

# **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

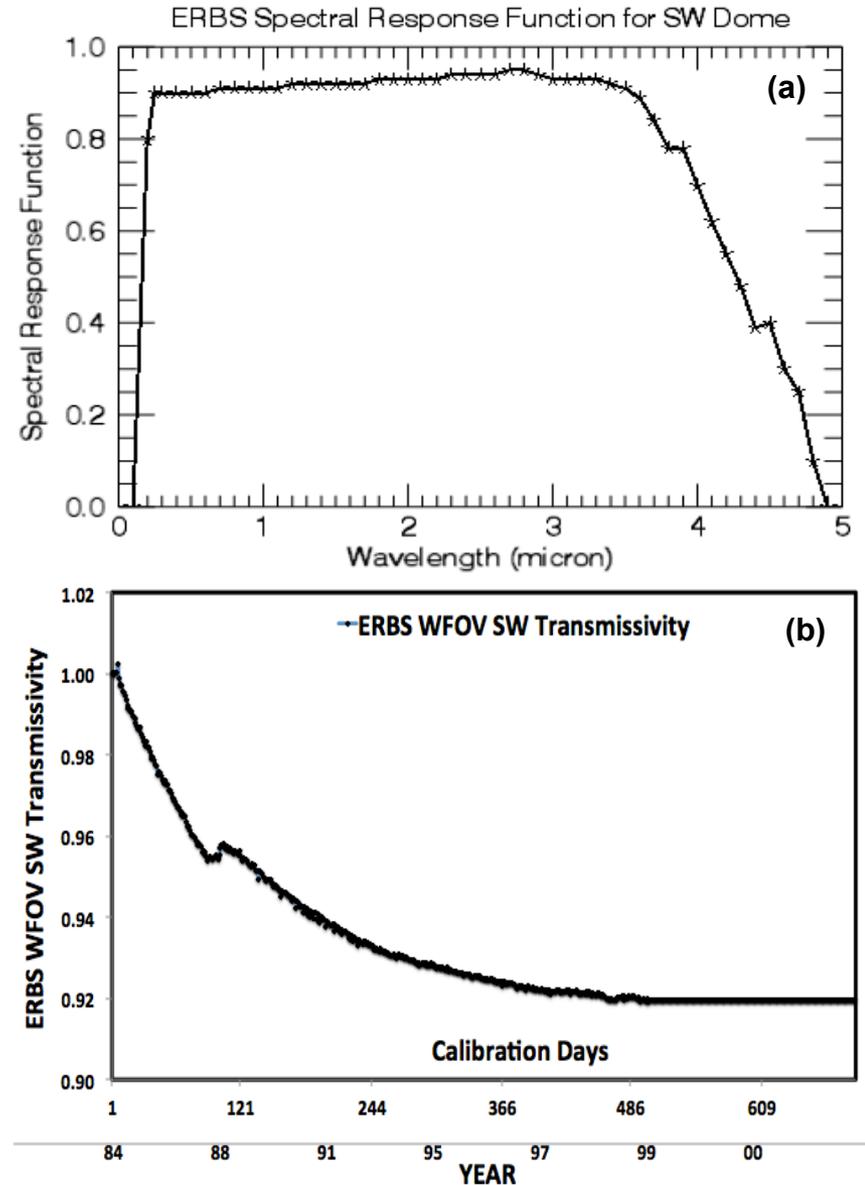


Fig. 1. (a) ERBS SW DOME Spectral Response Function  
(b) Time Series of ERBS SW DOME Transmission

# ERBS Wide-Field-of-View (WFOV) Nonscanner Longwave and Shortwave Channel

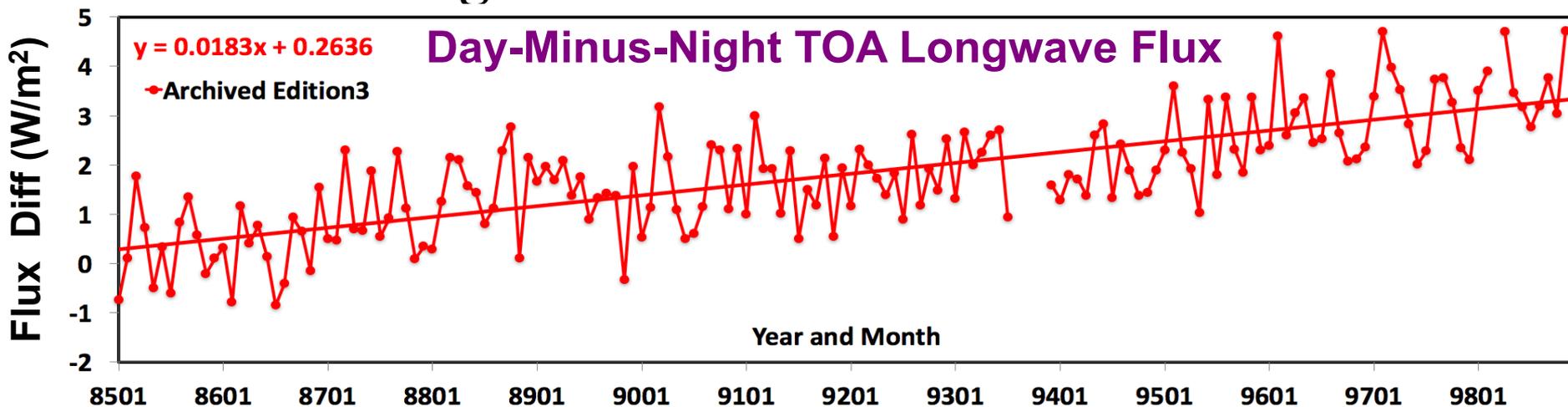


Fig 1: ERBS WFOV Nonscanner Monthly Mean Day-minus-Night Longwave Flux over  $20^\circ$  NS  
Period 1, 1985-1989. Period 2, 1994-1998 (Pinatubo Eruption in 1991, Battery Issue 1993)

