

The Effect of El Niño/La Niña Oscillations on Recent Anomalies and Trends of OLR

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1. UMBC GEST
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Comparison of Anomalies and Trends of CERES and AIRS OLR

Data sets used

CERES Terra Edition-2 OLR extends through February 2010

AIRS Version-5 OLR extends through September 2010

Common time period September 2002 through February 2010

AIRS and CERES OLR anomalies are based on 7-year climatologies

Anomalies and trends are compared for the period September 2002 through February 2010



Significance of AIRS OLR and Clear Sky OLR

AIRS OLR is a computed product for each AIRS FOR using an OLR RTA

Input data is AIRS retrieved T_{skin} , ϵ_{W} , $T(p)$, $q(p)$, $O_3(p)$, $\alpha\epsilon$, and p_{cloud}

AIRS Clear Sky OLR is also computed for each AIRS FOR using same parameters but setting $\alpha_{\text{A}} = 0$

CERES is a measured product

If anomalies and trends of AIRS OLR closely match those of CERES, then:

This validates anomalies and trends of both AIRS OLR and CERES OLR

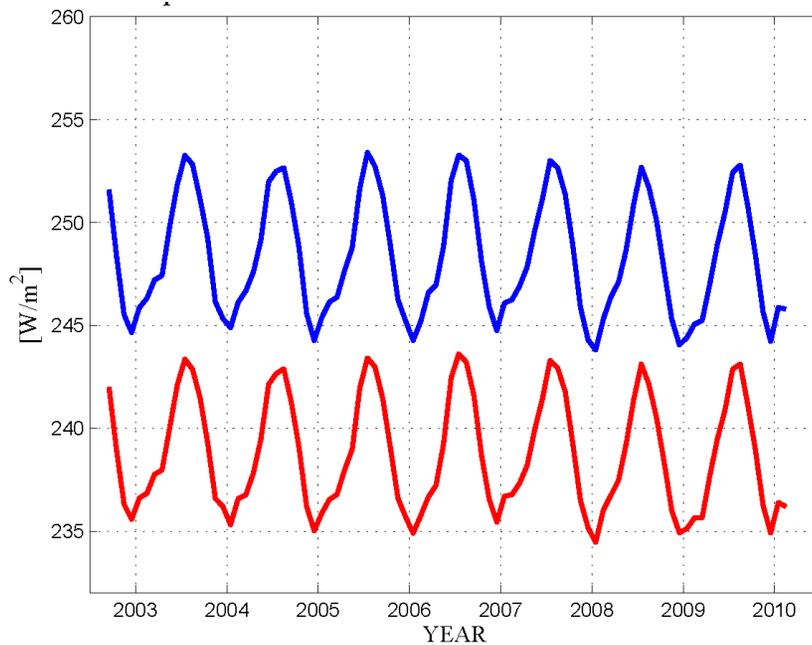
This indirectly validates anomalies and trends of AIRS retrieved products

In addition, anomalies and trends of OLR can now be attributed to those of its component parts

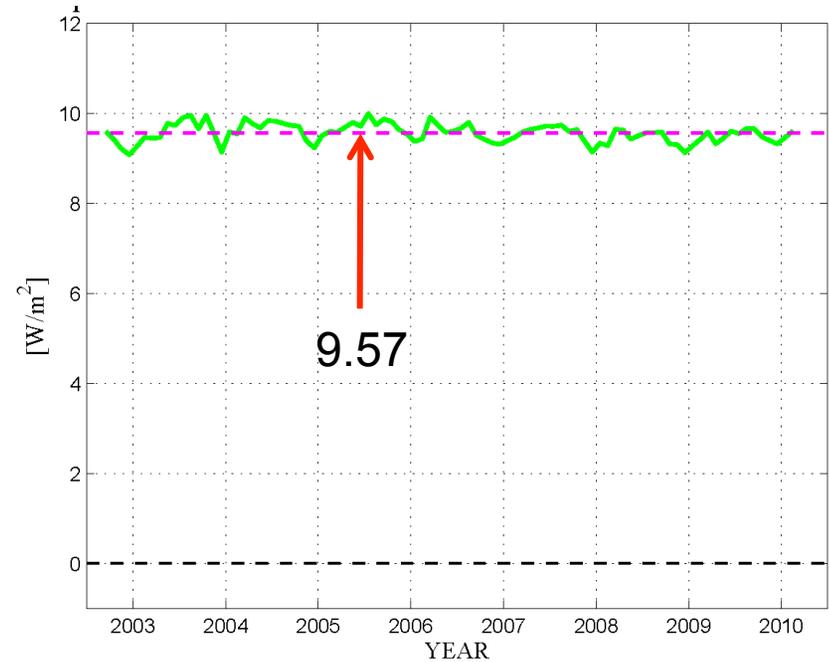


Comparison of OLR Time Series

Time Series of Global All Sky OLR September 2002 through February 2010 Time Series of Global All Sky OLR Differences September 2002 through February 2010



— AIRS Version-5
— Terra CERES



— AIRS Version-5 minus Terra CERES



Comparison of OLR Anomaly Time Series

Global All Sky OLR Anomaly Time Series
September 2002 through February 2010



— AIRS Version-5 Trend = $-0.111 \text{ W/m}^2/\text{yr}$
— Terra CERES Trend = $-0.089 \text{ W/m}^2/\text{yr}$
— AIRS minus Terra CERES
Correlation = 0.960

Tropical OLR Anomaly Time Series
September 2002 through February 2010

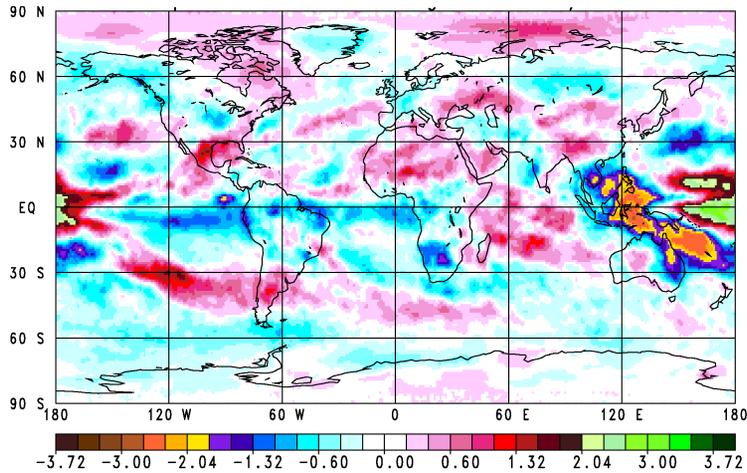


— AIRS Version-5 Trend = $-0.180 \text{ W/m}^2/\text{yr}$
— Terra CERES Trend = $-0.164 \text{ W/m}^2/\text{yr}$
— AIRS minus Terra CERES
Correlation = 0.981



