008 | \_7039 | \_7069 | \_7100 | \_7130 |
| 1988t | \_7161 | \_7192 | \_7221 | \_7252 | \_7282 | \_7313 | \_7343 | \_7374 | \_7405 | \_7435 | \_7466 | \_7496 |
| 1989 | \_7527 | \_7558 | \_7586 | \_7617 | \_7647 | \_7678 | \_7708 | \_7739 | \_7770 | \_7800 | \_7831 | \_7861 |
| 1990 | 244\_7892 | \_7923 | \_7951 | \_7982 | \_8012 | \_8043 | \_8073 | \_8104 | \_8135 | \_8165 | \_8196 | \_8226 |
| 1991 | \_8257 | \_8288 | \_8316 | \_8347 | \_8377 | \_8408 | \_8438 | \_8469 | \_8500 | \_8530 | \_8561 | \_8591 |
| 1992t | \_8622 | \_8653 | \_8682 | \_8713 | \_8743 | \_8774 | \_8804 | \_8835 | \_8866 | \_8896 | \_8927 | \_8957 |
| 1993 | \_8988 | \_9019 | \_9047 | \_9078 | \_9108 | \_9139 | \_9169 | \_9200 | \_9231 | \_9261 | \_9292 | \_9322 |
| 1994 | \_9353 | \_9384 | \_9412 | \_9443 | \_9473 | \_9504 | \_9534 | \_9565 | \_9596 | \_9626 | \_9657 | \_9687 |
| 1995 | 244\_9718 | \_9749 | \_9777 | \_9808 | \_9838 | \_9869 | \_9899 | \_9930 | \_9961 | \_9991 | \*0022 | \*0052 |
| 1996t | 245\_0083 | \_0114 | \_0143 | \_0174 | \_0204 | \_0235 | \_0265 | \_0296 | \_0327 | \_0357 | \_0388 | \_0418 |
| 1997 | \_0449 | \_0480 | \_0508 | \_0539 | \_0569 | \_0600 | \_0630 | \_0661 | \_0692 | \_0722 | \_0753 | \_0783 |
| 1998 | \_0814 | \_0845 | \_0873 | \_0904 | \_0934 | \_0965 | \_0995 | \_1026 | \_1057 | \_1087 | \_1118 | \_1148 |
| 1999 | \_1179 | \_1210 | \_1238 | \_1269 | \_1299 | \_1330 | \_1360 | \_1391 | \_1422 | \_1452 | \_1483 | \_1513 |
| 2000t | 245\_1544 | \_1575 | \_1604 | \_1635 | \_1665 | \_1696 | \_1726 | \_1757 | \_1788 | \_1818 | \_1849 | \_1879 |
| 2001 | \_1910 | \_1941 | \_1969 | \_2000 | \_2030 | \_2061 | \_2091 | \_2122 | \_2153 | \_2183 | \_2214 | \_2244 |
| 2002 | \_2275 | \_2306 | \_2334 | \_2365 | \_2395 | \_2426 | \_2456 | \_2487 | \_2518 | \_2548 | \_2579 | \_2609 |
| 2003 | \_2640 | \_2671 | \_2699 | \_2730 | \_2760 | \_2791 | \_2821 | \_2852 | \_2883 | \_2913 | \_2944 | \_2974 |
| 2004t | 245\_3005 | \_3036 | \_3965 | \_3096 | \_3126 | \_3157 | \_3187 | \_3218 | \_3249 | \_3279 | \_3310 | \_3340 |
| 2005 | \_3371 | \_3402 | \_3430 | \_3461 | \_3491 | \_3522 | \_3552 | \_3583 | \_3614 | \_3644 | \_3675 | \_3705 |
| 2006 | \_3736 | \_3767 | \_3795 | \_3826 | \_3856 | \_3887 | \_3917 | \_3948 | \_3979 | \_4009 | \_4040 | \_4070 |
| 2007 | \_4101 | \_4132 | \_4160 | \_4191 | \_4221 | \_4252 | \_4282 | \_4313 | \_4344 | \_4374 | \_4405 | \_4435 |
| 2008t | 245\_4466 | \_4497 | \_4526 | \_4557 | \_4587 | \_4618 | \_4648 | \_5679 | \_4710 | \_4740 | \_4771 | \_4801 |
| 2009 | \_4832 | \_4863 | \_4891 | \_4922 | \_4952 | \_4983 | \_5013 | \_5044 | \_5075 | \_5105 | \_5136 | \_5166 |
| a. Jan. 0.5 (UT) is the same as Greenwich noon (12h) UT, Dec. 31. \* These dates begin with 245 t Denotes leap years |

# Application of the Data Set

*[Product Specific Information]*

# Future Modifications and Plans

Modifications to the *XYZ* product are driven by validation results and any EOS-AM related parameters. The ASDC provides users notification of changes.

