

# CERES/Terra and CERES/Aqua Edition2 ERBE-like TOA Fluxes

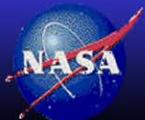
Takmeng Wong

NASA Langley Research Center, Hampton, Virginia

30<sup>th</sup> CERES Science Team Meeting

Boulder, Colorado

March 29, 2004

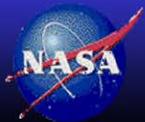


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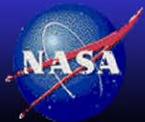
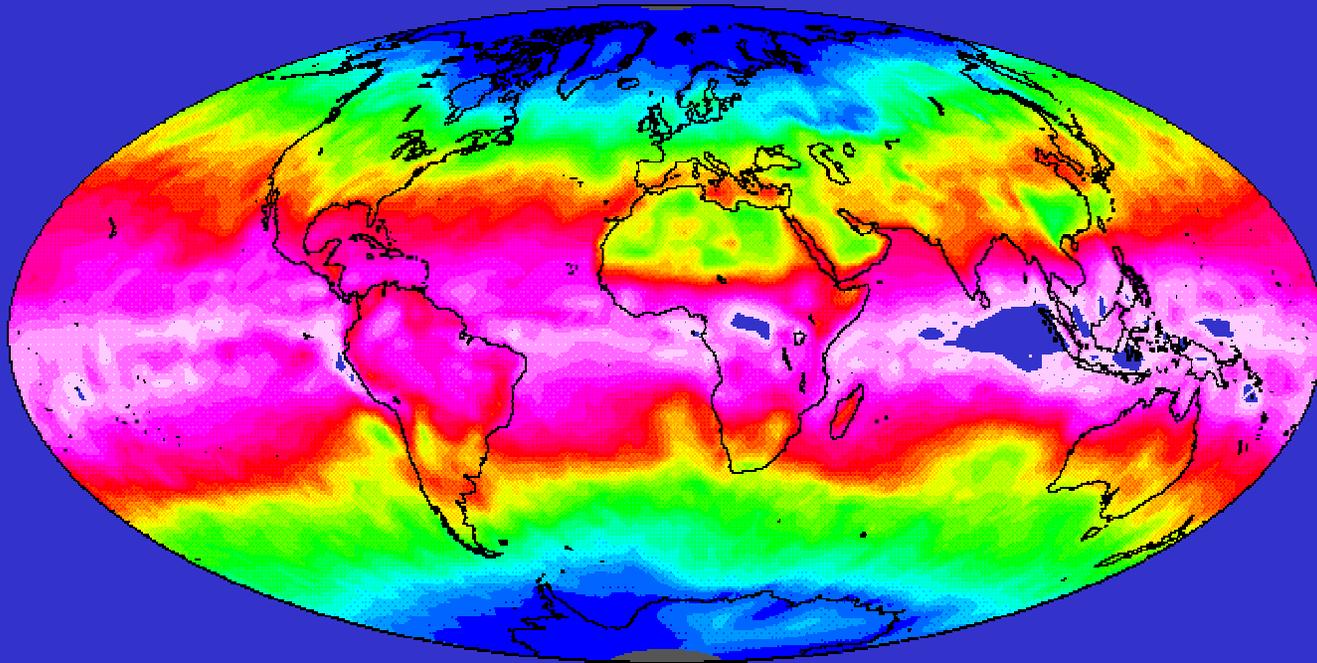


## Objectives

- Give an Overview of CERES ERBE-like Products
- Update Comparison of Terra and Aqua ERBE-like TOA Fluxes using CERES Aqua Edition2 Data: Zonal, Tropical, and Global Scale; Monthly and Annual Mean Time Scale