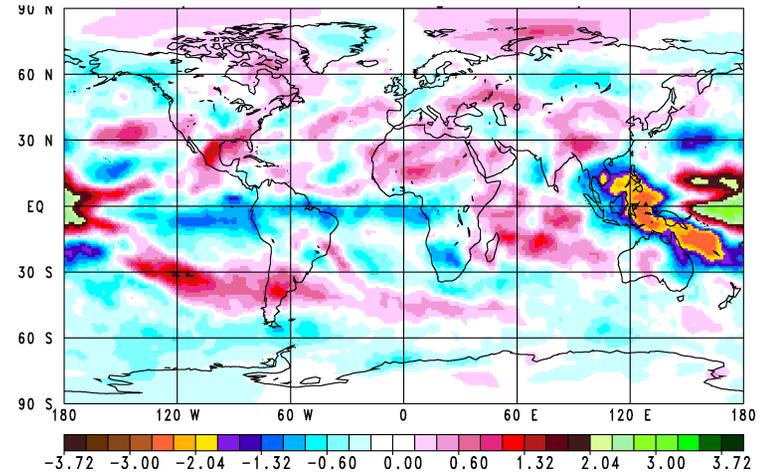
OLR Spatial Trends $W/m^2/yr$ September 2002 through February 2010

AIRS Version-5



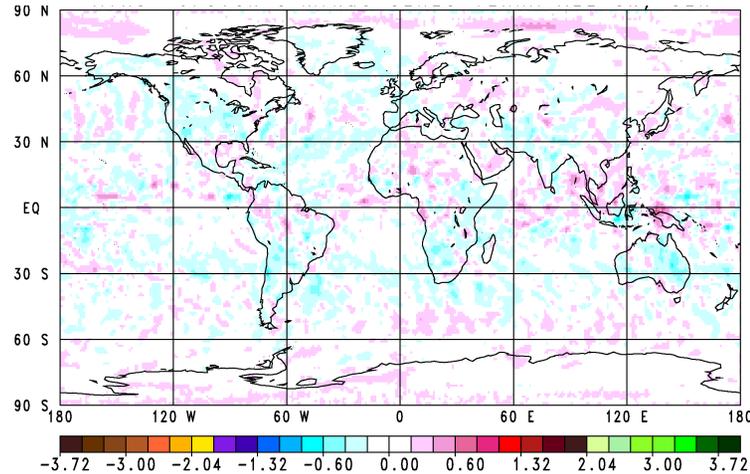
Global Mean = -0.111 Standard Dev = 0.696

CERES Terra



Global Mean = -0.089 Standard Dev = 0.687

AIRS Version-5 minus CERES Terra



Global Mean = -0.022 Standard Dev = 0.151 Correlation = 0.969

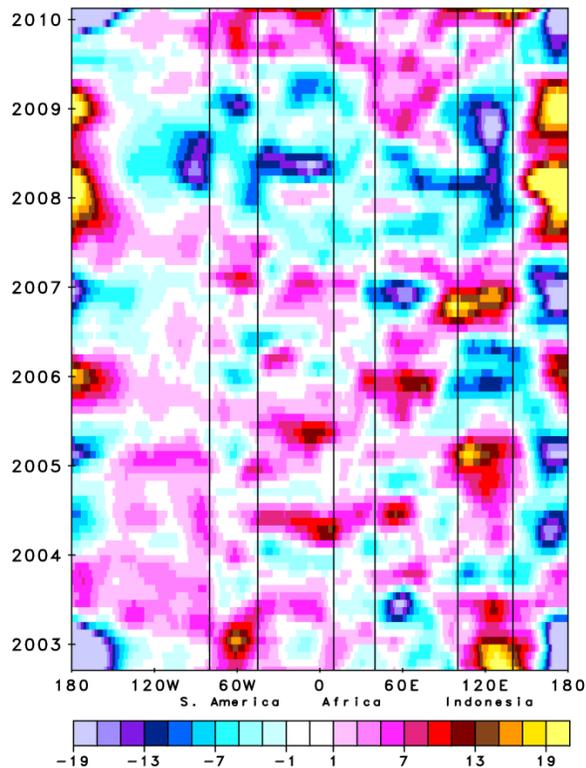


Comparison of OLR Anomaly Hovmöller Diagram

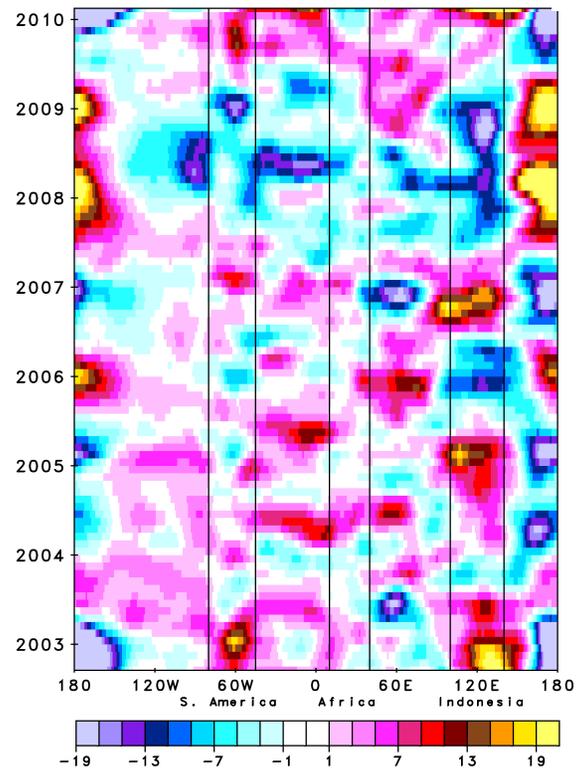
Monthly Mean OLR Anomaly (W/m^2) Tropics $5^{\circ}N$ to $5^{\circ}S$

