CERES ES4 Terra Edition2 Data Quality Summary

Investigation:	**CERES**
Data Product:	**ERBE-like Monthly Geographic Averages (ES4)**
Data Set:	**Terra (Instruments: FM1, FM2)**
Data Set Version:	**Edition2**

The purpose of this document is to inform and to update users of the best current understanding of the accuracy of this CERES data product, to briefly summarize key validation results, to provide cautions where users might easily misinterpret the data, to provide helpful links to further information about the data product, algorithms, and accuracy, to give information about planned data improvements, and finally to register users of this data product so that we can automate the process of keeping users informed of new validation results, cautions, or improved data sets that become available in the future.

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 that all scientific users of this data product should be familiar with. We strongly suggest that users re-check this document for the latest status before publication of any scientific papers using this data product: this would apply to both authors and reviewers of such research papers.

The quality of the CERES Terra ES4 data is comparable to the quality of the ERBE ERBS single-satellite S9 data in terms of instantaneous gridded and monthly mean fluxes and scene identification. The major differences between CERES/Terra and ERBE/ERBS are the field of view resolution, the spectral response of the instruments, the inclusion of rotating scanner plane data in the CERES product, and the local time of observation of CERES/Terra.

The deep space calibration maneuvers planned for early in the Terra mission were delayed, resulting in larger uncertainties in the CERES Terra scan angle dependent offsets (zero-level counts) used in the level 1b BDS data product. BDS level 1b data is the input to the ES4 data product. The early unavailability of deep space scans puts a larger uncertainty on the CERES archived data products, and the Edition2 archived Data Quality Summary gives an estimate of this uncertainty. The Edition2 archived/validated version of the CERES Terra data uses offsets determined using ground calibration data. While CERES/TRMM showed consistency of ground and in-space determined offsets of 1 digital count or better (roughly 0.5% or better) further indirect analysis as well as final deep space scans are required to confirm this level of consistency on the Terra instruments.

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Nature of ES4 Product:

The CERES ES4 data product contains the "ERBE-like" temporally and spatially averaged shortwave (SW) and longwave (LW) top-of-the-atmosphere (TOA) fluxes derived from one month of CERES data from the Terra spacecraft. Instantaneous TOA fluxes from the ES8 product have been spatially averaged on the same 2.5° equal-angle grid used by the Earth Radiation Budget Experiment (ERBE). Temporal interpolation algorithms identical to those used by ERBE have been applied to produce daily, monthly-hourly, and monthly mean fluxes from the instantaneous gridded data. The ES4 contains the temporally averaged values of TOA total-sky LW, total-sky SW, clear-sky LW, and clear-sky SW flux, total-sky albedo and clear-sky albedo for each 2.5° region observed during the month. In addition, the 2.5° regional means have been combined to produce 5° regional, 10° regional, 2.5° zonal, 5° zonal, 10° zonal, and global mean fluxes.

A full list of parameters on the ES4 is contained in the CERES Data Product Catalog (PDF) and a full definition of each parameter is contained in the ES4 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. Depending upon the instruments analyzed, these data sets may be referred to as "CERES Terra FM1 Edition2 ES4", "CERES Terra FM2 Edition2 ES4", "CERES Terra FM1+FM2 Edition2 ES4", "CERES PFM+FM1+FM2 Edition2 ES4", "CERES PFM+FM1 Edition2 ES4", or "CERES PFM+FM2 Edition2 ES4."

Processing Updates in Current Edition:

The CERES Terra Edition2 ES4 data product contains three major corrections to the earlier Edition1 product. They are (1) instrument calibration updates for both FM1 and FM2 instruments, (2) snow map algorithm correction, and (3) recovery of missing Edition1 data.

