FLASHFlux SSF Terra Version2
FLASHFlux SSF Aqua Version2
Data Quality Summary

Investigation:	**FLASHFlux**
Data Product:	**Single Scanner Footprint TOA/Surface Fluxes and Clouds (SSF)**
Data Sets:	**Terra (Instruments: CERES-FM1 or CERES-FM2, MODIS)**
	Aqua (Instruments: CERES-FM3 or CERES-FM4, MODIS)
Data Set Family:	**Version2**
Data Set Versions:	**Version2A, Version2B, Version2C, Version2D, Version2E, Version2F, Version2G, Version2H**

The Fast Longwave and SHortwave Flux (FLASHFlux) project is based upon the algorithms developed for and data collected by the Clouds and the Earth's Radiant Energy Systems (CERES) project. CERES is currently producing world-class climate data products derived from measurements taken aboard NASA's Terra and Aqua spacecrafts. While of exceptional fidelity, these data products require a considerable amount of processing to assure quality and verify accuracy and precision. The result is that CERES data are typically released more than six months after acquisition of the initial measurements. For climate studies, such delays are of little consequence especially considering the improved quality of the released data products. There are, however, many uses for the CERES data products on a near real-time basis. These include CERES instrument calibration and subsystem quality checks, CloudSat operations, seasonal predictions, land and ocean assimilations, support of field campaigns, outreach programs such as S'COOL, and application projects for agriculture and energy industries.

The FLASHFlux project was envisioned as a conduit whereby CERES data could be provided to the community within a week of the initial measurements, with the trade-off that some degree of fidelity would be exacted to gain speed. Since the FLASHFlux project was created to provide retrievals for the entire globe, this document will focus on the Model B parameters (SSF-46 through SSF-49) that provide surface fluxes for cloudy and clear sky conditions.

The purpose of this document is to inform potential users of the FLASHFlux data of the differences between the FLASHFlux and CERES data product which have the same designation. This document also provides potential users with information concerning the difference between versions within the Version2 family. This document provides the data users with: cautions where they could possibly misinterpret the data; links to further information about the data product, algorithms, and accuracy; and information about planned changes. Even though the FLASHFlux endeavor intends to incorporate the latest input data sets and improvements into its algorithms, there are no plans to reprocess the FLASHFlux data products once these modifications are in place. Thus, in contrast to the CERES data products, the FLASHFlux data products are **not** to be considered of climate quality. Users seeking climate quality should instead use the CERES data products.

The FLASHFlux Version2 data sets refer to all files within the Version2 family. When changes are made that may noticeably affect one or more output parameters, the letter which follows the version number is changed (e.g., Version5D, Version5E, and Version5F would all belong to the Version5 family of SSF files). All files with the same number belong in the same version family, regardless of the letter that follows. Substantial changes will result in a version number change, which also changes the version family. By definition, adding or removing SSF parameters will always result in a version number/family change. Every SSF version family has its own Data Quality Summary. The Terra and Aqua data sets with the same Version number will usually be produced and made publicly available at nearly the same time. There is, however, no FLASHFlux requirement which stipulates that this must be done. In addition, there is no requirement that Terra and Aqua data sets with the same Version number and letter are produced using identical coding and/or inputs (See Data Sets within the Version2 family table in this data quality document).

The switch from Version1 to Version2 occured when FLASHFlux processing began using a GEOS-5 based Meteorological Ozone and Aerosol (MOA) input. The FLASHFlux Version1 family of data sets used a GEOS-4 based MOA input.

Please note, this document is a high-level summary and represents the minimum information for scientific users of this data product. We strongly urge authors, researchers, and reviewers of research papers to periodically re-check this URL for the latest status of this Data Set Version and particularly before publication of any scientific papers using the data.

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Nature of the SSF Product

The Terra and Aqua SSF data sets contain over 160 parameters which are associated with each field of view. These parameters contain information on time and position, viewing angles, surface maps, scene type, filtered and unfiltered radiance, top-of-atmosphere (TOA) and surface fluxes, footprint area (clear, cloudy and full), footprint imager radiance statistics, and MODIS land and ocean aerosols. The parameters of immediate concern for FLASHFlux are the TOA and surface fluxes associated with SW Model B (LPSA) and LW Model B (LPLA). The full, clear and cloudy footprint area parameters contain meteorological data that are also critical to calculating the surface fluxes.