September 2002 through February 2010

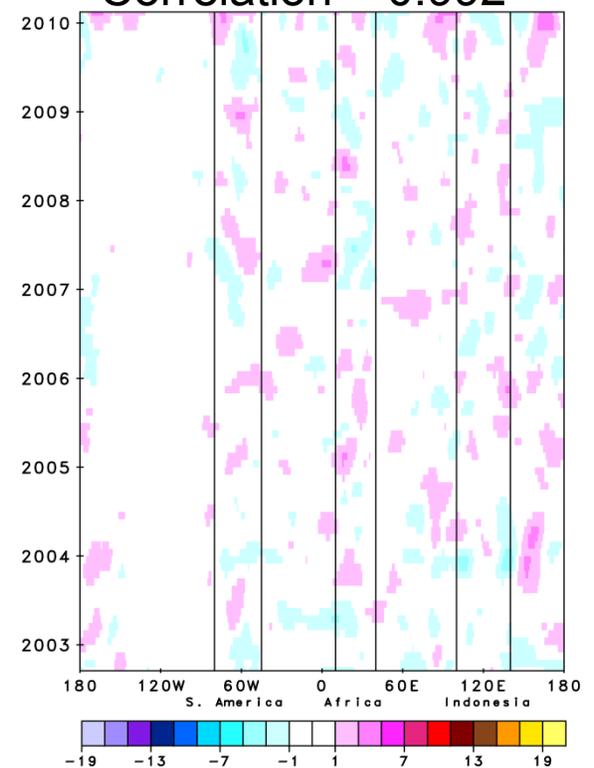
AIRS



CERES Terra



AIRS minus CERES Terra OLR
Correlation = 0.992



Comparison Summary

Anomalies and Trends of AIRS and CERES Edition-2 OLR agree very closely in all details

AIRS and CERES Global and Tropical mean trends over the period September 2002 through February 2010 agree to within $\pm 0.01 \text{ W/m}^2/\text{yr}$

Patterns of AIRS and CERES OLR trends have a spatial correlation of 0.97

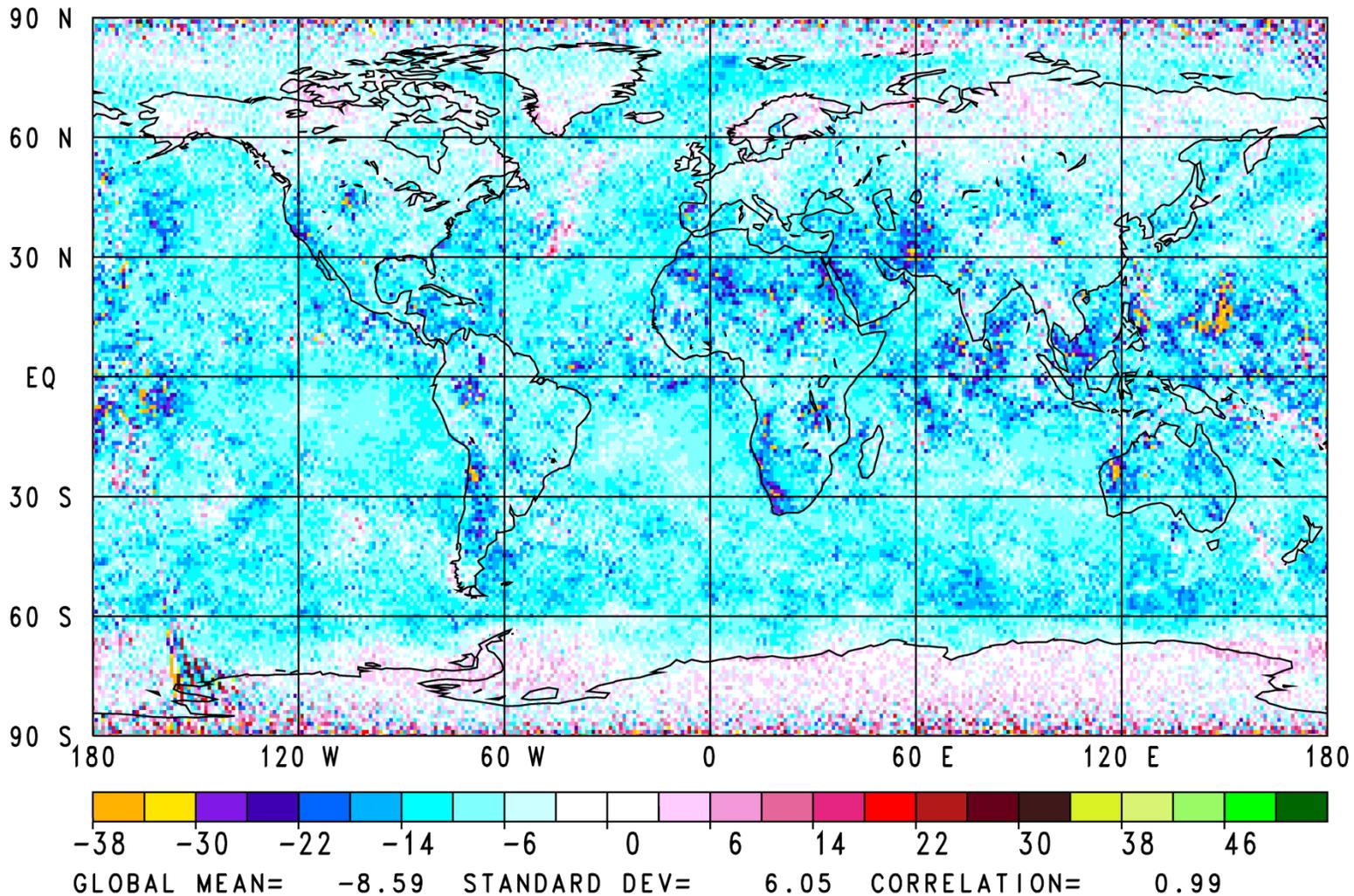
AIRS and CERES Tropical OLR Hovmöller anomaly time series have temporal correlation of 0.99

