CERES SYN/AVG/ZAVG Terra Edition2C
CERES SYN/AVG/ZAVG Aqua Edition2B
Data Quality Summary

Investigation: **CERES**
Data Product: **Synoptic Radiative Fluxes and Clouds (SYN)**
                                   Monthly Regional Radiative Fluxes and Clouds (AVG)
                                   Monthly Zonal and Global Radiative Fluxes and Clouds (ZAVG)

Data Set: **Terra (Instruments: CERES-FM1 or CERES-FM2, MODIS)**
                                   Aqua (Instruments: CERES-FM3 or CERES-FM3, MODIS)
Data Set Version: **(Terra) Edition2C**
                                   (Aqua) Edition2B

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 SYN/AVG/ZAVG Product

This document discusses SYN/AVG/ZAVG versions Terra Edition2C and Aqua Edition2B. Any data quality issues with Terra are applicable to Aqua or the other way around. Any reference to the Terra specific CERES data products such as the CRS can be easily interchanged with the appropriate Aqua CERES product. For example the CRS Data Quality Summary can be obtained from either the CERES Terra Edition2C CRS or CERES Aqua Edition2B depending on the given satellite. 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 and Aqua Edition2B SYN/AVG/ZAVG product. Any differences are due entirely to changes from the input, such as differences in the Terra or Aqua SSF. **The user should always use the latest Edition that is available.** Both Terra and Aqua SYN/AVG/ZAVG use the same GEO cloud property retrievals, however the GEO fluxes are normalized to the specific CERES instrument given in the product name.

The Synoptic Radiative Fluxes and Clouds (SYN), Monthly Regional Radiative Fluxes and Clouds (AVG), Monthly Zonal and Global Radiative Fluxes and Clouds (ZAVG) archival data products contain 3-hourly (SYN), monthly regional mean (AVG), and monthly zonal & global mean (ZAVG) surface and atmospheric Langley Fu-Liou radiative transfer modeled fluxes consistent with CERES observed fluxes. The SYN/AVG/ZAVG fluxes and cloud properties can be compared directly with climate model results at either the 3-hourly or monthly level. The SYN 3-hourly fluxes are GMT based. The daily fluxes are obtained by taking the mean of 8 3-hourly-fluxes and the monthly flux is derived from the mean of the daily fluxes. Also, monthly 3-hourly fluxes are provided on the regional, zonal and global levels.

The profile and surface fluxes are obtained from Langley Fu-Liou radiative transfer code using merged CERES (MODIS derived) and 3-hourly geostationary cloud properties, which have been temporally interpolated using the same algorithm as in the CERES-SRBAVG-GEO product.

Other input datasets include GEOS4 meteorological data, SMOBA ozone, MODIS MOD04 and MATCH aerosols, apriori ocean spectral albedos, and satellite retrieved broadband surface albedos over land and snow using apriori surface spectral characteristics. The fluxes are derived hourly for pristine (clear-sky no aerosol), clear-sky, all-sky no-aerosol, and all-sky conditions. The radiative transfer fluxes are first computed with the initial input and labeled as "untuned" and then recomputed as "tuned" fluxes, which are partially constrained to CERES TOA observations by slightly changing the initial input, in order to achieve consistent flux and cloud property dataset. The constrainment adjustments to the GEOS4 and cloud properties are also provided. The product also contains UVA, UVB and PAR fluxes. The SYN data product is released by the CERES Surface and Atmosphere Radiation Budget (SARB) working group and the algorithm is similar to the CERES Clouds and Radiative Swath (CRS) data product except for the inclusion of GEO fluxes and cloud properties. Further information can be read in the [CERES CRS Data Quality Summary](#).

CERES data input to the SYN/AVG/ZAVG subsystem is the CERES FSW product and concurrent diurnal data from geostationary satellites. The CERES FSW product contains the instantaneous gridded SSF and CRS archival data product. The 3-hourly geostationary derived fluxes have been normalized with CERES fluxes. The geostationary two-channel cloud property retrieval is a subset of the CERES code. The geostationary dataset provides temporal sampling between CERES measurements. This technique represents a major advancement in the reduction of temporal sampling errors (Young et al. 1998). Both observed and interpolated cloud properties and TOA fluxes are used to provide hourly GMT input to the radiative transfer model. The SYN/AVG/ZAVG is processed only for one CERES instrument, the instrument in cross-track mode, which provides uniform footprint spatial sampling.

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.