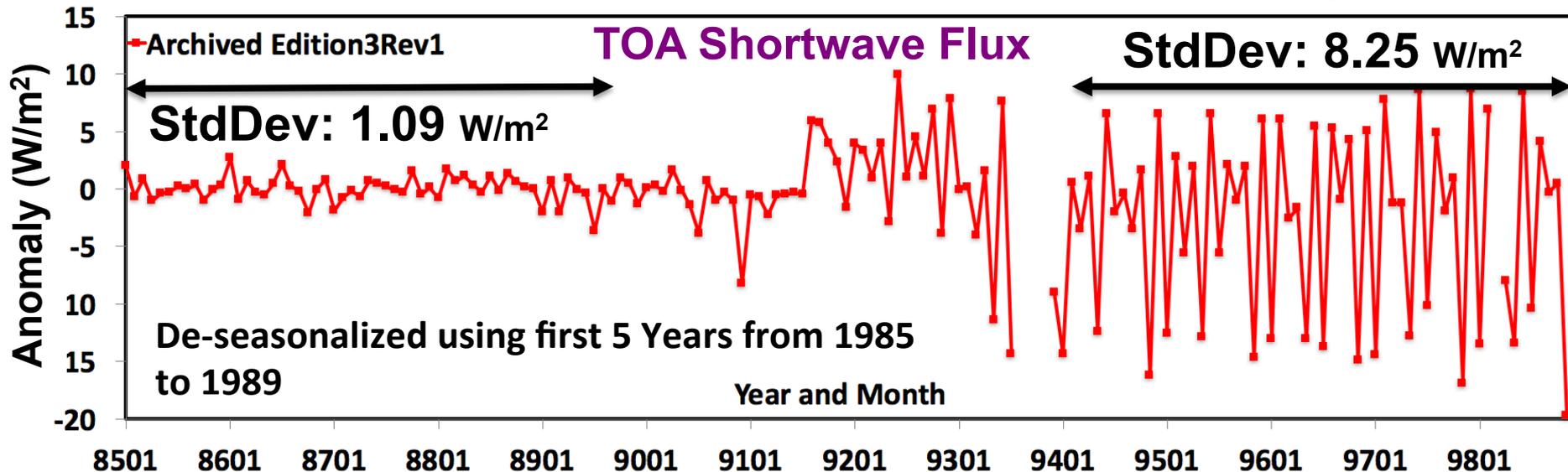
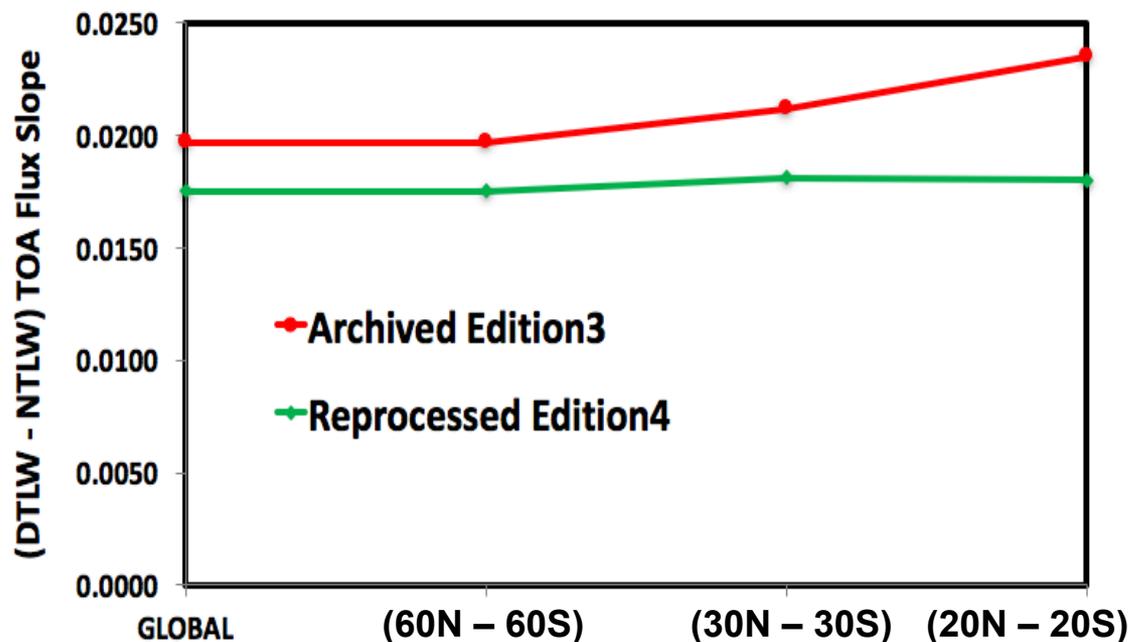
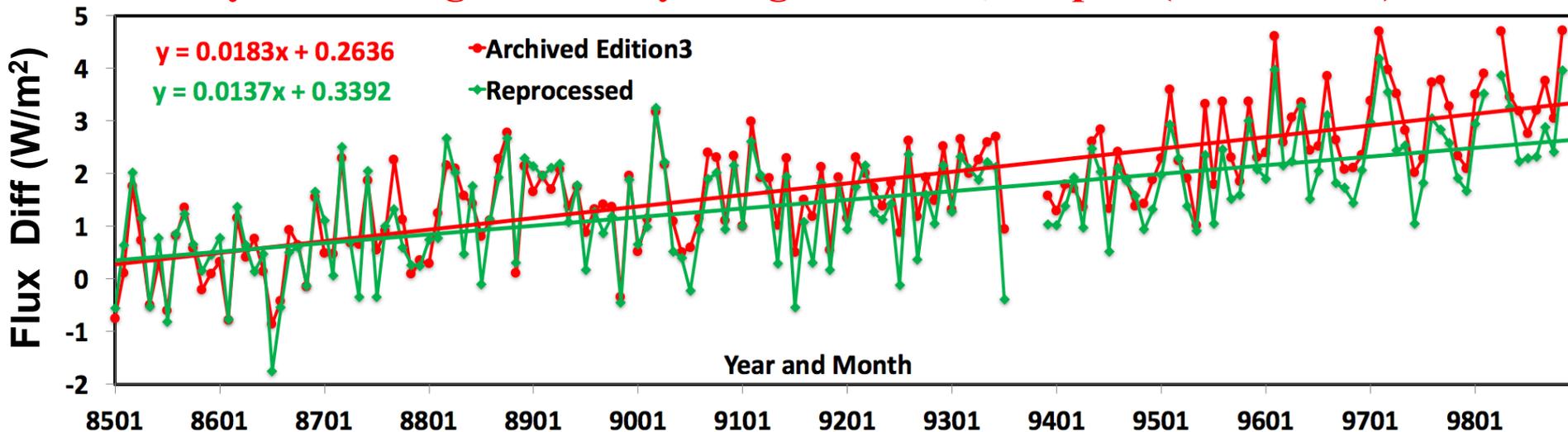


Fig 2: ERBS WFOV Nonscanner Monthly Mean Deseasonalized Shortwave Flux over  $60^\circ$  NS