Version-5 AIRS OLR is biased 9.6 W/m^2 high compared to CERES Terra Edition-2 OLR

Version-6 AIRS OLR will agree with CERES Terra Edition-2 OLR to within 1 W/m^2



AIRS Version-6 OLR minus Version-5 OLR 6-Day Average Watts/m²



Effect of El Niño on Tropical T_{skin} , $q(p)$, cloud cover, OLR, and OLR_{CLR} Anomalies and Trends

Data Used

AIRS Version-5 OLR, OLR_{CLR} , T_{skin} , $q(p)$, α 

8-year time period September 2002 through August 2010

Anomalies are based on 8-year AIRS monthly mean climatologies

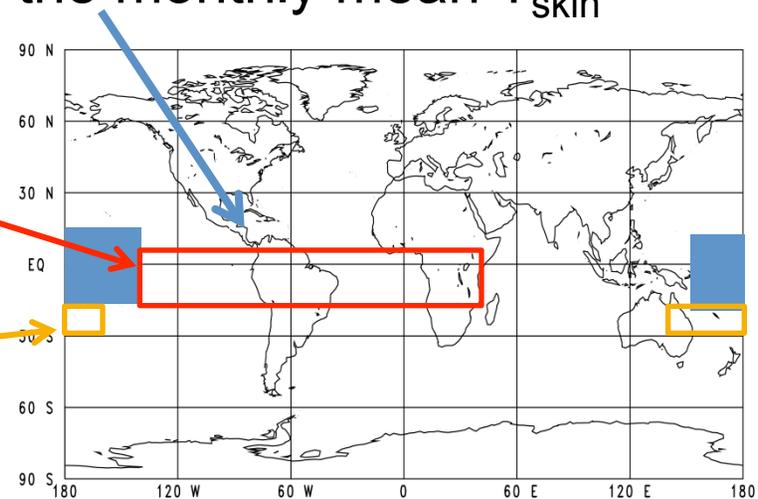
Important regions highlighted in subsequent figures

- 1) El Niño Region: 15°N to 15°S , 140°W westward to 160°E

We define the El Niño Index as the monthly mean T_{skin} anomaly averaged over the El Niño region

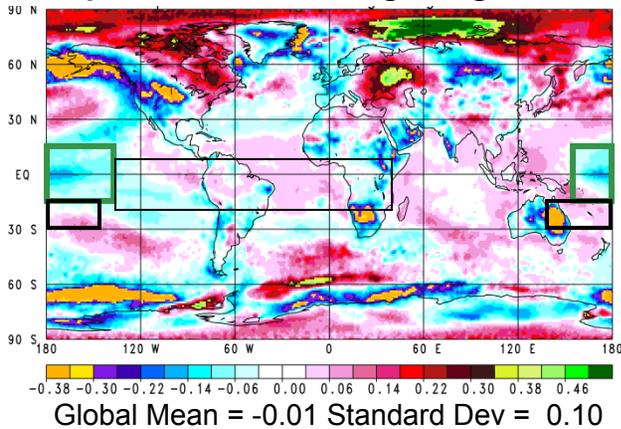
- 2) OLR Region 1: 8°N to 20°S , 140°W , eastward to 40°E
East of El Niño region

- 3) OLR Region 2: 15°S to 30°S , 160°W , westward to 140°E
South of El Niño region

