CERES ES8 TRMM-PFM Transient-Ops Data Quality Summary

Investigation:	**CERES**
Data Product:	**ERBE-like Instantaneous TOA Estimates (ES8)**
Data Set:	**TRMM**
Data Set Version:	**Transient-Ops and Transient-Ops2 -CAUTION ADVISED**

The purpose of this page is to inform you of instrument-related phenomena that make this Data Set Version somewhat different than the previous ES8 data product from the CERES instrument on TRMM. While the differences are small, they may be scientifically important. The accuracies of the fields in this Data Set Version have **NOT** been fully determined by the CERES Team. Users of these data may wish to consult the ES8 TRMM Edition1 Data Quality Summary regarding the typical properties of this type of data product for data from the first nine months of CERES instrument operation on the TRMM spacecraft. That document briefly summarizes key validation results, provides cautions where users might easily misinterpret the data, provides helpful links to further information about the data product, the algorithms, and the data accuracy, as well as information about planned data product improvements. This summary also automates registration in order to keep you informed of new validation results, cautions, or improved data sets as they become available.

Please note that 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 it.

The quality of the CERES ES8 data is comparable to the quality of the ERBS S8 data of instantaneous radiances, fluxes, and scene types. Generally, radiance uncertainties are at the 1% level or less. Some differences between CERES-TRMM and ERBE-ERBS are: the field of view resolution, the spectral response of the instruments, and the tropical-only coverage of TRMM.

The **Transient-Ops** version of this Data Set refers to data collected from the end of August, 1998, until about a month after the EOS Terra launch, during which instrument operations were substantially reduced to conserve instrument life. At the end of August of that year, the power converters on the TRMM instrument were observed to operate outside the design range for voltage control. After a period of investigation and exploratory instrument operation, NASA instrument engineers and the CERES team concluded that this problem had not changed the instrument calibration. However, they did expect that the CERES TRMM instrument had a moderate risk of becoming inoperable if spacecraft power failed while the instrument was operating and then was restored. As a result, during the Transient-Ops period, the CERES TRMM instrument was turned on about two days per month - with particular attention to obtaining data in support of intercomparison with the ScaRaB radiation budget observations and the INDOEX and NAURU99 field campaigns. Because of the brief periods when the instruments were turned on, the temperature of the detector heat sinks varied more than it does during continuous observations. The thermal non-equilibrium, in turn, changes the effective gain of the instruments by up to about 0.5%. The CERES Team expects to resume normal operations with the CERES TRMM instrument after the launch of Terra. **The CERES Team recommends caution in using the data in this Data Set Version for scientific investigations.**

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Nature of the ES8 Product

This document discusses the **E**RBE-Like **S**cience Product **8 [ES8]** data set version **Transient-Ops**. The files in this data product contain one day (24 hours) of filtered and unfiltered radiances, Top of the Atmosphere (TOA) fluxes, and cloud cover with underlying surface type. Each radiance is located in colatitude and longitude and the viewing angles are calculated. The unfiltering algorithm produces radiances for three spectral bands for each measurement point or footprint:

- the longwave (LW) band that deals with energy emitted by the Earth's surface and atmosphere over the wavelength range from about 5 microns to beyond 200 microns,
- the shortwave (SW) band that deals with reflected sunlight over the wavelength range from about 0.3 microns to about 5 microns, and
- the window (WN) band that deals with energy emitted mostly by the Earth's surface over the wavelength range from about 8 microns to about 12 microns.

Radiances are converted to fluxes at the TOA for the SW and LW bands. Only filtered and unfiltered radiances are recorded for the WN band on this product.

The data are organized by time of observation. The two principle scan modes are the Fixed Azimuth Plane (FAP) and the Rotating Azimuth Plane (RAP) mode. In both cases the instrument scans across the Earth with views of space on either side which gives a full Earth view. The FAP mode produces uniform area sampling while the RAP mode produces angular sampling of the radiances.

A full list of parameters on the ES8 is contained in the CERES Data Product Catalog (PDF) and a full definition of each parameter is contained in the ES8 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. This data set may be referred to as "CERES TRMM Transient-Ops2 ES8."

Data Accuracies

Because the heat sink temperature varies over the short observing periods covered by the granules in this Data Set, the uncertainties of the filtered radiances and of all the quantities that depend on them are somewhat larger than those in the typical CERES TRMM data products - and vary with time within the granules of this Data Set Version. Each channel is different in the amplitude of the "effective gain change". In addition, the CERES Team has not had sufficient time to evaluate the propagation of this change through the various fields in the data product. One could anticipate small changes in spectral corrections in going from filtered radiance to unfiltered, in the statistics of scene ID classes, and in the fluxes calculated using the ERBE MLE ADM's. While it appears that the filtered radiances are only slightly affected by the transient thermal behavior of the instrument, the CERES team has not quantified the effect on parameters beyond the filtered radiances.

Differences Between CERES and ERBE

- The resolution of CERES-TRMM is 10 km at nadir, and the resolution of ERBE-ERBS is 40 km at nadir so that the surface area observed from ERBS is 16 times larger than the area observed from TRMM.
- The nominal scan mode for ERBE was crosstrack to provide good area coverage. CERES has two scan modes. The Fixed Azimuth Plane (FAP) scan mode is similar to the ERBE scan mode. The Rotating Azimuth Plane (RAP) scan mode was added to CERES to provide angular coverage for Angular Distribution Models construction.
- The longwave channel on ERBE was replaced by an 8 to 12 micron window channel on CERES.
- The data rate on ERBE was 30 measurements per second. The data rate on CERES is 100 measurements per second.
- The ERBE S8 data product was about 36 MB in size. The CERES ES8 data product is about 480 MB.
- ERBS had an orbital inclination of 57 degrees. TRMM is restricted to the Tropics with an orbital inclination of 35 degrees.