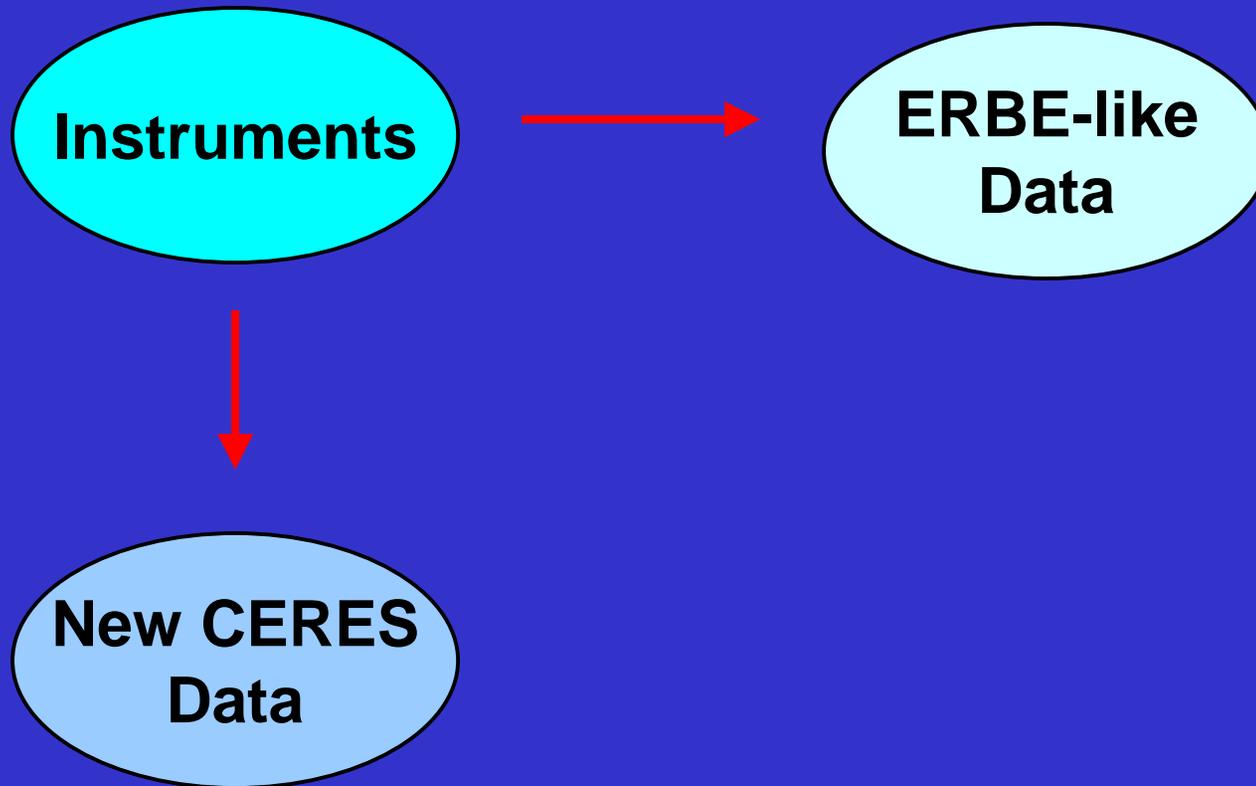
# Overview of CERES ERBE-like Products



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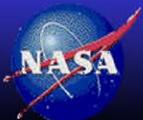
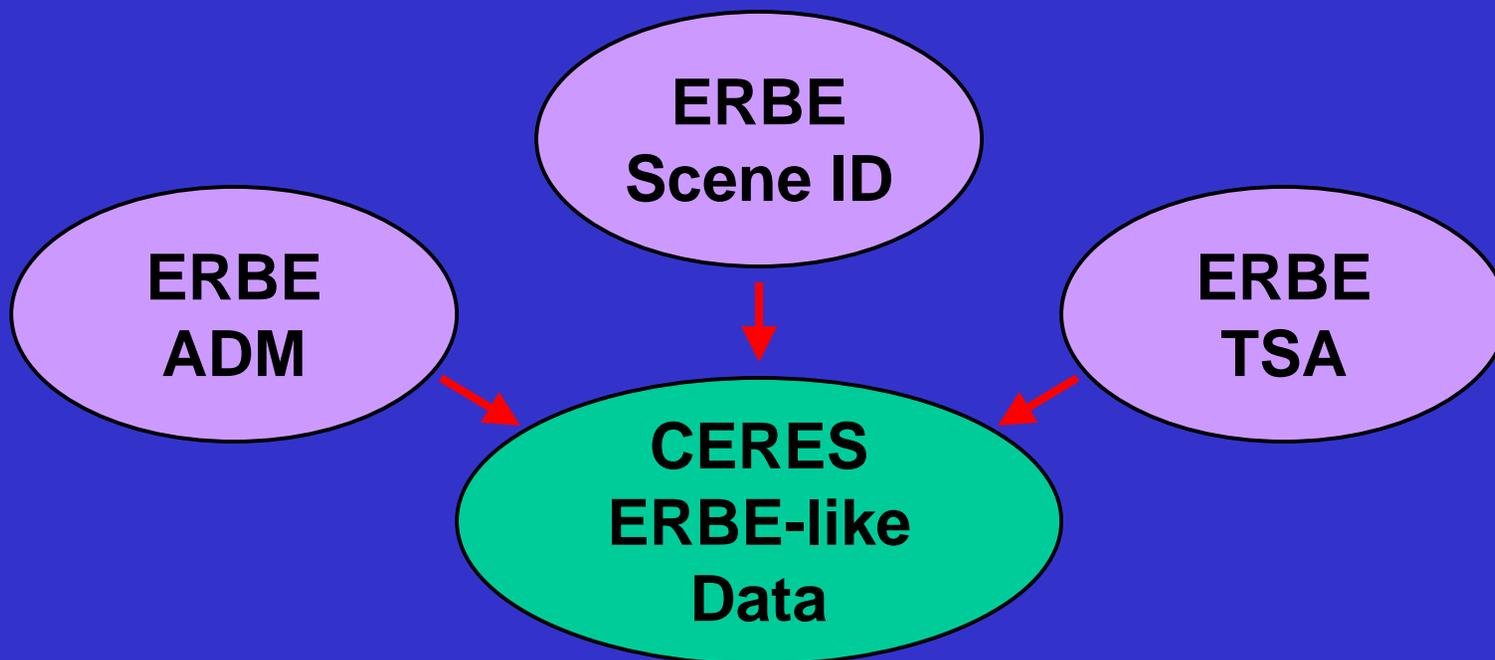


# CERES Data Products



## ERBE-like Algorithms

- CERES ERBE-like Products Are Based on ERBE Algorithms (ERBE ADM, ERBE Broadband Scene ID, and ERBE Time-Space Averaging); Consistent with ERBE Products



## Nature of ERBE-like Products

**CERES ES8**



Identical to ERBE S8 Product:  
Instantaneous Footprint Level  
Data Including Radiances and  
Fluxes

**CERES ES4**



Identical to ERBE S4 Product:  
Monthly Mean Fluxes (Days,  
Hours), Monthly Mean Hourly  
Fluxes, and Monthly Mean  
Daily Fluxes

**CERES ES9**



Identical to ERBE S9 Product:  
ES-4 Plus Instantaneous  
Gridded Hourly Box Data



## Current Editions of ERBE-like Products

### **Edition1**



Usually Available One Month after Observations and Does Not Include on-orbit Calibration Corrections (Use with Cautions)

### **Edition2**



Contains on-orbit Instrument Drift Calibration Corrections and Takes Longer to Produce



## Current Status of ERBE-like Ed2 Products

**TRMM Ed2  
PFM**



January to August 1998 and March 2000, 40N to 40S Only, Orbits Precess with Time and Cover All 24 Local Hours in 46 Days (23 Days at Equator)

**Terra Ed2  
FM1 and FM2**



March 2000 to June 2003, Global Coverage, 10:30 am Equatorial Crossing Time (ECT)

**Aqua Ed2  
FM3 and FM4**



July 2002 to August 2003, Global Coverage, 1:30 pm ECT



# Science Studies using ERBE-like Products

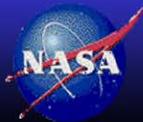
Radiative Effects of 1998  
ENSO of Event

Radiative Energy Budget of  
African Monsoon

Intraseasonal Variability of  
Radiation Fields

Decadal Changes in  
Radiation Budget

Validations of GCMs

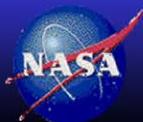
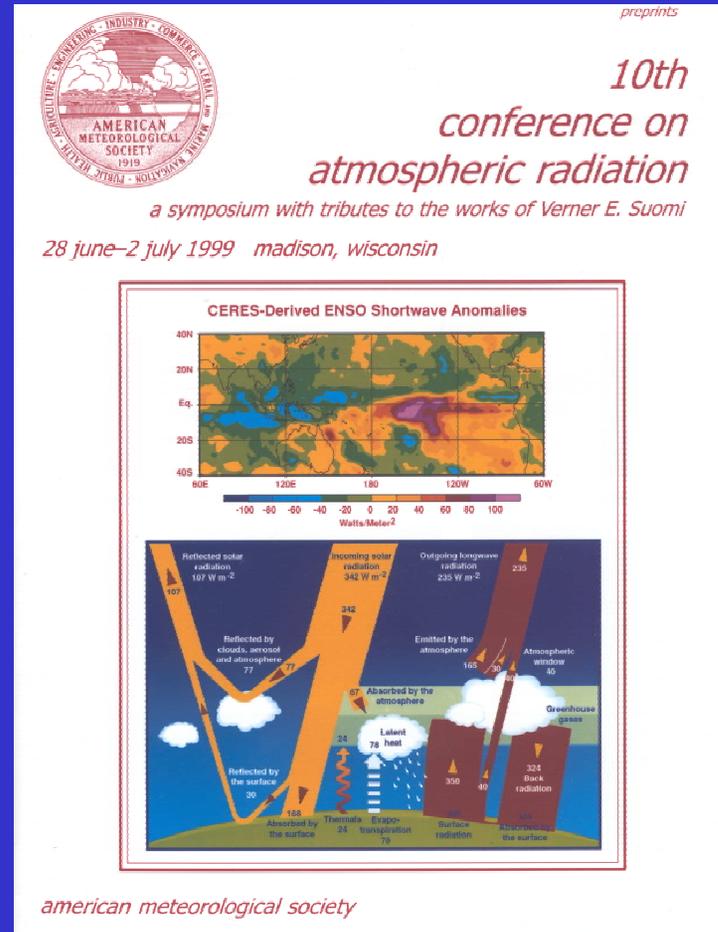


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# Science Studies using ERBE-like Products

- Radiative Effects of 1998 ENSO of Event
- Radiative Energy Budget of African Monsoon
- Intraseasonal Variability of Radiation Fields
- Decadal Changes in Radiation Budget
- Validations of GCMs