CERES defines SW (shortwave or solar) and LW (longwave or thermal infrared) in terms of physical origin, rather than wavelength. As with CERES, FLASHFlux refers to the solar radiation that enters or exits the Earth-atmosphere system as SW. LW is the thermal radiant energy emitted by the Earth-atmosphere system. Emitted radiation that is subsequently scattered is still regarded as LW. Roughly 1% of the incoming SW is at wavelengths greater than 4 µm. Less than 1 Wm^{-2} of the OLR is at wavelengths smaller than 4 µm. The unfiltered window (WN) radiance and flux represent emitted thermal radiation over the 8.1 to 11.8 µm wavelength interval.

The Terra and Aqua SSF data sets are unique products for studying the role of clouds, aerosols, and radiation. Each CERES footprint (nadir resolution 20-km equivalent diameter) on the SSF includes reflected shortwave (SW), emitted longwave (LW) and window (WN) radiances and TOA fluxes from the CERES instrument with temporally and spatially coincident imager-based radiances, cloud properties, aerosols, and meteorological information from a fixed 4-dimensional analysis provided by the Global Modeling and Assimilation Office (GMAO). Cloud properties are inferred from the Moderate-Resolution Imaging Spectroradiometer (MODIS) imager radiances. MODIS flies with CERES on both the Aqua and Terra spacecraft. MODIS is a 36-channel; 1-km, 500-m, and 250-m nadir resolution; narrowband scanner operating in crosstrack mode. To infer cloud properties, CERES uses a 1-km resolution MODIS radiance subset that has been subsampled to include only the data that corresponds to every fourth 1-km pixel and every second scanline. The SSF retains footprint imager radiance statistics for 5 of the 19 MODIS channels (SSF-115 through SSF-131). The SSF contains footprint aerosol parameters from both the 10-km spatial resolution MODIS aerosol product (SSF-132 through SSF-160) and the NOAA/NESDIS algorithm (SSF-73 through SSF-78). Surface fluxes derived from the CERES instrument using several different techniques (algorithms) are also provided. Sampling of the CERES footprints is performed to reduce processing time and data volume. When the viewing zenith is less than 63°, the SSF data sets contain only every other CERES footprint. All footprints with a viewing zenith (as defined in the CERES SSF Collection Guide) greater than or equal to 63° are included in the SSF.

The SSF product combines the absolute calibration and stability strengths of the broadband CERES radiation data with the high spectral and spatial resolution MODIS imager-based cloud and aerosol properties. A major advantage of the SSF over the traditional ERBE-like ES-8 TOA flux data product is the angular models derived from CERES Rotating Azimuth Plane data that allow accurate radiative fluxes not only for monthly mean regional ensembles (ERBE-like capability) but also as a function of cloud type. Fluxes in the SSF are based on sets of global Terra and Aqua Angular Distribution Models (ADMs). Using these ADMs assures that accurate fluxes can be obtained for classes of both optically thin clouds and optically thick clouds. This is a result of empirical CERES angular models that classify clouds by optical depth, cloud fraction, and water/ice classes. ERBE-like TOA fluxes are only corrected for simple clear, partly-cloudy, mostly-cloudy, and overcast classes. In addition, clear-sky identification and clear-sky fluxes are expected to be much improved over the ERBE-like equivalent, because of the use of the imager cloud mask, as well as the angular models incorporating ocean wind speed and surface vegetation class.

CERES footprints containing one or more MODIS imager pixels are included on the SSF product. Since the MODIS imager can only scan to a maximum viewing zenith angle (VZA) of ~65°, this means that only CERES footprints with VZA < 67° are retained on the SSF when CERES is in the crosstrack scan mode. Sampling of the CERES footprints is performed to reduce processing time and data volume when the VZA is less than 63°. On March 30, 2005, the CERES Aqua FM4 instrument's SW channel stopped functioning, and therefore, FLASHFlux will process only Aqua FM3 data. On Terra, FLASHFlux has the choice to process either FM1 or FM2 data. FLASHFlux will typically choose to process the Terra instrument that is in the crosstrack scan mode. To determine operations on a given day from any previous month, refer to the CERES Operations in Orbit.

