From El Nino to Atlantic Nino: pathways as seen in the QuikScat winds

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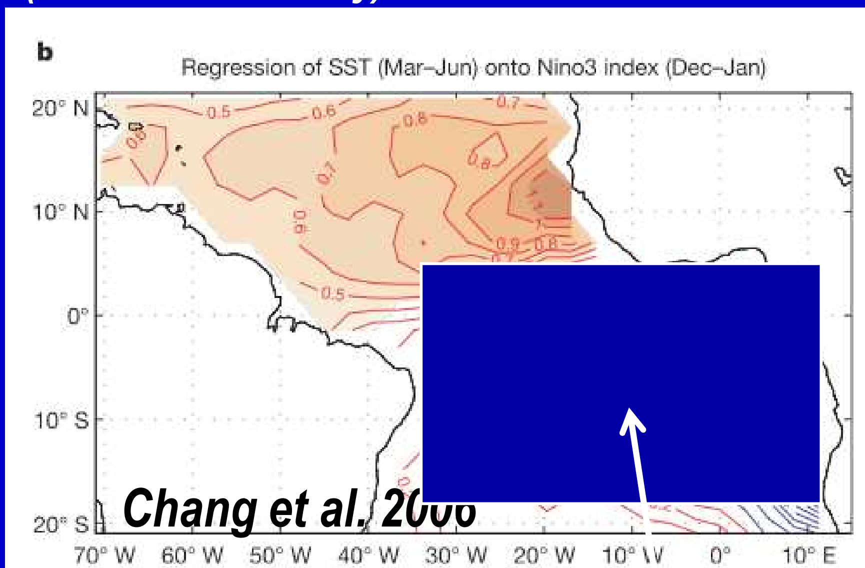
First…a disclaimer

What control the climate variability of the Atlantic Niños?

Lagged regression of boreal spring SST anomalies in the tropical Atlantic (March-June) with Nino3 Index of the previous winter (December-January)



Atlantic Nino region

Zebiak 1993:

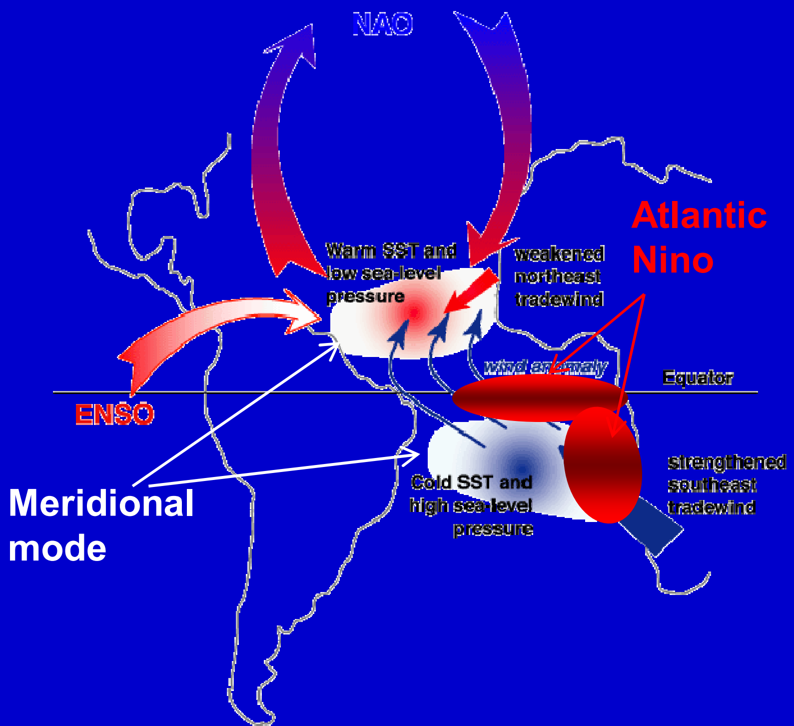
"The tropical Atlantic differs from the tropical Pacific in that it has proportionally more variability not attributable to the equatorial coupled mode. One aspect of this is the lower frequency, tropical basin-scale patterns. Additional contributors may be <u>land surface interaction</u> and global-scale forcing related to <u>ENSO</u>."

Chang et al. 2006:

It is unclear what causes the winds in the western equatorial Atlantic to respond strongly to some El Niños, but not others. The state of tropical Atlantic determines the ENSO influence.

What process might bridge the temporal gap between ENSO influence and Atlantic Niños on seasonal scale

- ENSO influence peaks in boreal winter, whereas Atlantic Nino peaks in boreal summer.
- Okumura & Xie 2006: the meridional mode of Atlantic SST anomalies.