# 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.

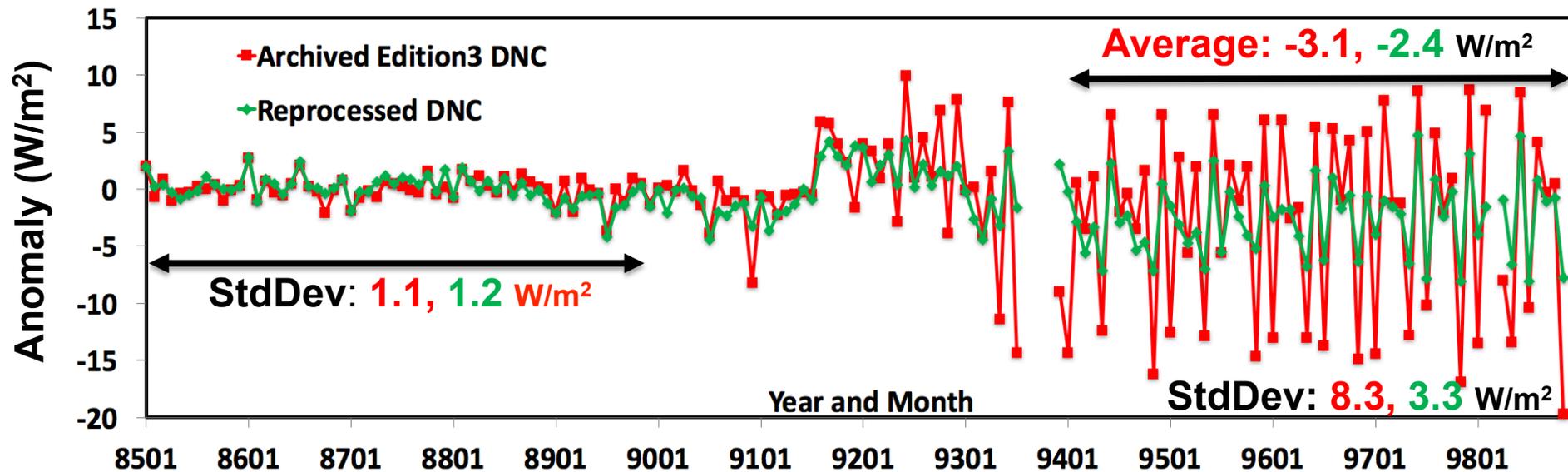
# Corrections/Update

- **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/m<sup>2</sup> in Period 2.