A full list of parameters on the SSF is contained in the SSF section of the CERES Data Products Catalog (PDF) and a definition of each parameter is contained in the SSF Collection Guide.

This Quality summary is written for all files within the Version2 family. The FLASHFlux Version2 SSF uses meteorological input data based on the Global Modeling and Assimilation Office (GMAO) GEOS-5 DAS gridded output. This differs from the FLASHFlux Version1 SSF which used the GMAO GEOS-4 first look data as input. The FLASHFlux Terra and Aqua Version2 SSFs contain the same parameters as the CERES Terra and Aqua Edition2 SSFs and the FLASHFlux Terra and Aqua Version1 SSFs and are written in an identical manner. Users are referred to the CERES SSF Collection Guide which functions as a user's guide.

In many ways, the FLASHFlux Single Scanner Footprint (SSF) Version2 family of data sets for Terra is similar to the CERES-Terra Edition2B SSF data set. Therefore, users are referred to the Terra Edition2B SSF Data Quality Summary for discussion of the Terra product.

Likewise, the FLASHFlux Single Scanner Footprint (SSF) Version2 family of data sets for Aqua is similar to the CERES-Aqua Edition2B SSF data set. Therefore, users are referred to the Aqua Edition2A and Edition2B SSF Data Quality Summary for discussion of the Aqua product.

When referring to a FLASHFlux data set, please include FLASHFlux, the satellite name (Terra or Aqua) and/or the CERES instrument designation (FM1, FM2, FM3 or FM4), the specific data set version or the data set version family, and the data product. Multiple files that are identical in all aspects of the filename except for the 6 digit configuration code (see CERES SSF Collection Guide) differ little scientifically.

Thus, users may analyze FLASHFlux data from the same satellite/instrument, data set version, and data product without regard to configuration code. If all the files come from one data set version, refer to the data set using that specific data set version. For example, users working only with Terra Version2A files should refer to "FLASHFlux Terra Version2A SSF," and users working with the Aqua Version2A files should refer to "FLASHFlux Aqua Version2A SSF." If the files are from numerous data set versions of the same family, then refer to the data set as "FLASHFlux Terra Version2 SSF"or "FLASHFlux Aqua Version2 SSF."

Users **must** analyze FLASHFlux and CERES data sets separately.
Users should analyze FLASHFlux data sets from different version families separately.

Similarities between FLASHFlux and CERES

Both FLASHFlux and CERES rely upon the same SW Model B and LW Model B algorithms to produce the surface fluxes. Hence, both FLASHFlux and CERES rely upon similar input data sets from the meteorological products and MODIS. The FLASHFlux SSF is sampled in the identical manner as the CERES SSF.

Differences between FLASHFlux and CERES

FLASHFlux and CERES SSF are very similar in many ways; however, there are important differences that users should consider. These are listed below.

- FLASHFlux will provide high quality data sets to the community within a week of the initial measurements. Since the FLASHFlux data sets will **not** be reprocessed into consistent time series records, they should **not** be intermixed with the CERES climate quality data sets.
- FLASHFlux input data sets and algorithms will change as improvements become available; however, no reprocessing will be implemented.
- FLASHFlux Version2 uses GEOS-5 data as input starting with GEOS-5.0.1 in July 2006, changing to GEOS-5.1.0 in January 2008, and to GEOS-5.2.0 in October 2008. Exact dates of transitions between GEOS versions are presented in the tables in the "Data Sets within the Version2 family" section below. Note that valid data dates in the tables below start one month before the transition dates given above. This enabled an examination of the results during the overlapping month and ensure a smooth transition between changing versions. In contrast, CERES Edition2 uses a frozen version of GEOS-4 (4.0.3) up to 31 December 2007, and a frozen version of GEOS-5 (G5-CERES) after that date.
- FLASHFlux SSF processes very shortly after the data date, and therefore, users may find more data gaps than with the CERES SSF. Please consult the FLASHFlux data tables to learn of abnormalities of missing data in the production (FLASHFlux Processing Metadata).
- FLASHFlux uses a quicklook CERES input that is not of CERES Edition2 quality. To provide the best possible near-realtime CERES radiances and fluxes, a special set of correction coefficients that contain the latest gain, spectral correction, and Rev1 scaling factor adjustments are used to process the data. These correction coefficients are updated whenever a new set of adjustments are computed from the CERES Edition data.
- CERES Rev1 corrections are included in the special set of correction coefficients used by FLASHFlux and should **not** be applied again by the user.
- Data from only one Terra and one Aqua instrument are processed each day. The selected instrument is typically in the crosstrack mode of operation. When possible, the data from the same instrument are processed for the entire month. To determine the mode of operations for each instrument in previous months, users should refer to CERES Operations in Orbit.