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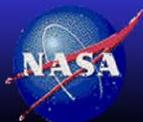
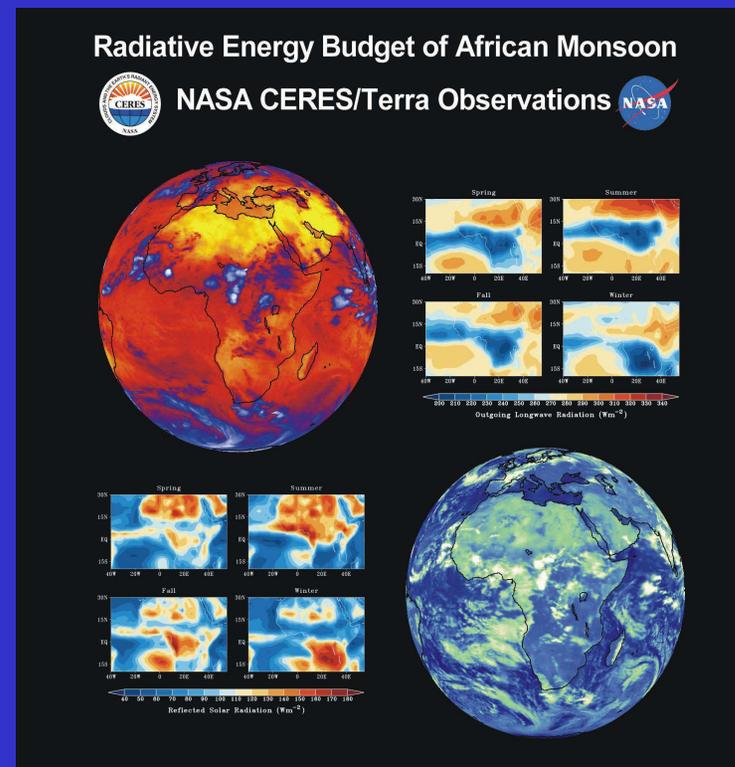
Radiative Effects of 1998  
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→ Radiative Energy Budget of  
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Intraseasonal Variability of  
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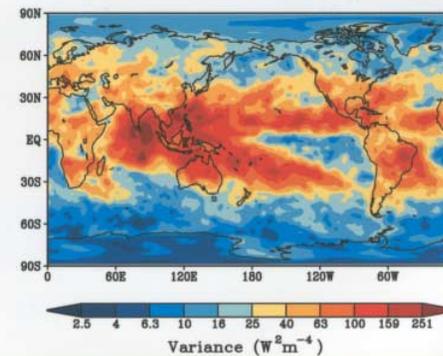
Validations of GCMs

**16th Conference on  
Probability and Statistics  
in the Atmospheric Sciences**

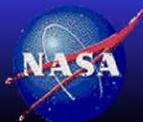


**13-17 January 2002  
Orlando, Florida**

**Intraseasonal Variability of Outgoing Longwave Radiation  
Derived from CERES/Terra Observations**



AMERICAN METEOROLOGICAL SOCIETY



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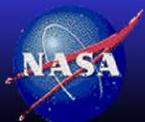
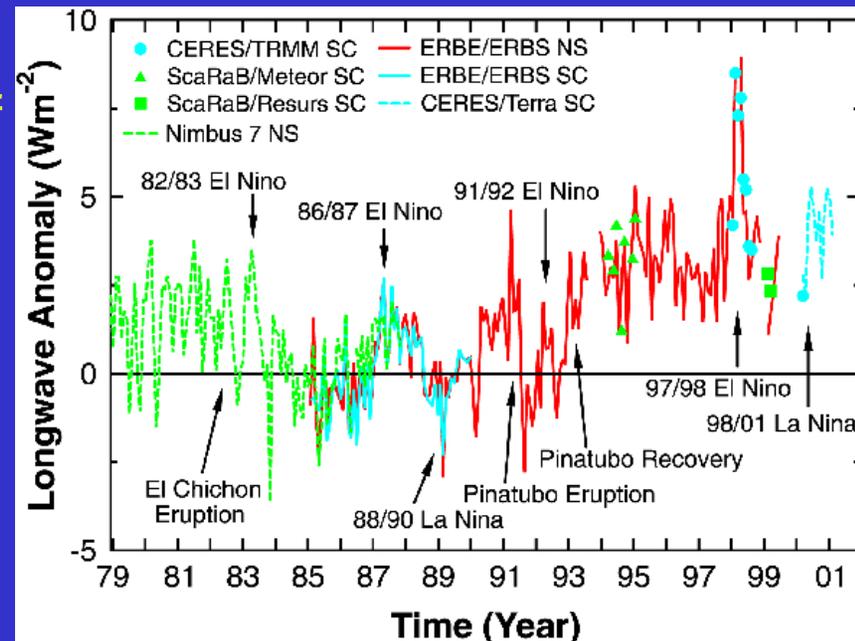
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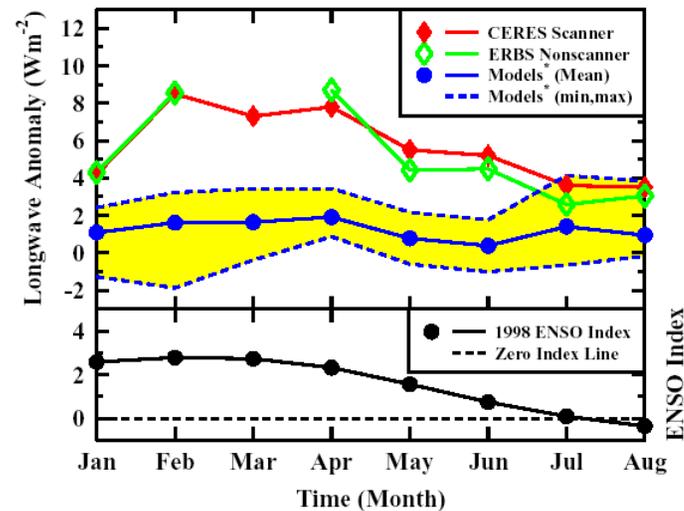
Intraseasonal Variability of  
Radiation Fields

Decadal Changes in  
Radiation Budget



Validations of GCMs

1998 El Niño Tropical Mean (20S - 20N) Longwave Flux Anomalies  
(Anomalies Referenced to 1985 through 1989 Baseline)



\*5 Climate Models and NCEP Re-analysis; All used observed SSTs; Climate Models: NCAR-CSM (Kiehl) UKMO (Allan, Slingo), GFDL and GFDL-EP (Soden, Gordon), CSU (Randall)

