EARTHDATA ASDC	**ERBS S10n Edition4.1 Data Quality Summary**	

Investigation:	**ERBE MEaSUREs**
Data Product:	**ERBS S10n**
Data Set:	**ERBS WFOV Nonscanner Instruments**
Data Set Version:	**Edition4.1**

This document provides a high-level quality summary of the Earth Radiation Budget Experiment (ERBE) data products containing flux at Top-of-Atmosphere (TOA) measured using Earth Radiation Budget Satellite (ERBS) Wide-Field-of-View (WFOV) Nonscanner instruments. It only contains minimum information required to access the data quality. For more information, users are recommended to refer Wong et al. (2006), Shrestha et al. (2019), the previous ERBS S10n Edition4 data quality summary, and the NASA ASDC ERBE MEaSUREs webpage. The ERBS S10n Edition4.1 data are stored in netCDF4 format.

1.0 Nature of ERBS S10n data product

The ERBS S10n contains top-of-atmosphere (TOA) fluxes for solar incoming radiation, reflective shortwave radiation, outgoing longwave radiation, and downward net radiation derived from the ERBS WFOV Nonscanner instrument for the period from 1985 to 1999. The ERBS WFOV data is placed on the 10-degree ERBE equal-angle grid system and the regional data covered an area between 60 N and 60S. The Edition4.1 contains both regional data and large area mean (LAM) time series. The ERBS WFOV regional data are produced for several temporal periods to maximize data usage. These regional data are

- The 36-day regional data (36Day) provides 36-day mean estimates between 30N and 30S
- The 72-day regional data (72Day) provides 72-day mean estimates between 60N and 60S
- The annual regional data (72DayAnnual) provides annual mean estimates between 60N and 60S

The four LAM time series datasets provide additional information to assist user. These time series data are

- The 36-day LAM time series (36Day) for 30N to 30S
- The 72-day LAM time series (72Day) for 60N to 60S, 0 to 60N, 0 to 60S, and the globe (90N to 90S)
- The annual LAM time series (72DayAnnual) for 60N to 60S, 0 to 60N, 0, to 60S, and the globe (90N to 90S)
- The annual LAM filled time series (72DayAnnualGlobalFilled) for the globe (90N to 90S)

While the first three set of time series contain time periods with missing data, these missing data have been filled with estimated values in the fourth set of time series using other available information to provide a complete coverage for the period from 1985 to 1999.

2.0 Processing update in Current Edition

The ERBS S10n Edition4.1 data provides an incremental update to the original Edition4 dataset that was released in 2018. Edition4.1 contains the following changes to the Edition4 data.

- Updated ERBS WFOV longwave (LW) and shortwave (SW) offsets to CERES EBAF4.1
- Provided partial year data for 1999; the current ERBS WFOV S10n dataset ended in September 30, 1999
- Added new post-processing data quality control to filter out data periods with significant time sampling issues, due to instrument anomaly problems, which resulted in more than 33% missing daily observations in any single period and replaced those data periods with missing data flag value (i.e., -999.0). These missing data flag periods now include
    - 36Day: 1993 cycle 7, 8, 9; 1998 cycle 3, 10; 1999 cycle 1, 8, 9, 10
    - 72Day: 1993 cycle 4, 5; 1998 cycle 2, 5; 1999 cycle 1, 4, 5
    - 72DayAnnual: 1993, 1998, 1999

- Implemented post-processing routines to
    - Correct minor regional Total Solar Irradiance (TSI, or incoming solar radiation) data quality issue for few 36-day and 72-day data periods in 1993 and 1998 and recomputed SW and Net using rectified TSI
    - Compute annual regional TSI mean based on full year mean data (365 or 366 days) instead of 360 day mean from five 72-day cycles data and recomputed SW and Net using rectified full year mean TSI
- Included a new timeseries dataset (72DayAnnualGlobalFilled) with estimated annual global mean for 1993, 1998 and 1999, due to missing data in the 72DayAnnual time series, using linear interpolation for 1993 and 1-year/2-year change relative to 1997 in Beta version of GEWEX SRB Release 4 data for 1998/1999, respectively and created a new continuous global annual mean time series dataset with no missing data flag values
- Fixed minor NetCDF time coordinate issue using real time value instead of 36-day or 72-day cycle number