Data Sets within the Version2 family

Version2A (available by request only; see CERES SSF products)

Terra	Aqua
• Uses collection 5 MODIS data as input. • Uses GMAO's GEOS-5.0.1 as input to Meteorological, Ozone, and Aerosol Data (MOA). • Terra processing uses the ERBE TOA albedo map. • Terra processing uses the ERBE surface albedo map. • CERES provides a special set of calibration coefficients that contain the nominal instrument gain and spectral correction information. • Valid data dates: Jul 1, 2006 - Apr 1, 2007	• Uses collection 5 MODIS data as input. • Uses GMAO's GEOS-5.0.1 as input to Meteorological, Ozone, and Aerosol Data (MOA). • Aqua processing uses the Terra 46-month TOA albedo map. • Aqua processing uses the Terra 46-month surface albedo map. • CERES provides a special set of calibration coefficients that contain the nominal instrument gain and spectral correction information. • Valid data dates: Jul 1, 2006 - Apr 1, 2007

Version2B

Terra	Aqua
• Revised calibration coefficients provided relative to 8/2007 using the Rev1 scaling factor. • Valid data dates: Mar 31, 2007 - Oct 8, 2007	• Revised calibration coefficients provided relative to 8/2007 using the Rev1 scaling factor. • SW Model B code that produces surface flux parameters updated to accept Column Ozone inputs which exceed 500 dobson units • Valid data dates: Mar 31, 2007 - Oct 8, 2007

Version2C

Terra	Aqua
• SW Model B code that produces surface flux parameters updated to accept Column Ozone inputs which exceed 500 dobson units. • All SW and LW Model A surface flux parameters (SSF-41 to SSF-45) set to CERES default value. • Overestimation of downward LW surface flux (SSF-47) over dry/arid regions has been corrected. • Conversion procedure used in SW Model B (SSF-46 and SSF-48) was modified to correct dependence of instantaneous clear-sky albedo on cosine of solar zenith angle. • Incorporates the Briegleb-type solar zenith angle model • Terra processing was updated to use the Terra 46-month surface albedo map instead of the ERBE surface albedo map; however, the ERBE TOA albedo map was not replaced. • Valid data dates: Sep 30, 2007 - Dec 31, 2007	• All SW and LW Model A surface flux parameters (SSF-41 to SSF-45) set to CERES default value. • Overestimation of downward LW surface flux (SSF-47) over dry/arid regions has been corrected. • Conversion procedure used in SW Model B (SSF-46 and SSF-48) was modified to correct dependence of instantaneous clear-sky albedo on cosine of solar zenith angle. • Incorporates the Briegleb-type solar zenith angle model • Valid data dates: Sep 30, 2007 - Dec 31, 2007
For details of above items, see Cautions and Helpful Hints	

Version2D

Terra	Aqua
• Uses Meteorological, Ozone, and Aerosol Data (MOA) based on GMAO's GEOS-5.1.0. (Previously, MOA was based on GEOS-5.0.1) • Valid data dates: Nov 30, 2007 - Sep 30, 2008	• Uses Meteorological, Ozone, and Aerosol Data (MOA) based on GMAO's GEOS-5.1.0. (Previously, MOA was based on GEOS-5.0.1) • Valid data dates: Nov 30, 2007 - Sep 30, 2008

Version2E

Terra	Aqua
• Uses Meteorological, Ozone, and Aerosol Data (MOA) based on GMAO's GEOS-5.2.0. (Previously, MOA was based on GEOS-5.1.0) • Valid data dates: Sep 1, 2008 - Jun 30, 2009 Information about the GEOS-5.2.0 can be found at the GMAO web site.	• Uses Meteorological, Ozone, and Aerosol Data (MOA) based on GMAO's GEOS-5.2.0. (Previously, MOA was based on GEOS-5.1.0) • Valid data dates: Sep 1, 2008 - Jun 30, 2009 Information about the GEOS-5.2.0 can be found at the GMAO web site.