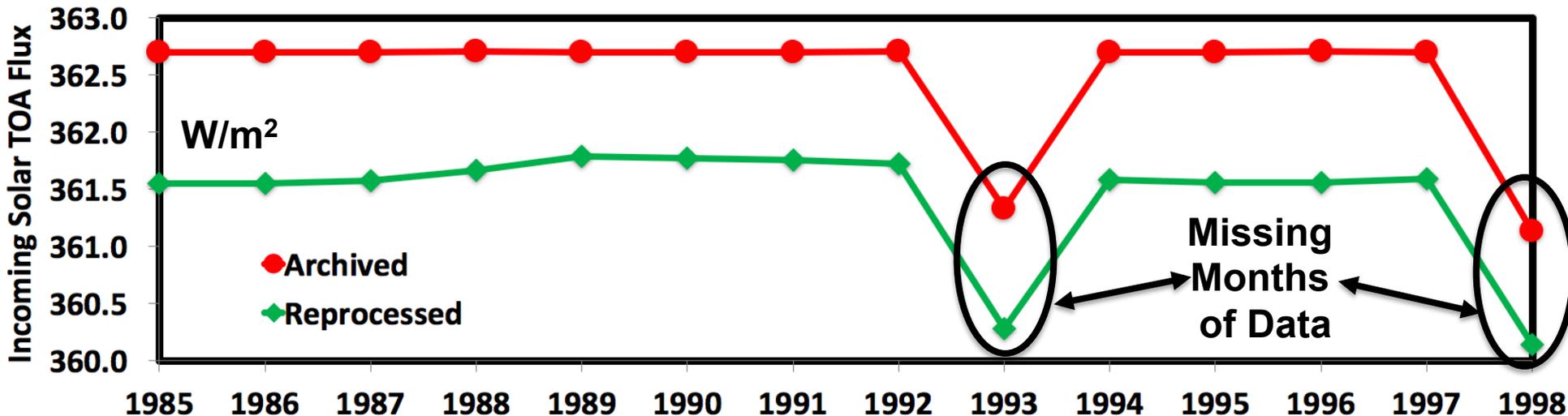


Deseasonalized Shortwave using first 5 Years from 1985 to 1989

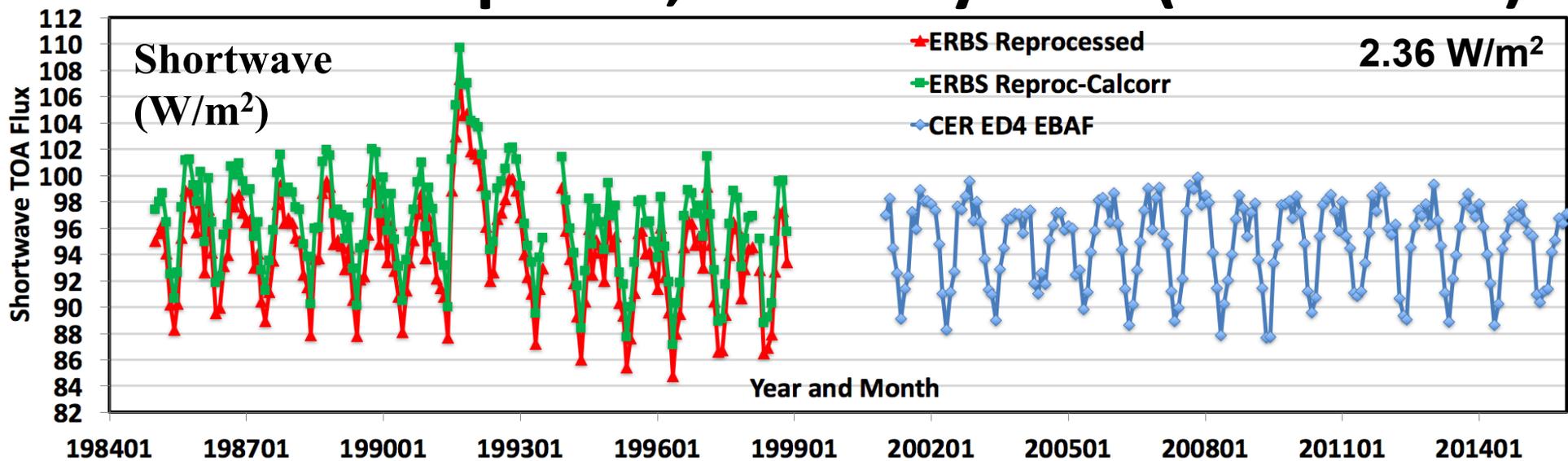
# Update Incoming Solar TOA Flux

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

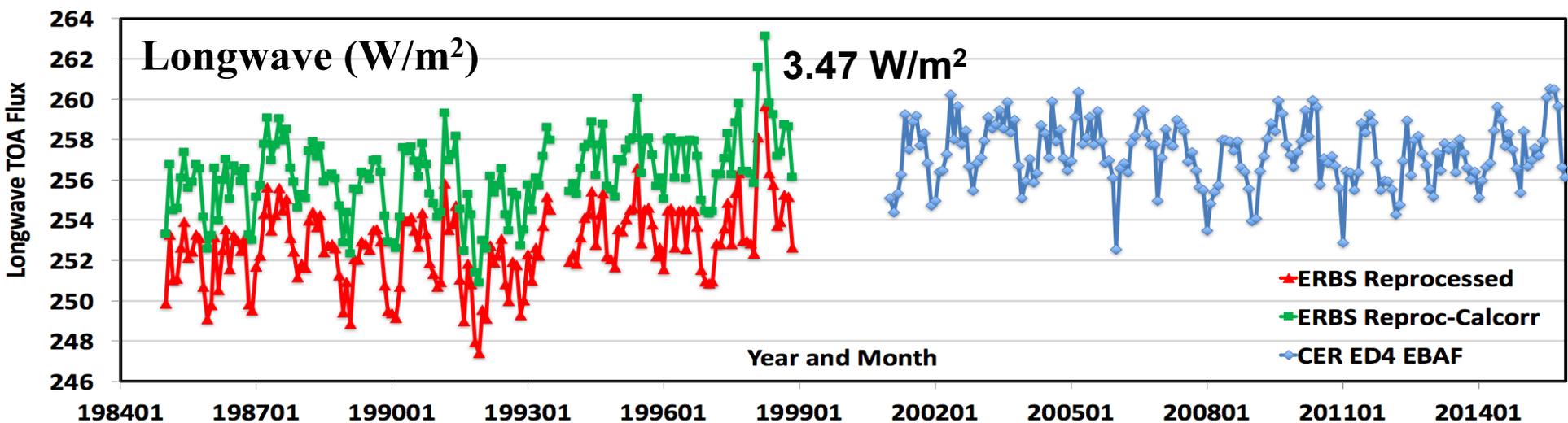
- ERBS previous processing considered constant daily solar incoming flux at 1365 W/m<sup>2</sup> (red)
- Actual observation of daily solar incoming flux from SORCE is used in the reprocessing (green)
- Figure shows that using the SORCE observations results in ~1.25 W/m<sup>2</sup> reduction in annual incoming solar flux.



# Calibration Update, Monthly Flux (20°N-20°S)



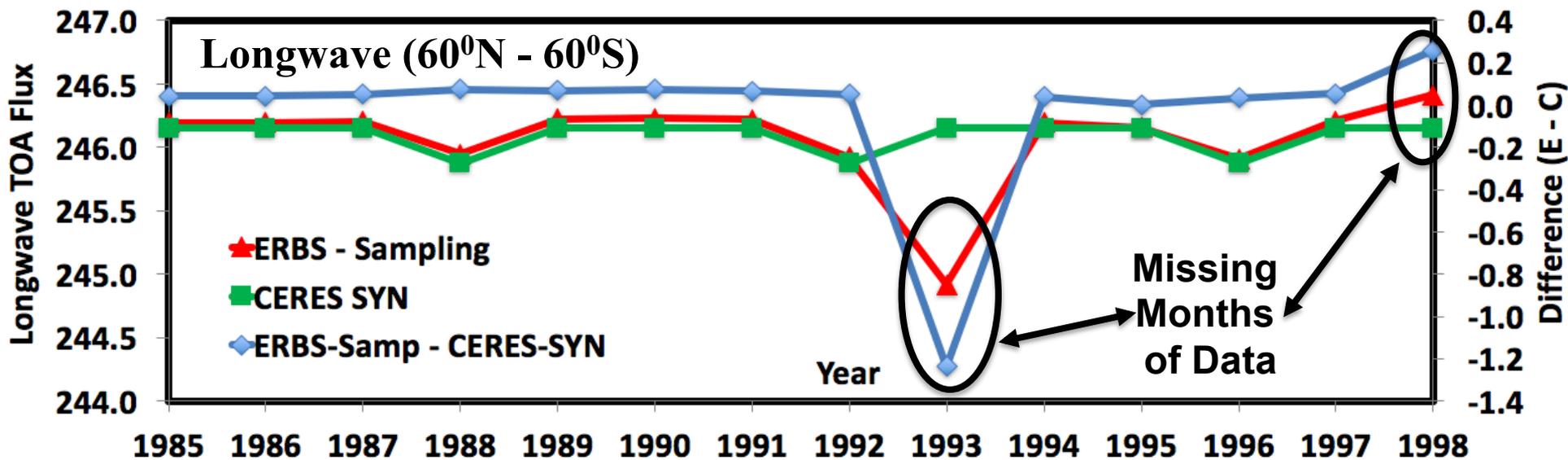
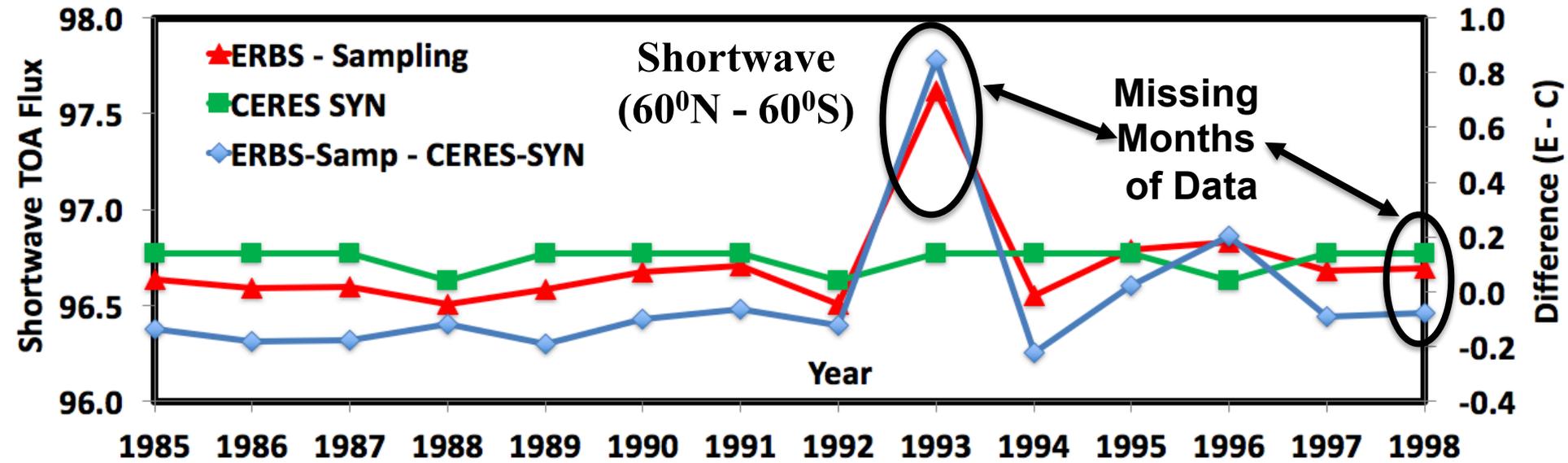
- Tilted ERBS WFOV shortwave nonscanner observation during the gap is used to transfer calibration from CERES to ERBS
- TRMM Longwave observations during the gap is used to transfer calibration from CERES to ERBS