# Software Description

There is a C/Fortran90 read program that interfaces with the HDF libraries and a README file available from the LaRC ASDC User Services. The program was designed to run on a Unix workstation and can be compiled with a C/Fortran90 compiler.

*[Correct for fortran or C] {Pointer to ASDC read program}*

# Contact Data Center/Obtain Data

EOSDIS Langley DAAC Telephone: (757) 864-8656

USer and Data Service Office FAX: (757) 864-8807

NASA Langley Research Center E-mail: larc@eos.nasa.gov

Mail Stop 157D URL: <http://eosweb.larc.nasa.gov/>

2 South Wright Street

Hampton, VA 23681-2199

USA

# Output Products and Availability

Several media types are supported by the Langley ASDC CERES Web Order Tool. Data can be downloaded from the Web or via FTP. Alternatively, data can be ordered on media tapes. The media tapes supported are 4mm 2Gb (90m), 8mm 2Gb (8200), 8mm 5Gb (8500), and 8mm 7Gb (8500c).

Data ordered via the Web or via FTP can be downloaded in either Uncompressed mode or in UNIX Compressed mode. Data written to media tape (in either Uncompressed mode or in UNIX Compressed mode) is in UNIX TAR format.

# References

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2. TRW DRL 64, 55067.300.008E; In-flight Measurement Analysis (Rev. E), March 1997.
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5. Release B SCF ToolKit User's Guide for the ECS Project, June 1998.
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# Glossary of Terms

Term-1 CERES Point Spread Function

A Point Spread Function (PSF) is a two-dimensional bell-shaped function that defines the CERES instrument response to the viewed radiation field. Due to the response time, the radiometer responds to a larger FOV than the optical FOV and the resulting PSF centroid lags the optical FOV centroid by more than a degree of cone angle (See ) for normal scan rates (See ).

Term-2 Earth Equator, Greenwich Meridian System

The Earth equator, Greenwich meridian system is an Earth-fixed, geocentric, rotating coordinate system with the X-axis in the equatorial plane through the Greenwich meridian, the Y-axis lies in the equatorial plane 90o to the east of the X-axis, and the Z-axis is toward the North Pole.

Term-3 Earth Surface

The surface of the Earth as defined by the WGS-84 Earth Model. The WGS-84 model of the Earth surface is an ellipsoid where a = 6378.1370 km and b = 6356.7523 km (See ).

Term-4 Earth Point

The viewed point on the Earth surface (See ), or the point at which the PSF centroid intersects the Earth surface.

Term-5 Field-of-View

The terms Field of View (FOV) and footprint are synonymous (See ). The CERES FOV is determined by its PSF which is a two dimensional bell-shaped function that defines the CERES instrument response to the viewed radiation field.

The resolution of the CERES radiometers is usually referenced to the optical FOV and is 1.3o in the along-track direction and 2.6o in the cross-track direction. For TRMM with a satellite altitude of 350 km, the nadir optical FOV is 8 16 km which is frequently referred to as an equivalent circle with a 10 km diameter, or simply as 10 km resolution. For EOS-AM with a satellite altitude of 705 km, the optical FOV at nadir is 16 32 km or 20 km resolution.

The CERES footprint size is referenced as an oval area representing ~95% of the PSF response (See ). Since the PSF is defined in instrument angular space, the CERES FOV is a constant in angular space, but grows in surface area from a minimum at nadir to a larger area at shallow viewing angles (See ). At nadir, this oval for TRMM is 19 15 km (EOS-AM is 38 31 km) and grows to 138 38 km (EOS-AM is 253 70 km) at a 70o viewing zenith angle.

The ToolKit routine PGS\_CSC\_GetFOV\_Pixel returns the geodetic latitude and longitude of the intersection of the FOV centroid and the selected Model Surface. The returned longitudes are transformed from radians to degrees and then converted from to ±180o to 0o .. 360o. The returned geodetic latitudes are transformed from radians to degrees and then converted to geodetic colatitude using (90.0-latitude).