The new, updated Edition2 calibrations are used to address instrument drift problems found in the Edition1 data product; especially those associated with the CERES FM2 instrument. These include changes in sensor radiometric gains from ground to flight for both FM1 and FM2 total, window, and shortwave channels, on-orbit drifts in the sensor gains for both FM1 and FM2 total channels, and on-orbit drifts in the FM2 total channel spectral response function. A detailed description of these calibration changes can be found in the CERES Terra Edition2 ES8 Data Quality Summary. Over the first 11 months, the net effect of these calibrations changes (see Fig. 1 below) on the global mean all-sky CERES Terra Edition2 ES4 monthly mean radiative fluxes relative to the Edition1 data product include (1) a small decrease in all-sky shortwave FM2 minus FM1 differences of about 0.3 Wm^{-2} and (2) an increase in all-sky longwave FM2 minus FM1 differences of about 0.9 Wm^{-2} in the earlier part of the 11-month Edition2 time series to a decrease in all-sky longwave FM2 minus FM1 differences of about 0.8 Wm^{-2} by the end of the 11-month Edition2 time series. Similar changes are also noted in the clear-sky radiative fluxes. These monthly mean changes are consistent with the instanteneous changes outlined in the Edition2 ES8 data quality summary. With the new updated calibrations, the CERES Team now recommends using Edition2 measurements from both FM1 and FM2 instruments

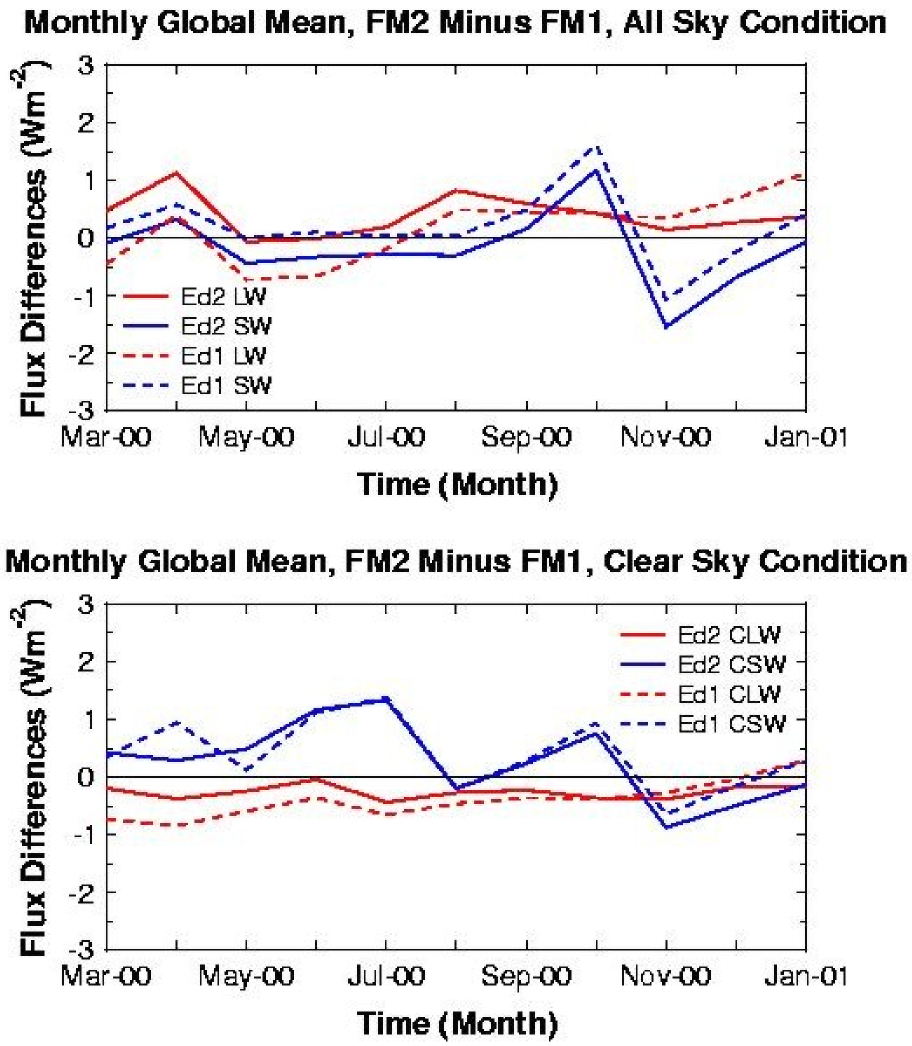

Figure 1. Comparison of global monthly mean FM1 and FM2 fluxes (FM2 minus FM1) between Edition1 and Edition2 data product.