Cautions When Using Data

There are several cautions the CERES Team notes regarding the use of the CER_ES8_TRMM_Transient-Ops and Transient-Ops2 data. The comments here are intended to provide some ties to the general characteristics of the CERES data from the Edition1 version of the ES8 product:

- TRMM is observing more clear sky than ERBE due in part to the difference in footprint size. The resolution of CERES-TRMM is 10 km at nadir and the resolution of ERBE-ERBS is 40 km at nadir so that the surface area observed by ERBS is 16 times larger than the area observed by TRMM. For the time period of January through July in the Tropics (20 degrees north latitude to 20 degrees south), ERBS observed about 17% clear sky and TRMM observed about 28% clear sky. ERBS also observed about 17% overcast and TRMM observed about 16% overcast. It is not fully understood why the overcast for TRMM decreased instead of increasing like clear sky. Overall, the cloud fraction was 46% for ERBS and 40% for TRMM.
- The ERBE scene identification algorithm (Maximum Likelihood Estimator, MLE) in conjunction with the ERBE angular distribution models (ADMs) 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 TRMM fluxes also have these biases with viewing angle.
- The strong 1998 El Nino occurred during the ES8 data period and has had an influence on the results. The scene identification algorithm operates with a priori climatological data which is probably inadequate for the El Nino period of increased ocean temperatures and perhaps changes in atmospheric water vapor distribution. The increased temperature of the tropics will be interpreted as less cloud and will introduce errors in the inversion from radiance to flux.
- Some applications of the ES8 data will need to make the distinction between Rotating Azimuth Plane (RAP) data and Fixed Azimuth Plane (FAP) data. In general, the TRMM scan mode has been one day of RAP scanning followed by two days of FAP scanning. Also, every 15th day is alongtrack scanning. All 3 scan modes can occur on the same day so that the data parameter "Scanner Operation Flag Word" must be examined for each data record to sort on scan mode. **In addition to these normal operational modes, the data from the Transient-Ops period also has more frequent internal calibration observations during which the engineering team were diagnosing the causes of the anomalies and evaluating the stability of the instrument calibration. Because of these differences from normal operations, users are particularly urged to examine the "Scanner Operation Flag Word" for each data record.**
- Data Users are strongly urged to examine the flags for each footprint in order to determine if the data for that footprint are good or bad.
- **During the two to three day observing period characteristic of the data collection in this Data Set Version, the heat sink temperatures varied more than they do during normal operation of the CERES instruments. The effect is roughly equivalent**

to a gain decrease of about 0.5% at the beginning of the observing period - although the exact "gain change" varies from channel to channel. As the instruments approach normal equilibrium operating conditions, this "gain change" decreases.

- The Transient-Ops2 data set version includes several corrections to improve data coverage during intermittent operations, including:
    1. identify cross-track mode rather than transitional mode when the azimuth encoder toggles the least significant bit
    2. only restart the second time constant numerical filter when data is missing
    3. apply offsets to the raw counts used to calculate the spaceclamp

Validation Study Results

The validity of the filtered radiances, unfiltered radiances, TOA fluxes, and identified scene types has been examined with various validation studies and quality checks. The validation of the filtered radiances is discussed in the BDS TRMM Edition1 Data Quality Summary and the ES8 TRMM Edition1 Data Quality Summary. Data users who need data from the Transient-Ops Data Set Version are urged to consult the Data Quality Summary for Edition1 for a detailed summary.

Quality Assurances

There are a number of quality checks which are listed below.

- The LW flux is rejected if it is outside the range 50 to 450 Wm^{-2}. About 0.00% of the LW flux is rejected.
- The SW flux is rejected if albedo is outside the range 0.02 to 1.00. About 0.06% of the SW flux is rejected.
- The LW and SW flux is rejected if viewing zenith is greater than 70 degrees. About 8.5% of the flux is rejected.
- The SW flux is rejected if anisotropy from the ADM is greater than 2.0. About 0.68% of the SW flux is rejected.
- The unfiltered radiances and fluxes for SW and LW are rejected if the MLE identified scene is more that 8 sigma from the expected a priori scene. About 0.01% of the scenes are rejected.
- Filtered radiances flagged "bad" are not used. About 0.3% of the SW radiances, 0.4% of the TOT radiances, and 0.2% of the WN radiances are flagged "bad".

Expected Reprocessing

The CERES Team expects to reprocess the S8 data product for ERBS, NOAA-9, NOAA-10, and the ES8 data product for TRMM in the late 2000 to mid-2001 time frame. 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 contribution to reprocessing will be an improved set of Angular Distribution Models (ADMs) 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 the CERES and ERBE footprints will be similar in size. **The Transient-Ops Data Set Version will also be reprocessed as part of this general processing.**

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 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.

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 EOSDIS Distributed Active Archive 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. It also helps us to keep our product related references current.

Feedback

For questions or comments on the CERES Quality Summary, contact the NASA Langley DAAC User and Data Services staff.

Document Creation Date: July 22, 1999
Modified: Dec 1999; Feb 2000; Mar 2000; Apr 2000 (non-science); Aug 2001 (non-science); Dec 2001
Most Recent Update: December 12, 2001