Decadal Variability: ERBS, ISCCP, Surface Cloud Observer, and Ocean Heat Storage

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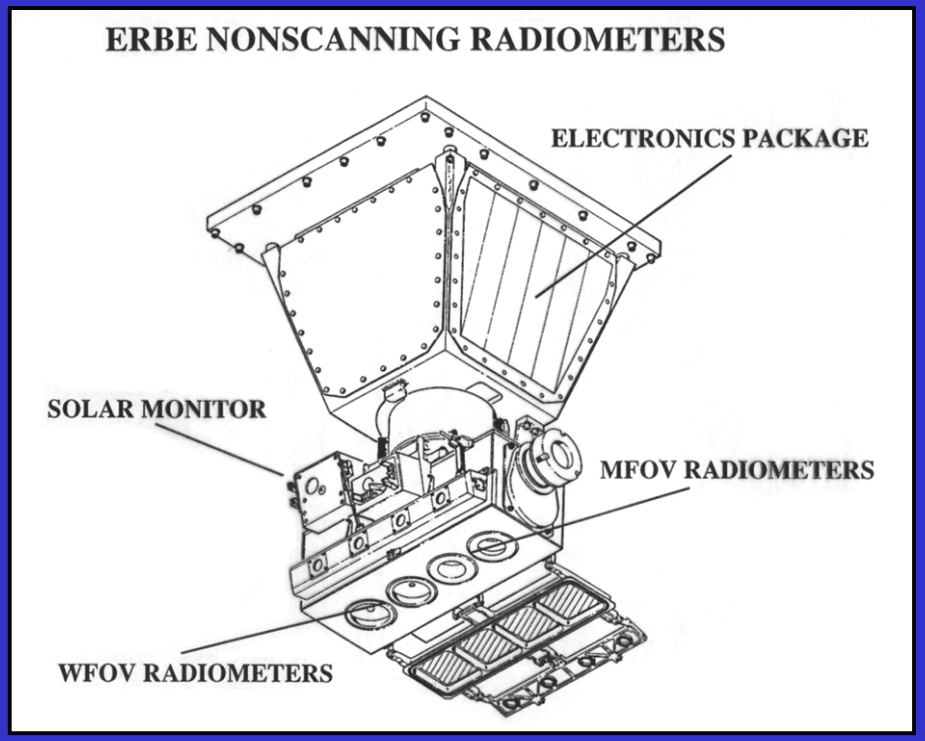
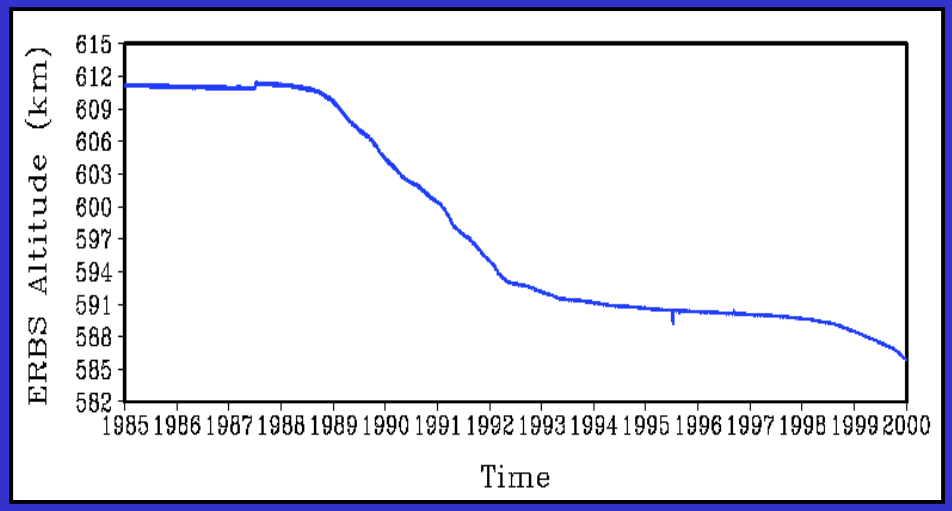
Objectives

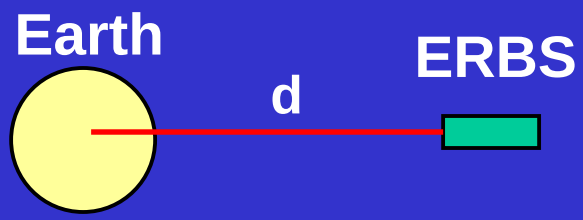
- Give an Update on Satellite Altitude Corrected ERBS Nonscanner Decadal TOA Fluxes
- Examine Consistency of ERBS Decadal Record with Recent Decadal Studies using ISCCP, Surface Cloud Observer, and Ocean Heat Storage Data