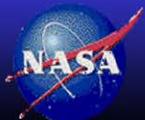
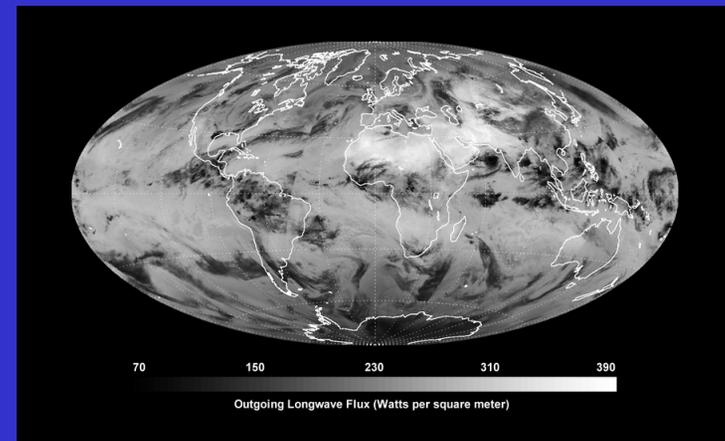
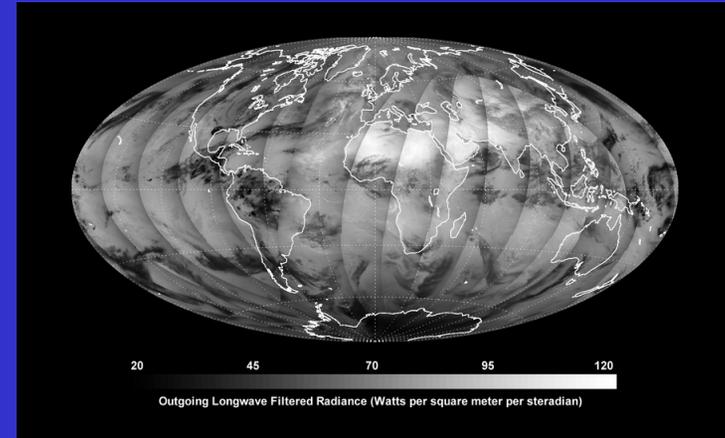
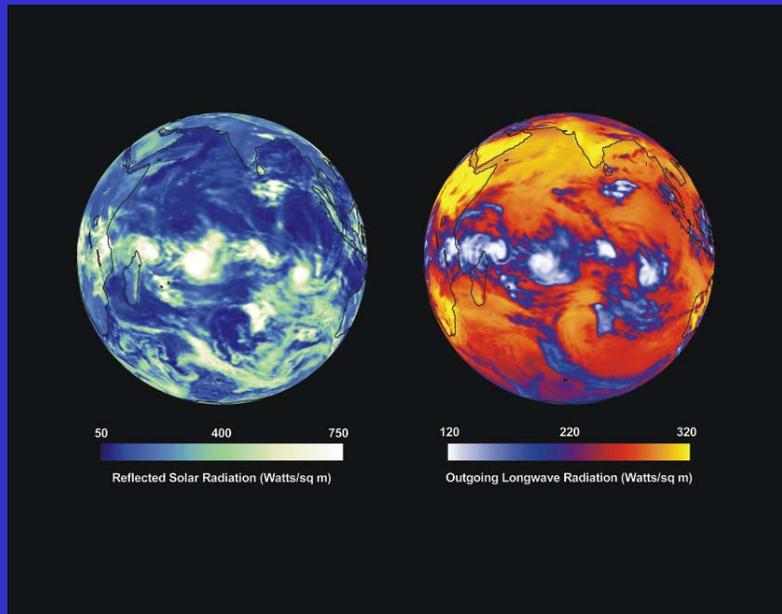


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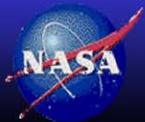
# Earth Images from ERBE-like Products

- Numbers of Earth Images from the ERBE-like Products Were Released to the Public By NASA Earth Science Enterprise



## Ordering CERES ERBE-like Products

- ERBE-like Data Can be Ordered on-line through the Atmospheric Sciences Data Center at NASA Langley Research Center (URL: <http://eosweb.larc.nasa.gov/>)
- All Data Are in HDF Format and Can be Viewed using CERES ViewHDF Software
- Documentations Can be Found at the CERES Website (URL: <http://asd-www.larc.nasa.gov/ceres/ASDceres.html>)

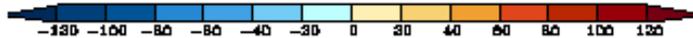
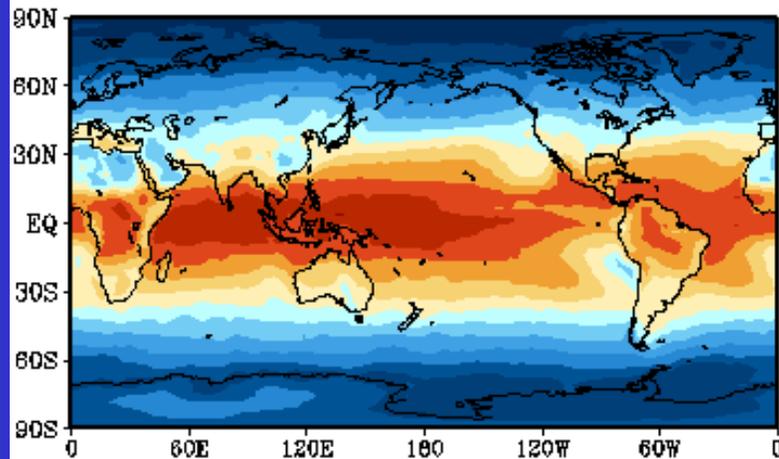


# Updated Comparison of Terra and Aqua ERBE-like Edition2 TOA Fluxes

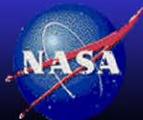
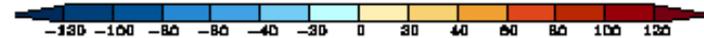
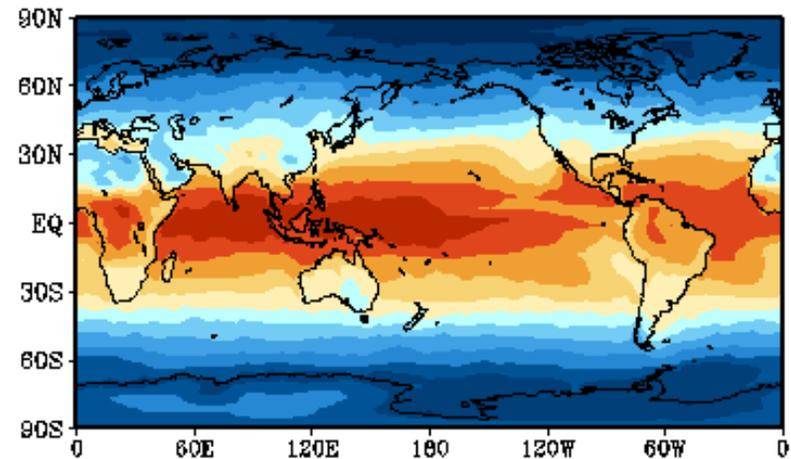
CERES All-sky Net Radiation, Annual Mean

July 2002 to June 2003

Terra



Aqua

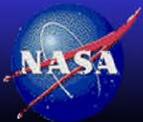


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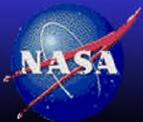
# Summary from Last Meeting

- CERES/Aqua and Terra ERBE-like Fluxes Show Regional Differences (both monthly and annual Mean) Consistent With Diurnal Sampling Differences of the Two EOS Satellites
- **Time Series of Global/Tropical Mean Flux Differences (Aqua-Terra) Show a Small Positive Slope in the All-sky Longwave Fluxes After 12/2002 → Appears To be on-orbit Drift of the Aqua Instruments in Ed1 Data**
- However, Time Series of Global/Tropical Mean Clear Flux Differences (Aqua-Terra) Are Very Small → No Changes
- Annual Mean Zonal Mean SW Differences (Aqua-Terra) Show Largest Differences In the S.H.; Consistent with the Larger Differences in Daytime Sampling Time between the Two Satellites.
- Annual Mean Global Mean Differences (Aqua-Terra) Are Less Than  $1 \text{ Wm}^{-2}$  For LW, SW, and Net. Clear-sky Fluxes Differences Are Less Than  $2.7 \text{ Wm}^{-2}$
- Annual Mean Tropical Mean Differences (Aqua-Terra) Are Less Than  $1 \text{ Wm}^{-2}$  For LW and SW and Less Than  $1.5 \text{ Wm}^{-2}$  For Net. Clear-sky Fluxes Differences Are Less Than  $2.6 \text{ Wm}^{-2}$