# Sampling Correction

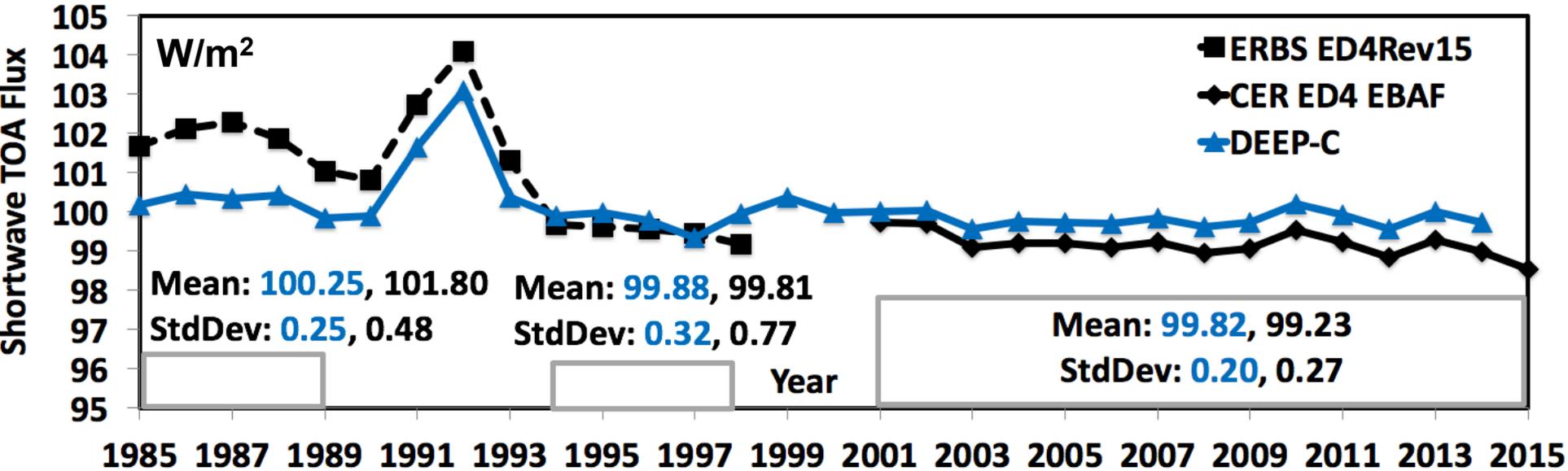
- **ERBS is in the precessing orbit, causing uncertainties due to partial diurnal coverage outside tropics**
- **Due to nighttime longwave observations, this effect is smaller in the longwave channel than in shortwave**
- **Simulation study to generate sampling corrections:**
  - **Use CERES EBAF Edition4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

# Sampling Correction



- **Reprocess**
- **Apply All Corrections**
- **Apply conversion factor to convert the large area mean from (60<sup>0</sup>N-60<sup>0</sup>S) to Global, derived from CERES EBAF Edition4**

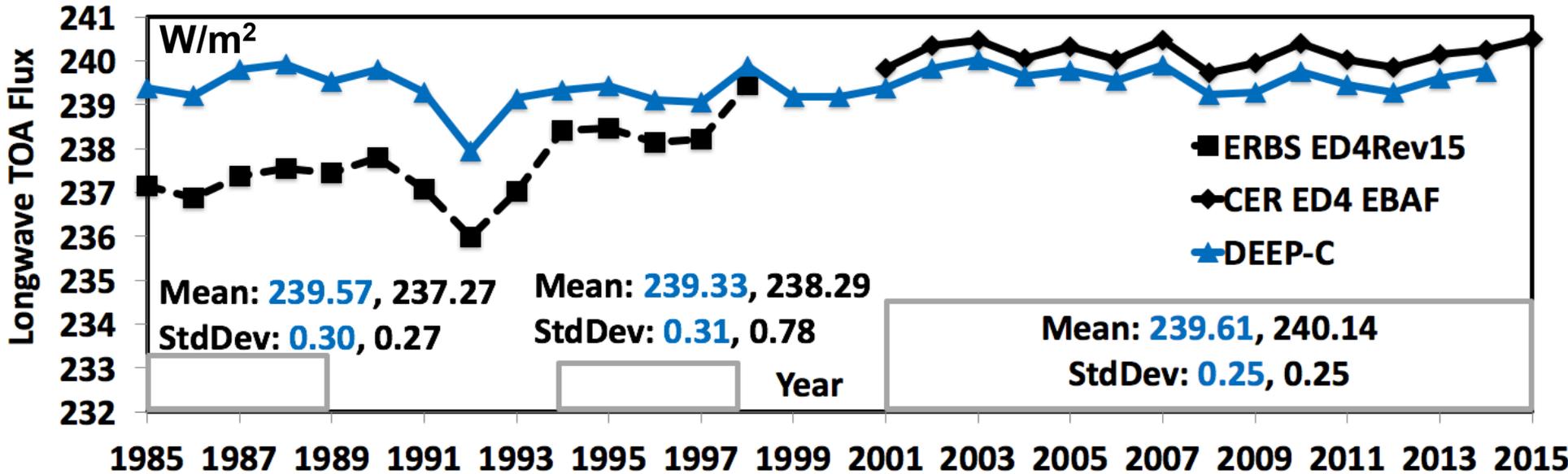
# Annual Global Reflected Shortwave Radiation



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

ERBS Uncertainty: 0.24%			
	Period 1 (1985-1999)	Period 2 (1994-1998)	Period2 – Period1
ERBS	101.80	99.81	-1.99
DEEP-C	100.25	99.88	-0.37
Diff	1.55	-0.07	

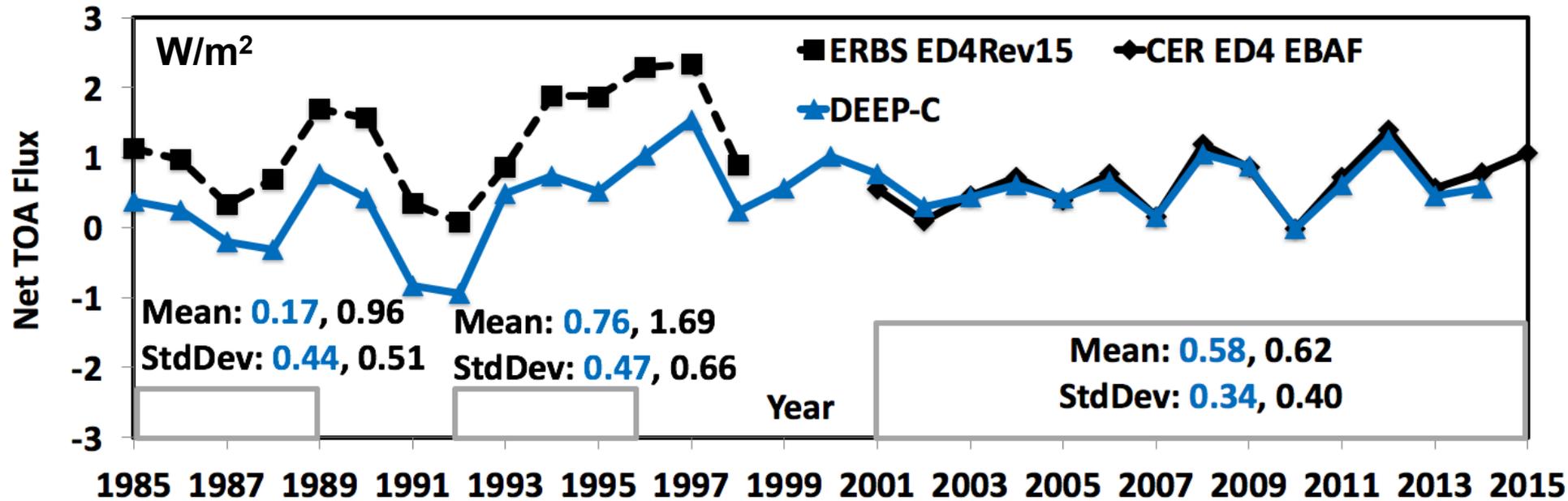
# Annual Global Longwave Radiation



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

ERBS Uncertainty: 0.14%			
	Period 1 (1985-1999)	Period 2 (1994-1998)	Period2 – Period1
ERBS	237.27	238.29	1.02
DEEP-C	239.57	239.33	-0.24
Diff	-2.3	-1.04	