Satellite Altitude Corrected ERBS Nonscanner TOA Fluxes



The Problem

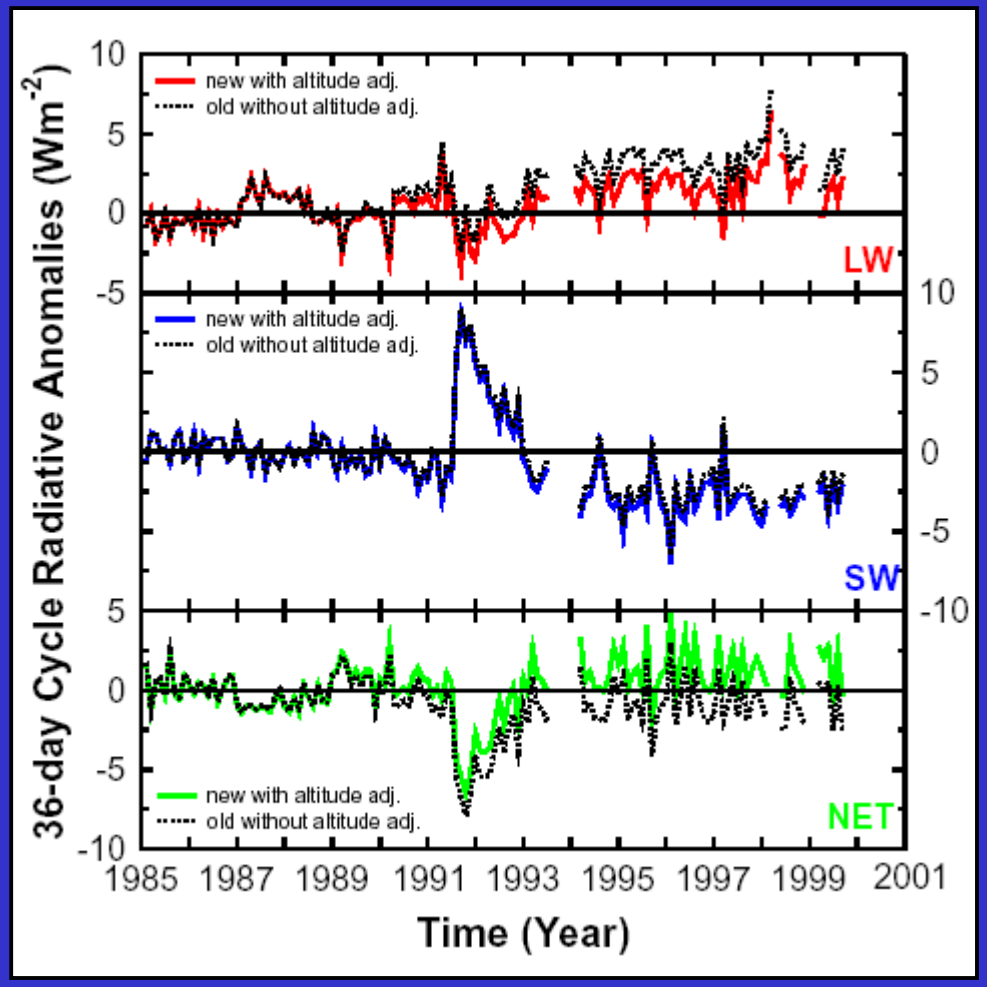




Energy ~ 1 / d^2

- ERBS Altitude Began to Drop After 1988 Due to ERBE Science Team Decision on Canceling the Satellite Altitude Adjustment Maneuver
- This Satellite Altitude Change Is Not Included in the ERBS Nonscanner Inversion Algorithm
- This Omission Causes A Small Systematic Increase in ERBS Nonscanner TOA Fluxes over the 15-year Period

Effects on Tropical Mean Decadal Changes



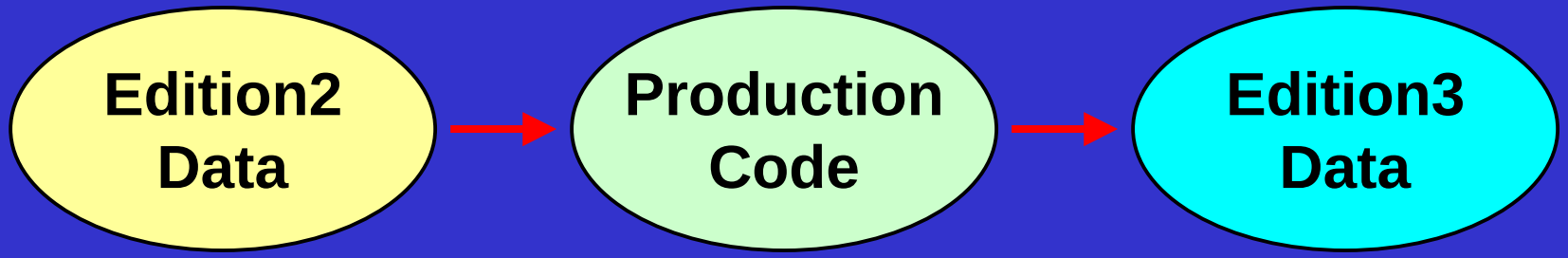
- The Inclusion of ERBS Altitude Changes will Lower the Reported Tropical Mean Decadal Changes in the 2002 Science Paper by About 1.5 Wm^{-2} in the Outgoing Longwave and 0.8 Wm^{-2} in the Reflected Shortwave Fluxes