Version2F (available by request only; see CERES SSF products)

Terra	Aqua
• Corrects a small error in TOA SW fluxes caused by erroneous values of spectral correction coefficients, which have now been corrected. Use of corrected coefficients results in a 0.01% increase in TOA SW fluxes compared to Version2E values. No other parameters are affected. • Valid data dates: Jun 30, 2009 - Jul 31, 2010	• Corrects a small error in TOA SW and window fluxes caused by erroneous values of spectral correction coefficients, which have now been corrected. Use of corrected coefficients results in a 0.01% increase in TOA SW fluxes and a 3.6% increase in window fluxes compared to Version2E values. • Valid data dates: Jun 30, 2009 - Jul 31, 2010

Version2G

Terra	Aqua
• New snow/ice maps (1/16-degree mesh) obtained from NSIDC were implemented into the cloud retrieval. • A script that designated the backup MOA input files was corrected to read the appropriate files for stratospheric water vapor, Pinker/Stowe aerosols and ozone for each month. • An initialization error found in the MOA code was corrected.	• New snow/ice maps (1/16-degree mesh) obtained from NSIDC were implemented into the cloud retrieval. • A script that designated the backup MOA input files was corrected to read the appropriate files for stratospheric water vapor, Pinker/Stowe aerosols and ozone for each month. • An initialization error found in the MOA code was corrected.

This did not affect FLASHFlux results. • Three subroutines in the cloud code dealing with transition between polar and non-polar algorithms and ozone absorption were replaced by revised versions. • A code error affecting computation of TOA SW flux in the inversion subsystem was corrected. • A script error that had resulted in the reading of an ancillary file for the month of August, regardless of the month being processed, was corrected to read the ancillary file for the current month being processed. This ancillary file contains precomputed values for the angular distribution models for land surfaces. • A clear-sky TOA albedo file based on 70 months of Terra observations was substituted for one based on 48 months of ERBE observations, which had been used in all earlier versions of the Terra processing. • A clear-sky surface albedo file based on 70 months of Terra observations was substituted for one based on 46 months of Terra observations, which had been used since Version2C of the Terra processing. • Valid data dates: Dec 31, 2008 - Dec 31, 2011	This did not affect FLASHFlux results. • Three subroutines in the cloud code dealing with transition between polar and non-polar algorithms and ozone absorption were replaced by revised versions. • A code error affecting computation of TOA SW flux in the inversion subsystem was corrected. • A script error that had resulted in the reading of an ancillary file for the month of August, regardless of the month being processed, was corrected to read the ancillary file for the current month being processed. This ancillary file contains precomputed values for the angular distribution models for land surfaces. • A clear-sky TOA albedo file based on 70 months of Terra observations was substituted for the one based on 46 months of Terra processing, which had been used in all earlier versions of the Aqua processing. • A clear-sky surface albedo file based on 70 months of Terra observations was substituted for one based on 46 months of Terra observations, which had been used in all earlier versions of the Aqua processing. • Valid data dates: Dec 31, 2008 - Dec 31, 2011

Version2H

Terra	Aqua
• Processing for this version was moved from a SGI system to an IBM system. Differences between these platforms and their accompanying compilers gave rise to small differences in fluxes but those were always within +/- 1 Wm^{-2} range. • A small error found in the order of compilation of a number of subroutines in the cloud subsystem was corrected. This correction resulted in small changes in retrieved cloud properties and gave rise to a 4-5 Wm^{-2} increase in nighttime downward LW fluxes over some ocean regions. • Valid data dates: Dec 31, 2011 - present	• Processing for this version was moved from a SGI system to an IBM system named. Differences between these platforms and their accompanying compilers gave rise to small differences in fluxes but those were within always +/- 1 Wm^{-2} range. • Valid data dates: Dec 31, 2011 - present
For details of above items, see Cautions and Helpful Hints	

Cautions and Helpful Hints

Users are referred to the CERES Terra Edition2B SSF Data Quality Summary and the CERES Aqua Edition2A and Edition2B SSF Data Quality Summary for full lists of cautions and helpful hints that apply to that satellite's SSFs. Cautions and Hints that pertain exclusively to FLASHFlux are listed below.