The snow map algorithm correction is used to address incorrect snow map assignment found in the Edition1 data product. The ERBE snow map algorithm is designed to assign snow to a region if it contains snow every day of the month. However, an error in array initialization was discoverd in the snow map algorithm prior to the Edition2 data reprocessing. This error causes the regional snow assignment decision to be based only on snow information from the first day of each month. The effect of this error (see Fig. 2 below) is to produce excessive assignment of snow regions during spring season when snow coverage can decrease significantly over the month period. This error can have large impact on the Edition1 monthly mean regional radiation fields over regions that are sensitive to changes in snow coverage. For example, the Edition1 regional all-sky longwave and shortwave fluxes can be 2 and 20 Wm^{-2}, respectively, too low over the affected regions. The

Edition1 regional clear-sky longwave fluxes can also be 20 to 30 Wm^{-2} too low at the same regions. For the all-sky shortwave fluxes, the Edition1 can be 120 to 160 Wm^{-2} too high for the same locations. While this snow map problem only caused very small changes in both global mean clear-sky longwave flux (less than 0.25% error) and global mean all-sky longwave and shortwave fluxes (less than 0.15% error), it can resulted in a 5% error on Edition1 global mean clear-sky shortwave flux. The new Edition2 data have completely removed these snow map algorithm errors in the final data product.