Peak of Equatorial Amazon rainfall

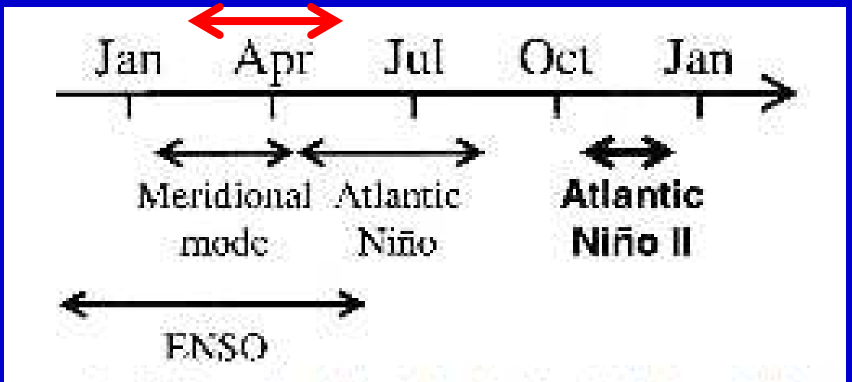
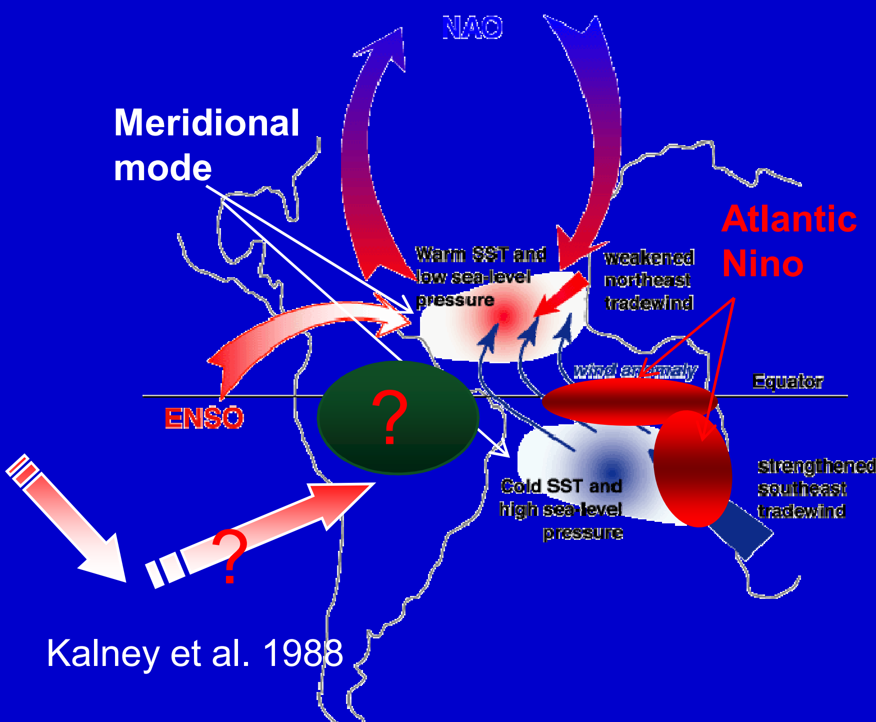


FIG. 16. Seasonality of the dominant modes of climate variability in the tropical Atlantic, modified after Sutton et al. (2000). The present study shows that the Atlantic Niño II fills an important gap in early boreal winter.

Okumura and Xie 2006

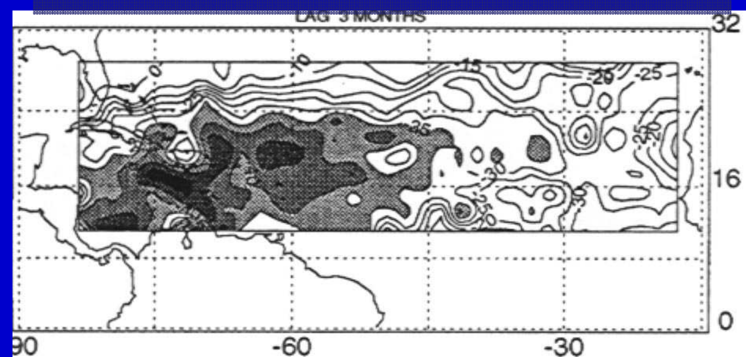
Is the meridional mode the only pathway for ENSO influence on Atlantic Nino?

- *The SSTA in the N. tropical Atlantic is better correlated with river flow in the S. America than with ENSO index.*
- *Are there other pathways, esp. through change of S. American rainfall, for ENSO to influence Atlantic Nino?*

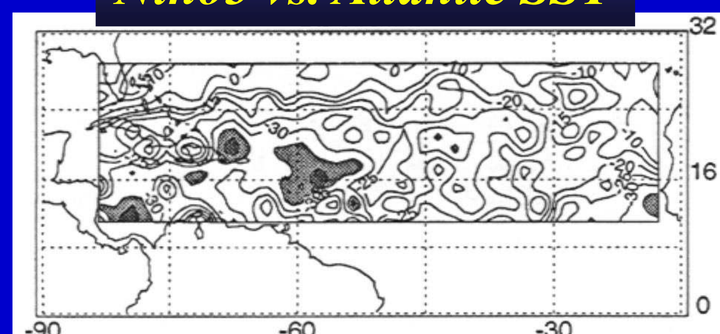


Kalney et al. 1988

Columbia Rivers vs. Atlantic SST



Nino3 vs. Atlantic SST



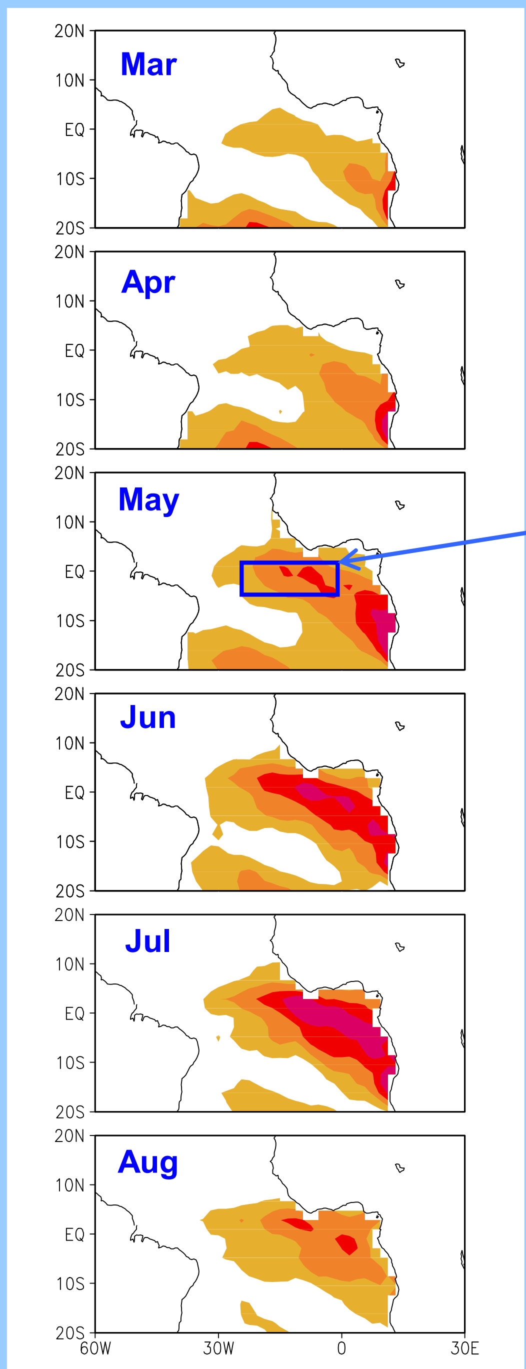
Poveda & Mesa 1997: Atlantic SST anomalies, anomalies of Columbia River flow, Niño3 (1946-95).