- FLASHFlux only produces data sets for one crosstrack CERES instrument from each satellite. The instrument in crosstrack mode for a satellite may change over time. Instrument operation modes typically change at a monthly boundary and are seldom made in the middle of a month. When a failure or anomaly is detected, the instrument FLASHFlux processes may abruptly switch in the middle of a month.

- Users should **not** apply the Rev1 user applied revisions discussed in the CERES Data Quality Summary to a FLASHFlux data set. As CERES Rev1 scaling factors become available, they will be included in the FLASHFlux data sets via the set of correction coefficients used to unfilter the CERES radiances.

- The Model B surface flux parameters (SSF-46 to SSF-49) have been validated for the Version2 family of data sets. These surface fluxes are computed for all-sky conditions, unlike the Model A surface flux parameters (SSF-41 to SSF-45) which are limited to footprints with a clear area coverage (SSF-81) of 99.9% or more. Because of their limited value, SW, LW, and WN surface flux parameters (SSF-41 to SSF-45) from SW and LW Models A are set to default for all footprints, regardless of clear area coverage. Only Model B surface flux parameters are retained in FLASHFlux SSF products.

- Users are cautioned about a flaw that was discovered toward the end of March 2007 in the SW Model B code that produces SW flux parameters SSF-46 and SSF-48. For certain footprints at high latitudes of the northern hemisphere, especially over Siberia during winter and early spring, the value of column ozone exceeded 500 dobson units, the upper limit prescribed in the code. For those footprints, values of SSF-46 and SSF-48 could not be computed in the code and default values were recorded in their place. The values of SSF-46 and SSF-48 for the affected footprints are, therefore, missing but they are not erroneous. Note that this condition has been corrected beginning with Version2B Aqua and Version2C Terra.

- Beginning with Version2C, changes described below were implemented in FLASHFlux processing:

    1. SW, LW, and WN surface flux parameters (SSF-41 to SSF-45) from SW and LW Models A are set to CERES default for all

footprints, regardless of clear area coverage.

2. Overestimation of downward LW flux (DLF), frequently encountered during validation of LW Model B results over dry/arid regions, was remedied by constraining the near-surface air temperature (used in the DLF computation) whenever a large difference is detected between the surface skin temperature and the air temperature of the lowest layer of the atmosphere.

3. It was determined that the process of converting clear-sky TOA albedo climatology to instantaneous/footprint values and its transfer from TOA to surface used in SW Model B resulted in incorrect dependence of instantaneous clear-sky surface albedo on cosine of solar zenith angle. The conversion procedure was modified to incoporate a Briegleb-type solar zenith angle model.

- Comparison of global average surface downward LW fluxes for the overlap period in Dec 2007, the transition between Version2C and Version2D, we find a global monthly averaged difference of 2.7 Wm^{-2}. This corresponds to the change between GEOS 5.0.1 and GEOS 5.1.0. The change in surface fluxes represents a major discontinuity in the month-to-month surface flux variability. However, this change is not shown to affect the LW TOA fluxes.

- Comparison of the near-surface and skin temperatures between GEOS-5.1.0 and GEOS-5.2.0 shows differences over ice surfaces such as over Greenland and Antarctica. There may be discontinuities over these surfaces from August 31, 2008 Version2D (using GEOS-5.1.0) and September 1, 2008 Version2E (using GEOS-5.2.0) that exceed ± 10 K. User caution is advised.

- Beginning with Version2G, changes described below were implemented in FLASHFlux processing:

1. New snow/ice maps obtained from NSIDC were implemented into the cloud retrieval.

2. A script that designated the backup MOA input files was corrected to read the appropriate files for stratospheric water vapor, the Pinker/Stowe aerosols and ozone data for each month.