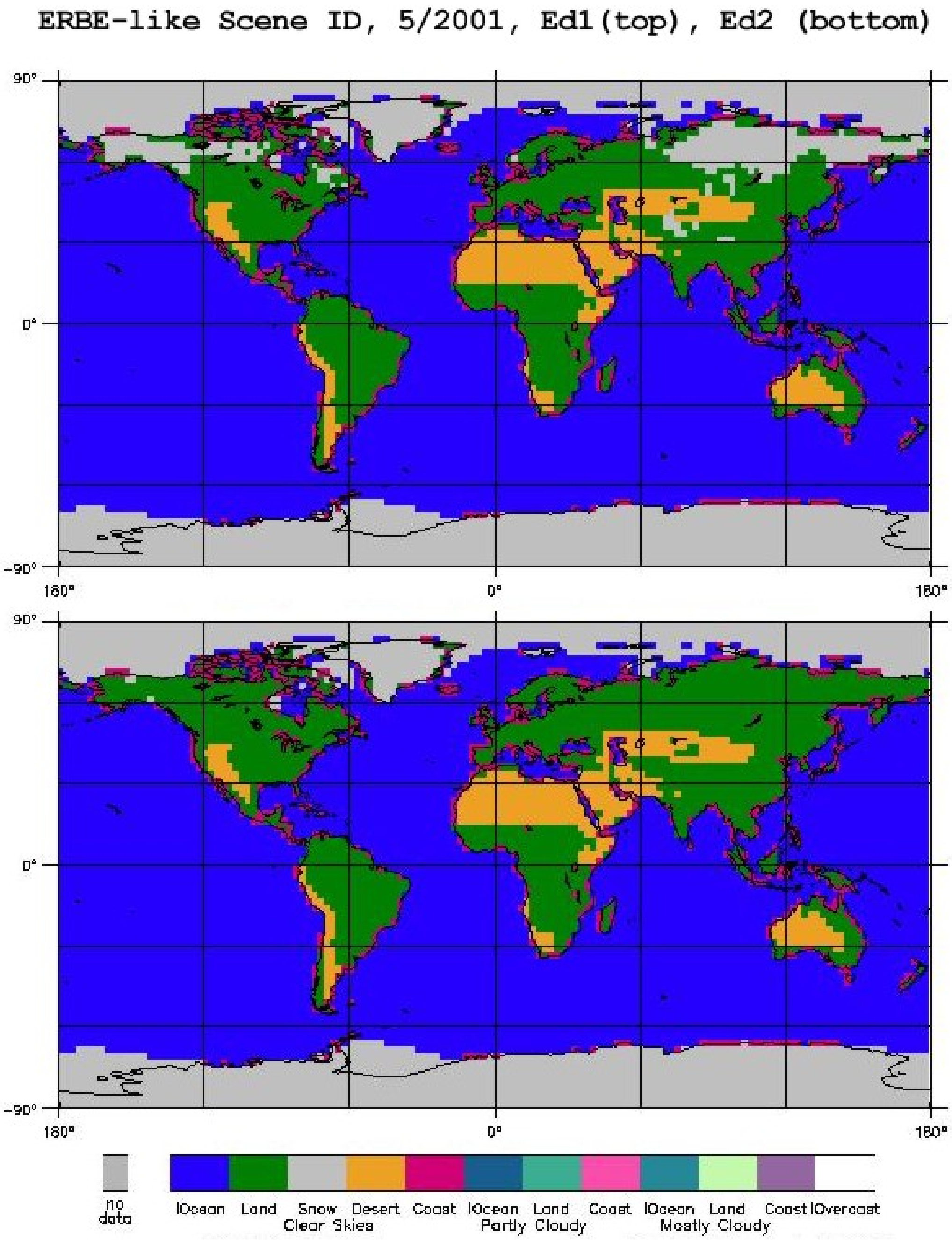

Figure 2. Comparison of monthly mean ERBE-like scene ID between Edition1 (top) and Edition2 (bottom) data product.

The Edition1 ES8 data contain some missing orbits during the first year of CERES/Terra operation. These missing data had been recovered and are included in the new Edition2 datasets. These missing data have very little effects on the Edition1 ES-4 monthly global mean all-sky and clear-sky fluxes. They also do not affect the Edition1 ES-4 monthly mean regional clear-sky fluxes. However, they do introduce small bias into the Edition1 ES-4 monthly mean regional all-sky fluxes. These bias errors are especially visible for all-sky shortwave fluxes (see areas just west of the international date line in Fig 3 below). The new Edition2 data have completely removed errors caused by these missing Edition1 data in the final data product.

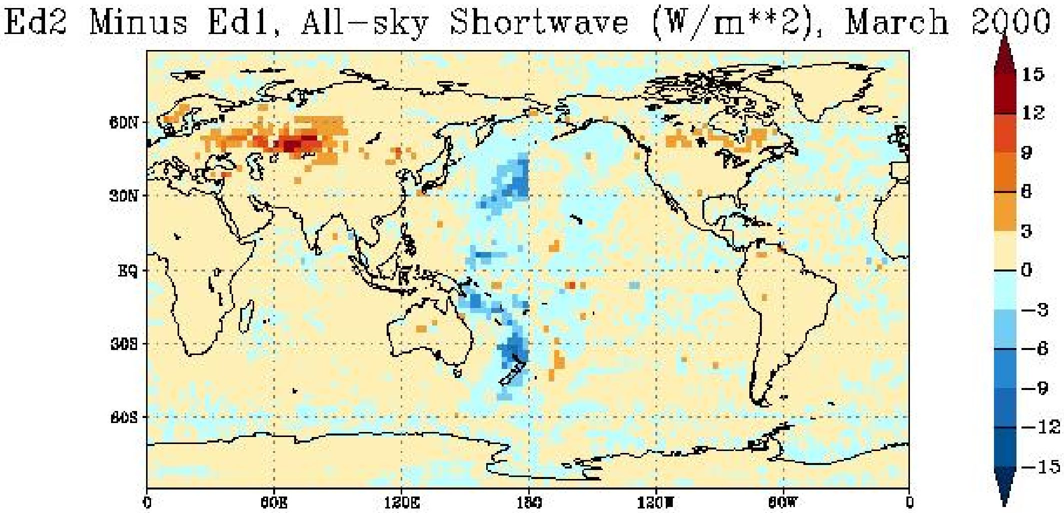

Figure 3. Differences (ed2 minus ed1) in monthly mean regional all-sky shortwave flux between Edition2 and Edition1 data product.