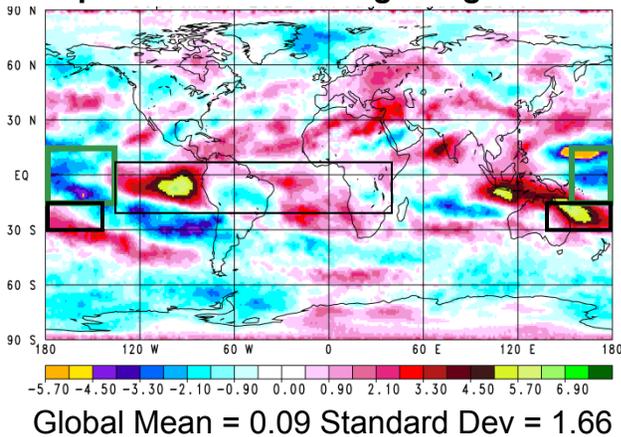


Effects of El Niño on Temperature and Water Vapor Anomalies and Trends

**AIRS Surface Skin Temperature Trend (°K/yr)
September 2002 through August 2010**

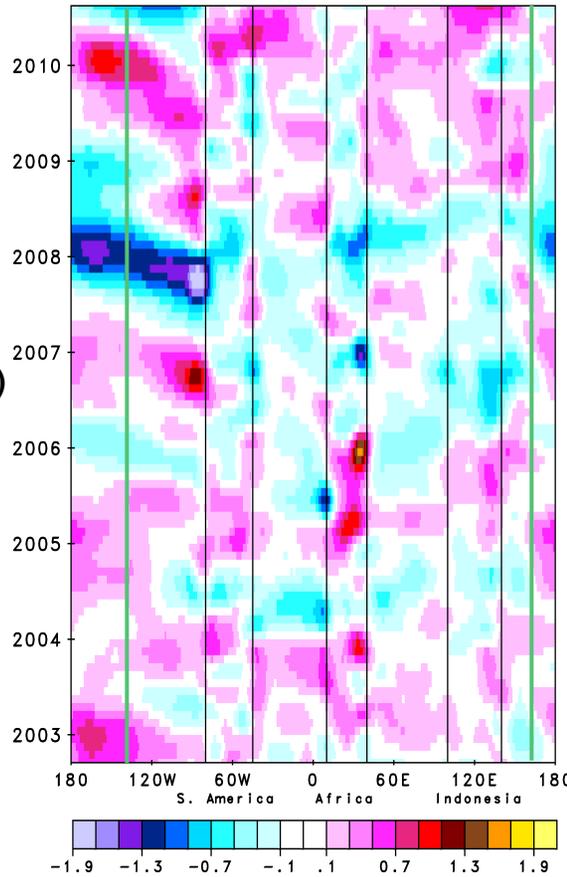


**AIRS 500 mb Specific Humidity Trend (%/yr)
September 2002 through August 2010**

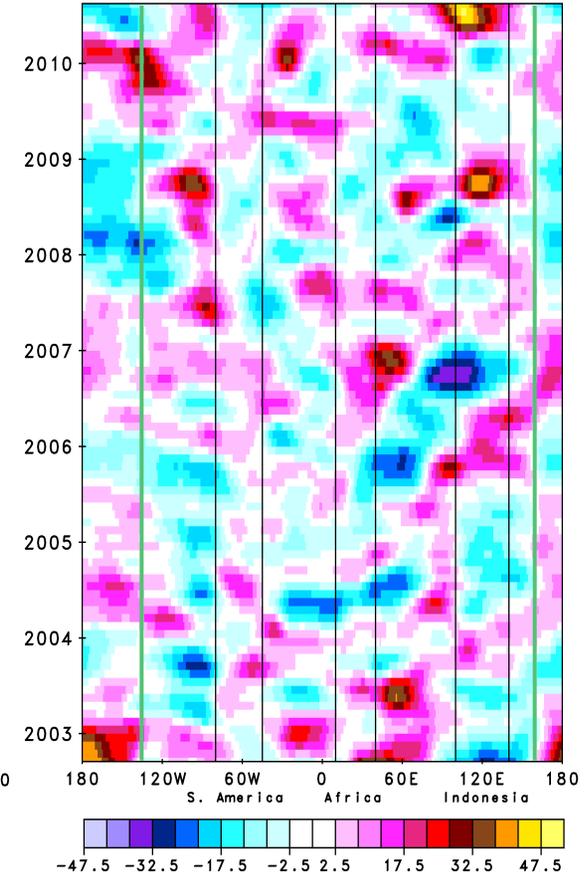


September 2002 through August 2010

Surface Skin Temperature Anomaly (K)
8°N to 20°S



500 mb Specific Humidity Anomaly(%)
8°N to 20°S

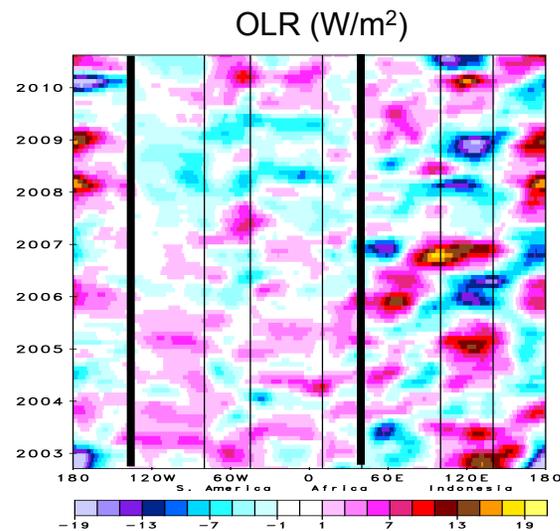
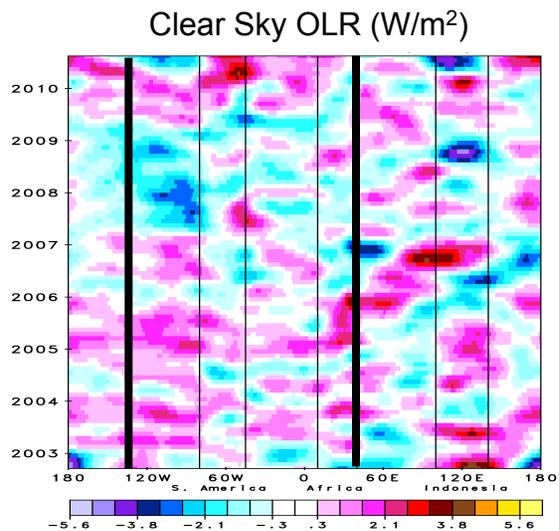
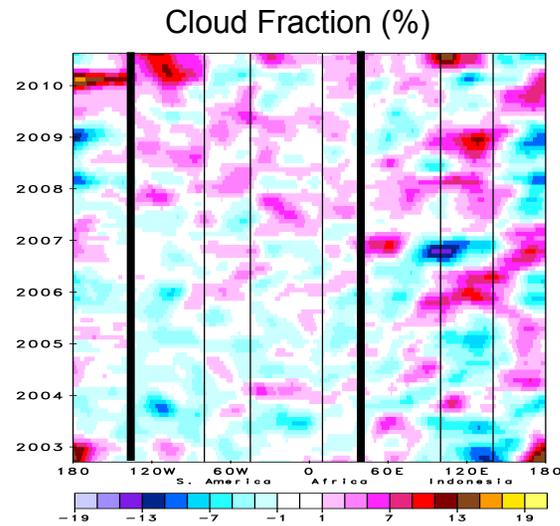
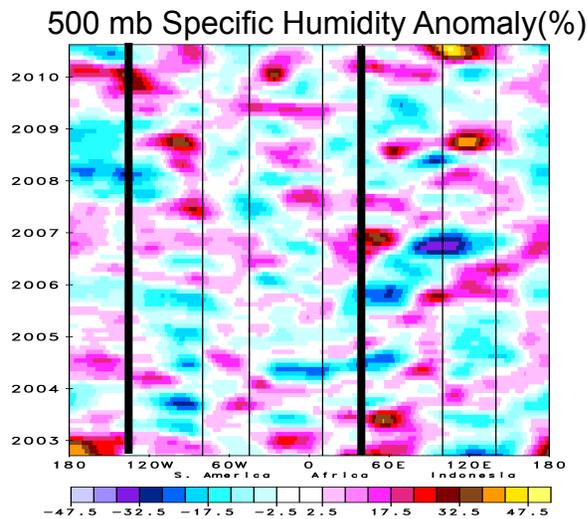