3. Three subroutines were revised in the cloud code to improve the transition between polar and non-polar algorithms, the calculations of the ozone absorption, and the accuravy fo the retrievals for the solar zenith angles between 90 and 95 degrees.

4. A correction was made to a script error that had resulted in the reading of an ancillary file for only the month of August, regardless of the month being processed. The script now reads the ancillary file for the current month being processed. Note, this ancillary file contains precomputed values for the angular distribution models for land surfaces.

5. A clear-sky TOA albedo file based on 70 months of Terra observations was substituted for the one based on 48 months of ERBE observations, which had been used in all earlier versionsof the Terra Processing, and for the one based on 46 months of Terra processing, which had been used in all earlier versions of the Aqua processing.

Accuracy and Validation

The CERES Terra Edition2B SSF accuracy and validation discussions, which are organized into sections, may be of interest to users of the FLASHFlux Terra Version2 SSF. The CERES Terra Edition2A and Edition2B SSF have identical Cloud properties and the discussion thereof is from Edition2A. For convenience, links to these sections are provided here. Please read those sections which correspond to the parameters of interest.

- Terra Cloud properties
- Terra Aerosol properties
- Terra Spatial matching of imager properties and broadband radiation
- Terra TOA fluxes
- Terra Surface fluxes

Likewise, the CERES Aqua Edition1B, Edition2A, and Edition2B SSF accuracy and validation discussions, which are organized into sections, may be of interest to users of the FLASHFlux Aqua Version2 SSF. CERES Aqua Edition1B, Edition2A, and Edition2B SSF have identical Cloud, Aerosol, and Spatial matching properties, and all discussion thereof are from Edition1B. TOA fluxes were updated for Edition2A and remain the same for Edition2B. Surface fluxes differ for each Edition. The FLASHFlux surface fluxes most closely resemble those of Edition2B. For convenience, links to the most appropriate CERES Aqua sections are provided here. Please read those sections which correspond to the parameters of interest.

- Aqua Cloud properties
- Aqua Aerosol properties
- Aqua Spatial matching of imager properties and broadband radiation
- Aqua TOA fluxes
- Aqua Surface fluxes

Validation of the FLASHFlux results is actively being pursued. The accuracy of FLASHFlux results will be documented in this work as they become available.

Overview of the Fast Algorithms

SW Algorithm (LPSA)

The Langley Parameterized Shortwave Algorithm (LPSA), as described in Gupta et al. (2001), was developed to provide a fast radiative transfer method to derive the Earth's shortwave (SW) surface radiation budget. Selected by the GEWEX/SRB workshop in 1993 to monitor the performance of their primary SW algorithm, LPSA has also been used by the WCRP/SRB project to produce global insolation datasets. In addition, the CERES project has employed the LPSA to calculate both instantaneous Single Scanner Footprint (SSF) surface fluxes and Time Interpolation and Spatial Averaging (TISA) data products. The LPSA consists of physical parameterizations that account for the attenuation of solar radiation in simple terms separately for clear and cloudy atmospheres. Thus, LPSA is able to directly calculate the surface insolation using the incident TOA SW flux, the transmittance of the clear atmosphere, and the transmittance of the clouds (Darnell et al., 1988; 1992). The clear-sky transmittance is dependent upon the broadband extinction optical depth, which accounts for all absorption and scattering processes in the clear atmosphere, and the backscattering of surface reflected radiation by the atmosphere (gases and aerosols). The contribution of the aerosol attenuation was computed on the basis of five surface scene types tabulated by Gupta et al (2001) for the aerosol optical depth values in Staylor (1985), and the adjusted single scattering albedo and asymmetry parameter values in Deepak and Gerber (1983). Kratz et al (2010) have reported on a validation effort that compared the LPSA model-derived surface fluxes using Terra and Aqua data to the ground truth surface sites.