# Annual Global Net Radiation



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

ERBS Uncertainty: 0.4 W/m <sup>2</sup>			
	Period 1 (1985-1999)	Period 2 (1994-1998)	Period2 – Period1
ERBS	0.96	1.69	0.73
DEEP-C	0.17	0.76	0.59
Diff	0.79	0.93	

# 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**

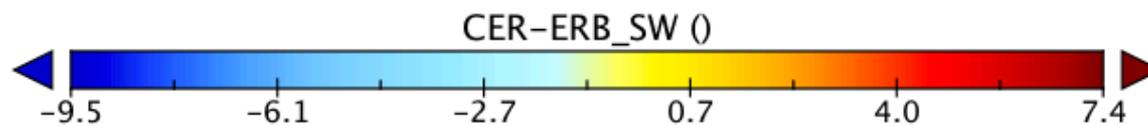
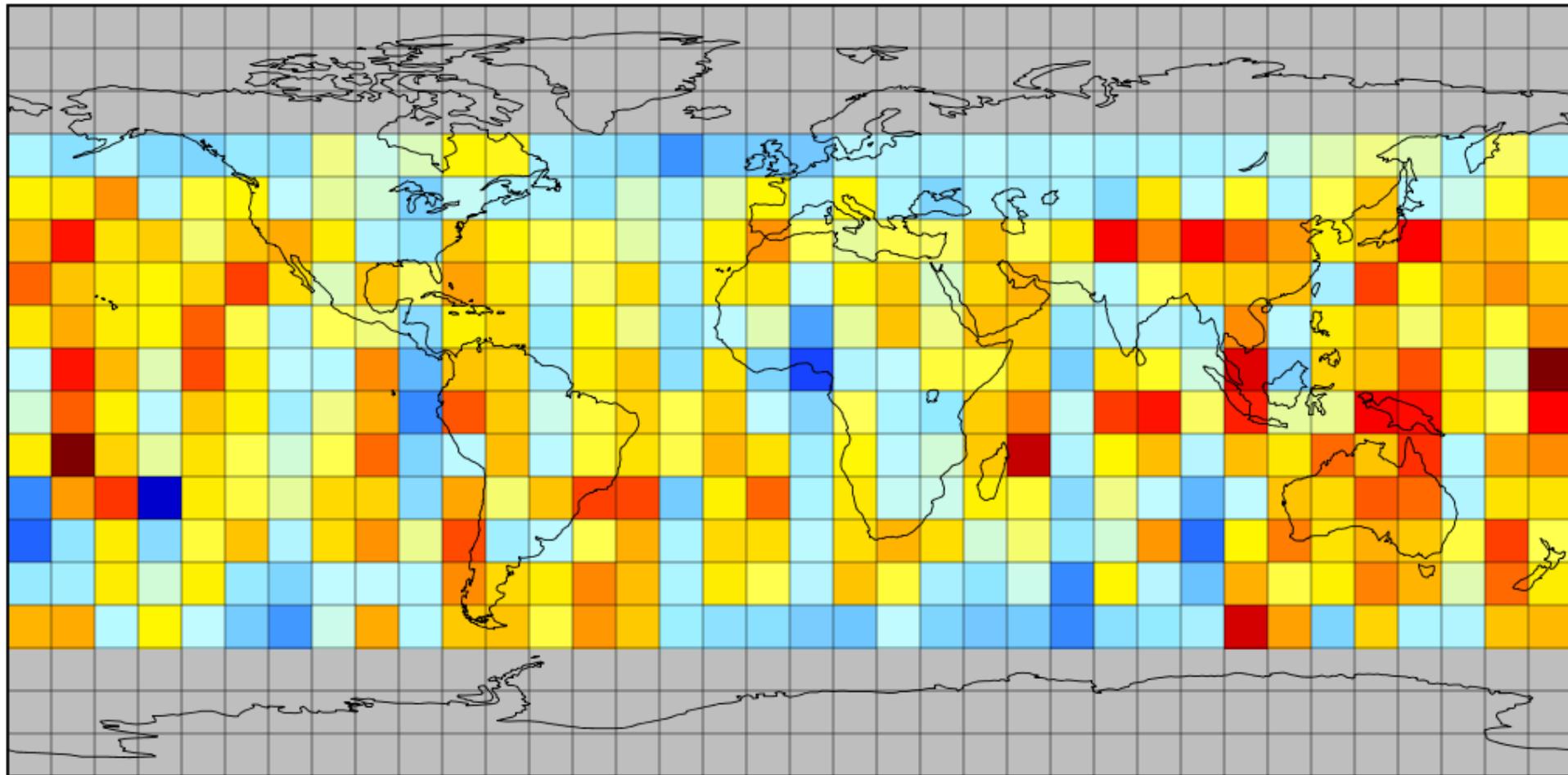
# Summary

- **Reprocessing with spectral unfiltering**
  - Reduced the observed day-minus-night 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,  $-1.99 \text{ W/m}^2$
  - Longwave,  $1.02 \text{ W/m}^2$