SYN/AVG/ZAVG Edition2-Rev1

The CERES Science Team has **already** applied the [table of scaling factors for Terra](#) and [table of scaling factors for Aqua](#) to the observed TOA SW fluxes so the tuning of the computed fluxes are consistent with the Rev1 corrections that other products need to apply. **The user should not apply the Rev1 corrections** as outlined in other product Data Quality Summary.

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 and Aqua FM3 and FM4 data respectively. A complete description of the physics of this darkening appears in the [CERES Terra BDS](#) and [CERES Aqua BDS](#) Quality Summaries under the Expected Reprocessing section.

Cautions and Helpful Hints

Users wishing to view AVG or ZAVG data sets using MATLAB are advised that some versions of MATLAB require a workaround. See [AVG/ZAVG: 0-length Vdata MATLAB Bug Fix](#).

The CERES Science Team notes several cautions regarding the use of CERES Edition2 SYN/AVG/ZAVG data:

- The following **SYN** observed "Cloud Properties for Four Cloud Layers" **zonal** (temporal) **standard deviations** were not computed properly and are meaningless.
    Ice Water Path
    Bottom Pressure
    Effective Temperature
    Effective Pressure
    Top Pressure
  This error will be corrected in the next edition.

- The following Constrainment Adjustments were not computed properly, are meaningless and should **not** be used in the SYN, AVG and ZAVG products.
    Mean visible optical depth - adjusted
    Mean cloud fractional area - adjusted
    Mean cloud effective temperature - adjusted
  This error will be corrected in the next edition.

- Users are advised to range check SYN, AVG, and ZAVG parameter values prior use and disregard all values, which are outside of the published expected range. CERES has found that in some AVG files large, non-default parameter values were written out in place of the CERES default value. CERES does not know the cause of this problem and is unable to predict when the problem may occur. Therefore, CERES cannot state with certainty that the problem is limited to the AVG data sets and never occurs within the SYN or ZAVG datasets.

- 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.

- Retrievals of land, snow and sea-ice surface albedo are not of best quality at non-Terra overpass times, especially at low sun, since TOA clear sky used for surface albedo retrieval is then based on monthly averaged diurnally modeled TOA flux at non-Terra overpass times.

- The daytime LW TOA observed flux values on the Edition2 SYN/ZAVG/ZAVG products have been modified from the values on the rest of the Edition2 CERES products such as the SSF. As described earlier the SYN/AVG/ZAVG SW flux has the Rev1 correction already included. The LW flux being the difference of the total and shortwave channels during the day suffers from spectral degradation differences in the UV part of these channels. A correction to the Edition2 SYN/AVG/ZAVG LW flux based upon a beta version of Edition3 CERES calibration has been applied. The correction is based on the difference of the CERES Edition2 SW minus LW TOA flux. The form of the parameterization is R= a0+a1*(SW-LW) + a2*(SW-LW)**2. Where R is the ratio applied to the Edition2 LW TOA flux. In the mean this correction adds about 1Wm^{-2} to the Edition2 LW fluxes. However, the correction as a percentage is larger (~3%)for bright/cold scenes and less (~0.5%) for dark/warm scenes. The coefficients are determined monthly separately for each CERES instrument.
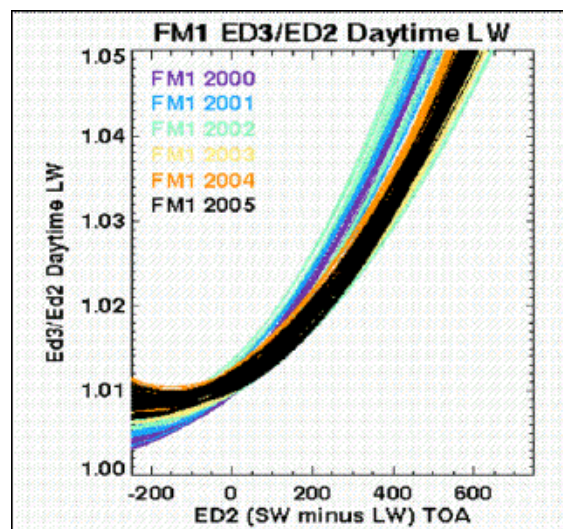

Fig. 1. *Plot showing the monthly daytime LW flux correction applied to the SYN/AVG/ZAVG Edition2 observed TOA flux for FM1.*