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.

ES4 Edition2_Rev1

The CERES Science Team has approved a table of scaling factors which users should apply to the single instrument Edition2 ES4 Net radiant flux, Shortwave flux, and Albedo parameters utilizing the following equations. (Users should not apply corrections to multiple satellite data sets such as the FM1+FM2 ES4 or PFM+FM1+FM2 ES4.)

- Shortwave $flux_{rev1}$ = Shortwave $flux_{orig}$ * scaling factor
- $Albedo_{rev1}$ = $Albedo_{orig}$ * scaling factor
- Net radiant $flux_{rev1}$ = Net radiant $flux_{orig}$ - Shortwave $flux_{orig}$ * (scaling factor - 1.0)

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 respectively. A complete description of the physics of this darkening appears in the CERES BDS Quality Summaries under the Expected Reprocessing section. After application of this revision to the Edition2 ES4 product, users should refer to the data as Terra ES4 Edition2_Rev1.

Data Accuracy Table

Errors from Temporal Interpolation and Spatial Averaging (Young et al., 1998)

	Mean Global Bias (Wm^{-2})				Mean Regional 1 std.dev. (Wm^{-2})			
	July		April		July		April	
	LW	SW	LW	SW	LW	SW	LW	SW
All Latitudes 45°N - 40 °S	1.3 (0.5%)	-6.0 (6%)	0.9 (0.4%)	-0.5 (0.5%)	2.9 (1%)	9.7 (<10%)	2.7 (1%)	6.4 (6%)
Science Require ment	2 - 5	2 - 5	2 - 5	2 - 5	10	10	10	10

Differences Between CERES and ERBE

1. The resolution of CERES Terra is 20 km at nadir and the resolution of ERBE ERBS is 40 km at nadir so that the surface area observed by ERBS is 4 times larger than the area observed by Terra.

2. The nominal scan mode for ERBE was crosstrack to provide good area coverage. Terra has three scan modes. The Fixed Azimuth

Plane scan mode is similar to ERBE. The Rotating Azimuth Plane (RAP) scan mode was added to Terra to provide angular coverage for Angular Distribution Models construction. Along-track scan mode data are used for validation of CERES instantaneous fluxes and are not included on the monthly mean ES4 products.

3. The Terra orbit is in a sun-synchronous orbit with an equatorial crossing time of approximately 10:30 AM. The ERBS had an inclination of 57° and a precessionary period of 72 days.

4. The longwave channel on ERBE was replaced by an 8 to 12 µm window channel on Terra.

5. The data rate on ERBS was 30 measurements per second. The data rate on CERES is 100 measurements per second.

6. The ERBE ERBS S4 data product is a binary file of about 15 MB. The CERES ES4 product is an HDF file of about 27 MB.

7. CERES ES8 uses a different unfiltering algorithm (Loeb et al., 2000) than ERBE.

Cautions When Using Data

From launch through October 2001, the Terra FM1 and FM2 instruments alternated between Rotating and Fixed Azimuth Plane Scanning modes on a 3-month cycle. Previously the team recommended users use ERBE-like products containing only Fixed Azimuth Plane Scanning data regardless of which instrument made the measurements; this is no longer the case.

Users should consult the CERES/EOS operations web page to determine the scanning mode of the FM1 and FM2 instruments on any given day.

The CERES BDS and ERBE-like data products may be advanced to Edition3 status in the future. 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).

There are several cautions the CERES Team notes regarding the use of the CERES Terra Edition2 ES4 data:

1. Users are responsible for applying revisions as noted in the section entitled "User Applied Revisions to Current Edition".

