CERES_CRS1deg-Hour_Ed4A
Data Quality Summary

Version 1
Updated 3/15/2024

Investigation: **CERES**
Data Products: **CRS1deg-Hour**

Data Sets: **Terra, Aqua**

Data Set Versions:	**Terra Edition4A**	**Release Date: March 15, 2024**
	Aqua Edition4A	**Release Date: March 15, 2024**

CERES Visualization, Ordering and Subsetting Tool: https://ceres.larc.nasa.gov/data/

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 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 is a high-level summary and represents the minimum information needed by scientists for appropriate and successful use of this data product. It is strongly suggested that authors, researchers, and reviewers of research papers re-check this document (especially Cautions and Helpful Hints) for the latest status before publication of any scientific papers using this data product.

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1.0 Nature of the CERES_CRS1deg-Hour_Ed4A Products

The level 3 (L3) CERES CRS1deg-Hour product provides hourly 1°-gridded means of the instantaneous computed radiative fluxes from the Aqua or Terra CRS Edition4A product. The computed instantaneous fluxes are obtained from radiative transfer calculations initialized using observation-based input data sources at the CERES footprint resolution by the level 2 (L2) CRS algorithm. Since no diurnal integration or correction is performed for the CRS1deg-Hour product, the fluxes are at the CERES observation time (i.e., instantaneous fluxes). The CRS1deg-Hour products are processed separately for each satellite using observations from the instrument that is in cross-track mode. The instantaneous gridded means are organized in daily files.

In this product, the computed shortwave (SW) and longwave (LW) fluxes are available at top-of-atmosphere (TOA), within-atmosphere (70, 200, 500, and 850 hPa), and surface, for four different combinations of aerosol and clouds; i.e., all-sky (clouds+aerosol), clear (aerosol only), no-aerosol (clouds only), and pristine conditions. Therefore, cloud or aerosol radiative effects can be easily estimated by using this product.

The description of the radiative transfer model inputs and validation results are provided in the Level 2 CRS Ed4 Data Quality Summary. Scott et al. (2022) also provide a detailed description of the L2 Edition 4 (Ed4) CRS algorithm.

2.0 Averaging L2 CRS Variables for Producing CRS1deg-Hour Product

Computed radiative fluxes and related model input parameters are provided at a CERES footprint resolution in the L2 CRS product. The input parameters include surface albedo, surface emissivity, temperature/humidity profiles, aerosol types and corresponding optical thickness (AOT), and cloud fraction/phase/height/optical thickness. These parameters are hourly averaged and gridded for the CRS1deg-Hour Product.

The footprint-scale variables in the L2 CRS product are linearly averaged on a 1°×1° grid for an hour window. Shortwave (SW) flux variables are further normalized by the cosine of the solar zenith angle of the CERES footprint that is closest to the center of the grid box.

The averaging is performed separately for the cross-track CERES instrument on Terra and Aqua. CERES instruments fly on the Terra (descending sun-synchronous orbit with an equator crossing time of 10:30 A.M. local time) and Aqua (ascending sun-synchronous orbit with an equator crossing time of 1:30 P.M. local time) satellites. Examples of orbital swaths are shown in Figure 2-1.

Figure 2-1 shows an example of the comparison between CRS-computed and CERES-derived (observed) fluxes for an hour track at 01:00-02:00 UTC on January 1, 2018, from two CERES instruments on (a) Terra and (b) Aqua. In both instruments, the spatial distributions of the computed and observed fluxes agree well. Biases in computed SW fluxes to observations are slightly positive over cloudy regions, which is discussed in Scott et al. (2022). The magnitude of the LW biases is generally smaller than that of the SW biases.

