CERES BDS S-NPP Edition 2 Data Quality Summary

Investigation:	**CERES**
Data Product:	**Bi**Directional **S**can (BDS)
Data Set:	**S-NPP (Instrument: FM5)**
Data Set Version:	**Edition 2**

Subsetting Tool Availability: http://ceres.larc.nasa.gov/products.php

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.

User applied revisions are a method CERES uses to identify improvements to existing archived data products that are simple for users to implement and allow correction of data products that would not be possible in the archived versions until the next major reprocessing 1 to 2 years in the future. All revisions applicable to this data set are noted in the section User Applied Revisions for Current Edition.

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.

NOTE: To navigate the document, use the Adobe Reader bookmarks view option. Select "View" "Navigation Panels" "Bookmarks".

Distributed by the Atmospheric Science Data Center
http://eosweb.larc.nasa.gov

TABLE OF CONTENTS

Section Page

1.0 Nature of the BDS Product 1
2.0 Processing Updates in Current Edition 2
2.1 User Applied Revisions for Current Edition 2
3.0 Validation and Quality Assurance Process for this Data Set 2
4.0 Current Estimated uncertainty of Data in this Data Set 2
4.1 Radiometric Uncertainty 2
4.2 Geolocation Uncertainty 4
5.0 Cautions and Helpful Hints 4
6.0 Version History 4
6.1 Edition1-CV 4
6.2 Edition 1 5
6.3 Edition 2 6
7.0 Expected Reprocessing 6
8.0 References 7
9.0 Attribution 7
10.0 Feedback and Questions 7

LIST OF FIGURES

<u>Figure</u> <u>Page</u>

Figure 6-1 FM 5 Edition 1 In-Flight Gain Adjustment.. 6

LIST OF TABLES

Table Page

Table 4-1. Fidelity Intervals - Total ... 3
Table 4-2. Fidelity Intervals - Shortwave ... 3
Table 4-3. Fidelity Intervals - Window ... 4
Table 4-4. Geolocation Uncertainty Budget ... 4
Table 6-1. FM 5 Edition1-CV Ground to flight Gain Shift ... 5
Table 6-2. FM 5 Edition 1 Ground to flight Gain Shift ... 5
Table 6-3. FM 5 Edition 2 Ground to flight Gain Shift ... 6

1.0 Nature of the BDS Product

This document discusses the **B**i**D**irectional **S**can (**BDS**) data set version **Edition 2** for S-NPP. 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) covers the wavelength range from about 0.3 µm to beyond 200 µm,
- A shortwave channel (SW) covers the wavelength range from about 0.3 µm to about 4.5 µm,
- A window channel (WN) covers the wavelength range from about 8.0 to about 12.0 µm

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 CERES instrument on S-NPP will operate continually in a Fixed Azimuth Plane Scan (FAPS). The FAPS scans are taken with a cross-track azimuth (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. To determine CERES instrument operations on any given day, refer to the CERES Operations in Orbit.

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 the 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 Products 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 S-NPP FM5 Edition2 BDS".

2.0 Processing Updates in Current Edition

Corrections implemented in the CERES Edition 2 S-NPP BDS products consist of:

1. Correction for erroneous ground-to-flight gain adjustment algorithm that was applied to Edition 1 products.

2.1 User Applied Revisions for Current Edition

The purpose of User Applied Revisions is to provide the scientific community early access to algorithm improvements which will be included in the future Editions of the CERES data products. The intent is to provide users simple algorithms along with a description of how and why they should be applied in order to capture the most significant improvements prior to their introduction in the production processing environment. ***It is left to the user to apply a revision to data ordered from the Atmospheric Science Data Center***. Note: Users should never apply more than one revision. Revisions are independent and the latest, most recent revision to a data set includes all of the identified adjustments.

There are currently no user applied revisions for this data product.

3.0 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:

1. Development of an error budget for the ground and in-flight calibrations.
2. Determination of instrument offsets using flight calibration data.
3. Verification of ground calibration transfer to orbit using internal sources in flight.
4. Monitoring of calibration stability using internal and solar calibration sources in flight.
5. 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.