- The modeled SW fluxes have been computed for a temporally and spatially integrated solar flux for a particular GMT hour increment centered on the GMT half hour and CERES 1° nested grid. The twilight correction that was applied to the SRBAVG SW fluxes were not applied to SYN/AVG/ZAVG fluxes to account for SW flux from solar zenith angles greater than 90°. In general, the regional correction is < 0.5 Wm^{-2} and the global mean correction is 0.2 (Kato and Loeb 2003). The SYN/AVG/ZAVG modeled computed fluxes are based on a spectral solar flux 1365.04 Wm^{-2}, instead of the CERES reference insolation of 1365 Wm^{-2}. All differences between the SRBAVG and SYN/AVG/ZAVG incoming solar flux computations can be examined in this article. Loeb, L.G., B. A. Wielicki, D. R. Doelling, G. L. Smith, D. F. Keyes, S. Kato, N. M. Manalo-Smith, T. Wong, Towards Optimal Closure of the Earth's Top-of-Atmosphere Radiation Budget, Submitted *J of Climate*. The SYN/AVG/ZAVG has the more precise estimation of the imcoming solar than the SRBAVG product

- The SYN/AVG/ZAVG cloud properties differ slightly from the SRBAVG2 Terra Edition2D (MODIS and GEO cloud) product. The GEO nighttime single-channel IR-only cloud algorithm computes cloud fraction, pressure, temperature and phase. The GEO daytime visible and IR algorithm includes cloud optical depth, emissivity, top and base pressure. The GEO cloud algorithm does not retrieve cloud liquid, ice water path, and particle size. Usually cloud properties are linearly interpolated between cloudy measurements and extrapolated when no cloud information is available for each of the 4 cloud layers independently. However, if there is no MODIS measured particle size or water path for a measured GEO cloud condition, the liquid and ice particle size is assumed to be 10µm and 60µm respectively. For consistency, the water path is recomputed from the optical depth and particle size. The GEO clouds are identical for the Terra and Aqua based products, however the GEO derived fluxes used in the temporal interpolation are normalized to the given satellite.

- More than 99.5% of all 1-hourly input to the model are consistent in both flux and cloud properties, each parameter being interpolated independently. However for 0.5% of the input cases the modeled fluxes could not be computed. Most of these occur near the terminator, where no CERES SW measurements are available for the month. Rarely, a cloud top may be below the bottom. The total number of modeled flux calculations is available in the "number of observed, untuned, and tuned, for LW and SW hourboxes".

- Only data from one CERES instrument in cross-track mode is processed to generate the SYN/AVG/ZAVG product for a given month. The instrument in cross-track mode may change over time. Refer to the CERES instrument scan mode monthly table to determine processing instrument.

Accuracy and Validation

The primary goal of the SYN/AVG/ZAVG product is to provide climate quality monthly mean radiative transfer fluxes consistent with the CERES observed fluxes and cloud properties. For the inputs to the SYN/AVG/ZAVG products, users should consult the SSF Data Quality Summary for the accuracy associated with CERES TOA fluxes and cloud properties. The validations of the Langley Fu-Liou radiative transfer modeled fluxes are available in the CERES CRS Data Quality Summary. Validation of the geostationary flux and cloud properties are noted in the SRBAVG Data Quality Summary. For accuracy on the SYN/AVG/ZAVG product fluxes the validation has been organized by parameter as follows.

- Computed flux validation
- Accuracy and Validation of the TOA and surface computed fluxes based on GEO cloud properties
- UV and PAR flux validation

Further validation of the SYN/AVG/ZAVG product is planned when the Terra and Aqua time records are processed through October 2005. The validation will focus on the GEO cloud and computed flux EOF analysis to determine any GEO artifacts, which are not predicted. Also, a surface flux temporal trend analysis, with respect to ground observations, will be performed.

References

List of CERES SYN/AVG/ZAVG References

Expected Reprocessing

There is no scheduled reprocessing of the **CERES SYN/AVG/ZAVG** Edition2 product. It is expected that the Edition2 processing will be completed in Fall 2009. Whenever the SRBAVG product data record is extended the SYN/AVG/ZAVG product will also be extended. The next scheduled reprocessing will be for CERES Edition3 products with improved MODIS cloud retrievals, CERES instrument calibration, GEO temporal averaging techniques, and computed flux algorithm. The earliest expected date of Edition3 SYN/AVG/ZAVG is 2011. Notification of any changes and reprocessing 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 SRBAVG 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.

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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