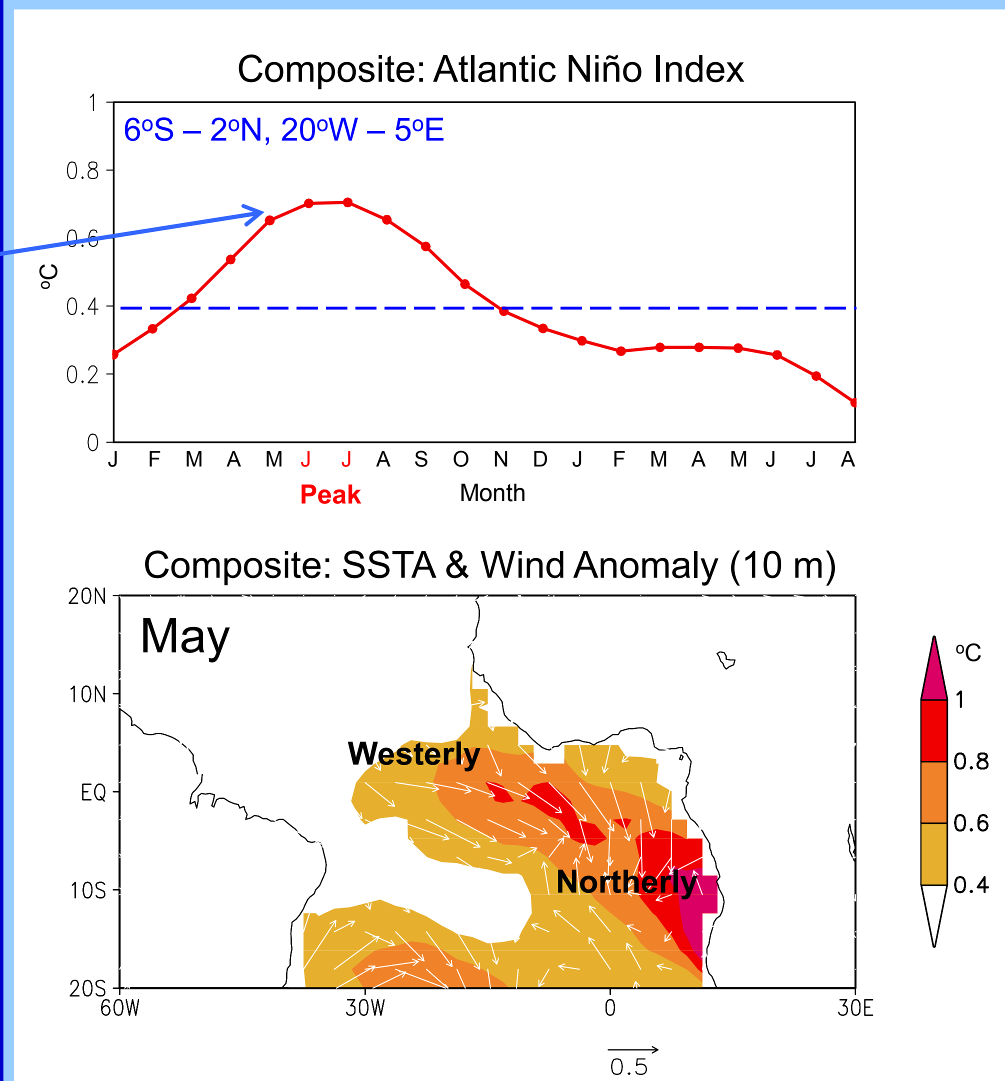
Data Sets :

- ***QuikScat daily surface wind: daily ocean surface wind at 1˚ lat/lon resolution, 1999-2007;***
- ***DT-MSLA merged altimeter data: 7-day running mean of sea-level height anomalies at 1/3˚ resolution. A merged product of Topex/Poseidon, Jason-1, and European Research Satellite (ERS) altimeter data produced by the French Archiving, Validation, and Interpolation of Satellite Oceanographic Data (AVISO) project;***
- ***TRMM daily rainrate data (3B42): 1˚ lat/lon resolution.***
- ***NCEP Reanalysis: Sea surface Temperature (SST), winds above the surface, 6 hrs, 2.5˚ lat/lon resolution***
- The Prediction and Research Moored Array in the Atlantic (PIRATA) buoys: Thermocline depth

