CERES Terra Edition2 SFC
CERES Aqua Edition2 SFC
Data Quality Summary

Investigation:	**CERES**
Data Product:	**Monthly Gridded TOA/Surface Fluxes and Clouds (SFC)**
Data Set:	**Terra (Instruments: CERES-FM1 or CERES-FM2, MODIS)** **Aqua (Instruments: CERES-FM3 or CERES-FM4, MODIS)**
Data Set Version:	**(Terra) Edition2A, Edition2B, Edition2C, Edition2F, Edition2G** **(Aqua) Edition2A, Edition2B, Edition2C, Edition2D**

The purpose of this document is to inform users of the accuracy of this data product as determined by the CERES Science Team. The document summarizes user applied revisions (e.g. Rev1), key validation results, provides cautions where users might easily misinterpret the data, provides links to further information about the data product, algorithms, and accuracy, and 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 to 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.

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Nature of the SFC Product

This document discusses SFC versions Terra Edition2A/B/C/F/G and Aqua Edition 2A/B/C/D. This document was written for both Terra and Aqua Edition2 products, since the purpose of the SFC is to spatially grid the SSF parameters. The CERES product edition naming convention is a function of input and algorithm differences. Consistent input and algorithms are necessary to avoid algorithm shock to the output parameters in order to retain a consistent climate quality record. See the table of CERES Edition2 product versions. There are no algorithm or coding changes between Terra Edition2C/F/G and Aqua Edition 2A/B/C/D. Any differences are due entirely to changes from the input, such as differences in the Terra and Aqua SSF. The difference between Terra Edition2C and 2F or Aqua Edition2B or 2C is that the latter uses collection 5 MODIS data as input. There are no edition versions between Terra Edition2C and 2F. There are coding changes between Terra Edition 2A, 2B and 2C and these changes are documented in Cautions and Helpful hints. **The user should always use the latest Edition that is available.** The difference between Terra Edition2C and 2F or Aqua Edition2B or 2C is that the latter uses collection 5 MODIS data as input. The difference between Terra Edition2F and 2G or Aqua Edition2C and 2D is that the latter uses GFDL GEOS5.2 instead of GEOS-4 atmospheric profiles.

The Monthly Gridded TOA/Surface Fluxes and Clouds (SFC) archival data product contains hourly single scanner flux and cloud parameters averaged over 1.0-degree regions. Input to the SFC Subsystem is the Single Scanner Footprint TOA/Surface Fluxes and Clouds (SSF) archival data product. Each SFC covers a single month of data from a single CERES instrument mounted on one satellite. Individual SFC Edition2 files contain information for five consecutive latitude bands.

Instantaneous CERES footprint data are sorted by region and time. Gridded means of SSF data are calculated in hourly local solar time increments for each region with at least one CERES observation. These region/time increments are centered on the local half-hour and are referred to as "hourboxes." The major categories of data output on the SFC are as follows:

- Region-specific data such as surface properties and elevation
- Time and viewing geometry data
- Total-sky radiative fluxes at the top of the atmosphere (TOA) and surface

- Clear-sky radiative fluxes at TOA and surface
- Layer mean cloud properties for 4 pressure layers
- Shortwave flux averages for the prominent angular directional model (ADM) scene classes.

All CERES footprints with a non-default value of either Shortwave (SW) or Longwave (LW) flux are used in the SFC product. CERES data collected during the Rotating Azimuth Plane (RAP), crosstrack, and the alongtrack scan modes are used.

A full list of parameters on the SFC is contained in the CERES Data Product Catalog (PDF) and a full definition of each parameter will be contained in the SFC 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 that are identical in all aspects of the filename except for the 6 digit configuration code 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. Depending upon the instrument analyzed, these data sets may be referred to as
"CERES Terra FM1 Edition2A SFC", "CERES Terra FM2 Edition2A SFC",
"CERES Terra FM1 Edition2B SFC", "CERES Terra FM2 Edition2B SFC",
"CERES Terra FM1 Edition2C SFC", "CERES Terra FM2 Edition2C SFC",
"CERES Terra FM1 Edition2F SFC", "CERES Terra FM2 Edition2F SFC",
"CERES Terra FM1 Edition2G SFC", "CERES Terra FM2 Edition2G SFC",
"CERES Aqua FM3 Edition2A SFC", "CERES Aqua FM4 Edition2A SFC",
"CERES Aqua FM3 Edition2B SFC", "CERES Aqua FM4 Edition2B SFC",
"CERES Aqua FM3 Edition2C SFC", "CERES Aqua FM4 Edition2C SFC",
"CERES Aqua FM3 Edition2D SFC", or "CERES Aqua FM4 Edition2D SFC",

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 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.

SFC Edition2-Rev1

The Edition2-Rev1 is applicable to all Aqua and Terra Edition2 SFC parameters regardless of Edition2 letter. The CERES Science Team has approved a table of scaling factors for Terra and a table of scaling factors for Aqua which users should apply to the Edition2C SFC parameters.