Term-6 Geocentric Subsolar Point

The point on a surface where the geocentric zenith (See ) vector points toward the Sun (See ).

Term-7 Geocentric Zenith

A vector from the center of the Earth (See ) to the point of interest.

Term-8 Geodetic Subsolar Point

The point on a surface where the geodetic zenith (See ) vector points toward the Sun (See ). Although the geocentric latitude c and the geodetic latitude d are equal, the geocentric subsolar point is different from the geodetic subsolar point.

Z

Geocentric

Subsolar

Point

Geocentric

Subsolar

Point

Ellipsoid

Surface Tangent

b

a

Sun

Geocentric

Zenith

X

Y

c

d

Z Geodetic

Zenith

Figure ‑. Subsolar Point

The ToolKit routine PGS\_CBP\_Earth\_CB\_vector calculates the Earth-Centered Inertial (ECI) position vector from the Earth to the Sun. A second ToolKit routine, PGS\_CSC\_ECItoECR, transforms the position vector to the ECR or Earth equator, Greenwich meridian rectangular coordinate system. From these coordinates, the geocentric colatitude and longitude of the Sun are calculated.

Term-9 Geodetic Zenith

The vector normal to an ellipsoid (See ) at a point on the surface. At a point on the surface the geocentric latitude c and the geodetic latitude d are related by .. We can determine the radial distance r as a function of the geocentric latitude c by setting
x = r cosc), y = 0, z = r sin(c) in the ellipsoidal model and solving for r or

The semi-major axis (a) and the semi-minor axis (b) are defined by either the Earth Surface (See ) or the TOA (See ).

Ellipsoid

Geodetic

Zenith

Geocentric

Zenith

Surface

Tangent

a

b

Z

Y

c

d

r

X

Figure ‑. Ellipsoid Earth Model

Term-10 Julian Date

A continuous count of time in whole and fractional days elapsed at the Greenwich meridian since noon on January 1, 4714 BCE. (See )

Term-11 Subsatellite Point

The point on a surface below the satellite or the intersection point of a line dropped from the satellite through the surface (See ). The geocentric subsatellite point is on the radius vector to the center of the earth. The geodetic subsatellite point is on the geodetic zenith vector or the line dropped from the satellite is normal to the surface at the intersection point.

The ToolKit routine PGS\_CSC\_SubSatPoint returns the geodetic latitude and longitude of the subsatellite point. The returned longitudes are transformed from radians to degrees and then converted from to ±180o to 0o..360o. The returned latitudes are transformed from radians to degrees and then converted to colatitude using (90.0 - latitude).

Z

b

a

Geocentric

Subsatellite

Point

Geocentric

Zenith

Geodetic

Zenith

Surface

Tangent

X

Ellipsoid

c

d

Y

Geocentric

Subsatellite

Point

Satellite

Figure ‑. Subsatellite Point

Term-12 Target Point

The point at which the PSF (See ) centroid intersects the TOA (See ).

Term-13 Top-of-the-Atmosphere (TOA)

The TOA is a surface approximately 30 km above the Earth surface (See ). Specifically, the TOA is an ellipsoid where a = 6408.1370 km and b = 6386.651 km (See ).

Term-14 TOA Point

The viewed point at the TOA, or the point at which the PSF centroid intersects the TOA (See ).

# List of Acronyms

ADM Angular Distribution Model

APID Application Identifier

APD Aerosol Profile Data

ATBD Algorithm Theoretical Basis Document

AVG Monthly Regional Radiative Fluxes and Clouds

AVHRR Advanced Very High Resolution Radiometer

BCE Before Current Era

BDS BiDirectional Scan (data product)

CADM CERES Angular Distribution Model

CER CERES

CERES Clouds and the Earth’s Radiant Energy System

CID Cloud Imager Data (data product)

CRH Clear Reflectance History (data product)

CRS Clouds and Radiative Swath (data product)

CW Cable Wrap

DAAC Distributed Active Archive Center

DAC Digital to Analog Converter

DAO Data Assimilation Office

DAP Data Acquisition microProcessor

DMA Direct Memory Access

DMS Data Management System

ECR Earth-Centered Rotating

EDDB ERBE-Like Daily Database Product

EDOS EOS Data Operations System

EOS Earth Observing System

EOS-AM EOS Morning Crossing Mission (Renamed Terra)