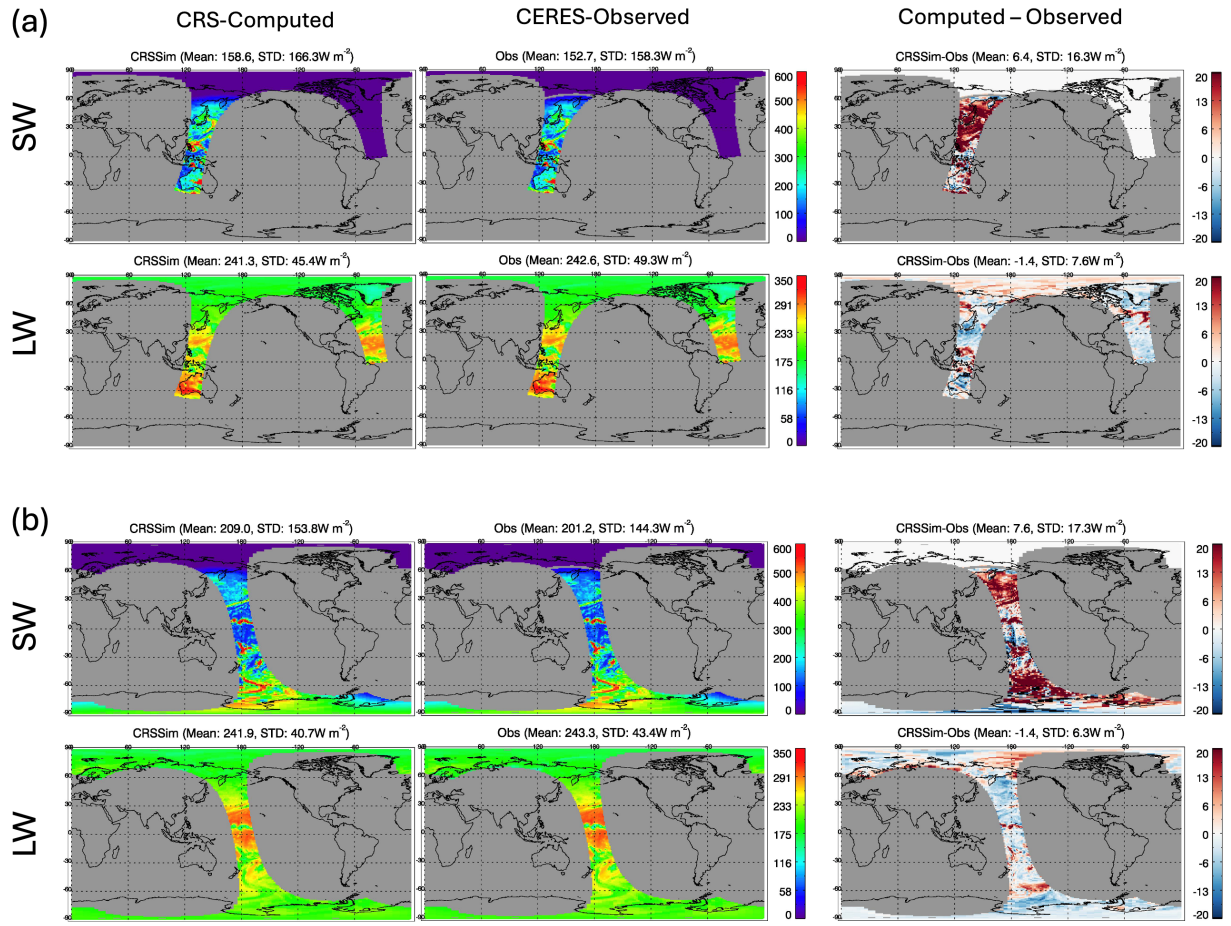

Figure 2-1. (a) CRS-Computed (left), CERES-observed (middle), and computed minus observed (right) TOA upward fluxes for SW (top row) and LW (bottom row) channels for all skies (aerosol + clouds). One-hour CERES track on Terra observed at 1:00–2:00 UTC on January 1, 2018 is used. (b) Same as (a) but from CERES on Aqua.

Figure 2-2 shows an example of the estimation of cloud radiative effect (CRE) on SW fluxes. In this example, the CRE is computed as the differences in fluxes for all-sky (aerosol+clouds) and clear-sky (aerosol only) conditions. When cloud layers exist, reflected SW fluxes at TOA are increased, transmitted SW fluxes at the surface are decreased, and atmosphere-aboserved SW fluxes are slightly increased. For estimating aerosol radiative effect, the differences in fluxes for clear-sky (aerosol only) and pristine conditions can be used.