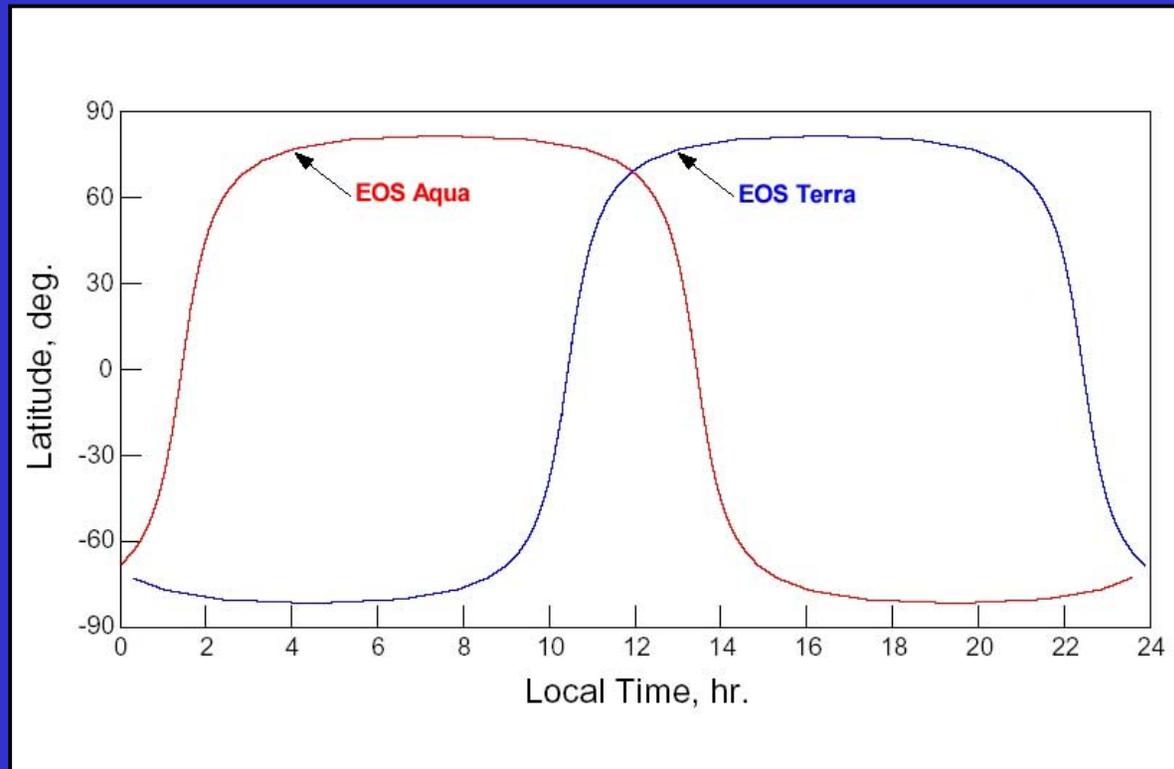


## Datasets

- CERES/Terra Edition2 and CERES/Aqua **Edition2** ERBE-like Dataset (7/2002 To 6/2003) → Latest Data Containing Instrument Drift Corrections
- Combined FM1 and FM2 Data to Form A Single Terra Dataset
- Combined FM3 and FM4 Data to Form A Single Aqua Dataset



# Terra (10:30am) and Aqua (1:30pm) Orbit



N.H. Polar Regions: Aqua (am), Terra (pm)

Both Orbits overlap at Near Noon and Midnight at Polar Regions

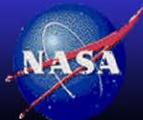
SW Temporal Sampling Differences Increase from North to South; Greatest in S.H.



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# Monthly Mean Comparisons



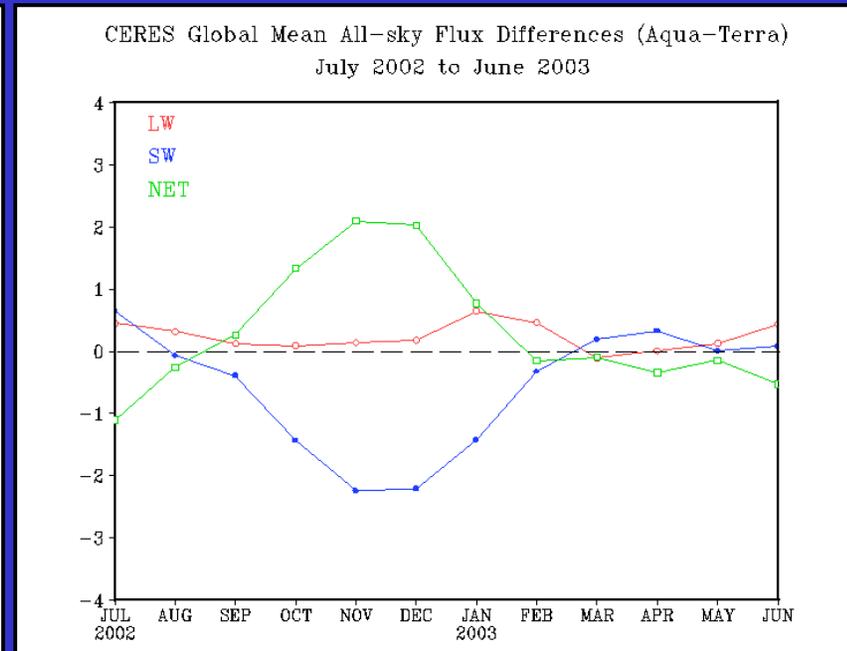
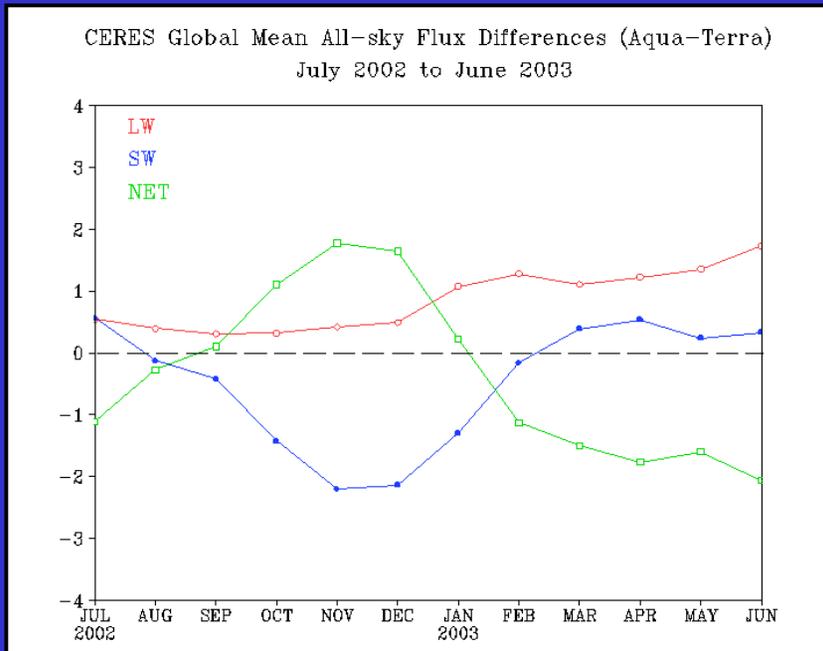
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# Time Series of Global Mean Fluxes

