CERES BDS Aqua Edition1
Data Quality Summary

Investigation:	**CERES**
Data Product:	**B**i**D**irectional **S**can (BDS)
Data Set:	**Aqua (Instruments: FM3, FM4)**
Data Set Version:	**Edition1, Edition1-CV**

The CERES Team cautions users that the Edition1 and Edition1-CV BDS data products utilize static calibration coefficients and do not attempt to correct for any temporal changes in the on-orbit radiometric performance of the instruments. The Edition1 and Edition1-CV BDS Data Product is used primarily as the input to the CERES Instrument Working Groups Cal/Val protocol. The Edition2 and later Data Set versions account for on-orbit radiometric performance changes and are thus recommended for use in scientific studies.

The purpose of this document is to inform users of the accuracy of this data product as determined by the CERES Team. This document briefly summarizes key validation results, provides cautions where users might easily misinterpret the data, provides links to further information about the data product, algorithms, and accuracy, gives information about planned data improvements. This document also automates registration in order to keep users informed of new validation results, cautions, or improved data sets as they become available.

This document is a high-level summary and represents the minimum information needed by scientific users of this data product. It is strongly suggested that authors, researchers, and reviewers of research papers re-check this document for the latest status before publication of any scientific papers using this data product.

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Nature of Data Product

In this document, Edition1 and Edition1-CV are used interchangeably.

The Edition1-CV version is a reprocessed version of Edition1, whose production ceased in November 2005, which uses consistent configuration codes over the entire product lifetime.

This document discusses the **B**i**D**irectional **S**can (**BDS**) data set version **Edition1** for Aqua. Additional information in the Description/Abstract Guide. The files in this data product contain one day (24 hours) of filtered radiances with geolocations for each footprint. There are three channels for each footprint:

- A total channel (TOT) that covers the wavelength range from about 0.4 microns to beyond 200 microns,
- A shortwave channel (SW) that covers the wavelength range from about 0.4 microns to about 4.5 microns,
- A window channel (WN) that covers the wavelength range from about 8.0 to about 12.0 microns

A filtered radiance for a particular channel is the integration over the wavelength of the product of radiance and the dimensionless spectral response for that channel.

The data are arranged in 6.6 second scans, with 660 samples per scan. Under normal conditions, the two CERES instruments on Aqua each operate on a 6 month cycle where the first three months are in a Fixed Azimuth Plane Scan (FAPS) mode and the second three months in a Rotating Azimuth Plane Scan (RAPS) mode. The cycles of the two instruments are offset by three months such that there is always one instrument operating in the FAPS mode and one in the RAPS mode. Every 14 days the RAPS instrument will be operated in a fixed azimuth along-track mode, during which spatial coverage in extremely limited. To determine CERES instrument operations on any given day, refer to the CERES Operations in Orbit. Typically, the FAPS instrument scans in a cross-track fashion (perpendicular to the satellite ground track), so that the footprints nearly cover the swath beneath the satellite from one limb to the other and then back in the reverse direction. The RAPS scans also sample the swath from limb-to-limb, but the spatial coverage has gaps that are scattered across the observable swath.

Data Users are strongly urged to use the field-of-view locations included in this data product rather than attempting to locate the

footprints based on satellite orbit, scan elevation angle, and scan azimuth. Data Users should note that the colatitude and longitude given in the geolocation have a default coordinate system that is geodetic. In a few cases (such as the viewing angles), the coordinate system may be geocentric. Users of this data should also note that geolocation is generally given for a point on the Earth's surface and for a point on a surface 30 Km above the nominal geoid used in ERBE. Users are responsible for taking care to understand and account for differences between geocentric locations and geodetic one as well as the difference in altitude.

The CERES Team has gone to considerable effort to identify and remove instrument artifacts from these data. As part of their work, the Team sets quality assessment flags for each instrument. **Data Users are also strongly urged to examine the flags that the CERES Team sets in order to determine if the data for that footprint are assessed as good.** A full list of parameters on the BDS is contained in the CERES Data Product Catalog and a full definition of each parameter is contained in the BDS Collection Guide.

When referring to a CERES data set, please include the satellite name and/or the CERES instrument name, the data set version, and the data product. Multiple files which are identical in all aspects of the filename except for the 6 digit configuration code (see Collection Guide) differ little, if any, scientifically. Users may, therefore, analyze data from the same satellite/instrument, data set version, and data product without regard to configuration code. The current data set may be referred to as "CERES Aqua FM4 Edition1 BDS", "CERES Aqua FM3 Edition1 BDS", "CERES Aqua FM4 Edition1-CV BDS", or "CERES Aqua FM3 Edition1-CV BDS".

Validation and Quality Assurance Process for this Data Set

The CERES Team has performed the following validation and quality assurance processes on this data set:

- Development of an error budget for the ground and in-flight calibrations
- Determination of instrument offsets using ground calibration data
- Verification of ground calibration transfer to orbit using internal and solar calibration sources in flight
- Monitoring of calibration stability using internal and solar calibration sources in flight
- Verification of geolocation using coast-line crossings

Data Users who have detailed questions about these studies should consult the Algorithm Theoretical Basis Documents or the CERES Validation Documents.