LW Algorithm (LPLA)

The Langley Parameterized Longwave Algorithm (LPLA) is a fast parameterization derived from an accurate narrowband radiative transfer model (Gupta 1989). Because of its accuracy and global applicability, the LPLA was chosen to be incorporated into the processing of both the GEWEX/SRB and CERES Single Scanner Footprint (SSF) datasets. The LPLA computes the downward longwave (LW) flux (DLF) in terms of an effective emitting temperature of the atmosphere, the column water vapor, the fractional cloud amount, and the cloud-base height for each footprint (Gupta et al., 1992). The effective emitting temperature is a weighted-average of the surface skin temperature and temperatures of the lower tropospheric layers. The effective temperature of the surface is dependent upon the surface emissivity (Wilber et al., 1999). The effective emitting temperature and column water vapor are computed from the temperature and humidity profiles available from the MOA (Meteorology, Ozone, and Aerosols) database which is maintained for all CERES processing (Gupta et al., 1997). Fractional cloud amount and cloud-base height are available for the flux calculation from the CERES cloud subsystem processing (Minnis et al., 1997). The LPLA, which inherently assumes that the LW TOA and surface fluxes are decoupled, can be used to calculate the surface LW fluxes for both clear and cloudy conditions. Kratz et al (2010) have reported on a validation effort that compared the LPLA model-derived surface fluxes using Terra and Aqua data to the ground truth surface sites. As a result of the validation studies, an improvement in the LPLA has been implemented to better handle downward longwave fluxes for very high temperature surface such as daytime dry/arid regions (Gupta et al., 2010)

Overview of the Input Requirements for the Agorithms

Meteorological data

In addition to the meteorological data available through the CERES SSF product, the LPSA also requires total column ozone amounts, which are only available through the FLASH MOA product. As currently implemented, both the LPSA and LPLA obtain all the required meteorological data to process the CERES data directly through FLASH MOA. The FLASH MOA data product, and hence the FLASH SSF meteorological parameters, currently rely upon the GMAO GEOS-5 products.

Ancillary Data

To improve the accuracy of the derived LW fluxes, the LPLA makes use of external surface emissivity maps which were produced at LaRC (Wilber et al., 1999).

Future Changes

FLASHFlux will not be able to hold the SSF processing constant. As inputs and algorithms change, the quality of the data product will also change. Minor changes that do not impact the science will be denoted by an increase in the 6 digit configuration code that appears just before the data date and hour. Changes that impact the science enough to be noted will result in a letter change within the data set version. Major changes will result in a change to the data set family.

The following are expected to have an impact on the FLASHFlux SSF products:

1. The FLASHFlux products will be made available via the improved CERES ordering tools that will provide for subsetting, interactive graphics and ascii data retrievals.
2. CERES provides updated Terra and/or Aqua unfiltering coefficients.
3. The next version of LPSA will replace the WCP-55 aerosol parameters with MATCH aerosol (Collins et al., 2001) optical depths and OPAC single scattering albedos and asymmetry parameters (Hess et al., 1998).
4. The next version of the LPSA will also replace the original LPSA Rayleigh scattering formulation with a Rayleigh scattering formulation based upon the work of Bodhaine et al (1999).
5. To capture transient events, we plan to incorporate near real-time MODIS aerosol optical depths into the LPSA.
6. The next version of LPLA will take into account severe LW surface flux underestimations caused by strong, but shallow temperature inversions.

7. More advanced versions of the emissivity maps are under development and will use wind speed data over water surfaces, and ASTER and MODIS retrievals over land surfaces.

Referencing Data in Journal Articles

The FLASHFlux and CERES Teams have 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 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.

Stackhouse, P. W., D. P. Kratz, G. R. McGarragh, S. K. Gupta, and E. B. Geier, 2006: Fast Longwave and Shortwave Radiative Flux (FLASHFlux) Products From CERES and MODIS Measurements. 12th Conference on Atmospheric Radiation, American Meteorological Society, Madison, Wisconsin, 10-14 July 2006.

Kratz, D. P., S. K. Gupta, A. C. Wilber, and V. E. Sothcott, 2010: Validation of the CERES Edition 2B Surface-Only Flux Algorithms, ***J. Appl. Meteor. Climatol.***, **49**, 164-180, doi:10.1175/2009JAMC2246.1.

When Langley DAAC data are used in a publication, **we request the following acknowledgment be included:**

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

The Langley DAAC 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. This also helps us to keep the product related references current.

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Temperature Fields (System 12.0). CERES Algorithm Theoretical Basis Document (ATBD Release 2.2). ***NASA/RP-1376***, 20 pp.

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Feedback and Questions

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

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