El Niño area enclosed in green around dateline



Tropical Water Vapor, Cloud, and OLR Anomaly Time Series

AIRS Monthly Anomalies September 2002 through August 2010 Tropics 8°N to 20°S



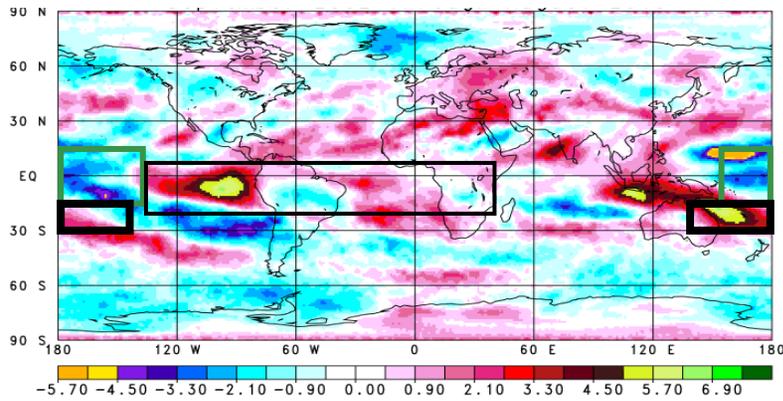
Region 1
enclosed in
thick black



Relationship between Water Vapor, Cloud, and OLR Trends

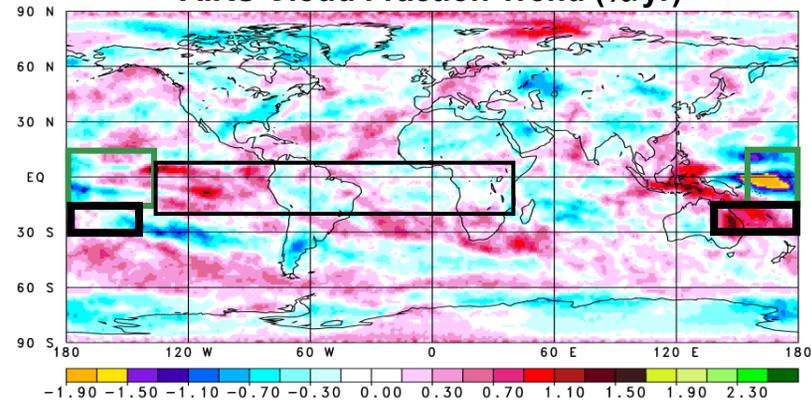
September 2002 through August 2010

AIRS 500 mb Specific Humidity Trend (%/yr)



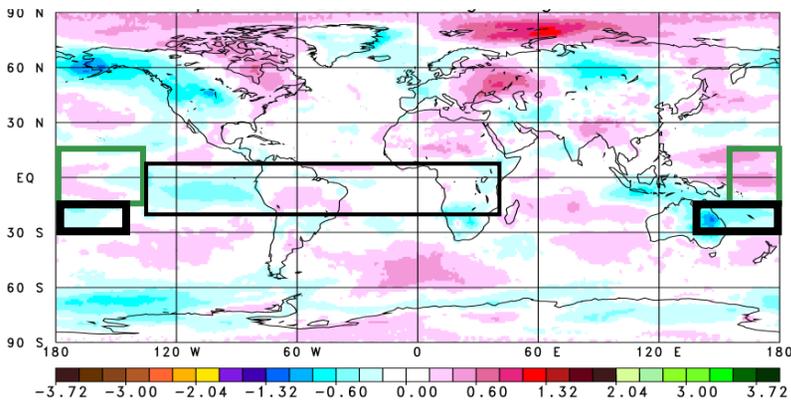
Global Mean = 0.09 Standard Dev = 1.66

AIRS Cloud Fraction Trend (%/yr)



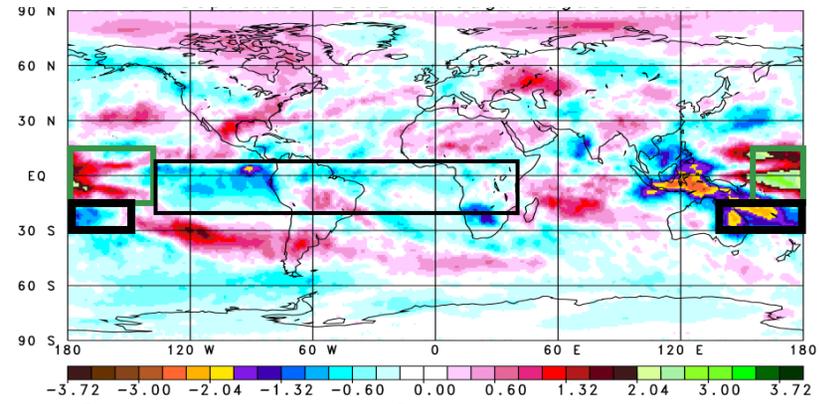
Global Mean = 0.00 Standard Dev = 0.39

AIRS Clear Sky OLR Trend (W/m²/yr)



Global Mean = -0.01 Standard Dev = 0.22

AIRS OLR Trend (W/m²/yr)