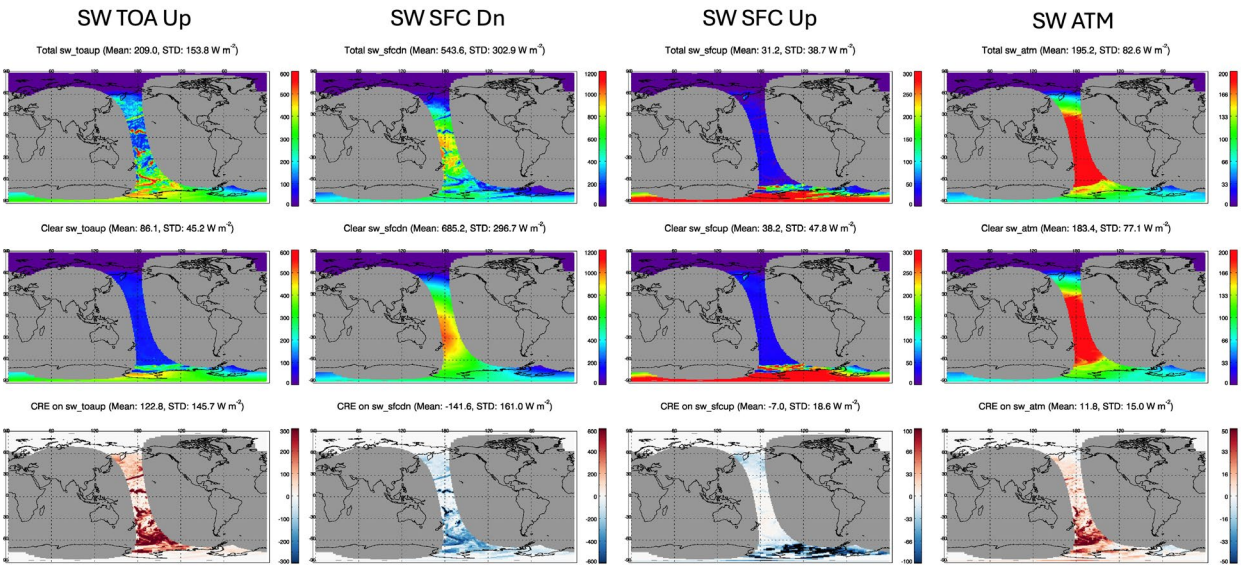

Figure 2-2. Cloud radiative effect (CRE) on SW TOA upward (first column), surface downward (second column), surface upward (third column), and atmosphere-absorbed (fourth column) fluxes. The CRE is defined as the all-sky (aerosol and clouds) minus clear-sky (aerosol only) fluxes. The one-hour CERES track on Aqua observed at 1:00–2:00 UTC on January 1, 2018 is used.

3.0 Cautions and Helpful Hints

The CERES Science Team notes several CAUTIONS and HELPFUL HINTS regarding the use of CERES_CRS1deg-Hour Ed4A:

The clouds, aerosol, and auxiliary parameters in the L2 SSF product are used for the radiative transfer calculations at the CERES footprint resolution for the L2 CRS product. Then the computed instantaneous fluxes are gridded hourly for the L3 CRS1deg-Hour product. Therefore, issues in L2 SSF clouds, aerosol, and auxiliary parameters directly affect the quality of the L3 CRS1deg-Hour product. Therefore, it is strongly recommended to check the Data Quality Summaries (DQS) of L2 SSF and L2 CRS products before using the L3 CRS1deg-Hour products.