SST Composite
11 warm events
1948–2005

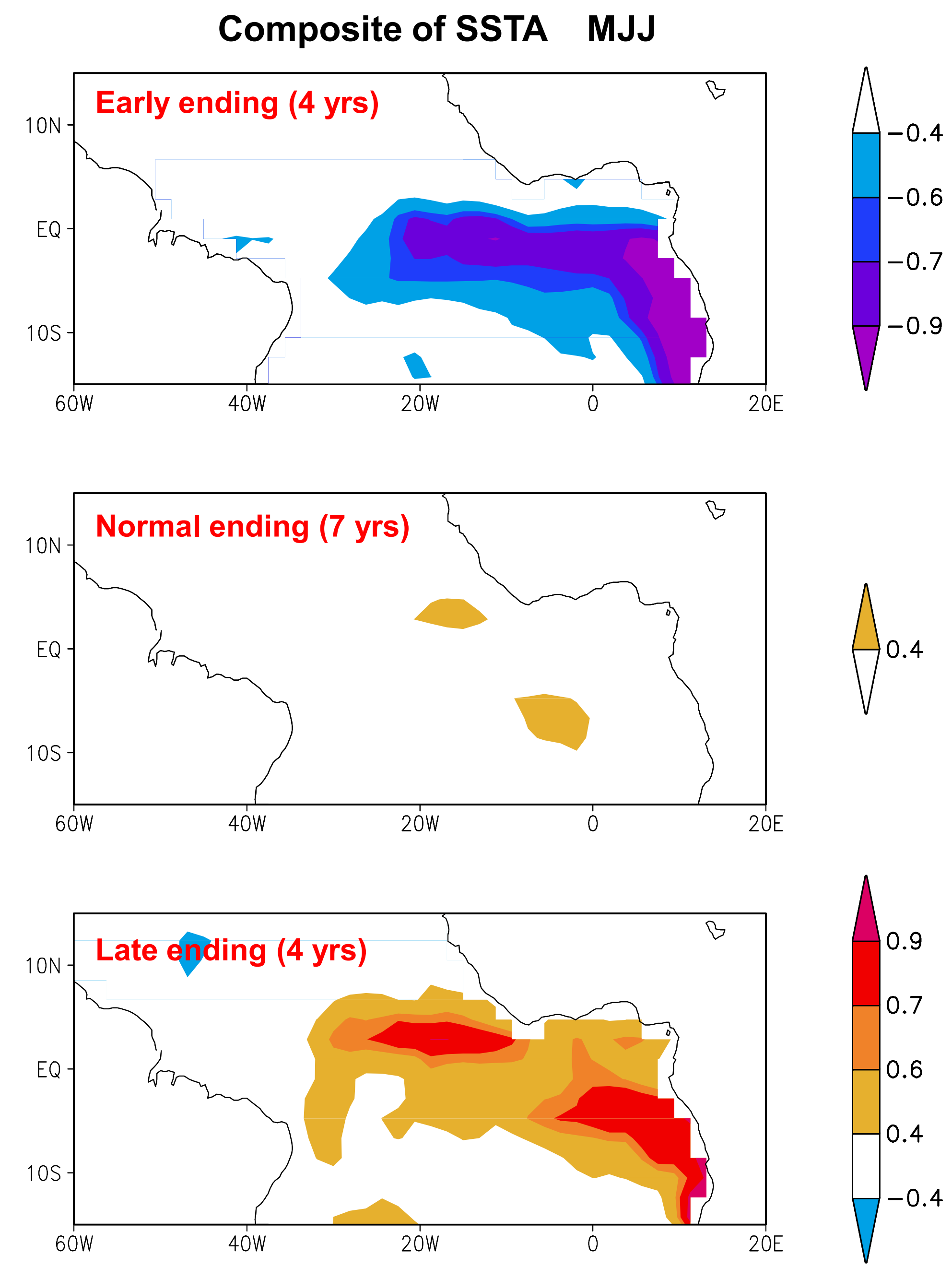
Atlantic Niño starts during March-May season:





Link between Changes in wet season ending in the Amazon and Atlantic Niño:

Amazon Wet season	*Atlantic Niño*
Early ending in spring Weak Kelvin wave	*cold phase in summer*
Late ending in spring Strong Kelvin wave	*warm phase in summer*



Data: 1979–1997
Ending date: Marengo

What is the underlying physical process?

- The leading EOF mode capture the convective coupled Kelvin Wave:

- **Eastward propagating**
- **Phase speed: 15 m/s**
- **Zonal wavenumber 6**
- **Period: 6–7 days**