## Aqua Ed1 - Terra Ed2 (Old)

## Aqua Ed2 - Terra Ed2 (New)

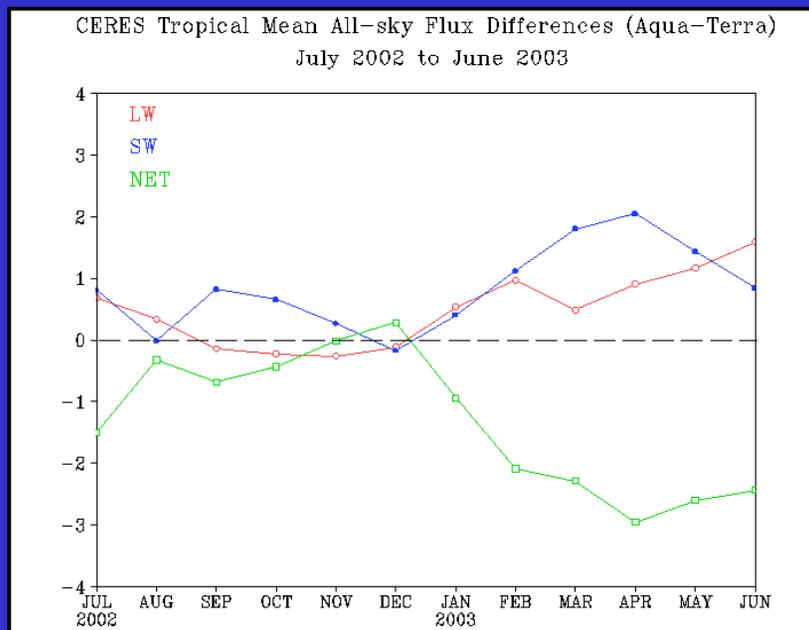


- Aqua Ed2 Data Remove Drift in Aqua Ed1 Longwave Flux

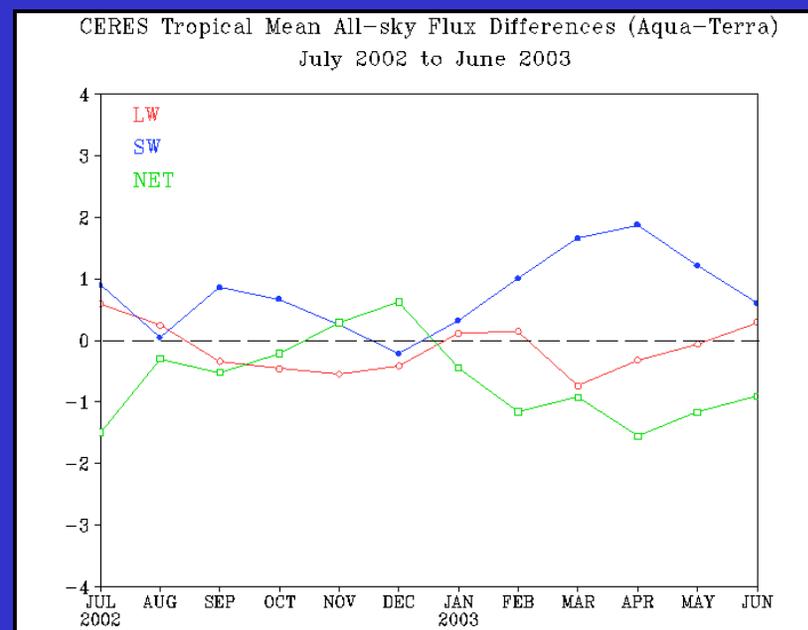


# Time Series of Tropical Mean Fluxes

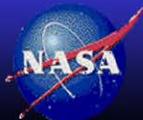
## Aqua Ed1 - Terra Ed2 (Old)



## Aqua Ed2 - Terra Ed2 (New)



- Aqua Ed2 Data Remove Drift in Aqua Ed1 Longwave Flux



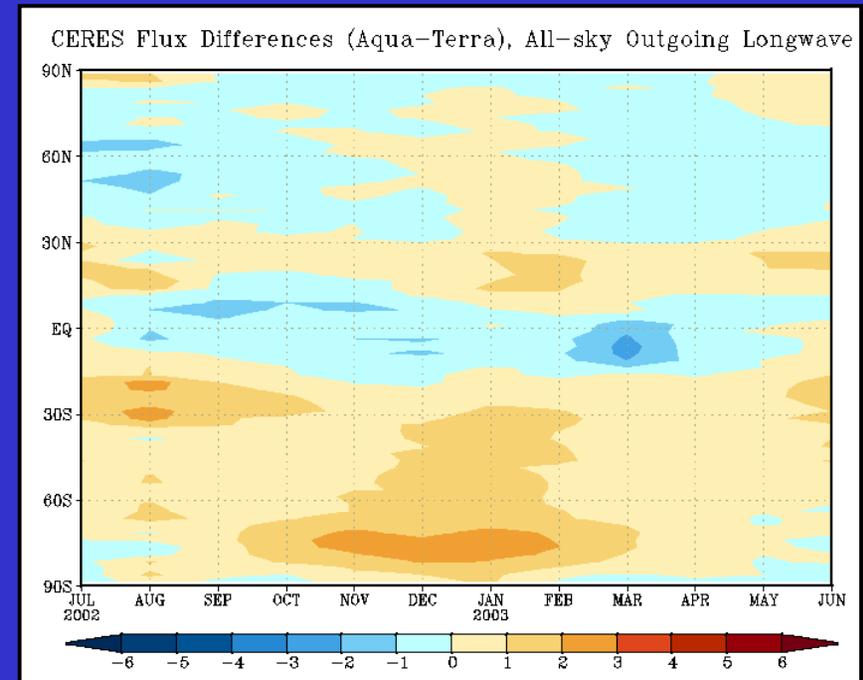
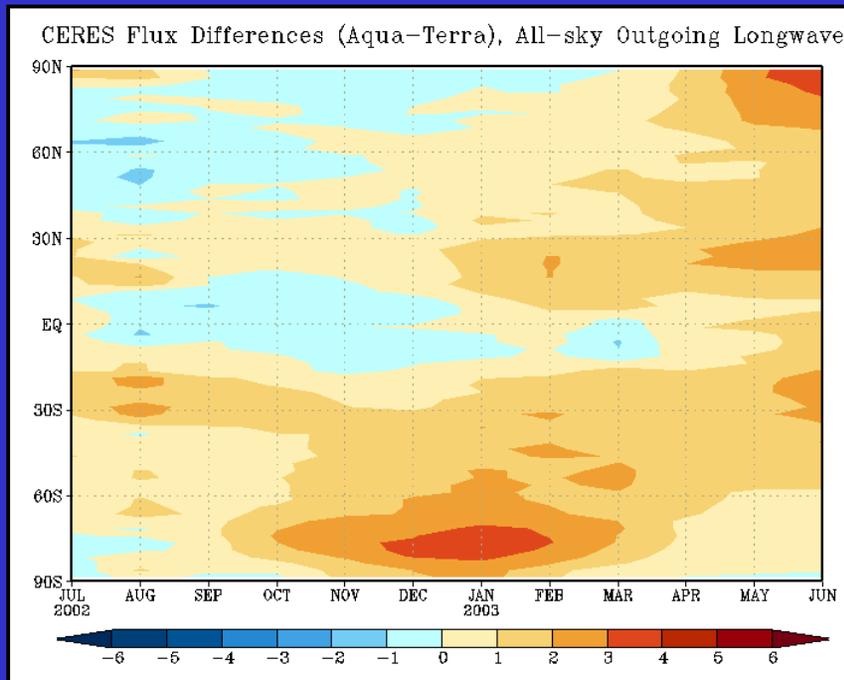
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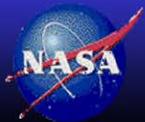
# Aqua - Terra Zonal Mean LW Differences