OLR: 3.5 → 2.0 Wm^{-2}

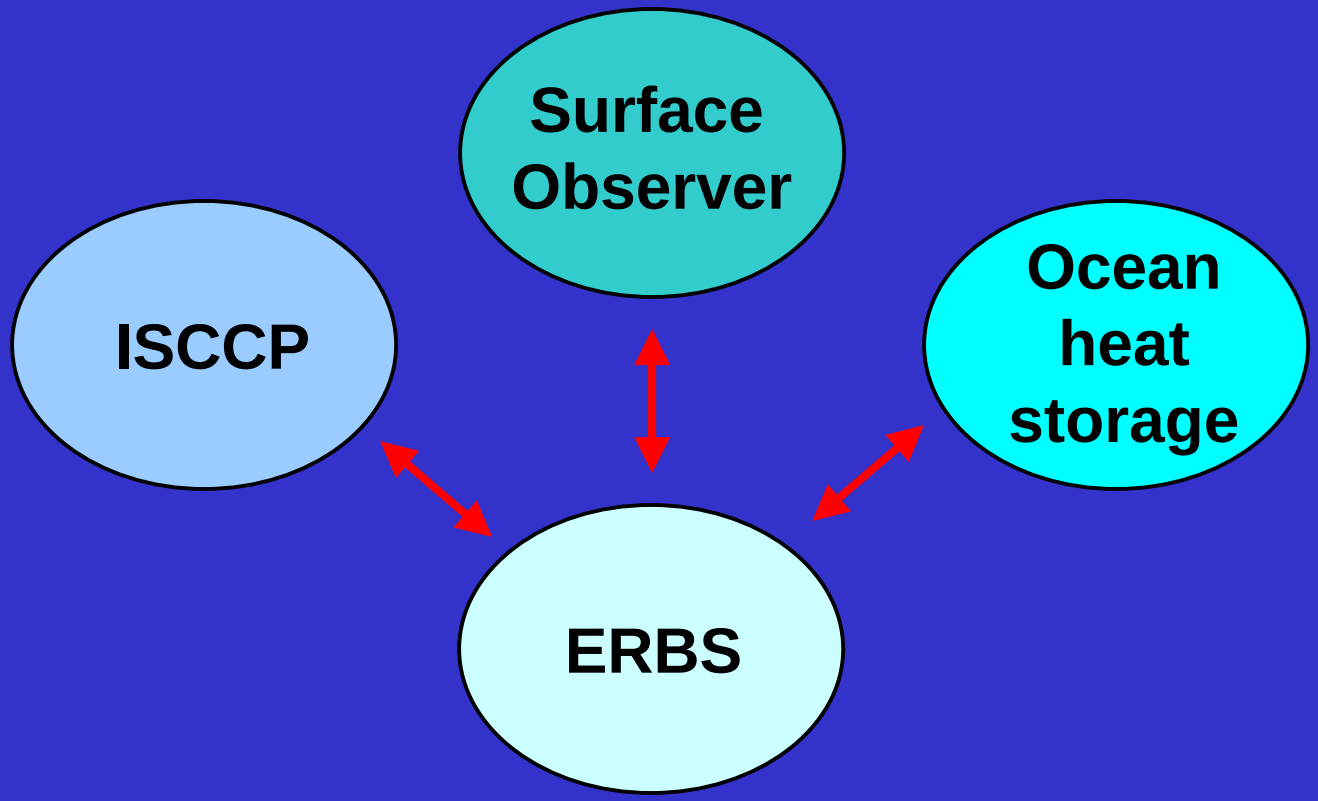
RSW: -2.5 → -3.3 Wm^{-2}

ERBS Nonscanner Edition3 Data

- New Software Patch Has Been Developed To Account for Changes in ERBS Satellite Altitude
- The Entire ERBS Nonscanner Edition2 Data will Be Reprocessed Once Software Testing to the Production Code is Completed
- The New Data will Be Released to the Public as Edition3 Dataset



Data Consistency Check: ERBS, ISCCP, Surface Cloud Observer, and Ocean Heat Storage Data



Recent Decadal Studies

ERBS Vs. ISCCP Clouds and NCEP

Hatzidimitriou, D., et al., 2004: On the Decadal Increase in the Tropical Mean Outgoing Longwave Radiation for the period 1984-2000, Submitted to Journal of Atmospheric Chemistry and Physics

ERBS Vs. Surface Cloud Observer

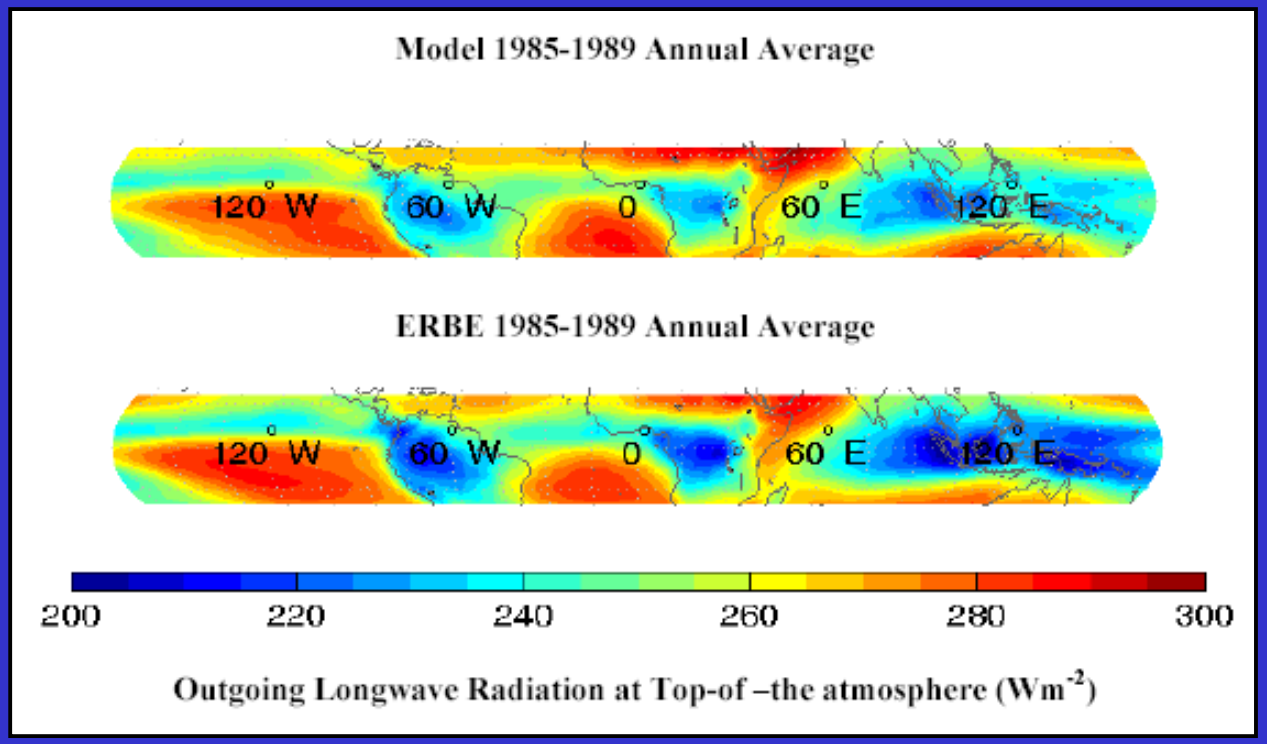
Norris, J. R., 2004: Changes in Near-Global Cloud Cover and Reconstructed Radiation Flux Since 1952, Submitted to Journal of Climate

ERBS Vs. Ocean Heat Storage

Willis, J., D. Roemmich, and B. Cornuelle, 2003: Interannual Variability in Upper-Ocean Heat Content,Temperature and Thermosteric Expansion on Global Scales, Submitted to Journal of Geophysical Research

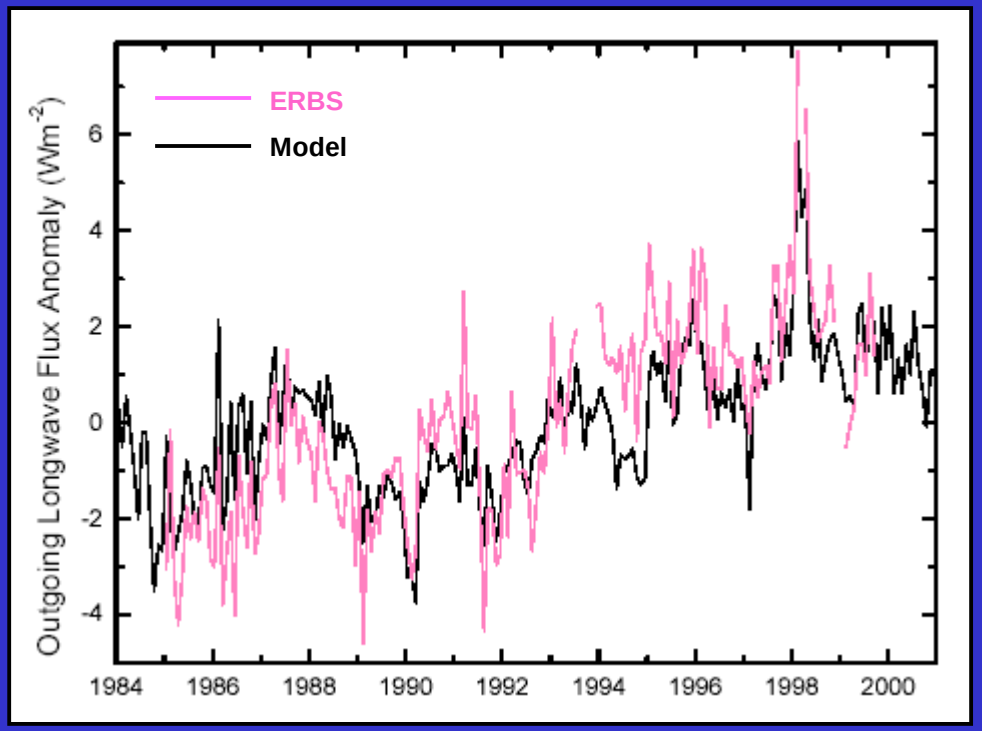
I: ERBS Vs. ISCCP Clouds and NCEP Temperature and Moisture

- Simulate Decadal Tropical (20N to 20S) TOA Longwave Fluxes using ISCCP Clouds and NCEP Temperature and Moisture as Inputs to Radiative Transfer Model



I: ERBS Vs. ISCCP Clouds and NCEP Temperature and Moisture (Cont.)

- Time Series of the Simulated OLR Anomaly Agrees Well with the Observed ERBS Nonscanner OLR Anomaly



Decadal OLR Trend (Wm^{-2}/Decade)

ERBS Observation	Model Simulation
3.5±0.3	1.9±0.2

2.0±0.3
(Alt Adj)

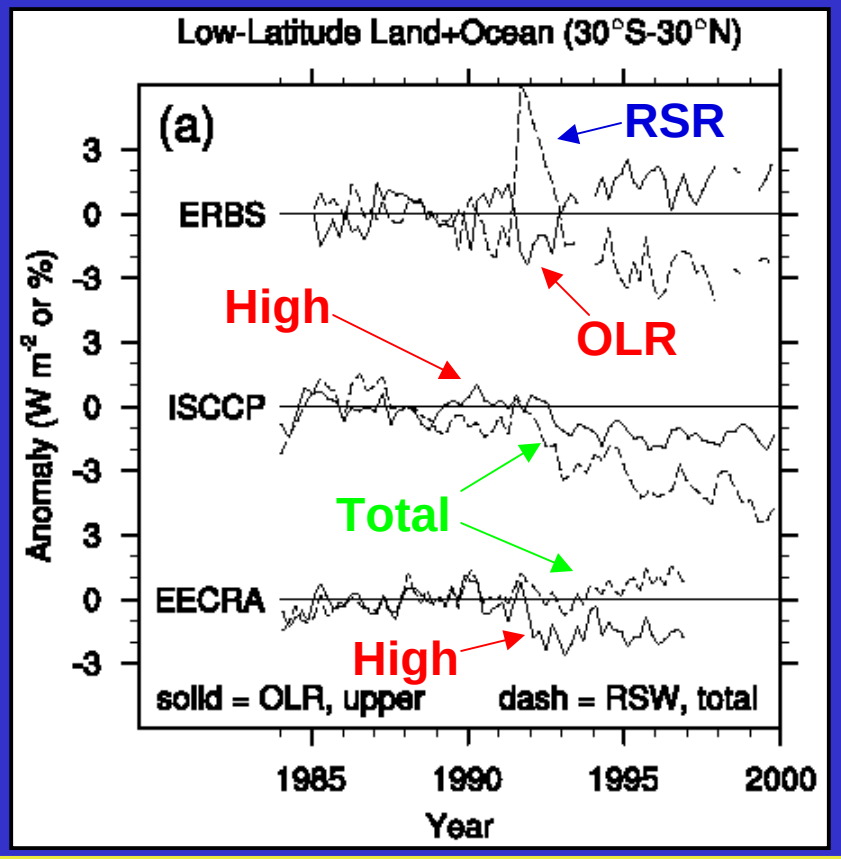
I: ERBS Vs. ISCCP Clouds and NCEP Temperature and Moisture (Cont.)

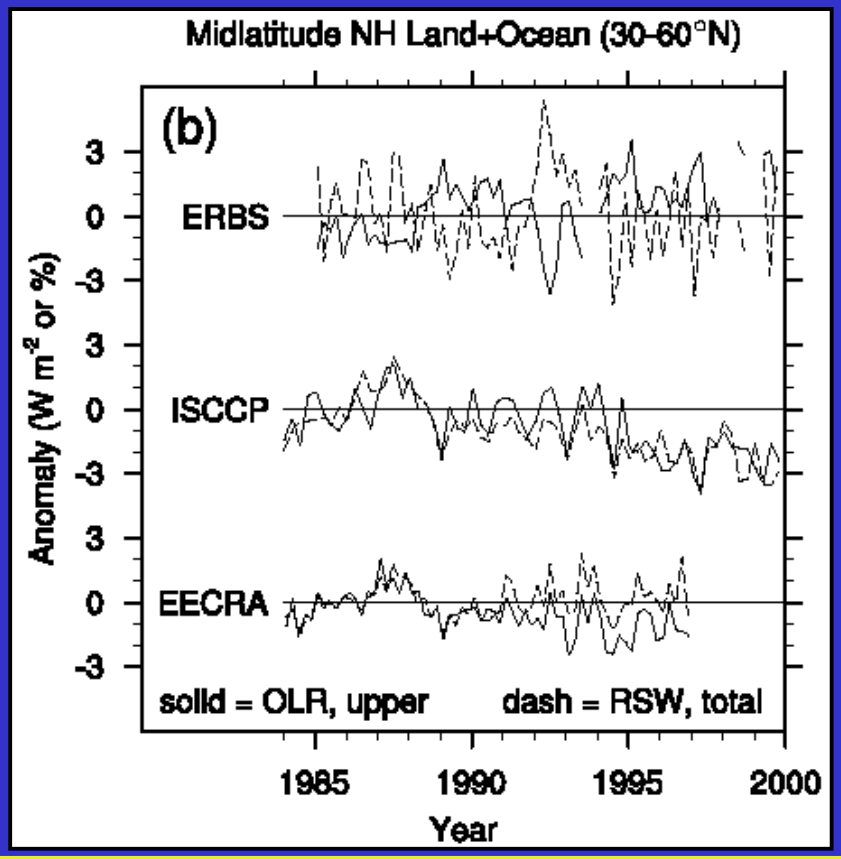
- The Decreases in High Level Cloud Amount Make the Most Significant Contribution to the Observed Increases In OLR between 1984 to 2000

Parameter	Decadal trend	Outgoing longwave radiative forcing at TOA (Wm^{-2})
Low-level cloud amount	-6.5±0.4 %	0.23 ↑
Mid-level cloud amount	1.6±0.4 %	0.1↓
High-level cloud amount	-10.1±0.5 %	1.5 ±0.1 ↑
Low-level cloud top pressure	-1.8±0.2%	0.34↓
Atmospheric temperature at 50hP (K)	-0.9 ±0.2K	0.2↓
Precipitable water 500-300hP (gcm^{-2})	-3.1±0.6 %	0.53↑

II: ERBS Vs. Surface Cloud Observer

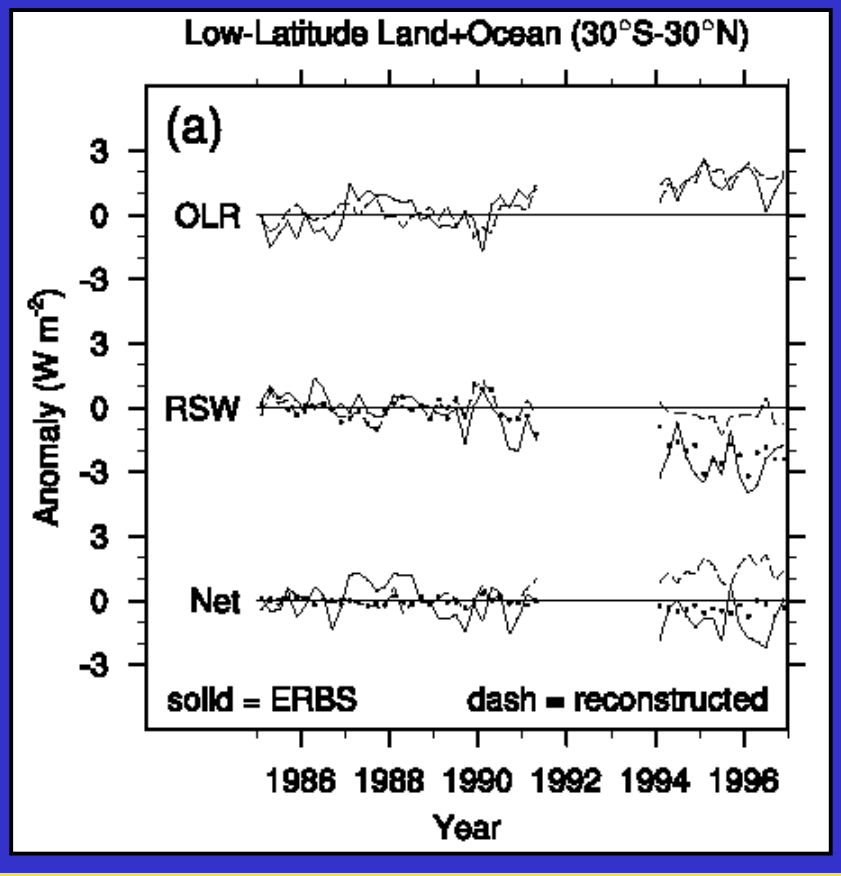
- The Changes in ERBS Fluxes Correspond To Decreases in Surface Observed Upper Level Cloud Amount

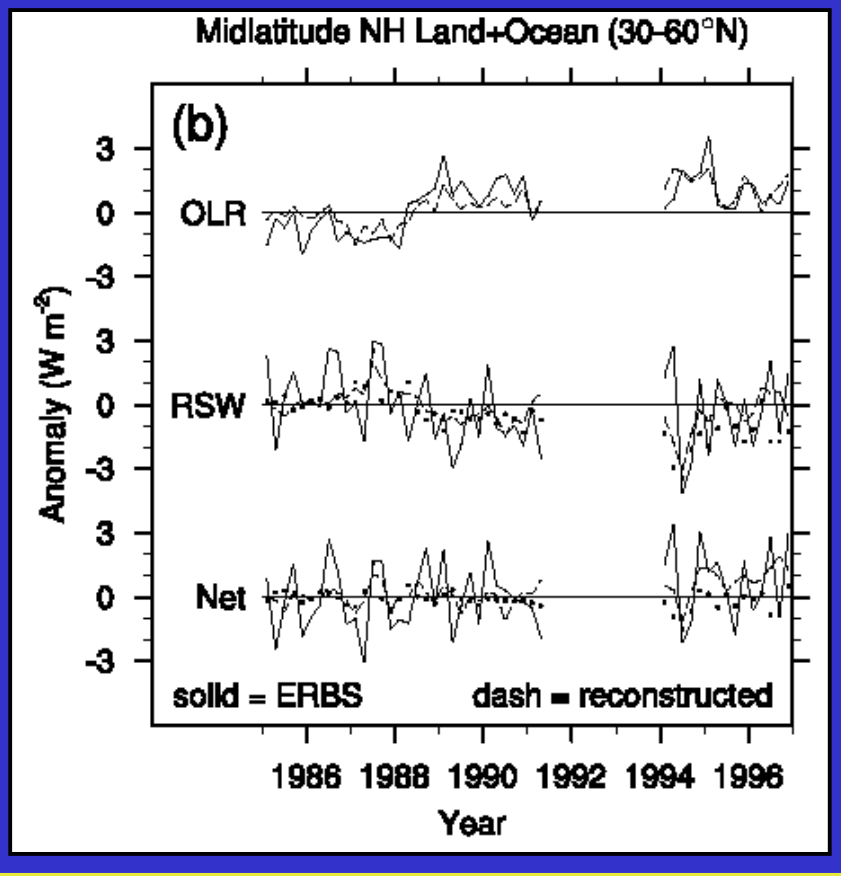




II: ERBS Vs. Surface Cloud Observer (Cont.)

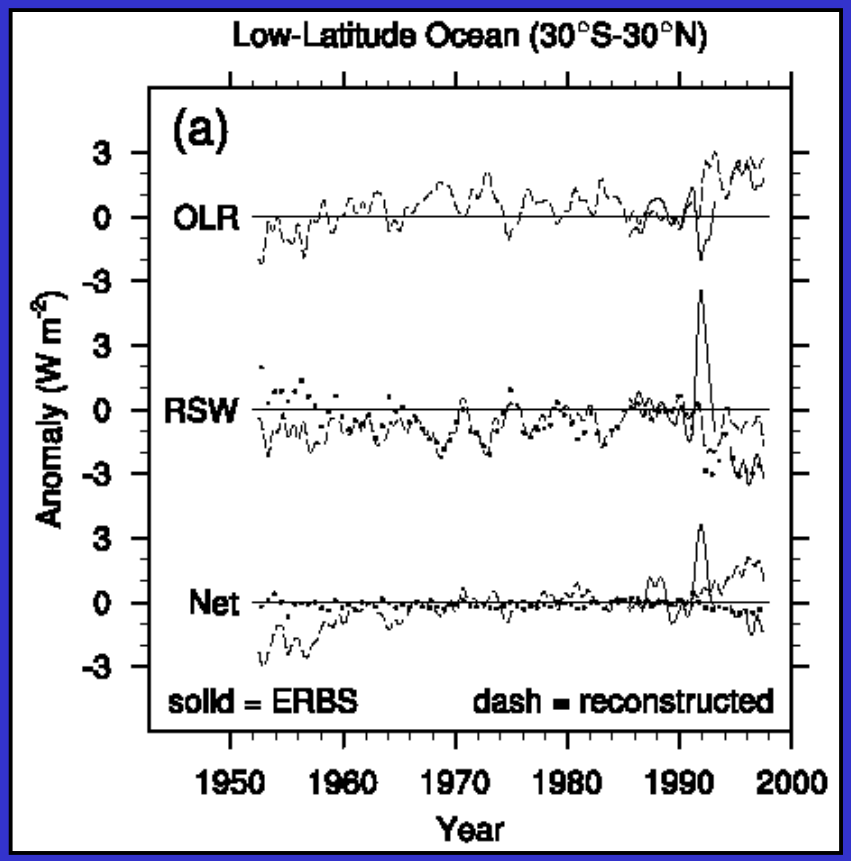
- Construct Empirical Model for Diagnosing OLR and RSW Based on Surface Cloud Observer Data

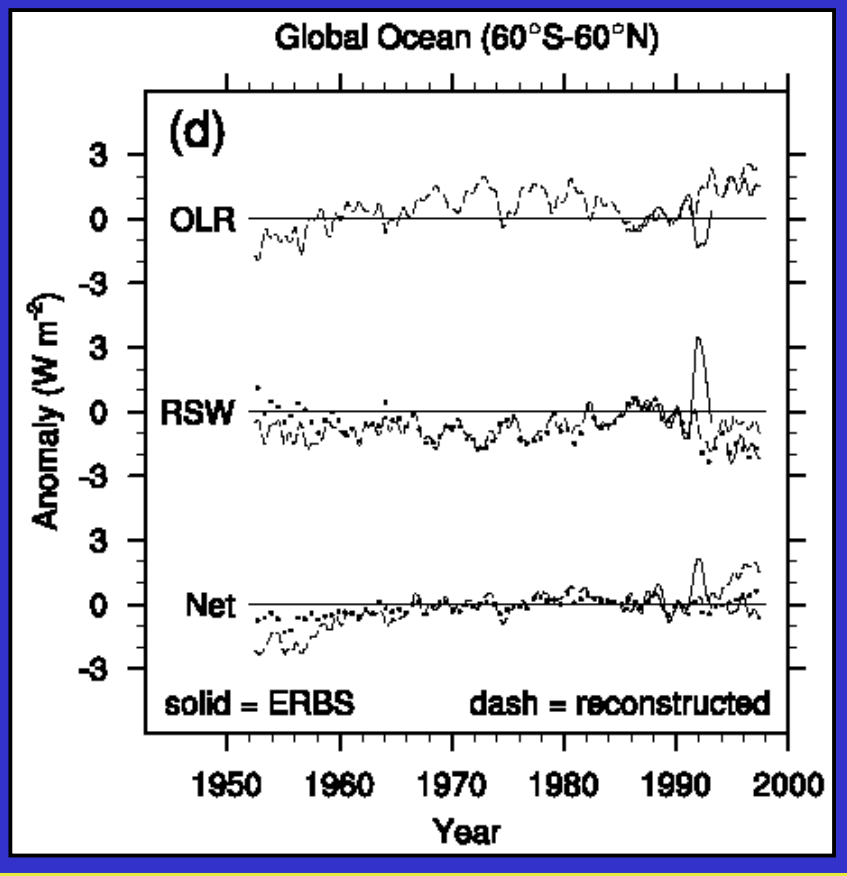




II: ERBS Vs. Surface Cloud Observer (Cont.)

- Extend the Radiation Record Back to 1950 using Surface Cloud Observer Report and Empirical Model

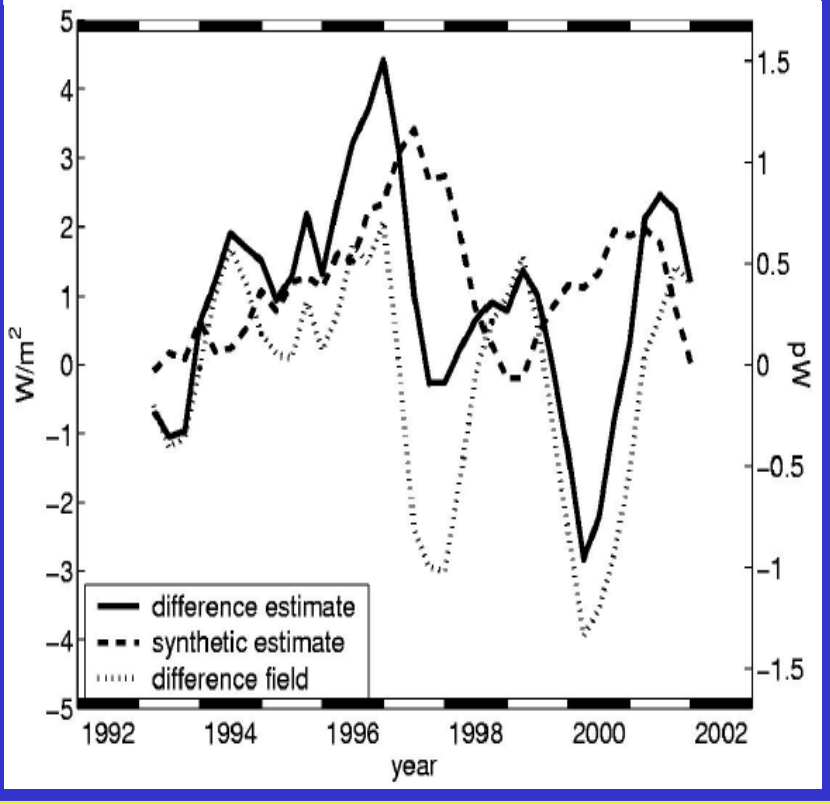




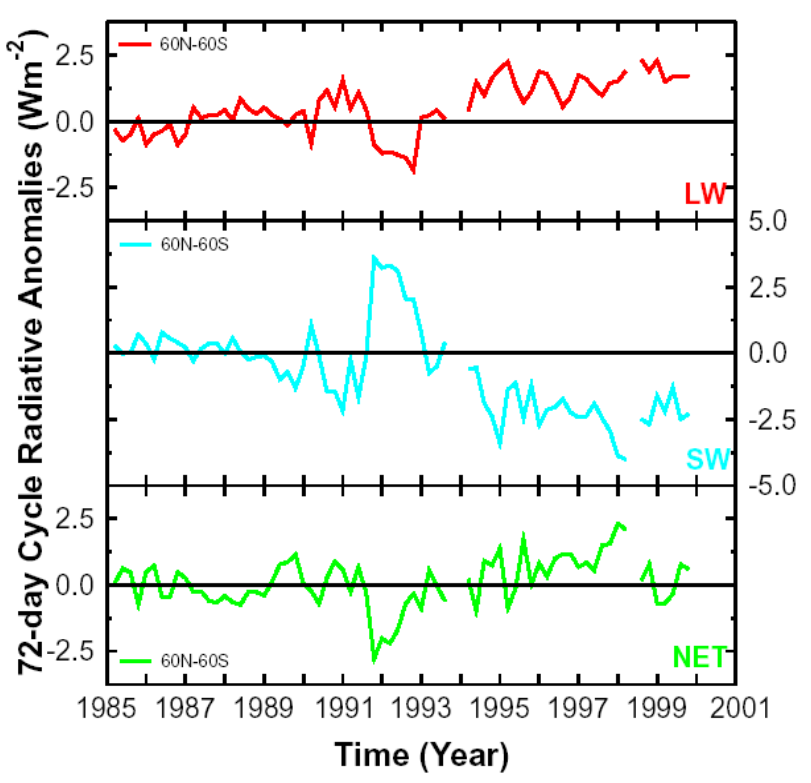
III: ERBS Vs. Ocean Heat Storage

- New Evidence of Large Interannual Variability of Ocean Heat Storage, Similar to ERBS Variability