**Thank You !!!**

# **Backup Slides**

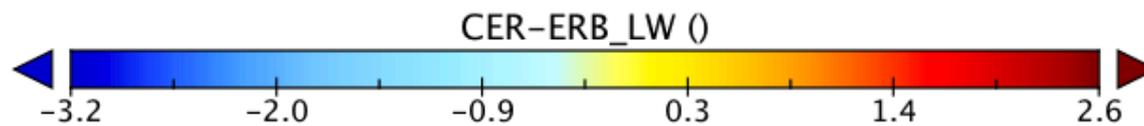
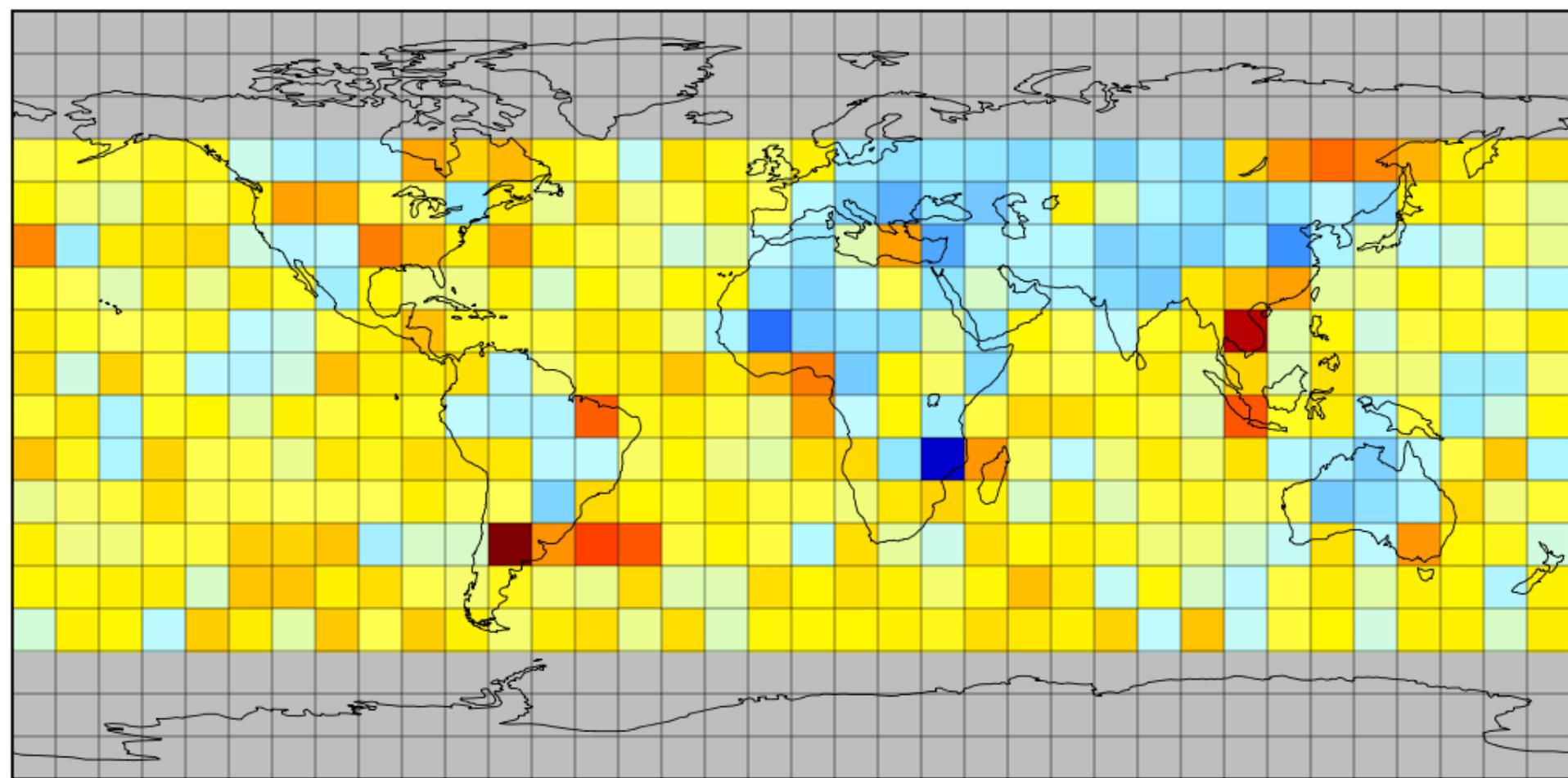
# Sampling Correction



Data Min = -9.5, Max = 7.4, Mean = -0.3

CER\_SYN – ERBS\_DIURN for **72Day Shortwave (Cycle 1, 1997)**

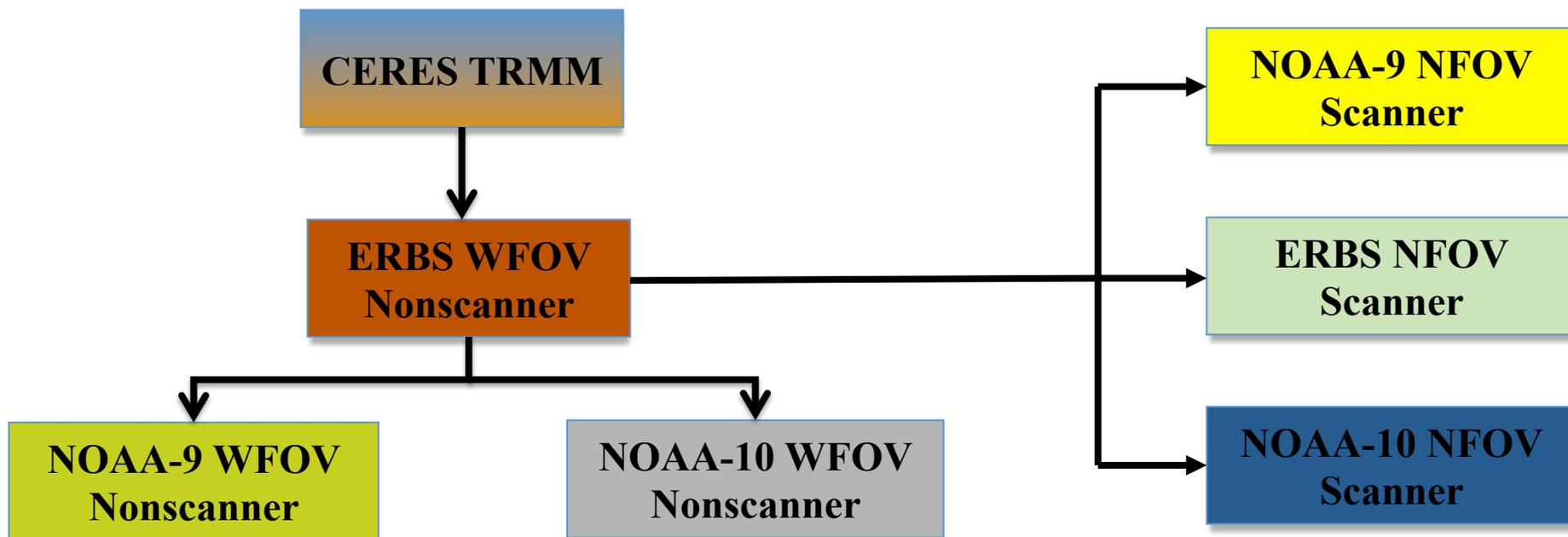
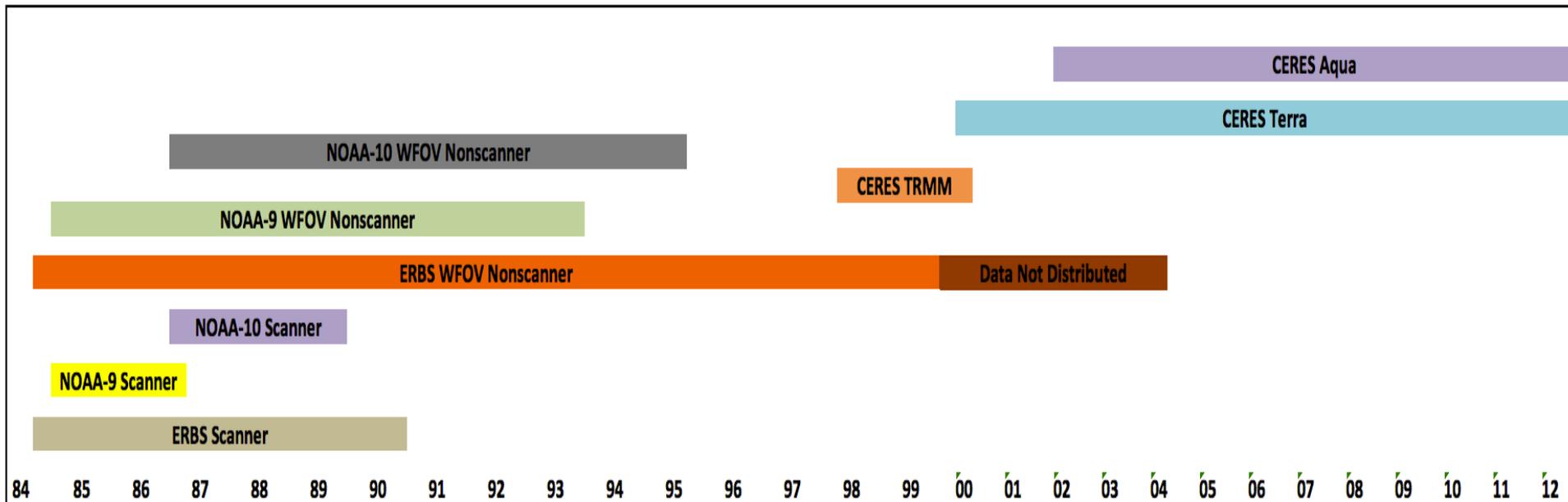
# Sampling Correction