EOS-PM EOS Afternoon Crossing Mission

EOSDIS Earth Observing System Data and Information System

ERBE Earth Radiation Budget Experiment

ERBS Earth Radiation Budget Satellite

FAPS Fixed Azimuth Plane Scan

FM Flight Model

FOV Field-of-View (See )

FSW Monthly Single Satellite Fluxes and Clouds

GAP Gridded Analysis Product

GB Gigabyte

GEO Geostationary Narrowband Radiances

GMS Geostationary Meteorological Satellite

GGEO Gridded Geostationary Narrowband Radiances

GOES Geostationary Operational Environmental Satellite

H High

HDF Hierarchical Data Format

IES Instrument Earth Scans (data product)

IGBP International Geosphere Biosphere Programme

INSTR Instrument

ISCCP International Satellite Cloud Climatology Project

IWC Ice Water Content

LaRC Langley Research Center

LaTIS Langley TRMM Information System

L Low

LM Lower Middle

LW Longwave

LWC Liquid Water Content

MAM Mirror Attenuator Mosaic

MB Megabyte

METEOSAT Meteorological Satellite

MISR Multi-angle Imaging SpectroRadiometer

MOA Meteorological, Ozone, and Aerosols (data product)

MODIS Moderate Resolution Imaging Spectrometer

MWH Microwave Humidity (data product)

NASA National Aeronautics and Space Administration

NOAA National Oceanic and Atmospheric Administration

OPD Ozone Profile Data (data product)

PFM Prototype Flight Model (on TRMM)

PSA Product Specific Attribute

PSF Point Spread Function (See )

QA Quality Assessment

RAPS Rotating Azimuth Plane Scan

SARB Surface and Atmospheric Radiation Budget

SBUV-2 Solar Backscatter Ultraviolet/Version 2

SDS Scientific Data Set

SFC Hourly Gridded Single Satellite TOA/Surface Fluxes and Clouds (data product)

SPS Solar Presence Sensor

SRB Surface Radiation Budget

SRBAVG Surface Radiation Budget Average (data product)

SS Subsystem

SSF Single Satellite CERES Footprint TOA and Surface Fluxes, Clouds (data product)

SSM/I Special Sensor Microwave/Imager

SURFMAP Surface Map

SW Shortwave

SWICS Shortwave Internal Calibration Source

SYN Synoptic Radiative Fluxes and Clouds

TBD To Be Determined

TISA Time Interpolation and Spatial Averaging

TMI TRMM Microwave Imager

TOA Top-of-the-Atmosphere (See )

TOT Total

TRMM Tropical Rainfall Measuring Mission

UM Upper Middle

URL Uniform Resource Locator

UT Universal Time

UTC Universal Time Code

VIRS Visible Infrared Scanner

WN Window

ZAVG Monthly Zonal and Global Average Radiative Fluxes and Clouds (data product)

| Unit Definitions |
| --- |
| Units | Definition |
| AU | Astronomical Unit |
| cm | centimeter |
| count | count, counts |
| day | day, Julian date |
| deg | degree |
| deg sec-1 | degrees per second |
| du | Dobson units |
| fraction | fraction 0..1 |
| g kg-1 | gram per kilogram |
| g m-2 | gram per square meter |
| hhmmss | hour, minute, second |
| hour | hour |
| hPa | hectoPascals |
| in-oz | inch-ounce |
| K | Kelvin |
| km | kilometer, kilometers |
| km sec-1 | kilometers per second |
| m | meter |
| mA | milliamp, milliamps |
| micron | micrometer, micron |
| msec | millisecond |
| mW cm-2sr-1m-1 | milliWatts per square centimeter per steradian per micron |
| m sec-1 | meter per second |
| N/A | not applicable, none, unitless, dimensionless |
| percent | percent, percentage 0..100 |
| rad | radian |
| sec | second |
| volt | volt, volts |
| W h m-2 | Watt hour per square meter |
| W2 m-4 | square Watt per meter to the 4th  |
| W m-2 | Watt per square meter |
| W m-2sr-1 | Watt per square meter per steradian |
| W m-2sr-1m-1 | Watt per square meter per steradian per micron |
| oC | degrees centigrade |
| m | micrometer, micron |

# Document Information

## Document Creation Date – February 1998

## Document Review Date - July 1998

## Document Revision Date

Month 1999 Comment

## Document ID

LD\_007\_010\_001\_00\_00\_0\_yyyymmdd (Release Date) *[get this from ASDC User Services]*

## Citation

Please provide a reference to the following paper when scientific results are published using the CERES *XYZ* TRMM data:

“Wielicki, B. A.; Barkstrom, B.R.; Harrison, E. F.; Lee III,R.B.; Smith, G.L.; and Cooper, J.E., 1996: Clouds and the Earth’s Radiant Energy System (CERES): An Earth Observing System Experiment, Bull. Amer. Meteor. Soc., 77, 853-868.”