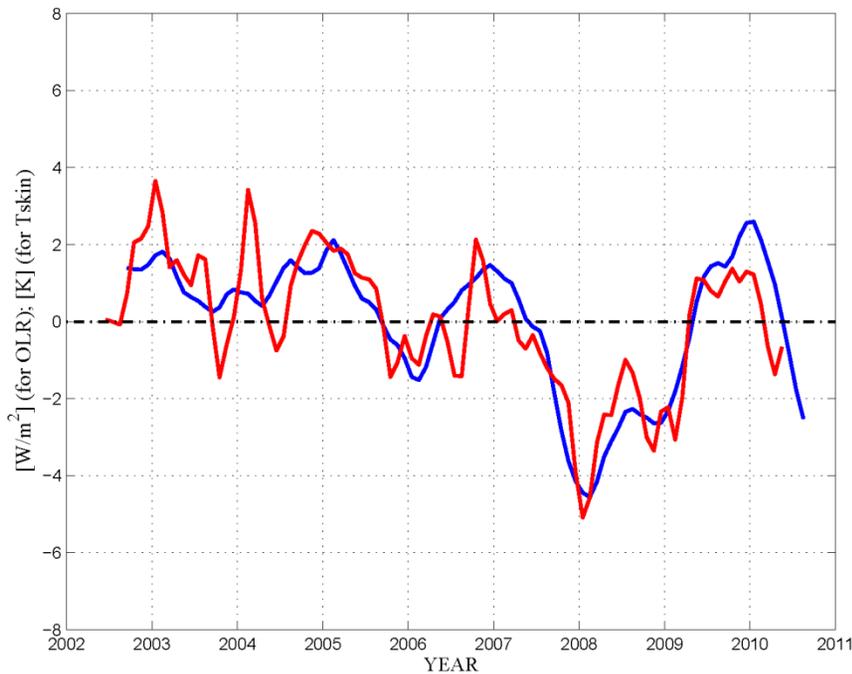


Global Mean = -0.091 Standard Dev = 0.625



Relationship between El Niño Index and OLR Anomaly Time Series in Region 1 and Region 2

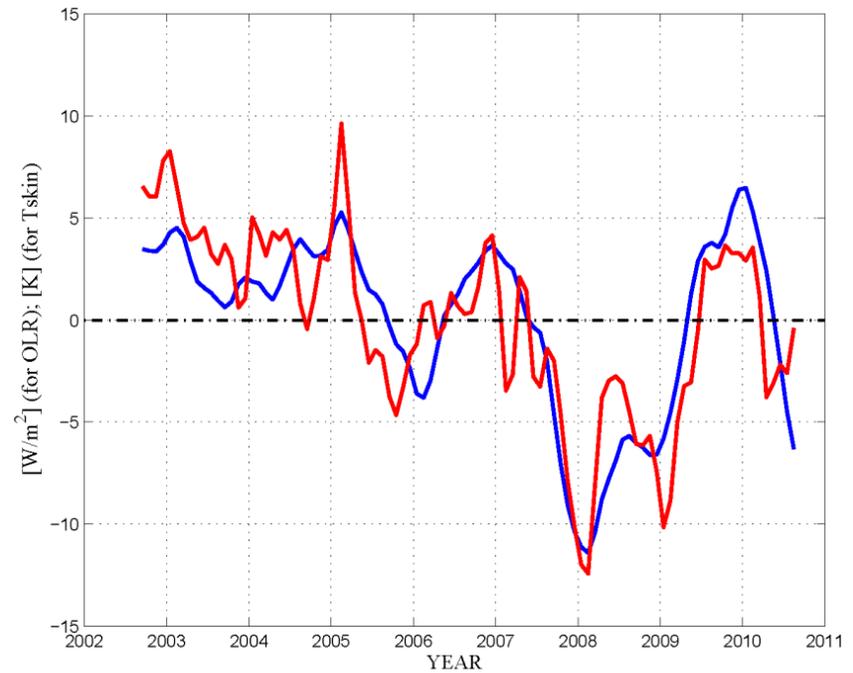
Region 1



— OLR lagged 3 months for Region 1; Trend = $-0.36 W/m^2/yr$
— T_{skin} times 4 for El Niño Region

Lagged Correlation = 0.853

Region 2



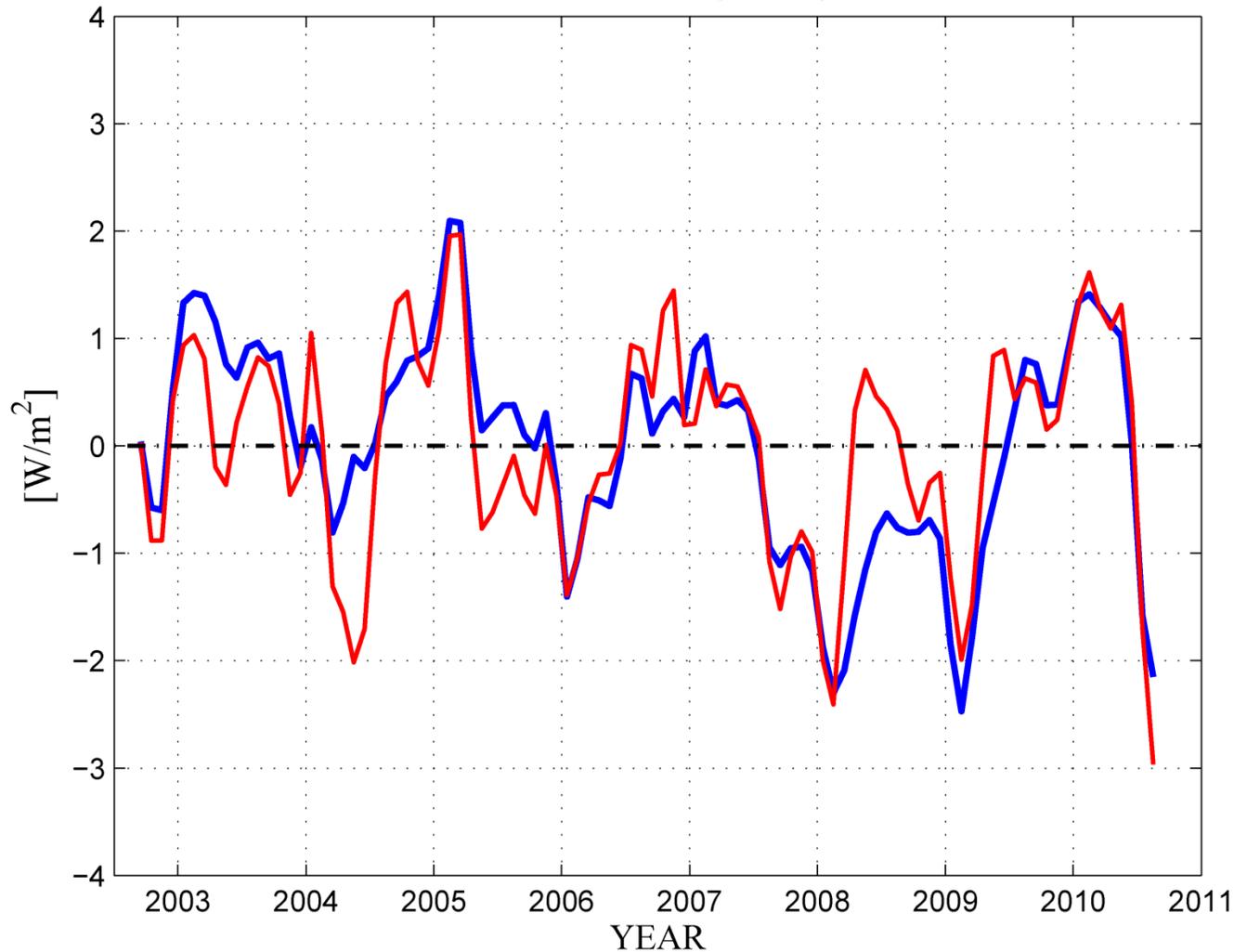
— OLR for Region 2; Trend = $-1.102 W/m^2/yr$
— T_{skin} times 10 for El Niño Region