- Kelvin wave captures the major feature of the ITCZ

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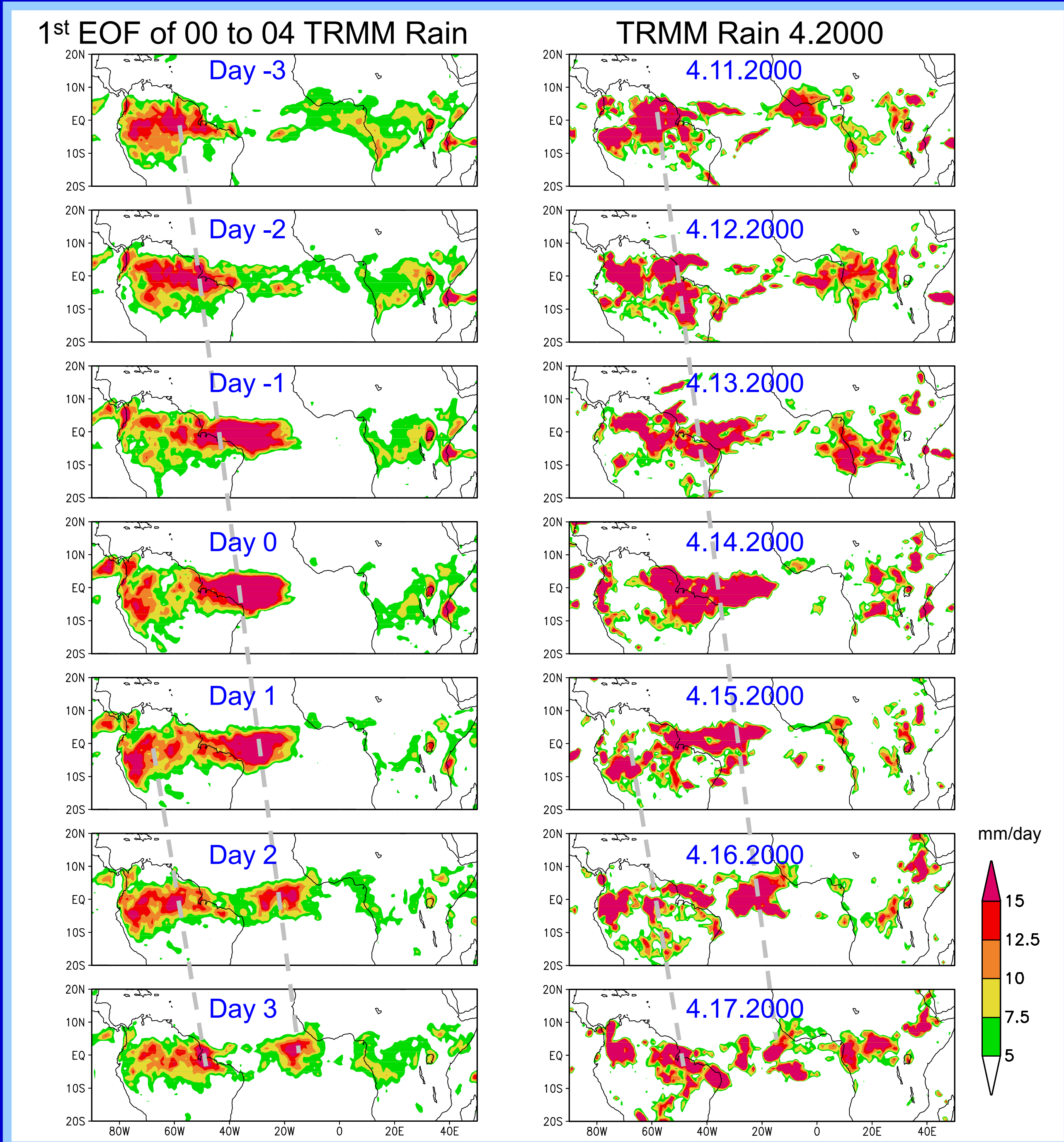
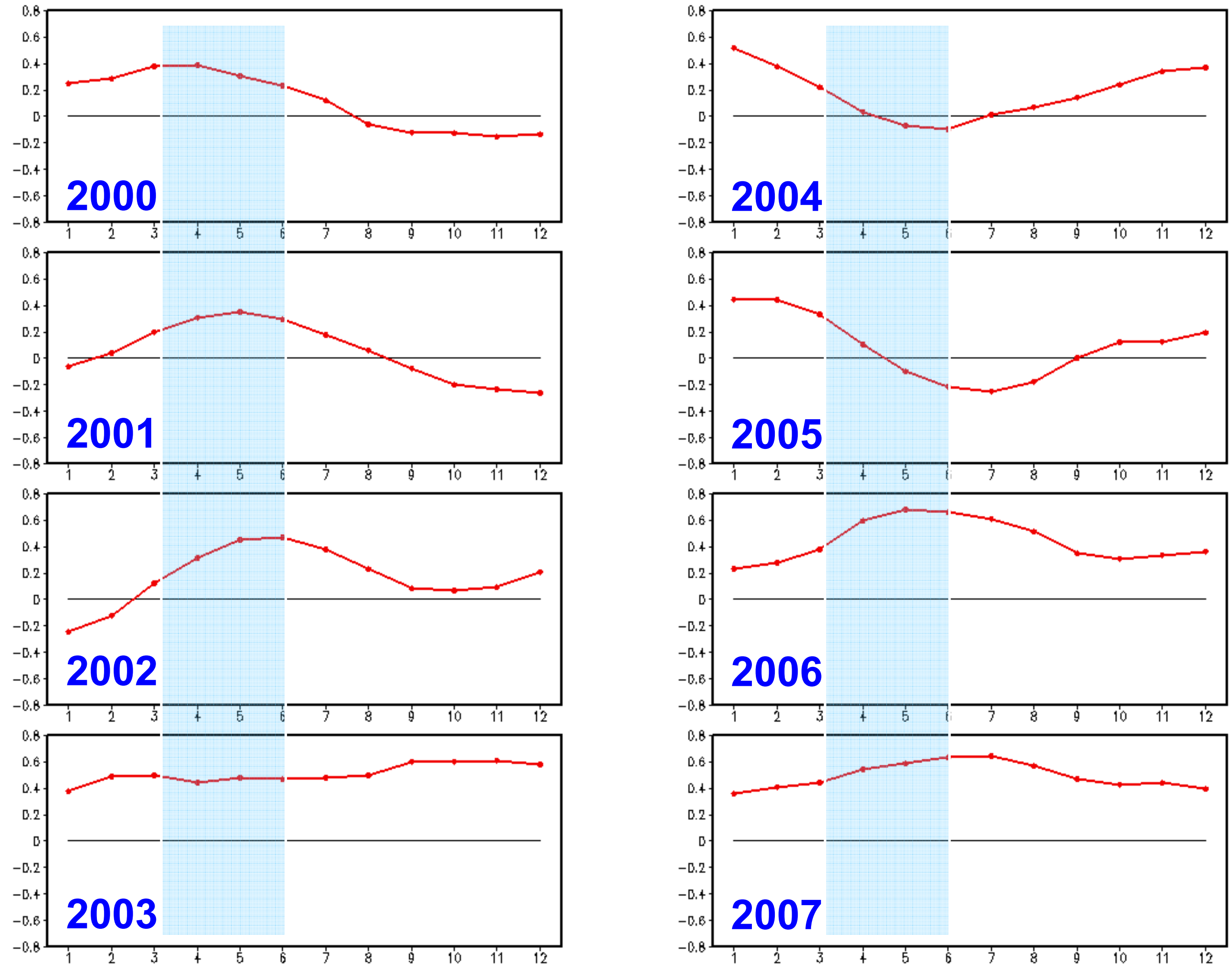
Wang & Fu 2007