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The Langley ASDC Science, User & Data Services Office.

CERES Metadata

This section describes the metadata that are written to all CERES HDF products. describes the CERES Baseline Header Metadata that are written on both HDF and binary direct access output science data products. The parameters are written in HDF structures for CERES HDF output products and are written as 80-byte records for binary direct access output products. Some parameters may be written in multiple records. describes the CERES\_metadata Vdata parameters which are a subset of the CERES Baseline Header Metadata and are also written to all CERES HDF output products. For details on CERES Metadata, see the CERES Software Bulletin “CERES Metadata Requirements for LaTIS” (Reference ).

 lists the item number, parameter name, units, range or allowable values, the data type, and the maximum number of elements. Note that there are two choices for parameters 22-25 and two choices for parameters 26-29. The choices depend on whether the product is described by a bounding rectangle or by a GRing. Abbreviations used in the Data Type field are defined as follows:

 s = string date = yyyy-mm-dd

 F = float time = hh:mm:ss.xxxxxxZ

 I = integer datetime = yyyy-mm-ddThh:mm:ss.xxxxxxZ

| Table ‑. CERES Baseline Header Metadata |
| --- |
| Item | Parameter Name | Units | Range | Data Type | No. of Elements |
| 1 | ShortName | N/A | N/A | s(8) | 1 |
| 2 | VersionID | N/A | 0 .. 255 | I3 | 1 |
| 3 | CERPGEName | N/A | N/A | s(20) | 1 |
| 4 | SamplingStrategy | N/A | CERES, TRMM-PFM-VIRS, AM1-FM1-MODIS, TBD | s(20) | 1 |
| 5 | ProductionStrategy | N/A | Edition, Campaign, Diagnostic- Case, PreFlight, TBD | s(20) | 1 |
| 6 | CERDataDateYear | N/A | 1997 .. 2050 | s(4) | 1 |
| 7 | CERDataDateMonth | N/A | 1 .. 12 | s(2) | 1 |
| 8 | CERDataDateDay | N/A | 1 .. 31 | s(2) | 1 |
| 9 | CERHrOfMonth | N/A | 1 .. 744 | s(3) | 1 |
| 10 | RangeBeginningDate | N/A | 1997-11-19 .. 2050-12-31 | date | 1 |
| 11 | RangeBeginningTime | N/A | 00:00:00.000000Z ..24:00:00:000000Z | time | 1 |
| 12 | RangeEndingDate | N/A | 1997-11-19 .. 2050-12-31 | date | 1 |
| 13 | RangeEndingTime | N/A | 00:00:00.000000Z ..24:00:00:000000Z | time | 1 |
| 14 | AssociatedPlatformShortName | N/A | TRMM, AM1, PM1, TBD | s(20) | 1 - 4 |
| 15 | AssociatedInstrumentShortName | N/A | PFM, FM1, FM2, FM3, FM4, FM5, TBD | s(20) | 1 - 4 |
| 16 | LocalGranuleID | N/A | N/A | s(80) | 1 |
| 17 | PGEVersion | N/A | N/A | s(10) | 1 |
| 18 | CERProductionDateTime | N/A | N/A | datetime | 1 |
| 19 | LocalVersionID | N/A | N/A | s(60) | 1 |
| 20 | ProductGenerationLOC | N/A | SGI\_xxx, TBD | s(255) | 1 |
| 21 | NumberofRecords | N/A | 1 .. 9 999 999 999 | I10 | 1 |
| 22 | WestBoundingCoordinate | deg | -180.0 .. 180.0 | F11.6 | 1 |
| 23 | NorthBoundingCoordinate | deg | -90.0 .. 90.0 | F11.6 | 1 |
| 24 | EastBoundingCoordinate | deg | -180.0 .. 180.0 | F11.6 | 1 |
| 25 | SouthBoundingCoordinate | deg | -90.0 .. 90.0 | F11.6 | 1 |
| 22 | GRingPointLatitude | deg | -90.0 .. 90.0 | F11.6 | 5 |
| 23 | GRingPointLongitude | deg | -180.0 .. 180.0 | F11.6 | 5 |
| 24 | GRingPointSequenceNo | N/A | 0 .. 99999 | I5 | 5 |
| 25 | ExclusionGRingFlag | N/A | Y (= YES), N (= NO) | s(1) | 1 |
| 26 | CERWestBoundingCoordinate | deg | 0.0 .. 360.0 | F11.6 | 1 |
| 27 | CERNorthBoundingCoordinate | deg | 0.0 .. 180.0 | F11.6 | 1 |
| 28 | CEREastBoundingCoordinate | deg | 0.0 .. 360.0 | F11.6 | 1 |
| 29 | CERSouthBoundingCoordinate | deg | 0.0 .. 180.0 | F11.6 | 1 |
| 26 | CERGRingPointLatitude | deg | 0.0 .. 180.0 | F11.6 | 5 |
| 27 | CERGRingPointLongitude | deg | 0.0 .. 360.0 | F11.6 | 5 |
| 28 | GRingPointSequenceNo | N/A | 0 .. 99999 | I5 | 5 |
| 29 | ExclusionGRingFlag | N/A | Y (= YES), N (= NO) | s(1) | 1 |
| 30 | AutomaticQualityFlag | N/A | Passed, Failed, or Suspect | s(64) | 1 |
| 31 | AutomaticQualityFlagExplanation | N/A | N/A | s(255) | 1 |
| 32 | QAGranuleFilename | N/A | N/A | s(255) | 1 |
| 33 | ValidationFilename | N/A | N/A | s(255) | 1 |
| 34 | ImagerShortName | N/A | VIRS, MODIS, TBD | s(20) | 1 |
| 35 | InputPointer | N/A | N/A | s(255) | 800 |
| 36 | NumberInputFiles | N/A | 1 .. 9999 | I4 | 1 |

 describes the CERES\_metadata Vdata parameters which are written to all CERES HDF output science products.

Table ‑. CERES\_metadata Vdata

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Item | Parameter Name | Units | Range | DataType |
| 1 | ShortName | N/A | s(32) | 1 |
| 2 | RangeBeginningDate | 1997-11-19 .. 2050-12-31 | s(32) | 2 |
| 3 | RangeBeginningTime | 00:00:00.000000Z .. 24:00:00:000000Z | s(32) | 3 |
| 4 | RangeEndingDate | 1997-11-19 .. 2050-12-31 | s(32) | 4 |
| 5 | RangeEndingTime | 00:00:00.000000Z .. 24:00:00:000000Z | s(32) | 5 |
| 6 | AutomaticQualityFlag | Passed, Failed, or Suspect | s(64) | 6 |
| 7 | AutomaticQualityFlagExplanation | N/A | s(256) | 7 |
| 8 | AssociatedPlatformShortName | TRMM, EOS AM-1, EOS PM-1, TBD | s(32) | 8 |
| 9 | AssociatedInstrumentShortName | PFM, FM1, FM2, FM3, FM4, FM5, TBD | s(32) | 9 |
| 10 | LocalGranuleID | N/A | s(96) | 10 |
| 11 | LocalVersionID | N/A | s(64) | 11 |
| 12 | CERProductionDateTime | N/A | s(32) | 12 |
| 13 | NumberofRecords | 1 .. 9 999 999 999 | 4-byte Integer | 13 |
| 14 | ProductGenerationLOC | SGI\_xxx, TBD | s(256) | 14 |

The *XYZ* Product Specific Attribute (PSA) metadata are listed in . The definitions that are nearly identical for several parameters are defined only once, even though individually distinct parameters exist as shown in the table below.

Table ‑. *XYZ* Product Specific Metadata

|  |  |  |  |
| --- | --- | --- | --- |
| **Item** | **Parameter Name** | **Range** | **DataType** |
| 15 | Percent Total Channel Bad | 0.0 .. 100.0 | F11.6 |
| 16 | Percent Window Channel Bad | 0.0 .. 100.0 | F11.6 |
| 17 |  | Record Size (bytes) =nnn |  |

**PSA-1 Percent Total Channel Bad**

**PSA-2 Percent Window Channel Bad**

The percent of radiance samples that failed various edit checks and were then marked Bad during science processing.