Aqua Ed1 - Terra Ed2  
(Old)

Aqua Ed2 - Terra Ed2  
(New)



- Aqua Ed2 Data Remove Drift in Aqua Ed1 Longwave Flux



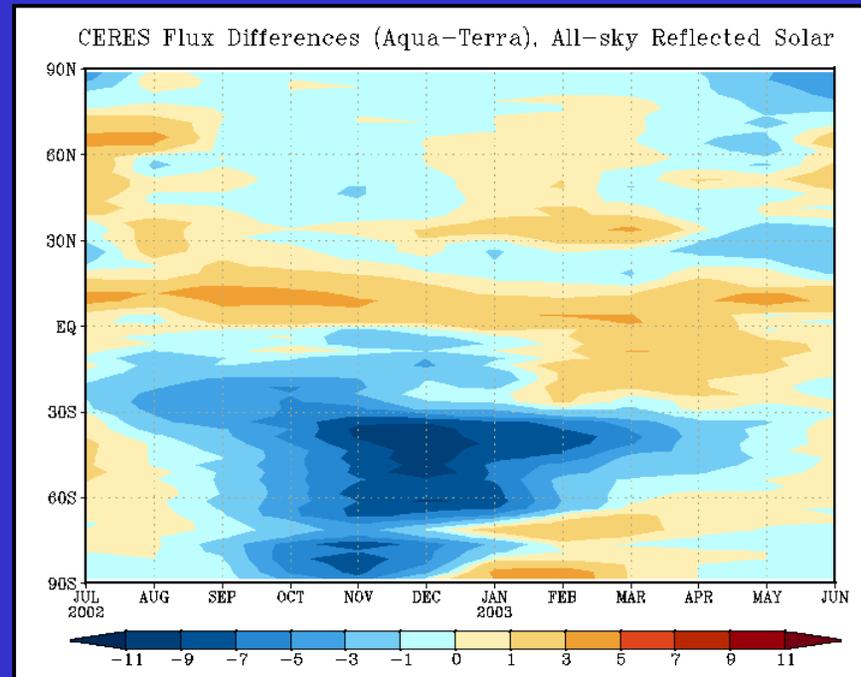
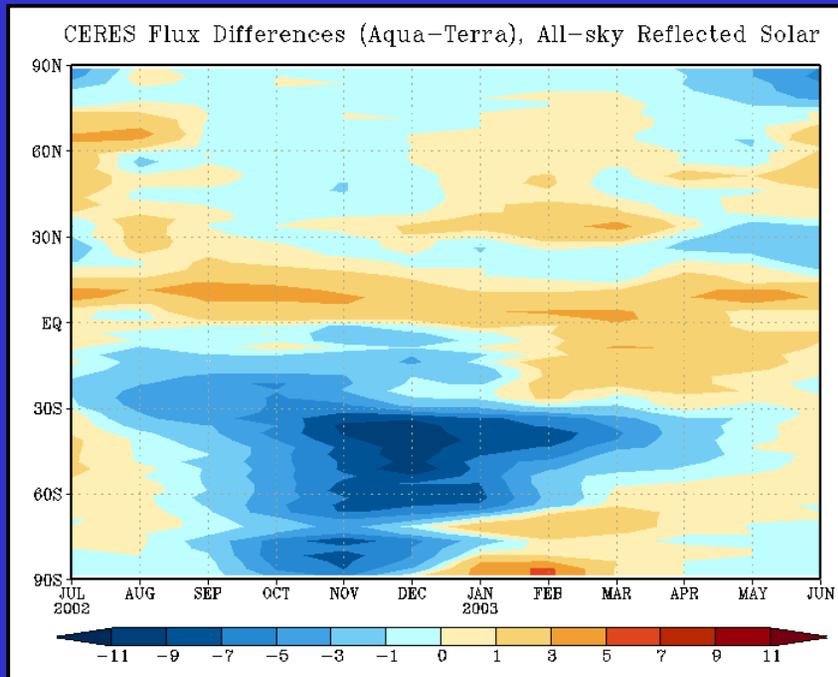
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# Aqua - Terra Zonal Mean SW Differences

Aqua Ed1 - Terra Ed2  
(Old)

Aqua Ed2 - Terra Ed2  
(New)



- Very Little Changes Between Ed2 and Ed1 Shortwave Flux



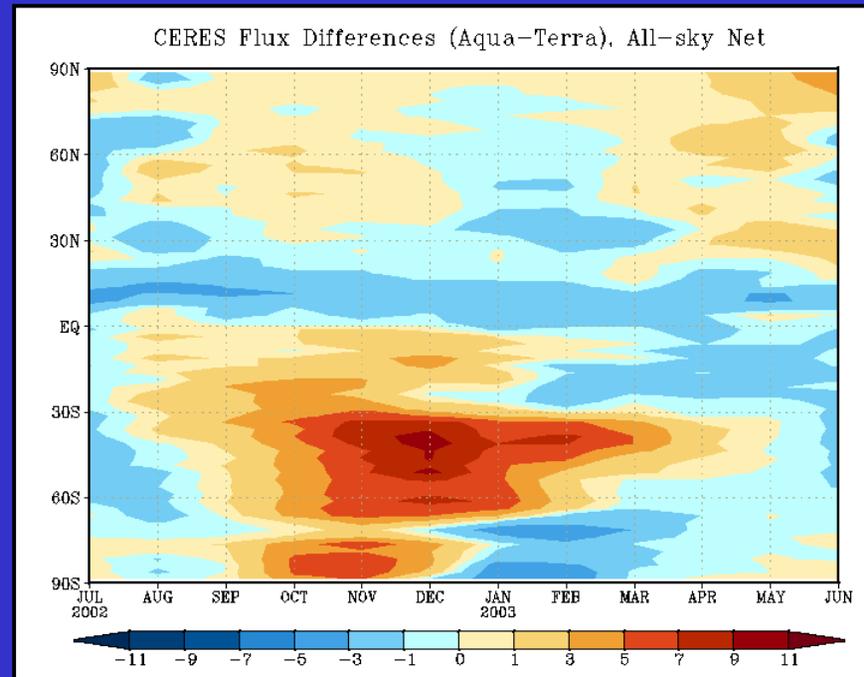
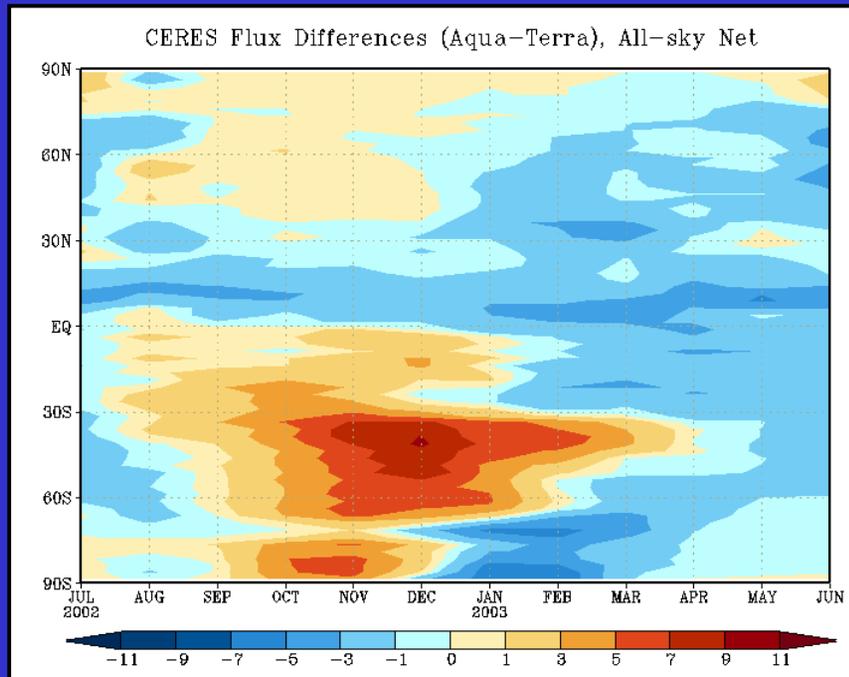
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# Aqua - Terra Zonal Mean Net Differences