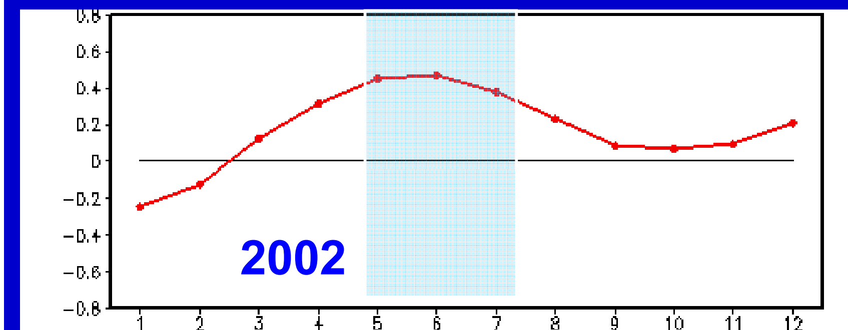
TRMM data
2000–2003



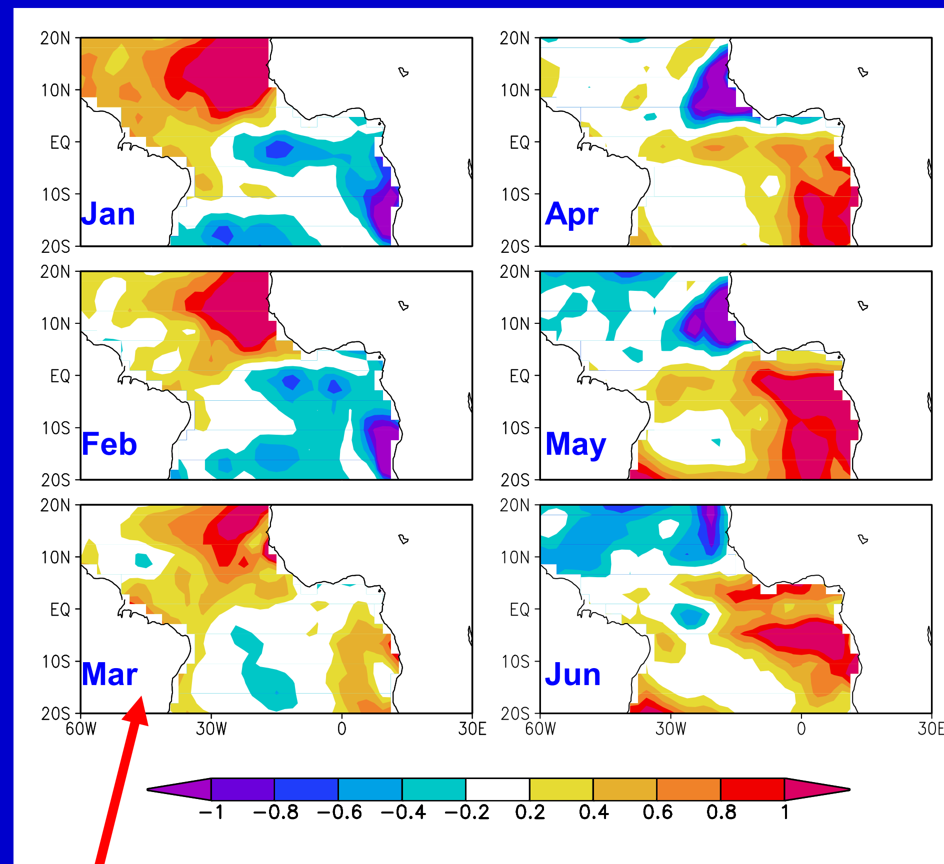
Atlantic Nino Index (6S–2N, 20W–5E)



Atlantic Nino Index (6S–2N, 20W–5E)