2. CERES-Terra is observing more clear sky than ERBE due in part to the difference in footprint size. The resolution of CERES Terra is 20 km at nadir and the resolution of ERBS is 40 km at nadir so that the surface area observed by ERBS is 4 times larger than the area observed by Terra. For March 2000, ~23% of Terra-FM1 footprints, ~22% of Terra-FM2 footprints, and ~24% of CERES-TRMM footprints are classified as clear-sky. The mean percentage of clear ERBE ERBS footprints during March 1985-1990 is only ~17%. ERBS also observed about 17% overcast and CERES Terra and TRMM observed about 16% overcast. It is not fully understood why the overcast for Terra decreased instead of increasing as for clear sky.

3. The ERBE scene identification algorithm (MLE) in conjunction with the ERBE angular distribution models (ADM) are known to erroneously produce albedo growth from nadir to the limb. The ERBE ADMs are probably insufficiently limb-darkened in longwave and insufficiently limb-brightened in shortwave. The CERES Terra fluxes also have these biases with viewing angle.

4. The spectral responses of the CERES shortwave and total channels differ from that on ERBE at wavelengths below 1 µm. CERES uses silver mirrors, which offer much more uniform spectral response from 0.4 µm to 100 µm than the ERBE aluminum mirrors, but are less responsive below 0.4 µm. A new spectral unfiltering algorithm has been developed and applied to the CERES data. As a result, the CERES radiances are less sensitive to spectral correction for land, desert, and cloudy scenes. The greatest impact of this change is on SW fluxes, particularly for clear and partly cloudy ocean scenes. Overall, CERES clear-sky SW fluxes are 5-6% lower than ERBE ERBS fluxes for all scene types.

5. The Terra spacecraft is in a sun-synchronous orbit with equatorial crossing times of 10:30 AM and 10:30 PM. The temporal sampling pattern of Terra is very different from temporally precessing ERBS. ERBS observed all local times over a period of 72 days. Except for polar regions, Terra will generally observe a region only twice per day. Users should be aware that this temporal sampling can cause large errors in the modeling of diurnal variations of flux, particularly for regions with pronounced diurnal cycles of cloudiness.

6. During March 2000, the CERES Terra instruments operated in a standard mode of 2 days of crosstrack scanning followed by 1 day of rotating azimuth plane (RAP) scanning. Beginning in April 2000, the standard operation was for one instrument scanning in crosstrack mode for the entire month with the other instrument in RAP scanning mode. Both the crosstrack and RAP data have been used in the computation of CERES monthly mean fluxes. ERBE data were exclusively crosstrack.

Validation Study Results

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

Pre-Launch

1. The CERES ERBE-like operational code has been tested for consistency with the historical ERBE algorithm. The CERES code was

run using ERBE data as input. Monthly mean SW and LW fluxes have been calculated that reproduce ERBE values to better than 0.1%.

2. An error analysis of spatial averaging and temporal interpolation errors has been performed using one month of 1-hourly, 4-km GOES data. In summary:

   - Spatial errors have been computed using simulated CERES footprints constructed by convolving the GOES pixels with the CERES point spread function. These footprints can be averaged on a grid and compared with regional averages of the GOES pixels. Currently, results are only available for the CERES 1.0° grid. For crosstrack data, the rms SW and LW flux spatial gridding errors are 10.1 Wm^{-2} (5%) and 2.3 Wm^{-2} (1%) respectively, with no bias error for either. Errors for RAP data are twice as large with SW errors of 23.1 Wm^{-2} and and LW errors of 5.6 Wm^{-2}. Currently, the best estimate for instantaneous gridding error for the 2.5° ERBE-like grid is given by Stowe et al., (J. of Atmos. & Ocean. Tech, 1994). For CERES-like footprints, Stowe et al. calculated crosstrack errors of ~8.5 Wm^{-2} and ~1.3 Wm^{-2} for SW and LW, respectively.

   - Temporal errors were calculated by temporally sampling GOES data and comparing monthly means computed from these data with means from the complete time series. SW and LW rms monthly mean errors are <10 Wm^{-2} (<10%) and <3 Wm^{-2} (<1%), respectively. Bias errors for LW are < 0.5Wm^{-2}. For SW, mean biases can be -6 Wm^{-2} due to the morning sampling from the sun-synchronous orbit. The effects of the spatial gridding errors on monthly mean errors are negligible in the LW and only increase monthly SW rms errors by ~0.5 Wm^{-2}.