4.0 Current Estimated uncertainty of Data in this Data Set

4.1 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:

1. Sample-dependent offsets - determined from ground calibration data.

2. Determination of the gain - primarily using ground calibrations that have systematic errors from sources such as blackbody emissivities, calibration masks, and spectral response measurements.
3. 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 S-NPP Edition 2 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 $Wm^{-2}sr^{-1}$ with a probability of 99.7%. Roughly speaking, the fidelity interval we quote is a "3 sigma" value.

Table 4-1. Fidelity Intervals - Total

Total Channel						
Filtered Radiance in File [$Wm^{-2}sr^{-1}$]		**30**	**60**	**90**	**120**	**150**
Filtered Radiance Interval with 99.7% Probability true Filtered Radiance is this close [$Wm^{-2}sr^{-1}$]	**FM5**	0.184	0.182	0.189	0.196	0.198

Table 4-2. Fidelity Intervals - Shortwave

Shortwave Channel						
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 [$Wm^{-2}sr^{-1}$]	**FM5**	0.215	0.221	0.220	0.208	0.223

Table 4-3. Fidelity Intervals - Window

Window Channel						
Filtered Radiance in File [$Wm^{-2}sr^{-1}$]		**3**	**10**	**20**	**30**	**35**
Filtered Radiance Interval with 99.7% Probability true Filtered Radiance is this close [$Wm^{-2}sr^{-1}$]	**FM5**	0.178	0.175	0.180	0.179	0.177

4.2 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**).

Table 4-4. Geolocation Uncertainty Budget

Component		**Angular Bias**	**Nadir Location Bias**	**Standard Deviation**
FM5	Along-Track	-0.02 degrees	-0.28 km	4.66 km
	Across-Track	+0.07 degrees	+1.06 km	5.83 km

5.0 Cautions and Helpful Hints

It is left to the user to apply applicable revisions to their data as described in the section entitled User Applied Revisions for Current Edition. Data users need to be aware of CERES spectral response tabulations for each channel when they apply filtered radiances to such investigations as verifying agreement with theoretical radiative transfer calculations. (For a figure showing the spectral response of each channel, see the Subsystem 1.0 ATBD.)

6.0 Version History

6.1 Edition1-CV

In Edition1-CV, the CERES BDS products are produced based on static ground calibration coefficients with no temporal corrections. However, the following corrections were implemented in production based on in-flight data.

1. A ground-to-flight gain shift. These changes are made to account for changes between ground and in-flight calibration environments, on-orbit changes in instrument responsivity, and effects due to changes in sensor spectral response functions. The values are shown in the following table.

Table 6-1. FM 5 Edition1-CV Ground to flight Gain Shift

FM 5 (%)		
Total	**Window**	**Shortwave**
-0.11	0.02	-0.02

2. For the radiometric measurements, the instrument noise is probably the dominant contributor to the precision. To help reduce the noise due to scan-dependent offsets uncertainty, the NPP spacecraft performed a deep space pitchover maneuver in February 2012. This maneuver allowed CERES to make final measurements of their scan dependent offsets by allowing the instrument to scan deep space.

6.2 Edition 1

In Edition 1, the following updates were made to the BDS Data products.

1. Corrections for ground to flight changes based on in-flight data. This chart has been updated and will be used with Edition 2 processing.

Table 6-2. FM 5 Edition 1 Ground to flight Gain Shift

FM 5 (%)		
Total	**Window**	**Shortwave**
-0.22	0.04	-0.05

2. Corrections for on-orbit gain drifts in the calibration coefficients, shown below, using an off-line derived algorithm.
3. Applied gain correction coefficients using one gain value per month; no daily interpolations.

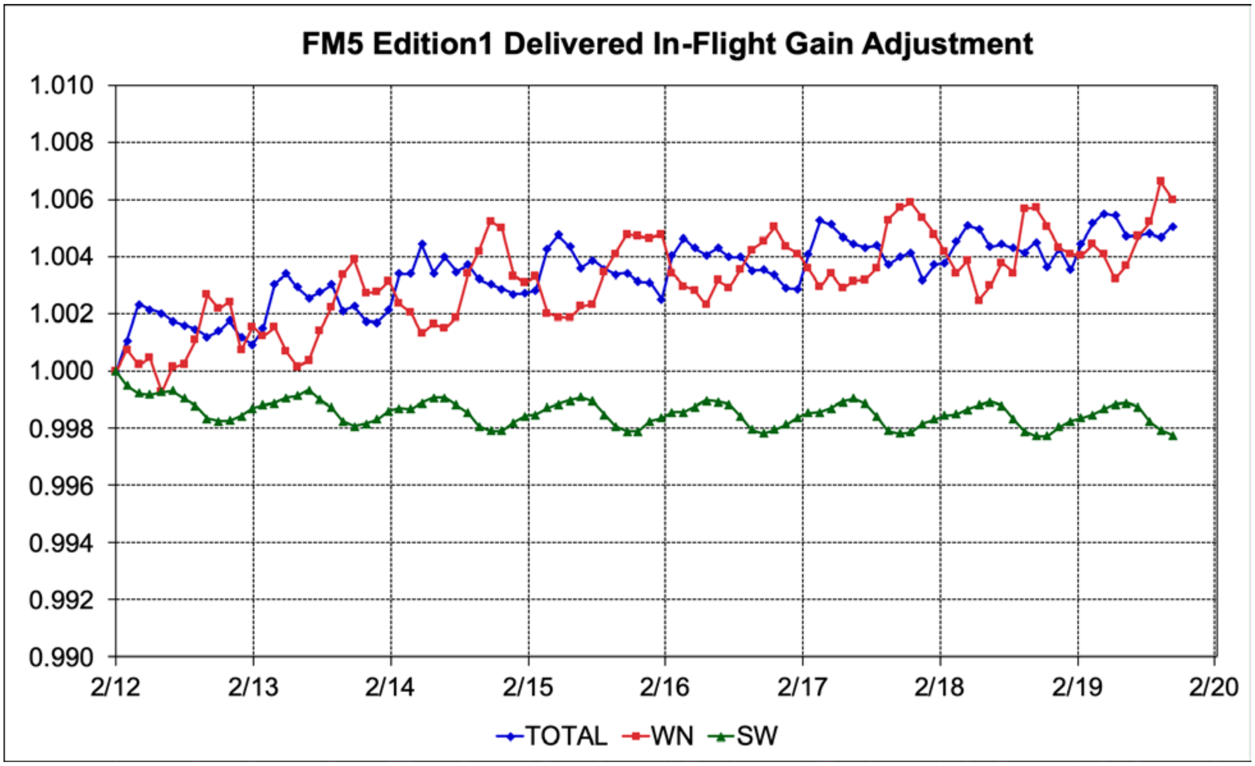

Figure 6-1 FM 5 Edition 1 In-Flight Gain Adjustment

6.3 Edition 2

In Edition 2, the following updates were made to the BDS Data product:

1. Correction for erroneous ground-to-flight algorithm that was applied to Edition 1 products.
2. Minor adjustments in the total channel ground-flight algorithm to account for on-orbit detector bias voltage.

Table 6-3. FM 5 Edition 2 Ground to flight Gain Shift

FM 5 (%)		
Total	**Window**	**Shortwave**
-0.11	0.02	-0.02

7.0 Expected Reprocessing

There is no expected reprocessing planned at this time.

8.0 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.

9.0 Attribution

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 S-NPP Edition 2 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.

10.0 Feedback and Questions

For questions or comments on the CERES Data Quality Summary, contact the Atmospheric Science Data Center.

For questions about the CERES subsetting/visualization/ordering tool at http://ceres.larc.nasa.gov/order_data.php, please click on the feedback link on the left-hand banner.

Document Creation Date: March 2, 2020
Modified: n/a
Most Recent Update: n/a