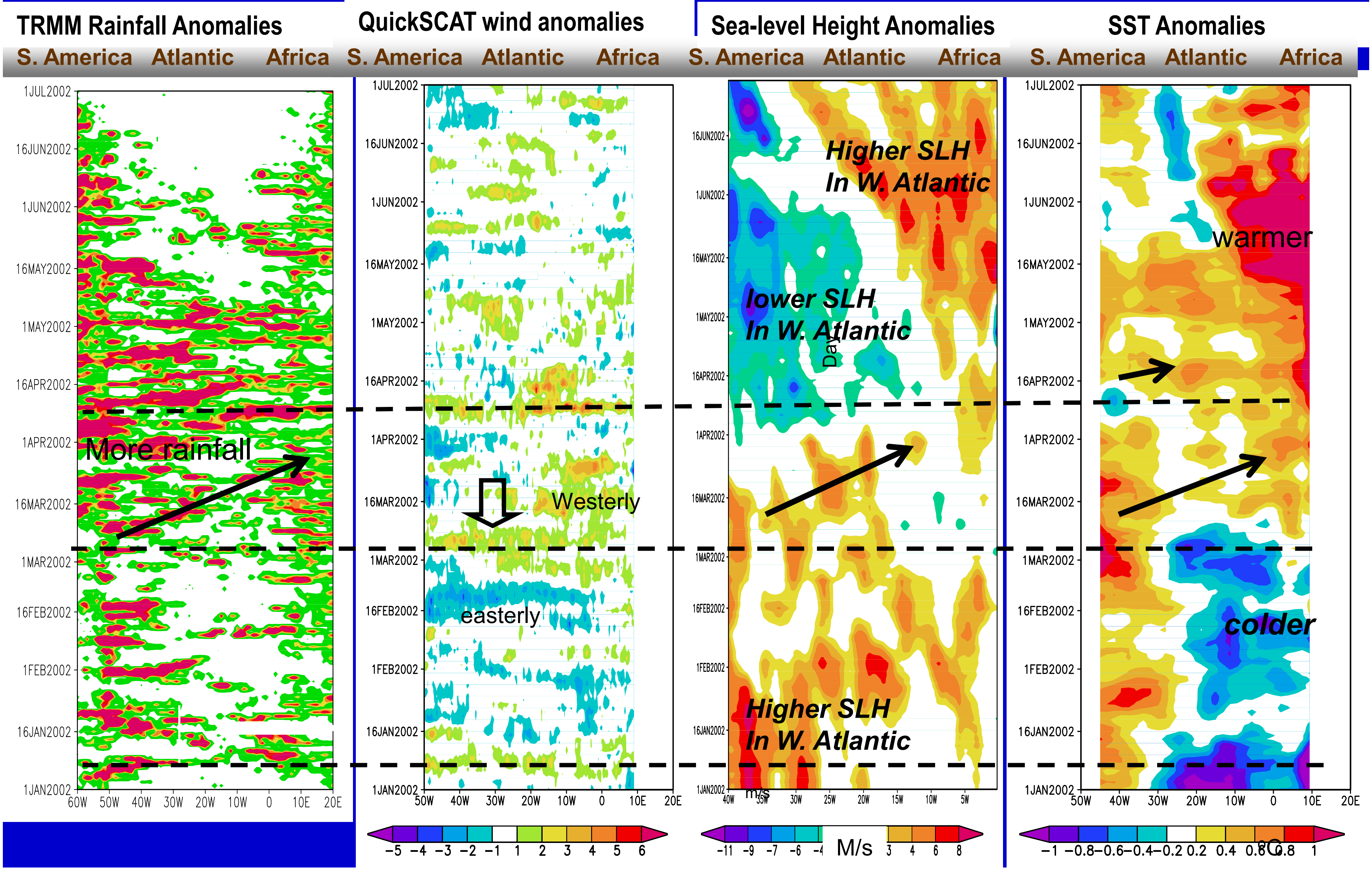
SST Anomalies



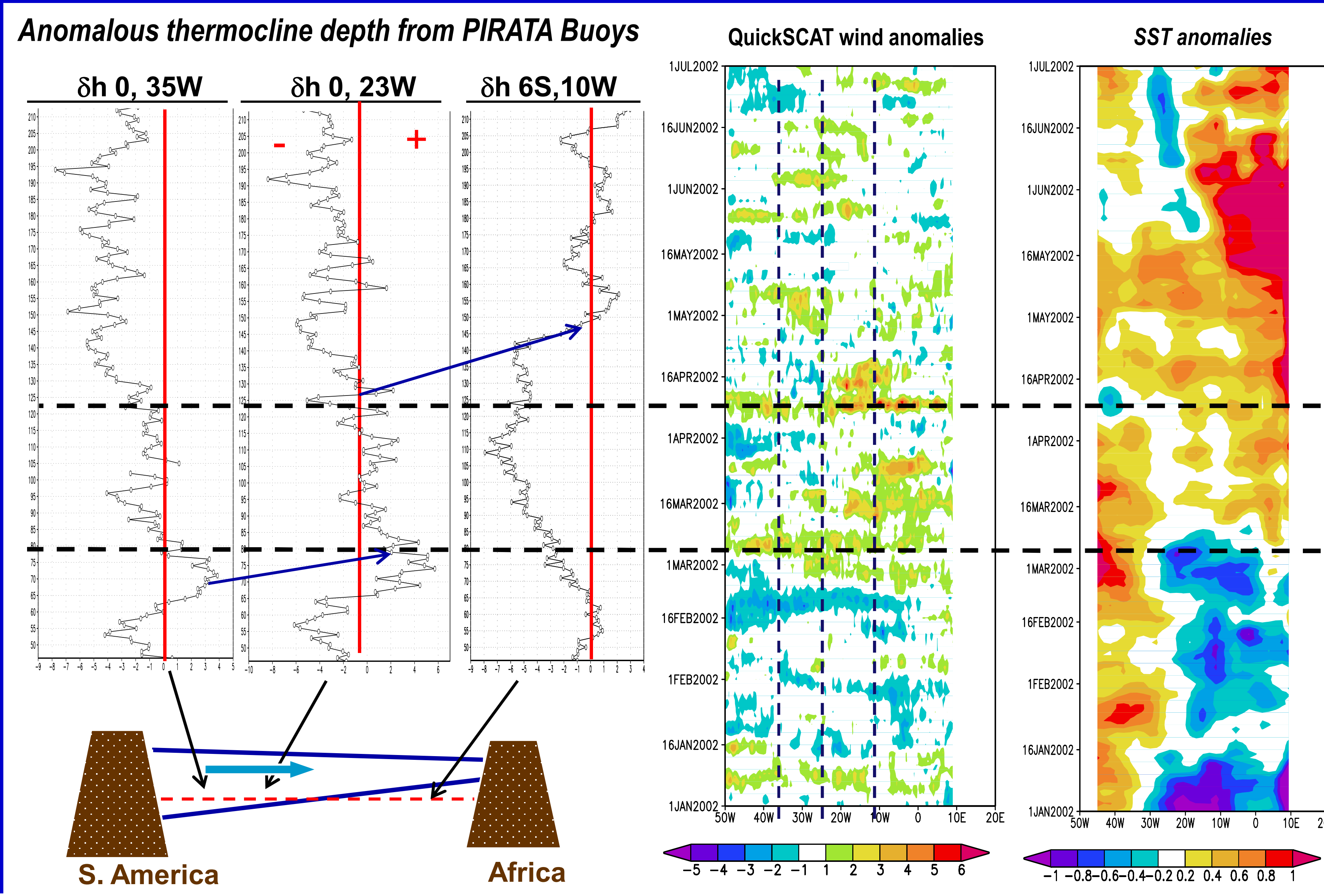
Cold to warm transition occurred in March.

How do convection coupled Kelvin waves trigger Atlantic Niño?

Kelvin wave originated from S. America ⇒ westerly surface wind anomalies ⇒ Oceanic Kelvin waves increase SLH in E. Atlantic ⇒ warmer SSTA in the E. Atlantic