- The CERES_CRS1deg-Hour_Ed4A product can be visualized, subsetted, and ordered from: https://ceres.larc.nasa.gov/data/.
- The CERES CRS1deg-Hour Ed4A is a single-satellite product. There is no CRS1deg product that combines measurements from multiple satellites.
- Cloud optical depth in the CRS1deg-Hour product refers to the linearly averaged value on a 1°×1° grid of the logarithmically averaged cloud optical depth at a CERES footprint resolution in the L2 CRS product. Note that for the radiative transfer calculations in the L2 CRS algorithm, the logarithmically averaged cloud optical depth at a CERES footprint is used.
- The L2 Ed4 CRS algorithm contains a bug that affected the data type conversion of the MATCH aerosol optical thickness (AOT). As a result, when MATCH AOT > 3.2768, negative values were stored in the L2 CRS product. This is partly handled in the L3 CRS1deg-Hour product. However, rarely, if the MATCH AOT > 9.8034, the value is actually stored as MATCH AOT – 6.5536.
- The Fu-Liou radiative transfer calculation fails when one or some of the input parameters are out of the expected ranges. In this case, computed fluxes are assigned as default values. Note in some cases, observed TOA fluxes are not available where there are not valid CERES radiances and in the twilight zone for SW fluxes, but the computed fluxes are still available from the radiative transfer calculations.
- Computed flux profiles are provided at 6 vertical levels, TOA, 70 hPa, 200 hPa, 500 hPa, 850 hPa, and surface. Accordingly, temperature, water vapor mixing ratio, and pressure profiles are provided with the same dimension. However, temperature and water vapor profiles are not strictly provided at TOA from the reanalysis dataset, and these are filled with default values. This could be approximated as the values at 0.01 hPa and will be included in future versions.
- The upper tropospheric humidity is calculated from the vertical integration of the relative humidity (%) between 200 hPa and 500 hPa pressure levels. In this upper troposphere, specific humidity is small due to the dry conditions. As a result, the error due to the simplified water vapor unit conversion (e.g., specific humidity into saturation vapor pressure) can significantly change the relative humidity, and sometimes it occurs that the relative humidity is > 100%.
- In the L2 CRS Ed4 algorithm, a surface-reflected component was turned off in the LW computations. This underestimated LW upward surface fluxes by 10 W m^{-2}, and TOA upward fluxes by 0.6 W m^{-2}. This issue also affects the L3 CRS1deg-Hour product. This surface-

reflected component will be included in future versions of the L2 CRS and L3 CRS1deg products.

4.0 Accuracy and Validation

The accuracy of computed instantaneous fluxes is discussed in Section 5 of Level 2 CRS Ed4 Data Quality Summary.

5.0 References

Please check Section 6 of Level 2 CRS Ed4 Data Quality Summary.

Scott, R. C., F. G. Rose, P. W. Stackhouse Jr., N. G. Loeb, S. Kato, D. R. Doelling, D. A. Rutan, P. C. Taylor, and W. L. Smith, Jr., 2022: Clouds and Earth's Radiant Energy System (CERES) Cloud Radiation Swath (CRS) Edition 4 Data product, J. Atmos. Oce. Tech., 39(11), 1781–1797, https://doi.org/10.1175/JTECH-D-22-0021.1

6.0 Expected Reprocessing

There are no plans to reprocess the CRS1deg-Hour Ed4A record until the CERES Edition 5 suite of data products are available. Any updates to the CERES CRS1deg-Hour products will be available for subsetting/visualization/ordering at: https://ceres.larc.nasa.gov/data/.

7.0 Attribution

When referring to the CERES CRS1deg-Hour product, please include the product and data set version as: “CERES Terra CRS1deg-Hour Ed4A” or “CERES Aqua CRS1deg-Hour Ed4A.”

The CERES Team has put forth considerable effort 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 Terra/Aqua CRS1deg-Hour Edition4A products:

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.

The CERES data products now have DOIs. To cite the data in a publication, use this format:

CERES Science Team, Hampton, VA, USA: NASA Atmospheric Science Data Center (ASDC), Accessed <**author citing data inserts date here**> at doi: (appropriate product)

For CRS1deg-Hour:
10.5067/Aqua/CERES/CRS1degHour_L3.004A
10.5067/Terra/CERES/CRS1degHour_L3.004A

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 Atmospheric Science Data Center." The Langley ASDC 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.

When CERES data obtained via the CERES web site are used in a publication, we request the following acknowledgment be included: “These data were obtained from the NASA Langley Research Center CERES ordering tool at https://ceres.larc.nasa.gov/data/.”

8.0 Feedback and Questions

For questions or comments on this CERES CRS1deg-Hour Data Quality Summary, contact the User and Data Services staff at the Atmospheric Science Data Center.

For questions about the CERES subsetting/visualization/ordering tool at https://ceres.larc.nasa.gov/data/, please email LaRC-CERES-Help@mail.nasa.gov.

9.0 Document Revision Record

The Document Revision Record contains information pertaining to approved document changes. The table lists the Version Number, the date of the last revision, a short description of the revision, and the revised sections.

Document Revision Record

Version Number	Date	Description of Revision	Section(s) Affected
V1	03/15/2024	• New document	All