TOA SW and LW Irradiances Derived from ERBS Nonscanner Observations Consistent with CERES Irradiances

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Project Overview

• Supported by NASA’s Making Earth System Data Records for Use in Research Environments (MEaSUREs) program
  • Reprocess ERBE Wide-field-of-View (WFOV) Nonscanner radiation products
    • Characterize dome degradation to estimate time and spectral dependent degradation factor to derive its spectral response function
    • Implement Spectral Unfiltering by identifying surface and cloud properties over WFOV nonscanner footprints
  • Processed 14 Years (1985-1998) of ERBS WFOV nonscanner data.
ERBS WFOV SW Dome Transmission

- Fig (1.a) shows the original spectral response function (SRF) and (1.b) shows the time series of transmission for ERBS WFOV nonscanner shortwave (SW) dome.

- The transmission in Fig (1.b) is derived from solar measurements and shows that it degraded approximately 8% over time.

- The correction implemented in the historical processing assumed constant spectral degradation (gray assumption).

- However, recent development from analysis of CERES data indicates that transmissivity of shorter wavelength degrades faster suggesting a need for spectrally dependent degradation correction.

Fig. 1. (a) ERBS SW DOME Spectral Response Function (b) Time Series of ERBS SW DOME Transmission.
**ERBS Wide-Field-of-View (WFOV) Nonscanner Longwave and Shortwave Channel**

**Fig 1:** ERBS WFOV Nonscanner Monthly Mean Day-minus-Night Longwave Flux over 20° NS

- **Period 1,** 1985-1989.

**Day-Minus-Night TOA Longwave Flux**

\[ y = 0.0183x + 0.2636 \]

- Archived Edition3

**Fig 2:** ERBS WFOV Nonscanner Monthly Mean Deseasonalized Shortwave Flux over 60° NS

- **StdDev:** 8.25 W/m²
- **StdDev:** 1.09 W/m²

De-seasonalized using first 5 Years from 1985 to 1989

**TOA Shortwave Flux**
ERBS Wide-Field-of-View (WFOV) Nonscanner
Day-Minus-Night Monthly Longwave Flux, Tropics (20°N - 20°S)

Reprocessing reduced the day-minus-night longwave slope by ~34% (top figure), while this slope is consistent across all regions (left figure) compared to the archived data.

The remaining slope is accounted for by applying this correction to shortwave and longwave flux.
Corrections/Update

• Day-Minus-Night Longwave Flux Trend Corrections
  – Remaining Slope corrections after reprocessing

• Update Incoming Solar TOA Flux

• Calibration Transfer (with CERES EBAF Edition4)

• Sampling Correction
Day-Minus-Night Trend Corrections

Monthly Shortwave Flux Anomaly, (60°N - 60°S)

- Fig shows the deseasonalized shortwave monthly mean flux over (60°N – 60°S) latitude after applying the day-minus-night trend corrections to both archived edition3 (red) and reprocessed (green) data.

- The standard deviation is consistent in period 1, while standard deviation is significantly reduced from 8.25 to 3.25 w/m² in Period 2.

Deseasonalized Shortwave using first 5 Years from 1985 to 1989
Update Incoming Solar TOA Flux

Annual Incoming Solar TOA Flux, (60°N - 60°S)

- ERBS previous processing considered constant daily solar incoming flux at 1365 W/m² (red)

- Actual observation of daily solar incoming flux from SORCE is used in the reprocessing (green)

- Figure shows that using the SORCE observations results in ~1.25 W/m² reduction in annual incoming solar flux.

![Graph showing the comparison of archived and reprocessed solar flux data with missing months of data highlighted.](image-url)
Calibration Update, Monthly Flux (20°N-20°S)

Shortwave (W/m²)

- Tilted ERBS WFOV shortwave nonscanner observation during the gap is used to transfer calibration from CERES to ERBS
- TRMM Longwave observations during the gap is used to transfer calibration from CERES to ERBS

Longwave (W/m²)

2.36 W/m²

3.47 W/m²
Sampling Correction

- ERBS is in the precessing orbit, causing uncertainties due to partial diurnal coverage outside tropics
- Due to nighttime longwave observations, this effect is smaller in the longwave channel than in shortwave
- Simulation study to generate sampling corrections:
  - Use CERES EBAF Edition4 data
  - Replace ERBS flux with CERES flux, keeping the original ERBS sampling
Sampling Correction

Shortwave (60°N - 60°S)

Longwave (60°N - 60°S)
• Reprocess
• Apply All Corrections
• Apply conversion factor to convert the large area mean from (60°N-60°S) to Global, derived from CERES EBAF Edition4
Annual Global Reflected Shortwave Radiation

- Global TOA radiative mean flux (W/m$^2$) for two periods, the 1985–89 period and the 1994–98 period

**ERBS Uncertainty: 0.24%**

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[http://www.met.reading.ac.uk/~sgs02rpa/research/DEEP-C/GRL/](http://www.met.reading.ac.uk/~sgs02rpa/research/DEEP-C/GRL/)
Global TOA radiative mean flux ($W/m^2$) for two periods, the 1985–89 period and the 1994–98 period:

- **ERBS Uncertainty:** 0.14%

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• Global TOA radiative mean flux (W/m²) for two periods, the 1985–89 period and the 1994–98 period

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ERBS WFOV Nonscanner Data Release

- Regional (Yearly NetCDF Files)
  - Daily
  - 36Day
  - 72Day
  - 72DayAnnual

- Large Area Mean Time series (Three NetCDF Files)
  - 36Day Mean
    - 30NS
  - 72Day Mean
    - 60NS, 00-60N, 00-60S
    - 00-90N, 00-90S, 90NS
  - 72DayAnnual Mean
    - 60NS, 00-60N, 00-60S
    - 00-90N, 00-90S, 90NS
Summary

• Reprocessing with spectral unfiltering
  – Reduced the observed day-minus-might longwave trends by 35%
  – Improved data estimates for periods after Mt. Pinatubo and battery issue (shown by standard deviation)

• Uncertainty due to sampling with ERBS precessing orbit appears to be relatively small (Global mean)

• The ERBS WFOV nonscanner observation shows some offset in the TOA radiation flux (1994-1998 vs 1985-1999)
  – Shortwave, -1.99 W/m²
  – Longwave, 1.02 W/m²
Thank You !!!
Backup Slides
Sampling Correction

CER_SYN – ERBS_DIURN for 72Day Shortwave (Cycle 1, 1997)
CER_SYN – ERBS_DIURN for 72Day Longwave (Cycle 1, 1997)
Transfer Calibration from CERES to ERBE

CERES TRMM

NOAA-9 WFOV Nonscanner

NOAA-10 WFOV Nonscanner

ERBS WFOV Nonscanner

Data Not Distributed

CERES Aqua

CERES Terra

NOAA-9 Scanner

NOAA-10 Scanner

ERBS Scanner

NOAA-9 NFOV Scanner

NOAA-10 NFOV Scanner

ERBS NFOV Scanner
ERBS 72Day Longwave 60N – 60S
CERES Monthly Longwave 60N – 60S
Backup Slides
ERBS Wide-Field-of-View (WFOV) Nonscanner
Monthly Deseasonalized Shortwave Flux, (60°N - 60°S)

- Fig shows the deseasonalized shortwave monthly mean flux over (60°N – 60°S) latitude for archived edition3 (red) and reprocessed (green) ERBS WFOV nonscanner observations.

- The standard deviation is consistent in period 1, while standard deviation is significantly reduced from 8.20 to 3.24 w/m² in Period 2.