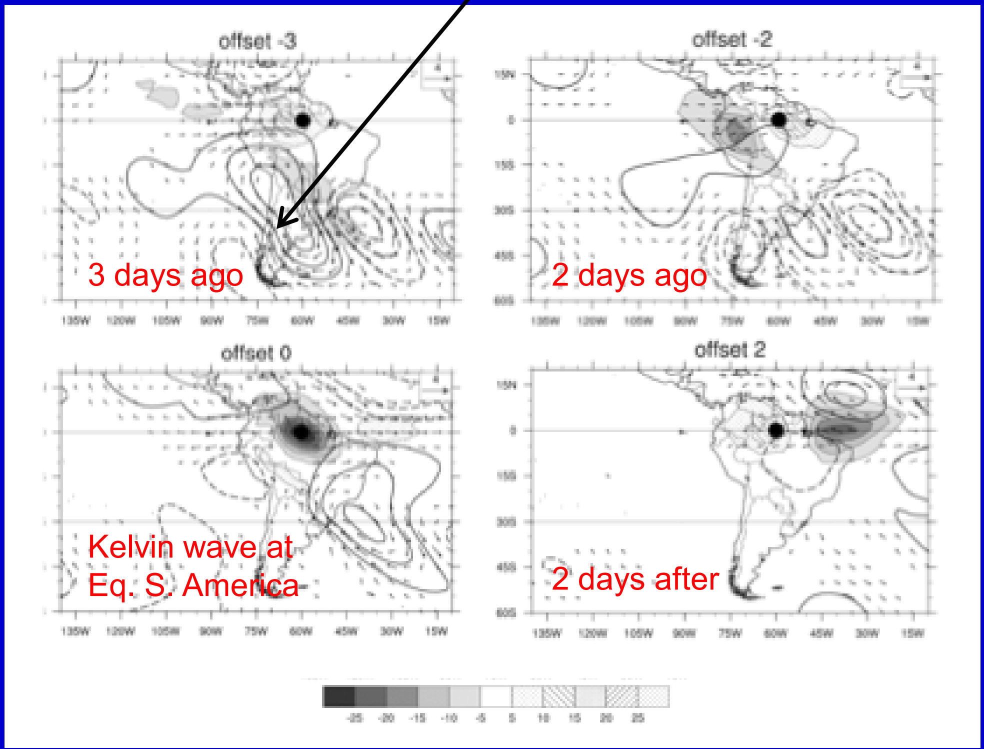


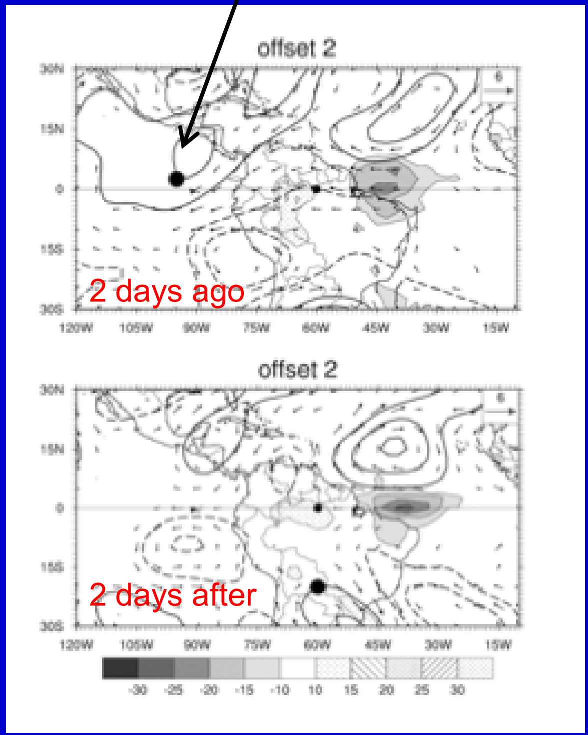
In situ buoy data show changes in E-W slope of the thermocline depth consistent with winds and SSTA:



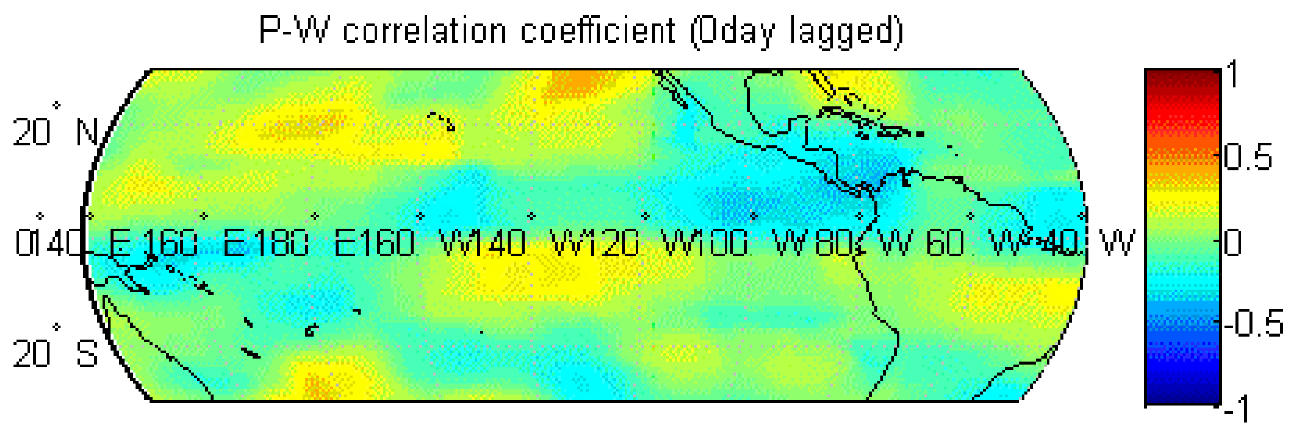
What control the variability of the convective coupled Kelvin waves in the S. America?

- Liebmann et al. 2008: Convective Kelvin waves in the S. America are forced by Rosbby waves from two sources:
    - The Central America and
    - The extratropical S. America.



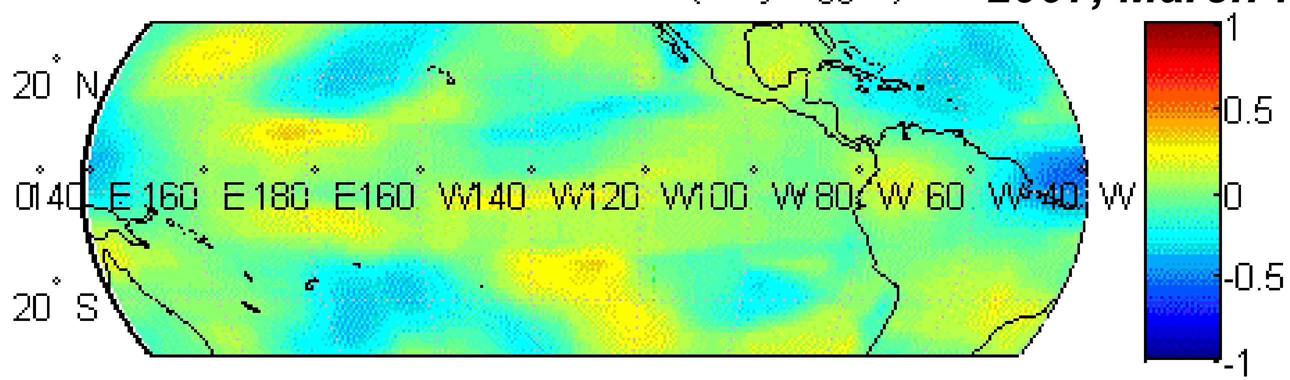


Two pathways for ENSO to influence winds to influence Atlantic Nino through changes of S. American rainfall:



2002, March-May

2007, March-May



Lead correlation between rainfall anomalies in the pacific and S. America and zonal wind anomalies in the equatorial W. Atlantic ocean.

Summary:

- Our preliminary analysis suggests that the rainfall change in S. America may play an important role in bridge the ENSO influence on Atlantic Ninos;
- ENSO influences can be carried out through two additional pathways using S. America as a spring board.