Post-Launch

1. The CERES TRMM ERBE-like data have been compared with ERBS non-scanner data for verification of calibration. Tropical (20° N - 20° S) monthly mean ocean total-sky LW fluxes have been averaged for all available months of ERBS scanner (1/85 - 12/89), ERBS non-scanner (1/85 - 8/98), SCARAB scanner (3/94 - 2/95), and CERES TRMM scanner (1/98 - 8/98) data. Scanner - non-scanner differences for each of the 3 scanners agree to < 1%.

2. Instantaneous CERES TRMM ERBE-like fluxes have been compared with ERBS non-scanner data. Comparisons using data from January through August 1998 have demonstrated agreement to within 0.1% for both SW flux, 0.5% for nighttime LW flux, and 2.5% for daytime LW flux. ERBS non-scanner data are not available for the CERES Terra time period.

3. The first eight months of CERES TRMM and the first three months of CERES Terra ERBE-like data have been compared with the historical ERBE ERBS scanner data from 1985-1989. The emphasis of this study has been on comparisons of tropical mean fluxes (defined as the average of all regions between 20°N and 20°S) in order to minimize temporal sampling differences.

   The main results include:

   - Total-sky LW flux - the CERES TRMM LW fluxes are 3.5-8.8 Wm^{-2} (1.5-3.5%) higher than ERBE. The difference maximizes in February, which is also the maximum of the 1998 El Niño event. The difference is minimized in August when El Niño has essentially disappeared. As explained above, a corresponding increase in total-sky LW flux from ERBE (1985-1989) to 1998 is also seen in the ERBS non-scanner data. During 2000, both CERES TRMM and Terra remain 2.5-3.5 Wm^{-2} greater than ERBE, with agreement between Terra FM1, Terra Fm-2 and TRMM better than 1 Wm^{-2}.

   - Clear-sky LW flux - The CERES TRMM clear-sky LW fluxes are 1-3 Wm^{-2} (0.2-1.0)% higher than ERBE in 1998. This difference also maximizes in February and minimizes in August. The differences have been shown to be consistent with variations in sea surface temperature and atmospheric humidity associated with El Niño (Wong et al., 2000). During 2000, CERES TRMM and CERES FM1 fluxes are in agreement with ERBE means to within 0.2 Wm^{-2}. FM2 clear-sky LW fluxes are consistently ~1 Wm^{-2} less than FM1. This is believed to be caused by an inconsistency between the SW channel and the SW portion of the total channel in FM1 (for details see the ES8 Data Quality Summary.)

   - Total-sky SW flux - The difference between CERES TRMM and the 5-year mean ERBE data varies between -0.6 and -5.0 Wm^{-2} (-0.6 and -5%). However, the 2 std.dev. bound for the month-to-month temporal sampling variability of the total-sky SW tropical mean for this time period is 5%. Seasonal (3-month) means of SW flux reduce the impact of temporal sampling to a 2 std.dev. bound of 2.5%. The CERES SW flux tropical seasonal means are lower than ERBE ERBS by 3-4% which implies that there may be a real difference between ERBE and CERES SW fluxes. This bias persists into 2000, where the CERES Terra total-sky SW fluxes are 5-6% less than the ERBE means for all 3 months. The FM1 and FM2 means agree to better than 1%. The Terra sampling produces less month-to-month variability in the bias than TRMM. However, the sun-synchronous 10:30 orbit can produce a systematically low estimate for the total-sky SW flux due to sampling at the minimum of the diurnal cloudiness cycle for convective regions.

   - Clear-sky SW flux - The 1998 CERES TRMM fluxes are on the average 5.6%, 5.3%, and 6.1% lower than ERBE for ocean, land and desert regions, respectively. The clear ocean difference is reduced to ~4% when the CERES spatial resolution is reduced to simulate the ERBS field of view. The land and desert differences are reduced only slightly by changing the spatial resolution. CERES Terra fluxes are 1%-1.5% lower than TRMM and ~5.5% lower than ERBE. FM1 and FM2 fluxes agee within 1%.

   - Scene identification - In general, CERES classifies more footprints as clear than ERBE. This difference is also greatest in February with CERES TRMM classifying 33% of the observations as clear, while ERBE classifies only 20% as clear. The difference in July is decreased to 22% vs. 16%. Of the remaining difference, about 2% can be attributed to the smaller CERES footprint size. For March 2000, ~23% of Terra-FM1 footprints, ~22% of Terra-FM2 footprints, and ~24% of CERES-TRMM footprints are classified as clear-sky. The mean percentage of clear ERBE ERBS footprints during March 1985-1990 is only ~17%. ERBS also observed about 17% overcast and CERES Terra and TRMM observed about 16% overcast. It is not fully understood why the overcast for Terra decreased instead of increasing as for clear sky. April and May 2000 reveal similar results to March.

4. During March 2000, both FM1 and FM2 were scanning in crosstrack mode for 11 days. A comparison of matched gridded data from these days reveals agreement between fluxes derived from the two instruments to within 0.5% for both LW and SW. Instantaneous gridded rms flux differences are 1% for LW and 3% for SW.

5. Fluxes produced using crosstrack and rotating-azimuth data were also compared using data from March-May 2000. Biases between the instruments were statistically equivalent to the biases when both instruments are in crosstrack mode. Instantaneous gridded rms flux differences increase to 2% for LW and 9% for SW.

6. A comparison of daytime and nighttime LW fluxes was performed for March-May 2000 CERES Terra data. The mean difference for FM2 is ~0.5-1.0% greater than for FM1, which is consistent with a similar comparison of day-night radiance differences between FM1, FM2, and CERES TRMM. This is explained in more detail in the ES8 Data Quality Summary.

7. Directional models of the variation of albedo with solar zenith angle (SZA) have been constructed using CERES TRMM and ERBE ERBS data for each of the 12 ERBE scene types. Comparisons of these models reveal no significant differences.

References

1. Loeb, N.G., K.J. Priestley, D.P. Kratz, E.B. Geier, R.N. Green, B.A. Wielicki, P. O'R. Hinton, and S.K. Nolan, 2000: Determination of unfiltered radiances from the Clouds and the Earth's Radiant Energy System (CERES) instrument. *J. Appl. Meteor.* (in press).

2. Stowe, L., R. Hucek, P. Ardanuy, and R. Joyce, 1994: Evaluating the Design of an Earth Radiation Budget Instrument with System Simulations. Part II: Minimization of Instantaneous Sampling Errors for CERES-I. *J. Atmos. and Oceanic Tech*., **11**, 1169-1183.

3. Wong, T., D. F. Young, M. P. Haeffelin, and S. Weckmann, On the Validation of the CERES/TRMM ERBE-like Monthly-mean Clear-sky Longwave Dataset and the Effects of El Nino, *J. Climate*, **13**, 4256-4267, 2000.

4. 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

The current "Edition2" data are expected to be reprocessed into a validated/archived/publishable Edition3 after the Terra deep space maneuver if the in-space determined offsets are found to be significanly different than their ground determined values. The Edition3 version will use the deep space determined zero-level offsets.

The CERES team expects to reprocess the S4 data product for ERBS, NOAA 9, NOAA 10, and the ES4 data product for TRMM and Terra in the future. The purpose of the reprocessing is to generate a consistent, long-term climate record where advances in the data calibration and processing will be incorporated to remove former errors. The major contributions to reprocessing will be an improved set of Angular Distribution Models based on CERES data and the MLE as the scene identifier. Other improvements will be more accurate scanner offsets for NOAA 9 and NOAA 10, correction of the low daytime longwave flux for NOAA 9, drift corrections, and a possible resolution correction for CERES so that CERES and ERBS footprints will be similar in size.

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 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 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 Data Center at Langley 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 Quality Summary, contact the User and Data Services staff at the Atmospheric Science Data Center.

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