3.0 Differences between new Edition4.1 and old Edition4

Figure 1 shows the TOA annual global mean time series for incoming solar radiation (TSI), reflected shortwave radiation (SW), outgoing longwave radiation (LW) and net downward radiation (Net) from 1985 to 1999 for both ERBS WFOV S10n Edition4 and Edition4.1 while Table 1 summaries their corresponding climatological (1985 to 1998) annual global mean values, their 2-sigma interannual variability as well as the differences between these two datasets.

Table 1. ERBS S10n climatological global annual mean and 2-sigma interannual variability from 1985 to 1998 in Wm^{-2} for Edition4, Edition4.1, and their corresponding differences (Ed4.1 minus Ed4) for incoming solar radiation (TSI), reflected shortwave radiation (SW), outgoing longwave radiation (LW), and net downward radiation (Net).

	Edition4.1	Edition4	Ed4.1 minus Ed4
TSI	340.04 (0.17)	339.95 (0.54)	0.09 (0.51)
SW	101.45 (2.88)	101.10 (2.93)	0.35 (0.35)
LW	238.64 (1.41)	237.99 (1.53)	0.65 (0.21)
Net	-0.05 (1.64)	0.85 (1.64)	-0.91 (0.25)

As seem in the figure and table, the time sampling issues in Edition4 that caused the spikes in the 1993 and 1998 TSI data have been eliminated in Edition4.1 using new data quality control algorithm. This data quality control algorithm also has an effect of quieting down the noise in the Edition4 data as seen by the smaller interannual variabilities (TSI, SW, and LW) in the Edition4.1 data. The SW and LW have been revised upward slightly relative to Edition4 due to updated ERBS-to-CERES offset values. The combined changes in TSI, SW, and LW cause the Edition4.1 Net value to decrease relatively to the Edition4 baseline. The new Edition4.1 Net time series are now closer to net radiative balance (i.e., zero net value) as compared to Edition4 value (i.e., -0.05 vs. 0.85 as shown in Table 1).

Figure1. Comparisons between ERBS S10n Edition4 (red) and Edition4.1 (blue) time series of global annual mean TOA fluxes in Wm^{-2} from 1985 to 1999 for incoming solar radiation (TSI), reflected shortwave radiation (SW), outgoing longwave radiation (LW), and net downward radiation (Net).

4.0 Data Accuracy Table

Table 2: Uncertainty (1σ) in the global annual mean TOA fluxes derived from ERBS WFOV Nonscanner observations.

Source	Shortwave (%)	Longwave (%)
WFOV Calibration[1]	2.5 (0.1)[a]	1.9 (0.1)[a,b]
Calibration against CERES	0.3	0.1
CERES Instrument Calibration[2]	1.0	0.75
Inversion	< 1.0	0.5
Time and Space Sampling	0.2	0.03
Scaling 60N-60S to Global	0.1	0.1
Total Uncertainty	2.9 (1.1)	2.0 (0.8)

[1] Luther et al. (1986) and Lee et al. (2004)
[2] Loeb et al. (2009)
[a] Instrument stability uncertainty
[b] Both daytime LW, which is the same as SW, and nighttime LW uncertainties are 0.1%

5.0 Caution When Using Data

There are several cautions the ERBS WFOV Team notes regarding the use of the ERBS S10n Edition4.1 data:

- The ERBS WFOV data is an all-sky only data product. No clear-sky information is available from this dataset.
- Due to the very large field-of-view size of the WFOV Nonscanner instrument, the regional resolution of the ERBS WFOV data is 10-degree.
- Due to the 72-day precessing nature of the ERBS satellite orbit, the temporal resolution of the ERBS WFOV data is given only in 36-day mean, 72-day mean, and annual mean. Monthly mean data are not provided to avoid aliasing of the diurnal cycle of shortwave radiation into the monthly mean shortwave data over the long-term record.
- There were several time periods of missing data during 1993, 1998, and 1999. The ERBS WFOV data during these periods have been set to the default missing data value of -999.0 for fluxes and -999 for count value.
- Details of Edition4 processing are discussed in the Edition4 data quality summary. Other than the update discussed in Section 2 of this document, Edition4.1 processing is the same as the Edition4 processing.

6.0 References

Lee III, R. B., R. S. Wilson, G. L. Smith, K. A. Bush, S. Thomas, D. K. Pandey, and J. Paden, 2004: On-orbit Characterization of the Earth Radiation Budget Experiment Broadband Shortwave Active Cavity Radiometers Sensors Response, Proc. SPIE 5660, doi: 10.1117/12.578822

N. G. Loeb, B. A. Wielicki, D. R. Doelling, G. L. Smith, D. F. Keyes, S. Kato, N. Manalo-Smith, and T. Wong, 2009: Toward Optimal Closure of the Earth's Top-of-atmosphere Radiation Budget. Journal of Climate, 22(3), 748-766, doi: 10.1175/2008JCLI2637.1

Luther, M. R., J. E. Cooper, and G. R. Taylor, 1986: The Earth Radiation Budget Experiment Nonscanner Instrument. Reviews of Geophysics, 24(2), 391-399, doi: 10.1029/RG024i002p00391

Shrestha, A. K., S. Kato, T. Wong, P. Stackhouse, R. P. Loughman, 2019: New Temporal and Spectral Unfiltering Technique for ERBE/ERBS WFOV Nonscanner Instrument Observations. IEEE Transactions on Geoscience and Remote Sensing, 57(7), 4600-4611, doi: 10.1109/TGRS.2019.2891748

Wong, T., B. A. Wielicki, R. B. Lee, G. L. Smith, K. A. Bush, J. K. Willis, 2006: Reexamination of the Observed Decadal Variability of the Earth Radiation Budget using Altitude-corrected ERBE/ERBS Nonscanner WFOV Data. J. Climate, 19(16), 4028-4040, doi: 10.1175/JCLI3838.1

7.0 Expected Reprocessing

There are no scheduled revisions of the ERBS S10n Edition4.1 dataset currently. Notification of any changes will be sent to registered users.

8.0 Referencing Data in Journal Articles

Please provide a reference to the following papers when you publish scientific results with the ERBS S10n Edition4.1 data:

Barkstrom, B. R., 1984: The Earth Radiation Budget Experiment (ERBE). Bull. Amer. Meteor. Soc., 65, 1170-1185, doi: 10.1175/1520-0477(1984)065<1170:TERBE>2.0.CO;2

Shrestha, A. K., S. Kato, T. Wong, P. Stackhouse, R. P. Loughman, 2019: New Temporal and Spectral Unfiltering Technique for ERBE/ERBS WFOV Nonscanner Instrument Observations. IEEE Transactions on Geoscience and Remote Sensing, 57(7), 4600-4611, doi: 10.1109/TGRS.2019.2891748

Wong, T., B. A. Wielicki, R. B. Lee, G. L. Smith, K. A. Bush, J. K. Willis, 2006: Reexamination of the Observed Decadal Variability of the Earth Radiation Budget using Altitude-corrected ERBE/ERBS Nonscanner WFOV Data. J. Climate, 19(16), 4028-4040, doi: 10.1175/JCLI3838.1

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.

9.0 Feedback

For questions or comments on the ERBS S10n Edition4.1 Data Quality Summary, contact the User and Data Services staff at the Atmospheric Science Data Center.

Document Creation Date: September 15, 2020
Modification History:
Most Recent Modification:
