Global Ocean Heat Storage & Net Radiation: Interannual Variations

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Tropical (20S - 20N)
TOA Radiation Anomalies:
Observations (color) vs. Climate Models

- Climate noise 0.3 Wm\(^{-2}\)
- SW reflected lower 90s
- Global dimming recovery?
- Net heating in 90s
- Opposite sign of Iris negative cloud feedback hypothesis
- Surface heating would be 3% in tropical mean precipitation
- Climate models driven with observed SSTs, not Pinatubo
- Pinatubo signal cooling
- Missing cloud feedbacks?
- Natural variability?
Ocean Heat Storage vs ERBS/CERES Global Net Anomalies

- Blue line: Ocean Heat Storage
- Red line: ERBS Edition 3
- Green line: CERES Edition 2

Heat Storage/Net Flux (Wm⁻²)

Time (Year)


Globally Averaged Ocean Heat Content Variability

Figure 3. Globally averaged heat content variability. Error bars on the difference estimate (combined altimeter and in situ data) are $2.4 \times 10^7$ J/m$^2$ as described in the text. Warming rates are calculated from the 10-year changes in heat content.

Willis et al, JGR, 2004
Heat Content Variability: Global and Tropical

Figure 8. Interannual variability in heat content integrated over the region from 20° N to 20° S (solid line) and over the entire globe (dashed line).

Willis et al, JGR, 2004
10-yr Temperature Trends versus Ocean Depth

Figure 9. Ten-year trend in zonally averaged temperature vs. depth and latitude.

Willis et al, JGR, in press
New Ocean Heat Storage Versus Levitus Data

Figure 12. Decadal heat storage calculated as the 10-year difference of the 40-year time series of heat content published by Levitus et al. [2000a]. The single point represents the 10-year heat storage rate from the present analysis, as calculated in Section 3.1.

Willis et al, JGR, in press
Global Radiation and Ocean Heat Storage: What does it mean?

- Climate atmos. noise only 0.3 Wm\(^{-2}\)
- Ocean/Rad diff = 0.4 Wm\(^{-2}\) \(1\sigma\)
  = ocean spatial sampling noise
- ERBS cavity radiometer gain change = 0.1\% or 0.2 Wm\(^{-2}\)
- 1.5 Wm\(^{-2}\) variations larger than expected
- IPCC forcing = 0.6 Wm\(^{-2}\)/decade
- All other heat storage mechanisms are smaller by factor of 10 or more
- Aerosol/greenhouse forcing changes small except Pinatubo in 91-93
- Large changes = variations in net cloud radiative forcing
- Not clear if ocean => cloud or cloud => ocean
- Non-equilibrium link of ocean/cloud must be unscrambled in model/data
What about 1 Wm$^{-2}$ CERES SW Flux Change?

Ocean Heat Storage vs ERBS/CERES Global Net Anomalies

- Ocean Heat Storage
- ERBS Edition3
- CERES Edition2
- CERES Edition2 (rev1)

Time (Year)