Current Estimated uncertainty of Data in this Data Set

Radiometric Uncertainty:

The filtered radiances in this data product contain instrument noise, which acts like a Gaussian random variable added to each value. The algorithm that converts the raw instrument counts to filtered radiances also contains uncertainties from several sources:

- Sample-dependent offsets - determined from ground calibration data
- Determination of the gain - primarily using ground calibrations that have systematic errors from sources such as blackbody emissivities, calibration masks, and spectral response measurements
- Possible changes in instrument radiometric characteristics owing to differences between the space environment and the calibration environment

The CERES Team has evaluated the ground calibration uncertainties and continually monitors the calibration stability using internal flight sources, solar calibrations and vicarious studies. We recognize that different uncertainties affect measurements with different time and space scales. Measurement precision is the random component of uncertainty for a particular time and space scale. Accuracy is the agreement of an ensemble average of the measurements with true values on the particular time and space scale. For the radiometric measurements in the Aqua Edition1 BDS data products, the instrument noise is probably the dominant contributor to the precision, while systematic errors are more likely to affect the gain of the instrument, and thereby its accuracy. The following tables give a more quantitative assessment of the ground calibration uncertainty, using the concept of a fidelity interval.

Fidelity Intervals. These initial estimates include instrument noise, uncertainty in determination of scan dependent offsets, and statistical uncertainty in the estimates of the calibration coefficients during ground calibration (primarily instrument gain). Confidence in the long term instrument stability depends on the experience gained over several years using the in-orbit calibration studies. The fidelity intervals are intended to convey the upper and lower bounds of filtered radiance within which the true value might lie for a particular measurement in the data files. They are symmetric about the measured value, so the tables only contain one-sided intervals. For example, for a total filtered radiance value of 30 $Wm^{-2}sr^{-1}$, the true value is likely to be between 30 - 0.32 $Wm^{-2}sr^{-1}$ and 30 + 0.32 $Wm^{-2}sr^{-1}$ with a probability of 99.7%. Roughly speaking, the fidelity interval we quote is a "3 sigma" value.

Total Channel

Total Filtered Radiance in File [$Wm^{-2}sr^{-1}$]		**30**	**60**	**90**	**120**	**150**
Filtered Radiance Interval with 99.7% Probability true Filtered	**FM3**	.079	.074	.073	.075	.082

Radiance is this close [Wm^{-2}sr^{-1}]	**FM4**	.081	.076	.075	.077	.084

Shortwave Channel

Total Filtered Radiance in File [Wm^{-2}sr^{-1}]		**0**	**10**	**25**	**35**	**45**
Filtered Radiance Interval with 99.7% Probability true Filtered Radiance is this close [Wm^{-2}sr^{-1}]	**FM3**	.69	.65	.62	.63	.65
	FM4	.68	.64	.61	.62	.64

Window Channel

Total Filtered Radiance in File [Wm^{-2}sr^{-1}]		**1.5**	**3**	**5**	**7.5**	**10**
Filtered Radiance Interval with 99.7% Probability true Filtered Radiance is this close [Wm^{-2}sr^{-1}]	**FM3**	.03	.029	.029	.031	.034
	FM4	.028	.027	.027	.029	.032

Geolocation Uncertainty:

The footprints in these data sets have a colatitiude and longitude identified at the centroid of the Point Spread Function (PSF) (figure 1-5 in the Subsystem 1.0 ATBD provides an illustration of the PSF). There are two independent degrees of freedom associated with this centroid. Using the coast-line validation approach to provide an estimate of geolocation uncertainty, the CERES Team has apportioned these uncertainties into a component in the **satellite ground track** direction (**along-track**) and a component perpendicular to the **satellite ground track** direction (**cross-track**). See "Quick Look Results - Data Validation" for visualization of sample coast-line measurements.

Cautions When Using Data

The CERES Team cautions users that the Edition1 and Edition1-CV BDS data products utilize static calibration coefficients and do not attempt to correct for any temporal changes in the on-orbit radiometric performance of the instruments. The Edition1 and Edition1-CV BDS Data Product is used primarily as the input to the CERES Instrument Working Groups Cal/Val protocol. The Edition2 and later Data Set versions account for on-orbit radiometric performance changes and are thus recommended for use in scientific studies.

Note that the Rotating Azimuth Plane CERES data has gaps in spatial sampling caused by its full azimuth sampling. These gaps increase spatial sampling errors for a single 2.5 degree grid box on a single satellite overpass to about 10 Wm^{-2} (1 sigma) and for monthly mean grid box values to about 2 Wm^{-2} (1 sigma).

Expected Reprocessing

The Aqua Spacecraft is expected to perform a deep space pitchover maneuver. This maneuver will allow CERES to make final measurements of their scan dependent offsets by allowing the instruments to scan deep space. If these measurements demonstrate significant change from pre-flight values, they will be incorporated in future data product editions. An update will be posted in the Quality Summary once this maneuver is completed and the measurements analyzed.

References

Currey, C. , L. Smith, and B. Neely, 1998, "Evaluation of Clouds and the Earth's Radiant Energy System (CERES) scanner point accuracy using a coastline detection system", Proc. of SPIE, *Earth Observing Systems III*, **3439**, 367-376.

Priestley et al., "Postlaunch Radiometric Validation of the Clouds and the Earth's Radiant Energy System (CERES) Proto-Flight Model on the Tropical Rainfall Measuring Mission (TRMM) Spacecraft through 1999", *J. Appl. Meteor.*, **39 (12)**, 2249-2258, December 2000.

Referencing Data in Journal Articles

The CERES Team has gone to considerable trouble to remove major errors and to verify the quality and accuracy of these data. **Please**

provide a reference to the following paper when you publish scientific results with the CERES Aqua Edition1 BDS data:

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

When data from the Langley Atmospheric Science Data Center are used in a publication, **we request the following acknowledgment be included:**

"These data were obtained from the Atmospheric Science Data Center at NASA Langley Research Center."

The Langley Data Center requests a reprint of any published papers or reports or a brief description of other uses (e.g., posters, oral presentations, etc.) of data that we have distributed. This will help us determine the use of data that we distribute, which is helpful in optimizing product development. It also helps us to keep our product-related references current.

Feedback:

For questions or comments on the CERES Data Quality Summary, contact the User and Data Services staff at the Atmospheric Science Data Center.

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