Aqua Ed1 - Terra Ed2  
(Old)

Aqua Ed2 - Terra Ed2  
(New)



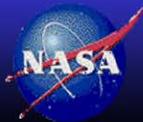
- Changes in Ed2 Longwave Flux → Changes in Ed2 Net Flux



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# Annual Mean Comparisons (July 2002 – June 2003)

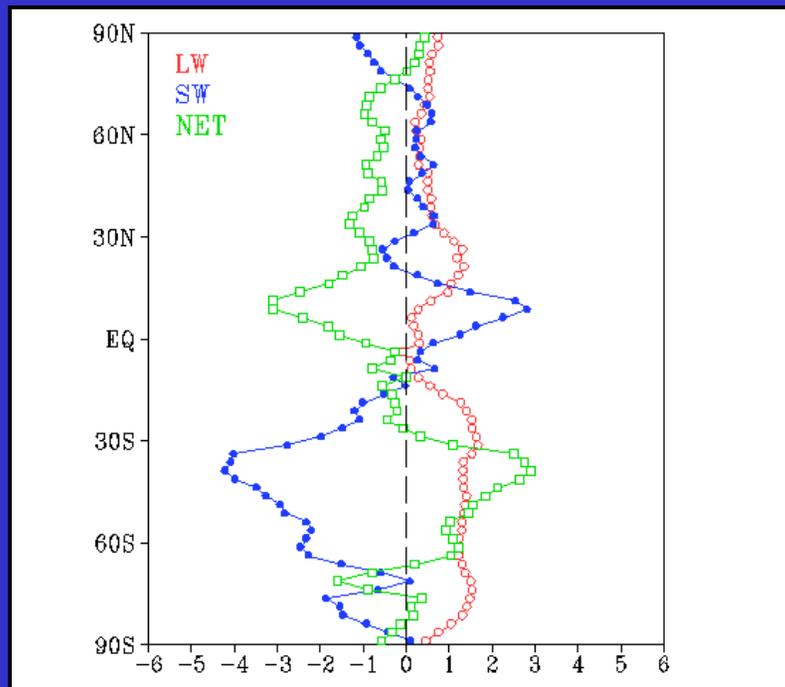


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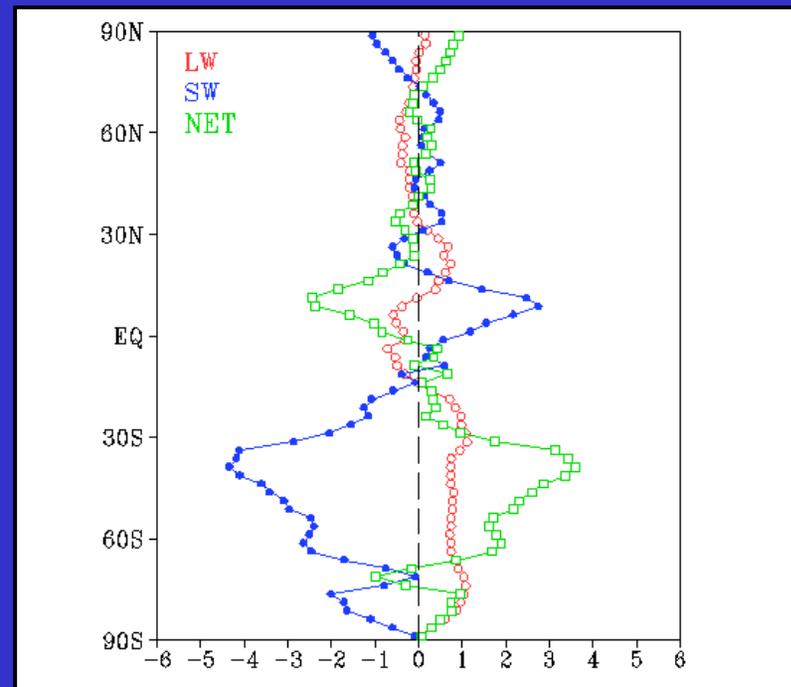


# Aqua-Terra Zonal Mean All-sky Differences

## Aqua Ed1 - Terra Ed2 (Old)



## Aqua Ed2 - Terra Ed2 (New)



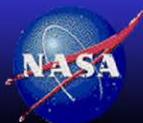
- Aqua and Terra Longwave Fluxes Agree Better in Ed2 Data



## Terra and Aqua Global/Tropical Mean Fluxes

Global	Terra	Aqua	Aqua-Terra	Old Diff
LW	238.9	239.2	0.3	0.9
SW	97.2	96.6	-0.6	-0.5
Net	5.3	5.6	0.3	-0.4
Albedo	28.46%	28.29%	-0.17%	-0.14%

Tropics	Terra	Aqua	Aqua-Terra	Old Diff
LW	256.4	256.3	-0.1	0.5
SW	90.4	91.2	0.8	0.9
Net	62.6	61.9	-0.7	-1.4
Albedo	22.09%	22.28%	0.19%	0.20%



## Summary

- Aqua ERBE-like Edition2 Makes Significant Improvement to the Time Series of Global/Tropical Mean Aqua-Terra Flux Differences
- The Small Positive Slope in the Global/Tropical Mean Aqua-Terra Longwave Flux Difference Reported in the Previous Meeting Has Been Eliminated
- Aqua and Terra ERBE-like Ed2 Data Are more Consistent with Each Other
- Both Aqua and Terra ERBE-like Ed2 Data Show a Global Annual Net Imbalance of  $5 \text{ Wm}^{-2}$  for the Period between 7/2002 and 6/2003