Global Average Ocean Heat Storage

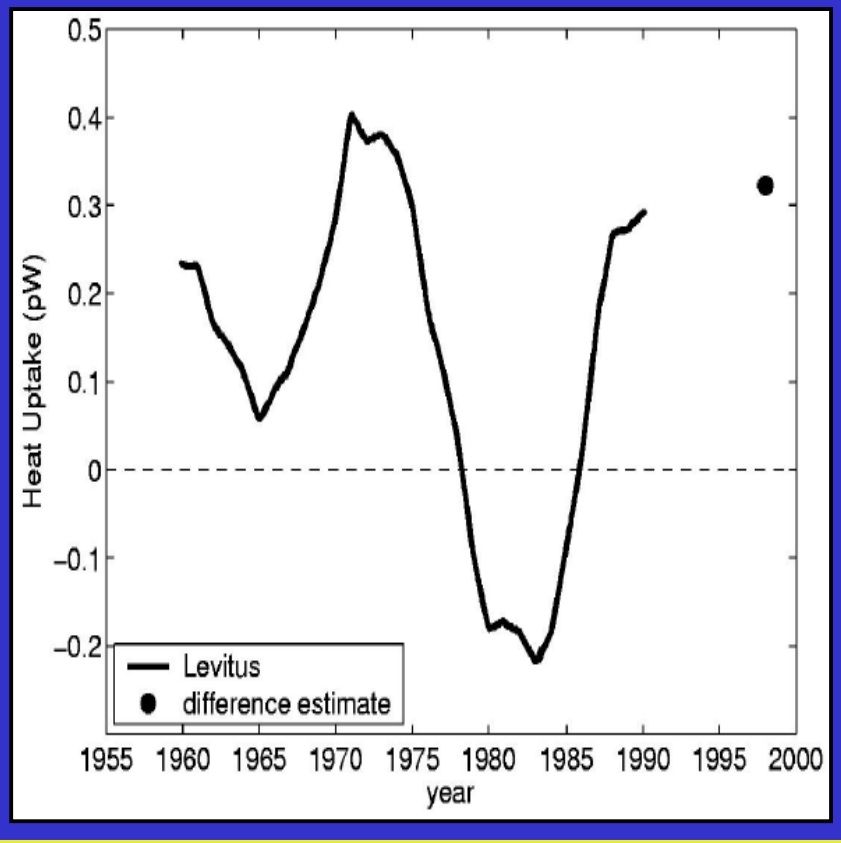


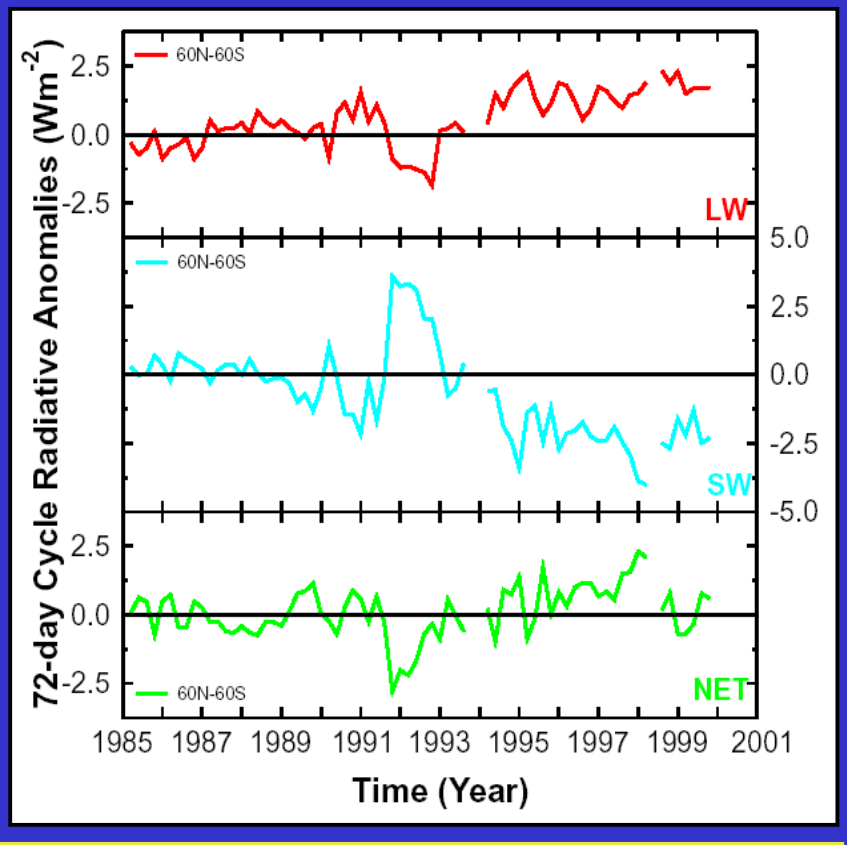
Near-Global ERBS TOA Fluxes



III: ERBS Vs. Ocean Heat Storage (Cont.)

- Large Decadal Variability of Ocean Heat Storage Is Possible in Our Climate System, Similar to ERBS Variability





Summary

- ERBS Altitude Adjustment Will Lower the Reported Tropical Mean Decadal Changes by 1.5 Wm^{-2} in the Outgoing Longwave and 0.8 Wm^{-2} in the Reflected Shortwave
- Model Simulated OLR Using ISCCP Clouds and NCEP Temperature and Moisture Agrees with ERBS Observations; Deceases in ISSCP High Cloud Amount Are the Main Reason for the Observed OLR Increases
- Surface Observer Report Also Shows Good Agreements with ERBS Results
- Reconstructed Radiation Record from Surface Observer Report Show Large Variability in TOA Radiation
- New Ocean Data Shows Large Interannual and Decadal Variability in Ocean Heat Storage; Similar to those in the ERBS Record