Correlation = 0.819



AIRS OLR Tropical Anomaly Time Series

September 2002 through August 2010



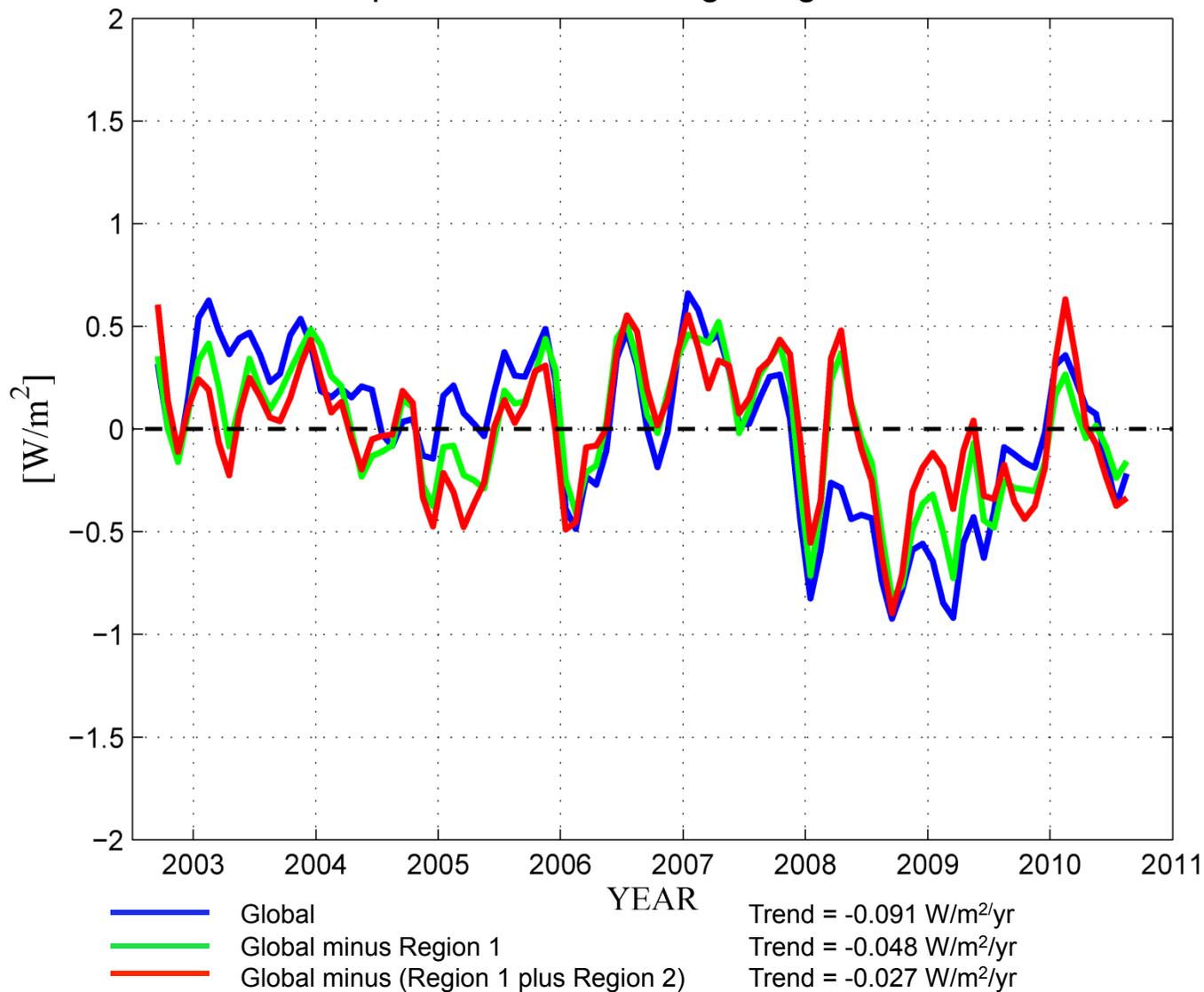
— Tropical Trend = -0.146 W/m²/yr
— Tropical minus Region 1 Trend = -0.020 W/m²/yr

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AIRS OLR Global Anomaly Time Series

September 2002 through August 2010



Attribution of Negative OLR trends for the period September 2002 through August 2010

Recent negative global and tropical OLR trends are a result of phases of El Niño/La Niña oscillation

September 2002 was the end of a strong El Niño period

2008 – 2009 was a strong La Niña period

The Region 1 (8°N to 20°S , 140°W eastward to 40°E) OLR anomaly is highly correlated with the El Niño index three months earlier

2002 El Niño resulted in positive anomalies of atmospheric water vapor and cloud cover and negative anomalies of OLR over Region 1

Opposite situation occurs in 2008 - 2009 La Niña



Attribution of Negative OLR trends for the period September 2002 through August 2010 (cont)

The Region 2 (20°S to 30°S, 160°W westward to 140°E) OLR anomaly is highly correlated with the concurrent El Niño index

Tropical OLR trends (-0.146 W/m²/yr) are reduced to -0.020 W/m²/yr outside of Region 1

Global OLR trends (-0.091 W/m²/yr) are reduced to -0.048 W/m²/yr outside of Region 1 and to -0.027 W/m²/yr outside of Region 1 and Region 2