Data Min = -3.2, Max = 2.6, Mean = -0.1

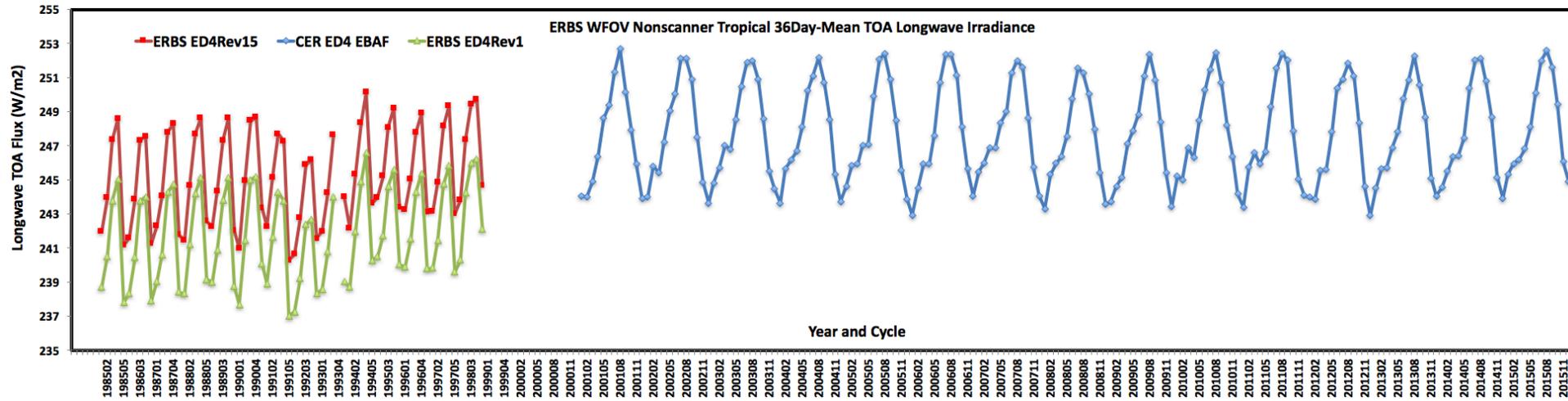
CER\_SYN - ERBS\_DIURN for **72Day Longwave (Cycle 1, 1997)**

# Transfer Calibration from CERES to ERBE



# ERBS 72Day Longwave 60N – 60S

## CERES Monthly Longwave 60N – 60S

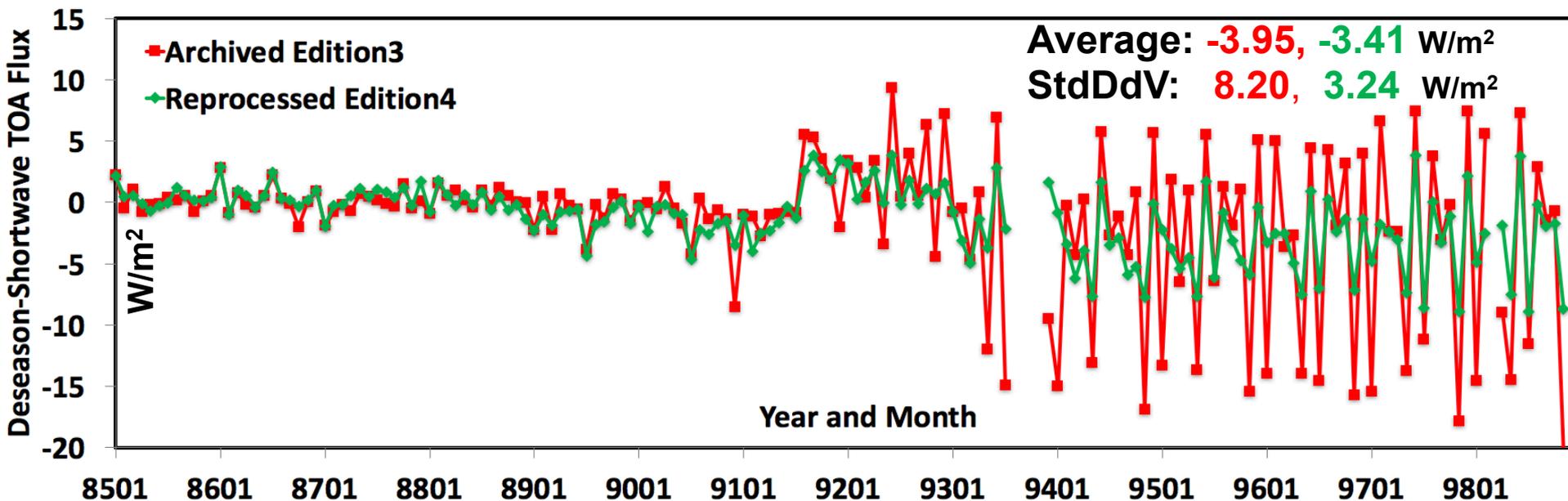


# **Backup Slides**

# ERBS Wide-Field-of-View (WFOV) Nonscanner

## Monthly Deseasonalized Shortwave Flux, (60°N - 60°S)

Period 1, 1985-1989. Period 2, 1994-1998 (Pinatubo Eruption in 1991, Battery Issue End 1992)



- 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/m<sup>2</sup> in Period 2.