For the ***SFC SW TOA Fluxes (Up)***, users should use the following equation:

- $SW_{TOA}Flux_{rev1} = SW_{TOA}Flux_{orig} * scaling\_factor$

The SFC SW TOA Fluxes (Up) are listed in the table below:

SFC TOA SW Flux	SDS Index
SW TOA Clear-Sky Flux	SFC-29
SW TOA Total-Sky Flux	SFC-33

For the ***SFC TOA Albedos***, users should use the following equation:

- $Albedo_{rev1} = Albedo_{orig} * scaling\_factor$

The SFC TOA Albedos are listed below:

SFC TOA Albedo	SDS Index
ALB TOA Clear-Sky	SFC-32
ALB TOA Total-sky	SFC-36

For the ***SFC Net SW SRF Fluxes***, users should use the following equation:

- $Net_{SRF}Flux_{rev1} = Net_{SRF}Flux_{orig} - SW_{TOA}Flux_{orig} * (scaling\_factor - 1.0)$

The SFC Net SW SRF Fluxes are listed below:

SFC Net SW SRF Fluxes	SDS Index
Net SW SRF Model A Clear-Sky Flux	SFC-40
Net SW SRF Model B Clear-Sky Flux	SFC-44
Net SW SRF Model A Total-sky Flux	SFC-49
Net SW SRF Model B Total-Sky Flux	SFC-53

For the ***SFC SW SRF Fluxes (Down)***, no correction should be applied, and thus:

- $SW_{SRF}Down_{rev1} = SW_{SRF}Down_{orig}$

The SFC SW SRF Fluxes (Down) are listed below:

SFC SW SRF Fluxes (Down)	SDS Index
SW SRF Model A Clear-Sky Flux	SFC-37
SW SRF Model B Clear-Sky Flux	SFC-42
SW SRF Model A Total-Sky Flux	SFC-46
SW SRF Model B Total-Sky Flux	SFC-51

This revision is necessary to account for spectral darkening of the transmissive optics on the CERES SW channels. By June 2005, this darkening has reduced the average global all-sky SW flux measurements by 1.1 and 1.8 percent for Terra FM1 and FM2 data respectively. By June 2005, this darkening has reduced the average global all-sky SW flux measurements by 1.1 and 1.8 percent for Aqua FM3 and FM4 data respectively. A complete description of the physics of this darkening appears in the CERES BDS Terra Edition2 Quality Summary under the Expected Reprocessing section. After application of this revision to the SFC Edition2, append Rev1 to the product name when referring to the SFC Edition2 dataset. For example, Terra Edition2C SFC product would be referred to as Terra Edition2C SFC-Rev1.

Cautions and Helpful Hints

There are several cautions and helpful tips that the CERES Science Team notes regarding the use of CERES-Terra SFC data:

Applicable to Terra Edition2A SFC product only:

- The Julian time is set to default for all hours. The SFC file provides the user with the local time of the averaged data, but the exact Julian time of the observations is unavailable.
- ADM scene class 591 has been mistakenly used to denote both scenes with significant snow or ice cover and "unknown" scene types (see the scene type definition table). Users can determine the correct type by checking the surface type percentages under the "Surface Map and Full-Clear Area Data". The sum of surface types 15 (permanent snow), 19 (fresh snow), and 20 (sea ice) provides the total amount of snow/ice in the scene. If this total percentage equals the fractional coverage of scene type 591, then this scene is correctly classified as scene type 591 (snow/ice). If these percentages are not equal, then this scene should have been classified as scene type 592 (unknown), which is reserved for scenes with insufficient imager data to determine cloud properties. Additionally, users should also check for default values in the Imager Mean radiances under "Imager Radiance Statistics". If the mean radiance values are default, then this scene should also be classified as scene class 592 (unknown).
- The user should also be aware that scenes with no imager radiance data could be mistaken for clear scenes. In these cases, the four cloud layer amounts are incorrectly defined as 0., but should have been set to default values. Users can screen these cases by checking for default values in the Imager Mean radiances under "Imager Radiance Statistics". If the channel 1 and 4 radiances are default, then the cloud amount should be considered to be undefined.

Applicable to Terra Edition2B SFC product only:

- There is one known issue concerning the data products on this edition of the SFC. Observations from the last 12 hours of each month can have erroneous hourbox indices. Users can identify these hours by viewing the complete list of hourbox indices for a specific region. These indices should be in ascending order. Any index that is lower than the previous index indicates that this hourbox, and all successive hourboxes from this region, are invalid and should not be used in analysis by the user.

Applicable to Aqua SFC product only:

- To reduce the effect of electronic crosstalk signals in Window channel measurements induced by high Shortwave (bright) scenes, a bridge balance memory patch was developed and uploaded on September 30, 2004 and unloaded on October 12, 2004. This patch was intended to modify the Window bridge balance set to point to midrange (2048). This patch, however, inadvertently set the bridge balance set points to midrange (2048) for all 3 channels. This reduced the dynamic range for the Total and Shortwave channels leading to saturated radiometric measurements. Saturations typically occurred for the brightest earth-viewing scenes, resulting in data dropout at high radiance values. As a result of this, some regional and zonal monthly mean SW and LW TOA fluxes are biased in October 2004 due to missing fluxes from DCCs. The problem also causes biases in global mean fluxes. While the Aqua Edition2C dataset does not include the affected data, users looking at both the Edition2B and Edition2C datasets need to be aware of this error.

Applicable to all CERES SFC Edition2 products:

- TOA SW data are corrected to a common solar zenith angle (SZA) before averaging in each hourbox. This requires two corrections:
    1. The modification of the solar insolation from the SZA of the observation to the SZA of the central time of the hourbox,
    2. The correction of the observed albedo to the SZA of the central time using directional models of albedo as a function of SZA and scene type.

  For surface SW fluxes, only the correction based on the change in solar insolation is applied. There is no correction for the change of albedo with SZA.

- Mean SW fluxes are calculated for up to 20 ADM scene classes in each hourbox. These scene classes are a function of surface type, cloud amount, cloud phase, and optical depth and are consistent with the ADM types used for producing fluxes from the CERES instrument aboard the Tropical Rainfall Measuring Mission (TRMM) (see a discussion of TRMM ADM). These ADM scene classes are different from the ADM classes used to calculate fluxes on the Terra Edition2B SSF (see the CERES SSF Terra Edition2 Data Quality Summary). The data are sorted consistently with the TRMM ADM scene classes so that these data can be used with directional models (DRM) of the variation of albedo with solar zenith angle that were developed from TRMM data. These DRM are used to interpolate the measured albedos to unobserved hours of the day during the calculation of the monthly mean SW flux. TRMM data are used for DRM development since the TRMM orbit precesses through all local times and therefore samples the full range of SZA. The sun-synchronous Terra and Aqua orbits do not provide the SZA sampling necessary for ADM and directional model development.

- The mean clear-sky flux for each hourbox is calculated using only footprints with cloud amounts less than 0.1%.

- The SFC product contains data collected from rotating azimuth (RAP), alongtrack, and crosstrack scanning operating modes. Users can identify hours that include RAP data by checking the viewing zenith angle and relative azimuth angles for default values. These parameters cannot be defined for RAP data. The user can check the scan mode used on a given day by consulting the CERES Operations in Orbit web site.

- Users should be careful about comparisons of SFC CERES TOA fluxes with ERBE or ERBE-like fluxes. The geographic location of a CERES flux estimate is at the surface geodetic latitude and longitude of the CERES footprint centroid. On ERBE, all fluxes are located at a geocentric latitude and longitude corresponding to the 30-km level. Other differences are expected due to:
    1. The viewing zenith angle cut-off for ERBE-like footprints is 70°. For the Terra SFC, it is limited to 65° in crosstrack mode.
    2. ERBE-like fluxes were derived from ADMs developed from ERBE and NIMBUS-7 data. The SFC fluxes were derived using the new CERES ADMs.

  An overview of the ERBE-like/CERES flux differences can be found in the CERES SSF Terra Edition2 Data Quality Summary

- All CERES footprints with a non-default value of either SW or LW flux have been used as input to the SFC.

- The SFC contains gridded means of all data currently available on the SSF product. Users should consult the CERES SSF Terra Edition2 Data Quality Summary for information concerning the availability and accuracy of individual parameters. For instance, Shortwave Model A surface fluxes are limited to clear-sky footprints. Longwave Model A surface fluxes are also limited to clear-sky footprints. Shortwave Model B and Longwave Model B surface fluxes, however, are available for all-sky.

- The User should be aware that the Terra SFC contains aerosol parameters from MODIS that are not included on the TRMM SFC product. This results in a slight change in the read routines.

Accuracy and Validation

The User should consult the CERES SSF Terra Edition2 Data Quality Summary for information on the accuracy of the data used as input to the SFC. There are no known issues with the accuracy of the sorting and gridding of the data to produce the SFC.

References

An overview of the temporal interpolation and spatial averaging algorithms used for CERES can be found in the following reference:

Young, D. F., P. Minnis. D. R. Doelling, G. G. Gibson, and T. Wong, 1998: Temporal Interpolation Methods for the Clouds and Earth's Radiant Energy System (CERES) Experiment. *J. Appl. Meteorol.*, **37**, 572-590.

Expected Reprocessing

At this time, there are no scheduled revisions of the CERES Edition2 SFC data set. The CERES Team will continue detailed examination and documentation of the ground calibration and characterization data, as well as the in-flight calibration opportunities. Any future reprocessing of the Terra SSF will require an updated version of the SFC. Notification of any changes will be sent to registered users

Attribution

The CERES Team has gone to considerable trouble to remove major errors and to verify the quality and accuracy of this data. Please provide a reference to the following paper when you publish scientific results with the CERES SFC Edition2 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 Langley ASDC data are used in a publication, we request the following acknowledgment be included: "These data were obtained from the NASA Langley Research Center EOSDIS Distributed Active Archive Center."

The Langley ASDC requests two reprints of any published papers or reports which cite the use 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.

When referring to a CERES product, please include the satellite name (Terra or Aqua), the dataset version (Edition2A/B/C/F), and the product name (SFC). For example, use CERES Terra Edition2C SFC data.

Feedback and Questions

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

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